

# The Food of Post-Larval Fish.

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With Figures 1-7 in the Text.

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ALTHOUGH much investigation has been made on the food of adult fish the information as to the food of the very young is scattered and fragmentary. It is the purpose of this paper to report on the food of a number of post-larval fish which have been examined fresh from the tow-nettings through the year 1917 from Plymouth Sound within the Breakwater and outside as far as the region of the Panther and Knap Buoys (about  $2\frac{1}{2}$  miles from the shore) and occasionally from Cawsand Bay. The food of a number of preserved post-larval fish has also been investigated which were taken in the Young Fish Trawl in 1914 and reported on by Dr. Allen (1917). These latter were mostly examined as mounted and cleared preparations, the food usually being plainly seen. Others from this lot were examined by dissecting out the alimentary canal—a method not so satisfactory for preserved material although answering very well for the fresh fish which were all examined by this latter method.

A systematic examination of post-larval fish from tow-nettings was made by A. Scott (1906), who used the above methods, but the number examined was not large. Herdman (1893–1898) had also previously noted the contents of the alimentary canal in several young fish, chiefly those beyond the post-larval stages. Petersen (1894, 1917) also notes the food of young fish, especially *Pleuronectidæ*. Other records have chiefly to do with the food of artificially reared fish, when the food picked out by the post-larval fish from plankton given to them is noted.

In all these records it is found that the Copepoda form the chief food of nearly all larval and post-larval fish with other Entomostraca and Mollusk larvæ. It now seems to be a well established fact that the majority of young fish eat the small animals from the plankton more than the diatoms and other unicellular organisms, except in cases of some of the very young fish which have been found to eat diatoms before taking to animal food (Kyle (1898) found Dab from 10 to 16 mm. with

stomachs full of diatoms), and in the few exceptional cases of fish which are true vegetarians. As examples of these latter cases Herdman (1912) shows that post-larval plaice first feed on diatoms before taking animal food; Dannevig (1897 and 1898) also found that the young plaice first took diatoms and in some cases Infusoria. The Grey Mullet which is herbivorous, with its mouth-parts adapted for browsing, eats in its post-larval stage according to Cunningham (1890) chiefly diatoms, although A. Scott (1898) has found that the older young eat Copepods as well as diatoms. Professor S. A. Forbes (1882-1884) shows that the young Whitefish (*Coregonus clupeiiformis*) in a tank with only vegetable food nearly all died, whilst they fed eagerly on Entomostraca. Even before the yolk is absorbed a pair of small teeth are developed, well adapted for seizing animal food such as these small Crustacea (chiefly Copepods). Young herring take Mollusk larvæ before the yolk is absorbed, as do also the pipe-fish, *Nerophis lumbriciformis*, which hatched in a jar in the laboratory. Mollusk larvæ seem often to be taken very early, even before Copepods.

That a certain amount of selection of food takes place is evident from previous records and from our own observations. Dannevig (1897) states that only one species at one time was eaten by the baby plaice although different individuals might eat different species. It seemed as though one individual got used to a certain food and stuck to it for a time. Petersen (1894) shows that the Dab, living with the Plaice, selects Copepods of other species from those chosen by the latter fish, and Herdman shows that the natural food of fish is often that which is not most frequently present, so that the fish must hunt for it.

The following records show that certain fish undoubtedly prefer certain food; frequently two or three fish will like the same kind. For instance, *Solea variegata* and the few *Solea vulgaris* examined like the same food as the Dab, e.g. chiefly *Podon*, *Temora* and *Euterpina*, so that it may well be that the very abundant Dab takes away, in its very young stages, the food from its more valuable relatives. It is to be noted, however, that whereas *Solea* eats Crustacea as big as *Temora* almost at once, the Dab, *Pleuronectes limanda*, has a period up to about 5 mm. when no Crustacea are found in its alimentary canal, so that it most probably first eats softer food. It is not in the least the case that all Pleuronectids eat the same food, for one of the Top-knots, *Scophthalmus norvegicus*, specially eats *Pseudocalanus*, which is only very rarely found in the Soles and Dab, and *Arnoglossus* although not eating Copepods for some time also likes *Pseudocalanus*. *Podon*, probably *P. intermedius*, is a favourite with many young fish, and is often taken by the very young ones before Copepods; probably it is more easily digested. It heads the list of the food of post-larval fish in these records.

As regards the Copepods, we naturally find that the fish with the smallest mouths eat the smallest forms, both large and small being eaten by those with large mouths. Thus *Arnoglossus* up to about 20 mm. having a small mouth does not take larger forms than *Pseudocalanus*, whereas *Solea variegata* at 4 mm. can eat full-grown *Temora*, and *Scophthalmus norvegicus* at 4.5 mm. can eat full-grown *Metridia lucens*. It is a striking fact that *Calanus finmarchicus*, which is abundant, is eaten very little by these post-larval fish. It is apparently too large for any but the fair-sized young ones. The nauplii are seen oftener as food for the small ones, and probably are frequently among the unidentifiable Copepod remains. Fish caught in the act of swallowing Copepods always show the tail sticking out of the mouth, so that they are swallowed head first.

The commonest food in order of frequency is the following: *Podon* (probably *intermedius*), *Pseudocalanus elongatus*, *Temora longicornis* and *Euterpina acutifrons* in the proportion of 6:4:3:2, *Metridia lucens* and *Balanus nauplii* coming next, and afterwards other Copepods such as *Oncaea* sp., *Acartia* sp. *Corycaeus anglicus*, *Centropages typicus*, *Calanus finmarchicus* in order, with nauplii especially of *Temora* and in very few cases *Microsetella norvegica*, *Harpacticus uniremis*, *Longipedia Scotti*, *Isias clavipes*, *Idya furcata*, *Oithona similis* and *Anomalocera pattersoni*. Cypris stages of *Balanus* occurred at certain times and *Evadne* sp. *Podon* and *Evadne* are not found in the winter but most of the fish that had eaten *Podon* were in summer hauls, and the *Balanus* nauplii which swarm in spring, beginning in February, were chiefly taken by young herring. The Copepods most frequently taken as food are amongst the commonest in the ordinary tow-nettings, although the Harpacticid *Euterpina acutifrons* occurs much more frequently in fish than in the tow-nettings, and the *Oncaea* (probably *media*) has not been taken with the tow-nets here. These two and *Metridia lucens* are evidently commoner outside, and the hauls in which the fish were taken which had chiefly eaten these were from the region of the Eddystone and Rame Head, the other common forms, *Podon*, *Temora* and *Pseudocalanus* also evidently abounding there. Besides Copepods and Cladocera small ova were frequently found in the fishes, especially the Pleuronectids and Herring; these were spherical and usually measured about 0.2 mm. in diameter. The very young fish frequently contained only these.

Very few unicellular organisms besides these ova were found in the young fish. Diatoms when present were sometimes in the Copepods eaten or in their faeces, but not very often free in the alimentary canal. In one instance a perfect specimen of a *Coccosphæra* was found in a Pouting, *Gadus luscus*. On another occasion a young *Ammodytes* contained several *Rhizosolenia Shrubsolei*.

To show that a certain amount of selection does take place a list was made of the food inside the fish from 2 hauls, and the food of each fish noted. For this purpose Hauls XIII and XIIIa were selected, both with the Young Fish Trawl, 1914. Haul XIII May 19th, 11.35 p.m. Mid-water, Eddystone, N. 6½, 39 fms. Haul XIIIa May 22nd, Eddystone, S.W. 3 miles, 28 fms.

## Haul XIII.

Contained the following fish :—

406 <i>Clupea</i> sp.	1 <i>Arnoglossus</i> sp.
1 <i>Ammodytes</i> sp.	84 <i>Scophthalmus norvegicus</i> .
8 <i>Gadus merlangus</i> .	1 <i>Zeugopterus unimaculatus</i> .
7 <i>G. luscus</i> .	4 <i>Z. punctatus</i> .
158 <i>G. minutus</i> .	48 <i>Solea variegata</i> .
5 <i>Onos mustela</i> .	5 <i>Gobius</i> sp.
1 <i>Labrus bergylta</i> .	150 <i>Crystallogobius Nillsoni</i> .
70 <i>Pleuronectes limanda</i> .	13 <i>Trigla</i> sp.
55 <i>P. microcephalus</i> .	20 <i>Callionymus lyra</i> .

These contained the following food :—

## DIATOMACEÆ.

*Paralia sulcata*.  
*Pleurosigma* sp.  
*Navicula* sp.  
*Guinardia flaccida*.  
*Lauderia borealis*.

## PERIDINIALES.

*Dinophysis* sp.  
*Diplopsalis lenticula*.  
*Prorocentrum micans*.  
*Peridinium ovatum*.  
*P. pallidum*.  
*P. cerasus*.  
*P.* sp.

## INFUSORIA.

*Tintinnopsis ventricosa*.

## CIRRIPEDIA.

*Balanus* nauplii and cypris stages.

## CLADOCERA.

*Podon* (cf. *intermedius*).

## COPEPODA.

*Calanus finmarchicus*.  
*Pseudocalanus elongatus*.  
*Metridia lucens*.  
*Paracalanus parvus*.  
*Temora longicornis*.  
*Acartia* (cf. *Clausi*).  
*Oncaea* (cf. *media*).  
*Coryceus anglicus*.  
*Euterpina acutifrons*.  
 Also ova.

