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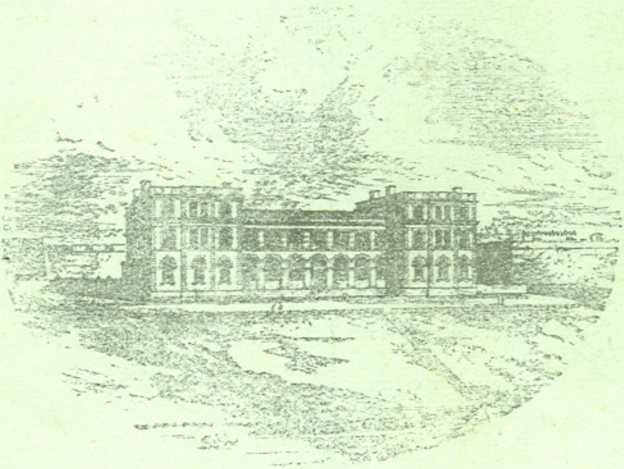

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The Pelagic Young and Early Bottom Stages of Teleosteans.

By

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With 9 Figures in the Text.

CONTENTS

INTRODUCTION.

THE present report deals with the young fish which were collected in the neighbourhood of Plymouth during the summer and autumn of 1919, from the beginning of July to the end of September, by small meshed nets operated from the Association's steamer *Oithona*. It is a supplement to Dr. Allen's report on the "Post-larval Teleosteans collected near Plymouth during the Summer of 1914," published in Vol. XI, No. 2 (May, 1917), of this Journal, and to the writer's "General Report on the Larval and Post-larval Teleosteans in Plymouth Waters" in Vol. X, No. 2 (June, 1914).

The total number of fish examined amounts to 16,400, which are referable to 24 families, 39 genera and 71 species. All the forms are stages in the life histories of fishes, which are well known as adults.

The pelagic young of the species of *Gadus* and *Pleuronectes* are poorly represented in the catches, but this is not surprising when one considers the lateness in the year when the hauls were made. Similarly the young of early spawners like the Herring are absent.

The pelagic young of the Hake (*Merluccius merluccius*) appear for the first time since investigations with small meshed nets have been undertaken in the Plymouth area, the only other records of their occurrence in the western area of the English Channel being those which were taken by the Danish research steamer *Thor*, *vide* Schmidt (1909).

Most of the commercially important fish occur only in moderate numbers in the pelagic young stage, but the records show a bigger average for those species which support at Plymouth the chief economic fisheries. This is proved for the Whiting (*Gadus merlangus*), Mackerel (*Scomber scomber*) and Pilchard (*Sardina pilchardus*).

The most abundant post-larvæ belong to those species which are economically of little importance except as food for other fish. Gobies predominate and about 7000 young stages appear in the captures. Sand-eels (*Ammodytes*) and Wrasses are also fairly numerous.

The catches of the Mosquito and Cotton Trawls show that many of the economic species live during their adolescent stage in the shallower waters close inshore. Such are :—

Gadus pollachius.
,, merlangus.
,, luscus.
Pleuronectes platessa.
,, limanda.
Mullus surmuletus.

Trigla gurnardus.
,, hirundo.

The spawning periods are here recorded for Plymouth area. These have been determined from the examination of ripe female fish, from the records of eggs and newly hatched larvæ whose identification has been certain, and from the occurrence of the early pelagic young.

The figures accompanying the text were kindly drawn for the writer by Mr. E. Ford, Assistant Naturalist, who also helped in the collection of the material.

AREA INVESTIGATED.

The hauls of the young fish and cotton trawls were made chiefly in the area lying between the line, Bolt Tail—Eddystone—Looe and the shore, while investigations were extended beyond the 40-fathom line to a distance of about 25 miles S.W. of the Eddystone Rocks. The hauls are summarised for the various depths in Table 1.

TABLE I.

APPARATUS. A=Young Fish Trawl of stramin.
B= ,, ,, ,, mosquito netting.
C=Cotton Trawl $\frac{1}{2}''$ mesh ($\frac{1}{4}''$ square).

	A and B			C		
Depth in fms.	No. of Hauls.	Duration of Haul in min.	No. of hrs. fishing.	No. of Hauls.	Duration of Haul in min.	No. of hrs. fishing.
<10	17	22·64	6·4	15	30	7·5
10–20	10	21·5	3·5	2	20	0·6
20–30	46	21·08	16·16	4	27·5	1·8
30–40	4	22·5	1·4	4	36·25	2·4
40–45	7	30	3·5	6	30	3·0

The depths here represent the total depth of water at each station.

Systematic search was made both in the shallower waters of the bays and in the deeper water of midchannel for the adolescent stages of the young of the Mackerel, Pilchard and Anchovy, but the results were negative.

The number of hauls per month is as follows for nets A, B and C :—

TABLE II.

	A	B	C
July	30	—	—
Aug.	25	4	5
Sept.	—	25	26

APPARATUS.

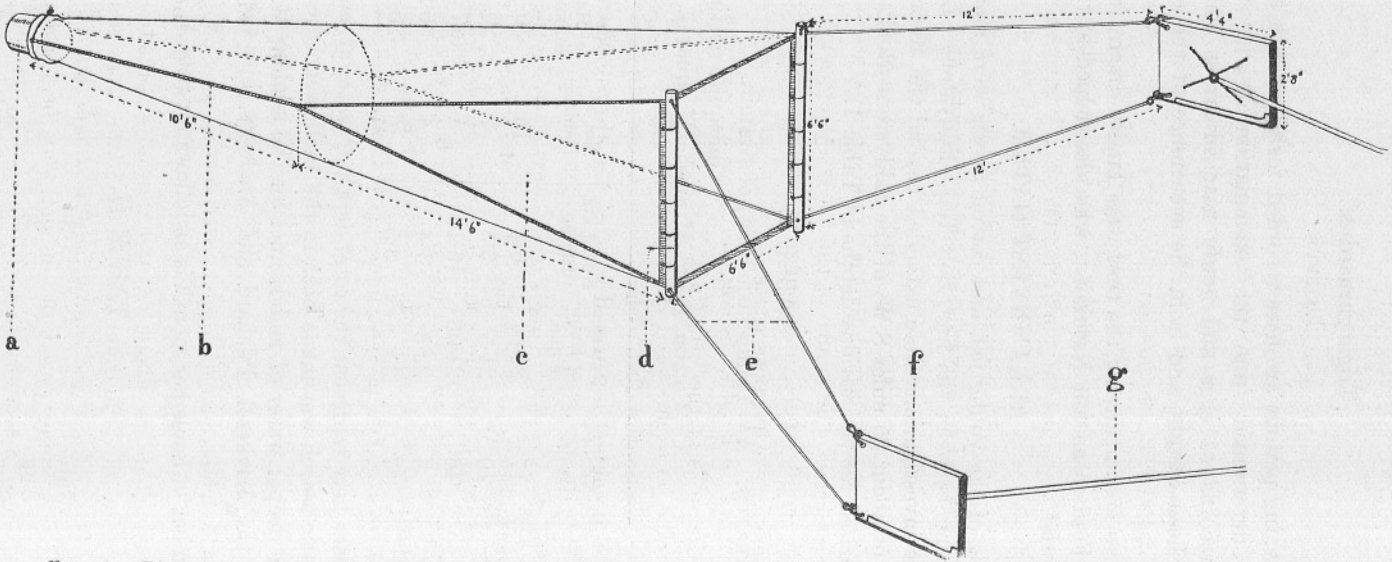

FIG. 1.—Diagram of Young Fish Trawl. Types A. and B. (*c*) Galvanised iron bucket. (*b*) Salvage rope. (*c*) Wing. (*d*) Pole. (*e*) Lanyard. (*f*) Otter Board. (*g*) Warp.

Del. E. FORD.

Apparatus.

Fig. 1 gives in diagrammatic form the type of young fish trawl as used in the Plymouth investigations. It is a modified form of Dr. C. G. J. Petersen's Yngel-trawl, a description and figure of which are published by Dr. Johs Schmidt in "Skrifter udgivne af Kommissionen for Havundersogelser," No. 1, 1904, p. 36. The dimensions given in Fig. 1 are those which were taken from the nets in use.

On the *Oithona*, a single warp with two bridles, each 20 fathoms in length, is led from the winch over a series of roller blocks along the port side and over a roller on the port quarter. The bridles are shackled to Otter Boards, 3′ by 3′ 9″. Two pairs of lanyards of 2″ manilla rope connect the Otter Boards with two wooden poles which keep the mouth of the net open. The lanyards are 12′ in length and pass through drilled holes, one at the top and one at the bottom of each pole. A narrow strip of canvas about 6″ in depth encircles the mouth of the net, the sides of which are lashed to the poles by separate lashings, rove through six eyelets. The mouth of the net is $6\frac{1}{2}'$ square. A rectangular opening with smaller poles and longer headline and foot rope has been found to answer the purpose quite as well. There are two triangular wings about $14\frac{1}{2}'$ in length. Salvage ropes of $\frac{1}{2}''$ to $\frac{3}{4}''$ manilla or hemp run along the sides of the wings and are continued to the "cod-end," as a single rope on each side of the net. These give greater strength to the net and are essential during the process of hauling on board the ship. The breadth of the net is reduced to 5′ at the apex of the wings and to 2′ at the cod-end. A galvanized iron bucket 1′ long by 8″ in diameter is attached to the cod-end. This is more convenient for the transference of the catch and seems to reduce the liability of damage to the specimens. The strain is taken off the cod-end of the net by lashing the ends of the salvage ropes to two iron loops on the bucket, while the cod-end is also strengthened by the addition of a narrow strip of canvas covering.

The nets used in the present investigations are designated as Types A, B and C.

TYPE A.

This is a net made of the Danish material "Stramin," which is composed of threads of closely spun hemp yarn. Each thread is made up of two strands which have undergone considerable stretching and torsion, to give greater strength and to reduce to a minimum the teasing out of the fibres. There are about 12 meshes or 13 threads to an inch. The threads are woven over and under each other and there is no attempt at knotting. The meshes are approximately square, but are not uniform in size. The catching power of the net may be vitiated by the disintegration of the material.

TYPE B

Type B is composed of fine cotton mosquito netting. Two strands of fine cotton are twisted loosely along their whole length and the corners of the mesh are so arranged that single strands from the two adjacent sides of the " square " cross each other and bind the whole together. There is no knotting of the threads. The twisting of the strands and the tenacity of the fibres prevent to a great extent the " running " of the net when damaged. This material is much more elastic than stramin, and tends to pull more in one direction than in another. Care must be taken in the making of a net of this material so that the strain imposed on the net pulls the meshes out to a definite and open square formation. When stretched out in this way, there are 9 to 10 meshes to an inch.

TYPE C.

The apparatus designated as C is a cotton trawl, devised on similar lines to types A and B with a mesh of $\frac{1}{2}''$ diagonally from knot to knot. This is still in the experimental stage and further improvements are contemplated. Its efficiency, however, in securing the early bottom stages is well shown. To avoid confusion in the meaning of the mesh $\frac{1}{2}''$ net, it may also be described as a mesh of $\frac{1}{4}''$ between the knots along the square or 1″ all round. The cotton is 9 ply. This net was also " cutched."

The towing speed of Types A and B is generally from slow to half—from 1 to 3 mls. per hour. This, however, depends largely on the tides and the condition of the sea. Against a strong flood or ebb tide the revolutions of the engine will naturally be increased to keep the net from sinking to the bottom. The fault of the net generally lies in the bulk of the poles, which set up a strong wash at its mouth, but this is difficult to obviate. The length of the net is probably sufficient to retain the young fish which are caught.

The depth at which the captures were made is designated in the Tables IX and X by the letters S. M. B. for surface, midwater and bottom hauls, intermediate hauls being shown as S.–M. (surface to midwater) and M.–B. (midwater to bottom). The depths have been estimated from the amount of warp used, from the speed of the vessel, and from the prevailing sea conditions. This method may be open to criticism, but in these comparatively shallow waters of the Channel the method adopted is the simplest and most convenient and seems to meet the case quite well.

The duration of the hauls is not quite uniform, as it is almost impossible to hit off an exact time limit. The mean is about 30 minutes.

The selective power of the nets is well shown, but the material used has not always been perfect. This has been the chief difficulty and is explained by the present-day conditions of trade.

DETERMINATION OF THE MATERIAL.

The catches of the young fish trawls were transferred to glass jars. A few of the more active fish were picked out and kept alive for special study. The remainder of the catch was immediately killed with a weak solution of formalin, to prevent the medusæ from making their customary depredations on the young fish. When time and conditions allowed, most of the fish were picked out on board ship. The whole of the material was handed over to Dr. Lebour for investigation of the food contents and she also identified the species, and recorded the measurements before cutting them up. The rarer fish and the Gurnards were kept intact and dealt with by the writer. Mr. Ford determined the Ammodytidæ (Sand eels).

The young fish have been determined by the use of existing literature, which is now fairly comprehensive. There are still many gaps to fill in and an accurate determination is essential before the broader biological problems can be tackled. Comprehensive collecting during a complete year has not been possible. There is much still to be done in the earlier and later months of the year before we can arrive at a complete story of the distribution and numbers of young fish near Plymouth. The measurements of the young fish have been recorded to the nearest half millimetre. Here, as always, the length is the total length—tip of snout to tip of caudal fin.

POST-LARVAL CHARACTERS.

The peculiar structures of the post-larval young of Teleosteans have often enough been described, *vide* Regan, 1916, and Fage, 1918. In most cases the young are so markedly different in the pelagic stage from the adult that the characters so well known for the determination of the latter are often of little use for the identification of the former. Generally, the structure and shape of the young are adapted to their particular mode of life and are " oriented by hereditary factors." The pelagic life is more or less transitory, in some it is of short duration, in others long. A long larval or post-larval life is generally associated with deeper water spawners e.g. *Conger vulgaris* ; a short pelagic existence with coastal spawners, e.g. *Gadus luscus*. This must be accepted, however, with modification.

The surest determination of a species is to be found in the counting of the vertebræ and fin rays (if these be developed), and this method has been adopted in all doubtful cases.

NUMERICAL RESULTS.

The following data have been compiled to show roughly the comparison in the seasonal distribution of the numbers of young fish caught with the young fish trawl (Types A and B) during the months July, August and September for the years 1913, 1914 and 1919. It must be understood, however, that the comparisons are by no means conclusive owing to the fact, which Dr. Allen (1917) has already pointed out, that no two nets have the same catching power and that the number of hauls at the different depths is far from being uniform either in actual numbers or in the duration of each haul. Still, the data at disposal justify some consideration.

TABLE III.

APPARATUS A and B. Period : July only.

Year. (July.)	Total number of young fish.	Total number of hours' fishing.	number of fish per hour.	Total number of hauls.	Average number of fish per haul.
1913	1206	9·8	123	29	41
1914	1885	12·6	149	38	49
1919	4214	11·6	363	30	140

The hauls, Table III, were distributed over the various depths as shown in Table IV, where the depths represent the total depth of water at the particular localities.

TABLE IV.

APPARATUS A and B.

Depth in fathoms	0–10	10–20	20–30	30–40
Year.	Number of hauls.	Number of hauls.	Number of hauls.	Number of hauls.
1913	9	5	14	1
1914	9	5	14	11
1919	1	4	21	4

Table III gives a general summary for July month. This month has been selected as investigations practically ceased after that month in 1914, and because in July, 1919, Type A net was used solely, being replaced in August by Type B. The average duration in minutes per haul in July for each year was 20·3 for 1913, 20 for 1914, and 23·5 for 1919.

COMPARATIVE RESULTS for years 1913 and 1919 for hauls taken between the 20 and 30 fathom lines.

The area of intensive fishing lies between the 20 and 30 fathom lines, and the same conclusion with regard to the numbers of young for the months July, August and September for the years 1913 and 1919 still holds good. They are much more numerous in 1919.

TABLE V.

Apparatus A and B. Period : July, August, September.

Year.	Total number of hauls.	Total number of specimens.	Number of hours' fishing.	Average number of fish per hour.
1913	74	2137	26·1	81
1919	48	5543	18·08	306

Frequency in numbers of the more abundant young fish is shown in the following list, where the figures represent the number of fish per hour's fishing in the hauls taken between the 20 and 30 fathom contour lines.

	1913	1919
Clupea and Sardina	7	51
Ammodytes	6	25
Scomber	—	7
Caranx	—	13
Labrus	3	38
Trigla	4	19
Gobius	11	47
Arnoglossus	29	9
Gadus merlangus	—	3
,, minutus	—	10
Trachinus vipera	6	8
Callionymus	7	46

Comparison in total captures for years 1913, 1914 and 1919 for the months July, August and September.

TABLE VI.

Apparatus A and B.

Year.	Total number of fish.	Total number of hours' fishing.	Average number of fish per hour.	Total number of hauls.	Average number of fish per haul.
1913	5266	55·5	94	160	32
1914	1908	13·7	139	41	46
1919	11669	31·08	375	84	138

Table VI gives a comparison between the three years for July, August and September. The average duration per haul being 20·8 minutes in 1913, 20·2 in 1914 and 23·5 in 1919. In 1914 only two hauls were made in August and one in September.

The greater abundance of young fish in 1919 is very striking. This may be due to many causes, among which are :—

(*a*) The greater selective power of the nets used in 1919.

(*b*) 1919 being a year of greater production of the young.

(*c*) 1919 being a later spawning year for some of the species as shown for the Mackerel.

The more abundant types are represented in the following list, where the numbers are the total number of fish captured during the same period—July to September (inclusive) for all the hauls of nets A and B.

	1913 (160 hauls)	1914 (41 hauls)	1919 (84 hauls)
Clupea and Sardina .	413	341	1674
Arnoglossus . .	1270	130	482
Caranx . . .	90	Nil	308
Ammodytes . .	619	91	717
Callionymus . .	475	458	1140
Labrids (4 genera) .	247	67	756
Trachinus . .	535	65	264
Scomber . .	2	3	178
Gobies (4 genera) .	1136	631	4782
Trigla . . .	175	23	504

It will be seen that the marketable fishes are weakly represented during this period. An important exception is the Pilchard, which shows an abnormally large number of young for 1919. It is interesting also to note that the adult pilchard fishery at Plymouth and along the Cornish coast during the latter part of 1919 was the richest experienced for over twenty years.

The larger number of Mackerel in 1919 may be attributed to a year of later spawning. The years 1914 and 1919 showed an equal number of the young of this species—those in 1914 appearing in greatest numbers in June month. On the other hand, Arnoglossus (Scaldback) and Trachinus (Weever) were relatively most abundant in 1913.

PRODUCTIVE HAULS.

An interesting feature of the 1919 captures is the large proportion of hauls with nets A and B which are rich both in the number of species and of specimens. The hauls which show the highest percentage of species and of specimens were taken in greater numbers in localities where the total depth of water exceeded 20 fathoms, and where one would naturally expect a mixture of the young of inshore and offshore spawners, but there is also in these deeper waters an influx of forms which undoubtedly have drifted with the general up-channel current from the west. The following list shows a few of these rich hauls :—

TABLE VIII.

Apparatus A and B.

No. of haul.	Duration of haul in minutes.	Total depth in fathoms.	No of species in haul.	No of specimens in haul.
2	30	16	16	148
6	30	12	16	166
9	30	29	17	399
11	25	26	19	288
12	25	26	23	272
13	20	26	17	203
14	20	27	14	432
28	30	28	23	316
62	30	41	15	268
64	30	41	12	368
66	30	41	14	264
77	30	4–7	12	2320 (2269 are one species)

EXPLANATION OF CHART AREAS AND POSITIONS.

The Chart Area of each haul in Tables IX and X is that shown in the Chart published in Vol. X, No. 2, June, 1914. The positions have been calculated from cross-bearings. For convenience in estimating the locality of each haul, the nearest observed point is shown in Tables IX and X as bearing a definite magnetic direction and a fixed distance from the actual position of the haul.

The localities of Hauls 62 to 68 (inclusive) for nets A and B and Hauls 7 to 16 (inclusive) for net C were determined from astronomical "fixes," which were kindly taken for the writer by Mr. E. W. Nelson.

TABLE IX.

List of Stations. Apparatus A.

Explanation. S.=surface. M.=midwater. B.=bottom. N.H.=Night Haul.

No. of Haul.	Date.	Depth of Haul.	Duration of Haul in minutes.	Locality.	Total Depth in fathoms.	Chart Area.
1	3.vii.19	B.	20	Rame Penlee . . .	7	T.
2	7.vii.19	B.	30	Rame N. 37° W. 1¼ miles .	15	T.
3	9.vii.19	M.	25	Eddystone E.N.E. 6 miles .	36	O.
4	10.vii.19	B.	90	Rame N. 14° E. 4½ miles .	28	S.
				to to (3 hauls)	to	
				,, N. 8° E. 2½ miles	26	T.
5	11.vii.19	B.	30	Rame N. 5° E. 1¾ miles .	24	T.
6	18.vii.19	M.–B.	30	Penlee N. 9° W. ¾ mile .	12	T.
7	18.vii.19	M.–B.	25	Penlee N. 10° E. 2¼ miles .	24	T.
8	18.vii.19	M.–B.	20	Rame N. 2° W. 3¼ miles .	27	T.
9	18.vii.19	M.–B.	30	Rame N. 5° E. 4½ miles .	29	S.
10	21.vii.19	B.	20	Rame E.N.E. 2 miles . .	25	T.
11	21.vii.19	B.	25	Rame E. by N. 2¾ miles .	26	T.
12	21.vii.19	B.	25	Rame E. ½ N. 4 miles . .	26	T.
13	21.vii.19	B.	20	Rame E. ¼ N. 5¼ miles . .	26	M.
14	24.vii.19	M.	20	Rame E. ¾ N. 4½ miles . .	27	T.
15	24.vii.19	S.	25	Looe N. 15° W. 2 miles .	10	M.
16	24.vii.19	M.	20	Looe N. 3° W. 4 miles . .	25	M.

No. of Haul.	Date.	Depth of Haul.	Duration of Haul in minutes.	Locality.	Total Depth in fathoms.	Chart Area.
17	28.vii.19	M.	20	Penlee N. 23° E. $\frac{3}{4}$ mile	13	T.
18	28.vii.19	M.–B.	20	Rame N. $1\frac{1}{2}$ miles	24	T.
19	28.vii.19	M.	20	Rame N.N.E. $2\frac{1}{2}$ miles	27	T.
20	29.vii.19	B.	20	Mewstone N.E. $1\frac{1}{4}$ miles	22	W.
21	29.vii.19	B.	20	Mewstone N. $1\frac{1}{4}$ miles	20	W.
22	29.vii.19	M.	20	Mewstone N. $\frac{1}{2}$ E. $4\frac{1}{4}$ miles	25	X.
23	29.vii.19	S.	20	Mewstone N. $4\frac{1}{2}$ miles	24	X.
24	29.vii.19	B.	20	Eddystone N. 70° W. $7\frac{1}{4}$ miles	32	X.
25	29.vii.19	B.	20	Eddystone N. 64° W. $7\frac{1}{2}$ miles	33	X.
26	29.vii.19	B.	20	Bolt Tail E.N.E. $7\frac{1}{4}$ miles	33	Z.
27	31.vii.19	S.	20	Rame N. by W. $5\frac{1}{2}$ miles	29	X.
28	31.vii.19	B.	30	Rame N. 13° W. $4\frac{3}{4}$ miles	28	X
29	1.viii.19	B.	20	Rame E. $\frac{1}{2}$ N. 1 mile	16	T.
30	1.viii.19	B.	20	Rame N. 62° E. $2\frac{1}{2}$ miles	26	T.
31	1.viii.19	B.	20	Rame N. 60° E. $3\frac{1}{2}$ miles	27	T.
32	1.viii.19	S.	20	Rame N. 55° E. $4\frac{1}{4}$ miles	28	T.
33	5.viii.19	M.	20	Penlee N. 3° W. $1\frac{1}{4}$ miles	15	T.
34	5.viii.19	B.	20	Penlee N. 2° E. 4 miles	27	W.
35	5.viii.19	B.	20	Eddystone S. 66° W. $4\frac{1}{2}$ miles	29	S.
36	5.viii.19	S.	20	Eddystone W. by S. 3 miles	30	S.
37	5.viii.19	B.	20	Eddystone S. 71° W. $2\frac{3}{4}$ miles	30	S.
38	5.viii.19	M.	20	Eddystone S. 59° W. $3\frac{1}{4}$ miles	30	S.
39	5.viii.19	B.	25	Rame N. 14° E. $3\frac{3}{4}$ miles	28	S.

No. of Haul.	Date.	Depth of Haul.	Duration of Haul in minutes.	Locality.	Total Depth in fathoms.	Chart Area.
40	7.viii.19	S.	20	Yealm River Entrance .	7	W.
41	7.viii.19	M.	20	Yealm Head N.N.E. $\frac{1}{4}$ mile .	7	W.
42	7.viii.19	B.	20	Stoke Point E. $\frac{1}{2}$ S. $\frac{3}{4}$ mile .	7	W.
43	7.viii.19	B.	20	Stoke Point E.N.E. $1\frac{1}{2}$ miles .	21	W.
44	8.viii.19	M.–B.	20	Rame N. 20 E. $3\frac{1}{4}$ miles .	28	T.
45	8.viii.19	M.	20	Rame N. 17° E. 4 miles .	28	S.
46	8.viii.19	S.	20	Eddystone W.S.W. $2\frac{1}{4}$ miles .	30	S.
47	8.viii.19	B.	20	Eddystone W. $\frac{1}{2}$ mile . .	20	S.
48	11.viii.19	B.	25	Rame N. 58° E. 5 miles .	27	S.
49	11.viii.19	B.	15	Rame N. 36° E. $\frac{3}{4}$ mile . .	20	T.
50	13.viii.19	M.	20	Shagstone to Mewstone .	7	W.
51	13.viii.19	M.	20	Yealm Head E. by S. $\frac{1}{2}$ mile .	7	W.
52	13.viii.19	M.	20	Yealm Head N. 39° E. $\frac{1}{4}$ mile	10	W.
53	13.viii.19	M.	20	Stoke Point E. $\frac{3}{4}$ mile .	10	W.

List of Stations. Apparatus B.

No. of Haul.	Date.	Depth of Haul.	Duration of Haul in minutes.	Locality.	Total Depth in fathoms.	Chart Area.
54	13.viii.19	M.	20	Stoke Point N. 72° E. 1 mile .	19	W.
55	14.viii.19	B.	20	Yealm Head E.N.E. 1 mile .	17	W.
56	15.viii.19	B.	40	Polperro N. 37° W. $4\frac{1}{2}$ miles (2 hauls)	26	M.
57	1.ix.19	B.	40	Rame N. 7° W. 3 miles .	27	T.
58	1.ix.19	B.	20	Penlee W. $\frac{1}{2}$ mile . .	9	T.

No. of Haul.	Date.	Depth of Haul.	Duration of Haul in minutes.	Locality.	Total Depth in fathoms.	Chart Area.
59	3.ix.19	S.	20	Rame E. 3½ miles . .	24	T.
60	3.ix.19	M.	20	Rame E. 4½ miles . .	26	T.M.
61	3.ix.19	B.	20	Rame E. 5 miles . . .	26	M.
62	9.ix.19	S.	30	50° 0′·5 N. 4° 35′ W. N.H. .	41	—
63	9.ix.19	M.	30	50° 0′·25 N. 4° 34·8 W. N.H.	41	—
64	9.ix.19	B.	30	50° N. 4° 34′·7 W. N.H. .	41	—
65	9.ix.19	S.	30	49° 59′·7 N. 4° 34′·5 W. N.H.	41	—
66	9.ix.19	B.	30	49° 59′·5 N. 4° 34′·6 W. N.H.	41	—
67	10.ix.19	S.	30	49° 58′·5 N. 4° 25′·2 W. N.H.	41	—
68	10.ix.19	M.	30	49° 59′·5 N. 4° 24′·5 W. N.H.	41	—
69	17.ix.19	B.	30	Eddystone S. by W. 1½ miles.	31	S.
70	17.ix.19	B.	20	Eddystone S. 2½ miles . .	30	S.
71	17.ix.19	B.	25	Eddystone S. by E. 3½ miles .	29	S.
72	17.ix.19	B.	30	Eddystone S. 3° E. 3¼ miles .	29	S.
73	17.ix.19	B.	30	Rame N. 55° E. 2¾ miles .	29	T.
74	19.ix.19	B.	20	Whitsand Bay E. . . .	5	T.U.
75	19.ix.19	M.	20	Rame Penlee . . .	7	T.
76	25.ix.19	B.	30	Cawsand Bay . . .	4–7	T.U.
77	25.ix.19	B.	30	Cawsand Bay . . .	4–7	T.U.
78	25.ix.19	B.	20	West Channel (Sound) .	7	T.V.W.
79	25.ix.19	M.–B.	40	West Channel . . .	7	T.V.W.
80	25.ix.19	M.–B.	20	West Channel . . .	7	T.V.W.
81	29.ix.19	B.	20	Rame N. 58° E. 5 miles .	27	S.

TABLE X.

List of Stations. Apparatus C.

No. of Haul.	Date.	Depth of Capture.	Duration of Haul in minutes.	Locality.	Total depth in fathoms.	Chart Area.
1	19 Aug. 19	S.–M.	20	Plymouth Sound (White Patch)	6	V.
2	,,	S.–M.	20	Cawsand Bay (Zostera) .	4–7	T.U.
3	,,	M.	20	,, ,, ,, .	4–7	T.U.
4	25 Aug. 19	B.	40	,, ,, ,, .	4–7	T.U.
5	26 Aug. 19	B.	24	,, ,, ,, .	4–7	T.U.
6	3 Sept. 19	B.	20	Rame E. 5 miles	27	M.
7	8 Sept. 19	S.	55	50° 02′·3 N. 4° 35′·5 W. N.H.	40	—
8	,,	M.	30	50° 01′·7 N. 4° 35′·4 W. N.H.	40	—
9	,,	B.	30	50° 01′·3 N. 4° 35′·2 W. N.H.	40	—
10	,,	S.	30	50° 00′·8 N. 4° 35′ W. N.H. .	40	—
11	9 Sept. 19	B.	30	49° 49′ N. 4° 28′·5 W. N.H. .	43	—
12	,,	M.	30	49° 50′·6 N. 4° 28′ W. N.H. .	43	—
13	,,	M.–B.	30	49° 52′ N. 4° 27′·5 W. N.H.	43	—
14	,,	S.–M.	30	49° 54′ N. 4° 26′·8 W. N.H. .	44	—
15	,,	M.–B.	30	49° 56′ N. 4° 26′ W. N.H. .	42	—
16	10 Sept. 19	S.	30	50° 00′·5 N. 4° 23′·5 W. N.H.	41	—
17	12 Sept. 19	B.	30	Mewstone N. 53° E. 3 miles .	26	W.
18	,,	B.	30	Rame N. 48° E. $1\frac{1}{2}$ miles .	30	T.

No. of Haul.	Date.	Depth of Capture.	Duration of Haul in minutes.	Locality.	Total depth in fathoms.	Chart Area.
19	16 Sept. 19	M.	25	Whitsand Bay E. . .	4–5	T.U.
20	,,	B.	25	,, ,, ,, . .	4–5	T.U.
21	,,	B.	25	,, ,, ,, . .	4–5	T.U.
22	,,	B.	30	,, ,, ,, . .	4–5	T.U.
23	,,	B.	30	,, ,, ,, . .	4–5	T.U.
24	18 Sept. 19	B.	45	,, ,, ,, . .	5–6	T.
25	,,	B.	45	,, ,, ,, . .	5–6	T.
26	23 Sept. 19	B.	20	Cawsand Bay (Zostera) .	4–7	T.U.
27	,,	B.	25	, ,, ,, . .	4–7	T.U.
28	29 Sept. 19	B	10	Whitsand Bay E. . .	6–10	T.
29	,,	B.	10	Rame E.S.E. $2\frac{1}{2}$ miles . .	15	T.
30	,,	B.	30	Rame E. by S. 3 miles . .	19	T.
31	,,	B.	30	Rame E.N.E. 4 miles . .	27	T.

ISOSPONDYLI.

CLUPEIDÆ.

Clupea sprattus L.	Sprat.
,, harengus L.	Herring.
Sardina (Clupea) pilchardus (Walb.)	Pilchard.

The young fry of the Clupeidæ are produced in very large numbers in the neighbourhood of Plymouth, and these belong to three species, *Clupea harengus* (Herring), *Clupea sprattus* (Sprat) and *Sardina pilchardus* (Pilchard). *Alosa alosa* (Shad) occurs not uncommonly in the adult stage in the estuaries, as for instance at Saltash, where they are caught in tuck nets in autumn, but their young stages appear to have escaped notice.

The spawning period at Plymouth for the three species shows a good deal of overlap, but the maximum spawning months for each of the three appear to be more distinct.

		Maximum.
Herring	xii.–i.	(?) i.
Sprat	i.–vii.	iii.–v.
Pilchard	iv.–x.	vi. and viii.

The 1919 material shows a capture of 1674 post-larvæ—nearly all of which are Pilchard, with an average of about 20 specimens per haul estimated for the three months. These occurred in 66 hauls, an average of 51 specimens per hour's fishing for the three months' period.

Clupea sprattus L. Sprat.

Apparatus A and B.

Month.	Total No. of Hauls.	No. of Hauls in which species occurs.	No. of specimens.	Size in mm.	Average No. per haul.
July	30	11	57	13–27	1·9
Aug.	29	5	19	18–25	0·6

Few post-larvæ of the Sprat occurred so late in the year—all those recorded being still in the " nude " stage. The larger " vêtu " (scaled) and " silvery " types from about 30 to 60 mm. (or more) were found in large shoals mixed with Herring in July in the rock pools below the Laboratory, the largest of those being probably about six months old. The distribution of the post-larvæ is general, specimens occurring outside the Eddystone, though they are more frequent closer inshore.

Sardina (clupea) pilchardus (Walb.).

Apparatus A and B.

Month.	Total No. of Hauls.	No. of Hauls in which species occurs.	No. of specimens.	Size in mm.	Average No. per haul.
July	30	23	528	6–26	17·6
Aug.	29	19	521	8–25	17·9
Sept.	25	19	471	9–28·5	18·8

The number of post-larval pilchards is large. For the whole period of three months, the number of hours' fishing totalled 31·08, so that the average number of specimens for one hour's fishing of the young fish trawls A and B works out at about 48.

In the cotton trawl C, 146 specimens (13–28 mm.) were secured in 10 hauls in August and September, an average of 4·7 specimens per haul for a total of 31 hauls. The larger size of the mesh of this net accounts for the small numbers—those which were captured being generally twisted round the "meshing." The prime object of this net was to catch the larger "poutines vêtues" and "palailles" stages (Marion, 1888, Pouchet, 1888) from 40 to 70 mm. and systematic investigations were carried out both in the shallower water of the bays and in the deeper midchannel water. Both localities, however, gave negative results during August and September months. This negative result, however, is probably not the real state of things, and two important factors have to be considered in (1) the catching power of the net and (2) in the ability of the young to escape the net.

The "poutines nues"—all the above records belong to this stage—are exceedingly abundant, having been taken over the whole of the area investigated from the Sound out to and beyond the 40-fathom line. Cunningham (1893) was the first to record captures from brackish water at Saltash, while this year (October) a few were taken by Dr. J. H. Orton in Millbay dry dock. The "nude" stage probably exceeds 40 mm. when there is a reduction in length in the change to the "poutines vêtues." The "palailles" or Sardine stage, with the scales larger and giving the fish its silvery appearance, have been taken at end of October and in November. The writer has the following three records :—

(1) One specimen, 90 mm. (snout to tip of caudal), secured by hand in a rock pool at entrance to Millbay Docks on 29th October, 1919. This was caught by W. Searle, of the Laboratory.

(2) One specimen, 72 mm. (snout to tip of caudal), from stomach of *Gadus virens* landed at Newlyn on 17th November, 1913. This specimen was sent to the Laboratory by Mr. Matthias Dunn.

(3) One specimen, 69 mm. (snout to tip of caudal) from mouth of *Zeus faber* landed on quay at Mevagissey on 18th November, 1913, and sent to the Laboratory by Mr. Howard Dunn.

The two smallest specimens are probably the young of the same year, and the largest probably spawned in October of the previous year and thus one year old (cf. Cunningham, 1891, 1899, 1900 ; Hjort, 1913 ; and Fage, 1913).

TABLE XI.

Apparatus A. and B.

Record of Clupea and Sardina.

No. of Haul.	Date.	Depth.	*C. sprattus.* No.	*C. sprattus.* Size in mm.	*S. pilchardus.* No.	*S. pilchardus.* Size in mm.	*C. sp.* No.	*C. sp.* Size in mm.
1	3.vii.19	B.	2	13–18	—	—	—	—
2	7.vii.19	B.	6	18–23	83	12–25	—	—
3	9.vii.19	M.	3	16·5–20	26	12–17	—	—
4	10.vii.19	B.	1	18	2	14–20	—	—
5	11.vii.19	B.	9	15–24	1	15	—	—
6	18.vii.19	M.–B.	2	20–21	13	16–24	—	—
7	,,	M.–B.	5	18–21	13	16–22	—	—
8	,,	M.–B.	—	—	3	19–21	—	—
9	,,	M.–B.	—	—	16	9–21·5	—	—
10	21.vii.19	B.	—	—	26	11–22	—	—
11	,,	B.	—	—	49	11–24	—	—
12	,,	B.	—	—	12	11–21	—	—
13	,,	B.	—	—	22	13–22	—	—
14	24.vii.19	M.	18	15–27	62	13–25	—	—
15	,,	S.	7	22–25	71	12–23	—	—
16	,,	M.	—	—	—	—	73	13–23
17	28.vii.19	M.	—	—	2	15–26	—	—
19	,,	M.	—	—	—	—	2	7–8
21	29.vii.19	B.	—	—	3	9–14	—	—
22	,,	M.	—	—	21	9–12	—	—
23	,,	S.	—	—	11	6–11	—	—
24	,,	B.	—	—	26	7–18	—	—
25	,,	B.	—	—	29	9–15	—	—
26	,,	B.	—	—	29	6–14	—	—
27	31.vii.19	S.	3	17–25	2	21	—	—
28	,,	B.	—	—	7	13–20	—	—

No. of Haul.	Date.	Depth.	*C. sprattus.* No.	Size in mm.	*S. pilchardus.* No.	Size in mm.	*C. sp.* No.	Size in mm.
29	1.viii.19	B.	—	—	1	8	—	—
30	,,	B.	—	—	7	9–14	—	—
31	,,	B.	—	—	9	11–19	—	—
33	5.viii.19	M.	—	—	1	11	—	—
34	,,	B.	—	—	15	8–15	—	—
35	,,	B.	—	—	35	9–21	—	—
36	,,	S.	—	—	48	13–25	—	—
37	,,	B.	1	21	15	11–21	—	—
38	,,	M.	—	—	37	10–23	—	—
39	,,	B.	—	—	123	9·5–20	—	—
41	7.viii.19	M.	—	—	3	10–21	—	—
42	,,	B.	1	21	3	17·5–24	—	—
43	,,	B.	—	—	4	13·5–22	—	—
44	8.viii.19	M.–B.	—	—	14	11–19	—	—
45	,,	M.	—	—	12	10–20	—	—
46	,,	S.	4	19–25	21	9–25	—	—
47	,,	B.	—	—	21	12–22	—	—
48	11.viii.19	B.	—	—	2	14–15	—	—
52	13.viii.19	M.	1	18	—	—	—	—
56	15.viii.19	B.	12	18–22	150	14–20	—	—
57	1.ix.19	B.	—	—	71	12–25	—	—
58	,,	B.	—	—	9	12–28	—	—
60	3.ix.19	M.	—	—	17	11–23	—	—
61	,,	B.	—	—	65	12–23	—	—
62	9.ix.19	S.	—	—	76	14·5–28·5	—	—
63	,,	M.	—	—	4	18–23	—	—
64	,,	B.	—	—	8	17–27	—	—
65	,,	S.	—	—	76	14–24	—	—
66	,,	B.	—	—	37	14–23	—	—
67	10.ix.19	S.	—	—	21	14–20	—	—
68	,,	M.	—	—	32	11–22·5	—	—
69	17.ix.19	B.	—	—	3	15–27	—	—
70	,,	B.	—	—	9	14–23	—	—
71	,,	B.	—	—	1	21	—	—
72	,,	B.	—	—	2	24–26	—	—
75	19.ix.19	M.	—	—	2	21–25	—	—
76	25.ix.19	B.	—	—	18	10–24·5	—	—
79	,,	M.–B.	—	—	5	10–19	—	—
80	,,	M.–B.	—	—	15	9–28	—	—

TABLE XII.

Apparatus C.

Record of Sardina pilchardus.

No. of haul.	Date.	Depth.	No.	Size in mm.
1	19.vii.19	S.–M.	10	17–23
2	,,	S.–M.	31	19–26
3	,,	M.	7	22–24
4	25.viii.19	B.	88	19–25
8	8.ix.19	M.	2	20
11	9.ix.19	B.	2	22–27
12	,,	M.	1	28
13	,,	M.–B.	1	13
14	,,	S.–M.	2	16–29
16	10.ix.19	S.	3	15–24

SOLENICHTHYES.

SYNGNATHIDÆ. PIPE FISHES.

Syngnathus acus L.
,, rostellatus Nilss.
Siphonostoma tyyhle L.
Nerophis æquoreus L.

Apparatus A and B.

Syngnathus rostellatus was the only species which occurred off shore, and only two young stages were captured, one of 21 mm. in Haul 7 on 18th July, 1919, and one of 56 mm. in Haul 69 on 17th September, 1919.

Siphonostoma typhle occurred as a single individual in Haul 77 (Cawsand Bay) at a length of 97 mm. on 25th September, 1919, and *Nerophis æquoreus* was represented by two young forms, 12 to 22 mm. in length, captured in Haul 80, West Channel, on the same date.

Apparatus C.

Adolescent and adult stages of *Syngnathus acus, S. rostellatus* and *Siphonostoma typhle* were taken with the cotton trawl C in August and September in Whitsand and Cawsand Bays, all in shallow water close inshore. *Siphonostoma typhle* was found to be carrying the young in the brood pouch in August. The records here given of these three species are not quite representative, as many rich hauls of these fish were transferred alive from the Cawsand Bay Zostera bed to the aquarium tanks for special public exhibition. *Nerophis lumbriciformis* was also present in these hauls, which were made with the cotton net and with the ordinary shrimp trawl.

TABLE XIII.

Apparatus A and B.

Record of Syngnathidæ.

No. of Haul.	Date.	Depth.	*Syngnathus rostellatus.* No.	Size in mm.	*Siphonostoma typhle.* No.	Size in mm.	*Nerophis aequoreus.* No.	Size in mm.
7	18.vii.19	M.–B.	1	21	—	—	—	—
69	17.ix.19	M.	1	56	—	—	—	—
77	25.ix.19	B.	—	—	1	97	—	—
80	,,	B.		—	—	—	2	12–22

TABLE XIV.

Apparatus C.

Record of Syngnathidæ.

No. of Haul.	Date.	Depth.	*Syngnathus acus.* No.	Size in mm.	*S. rostellatus.* No.	Size in mm.	*S. typhle.* No.	Size in mm.
5	26.viii.19	B.	—	—	—	—	1	220
22	16.ix.19	B.	8	95–145	—	—	—	—
23	,,	B.	2	98–105	—	—	—	—
24	18.ix.19	B.	—	—	4	95–105	—	—
25	,,	B.	—	—	13	77–140	—	—
26	23.ix.19	B.	—	—	—	—	7	185–295
27	,,	B.	—	—	2	100–105	1	175

APODES.

CONGRIDÆ.

Leptocephalus congri vulgaris (L. Morrisii).

Apparatus B.

A single Leptocephalus stage of the Conger occurred in Haul 69 (Bottom) on 17th September, 1919. It measured approximately 115 mm. when brought in alive to the Laboratory. Fortunately the young fish has survived and enabled observations to be made on its rate of growth. The reduction in length during metamorphosis is a distinctive feature.

The specimen has been carefully looked after by Mr. Ford, who gives in the same volume of this Journal a few notes on his observations along with a table of the captures of Leptocephali of the Conger round our coasts.

ANACANTHINI.

GADIDÆ.

GADUS POLLACHIUS L. Pollack.

In the 1919 hauls, July to September (inclusive) pelagic young of the Pollack had disappeared, with the exception of one post-larva of 5 mm. secured on 21st July, 1919. This result is not surprising as the Pollack is a spring spawner in this area, and may well have reached the bottom stage by July. Adolescent stages have been taken in Cawsand Bay at lengths from 3 to 5 cm. in June. They are extreemly abundant in the Zostera bed of Cawsand Bay, and are invariably present in every haul of the shrimp trawl in summer and autumn. Two hauls (Nos. 4 and 5, Apparatus C) gave 53 fish from 60 to 120 mm. in length for a total duration of 64 minutes.

Spawning Period : i–vi.

GADIDÆ.

GADUS MERLANGUS L. Whiting.

This was the most frequent Gadoid. in the pelagic young stage during the period of the 1919 investigations. Sixty-nine post-larvæ, 5–17 mm., were captured in July and 11 varying from 5 mm. upwards in August, all in the area between Rame Head and the Eddystone. The average per haul (23·5 minutes) for July is 2·3. Dr. Allen gives the maximum number per haul (ca. 20 minutes) for the years 1906–1914 as 33·6 for May month. This is a fairly high percentage, especially for a fish of commercial importance, and shows a large production of the young fry in this area.

The adolescent period is passed in shallow water close to the shore, and a few examples 65–85 mm. were caught in Cawsand and Whitsand Bays with the cotton trawl C in September. These are the young spawned in the earlier part of the year and are at least six months old.

Spawning Period : ii–vii.

GADIDÆ.

GADUS LUSCUS L. Bib (auctorum).
Pout—Plymouth.

The pelagic young stages of this species were extremely limited in number, as only 7 post-larvæ from 8–15 mm. in length were taken during the autumn of 1919. The records from 1906–14 gave only 74 post-larvæ—44 of which were captured in May—so far the maximum month—with an average of only 1·5 per haul of 20 minutes' duration. These records are supplemented for the earlier months of the year by a few captures in Plymouth Sound recorded by Lebour (1917–1918). The writer is inclined to the idea, however, that a more systematic investigation during the earlier months of the year will supply a better indication of the real state of things with regard to the frequency of the early young of this species. The adult is extremely plentiful in the fishing areas both inside and outside the Eddystone, and forms with *Gadus pollachius* (Pollack), *G. merlangus* (Whiting) and *G. minutus* (Poor-Cod) the chief representatives of the Gadoids in the Plymouth area.

The captures of the early bottom stages by the cotton trawl C are not quite representative of the state of things. They are limited to 6 fish from 33 to 43 mm. captured in one haul in the deeper water off Whitsand Bay, though a few have been taken with the shrimp trawl in the Zostera bed of Cawsand Bay at corresponding sizes also in September.

Spawning Period: xi–vi.

Gadus minutus. Poor Cod (auctorum). Bib—Plymouth.

Pelagic young of this species were absent from the hauls made in July, August and September, 1919. Dr. Allen gives the maximum average number of post-larvæ per haul of 20 minutes as 13·5 in May.

The early bottom stages, however, were well represented in the 1919 material, and their distribution was quite general over the whole area—extending from close inshore out to midchannel, where captures were registered from a depth of 44 fathoms. Table XV records the capture of 196 specimens, 40–160 mm., secured in 5 hauls in July and August with the mosquito net B, while the cotton net C captured 1111, varying from 58 to 175 mm., during the same period, an average number for the latter of 35·8 specimens per haul of an average duration of 28·3 minutes. One half-hour haul in locality $1\frac{1}{2}$ miles S. by W. from Rame Head gave 938 bottom stages from 65–90 mm. in length.

Mature adults of this species vary from 150 to 230 mm., but seldom very much larger, so that the present records contain many fish which are undoubtedly over one year old.

Spawning Period: ii–vi.

TABLE XV.

Apparatus A and B.

Record of Gadus sp.

No. of Haul.	Date.	Depth.	*G. pollachius.* No.	*G. pollachius.* Size in mm.	*G. merlangus.* No.	*G. merlangus.* Size in mm.	*G. luscus.* No.	*G. luscus.* Size in mm.	*G. minutus.* No.	*G. minutus.* Size in mm.
1	3.vii.19	B.	—	—	3	6–9	—	—	—	—
2	7.vii.19	B.	—	—	2	12–17	—	—	—	—
4	10.vii.19	B.	—	—	14	6–17		—	—	—
6	18.vii.19	M.–B.	—	—	4	8–12·5	—	—	—	—
7	,,	M.–B.	—	—	2	11	—	—	—	—
8	,,	M.–B.	—	—	3	6·5–9	—	—	—	—
9	,,	M.–B.	—	—	7	7–11	—	—	—	—
11	21.vii.19	B.	—	—	9	6–11	1	8	—	—
12	,,	B.	1	5	11	5–10·5	—	—	—	—
13	,,	B.	—	—	7	7–13	—	—	—	—
19	28.vii.19	M.	—	—	1	13	—	—	—	—
20	29.vii.19	B.	—	—	1	11	—	—	—	—
28	31.vii.19	B.	—	—	5	6–9	—	—	—	—
29	1.viii.19	B.	—	—	1	12	—	—	—	—
32	,,	S.	—	—	4	20–40	—	—	—	—
33	5.viii.19	M.	—	—	1	8	—	—	—	—
34	,,	B.	—	—	1	7	—	—	—	—
35	,,	B.	—	—	4	5–7·5	—	—	—	—
56	15.viii.19	B.	—	—	—	—	—	—	1	40
64	9.ix.19	B.	—	—	—	—	—	—	9	51–89
72	17.ix.19	B.	—	—	—	—	—	—	100	64–160
73	,,	B.	—	—	—	—	2	14	79	69–110
81	29.ix.19	B.	—	—	—	—	4	11–15	7	82–143

TABLE XVI.

Apparatus C.

Record of Gadus sp.

No. of Haul.	Date.	Depth.	*G. pollachius.* No.	*G. pollachius.* Size in mm.	*G. merlangus.* No.	*G. merlangus.* Size in mm.	*G. luscus.* No.	*G. luscus.* Size in mm.	*G. minutus.* No.	*G. minutus.* Size in mm.
4	25.viii.19	B.	12	60–120	—	—	—	—	24	58–90
5	26.viii.19	B.	41	76–109	—	—	—	—	30	73–104
11	9.ix.19	B.	—	—	—	—	—	—	1	60
15	,,	M.–B.	—	—	—	—	—	—	2	70–78
17	12.ix.19	M.	—	—	—	—	—	—	92	68–175
18	,,	B.	—	—	—	—	—	—	938	65–90
20	16.ix.19	M.	—	—	1	65	—	—	—	—
21	,,	B.	—	—	1	70	—	—	—	—
24	18.ix.19	B.	—	—	1	82	—	—	—	—
26	23.ix.19	B.	—	—	—	—	—	—	—	—
27	,,	B.	—	—	2	67–85	—	—	—	—
29	29.ix.19	B.	—	—	—	—	—	—	—	—
30	,,	B.	—	—	3	78–80	6	33–43	—	—

GADIDÆ.

Molva molva L. Common Ling.

Ten post-larvæ of the Common Ling, 6–17 mm. in length, occurred in three hauls on the Rame Eddystone Grounds in July. For 1914, Dr. Allen records a similar number, 8–20 mm. in length, from May to July, while the investigations during the years 1906–1913 yielded only 30 young stages, so that it may be safely considered that the production of the young fry in the area investigated is very small. Schmidt (1906, 1909) has already remarked on the scarcity of the young pelagic stages in the English Channel, their absence in the shallower water of the east, and their presence in small quantity in the deeper water of the west. Adult Ling have only occasionally been taken in the deeper water off Plymouth, but they increase in number westward. No ripe females have been examined.

Spawning Period : iv–vi.

TABLE XVII.

Apparatus A.

Record of Molva molva.

No. of Haul.	Date.	Depth.	No.	Size in mm.
4	10.vii.19	B.	4	6–15
8	18.vii.19	M.–B.	1	11·5
12	21.vii.19	B.	5	10–17

GADIDÆ.

Merluccius merluccius L. Hake.

Thirteen young Hake from 4·5 to 13 mm. occurred in 8 hauls from the end of July to middle of September, 1919. These are apparently the first observations on the young of this species in Plymouth waters. Ten of these were captured in deeper water of about 40 fathoms in midchannel, 15 miles W.S.W. of the Eddystone Rocks, but three appeared in hauls between Rame Head and Eddystone over depths ranging from 20 to 30 fathoms. They agree very well with Schmidt's excellent figures and descriptions (1907 a). The distribution of this species in the area investigated is similar to that for the Common Ling. Both show a tendency to occur in deeper water, though the records are rather few to draw conclusions. Schmidt (1909) records a few small individuals which were captured in the western part of the English Channel in May and June.

Spawning Period : vi.–viii.

One ripe female was observed by the writer in July, 1913. This was secured in the *Oithona's* Otter Trawl, in the fishing grounds outside the Eddystone.

TABLE XVIII.

Apparatus A and B.

Record of Merluccius merluccius.

No. of Haul.	Date	Depth.	No.	Size in mm.
28	31.vii.19	B.	1	5·5
44	8.viii.19	M.–B.	1	5
47	,,	B.	1	4·5
62	9.ix.19	S.	1	13
63	,,	M.	1	9·5
64	,,	B.	4	9–10
66	,,	B.	3	7–11
69	17.ix.19	B.	1	10

GADIDÆ.

Raniceps raninus L. Lesser Forkbeard.

Apparatus B.

A single post-larva, 12 mm. in length, was taken in a surface night haul (No. 67) on 10th September, 1919, in latitude 49° 58′·5 N., longitude 4° 25′·2 W. over a depth of 41 fathoms. It is well represented by Schmidt's figure of a specimen, 12¼ mm. (1907 b). For 1914, Dr. Allen records a post-larva 8 mm. in length at the end of July, while the writer recorded eight specimens (4·5–18·5 mm.) in August and September, 1913. The distribution of the post-larvæ here recorded is identical with that for the Ling and the Hake. They were all secured over total depths greater than 20 fathoms, in localities west of Rame Head, round the Eddystone Rocks and in midchannel. Their numbers are exceedingly few and give indications that the area in question is poorly represented by this species.

The writer, so far, has not observed any adults in this area, though they are known to have been captured farther west off the Cornish coast, through observations by Mr. Matthias Dunn, Newlyn, who has sent specimens to the Laboratory for identification.

Spawning Period : vi–viii.

GADIDÆ.

ONOS MUSTELUS L.	Five-bearded Rockling.
,, TRICIRRATUS BLOCH.	Three ,, ,,
,, CIMBRIUS L.	Four ,, ,,

The identification of the early young Rocklings still remains doubtful. Most of those recorded in Table VII belong to the five-bearded species, *O. mustelus*, 23 specimens, 4–8 mm., having been secured in July, and beginning of August. These occurred in 13 hauls taken inside and outside the Eddystone.

On 29th September, 1919, Bottom Haul No. 31 of the cotton trawl C yielded a single adult *Onos cimbrius* 160 mm. in length. This species has only been taken occasionally in the adult stage near Plymouth and the spawning period for this area has not been recorded. The writer, however, secured a ripe female, 150 mm. in length, in a "Mosquito" townet attached to the Otter Trawl on 2nd September, 1913, in locality 3½ miles W.S.W. from Rame Head at a depth of 26 fathoms. The eggs measured (after the specimen had been in formalin) ·8 to ·875 mm. In this 150 mm. specimen, the first ray of the anterior dorsal measured 33 mm. and the head 26 mm.

	O. mustelus.	*O tri-cirratus.*	*O. cimbrius.*
Spawning Period :	i–vii.	v–viii.	ix.

TABLE XIX.

APPARATUS A AND B.

RECORD OF ONOS sp.

No. of Haul.	Date.	Depth.	*O. mustelus.* No.	Size in mm.	*O. tri-cirratus.* No.	Size in mm.	*O. sp.* No.	Size in mm.
2	7.vii.19	B.	2	6–8	—	—	—	—
3	9.vii.19	M.	1	8	—	—	—	—
4	10.vii.19	B.	1	5	—	—	—	—
9	18.vii.19	M.–B.	2	6–8	—	—	—	—
11	21.vii.19	B.	2	5–6	1	31	—	—
12	,,	B.	4	5–7	—	—	—	—
13	,,	B.	1	6·5	—	—	—	—
14	24.vii.19	M.	1	8	—	—	—	—
24	29.vii.19	B.	4	6–7	—	—	—	—
25	,,	B.	2	4–5	2	23–25	—	—
26	,,	B.	—	—	—	—	1	10
27	31.vii.19	S.	—	—	—	—	1	9
28	,,	B.	1	6	—	—	—	—
31	1.viii.19	B.	1	5	—	—	—	—
39	5.viii.19	B.	1	7	—	—	—	—

ZEOMORPHI.

CAPROIDÆ.

CAPROS APER L. Boarfish.

Three post-larvæ 6–7 mm. in length, were secured in September, 1919. These were in two surface night hauls—one 6·3 mm. in Haul 62 on 9th September and two 6–7 mm. in Haul 67 on 10th September, 1919, both over depths of 41 fathoms. Eleven young stages—3·3 to 6 mm. were recorded during August and September, 1913, and these were also secured in deeper water chiefly round the Eddystone Rocks. All the Plymouth records so far are confined to hauls in water of over 20 fathoms in total depth, while the post-larvæ have occurred in surface, midwater and bottom hauls.

In Plymouth waters, spawning extends—according to Cunningham, Holt and Hefford—from June to August, with a maximum in July, and may take place not far from the shore, as Holt has already remarked. The writer has trawled numerous ripe adults of this species on the in-shore fishing grounds between the Eddystone and Rame Head in July and August.

Spawning Period : vi–viii.

TABLE XX.

APPARATUS B.

RECORD OF CAPROS APER.

No. of haul.	Date.	Depth.	No.	Size in mm.
62	9.ix.19	S.	1	6·3
67	10.ix.19	S.	2	6–7

HETEROSOMATA.

PLEURONECTIFORMES.

BOTHIDÆ.

Sub-Fam. PLATOPHRINÆ.

ARNOGLOSSUS LATERNA (Will) SCALDBACK.