The Diatoms and Peridinales were nearly all inside the Copepods. The Copepods chiefly taken were *Pseudocalanus*, *Temora*, *Euterpina* and *Metridia*. *Solea variegata* and *Pleuronectes limanda* ate chiefly *Podon* and *Temora*, *Solea* also eating *Euterpina*, *Oncaea*, *Coryceus* and *Balanus* larvæ, neither containing *Pseudocalanus*. On the other hand *Pseudocalanus* was the chief food of *Scophthalmus norvegicus*, which hardly ever took *Temora*, but in addition to *Pseudocalanus* contained

*Metridia* and occasionally *Podon*, *Acartia*, *Paracalanus*, *Oncaea* and *Euterpina*. *Pseudocalanus* was also almost the only food of *Gadus minutus* and *G. merlangus*. The *Clupea* were all empty and no food was found in *Pleuronectes microcephalus*. Those of the *Crystallogobius* examined (not all as they were almost adult) contained *Calanus finmarchicus*, showing that it was present although not taken by the other fish. *Callionymus lyra* eats almost anything. Besides the above food, many of the fish contained ova.

## Haul XIIIa.

Contained the following fish :—

45 <i>Pleuronectes limanda</i> .	59 <i>Gadus</i> sp.
11 <i>Solea variegata</i> .	8 <i>Trigla</i> sp.
1 <i>S. vulgaris</i> .	1 <i>Labrus bergylla</i> .
10 <i>Zeugopterus punctatus</i> .	1 <i>Ammodytes</i> sp.
2 <i>Scophthalmus norvegicus</i> .	34 <i>Callionymus lyra</i> .

The fish contained the following food :—

PERIDINIALES.	<i>Pseudocalanus elongatus</i> .
<i>Peridinium ovatum</i> .	<i>Paracalanus parvus</i> .
<i>P. sp.</i>	<i>Temora longicornis</i> .
INFUSORIA.	<i>Centropages typicus</i> .
<i>Tintinnopsis ventricosa</i> .	<i>Acartia</i> (cf. <i>Clausi</i> ).
CLADOCERA.	<i>Oncaea</i> (cf. <i>media</i> ).
<i>Podon</i> (cf. <i>intermedius</i> ).	<i>Idya furcata</i> .
COPEPODA.	<i>Euterpina acutifrons</i> .
<i>Calanus finmarchicus</i> .	AMPHIPODA.
	<i>Apherusa</i> (cf. <i>Clevei</i> ).

Thus the two hauls contain very similar food. Again we find that *Solea variegata* ate chiefly *Temora*, also *Euterpina* and occasionally *Oncaea* and *Acartia* but no *Pseudocalanus*. *Solea vulgaris* ate *Temora* and *Euterpina* and *Pleuronectes limanda* chiefly *Temora* and *Podon* but not *Pseudocalanus*. *Zeugopterus punctatus* ate chiefly *Temora* but also *Calanus*, *Oncaea* and *Euterpina*. Again *Scophthalmus norvegicus* ate chiefly *Pseudocalanus*, although *Paracalanus*, *Euterpina* and *Temora* are present. *Pseudocalanus* is also eaten by the *Gadus* sp. with several other Copepods including occasional *Calanus*, and by *Trigla* and *Ammodytes*. Again *Callionymus lyra* eats a variety, including *Apherusa*. From these notes it will be seen that certain fish do undoubtedly take certain foods in preference to others, and this is specially well shown in *Solea* and *Pleuronectes limanda*, which like *Podon* and *Temora*, and almost entirely pass over *Pseudocalanus* although present in abundance.

## LABRUS BERGYLTA ASC. BALLAN WRASSE.

Thirty-nine specimens were examined which came in the tow-nettings from both outside and inside the Breakwater, from June to September, and were examined fresh. They measured from 2.5 mm. to 11 mm., the small specimens being somewhat contracted so that they naturally were longer. The smallest were either empty or contained indistinguishable green food remains, those from 4 to 5 mm. containing almost entirely Copepod nauplii, especially *Temora*, with occasional remnants of diatoms (*Navicula*) and peridinians, with green food remains. At 6 mm. Copepods and Copepod nauplii were taken, one specimen containing the following:—

10 <i>Cittarocyclus denticulata</i> .	2 <i>Prorocentrum micans</i> .
1 <i>Temora longicornis</i> .	6 <i>Peridinium</i> sp.
3 <i>Euterpina acutifrons</i> .	1 <i>Lithomelissa setosa</i> .
1 Copepod <i>indet.</i>	1 <i>Tintinnopsis beroidea</i> .

The larger specimens contained Copepod remains including *Temora* and *Pseudocalanus*, and also *Podon*. Altogether 20 out of the 39 contained Copepod nauplii or young copepodid stages, so that evidently this, with small planktonic organisms, is their chief food in the post-larval state.

## CARANX TRACHURUS L. HORSE MACKEREL.

Four specimens of young Horse Mackerel were examined, from inside and outside the Breakwater and Cawsand Bay,\* in September and October, measuring 30 to 40 mm. They all contained Crustacea, chiefly Copepods including *Calanus*, *Centropages typicus* (15 in one specimen), *Temora* and many Harpacticids, including *Idya furcata*. Crab zoeæ and *Porcellana* larvæ were also present.

## SCOMBER SCOMBER L. MACKEREL.

Twenty-five Mackerel were examined fresh from the tow-nettings, measuring 3 to 16 mm., from inside and outside the Breakwater from the end of July to the middle of September. The very smallest either contained nothing or green food remains, but one of 3.5 mm. contained 2 *Temora* nauplii and another a larval gastropod. Nine specimens contained nothing, the remainder contained green food remains and Copepod remains which seemed to be almost entirely *Temora* nauplii. The specimen of 16 mm. with remains of Copepods in its alimentary canal had in its mouth (swallowed head first) 4 adult *Temora longicornis* which it had probably taken after capture.

\* For a Plan of Plymouth Sound showing where the tow-nettings were taken, see Fig. 7, p. 459.

## TRACHINUS VIPERA CUV. LESSER WEAVER.

Three specimens examined fresh from the tow-nettings from outside the Breakwater, 2 of 22 mm. in September, 1 of 5 mm. in October. One big one contained indistinguishable Copepod and other Crustacea remains, the other contained one *Pseudocalanus elongatus* and one *Anomalocera Pattersoni*. The small one contained 3 *Pseudocalanus elongatus* and one *Temora* nauplius.

## LOPHIUS PISCATORIUS L. ANGLER.

Six specimens from outside the Breakwater were examined fresh from the tow-nettings in July, measuring 4 to 8.5 mm., 4 contained nothing, the other 2 indistinguishable Copepod remains.

## COTTUS BUBALIS EUPH. FATHER LASHER.

Twenty-two specimens, fresh, from the tow-nettings, were examined in March and April from inside and outside the Breakwater, measuring 4.5 to 10 mm. The smallest were however contracted and probably really were longer. The specimen of 10 mm. contained no food, one of 7 mm. contained a *Temora longicornis*; all the rest, excluding 4 containing nothing, contained green remains, Crustacea remains, diatoms or *Balanus* nauplii. The *Balanus* nauplii were in 7 specimens, and were in the smallest specimens. Evidently *Cottus bubalis* takes a mixed diet. One of 4.5 mm. contained the following:—

- 2 larval gastropods.
- 1 *Biddulphia regia*.
- 1 *Coscinodiscus radiatus*.
- 15 *Thalassiosira gravida*.

Another specimen also contained *Thalassiosira*, so that here we have one of the post-larval fish which does take diatoms as food.

## TRIGLA GURNARDUS L. GREY GURNARD.

Only one specimen of 8 mm., from tow-nettings in the West Channel, contained one *Podon*.

## AGONUS CATAPHRACTUS L. ARMED BULLHEAD.

Two specimens, one from inside and one from outside the Breakwater in February and March, examined fresh from the tow-nettings. One contained nothing, the other one *Coscinodiscus excentricus*.



## BLENNIUS GALERITA L. MONTAGU'S BLENNY.

One specimen from the White Patch, 17 mm. long, fresh from tow-nettings, July, contained 5 *Temora longicornis*.

## BLENNIUS GATTORUGINE BLOCH.

One specimen from the west end of Breakwater, fresh from tow-nettings, August, contained remains of crab zoeæ and Crangon larvæ.

## GOBIUS MINUTUS PALL.

Twenty-four specimens, from both inside and outside the Breakwater, from fresh tow-nettings from July to September, were examined, measuring 2 to 14 mm. The smallest and most of those from 4 to 5 mm. contained no food, but one of 4 mm. contained remains of Copepod nauplii and one of 4.5 mm. contained a *Temora* nauplius. Those of 6 mm. contained Copepod remains including *Calanus* nauplii. From 6.5 mm *Pseudocalanus* was eaten and was in 3 specimens, one of which (14 mm. long) contained 3 *Pseudocalanus* and 4 *Temora*. Another of 14 mm. contained 3 *Acartia* sp. (probably *A. Clausi*).

The other *Gobius* species have not been identified. I have designated them *Gobius* sp. (a) and *Gobius* sp. (b). A third, very small and with orange and yellow pigment, contained no food.

## GOBIUS SP. (a).

Nineteen specimens, from both inside and outside the Breakwater, fresh from tow-nettings, measuring 2 to 4 mm., in March and April. Ten contained nothing, one of 3 mm. contained a larval bivalve, one of 3.5 mm. a *Balanus* nauplius. One contained a *Coscinodiscus* and the remainder had green food remains in them.

## GOBIUS SP. (b).

This is very like the larva of *Gobius niger* but with less pigment, and possibly may be *G. paganellus*. Nine specimens were examined from both inside and outside the Breakwater, in August fresh from the tow-nettings, measuring 11 to 13 mm. Two contained no food, one the remains of diatoms, including *Skeletonema costatum*, 2 contained green food remains and one a *Balanus* nauplius. The rest contained Copepods, all identified being *Temora*, adult, young and nauplii.

## CRYSTALLOGOBIUS NILSSONI v. DÜB. &amp; KOR.

One fresh specimen from tow-nettings outside the Breakwater, October, measuring 21 mm. contained nothing. Twenty-eight preserved specimens from Haul XIII Y.F.T. 1914, all contained Crustacea, 13 contained *Podon*, and 2 *Calanus finmarchicus*, many remains probably representing the latter species. The specimens measured from 26 to 37 mm.

## CALLIONYMUS LYRA L. DRAGONET.

Forty-six fresh specimens from the tow-nettings were examined, from both inside and outside the Breakwater from March to October, from 1.5 to 8 mm. Up to 2 mm. yolk was present but diatoms or green food was sometimes present. *Coscinodiscus excentricus* and *C. sp. Paralia sulcata*, *Navicula* sp. and *Pleurosigma* sp. were present, at 3 mm. *Euterpina* was eaten, *Balanus nauplii* occasionally. Many of these small ones were empty.

222 preserved specimens from the Young Fish Trawl 1914 were examined, from 3 to 13 mm. At 3.5 mm. *Pseudocalanus* is eaten. After that a variety of Copepods including *Oncaea*, *Euterpina*, *Corycæus*, *Temora*, *Idya*, *Paracalanus*, *Calanus* and *Centropages*, with occasional *Podon* and *Apherusa*, also ova. The commonest Copepods taken are *Pseudocalanus* and *Euterpina*, *Temora* coming next. *Callionymus lyra* is thus a very miscellaneous feeder, beginning with diatoms when very young and soon feeding almost exclusively on Copepods.

## CYCLOGASTER MONTAGUI DONOV.

Four specimens from both inside and outside the Breakwater, March and April, 3.5 to 4.5 mm. Two contained nothing; one, diffuse brownish food remains, and one, remains of Crustacea.

## CYCLOPTERUS LUMPUS L. LUMP SUCKER.

Two specimens from amongst the *Zostera* outside the Breakwater in July and August, 15 and 18 mm. That of 15 mm. contained 5 Amphipoda indet., and 1 *Harpacticus uniremis*, the other contained remains of *Eupagurus* larvæ and other larval decapods.

## LEPADOGASTER CANDOLLEI. RISSO.

Nine specimens from both within and outside the Breakwater, July and August, 4 to 8 mm. One of 4 mm. contained two young *Temora*, all the others (except one with nothing in it) contained remains of Copepods, including *Temora* nauplii and Harpacticids.

## LEPADOGASTER GOUANI LACEP.

Five specimens from outside the Breakwater, August and October, 4 to 6 mm. The largest contained 1 *Centropages typicus* and 2 *Pseudocalanus elongatus*, 2 contained nothing, and the others Copepod nauplii and Harpacticids.

## RHAMPHISTOMA BELONE (L.). GAR-FISH.

Sixteen specimens from both within and without the Breakwater, July and August, from amongst *Zostera*, 10 to 29 mm., 6 contained nothing, 6 contained *Harpacticus uniremis*, the rest greenish food remains and 1 *Pleurosigma* sp.

## PLEURONECTIDÆ.

Very few Pleuronectids were obtained fresh from the tow-nettings, but a large number from the Young Fish Trawl, 1914, were examined in a preserved state for food and show some interesting features. Thus we find they fall into two groups according to the form of the alimentary canal, which influences the food taken in the young forms. In the first group we may place those with a large mouth and a thick and short gullet and stomach; to this group belong *Solea variegata*, *S. vulgaris*, *S. lascaris*, *Pleuronectes limanda*, *Rhombus maximus*, *R. lævis*, *Zeugopterus punctatus*, *Z. unimaculatus* and *Scophthalmus norvegicus*. With this character goes the habit of taking such food as small Copepods and Cladocera at an early stage, so that the newly hatched fish very soon, and in some cases almost immediately, takes this food. The Plaice *Pleuronectes platessa* would probably be included in this group although in the very first stages after hatching it is known to eat diatoms and larval mollusks, soon however taking to Copepods and other small Crustacea, especially Entomostraca. The nearest to the Plaice in this respect is the Dab, *P. limanda*, which seems not to begin to eat Copepods until about 5 mm. in length, although it hatches under 3 mm. On the other hand *Solea variegata* hatches at about 2.5 mm. and at 4 mm. it may contain a fairly large *Temora* measuring 1.5 mm. *Scophthalmus norvegicus* hatches at about 2.5 mm. and still has yolk at 3.27 mm., but at 4.5 mm. it can eat a *Metridia* 2 mm. long. In these cases Copepods must be eaten very soon after hatching.

In the second group we may include *Pleuronectes flesus*, *P. microcephalus* and *Arnoglossus laterna* which have a long and narrow gullet and stomach, and these apparently do not eat Copepods or any Crustacea until a greater size is reached—the alimentary canal in the small specimens being either empty or showing indications of a diet of unicellular

organisms, ova, diatoms or other microscopic plants. Thus in *Pleuronectes microcephalus* Copepods were only found in very few and these of the smallest kind in the larger fish, ova occurred in many, and diatoms (*Navicula* and *Pleurosigma*) and Peridinians in a few. In *Arnoglossus*

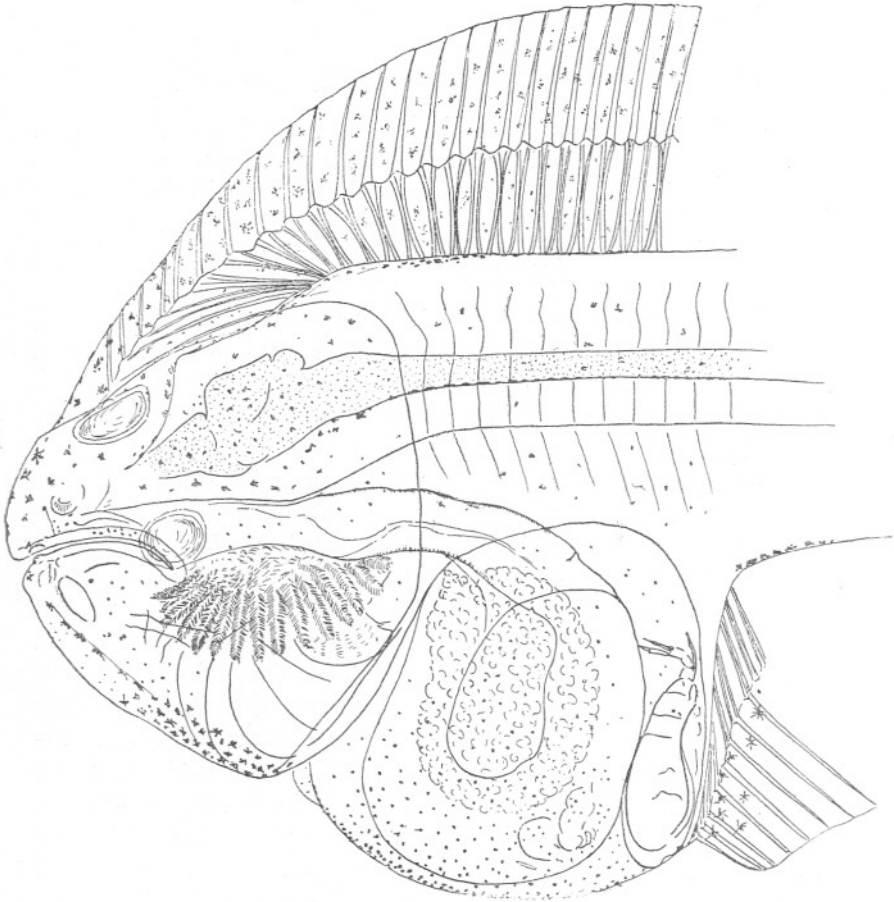


FIG. 1.—Post-larval *Solea variegata* 12 mm. long, from balsam preparation. Eyes seen through from left side.

only in those over 8 mm. were there any Copepods (*Pseudocalanus*). *Pleuronectes flesus* from 5.5 to 10 mm. had nothing inside larger than diatoms, but often diffuse masses which were apparently remains of unicellular organisms. Thus we have a great contrast between the two groups and a correlation between a large mouth with a broad, short gullet and stomach and an early diet of Entomostraca, and between a

small mouth with a long and narrow gullet and stomach and an early more or less vegetarian diet, only going on to Entomostraca at a much later stage. (See Figs. 1-6.)