The scales in the adult are very deciduous, hence the popular name of Scaldback. The pelagic young occur in 53 hauls out of 84, with an average of 5·7 specimens per haul. The maximum number is in September, when the average per haul is 11·6 specimens. They are distributed generally over the whole area, fewer inshore than in the deeper water offshore, and are extremely common on the Rame-Eddystone grounds. Post-larvæ have not been recorded earlier than May nor later than beginning of October, so that the spawning period, judged from the lengths of the very early stages, probably lies between the end of April and middle of September for this neighbourhood. The eggs of *A. laterna* and *grohmanni* have been observed in June and July.

The smallest completely metamorphosed *A. laterna* was 24 mm., though there is a good deal of variation in the length. Specimens 24·5 mm. and 25·6 had only just begun, while post-larvæ at 19·5 and 22 mm. were at least half-way through their metamorphosis, the right eye being almost on the top of the ridge at the smaller of these two lengths and just over the top at the larger length, while the dorsal fin in the latter had not yet reached the snout, the usual gap still being present, where the right eye had travelled round the head. The reduction in length at metamorphosis is very noticeable.

The hauls of the cotton trawl C record the capture of adolescent stages of *A. laterna* from 28 mm. upwards in the shallow water of the bays and in deeper water between Rame Head and Eddystone.

Spawning Period : vi–viii.

TABLE XXI.

Apparatus A and B.

Record of Arnoglossus sp.

No. of haul.	Date.	Depth.	*A. laterna.* No.	*A. laterna.* Size in mm.	A. sp. No.	A. sp. Size in mm.
1	3.vii.19	B.	2	9–11·5	—	—
4	10.vii.19	B.	—	—	2	5–7·5
7	18.vii.19	M.–B.	3	4–11	—	—
8	,,	M.–B.	—	—	1	4
9	,,	M.–B.	5	4–10	—	—
10	21.vii.19	B.	5	4–18	—	—
11	,,	B.	8	6–13 5	—	—
12	,,	B.	4	7–19	—	—
13	,,	B.	4	8–15	—	—
14	24.vii.19	M.	—	—	1	7·5
18	28.vii.19	M.–B.	—	—	1	10
19	,,	M.	—	—	1	4

No. of haul.	Date.	Depth.	*A. laterna.* No.	Size in mm.	A. sp. No.	Size in mm.
20	29.vii.19	B.	4	6–19	—	—
21	,,	B.	5	5	—	—
22	,,	M.	24	4·5–11	—	—
23	,,	S.	6	4–9	—	—
24	,,	B.	3	7–10·5	—	—
25	,,	B.	4	7–11	—	—
26	,,	B.	—	—	3	9–11
28	31.vii.19	B.	7	11–24	—	—
30	1.viii.19	B.	2	4·5–6	—	—
31	,,	B.	6	8–21	—	—
32	,,	S.	1	6	—	—
33	5.viii.19	M.	2	5–5·5	—	—
34	,,	B.	5	5–13	—	—
35	,,	B.	4	5–16	—	—
36	,,	S.	1	9·5	—	—
37	,,	B.	10	9–16	—	—
38	,,	M.	7	5–9	—	—
39	,,	B.	9	5–9	—	—
41	7.viii.19	M.	1	8	—	—
42	,,	B.	3	7–14·5	—	—
43	,,	B.	6	7–17	—	—
44	8.viii.19	M.–B.	9	5–11	—	—
45	8.viii.19	M.	5	11–19	—	—
47	,,	B.	7	6·5–12	—	—
48	11.viii.19	B.	5	5–16	—	—
54	13.viii.19	M.	1	10	—	—
55	14.viii.19	B.	2	10–15	—	—
56	15.viii.19	B.	13	11–18	—	—
57	1.ix.19	B.	3	7–15	—	—
62	9.ix.19	S.	—	—	55	6–21·5
63	,,	M.	—	—	4	8–17
65	,,	S.	—	—	24	7–21
66	,,	B.	—	—	23	8–22
67	10.ix.19	S.	—	—	100	6–20
68	,,	M.	1	24	22	7–24
69	17.ix.19	B.	—	—	10	10–19
70	,,	B.	—	—	4	9–20
74	19.ix.19	B.	—	—	1	12·5
76	25.ix.19	B.	—	—	6	8–12
79	,,	B.	—	—	21	9–17
80	,,	M.–B.	—	—	16	9–14·5

TABLE XXII.

Apparatus C.

Record of Arnoglossus sp.

No. of haul.	Date.	Depth.	*A. laterna.* No.	*A. laterna.* Size in mm.	A. sp. No.	A. sp. Size in mm.
4	25.viii.19	B.	2	13–15	—	—
6	3.ix.19	B.	4	7–15	—	—
7	8.ix.19	S.	3	17–23	—	—
8	,,	M.	6	17–24	—	—
10	,,	S.	—	—	5	11–23
11	9.ix.19	B.	—	—	2	24–27
12	,,	M.	—	—	2	25–29
14	,,	S.–M.	—	—	1	26
15	,,	M.–B.	—	—	2	19–24
17	12.ix.19	B.	5	95–115	—	—
18	,,	B.	14	90–130	—	—
21	16.ix.19	B.	3	42–105	—	—
22	,,	B.	4	49–111	—	—
23	,,	B.	1	44	—	—
24	18.ix.19	B.	—	—	5	46–118
28	25.ix.19	B.	1	35	—	—
30	,,	B.	16	28–132	—	—
31	,,	B.	2	92–100	—	—

Sub-Fam. BOTHINÆ.

Rhombus maximus L. Turbot.
,, lævis Rond. Brill.

Few post-larvæ of either species were taken in the hauls of the young fish trawls, and they disappeared from the captures in the beginning of August. The investigations for the years 1906–1914 and 1919 show that the spawning of the Turbot during July and August and the Brill in July is very small indeed, as the records of the young fish trawl for all the years are extremely few. That the maximum spawning period for each species occurs earlier in the year, and that both species are well represented in the Plymouth area are proved by the abundance of the later pelagic young and early bottom stages.

Young metamorphosing stages of the Brill, still at the surface, occur regularly in large numbers in May and June in the areas close inshore. Garstang (1895) remarks, " Every year at this time (May month) the harbour is invaded by shoals of young Brill (*Rhombus lævis*) in their pelagic stage." Numerous early bottom stages of the Turbot 25–50 mm. in length have been taken with hand nets, worked from the shore in Whitsand Bay in August and September.

The working of a shore seine would add greatly to our knowledge of the numbers of these two important species in the Plymouth area.

	R. maximus.	*R. lævis.*
Spawning Period:	(?) vi–viii.	(?) iv–viii.

TABLE XXIII.

APPARATUS A AND B.

RECORD OF RHOMBUS sp.

No. of haul.	Date.	Depth.	*R. maximus.* No.	*R. maximus.* Size in mm.	*R. lævis.* No.	*R. lævis.* Size in mm.
14	24.vii.19	B.	—	—	9	4–6·5
17	28.vii.19	M.	—	—	1	4
27	31.vii.19	S.	1	7	—	—
37	5.viii.19	B.	1	6	—	—
44	8.viii.19	M.–B.	—	—	1	6·5

SCOPHTHALMUS NORVEGICUS Gunther.—Norway TOPKNOT.
" UNIMACULATUS Bnp.
ZEUGOPTERUS PUNCTATUS (Bloch).

Post-larvæ of *Lepidorhombus megastoma* (Don.), the MEGRIM have not been observed in the hauls of the young fish trawl, though the adult is of common occurrence in the deeper water off Plymouth.

The commonest post-larva belongs to the Norway Topknot, *Scophthalmus norvegicus*, 271 specimens from 4·5 to 11 mm. having been secured. The maximum number was taken in July with an average of 8·6 per haul for this month. Dr. Allen gives an average of 14·6 per haul for the previous years in May month, which approximates more to the middle of the spawning period, which extends from March to June. Metamorphosis is nearing completion in specimens of 11 mm. of *S. norvegicus* and thus at a smaller size than Petersen (1909) records for his specimens. The dorsal fin has extended on to the snout and the migrating eye is completely closed in. The pectorals have become more elongated and permanent rays have developed.

Only two post-larvæ of *Zeug. punctatus* were recorded in July, and these were in process of metamorphosis. The eggs of this species have been observed from February to May, so that their comparative absence from the pelagic hauls is easily explained.

Post-larvæ of the Norway Topknot (*S. norvegicus*) are distributed over the whole of the area investigated. One adolescent stage of 26 mm. was secured in Haul 15 of the cotton trawl C on 9th September, 1919, at a depth of 42 fathoms.

	S. norvegicus.	*S. unimaculatus.*	*Z. punctatus.*
Spawning Period :	iii–vi.	iv–vi.	ii.–v.

TABLE XXIV.

Apparatus A and B.

Record of Scophthalmus and Zeugopterus.

No. of Haul.	Date.	Depth.	*S. norvegicus.* No.	Size in mm.	*S. unimaculatus.* No.	Size in mm.	*Z. punctatus.* No.	Size in mm.
3	9.vii.19	M.	2	9	—	—	—	—
4	10.vii.19	B.	20	5·5–9	—	—	—	—
5	11.vii.19	B.	—	—	2	7	—	—
6	18.vii.19	M.–B.	3	7–9	—	—	—	—
7	„	M.–B.	1	5·5	—	—	—	—
9	„	M.–B.	11	5·5–8	—	—	—	—
10	21.vii.19	B.	32	5–10	—	—	1	8
11	„	B.	52	5–10	—	—	1	10·5
12	„	B.	69	6–10	—	—	—	—
13	„	B.	53	4·5–11	—	—	—	—
18	28.vii.19	M.–B.	1	7	—	—	—	—
23	29.vii.19	S.	1	5	—	—	—	—
24	„	B.	3	6–9	—	—	—	—
25	„	B.	6	5–7	—	—	—	—
26	„	B.	4	5·5–8	—	—	—	—
28	31.vii.19	S.	1	6·5	—	—	—	—
31	1.viii.19	B.	9	6–9	—	—	—	—
34	5.viii.19	B.	1	5	—	—	—	—
47	8.viii.19	B.	1	8·5	—	—	—	—
63	9.ix.19	M.	1	11	—	—	—	—

PLEURONECTIDÆ.

Pleuronectes platessa L. Plaice.
„ limanda L. Common Dab.
„ microcephalus Don. Lemon Dab.
flesus L. Flounder.

	P. platessa.	*P. limanda.*	*P. microcephalus.*	*P. flesus.*
Spawning Period :	xii–v.	ii–vi.	ii–vii.	ii–iv.

P. limanda. Common Dab.

Only two post-larvæ, 12·5 and 13 mm., were taken in the beginning of July, after which time they disappeared from the pelagic hauls. The maximum month for post-larvæ falls in May.

The captures with the cotton trawl C were taken mostly in shallow water close inshore. The small number of hauls must be considered in the estimation of the number of fish captured.

P. microcephalus. Lemon Dab.

The pelagic young of this species persist in the hauls later than any of the other species of *Pleuronectes*. This is due not to a later spawning period but to a longer pelagic life. The species is a deeper water form and the main spawning probably takes place well offshore.

No early bottom stages were secured in the area under investigation.

The largest post-larva observed at Plymouth was taken in Haul 48 on 2nd July, 1914, and measured 18·5 mm.

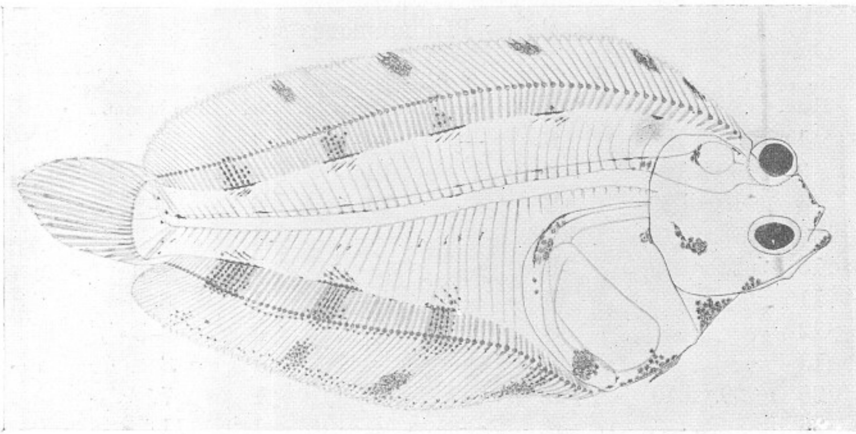

Fig. 2.—Metamorphosing stage of *Pleuronectes microcephalus* Don. Length 18·5 mm., Haul 48, Apparatus A, 2nd July, 1914. Del. E. Ford.

The above figure is drawn from a mounted specimen. The numerical characters are definitely as follows :—

D. 88. A. 75. Verebræ 13 + 35.

There is nothing new to add to the descriptions of Holt (1893) and Petersen (1904). It is just a shade further advanced than Petersen's specimen of 18 mm. (1904), and is about half-way through metamorphosis. The migrating eye has not quite reached the dorsal ridge and the pectorals have still got larval rays.

P. platessa. Plaice.

The records of the cotton trawl C are few and cannot be taken as representative of the true state of things. The hauls with this net are not quite comprehensive enough in regard to locality. There is undoubtedly an abundance of the young in the Sound, even in the more brackish water, and they have been taken in large numbers along with young Turbot with hand nets worked from the shore in Whitsand Bay. The shallowness of the water in these localities prevented the *Oithona* from making the necessary captures.

TABLE XXV.

Apparatus A and B.

Record of Pleuronectes sp.

No. of Haul.	Date.	Depth.	*P. limanda.* No.	*P. limanda.* Size in mm.	*P. microcephalus.* No.	*P. microcephalus.* Size in mm.
1	3.vii.19	B.	—	—	1	12
3	9.vii.19	M.	1	12·5	—	—
4	10.vii.19	B.	1	13	2	9–11
9	18.vii.19	M.–B.	—	—	1	8
10	21.vii.19	B.	—	—	2	7–9
11	,,	B.	—	—	1	8
12	,,	B.	—	—	4	6–8
13	,,	B.	—	—	1	8
25	29.vii.19	B.	—	—	1	7
26	,,	B.	—	—	1	11
28	31.vii.19	B.	—	—	2	7–8
29	1.viii.19	B.	—	—	1	10
64	9.ix.19	B.	—	—	1	18
66	9.ix.19	B.	—	—	1	10
80	25.ix.19	B.	1	56	—	—

TABLE XXVI.

Apparatus C.

Record of Pleuronectes sp.

No. of Haul.	Date.	Depth.	*P. limanda.* No.	*P. limanda.* Size in mm.	*P. platessa.* No.	*P. platessa.* Size in mm.
5	26.viii.19	B.	7	35–54	—	—
17	12.ix.19	B.	1	35	—	—
18	,,	B.	1	65	—	—
20	16.ix.19	B.	3	58–63	—	—
21	,,	B.	16	27–65	—	—
22	,,	B.	26	44–145	4	95–120
23	,,	B.	54	41–135	1	111
24	18.ix.19	B.	42	48–68	2	97–112
25	,,	B.	8	42–60	6	95–115
26	23.ix.19	B.	5	42–60	—	—
27	,,	B.	47	26–62	—	—
28	29.ix.19	B.	1	32	—	—
30	,,	B.	6	44–79	—	—
31	,,	B.	2	34–53	—	—

SOLÆIFORMES.

SOLEIDÆ.

Solea vulgaris Quens. Common Sole.

Only one post-larva, 4·5 mm. in length, belonged to this species. This was taken in Haul 7, apparatus A, on 18th July, 1919. Post-larvæ of this species have never been taken in any numbers near Plymouth, and yet the adults are frequently trawled in the inner and outer Eddystone grounds and in the bays. The scarcity of the pelagic young is probably due, as also in the Plaice, to the maximum spawning period for Plymouth being in the earlier months of the year.

No early bottom stages were secured with the cotton trawl.

Solea variegata, Don. Thickback.

This is the species of the Genus Solea which occurs most frequently in the pelagic stage in the Plymouth area. The maximum number of post-larvæ has been recorded for May month, *vide* Allen (1917), who gives an average of 9·6 specimens per haul of 20 minutes for this month. The scarcity in numbers of the pelagic young during the autumn of 1919 is then easily explained. The records, however, prove that some adults spawn as late as July. The post-larvæ have been found chiefly in water of a total depth of over 20 fathoms.

Determination of the Post-larvæ.

The number of fin rays and vertebræ for this species has been given by the various authors, cf. Holt and Byrne (1905) as :—

D 63–77. A 52–61. Vertebræ 9(10)+30(31)(32).

Petersen (1909) recorded a range of 46–60 anal rays in 6 post-larvæ, but the smaller number is obviously due to the fact that the full number of rays was not developed. An examination was made of 21 adults, 171–195 mm. in length, which were secured in the outer Eddystone grounds on 12th November, 1919. These were all females. The numerical results are here summarized :—

Dorsal Fin Rays.

No. of Fin Rays	68	70	71	72	73	75	76	77	78
No. of Specimens	2	3	1	2	6	2	3	1	1

Anal Fin Rays.

No. of Fin Rays	52	53	54	55	56	57	58	59	60	61
No. of Specimens	1	3	1	3	2	3	2	2	3	1

Vertebræ.

No. of vertebræ	40	41	42
No. of specimens	6	10	5

The range in number of rays and vertebræ is for these specimens

D 68–78 (one more than the accepted number for this species)
A 52–61
Vertebræ 40–42.

The Plymouth post-larvæ, of which about 50 were stained and dehydrated, gave (with one exception) 10+30 vertebræ, the exception being 10+31.

The dorsal and anal rays showed, according to their development, a good deal of variation, but the number recorded in the larger specimens came well within the range noted above.

Petersen (1909) has described six post-larvæ, 6·9–18·3 mm., which undoubtedly belong to this species. Kyle (1913) seems to doubt Petersen's identification because of the absence of barred pigmentation, but this doubt can be ruled out, as this pigment character is wanting entirely in the pelagic young of this species, though it is present in the early bottom stages. Barred pigmentation is not a reliable index to specific identification. In *Solea lascaris,* for example, it is absent in the adult, but present in the pelagic young, *vide* Kyle (1913) and Clark (1914).

The striking feature of most of the Plymouth specimens is their comparatively greater breadth than Petersen's post-larvæ. They are more in agreement with Kyle's (1913) Mediterranean specimen. The protrusion of the abdomen is also characteristic of many but not all the post-larvæ.

There is no sign in any of the specimens of an air-bladder.

The post-larvæ range from 4 to 12·3 mm.

The Thickback is put on the market at Plymouth, but, owing chiefly to its small size, the fishery is not of great economic value. The adult occurs commonly on the inner and outer Eddystone grounds, but is trawled more frequently in the latter locality.

DESCRIPTION OF POST-LARVÆ.

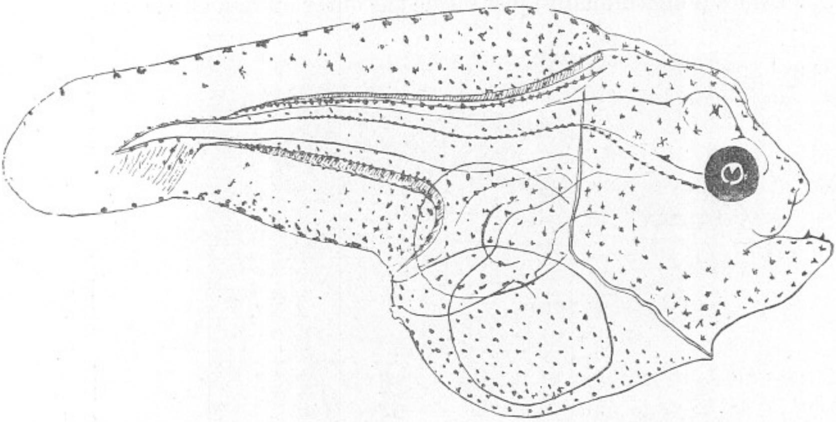

FIG. 8.—*Solea variegata.* Length 4 mm. Haul 10, Apparatus A, 19th May, 1914. Del. E. FORD.

4 mm.—This is the smallest post-larva in the collection. It follows on Cunningham's 2·52 mm. larva (1896), with the two longitudinal rows of large black stellate chromatophores along the dorsal and anal fin membranes. The eyes are perfectly symmetrical and about equal to the snout length, which is contained about $4\frac{1}{2}$ times in the length of the head. The length of the head is about $\frac{1}{3}$ of the total length (including caudal). The anus is slightly nearer to the caudal than to the tip of the snout. The depth of the body is considerable, about half the total length. The pectorals are pedunculated and do not quite reach to the anus. The mid-brain is well arched and follows the dorsal contour of the head. Fin rays are not developed : interspines are just indicated. The notochord is straight. The pigmentation is characteristic. Five longitudinal

rows dominate—one each on the margins of the dorsal and anal fin membranes, one each on the proximal ends of the dorsal and anal interspines and one along the dorsal half of the notochord. The rows along the dorsal interspines and on the notochord extend on to the head. These consist of stellate chromatophores which are slightly larger than the pigment cells which are scattered over the greater part of the head and body. The number of chromatophores along the proximal ends of the interspines is much greater than in the other three species of Soles which occur at Plymouth, but it is difficult to count them accurately as the pigment cells appear to be drawn out longitudinally and to merge into each other. The pigment cells of the body appear, according to condition, as small stellate chromatophores or as small dots. They occur sparingly on the sub-orbital region, on the dorsal and anal fin membranes posteriorly and on the caudal. The colouration of the pectorals is confined to a ring of small black lines (longitudinally) just inside the outer margin of the fin.

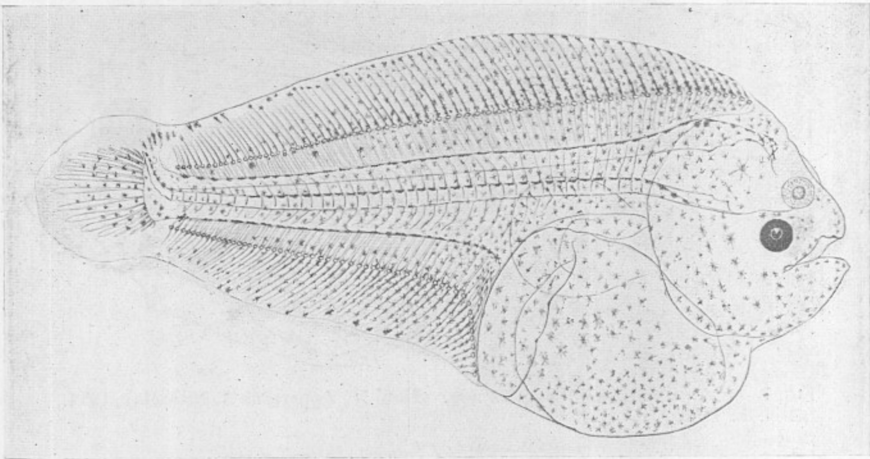

FIG. 4.—*Solea variegata*. Length 9 mm. Haul 13, Apparatus A, 22nd May, 1914. Del. E. FORD.

9 mm.—Tip of snout to anus 4 mm. Greatest depth of fish (including dorsal fin) 4·25 mm. Head four times in total length (including caudal). Diameter of eye less than length of snout, which is contained about four times in length of head. Pectorals reach to vertical through anus. They are pedunculated, rounded and about equally developed on both sides.

Fin Formula.—D ca. 69. A ca. 55. Vertebræ 10+30.

The scheme of pigmentation is much the same as in the smaller specimen, but the rows of large chromatophores along the dorsal and anal fin margins are much subdued. The interspines are now well developed, but the fin rays are still short of their full length. The dorsal fin has extended on to the head. The left eye has moved forward and upward, but is still below the dorsal ridge. The notochord is bent upward. The pelvic fin has not yet appeared.

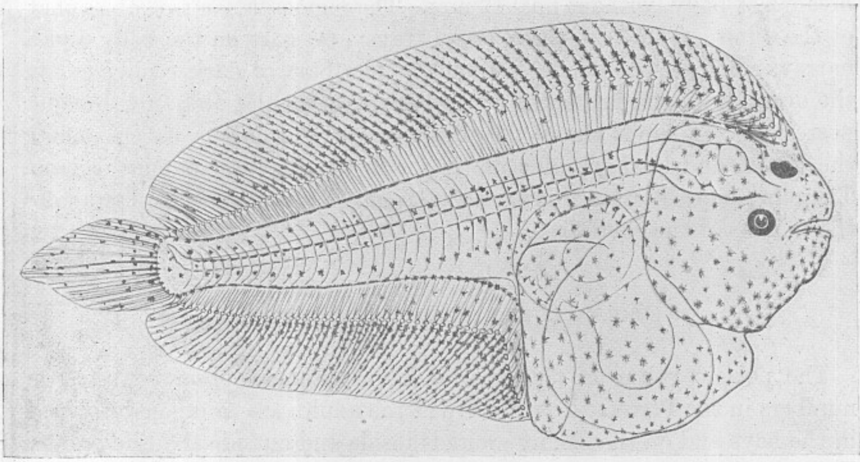

FIG. 5.—*Solea variegata.* Length 12·3 mm. Haul 14, Apparatus A, 25th May, 1914. Del. E. FORD.

12·3 mm.—Tip of snout to anus ca. 4·875 mm. Greatest depth of body (excluding dorsal fin) ca. 5 mm. Head about four times in total length (including caudal). Pectorals reach slightly beyond the vertical through the anus. The left eye has migrated round to the right side and the notch has closed up. The dorsal fin has moved forward, the first ray being vertically over the middle of the left (migrating) eye. The first interspine is roughly parallel to the outline of the brain and to it is attached the succeeding ray.

Fin Formula.—D 71. A 57. Vertebræ 10+30.

No permanent rays are as yet developed in the pectorals, while the pelvics are just indicated. Metamorphosis is still far from being completed. The pigmentation is much the same as in the younger specimens. The two rows along the margins of the dorsal and anal fins have disappeared. The dorsal and anal fins are well covered along the rays with stellate chromatophores. The sub-orbital region is sparsely pigmented, as also are the interspinous regions, except for a short distance anteriorly, and on the middle of the body over the vertebral region. In all the specimens the pigment, as Petersen has remarked, is "distinctly scattered."

The smallest adolescent stage with typical adult characters is a specimen of 42·5 mm. (measured on a formalin specimen) which was captured at a depth of 29 fathoms, Eddystone bearing, S.W. 3 miles, on 5th March, 1914, in a small meshed pocket attached to the cod-end of the *Oithona's* otter trawl. The shape resembles Petersen's 18·3 mm. post-larva. The head measures 9·5 mm., tip of snout to anus 8 mm. and the greatest breadth of body (without fins) 12 mm. The pigmentation resembles that of the adult. There are three broad transverse bars on the body and a narrower one on the caudal peduncle. The bars of darker pigment on the dorsal and anal fins occur at regular intervals and are much broader posteriorly. There is almost a continuous series of darker blotches along the dorsal and anal margins of the body on the interspinous regions. There is a suggestion in this formalin specimen of a transverse bar across the middle of the caudal.

Solea lutea (Risso). Solenette.

The pelagic young of this species have not been observed in large numbers in the Plymouth area, though the adults are commonly trawled in the bays and on the fishing grounds inside and outside the Eddystone. Two post-larvæ, 5–6 mm. in length, were taken in July, 1919, between Rame Head and the Eddystone. The cotton trawl C captured 8 adults, 60–123 mm., in the shallower waters of Cawsand and Whitsand Bays and in deeper water between Rame Head and Eddystone.

The smallest early bottom stages observed by the writer were 3 specimens, 19·5–22·5 mm. Two of these—19·5 and 21·5 mm.—were secured from a depth of 7½ fathoms in a Mosquito tow net attached to one of the otter trawl boards in Whitsand Bay on 12th August, 1913, while the third specimen, 22·5 mm., was brought up in the " D " net from a depth of 27 fathoms in locality 3½ miles W.S.W. from Rame Head on 2nd September, 1913.

The numerical characters were the following :—

D 71–77. A 54–63. Vertebræ 9+29.

These specimens are similarly pigmented to the Mediterranean specimens, described by Kyle (1913). There are 9 to 10 large black blotches longitudinally along the dorsal and 5 to 6 along the anal interspinous regions. There are also 5 broad spots, equally spaced, along the vertebral column, the first at the edge of the operculum, the last on the penultimate vertebra. Lines of pigment are distributed along the rays of the dorsal and anal fins at fairly regular intervals, but there is only a suggestion of these occurring alternately at the base and at the tip.

Solea lascaris. Risso.

Only four post-larvæ, 8·5–13 mm. in length, were attributable to this species and these were taken at the end of September. Previous records are for July, August and September, but the production of the young in the neighbourhood is small. These four pelagic young fish were taken close inshore at the western entrance to the Sound. The species has a shallow water distribution.

The smallest early bottom stage is a specimen of 22·5 mm. measured on 30th October, 1919. This was reared in the aquarium from a length of about 12 mm., having been captured at that length in Haul 30, Apparatus C, 19th September, 1919, in locality Rame Head bearing E. by S., 3 miles. There is thus a growth of 10·5 mm. in about four weeks.

On staining and clearing, the specimen gave quite definitely the following numerical characters :—

D 84. A 69. Vertebræ 9 + 37.

The specimen has completed its metamorphosis, as proved by the forward movement of the dorsal fin on to the snout, and by the permanent rays being developed in the pectorals. The length of the head is contained about four times in the total length (including caudal) : the greatest depth of the body (without fins) slightly less than three times. The pectorals are small, that of the left (blind) side being the smaller. The tumid nostril of the blind side is oval, rosette shaped, and large, being equal to about $\frac{3}{8}$ of the longitudinal diameter of the eye.

The pigmentation resembles that of the adult. The right (eyed) side is a felted mass of small black spots or stellate chromatophores with here and there an aggregation of large black stellate chromatophores. The barred pigmentation so characteristic of the post-larvæ has entirely disappeared. The blind side still supports a few large stellate chromatophores, but these are not prominent. Scales are developed all over the body and have one or more spines—the majority still being one-spined. Teeth are very well developed on the left (blind) side. This young fish follows on the metamorphosed specimen of 11·25 mm., described and figured (Fig. 11) on page 371, Vol. X, No. 2, of this Journal.

Solea sp.

	S. vulgaris.	*S. variegata.*	*S. lutea.*	*S. lascaris.*
Spawning Period :	ii–vi	ii–vii.	iii–vii.	vi–viii.

TABLE XXVII.

Apparatus A and B.

Record of Solea sp.

No. of Haul.	Date.	Depth.	*S. vulgaris.* No.	*S. vulgaris.* Size in mm.	*S. variegata.* No.	*S. variegata.* Size in mm.	*S. lutea.* No.	*S. lutea.* Size in mm.	*S. lascaris.* No.	*S. lascaris.* Size in mm.
7	18.vii.19	M.–B.	1	4.5	—	—	—	—	—	—
8	,,	M.–B.	—	—	—	—	1	6	—	—
9	,,	M.–B.	—	—	2	4–5	—	—	—	—
11	21.vii.19	B.	—	—	2	5–7·5	1	5	—	—
12	,,	B.	—	—	1	8	—	—	—	—
25	29.vii.19	B.	—	—	4	5–9	—	—	—	—
26	,,	B.	—	—	1	7	—	—	—	—
31	1.viii.19	B.	—	—	1	8	—	—	—	—
32	,,	S.	—	—	1	6	—	—	—	—
37	5.viii.19	B.	—	—	1	5	—	—	—	—
78	25.ix.19	B.	—	—	—	—	—	—	1	9·2
80	,,	M.–B.	—	—	—	—	—	—	3	8·5–13

TABLE XXVIII.

APPARATUS C.

RECORD OF SOLEA sp.

No. of Haul.	Date.	Depth.	*S. lutea.* No.	*S. lutea.* Size in mm.	*S. lascaris.* No.	*S. lascaris.* Size in mm.
27	23.ix.19	B.	1	85	—	—
28	29.ix.19	B.	1	60	—	—
30	,,	B.	5	60–97	1	12
31	,,	B.	1	123	—	—

PERCOMORPHI.

PERCOIDEI.

SERRANIDÆ.

SERRANUS CABRILLA L. SEA-PERCH.

In Vol. X, No. 2, of this Journal published in June, 1914, a footnote on page 392 recorded the identification of the young stages of this species, but descriptions and figures were not given as the series was far from being complete and many of the specimens were badly damaged. Meantime, however, Fage (1918) has given us excellent figures and descriptions of the young stages, ranging in length from 5–24 mm. These were all captured in the Mediterranean, but two post-larvæ, 9–11 mm., were taken in the English Channel off Cherbourg. The Channel specimens differ slightly in the arrangement of their pigmentation from those of the Mediterranean.

The production of the young in the Plymouth area is small. The post-larvæ were taken only in August and September, and these were scattered over the whole of the area outside the twenty-fathom contour line. Fage's description of a 5 mm. fish holds good for those of 4 mm. occurring in the present collection. There is no trace of the first dorsal fin, and it is not till almost 5·5 mm. that a definite "thickening" appears at its base. Fig. 6 illustrates the point in question. At about 6 mm. the third spine of the first dorsal fin becomes elongated as in Fig. 7, but it is an extremely delicate structure. In the later stages up to 9 mm. the third spine becomes stouter and longer, being equal in length almost to the pelvics. The fin formula and number of vertebræ could only be counted with certainty in the larger post-larvæ from 8–9 mm. and upwards, an observation which Fage has already noted.

D X 14. A III 7. Vertebræ 10 + 14.

The spinous and rayed sections of the dorsal and anal fins are continuous as in the adult. The spine of the pelvic fin is just indicated;

the second ray is the longest and is slightly longer than the third spine of the first dorsal. The pigmentation is peculiarly variable, a character which has been already noted for Channel post-larvæ and for the very early young, *vide* Hefford (1906), Fage (1918). The normal pigmentation appears to be as in Fig. 7. The variations in pigment are :—

1. Absence or reduction of large dorsal chromatophore with presence of large anal chromatophore.

2. Absence or reduction of large anal chromatophore with presence of large dorsal chromatophore.

3. Small chromatophores occasionally continuous along the base of the anal fin.

4. Single large black chromatophores occasionally present in the younger stages, at the beginning of the dorsal fin membrane and halfway along this membrane between the origin of the fin and the large dorsal chromatophore. The dorsal and posterior half of the abdominal cavity is always densely pigmented.

Spawning : vii–viii.

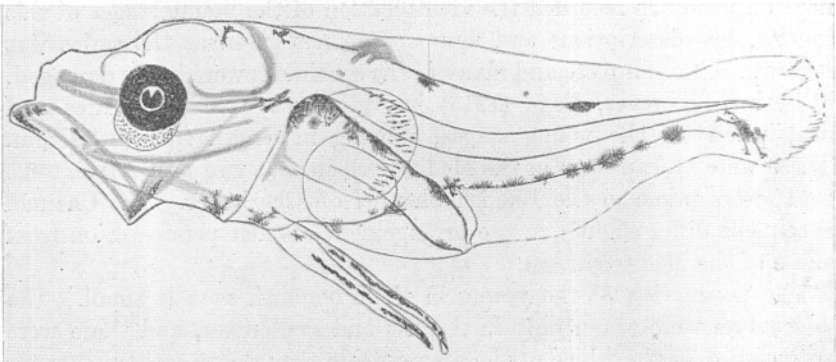

FIG. 6.—*Serranus cabrilla* L. Length 5·5 mm. Haul 179A, Apparatus A, 29th September, 1913. Del. E. FORD.

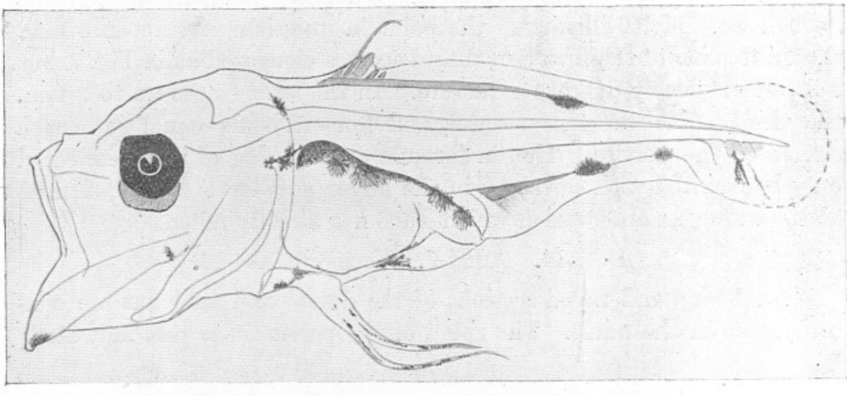

FIG. 7.—*Serranus cabrilla* L. Length ca. 6 mm. Haul 105A, Apparatus A, 29th August, 1913. Del. E. FORD.

These two figures illustrate the growth of the dorsal and anal fins. At 5·5 mm. the first dorsal is indicated by a thickening of the base—the second dorsal and anal have not made their appearance. At 6 mm. the filiform spine of the first dorsal has grown out, while at the same time the base of the anal and second dorsal are beginning to show up. The filiform ray is extremely delicate.

There is nothing new to add to Fage's (1919) excellent descriptions of a complete series. The balancing organs are the elongated pelvics and first dorsal and the well-developed pectorals. The variation in pigment—already remarked for Channel specimens—is well shown in Figs. 6 and 7.

TABLE XXIX.

Apparatus A and B.

Record of Serranus cabrilla.

No. of haul.	Date.	Depth.	No.	Size in mm.
62	9.ix.19	S.	3	7–8
64	,,	B.	1	6·5
65	,,	S.	1	9
66	,,	B.	1	8
67	10.ix.19	S.	3	8–9
70	17.ix.19	B.	1	7·5
72	,,	B.	1	7

TABLE XXX.

Apparatus A.

Record of Serranus cabrilla 1913.

No. of haul.	Date.	Depth.	No.	Size in mm.
57 A	2.viii.13	M.	1	6
99 ,,	26.viii.13	M.	8	4–6
105 ,,	29.viii.13	M.	6	4–6·5
119 ,,	5.ix.13	M.	1	5
142 ,,	15.ix.13	B.	1	5·25
145 ,,	,,	M.	1	4·5
155 ,,	20.ix.13	B.	1	5·5
156 ,,	,,	M.	3	5·5–6·5
171 ,,	26.ix.13	M.	1	5
172 ,,	,,	M.	1	6·5
174 ,,	,,	B.	3	5–7
176 ,,	,,	B.	1	5
177 ,,	,,	S.	2	5–5·5
179 ,,	29.ix.13	B.	1	6·5
180 ,,	30.ix.13	M.	1	4·5

PERCOIDEI.

CARANGIDÆ.

CARANX (TRACHURUS) TRACHURUS (L). SCAD OR HORSE MACKEREL.

The distribution of the post-larval Scads is general over the whole of the area investigated. The adolescent stages from 35 to 65 mm. occurred in very shallow water close inshore in Cawsand Bay and Whitsand Bay East, though young fish of the same size were also captured between Rame Head, Eddystone and the 40-fathom line. The average number per haul of the young fish trawls A and B was 2 for July, 6·8 for August and 1·8 for September.

The number of young stages taken during the three months in 1919 totalled 308—a number far in excess of any previous year, and even surpassing the total number for all the previous years, 1906–1914, when only 99 specimens were secured. This increase in numbers during 1919 may be explained by the more systematic collecting with different meshed nets, but there is also a suggestion that the species varies in abundance in different years.

Spawning Period: vi–viii.

TABLE XXXI.

APPARATUS A AND B.

RECORD OF CARANX TRACHURUS.

No. of haul.	Date.	Depth.	No.	Size in mm.
9	18.vii.19	M.–B.	2	5·5–6·5
12	21.vii.19	B.	4	4–8
20	29.vii.19	B.	1	14
22	,,	M.	1	4
24	,,	B.	26	3·5–7
25	,,	B.	12	4–6
26	,,	B.	11	6–8
28	31.vii.19	B.	5	6·5–9
30	1.viii.19	B.	1	4·5
32	,,	S.	2	6–8
34	5.viii.19	B.	4	5–6
35	,,	B.	22	5–6
36	,,	S.	1	6
37	,,	B.	49	3–6
38	,,	M.	20	4–6
39	,,	B.	23	4–6
42	7.viii.19	B.	1	6·5

No. of haul.	Date.	Depth.	No.	Size in mm.
44	8.viii.19	M.–B.	21	4–6
45	,,	M.	2	7
47	,,	B.	16	4–6
48	11.viii.19	B.	11	4·5–7
49	,,	B.	3	3–5
54	13.viii.19	M.	8	4–9
56	15.viii.19	B.	16	6–9
57	1.ix.19	B.	7	5–10
58	,,	B.	2	6–7
59	3.ix.19	S.	2	14–24
60	,,	B.	6	4·5–25
62	9.ix.19	S.	2	8–11
64	,,	B.	1	8
65	,,	S.	2	
66	,,	B.	4	
67	10.ix.19	S.	4	8–14
68	,,	M.	3	8–11
70	17.ix.19	B.	1	10
71	,,	B.	1	35
72	,,	B.	4	11·5–16
73	,,	B.	1	19
74	19.ix.19	B.	3	33–60
80	25.ix.19	M.–B.	3	45–50

TABLE XXXII.

APPARATUS C.

RECORD OF CARANX TRACHURUS

No. of haul.	Date.	Depth.	No.	Size in mm.
7	8.ix.19	S.	1	19
22	16.ix.19	B.	3	ca. 35
24	18.ix.19	B.	4	35–65
25	,,	B.	6	40–55
27	23.ix.19	B.	3	45–50

PERCOIDEI.

MULLIDÆ.

MULLUS SURMULETUS L. RED MULLET.

There are no records of the pelagic young stages of this species in the young fish trawls A and B for 1919, but a few adolescent stages 58–60 mm.

in length were captured by the cotton trawl C in Whitsand Bay. The shrimp trawl also secured one of 51 mm. in Cawsand Bay on 30th September, 1919. The average number per half-hour is one specimen, so that one may conclude that the young are not by any means numerous in the Plymouth area. The adults are now rarely captured in the neighbourhood, though the shore seine fishermen state that they were quite frequent a few years ago. Early young stages from 4·5 to 7·7 mm. have been recorded by the writer for the years 1906–1913, in June, July and August, none being recorded for 1914.

Spawning Period : v–vii.

TABLE XXXIII.

APPARATUS C.

RECORD OF MULLUS SURMULETUS L.

No. of haul.	Date.	Depth.	No.	Size in mm.
20	16.ix.19	B.	1	58
22	,,	B.	1	60
12	,,	B.	2	ca. 60
26	23.ix.19	B.	1	60

AMMODYTIDÆ.

AMMODYTES TOBIANUS L. LESSER SAND-EEL.
,, LANCEOLATUS, Lesauv. GREATER SAND-EEL.

The material contains examples of these two species, and the characters by which they have been determined appear as a separate publication by Mr. E. Ford in the same volume of this Journal.

The spawning period for each species is still problematical, no examination having been made of the sexual condition of the adult nor have the demersal eggs been secured. Lebour (1917) gives the following records for post-larvæ of *A. tobianus* from tow-nettings in the Sound :—

Month.	No. of specimens.	Size in mm.
January . . .	19	4–6
February . .	16	3–6
March . . .	69	4–9
April . . .	1	21
May . . .	24	4–19
June . . .	2	5–14
November . .	2	4–5

These suggest a winter and spring spawning with a probable maximum in spring, and also an extension to the warmer months. That some individuals spawn in the summer months is proved by the 1919 records

Post-larvæ of *A. lanceolatus* appear in greatest numbers in summer and early autumn, the months of greatest frequency being July and August. The pelagic young of both species are distributed generally over the whole area, both frequently occurring in the same haul. *A. tobianus* shows a greater frequency in inshore hauls, *A. lanceolatus* in offshore.

The average number of young fish per haul of the trawls A and B is as follows :—

	July.	August.	September.
A. tobianus . .	0·5	0·4	3·6
A. lanceolatus . .	11·4	8·2	0·64

The September average of *A. tobianus* is due to the capture of early bottom stages. The small average for July and August for the same species and their absence from the pelagic hauls in September indicates that the main spawning is finished and that only a few individuals spawn during the summer.

The early bottom stages of *A. lanceolatus* were not secured with the cotton trawl, but 94 adolescent stages of *A. tobianus*, 110–140 mm. in length, were taken in Whitsand Bay on sandy bottom at a depth of 4 to 6 fathoms.

	A. tobianus.	*A. lanceolatus.*
Spawning Period :	(?) xii.–viii.	vi.–viii.

TABLE XXXIV.

Apparatus A and B.

Record of Ammodytes sp.

			A. tobianus.		*A. lanceolatus.*	
No. of haul.	Date.	Depth.	No.	Size in mm.	No.	Size in mm.
2	7.vii.19	B.	1	13	7	6·5–21
3	9.vii.19	M.	—	—	5	14–19
4	10.vii.19	B.	—	—	2	16–20
5	11.vii.19	B.	1	16	—	—
6	18.vii.19	M.–B.	1	8·5	5	9–23
7	,,	M.–B.	1	10	15	10–18
8	,,	M.–B.	—	—	3	12–14
9	,,	M.–B.	—	—	32	8–13
10	21.vii.19	B.	—	—	8	9–18
11	,,	B.	—	—	54	7–23
12	,,	B.	—	—	20	5·5–19
13	,,	B.	—	—	46	9–19
14	24.vii.19	M.	—	—	3	15–17
15	,,	S.	5	8·5–11·5	2	6·5–21
16	,,	M.	1	10·5	6	10·5–18
17	28.vii.19	M.	1	9	—	—
18	,,	M.–B.	2	5–6	—	—
19	,,	M.	2	6–8·5	—	—

No. of haul.	Date.	Depth.	*A. tobianus.* No.	*A. tobianus.* Size in mm.	*A. lanceolatus.* No.	*A. lanceolatus.* Size iu mm.
20	29.vii.19	B.	1	18	—	—
21	,,	B.	—	—	1	11
22	,,	M.	—	—	10	7–27
23	,,	S.	—	—	1	9
24	,,	B.	—	—	25	8–22
25	,,	B.	1	6	38	7–19
26	,,	B.	—	—	36	7·5–24
27	31.vii.19	S.	—	—	1	12
28	,,	B.	—	—	22	10–19
29	1.viii.19	B.	1	6·5	—	—
30	,,	B.	—	—	3	7·5–29
31	,,	B.	—	—	8	10–18
32	,,	S.	1	12	1	13
33	5.viii.19	M.	—	—	1	14
34	,,	B.	—	—	53	8–14
35	,,	B.	—	—	17	7–13
37	,,	B.	—	—	21	8–16
38	,,	M.	—	—	12	7·5–18
39	,,	B.	—	—	31	7–21
40	7.viii.19	S.	1	9	—	—
41	,,	M.	4	6·5–10·5	2	9–18
42	,,	B.	1	7	1	14
43	,,	B.	—	—	3	19–20
44	8.viii.19	M.–B.	—	—	15	9–18
45	,,	M.	—	—	9	10–18
46	,,	S.	—	—	4	14–19
47	,,	B.	—	—	13	7·5–16
48	11.viii.19	B.	—	—	4	8–16
51	13.viii.19	M.	1	9·5	1	25
52	,,	M.	—	—	2	5–14·5
53	,,	M.	3	6–8·5	—	—
55	14.viii.19	B.	—	—	2	22–24
56	15.viii.19	B.	—	—	37	12–28
57	1.ix.19	B.	—	—	4	12–21
58	,,	B.	—	—	1	22
59	3.ix.19	S.	1	9	—	—
60	,,	M.	—	—	2	14–18
63	9.ix.19	M.	—	—	2	15–34
64	,,	B.	—	—	4	11–25
66	,,	B.	—	—	3	12–16
74	19.ix.19	B.	83	110–120	—	—
75	,,	B.	6	115–140	—	—

TABLE XXXV.

APPARATUS C.

RECORD OF AMMODYTES.

No. of Haul.	Date.	Depth.	*A tobianus.* No.	*A tobianus.* Size in mm.	*A lanceolatus.* No.	*A lanceolatus.* Size in mm.
6	3.ix.19	B.	—	—	2	11–15
22	16.ix.19	B.	4	110–120	—	—
24	18.ix.19	B.	1	120	—	—

CEPOLIDÆ.

CEPOLA RUBESCENS L. RED BAND FISH.

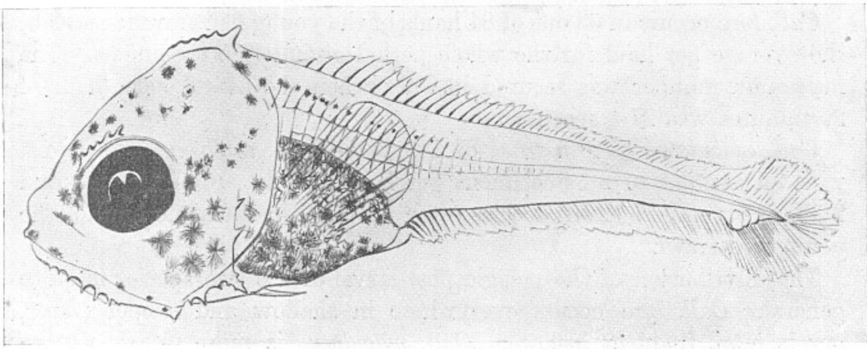

FIG. 8.—*Cepola rubescens* L. Length 7 mm. Haul 62, Apparatus B, September 9th, 1919. Del. E. FORD.

A single post-larva of 7 mm. belonging to this species was taken in Haul 62 (Surface) on 9th September, 1919, over a total depth of 41 fathoms. The capture is interesting as being the first young stage which has been recorded from Plymouth waters. Fage (1918) gives several records of post-larvæ from 4·5 to 10 mm. in length which were captured in the Mediterranean from July to September, and figures one of 6 mm., while Lo Bianco (1909) gives interesting notes on the later post-larvæ, which take on the rose red colour at 20 mm.

The Plymouth post-larva shows the characteristic denticulated supra-occipital and supra-orbitals. The lower surface of the mandible and the posterior and lower margins of the præopercula are also armed with spines. The head is broad and high. The specimen was stained and mounted and the fin rays were found as yet to be undeveloped, while only the first few vertebræ were calcified.

The adult is not uncommon in the vicinity of Plymouth and occurs in the captures of the otter trawls which are operated from small motor boats. A few adults, 385–505 mm., were caught in January, 1920, in Whitsand Bay by Looe boats. In these the reproductive organs were very minute.

Spawning Period : viii.

CALLIONYMIDÆ.

CALLIONYMUS LYRA (L.) DRAGONET.
,, MACULATUS (Rafin.) SPOTTED DRAGONET.

Two species are represented in the 1919 material, of which *Call. lyra* is much the commoner. Fage (1918) gives an excellent account of the young stages and a key for the identification of the species.

Call. lyra occurs in 53 out of 84 hauls of the young fish trawls A and B, the average per haul for the whole period giving 11·5 specimens. The maximum number was secured in July when the average per haul of 20 minutes was 27·4 specimens.

Call. maculatus gave a total of 149 post-larvæ, secured in 20 hauls, with an average of 2·1 specimens per haul in July, 0·7 in August and 2·5 for September. Both species often occurred in the same haul of the young fish trawl.

The distribution of the pelagic post-larvæ of the two species is quite general. *Call. lyra* occurs everywhere in shallow and deeper water, but is more frequent inshore. *Call. maculatus* is more in accordance with a deeper water form, and most of the records are over greater depths.

The spawning period for the two species differs considerably. *Call. lyra* is spread over the first 8 months of the year, while *Call. maculatus* spawns only in the warmer months.

Young adult stages of both species were taken with the cotton trawl C. Here again *Call. lyra* occurs more frequently and practically everywhere, but more abundant close inshore in the bays. Only a few specimens of *Call. maculatus* were secured and all these were in deeper water.

	C. lyra.	*C. maculatus.*
Spawning Period :	i–viii.	vi–viii.

TABLE XXXVI.

Apparatus A and B.

Record of Callionymus sp.

No. of Haul.	Date.	Depth.	*C. lyra.* No.	*C. lyra.* Size in mm.	*C. maculatus.* No.	*C. maculatus.* Size in mm.
1	3.vii.19	B.	2	4	—	—
2	7.vii.19	B.	2	5–6	—	—
3	9.vii.19	M.	3	5–6	—	—
4	10.vii.19	B.	22	3–9	—	—
6	18.vii.19	M.–B.	25	3–8	—	—
7	,,	M.–B.	8	4·5–7·5	—	—
8	,,	M.–B.	32	3–8·5	—	—
9	,,	M.–B.	201	4–7	—	—
11	21.vii.19	B.	27	3–9·5	—	—
12	,,	B.	28	3–8	—	—
13	,,	B.	1	3·5	—	—
14	24.vii.19	M.	80	3–9	—	—
15	,,	S.	21	3–8	—	—
16	,,	M.	71	3·5–8	—	—
17	28.vii.19	M.	24	4–10	—	—
18	,,	M.–B.	19	3–9	—	—
19	,,	M.	18	4·5–8	—	—
21	29.vii.19	B.	1	3	—	—
22	,,	M.	3	5–7	—	—
23	,,	S.	4	4–6	—	—
24	,,	B.	24	4–8	—	—
25	,,	B.	6	3–5	—	—
26	,,	B.	66	4–11	7	5–10
27	31.vii.19	S.	1	3·5	—	—
28	,,	B.	135	4–10	58	3·5–9
29	1.viii.19	B.	28	4–8	—	—
30	,,	B.	4	6–7	6	4–6
31	,,	B.	15	4·5–9	—	—
32	,,	B.	4	5–7	—	—
33	5.viii.19	M.	1	5	—	—
34	,,	B.	8	4–6	—	—
35	,,	B.	7	3–6·5	1	6
37	,,	B.	11	2·5–7	2	6–7
38	,,	M.	6	4–6	—	—
39	,,	B.	11	3·5–8	—	—
41	7.viii.19	M.	2	5·5–7	—	—

No. of Haul.	Date.	Depth.	C. lyra. No.	C. lyra. Size in mm.	C. maculatus. No.	C. maculatus. Size in mm.
43	7.viii.19	B.	12	4–7	—	—
44	8.viii.19	M.–B.	18	4–6	4	5–6
45	,,	M.	—	—	1	7
46	,,	S.	1	4·5	—	—
47	,,	B.	2	5–6	2	5–6·5
48	11.viii.19	B.	4	5–9	1	8
49	,,	B.	1	5	—	—
52	13.viii.19	M.	1	7·5	—	—
54	,,	M.	1	8·5	1	8
55	14.viii.19	B.	1	9·5	2	5·5–7
56	15.viii.19	B.	5	5–7	1	6
60	3.ix.19	M.	1	4	—	—
63	9.ix.19	M.	—	—	11	7–10
64	,,	B.	1	11	30	6–12
65	,,	S.	—	—	7	6–8
66	,,	B.	—	—	6	6–10
68	10.ix.19	M.	—	—	5	7–11·5
73	17.ix.19	B.	—	—	2	15–29
77	25.ix.19	B.	1	82	—	—
78	,,	B.	—	—	1	9
79	,,	M.–B.	—	—	1	9
81	29.ix.19	B.	1	138	—	—

TABLE XXXVII.

Apparatus C.

Record of Callionymus sp.

No. of Haul.	Date.	Depth.	C. lyra. No.	C. lyra. Size in mm.	C. maculatus. No.	C. maculatus. Size in mm.
4	25.viii.19	B.	36	33–67	—	—
5	26.viii.19	B.	4	45–68	—	—
6	3.ix.19	B.	1	170	—	—
18	12.ix.19	B.	6	35–140	5	70–120
21	16.ix.19	B.	7	50–82	—	—
22	,,	B.	8	40–82	—	—
23	,,	B.	26	42–85	—	—
24	18.ix.19	B.	30	40–85	—	—
26	23.ix.19	B.	30	46–145	—	—
27	,,	B.	318	45–140	—	—
28	29.ix.19	B.	1	76	—	—
30	,,	B.	9	35–255	3	82–98
31	,,	B.	1	81	1	100

LABRIDÆ.

LABRUS BERGYLTA Asc.
,, MIXTUS (L.)
CTENOLABRUS RUPESTRIS (L.)
CRENILABRUS MELOPS (L.)
CENTROLABRUS EXOLETUS L.

The five species of Wrasses show a considerable production of the young pelagic fry, nine specimens per haul for the three months in 1919. They occur most abundantly in July when the average per haul gives 18·7 specimens. Five species are represented in the collection, three of which seem to be imperfectly known in the younger pelagic stages, these being recorded here as Labrid types. A separate paper will be published shortly by one of us on the identification of the doubtful species. The later stages, however, where the adult characters are developed are easy to identify, and all five species occur in the cotton trawl collection. These later stages are developed in comparatively shallow water close inshore. They are abundant in the Zostera bed of Cawsand Bay.

Coris julis (L.) occurs in the adult stage in the neighbourhood, but its young stages have not been observed.

TABLE XXXVIII.

APPARATUS A AND B.

RECORD OF LABRIDÆ.