The large-mouthed forms do not all take the same kind of Crustacean food, but certain groups seem to do so. Thus *Solea variegata*, *S. vulgaris* and *S. lascaris*, *Pleuronectes limanda*, *Zeugopterus punctatus* and *Z. unimaculatus* take much the same sort of food, but *Scophthalmus norvegicus* differs in taking *Pseudocalanus* and *Metridia* chiefly, forms hardly

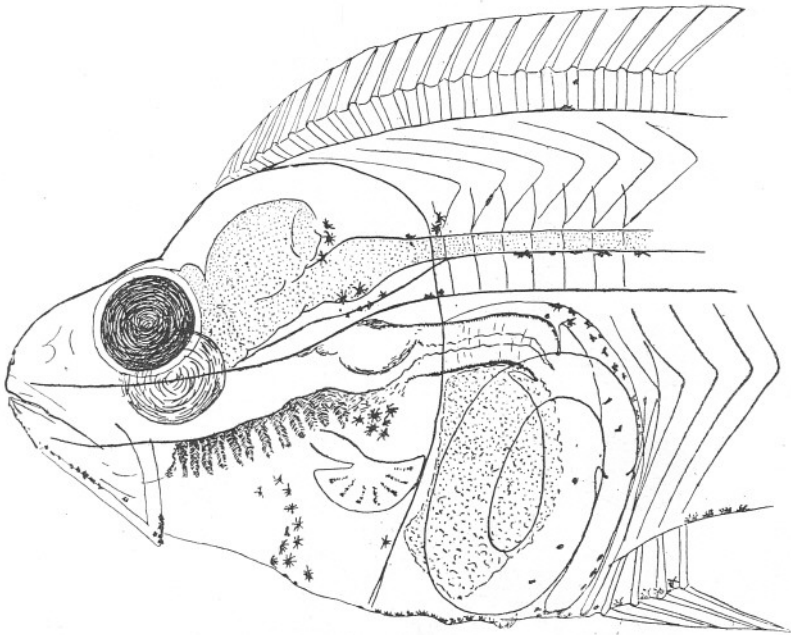


FIG. 2.—Post-larval *Pleuronectes limanda*, 12 mm. long, from a balsam preparation. Right eye seen through from left side.

taken at all by those mentioned above, *Pseudocalanus* on the other hand being the chief food of the larger post-larval *Arnoglossus*.

#### SOLEA VULGARIS QUENSEL. COMMON SOLE.

Fourteen specimens examined, preserved, from Young Fish Trawl, 1914, 5.5 to 9.5 mm. The smallest contained Copepod remains, 3 contained nothing, 2 were indistinguishable and 2 contained ova. The rest contained Copepods (*Temora* and *Euterpina* and *Oncaea*), *Balanus* cypris stage and one contained a *Prorocentrum micans*. A. Scott (1906)

found in a Sole of 7.5 mm., *Longipedia minor*, *Ectinosoma Sarsi* and *E. Normanni*, all littoral Copepods. Holt and Byrne (1905) state that between 7 and 11 mm. they feed largely on the larvæ of other fishes.

#### SOLEA LASCARIS BONAP. LEMON SOLE.

Two specimens only, preserved, from Young Fish Trawl, 1914, 9.5 and 10.5 mm., one indistinguishable, the other containing *Temora* and *Euterpina*.

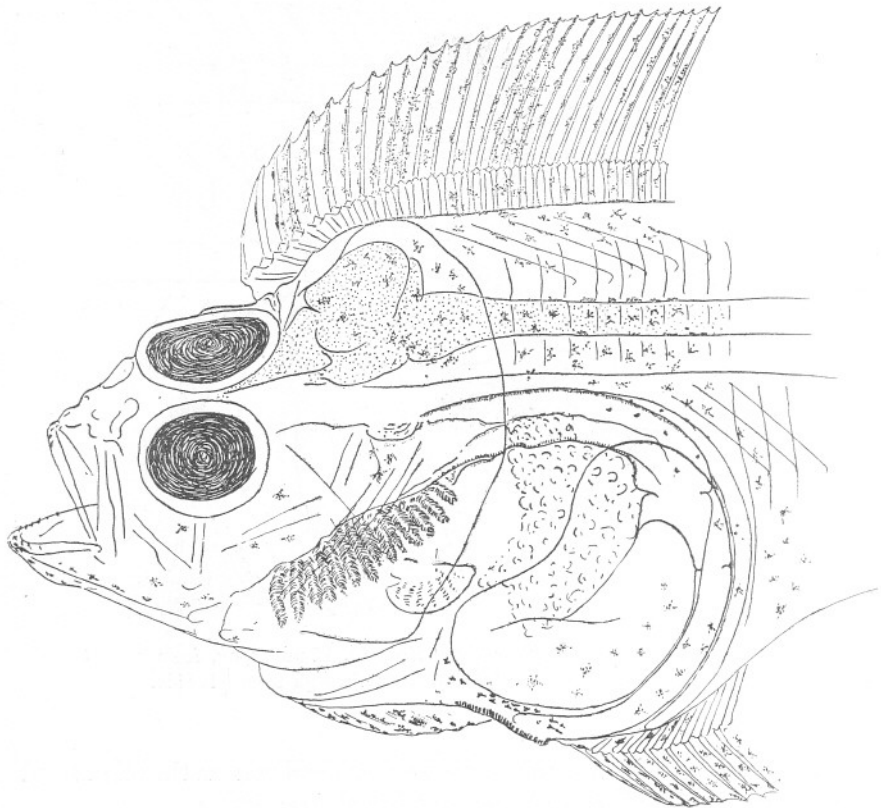


FIG. 3.—Post-larval *Scophthalmus norvegicus*, 12 mm. long.

#### SOLEA VARIEGATA DONOV. THICKBACK.

221 specimens of the "Thickback" were examined, from the Young Fish Trawl, 1914, preserved. They varied in length from 4 mm. to 11.5 mm., and as it hatches at about 2.5 mm. some of them must be very

young. Twenty-two contained nothing, but the remainder had a good deal of food inside them, the smallest eating the same as the largest. Nearly all the food was Crustacea and small ova of two kinds, one with a tough sheath, the others without, and perhaps being ova of Copepods. The majority of the Crustacea were Copepods, Cladocera (*Podon*) coming next in abundance, and the cypris stage of *Balanus*. Of the Copepods the

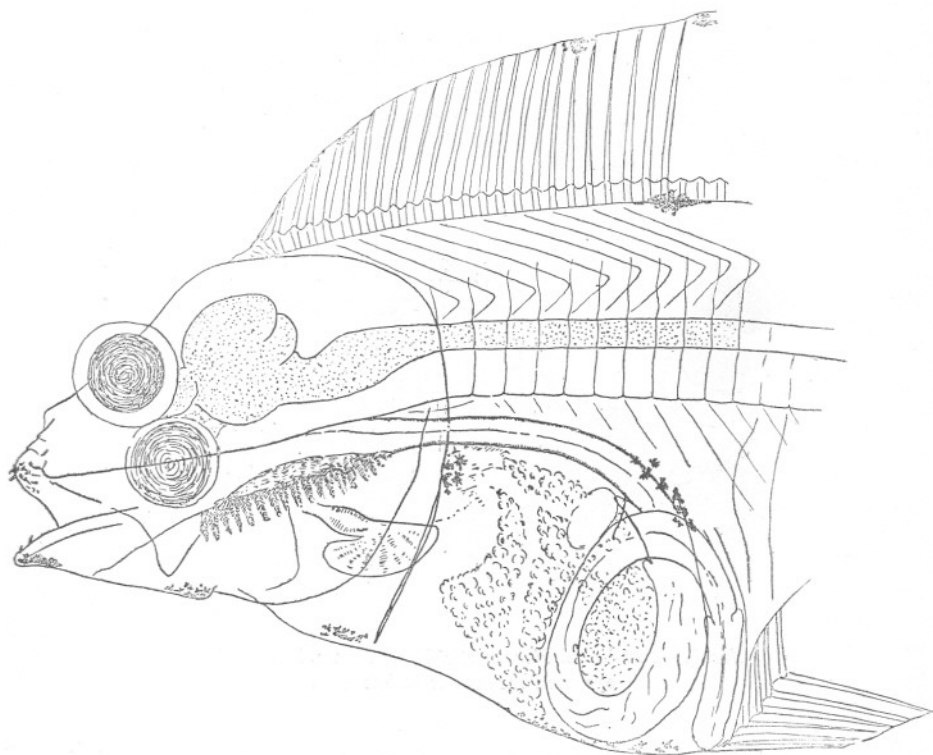


FIG. 4.—Post-larval *Pleuronectes microcephalus*, 12 mm. long. Right eye seen through from left side.