No. of Haul.	Date.	Depth.	*Labrus mixtus.* No.	Size in mm.	*Ctenolabrus rupestris.* No.	Size in mm.	*Labrid types.* No.	Size in mm.
1	3.vii.19	B.	5	10–11	—	—	7	6–7
2	7.vii.19	B.	—	—	1	10	19	5–8
3	9.vii.19	M.	—	—	—	—	1	5
6	18.vii.19	M.–B.	—	—	—	—	22	5–10
7	,,	M.–B.	4	7–9	—	—	27	4·5–9·5
8	,,	M.–B.	—	—	—	—	14	4·5–7
9	,,	M.–B.	3	8–9·5	1	8	2	4–5
10	21.vii.19	B.	—	—	—	—	1	4
11	,,	B.	—	—	—	—	7	4·5–8
12	,,	B.	1	9	—	—	11	5–7
13	,,	B.	7	8–12	3	10	3	6·5–8·5
14	24.vii.19	M.	4	9–10	—	—	190	5–8

No. of Haul.	Date.	Depth.	*Labrus mixtus.* No.	Size in mm.	*Ctenolabrus rupestris.* No.	z mm.	*Labrid types.* No.	Size in mm.
15	24.vii.19	S.	—	—	—	—	62	4–8
16	,,	M.	1	8	—	—	18	5·5–9
17	28.vii.19	M.	—	—	2	9–9·5	32	4·5–9
18	,,	M.–B.	—	—	2	7–8	39	4–8
19	,,	M.	—	—	—	—	28	4–7·5
20	29.vii.19	B.	—	—	—	—	12	5–8
21	,,	B.	—	—	1	8	9	4–7
22	,,	M.	—	—	3	7–9	5	4–6
23	,,	S.	—	—	1	8	—	—
24	,,	B.	—	—	2	7–8	—	—
25	,,	B.	—	—	1	7·5	—	—
26	,,	B.	—	—	8	7–9	—	—
28	31.vii.19	B.	1	6	3	9–10	1	8
29	1.viii.19	B.	—	—	—	—	35	4–7
30	,,	B.	—	—	—	—	6	4·7–7·5
31	,,	B.	—	—	6	8–9	—	—
32	,,	S.	—	—	2	7–9	1	6
33	5.viii.19	M.	—	—	—	—	8	5–7
34	,,	B.	—	—	—	—	1	5
35	,,	B.	—	—	—	—	2	5
39	,,	B.	—	—	2	6·5–7	5	4–6
40	7.viii.19	S.	—	—	—	—	4	7–7·5
41	,,	M.	—	—	—	—	50	4–9
42	,,	B.	—	—	—	—	19	4–8
43	,,	B.	—	—	1	9	16	4–9
44	8.viii.19	M.–B.	—	—	—	—	1	4
47	,,	B.	—	—	—	—	1	5
49	11.viii.19	B.	—	—	—	—	10	5–7
50	13.viii.19	M.	—	—	—	—	2	7–8
51	,,	M.	—	—	1	11	2	6·5–9
52	,,	M.	—	—	—	—	10	4·5–9
53	,,	M.	—	—	—	—	2	6–7·5
54	,,	M.	—	—	—	—	1	8
67	10.ix.19	S.	—	—	—	—	1	11
77	25.ix.19	B.	—	—	3	32–40	—	—

TABLE XXXIX.

Apparatus C.

Record of Labridæ.

No. of Haul.	Date.	Depth.	*Centrolabrus exoletus.* No.	Size in mm.	*Labrus mixtus.* No.	Size in mm.	*Labrus bergylta* No.	Size in mm.	*Ctenolabrus rupestris* No.	Size in mm.	*Crenilabrus melops.* No.	Size in mm.
4	25.viii.19	B.	—	–	2	39–44	2	30–37	25	30–39	14	25–38
5	26.viii.19	B.	2	28–37	2	36–37	2	27–37	8	29–37	2	22–23
27	23.ix.19	B.	—	—	—	—	—	—	2	35–43	5	43–59
29	29.ix.19	B.	—	—	—	—	—	—	1	98	—	—

TRACHINIDÆ.

TRACHINUS VIPERA, C. & V. Lesser Weever.
„ DRACO, L. Greater Weever.

The pelagic young of *Trachinus vipera* (Lesser Weever) are distributed generally over the whole of the area investigated. Out of 84 hauls this species occurred in 52, but with an average of only 3 fish per haul. The total number examined was 252 with a range in length from 3 to 11 mm. The maximum number (149) was in July, and the pelagic stages were still being got at the end of September.

Adolescent stages from 59 to 98 mm. were taken in shallow water with the cotton trawl C in Whitsand Bay. Several hundreds were captured with the shrimp trawl in the same locality in 4–6 fathoms, and were transferred alive to the aquarium tanks, where they seemed to come to rest on the bottom and to lie partly on their sides. Their habitat appears to be on sandy bottoms, where they can rest partly hidden in the sand.

Pelagic young of *Trachinus draco* (Greater Weever) occurred very sparingly and outside the 20-fathom line. Its distribution appears to be more in deeper water. The records extend from end of July to the middle of September when they disappear from the pelagic hauls, the largest post-larva being 12 mm. in length.

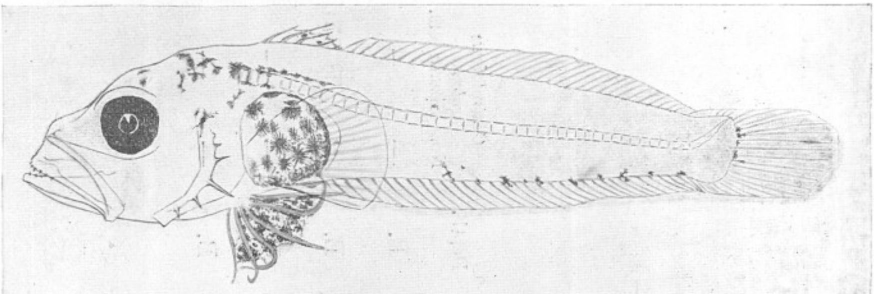

FIG. 9.—*Trachinus draco* L. Length 12 mm. Haul 65, Apparatus B, September 9th, 1919. Del. E. FORD.

The above figure is drawn from a stained and mounted specimen whose length in formalin was 12 mm. The præmaxillæ are shown protruded. The head is contained from $3\frac{1}{2}$ to $3\frac{3}{4}$ times in total length, the greatest depth about 5 times. The diameter of the eye is slightly less than the snout length. The numerical characters are :—

D VI 31.
A 32.
Vertebræ 11+31.

The first dorsal so far is not well defined—five of the spines can be counted quite definitely—the first three being close together and separated by a wider space from the fourth. The two dorsal fins are connected by a membrane. Another specimen of 11 mm. gives D VI 31 A 30. The vertebræ are definitely 42. Fage (1919), p. 122, gives similar numbers for a 9·5 mm. fish, but there is obviously a printer's error in the number of vertebræ, which should read 11+31.

The pigmentation is well shown in the above figure. Two black spots appear on the first dorsal. The abdominal region and the pelvic fins are densely pigmented with black stellate chromatophores. There is a row of chromatophores usually six or more along the base of the anal fin, while an aggregation of black chromatophores is present at the base of the mid-caudal rays.

	T. vipera.	*T. draco.*
Spawning Period :	iv–viii.	vi–viii.

TABLE XL.

Apparatus A and B.

Record of Trachinus sp.

No. of Haul.	Date.	Depth.	*Trachinus vipera* No.	*Trachinus vipera* Size in mm.	*Trachinus draco.* No.	*Trachinus draco.* Size in mm.
2	7.vii.19	B.	3	5–6	—	—
4	10.vii.19	B.	7	3–5	—	—
6	18.vii.19	M.–B.	7	4·5–6	—	—
7	,,	M.–B.	10	5–6	—	—
8	,,	M.–B.	13	4–10	—	—
9	,,	M.–B.	32	4–8	—	—
11	21.vii.19	B.	6	5–7	—	—
12	,,	B.	3	7–7·5	—	—
13	,,	B.	15	4·5–7	—	—
14	24.vii.19	M.	18	5–9	—	—
15	,,	S.	9	4·5–9·5	—	—
16	,,	M.	2	5·5–6·5	—	—
17	28.vii.19	M.	2	7–11	—	—

No. of Haul.	Date.	Depth.	*Trachinus vipera.* No.	Size in mm.	*Trachinus draco.* No.	Size in mm.
18	28.vii.19	M.–B.	3	6–9	—	—
19	,,	M.	4	6–9·5	—	—
21	29.vii.19	B.	2	4–5	1	5
22	,,	M.	2	4–6	—	—
23	,,	S.	1	8·5	—	—
24	,,	B.	4	5–7	—	—
25	,,	B.	4	5–6	—	—
26	,,	B.	2	4–6·5	—	—
29	1.viii.19	B.	2	6–7	—	—
30	,,	B.	1	5	—	—
32	,,	S.	3	5·5–7·5	—	—
33	5.viii.19	M.	3	5–7	—	—
34	,,	B.	7	4–7	1	6
35	,,	B.	4	4·5	1	4·5
37	,,	B.	2	5–6	—	—
39	,,	B.	8	4·5–7	—	—
40	7.viii.19	S.	7	4·5–8	—	—
41	,,	M.	3	4·5–7	—	—
42	,,	B.	2	4·5–6	1	6
43	,,	B.	2	5–7	—	—
44	8.viii.19	M.–B.	1	6	—	—
46	,,	S.	2	7	—	—
48	11.viii.19	B.	8	4–7	—	—
49	,,	B.	1	5	—	—
51	13.viii.19	M.	1	4·5	—	—
52	,,	M.	5	5·5–6	—	—
55	14.viii.19	B.	1	8	—	—
56	15.viii.19	B.	1	8·5	—	—
58	1.ix.19	B.	2	6–9	—	—
62	9.ix.19	S.	7	7–10	—	—
64	,,	B.	1	9	—	—
65	,,	S.	1	7	3	8–12
66	,,	B.	—	—	1	9
67	10.ix.19	S.	14	6–11	4	8–11
68	,,	M.	3	7·5–8	—	—
69	17.ix.19	B.	1	6	—	—
75	19.ix.19	M.	1	7	—	—
76	25.ix.19	B.	4	7–9	—	—
79	,,	M.–B.	2	9·5–10·5	—	—
80	,,	M.–B.	3	7–9·5	—	—

TABLE XLI.

Apparatus C.

Record of Trachinus vipera.

No. of Haul.	Date.	Depth.	*Trachinus vipera.* No.	Size in mm.
20	16.ix.19	B.	1	78
22	,,	B.	1	78
23	,,	B.	1	80
24	18.ix.19	B.	14	59–88
25	,,	B.	16	68–98

SCOMBROIDEI.

Scomber scomber L. Mackerel.

The early young of the Mackerel were moderately plentiful during the autumn of 1919. One hundred and seventy-eight post-larvæ from 5 to 13·5 mm. occurred in 30 hauls of the trawls A and B during July and the first half of August. No post-larvæ were taken after August 13th and no adolescent stages were found, though a special search was made for these forms both in the shallower water of the bays and in the deeper waters in midchannel. Dr. Allen (1917) recorded a similar number of post-larvæ for the year 1914, and these were taken chiefly in May and June. The largest post-larva was 16 mm., and was secured in July. There are few post-larvæ over 12 mm. in length in the collections for these two years, and this is evidently about the average length at which they disappear near Plymouth. The pectoral and caudal fins are strongly developed at an early age, the young fish soon become active swimmers and apparently are able to avoid capture. It seems highly probable that the young gather in shoals, well offshore and return to the bays for feeding purposes the following year.

The spawning period of the Mackerel occurs from May to July at Plymouth. There are no records of spawning earlier than May month, though a later spawning has been observed for some years, *vide* Lebour (1918) for the record of post-larvæ in September, 1917. The young fish from 10 to 11·5 mm. secured at the end of May, 1914, were thus probably only about three weeks old. As the length of the newly hatched larva is about 3·5 mm. this would give a growth of 6·5 to 8 mm. in three weeks. The slightly larger fish from 43 to 50 mm. (tip of snout to tip of caudal lobes) have seldom been captured, but several were taken by Mr. G. T. Atkinson at this length in latitude 56° 20′ N. and longitude 2° 23′ W. on August 13th, 1913. These were secured at the surface at night time. In assuming the spawning period for the North Sea to be from May to August, these fish would at most be three months old. The writer, while engaged in naval duties, secured several specimens, 128 to 157 mm. (tip of snout to tip of caudal), in October, 1918, from the stomachs of Haddock and Whiting which were trawled a few miles off the River Tyne. These October specimens (128–157 mm.) when ranged alongside the August specimens (43–50 mm.) would appear to be fourteen months old, as it seems highly improbable that a 40 mm. fish would increase to 120 mm. in two months. This estimation of the rate of growth of the Mackerel would thus work out at an average of about 10 mm. a month—a figure which agrees well with the rate of growth estimated above for the Plymouth post-larvæ (cf. Allen, 1897, Ehrenbaum, 1912, and Nilson, 1914).

Spawning Period : v–viii.

TABLE XLII.

Apparatus A and B.

Record of Scomber scomber.

No. of specimens at each length.

No. of Haul.	Date.	Depth.	Length in mm. 5	5·5	6	6·5	7	7·5	8	8·5	9	9·5	10	10·5	11	11·5	12	12·5	13	13·5
2	7.vii.19	B.	—	—	—	—	1	—	—	—	—	1	—	—	—	—	—	—	—	—
3	9.vii.19	M.	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
4	10.vii.19	B.	5	2	4	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7	18.vii.19	M.–B.	—	—	—	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—
8	,,	M.–B.	—	1	—	2	1	—	1	1	2	1	1	—	—	—	—	—	—	—
9	,,	M.–B.	—	—	—	9	1	—	1	1	—	—	—	—	—	—	—	—	—	—
10	21.vii.19	B.	—	—	—	—	—	—	—	2	1	—	—	—	—	—	—	—	—	—
11	,,	B.	—	—	—	—	—	1	2	1	—	—	—	—	1	—	—	—	—	—
12	,,	B.	—	—	—	—	2	1	3	2	2	4	—	1	1	—	—	—	—	—
13	,,	B.	—	—	—	—	—	—	1	1	—	1	—	1	—	—	—	—	—	—
14	24.vii.19	M.	—	—	—	—	—	2	2	6	3	1	1	3	2	—	1	—	—	—
15	,,	S.	—	—	—	—	—	—	—	2	—	—	1	1	—	—	—	—	—	—
21	29.vii.19	B.	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
22	,,	M.	—	—	—	2	4	2	—	—	—	—	1	—	—	—	—	—	—	—
23	,,	S.	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
24	,,	B.	—	—	—	2	1	—	1	—	—	—	—	—	—	—	—	—	—	—
25	,,	B.	—	—	2	1	2	—	—	—	—	1	—	—	—	—	—	—	—	—
26	,,	B.	—	—	1	1	2	2	1	—	—	1	—	—	—	1	—	—	—	—
28	31.vii.19	B.	—	—	—	—	—	—	—	2	—	1	—	—	—	—	—	—	—	—
29	1.viii.19	B.	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
31	,,	B.	—	—	—	—	1	2	1	—	—	2	1	1	1	—	—	—	—	—
32	,,	S.	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
34	5.viii.19	B.	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
35	,,	B.	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
37	,,	B.	—	—	—	—	1	1	—	—	1	—	—	—	—	—	—	—	—	—
38	,,	M.	—	—	—	—	1	1	—	—	1	—	—	—	—	—	—	—	—	—
39	,,	B.	1	4	1	2	—	2	3	2	—	—	—	—	—	—	—	—	—	—
46	8.viii.19	S.	—	—	—	—	—	1	1	—	1	—	—	—	—	—	—	—	—	—
48	11.viii.19	B.	—	—	—	—	1	1	—	1	1	—	—	—	—	—	—	—	—	—
51	13.viii.19	M.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1

GOBIOIDEI.

GOBIIDÆ.

Gobius minutus Pall.	Gobius ruthensparri Euph.
„ pictus Malm.	„ elongatus Canest.
„ paganellus L.	„ jeffreysii Gunther.
„ microps Kroyer.	„ niger L.
Lebetus scorpioides Coll.	Aphya pellucida (Nardo).
Crystallogobius nilssoni Dub. and Kor.	

The young Gobies are referable to the above genera and species, most of which are abundant in the Plymouth area, *vide* Lebour (1919). The young Fry are produced in large numbers, as many as 4782 specimens having been taken in the young fish trawls A and B during July, August and September, 1919, with an average per haul of 56·6 specimens for this period, the most abundant species in the hauls being *Gobius ruthensparri*, *G. elongatus*, *G. jeffreysii* and *Crystallogobius nilssoni*. One haul of the young fish trawl B (No. 77) yielded 2269 specimens of *G. ruthensparri*, ranging from 16–52 mm., most of these being adult fish. *Gobius elongatus* and *G. jeffreysii* occurred most frequently in September, when the average numbers per haul were 19·8 for the former and 18·6 for the latter. Both species were taken at lengths less than 10 mm. from July to September so that spawning takes place for these two species at least during July and August. Most of the *Crystallogobius* and *Aphya* are adult fish, few young stages having been captured. The spawning of *Crystallogobius* has been noted for June, and the appearance of the very young suggests an extension to end of August. *Aphya* probably spawns slightly earlier in the neighbourhood.

The distribution of the young Gobies is well marked. In the Genus Gobius there are two species, *G. elongatus* and *G. jeffreysii*, which are distinctly deeper water types. All the young of these two species were captured beyond the 20-fathom line. The maximum for both is in hauls taken over the greatest depths (total) recorded in this area. The remaining species of Gobius occurred closer inshore, though two species, *G. minutus* and *G. pictus*, were taken in a few hauls in water just over 20 fathoms. *Lebetus scorpioides* and *Crystallogobius nilssoni* are similarly distributed to *Gobius elongatus* and *G. jeffreysii*, while *Aphya* appears in the hauls as an inshore form. The abundance of the Gobies both in the adult and young stages forms an efficient supply of food for some of the commercially more important fishes.

The hauls of the cotton trawl C are equally interesting and here *Gobius minutus* is the most abundant, giving an average of 68·8 specimens per haul. One haul of 25 minutes' duration in Cawsand Bay (No. 27) yielded no less than 1532 specimens from 35–73 mm. in length.

TABLE XLIII.

Apparatus A and B.

Record of Gobius sp.

No. of haul.	Date.	Depth.	*G. minutus.* No.	Size in mm.	*G. pictus.* No.	Size in mm.	*G. paganellus.* No.	Size in mm.	*G. microps.* No.	Size in mm.	*G. ruthensparri.* No.	Size in mm.	*G. elongatus.* No.	Size in mm.	*G. jeffreysii.* No.	Size in mm.	*G. sp.* No.	Size in mm.
1	3.vii.19	B.	—	—	—	—	13	6–11	—	—	—	—	—	—	—	—	—	—
2	7.vii.19	B.	10	5–8	2	8–10	2	9–11	—	—	—	—	—	—	—	—	1	10
4	10.vii.19	B.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6	18.vii.19	M.–B.	—	—	14	5–6	6	6–9	50	3·5–8	—	—	—	—	—	—	—	—
7	,,	M.–B.	—	—	—	—	—	—	—	—	—	—	3	6–7	8	4–6	4	6–9
8	,,	M.–B.	1	6	7	4·5–7	—	—	—	—	—	—	—	—	—	—	—	—
9	,,	M–B.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	33	3–8
10	21.vii.19	B.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	73	4–15
11	,,	B.	—	—	—		—	—	—	—	—	—	3	4·5–5·5	—	—	—	—
12	,,	B.	—	—	—	—	—	—	—	—	—	—	1	6·5	2	5	—	—
13	,,	B.	—	—	—	—	—	—	—	—	—	—	4	5·5–6·5	—	—	—	—
14	24.vii.19	M.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	7·5–9
15	,,	S.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	6·5–7
17	28.vii.19	M.	—	—	2	4–7	—	—	1	4	—	—	—	—	—	—	—	—
19	,,	M.	—	—	—	—	—	—	3	5·5–6	—	—	—	—	—	—	—	—
21	29.vii.19	B.	—	—	3	5–6	—	—	—	—	—	—	—	—	—	—	—	—
22	,,	M.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10	4–11
23	,,	S.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	4–6
24	,,	B.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	48	3·5–9

No. of haul.	Date.	Depth.	G. minutus. No.	G. minutus. Size in mm.	G. pictus. No.	G. pictus. Size in mm.	G. paganellus. No.	G. paganellus. Size in mm.	G. microps. No.	G. microps. Size in mm.	G. ruthensparri. No.	G. ruthensparri. Size in mm.	G. elongatus. No.	G. elongatus. Size in mm.	G. jeffreysii. No.	G. jeffreysii. Size in mm.	G. sp. No.	G. sp. Size in mm.
25	29.vii.19	B.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	16	4–9
26	,,	B.	—	—	—	—	—	—	—	—	—	—	15	6–16	24	5–6	—	—
28	31.vii.19	B.	—	—	—	—	—	—	—	—	—	—	26	4–12	9	4–9	—	—
29	1.viii.19	B.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	5–8
30	,,	B.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	4·5–7
33	5.viii.19	M.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	6·5–7·5
35	,,	B.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	4–7
37	,,	B.	—	—	—	—	—	—	—	—	—	—	1	10	1	5	—	—
38	,,	M.	—	—	—	—	—	—	—	—	—	—	1	7	1	5	—	—
39	,,	B.	—	—	—	—	—	—	—	—	—	—	3	4·5–12	—	—	—	—
40	7.viii.19	S.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8	5–12
41	,,	M.	13	3·5–9·5	—	—	—	—	—	—	—	—	—	—	—	—	—	—
42	,,	B.	—	—	10	5–8	—	—	—	—	—	—	—	—	—	—	—	—
43	,,	B.	—	—	5	5–9·5	—	—	—	—	—	—	—	—	—	—	—	—
44	8.viii.19	M.–B.	—	—	—	—	—	—	—	—	—	—	8	5–13	—	—	—	—
47	,,	B.	—	—	—	—	—	—	—	—	—	—	3	10–12	—	—	—	—
49	11.viii.19	B.	—	—	—	—	—	—	—	—	—	—	—	—	1	6	1	8= G. niger
50	13.viii.19	M.	—	—	3	6	—	—	—	—	—	—	—	—	—	—	—	—
51	,,	M.	—	—	4	7–13	1	9	—	—	—	—	—	—	—	—	—	—
52	,,	M.	—	—	8	5–13·5	—	—	—	—	—	—	—	—	—	—	—	—
53	,,	M.	—	—	9	4–15	—	—	—	—	—	—	—	—	—	—	—	—
54	,,	M.	—	—	7	7–13·5	—	—	—	—	—	—	—	—	—	—	—	

No. of Haul.	Date.	Depth.	*G. minutus.* No.	*G. minutus.* Size in mm.	*G. pictus.* No.	*G. pictus.* Size in mm.	*G. paganellus.* No.	*G. paganellus.* Size in mm.	*G. microps.* No.	*G. microps.* Size in mm.	*G. ruthensparri.* No.	*G. ruthensparri.* Size in mm.	*G. elongatus.* No.	*G. elongatus.* Size in mm.	*G. jeffreysii.* No.	*G. jeffreysii.* Size in mm.	*G. sp.* No.	*G. sp.* Size in mm.
55	14.viii.19	B.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	110	7–16
56	15.viii.19	B.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	99	9–15
57	1.ix.19	B.	—	—	—	—	—	—	—	—	—	—	22	9–13	—	—	—	—
58	,,	B.	—	—	18	8–14	—	—	—	—	70	16–40	—	—	—	—	—	—
62	9.ix.19.	S.	—	—	—	—	—	—	—	—	—	—	15	13–22	42	6–19	—	—
63	,,	M.	—	—	—	—	—	—	—	—	—	—	60	14–39	165	11–32	—	—
64	,,	B.	—	—	—	—	—	—	—	—	—	—	88	16–39	119	7–28	—	—
65	,,	S.	—	—	—	—	—	—	—	—	—	—	3	11–19	7	9–19	—	—
66	,,	B.	—	—	—	—	—	—	—	—	—	—	73	9–21	51	5–19	—	—
67	10.ix.19	S.	—	—	—	—	—	—	—	—	—	—	9	9–20	1	9	—	—
68	,,	M.	—	—	—	—	—	—	—	—	—	—	23	17–27	81	5–19	—	—
69	17.ix.19	B.	—	—	—	—	—	—	—	—	—	—	4	10–13	—	—	—	—
70	,,	B.	—	—	—	—	—	—	—	—	—	—	10	9–17	—	—	—	—
71	,,	B.	—	—	—	—	—	—	—	—	—	—	11	9–16	—	—	—	—
72	,,	B.	—	—	—	—	—	—	—	—	—	—	23	11·5–20	—	—	—	—
73	,,	B.	—	—	—	—	—	—	—	—	—	—	101	9–24	—	—	—	—
76	25.ix.19	B.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	11–13
77	,,	B.	120	44–60	—	—	—	—	—	—	2269	16–52	—	—	—	—	—	—
78	,,	B.	—	—	—	—	—	—	—	—	1	22	—	—	—	—	1	7
81	29.ix.19	B.	—	—	—	—	—	—	—	—	—	—	55	15–30	—	—	—	—

TABLE XLIV.

Apparatus C.

Record of Gobius sp.

No. of haul.	Date.	Depth.	*G. minutus.* No.	*G. minutus.* Size in mm.	*G. pictus.* No.	*G. pictus.* Size in mm.	*G. ruthensparri.* No.	*G. ruthensparri.* Size in mm.	*G. elongatus.* No.	*G. elongatus.* Size in mm.	*G. jeffreysii.* No.	*G. jeffreysii.* Size in mm.
4	25.viii.19	B.	37	33–52	9	30–47	21	24–35	—	—	—	—
5	26.viii.19	B.	18	27–60	3	50	106	23–45	—	—	—	—
6	3.ix.19	B.	—	—	—	—	—	—	3	7–24	2	29–32
8	8.ix.19	M.	—	—	—	—	—	—	1	32	—	—
9	,,	B.	—	—	—	—	—	—	9	25–43	1	28
11	9.ix.19	B.	—	—	—	—	—	—	5	27–35	—	—
12	,,	M.	—	—	—	—	—	—	5	14–35	2	28–41
13	,,	M.	—	—	—	—	—	—	5	14–37	—	—
15	,,	M.	—	—	—	—	—	—	4	29–35	5	24–42
16	10.ix.19	S.	—	—	—	—	—	—	1	17	—	—
17	12.ix.19	B.	—	—	—	—	—	—	2	36	—	—
18	,,	B.	—	—	—	—	—	—	3	44–50	—	—
20	16.ix.19	B.	6	37–85	—	—	—	—	—	—	—	—
21	,,	B.	53	40–80	—	—	—	—	—	—	—	—
22	,,	B.	62	32–75	—	—	—	—	—	—	—	—
23	,,	B.	129	33–80	—	—	—	—	—	—	—	—
24	18.ix.19	B.	80	33–80	—	—	—	—	—	—	—	—
25	,,	B.	6	40–70	—	—	—	—	—	—	—	—
26	23.ix.19	B.	181	40–68	—	—	50	33–47	—	—	—	—
27	,,	B.	1532	35–73	3	41–50	14	32–44	—	—	—	—
30	29.ix.19	B.	27	28–62	—	—	—	—	—	—	—	—
31	,,	B.	5	40–56	—	—	—	—	—	—	—	—

TABLE XLV.

Apparatus A and B.

Record of Crystallogobius and Aphya.

No. of Haul.	Date.	Depth.	*C. nilssoni.* No.	*C. nilssoni.* Size in mm.	*A. pellucida.* No.	*A. pellucida.* Size in mm.
1	3.vii.19	B.	2	42–44	—	—
19	28.vii.19	M.	1	4	—	—
22	29.vii.19	M.	1	4	—	—
27	31.vii.19	S.	—	—	1	54♂
28	,,	B.	3	1 at 23♂ 2 at 28–29♀	1	47♀
57	1.ix.19	B.	3	14–31	—	—
62	9.ix.19	S.	62	5–25	—	—
63	,,	M.	11	5·5–31	—	—
64	,,	B.	102	4–32	—	—
65	,,	S.	17	9–29	—	—
66	,,	B.	53	4–34	—	—
67	10.ix.19	S.	2	10–15	—	—
68	,,	M.	29	6–22	—	—
69	17.ix.19	B.	9	10–36	—	—
70	,,	B.	10	9–25	—	—
71	,,	B.	16	11–30	—	—
72	,,	B.	9	17–31	—	—
73	,,	B.	21	15–44	—	—
76	25.ix.19	B.	—	—	3	19–23
77	,,	B.	—	—	16	21–50
78	,,	B.	—	—	8	19–26
81	29.ix.19	B.	224	14–31	—	—

TABLE XLVI.

Apparatus C.

Record of Crystallogobius and Aphya.

No. of Haul.	Date.	Depth.	*C. nilssoni.* No.	*C. nilssoni.* Size in mm.	*A. pellucida.* No.	*A. pellucida.* Size in mm.
4	25.viii.19	B.	—	—	1	45
5	26.viii.19	B.	—	—	1	48
6	3.ix.19	B.	5	30–38	—	—
13	9.ix.19	M.	1	11	—	—
14	,,	S.	1	16	—	—
16	10.ix.19	S.	3	5–10	—	—
19	16.ix.19	M.	—	—	1	20

TABLE XLVII.

APPARATUS A AND B.

RECORD OF LEBETUS SCORPIOIDES.

No. of Haul.	Date.	Depth.	No.	Size in mm.
1	3.vii.19	B.	1	6·5
13	21.vii.19	B.	1	5
28	31.vii.19	B.	2	4–7
38	5.viii.19	M.	1	6
39	,,	B.	2	5–6
45	8.viii.19	M.	1	7
47	,,	B.	2	6–7
48	11.viii.19	B.	1	5
62	9.ix.19	S.	1	5
63	,,	M.	10	9–12

BLENNIOIDEI.

BLENNIIDÆ. BLENNIES.

The pelagic young Blennies occur in 34 hauls, with an average per haul of 1·3 specimens. These are mostly *Blennius ocellaris*, whose spawning period extends from June to August in the neighbourhood. The distribution is general and again suggests inshore and offshore types, the offshore type being *B. ocellaris*. The early young of this species resemble closely the young of the Mackerel, at the same size.

TABLE XLVIII.

APPARATUS A AND B.

RECORD OF BLENNIUS sp.

No of Haul.	Date.	Depth.	No.	Size in mm.
2	7.vii.19	B.	5	6–7
3	9.vii.19	M.	1	7
5	11.vii.19	B.	1	5
7	18.vii.19	M.–B.	3	4–6
8	,,	M.–B.	3	3–8
12	21.vii.19	B.	2	5–8
13	,,	B.	9	6–7

No. of Haul.	Date.	Depth.	No.	Size in mm.
14	24.vii.19	M.	15	4–8
15	,,	S.	8	4–8
17	28.vii.19	M.	3	8–8·5
18	,,	M.–B.	·6	6–10
19	,,	M.	13	4·5–8
20	29.vii.19	B.	6	10–12
21	,,	B.	6	5–6
22	,,	M.	2	5–7
23	,,	S.	1	6·5
24	,,	B.	4	7–9
27	31.vii.19	S.	1	7
29	1.viii.19	B.	4	5·5–6·5
30	,,	B.	2	5–7
31	,,	B.	2	6·5–8
33	5.viii.19	M.	2	5–6·5
35	,,	B.	4	6
36	,,	S.	2	6·5–9
37	,,	B.	1	5
41	7.viii.19	M.	1	7
42	,,	B.	1	8
46	8.viii.19	S.	2	7–7·5
47	,,	B.	2	6·5–8
49	11.viii.19	B.	1	6
57	1.ix.19	M.	1	8
62	9.ix.19	S.	1	14
65	,,	S.	1	12
80	25.ix.19	M.–B.	1	8·5

SCLEROPAREI.

SCORPÆNOIDEA. SCORPÆNIFORMES.

TRIGLIDÆ.

TRIGLA GURNARDUS L. GREY GURNARD.
,, CUCULUS L. RED GURNARD.
,, HIRUNDO Bl. SAPPHIRINE GURNARD (Tub).
,, LINEATA L. STREAKED GURNARD (Polperro Bull dog).

The material collected from July to end of September, 1919, contains 501 examples of the pelagic young Gurnards, which occurred in 51 hauls of the young fish trawls A and B, an average of 5·9 specimens per haul for the whole period. The determination of the species has been rather difficult, owing to the similarity of the young forms, more especially those before the formation of the dorsal and anal fin rays. *T. gurnardus*, however, and *T. cuculus* are the predominant species, and they occur often in the same haul. Of the former species, little doubt may be attached to the identification, which is in agreement with that of other authors, notably M'Intosh and Prince (1890), M'Intosh and Masterman (1897), Ehrenbaum (1905–1909), and Fage (1918).

T. cuculus, so far as examination of known literature goes, is practically an unknown quantity, but the writer is strongly convinced that the material under investigation and recorded here as *Trigla* sp. B. belongs almost solely to this species, though one or two represent the very early young of *T. hirundo* (cf. Jaquet, 1907) and *T. lineata*. Confirmation of the last species was obtained by securing a good artificial fertilization and by rearing the larva to the period of the absorption of the yolk sac. Investigation on the early young stages is being continued and the results will be published in due course.

The pelagic young of *T. gurnardus* are distributed generally over the shallower and deeper waters. *T. cuculus* seems to show a maximum number over depths greater than 20 fathoms, occurring only occasionally in the shallower water.

There is not much difficulty in the determination of the adolescent stages. The hauls of the cotton trawl C contain examples of three species, *T. gurnardus*, *cuculus* and *hirundo*, while *T. lineata* is absent. *T. gurnardus* and *T. hirundo* were taken in water of 4–6 fathoms in Whitsand Bay, showing that these two species come inshore during their adolescent stage. *T. cuculus*, on the other hand, has not been taken in the adolescent stage in water less than 20 fathoms in depth, several adolescent stages having been taken from time to time in small meshed nets attached to the otter trawl in the area between Rame Head and Eddystone and in the deeper mid-channel waters. *T. lineata* has a similar distribution to *T. cuculus*, and only one adolescent stage has been observed by the writer, a specimen of 85 mm., which was taken in the deeper water off Whitsand Bay.

T. lyra, another deep water form, so far has not been observed in the early stages, nor has the adult been observed in spawning condition.

	T. gurnardus.	*T. cuculus.*	*T. hirundo.*	*T. lineata.*
Spawning Period :	i–viii.	iv–viii.	vi.	vi–vii.

TABLE XLIX.

Apparatus A and B.

Record of Trigla sp.

No. of Haul.	Date.	Depth.	*T. gurnardus.* No.	*T. gurnardus.* Size in mm.	*Trigla* sp. B. No.	*Trigla* sp. B. Size in mm.
3	9.vii.19	M.	—	—	2	4·5–5·5
4	10.vii.19	B.	9	6·5–8	12	6–18
5	11.vii.19	B.	7	6–8·5	—	—
6	18.vii.19	M.–B.	—	—	1	5
7	,,	M.–B.	7	9–13·5	1	6
8	,,	M.–B.	2	9–9·5	2	7·5–8·5
9	,,	M.–B.	10	7–12	25	4–8·5
10	21.vii.19	B.	8	7–13	13	5·5–11·5
11	,,	B.	37	4·5–10·5	17	4–10·5
12	,,	B.	60	5–13	11	5·5–9
13	,,	B.	22	6·5–13·5	—	—
15	24.vii.19	S.	4	10–12	—	—
16	,,	M.	2	8·5–12	—	—
17	28.vii.19	M.	3	8–12·5	2	8–9
18	,,	M.–B.	3	6·5–11	—	—
19	,,	M.	1	6·5	—	—
20	29.vii.19	M.	1	7	—	—
22	,,	M.	6	6–9·5	—	—
24	,,	B.	1	8·5	17	5–9
25	,,	B.	20	5·5–10	3	5–7
26	,,	B.	25	5–16	4	5–12
28	31.vii.19	B.	12	6–15	9	5·5–10
30	1.viii.19	B.	2	7–10·5	—	—
31	,,	B.	13	6–17·5	6	6
32	,,	S.	2	7–8	—	—
33	5.viii.19	M.	2	9·5–12	—	—
34	,,	B.	3	6–15	1	6
37	,,	B.	3	7–9·5	6	5–7
38	,,	M.	1	7	3	5–6
39	,,	B.	—	—	1	5
41	7.viii.19	M.	1	10	—	—
42	,,	B.	3	6–12	—	—
43	,,	B.	9	7–11	1	7·5
44	8.viii.19	M.–B.	2	7–8	5	5–9
45	,,	M.	3	6–10	—	—
47	,,	B.	—	—	8	5–11
48	11.viii.19	B.	3	7–16	10	5–7·5

No. of Haul.	Date.	Depth.	*T. gurnardus.* No.	Size in mm.	*Trigla sp* B. No.	Size in mm.
49	11.viii.19	B.	5	9–14	—	—
51	13.viii.19	M.	1	7	—	—
52	,,	M.	—	—	1	6
54	,,	M.	1	6·5	1	6
55	14.viii.19	B.	1	8	1	13
56	15.viii.19	B.	26	7–13	6	7–10·5
57	1.ix.19	B.	2	6–10	1	10
58	,,	B.	1	7	—	—
60	3.ix.19	M.	1	9	1	7
61	,,	B.	—	—	1	8
62	9.ix.19	S.	1	6	—	—
65	,,	S.	—	—	1	11
66	,,	B.	—	—	1	7·5
79	25.ix.19	—	—	—	1	20

TABLE L.

Apparatus C.

Record of Trigla sp.

No. of haul.	Date.	Depth.	*T. gurnardus.* No.	Size in mm.	*T. cuculus.* No.	Size in mm.	*T. hirundo.* No.	Size in mm.
7	8.ix.19	S.	1	19	—	—	—	—
8	,,	M.	—	—	1	16	—	—
10	,,	S.	1	22	—	—	1	15
12	9.ix.19	M.	—	—	1	22	—	—
16	10.ix.19	S.	2	18	—	—	—	—
17	12.ix.19	B.	1	57	—	—	—	—
18	,,	B.	—	—	1	48	—	—
20	16.ix.19	B.	1	78	—	—	—	—
22	,,	B.	—	—	—	—	9	75–110
25	18.ix.19	B.	—	—	—	—	1	82
30	29.ix.19	B.	5	47–70	—	—	—	—

COTTIFORMES.

AGONIDÆ.

Agonus cataphractus L. Pogge.

No pelagic young of this species were secured. Two bottom stages, ca. 55 mm. in length, were captured in the cotton trawl C, one in Haul 22 on 16th September, 1919, and one in Haul 24 on 18th September, 1919, both in Whitsand Bay East in depths from 4 to 6 fathoms. The species is not uncommon in the neighbourhood.

Spawning Period : iii–iv.

CYCLOPTERIDÆ.

Liparis montagui Donov.

One post-larva, 6 mm. in length, occurred in Haul 6 of the young fish trawl A on 18th July, 1919 (midwater to bottom). There are comparatively few records of this species in the early stages, but the adult occurs close in shore fairly frequently.

GASTROSTEOIDEA.

GASTROSTEIDÆ.

Spinachia vulgaris Flem.

No early pelagic stages of this species were taken. The captures of the cotton net C ranged from 61–95 mm. in length, and these were adults. The species is extremely common in the shallower waters close inshore, being very abundant in the Zostera bed of Cawsand Bay.

TABLE LI.

Apparatus C.

Record of Spinachia vulgaris.

No. of Haul.	Date.	Depth.	No.	Size in mm.
4	25.viii.19	B.	3	61–80
5	26.viii.19	B.	1	70
26	23.ix.19	B.	4	73–95

XENOPTERI.

GOBIESOCIDÆ.

Lepadogaster bimaculatus Penn.
„ gouani Lacep.
„ candolli L.

The hauls of the young fish trawls A and B contain the above three species. Two are inshore forms—*L. gouani* and *L. candolli*—while *L. bimaculatus* appears to be a definite offshore type, and is the only one of the three species which was taken in the deeper water hauls. The post-larvæ of *L. bimaculatus* are scattered over the whole of the area, 43 specimens having been taken from end of July to middle of September. Two adults, 33 to 35 mm. occurred in Haul 6 of the cotton trawl C on 3rd September, 1919, at a depth of 27 fathoms in locality 5 miles west of Rame Head.

Spawning Period: *L. bimaculatus*, v–viii.

TABLE LII.

Apparatus A and B.

Record of Lepadogaster sp.

No. of haul.	Date.	Depth.	*L. candolli.* No.	*L. candolli.* Size in mm.	*L. gouani.* No.	*L. gouani.* Size in mm.	*L. bimaculatus.* No.	*L. bimaculatus.* Size in mm.
1	3.vii.19	B.	1	7	—	—	—	—
2	7.vii.19	B.	—	—	1	6	—	—
6	18.vii.19	M.–B.	9	5·5–7	3	6	—	—
8	,,	M.–B.	1	6	—	—	—	—
14	24.vii.19	M.	1	6	—	—	—	—
28	31.vii.19	B.	—	—	—	—	1	9
30	1.viii.19	B.	1	6	—	—	—	—
34	5.viii.19	B.	—	—	—	—	1	6·5
37	,,	B.	—	—	—	—	3	4–9
40	7.viii.19	S.	—	—	—	—	1	6
41	,,	M.	5	4–6·5	—	—	5	4–6·5
42	,,	B.	4	5·5–7	—	—	1	6·5
43	,,	B.	5	6–7	—	—	1	5
44	8.viii.19	M.–B.	—	—	—	—	3	4–10
45	,,	M.	—	—	—	—	2	9–9·5
50	13.viii.19	M.	—	—	1	8	—	—
51	,,	M.	3	5·5–6·5	—	—	1	5
52	,,	M.	1	5·5	—	—	—	—
53	,,	M.	—	—	—	—	1	6
56	15.viii.19	B.	—	—	—	—	7	7–10
58	1.ix.19	B.	—	—	1	4	1	9
61	3.ix.19	B.	—	—	—	—	1	7
62	9.ix.19	S.	—	—	—	—	1	10
63	,,	M.	—	—	—	—	2	13–14
65	,,	S.	—	—	—	—	1	8
66	,,	B.	—	—	—	—	7	6–12
68	10.ix.19	M.	—	—	—	—	1	11
70	17.ix.19	B.	—	—	—	—	1	7
72	,,	B.	—	—	—	—	1	11·5

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The Post-Larval Stages of Ammodytes Species Captured during the Cruises of s.s. "Oithona" in Plymouth Waters in the Year 1919.

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With two figures in the text.

THE post-larval stages of Ammodytes species captured in the young fish trawl and small-meshed nets during the cruises of s.s. *Oithona* in the year 1919 were separable into two well-defined series, A and B respectively. Details of the hauls of the trawl and nets with dates and localities are to be found on pages 210–212 of Mr. R. S. Clark's account of the cruises in the present volume.

Considering the adult forms of Ammodytes known to occur in Plymouth waters, it is observed that *Ammodytes lanceolatus*, Lesauvage, and *Ammodytes tobianus*, L. are frequently met with, but no record is to hand at present of the occurrence of *Ammodytes cicerellus*, Rafin., although the latter has been taken frequently in the Atlantic. In regard to the larvæ and post-larvæ, none comparable to those assigned to *A. cicerellus* by Louis Fage (1, p. 17) have been described previously as occurring in this district, nor have such forms revealed themselves in the material under present consideration.

In endeavouring to identify the post-larvæ of any species, a study of the characters of the adults is often of great help, but in the case of Ammodytes species the only features of the adult which seem to be of value in this respect are the number of vertebræ and the relative length of the head to the total length of the body, and even so these characters, on account of the difficulty of determining them, are not so helpful as they would appear to be. Other characters have therefore to be sought for, and the following are those by which Series A and B have been distinguished :—

(A) Length of the upper jaw in relation to the diameter of the eye.
(B) Presence or absence of teeth-like structures in the upper jaw.
(C) Pigmentation.
(D) Number of vertebræ.

SERIES A.

(A) Length of Upper Jaw in Relation to the Diameter of the Eye.

Table I gives the proportion of these characters for 51 individuals, and it will be seen that as the length increases the ratio $(\frac{j}{e})$ increases for lengths up to 23 mm. at least. A comparison with $(\frac{j}{e})$ for Series B (see p. 245) will show the significance of this character in distinguishing the two series.

TABLE I.

Length of Upper Jaw in Relation to the Diameter of the Eye in Series A.

Length of fish in mm. groups.	Number of specimens.	$\frac{\text{Length of upper jaw}}{\text{Diameter of eye}} = \left(\frac{j}{e}\right)$
5	1	1·4
6	1	1·4
7	1	1·3
8	3	1·7
9	3	1·6
10	4	1·8
11	5	1·9
12	4	1·9
13	3	1·7
14	3	1·9
15	2	1·9
16	4	1·9
17	1	2·0
18	4	2·0
19	5	2·0
20	4	2·1
23	1	2·2
27	1	2·1
34	1	1·8

(B) Teeth-like Structures in Upper Jaw.

In every specimen of this series examined, with one possible exception of 5 mm. in length, thorn-like teeth structures are present in the upper jaw which are easily visible under a low power of the microscope. Even in the possible exception referred to there is an indication of one tooth, but not conclusive enough for a definite assertion to be made. It is the only specimen of this length available for examination.

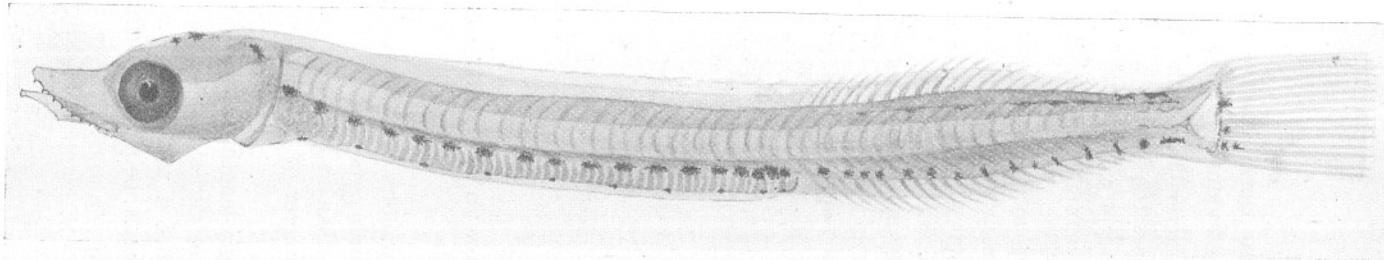

FIG. 1.—*Ammodytes lanceolatus.* Length 12 mm. Oithona station, No. 24. 29th July, 1919. Del., E. FORD.

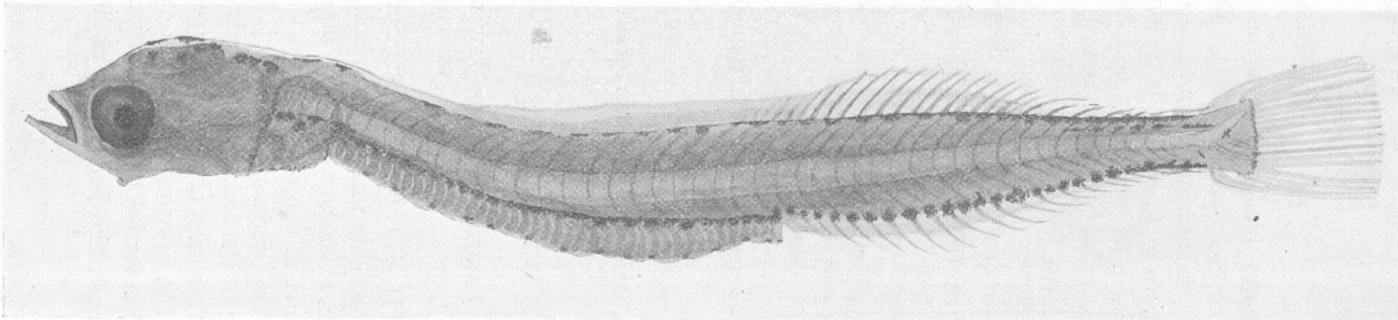

FIG. 2.—*Ammodytes tobianus.* Length 12·5 mm. Oithona station, No. 2. 7th July, 1919. Del., E. FORD.

(C) Pigmentation.

The black pigment situated on the extreme dorsal surface of the body is of great use in distinguishing the individuals of this series. From the shortest length up to 20 mm. on average, with an occasional exception up to 22 mm., it is restricted to two black stellate chromatophores which are strikingly persistent just in front of the root of the tail on the dorsal surface of the body. No other black pigment is present between these two chromatophores and the neck. Beyond 20 mm. on average, however, other black chromatophores make their appearance at the base of the rays of the dorsal fin, commencing posteriorly, until at 27 mm. a more or less continuous row is present which extends forward from the root of the tail to just in front of the anus.

At about 10 mm. in length a row of black chromatophores commences at the posterior end above the dorsal surface of the vertebral column and beneath the two dorsal chromatophores referred to above, and gradually extends forward. This row is quite distinct from the subsequent one which commences at 20 mm.

Fig. 1 illustrates the general pigment scheme of a post-larva of 12·0 mm.

(D) The Number of Vertebræ.

In this series the vertebræ total 68 or 69.

SERIES B.

(A) Length of Upper Jaw in Relation to the Diameter of the Eye.

Table II gives the proportion of these characters for 17 individuals of the available material in which the measurements were obtainable. It is seen that the ratio ($\frac{j}{e}$) is much smaller than in Series A. It has been found in one or two cases that the diameter of the eye actually exceeds the length of the upper jaw.

Owing to the lack of individuals of the longer lengths in the material some larger ones of a similar type to those of Series B from material collected in previous years were examined, and it was found that the ratio ($\frac{j}{e}$) never led to any confusion with Series A, being always smaller for corresponding lengths. ($\frac{j}{e}$ at 29 mm.$=1{\cdot}5$)

TABLE II.

Length of Upper Jaw in Relation to the Diameter of the Eye in Series B.

Length of fish in mm. groups.	Number of specimens.	$\frac{\text{Length of upper jaw}}{\text{Diameter of eye.}} = \left(\frac{j}{e}\right)$
6	2	1·0
7	4	1·1
8	2	1·2
9	3	1·1
10	2	1·0
11	2	1·0
12	2	1·1

(B) Teeth-like Structures in Upper Jaw.

No individual of this series showed any signs of the presence of the conspicuous teeth so characteristic of Series A, nor have I been able to observe them in individuals from the material of the previous years of the same type as Series B, although the individuals of same type as Series A showed the teeth quite clearly.

(C) Pigmentation.

In specimens of the shorter lengths the black pigment dorsally consists of chromatophores along the base of the dorsal fin in the posterior region. It is always well marked, and rapidly assumes the form of a continuous row of chromatophores along the base of the dorsal fin. At between 9 and 10 mm. in length this row has extended forward completely to the neck.

At about 9 mm. an additional row appears above the dorsal surface of the vertebral column similar to that described in specimens of Series A.

In general, individuals of Series B seem to be pigmented much more heavily than those of Series A. (cf. Figs. 1 and 2).

(D) The Number of Vertebræ.

Difficulty has been experienced in this determination owing to the small size of the available specimens, but in the largest of Series B 65 vertebræ have been counted.

Considering Series A and B together, two other features present themselves which are quite useful in demonstrating further differences, although they are not so serviceable in practical identification as the ones already utilised :—

(1) The individuals of Series B appear to have their body structures such as tail and fin rays developed at shorter lengths than those of Series A.

(2) In the older stages from say 11 mm. upwards, the head of individuals of Series A is longer relative to the length of the body than in those of Series B, but this difference is not so obvious in younger specimens.

On comparing the foregoing descriptions with those of the known investigators of Ammodytes species there seems no doubt that Series A and B are respectively *A. lanceolatus* and *A. tobianus*, and in support of this conclusion each of the distinguishing characters may be considered in turn to show to what degree the observations of Series A and B agree with or differ from the descriptions of these said investigators :—

(1) Length of Upper Jaw in Relation to the Diameter of the Eye.

Ehrenbaum (2, p. 190) remarks on the relatively longer upper jaw in *A. lanceolatus* than in *A. tobianus* in relation to the diameter of the eye at lengths exceeding 15 mm., whereas in Series A the upper jaw is relatively longer at all observed lengths than in the corresponding lengths of Series B.

(2) Teeth-like Structures in Upper Jaw.

I have not been able to find any reference in available literature to the previous observation of the presence in *A. lanceolatus* and absence in *A. tobianus* of these structures, and this has caused me no little surprise in view of the celebrated observers who have studied these species. They are so clearly defined in the specimens of *A. lanceolatus* that I have examined, and equally indistinguishable in those of *A. tobianus*, that they must be pointed out as a very distinctive character.

(3) Pigmentation.

Both Ehrenbaum (3, p. 300 and 2, p. 189, Taf. VII, Figs. 70 and 71) and Louis Fage (1, p. 20) have emphasized the fact of the presence of the characteristic two black chromatophores on the dorsal surface of the body in *A. lanceolatus*. Ehrenbaum, however, has figured a post-larva of 12·5 mm. (2, Taf. VII, Fig. 72) which has a continuous row of black pigment spots along the dorsal surface. This would appear to be different from the corresponding stage of Series A, but it is interesting to note, however, that Fage (1, p. 20) describes his corresponding specimens of *A. lanceolatus* as being comparable with this same figure of Ehrenbaum, with the exception that in each the dorsal pigment of the body is reduced to two precaudal chromatophores which are only visible in the youngest stages. It will be observed that the pigmentation scheme of Ehrenbaum's post-larva is very similar to that of Series B, and I would suggest that the specimen may be *A. tobianus* and not *A. lanceolatus*.

In regard to *A. tobianus*, the descriptions and figures given by Dantan (4, p. lxv, and Fig. 3) agree very well with the corresponding stages of Series B. Fage (1, p. 21) also gives a description of an individual of 14 mm. which has a double uninterrupted row of brown pigment spots extending dorsally from the neck to the root of the tail—a similar feature to that presented in Series B. Dannevig (5, p. 29, Pl. III, Figs. 23 and 24) gives figures of *A. tobianus* which agree fairly well with Series B, although the pigment is not shown very clearly in the reproduction.

In regard to Ehrenbaum's description of the earlier stages of *A. tobianus* (3, pp. 298, 299) it will be noticed that the pigmentation is not described as of such heavy intensity as has been pointed out in Series B. In the latter, throughout the material all the individuals present a more intense pigment scheme than in Series A.

(4) The Number of Vertebræ.

The numbers observed in Series A and Series B are in agreement with those obtained by other workers, except that in Series B no individual was obtained with less than 65 vertebræ, a result no doubt due to the small number of specimens available for examination.

(5) Length of Head in Relation to Body Length.

Ehrenbaum (2, p. 190) remarks on the relatively longer head in *A. lanceolatus*. This has been pointed out in the case of the larger specimens of Series A.

In conclusion it is of interest to notice that the material from which the above observations have been made was obtained during the summer months, thus giving evidence that *Ammodytes tobianus* spawns in the Plymouth waters during this season of the year. It is not proposed, however, to discuss in this account the extent of the spawning period or periods of this species.

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Note on a Leptocephalus Stage of the Conger.

By

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On September 17th, 1919, a specimen of *Leptocephalus Congri vulgaris* (*L. Morrisii*) was captured in " bottom " haul No. 69 of the young fish trawl in locality Eddystone bearing S. by W. (magnetic) $1\frac{1}{2}$ miles, over a depth of 31 fathoms.* It was alive and active when taken, measuring between 115 and 120 mm. in length, and has been kept alive up to the present date in a glass aquarium under circulation. It was at a fairly advanced stage of development, intermediate between those exhibited in Figs. 2 and 3, Pl. I of Schmidt (1), the dorsal fin commencing slightly farther back than in Fig. 3, and the median row of pigment spots along either side of the body not extending forward beyond about 1 cm. in front of the commencement of the dorsal fin. There is a close resemblance also to the specimen figured by Fulton (2), with the exception that, as just pointed out, the median row of pigment along the body on either side does not reach forward quite to the head, and in addition the pigment spots at the base of the dorsal fin rays are only two or three in number, situated at the extreme posterior end of the fin.

Since the date of capture, observations have been made periodically and certain measurements taken as accurately as possible, but on account of the movements of the fish the latter could only be obtained approximately.

On October 5th, that is eighteen days after transference to its aquarium, the normal retrograde metamorphosis had resulted in a reduction in length to between 80 and 90 mm., and its former " ribbon " shape was being superseded by the eel-like form, with a corresponding loss of transparency, while the dorsal fin had moved forward a considerable amount.

The pigmentation had intensified, and the upper surface throughout its whole length had become covered by a fairly uniform ground colouring. On the head this was quite dense, and reached down to about the level of the middle of the eye. On the body pre-anally it extended

* See page 181 of present volume of Journal.

well down over the level of the vertebral column. The exact nature of this ground colouring could not be made out on the constantly moving specimen, but appeared to consist of very fine stellate closely set chromatophores. The air bladder was conspicuous and silvery. The vertebral column appeared to be very deeply pigmented along its dorsal surface. The median row of pigment spots along each side of the body had now extended forward completely to the head, and each of the rays of both dorsal and anal fins presented a pigment spot at its base. The additional pigment row above the one at the base of the anal fin was also clearly defined. The tail pigment had been augmented, and extended along the fin rays with a barred appearance distally. Blood vessels of reddish appearance were noticeable in the gills, along the dorsal surface of the alimentary canal, and post-anally immediately beneath the vertebral column to the extreme end of the body ; and in addition two smaller vessels of short length parallel to the main vessel were seen, one above and one below, at a point about 2 cm. from the posterior end of the body with cross anastomosing connections.

On October 20th, the following body dimensions were noted as accurately as possible under the circumstances :—

Total length	= Between 83 and 85 mm.
Pre-anal length	= ca. 29 mm.
Distance from snout to commencement of dorsal fin	= ca. 15 mm.
Maximum depth (minus fins)	= ca. 5 mm.
Diameter of eye	= ca. 2 mm.
Pre-orbit	= ca. 3 mm.

The dorsal fin had moved still farther forward, and the pectoral fins now reached back almost to its commencement. The latter had a band of pigment at their base and irregularly scattered stellate chromatophores along the rays. The nasal papillæ were well marked at this stage.

The ground colouring had now extended farther down the body to about three-quarters of its depth, while the under side of the body had become silvery. On the head the lower limit of the former was from the mouth to the lower edge of the eye, leaving the lower jaw and front portion of the operculum unpigmented. Both on the dorsal and anal fins, more especially on the former, pigment was present irregularly along the rays.

The fish is alive at the present date, and apparently in a healthy condition. It remains quiescent under some stones in its aquarium, and never leaves their shelter during the daytime unless made to do so, returning immediately after the disturbance has ceased. Although quantities of plankton, small amphipods, and pieces of finely chopped worm have been placed in the aquarium at intervals no attempt at feeding has been actually observed, but at night the fish exhibits more activity, moving over and around the stones.

Schmidt in his summary of the life-cycle of *Conger vulgaris* fixes the spawning period in spring and summer, with the metamorphosis in the following spring and summer. Our specimen which when captured had already begun its metamorphosis has since practically completed it, so that we may estimate the age at capture at certainly well over one year, with a possibility of eighteen months.

SUMMARY OF CAPTURES AROUND BRITISH ISLES.

Area.	Locality of Capture.	Identified by	Year of Capture	Month of Capture.	No. Specimens.	Length of Specimens.	Depth over which Captured.
Scotland	West Coast	McIntosh and Masterman	1869	—	1	—	—
	Loch Scridain	,,	1890	June	1	80 mm.	—
	Moray Firth (South of Smith Bank)	Fulton	1903?	Feb.	1	123 mm.	24 fms.
	Smith Bank (Moray Firth)	,,	1903?	Dec.	1	145 mm.	28 fms.
	Aberdeen Bay	,,	1904	May	1	ca. 5 ins.	4–5 fms.
	Orkneys and Shetlands	Bowman	1911	Aug.	1	128 mm.	102 metres
Ireland	55°N. 9°W.	Schmidt	1905	June	1	137 mm.	116 m.
	50°–52°N. 10°–12°W.	,,	1905	June	5	113–135mm.	960–1420 m.
			1906	May	5	112–154mm.	75–1450 m.
			1906	June	5	130–158mm.	475–2480 m.
			1906	Sept.	1	—	1030 m.
English Channel	Plymouth Sound	Cunningham	1895	July	1	112·5 mm.	Between-tide marks.
	Off Cape Gris Nez	Gilson	1898	May	1	124 mm.	25 fms.
	Between Penlee Point and Eddystone	?*(M.B.A. Laboratory Museum)	1906	March	1	ca. 125 mm.	—
	Eddystone, bearing S. by W. (mag.) 1½ miles	Clark	1919	Sept.	1	115–120 mm.	31 fms.

The above summary does not include earlier specimens of which precise information is not available. Couch, for example, in "Fishes of British Islands, 1865," figures *Leptocephalus Morrisii*, and refers to its

* This specimen belonging to the M.B.A. Laboratory Museum at Plymouth does not appear to have been recorded previously. It was preserved in formalin originally, and labelled as having been ejected from the stomach of a mackerel, and brought in by a fisherman, but the length of the specimen was not recorded. The estimation of the latter, which is given above, was made in November, 1919.

occurrence off the Cornish coast, while Cunningham in "Marketable Marine Fishes, 1896," makes reference to two specimens taken during the Irish survey.

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The Eggs of *Gobius minutus, pictus* and *microps*.

By

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With 3 plates.

The eggs of *Gobius minutus* and *Gobius microps* are already known, Petersen (1892, 1917) having distinguished between them and figured them. Apparently the only mention of those of *Gobius pictus* is by Holt and Byrne (1901) who give the size of the eggs as about 0·80 mm. high by 0·65 mm. broad. *Gobius minutus* and *pictus* often occur together in the Sound and at the mouth of the Cattewater, but *pictus* is chiefly to be found near coarse sandy bottoms such as one gets near Duke Rock and New Grounds. *Gobius microps* occurs usually higher up the rivers, but the eggs and young are to be found occasionally in the Sound in the same localities as *minutus* and *pictus*.

Shells with eggs on them are commonly dredged in the Sound, those between Plymouth and the Breakwater are usually *minutus*, but *pictus* eggs are dredged from New Grounds and *microps* sometimes in the Cattewater.

In order to distinguish the eggs of these three species, and especially to obtain the eggs of *G. pictus*, adults of all three species were isolated in separate tanks with shells on the bottom on which the fish laid their eggs. The adults of *minutus* were from the Cattewater, those of *pictus* from New Grounds, and *microps* from Chelson Meadow, which opens into the Laira and where the water varies much in salinity, from almost fresh to ordinary sea-water strength. *G. minutus* and *pictus* were put into the tanks into ordinary running sea-water, straight from the vessel in which they were brought in from the dredge. *G. microps* which were caught in Chelson Meadow at the time when the water was almost fresh were put into a laboratory tank filled with fresh water and sea-water allowed to run in very slowly. In this way the fish were gradually accustomed to the ordinary sea-water of the laboratory and it was a week before this salinity was reached. Experiments were made in keeping the *Gobius microps* in fresh-water, but these died ; showing that a certain salinity is necessary.

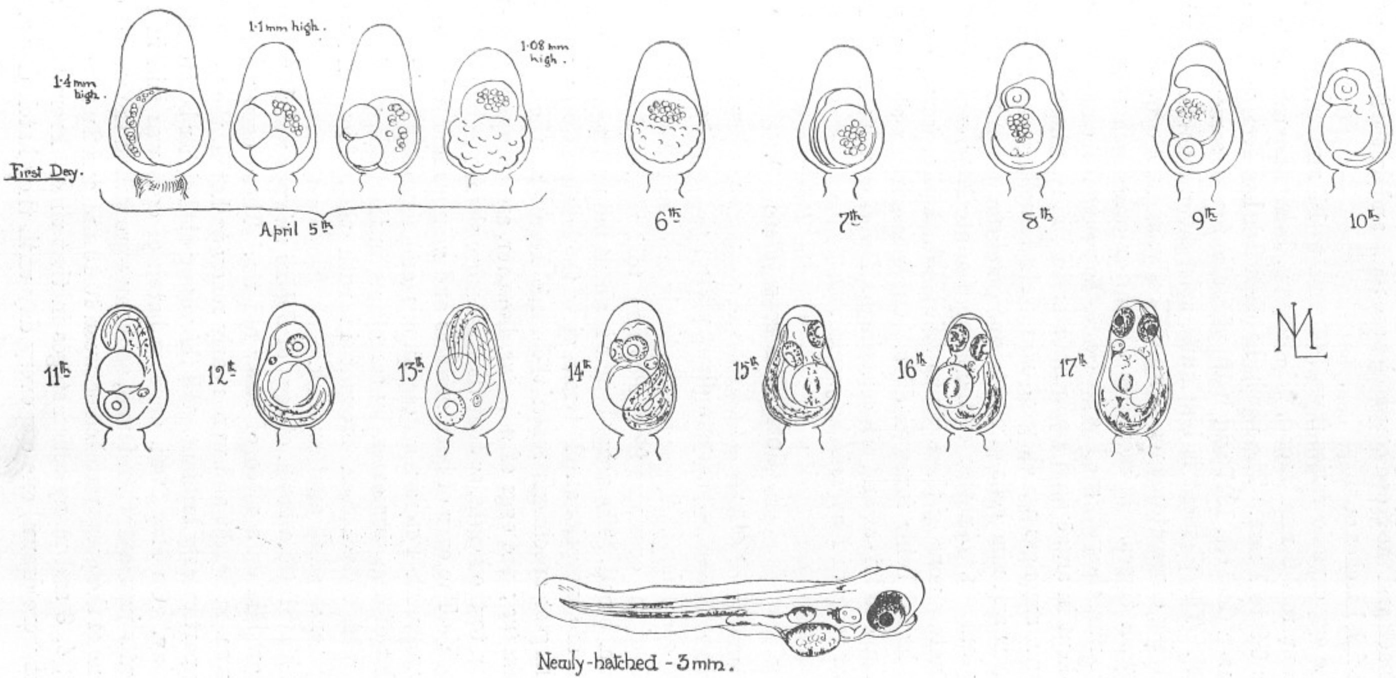
It was very difficult to rear the young when once they were hatched. When the eggs were very near hatching they were put in small aërated aquaria standing in running water. In these they were hatched and some of the young were left in the original aquarium whilst others were transferred to various glass vessels either aërated or not. Only two of the young survived, both *G. microps.* One of these died aged two months, the other is still alive, aged seven months, and is 20 mm. long. Those that lived were reared in a glass jar of three pints capacity containing sea-water, not aërated but containing a small stone with some green Ulva growing on it, twelve fish were placed in this jar directly they were hatched, and ten died in a few days. The remaining two at first ate Ulva spores, then larval Copepods, chiefly harpacticid nauplii which were in the water and from fine plankton which was given in small quantities. Afterwards they ate small adult Copepods. The only one remaining is now eating small Amphipods and fresh water Isopods. The water in the jar has never been changed, only a little fresh water added to make up for evaporation. In selecting the stone with Ulva, care was taken to have no burrowing worms such as *Polydora* as these eat the young fish. It is very interesting to watch the way the *Polydora* will encircle a fish with its long tentacles and place it in its mouth. Also there must not be too many Harpacticids, as these also eat the fish. One or two may be allowed to remain so that nauplii may hatch out for food for the little fish.

Gobius minutus (Plate I).

On April 1st, 1918, a batch of eggs of *G. minutus* was laid in the tank by the isolated specimens. These exactly correspond to several brought in from the Sound and were laid on a valve of the oyster *Ostraea edulis.* Petersen remarks that both *G. minutus* and *G. microps* prefer the shells of *Mya arenaria* although *Cardium* and *Mytilus* are present. At Roscoff, Guitel (1892) in his delightful account of the breeding habits of *G. minutus* gives *Tapes* and *Cardium* as the shells commonly used. Those from the Sound were on *Cardium echinatum, Cardium norvegicum* and *Mya truncata* at various dates from March to July. After the first batch several more were laid in the tank. The illustrations are from some dredged in the Sound which were evidently just laid, as many were in the one-celled stage, other stages from two-cells to a many-celled stage being seen the same day, and these correspond well with those laid in the tank. A drawing was made of an egg every day until they hatched in fourteen days. On the second day the blastoderm is well differentiated, on the third day the embryo and neural groove can be distinctly seen ; eyes show on the fourth day, slight pigment on the body on the fifth ; eye-pigment begins on the sixth day and gradually increases as the body pigment becomes more concentrated. On the thirteenth day the pupils

PLATE I.

Gobius minutus, eggs laid on Mya truncata, dredged in Plymouth Sound, drawn every day till hatched.



are black and the blood corpuscles are red. and on the fourteenth day the little fish hatches out.

The egg capsule varies from 1·08 mm. to 1·4 mm. in height and about 0·7 mm. to 0·8 mm. broad, 1·1–1·2 mm. being the usual size, Petersen gives 0·9 to 1 mm. The newly hatched fish has been well described by Petersen (loc. cit. 1917 and 1919) who also figures some stages of the egg (1892). The pigment is black and a bright orange-yellow, arranged in ramifying chromatophores along the body, and the eye is iridescent with yellowish tinges. It measures 3 mm. or a little more when hatched. At 3·5 mm. the yolk sac has gone and the young fish eats small organisms. One kept in an aërated aquarium standing in running water ate several diatoms amongst which were many *Asterionella japonica*, *Skeletonema costatum* and nine cells of *Chætoceros curvisetus* given it with some very fine plankton. Another of the same size ate a Copepod nauplius. Unfortunately none of these young fish lived, the longest time that any of them lasted being fourteen days. Other specimens ate Copepod larvæ and Annelid larvæ, and one contained a *Peridinium*, probably *P. ovatum*, and two cells of *Thalassiosira gravida*.

Gobius microps (Plate II).

A number of *Gobius microps* were obtained from Chelson Meadow, as described above, and on May 9th, a batch of eggs was found on a valve of *Pecten opercularis*. These had probably been laid about three days. The height of the eggs was from 0·85 mm. to 1 mm. high and 0·65 mm. to 0·7 mm. broad. The usual height is about 0·8 mm. to 0·9 mm., those of 1 mm. are exceptional. Petersen gives the height as 0·7 mm. to 0·9 mm. The largest specimens reach the same height as the smallest eggs of *G. minutus*; the eggs of *minutus*, however, are always narrower in proportion to the height, so that they are more slender in build than those of *microps*. The eggs of both *minutus* and *microps* laid in the tanks agree very well with Petersen's descriptions and figures. Unfortunately this first lot of eggs was eaten by something in the tank, possibly a stickleback which had been brought in with the gobies, and which was finally removed to another tank.

On May 15th, a batch of eggs of *Gobius microps* was found in Chelson Meadow laid on a piece of rusty old tin. These eggs measured 0·80–0·86 mm. in height and were nearly ready to hatch, the yellow pigment being particularly brilliant. All the young died either before or just after hatching. On May 20th, another batch of eggs was laid in the tank, evidently just laid when found, as many were still in the one-celled stage and one of these was watched between 10.15 a.m. and 2 p.m., going through the 2, 4, 8 and many-celled stages in that time. From this batch the figures were drawn, one egg every day until they hatched out. On the

Gobius microps, laid in tank May 20th 1919, on valve of Pecten opercularis, drawn every day till hatched.

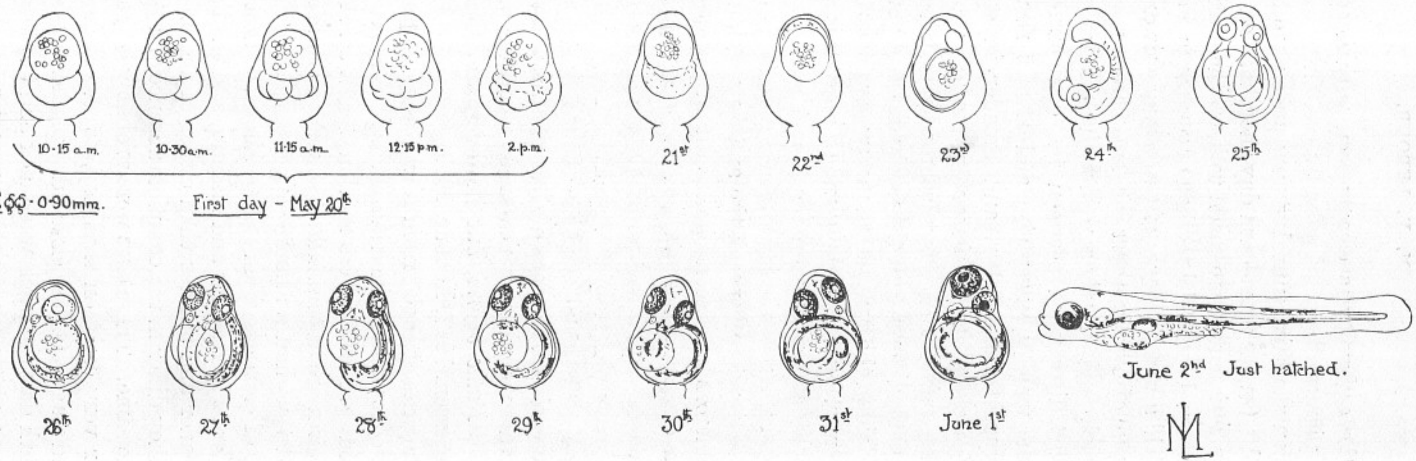


PLATE II.

fourth day the embryo was clearly seen with head and eyes, on the seventh day pigment began, gradually concentrating, the eyes getting darker, until on the thirteenth day the pupils were black and the blood corpuscles red. On the fourteenth day they hatched at 3 mm., or rather less. Many experiments were made to keep them alive, only two living more than sixteen days. The method of rearing is described above.

On May 27th, a batch of eggs of *G. microps* was dredged in the Cattewater on a valve of *Cardium norvegicum.* These eggs measured 0·8 mm.–0·9 mm. in height and exactly agreed with those laid in the tank.

We can thus distinguish between the eggs of *Gobius minutus* and *microps* by the usually larger size and always more slender build of *minutus, microps* being smaller, and broader in comparison with its height. An occasional large *microps* egg may be the same height as an unusually small *minutus* egg, but is broader and has a squatter build. There is very little difference in the newly hatched young, those hatching from the eggs laid in the tanks both measuring about 3 mm. ; *G. minutus* may reach 3·5 mm. before hatching and *G. microps* is sometimes less than 3 mm. The chromatophores on the dorsal part of the body are both large in *microps,* whereas the front one in *minutus* is usually small. The unpaired chromatophore beneath the auditory region in *microps* is very pronounced, whereas it is inconspicuous although present in *minutus,* and *microps* has a chromatophore behind the eye which is not present in *minutus.*

Gobius pictus (Plate III).

Having differentiated the eggs of *Gobius minutus* and *microps* it is easy to distinguish those of *pictus,* which are smaller than *microps* and are very much more like *Ruthensparri,* but the latter are slightly shouldered at the top (see Petersen, 1917, Lebour, 1919).

Some *Gobius pictus* dredged from New Grounds were isolated in a tank and a batch of eggs was obtained in a shell of *Patella vulgata* on April 26th. These measured 0·75 mm. to 0·8 mm. in height and in shape resembled those of *microps* more than *minutus,* as they were broad compared with the height and thus had a stumpy appearance. A distinct feature was the separation of each egg from its neighbour, so that the eggs were not so close together as in *minutus* and *microps,* and the base for attachment was much broader and shorter than either of these. From the eggs of *Ruthensparri* they differ in the complete absence of a "shoulder," the size being much the same. These eggs were probably laid the day before they were found, or very early on that day, as the blastoderm had reached the many-celled stage. On the eighth day pigment appeared on the body, on the thirteenth day the pupil was black and the blood corpuscles were red, and on the fourteenth day the young fish hatched. Unfortunately

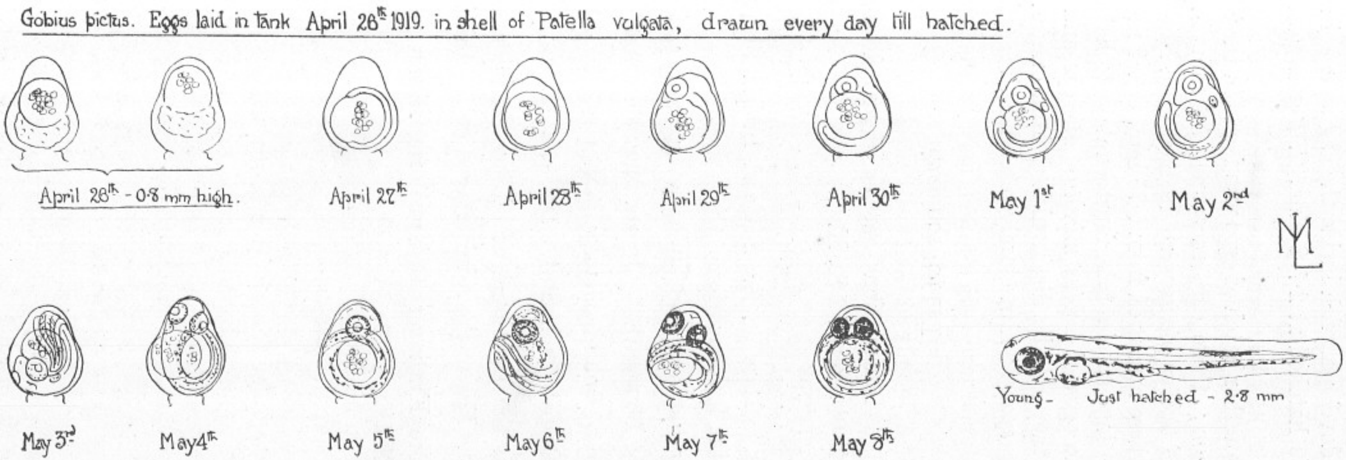

Gobius pictus. Eggs laid in tank April 26th 1919. in shell of Patella vulgata, drawn every day till hatched.
April 26th - 0·8 mm high.
April 27th
April 28th
April 29th
April 30th
May 1st
May 2nd
May 3rd
May 4th
May 5th
May 6th
May 7th
May 8th
Young - Just hatched - 2·8 mm

PLATE III.

none of these lived for more than a few days. The pigment is not nearly so intense in the developing fish inside the egg as it is in *G. Ruthensparri* and the young is hatched at 2·7–3 mm., *G. Ruthensparri* being hatched at 2·2–2·5 mm.

On May 13th, another batch of eggs was found in the tank in a valve of *Cardium echinatum;* these eggs measured 7·2 mm. in height. Other batches of eggs of *Gobius pictus* were dredged from New Grounds on the sandy bottom ; these measured from 0·75 mm. to 0·8 mm. in height.

The eggs of all three species take fourteen days to hatch, and it is seen that although the eggs of *Gobius minutus*, *microps* and *pictus* are very much alike, yet they can be distinguished from one another and from those of *G. Ruthensparri* which closely resemble those of *pictus*.

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The Food of Young Fish.

No. III (1919).

By

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CONTENTS.

INTRODUCTION.

The investigation of the food of larval and post-larval fish from Plymouth Sound and beyond for three years has brought out some interesting facts. For the first two years fresh material from the tow-nets was examined together with old material from the Young Fish Trawl (Lebour, 1918, 1919). During the present year, in addition to the tow-nettings, fresh material from the Young Fish Trawl was also available from July to the end of September, and several fish from outside the Sound examined which had not been obtainable for the last two years. We thus have a fair number of young Mackerel, Ling, Hake and Gurnard and several others.

The fish were either examined fresh or with the addition of a little formalin, and the food ascertained as soon as possible.

In this way fish newly hatched and post-larval stages, usually not larger than 20 mm., but a few larger adolescent stages were examined, special attention being given to the food fishes.

The food was investigated either by examination of specimens cleared and mounted, or, more usually, and this year entirely, by dissecting out the alimentary canal of the fish.

One finds that certain copepods and other Entomostraca constitute by far the larger part of the food of nearly all the very young fish, and that usually each species of fish selects its own favourite food to which it keeps, indiscriminate feeding seldom or never taking place, and one can usually assign to each fish its own particular food. The diet of the fish, however, depends to some extent on the size of the mouth and gullet, and in a few fish a unicellular diet is the rule up to a considerable size.

Few fish are vegetarians, and it is unusual for any but the youngest fish to eat diatoms. An exceptional occurrence was a piece of a branched alga inside a Wrasse, *Ctenolabrus rupestris*, of 39 mm. in length. Very young Herring and Sprat and a few others often contain green remains which probably belong to some algæ, and occasionally diatoms can be recognized in this, but even before the yolk sac is absorbed the gut may contain larval mollusks and small crustaceans, as in the young Herring.

DIATOMS.

Diatoms very rarely occurred in any quantity, hardly ever more than one individual or one chain of individuals in the same fish. An exception was a young *Ammodytes* of 10 mm. which contained 6 *Rhizosolenia Shrubsolei*, a needle-like diatom with a sharp spine at each end. Fish hatched in the Aquarium and fed on very fine plankton also ate diatoms. A newly hatched Plaice fed on a *Navicula*-like form growing at the bottom of a glass aquarium. Young Gobies only a few days old ate *Asterionella*, *Thalassiosira* and *Chætoceros* besides *Skeletonema* (the commonest diatom in the plankton).

The following is a list of diatoms found in the young fish :—

Rhizosolenia Shrubsolei	in *Ammodytes* sp.
Thalassiosira gravida	in *Cottus bubalis, Gobius minutus.*
Chætoceros curvisetus	in *Gobius minutus.*
Skeletonema costatum	in *Gobius minutus.*
Asterionella japonica	in *Gobius minutus.*
Biddulphia regia	in *Cottus bubalis.*

Paralia sulcata	in *Callionymus lyra*, *Pleuronectes limanda*, *P. flesus*, *Scophthalmus norvegicus*, *Clupea harengus*, *Lepadogaster bimaculatus*, *Solea variegata*, *Arnoglossus* sp.
Lauderia borealis	inside a copepod in *Solea variegata*.
Guinardia flaccida	inside a copepod in *Solea variegata*.
Coscinodiscus radiatus	in *Cottus bubalis*.
,, *excentricus*	in *Agonus cataphractus*, *Callionymus lyra*, *Clupea sprattus*.
,, sp.	in *Gobius* sp., *Pleuronectes limanda*, *Gadus luscus*, *Ammodytes tobianus*, *Caranx trachurus*, *Clupea harengus*, *Amphioxus lanceolatus*.
,, *Grani*	in *Gadus merlangus*.
Thalassiothrix nitzschioides	in *Clupea sprattus*.
Fragillaria sp.	in *Pleuronectes limanda*.
Tabellaria sp.	in *Arnoglossus* sp.
Melosira sp.	in *Ammodytes tobianus*.
Hyalodiscus stelliger	in *Clupea harengus*.
Campylodiscus sp.	in *Clupea harengus*.

All these are diatoms commonly found in the plankton.

PERIDINIANS.

Peridinians occasionally occurred :—

Dinophysis sp.	in *Gadus minutus*, *Pleuronectes limanda*, *Solea variegata*.
Prorocentrum micans	in *Labrus* (*bergylta* type), *Solea variegata*, *Pleuronectes limanda*, *Scophthalmus norvegicus*, *Clupea harengus*.
Diplopsalis lenticula	in *Solea variegata*.
Peridinium ovatum	in *Scophthalmus norvegicus*, *Pleuronectes limanda*, *Solea variegata*.
P. cerasus	in *Solea variegata*.
P pallidum	in *Solea variegata*.
P. sp.	in *Labrus* (*bergylta* type), *Solea variegata*, *Pleuronectes microcephalus*, *Gobius minutus*, *Clupea harengus*.
Goniaulax spinifera	in *Clupea harengus*.

Those in the flat fishes were probably inside the copepods they had eaten, but those in the Herring, Bib (*Gadus minutus*), *Gobius* and *Labrus* certainly were taken in the free state.

FLAGELLATA.

The flagellate *Phæocystis* usually appears in enormous quantities in May and June in the Sound, its gelatinous masses clogging the nets and interfering in every way with collecting.

The young Flounder (*Pleuronectes flesus*) before its metamorphosis and its transition to the bottom stage feeds largely on this, its gut sometimes being full of it. Specimens up to 11 mm. kept in a small aquarium were fed on it and devoured it eagerly. *Halosphæra viridis* was occasionally taken by the young Herring, Sprat, Pipe-fish (*Nerophis*) and Scad (*Caranx*).

COCCOSPHÆRALES.

A perfect specimen of a coccosphere (*Coccosphæra* sp.) was found in a Pouting (*Gadus luscus*) of 3 mm.

SILICOFLAGELLATA.

The silicoflagellate (*Distephanus speculum*) occurred in a Dab (*Pleuronectes limanda*) of 6 mm.

FORAMINIFERA.

Foraminifera, chiefly *Polystomella*, are sometimes found in the fish feeding among the *Zostera*, but as these were all fish of a fair size, between 30 and 60 mm., and as the foraminifera nearly always occurred singly, they had probably been taken in accidentally. They occurred in the following fish :—

Labrus bergylta, 37 mm.
Crenilabrus melops, 35 mm.
Ctenolabrus rupestris, 35–37 mm.
Mullus surmuletus, 60 mm.
Gobius minutus, 49–51 mm.

RADIOLARIA.

The radiolarian *Lithomelissa* occurred in a Wrasse (*Labrus* sp. *bergylta* type) of 6 mm.

INFUSORIA.

The only recognisable Infusoria were Tintinnids :—

Tintinnopsis beroidea	in	*Labrus* (*bergylta* type).
T. ventricosa	in	*Solea variegata*, *Pleuronectes limanda*, *Scophthalmus norvegicus*.
T. sp.	in	*Clupea harengus*.
Cittarocyclis denticulata	in	*Labrus* (*bergylta* type).

Here again those in the flat fish were probably from the copepods, those in the Herring and the Wrasse having probably been taken in free.

It is only occasionally that these unicellular organisms are seen, although it is probable that *Clupea* species and *Ammodytes tobianus* feed principally on these up to about 10 mm. or more. It is much more usual to find in these forms the gut empty or with an occasional larval mollusk, copepod or egg (copepod ?).

OVA.

It was found this year that eggs formed a fairly large portion of the food of some of the young fish. It was difficult to identify them, but they appear to be the eggs of copepods. The diameter is about 1·6 mm. or less, and this approximates to the size of the eggs of *Calanus finmarchicus*. As *Calanus* has free eggs it is quite possible that they may form part of the food of the little fish. Some of these eggs were recorded previously as spores. This year they were found in the following fish :—

Gadus merlangus, *Labrus* (*bergylta* type), *Labrus mixtus*, *Caranx trachurus*, *Scomber scomber*, *Trachinus vipera*, *Gobius microps*, *Pleuronectes microcephalus*, *Rhombus lævis*, *Scophthalmus norvegicus*, *Ammodytes lanceolatus*.

One *Pleuronectes microcephalus* of 7 mm. contained 72 of these eggs.

ANNELIDA.

A few adolescent stages of *Pleuronectes platessa*, *Gobius pictus* and *Gadus minutus* contained remains of annelids which were not seen in the very small fish.

Certainly the principal food of the young fish is small crustacea, the Cladocera, *Podon* and *Evadne*, *Balanus* larvæ, and, foremost in importance, certain copepods, both adults and larval stages. Decapod larvæ and other crustacean larvæ and also adults are taken by the larger sized fish, but copepods are taken by many of the fish from the newly hatched to the adolescent stages, and, in some cases, to the adult stage.

CLADOCERA.

In the Sound and outside *Podon* and *Evadne* are only available in large quantities in the summer months. When these are in season they are great favourites, and nearly all the small fish will eat them, usually in addition to the copepods on which they feed at other times. Even the almost newly hatched fish, sometimes still with a yolk sac, can eat *Podon* and *Evadne*. Details of the fish eating these will be found under the separate headings.

OSTRACODA.

Crenilabrus melops of 22 mm. contained remains of ostracods.

COPEPODA.

Copepods undoubtedly form the chief food of larval and post-larval fish, and each fish usually keeps to one or more species of copepod, which may be varied as the presence of the copepods varies. The accumulated results show that by far the greater number of the fish eat one or more of the four commonest species of copepod—*Pseudocalanus elongatus*, *Acartia clausi*, *Temora longicornis* and *Calanus finmarchicus*, and each species of fish usually has a favourite amongst these to which it keeps more or less strictly. Thus the favourite food of the Whiting (*Gadus merlangus*) up to about 9 mm. or more is undoubtedly *Pseudocalanus*, but this copepod is not so abundant in the early summer as it is at other times, and then the Whiting will take *Acartia* and *Calanus*, hardly ever *Temora*, although the last may be very common. On the other hand, most of the species of *Solea* and also *Pleuronectes limanda* will take *Temora* and hardly ever *Pseudocalanus*, whilst *Pseudocalanus* and *Acartia* are specially taken by *Scophthalmus norvegicus*. It is to be noted that the Dab takes the same food as the Soles in the very young stages.

These four common copepods occur practically all the year round in the whole area investigated with short periods of disappearance of one or another species, but they are most abundant in spring and summer and commonly breed during this period, when the young fish are at their maxima. Many very small fish eat the nauplii and small copepodid stages, as do also the older fish with small mouths and narrow gullets, while the large-mouthed young forms will take adult copepods when almost newly hatched.

Amongst the other copepods eaten are *Paracalanus parvus*, *Euterpina acutifrons*, *Metridia lucens* and *Oithona similis*, also a few rarer forms, but none of these is eaten so often as the four common species mentioned above. Harpacticids are fairly often eaten by the adolescent stages feeding among the *Zostera*.

CIRRIPEDIA.

Balanus nauplii occur in numbers in winter and early spring and again in July and August. At these times they are eaten a great deal by most of the young fish, particularly those newly hatched. Cypris stages are occasionally taken.

SCHIZOPODA.

Young *Scomber*, *Labrus mixtus*, *Trigla gurnardus* and *Rhombus maximus* contained euphausiid larvæ. Adolescent stages of *Trachinus vipera*, *Arnoglossus laterna* and *Gadus minutus* contained mysid remains, but except in these adolescent stages schizopods do not form a large part of the food.

CUMACEA.

The only Cumaceids seen were in adolescent stages of *Pleuronectes limanda* and *P. platessa.*

ISOPODA.

A few adolescent stages conta'ned isopods. A *Crenilabrus* of 33 mm contained isopod remains, and an *Onos mustela* contained a *Gnathia.* Several small fish in captivity ate young isopods.

AMPHIPODA.

Amphipods are eaten by few of the very young fish, but frequently by the adolescent stages. A *Callionymus* of 13 mm. had eaten a young *Apherusa* and a young *Rhombus maximus* of 13 mm. had also eaten an *Apherusa.* The following adolescent stages contained remains of Amphipods: *Crenilabrus melops, Centrolabrus rupestris, Trachinus vipera, Gobius pictus, Callionymus lyra, Pleuronectes limanda, Pleuronectes platessa, Arnoglossus laterna, Gadus pollachius.* A Whiting of 24 mm. ontained a *Hyperia* and small Whiting, Pollack and Gobies in captivity would take young amphipods.

DECAPODA.

Decapods seldom occurred except in the adolescent stages. A Whiting (*Gadus merlangus*) contained a zoëa of *Carcinas mœnas*, a *Trigla gurnardus* of 13.5 mm. contained a crab zoëa and one of 8 mm. contained remains of decapod larvæ. A *Cyclopterus lumpus* of 15 mm. contained a *Eupagurus* larva. Adolescent stages contained the following :—

Pandalus sp.	in *Gobius minutus, Callionymus lyra, Arnoglossus laterna, Gadus minutus, Onos* sp., *Gasterosteus spinachia.*
Crangon sp.	in *Pleuronectes limanda, Arnoglossus laterna, Gasterosteus spinachia.*
Gebia larva	in *Pleuronectes limanda.*
Hippolyte sp.	in *Gadus pollachius, Gadus merlangus.*
Eupagurus larva	in *Gadus minutus.*
Porcellana larva	in *Caranx trachurus, Clupea sprattus.*
Brachyura zoëæ	in *Pleuronectes limanda, Gadus merlangus, Gadus pollachius.*
Brachyura megolopæ	in *Callionymus lyra, Pleuronectes limanda, Gadus pollachius, Onos* sp.

Decapod remains in *Labrus mixtus*, *Ctenolabrus rupestris*, *Mullus surmulatus*, *Trachinus vipera*, *Gobius minutus*, *Gobius pictus*, *Callionymus lyra*, *Gadus merlangus*, *Gadus pollachius*.

In captivity many of the larger young fish ate decapods, thus *Cyclopterus lumpus*, 20–25 mm. ate *Leander* larvæ, *Crangon* and *Gebia* larvæ; *Solea vulgaris* at 30 mm. ate larvæ of *Crangon*, *Gebia* and *Hippolyte* and also *Porcellana* larva; *Solea lascaris* at about 20 mm. ate the smaller decapod larvæ, and *Gadus merlangus*, 22 mm., ate larval *Gebia* and an occasional crab zoëa or megalopa, crab megalopa also being eaten by a Pollack of 26 mm.

Thus as the fish grow decapod larvæ and other crustacea are eaten, but even the larg fisher, 20–30 mm., often seem to prefer copepods.

MOLLUSCA.

Besides crustacea, larval mollusks are almost the only recognisable metazoa eaten by the young fish. These occur occasionally in many species along with crustacea. Young Herring, Brill and Turbot often eat them, and the young Gar-fish *Belone* (*Rhamphistoma*) *belone* even up to 36 mm., after the elongation of the lower jaw, seems to eat them habitually. During this year the tow-nets contained enormous numbers of larval mollusks, chiefly gastropods and numerous pteropods of the genus *Limacina*. These latter seem to be very seldom eaten by the fish, and were nearly always refused when given to the young fish in captivity. The larval gastropods were eaten fairly often when they were so numerous. The following small fish from 3·5 to 11 mm. had eaten them: *Labrus* (*bergylta* type), *Cottus bubalis*, *Agonus cataphractus*, *Gobius microps*, *Liparis montagui*, *Lepadogaster candolli*, *Gadus merlangus*, *Onos* sp., *Clupea harengus*. Adolescent stages of the following from 27 to 120 mm. had eaten many: *Callionymus lyra*, *Caranx trachurus*, *Gobius Ruthensparri*, *Pleuronectes limanda*, *Gadus pollachius*, and *Ammodytes tobianus*.

Certain of the post-larvæ eat other young fish. Thus the Mackerel at 9 mm. may contain fish remains. One of 13·5 mm. had eaten a Blenny of 7 mm. After 10 mm. fish remains are fairly common in the young Mackerel. The Whiting also eats fish at an early age, and at 22 mm. it has been seen to eat another Whiting of 10 mm., while later they habitually eat fish. The Pollack (*Gadus pollachius*) and the Bib (*Gadus minutus*) in the adolescent stage, 75–115 mm., eat fish which forms the chief food of the Pollack at this size, the Bib more often eating decapods.

Adolescent Brill from about 25 mm. also habitually eat fish, and a Dab (*Pleuronectes limanda*) of 60 mm. contained a young fish of 25 mm. (*Ammodytes*). A Turbot (*Rhombus maximus*) of 98 mm. had eaten a *Callionymus*.

Of the many young fish examined which are of no importance as human food, *Callionymus*, *Trachinus* and *Gobius* are of special abundance, and all these eat the various species of Entomostraca. As much of their food is the same as that taken by most of the young food fishes, it must necessarily follow that they are competitors with these for food, and this may be the cause of the dearth of young food fishes in many parts.

When large numbers of young fish were examined from both shallow and deep waters, from within the Breakwater and from the region bounded by the 30-fathom line, it was found that the diet of each species varied very little; thus the Whiting, wherever it was caught, took *Pseudocalanus* (most often), *Acartia* and *Calanus*, but very seldom *Temora*. *Labrus* (*bergylta* type) always preferred *Temora*, usually the nauplius. The diet of any species of fish was found to be practically the same, whether it was feeding in the Sound or outside.

The large number of empty guts in some of the young fish, especially the clupeoids, is striking. Green food remains are often found in the very young sprat, but the Herring and Pilchard are more often empty.

A list of the fish from the tow-nets is given at the end of this paper. Those from the Young Fish Trawl and ½-inch net are recorded in Mr. Clark's paper in the same number of this Journal (pp. 163–164). The numbers of the hauls given here refer to those recorded by him, where all data can be found. For convenience, the following letters are used to designate the various nets used:—

A Young Fish Trawl.
B ½-inch Cotton Trawl.
C Shrimp Trawl.
D Tow-net, Cheese-cloth (84 cm.).
E Tow-net, Mosquito Netting (74 cm.).
F Muslin Net (84 cm.).

For the various points inside the Sound the plan of the Sound may be referred to. (Lebour, 1917, p. 459.)

The common names of the fish given here are those used by the fishermen in these parts, and do not necessarily correspond with local names in any other area.

Tow-nettings taken regularly from the Sound and outside on the same dates as the hauls, and examined by Miss Webb and partly by the writer, show, much as they did last year, that the four commonest copepods are *Temora*, *Pseudocalanus*, *Calanus* and *Acartia*, and that these are the commonest food of most of the young fish. In August and September large numbers of larval mollusks and the pteropod *Limacina* were present. The latter seems hardly ever to be eaten by the fish, but the larval mollusks, especially the gastropods, were taken by several (see above). Except for these it seems that the copepods and cladocera (when these latter are present) and *Balanus* larvæ, with larval decapods in the older forms are really the only inhabitants of the plankton that need be taken into account (the few exceptions of the unicellular organisms are given above). Therefore the plankton from the medium and coarse nets is of the most importance with regard to the young fish food.

JANUARY.

With the exception of one *Cottus bubalis* containing a larval bivalve and a *Balanus* nauplius, the only young fish caught in the tow-nets were Herrings. A large proportion of these were empty, but those that had anything inside had eaten chiefly larval gastropods and *Pseudocalanus*; a few *Coryceus* and *Oithona* also being taken, *Tintinnopsis*, *Coscinodiscus* and larval bivalves. All these except *Coryceus* are recorded from the plankton during the month. *Coryceus* is usually present at this time, *Pseudocalanus* being very common.

FEBRUARY.

Herring were not so numerous; Sprat and *Ammodytes tobianus* were common; *Cottus bubalis*, *Gobius* sp. (probably *minutus*), *Agonus cataphractus*, *Gadus luscus*, *Cyclogaster montagui* and *Anguilla vulgaris*, the latter with no food. The Herring were eating *Pseudocalanus*, *Paracalanus*, *Acartia*, *Balanus* nauplii, eggs (copepod ?) and larval gastropods. The Sprat and *Ammodytes* contained green food remains, one diatom (*Melosira*) being seen in an *Ammodytes*. *Cottus bubalis* and *Cyclogaster* had eaten larval gastropods, *Agonus* had eaten *Balanus* nauplii, *Temora longicornis* a larval bivalve and an harpacticid. *Gadus luscus* had no food, and *Gobius* green food remains.

The *Balanus* nauplii were common in the plankton, having begun in January. *Temora* nauplii and other copepod nauplii were common. *Pseudocalanus* and *Acartia* were common. *Paracalanus* was the only copepod among the food seen which is not recorded in the plankton, and this was present early in March. *Calanus* was commonly present this month, but was not seen inside any fish.

MARCH.

In March the Herring had disappeared. The young Sprat were very abundant, but those examined contained no food except one with a

Pseudocalanus inside it. *Ammodytes tobianus, Agonus cataphractus, Pholis gunnellus, Callionymus lyra, Cottus bubalis, Gadus luscus* and *Gobius* sp. present, but few individuals and none containing any food except a *Cottus bubalis* containing a *Balanus* nauplius.

A large number of Sprat eggs were in the tow-nets, and these tow-nets were full of life, *Pseudocalanus* and *Balanus* nauplii being common, so there is nothing there to account for the dearth of food in the little fish.

APRIL.

In April the Sprat were dwindling in numbers, disappearing in the middle of the month and containing no food. *Gadus merlangus* was fairly common and eating almost entirely *Pseudocalanus, Gadus luscus* also eating *Pseudocalanus. Cottus bubalis* eating *Pseudocalanus* and *Temora, Callionymus lyra* also eating *Pseudocalanus*, and *Temora* nauplii. *Ammodytes tobianus* with crustacea remains, *Solea variegata* and *Solea vulgaris* with no food, *Pleuronectes limanda* with a *Temora* nauplius.

In the tow-nets *Pseudocalanus* and *Temora* were the commonest copepods, although *Calanus* was present and *Acartia* common. *Balanus* nauplii were dwindling, *Podon* begins and *Phæocystis* was present at the end of the month.

MAY.

In May there were a few Sprat present with no food. *Gadus merlangus* was the commonest fish, feeding chiefly on *Pseudocalanus*, but also on *Calanus, Acartia* and an occasional *Temora* and *Balanus* nauplius. *Gadus minutus* containing *Pseudocalanus* and *Temora, Gadus pollachius* containing *Calanus, Acartia* and *Podon. Callionymus lyra* with *Temora, Pseudocalanus* and *Temora* nauplii, *Zeugopterus punctatus* with *Temora* nauplii, *Pleuronectes flesus* eating *Phæocystis, Pleuronectes limanda* with *Temora* nauplii, *Onos* sp. with *Temora* and copepod nauplii, *Labrus* (*bergylta* type) with copepod remains and eggs, *Roccus labrax* with copepod remains.

Phæocystis abounded this month, the only fish feeding on it being the Flounder (*Pleuronectes flesus*). *Temora* was very common, also *Acartia. Pseudocalanus* not quite so abundant, *Calanus* common. The fish were eating a great deal of *Temora*, and the Whiting was taking *Calanus* and *Temora* as well as *Pseudocalanus*, and also *Podon*. From January the decapod larvæ had been steadily increasing.

JUNE.

In June *Gadus merlangus* was still common and still eating *Pseudocalanus* but also *Acartia* and *Calanus* and an occasional *Temora* and a zoëa of *Carcinus mænas*. A few Sprat with no food, *Pleuronectes limanda* with no food, *Solea vulgaris* alive, *Callionymus lyra* with *Pseudocalanus*, *Paracalanus* and *Calanus*. *Onos* sp. with no food, *Labrus* (*bergylta* type) with copepod nauplii, *Roccus labrax* with no food, *Gobius minutus* with no food, *Blennius* sp. with no food.

Pseudocalanus was not at all common in the tow-nets this month, but *Calanus* abundant and also *Acartia*. *Temora* fairly common, *Podon* and various decapod larvæ abundant.

JULY.

In July the fish from the tow-nets were taken chiefly from outside, some as far as the Eddystone Grounds, but the food still consisted chiefly of *Calanus, Temora* and *Pseudocalanus*. Most of the fish, however, came from the Young Fish Trawl.

It was found throughout this investigation that fish of the same species eat much the same food from any locality, and the common copepods in the Sound are also common throughout the area investigated.

Among the fish caught were numerous *Gobius* spp. consisting of *G. elongatus* and *Jeffreysii*, and *Crystallogobius* from the deeper waters, *G. minutus, pictus, paganellus, niger, microps* and *Ruthensparri* with occasional *Aphya* from the more inshore waters. All these eat various small copepods of the commonest kinds, chiefly *Pseudocalanus* and *Acartia*, as does also *Callionymus lyra* (chiefly *Pseudocalanus* and *Temora*). The few Sprat contained no food, Pilchard chiefly were empty, but a few contained eggs (copepod ?), *Pseudocalanus*, *Oithona*, *Acartia* and copepod nauplii (*Calanus* and others). *Labrus* (*bergylta* type), *L. mixtus* and *Ctenolabrus rupestris* all ate *Temora*, chiefly the nauplii, other copepod nauplii (including *Calanus*) and *Podon*, the *Labrus* species also eating *Pseudocalanus*, eggs (copepod ?), *Paracalanus*, *Acartia* and harpacticids, *Labrus* (*bergylta* type) also eating larval gastropods and bivalves and *Balanus* nauplii, but by far the commonest of *Labrus* (*bergylta* type) was *Temora* nauplii. One *Labrus mixtus* had eaten an euphausiid larva. *Gadus merlangus* had eaten *Pseudocalanus* again to a large extent, also *Acartia*, *Calanus* and *Temora* occasionally, an *Oithona*, 2 zoëæ of *Carcinus mænus* and a few eggs (copepod ?). Adolescent stages from Cawsand contained *Calanus*, *Temora* and *Podon*. *Gadus luscus* contained copepod remains ; adolescent stages of *G. pollachius* contained chiefly *Calanus* and *Temora*. *Lepadogaster* had eaten *Temora* (young copepodid stages and nauplii), other copepod and *Balanus* nauplii, larval bivalves and harpacticids. *Scomber* chiefly with copepod nauplii (especially *Temora* and *Calanus*), *Podon*, *Evadne*, euphausiid larvæ and eggs (copepod ?). *Molva molva* with *Calanus*, *Pseudocalanus*, *Paracalanus* and *Podon*. *Merlucius merluccius* with *Pseudocalanus*, *Trachinus vipera* chiefly *Temora*, especially the nauplii and young copepodid stages, *Podon*, eggs (copepod ?) and *Pseudocalanus*. *Trigla gurnardus* chiefly with *Pseudocalanus* and *Paracalanus*, an occasional *Temora*, *Calanus*, *Podon* and copepod nauplii. Decapod larvæ including a crab zoëa occurred twice in *Trigla* and remains of fish once. *Blennius* sp. contained copepod remains, *Podon* and copepod eggs. *Rhombus maximus* with *Podon*, and *Calanus* nauplii, *Rhombus lævis* with young *Temora* and nauplii and other copepod nauplii. *Pleuronectes limanda* with *Temora* and *Pseudocalanus*, adolescent stages from the Cattewater with chiefly *Calanus*, also harpacticids, *Acartia*, larval decapods including *Gebia* and crab zoëæ and once the remains of a fish. One *Pleuronectes flesus* from the Cattewater, 30 mm., contained crustacea remains. *Pleuronectes microcephalus* contained *Temora* nauplii, *Arnoglossus* sp. no food, *Scophthalmus norvegicus* chiefly *Acartia*, a fair number of *Pseudocalanus*, *Oithona*, copepod nauplii (chiefly *Temora* and *Calanus*) an occasional *Paracalanus* and *Metridia*. *Ammodytes laceolatus* contained *Acartia*, *Pseudocalanus*, *Paracalanus* and eggs (copepod ?).

In the tow-nets *Pseudocalanus* was abundant at times, but sometimes not present at all. *Calanus* was common throughout the month, *Temora* and *Acartia* also common, *Paracalanus* not uncommon, *Podon* very common, *Evadne* common at times ; *Balanus* nauplii reappeared this month. Decapod larvæ abounded but were only rarely taken by the fish. Mollusk larvæ fairly common.

AUGUST.

In August nearly all the fish were from the Young Fish Trawl. The few Sprat present contained no food, Pilchard chiefly no food but a few copepod nauplii and eggs. Young *Labrus* (*bergylta* type) were much less abundant and still containing *Temora*, *Pseudocalanus* and *Podon*. Adolescent stages from Cawsand containing harpacticids, and adolescent *L. mixtus* containing remains of decapods and harpacticids. Adolescent *Crenilabrus melops* contained young amphipods and harpacticids. *Ctenolabrus rupestris* contained young *Temora*, *Temora* nauplii and other copepod nauplii, whilst the adolescent stages contained remains of decapods, amphipods and harpacticids. All these adolescent labrids came from Cawsand Bay, where they were feeding on the commonest crustacean food. *Caranx trachurus* were eating chiefly *Temora* nauplii, *Pseudocalanus* and *Podon* with a few *Paracalanus*, *Centropages*, *Coryceus*, *Halosphæra* and *Coscinodiscus*. *Scomber* chiefly with copepod nauplii, especially *Calanus* and *Temora*, and a good many *Podon*, eggs (copepod ?) were also present and some fish remains. *Trachinus vipera* chiefly with *Temora*, but also with *Pseudocalanus*, *Podon* and *Evadne*. Adolescent stages from Cawsand with mysids, *Crangon* and amphipods which abound in the water where they feed. *Trigla gurnardus* chiefly with

Pseudocalanus, also *Calanus* nauplii, *Paracalanus*, euphausiid larvæ and a crab zœa. The young gobies and *Callionymus* with various copepods, adolescent stages of *Gobius minutus* with harpacticids and larval decapods, of *G. pictus* with amphipods decapod larvæ and annelids, of *G. Ruthensparri* with many larval gastropods and bivalves, *Pseudocalanus* and decapod larvæ, of *Crystallogobius* with *Temora* and other copepods. Adolescent stages of *Callionymus* with small *Pecten opercularis*, *Montacuta* (?), *Nucula*, *Lacuna* and *Modiolaria*, also amphipods, harpacticids and decapod larvæ including crab megalopæ. *Lepadogaster Candolli* with *Pseudocalanus*, *Podon*, *Evadne* and copepod nauplii (*Temora* and others); *L. bimaculatus*, which occurs in the deeper water, almost entirely with *Temora*, *Rhombus maximus* with euphausiid larvæ, *R.* with eggs (copepod ?). *Pleuronectes limanda*, adolescent, with harpacticids. *Arnoglossus*—no food except two which contained *Pseudocalanus*. *Scophthalmus norvegicus* with chiefly *Acartia*, also *Pseudocalanus*, *Calanus*, *Paracalanus*, *Podon*, the nauplius of *Temora*, and eggs (copepod ?). *Gadus merlangus* with chiefly *Calanus*, also *Pseudocalanus* and *Acartia*, whilst one adolescent stage contained *Calanus*. Adolescent stages of *Gadus pollachius* from Cawsand chiefly with fish remains amongst which were *Gobius Ruthensparri*, which occur there in great numbers, and *Labrus* sp., also decapods. Adolescent stages of *Gadus minutus* from Cawsand chiefly with decapod remains (*Pandalus*, *Leander*, *Crangon*, *Eupagurus*) and copepod remains (*Calanus*, *Temora* and others), also *Podon*. *Merlucius merluccius* with *Calanus* only. *Ammodytes lanceolatus* with *Paracalanus*, *Pseudocalanus* and, once, a *Temora*. *Spinachia vulgaris* from Cawsand with *Pandalus*, *Crangon* and other decapod remains.

The tow-nets contained an enormous number of larval mollusks and the pteropod *Limacina*. The latter was not eaten so far as was observed, but *Gobius Ruthensparri* had eaten a large quantity of larval gastropods, and *Callionymus* had eaten many of the fully formed mollusks. *Calanus* and *Temora* were abundant, *Acartia* very common, *Pseudocalanus* and *Calanus* not so common, *Anomalocera Pattersoni* occurred fairly often and was eaten by *Gadus minutus*. *Podon* was still present in numbers and was eaten by several fish. Larval decapods abounded and formed the food of several of the adolescent fish, the smaller fish still keeping almost entirely to the copepods and *Podon*.

SEPTEMBER.

In September many of the fish were caught in midnight hauls, Sept. 8th and 9th; a good many also were adolescent stages from Cawsand. None of the Pilchards examined contained any food. One adolescent *Labrus bergylta* contained harpacticids; adolescent *Crenilabrus melops* contained amphipods and harpacticids, and adolescent *Ctenolabrus* *rupestris* contained amphipods, decapods and copepods. *Mullus surmuletus* with amphipod and harpacticid remains. *Caranx trachurus* with *Centropages typicus*, *Calanus*, *Acartia*, *Pseudocalanus*, *Temora*, *Coryceus*, *Oithona*, *Podon* and eggs (copepod ?), whilst the adolescent stages contained chiefly larval gastropods. Adolescent *Trachinus vipera* with *Crangon*, mysids and amphipods. A *Trigla gurnardus* from a midnight haul, 22 mm., and a *Trigla* sp., 15 mm., both contained *Calanus*. The *Gobius* species and *Crystallogobius* contained various copepods, but these and *Callionymus* were not specially examined. *Rhombus maximus* contained larval gastropods, *Pseudocalanus* and a *Calanus*, one adolescent specimen containing a *Callionymus*. Adolescent stages of *Pleuronectes limanda* with amphipods, cumaceids, larval gastropods and bivalves and harpacticids. *Pleuronectes microcephalus*, midnight haul, with no food. Adolescent stages of *Pleuronectes platessa* with remains of amphipods, annelids, cumaceids and a *Solen*. *Arnoglossus laterna*, adolescent stages, with remains of amphipods, mysids, *Crangon vulgaris* and *trispinosus*, *Leander*, *Pandalus*, *Calanus*, *Centropages* and harpacticids. Smaller specimens of *Arnoglossus* with no food. Adolescent stages of *Gadus merlangus* with *Temora*, *Calanus* and remains of decapod larvæ, of *Gadus luscus* with *Acartia*, *Labidocera Wollastoni* and the larva of *Eupagurus*, of *Gadus minutus* with *Calanus*, *Temora*, *Candacia*, *Pseudocalanus*, *Labidocera*, decapod larvæ including *Leander*, *Crangon*, *Eupagurus* larva and mysids. *Raniceps raninus* with *Calanus*. Adolescent *Ammodytes tobianus* from Whitsand Bay with larval gastropods, larval decapods, *Centropages*, *Acartia*, *Oithona* and other copepods. Post-larval *Ammodytes lanceolatus* with *Pseudocalanus*.

The tow-nets again contained large quantities of larval gastropods and bivalves, and also *Limacina*. The larval gastropods were eaten in numbers by the adolescent *Caranx trachurus* and *Pleuronectes limanda*, also by young *Rhombus maximus*. *Acartia* and *Calanus* were the commonest copepods eaten by many of the fish, *Temora* fairly common, *Pseudocalanus* usually present but not very abundant, *Centropages typicus* fairly common, eaten by *Caranx trachurus* and adolescent *Arnoglossus laterna*; *Oithona similis*, *Candacia armata* and *Podon* occurred sparingly, *Oithona* and *Podon* eaten by *Caranx*, *Candacia* eaten by *Gadus minutus*.

The young fish were not collected after September.

CLUPEIDÆ.

CLUPEA SPRATTUS L. Sprat.

One hundred and twenty-two specimens, 2–22 mm. in length, were examined from the tow-nets February to June. Towards the end of March the newly hatched Sprats brought in from the tow-nets were too numerous to count, and a large number of eggs of the same species were also brought in. The first young were seen on February 4th, 2 mm. in length, but these contained no food. Out of 122 specimens 116, ranging from 2 to 22 mm., contained no food ; 3 contained green food remains ; 1 of 15 mm. contained 18 *Pseudocalanus ;* 1 of 22 mm., May 16th, contained 2 *Pseudocalanus ;* 1 of 20 mm., May 13th, contained an harpacticid and an egg (copepod ?).

Other records are the following :—

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
A	1	2	16–18	No food.
	56	4	19–23	,,
C	Cawsand, July 2	1	55	*Porcellana* larva and copepod remains.

Previous records show many of the very young with green food remains inside, many empty, a few with unicellular organisms and a few with copepods. One of 8 mm. in July contained two *Temora* nauplii, while larger specimens, 27 and 32 mm., contained *Pseudocalanus*, *Balanus* cypris larvæ and larval gastropods. It is evident that the Sprat at an early age eats small copepods in the nauplius stage and adult copepods only a little later.

CLUPEA PILCHARDUS Walb. Pilchard.

Two hundred and seventy-one Pilchards were examined, chiefly from the Young Fish Trawl, but very few contained any food.

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
A	2	3	15–18	Eggs (copepod ?).
		1	18	Copepod remains.
		64	12–25	No food.
	3	2	15–19	*Pseudocalanus.*
		1	13	Remains of copepod nauplius.
		1	20	Remains of small crustacea, probably copepods.
		8	13–19	No food.
	4	1	20	*Calanus* nauplius.
		2	14–19	No food.
	13	1	14	Young *Acartia.*
		1	14	*Oithona similis.*
		18	13–24	No food.
	31	2	12–19	Copepod nauplii.
		6	11–14	No food.

Net.	Haul.	No. of Individuals.	Length. in mm.	Food.
	38	27	10–23	No food.
	39	11	9–15	„
	40	3	10–21	„
	42	4	13–24	„
	43	4	13–22·5	„
	44	14	11–18	„
	45	10	10–20	„
	46	23	9–24	„
		1	22	Copepod nauplius three eggs (copepod ?).
		1	22	Egg (copepod ?).
	47	21	12–22	No food.
	48	2	14–15	„
	56	3	16–22	„
D	Cawsand Bay, Aug. 20	3	20–23	„
D	Rame Head, N.N.W., Mewstone, E.N.E., Aug. 21	13	19–22	„
F		8	17–21	„
B	7	2	20	„
Coarse Tow-net, Eddystone–Looe, July 14		3	15–21	„
Coarse Tow-net outside Breakwater, July 22		2	19–20	„
Coarse Tow-net on Young Fish Trawl, July 21		2	18–22	„
Coarse Tow-net, Polperro–Looe Is., July 25		1	18	„

Thus out of 271 specimens ranging from 9 to 25 mm. only 13 contained any food. In 3 cases the food consisted of 1 egg each (probably copepod); in 3 cases definite copepods, *Pseudocalanus*, *Acartia* and *Oithona;* in 4 cases copepod nauplii; in 1 case copepod remains not identifiable; and in 1 case crustacea remains, probably copepod.

Previous records show 1 out of 13 to have food inside, and that a copepod. Thus in every case when food occurred it consisted of copepods in some form (taking the eggs to belong to a copepod).

CLUPEA HARENGUS L. Herring.

One thousand and thirty-two young Herring, 8–15 mm. in length, were examined from the tow-nets from inside and outside the Breakwater in January and February; 725 of these contained no food.

Out of 198, Jan. 13th, 10 (8–11 mm.) contained larval gastropods, 6 also contained larval bivalves, 2 also copepod nauplii, 3 also young copepods, and 2 also *Tintinnopsis* sp.; 6 contained *Pseudocalanus*, 3 contained larval bivalves, 2 contained young *Coryceus*, 1 a *Balanus* nauplius, 1 a copepod nauplius and 1 a *Coscinodiscus* sp.