Harpacticid *Euterpina acutifrons* is the most frequent, occurring in 60 out of the 221 specimens, as many as 5 or 6 often being found in one individual. From May 22nd they are particularly abundant in Hauls XIII to XVII (for particulars of the hauls see Allen (1917) both from the region of the Eddystone and Rame, evening and morning, midwater and surface, and occur in fish from 4 mm. to 10.5 mm. long, very often

with *Temora longicornis* and *Podon* (probably *intermedius*). *Temora*, as many as 6 in one individual, occurs in 51 out of 221 specimens, in all hauls except XVII and XXII (only one *Solea variegata* in the latter). They also are contained in the smallest (4 mm.) and the largest (11.5 mm.). A specimen of 4 mm. can swallow a *Temora* 1.5 mm. long. Other Harpacticids occurring rarely are *Longipedia Scotti* and *Microsetella norvegica*. *Oncaea* (cf. *media*) occurs fairly frequently, as many as 4 together, male and female, female the commonest. *Oncaea media* is a species not hitherto

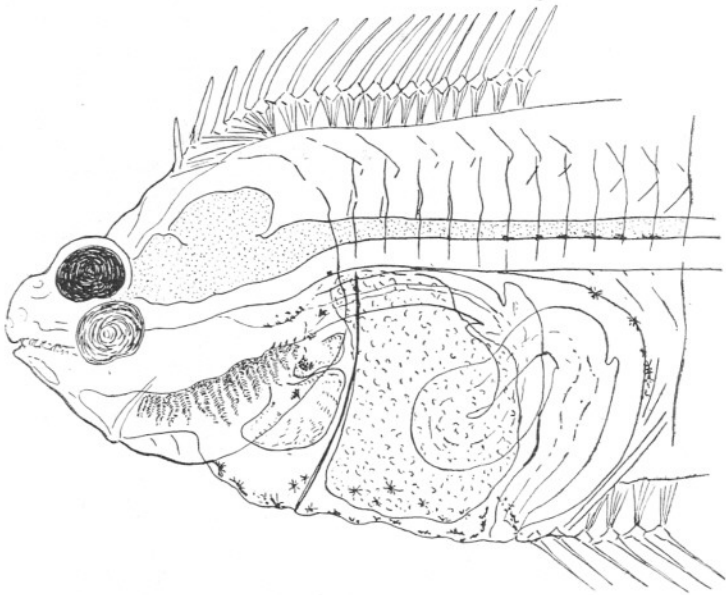


FIG. 5.—Post-larval *Pleuronectes flesus*, 10 mm. long. Right eye seen through from left side.

recorded from Plymouth; the length of the body is less than it is in *O. mediterranea* and *O. venusta* and the caudal furca are different. It occurs in 25 out of 221. *Corycaeus anglicus* occurs rarely, *Acartia* (cf. *Clausi*) and *Pseudocalanus elongatus* occur once only, singly, and evidently not liked by the fish, as they certainly occur in the hauls and are taken by other young fish (e.g. *Scophthalmus*).

*Podon intermedius* occurs in 76, thus it is the form most frequently taken. It occurs in specimens from most of the hauls, in the smallest and also in the largest.

*Balanus* cypris stages occur in 9 specimens. Larval gastropods occur only occasionally. Besides the ova, minute organisms such as Infusoria,



Peridiniales and diatoms occasionally occur, generally contained in diffuse masses, which may be from the alimentary canal of the Crustacea eaten. They apparently form an unimportant part of the diet. *Tintinnopsis ventricosa* is the only Infusorian, *Peridinium* sp. and *Prorocentrum micans* the only Peridinians and *Paralia sulcata*, *Navicula* sp. and *Pleurosigma*

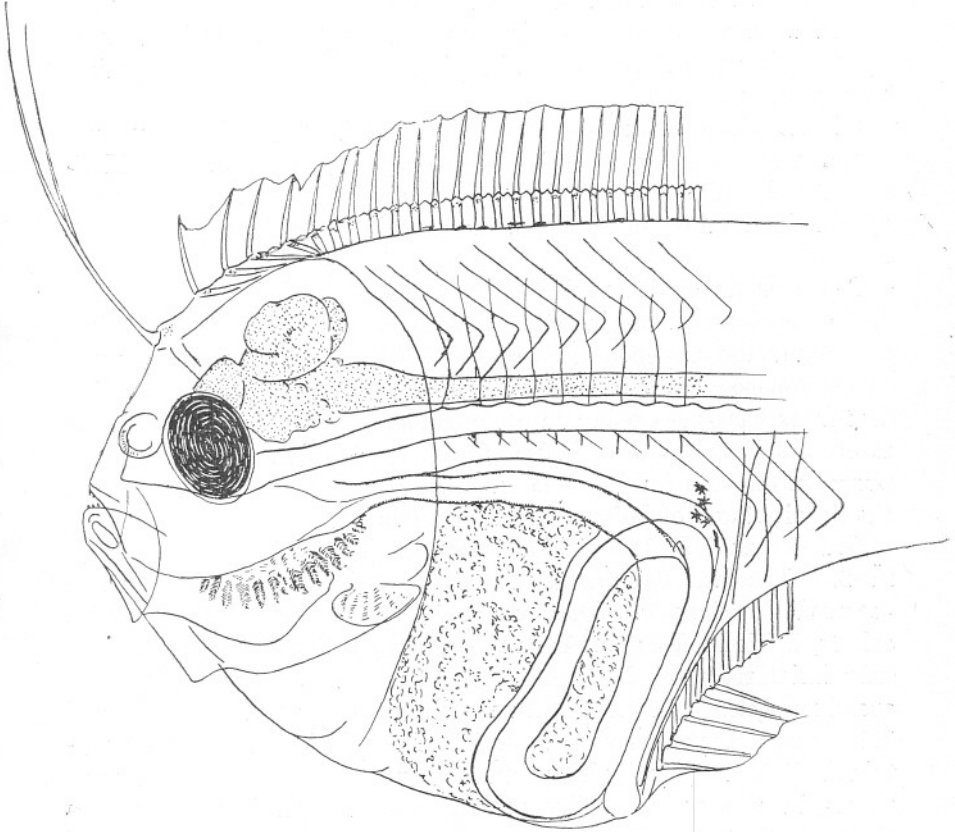


FIG. 6.—Post-larval *Arnoglossus laterna*, 12 mm. long.

sp. occur among the diatoms, especially chains of *Paralia sulcata*. Small bodies, possibly spores, also occur.

Apparently the smallest and the largest specimens feed on the same kind of food, as no difference was found. Also in May and June the months when the hauls were taken, no difference is found. Although so few specimens of *Solea vulgaris* and *S. lascaris* were examined, the evidence seems to point to their taking the same kind of food as *S. variegata*.

## PLEURONECTES LIMANDA L. DAB.

1353 specimens of the "Dab" were examined, preserved, from the Young Fish Trawl, 1914. These measured from 4 to 17 mm. in length. 416 contained no food, chiefly the smaller specimens; in those from 4 to 4.5 mm. no food could be detected, the food taken at this stage probably being very minute. Remains of small Copepods first occurred in those of 5 mm. Fairly large Copepods, such as *Temora*, occurred from 7 mm. upwards, but not in those of a smaller size. Nearly all the food recognized was Crustacea or ova.

Of the Crustacea recognizable *Podon* (cf. *intermedius*) was the commonest, occurring in 427. Those from Hauls V to X and XVII to XLVIII did not contain *Podon*, which looks as if *Podon* if present in numbers is preferred, but certain Copepods may be taken instead.

Copepods, Copepod nauplii, Copepod remains and fæces occurred in 382, Crustacea remains, indistinguishable, in 91. *Temora longicornis* is the commonest Copepod, occurring in 170 from 7 mm. long upwards. Other Copepods were Harpacticids in 52, 46 of which were *Euterpina acutifrons*, the others being unrecognizable. Other Copepods occurring rarely are *Pseudocalanus* (in 10), *Oncaea* (in 7), *Metridia lucens* (in 3) *Corycaeus anglicus* (in 3). The only other Crustacea recognizable were the Cypris stages of *Balanus* in one specimen.

Ova occurred in 198 specimens, spores (?) in 10, larval Mollusks in 2. Diatoms, Peridinians, Infusoria and *Distephanus speculum* occurred occasionally. Diatoms in 13, 6 of which were *Paralia sulcata*, 1 *Pleurosigma* sp., 1 *Fragillaria* sp., 1 *Coscinodiscus* sp. The only Infusoria were *Tintinnopsis ventricosa* in 6. Two *Distephanus speculum* occurred in one of 6 mm. Kyle (1898) examined 30 out of 300 young Dabs measuring 10 to 16 mm., and found they only contained diatoms (*Coscinodiscus* and others) although Copepods were resented in the water. The present records certainly show that Crustacea are taken earlier.

## PLEURONECTES FLESUS L. FLOUNDER.

Two fresh post-larval Flounders were examined from the tow-nettings, one from inside and one from outside the Breakwater in May. The first, 8.5 mm. contained nothing, the second, 10.5 mm. which occurred on May 31st, when the tow-nettings were full of the flagellate *Phaeocystis*, had its alimentary canal full of *Phaeocystis* spores. Forty-two preserved specimens from the Young Fish Trawl, 1914, were examined, 5.5 to 10.5 mm., 15 of which contained nothing, the rest diffuse remains almost

certainly vegetable, one containing *Paralia sulcata* and *Fragillaria* sp. Not one contained any Crustacea remains, and here we have a very distinct difference between the Flounder and Dab and the various species of Solea. The gullet and stomach of the Flounder is long and narrow and the mouth small, which go with its method of feeding.

#### PLEURONECTES MICROCEPHALUS. DONOV. MERRY SOLE.

Only one fresh specimen was obtained from the tow-nettings, West Channel in April, but it was very small, 4 mm. with yolk sac and no food.

247 preserved specimens from the Young Fish Trawl, 1914, were examined, 5.5 mm. to 18.5 mm. Of these 195 contained no food, 35 contained ova; only one Copepod was distinguished, *Euterpina acutifrons*, in a specimen 10 mm. long. *Podon* (cf. *intermedius*) occurred in 3, 8.5 to 10 mm. long. Sixteen contained remains of Crustacea, 5 of which were recognizable as remains of small Copepods. One *Peridinium* sp. occurred and diatoms (*Navicula* and *Pleurosigma*) occurred in 3.

Thus the food of the "Merry Sole" is much more like that of the Flounder, than of the Dab and Sole, and its mouth and alimentary canal are of the small and narrow type which seems to go with a vegetarian diet, or at any rate a diet of small and soft organisms other than Crustacea.