Out of 358, Jan. 17th, 36 (7–12 mm.) contained larval gastropods and 1 also contained a *Pseudocalanus*; 5 contained only *Pseudocalanus*, 1 a young *Coryceus*, 2 a larval bivalve and 1 an harpacticid.

Out of 25, Jan. 21st, (9–16 mm.), 4 contained larval gastropods, 1 also a *Pseudocalanus* and 2 (10·5–16 mm.) contained only *Pseudocalanus*.

Out of 20, Jan. 24th (9–11 mm.), 1 contained a larval gastropod, 1 (10 mm.) an *Oithona similis*, 1 (9 mm.) a *Pseudocalanus*, and 4 copepod nauplii, and 1 (11 mm.) a *Pseudocalanus* only.

Out of 11, Jan. 27th, 1 (11 mm.) contained copepod remains.

Out of 5, Jan. 29th, 1 (10 mm.) contained a *Pseudocalanus*.

Out of 5, Jan. 31st, 2 (10–11 mm.) contained *Pseudocalanus*.

Out of 16, Feb. 4th, 2 (11 mm.) contained *Pseudocalanus*.

Out of 6, Feb. 6th, 1 (12 mm.) contained a larval gastropod and 1 (12 mm.) a *Paracalanus* and an *Acartia*.

Out of 10, Feb. 7th, 1 (8·5 mm.) contained a *Balanus* nauplius.

Out of 11, Feb 12th, 4 (11–13 mm.) contained *Pseudocalanus* and 1 contained copepod remains.

Out of 3, Feb. 18th, 1 (11 mm.) contained a *Balanus* nauplius.

Out of 7, Feb. 20th, 1 contained an egg (copepod). None of the others contained food.

Larval gastropods occur most frequently as food of the young Herring, being present in 176 altogether from 8–12 mm. Larval bivalves occur in 10 (7–11 mm.), *Pseudocalanus* occurs in 29 (8·5–16 mm.), *Coryceus* in 2 (9–10·5 mm.), *Paracalanus* in 1. Young copepods occur in 4, copepod nauplii in 2, *Tintinnopsis* sp. in 3, *Coscinodiscus* sp. in 1, *Balanus* nauplii in 1. Therefore larval gastropods are much the commonest, small copepods coming next. The yolk sac was still present in many of the specimens up to 9 mm., but, as before, it was found that food may be taken at 7 mm., even when the yolk sac is present.

Previous records agree in the large number without any food inside, green food remains sometimes being found in the very smallest, with occasional diatoms, afterwards larval gastropods and bivalves, copepod nauplii and small adult copepods, *Balanus* nauplii also being taken fairly frequently. In 1917 some of the young Herring contained sand grains, and some contained various unicellular organisms, diatoms, Peridinians and, probably, *Halosphæra*. As noticed before, our own records agree with those of H. A. Myer (1880) with artificially reared Herring, which first contained greenish matter; later on larval mollusks, copepods and nauplii, the copepod diet increasing as the fish grew.

Thus all the three common Clupeoids, Herring, Sprat and Pilchard, feed on small copepods when they reach a certain size, the Herring specially liking larval mollusks when very small.

ANGUILLIDÆ.

ANGUILLA VULGARIS L. Eel.

One specimen in a tow-net from the region of the Panther, Feb. 4th, 76 mm. long, contained no food.

GADIDÆ.

GADUS MERLANGUS L. Whiting.

One hundred and eighty-nine Whiting were examined from the tow-nets, from inside and outside the Breakwater, April 3rd to July 1st, 3–17 mm. long. Sixty-six contained no food, 49 contained *Pseudocalanus*, 13 contained indistinguishable copepod remains, 15 contained copepod nauplii, 2 contained green food remains, 2 contained eggs (copepod ?), 2 contained larval mollusks, 4 contained *Temora* (all young except 1) and 1 a *Temora* nauplius. Nine contained *Acartia*, 1 contained *Paracalanus*, 1 an harpacticid, 1 a *Centropages typicus*, 1 a *Balanus* nauplius and 1 a zoëa of *Carcinas mœnas* (in the mouth). Sixteen contained *Calanus*, but all but one of these were in the mouth, having probably been taken after capture. The largest (17 mm.) contained *Pseudocalanus*. The Trematode *Derogenes varicus* occurred in 3, and *Pharyngora bacillaris* in 1.

The following records are from the other nets :—

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
A	1	1	6	2 *Temora* nauplii.
		1	8	2 *Pseudocalanus*, 2 *Carcinus mœnas* zoëæ (in mouth).
		1	9	No food.
	2	1	12	3 *Pseudocalanus*, 2 eggs (copepod ?).
		1	17	2 *Calanus*.
	4	6	8–14	*Pseudocalanus*.
		2	8–9	*Pseudocalanus* and copepod nauplii.
		1	7	*Pseudocalanus* and *Calanus* nauplii.

Net.	Haul.	No. of Individuals.	Length. in mm.	Food.
		1	14	*Pseudocalanus* and *Calanus*.
		1	17	*Pseudocalanus* and eggs (copepod ?).
		1	7	Remains of copepod nauplii.
	6	1	8	Copepod remains.
		1	11	No food.
		1	11	*Pseudocalanus*.
		1	12·5	2 *Podon*, 2 *Oithona*, 8 eggs (copepod).
	7	1	11	3 *Podon*, 3 *Acartia*, 1 *Pseudocalanus*.
		1	11	Copepod remains.
	8	2	6·5–9	*Pseudocalanus*.
		1	7	2 *Temora* nauplii.
	9	1	9	No food.
		1	7	Copepod remains.
		1	8·5	1 *Acartia*.
		1	10	1 *Calanus*.
		1	10	1 *Podon*, 3 *Acartia*, remains of young copepods.
		1	10 ca	*Pseudocalanus*.
		1	11	2 *Pseudocalanus*, 3 *Calanus* nauplii.
	11	3	6–7·5	No food.
		3	7–7·5	*Pseudocalanus*.
		1	9	2 *Acartia*, 1 egg (copepod ?).
		1	10	Copepod remains.
		2	10·5	*Temora* nauplii.
		1	11	*Calanus* (in mouth).
	12	3	5·5–7	No food.
		1	9	4 *Pseudocalanus*.
		1	5	2 *Pseudocalanus*, 1 *Calanus* nauplius.
		1	10·5	3 *Paracalanus*.
		1	6	Remains of copepod nauplii.
		2	9	Remains of young *Temora*.
		1	7	2 young *Temora*, 2 *Temora* nauplii.
		1	7·5	Copepod remains.
	13	1	7	No food.
		1	6	2 *Paracalanus*.
		1	9	3 *Pseudocalanus*.

Net.	Haul.	No. of Individuals.	Length. in mm.	Food.
		1	9	Copepod remains.
		1	10	1 young *Temora*, 1 *Paracalanus*
		1	11	2 *Acartia*, 1 *Temora*.
		1	13	2 *Temora*, 2 *Paracalanus*.
	19	1	13	1 *Pseudocalanus*, 2 *Acartia*, 1 *Oithona*.
	28	1	6	1 *Acartia*.
		1	7	No food.
		1	8	3 *Temora*, nauplii, 1 *Acartia*, 1 young *Pseudocalanus*.
		1	9	3 *Pseudocalanus*, 1 young *Acartia*.
		1	9	5 *Pseudocalanus*.
	29	1	12	Egg (copepod ?).
	32	1	20	No food.
		4	22–40	*Calanus*.
	33	1	8	1 *Pseudocalanus*.
	34	1	7	No food.
	35	2	5–6	,,
		1	7	3 *Acartia*.
		1	7·5	Copepod remains.
Coarse Tow-net, Rame Head N.E., Mewstone E. ½ S., July 21		1	13	5 *Pseudocalanus*, 1 *Calanus*.
E	Rame Head N.N.W. Mewstone E.N.E. bottom, Aug. 21	1	36	9 *Calanus*.
B	20	1	65	Copepods, chiefly *Temora*.
	21	1	70	No food.
	24	1	82	Remains of mysids.
	27	2	67	*Calanus* and remains of decapod larvæ.
	31	3	78–80	No food.
C	Cawsand, July 2	4	38	Copepod and *Podon* remains.
		1	45	Remains of *Hippolyte* (cf. *varians*), *Temora*, *Calanus*, harpacticids.
		1	48	*Podon*, *Calanus*.
		1	50	*Calanus*, *Temora*, *Hippolyte*.

One from the Young Fish Trawl, July 7th, 12 mm., contained the Trematode *Derogenes varicus*.

It is thus seen that, as before, the favourite food is copepods, and the copepod most frequently eaten is *Pseudocalanus*. As before noticed, *Calanus* is taken fairly often by those of 9 mm. and upwards, and it is often seized after capture, being in the mouth when examined. It is usually towards the middle of May and after that *Calanus* is taken, a fact coinciding with the usual rarity of *Pseudocalanus* at those times. Experimental feeding has shown that the Whiting prefers *Pseudocalanus* and *Acartia*, which are taken before *Calanus*, *Calanus* in its turn being preferred to *Temora*. Larger specimens, 22–75 mm., have been shown to eat fish.

GADUS LUSCUS L. Pouting.

Fourteen specimens from the tow-nets, from inside and outside the Breakwater were examined, February–May, 2·5–10 mm. Only 2 contained any food (6·5–7 mm.), both containing *Pseudocalanus*. One of 23 mm. caught in a hand net outside Chelson Meadow in the Laira, May 15th, contained remains of crustacea.

The following records are from the other nets :—

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
A	11	1	8	Copepod remains.
	73	1	14	,, ,,
		1	14	2 *Pseudocalanus*.
	81	3	11–13	No food.
		1	15	2 copepods (*Calanus* ?).
B	31	2	40–43	Copepod remains.
		1	33	Many *Acartia*.
		1	37	1 *Eupagurus* larva, 1 *Labidocera Wollastoni*.
C	Cawsand, July 7	1	43	Many *Podon*, harpacticids, *Temora*, *Calanus*.
		1	53	Harpacticids, *Calanus*, *Temora*.

Previous records show green food remains, unicellular organisms and copepod nauplii in the smallest specimens. At 4 mm. *Pseudocalanus* is taken, this again being the favourite food, other copepods eaten being *Calanus*, *Acartia* and *Candacia*.

GADUS POLLACHIUS L. Pollack.

One specimen from the coarse tow-net, near the Breakwater, May 20th, 13 mm., contained 1 young *Calanus*, 2 *Acartia* and 1 *Podon*.

The remainder examined were adolescent stages.

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
B	4	1	60	53 larval gastropods, indistinguishable food remains.
	5	2	113–114	No food.
		2	97	Remains of fish and decapods.
		1	76	1 *Hippolyte.*
		1	95	Decapod remains.
		24	75–115	Fish remains.
		1	91	Remains of *Labrus.*
		2	105–109	*Gobius Ruthensparri.*
C	Cattewater, June 20	1	44	*Leander* larva, *Calanus.*
		1	45	*Calanus, Temora, Oithona.*
		1	45	*Temora,* harpacticids
		1	45	Crab zoëa, *Temora, Calanus,* harpacticids.
		1	45	*Temora, Calanus.*
		1	45	Crab megalopa, *Calanus, Temora,* harpacticids.
		1	50	*Podon,* amphipods, crab zoëæ, *Temora.*
	Cawsand, July 2	1	44	*Leander, Calanus.*
		1	45	*Calanus, Temora, Oithona.*
		1	45	*Temora,* harpacticids.
		1	45	Crab zoëa, *Temora, Calanus,* harpacticids.
		1	45	*Temora, Calanus.*
		1	45	Crab megalopa, *Calanus, Temora,* harpacticids.

Previous records show that the young Pollack from 5·5 to 25 mm. eat chiefly copepods, the favourite again being *Pseudocalanus, Calanus* coming next. Apparently up to about 25 mm. or more copepods are almost exclusively eaten ; between 40 and 70 mm., copepods, larval decapods and larval mollusks ; after that fish seem to form the chief food.

GADUS MINUTUS O. F. MÜLLER. BIB (POOR COD).

Four specimens were examined from the tow-nets in May, from inside and outside the Breakwater, 6–13 mm. One contained no food, 2 contained copepod remains and 1, 13 mm., contained a *Pseudocalanus* and a young *Temora.*

The remainder were adolescent stages :—

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
A	56	1	40	*Crystallogobius*, many *Podon*, *Calanus*, *Temora*, remains of decapod larvæ.
	64	1	75	*Temora*.
		1	72	*Temora*, *Candacia*, decapod larvæ remains.
		1	51	*Temora*, decapod larvæ remains.
	72	1	64	Many *Acartia*.
		5	83–160	Decapod remains (*Leander* ?).
	73	5	69–110	*Crangon* remains.
	81	1	82	Many *Eupagurus* larvæ, *Calanus*.
		1	135	1 *Labidocera Wollastoni*, many *Calanus*.
		1	143	4 *Crystallogobius*, mysids, many *Calanus*.
B		3	97–105	*Pandalus Montagui*.
		3	90–102	Decapod remains.
		19	73–105	Indistinguishable.
	11	1	60	Crustacea remains.
	15	1	70	*Candacia*, *Temora*, decapod larvæ.
		1	78	Copepod remains, decapod larvæ, young amphipods and isopods.
	17	3	80–85	Copepod remains.
		1	80	No food.
		1	75	Many *Calanus*.
		1	85	*Calanus*, *Pseudocalanus*.
		1	95	Copepod and annelid remains.
	26	1	85	Many *Calanus*, decapod larvæ, *Candacia*.
	27	1	86	Copepod remains.
		1	92	Many *Calanus*, decapod larvæ remains.
		1	76	Many *Calanus*.

Previous records of young Bib from 6–14 mm. show *Pseudocalanus* as the favourite food. It is here shown that the food of the adolescent stages, from 40 to 160 mm., is chiefly crustacea—copepods, especially

Calanus and *Temora*, *Podon*, decapods and their larvæ, and, in a few cases, remains of fish (*Crystallogobius*). Only 2 out of 32 contained fish, crustacea being eaten more by the Bib than by the Pollack at this size.

The interesting fact is apparent that all the *Gadus* species common in this district—Whiting, Pollack, Bib and Pouting, in their young stages, eat *Pseudocalanus* more than anything else, *Acartia* and other small copepods also being taken, probably when *Pseudocalanus* is not so abundant. *Calanus* is taken by the larger but rarely by the smaller fish. Both *Temora* and *Calanus* are taken by the adolescent stages, which also eat the larger decapod larvæ, small amphipod, and other crustacea. So far as has been observed all but the Pouting may eat fish in the adolescent stages. This seems to be habitual in the Pollack, which will also take crustacea along with the fish, common in the Whiting, which can eat fish at 22 mm., but also eats many crustacea, and rare in the Bib, which occasionally eats *Crystallogobius*, but more often has been found to have eaten crustacea.

MOLVA MOLVA L. Ling.

Ten specimens from the Young Fish Trawl were examined :—

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
A	4	1	6	6 Copepod nauplii.
		1	ca 12	5 *Pseudocalanus*.
		1	15	Kept alive, died in 2 days, no food.
		1	15	No food.
	8	1	11·5	2 *Pseudocalanus*, other copepod remains.
	12	2	13–17	*Calanus*.
		1	10	4 *Paracalanus*.
		1	12	1 *Calanus*, 1 *Paracalanus*.
		1	15 ca	*Calanus*, *Podon*.

Again *Calanus* and *Pseudocalanus* are eaten and also *Paracalanus*. There are too few specimens to judge which is the favourite.

MERLUCCIUS MERLUCCIUS. Hake.

Twelve specimens were examined from the Young Fish Trawl :—

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
A	28	1	5·5	*Pseudocalanus*.
	44	1	5	*Calanus* nauplii.
	47	1	13	*Calanus* remains.
	63	1	9·5	,, ,,
	64	4	8 ca–10	,, ,,
	66	2	7–8	,, ,,
		1	11	No food.
	69	1	10	*Calanus* remains.

From these few observations it seems likely that the young Hake, like the *Gadus* species, begins by taking *Pseudocalanus*, *Calanus* afterwards being frequently eaten.

RANICEPS RANINUS L. Lesser Forkbeard.

One specimen from the Young Fish Trawl (Haul 67), 12 mm., contained remains of *Calanus*.

ONOS Sp. Rockling.

These are probably *Onos mustela*, but the identification is not certain. Out of 6 from the tow-nets from inside and outside the Breakwater, May–July, 4–10 mm., 2 contained no food, 1 a young *Temora*, 1 a copepod nauplius, 1 copepod remains and 1 an egg (probably copepod).

The following are other records :—

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
A	2	1	6	Egg (copepod ?).
		1	8	Larval gastropod.
	4	1	5·5	No food.
	13	1	6·5	1 *Acartia*, 5 copepod nauplii.

Previous records show *Pseudocalanus* and young *Temora* as food, also *Oithona* and other copepods. In captivity the young Rockling ate almost anything and specimens from the Cattewater (12–27 mm.) contained larval gastropods, harpacticids and larval decapods.

BOTHIDÆ.

ARNOGLOSSUS Sp.

Very few of the young *Arnoglossus* contained any food :—

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
A	47	2	10–11·5	*Pseudocalanus*.
		5	7–9·5	No food.
	58	1	15	*Pseudocalanus*.
		1	14	No food.
	1	2	9–11·5	,,
	13	4	8–15	,,
	14	1	7·5	,,
	29	2	4·5–6	,,
	31	7	8–21	,,
	32	1	6	,,

Net.	Haul.	No. of Individuals.	Length. in mm.	Food.
	33	2	5–5·5	No food.
	34	5	5–13	,,
	35	4	5–16	,,
	37	11	9–16	,,
	38	7	5–9	,,
	39	10	5–9	,,
	40	1	8	,,
	42	3	7–14·5	,,
	43	6	7–17	,,
	44	9	5–11	,,
	46	4	11–19	,,
	48	11	5–16	,,
	54	1	10	,,
	56	9	13–18	,,
	57	1	7	,,
	63	4	8–17	,,
	64	6	6–9	,,
	69	5	9–13	,,
	70	10	10–19	,,
	71	4	9–20	,,
B	6	6	7–25	,,
	12	6	17–24	,,
	*17	4	90–100	Amphipod remains.
		1	96	No food.
		1	95	Remains of *Crangon*, *Leander* and amphipods.
		1	98	*Crangon* remains.
		2	100–105	Remains of amphipods and decapods.
		1	115	Remains of amphipods and mysids.
	21	3	42–105	*Crangon* remains.
	23	1	44	2 *Crangon trispinosus*.
	24	1	46	Mysid remains.
	25	1	95	*Crangon* remains.
	29	1	35	4 *Calanus*, 2 young amphi pods.
	30	1	92	1 *Pandalus*, 1 mysid, 2 amphipods.
	1	1	100	Mysid and amphipod remains.
	31	1	24	Harpacticids.

Net.	Haul.	No. of Individuals.	Length. in mm.	Food.
		1	26	2 *Centropages typicus*, harpacticids.
		1	28·5	1 *Centropages typicus*.
		1	44	Mysid and amphipod remains.
		1	104	Young *Crangon vulgaris*, mysid and amphipod remains.

From * the adolescent stages all belong to *Arnoglossus laterna* and most of the younger forms are probably that species.

Previous records show an enormous number of empty fish, and when food is present it is nearly always *Pseudocalanus* or some other small copepod, or else unicellular organisms. It seems very probable that the usual food up to about 20 mm. or more is chiefly soft and unicellular, the remains of which would not be easily seen. At and after 24 mm. more copepods are eaten, often large species, and over 40 mm. larger crustacea-decapod larvæ, and adult *Crangon*, mysids and amphipods.

RHOMBUS MAXIMUS L. Turbot.

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
A	28	1	7	4 *Podon*, 1 *Calanus* nauplius.
	37	1	6	2 Euphausiid larvæ.
	57	1	8	7 larval gastropods, 1 *Pseudocalanus*, 1 *Calanus* nauplius.
B	23	1	98	1 *Callionymus lyra*.

The few records previously given show copepods (*Temora* and *Centropages*), *Balanus* nauplii and an amphipod *Apherusa* as food.

RHOMBUS LÆVIS Rondel. Brill.

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
A	14	2	4–5	*Temora* nauplii.
		1	5	3 Calanoid nauplii, 1 *Temora* nauplius.
		1	5	8 Calanoid nauplii.
		1	5	1 young *Temora*, 3 *Temora* nauplii.
		1	5	1 egg (copepod ?).
	17	1	4	Calanoid nauplii, remains of young copepod.
D	Rame Head, bearing N.N.W., 3 miles, Aug. 21	1	6	6 eggs (copepod ?).

Previous records of Brill, 14–18 mm., show various copepods, *Podon*, decapod larvæ and larval mollusks. Those from about 25 mm. had eaten young fish.

SCOPHTHALMUS NORVEGICUS Gunther.

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
A	3	1	9	2 *Pseudocalanus* 2 *Oithona*.
		1	9	2 *Acartia*.
	4	3	5·5–9	No food.
		2	9	*Pseudocalanus*, *Acartia*.
		3	8–9	*Pseudocalanus*.
		1	5·5	*Calanus* nauplius, *Temora* nauplius.
		1	5·5	*Calanus* nauplii.
		1	6	1 *Oithona*, 1 *Calanus* nauplius.
		1	6	1 *Pseudocalanus*, 1 *Oithona*, 1 young *Temora*, 1 *Calanus* nauplius.
		1	7	2 *Oithona*, 1 young *Pseudocalanus*, 2 copepod nauplii.
		1	9	2 copepod eggs.
		1	9	3 *Pseudocalanus*, 1 *Calanus*.
		1	9	3 *Acartia*.
		1	9	1 *Calanus*, 2 *Acartia*, 1 *Pseudocalanus*, 3 young *Temora*.
	13	1	4·5	No food.
		2	6·5	*Oithona*.
		3	6·5–7	Copepod remains.
		24	6·5–11	*Acartia*.
		6	6·5–9	*Acartia*, *Oithona*.
		1	6·5	*Pseudocalanus*, *Oithona*.
		2	9–10	*Pseudocalanus*, *Acartia*.
		4	7·5–9	*Paracalanus*, *Acartia*.
		1	7	*Paracalanus*, *Oithona*.
		1	7	5 *Acartia*, copepod nauplius.
		1	6·5	1 *Oithona*, 1 *Temora* nauplius, 1 Calanoid nauplius.
		1	7	1 *Temora* nauplius, 1 *Paracalanus*.
		1	7·5	1 *Oithona*, 1 Calanoid nauplius.
		1	8	2 *Acartia*, 1 *Metridia*.
		1	8	7 *Acartia*, 1 *Oithona*, 1 egg (copepod ?).

Net.	Haul.	No. of Individuals.	Length. in mm.	Food.
		1	8	2 *Oithona*, 1 *Acartia*, 1 copepod nauplius.
		1	10	1 *Calanus*, 6 *Acartia*, 1 *Podon*.
	28	1	6·5	No food.
	31	3	6–8·5	,,
		3	8–9	*Acartia*.
		1	6	1 *Pseudocalanus*.
		1	8	1 *Pseudocalanus*, 1 *Temora* nauplius.
		1	8	Copepod remains.
	34	1	5	No food.
	47	1	8·5	*Pseudocalanus* remains, eggs (copepod ?).
Coarse Tow-net attached to dredge Eddystone–Looe, July 14		1	10	*Pseudocalanus*.
Medium Tow-net Penlee–Breakwater, July 15		1	4	*Temora* nauplius.

Comparing this with previous records we find much the same sort of food, but whereas from the 1914 material *Pseudocalanus* was the favourite food, *Acartia* is the favourite this year. It is evident that *Scophthalmus* prefers these two, but it is also fond of *Metridia*, which is larger, although it seldom takes *Temora*.

ZEUGOPTERUS PUNCTATUS (Bl.).

On April 30th one specimen, 11 mm. long, was brought in alive from near the Breakwater and kept alive for several days. It was almost completely symmetrical and swimming upright, and fed on small copepods, chiefly *Temora* and *Acartia*. Another on May 9th, 6 mm., died the next day and did not feed. One, April 30th, from the Knap, 5 mm., contained one *Temora* nauplius, 3, May 4th and 16th, Penlee and Knap, 4–5 mm., contained no food.

Previous records show that copepods are chiefly eaten, *Temora* being the favourite.

PLEURONECTIDÆ.

PLEURONECTES PLATESSA L. Plaice.

Two Plaice eggs occurred in the tow-nets, one from near the Breakwater, Feb. 4th, and one from the region of the Knap, Feb. 14th. Both hatched, and lived 14 and 12 days respectively. The second never ate, but the first hatched on Feb. 6th, and on Feb. 10th the yolk sac was nearly gone and the fish was feeding on diatoms which were growing on the bottom of the jar, chiefly *Navicula* sp. *Nitzschia closterium* was also growing in the jar. After Feb. 11th the Plaice looked ill and died on Feb. 20th.

On March 20th a Plaice 13 mm. long and metamorphosed occurred in the tow-nets from within the Breakwater, but contained no food.

Adolescent stages occurred as follows :—

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
B	20	3	105–120	Remains of amphipods and annelids.
		1	114	Remains of amphipods, annelids and harpacticids.
	23	1	111	Amphipod remains.
	24	1	97	Cumaceids, *Crangon* and amphipod remains.
		1	112	1 *Solen*, remains of annelids and amphipods.

PLEURONECTES LIMANDA L. Dab.

Sixteen specimens (5–12 mm.) from the tow-nets were examined, from inside and outside the Breakwater, April to June. Only two of these contained food, a *Temora* nauplius in one of 5 mm. and copepod remains in one of 12 mm. Other records are the following :—

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
A	4	1	13	2 *Pseudocalanus*, 5 *Temora*.
B	5	4	35–54	Harpacticids with sand and foraminifera.
	18	1	35	Copepod remains.
	20	2	58–63	Young amphipods.
		1	58	Young amphipods, cumaceid.
	21	1	27	Many young amphipods, larval bivalve, cumaceids, harpacticids.
		1	29	Amphipods, harpacticids, larval bivalves, larval gastropods.
		1	32	Young amphipods, larval gastropods, harpacticids.
		1	45	Larval gastropods, eggs (copepod ?).

Net.	Haul.	No. of Individuals.	Length. in mm.	Food.
		1	48	No food.
		1	48	Amphipods, larval gastropods.
		1	65	Young amphipods.
	24	3	50–68	Young amphipods, cumaceids.
		1	48	3 cumaceids, remains of *Crangon* and amphipods.
		1	48	Young amphipods.
		1	50	Young amphipods, larval mollusks.
C	Cattewater, July 2	8	20–30	Harpacticids.
		3	40–45	Harpacticids, *Calanus*.
		2	40	*Calanus*, crab zoëa.
		1	40	*Calanus*, *Temora*.
		1	40	*Calanus*.
		1	40	*Podon*, *Calanus*, harpacticids, crab zoëa.
		1	40	*Podon*, *Calanus*, harpacticids, *Acartia*.
		1	40	*Calanus*, harpacticids, crab zoëa.
		1	45	Harpacticids, *Temora*, *Acartia*.
		1	60	*Gebia* larva, crab megalopa, *Calanus*, *Ammodytes*.

Previous records show the food of the Dab from 4 to 17 mm. to be *Podon* and various copepods, *Temora* being the commonest, harpacticids, chiefly *Euterpina*, also being very common. It is now shown that in those from 20–60 mm. the food is again very often harpacticids, amphipods, cumaceids, larval decapods (often crab zoëæ), larval mollusks (chiefly *Calanus*) and also fish being taken. Copepods are, however, still the commonest food.

PLEURONECTES FLESUS L. Flounder.

From the tow-nets, Panther, May 13th, one of 10 mm. contained no food, 3 of 11 mm. on the same date were kept alive for some time and their feeding was interesting. When brought in there was a great deal of *Phæocystis* in the jar, which was just at this time flourishing in great abundance in the Sound and interfering considerably with the tow-nets. The little Flounders were feeding on this and still continued to do so in the aquarium. They were perfectly transparent, with the eyes in the process of coming over, but not completely in the adult position. On May 15th as the *Phæocystis* fouled the water, the water was changed and fine plankton given to the fish, which continued to eat green stuff, probably *Phæocystis* spores, and ignored the crustacea. On May 17th the colour was changing and the eyes completely turned. The food was still minute green organisms. On May 20th complete metamorphosis had taken place. One copepod (*Temora ?*) besides greenstuff was seen inside one specimen. On May 21st one died having a *Calanus* inside. The others were eating copepods, *Temora* and *Acartia*, the metamorphosis thus coinciding with change in diet. They still measure 11 mm. On May 27th some eggs of *Gobius* attached to a valve of *Cardium* were put into the aquarium, and feeding on these were some *Calma*, a nudibranch which eats *Gobius* eggs. The *Calma* had also laid eggs, and the Flounders were full of opaque food which was almost certainly the eggs of *Calma* which they must have eaten. These continued to eat small copepods until June 24th when they were killed.

On May 23rd a young Flounder, 9 mm. long and not yet metamorphosed, was caught in a tow-net in Chelson Meadow and kept alive in water $\frac{2}{3}$ fresh and $\frac{1}{3}$ salt, with some green freshwater weed in the aquarium. This Flounder was full of green food and ate minute food from fine plankton that was given to it. By June 15th it had metamorphosed and was eating small copepods.

In 1917 a Flounder of 10·5 mm. on May 31st was full of *Phæocystis*. Most of the others examined, not yet metamorphosed, contained no food, or else vegetable matter only. In one case diatoms were present (*Paralia* and *Fragillaria*).

Young metamorphosed Flounders occur habitually in large numbers up the rivers, their food being chiefly small crustacea.

It is thus shown that the usual food of the young Flounder up to about 11 mm., and before undergoing metamorphosis, is minute unicellular organisms, chiefly vegetable. After metamorphosis the diet apparently changes to copepods and other small crustacea.

PLEURONECTES MICROCEPHALUS Donov. Lemon Dab.

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
A	1	1	12	No food.
	4	2	9–11	*Temora* nauplii.
	15	1	8 ca	No food.
	26	1	11	2 *Temora* nauplii, 1 egg (copepod ?).
	28	1	7	72 eggs (copepod ?).
		1	8	No food.
	65	1	10	,,
B	11	1	19	,,

The last specimen contained the Trematode *Derogenes varicus*.

Previous records show many specimens with no food, and what there is consists chiefly of very small crustacea and unicellular organisms. It seems evident that the young *Pleuronectes microcephalus* is incapable of eating any large copepods and that its diet up to the time of metamorphosis consists of very small organisms, its food being more like that of the Flounder than of the Dab and Soles.

SOLEIDÆ.

SOLEA VULGARIS Quensel. Common Sole.

From the tow-nets one, 4 mm., April 11th, West Channel, contained no food. Three, 9–11 mm., April 1st to June 1st, from inside and outside the Breakwater were kept alive for some time and ate copepods of various kinds.

Previous records show copepods (*Temora, Euterpina, Oncæa*) and *Balanus* larvæ as the principal food.

SOLEA VARIEGATA Donov. Thickback.

From the tow-nets, 1 from New Grounds, April 5th, 4·5 mm., contained no food, 3 from Knap and Panther, April 30th, 7–8 mm., were kept alive, feeding on small copepods, but soon died.

Previous records show *Podon*, various harpacticids, *Temora, Balanus* larvæ and several other copepods as food of the post-larval Thickback.

SOLEA LASCARIS Bonap. Sand Sole.

Three live specimens from Panther and Knap, 2 of 7 mm., 1 of 8 mm., put into a small aerated aquarium. These were all quite symmetrical, and fed on small copepods, chiefly *Temora* and *Acartia*, from which they selected the smallest. All died.

It has been shown (Lebour, 1917) that the food of the flat-fishes agrees naturally with the large-mouthed and small-mouthed forms, and that the former take in copepods almost as soon as they are hatched and the latter only take these at a later stage. To the wide-mouthed group belong the Turbot, Brill, species of *Solea*, the Dab and probably the Plaice, *Zeugopterus* and *Scophthalmus;* to the small-mouthed group belong the Flounder, *Arnoglossus* and *Pleuronectes microcephalus*. The Flounder certainly takes unicellular organisms up to about 11 mm., the other two probably do also. When copepods are taken by these they are always small, generally *Pseudocalanus* and *Acartia*, very seldom *Temora*, except in the nauplius or young copepodid stages. *Arnoglossus* has a decided preference for *Pseudocalanus*, even at a length of over 19 mm., and *Pleuronectes microcephalus* also seems to prefer *Pseudocalanus*. The wide-mouthed forms, however, do not all prefer the larger copepods, for whereas all the species of *Solea* examined, the Dab, Turbot, Brill and

Zeugopterus have a decided preference for *Temora*, most of these are also fond of the small harpacticid *Euterpina acutifrons*, and *Scophthalmus*, which can eat an adult copepod almost directly it is hatched, most certainly prefers *Acartia* and *Pseudocalanus* and very rarely takes *Temora*, although it likes *Metridia*.

Nearly all these wide-mouthed forms and also *Pleuronectes microcephalus* will take *Podon*, which seems to be much beloved by most young fish.

SERRANIDÆ.

MORONE LABRAX L.

Two specimens from the region of the Panther Buoy in May and June, 6 mm. One contained copepod remains, the other no food.

CARANGIDÆ.

CARANX TRACHURUS L. SCAD.

Ninety specimens, chiefly from the Young Fish Trawl were examined in August and September, ranging from to 4 to 65 mm. :—

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
A	32	1	6	No food.
		1	8	Remains of *Temora* nauplius.
	44	7	4–6	No food.
		2	4·5–5	Copepod nauplii.
		1	5	Copepod remains.
		1	5	Egg (copepod ?).
		1	5	1 *Pseudecalanus*.
	45	2	7	Copepod remains.
	56	1	6	No food.
		3	8–9	*Temora*.
		6	6–7	Young *Temora*.
		2	6	Young *Temora*, eggs (copepod ?).
		1	6	1 young *Temora*, 1 young *Pseudocalanus*.
		1	7	3 young *Temora*, 2 *Calanus* nauplii
		1	7	1 *Temora*, 1 *Podon*, 1 egg (copepod ?).
	59	1	14	Copepod remains, eggs (copepod ?).
		1	24	1 *Calanus*, 1 *Acartia*, 1 *Podon*, eggs (copepod ?).
	60	1	15	No food.

Net.	Haul.	No. of Individuals.	Length. in mm.	Food.
		1	10	Many eggs (copepod ?).
		1	13	1 *Centropages typicus*, many eggs (copepod ?).
		1	13	1 *Centropages typicus*, 2 *Pseudocalanus*, many eggs (copepod ?).
	61	3	4·5–7	No food.
		1	9·5	3 *Acartia*.
		1	9·5	1 *Centropages typicus*, other copepod remains.
		1	25	1 *Centropages typicus*, 1 *Calanus*, several *Temora* and *Pseudocalanus*.
		2	8–11	No food.
	64	1	8	"
	70	1	10	3 *Temora*, 1 *Calanus*.
	71	1	35	Many *Acartia*, 1 *Coryceus*.
	72	1	11	4 *Pseudocalanus*.
		1	11·5	Copepod remains.
		1	14	1 *Oithona*, remains of *Pseudocalanus*.
		1	16	Many *Acartia*.
	73	1	19	Remains of *Calanus* and *Podon*.
	74	1	33	No food.
		2	49–60	Larval gastropods.
	78	1	39	No food.
B	7	1	20	6 *Pseudocalanus*, 1 decapod larva.
	22	1	35	Copepod and larval decapod remains.
	24	1	33	Larval gastropods.
	25	2	40–55	No food.
		4	47–48	Larval gastropods.
	27	1	45	Many *Calanus*.
		1	45	Copepod remains.
		1	50	Many *Acartia*.
F	Rame Head N.N.W., Mewstone E.N.E., Aug. 21	1	8·5	1 *Halosphæra viridis*, 1 *Coscinodiscus* sp., 2 *Paracalanus*.
		1	13	2 *Centropages typicus*, 2 *Podon*.
		1	17	3 *Coryceus anglicus*, 2 *Paracalanus*.

Copepods are certainly the commonest food of *Caranx* from the smallest size to the largest examined. A variety of copepods is taken including *Centropages typicus* and *Paracalanus parvus*, besides the commoner *Temora*, *Calanus*, *Pseudocalanus* and *Acartia*. This agrees with the few previous records. No special favourite is apparent, and crab zoëæ, *Porcellana* larvæ, *Podon*, and decapod larvæ are also occasionally taken and sometime larval gastropods in considerable quantities by the adolescent stages which seem to eat either copepods or mollusks. The occurrence of large numbers of larval gastropods in the tow-nets towards the middle of August and September shows that when available in masses they are eaten largely by this fish.

MULLIDÆ.

MULLUS SURMULETUS L. RED MULLET.

From B, haul 20, one of 58 mm. contained amphipod and decapod larvæ. One of 60 mm., haul 27, contained amphipod and harpacticid remains and one *Polystomella*.

AMMODYTIDÆ.

AMMODYTES TOBIANUS L. LESSER SAND EEL.

Sixty-nine specimens were examined from the tow-nets from inside and outside the Breakwater, Feb.–April, ranging from 4 to 9 mm. Fifty contained no food, 8 were kept alive and ate nothing but soon died, 10 contained green food remains and 1 a diatom (*Melosira*). One of 9 mm. contained indistinguishable crustacea remains.

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
A	2	1	13	No food.
	59	1	9	,,
B	11	1	120	Larval gastropods.
A	74	4	110–112	Larval gastropods, copepod remains.
		1	110	Larval gastropods, larval decapods, copepod remains.
	75	1	115	Several *Centropages typicus*, *Acartia*, *Oithona*, other copepod remains.
		1	140	Indistinguishable copepod remains.

The last specimen was full of a species of a Trematode, *Hemiurus* sp., occurring along with the food remains.

In previous records nearly all the young *Ammodytes tobianus* contained green food remains, 2 containing diatoms (*Coscinodiscus*) and 1 a copepod nauplius. The larger specimens, 19–21 mm., contained copepod remains, including *Pseudocalanus*.

AMMODYTES LANCEOLATUS Lesauv. Larger Launce.

Nearly all the specimens were from the Young Fish Trawl :—

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
A	2	5	10–20	No food.
		1	14	Egg (copepod ?).
	3	4	14–15	No food.
	13	19	9–19·5	,,
		6	9–11	Eggs (copepod ?).
		7	11–19	*Acartia.*
		3	14–18	*Pseudocalanus.*
		1	13	*Paracalanus.*
		2	14–15	Copepod remains.
	15	2	19–21	No food.
	16	2	10·5–14 ca	,,
		1	16	2 *Acartia.*
		1	16·5	20 eggs (copepod ?).
		1	17·5	1 *Paracalanus.*
		14	18	1 *Pseudocalanus*, 1 *Paracalanus.*
	24	1	7	Several eggs (copepod ?).
	56	13	12–21	Indistinguishable copepod remains.
		9	16–25	*Pseudocalanus.*
		1	24	*Pseudocalanus*, *Paracalanus*, *Temora.*
		1	23	No food.
		1	20	2 *Pseudocalanus*, 2 *Paracalanus.*
		2	18–19	*Paracalanus.*
	58	3	12–21	Copepod remains.
		1	18	2 *Pseudocalanus.*
	60	2	14–18	*Pseudocalanus.*
B	6	2	11–15	*Pseudocalanus.*
Coarse Tow-net Rame, N.W. ½ N., Mewstone, N.E. by E. ½ E., Aug. 21		1	17	No food.

The specimens previously recorded as *lanceolatus* and 'probably *lanceolatus*' may have been the 2 species mixed together, as they undoubtedly occur together at times in the summer, although *lanceolatus* is the commoner in that season. As the specimens were not kept, it is difficult to say whether the 2 specimens (8–10 mm.) containing green food remains and *Rhizosolenia* were truly *lanceolatus* (Lebour, 1918, p. 456). As these new records show, eggs and copepods are commoner in the young *lanceolatus*, green food remains in *tobianus*.

CALLIONYMIDÆ.

CALLIONYMUS LYRA L. DRAGONET.

Forty specimens from the tow-nets, inside and outside the Breakwater, March to July, 2·5–8 mm., 11 contained no food, 8 were kept alive and were fed on miscellaneous small plankton, chiefly small copepods. The remainder all contained copepods. Four, 3–5 mm., contained *Pseudocalanus*, 4 contained *Temora* (1 an adult, 2 the young copepodid stages, and 1 a nauplius). One of 6 mm. contained *Calanus*.

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
A	1	1	5	Copepod remains.
		1	9	4 *Pseudocalanus*, 1 *Paracalanus*, 3 *Podon*.
	2	1	5	5 copepod nauplii.
		1	6	1 *Acartia*.
	3	1	6	No food.
		1	6	1 *Temora*, 2 young *Temora*.
	4	8	6–9	No food.
		2	7	*Pseudocalanus*.
		3	6–8	*Calanus* nauplii.
		1	6	*Temora* nauplius.
		1	6	4 copepod nauplii, eggs (copepod ?).
		2	6–9	Copepod remains.
	13	1	3·5	No food.
Tow-nets Rame–Mewstone, July 21		1	4	1 *Pseudocalanus*, 1 *Temora* nauplius.
		1	5	6 *Temora* nauplii.
		1	5	2 *Temora* nauplii, 1 young *Temora*.
Coarse Tow-net, Penlee, July 23		2	8–9	Copepod remains.
Coarse Tow-net, Rame–Penlee, July 23		1	9	4 *Podon*.

A few adolescent and adult stages were examined from the Young Fish Trawl :—

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
B	5	1	45	Sand and foraminifera.
		1	50	Harpacticids.
		1	58	2 *Pecten opercularis*, other shell remains.
		1	68	5 *Pecten opercularis* (ca 5–6 mm.), 1 *Montacuta ?* 1 *Pandalus*.
C	Cawsand, Aug. 27	1	35	Harpacticids.
		1	65	Amphipod remains, crab megalopa.
		1	68	Amphipod remains, *Pecten opercularis, Nucula, Lacuna*.
		1	70	Crustacea remains, *Modiolaria*.
		1	123	Decapod remains, *Pecten opercularis*.
	Cawsand, Aug. 18	1	40	Young amphipods.
		1	40	Young amphipods, sand.
		1	45	Young amphipods, sand, shell remains.
		1	85	Copepod and shell remains.

The above records from the young stages agree with those of previous years, miscellaneous food, chiefly copepods of various kinds, being eaten. The adolescent stages often take mollusks, with amphipods, decapods and copepods.

LABRIDÆ

The food of the young labrids has been investigated for the last two years almost entirely on the form called *Labrus bergylta*, with a few specimens of *Ctenolabrus rupestris*. This year in addition to these the young of *Labrus mixtus* has been examined, and also adolescent stages of all three, and also of *Crenilabrus melops*, which are all common in Cawsand Bay, feeding among the *Zostera*.

LABRUS SP. (BERGYLTA TYPE).

Sixty were examined from the tow-nets, May to August, from the region of the Breakwater, Penlee, Rame, Mewstone and Eddystone, 3·5–12 mm. long. Of these 48 contained copepod nauplii (26 containing *Temora* nauplii clearly identified, most of the others probably being *Temora* and the rest *Calanus*). Thirteen contained young *Temora* and 1 an adult *Temora ;* 3 contained *Pseudocalanus* and 1 an *Acartia*, 1 an *Oithona*, 1 harpacticids ; 8 contained *Podon*, 2 contained *Balanus* nauplii and 1 a larval gastropod.

Net.	Haul.	No of Individuals.	Length in mm.	Food.
A	1	1	7	1 *Podon*.
		1	7	1 larval gastropod, 3 larval bivalves, 1 *Podon*, 1 *Paracalanus*.
		1	7	2 *Podon*, 3 harpacticids, 1 larval bivalve.
		1	7	2 *Podon*, 3 harpacticids, 1 larval bivalve.
	3	1	5	Copepod remains.
	4	2	6	*Temora* nauplii.
		1	6	No food.
	13	1	6	2 *Temora* nauplii, 1 copepod nauplius indet, 1 egg (copepod ?).
		1	6·5	2 *Temora* nauplii, 2 Calanoid nauplii.
		1	8	5 young *Temora*, 1 *Oithona*.
	54	1	8	8 young *Temora*.
B	5	1	37	Harpacticids, 1 *Polystomella*.
	27	1	45	Harpacticids.

Thus of these 81 specimens from all parts, the majority contained *Temora*, either in the young copepodid stages or as nauplii, chiefly as nauplii. Other small copepods, such as *Oithona* and *Acartia*, are also taken, *Podon*, *Balanus* nauplii and occasional larval mollusks. The investigations of the previous two years show the same preference for copepod nauplii, especially *Temora* and also its other young stages. Twenty-one out of 54 (16 containing no food) in 1918 contained *Temora*, and 20 out of 39 in 1917 contained copepod nauplii, chiefly *Temora*.

LABRUS MIXTUS L.

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
A	1	1	10	6 *Podon*, 2 harpacticids.
		1	10	3 *Podon*, 1 *Pseudocalanus*.
		1	10	2 *Podon*, 2 *Pseudocalanus*, 1 *Paracalanus*.
		1	11	4 *Podon*, 1 *Temora*, 1 *Temora* nauplius.
		1	11	1 *Podon*, 2 *Temora*.
	13	2	9–9·5	*Acartia*.
		1	8	2 *Temora* nauplii, 1 egg (copepod ?).
		1	9	1 young *Temora*, 2 copepod nauplii, 1 egg (copepod ?).
		1	9·5	1 copepod nauplius, other copepod remains.
		1	10	1 *Oithona*.
		1	12	1 euphausiid larva.
	16	1	8	5 eggs (copepod ?).
B	4	2	39–44	Many harpacticids, decapod remains.
	5	1	37	No food.

Labrus mixtus thus eats copepods, but more of the small adults than the nauplii.

CRENILABRUS MELOPS (L).

These were all adolescent stages.

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
B	4	2	25–38	Harpacticids.
		4	30–35	Harpacticids and amphipods.
	5	1	22	Harpacticids and ostracods.
		1	23	No food.
	25	1	27	Young amphipods.
		1	33	Young amphipods, *Idotea*.
	27	1	33	Harpacticids.
		1	48	Amphipod remains.
C	Cawsand, Aug. 27	6	33–35	Amphipod and harpacticid remains.
		1	33	Amphipod remains.
		1	35	Amphipod and harpacticid remains, *Polystomella*.

These 18 specimens show the ordinary food of these adolescent stages to be harpacticids and amphipods.

CTENOLABRUS RUPESTRIS (L).

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
A	2	1	10	2 *Podon*, 1 *Calanus* nauplius.
	13	1	10	Copepod remains.
		1	10	2 *Podon*, 4 *Temora*.
		1	10	4 *Podon*, 1 *Temora*, other copepod remains.
	31	2	8	Young *Temora*.
		1	8	2 Calanoid nauplii, 2 *Temora* nauplii.
		1	8	3 copepod nauplii.
		1	8·5	2 *Calanus* nauplii.
		1	9	No food.
	32	1	7	,,
		1	9	Copepod remains.
	43	1	9	Remains of young *Temora*, *Temora* nauplii.
B	4	6	30–37	Decapod remains (chiefly *Crangon*).
		1	34	Harpacticids.
		1	34	Decapod remains, foraminifera.
		1	37	Harpacticids, 1 foram.
	5	2	36–37	Harpacticids.
		1	29	Young amphipods and harpacticids.
		1	37	Remains of decapod larvæ, young amphipods and harpacticids.
	24	1	33	Harpacticids.
	27	1	29	Amphipod and copepod remains.
		1	33	Remains of decapods.
		1	45	Amphipod remains.
C	Cawsand, Aug. 27	5	32–35	Amphipods.
		2	31–32	Amphipods, harpacticids and decapod remains.
		10	33–35	Harpacticids and amphipods.
		1	32	Amphipods and decapod larvæ.
		1	39	Amphipods, branched alga.
		1	35	Remains of harpacticids and amphipods, *Polystomella*.

It is thus evident that the food of *Ctenolabrus* consists of small copepods and *Podon* (*Temora* still being the favourite) in the smaller forms. In 1918 4 of 8–9 mm. were examined, 3 of which contained *Temora*. In the adolescent stages the food is amphipods and harpacticids with decapod larvæ.

All these young labrids seem to feed on much the same food: young copepods and *Podon* with occasional larval mollusks up to about 12 mm., *Temora* being the favourite food and *Temora* nauplii being specially frequent. Sizes between 12 and 28 mm. were seldom taken. After 28 mm. they eat chiefly amphipods and harpacticids with, less frequently, some decapod larvæ and isopods, all of which abound where the fish are feeding. An occasional *Polystomella* occurs inside the fish. These foraminifera are very common among the *Zostera* and are probably not taken in intentionally. In only one case a piece of alga was found inside a *Ctenolabrus*.

The food does not materially differ in young specimens from shallow or deeper water, *Temora*, usually in its larval state, being generally the commonest food at any depth where the fish are taken; this agreeing with records in former years.

TRACHINIDÆ.

TRACHINUS VIPERA C. AND V. LESSER WEEVER.

Most of the specimens were from the Young Fish Trawl:—

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
A	2	1	5	No food.
		1	5	Copepod remains.
		1	6	2 *Podon*.
	4	1	5	No food.
		2	5	*Calanus* nauplii.
	13	2	4·5–6	*Temora* nauplii.
		1	4·5	1 *Temora* nauplius, 1 egg (copepod ?).
		5	5–6·5	Young *Temora*, *Temora* nauplii.
		1	6	Young *Temora*.
		1	6	Young *Temora*, *Podon*.
		2	6–6·5	Remains of copepod nauplii.
		1	7	3 *Temora*, 1 *Pseudocalanus*.
	16	1	5·5	1 *Podon*, 2 copepod nauplii.
		1	6·5	1 *Podon*, 6 *Temora* nauplii, 2 eggs (copepod ?).
	32	2	5·5–7·5	*Temora*, eggs (copepod ?).
		1	6	No food.

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
F	Rame N.N.W., Mewstone E.N.E., Aug. 21	1	7	2 *Pseudocalanus*, 6 *Podon*, 1 *Evadne*.
B	20	1	78	No food.
	22	1	78	Remains of *Crangon*.
	24	1	63	Mysid remains.
		1	70	Young mysids.
		1	82	Amphipod remains.
		1	88	Copepod remains.
	25	2	68–70	Mysid remains.
		1	70	*Crangon* remains.
		1	98	*Crangon* and mysid remains.

In previous years all those examined contained copepods, except 1 larval *Gebia*, those eaten being *Pseudocalanus*, *Temora*, *Oithona*, *Coryceus* and *Anomalocera*, *Temora* being the commonest. *Temora*, both larval and adult stages, is thus shown to be the favourite food of *Trachinus vipera* in its young post-larval stages, other copepods also being taken, and *Podon*, *Evadne* and eggs (copepod ?).

In the adolescent stages *Crangon*, amphipods and mysids are also taken besides copepods, *Crangon* and mysids being the commonest.

SCOMBRIDÆ.

SCOMBER SCOMBER L. Mackerel.

One hundred and sixty-five young Mackerel were examined, all but 2 from the Young Fish Trawl from July 7th to August 13th, 5–13·5 mm. in length.

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
	1	1	7	No food.
		1	11	Remains of copepod nauplii.
	4	3	5–6·5	No food.
		10	5–7	Copepod nauplii remains.
		1	7	3 *Calanus* nauplii.
	7	1	7	No food.
		2	7–8	*Podon*.
	8	3	5·5 ca–10·5	No food.
		2	8·5–9	*Podon*.
		1	8	1 *Temora* nauplius, 1 egg (copepod ?).
		1	9	1 *Temora* nauplius.
		1	9·5	1 *Podon*, 1 egg (copepod ?).
		1	9·5	1 *Podon* 1 Calanoid nauplius, 3 eggs (copepod ?).

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
	9	7	6·5–8·5	No food.
		2	6·5	Remains of copepod nauplii.
		1	6·5	2 *Temora* nauplii
		1	6·5	1 *Podon*, remains of copepod nauplii.
	10	5	8·5–11	No food.
		1	7	1 *Temora* nauplius, 6 eggs (copepod ?).
		1	7	1 *Evadne*.
		1	9	1 *Podon*.
	12	11	7–10·5	No food.
		1	9	1 *Podon*, 3 eggs (copepod ?).
		1	9	1 egg (copepod ?).
		1	9·5	Remains of *Gobius*.
	13	2	10	No food.
		1	8·5	1 *Temora* nauplius, 1 egg (copepod ?).
	14	8	9–12	No food.
		2	8–11	*Podon*.
		1	10	1 *Podon*, 1 egg (copepod ?).
		1	8·5	Young *Temora*.
		1	7·5	1 copepod nauplius, 2 eggs (copepod ?).
		7	8–10	Eggs (copepod ?).
	15	2	8·5–9	Eggs (copepod ?).
		1	10·5	Copepod nauplius.
		1	10·5	1 *Podon*, 5 eggs (copepod ?).
	20	1	10	30 eggs (copepod ?).
	21	3	7–11	Eggs (copepod ?).
		2	6·5–7	*Evadne*, *Calanus* nauplii.
		1	7	3 *Calanus* nauplii, 1 *Evadne*, 3 eggs (copepod ?).
		1	7	1 *Temora* nauplius, 4 eggs (copepod ?).
		1	7	4 *Evadne*, 6 eggs (copepod?).
		1	7·5	1 calanoid nauplius.
	22	1	6·5	3 eggs (copepod ?).
	23	2	6	No food.
		1	7	2 copepod nauplii, 3 eggs (copepod ?).
		1	8	1 *Podon*.
	24	2	6–8	Eggs (copepod ?).

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
		1	6	2 *Calanus* nauplii.
		1	6·5	1 *Podon*.
		1	7	2 *Evadne*, 2 eggs (copepod?)
		1	10	1 euphausiid larva.
	25	4	6–10	No food.
		1	8	1 *Evadne*.
		3	6–8·5	*Evadne*, eggs (copepod ?).
		1	11	1 euphausiid larva.
	28	1	9·5	1 *Podon*, several eggs (copepod ?).
		1	9·5	Young fish.
			10	Remains of small fish, copepod remains.
	29	1	9	No food.
	31	9	7–11	,,
	32	1	9	,,
	33	1	6·5	,,
	35	1	9	,,
	37	2	7–8	,,
	38	1	7	,,
		1	7	1 *Calanus* nauplius, 1 mite.
		1	8	2 *Calanus* nauplii, many eggs (copepod ?).
		1	9	1 *Trachinus vipera*.
	39	11	5–9	No food.
		2	5–7	*Podon*, *Calanus* nauplii.
		1	8	1 *Podon*, 1 *Temora* nauplius, 2 eggs (copepod ?).
		1	7	Crustacea remains.
	46	1	6	1 *Podon*.
		2	9	*Podon*, eggs (copepod ?).
	48	1	7	No food.
		1	7	1 *Calanus* nauplius, copepod remains.
		1	9	1 young *Temora*, 2 calanoid nauplii, 2 eggs (copepod ?).
		1	9·5	1 calanoid nauplius.
	51	1	13·5	Young *Blennius* (7 mm. long).
Coarse Tow-net, Rame N.E., Mewstone E. $\frac{1}{2}$ S., July 21		2	8–10	Copepod remains.

From these notes it is seen that the young Mackerel often contains no food, 75 out of 165 being empty. The food taken by the others is chiefly copepod nauplii and eggs (probably copepod), 38 containing nauplii and 38 containing eggs. The nauplii are chiefly *Calanus* and *Temora*. Nineteen contained *Podon*, 10 contained *Evadne*, 2 contained euphausiid larvæ and 5, from 9 to 13·5 mm., contained young fish.

GOBIIDÆ.

GOBIUS MINUTUS L.

Most of the young specimens from the tow-nets, February to July, 3–7 mm., contained no food, a few containing copepod remains. The usual food seems to be miscellaneous copepods.

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
A	2	5	5–8	No food.
		10	6–8	Remains of copepod nauplii.
		4	6–7	*Acartia*.
B	5	1	45	Remains of *Pandalus*.
C	Cawsand Bay, Aug. 27	3	49–50	Harpacticids, sand, *Polystomella*.
		1	51	Larval decapod remains, sand, *Polystomella*.

Previous records show various copepods to be the chief food.

GOBIUS PICTUS. Malm.

Out of 16 specimens from the tow-nets from outside the Breakwater, 5–8 mm., July 6, 5–6 mm., contained no food, 6, 6–8 mm., contained *Acartia*, 1, 6 mm., a *Pseudocalanus*, 1, 7 mm., a young *Temora*, 2 contained copepod nauplii and 1 a *Balanus* nauplius. Out of 10 from a coarse tow-net scraping the bottom, Penlee, July 4, 6–11 mm., 2 contained no food, 4, 6–11 mm., contained *Balanus* nauplii, 2 an harpacticid and 1, 7 mm., an *Acartia*.

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
A	2	1	8	Copepod remains.
		1	10	1 *Oithona*.
	4	1	10	3 young *Temora*, 2 *Calanus* nauplii.
C	Cawsand, Aug. 27	1	47	Remains of annelids and amphipods.
		1	47	Remains of amphipods.
			48	Decapod remains.
			49	Decapod larvæ remains.

GOBIUS PAGANELLUS L.

Two from tow-nets, outside the Breakwater, July, 10 mm., 1 contained no food, 1 copepod remains.

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
A	1	4	6–11	No food.
		1	7	2 *Pseudocalanus*.
		1	8	2 *Pseudocalanus*, 1 harpacticid.
		1	11	2 *Pseudocalanus*, 1 *Temora* nauplius.
		1	7	1 *Acartia*.
		3	7–8	*Temora* nauplii.
		1	8	Larval bivalve.
	2	1	9	3 *Calanus* nauplii.
		1	11	Copepod remains.

GOBIUS MICROPS Kröyer.

	Haul.	No. of Individuals.	Length in mm.	Food.
A	1	1	7	Remains of small copepods.
		1	7	2 young *Pseudocalanus*.
		1	7	Copepod nauplii, eggs (copepod ?).
		1	8	1 *Temora* nauplius, 1 larval gastropod, 3 *Balanus* nauplii.

GOBIUS RUTHENSPARRI Euph.

One from a medium tow-net, Rame–Mewstone, July 21, 9 mm., contained a *Pseudocalanus*. The remainder examined were adolescent stages.

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
B	5	3	30–34	Larval gastropods, remains of copepods.
		1	25	1 larval gastropod, 1 larval bivalve, many *Pseudocalanus*.
		1	31	Larval gastropods, larval bivalves.
		1	35	Many *Paracalanus*.

Net.	Haul.	No. of Individuals.	Length. in mm.	Food.
C	Cawsand, Aug. 27	1	35	Many larval gastropods harpacticids 1 *Pseudocalanus*.
		1	37	Many larval gastropods, 1 crab megalopa.
		1	37	Larval gastropods, larval bivalves, 1 *Pseudocalanus*.

APHYA MINUTA (Risso).

Two adult specimens, B, haul 4, 45–48 mm., contained no food.

CRYSTALLOGOBIUS NILSSONI. Dub. and Kor.

Two adult specimens, A, haul 1, 42–44 mm., contained no food. One of 25 mm. (haul 56) contained 1 *Temora* and other copepod remains.

The gobies are miscellaneous feeders, although copepods form their chief food, with *Podon*, *Balanus* nauplii and occasional decapod larvæ. A specimen of *Gobius microps* reared in a glass jar, now 20 mm. long and seven months old, began by feeding on ulva spores, then fed on nauplii of the harpacticids breeding in the jar and on nauplii given to it in very fine plankton. Afterwards it ate the larger copepods and other small crustacea. It is now feeding on small fresh-water isopods and small crustacea from the plankton. Other gobies very soon after hatching ate diatoms, peridinians and small copepod nauplii.

BLENNIIDÆ.

BLENNIUS SP.

These were probably *Blennius ocellaris*. Six specimens from the townets, from outside the Breakwater, 4–8 mm., contained no food, 2 of 6 mm., contained copepod remains.

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
A	2	5	6–7	No food.
	3	1	7	,,
	13	3	5·5–6	,,
		1	7	1 *Podon*.
		1	6·5	Egg (copepod ?).
		1	6·5	2 copepod nauplii.
		1	7	2 calanoid nauplii.
		1	7	1 copepod nauplius, 2 eggs (copepod ?).

TRIGLIDÆ.

TRIGLA GURNARDUS L. GREY GURNARD.

Eighty-three specimens ranging from 6·5–13·5 mm. were examined from the Young Fish Trawl :—

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
A	4	1	6·5	Remains of *Pseudocalanus* and *Calanus* nauplii.
		1	7 ca	Copepod remains.
		1	8	Remains of *Pseudocalanus*.
		1	8 ca	Remains of *Pseudocalanus* and copepod nauplii.
	10	3	6	Unrecognisable.
	13	5	6·5–8	No food.
		8	8–12	*Paracalanus*.
		2	8	*Paracalanus*, *Temora*.
		2	9–9·5	*Pseudocalanus*.
		2	8–9·5	Young *Pseudocalanus*.
		2	11–12	*Pseudocalanus*, *Paracalanus*.
		1	8	Remains of copepod nauplii.
		1	9	1 *Temora*.
		1	10	*Pseudocalanus*, remains of copepod nauplii.
		1	12	1 *Paracalanus*, 1 *Pseudocalanus*, 1 larval euphausiid.
		1	13·5	3 *Calanus*, crab zoëa.
	14	1	8	Remains of decapod larva (mysis stage).
		1	12	Portion of fish's backbone.
	15	2	9·5–10	Crustacea remains.
	16	1	8·5	1 *Podon*, remains of *Calanus*.
		1	12	Remains of several *Calanus*.
	18	1	8	Remains of several *Calanus*.
		1	11 ca	Remains of euphausiid larvæ, *Podon*, copepods.
	20	1	7	2 *Podon*, copepod remains.
	22	1	7	Remains of *Calanus* nauplii and decapod larvæ.
		1	9	3 euphausiid larvæ.
	24	1	8·5	1 euphausiid larva, 1 egg (copepod ?).

Net.	Haul.	No. Individuals.	Length. in mm.	Food.
	25	3	7–10	Remains of *Calanus*.
		1	7	Remains of copepods and copepod nauplii, several eggs (copepod ?).
	26	2	11·5–13	Remains of *Calanus*.
		1	9	3 *Calanus*, 1 *Podon*.
	28	1	10	3 *Calanus*.
		1	11	Remains of euphausiid larvæ.
	30	1	10·5	Remains of *Calanus* and calanoid nauplii.
	31	1	7	1 *Pseudocalanus*, several calanoid nauplii.
		1	8	1 euphausiid larva, remains of copepod nauplii.
		1	8·5	Remains of *Calanus*.
		1	9	Remains of euphausiid larvæ.
	33	1	9·5	Remains of euphausiid larvæ.
		1	12	Remains of *Calanus*.
	35	1	8	No food.
		1	9·5	Remains of *Pseudocalanus*.
	41	1	10	Copepod remains.
	42	2	9·5–12	Remains of *Pseudocalanus*.
	44	1	7	Remains of *Pseudocalanus*.
		1	8	No food.
	56	8	7·5–9·5	Remains of *Pseudocalanus*.
		2	9–10·5	Remains of *Pseudocalanus* and *Calanus*.
		2	9	Remains of *Calanus*.
		2	10–11.5	Copepod remains (probably *Calanus*).
B	10	1	22	Remains of *Calanus*.
Coarse Tow-net, Cawsand Bay, Aug. 18		1	9	1 *Paracalanus*, other copepod remains.

It is thus seen that only 10 out of 85 contained no food, or unrecognisable, 66 contained copepods, 25 containing *Pseudocalanus*, 22 *Calanus*, 12 *Paracalanus* and only 3 containing *Temora*. Four contained *Podon*, 7 contained euphausiid larvæ, 1 a decapod larva and 1 part of a fish's backbone. Copepods evidently form the chief food of the post-larval *Trigla gurnardus*, although at 8 mm. they may eat euphausiid and decapod larvæ and at 12 mm. may eat fish. The few records in previous years show copepods and *Podon* to have been eaten.

COTTIDÆ.

COTTUS BUBALIS Euph. Bullhead.

Twenty-six specimens were examined from the tow-nets from both inside and outside the Breakwater, January to April, from 2·5 to 10 mm., 14, 2·5–5 mm., contained no food, 1 of 7 mm. was kept alive but died in three days containing no food, 1 of 10 mm. contained 1 *Pseudocalanus*, 3, 3·5–4 mm., contained larval gastropods, 3 of 4 mm. contained *Balanus* nauplii and 1 a larval bivalve, and 1 of 7 mm. contained a *Temora*.

Previous years have shown *Cottus bubalis* to take a varied diet, larval mollusks, copepods and cladocera all being eaten, besides occasional diatoms.

AGONIDÆ.

AGONUS CATAPHRACTUS (L). Armed Bullhead.

Seven specimens were examined from the tow-nets, from inside and outside the Breakwater, February to May, 7–18 mm. Three of these were kept alive, but died in a few days. Two of 12 and 18 mm. lived some time in the aquaria. At first the specimen of 12 mm. (April 22nd) was greenish yellow and black, very light towards the tail, but by April 26th it had become quite dark, and this and the specimen of 18 mm. were like the adult. Both ate copepods from the plankton, chiefly *Temora* and *Pseudocalanus*.

One of 7 mm. contained 2 *Balanus* nauplii, 1 young *Temora*, 1 larval bivalve and 1 harpacticid ; the other contained no food.

A specimen of 55 mm., B, haul 24, contained no food.

Two specimens in previous years contained *Balanus* nauplii and a *Coscinodiscus*.

CYCLOPTERIDÆ.

LIPARIS MONTAGUI Donov.

One specimen from a medium tow-net, Knap, February 25th, 3 mm. long, contained 2 larval gastropods. Previous records show copepods (*Acartia* and *Temora*) and indistinguishable crustacea remains.

GASTEROSTEIDÆ.

SPINACHIA VULGARIS Flem. 15-Spined Stickleback.

Three specimens (B, haul 4), 61–80 mm., 1 contained no food, 1 decapod remains, and 1 remains of *Pandalus*, *Crangon* and other crustacea. One (B, haul 5), 70 mm., contained no food.

Amphipods and harpacticids are previously recorded as food.

GOBIESOCIDÆ.

LEPADOGASTER CANDOLLI Risso.

Ten specimens from the tow-nets, inside and outside the Breakwater, July–August, 5–7 mm., 1 contained no food, 3 contained young *Temora* and 1 a *Temora* nauplius, and 2 other copepod nauplii. One contained a *Calanus* nauplius, 1 a *Balanus* nauplius, 3 larval bivalves and an harpacticid. One contained 2 harpacticids, 2 contained *Pseudocalanus* and 1 an *Evadne* and 7 *Podon*.

The same kind of food is recorded for previous years—small copepods (adults and nauplii), cladocera and *Balanus* nauplii being the chief food.

LEPADOGASTER BIMACULATUS Donov.

One specimen from a coarse tow-net, outside the Breakwater, July 22, 9 mm., contained a young *Temora*.

Net.	Haul.	No. of Individuals.	Length in mm.	Food.
A	56	6	7–10	*Temora*.
		1	10	2 *Temora*, *Paralia sulcata*.
	61	1	7	No food.

One specimen in 1918 contained *Balanus* larvæ and larval mollusks. One, kept alive, ate small copepods, *Podon* and *Balanus* larvæ.

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RECORD OF LARVAL AND POST-LARVAL FISH FROM THE TOW-NETTINGS, 1919.

Date. Jan.	Locality.	Fish.	No.	Size in mm.	Food present.
13	Knap to Penlee	Clupea harengus	46	8–11·5	Larval gastropods.
	West Channel to Breakwater	,,	71	8–11	Larval gastropods, *Pseudocalanus elongatus*.
	Knap to Panther	,,	81	8–11	Larval gastropods. *Pseudocalanus elongatus*, young *Corycaeus anglicus*.

Date. Jan.	Locality.	Fish.	No.	Size in mm.	Food present.
15	West Channel to Breakwater	,,	151	7–12	Larval gastropods, larval bivalves, *Pseudocalanus elongatus*-copepod nauplii, *Tintinnopsis* sp.
	Breakwater to New Grounds	,, ,,	200	8–12	Larval gastropods, young *Coryceus anglicus*, *Pseudocalanus elongatus*, larval bivalves, copepod nauplii, *Balanus* nauplii, *Tintinnopsis* sp., *Coscinodiscus* sp.
17	Panther.	,,	244	8–12	Larval gastropods, larval bivalves, *Pseudocalanus elongatus*-copepod nauplii.
	West Channel to Middle Sound	,,	84	8–12	Larval gastropods, larval bivalve, *Pseudocalanus elongatus*, harpacticids.
	Breakwater	,,	30	8–12	Larval gastropods.
21	Knap	,,	6	10–11	Larval gastropods.
	Middle Sound	,,	4	9–11	Larval gastropods, *Pseudocalanus elongatus*.
	Breakwater	,,	13	9–10	Larval gastropods.
	Panther	,,	5	8–16	*Pseudocalanus elongatus*.
24	Knap to Penlee	,,	4	10–11·5	*Oithona similis*, copepod remains.
		Cottus bubalis	1	4	*Balanus* nauplius, larval bivalve.
	Breakwater	Clupea harengus	6	9–11	Larval gastropod.
	Panther	,,	11	8·5–11	*Pseudocalanus elongatus*, copepod nauplii.
27	Middle Sound to Cattewater	,,	10	9·5–13	Copepod remains.
29	Panther	,,	2	9	No food.
	Knap	,,	4	10–11	*Pseudocalanus elongatus*.
	Breakwater	,,	1	11	No food.
	White Patch	,,	3	9–10	,,
31	Panther	,,	4	10–11	*Pseudocalanus elongatus*.
	Breakwater	,,	1	10	No food.
Feb. 4	Panther	,,	11	9–13	*Pseudocalanus elongatus*.
		Anguilla vulgaris	1	76	No food.
		Ammodytes tobianus	1	5	Green food remains.
	Breakwater	,,	1	5	No food.
		Clupea harengus	5	10–12·5	,,
	New Grounds to Breakwater	,,	1	11	*Pseudocalanus elongatus*.
		Clupea sprattus	3	2	No food.
		Cottus bubalis	1	3·5	Larval gastropods.
		Ammodytes tobianus	1	5	No food.
6	Breakwater to New Grounds	Gobius (cf. minutus)	1	3·5	Green food remains.

Date. Feb.	Locality.	Fish.	No.	Size in mm.	Food present.
6	Breakwater to New Grounds	Clupea harengus	6	9–12	Larval gastropod, *Paracalanus parvus*, *Acartia clausi.*
		Ammodytes tobianus	1	4·5	Green food remains.
	White Patch to Middle Sound	Clupea harengus	2	8·5–11	*Balanus* nauplius.
	White Patch	,,	3	8–12	No food.
	Breakwater to Middle Sound	,,	7	9–12	,,
7	Middle Sound to White Patch	Ammodytes tobianus	1	5	,,
	Duke Rock to Breakwater	Clupea sprattus	1	4	,,
12	Breakwater to Panther	,,	1	4·5	,,
		Clupea harengus	2	9–13	*Pseudocalanus elongatus.*
		Ammodytes tobianus	4	4–4·5	Green food remains.
	Panther to Knap	Clupea harengus	2	11–12	*Pseudocalanus elongatus.*
	New Grounds to West Channel	,,	6	9–13	*Pseudocalanus elongatus*, copepod remains.
		Cottus bubalis	1	3·5	Larval gastropod.
		Ammodytes tobianus	3	4–7	No food (7 mm. alive).
	White Patch to Middle Sound	,,	1	5	Diatom (*Melosira*).
	White Patch to Breakwater	Clupea harengus	1	9	No food.
14	Penlee to Panther	Cottus bubalis	1	7	Alive.
		Clupea harengus	5	8·5–14	No food.
		Clupea sprattus	3	3·5–4·5	Green food remains.
		Ammodytes tobianus	4	4–5	,, ,, ,,
	Breakwater	Clupea harengus	1	15	No food.
		Clupea sprattus	8	4–5	Green food remains.
18	Breakwater	Ammodytes tobianus	16	4–6	4 alive, others green food remains.
		Clupea sprattus	6	4·5–5	Green food remains.
	Middle Sound to Breakwater	,,	3	4–5	,, ,, ,,
		Clupea harengus	3	9·5–11	*Balanus* nauplii.
		Ammodytes tobianus	13	4–6	Green food remains.
	White Patch to Jennycliff	Ammodytes tobianus	3	5–5·5	No food.
		Cottus bubalis	1	5	,,
20	West Channel to New Grounds	Clupea harengus	4	9–11	,,
		Clupea sprattus	2	4–5	,,
		Ammodytes tobianus	3	4·5–6	No food (1 alive).
		Cottus bubalis	1	3	No food.
	Breakwater	Clupea harengus	3	8–11·5	Egg ?
		Clupea sprattus	4	4–5	No food.
		Ammodytes tobianus	2	4·5–5	,,
	West Channel	,,	3	4–6	No food (1 alive).
24	Breakwater	,,	1	5	No food.
		Clupea sprattus	5	6	,,
	Shagstone	,,	2	5	,,
		Clupea harengus	3	11·5	,,
		Agonus cataphractus	1	7	*Balanus nauplii*, *Temora longicornis*, juv., larval bivalve, harpacticid.

Date. Feb.	Locality.	Fish.	No.	Size in mm.	Food present.
25	Knap	Clupea sprattus	2	7	No food.
		Cyclogaster montagui	1	2	Larval gastropods.
	Panther	Cottus bubalis	1	4	,, ,,
		Gadus luscus	1	2·5	No food.
28	East Knap to Penlee	Agonus cataphractus	1	10	Alive.
	Knap	Clupea sprattus	2	5–6	Green food remains
March					
13	Breakwater	,,	1	4	No food.
		Cottus bubalis	1	4	*Balanus* nauplii.
	Panther to West Channel	Ammodytes tobianus	1	5·5	No food.
14	West end of Breakwater	Clupea sprattus	2	5	,,
		Agonus cataphractus	1	8	,,
	Panther	Pholis gunnellus	1	7	,,
		Clupea sprattus	5	3–15	*Pseudocalanus elongatus.*
	Knap	,,	2	3	No food.
		Ammodytes tobianus	1	4	,,
17	Penlee	Clupea sprattus	4	3–7	,,
	Penlee to Panther	,,	3	4	,,
		Gobius sp.	1	4	,,
		Gadus luscus	2	3	,,
		Cottus bubalis	1	4	,,
	Knap	Clupea sprattus	several	3–6	,,
		Callionymus lyra	3	2–5	,,
20	Knap	Pholis gunnellus	1	9	,,
		Clupea sprattus	1	5	,,
		Ammodytes tobianus	1	5	,,
	Breakwater to West Channel	Cottus bubalis	2	4	,,
		Pleuronectes platessa	1	13	,,
21	White Patch	Clupea sprattus	5	3–5	,,
	New Grounds	,,	3	3	,,
		Cottus bubalis	1	4	*Balanus* nauplii.
		Callionymus lyra	1	3	No food.
	New Grounds to West Channel	Clupea sprattus	2	3–4	,,
	Middle Sound	,,	2	3–4	,,
24	West Channel	Gadus luscus	2	2·5	,,
26	West Channel	Clupea sprattus	several	3–6	,,
	Knap	,,	,,	3–6	,,
	Knap–Penlee	,,	,,	3–6	,,
31	Knap	,,	2	3	,,
		Ammodytes tobianus	1	4	,,
	Breakwater	Gobius sp.	1	5	,,
		Cottus bubalis	1	5	,,
		Clupea sprattus	several	3–6	,,
		Gadus luscus	3	3	,,
		Callionymus lyra	1	3	,,
	Panther	Clupea sprattus	several	3–6	,,
		Gobius sp.	1	2·5	,,
		Callionymus lyra	1	3	,,
	Knap–Penlee	Clupea sprattus	several	3–6	,,
		Gobius sp.	1	3	,,
		Gadus luscus	1	2·5	,,
		Cottus bubalis	1	5	,,

Date. April.	Locality.	Fish.	No.	Size in mm.	Food present.
April 3	Knap	Gadus merlangus	2	7–8·5	*Pseudocalanus elongatus.*
		Clupea sprattus	3	3–5	No food.
	Panther	Gadus luscus	2	6·5–7	*Pseudocalanus elongatus.*
		Gadus merlangus	2	5–7	,, ,,
		Cottus bubalis	1	6	Copepod remains.
	Knap-Panther	Gadus merlangus	1	6	Crustacea remains.
		Callionymus lyra	1	3	No food.
		Clupea sprattus	4	4–6	,,
	Penlee to Knap	,,	5	4–6	,,
		Gadus merlangus	1	7	*Pseudocalanus elongatus.*
		Gadus luscus	1	3	No food.
		Ammodytes tobianus	1	9	Crustacea remains.
5	New Grounds	Clupea sprattus	several	3–6	No food.
		Gadus merlangus	3	3–5	*Pseudocalanus elongatus.*
		Cottus bubalis	2	3·5	No food.
		Solea variegata	1	4·5	,,
7	Knap	Gadus merlangus	3	3–5	Copepod nauplii.
	West Channel	Cottus bubalis	1	2·5	No food.
	Breakwater	,,	2	3–4	,,
		Gadus merlangus	1	2·5	,,
8	New Grounds	Clupea sprattus	2	6–7	,,
		Cottus bubalis	1	5	*Temora longicornis.*
	Panther	,,	4	3–4	No food.
		Clupea sprattus	8	4–8	,,
		Gadus merlangus	1	3	,,
	Breakwater	,,	1	3	Green food remains.
11	West Channel	Solea vulgaris	2	4–11	No food (1 alive).
		Cottus bubalis	1	4	No food.
	Breakwater	,,	1	4	,,
	New Grounds	Agonus cataphractus	1	12	Alive.
17	Panther	Cottus bubalis	1	12	,,
22	Knap	Gadus merlangus	3	3–5	*Pseudocalanus elongatus.*
		Solea vulgaris	2	6–6·5	No food.
	Knap to Penlee	Gadus merlangus	2	5–8	*Pseudocalanus elongatus.*
		Gobius (probably minutus)	1	6	No food.
23	Panther	Pleuronectes limanda	8	6–12	Alive.
	Penlee	Gadus merlangus	6	5–7	Larval bivalve, copepod remains, copepod nauplii, *Pseudocalanus elongatus.*
		Pleuronectes limanda	1	12	Alive.
	Knap-Penlee	Cottus bubalis	1	10	*Pseudocalanus elongatus.*
		Gadus merlangus	1	8	No food.
		Pleuronectes limanda	1	5	,,
29	New Grounds	Gadus merlangus	3	5–6	*Pseudocalanus elongatus.*
		Callionymus lyra	6	5–8	Alive.
	Melampus Buoy to New Grounds	Gobius minutus	1	8	,,
		Gadus merlangus	9	5–17	*Pseudocalanus elongatus*, eggs (copepod).
		Callionymus lyra	1	3	*Pseudocalanus elongatus.*
30	Panther	,,	2	6	Alive.

Date. April.	Locality.	Fish.	No.	Size in mm.	Food present.
30	Panther	Gobius minutus	2	6–7	No food.
		Solea variegata	1	7	Alive.
	West Channel to Breakwater	Solea vulgaris	1	9	,,
		Callionymus lyra	4	6	,,
		Gadus merlangus	1	6	,,
		Zeugopterus punctatus	1	11	,,
	Knap	,,	1	5	*Temora* nauplius.
		Solea variegata	2	7–8	Alive.
		Pleuronectes limanda	1	5	*Temora* nauplius.
		Gadus merlangus	2	5	*Pseudocalanus elongatus.*
		Callionymus lyra	1	5	*Temora* nauplius.
May.					
5	Knap	Zeugopterus punctatus	2	4–5	No food.
		Gadus merlangus	9	5–11	*Pseudocalanus elongatus,* copepod nauplius.
		Callionymus lyra	2	4	*Temora longicornis,* juv., copepod nauplius.
	Knap–Penlee	,,	1	4	Copepod remains.
		Gadus merlangus	4	7–9	*Pseudocalanus elongatus.*
	Panther	,,	9	4–12	,, ,,
	Breakwater to New Grounds	Callionymus lyra	2	4–5	,, ,,
13	Panther	Gadus merlangus	14	4–20	*Pseudocalanus elongatus,* copepod remains.
		Pleuronectes flesus	4	10–11	3 alive (1 no food).
		Clupea sprattus	2	15–22	No food.
		Gadus minutus	1	6	,,
	Breakwater	Gadus merlangus	13	6–11	*Calanus finmarchicus, Temora longicornis, Pseudocalanus elongatus,* eggs (copepod ?).
	Penlee–Knap	,,	10	6–8	Copepod remains.
		Clupea sprattus	1	20	Harpacticid, egg (copepod ?).
	Knap	Gadus merlangus	5	6–7	*Calanus finmarchicus, Acartia clausi,* copepod nauplius.
14	Middle Sound	Gadus minutus	1	11	Copepod remains.
		Gadus merlangus	3	6	Copepod remains, larval mollusk.
		Pleuronectes limanda	1	9	No food.
	White Patch	Gadus minutus	1	11	Copepod remains.
	East Channel	Callionymus lyra	1	8	Alive.
	Mid. Channel	Gadus merlangus	1	8	*Pseudocalanus elongatus,* harpacticid.
	Panther	Gadus luscus	1	10	No food.
16	Penlee to Knap	Clupea sprattus	1	22	,,
		Gadus merlangus	2	7	*Temora* nauplius.
		Zeugopterus punctatus	1	4	No food.
	Knap to Panther	Gadus merlangus	3	7–8	*Pseudocalanus elongatus.*
		Onos mustela	1	8	No food.
	West Channel to Breakwater	Gadus merlangus	1	8	Copepod remains.
		Callionymus lyra	1	5	,, ,,

Date. May.	Locality.	Fish.	No.	Size in mm.	Food present.
16	Breakwater	Gadus merlangus	4	7	*Pseudocalanus elongatus*, *Temora* nauplius.
		Clupea sprattus	1	22	*Pseudocalanus elongatus.*
19	Breakwater	Gadus merlangus	8	7–8	*Pseudocalanus elongatus*, *Acartia clausi*, *Temora longicornis*, juv., *Calanus finmarchicus*, *Balanus* nauplius.
		Labrus (bergylta type)	1	5	Copepod remains, eggs (copepod ?).
		Zeugopterus punctatus	1	6	Alive.
		Clupea sprattus	1	22	No food.
	Panther	Labrus (bergylta type)	1	4	,,
		Gadus merlangus	2	5–7	*Temora longicornis* juv., copepod remains.
	Penlee	Onos sp.	1	10	,,
		Trigla sp.	1	6	Not examined.
	Knap–Penlee	Gadus minutus	1	13	*Pseudocalanus elongatus*, *Temora longicornis.*
		Gadus merlangus	2	6	No food.
20	Breakwater	Clupea sprattus	3	9–15	,,
		Gadus merlangus	10	5–10	*Pseudocalanus elongatus*, *Calanus finmarchicus*, *Temora longicornis*, *Acartia clausi*, harpacticid, copepod nauplii.
		Gadus pollachius	1	13	*Podon* sp., *Calanus finmarchicus*, *Acartia clausi.*
		Onos sp.	1	6	*Temora longicornis*, juv.
27	Knap	Gadus merlangus	6	8–11	No food.
		Clupea sprattus	1	24	,,
	Panther	Merone labrax	1	6	Copepod remains.
28	Breakwater	Clupea sprattus	1	18	No food.
		Gadus merlangus	1	6·5	*Acartia clausi*, copepod nauplii.
	Panther	,,	1	10	*Calanus finmarchicus*, *Centropages typicus*, *Acartia clausi.*
	New Grounds to Breakwater	Onos sp.	1	4	Copepod nauplius.
June.					
2	Knap to Penlee	Solea vulgaris	1	11	Alive.
		Pleuronectes limanda	1	12	Copepod remains.
	Panther	Gadus merlangus	3	5–10	*Calanus finmarchicus*, *Pseudocalanus elongatus.*
		Callionymus lyra	1	5	No food.
		Merone labrax	1	6	,,
		Gobius minutus	1	5	,,
		Clupea sprattus	1	13	,,
	Breakwater	Gadus merlangus	1	9	*Carcinus mœnas* zoëa *Calanus finmarchicus*
		Trigla sp.	1	6	Not examined.
		Callionymus lyra	2	4	Copepod remains.
		Clupea sprattus	1	14	No food.

Date. June.	Locality.	Fish.	No.	Size in mm.	Food present.
3	Penlee to Knap	Gadus merlangus	10	5–8	*Pseudocalanus elongatus*, *Acartia clausi*, copepod nauplii, green food remains.
		Callionymus lyra	1	5	*Pseudocalanus elongatus.*
		Clupea sprattus	1	9	No food.
	Panther to Knap	,,	1	13	,,
		Gadus merlangus	1	5	,,
6	Knap to Penlee	,,	4	4–7	*Acartia clausi*, copepod nauplii.
		Callionymus lyra	1	5	*Paracalanus parvus.*
	Breakwater	Gobius minutus	2	6	No food.
	Panther	,,	1	5	,,
		Gadus merlangus	5	3–7	*Pseudocalanus elongatus*, copepod remains, copepod nauplii.
		Callionymus lyra	2	4–5	Copepod remains.
		Labrus (bergylta type)	1	3·5	No food.
	Breakwater	Gobius minutus	2	3·5	,,
16	Knap to Panther	Gadus merlangus	1	11	,,
		Blennius sp.	3	4	,,
		Labrus (bergylta type)	1	6	Copepod nauplius.
	Knap	,,	2	4–6	No food.
		Gadus merlangus	1	10	*Pseudocalanus elongatus.*
	Panther to Breakwater	,,	12	8·5–15	*Pseudocalanus elongatus*, *Calanus finmarchicus*, *Temora longicornis.*
		Labrus (bergylta type)	3	5	No food.
		Gobius minutus	1	5	,,
		Callionymus lyra	1	6	*Calanus finmarchicus.*
17	West Channel	Gadus merlangus	1	14	*Pseudocalanus elongatus*, *Calanus finmarchicus.*
		Onos sp.	1	8	No food.
July.					
1	Knap to Shagstone	Gobius minutus	1	5	,,
	Mewstone	Labrus (bergylta type)	2	7	*Podon intermedius*, *Pseudocalanus elongatus*, larval gastropods.
		Callionymus lyra	1	4	Harpacticid.
		Gadus merlangus	1	6	Copepod remains.
	Knap–Mewstone	Gobius minutus	3	6–7	No food.
		Blennius sp.	1	7	,,
2	Penlee	Gobius pictus	5	5–6	*Acartia clausi*, *Pseudocalanus elongatus.*
		Gobius sp.	1	6	No food.
		Callionymus lyra	1	4	*Pseudocalanus elongatus.*
4	Rame to Penlee	Gobius microps	4	7–8	*Pseudocalanus elongatus*, juv., *Temora* nauplius, *Balanus* nauplius, larval gastropods, eggs (copepod ?).
		Blennius sp.	2	6	Copepod remains.
	Scraping bottom Penlee Point N.E. Penlee Buoy E. by N.	,,	1	5	Not examined.

Date. July.	Locality.	Fish.	No.	Size in mm.	Food present.
	Scraping bottom Penlee Point N.E. Penlee Buoy E. by N.	Gobius pictus	10	6–11	,,
		Labrus (bergylta type)	2	8	,,
		Lepadogaster candolli	1	7	,,
14	Attached to dredge Eddystone S.E. Looe Is. N.E.	Gobius elongatus	2	17·5	,,
		Gobius jeffreysii	1	14	,,
		Scophthalmus norvegicus	1	10	,,
	Eddystone S.E., Looe Is. N. ½ E.	Clupea pilchardus	5	15–21	No food.
		Labrus (bergylta type)	3	5–7	*Oithona* sp., *Calanus* and *Temora* nauplii.
	Rame to Penlee	Onos sp.	1	7	Egg (copepod ?).
		Lepadogaster candolli	1	7	No food.
		Labrus (bergylta type)	3	5–7	*Temora longicornis* and nauplius, *Balanus* nauplii.
		Gobius pictus	1	7	*Balanus* nauplius.
	Eddystone S.E., Looe Is. N.N.E.	Labrus (bergylta type)	1	7	Not examined.
		Clupea pilchardus	1	19	,,
15	Mewstone	Gobius sp.	2	5·5	No food.
		Gobius pictus	1	7	Copepod remains.
		Gobius paganellus	1	10	,, ,,
		Labrus (bergylta type)	1	5	*Temora* nauplii.
		Lepadogaster candolli	1	6	*Temora*, juv., copepod nauplii.
	Penlee to Breakwater	Labrus (bergylta type)	4	5	*Temora*, juv., and nauplii, copepod nauplius.
		Scopthalmus norvegicus	1	4	*Temora* nauplius.
18	Rame N.W., Mewstone E. ½ N.	Labrus (bergylta type)	2	5	Not examined.
21	Rame Head N.E. Mewstone E.S.E.	Scomber scomber	2	8–10	Copepod remains.
		Gadus merlangus	1	13	*Pseudocalanus elongatus.*
		Labrus (bergylta type)	1	6	*Temora* nauplii.
		Gobius Ruthensparri	1	9	*Pseudocalanus elongatus.*
		Callionymus lyra	3	4–5	*Pseudocalanus elongatus, Temora* nauplii, young *Temora.*
	On Young Fish Trawl (Haul 10)	Clupea pilchardus	2	18–22	No food.
		Labrus (bergylta type)	1	5	*Temora* nauplii.
22	W. Breakwater	Trigla sp.	1	10 ca	Alive.
		Lepadogaster candolli	1	6	Harpacticids.
		Callionymus lyra	1	3·5	No food.
		Labrus (bergylta type)	1	6	Young *Temora* and nauplii.
		Blennius sp.	1	8	No food.
	Outside Breakwater	Clupea pilchardus	2	19–20	,,
		Gobius paganellus	1	10	,,
		Labrus (bergylta type)	4	4–7	Young *Temora* and nauplii, *Balanus* nauplii.
		Lepadogaster candolli	2	6–7	Young *Temora.*
		Lepadogaster bimaculatus	1	9	,,

Date. July.	Locality.	Fish.	No.	Size in mm.	Food present.
23	Rame Head	Callionymus lyra	1	9	*Acartia clausi*, *Temora* nauplius.
		Gobius pictus	4	6–7	*Acartia clausi*.
	Penlee	,,	3	5–8	*Acartia clausi*, young *Temora*.
		Callionymus lyra	2	8–9	Copepod remains.
		Labrus (bergylta type)	4	5–7	Young *Temora* and nauplii.
	Rame to Penlee	,,	10	4–8	,, ,,
		Gobius pictus	2	6–8	*Acartia clausi*, copepod nauplius.
		Callionymus lyra	1	9	Copepod remains.
25	Rame Head N.N.W., Penlee E.N.E.	Labrus (bergylta type)	1	12	*Temora* nauplii.
		Gobius sp.	1	8	Not examined.
	Polperro bearing N. ½ E. to N. ½ W. Looe Is. N.E. ½ N.	Clupea pilchardus	1	18	No food.
		Callionymus lyra	2	5–9	Not examined.
		Solea sp.	1	2·5	,,
		Lepadogaster candolli	1	5	,,
		Labrus (bergylta type)	5	5–6	*Temora* and other copepod nauplii.
		Trachinus vipera	1	6	No food.
Aug.					
8	Rame Head N.W., Penlee N. by E. ½ E.	Trigla gurnardus	1	6	Not examined.
		Caranx trachurus	2	2–5	
		Trachinus draco ?	1	6	,,
18	West Channel	Lepadogaster candolli	1	7	*Evadne*, *Podon*, *Pseudocalanus elongatus*.
	Cawsand Bay	Trigla gurnardus	1	9	*Paracalanus parvus*, other copepod remains.
		Gobius minutus	1	8	Not examined.
	Middle Sound to New Grounds]	Labrus (bergylta type)	1	6·5	*Podon*, *Temora longicornis*, *Pseudocalanus elongatus*.
		Lepadogaster candolli	2	5–6·5	*Temora* nauplius, *Calanus* nauplius, *Pseudocalanus elongatus*.
20	Off White Patch	Clupea pilchardus	10	17–23	No food.
	Cawsand Bay	,,	38	19–26	,,
21	E Rame Head N.N.W. Mewstone, E.N.E., bottom	Gadus merlangus	1	36	*Calanus finmarchicus*
	E Rame Head N.W. ½ N., Mewstone N.E. by E. ½ E.	Solea lascaris	1	12	Alive.
		Ammodytes tobianus	1	17	No food.
	D Rame Head N.N.W., Mewstone ca. E.N.E., midwater	Rhombus lævis	1	6	Eggs (probably copepod).

Date. Aug.	Locality.	Fish.	No.	Size in mm.	Food present.
29	F Rame Head N.N.W., Mew stone ca. E.N.E.	Syngnathus rostellatus	1	42	Not examined.
		Caranx trachurus	3	8·5–17	*Paracalanus parvus, Centropages typicus, Coryceus anglicus, Podon, Halosphæra viridis, Coscinodiscus* sp.
		Trachinus vipera	1	7	*Podon, Evadne, Pseudocalanus elongatus.*
		Trigla gurnardus	1	6	Not examined.
		Clupea pilchardus	8	17–21	No food.
		Arnoglossus sp.	2	14	Not examined.
	F Rame Head N.N.W., Mewstone ca. E.N.E.	Ammodytes lanceolatus	1	19	,,
		Clupea pilchardus	14	19–22	No food.
29	D Rame Head E by N. ¼ N., Eddystone S.E. ¼ S.	Arnoglossus sp.	1	7	Not examined.
		Trigla sp. (B form)	1	7	,,
	Coarse Tow-net, bottom, Penlee Point to Rame Head	Trachinus vipera	1	5·5	,,

The Number of Pyloric Cæca in the Herring.

(Supplement to "An Account of the Researches on Races of Herrings carried out by the Marine Biological Association at Plymouth, 1914–15.")

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In "An Account of the Researches on Races of Herrings carried out by the Marine Biological Association at Plymouth, 1914–15,"* Dr. J. H. Orton stated that the alimentary canal of each fish investigated was preserved for the future examination of the pyloric cæca. The present note gives the results of my counting of the latter, and the accompanying table on page 328 shows the number of pyloric cæca for each individual fish enumerated in Tables III and IV of the above publication.

The results may be summarized thus :—

Number of individuals examined	♀	475
,, ,, ,, ...	♂	600
	Total	1075

Distance from snout to end of mid-caudal ray in cm. groups.	Totals.	NUMBER OF PYLORIC CÆCA.														
		14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
19	4	—	—	—	—	1	2	—	1	—	—	—	—	—	—	—
20	37	—	1	2	1	1	2	7	9	6	3	1	1	3	—	—
21	113	—	—	4	6	9	26	17	14	14	10	7	3	2	1	—
22	220	—	3	2	4	16	31	34	36	38	29	14	9	3	—	1
23	319	1	1	5	12	10	33	45	65	52	41	26	16	9	3	—
24	242	1	2	5	3	14	19	44	48	33	22	26	16	5	3	1
25	119	—	1	2	4	10	7	11	17	22	22	13	5	3	1	1
26	17	—	—	—	—	6	2	2	1	1	3	—	2	—	—	—
27	3	—	—	—	—	—	—	1	—	—	1	—	—	—	—	1
28	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
All lengths.	1075	2	8	20	30	67	123	161	191	166	131	87	52	25	8	4

* *Journal M.B.A.*, Vol. XI, No. 1, March, 1916.

An analysis of the data shows that in the sample of fish investigated :—

(1) The general variation in the number of cæca is from fourteen to twenty-eight, the most frequent number being twenty-one.

(2) The length of fish from snout to end of mid-caudal ray varies from 19 to 28 cm., the most frequent length being 23 cm.

(3) There is no appreciable difference between males and females in respect to the number of pyloric cæca.

(4) As seen in the following table, although the mean of the number of pyloric cæca is greater in the longer fish, the successive increases are not sufficiently great to be of much significance.

Group.	No. of Fish.	No. of Pyloric Cæca. Mean.
19–22 cm.	374	$20{\cdot}85 \pm {\cdot}08$
23 cm.	319	$21{\cdot}35 \pm {\cdot}09$
24–28 cm.	382	$21{\cdot}40 \pm {\cdot}08$
All fish 19–28 cm.	1075	$21{\cdot}19 \pm {\cdot}05$

On concluding the examination of the Plymouth samples, I thought it would be interesting to count the pyloric cæca of herring from another district, to observe if any marked differences would be revealed. Accordingly by the courtesy of Mr. J. O. Borley of the Ministry of Agriculture and Fisheries, the alimentary canals of 197 inshore herring from Lowestoft were separately labelled with the length of fish from which extracted and forwarded to me.

The results of my counting are summarized below, but it should here be noted that the "length" of fish as forwarded me was the distance from snout to the end of the longest caudal ray, and not that from snout to the end of the mid-caudal ray as utilized in the Plymouth samples :—

Distance from snout to end of longest caudal ray.	Tota's.	NUMBER OF PYLORIC CÆCA.													
		16	17	18	19	20	21	22	23	24	25	26	27	32	34
20	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—
21	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
22	7	1	1	—	—	1	—	1	—	1	2	—	—	—	—
23	18	—	1	1	1	2	2	3	2	3	1	1	—	1	—
24	52	—	3	3	5	6	5	10	10	4	3	3	—	—	—
25	55	—	3	3	5	10	8	9	8	2	3	1	2	—	1
26	33	1	—	4	6	3	3	4	5	2	2	—	3	—	—
27	20	—	1	3	2	4	2	4	2	2	—	—	—	—	—
28	10	—	—	1	1	—	3	2	2	—	1	—	—	—	—
29	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—
All lengths.	197	2	9	17	20	26	23	33	29	14	12	5	5	1	1

It is seen that :—

(1) Fishes from 24 to 25 cm. from snout to end of longest caudal ray (which is approximately equivalent to from 21 to 22 cm. from snout to end of mid-caudal ray) are the most frequent.

(2) The commonest occurring number of pyloric cæca is twenty-two, in a general variation from sixteen to thirty-four.

Considering the relatively small number of specimens examined, it is apparent that there is no marked difference from the Plymouth samples, except perhaps the occurrence of two specimens with over thirty pyloric cæca, which may or may not be significant.

TABLE SHOWING NUMBER OF PYLORIC CÆCA IN FISH ENUMERATED IN TABLES III AND IV OF Dr. ORTON'S PUBLICATION. (*See Journal M.B.A.*, Vol. XI, No. 1, March, 1916.)

No. of Fish.	No. of Pyloric Cæca.	No. of Fish.	No. of Pyloric Cæca.	No. of Fish.	No. of Pyloric Cæca.	No. of Fish.	No. of Pyloric Cæca.	No. of Fish.	No. of Pyloric Cæca.	No. of Fish.	No. of Pyloric Cæca.	No. of Fish.	No. of Pyloric Cæca.	No. of Fish.	No. of Pyloric Cæca.	No. of Fish.	No. of Pyloric Cæca.
1	20	29	24	57	23	85	21	113	19	141	20	169	23	197	19	225	23
2	24	30	22	58	21	86	16	114	22	142	17	170	21	198	20	226	20
3	18	31	18	59	16	87	19	115	20	143	18	171	22	199	21	227	21
4	20	32	21	60	20	88	22	116	21	144	21	172	18	200	21	228	20
5	25	33	19	61	22	89	17	117	21	145	21	173	24	201	25	229	19
6	23	34	19	62	23	90	23	118	26	146	25	174	23	202	21	230	19
7	22	35	23	63	23	91	23	119	26	147	21	175	23	203	22	231	22
8	26	36	21	64	20	92	19	120	17	148	20	176	21	204	19	232	21
9	20	37	22	65	17	93	26	121	22	149	23	177	22	205	22	233	23
10	24	38	22	66	21	94	22	122	24	150	20	178	23	206	17	234	19
11	26	39	22	67	20	95	24	123	20	151	23	179	23	207	20	235	22
12	16	40	15	68	22	96	22	124	19	152	20	180	22	208	26	236	25
13	23	41	23	69	20	97	19	125	26	153	20	181	21	209	21	237	23
14	21	42	19	70	18	98	22	126	22	154	24	182	19	210	20	238	15
15	24	43	24	71	24	99	23	127	21	155	21	183	28	211	23	239	24
16	21	44	23	72	22	100	19	128	23	156	23	184	24	212	20	240	20
17	22	45	26	73	19	101	22	129	19	157	22	185	21	213	18	241	26
18	24	46	25	74	20	102	19	130	17	158	24	186	21	214	26	242	20
19	22	47	22	75	24	103	19	131	20	159	18	187	21	215	23	243	22
20	23	48	19	76	21	104	23	132	15	160	21	188	16	216	21	244	20
21	26	49	21	77	21	105	19	133	19	161	25	189	17	217	28	245	21
22	20	50	18	78	22	106	24	134	22	162	21	190	21	218	18	246	23
23	24	51	21	79	18	107	22	135	22	163	21	191	25	219	22	247	22
24	22	52	24	80	21	108	21	136	24	164	19	192	22	220	21	248	20
25	21	53	20	81	20	109	17	137	20	165	24	193	20	221	22	249	22
26	20	54	19	82	19	110	21	138	22	166	22	194	18	222	23	250	22
27	22	55	22	83	21	111	19	139	24	167	22	195	20	223	21	251	19
28	23	56	20	84	19	112	21	140	21	168	23	196	20	224	19	252	24

TABLE SHOWING NUMBER OF PYLORIC CÆCA—*continued*

No. of Fish.	No. of Pyloric Cæca.	No. of Fish.	No. of Pyloric Cæca.	No. of Fish.	No. of Pyloric Cæca.	No. of Fish.	No. of Pyloric Cæca.	No. of Fish.	No. of Pyloric Cæca.	No. of Fish.	No. of Pyloric Cæca.	No. of Fish.	No. of Pyloric Cæca.	No. of Fish.	No. of Pyloric Cæca.	No. of Fish.	No. of Pyloric Cæca.
253	20	285	19	317	21	349	22	381	21	413	21	445	22	477	22	509	20
254	23	286	19	318	17	350	23	382	23	414	23	446	21	478	22	510	22
255	18	287	20	319	18	351	25	383	21	415	23	447	19	479	19	511	23
256	23	288	23	320	18	352	18	384	23	416	23	448	24	480	19	512	21
257	19	289	21	321	21	353	21	385	19	417	23	449	24	481	24	513	27
258	20	290	19	322	26	354	16	386	18	418	23	450	17	482	19	514	17
259	23	291	20	323	24	355	24	387	19	419	21	451	24	483	23	515	21
260	20	292	28	324	26	356	22	388	22	420	22	452	18	484	25	516	22
261	19	293	19	325	23	357	25	389	18	421	21	453	20	485	20	517	19
262	21	294	22	326	24	358	19	390	18	422	22	454	21	486	21	518	20
263	24	295	16	327	22	359	21	391	20	423	19	455	20	487	23	519	24
264	19	296	25	328	24	360	23	392	22	424	20	456	21	488	23	520	19
265	21	297	20	329	23	361	19	393	24	425	20	457	21	489	21	521	18
266	21	298	27	330	20	362	27	394	23	426	21	458	20	490	21	522	21
267	20	299	21	331	21	363	20	395	24	427	19	459	21	491	22	523	21
268	21	300	21	332	25	364	18	396	23	428	20	460	22	492	23	524	18
269	21	301	16	333	25	365	23	397	18	429	23	461	22	493	22	525	20
270	23	302	21	334	17	366	25	398	21	430	21	462	22	494	20	526	23
271	21	303	21	335	19	367	16	399	23	431	22	463	24	495	20	527	20
272	21	304	22	336	24	368	18	400	21	432	18	464	21	496	21	528	21
273	21	305	20	337	17	369	17	401	18	433	23	465	19	497	23	529	16
274	20	306	19	338	25	370	20	402	18	434	20	466	21	498	20	530	19
275	26	307	22	339	19	371	21	403	20	435	18	467	21	499	21	531	20
276	20	308	22	340	19	372	19	404	20	436	17	468	21	500	25	532	20
277	17	309	20	341	18	373	20	405	22	437	23	469	17	501	19	533	23
278	18	310	22	342	25	374	19	406	19	438	22	470	20	502	22	534	24
279	21	311	21	343	22	375	18	407	24	439	20	471	19	503	19	535	19
280	24	312	21	344	24	376	20	408	19	440	23	472	20	504	20	536	18
281	19	313	23	345	23	377	20	409	22	441	21	473	15	505	21	537	21
282	21	314	21	346	24	378	22	410	21	442	20	474	17	506	19	538	15
283	19	315	22	347	20	379	25	411	19	443	18	475	21	507	22	539	20
284	20	316	23	348	23	380	21	412	24	444	19	476	21	508	21	540	23

TABLE SHOWING NUMBER OF PYLORIC CÆCA—*continued.*

No. of Fish.	No. of Pyloric Cæca.	No. of Fish.	No. of Pyloric Cæca.	No. of Fish.	No. of Pyloric Cæca.	No. of Fish.	No. of Pyloric Cæca.	No. of Fish.	No. of Pyloric Cæca.	No. of Fish.	No. of Pyloric Cæca.	No. of Fish.	No. of Pyloric Cæca.	No. of Fish.	No. of Pyloric Cæca.	No. of Fish.	No. of Pyloric Cæca.
541	16	573	21	605	18	637	25	669	19	701	25	733	18	765	20	797	22
542	22	574	22	606	24	638	20	670	23	702	20	734	18	766	23	798	21
543	22	575	23	607	24	639	23	671	19	703	18	735	20	767	23	799	22
544	21	576	21	608	24	640	25	672	22	704	24	736	22	768	26	800	19
545	23	577	19	609	23	641	23	673	22	705	18	737	25	769	16	801	21
546	17	578	20	610	23	642	20	674	18	706	24	738	23	770	21	802	22
547	25	579	24	611	20	643	20	675	16	707	22	739	19	771	19	803	19
548	21	580	16	612	20	644	21	676	25	708	19	740	20	772	22	804	24
549	18	581	19	613	26	645	19	677	17	709	22	741	22	773	21	805	21
550	20	582	21	614	21	646	20	678	20	710	21	742	22	774	20	806	25
551	18	583	21	615	20	647	23	679	18	711	23	743	23	775	20	807	19
552	23	584	26	616	23	648	21	680	20	712	22	744	22	776	21	808	23
553	24	585	15	617	22	649	25	681	21	713	17	745	19	777	21	809	21
554	21	586	24	618	23	650	21	682	25	714	24	746	21	778	25	810	22
555	20	587	24	619	25	651	22	683	26	715	21	747	24	779	15	811	20
556	19	588	21	620	22	652	20	684	19	716	14	748	20	780	19	812	19
557	19	589	21	621	26	653	18	685	20	717	24	749	20	781	22	813	22
558	21	590	20	622	17	654	18	686	20	718	17	750	20	782	19	814	24
559	22	591	20	623	17	655	22	687	22	719	26	751	21	783	23	815	22
560	24	592	22	624	21	656	19	688	21	720	18	752	23	784	24	816	21
561	21	593	22	625	21	657	23	689	20	721	24	753	22	785	19	817	21
562	23	594	20	626	19	658	21	690	20	722	17	754	24	786	23	818	16
563	25	595	20	627	26	659	22	691	27	723	21	755	22	787	22	819	21
564	25	596	24	628	21	660	22	692	19	724	26	756	23	788	23	820	20
565	21	597	23	629	18	661	21	693	20	725	25	757	25	789	22	821	21
566	19	598	17	630	22	662	23	694	20	726	24	758	20	790	18	822	19
567	24	599	21	631	23	663	18	695	20	727	23	759	18	791	21	823	18
568	25	600	24	632	23	664	19	696	23	728	20	760	20	792	18	824	19
569	22	601	20	633	22	665	20	697	25	729	19	761	16	793	22	825	22
570	22	602	21	634	18	666	15	698	20	730	20	762	24	794	20	826	19
571	20	603	21	635	19	667	19	699	23	731	23	763	23	795	21	827	21
572	21	604	21	636	21	668	23	700	19	732	18	764	27	796	25	828	21

TABLE SHOWING NUMBER OF PYLORIC CÆCA—*continued.*

No. of Fish.	No. of Pyloric Cæca.	No. of Fish.	No. of Pyloric Cæca.	No. of Fish.	No. of Pyloric Cæca.	No. of Fish.	No. of Pyloric Cæca.	No. of Fish.	No. of Pyloric Cæca.	No. of Fish.	No. of Pyloric Cæca.	No. of Fish.	No. of Pyloric Cæca.	No. of Fish.	No. of Pyloric Cæca.	No. of Fish.	No. of Pyloric Cæca.
829	25	857	24	885	20	913	25	941	27	968	24	995	23	1022	18	1049	22
830	21	858	22	886	23	914	19	942	20	969	21	996	19	1023	20	1050	23
831	22	859	21	887	25	915	20	943	16	970	16	997	19	1024	23	1051	20
832	22	860	21	888	21	916	21	944	22	971	20	998	21	1025	22	1052	19
833	21	861	20	889	22	917	25	945	22	972	20	999	23	1026	23	1053	21
834	21	862	20	890	21	918	22	946	17	973	23	1000	23	1027	20	1054	26
835	23	863	21	891	19	919	23	947	24	974	20	1001	21	1028	19	1055	23
836	22	864	19	892	23	920	20	948	24	975	26	1002	22	1029	20	1056	20
837	19	865	21	893	18	921	25	949	20	976	25	1003	21	1030	21	1057	19
838	21	866	19	894	24	922	22	950	22	977	21	1004	23	1031	24	1058	22
839	25	867	24	895	22	923	22	951	22	978	22	1005	19	1032	20	1059	21
840	20	868	25	896	24	924	20	952	22	979	24	1006	18	1033	24	1060	20
841	20	869	24	897	22	925	16	953	24	980	22	1007	22	1034	22	1061	23
842	22	870	22	898	21	926	19	954	16	981	20	1008	20	1035	16	1062	20
843	18	871	25	899	19	927	25	955	24	982	20	1009	18	1036	22	1063	23
844	22	872	24	900	22	928	22	956	22	983	19	1010	24	1037	20	1064	21
845	18	873	20	901	24	929	19	957	22	984	25	1011	21	1038	19	1065	20
846	18	874	21	902	22	930	22	958	20	985	21	1012	21	1039	24	1066	22
847	22	875	22	903	21	931	24	959	19	986	23	1013	25	1040	25	1067	19
848	18	876	19	904	27	932	24	960	23	987	18	1014	25	1041	22	1068	19
849	17	877	21	905	20	933	20	961	18	988	22	1015	23	1042	19	1069	20
850	19	878	20	906	22	934	20	962	23	989	28	1016	23	1043	22	1070	22
851	21	879	21	907	22	935	21	963	24	990	23	1017	22	1044	23	1071	21
852	23	880	23	908	21	936	17	964	20	991	23	1018	19	1045	23	1072	19
853	27	881	18	909	23	937	18	965	19	992	22	1019	22	1046	20	1073	21
854	22	882	24	910	22	938	25	966	21	993	22	1020	22	1047	26	1074	25
855	14	883	23	911	23	939	18	967	22	994	24	1021	17	1048	20	1075	21
856	22	884	18	912	21	940	20										

Clavella iadda, N.Sp.

A PARASITIC COPEPOD OF *GADUS MORRHUA*.

Including some further remarks upon *C. sciatherica*, with a detailed account of the renal excretory system.

By

W. Harold Leigh-Sharpe, B.Sc.(Lond.).

With 9 text figures.

TOGETHER with the specimens of *C. sciatherica*, Leigh-Sharpe, presented to me by Michael G. L. Perkins, and taken by him from various *Gadus morrhua* at Lowestoft, in August, 1918 (vide *Parasitology*, XI, 118, and footnote), was another tube containing about a dozen further specimens taken by him at the same date, from the identical hosts. He first called my attention to the fact that we had two distinct species of *Clavella* from the same fish, and to him I am primarily indebted for most of the following observations. The claims of the other specimens to be considered as members of a distinct and new species are :—

(1) Body less globose, longer than wide.
(2) Ovisacs tapering.

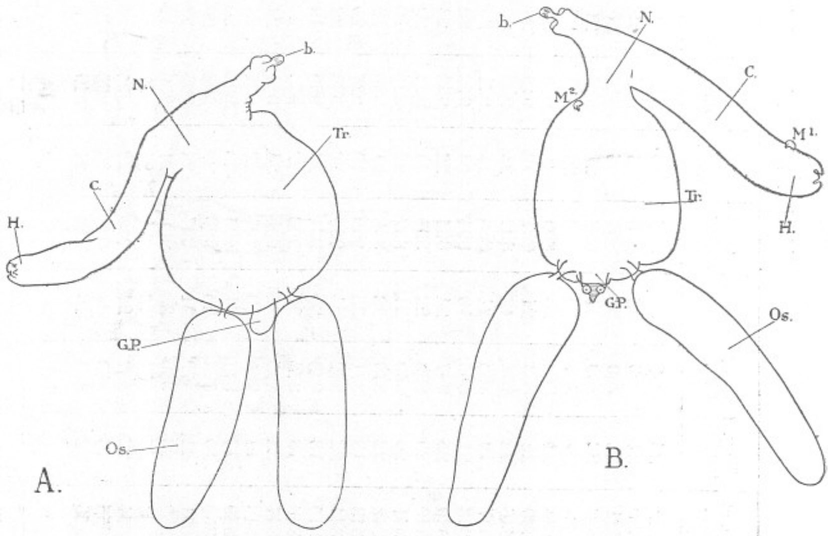

FIG. 1.—A. *Clavella sciatherica*. B. *Clavella iadda*. *H.*, head ; *C.*, cephalothorax ; *N.*, neck ; *b.*, bulla ; *Tr.*, trunk ; *G.P.*, genital process ; *Os.*, ovisacs ; *M.* 1. and *M.* 2., males. (Drawn by lantern projection from specimens mounted in Canada Balsam.)

(3) Posterior terminal prominences (trilobate genital process as in *C. irina*, Wilson, but less pronounced).

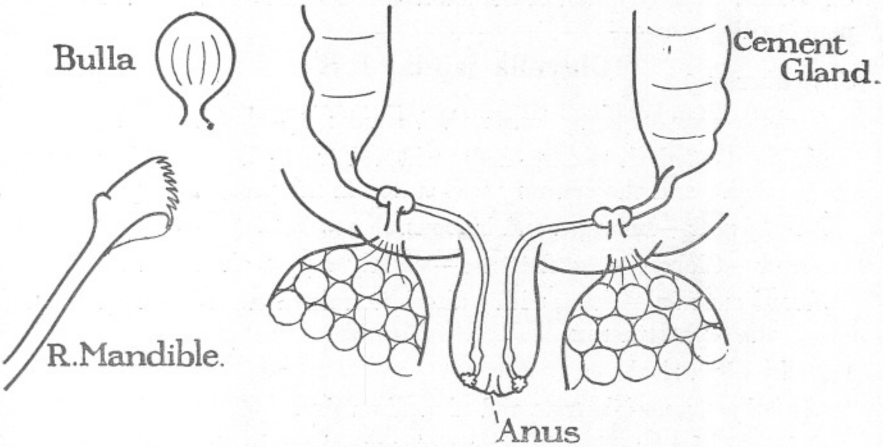

FIG. 2.—*Clavella sciatherica.* Bulla. Mandible. Posterior end of body showing genital process and ovisacs. (Drawn as Fig. 1.)

(4) Cephalothorax comparatively short, little curved, and in line with the second maxillæ.

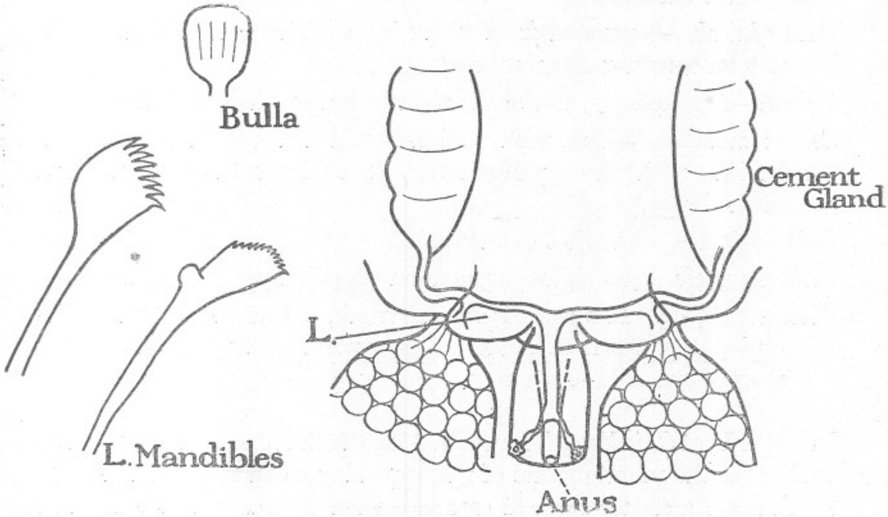

FIG. 3.—*Clavella iadda.* Bulla. Mandibles. Posterior end of body showing genital process and ovisacs. *L.* lateral lobes. (Drawn as Fig. 1.)