#### ARNOGLOSSUS SP. (WALB.).

These are chiefly *A. laterna*. 288 specimens, preserved, were examined from the Young Fish Trawl, 1914, 3.5 to 22.5 mm. long. Nearly all the smaller specimens were from the early hauls (XIII to XXXVI). Most of the larger specimens being from the later hauls (XLII to LXXXIII). The alimentary canals of all the small specimens up to 8 mm. (except one ovum in a specimen of 5 mm.) were empty; one of 8.5 mm. contained *Pseudocalanus*, but with that single exception those measuring 8.5 to 10 mm. were empty. From 10.5 mm. to 22.5 mm. some specimens contained Copepods, but very many were empty. 241 out of 288 were empty, and of these 208 were from the early hauls in which only 3 contained anything, one of 5 mm. containing an ovum, and 2 specimens of 14 mm. in Haul XXXVI containing *Pseudocalanus*, which is the earliest appearance of a Copepod in any of the specimens. Twenty-five contained Copepods, 18 of which were *Pseudocalanus* (as many as 15 in one specimen 19.5 mm. long), one contained *Paracalanus parvus* and one *Euterpina acutifrons*. From this it seems that the smaller specimens do not eat Copepods and the larger specimens only eat the small species. Only a

very few diatoms occurred, *Paralia sulcata* once and *Navicula* spp. in the Copepod faeces. Here again we have with the small mouth and narrow gullet and stomach an absence of Crustacea food in the young and only small Copepods in the older forms.

#### RHOMBUS MAXIMUS L. TURBOT.

Two specimens were examined fresh from tow-nettings from within and outside the Breakwater in August, 11.5 and 14 mm. The first contained 15 *Temora longicornis*, the second 2 *Balanus nauplii* and 3 *Centropages typicus*. One preserved specimen (mounted) from the Young Fish Trawl was too much pigmented for the food to be distinguishable.

#### RHOMBUS LÆVIS RONDEL. BRILL.

Two specimens were examined fresh from the tow-nettings within and outside the Breakwater in July and August, 14 and 18 mm. long. The first contained Copepod remains indistinguishable, the second contained 7 *Temora longicornis*, 3 *Centropages typicus*, 3 *Brachyura* zoæ, 9 *Hippolyte* larvæ and a Nematode probably parasitic. Five preserved specimens from the Young Fish Trawl, 1914, were also examined, all of which contained *Podon* (cf. *intermedius*) and one also contained *Centropages*. Cunningham (1890) found that young Brill of 2.2 to 2.5 cm. ate the young Flounders of 12 mm. and he thinks that they probably naturally prey upon young fish at that stage, when they are nearly completely metamorphosed.

Both the young Turbot and Brill have a very large mouth with a thick gullet and wide stomach.

#### ZEUGOPTERUS PUNCTATUS (BL.).

Thirty-five specimens examined, preserved, from the Young Fish Trawl, 1914, 5 to 10.5 mm. long. The smallest contained ova, but at 6 mm. a specimen contained 4 adult *Temora longicornis*. They appear to feed very much like *Solea*, 23 contained *Temora*, 10 contained *Euterpina acutifrons*, 2 contained *Onceea* (cf. *media*). *Calanus finmarchicus* occurred in one and *Metridia lucens* in one. Ova were frequent. A good many of the Copepod remains were indistinguishable.

#### ZEUGOPTERUS UNIMACULATUS (Risso).

Fifteen specimens, preserved, were examined from the Young Fish Trawl, 1914, 4.5 to 9.5 mm. long. The food content was not easily seen.

but all except 2 contained Crustacea. One of 4.5 mm. contained remains of Crustacea but indistinguishable. *Temora longicornis* occurred in 3, *Euterpina acutifrons* in one, *Podon* (cf. *intermedius*) in 3. *Paracalanus parvus* and *Pseudocalanus elongatus* occurred in one specimen.

These two *Zeugopterus* have large mouths and short and thick gullets and the food is much like *Solea* and *Pleuronectes limanda*.

#### SCOPHTHALMUS NORVEGICUS (GTHR.).

404 specimens, preserved, were examined from the Young Fish Trawl, 1914, 3.5 to 12 mm. long. There were only 2 of 12 mm. and neither of them contained any food. Thirty-six contained nothing, 34 contained ova only, two were indistinguishable and the rest contained Crustacea, chiefly Copepods, *Podon* occurring in several. Copepod remains which were indistinguishable were in 55 specimens of all sizes. The smallest (3.5 mm.) contained Copepod remains (probably *Pseudocalanus*) so as *Scophthalmus norvegicus* hatches at about 2.5 mm. it must take Copepod food almost directly. A specimen 4.5 mm. long contained a *Metridia lucens* 2 mm. long. One of 4 mm. contained a *Paracalanus parvus*, so there is no evidence that the smaller specimens eat anything different from the larger specimens, the same sort of food being found in all of them in these samples. A very few contained diatoms (*Paralia sulcata* and *Navicula* sp.), which very likely come from the alimentary canal of the Copepods. One specimen of 4 mm., which contained Copepod remains, contained also *Peridinium ovatum*, *Prorocentrum micans* and remains of other Peridinians. One contained *Tintinnopsis ventricosa*. Spores occurred once. Much more food was found in the specimens from Hauls X to XVI and little food in those from the later hauls.

Ova occurred in 34 specimens without anything else and in 65 specimens altogether. They are more abundant from the later hauls. Apparently when many Copepods are eaten these are not taken so much. All sizes eat them, but they are commonest in the smaller specimens of from 4 to 5.5 mm.

Copepods are evidently the favourite food and are found in 334 specimens. The favourite is certainly *Pseudocalanus elongatus*, which occurs in 158 specimens, as many as 6 at once and in all sizes from 4 to 11.5 mm., one of 3.5 mm. probably containing it also. It is very abundant, especially from Hauls X to XVI, absent from XVIII to XXVI.

The next favourite is *Metridia lucens*, which occurs in 75 specimens, up to 3 in one specimen, in all sizes from 4.5 mm. upwards, in the same hauls as *Pseudocalanus elongatus*. Next come *Acartia* (cf. *Clausii*) in 49, *Oncœa* (cf. *media*) in 26, *Paracalanus parvus* in 25, *Euterpina acutifrons*

in 20, *Temora longicornis* in 6 only, and *Temora nauplii* in 4. *Calanus finmarchicus* (juv.) in 2 and *Corycæus anglicus* in one.

It is thus seen that a variety of Copepods is taken, but *Pseudocalanus* markedly predominates.

Seventy-one specimens were in Haul X and these contain almost entirely Copepods, chiefly *Pseudocalanus* and *Metridia*, *Acartia* also being fairly frequent. *Euterpina* and *Oncaea* not common and *Podon* occurs a few times, *Temora* only once. Comparing this with *Solea variegata* from the same haul we find *Solea* has chiefly eaten *Temora* and *Podon*, so that selection of food must take place. It is the same in Hauls XI, XII and XIII. In XIII *Pleuronectes limanda* has also selected chiefly *Podon* and a few *Temora*. In Haul XVII large Copepods seem rare and in XXIII the fish have eaten little.

#### GADIDÆ.

The Whiting, *Gadus merlangus*, is the commonest gadoid in the tow-nettings, the Pouting, *G. luscus*, coming next. From the Young Fish Trawl a number of *G. merlangus* and *G. minutus* were examined, the Whiting not showing the food well in the preserved material. *Pseudocalanus* appears to be the favourite food of all the post-larval gadoids except the very young specimens.

#### GADUS MORRHUA L. COD.

Only one specimen from inside the Breakwater, fresh from the tow-nettings in May, 19 mm. This contained one *Calanus finmarchicus* and one *Temora longicornis*.

#### GADUS MERLANGUS L. WHITING.

Twenty-seven specimens examined fresh from the tow-nettings, April to July, from both inside and outside the Breakwater, from 4 to 34 mm. The first obtained on April 2nd and 4th were 4 mm. long; one had nothing inside, the other had 2 nauplii of *Calanus finmarchicus* and one *Coscinodiscus Granii*; one of 2.5 mm. ca. contained no food, but one of 3 mm. contained Copepod remains. The rest, excepting 3 which were empty, contained Copepod remains, of which 11 contained *Pseudocalanus elongatus* (from 1 to 3), 2 contained *Paracalanus parvus* and the rest were indistinguishable. The specimen of 34 mm. contained indistinguishable Copepods.

At 4 mm. nauplii are eaten and at 5 mm. full-sized *Pseudocalanus*.

171 preserved specimens from the Young Fish Trawl, 1914, were also

examined, but the contents were very difficult to identify. Size 6 to 11.5 mm., 49 contained nothing, 7 contained only ova, 2 contained *Evadne*, and the remainder contained Copepods. Except one *Oncaea*, all those identified were *Pseudocalanus*, and those not identified were probably *Pseudocalanus*.

#### GADUS LUSCUS L. POUTING.

Sixteen small specimens were examined fresh from the tow-nettings from both within and outside the Breakwater, from January to April, 1.5 to 7 mm. long. In October 2 more were obtained and one in November. The yolk sac was present in those up to 2.5 mm., and these contained no food, 2 of 3 mm. contained nothing, 2 contained green food remains and one (from the region of the Knap Buoy) contained a *Coscinodiscus* and a *Coccosphaera* sp. (cf. *atlantica*) in perfect condition. In October one of 4 mm. contained a *Pseudocalanus elongatus* and one of 7 mm. contained 2 *Pseudocalanus*, one *Acartia clausi* and one live *Calanus finmarchicus* just swallowed, with its tail sticking out of the mouth, apparently having been caught after the fish had been captured.