(5) Bulla widest at *apex* of the sphere (not at the *base* as in *C. sciatherica*).

(6) A slight difference in the mandibles.

The outline, in semi-profile, of *C. iadda*, is shown in Fig. 1, B. where, it is compared with *C. sciatherica*. The genital process is here shrunk by exosmosis. A description of the animals is best followed by the accompanying diagnoses :—

C. sciatherica ♀

Cephalothorax.—Plainly longer than trunk : $1\frac{1}{4}$–$1\frac{1}{2}$ times.

Head.—Cephalothorax gradually widened up to head. (This is very slight, and the contrary was stated in my previous paper.)

Base of neck.—Enlarged and bulbous.

Trunk.—Globose—not flattened—slightly longer than wide.

Second maxillæ.—Short, with a discoid termination. Not in line with the cephalothorax.

Bulla.—Spherical.

Genital process.—Elongate and of medium size.

Ovisacs.—Not tapering, 8–10 rows of approximately 20 ova in a row.

C. iadda ♀

Cephalothorax.—But little longer than trunk : $1\frac{1}{4}$ times at most. Dorsiventral curve only slight.

Head.—Not enlarged.

Base of neck.—Separated from trunk by a slight constriction. Base not bulbous nor differentiated.

Trunk.—Subquadrate, flattened, slightly longer than broad.

Second maxillæ.—Short, with a slightly widened discoid termination. In line with the cephalothorax, or at least the central third of the latter.

Bulla.—Ovate, somewhat cylindrical.

Genital process.—(See figure) of medium size, elongate, trilobed.

Ovisacs.—$1\frac{1}{3}$–$1\frac{1}{2}$ times as long as the trunk, about the length of the cephalothorax, not slender, but tapering. Approximately 28 rows of ova of 12–6 in a row.

In Fig. 1 B, of *C. iadda*, *M.* 1 and *M.* 2 are the shrivelled empty "skins" of males, for the minute joints of the appendages can still be made out. They indicate a flatter form of carapace than the males I described in *C. sciatherica*. I am not aware of any record of defunct males remaining attached to so old a female for such a length of time in any Lernæopod.

In *C. iadda* there appear to be two forms of mandible, one of which resembles that of *C. sciatherica*, but has sufficient differences from it to be noticeable. Age may have to be considered as the factor for this (cf. *Parasitology*, XI, 120, Fig. 4, of a mandible drawn from an immature specimen).

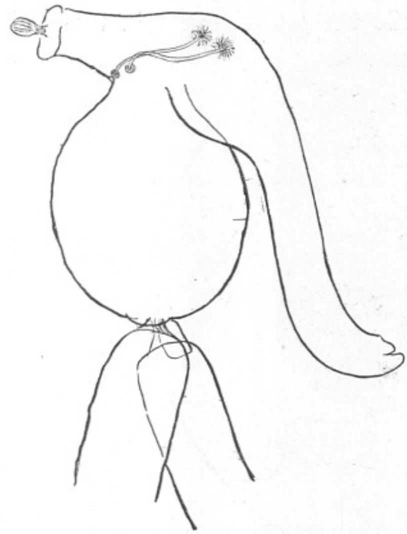

FIG. 4—*Clavella sciatherica*, in lateral aspect, showing excretory organs. × 13.

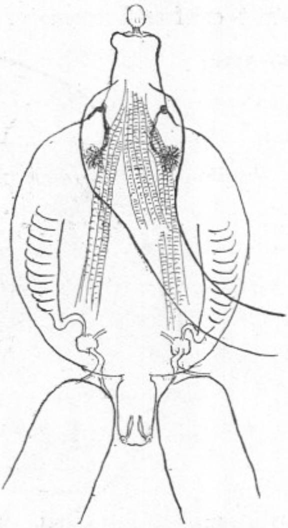

FIG. 5.—*Clavella sciatherica*, from above, showing excretory organs. × 13.

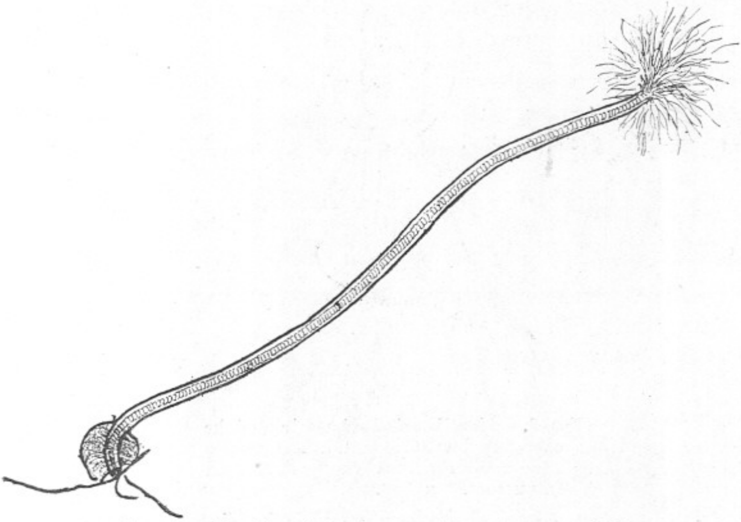

FIG. 6.—*Clavella sciatherica*, excretory organ. × 100.

The terminal claw of the maxillipedes is longer and more formidable than that previously observed in *C. sciatherica* (cf. *op. cit.*, XI, 119, Fig. 3), though I am bound to state the adults of the last-named species have a longer and stouter claw than I have figured for the immature female, so that in this particular there is hardly any difference between the two species.

I must confess I cannot reconcile the genital ducts in the genital

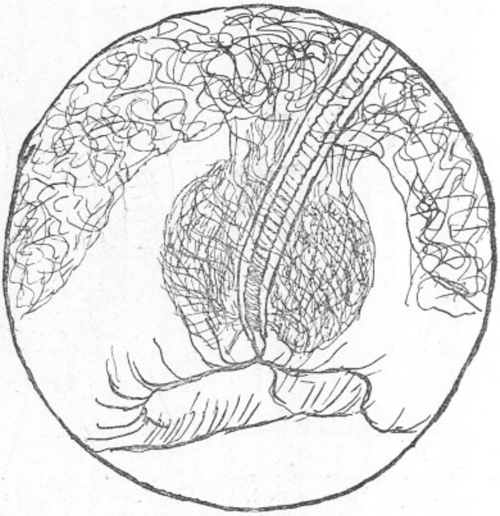

FIG 7.—*Clavella sciatherica*, external aperture of excretory duct. × 350.

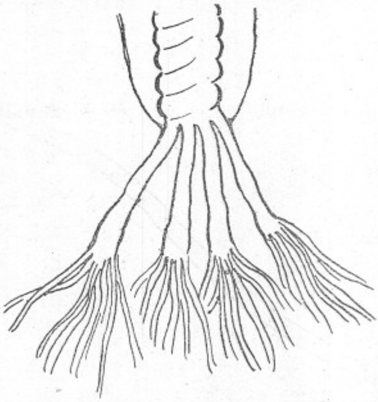

FIG. 8.—*Clavella sciatherica*, origin of the excretory duct at the gland. The tubules and ductules are each very much reduced in number. × 800.

process of the adults (Figs. 2 and 3) with the condition in the immature female (*op. cit.*, XI, 122, Fig. 6). Here they appear much more like the condition that obtains in *Lernæopoda* (*Parasitology*, VIII, 272, Fig. 6), although my former interpretation agreed with the remarks of Dr. C. B. Wilson. In Fig. 6 of *Clavella sciatherica*, *Os.* are evidently not, as stated, the apertures through which the ovisacs emerge, since here we have these crenated apertures, but the eggstrings pendant elsewhere. If they should prove to be the vulvæ then both Wilson and I have been previously wrong as to the existence of a single median vulva. On this view what I previously called spermatophores is fæcal matter in the intestine, the median vulva is the anus, and what I called anus (very indistinct) an accidental perforation: but none of this I am prepared to admit. To make matters more complicated Dr. Wilson denies that in *Clavella* the anus is in the genital process at all, that being the reason he prefers that name for the protuberance rather than abdomen.

The Renal Excretory Organs.—Their ducts and apertures on the base of the second maxillæ can be made out with great clearness in both species, and the following is, I believe, the first detailed account to be published for any of the Lernæopodidæ.

Fundamental Structure.—A number of excretory tubules join together to form a ductule (Fig. 8). From ten to twenty ductules unite to form

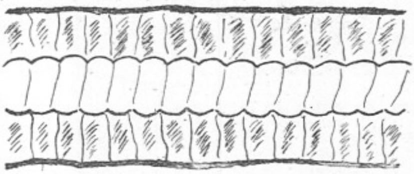

FIG. 9.—*Clavella sciatherica*, a portion of the excretory duct. × 800.

the main duct. The tubules are so numerous that it is impossible to count them.

There is thus formed a spherical "gland" composed of an intimate convolution of tubules at the origin of an excretory duct.

Two such glands are present, one on each side (Figs. 4 and 5), in the supero-lateral region of the proximal (enlarged in *C. sciatherica*) end of the cephalothorax. Each gland is separately provided with a duct.

The Excretory Ducts.—These are about 1.5 mm. in length and run down to open on the ventral surface at the junction of the trunk and the second maxillæ (Figs. 4 and 5).

Their walls are thick and highly refractile. They appear to be composed of a single layer of cells arranged spirally around a basement membrane which is spirally twisted, thus giving a peculiar appearance to the lumen, as though it had been moulded round a piece of thread (Figs. 6 and 9).

Termination of the Ducts.—The ducts debouch at introversions of the cuticle on either side of the ventral surface, at the bases of the second maxillæ, at their junction with the trunk.

At the termination the spirals of the lumen become closer, the lumen gradually narrowing. Then the spirals cease and the lumen widens out again, finally, however, forming a very much narrower duct.

Around this final portion of the duct is a spherical mass, which possibly is glandular, but in all probability serves as a sphincter muscle. It is connected with the duct and with the body substance by connective tissue (Fig. 7).

Dimensions :—

Average diameter of renal organ	=	150 μ.
,, ,, of tubules	=	0·2 μ.
,, ,, of ductules	=	1–2 μ.
,, ,, of excretory duct over all	=	20μ.
,, ,, ,, ,, ,, lumen	=	8 μ.
Length of duct	=	1–1·5 mm.
Diameter of sphincter muscle	=	75 μ.

In the opinion of Perkins and myself *C. iadda* is a fairly common central type from which the other three have been derived. An attempt to show this has been drawn up in the following tables :—

A. Bulla clavate . . . . **C. irina.**

B. Bulla spherical or ovate :—

- (*a*) Base of neck not differentiated. Ovisacs tapering :
  - (α) Trunk transverse . . . . **C. uncinata.**
  - (β) Trunk not transverse, longer than wide . . . . . . **C. iadda.**
- (*b*) Base of neck differentiated. Ovisacs not tapering. Trunk a trifle longer than wide **C. sciatherica.**

A. Genital process trilobate :—

- (*a*) Bulla clavate. . . . . . **C. irina.**
- (*b*) Bulla ovate . . . . . . **C. iadda.**

B. Genital process simple :—

- (*a*) Base of neck not differentiated. Trunk transverse. Ovisacs tapering . **C. uncinata.**
- (*b*) Base of neck differentiated. Trunk suborbicular, longer than wide. Ovisacs linear . . . . **C. sciatherica.**

Genital process trilobate	ovisacs tapering	IRINA		
		IADDA	Bulla spherical	second maxillæ in line with cephalothorax.
Genital process simple		UNCINATA		
		SCIATHERICA		

Sea-Temperature, Breeding and Distribution in Marine Animals.

By

By J. H. Orton, D.Sc.

Naturalist in the Plymouth Laboratory.

With 1 Figure and 2 Tables in the Text.

CONTENTS.

INTRODUCTION.

Breeding in marine animals has long been recognised in a vague way as being in some degree dependent upon sea-temperature. This attitude is well shown in Lo Bianco's last valuable contribution to our knowledge of the breeding periods of practically the whole fauna of the Gulf of Naples. In the Introduction to this work Lo Bianco (1, p. 531) gives tables of temperature observations for a number of years, but does not attempt to correlate them with the breeding periods observed. There are in the literature some observations of reproduction in particular animals being dependent upon particular temperatures, notably by Schmidt (2); but no attempt has been made, so far as I know, to show in a general way the connexion between breeding and temperature in marine animals. It is clear, however, from the writings of Appellöf that this naturalist had anticipated in his mind some of the results obtained from the experimental observations described briefly in the following pages and of the deductions made therefrom. It is believed that these experimental observations have afforded a clue which gives an insight into the way in which breeding may be correlated with temperature in a large number of marine animals, but owing to the inadequacies of breeding records and of observations on physical conditions in the sea only a brief survey has been attempted here, and a fuller discussion of the phenomena is reserved for a later work. In the following pages the extrusion of ripe ova, or the fertilisability of eggs with subsequent development, is taken as the criterion of breeding.

RESULTS OF OBSERVATIONS ON BREEDING IN MARINE ANIMALS OF KNOWN AGES OBTAINED BY EXPERIMENT.

In the course of a research on the rate of growth of marine invertebrates, two of the objects of which research were (see Orton, 3, p. 312)—

(1) the determination of the minimum size at which maturity is attained,

(2) the investigation of the rate of growth at different seasons of the year and under different conditions,

results were obtained which pointed to the factor of temperature being of paramount importance in controlling breeding (3, p. 314). The facts which led to this conclusion are as follows :

Experiments on the rate of growth of marine invertebrates were carried out by putting out in the sea at noted times various objects, such as floating rafts, shells and pieces of wood attached to fixed objects. Numerous experiments were made at different times of the year with the object of obtaining information of successive growths. Material was collected from the experimental plots from time to time, and all animals collected were examined fresh with a view to determine the sexual activity of the different animals at known ages. By this means it was found in several different animals belonging to entirely different phyla that quite small individuals or colonies of a very young age were actively reproducing at certain periods suitable to the particular animal for reproduction, but that relatively very large and growing individuals were not reproducing at other periods of the year. For instance, the data obtained with regard to the two sponges, *Grantia compressa* and *Sycon coronatum*, may be put shortly as follows :—

Species.	Maximum age.	Time of growth.	No. of specimens.	Size.	Breeding observations at end of growth period.
(1) *Sycon coronatum*	7 months & 20 days	June to January	One	24·8 cms. long	Not breeding.
(2) ,, ,,	8 months & 1 day	May to January	Several	14–16 cms. long	Not breeding.
(3) ,, ,,	4 months	May to Sept. & Oct.	Many	3–5 cms. long	Yielded crowds of embryos.
(4) *Grantia compressa*	10–11 months	June to Mar. & Apr.	Many	8×3·5 cms.	Immature ova present only
(5) ,, ,,	15 weeks to 5 months	June to Oct.	Many	1·3 cms. long × less than 1 cm. wide	Yielded crowds of embryos.

Thus it is seen that these animals grow to a large size in winter, but do not begin to breed until April or May. Individuals born in the summer, however, rapidly attain maturity,* and in one particular experiment relatively tiny animals were rapidly reproducing at an age less than 4 months, whereas enormous growing individuals of an age 7 to 8 months were not breeding in early spring. I have no doubt that the summer-born individuals may breed twice in the course of a lifetime, once in late summer, and again in the following late spring or early summer† (4, p. 322). Similar phenomena to these have been observed in *Leptoclinum gelatinosum* and *Botryllus violaceus* and in other animals. In searching for an explanation of these facts it was observed that the beginning and the end of the breeding period coincided with approximately the same sea-temperature, and since a large growth occurs in these species during the winter the factor of food in determining breeding can be eliminated.‡ There remains still, however, another important factor—namely, salinity—which may influence breeding. But there is some ground for the view that changes in salinity, at least in the deeper estuaries, are subject to similar fluctuations in summer as in winter, and that, except for periods after heavy rains, estuarine salinities at a given position in the estuary are fairly constant throughout the year. This view is supported by the observations of Mill (5) in the Firth of Forth, of Dickson (6), in the Kent and Essex Estuaries, the mouths of the Schelde and the Weser, and of Karsten (7) and Meyer (8) in the German Bight.§

An important factor in helping to maintain similar salinity conditions in estuaries at different periods of the year is the occurrence of an off-shore maximum of salinity in late autumn and winter off Western Europe at about the period of the maximum inflow of fresh water into the sea.|| (See Fig. 1, p. 348.) This problem will be discussed more fully later, but there will necessarily remain some uncertainty about the factor of salinities in estuaries until more detailed observations are available extending over a period of years; and in view of the importance of understanding the conditions of life of estuarine faunas—of which boring animals and young fishes are notable examples—and floras, it is to be hoped that physical investigations of this kind will be undertaken in many different localities. For the present, however, there is good reason for the view that in a

* On July 15th, 1920, tiny *Grantia compressa* 10×4 *millimetres* and *Sycon coronatum* 8 to 9×ca ·3 *millimetres* were collected and examined at once. Fully developed ciliated embryos were found in teasings of even these tiny individuals of both species. I have no doubt whatever that these specimens are young ones born in the summer of 1920. They cannot therefore be more than three months old, whilst the tiniest ones with embryos I estimate are probably not more than about one month old. (Compare the similar phenomena described on p. 352.)

† An experiment designed to test this point was in progress in the summer of 1914 but was neglected in order to take up temporary fishery work. An account of the life-history of Grantia is given by the writer in 3, p. 315.

‡ A review of all the data given here tends to show that there can be no qualitative effect of food.

§ A fuller discussion of the available data will be published shortly in a separate publication on breeding in the European oyster, *O. edulis*.

|| See J. von Hann. *Lehrbuch der Meteorologie*. Leipzig, 1915, p. 356.

deep estuary such as Plymouth Sound the salinity does not vary greatly throughout the year except after periods of heavy rains, and even at these times it is probable that bottom salinities are not greatly affected. The fact, therefore, that the sponges and other animals mentioned above do not breed when the sea-temperature falls below a certain level points to the paramount importance of temperature in controlling breeding phenomena in these animals. Subsequent investigations on the breeding periods of animals have strengthened the view of the importance of an appropriate temperature and weakened that of the effect of *normal* changes of salinity in controlling breeding in marine animals in general.

MARINE ANIMALS REQUIRING DEFINITE TEMPERATURE CONDITIONS FOR REPRODUCTION.

Such a view of the importance of temperature led at once to a variety of suggestions. The first suggestion came from a recollection of the paper by Allen (9) on the breeding periods of the mackerel (*Scomber scomber*), which it was recollected showed earlier breeding periods the further south the region of habitat, and later ones the more northern. These were investigated, and the conclusion arrived at that the mackerel does not spawn throughout its geographical range when surface temperatures are less than close on 12°–13° C. The details of this investigation will be given later. This result gave a spurt to apply the principle to all fishes, but in reviewing the literature with me, my co-worker, Mr. R. S. Clark, drew my attention to Schmidt's work on the species of East Atlantic Gadoids (1), all of which Schmidt found to spawn at fairly definite temperatures and within fairly narrow limits. This valuable paper was unknown to me at the time, and afforded an additional stimulus. Later I was also indebted to Clark for drawing my attention to the observations of Nilsson on the mackerel, which confirmed my earlier view of the minimum temperature at which this fish spawns. Nilsson (10) found that off the Swedish coast mackerel eggs were only taken between the temperatures of 57°·92 F. (14°·4 C.) and 59°·72 F. (15°·4 C.) from July 1–6 in 1911, and Nilsson makes the significant remark that "It is, moreover, highly probable, as several writers have already suggested, that the temperature here exerts a considerable influence, and that the mackerel do not discharge their genital products until the water has reached a certain degree of warmth." Following up this success, the breeding records of all marine animals were collected so far as they could be obtained and were examined; but it was soon found that in many cases records were too incomplete, or were not recorded in such a way as to enable one to extract the fundamental phenomena, or were not accompanied by sufficient data to enable one to correlate temperature with the onset of breeding in bulk. It was therefore decided to examine thoroughly what is known of breeding conditions in a few well-known animals. The European oyster (*O. edulis*) was quickly chosen as one for which a good deal of information might be available. A review of the literature bearing on the breeding conditions of this animal throughout its geographical range at once showed the importance authoritative naturalists attached to temperature conditions in the control of breeding in this mollusc. An exhaustive investigation of the degree of correlation between breeding and temperature throughout the geographical distribution of this animal was therefore undertaken and has now been completed. The results will shortly be published separately in detail. It was found that, as in the case of the mackerel, breeding begins earlier in the more southern and warmer regions, e.g. Italy, and later in the more northern and colder localities, as the more open oyster pools of Norway, and at intermediate times on the French, Dutch and English beds. Throughout its range this mollusc appears to begin to breed at a temperature of about 15°–16° C. in varying salinities from about 25°/₀₀ to as high as 36°/₀₀ or more in the Gulf of Naples, *and continues to breed so long as the temperature remains above this figure*, so that in the warmer situations there is a longer breeding period than in the colder ones. This important generalisation, namely, that breeding continues in this—and indeed in other—species while the temperature remains above a certain figure, it will be seen, agrees with that deduced from the observations on the sponges mentioned above, and further points to temperature as the main factor controlling breeding, always, of course, assuming normal biological conditions. This generalisation, as applied to the breeding period of a large number of marine animals, is discussed on pages 344–350. (See also Table II, p. 350.)

In the course of the investigation of the breeding conditions in this oyster the interesting record was found (11, p. 1) of the occurrence of the Copepod, *Paracartia grani*—which is a species belonging to a tropical genus—in the Espevik and Selo oyster ponds in Norway, where in summer tropical temperature conditions obtain (Friele, 12, p. 188). This crustacean, according to Sars, is an undescribed species whose allies are not found nearer to Norway than the West Coast of Africa, and whose nearest ally is a species living in New Guinea; it is not found in neighbouring fjords, and is considered by Sars as a relict of a warmer age. The Espevik and Selo ponds are amongst the warmest of the Norwegian oyster pools, and in the former a temperature as high as 35° C. may be attained in some years. The breeding period of this interesting form is not given, but its determination will be awaited with much interest.

Additional records of the importance of temperature as a controlling factor are given by Appellöf (13, p. 556, footnote) of *Mysis relicta*, an Arctic survival form which occurs in the depths of the cold North German lakes during summer and migrates landwards during autumn and winter, beginning to breed chiefly at a temperature of 3° C. *Pontoporeia affinis* is another similar form which reproduces in winter at between 0° and 7° C. Appellöf also makes the following suggestion, which is significant for the purposes of this research : " It will be interesting to find out whether the boreal forms which penetrate into boreo-arctic areas with high temperatures for a short portion of the year have a short period of reproduction there, seeing that farther south their reproduction is known to extend over several months." Semper (14, p. 428) quotes Brauer's observations on a species of freshwater form *Cheirocephalus*, which, whilst kept in water at a temperature of 19° C., exhibited no signs of sexual maturity, but which in water below 11° C. developed sexual functions in two days. In this case temperature would appear to be unquestionably the sole factor determining sexual activity.

As an illustration of the importance of temperature in breeding in animals whose environmental conditions are relatively easily controlled, the investigations of Dendy and Elkington (15) on the grain insects *Calandra oryzæ*, *C. granaria* and *Rhizopertha dominica* may be mentioned. Dendy and Elkington found the lower limit for breeding for the species of Calandra at about 65° F. (18·33° C.), and at about 70° F. (21·11° C.) for Rhizopertha. No doubt other cases could be given, but enough has been cited to demonstrate the great importance of temperature as a factor controlling breeding in marine and some other animals.

BREEDING PERIODS CORRELATED WITH PARTICULAR TEMPERATURE CONDITIONS.

The breeding periods of animals at Naples have been investigated and collected by Lo Bianco (1). At Plymouth similar records have been collected and published in the " Plymouth Marine Invertebrate Fauna " (16), and I have been able to obtain, by the kindness of the Council of the Millport Marine Biological Station and Mr. R. Elmhirst, the unpublished breeding records for the locality of the River Clyde.

From the examination of these breeding records and from a consideration of the general phenomena of breeding in marine animals, namely, the periodicity, the incidence and the extent of breeding in different localities, it would seem from the results described above that most animals under normal conditions begin to breed either at a definite temperature, which is a physiological constant for the species, or at a definite temperature change, namely, at either the maximum or the minimum temperature of the locality.

Further, in a particular locality it would appear that many animals, of which the oyster may serve as a type, continue to breed so long as the temperature remains above a certain figure; and again, of others which continue to breed so long as the temperature remains below a certain figure, so that in these cases the breeding period can be expressed on the average in terms of temperature or in terms of homothermal epochs on the sea-temperature curve for that locality. In different localities or latitudes a particular species may be a winter breeder in the warmer situations and a summer breeder in the colder ones (see p. 351), indicating that in this type breeding may be limited by maximum and minimum temperatures. Yet a further type of breeding is furnished by those animals which reproduce in a particular locality all the year round. It is an interesting fact that these latter forms have generally a wide distribution, such as *Ciona intestinalis*, which breeds all the year round at Naples (Lo Bianco, 1, p. 658), and very nearly, if not quite, all the year round at Plymouth. *Patella vulgata*, which has also a very wide distribution, breeds at Plymouth at about and after the attainment of the maximum sea-temperature and at about and after the arrival of the minimum. At the latter period tiny individuals less than 1 cm. long (Orton, 17, p. 373), with gonads not bigger than a few millimetres, are in possession of fully developed and active sperm; corresponding observations on tiny specimens in August have not yet been made.

The deduction that breeding in a species is determined by temperature has been applied to several animals for which only isolated breeding records have been made. For instance, *Styelopsis* (*Dendrodoa*) *grossularia* is recorded in the Plymouth Marine Fauna List, 1904, as breeding in May and October. Monthly observations made during 1919–1920, except for July,* have filled in all the gaps and extended the breeding period from early April to early December. This breeding period may be compared with that of *Aplysia punctata*, records for which occur from April to October (see "Plymouth Invertebrate Fauna," p. 277), and also those given on page 350. Many other gaps in the breeding periods of animals have been filled in or partially filled in and confidence obtained in predicting the extent of a particular breeding period when some indication is given of the temperature range of the species for breeding. Care must be taken, however, to take into consideration the method of spawning and the rate of growth in a species. Thus animals which extrude all their genital products at once, such as some of the Chitons and some Teleosts, may have one or more sharply defined breeding periods; but the oyster is an example of an animal which extrudes all its ova at once and continues to produce sexual products (see Hoek, 18,

* Tadpoles of this species have been obtained in numbers in July, 1920.

pp. 219, 221). The determination, however, of the normal breeding period of an animal is rendered more difficult from the almost general absence in the literature of the year of the breeding observations, for the temperature variations from the mean which occur over a long period will result in the lengthening out of the normal breeding period at each end in any animal which can be shown to be influenced by temperature and is closely observed from year to year. This lengthening out of the breeding period will be specially marked in animals which attain maturity in a few weeks or months. (See p. 352.) In all breeding observations, therefore, it is necessary to connote the year of observation as well as the month and date of month and locality.

Temperature observations in estuarine situations require special study, and steps are being taken to instal in a suitable situation for obtaining the kind of information required a continuous self-recording thermometer. It has not been possible to obtain even continuous daily readings at all the situations where a knowledge of the temperature variation is desirable, but fortunately observations are available for the Promenade Pier, Plymouth, where temperatures are taken daily at about 10 a.m. at a depth of 1 fathom in a position about 100 yards from the shore, where there is about 14 feet of water at low-water springs and a fair tidal current. Monthly means for the years 1912–19* (19) are given in Table I, p. 347, along with monthly means of the surface temperature off Prawle Point given by Gee (20) for the years 1904–13 for latitude ca. 50° 08′ N., 3° 49′ W., the nearest position to Plymouth for which figures are available. The monthly means of salinity at this station are also given along with those of rainfall, hours of sunshine and air temperature at Plymouth (21). It is deeply regretted that no observations are available on the salinities in Plymouth Sound, but a few surface salinity observations given by Matthews (22) for a position about ½ mile from the lighthouse outside Plymouth Breakwater are added. The means given in Table I have been plotted to give the curves shown in Fig. 1, p. 348, except that weekly means instead of monthly means have been used to show the seasonal variation in temperature of the sea in Plymouth Sound as represented by observations off the Promenade Pier, Plymouth. An examination of the whole table and the curves in Fig. 1, p. 348, will show at once an important general fact in the relation between estuarine and off-shore sea-temperatures first shown by Mill (5a), namely, that at two periods of the year, at about April and Sept.–Oct., estuarine and off-shore sea-temperatures are equal, and that temperatures inshore are lower in winter but higher in summer than off-shore. In a deep estuary such as

* I am much indebted to the Plymouth Borough Meteorologist, Mr. H. V. Prigg, for supplying detailed information of these observations.

Table I, giving mean monthly air- and sea-temperatures (in degrees Centigrade) and salinities at and off Plymouth and monthly means of hours of sunshine and rainfall at Plymouth.

Means.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
(*a*) Sunshine (1881–1910)* .	54	80	135	173	**220**	213	211	199	158	108	69	**49**
Air (Plymouth, 1871–1910)*												
(*b*) of maxima . .	8·22	8·61	10·00	12·56	15·50	18·33	19·78	19·67	17·67	14·06	10·94	8·89
(*c*) of minima . .	3·11	3·22	3·50	5·56	8·00	11·17	12·72	12·78	10·89	7·78	5·33	3·72
(*d*) of max.-min. . .	5·11	5·39	6·50	7·00	7·50	7·16	7·06	6·89	6·78	6·28	5·61	5·17
(*e*) Mean air	**5·67**	5·94	6·78	*9·06*	11·78	14·78	**16·28**	**16·22**	*14·28*	10·94	8·17	6·33
(*f*) Sea, Promenade Pier† (1912–1919) . .	8·61	**7·83**	7·94	*9·00*	11·22	13·44	15·00	**15·97**	15·53	*14·00*	12·00	10·33
(*g*) Sea off Prawle Point‡ 1904–1913 (50° 08′ N., 3° 49′ W.)	9·81	8·51	**8·33**	*9·04*	10·63	12·46	14·13	**15·22**	14·85	*14·33*	12·52	11·03
(*h*) Salinity off Prawle Point‡	35·126	·142	·123	·120	·111	·105	·097	·072	·068	·122	·163	·137
per thousand (1904–17)	3rd–24th	5th only					14th		13th & 21st		24th–29th	9th–20th
(*i*) Salinity Knap Buoy§ ‰ (1915–16) . . .	25·66–33·93	31·58					34·83		34·94		34·45	31·46–26·20
(*j*) Rainfall* (1871–1910) in in:	3·5	2·82	2·52	2·37	**1·94**	2·21	2·85	3·04	2·89	3·9	3·57	**4·29**

* Meteorological Office (see ref. 21). † Meteorological Office (19) and Plymouth Borough Meteorologist (see p. 346).
‡ Gee (ref. 20). § Matthews (see ref. 22).

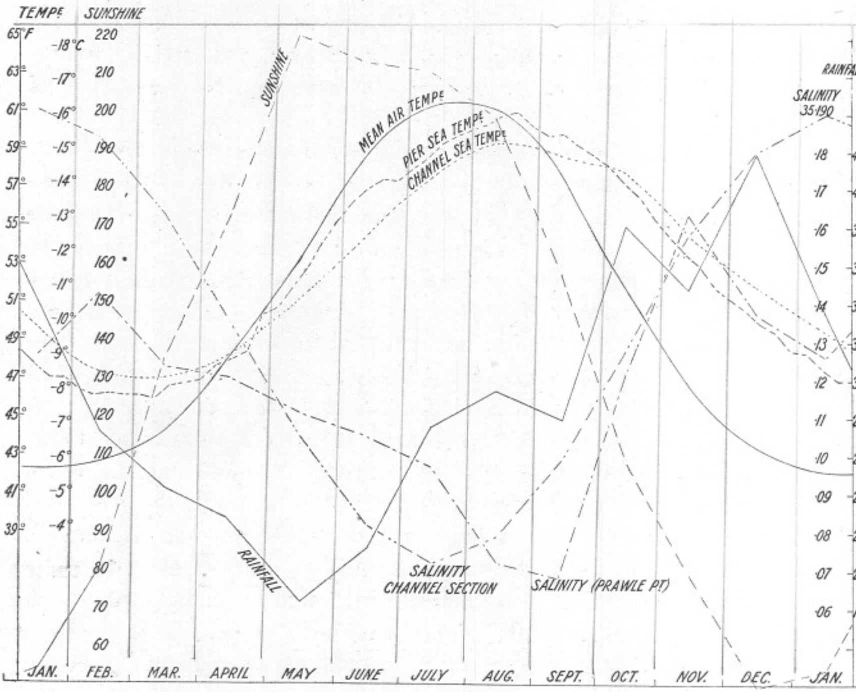

FIG. 1.—Curves of seasonal variation in some important meteorological and physical conditions which contribute to the seasonal variation in temperature and salinity in the waters of Plymouth Sound. The curves are derived from the monthly means given in Table I except that for temperature observations of the sea at a depth of 1 fathom off the Promenade Pier, Plymouth, which is plotted from weekly means.

These curves bring out the following facts for the Plymouth district :—

(*a*) The coincidence of mean air, mean Pier and mean Channel sea-temperatures in April, and of the two latter means in September–October.

(*b*) The rise of the mean air above the mean sea-temperature in April, and its fall below the mean sea-temperature in August–September.

(*c*) The successive lag on the curve of duration of sunshine of the curves of mean air, mean Pier and mean surface Channel sea-temperatures respectively.

(*d*) A maximum Channel salinity approximately coincident with the period of maximum rainfall.

(*e*) A maximum duration of sunshine coincident in May with a minimum amount of rainfall, and a general inverse relation between the duration of sunshine and the amount of rainfall.

Plymouth Sound this difference is not so well marked as in shallower estuaries. Another important point is that the mean air-temperature begins to rise above the off-shore sea-temperature also about April, and falls below again about September, as Dickson (6b) and Helland-Hansen and Nansen (23) have shown to be the case for the region of the East Atlantic.

Corresponding with this it is found that shallow water takes on a higher temperature than deeper water from about March–April and a lower temperature than deeper water from about September. Thus the temperature variations in the exact locality from which animals are obtained must be carefully considered; for instance, animals living on the shore or near high-water mark will exist under higher mean temperature conditions than those in deeper water from April until about September, when lower temperature conditions will occur. Thus, if the breeding periods of shallow water inhabitants are correlated with the Promenade Pier mean temperatures only, a certain amount of skew—which can be accounted for—will be observed. Owing to the fact that continuous temperature records in shallow water have not yet been made at Plymouth it has been considered advisable not to attempt at present to give any exact temperatures at which breeding begins in particular species in this district, although a good idea of the figures within fairly narrow limits has been obtained and can be deduced from the Pier temperatures, which can be considered reliable. A few examples of breeding records are given in the following list—as a sample—of animals which breed in the period between approximately homothermal epochs on the sea-temperature curve.* (See Table II, p. 350.) Approximately homothermal epochs on the *mean* temperature curve for records at the Promenade Pier are seen to be as follows: (1) end of March and end of January; (2) end of April and middle of December; (3) end of May and beginning of November; (4) beginning of July and beginning of October. In using this list it is important to bear in mind the variation in temperature conditions with locality mentioned above, as well as the possible overlap of breeding seasons from the mean due to temperature variation from the mean over a number of years, and the possible incompleteness of the records in a few cases. The months in which filling-in observations have been made by the writer are printed in italics. The habitats are taken mainly

* In view of the economic importance of the marine boring Lamellibranchs, it is worth while noting here that C. P. Sigerfors (Bull: Bureau of Fish: U.S.A., Vol. xxvii, p. 196) found that *Xylotrya gouldi* and *Teredo dilatata* were breeding at Beaufort, U.S.A., from May to August and probably later in the summer, an observation indicating that these species also breed between homothermous epochs. The breeding periods of the species of Teredo infesting British waters are not known, but it would appear to be a reasonable deduction from records in my possession that *T. norvegica* (?) breeds at Plymouth between the period about June–October.

from the Plymouth Fauna List (l.c.), supplemented in a few cases with observations of my own.

Table II, illustrating continuous breeding at Plymouth between approximately homothermal epochs.

Species.	Habitat.	Breeding Period.
*Bougainvillea ramosa** .	L.W. to ca. 30 fms.	April, May, *Aug.*, *Sept.*, *Oct.*
*Clytia Johnstoni** .	,,	Mar., *April*, May, July, *Aug.*, Sept., *Oct.*
Gonothyrœa loveni .	Chiefly low-water mark.	Mar., April, Sept., *Oct.*, Nov.
*Obelia geniculata** .	Chiefly low-water mark.	March–Sept., *Oct.*, *Nov.*††
Sycon coronatum .	Chiefly at, but also below L.W.	*May*, *June*, *July*, *Aug.*, *Oct.*, *Nov.*‡
Grantia compressa .	Chiefly between tide-marks, but also on floating objects.	†*April*, *May*, *June*, July, *Aug.*, *Oct.*, *Nov.*‡
Bunodes gemmacea§ .	Chiefly between tide-marks.	March, April, *July*, Sept.
Actinia equina§ .	,,	Jan.–Aug., *Sept.*, *Oct.*, *Nov.*, *Dec.*
Amphiura elegans§ .	L.W.–20 fms.	*April*, May–Sept.
Echinus miliaris .	L.W.–35 fms., chiefly between tide-marks.	*March*, *April*, May, *June*, *July*, end of *Aug.*
Ascidiella aspersa .	Chiefly at and below L.W. and R. Yealm bed.	*March*, April, *May*, June, July, *Sept.*, *Oct.*, *Nov.*, *Jan.*
Ciona intestinalis .	Chiefly just below L.W. and on floating objects in docks.	*April*, *May*, June, July, Aug., Sept., *Oct.*, *Nov.*
Clavellina lepadiformis	Chiefly at and below L.W., also 10–15 fms.	*May*, June, July, *Sept.*
Cardium edule‖ .	R. Yealm bed.	*March*, *April*, *May*, *June*, *July*, *Oct.*
Ostrea edulis .	R. Yealm and the Hamoaze, 0 to a few fms.	*June*,¶ *July*,¶ *Aug.*, *Sept.*

* In the case of *Clytia*, *Bougainvillea* and *Obelia* the breeding record, when given by the writer, is of medusæ extruded, but may only refer to the occurrence of gonophores in other cases. This, however, is probably sufficient. In an undescribed experiment carried out in October, 1919, on the rearing of medusæ in the sea, I obtained a Clytia medusa bearing gonads at an age of 10 days from the time of liberation from the gonophore. Wright (see Hincks, British Hydroid Zoophytes, p. 143), however, obtained the same medusa with gonophores in a few days and a young hydroid within a week of the liberation of the parent medusa. The medusa of Clytia may therefore be regarded as little more than a free-swimming gonad. In the other cases little is known of the length of time required in the sea for the development of the gonad, but E. T. Browne has informed me in conversation that they develop within a few weeks when reared even in the laboratory. In the sea the period is probably shorter. This limitation of the records must, however, be borne in mind.

† 1913. ‡ 1914. § With young. †† With gonophores 1919.

‖ Ripe eggs and sperm. This species is also known to have full gonads throughout the summer, and fertilised eggs were obtained in July and October.

¶ Ripe sperm and white ciliated embryos in June, and "black spat," i.e. shelled veligers in early July, 1920.

PHENOMENA OF HIBERNATION CORRELATED WITH TEMPERATURE.

Phenomena similar to those of breeding are observable in forms which hibernate. The Ascidian *Clavellina lepadiformis* has been carefully watched at the time of its appearance in spring about the end of May and its disappearance in autumn about the end of October. As these are approximately homothermal epochs, there is every ground for concluding that the phenomena are purely temperature effects, since both old and young colonies have been observed to go into hibernation. This species awakens in the spring, grows rapidly, and begins to breed within a few weeks of its first appearance. Breeding has been followed in this species into September, and is believed to occur practically up to the time of hibernation, as occurs in *Morchellium argus*, which behaves similarly to Clavellina. In these two forms breeding and growth appear to be especially closely connected.

Some hydroids also hibernate in winter at Plymouth and breed at and about summer, as *Plumularia pinnata*, *Antennularia antennina*,* and probably also *Antennularia ramosa* and *Bougainvillea ramosa*. It is an interesting fact that the two species of Antennularia and Bougainvillea are winter breeders at Naples (Lo Bianco, 1, p. 539). It is not unreasonable to expect that hibernation of these latter forms occurs at Naples in summer, and if this supposition is confirmed it will be possible to work out for these species the temperature range for breeding and the upper and lower temperatures at which hibernation occurs (see also p. 359).

BREEDING AND GROWTH.

The observations noted above on the occurrence of tiny breeding specimens in a suitable temperature medium and of relatively large specimens not breeding in unsuitable temperature conditions from which the factors of food and apparently salinity may be eliminated afford some insight into the different conditions necessary for growth and breeding, and for growth during breeding. Animals such as (*a*) *Grantia compressa*, *Sycon coronatum*, *Leptoclinum gelatinosum* and *Botryllus violaceus* grow to a large size during the non-breeding period; other

* The temperature phenomena of hibernation provoke a suggestion with regard to the experiments made by Drew and De Morgan on the restitution bodies of this species (Journ. Mar. Biol. Assoc., Vol. X, No. 3, p. 440). The experiments were performed in winter under uniform low temperature conditions (see p. 444). Restitution bodies were formed, but no polyps developed. Wilson (Journal of Exp. Zool., 1911) obtained polyps from restitution bodies, but his experiments were carried out in July. I therefore make the suggestion that if these experiments were repeated under temperature conditions which are more favourable for the physiological operations of the species more success might be obtained.

animals, such as (*b*) Clavellina, Morchellium, Plumularia and other forms hibernate during the non-breeding period; whilst others, as (*c*) *Cardium edule*,* and probably other bivalve molluscs, do not grow much during the non-breeding period. The animals in category (*a*) appear to have alternating periods mainly of growth and mainly of breeding, and the size attained in these forms will depend mainly upon the relative lengths of the breeding and the non-breeding periods in a particular locality. In category (*b*) growth and breeding is almost contemporaneous, as it also is in category (*c*), except probably for a short period of diminished growth, between each end of the breeding and resting periods, and in both cases it would seem that size in a particular locality will depend, among other factors, on the relative lengths of the growing and breeding periods. In the same species, therefore, size will vary, among other factors, inversely as the length of the breeding period. There are indications, however, that in all animals born into suitable breeding conditions gonad development occurs very early during the period of growth and at the expense of increase in size. Thus, in the instances quoted above tiny Grantia and Sycon of from 1 to a few cms. were reproducing in a lively manner in autumn; tiny Patella of about 1 cm. in length were sexually mature in winter; similarly quite small Clavellina and tiny colonies of Leptoclinum have been found extruding tadpoles; and Cardium and Crepidula are mature in less than a year; Obelia settles as a planula and grows into colonies which give off medusæ in a maximum period of 3 weeks during summer. Recently I have obtained small specimens of *Conchoderma virgatum*—some of which were extruding larvæ—from the bottom of a ship which was loaded in the River La Plata in fresh water and took 5 weeks to cross the Atlantic. The maximum age of these specimens was therefore 5 weeks, and a small proportion were already sexually mature. Hornell (24) obtained tiny pearl oysters $26\frac{1}{2} \times 25\frac{1}{2} \times 9$ mms. of an age not more than $3\frac{1}{2}$ months with ripe sexual products ready to be shed, and I have confidence in predicting that young specimens of the European oyster will be found to be sexually mature in the summer in which they are spawned in those situations where high temperature conditions obtain for a few months. Many other instances could be given of the attainment of sexual maturity at a very early age† where animals are born into suitable temperature conditions which

* I have obtained definite information by experiment that *Cardium edule* practically ceases to grow during the colder months.

† Tiny *Echinus miliaris* have frequently been found by workers in this Laboratory to be functionally mature. In an investigation of the sexual habits of this species (Journ. Mar. Biol. Assoc., Vol. X, No. 2, p. 254, 1914) I recorded size as well as state of growth, and find among the records ripe males and females in May at a size of 12 and 13 mm. in diameter. The ages of these are not actually known, but I should say they are certainly under a year judging from evidence in my possession relating to other specimens of this species.

continue for some time. In the tropics this phenomenon would be expected, but it also occurs, as I have shown above, in temperate regions.

The instances of early maturity given in this paragraph give some insight into the nature of the influences which affect the pre-breeding period in some marine animals. It is clear that when animals are born into breeding-temperature conditions—other things being normal—the sexual cells mature in a very short space of time; but in larger animals than these, which produce enormous quantities of eggs, different conditions are known to obtain. For instance, Turner,* in investigating the "Seasonal Cycle in the Perch (*Perca flavescens*) Spermary," found that "the beginning of the period of spermatogenesis and of the sudden increase in size of the testis is contemporaneous with the beginning of the seasonal reduction of the temperature of the water in which the perch is found," and that "the expulsion of the spermatozoa occurs at the same time as the seasonal rise in the temperature of the water" (l.c., p. 704). It is true that this fish is a freshwater form, and may therefore be receptive to influences in a manner different from marine fishes,† but the phenomena are suggestive and indicate a direction for further researches. This question is discussed a little more fully in the paper on the oyster referred to, but there is not enough information available to discuss the problem fully.

BREEDING UNDER STENOTHERMAL CONDITIONS.

It follows from these observations that in those parts of the sea where temperature conditions are constant or nearly constant, and where biological conditions do not vary much, that marine animals will breed continuously. This is apparently the case in the tropics, since Semper states (14, p. 110), with reference to the Philippines, that "What was far more striking in these islands was the total absence of all periodicity in the life of the sea-animals, particularly the Invertebrata. Among these I could not detect a single species of which I could not at all seasons find fully grown specimens, young ones and freshly deposited eggs." At

* Journal of Morphology, Vol. 32, No. 3, Sept., 1919, p. 704.

† Since the above was written Dr. Hjort has drawn my attention to the phenomena of seasonal variation in the gonad of herring taken off the Norwegian coast and recorded by himself (Pub: de Circonstance, No. 53, 1910), and E. Lea (Pub: de Circonstance, No. 66, 1913). The Table given by Lea (l.c., p. 24) is highly instructive and shows, as Dr. Hjort stated, that gonad development begins in these forms in the summer at about the period of maximum temperatures in the upper layers of water down to a depth of about 50 metres (see Hjort, 25, fig. 509, p. 709) and attains a maximum of development in the period February–April when spawning occurs. At this period minimum temperatures occur down to a depth of about 50 metres (see Hjort, 25, fig. 509). If the samples given by Lea above can be shown to belong to the same community or stock of herring, then it would appear that this fish—and probably many others—has its sexual activity controlled by temperature conditions in the same way as Turner has shown to be the case in the yellow perch.

the Philippines, Semper states that the surface temperature does not vary more than 2° C. throughout the year. This phenomenon appears to be generally recognised for the tropics, but it would appear that definite systematic work on the breeding and rate of growth throughout the year of a large number of animals in the tropics would still be very useful.

Other homothermal or stenothermal regions are the deeper parts of the sea and, to some extent, the polar regions. Systematic records of breeding of deep-sea animals may not be available for some time, but it would be well worth while recording the sexual condition of all animals taken from these regions. There are, indeed, some indications that breeding is continuous in these regions, since Hjort (25, p. 739) shows that many most interesting oceanic fishes are sexually mature at the minute size of only a few centimetres (Figs. 526, 529). Remarking on the possible periodicity of breeding in oceanic fishes, Hjort states that "the scarcity of fish eggs and the abundance of pelagic fish fry might appear to indicate a continuous production of rapidly hatching eggs, the larval and post-larval stages being of much longer duration, but a study of the ovaries of the adult fishes does not favour this supposition. In Cyclothone, for instance, the eggs seem to be equally developed in every portion of the ovary, and to ripen throughout the entire length of the ovary at the same time. During our cruise the ovaries were found to be ripest at Stations 53 and 64 on the southern section."

It is almost superfluous to point out that these facts do not negative the possibility that breeding may occur all the year round in deep-sea fishes; and, indeed, the same writer points out (l.c., p. 741) that "we are ignorant as to how often these small fishes reproduce their kind during the year," and (l.c., p. 738) that "it is quite evident that a short voyage in a steamer passing over enormous stretches of ocean in the course of a few days offers no opportunity of studying the conditions of propagation all the year round. I can only point out how desirable it is that the Atlantic should be examined at all seasons of the year, for only by this means can the conditions be fully understood." There can be no doubt that an oceanographical expedition to the Atlantic in winter would yield most valuable biological knowledge, providing work could be done. The fact, however, that minute fishes are mature in the deeper waters of the ocean strongly reminds one of the tiny invertebrate young which have grown and matured under temperature conditions suitable for breeding.

In the polar regions apparently examination of fresh material in bulk for breeding conditions is hardly practicable; but Murray and Chun have directed attention to the great prolificness of life in polar waters, and to the fact that several generations of a species appear to live side by side. Murray and Loeb, however, have both suggested that an explanation of these phenomena may be found in the greatly retarded rate of growth which it is postulated must occur in these low temperatures. It has to be admitted that there is nearly everything in favour of this view, but it may be observed that experiments on the effect of temperature on rate of development have been carried out apparently entirely on animals whose optimum temperature for growth is well above 0° C., consequently results obtained by reducing the temperature are based on abnormal conditions for the particular animal, and it may be doubted whether the abnormal results from one or a series of animals are sufficient to prove that they will hold for animals in which these abnormal conditions are normal. And, indeed, an examination of plankton made in the coldest period, i.e. February, at this station and compared with plankton at any other period of the year, gives anything but the impression of a general slowing up of development, and shows that reproduction is as active in general as probably at any other time of the year. However this may be, definite information on rate of growth in the polar regions might easily be obtained by buoying or sinking and anchoring different objects for marine animals to settle on and grow. Apart from these considerations, however, the alternation of long periods of daylight with long periods of darkness must alter the biological conditions profoundly, at least in the upper layers of the waters in the polar regions, and it may be doubted whether any form of marine life is independent of such a fundamental change whatever the remaining physical conditions of the habitat may be. Nevertheless it is to be expected that during constant biological conditions breeding will be found to be continuous in the polar regions. Hence it is well worth while to record the sexual condition of all animals taken in the polar regions.

BREEDING AND DISTRIBUTION IN MARINE ANIMALS.

It was quite early recognised that if temperature is of importance in the breeding of marine animals it must also be of immense importance in affecting their geographical distribution. Sea-temperature has long been regarded of importance in limiting distribution, and many writers have attempted to show the correlation, but only a few can be mentioned here. Hjort (25, and especially Chapter VII) and Appellöf (13) give numerous instances of the limitation of the geographical distribution of marine animals by temperature conditions, but it is only possible to quote here the general observations of these naturalists. Hjort defines the limits of the Arctic and boreal faunas of the Atlantic in terms of temperature (l.c., p. 637), and again (p. 777) of the boreal and warm-water forms. Appellöf also states (13, p. 526): "Generally speaking, the limits between a littoral and non-littoral zone seem to be less clearly defined in the arctic than in the boreal region. *The reason for this is obvious, if we remember that temperature largely controls distribution.** In high arctic latitudes the difference in temperature between deep and shallow waters is inconsiderable compared with that at corresponding depths in boreal areas. As a result, the forms find favourable conditions of existence so far as temperature is concerned at very different depths, and the vertical distribution of most of the arctic forms is far more extensive than that of boreal forms"; and again (l.c., p. 557), "it is not so much the depth as the temperature which regulates the distribution of animals."† Moreover, Appellöf is fully aware of the importance of suitable temperatures for reproduction, for he states (l.c., p. 556) "That many of our littoral animals are able to live in boreo-arctic areas at a low temperature depends upon their finding the conditions necessary for reproduction, namely, higher temperatures during a portion of the year"; and again, in a footnote to page 556: "It will be interesting to find out whether the boreal forms which penetrate into boreo-arctic areas with high temperatures for a short period of the year have a short period of reproduction there, seeing that farther south their reproduction is known to extend over several months." In my investigations of the breeding period of the oyster throughout its geographical range I have been able to show exactly the point Appellöf was thinking of when he wrote this (see p. 357), and it will be seen in general that if a species breeds at and above a certain temperature it must breed longer in general in a more southern or warmer locality of its distribution, since the sea-temperature in such situations will in general remain above that figure for a longer period.

Appellöf also states that *Tapes decussatus*, which is a species requiring greater warmth than generally prevails in the boreal region, occurs in isolated, shallow, sandy, open bays on the western coast of Norway from Bergen down to the south coast. These bays he found had sometimes a temperature of 23° or 24° C. in summer, and states that "Beyond question this high summer temperature, in combination with favourable bottom conditions and the salt water, enables *Tapes decussatus* to thrive and, what is more important, to reproduce itself."

Thus it is seen that no doubt can exist of the importance of temperature as a factor determining the distribution of marine animals, and one reason of this is now quite plain, namely, that different animals require definite temperatures for the purposes of reproduction.

* The italics are mine.

† Appellöf (l.c., p. 526–7) gives examples of animals whose vertical distribution may vary so much as from two thousand metres to less than thirty metres, and states in effect that this phenomenon is not uncommon.

Moreover, if temperature is of great importance for reproduction, then in general three conditions follow, namely :—

(1) Cosmopolitan forms should have a wide range of temperature for breeding.

(2) High latitude forms in relatively low latitude situations should find their breeding period at least in relatively low temperatures for the locality.

(3) Low latitude forms in relatively high latitudes should only breed in summer.

A few examples of each of these may be mentioned now. *Ciona intestinalis*, which has a very wide distribution (Hartmeyer),* breeds all the year round at Naples (Lo Bianco, l.c.) and very nearly all the year at Plymouth. *Balanus balanoides* is an example of a high latitude form which breeds at Plymouth at and about the arrival of the minimum temperature. *Styelopsis* (*Dendrodoa*) *grossularia* is a member of a northern genus on the edge of its southern distribution* which breeds throughout most of the year at Plymouth; and the European oyster is an example of a low latitude form which in the more open oyster ponds of Norway, on the northern limit of its distribution, only breeds in August or not at all (Helland-Hansen, 26), whilst in the Mare Piccolo, on the Gulf of Toranto, it breeds from April to October or longer (Bashford Dean, 29, p. 361).

These examples therefore show one way in which distribution may be limited by temperature conditions.

ORIGINATION OF SPECIES BY VARIATION OF BREEDING TEMPERATURE CONSTANTS.

It was originally intended to delay a consideration of the matter in this paragraph until a good number of cases were definitely and carefully correlated with breeding temperatures. But as Appellöf has anticipated the conception to some extent, it can only do good to throw the subject open to discussion. Appellöf (l.c., p. 555) states: "We have already seen that many species are common to both boreal and purely arctic areas, and we must ascribe their widespread distribution to their power of adapting themselves to very different temperatures. Most likely we are dealing here with physiologically distinct species, even though the differences do not appear in corresponding morphological alterations in bodily structure. Not that differences of this latter kind are by any means excluded, as I have previously shown how a species

* See O. Seeliger and R. Hartmeyer, Das Tier-Reich, H. G. Bronn, Tunicata, Dritter Band, I Abteilung, pp. 1540 and 1529. Leipzig, 189[illegible]–1911.

may vary morphologically in certain directions, according as it occurs in arctic or boreal tracts. Future researches regarding the time when reproduction begins in these widespread forms in the respective areas will possibly show that the temperature at which development takes place varies a good deal less than the temperature prevailing in the different areas seems to indicate." It is a matter of common knowledge that it is towards the limit of the distribution of a species that it often becomes difficult to distinguish an animal from its allies. And, indeed, this is an important source of trouble in determining the synonymy of an animal for the purpose of obtaining its breeding periods at different regions of its distribution. Appellöf has perceived that its reaction to temperature is one character in which an animal may begin to vary or to take advantage of variations at the limit of its distribution. It is perfectly conceivable that an animal may increase its temperature range advantageously down or up beyond the normal death-temperature or growth-temperature for the species. Mayer (27) has, indeed, shown that this phenomenon of raising the death-temperature above the normal for the species occurs in Aurelia in the tropics. Thus may arise what Appellöf calls physiological species. Possibly his term for a variety of this kind is too strong, and the term sub-species or "race" might more correctly interpret this phase of adaptation. Appellöf's conception may, however, be carried further in the light of this research. At the limit of distribution of a species which is supposed to depend upon a certain definite temperature or definite temperature range for reproduction an opportunity arises for the species to utilise any variation in its metabolic processes which permits of its reproducing under conditions different from those under which the parent stock exists. Variations of this kind might be immediately effective in extending the range of the stock. At first the new variety, sub-species or race might differ little from the parent stock, but the new influences to which it might be subjected outside the experience of the parent stock would probably be reflected sooner or later in definite morphological changes, as indeed Appellöf has already shown. Now, it is a curious fact that two well-known species in the Mediterranean appear to exhibit features somewhat corresponding to those pictured here, namely,

Ostrea edulis with varieties (?) *plicata*, *depressa*, *cristata*, *falcata*.
Mytilus edulis ,, ,, (?) *gallo-provincialis*.

O. edulis is described by Faber (28, p. 17) as abounding in the Gulfs of Trieste and Venice, but only rarely in the Quarnero, where var. *cristata* is the only oyster found in certain parts. In the whole of the Adriatic Faber describes (l.c., p. 88) five different kinds of oysters, namely, "*O. adriatica* (Lam.), found generally on the limestone beds of the

Adriatic, but neither in the lagoons nor in the oyster ponds ; *O. lamellosa* (Brocchi) (*Ostrica à lamelle*), a species which is reared in ponds on a large scale, attains to large dimensions, and is the most savoury of the Adriatic species ; three varieties of *O. edulis* (L.), viz. var. *depressa* (Phillipi) (*Ostrica communa depressa*, vulgo *Ostrichino*), a small species common to the lagoons and at Zaole, found attached to wood, and the mussels Pinna and Mytilus, and much liked on account of its savoury taste ; var. *cristata* (Auct. (?) Born. (?)) (*Ostrica commune crestata*), and var. *falcata* (Chiereghin) (*Ostrica commune falcata*), both found in the lagoons, ponds, harbours, on limestone and muddy beds. The former is the only kind which occurs in the Quarnero."