From the small amount of material available it would appear that the character of the food is changed at about 4 mm., those of a smaller size eating microscopic food and after that changing to a Copepod diet.

#### GADUS POLLACHIUS L. POLLACK.

Eleven preserved specimens from the Young Fish Trawl, 1914, were examined, 5.5 to 24 mm. The smallest contained Copepod remains, 2 contained nothing and the rest Copepods mostly indistinguishable, but 3 contained *Acartia* (cf. *clausi*) and one *Temora longicornis* and *Euterpina acutifrons*.

#### GADUS MINUTUS O. F. MÜLL. BIB.

140 preserved specimens from the Young Fish Trawl, 1914, were examined, from 6 to 14 mm. Of these 4 contained nothing, one contained ova, one a *Dinophysis* sp. and all the rest contained Copepods, 6 of which were indistinguishable, but all the rest contained *Pseudocalanus elongatus*. *Podon*, *Acartia*, *Euterpina* and *Metridia* each occurred once with *Pseudocalanus*. It is quite evident that *Pseudocalanus* is the favourite food of *Gadus minutus* and it occurs in those of all sizes examined.

## ONOS MUSTELA L. ROCKLING.

Thirteen fresh specimens from the tow-nettings were examined, from both inside and outside the Breakwater, from 2 to 26 mm. long, from March to August. The small ones below 3 mm. had a yolk sac and contained no food, but in one of 3 mm. 2 *Temora* nauplii were present. One of 5 mm. contained ova and one of 5.5 mm. *Temora* nauplii, 2 of the others contained nothing and the rest contained indistinguishable Copepod remains.

## AMMODYTES TOBIANUS L. LESSER SAND EEL.

Twelve specimens were examined fresh from the tow-nettings from both inside and outside the Breakwater, from 4.5 to 6.5 mm. from February to March and again in October. The smallest contained no food, but those from 5 mm., except one which was empty, all contained green food remains.

## AMMODYTES LANCEOLATUS LESAUR. LARGER LAUNCE.

Thirty specimens were examined fresh from the tow-nettings from both inside and outside the Breakwater, from 7 to 14 mm., from July to October. Twenty-one contained no food, one of 8 mm. contained green food remains, the rest contained Copepods, 4 indistinguishable, *Acartia clausi*, *Pseudocalanus elongatus*, *Oithona* sp. and Copepod nauplii being recognized. One of 10 mm. contained Copepod nauplii and 5 *Rhizosolenia Shrubsolei*, the only time that diatom was seen in a fish.

## GASTEROSTEUS SPINACHIA L. 15-SPINED STICKLEBACK.

Three 15-spined Sticklebacks were examined fresh from the tow-nettings, from among *Zostera*, both inside and outside the Breakwater in August and September, 7.5 to 8.5 mm. Two contained no food, the other contained remains of Amphipods and many Harpacticids.

## SYNGNATHUS ACUS L. GREATER PIPE FISH.

Five specimens were examined fresh from the tow-nettings from among the *Zostera* from both inside and outside the Breakwater, August to October, 2.5 to 6.5 cm. long. One contained nothing, one contained remains of *Temora* nauplii and *Pseudocalanus elongatus*, one contained 9 *Centropages typicus*, one contained many *Pseudocalanus*, one *Temora*,



2 *Acartia Clausi*, one *Corycæus anglicus* and the remains of *Centropages typicus*, the last contained 2 *Temora*, 4 *Centropages typicus*, many *Pseudocalanus* and 2 *Paracalanus parvus*.

#### SYGNATHUS ROSTELLATUS NILSS.

Three specimens examined fresh from the tow-nettings, from among *Zostera*, both inside and outside the Breakwater, August and September, 4.5 to 10.5 cm. Two contained remains of Decapods, the third contained 3 crab zoeæ, one *Acartia* sp., 8 *Pseudocalanus elongatus* and other Crustacea remains.

#### NEROPHIS LUMBRICIFORMIS YARR.

Three specimens examined fresh from the tow-nettings from both inside and outside the Breakwater, August and October, 10 to 40 mm. 2 contained nothing, the third a young Copepod and 3 Copepod nauplii.

The young begin to feed almost at once. A male with eggs from Wembury was put in a glass jar and kept at a uniform temperature by immersing in a tank and the eggs hatched. Plankton was given at once, and after the first day, when a large yolk sac was present, the little fish ate *Halosphaera viridis*, larval Mollusks and small Copepods.

#### CLUPEA HARENGUS L.

1795 larval and post-larval Herrings were examined fresh from the tow-nettings, from both inside and outside the Breakwater, from January to March and again in October, measuring 5.5 to 18 mm. The yolk sac was present in all those from 5.5 to 8 mm., but it may remain up to 12 mm. in exceptional cases. However, even with the yolk present, from 7 mm. food may be taken. The yolk seems to stay longer in some lots, as though there were a shortage of food in certain areas with a consequent lengthening of time in keeping the yolk. The smallest specimen with any food inside measured 7 mm., and that was only green food remains. At 8 mm. Harpacticids may be taken and larval Mollusks.

On January 30th, 589 specimens from 7 to 12 mm. (mostly 7 to 10 mm.) were taken and all of these, except one of 12 mm., contained no food, the exception containing one *Euterpina acutifrons*. Those measuring from 7 to 10 mm. all had the yolk sac still present. On February 1st another lot of 431, measuring from 8 to 10 mm. all had the yolk sac still present except one of 10 mm., but 35 contained food, 16 of these containing larval gastropods, 2 larval bivalves, 12 green food remains, one a Harpacticid, one a Copepod nauplius, one 2 Peridinians (*Prorocentrum micans* and

*Gonyaulax spinifera*), one a diatom (*Paralia sulcata*). Green food remains are in the smallest, then larval Mollusks, Copepods coming next. On February 6th, 120 specimens taken are much like the last, even those 11 mm. long. Most of them contain no food, but green food, larval gastropods, larval bivalves, *Temora* nauplii, ova and Harpacticids were present. On February 9th it is the same sort of thing, but on February 13th, when evidently the *Balanus* nauplii had just appeared, they were taken by several of the young herring. Out of 234 specimens from 7 to 12.5 mm. long, most of those above 8 mm. had lost the yolk, 46 contained *Balanus nauplii*, 2 contained *Pseudocalanus elongatus*, 4 contained *Euterpina acutifrons*, one contained *Oithona similis*, several contained larval gastropods, larval bivalves and green food remains. It seems that with the coming of abundance of food the yolk sac disappears much earlier. On February 22nd *Balanus* nauplii were again frequently eaten, *Oncaea* sp. once, *Evadne Nordmanni* once (peculiarly early for this Cladoceran). Up to March 15th the same kind of food is present and then the Herrings stop, not appearing again until October 17th, when from that date to the middle of December they were caught in small numbers measuring from 8 to 18 mm. but not containing any food.

The earliest caught Herring, January 10th to 23rd, were further advanced than those taken late in January and early in February. Several from 9.5 to 13 mm. containing *Euterpina acutifrons*, *Pseudocalanus elongatus* (one of 12 mm. containing 5 *Pseudocalanus*), *Oithona similis*, *Corycaeus anglicus* and Copepod nauplii, *Pseudocalanus* being the most frequent.

A few contained sand grains, others diatoms amongst which were *Campylodiscus* sp., *Hyalodiscus stelliger*, *Coscinodiscus* sp. and *Paralia sulcata*. The flagellate *Halosphaera viridis* was contained in 3, and possibly spherical bodies sometimes present are *Halosphaera*. The frequent presence of sand grains and the character of the diatoms, which are all bottom forms although often present in the plankton, suggests that the young herring sometimes feeds on the bottom.

From the above records it is seen that the larval herring eats before the yolk sac has gone, the earliest food being green food, afterwards larval Mollusks, both gastropods and bivalves, small Copepods and Copepod nauplii, *Balanus* nauplii and occasional diatoms and *Halosphaera viridis*. This agrees well with records by H. A. Meyer (1880) when feeding young Herring reared artificially. He found the greenish matter, larval gastropods and bivalves, Copepods and nauplii, the Copepod diet increasing as the fish grew. McIntosh (1889) has also noticed the green food remains in the very young Herring.