At Naples (Lo Bianco, l.c., p. 621) *O. edulis* occurs with a form described as *O. plicata* Chemn. (Osteco do Castrello), which occurs in shallower (and in summer hotter) water than *O. edulis*. Lo Bianco has obtained this form full of sexual products in May and July towards the hottest time of the year when very high temperatures may be expected in shallow water in this locality. Bashford Dean (29, p. 358) states "that the gulfs of the north (of Italy) do not appear to be favourable to the growth of the typical European oyster, *O. edulis*. The Gulf of Genoa produces a small oyster mainly for local consumption, *O. plicata* (more probably *O. edulis* var. *plicata*), a species delicately flavoured and appearing to find its best living conditions in waters as dense as 1·027 to 1·028. In the harbours of Trieste and Venice another variety of oyster occurs, *O. edulis venetianæ*. This is generally regarded as poorer in quality than *edulis*, and its production therefore competes but little with the southern industry."

It is therefore seen that in the Mediterranean, on the southern natural fringe of the distribution of *O. edulis*, great activity is occurring or has occurred in the production of varieties, and indications are given that these varieties are varying in the direction of reproducing under high temperature and high salinity conditions (*O. plicata* (?) (Dean and Lo Bianco, l.c.).

A thorough biological investigation of these Mediterranean oysters might therefore bring out facts of great value in the study of the mode of divergence of varieties from the parent stock. One of these forms, *O. plicata* or *O. edulis* var. *plicata*, appears to be a definite physiological variety or race of the kind expected by Appellöf and from the investigations described here.

A form of the genus Mytilus occurs in the Mediterranean and is identified by Lo Bianco (l.c., p. 620) as *M. galloprovincialis* ; but both Jeffreys (30, p. 105) and Forbes and Hanley (31, p. 171) regard this form as a variety of *Mytilus edulis*. After describing this form as a separate species, Dautzenberg and H. Fischer have reunited this form with the type under the species name *Mytilus edulis* (32, 1912, p. 361). As there are no anatomical features sufficiently developed to warrant the separation of these two forms, it would seem that it is in the direction of physiological characters, such as temperature conditions for reproduction and adaptability to different salinities and similar characters, that one must look for differences between the two forms. Thus in this species also some vague indication is given that an offshoot of the parent stock has become adapted to the relatively strange conditions in the Mediterranean Sea.

PHYSIOLOGICAL CONSTANTS OF A SPECIES.

In recognising temperature as a factor of paramount importance in determining the geographical distribution and breeding of marine animals, other conditions being suitable, it would appear that if sufficient information were available of the physiological or rather biological characters of a particular species, then one should be able to plot out on a map the limits of a region suitable for the habitat of that particular species, a region which should coincide with its geographical distribution. In this way information would be obtained of any other conditions limiting distribution, such as abnormal salinity conditions, lack of suitable food, depth and light, etc. The main characters, which would be important for this purpose, would appear to be included in the following list :—

Temperatures under normal salinity conditions.

(1) Upper death limit.
(2) Upper limit of growth or hibernation conditions.
(3) Maximum limit for breeding.
(4) Minimum limit for breeding.
(5) Lower limit of growth or hibernation conditions.
(6) Lower death point.
(7) Rate of change of temperature at different temperature levels causing death.

These characters would serve for probably all marine animals except littoral forms, and also as a guide for drawing up the more complicated tables which might be necessary for the latter.

CONCLUSION.

A review of all the information collected bearing on the influence of temperature changes on breeding leads one to the conclusion that a temperature stimulus of some kind is the normal impulse for inducing sexual activity in marine animals assuming normal biological conditions. In marine invertebrates, at least, the impression is gathered that normal salinity variations within the habitat of the species have little effect on breeding.

But an investigation of the conditions controlling breeding in a large number of species can only be satisfactorily made if breeding records are made in detail and the date and year mentioned and accompanied by reliable temperature and salinity observations for the habitat of the species. As it is now becoming the custom to connote all these data, there are good prospects of an important advance being made in the future in our knowledge of the conditions of life in the sea.

I am indebted to Dr. E. J. Allen for helpful criticisms, and the reader will already have learnt a small portion of my indebtedness to the writings of Prof. A. Appellöf and Dr. J. Hjort in the work on "The Depths of the Ocean," by Sir John Murray and Dr. Johan Hjort, a work which might very well be regarded as the marine biologist's vade-mecum.

SUMMARY.

The criterion of breeding is fertilisation resulting in subsequent development.

Experiments on rate of growth in marine invertebrates, carried out with the definite objects of obtaining information on (1) earliest age of maturity and (2) succession of seasonal growth, showed that in many animals tiny individuals are sexually mature at a very early age at a certain period of the year, whereas at other periods relatively large specimens of a greater age are not breeding.

These observations prove that food can be eliminated from the factors pre-eminently controlling breeding, and for reasons stated it is considered highly probable that salinity variations can also be eliminated largely as a controlling influence under normal conditions.

Hence it was deduced that sea-temperature must be the influence of paramount importance controlling breeding in marine animals under normal biological conditions.

It was observed that breeding in the special instances investigated was continued *throughout* a period which extended between approximately homothermous epochs of the yearly sea-temperature variation. Hence it is deduced that breeding of this kind is dependent upon the attainment of a minimum breeding temperature of the medium.

Such a minimum breeding temperature would therefore appear to be a physiological constant for the species.

With a view to applying this deduction, the degree of correlation between the breeding period of the European oyster and temperature has been exhaustively examined and the conclusion arrived at that this mollusc begins to spawn in a mean temperature of 15°–16° C. through-

out its geographical range. Further, this species *continues to produce mature sexual products* so long as the temperature remains above this figure. Hence there is a longer breeding period in the more southern or warmer oyster beds than in the more northern or colder ones. These results will be published shortly.

The breeding phenomena of the mackerel (*Scomber scomber*) were also examined and the conclusion arrived at that this animal begins to spawn throughout its geographical range at temperatures round about 12°–13° C., so that in its more southern or warmer habitats spawning begins earlier in the year than in its more northern or colder habitats.

It was found that there are in the literature some important observations and authoritative opinions on the paramount importance of temperature controlling breeding in particular marine animals.

A review of the breeding periods of marine animals at Naples (Lo Bianco), Plymouth ("Marine Invertebrate Fauna") and Millport (collected unpublished records) yielded much information in support of the deductions arrived at up to this time; but as a full consideration of all the facts will be a labour of years, an introductory study of them is all that is attempted here.

Temperature seems to influence breeding in marine animals in various ways which appear to be dependent upon the limitation of the breeding period by apparently constant maximum and/or minimum temperatures. *These temperatures appear to be physiological constants for the species.*

Hence in sedentary marine invertebrates the breeding period will depend, among other factors, upon the temperature range of the habitat and therefore mainly upon latitude. This phenomenon is well shown in the oyster, which breeds during seven months or more of the year in its more southern and warmer habitats, but during only one or two months or even not at all in some years in its more northern and colder ones.

Examples are given of breeding periods at Plymouth extending over a period of the year limited by homothermal epochs representing the minimum temperature for breeding in each species. There are examples in the breeding periods of animals at Naples of breeding in species being limited by approximately homothermal epochs representing the maximum temperatures for breeding in each species.

Perhaps the profoundest influence of temperature is at the minimum or the maximum temperature attained for a particular locality, and there are examples in the breeding records of

(1) many breeding periods beginning at or very close upon the minimum temperature for the locality, a type of breeding to which it will probably be found that a good many fishes conform, and

(2) other breeding periods beginning at or very close upon the maximum temperature for the locality.

Breeding periods must be also studied in the light of rate of growth of the species, method of spawning and habits.

Hibernation phenomena in some marine animals are shown to be controlled probably by definite temperatures and to resemble the breeding phenomena described. Many examples are given of tiny young animals being sexually mature at an early age when born into temperature conditions suitable for breeding, and the similarity of these conditions to those obtaining in the tropics is pointed out.

Pre-breeding influences are reviewed briefly.

The relation between breeding and growth, as manifested by the material obtained by experiment, is discussed shortly, and it is shown that *size and age at maturity are directly dependent upon temperature.* It would also appear that the dimensions of some species in a given locality are dependent, other things being equal, on the relative lengths of the breeding period and the non-breeding period; consequently it is to be expected that in different localities, or in different seasons, comparative size—other things being the same—will depend upon the relative length of these periods.

The breeding of marine animals under constant temperature conditions is discussed, for it would appear that if temperature is of paramount importance in controlling breeding periods, breeding should be continuous in homothermal regions under normal biological conditions.

In the stenothermal conditions of the tropics there is apparently good evidence that breeding in marine animals is continuous, but a thorough investigation of this problem is desirable. The breeding conditions of the deep-sea fauna at all periods of the year are not well known, and attention is directed to the importance of recording the sexual conditions of this community. But it is pointed out that the minute sexually mature deep-sea fishes resemble the phenomena of many tiny young invertebrates, which also become sexually mature when born into suitable breeding conditions. There are indications in the literature that breeding may be continuous in the polar regions in their respective summers, but the problem is here complicated by the abnormal seasonal biological conditions and the lack of information on the rate of growth of marine animals in the polar regions.

Since temperature is known to be of paramount importance in controlling distribution, it would seem that its influence on breeding is one of the ways in which the controlling effect is exerted. It is also suggested that divergences from the breeding-temperature constants—especially at the limits of the geographical distribution of a species—may be one method of origin of physiological sub-species or varieties, and the examples of the oyster and the mussel in the Mediterranean Sea are shortly discussed, and the nature of the information required in these problems is outlined.

This suggestion has been in part anticipated by Appellöf.

An investigation of the physical conditions in many estuaries and in littoral situations, and the connotation of the year with the date on which breeding observations are made, would give valuable help in further investigations on the influence of physical conditions on breeding in marine animals, and thus materally assist in the solution of many problems of the life in the sea.

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Marine Biological Association of the United Kingdom.

Report of the Council, 1919.

The Council and Officers.

Four quarterly meetings and one special meeting of the Council were held during the year, at which the average attendance was fourteen. A Committee of eight members of the Council visited and inspected the Plymouth Laboratory.

The thanks of the Association are due to the Royal Society, the Linnean Society, and the Royal Astronomical Society for the use of the rooms in which the Council meetings have been held.

Mr. E. T. Browne, having subscribed the sum of £500 to the funds of the Association, has been elected a Governor.

The Council has to record with regret the death of Lord Walsingham, the last to survive of the original Vice-Presidents of the Association elected in June, 1884.

The Plymouth Laboratory.

Before the outbreak of war a scheme had been put forward for enlarging the building at Plymouth, so as to provide properly equipped laboratories for work in general physiology, and also to secure much needed additional accommodation for the library. It was proposed to put the new laboratories within the main building, using for that purpose the space on the ground floor now occupied by the aquarium, and to build an entirely new and better aquarium on the land between the present building and the wall of the Citadel. Unfortunately, owing to the great cost of building there seemed little prospect of raising sufficient money at present to complete the whole of this scheme. It was decided, therefore, to undertake at once a part only, sufficient to provide one new laboratory together with a considerable extension of the library, and for this purpose to put up a small building which could eventually take its place in the larger scheme and form part of the proposed new aquarium. Owing to the generosity of two of its members the Council was fortunate in being able to proceed immediately with this smaller scheme, Dr. G. P. Bidder having offered to give £850 and Mr. E. T. Browne £500 towards it. Detailed plans of the proposed extension have been prepared, and it is hoped that actual building operations will have commenced before this report is in the hands of members. In order to equip the physiological laboratory satisfactorily an electrical installation is necessary, and it has therefore been decided to have a main cable from the town supply brought to the building. This will be an advantage in many ways, as we shall be able to introduce the electric light generally, and electrical power will be available for circulating the sea-water through the tanks. In addition to his own contribution to the building fund, Dr. Bidder has exerted himself to collect funds for this electrical installation and for additional equipment, and the sum of £420 already promised will enable great progress to be made.

The ejector which is used for pumping water from the sea to the storage reservoirs has been overhauled during the year by the makers, and steps are being taken to improve the rest of our pumping arrangements so as to bring them up to date and effect economies. The aquarium has been efficiently maintained and the increased receipts for the year show that it has been much used by the general public.

The demand for specimens for teaching purposes and museums has been exceptionally active this year, as will be seen from the statement of accounts, which shows total receipts of £844 from this source, the highest figure for any previous year being £516 in 1913.

The Boats.

The steamer *Oithona*, which was requisitioned by the Admiralty during the war, was returned to the Association in April. On account of the great cost of coal and wages we were only able to use her for the three months July, August, and September. During that time she was chiefly employed in collecting young stages of fishes with the Petersen young-fish trawl and with a special fine-meshed pelagic trawl, and in making hauls of the otter-trawl on the grounds off Plymouth, with a view to comparing the condition of these grounds with their condition before the war.

The general collecting work in Plymouth Sound with the small sailing boat *Anton Dohrn* has continued as usual throughout the year.

The Staff.

The members of the staff who served with His Majesty's Forces during the war have now all resumed work at the Laboratory. Miss G. E. Webb, who was a temporary assistant naturalist for the period of the war, has been appointed an assistant to Prof. Hill at University College, London. The permanent staff at the Laboratory now consists of the Director, Dr. E. J. Allen, F.R.S., five naturalists, Mr. L. R. Crawshay, Mr. E. W. Nelson, Dr. J. H. Orton, Mr. R. S. Clark, and Dr. Marie Lebour, with Mr. E. Ford, assistant naturalist.

Mr. L. R. Crawshay has recently received an appointment under the Colonial Office to study the sponge-fisheries of the Bahamas, and will in consequence soon be leaving Plymouth.

Occupation of Tables.

The following naturalists have occupied tables at the Plymouth Laboratory during the year :—

H. Graham Cannon, Cambridge (General Zoology).
L. R. Crawshay, Plymouth, Ray Lankester Investigator (Sponges).
Dr. P. Debaisieux (Louvain) (Parasitic Protozoa).
W. De Morgan, Plymouth (Protozoa).
H. M. Fox, London, Ray Lankester Investigator (Marine Diptera).
Prof. W. Garstang, Leeds, Ray Lankester Investigator (Ascidians).
Dr. E. S. Goodrich, F.R.S., Oxford (Parasitic Protozoa).
Mrs. Goodrich, Oxford (Parasitic Protozoa).
J. Gray, Cambridge (Effect of ions on ciliary movement).
L. T. Hogben, London (Gametogenesis in Nudibranchs).
Mrs. Redman King, Leeds, Ray Lankester Investigator (Enzymes in Echinoderms).
G. Paget, Cairo (Nets and Equipment).
F. A. Potts, Cambridge (Intra-vital staining).
Mrs. E. W. Sexton, Plymouth (Gammarus).
Dr. C. Shearer, F.R.S., Cambridge (Dinophilus).
Miss Tupper-Carey, Leeds (General Zoology).

General Work at the Plymouth Laboratory.

For some years before the war a systematic study of the distribution of the free swimming post-larval and young adult stages of fishes found in the neighbourhood of Plymouth was carried on during the summer months, Petersen's young-fish trawl being the net found most useful for their capture. In addition eggs and larvæ taken in ordinary tow-nets of bolting silk were collected and recorded. With the return of our staff from service in connection with the war and also of the steamer *Oithona*, these investigations were resumed, and during the months of July, August, and September Mr. Clark, assisted by Mr. Ford, made considerable collections, and has since been engaged in working out the results and preparing them for publication. A new cotton net with meshes about one-quarter inch square, worked in a similar way to the young-fish trawl, was also used with success for capturing young fish of the larger sizes. In the course of these investigations specially interesting series of post-larval mackerel and post-larval pilchards were obtained.

Dr. Marie Lebour has continued during the year her studies on the food of young fishes on similar lines to those followed in her earlier work, full reports upon which have been published in the Journal. Dr. Lebour contributed a paper on this subject to the British Association at the meeting held in Bournemouth in September. Dr. Lebour has also completed an account of the eggs, larvæ, and young stages of the different species of Gobies found at Plymouth, and is now occupied with a special study of young stages of herrings, sprats, and pilchards, which are by no means easy to distinguish.

In addition to the work on young fish, Mr. Clark examined the trawling grounds off Plymouth with the otter-trawl with a special view to comparing the present condition of the grounds with that which existed before the war. Investigations are also in progress on the life histories, food, and habits of the rough and spur-dogfishes and of the whiting, which are of great importance in the autumn and winter fisheries at Plymouth. Mr. Clark is also continuing a systematic study of the skates and rays.

Arising out of previous work on the culture of plankton diatoms, Dr. Allen has devoted some time to a study of the flagellates, especially the Chrysomonads, which occur frequently in the cultures. Comparatively little is at present known of the many flagellates which belong to the plankton and are of special interest as being perhaps the most primitive forms of life in the sea. Dr. Allen is also continuing his work on the Polychaetes of Plymouth.

Mr. L. R. Crawshay, who was appointed a Ray Lankester Investigator, has been making researches on the local sponge fauna. The Council are confident that the useful work which Mr. Crawshay has carried on for many years at Plymouth upon this group of animals will be of the greatest service to him in attacking the problems with which he will be called upon to deal in the important post to which he has just been appointed in connection with sponge-fisheries in the Bahamas.

Dr. J. H. Orton has taken up again his investigations on the rate of growth of invertebrates, amongst the methods employed in the research being (1) exposure in suitable localities of objects such as clean shells, wood or tiles upon which marine animals will fix; (2) keeping animals in floating boxes with perforated sides, moored in positions where a flow of pure sea-water will constantly pass through them, and (3) the periodical examination of selected surfaces on piers, wharves, buoys, and other similar structures, where animals are growing under perfectly natural conditions. Much valuable information has been secured already and full details will be published in the Journal. Dr. Orton has also been giving particular attention to determining the limits of the breeding seasons of many invertebrates, including such marketable shell-fish as mussels and cockles.

Miss G. E. Webb, before leaving to take up her new post at University College, completed a paper on the development of the larvæ of the different species of the Decapod Crustacean *Upogebia*, larvæ which are every year a characteristic feature of the plankton found near Plymouth.

Mr. E. W. Nelson has been engaged in working out the material which he collected on Scott's last Antarctic expedition, studying especially the diatoms taken in tow-nets.

A paper has been completed, and will shortly be published in the "Journal of Genetics," giving a further account of the experiments on the Mendelian inheritance of eye-colour in the Amphipod *Gammarus chevreuxi*, which Mrs. Sexton has been engaged upon for several years. This work attracted considerable attention from those interested in Mendelian studies, when some of the results were exhibited at the soirées of the Royal and Linnean Societies last spring.

The Trustees of the Ray Lankester Fund appointed the following Investigators, in addition to Mr. L. R. Crawshay, whose work has already been referred to, Prof. W. Garstang, Mrs. Redman King, and Mr. H. M. Fox, all of whom visited the Laboratory and occupied tables during the summer.

Published Memoirs.

The following paper, the outcome of work done at the Laboratory, has been published elsewhere than in the Journal of the Association :—

GOODRICH, E. S. *The Pseudopodia of the Leucocytes of Invertebrates.* Quart. Journ. Micr. Sci., Vol. LXIV, 1919, pp. 19–26.

The Library.

The thanks of the Association are again due to numerous Government Departments, Universities, and other institutions at home and abroad for copies of books and current numbers of periodicals presented to the Library. Thanks are due also to those authors who have sent reprints of their papers for the Library.

Donations and Receipts.

The receipts for the year include a grant from H.M. Treasury of £1000, one from the Board of Agriculture and Fisheries, Development Fund, £300, and the grants for two years (1918 and 1919) from the Fishmongers' Company, £1200. In addition to these grants there have been received a Governor's Contribution of £500, Annual Subscriptions (£142), Composition Fees (£47), Special Donations for Electrical Installation (£371), Rent of Tables in the Laboratory, including £25 from the University of London, and £20 from the Trustees of the Ray Lankester Fund (£45), Sale of Specimens (£844), and Admission to Tank Room (£206).

Vice-Presidents, Officers, and Council.

The following is the list of gentlemen proposed by the Council for election for the year 1920–21:—

President.

Sir E. RAY LANKESTER, K.C.B., LL.D., F.R.S.

Vice-Presidents.

The Duke of BEDFORD, K.G.
The Earl of DUCIE, F.R.S.
The Earl of STRADBROKE, C.V.O., C.B.
Viscount ASTOR.
Lord MONTAGU OF BEAULIEU.
The Right Hon. A. J. BALFOUR, M.P., F.R.S.
The Right Hon. Sir ARTHUR GRIFFITHS-BOSCAWEN, M.P.
The Right Hon. AUSTEN CHAMBERLAIN, M.P.
G. A. BOULENGER, Esq., F.R.S.
Sir ARTHUR STEEL-MAITLAND, Bart., M.P.
Prof. W. C. McINTOSH, F.R.S.

COUNCIL.

Elected Members.

Prof. W. M. BAYLISS, D.Sc., F.R.S.
L. A. BORRADAILE, Esq.
W. T. CALMAN, Esq., D.Sc.
W. C. DE MORGAN, Esq.
Prof. F. W. GAMBLE, D.Sc., F.R.S.
J. GRAY, Esq.
Sir SIDNEY F. HARMER, K.B.E., Sc.D., F.R.S.
E. W. L. HOLT, Esq.
JULIAN S. HUXLEY, Esq.
Prof. E. W. MACBRIDE, D.Sc., F.R.S.
H. G. MAURICE, Esq., C.B.
C. TATE REGAN, Esq., F.R.S.
T. H. RICHES, Esq.
Prof. D'ARCY W. THOMPSON, C.B., F.R.S.

Chairman of Council.

Sir ARTHUR E. SHIPLEY, G.B.E., D.Sc., F.R.S.

Hon. Treasurer.

GEORGE EVANS, Esq.

Hon. Secretary.

E. J. ALLEN, Esq., D.Sc., F.R.S.,
The Laboratory, Citadel Hill, Plymouth.

The following Governors are also members of Council:—

G. P. BIDDER, Esq., Sc.D.
E. T. BROWNE, Esq.
Commander Sir TREVOR DAWSON, Bart., R.N., D.S.O. (Prime Warden of the Fishmongers' Company).
W. T. BRAND, Esq. (Fishmongers' Company).
GEORGE EVANS, Esq. (Fishmongers' Company).
E. H. CHAPMAN, Esq. (Fishmongers' Company).
T. T. GREG, Esq. (Fishmongers' Company).
Major NIGEL O. WALKER, O.B.E. (Fishmongers' Company).
Prof. G. C. BOURNE, D.Sc., F.R.S. (Oxford University).
Sir ARTHUR E. SHIPLEY, G.B.E., D.Sc., F.R.S. (Cambridge University).
Prof. W. A. HERDMAN, C.B.E., D.Sc., F.R.S. (British Association).

List of Annual Subscriptions

Paid during the Year 1919.

	£	s.	d.
W. M. Aders, Esq.	1	1	0
E. J. Allen, Esq., D.SC., F.R.S.	1	1	0
G. L. Alward, Esq.	1	1	0
J. H. Ashworth, Esq., D.SC., F.R.S.	1	1	0
Prof. W. Bateson, F.R.S.	1	1	0
Prof. W. M. Bayliss, F.R.S.	1	1	0
Lieut.-Col. T. T. Behrens	1	1	0
Col. H. F. Bidder (1918 and 1919)	2	2	0
Mrs. M. G. Bidder	1	1	0
E. J. Bles, Esq., D.SC.	1	1	0
H. H. Bloomer, Esq.	1	1	0
L. A. Borradaile, Esq.	1	1	0
Prof. G. C. Bourne, F.R.S.	1	1	0
Col. Henry Bowles	1	1	0
Sir John Rose Bradford, K.C.M.G., F.R.S.	1	1	0
Brighton Corporation (Public Library)	1	1	0
H. H. Brindley, Esq.	1	1	0
E. T. Browne, Esq.	1	1	0
Mrs. E. T. Browne	1	1	0
L. W. Byrne, Esq.	1	1	0
W. T. Calman, Esq., D.SC.	1	1	0
Prof. Chas. Chilton	1	1	0
G. S. R. Kitson Clark, Esq.	1	1	0
J. Clark, Esq., D.SC.	1	1	0
J. F. Coonan, Esq.	1	1	0
L. R. Crawshay, Esq.	1	1	0
Commander G. L. C. Damant, R.N.	1	1	0
Mons. J. Delphy	1	1	5
W. C. De Morgan, Esq.	1	1	0
Prof. A. Dendy, F.R.S.	1	1	0
G. Despott, Esq.	1	1	0
F. A. Dixey, Esq.	1	1	0
C. Clifford Dobell, Esq.	1	1	0
F. Martin Duncan, Esq.	1	1	0
Director of Agriculture and Fisheries, Travancore (1918 and 1919)	2	2	0
Major E. V. Elwes	1	1	0
George Evans, Esq.	1	1	0
Richard Foster, Esq.	1	1	0
G. H. Fowler, Esq., B.A., PH.D. (1918 and 1919)	2	2	0
H. M. Fox, Esq.	1	1	0
Prof. F. W. Gamble, F.R.S.	1	1	0
Carried Forward	46	4	5

	£	s.	d.
Brought forward	46	4	5
Prof. J. S. Gardiner, F.R.S. (1917–19)	3	3	0
Prof. E. S. Goodrich, F.R.S.	1	1	0
J. Gray, Esq. (1918 and 1919)	2	2	0
Prof. F. Guitel		19	9
Sir Eustace Gurney	1	1	0
Prof. W. D. Halliburton, F.R.S.	1	1	0
H. Bertram Harding, Esq.	1	1	0
A. E. Hefford, Esq. (1917–19)	3	3	0
Prof. W. A. Herdman, C.B.E., F.R.S.	1	1	0
Prof. S. J. Hickson, F.R.S.	1	1	0
Prof. J. P. Hill, F.R.S.	1	1	0
W. T. Hillier, Esq., M.R.C.S.	1	1	0
T. V. Hodgson, Esq.	1	1	0
W. E. Hoyle, Esq., D.SC.	1	1	0
P. Hoyte, Esq.	1	1	0
J. S. Huxley, Esq. (1918 and 1919)	2	2	0
R. Kirkpatrick, Esq.	1	1	0
J. J. Lister, Esq., F.R.S.	1	1	0
Miss D. Jordan Lloyd (1918 and 1919)	2	2	0
Prof. E. W. MacBride, F.R.S.	1	1	0
W. N. McClean, Esq.	1	1	0
S. Makovski, Esq.	1	1	0
D. J. Matthews, Esq.	1	1	0
J. H. Midgley, Esq.	1	1	0
W. S. Millard, Esq.	1	1	0
P. Chalmers Mitchell, Esq., C.B.E., D.SC., F.R.S. (1918 and 1919)	2	2	0
The Right Hon. Lord Montagu of Beaulieu (1918 and 1919)	4	4	0
Rev. Canon A. Morford	1	1	0
C. C. Morley, Esq.	1	1	0
E. W. Nelson, Esq. (1919 and 1920)	2	2	0
Chas. Oldham, Esq.	1	1	0
J. H. Orton, Esq., D.SC.	1	1	0
Plymouth Corporation (Museum Committee) (1918 and 1919)	2	2	0
Plymouth Education Authority (1918 and 1919)	2	2	0
Rev. C. W. Poignand, R.N. (1918 and 1919)	2	2	0
Port of Plymouth Incorporated Chamber of Commerce	1	1	0
W. P. Pycraft, Esq.	1	1	0
W. H. St. Quintin, Esq.	1	1	0
Major G. Raymond	1	1	0
C. Tate Regan, Esq., F.R.S. (1917 and 1918)	2	2	0
J. T. Saunders, Esq.	1	1	0
R. E. Savage, Esq. (1916–19)	4	4	0
E. Schuster, Esq., D.SC.	1	1	0
T. B. Sprague, Esq., LL.D.	1	1	0
R. F. Scharff, Esq., PH.D.	1	1	0
W. L. Sclater, Esq.	1	1	0
Miss L. Sheldon	1	1	0
Sir Arthur Shipley, G.B.E., D.SC., F.R.S.	3	3	0
Sir W. Baldwin Spencer, K.C.M.G. (1919 and 1920)	2	2	0
Carried forward	120	14	2

	£	s	d.
Brought forward	120	14	2
Lieut.-Commander R. Spry	1	1	0
S. Takeda (1919 and 1920)	2	2	0
Sir H. F. Thompson, Bart.	1	1	0
Sir John I. Thornycroft, F.R.S.	1	1	0
Lieut.-Col. H. J. Walton, I.M.S.	1	1	0
N. E. Waterhouse, Esq. (1917–19)	3	3	0
A. W. Waters, Esq.	1	1	0
A. T. Watson, Esq.	1	1	0
Mrs. Weldon	1	1	0
W. A. Willes, Esq.	1	1	0
Col. H. A. Williamson (1915–19)	5	0	0
Warden of Fisheries, Punjab	1	1	0
R. Winckworth, Esq.	1	1	0
R. H. Worth, Esq.	1	1	0
	142	10	2

Special Donations for Electrical Installation and Building Fund.

1919	£	s.	d.
H. K. Anderson, Esq.	1	1	0
W. T. Brand, Esq.	10	0	0
J. Y. Buchanan, Esq., F.R.S.	45	0	0
Henry Bury, Esq.	1	1	0
Lieut.-Col. E. Kitson Clark	1	1	0
G. S. R. Kitson Clark	1	1	0
H. W. Devenish, Esq.	1	1	0
G. Evans, Esq.	25	0	0
J. F. Greenwood, Esq.	20	0	0
J. Gray, Esq.	5	0	0
Major Griffin	1	1	0
Sir Sidney F. Harmer, K.B.E., D.SC., F.R.S.	2	0	0
E. Heron-Allen, Esq., F.R.S.	10	0	0
The Hon. Edward Kitson	10	0	0
J. J. Lister, Esq., F.R.S.	2	2	0
Lieut.-Col. F. K. McClean	10	0	0
Capt. W. N. McClean	100	0	0
Mrs. Horace Porter	1	1	0
F. A. Potts, Esq.	5	0	0
T. H. Riches, Esq.	100	0	0
Owen Hugh Smith, Esq.	10	0	0
Major N. O. Walker, O.B.E.	5	0	0
N. E. Waterhouse, Esq.	5	0	0
	371	9	0
Governor's Contribution, E. T. Browne, Esq.	500	0	0
1920	871	9	0
G. P. Bidder, Esq., SC.D.	860	0	0
E. T. Browne, Esq.	10	0	0
T. Greg, Esq.	5	0	0
	£1746	9	0

THE MARINE BIOLOGICAL ASSOCIATION

Dr. *Statement of Receipts and Payments for*

GENERAL

	£ s. d.	£ s. d.
To Balance from Last Year :—		
Cash at Bankers	422 0 5	
Cash in hand	3 13 0	425 13 5
,, Current Receipts :—		
H.M. Treasury for the year to 31st March, 1920 ...	1,000 0 0	
Board of Agriculture and Fisheries for the year to 31st March, 1919	300 0 0	
The Worshipful Company of Fishmongers for the two years, 1918 and 1919	1,200 0 0	
Annual Subscriptions	142 10 2	
Rent of Tables (Ray Lankester Trustees, £20; University of London, £25)	45 0 0	
Interest on Investments	11 10 0	
,, Deposits ...	16 19 5	2,715 19 7
,, Extraordinary Receipts :—		
Donation, G. H. Fox	0 10 6	
Composition Fees	47 5 0	
Naval Bank—Dividend	0 19 11	48 15 5
,, Laboratory Boats and Sundry Receipts :—		
Sale of Apparatus	2 19 3	
,, ,, Specimens	843 19 11	
,, ,, Nets and Gear	10 11 5	
Hire of "Oithona"	177 0 0	
Other Items	5 1 5	1,039 12 0
		£4,230 0 5

The Association's Bankers hold on its behalf:—

£410 14s. 8d. New Zealand 4% Stock, 1943–63.
£500 0s. 0d. War Savings Certificates.
£78 9s. 4d. 4% War Loan, 1929–42 Registered Stock.

ELECTRICAL INSTALLATION

	£ s. d.
To Donations	371 9 0
,, Governor's Contributions, E. T. Browne	500 0 0
	£871 9 0

OF THE UNITED KINGDOM.

the Year ending 31*st December*, 1919. **Cr.**

FUND.

	£	s.	d.	£	s.	d.
By Investments in :—						
£127 War Savings Certificates	98	8	6			
£78 9s. 4d. 4% War Loan, 1929–42 Registered Stock	78	10	0	176	18	6
,, Salaries and Wages—						
Director	400	0	0			
Naturalists	672	11	5			
Assistant Naturalists	230	1	9			
Salaries and Wages	957	10	4	2,260	3	6
,, Travelling Expenses				60	6	3
,, Library..	110	15	2			
Less Sales	1	1	6	109	13	8
,, Journal..	162	3	6			
Less Sales..	18	6	8	143	16	10
,, Buildings and Public Tank Room—						
Gas, Water, and Coal	108	15	11			
Stocking Tanks and Feeding	19	6	5			
Maintenance and Renewals	80	0	9			
Rent, Rates, Taxes, and Insurance........................	101	13	1			
	309	16	2			
Less Admission to Tank Room	206	7	0	103	9	2
,, Laboratory, Boats, and Sundry Expenses—						
Glass, Apparatus, and Chemicals	182	7	11			
Purchase of Specimens	102	1	5			
Maintenance and Renewal of Boats, Nets, etc.	279	5	3			
Coal and Water for Steamer..................................	101	14	1			
Boat Hire and Collecting Expenses......................	16	11	3			
Stationery, Office Expenses, Carriage, Printing, etc.	161	4	9	843	4	8
,, Balance :—						
Cash at Bankers	526	11	4			
Cash in hand	5	16	6	532	7	10
				£4,230	0	5

Examined and found correct,

(Signed) N. E. Waterhouse.
W. T. Brand.
W. T. Calman.
J. O. Borley.

3 *Frederick's Place,*
Old Jewry, London, E.C. 2
28th January, 1920.

AND BUILDING FUND.

				£	s.	d.
By Balance :—						
Cash on Deposit	771	9	0			
Cash at Bank	100	0	0	871	9	0
				£871	9	0

Marine Biological Association of the United Kingdom.

LIST

OF

Governors, Founders, and Members.

1st June, 1920.

* Member of Council. † Vice-President. ‡ President.

Ann. signifies that the Member is liable to an Annual Subscription of One Guinea.

C. signifies that he has paid a Composition Fee of Fifteen Guineas in lieu of Annual Subscription.

I.—Governors.

The British Association for the Advancement of Science, *Burlington House, W.*	£500
The University of Oxford	£500
The University of Cambridge	£500
The Worshipful Company of Clothworkers, 41, *Mincing Lane, E.C.*	£500
The Worshipful Company of Fishmongers, *London Bridge, E.C.*	£14,305
Bayly, Robert (the late)	£1000
Bayly, John (the late)	£600
Thomasson, J. P. (the late)	£970
*G. P. Bidder, Esq., Sc.D., *Cavendish Corner, Cambridge*	£2360
*E. T. Browne, Esq., B.A., *Anglefield, Berkhamsted*	£510

II.—Founders.

1884	The Corporation of the City of London	£210
1884	The Worshipful Company of Mercers, *Mercers' Hall, Cheapside*	£341 5*s.*
1884	The Worshipful Company of Goldsmiths, *Goldsmiths' Hall, E.C.*	£100
1884	The Royal Microscopical Society, 20, *Hanover Square, W.*	£100
1884	The Royal Society, *Burlington House, Piccadilly, W.*	£350
1884	The Zoological Society, *Regent's Park, London, N.W.*	£100
1884	Bulteel, Thos. (the late)	£100
1884	Burdett-Coutts, W. L. A. Bartlett, 1, *Stratton Street, Piccadilly, W.*	£100
1884	Crisp, Sir Frank, Bart. (the late)	£100
1884	Daubeny, Captain Giles A.	£100
1884	Eddy, J. Ray (the late)	£100
1884	Gassiott, John P. (the late)	£100
‡1884	Lankester, Sir E. Ray, K.C.B., F.R.S., 44 *Oakley Street, Chelsea, S.W.*	£100

1884 The Rt. Hon. Lord Masham (the late) £100
1884 Moseley, Prof. H. N., F.R.S. (the late) £100
1884 The Rt. Hon. Lord Avebury, F.R.S. (the late) £100
1884 Poulton, Prof. Edward B., M.A., F.R.S., *Wykeham House, Oxford* £100
1884 Romanes, G. J., LL.D., F.R.S. (the late) £100
1884 Worthington, James (the late) £100
1885 Derby, the late Earl of £100
1887 Weldon, Prof. W. F. R., F.R.S. (the late) £100
1888 Bury, Henry, M.A., *Mayfield House, Farnham, Surrey* £100
1888 The Worshipful Company of Drapers, *Drapers' Hall, E.C.* £315
1889 The Worshipful Company of Grocers, *Poultry, E.C.* £120
1889 Thompson, Sir Henry, Bart. (the late) £110
1889 Revelstoke, The late Lord £100
*1890 Riches, T. H., B.A., *Kitwells, Shenley, Herts* £330
1902 Gurney, Robert, *Ingham Old Hall, Stalham, Norfolk* £105
1909 Harding, Colonel W., *The Hall, Madingley, Cambridge* £100
1910 Murray, Sir John, K.C.B., F.R.S. (the late) £100
1912 Swithinbank, H., F.R.S.E., F.R.G.S., *Denham Court, Denham, Bucks.* £100
1913 Shearer, Dr. Cresswell, F.R.S., 4, *Fitzwilliam Road, Cambridge* £100
1920 McClean, Capt. W.N., 1, *Onslow Gardens, S.W.* £100

III.—Members.

1900 Aders, Dr. W. M., *Zanzibar, East Africa* .... Ann.
*1895 Allen, E. J., D.Sc., F.R.S., *The Laboratory, Plymouth* .... Ann.
1889 Alward, G. L., *Enfield Villa, Humberstone Avenue, Waltham, Grimsby* Ann.
1910 Ashworth, J. H., D.Sc., F.R.S., *The University, Edinburgh* .... Ann.
†1911 Astor, Viscount, 4, *St. James's Square, London, W.* .... C.
1910 Atkinson, G. T., 43, *Parliament Street, London, S.W.* .... Ann.

1920 Baker, J. R., *New College, Oxford* .... Ann.
1884 Balfour, Sir I. Bayley, K.B.E., F.R.S., *Royal Botanic Gardens, Edinburgh* C.
1919 Bateson, Prof. W., F.R.S., *The Manor House, Merton, S.W.* 19 .... Ann.
1919 Bawcomb, J., "*Knaresboro,*" *Rose Walk, Purley, Surrey* .... Ann.
*1884 Bayliss, Prof. W. Maddock, D.Sc., F.R.S., *St. Cuthberts, West Heath Road, Hampstead* .... Ann.
1884 Bayly, Miss Anna, *Seven Trees, Plymouth* £50
1885 Beck, Conrad, 68, *Cornhill, E.C.* .... C.
1884 Beddington, Alfred H., 8, *Cornwall Terrace, Regent's Park, N.W.* .... C.
†1907 Bedford, His Grace the Duke of, K.G., *Endsleigh, Tavistock* .... C.
1919 Behrens, Lt.-Col. T. T., *United Service Club, Pall Mall, London, S.W.* Ann.
1918 Bevan, Miss E. M., 58, *Holland Road, Plymouth* .... Ann.
1903 Bidder, Colonel H. F., *Ravensbury Manor, Mitcham* .... Ann.
1910 Bidder, Mrs. M. G., *Cavendish Corner, Cambridge* .... Ann.
1912 Bles, E. J., D.Sc., *Elterholm, Madingley Road, Cambridge* .... Ann.
1910 Bloomer, H. H., 40, *Bennett's Hill, Birmingham* .... Ann.
1910 Borley, J. O., M.A., 43, *Parliament Street, London, S.W.* .... Ann.
*1918 Borradaile, L. A., *Selwyn College, Cambridge* .... Ann.
*1884 Bourne, Prof. Gilbert C., M.A., F.R.S., *Savile House, Mansfield Road, Oxford* .... Ann.

1898 Bowles, Col. Henry, *Forty Hall, Enfield* .... Ann.
1910 Bradford, Sir J. Rose, K.C.M.G., M.D., D.Sc., F.R.S., 8, *Manchester Square, London, W.* .... Ann.
1920 Brand, W. T., 58, *Eaton Place, London, S.W.* £20
1920 Buchanan, J. Y., F.R.S. £45
1902 Brighton Public Library (Henry D. Roberts, Chief Librarian) .... Ann.
1918 Brindley, H. H., *St. John's College, Cambridge* .... Ann.
1886 Brooksbank, Mrs. M., *Leigh Place, Godstone, Surrey* .... *C.*
1884 Brown, Arthur W. W., *Sharvells, Milford-on-Sea, Hants* .... *C.*
1892 Browne, Mrs. E. T., *Anglefield, Berkhamsted* .... Ann.
1897 Byrne, L. W., B.A., 7, *New Square, Lincoln's Inn, London, W.C.* .... Ann.

*1908 Calman, Dr. W. T., *British Museum (Natural History), Cromwell Road, S.W.* .... Ann.
1911 Chilton, Prof. C., *Canterbury College, Christchurch, New Zealand* .... Ann.
1884 Christy, Thomas Howard .... *C.*
1911 Clark, Dr. J., *Technical School, Kilmarnock, N.B.* .... Ann.
1910 Clark, G. S. R. Kitson, *Meanwoodside, Leeds* .... Ann.
1887 Clarke, Rt. Hon. Sir E., K.C., 2, *Essex Court, Temple, E.C.* £25
1886 Coates and Co., *Southside Street, Plymouth* .... *C.*
1885 Collier Bros., *George Street, Plymouth* .... *C.*
1920 Cooper, J. Omer, 6, *Queensland Road, Boscombe Park, Bournemouth* .... Ann.
1919 Coonan, J. F., *Balmoral House, Mumbles, Glamorgan* .... Ann.
1909 Crawshay, L. R., M.A., c/o The Colonial Secretary, *Nassau, Bahamas* .... Ann.

1919 Damant, Commander G. L. C., R.N., *Thursford, Cambridge Road, East Cowes* .... Ann.
1920 Darbishire, Prof. Otto V., *Botanical Department, The University, Bristol* .... Ann.
1885 Darwin, Sir Francis, F.R.S., 10, *Madingley Road, Cambridge* .... *C.*
1916 Delphy, J., *Laboratoire Maritime de Tatihou, par St. Vaast-la-Hougue (Manche), France* .... Ann.
*1906 De Morgan, W. C., *c/o National Provincial Bank, Plymouth* .... Ann.
1908 Dendy, Prof. A., F.R.S., *Vale Lodge, Hampstead Heath, N.W.* .... Ann.
1919 Despott, G., *Natural History Museum, Malta* .... Ann.
1884 Dewick, Rev. E. S., M.A., F.G.S., 26, *Oxford Square, Hyde Park, W.* .... *C.*
1915 Dick, G. W., J.P., c/o P.O. Box 28, *The Point, Durban, Natal* .... *C.*
1915 Director of Agriculture and Fisheries, *Travancore, Quilon, S. India* ... Ann.
1885 Dixey, F. A., M.A. Oxon., F.R.S., *Wadham College, Oxford* £26 5*s. and* Ann.
1910 Dobell, C. C., M.A., F.R.S., *Imperial College of Science and Technology, South Kensington, S.W.* .... Ann.
1890 Driesch, Hans, Ph.D., *Philosophenweg* 5, *Heidelberg, Germany* .... *C.*
†1889 Ducie, The Rt. Hon. the Earl of, F.R.S., *Tortworth Court, Falfield, R.S.O.* £50 15*s.*
1910 Duncan, F. Martin, 71, *St. Leonard's Road, East Sheen, S.W.* .... Ann.
1920 Dunkerly, J. S., B.Sc., *The University, Glasgow* .... Ann.
1884 Dunning, J. W., 4, *Talbot Square, London, W.* .... £26 5*s.*
1884 Dyer, Sir W. T. Thiselton, M.A., K.C.M.G., F.R.S., *The Ferns, Witcombe, Gloucester* .... *C.*

1908 Elwes, Maj. Ernest V., *Novar, Kents Road, Torquay* .... Ann.
1885 Ewart, Prof. J. Cossar, M.D., F.R.S., *University, Edinburgh*.............. £25
*1918 Evans, George, 1, *Wood Street, London, E.C.* 2 .... £25 and Ann.

1884 Fison, Sir Frederick W., Bart., *Boarzell, Hurst Green, Sussex* .... *C.*
1920 Ford, Herbert, *The Weald, Salcombe* .... Ann.
1897 Foster, Richard, *Windsworth, Looe, R.S.O.* .... Ann.
1885 Fowler, G. Herbert, B.A., Ph.D., *The Old House, Aspley Guise, Bedfordshire* .... Ann.
1912 Fox, H. M., *School of Medicine, Cairo* .... Ann.
1884 Fry, George, F.L.S., *Carlin Brae, Berwick-on-Tweed* £21

*1907 Gamble, Prof. F. W., D.Sc., F.R.S., *The University, Edmund Street, Birmingham* .... Ann.
1906 Gardiner, Prof. J. Stanley, M.A., F.R.S., *Caius College, Cambridge* ...... Ann.
1907 Garstang, Prof. W., D.Sc., *Meanwood Lodge, Stonegate Road, Leeds* ...... Ann.
1910 Goodrich, Prof. E. S., F.R.S., 53 *Banbury Road, Oxford* .... Ann.
1885 Gordon, Rev. J. M., 7, *Moreton Gardens, London, S.W.* .... Ann.
*1912 Gray, J., *King's College, Cambridge* .... £5 and Ann.
1920 Greenwood, J. F., *Ashmount, Haworth, Yorks*................................ £20
1920 Greg, T. T., *Coles, Buntingford, Herts* £5
1899 Guinness, Hon. Rupert, *Elveden, Thetford* ....£35 15s.
1900 Gurney, Sir Eustace, *Sprowston Hall, Norwich* .... Ann.

1920 Hall, Wilfred, *Newcastle-on-Tyne*.. Ann.
1884 Halliburton, Prof. W. D., M.D., F.R.S., *Church Cottage*, 17, *Marylebone Road, London, W.* .... Ann.
1884 Hannah, Robert, 82, *Addison Road, Kensington, W.* .... *C.*
1919 Harding, H. Bertram, F.R.M.S., 77 *Hannah Street, Porth, Glam.* ...... Ann.
*1885 Harmer, Sir Sidney F., K.B.E., D.Sc., F.R.S., 30, *Courtfield Gardens, S.W.* 5.. *C.*
1888 Haselwood, J. E., 3, *Richmond Terrace, Brighton* .... *C.*
1884 Haslam, Miss E. Rosa, *Ravenswood, Bolton* £20
1884 Heape, Walter, F.R.S., 10, *King's Bench Walk, Temple, London, E.C.* *C.*
1910 Hefford, A. E., B.Sc., 43, *Parliament Street, London, S.W.* 1.............. Ann.
*1884 Herdman, Prof. W. A., C.B.E., F.R.S., *Croxteth Lodge, Ullet Road, Liverpool*.. Ann.
1913 Heron-Allen, E., F.R.S., F.L.S., F.R.M.S., F.G.S., 33, *Hamilton Terrace, London, N.W.* .... £25 15s.
1884 Herschel, Col. J., R.E., F.R.S., *Observatory House, Slough, Berks.* ...... *C.*
1884 Hickson, Prof. Sydney J., M.A., D.Sc., F.R.S., *Ellesmere House, Wilenslow Road, Withington, Manchester* .... Ann.
1907 Hill, Prof. J. P., F.R.S., *The Zoological Laboratory, University College, London, W.C.*.. Ann.
1919 Hillier, W. T., M.R.C.S., *The Queen's Hospital for Children, Hackney Road, London, E.* .... Ann.
1897 Hodgson, T. V., *Highfield, Plympton, S. Devon* .... Ann.
*1905 Holt, E. W. L., *Department of Agriculture and Technical Instruction for Ireland (Fisheries Branch), Dublin* .... Ann.
1909 Hoyle, W. E., M.A., D.Sc., *National Museum of Wales, City Hall, Cardiff* Ann.

1918 Hoyte, P., *Windsor Lodge, First Avenue, Plymouth* .... Ann.
1920 Hutton, J. Arthur, *Woodlands, Alderley Edge* .... C.
*1912 Huxley, J. S., *The Museum, Oxford* .... Ann.

1885 Jackson, W. Hatchett, M.A., D.Sc., F.L.S., *Pen Wartha, Weston-super-Mare* .... Ann.
1914 Jarvis, P. W., *Colonial Bank, Trinidad, and* 27, *Crescent Lane, London, S.W.* .... Ann.

1911 Kirkpatrick, R., *British Museum (Natural History), Cromwell Road, S.W.* Ann.
1920 Kitson, The Hon. Edward, *Quarry Dene, Weetwood, Leeds* £10

1897 Lanchester, W. F., B.A., 19, *Fernshaw Road, Chelsea, London, S.W.* ... C.
1885 Langley, Prof. J. N., F.R.S., *Trinity College, Cambridge* .... C.
1895 Lister, J. J., M.A., F.R.S., *St. John's College, Cambridge* .... Ann.
1912 Lloyd, Miss D. Jordan, *The Mythe, Edgbaston, Birmingham* .... Ann.

*1910 MacBride, Prof. E. W., M.A., D.Sc., F.R.S., *Royal College of Science, South Kensington, S.W.* .... Ann.
1900 Macfie, J. W. Scott, *Rowton Hall, Chester* .... C.
1902 Major, Surgeon H. G. T., 24, *Beech House Road, Croydon* .... C.
1889 Makovski, Stanislaus, *Saffrons Corner, Eastbourne* .... Ann.
1885 Marr, J. E., M.A., F.R.S., *St. John's College, Cambridge* .... C.
1910 Matthews, D. J., *Rothamsted Experimental Station, Harpenden* .... Ann.
*1912 Maurice, H. G., C.B., *Ministry of Agriculture and Fisheries*, 43, *Parliament Street, S.W.* .... Ann.
1920 McClean, Lt.-Col. F. K. £10
1910 McClean, Capt. W. N., 1, *Onslow Gardens, London, S.W.* .... Ann.
1884 McIntosh, Prof. W. C., F.R.S., 2, *Abbotsford Crescent, St. Andrews* ...... C.
1884 Michael, Albert D., *The Warren, Studland, nr. Wareham, Dorset* ...... C.
1909 Midgley, J. H., B.Sc., *Birstwith, Torquay* .... Ann.
1919 Millard, W. S., c/o Messrs. Grindlay & Co., 54 *Parliament Street, London, S.W.* 1 .... Ann.
*1905 Mitchell, P. Chalmers, C.B.E., D.Sc., F.R.S., Secretary Zoological Society, *Regent's Park, London, N.W.* .... Ann.
†1914 Montagu of Beaulieu, The Rt. Hon. Lord, 62, *Pall Mall, London.* Ann., £2 2s.
1906 Morford, Rev. Canon Augustin, *St. Scholastica's Abbey, Teignmouth* ... Ann.
1915 Morley, C. C., c/o Messrs. Morley, Sellick and Price, Steam Trawler Owners, *Milford Haven* .... Ann.

1917 Nelson, Commander E. W., *The Laboratory, Plymouth* .... Ann.
1912 Newman, C. A., 449, *Glossop Road, Sheffield* .... Ann.

1911 Oldham, Chas., *The Bollin, Berkhamsted, Herts.* .... Ann.
1910 Orton, J. H., D.Sc., *The Laboratory, Plymouth* .... Ann.

1915 Pascual, Enrique, P.O. Box 8, *Galicia, Vigo, Spain* .... Ann.
1917 Phillips, M.A., *Devonshire House, Reigate Hill, Reigate* .... C.
1906 Plymouth Corporation (Museum Committee) .... Ann.
1910 Plymouth Education Authority .... Ann.

1917 Poignand, Rev. C. W., M.A., R.N., *H.M.S. Cumberland, Queenstown, Ireland* .... Ann.
1906 Port of Plymouth Incorporated Chamber of Commerce .... Ann.
1910 Porter, Horatio, 16, *Russell Square, London, W.C.* .... Ann.
1913 Potts, F. A., M.A., *Trinity Hall, Cambridge* .... £20 15s.
1919 Pycraft, W. P., British Museum (Natural History), *Cromwell Road, London, S.W.* .... Ann.

1893 Quintin, St. W. H., *Scampstone Hall, Rillington, Yorks* .... Ann.

1913 Raymond, Major G., *The Gymnasium, Western College Road, Plymouth* Ann.
*1916 Regan, C. Tate, F.R.S., British Museum (Natural History), *Cromwell Road, S.W.* .... Ann.
1919 Ritchie, A. D., M.A., *Trinity College, Cambridge* .... *C.*

1911 Saunders, J. T., M.A., *Christ's College, Cambridge* .... Ann.
1914 Savage, R. E., *Ministry of Agriculture and Fisheries*, 43, *Parliament Street, London, S.W.* .... Ann.
1888 Scharff, Robert F., B.Sc., Ph.D., F.L.S., *Acting Director, National Museum, Dublin* .... Ann.
1901 Schiller, F. W., *Park House, Weston, Stafford* .... Ann.
1909 Schuster, Edgar, D.Sc., 110, *Banbury Road, Oxford* .... Ann.
1884 Sclater, W. L., 10, *Sloane Court, London, S.W.* .... Ann.
1885 Scott, D. H., M.A., Ph.D., F.R.S., *East Oakley House, Oakley, Hants* .... *C.*
1900 Sexton, L. E., 3, *Queen Anne Terrace, Plymouth* .... Ann.
1904 Shaw, Joseph, K.C., *Bryanston Square, London, W.* £13
1885 Sheldon, Miss Lilian, *High Park, Bideford* .... Ann.
*1884 Shipley, Sir Arthur E., G.B.E., D.Sc., F.R.S., *Christ's College, Cambridge* .... *C. and* Ann., £3 3s.
1891 Sinclair, William F., 102, *Cheyne Walk, Chelsea, S.W.* .... *C.*
1884 Skinners, the Worshipful Company of, *Skinners' Hall, E.C.* £42
1889 Slade, Admiral Sir E. J. W., K.C.I.E., K.C.V.O., *Field Place, Horsham, Sussex* .... *C.*
1920 Smith, Owen Hugh, *Hay's Wharf, Southwark, London, S.E.* £10
1888 Spencer, Sir W. Baldwin, K.C.M.G., M.A., F.R.S., *University of Victoria, Melbourne* .... Ann.
1907 Sprague, Thomas Bond, M.A., LL.D., *West Holme, Woldingham, Surrey* Ann.
1917 Spry, Lt.-Commander R., 83, *Mount Gold Road, Plymouth* .... Ann.
1897 Straker, J., LL.M., F.Z.S., *Oxford and Cambridge Club, S.W.* .... *C.*

1919 Takeda, S., 61, *Castletown Road, West Kensington, London, W.* 14 .... Ann.
*1899 Thompson, Prof. D'Arcy W., C.B., F.R.S., *University, St. Andrews* .... Ann.
1890 Thompson, Sir H. F., Bart., 9, *Kensington Park Gardens, London, W.* Ann.
1884 Thornycroft, Sir John I., F.R.S., *Eyot Villa, Chiswick Mall* .... Ann.
1903 Torquay Natural History Society, *The Museum, Torquay* .... Ann.
1910 Travers, Miss R. C., *Tortington House, Arundel* .... *C.*

1884 Walker, Alfred O., *Ulcombe Place, Maidstone* .... Ann.
1919 Walker, Cecil F. A., 36, *Prince's Gardens, London, S.W.* 7 .... *C.*
1920 Walker, Major Nigel O., O.B.E. £5

1919 Walton, Lt.-Col. H. J., I.M.S., M.D., F.R.C.S., C.M.Z.S. c/o Messrs. H. S. King & Co., 9, *Pall Mall, London, S.W.* ... Ann.
1913 Warden of Fisheries, *Punjab, Upper Dharamsala, District Kangra, India* ... Ann.
1906 Waterhouse, N. E., 3, *Fredericks Place, Old Jewry, London, E.C.* £5 and Ann.
1909 Waters, Arthur W., F.L.S., *Alderley, McKinley Road, Bournemouth* ... Ann.
1909 Watson, A. T., *Southwold, Tapton Crescent Road, Sheffield* ... Ann.
1906 Weldon, Mrs., *Merton Lea, Oxford* ... Ann.
1919 Wells, G. P., *Easton Glebe, Dunmow, Essex* ... *C.*
1910 Willes, W. A., *Elmwood, Cranborne Road, Bournemouth* ... Ann.
1900 Willey, Prof. A., D.Sc., F.R.S., *McGill University, Montreal, Canada*... *C.*
1908 Williamson, Colonel H. A., *Carrington House, Shepherd Street, Mayfair, London, W.* ... Ann.
1884 Wilson, Scott, B., *Heather Bank, Weybridge Heath* ... *C.*
1919 Winckworth, Ronald, M.A., F.R.G.S., 37, *Upper Rock Gardens, Brighton* ... Ann.
1898 Worth, R. H., 42, *George Street, Plymouth* ... Ann.

IV.—Associate Members.

1914 Dunn, Howard, *Mevagissey, Cornwall.*
1914 Dunn, Matthias, J.P., *Newlyn, Cornwall.*
1904 Edwards, W. C., *Mercantile Marine Office, St. Andrew's Dock, Hull.*
1904 Freeth, A. J., *Fish Quay, North Shields.*
1904 Hurrell, H. E., 25, *Regent Street, Yarmouth.*
1904 Inskip, H. E., Capt., R.N., *Harbour Master's Office, Ramsgate.*
1904 Johnson, A., *Fishmongers' Company, Billingsgate Market, London, E.C.*
1889 Olsen, O. T., F.L.S., F.R.G.S., *Fish Dock Road, Great Grimsby.*
1904 Patterson, Arthur, *Ibis House, Great Yarmouth.*
1889 Ridge, B. J., *Newlyn, Penzance.*
1901 Sanders, W. J., *Rockvall, Brixham.*
1889 Sinel, Joseph, 8, *Springfield Cottages, Springfield Road, Jersey, C.I.*
1890 Wells, W., *The Aquarium, Brighton.*

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Founders		100	0	0
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Members of the Association have the following rights and privileges: they elect annually the Officers and Council; they receive the Journal of the Association free by post; they are admitted to view the Laboratory at Plymouth, and may introduce friends with them; they have the first claim to rent a place in the Laboratory for research, with use of tanks, boats, &c.; and have access to the books in the Library at Plymouth.

All correspondence should be addressed to the Director, The Laboratory, Plymouth.