## CLUPEA SPRATTUS L.

164 specimens were examined fresh from the tow-nettings, from both inside and outside the Breakwater, from January to May and from July to November, the bulk from January to April, measuring 3 to 27 mm. Those from 3 to 4 mm. have no eye pigment, a large yolk sac and no food. From 4.5 mm. the eye is pigmented and, although yolk may still be

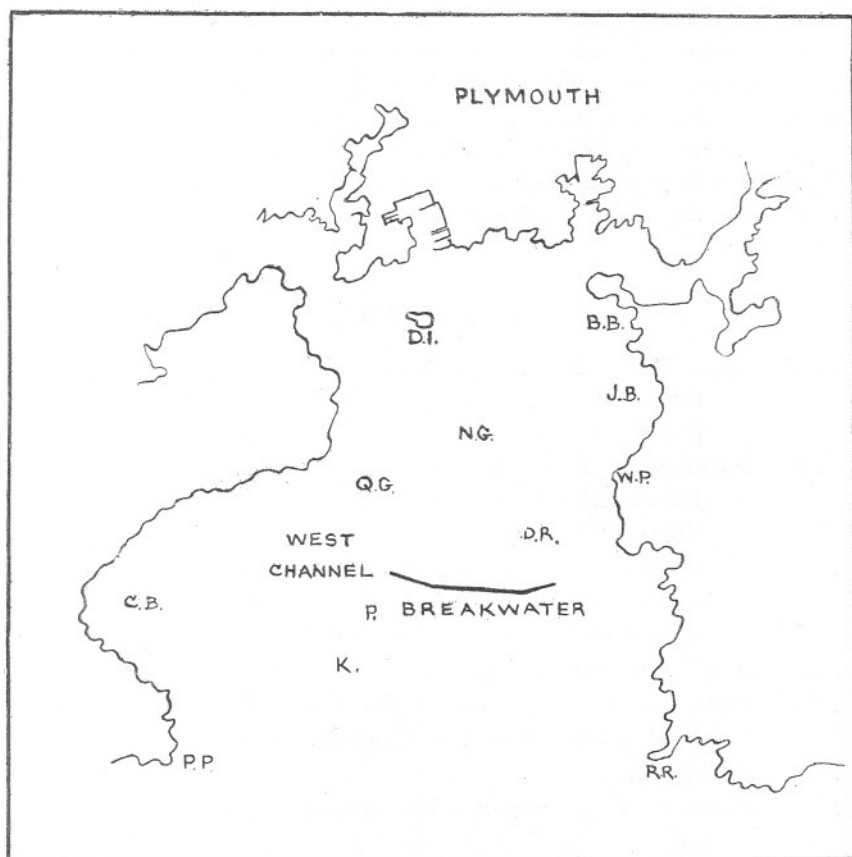


FIG. 7.—Plan of Plymouth Sound. B B=Batten Bay. C B=Cawsand Bay. D I=Drake's Island. D R=Duke's Rocks. J B=Jennycliff Bay. K=Knap Buoy. N G=New Grounds. Q G=Queen's Grounds. P=Panther Buoy. P P=Penlee Point. R R=Reny Rocks. W P=White Patch.

present, green food remains occur and also in the larger specimens. A spherical body which may be *Halosphaera* was present in one. From 4.5 mm. and upwards the yolk sac disappears, but green food remains are still present, probably from diatoms, as 6 *Thalassiothrix nitzschoides* were present in one of 5 mm. Not until July, in a specimen of 8 mm., is any crustacean food present, and this specimen contained 2 *Temora nauplii*

in addition to green food remains. On October 3rd a specimen of 27 mm. contained 2 *Pseudocalanus elongatus*.

It thus appears that green vegetable food is taken chiefly, although at 8 mm. small Crustacea may be eaten. An examination of preserved material showed poor results, although *Pseudocalanus* was present in a few specimens and also larval Mollusks. A. Scott (1906) records *Pseudocalanus elongatus* from 2 Sprats of 15 mm., so it is evidently a favourite food of the larval Sprat.

The tow-nettings were taken with ordinary coarse and medium nets, and sometimes with a bigger net, which although not giving much better results, caught the fish from the *Zostera*, which evidently were feeding there. These included *Rhamphistoma belone*, various pipe fish and *Cyclopterus lumpus*. A small plan is given showing the various localities from which the tow-nettings were taken. (Fig. 7.)

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

Date.	Locality.	Fish.	No.	Size in mm.	Food present.
Jan., 1917					
10]	West end of Break-water ]	<i>Clupea harengus</i>	15	9.5-11.5	<i>Oithona similis</i> , <i>Pseudocalanus elongatus</i> , <i>Euterpina acutifrons</i> , Copepod nauplii, larval bivalves.
	Knap	"	8	11-12	<i>Pseudocalanus elongatus</i> , <i>Euterpina acutifrons</i> , <i>Corycaeus anglicus</i> , young Harpacticids.
16	Off White Patch	"	2	10.5-11	<i>Pseudocalanus elongatus</i> .
	West end of Break-water	<i>Gadus luscus</i>	1	7	<i>Pseudocalanus elongatus</i> .
	West Channel	<i>Clupea harengus</i> ]	5	11.5-12	No food.
	Knap	"	4	10-12	<i>Pseudocalanus elongatus</i> .
	Knap	"	2	5.5-12	No food.
18	West Channel	"	10	5.5-13	<i>Pseudocalanus elongatus</i> .
	Off White Patch	"	3	5.5-12	<i>Oithona similis</i> .
	Breakwater	<i>Clupea sprattus</i>	1	3.5	No food.
	New Grounds	<i>Clupea harengus</i>	5	9-14	Copepod remains.
	Knap	"	14	6-13	<i>Pseudocalanus elongatus</i> , Harpacticids, Copepod nauplii.
	Knap	"	4	10-13	<i>Pseudocalanus elongatus</i> , <i>Oithona similis</i> , <i>Euterpina acutifrons</i> .
		<i>Clupea sprattus</i>	5	3.5-3.6	No food.
23	Batten Bay	<i>Gadus luscus</i>	1	4	"
	Off White Patch	<i>Clupea harengus</i>	1	11.5	"
	Inside Breakwater	"	2	9-12	"
	Inside Breakwater	"	2	11	"

Date.	Locality.	Fish.	No.	Size in mm.	Food present.	
Jan. 30]	Inside Breakwater	<i>Clupea harengus</i>	205	7-12	<i>Euterpina acutifrons</i> .	
		<i>Clupea sprattus</i>	1	4-4.5	No food.	
	Off White Patch	"	7	3-6	Green food remains.	
	Jennycliff Bay	<i>Clupea harengus</i>	112	7-10.5	No food.	
	West Channel	"	41	7-10.5	"	
Feb. 1	West Channel	<i>Clupea sprattus</i>	5	4-5	Green food remains.	
		<i>Clupea harengus</i>	147	8-10	Larval gastropods, green food remains.	
	Off White Patch	<i>Clupea sprattus</i>	3	3.2-5.5	No food.	
		"	2	4	"	
		<i>Clupea harengus</i>	284	8-11	Green food remains, larval gastropods, larval bivalves, <i>Paralia sulcata</i> , Harpacticids, <i>Prorocentrum micans</i> , <i>Gonyaulax spinijera</i> , Copepod nauplius.	
	6	Jennycliff Bay	"	41	9-12	Larval gastropods, <i>Temora</i> nauplius.
	Batten Bay	"	29	9-11	Larval gastropods	
	Middle of Breakwater	<i>Clupea sprattus</i>	1	3-5	No food.	
		<i>Clupea harengus</i>	16	9-12	Larval gastropods.	
	Breakwater	"	34	10-12	Green food remains, larval gastropods, <i>Temora</i> nauplii.	
9	New Grounds	"	79	7-10	Green food remains, larval gastropods.	
	White Patch	<i>Cottus bubalis</i>	1	5	No food.	
		<i>Clupea harengus</i>	54	7-10	Larval gastropods, ova, green food remains.	
	Jennycliff Bay	<i>Clupea sprattus</i>	3	4	No food.	
13	West Channel	<i>Clupea harengus</i>	45	8-10	Larval gastropods, ova.	
		"	56	7-12.5	<i>Pseudocalanus elongatus</i> , <i>Euterpina acutifrons</i> , Copepod remains, <i>Balanus</i> nauplii, green food remains, larval gastropods, larval bivalves, <i>Halosphæra viridis</i> , <i>Coscinodiscus radiatus</i> .	
	Breakwater	<i>Clupea sprattus</i>	4	4.5-5	Green food remains.	
		"	1	5.5	" " "	
		<i>Clupea harengus</i>	60	7-11.5	Green food remains, <i>Balanus</i> nauplii, larval gastropods, larval bivalves, <i>Campylodiscus</i> sp.	
	Off White Patch	"	30	8-11	<i>Balanus</i> nauplii, larval bivalves, ova, green food remains.	
	Jennycliff		<i>Clupea sprattus</i>	1	3-5	No food.
			<i>Cottus bubalis</i>	1	5	Crustacea remains.
			<i>Gobius</i> sp.	1	3-5	No food.
			<i>Clupea harengus</i>	88	8-12	Green food remains, <i>Balanus</i> nauplii, ova, larval gastropods, larval bivalves, <i>Euterpina acutifrons</i> , <i>Hyalodiscus stelliger</i> .
<i>Clupea sprattus</i>			1	4-5	No food.	

Date.	Locality.	Fish.	No.	Size in mm.	Food present.	
Feb.	Off White Patch Duke's Rock Jennycliff Bay New Grounds	<i>Clupea harengus</i>	6	10-12.5	<i>Balanus</i> nauplii.	
		"	20	9-12.5	<i>Balanus</i> nauplii, ova.	
		"	2	11	No food.	
		"	19	8.5-14	<i>Balanus</i> nauplii, Copepod nauplii, larval gastropods.	
22	Knap	"	35	9-12	Green food remains, larval gastropods, larval bivalves, <i>Balanus</i> nauplii, <i>Oncoea</i> sp., <i>Coscinodiscus</i> sp., <i>Hyalodiscus stelliger</i> .	
		<i>Clupea sprattus</i>	4	4.5-5	Green food remains.	
	Panther	<i>Agonus cataphractus</i>	1	8.5	No food.	
		<i>Clupea harengus</i>	32	8-10	Green food remains, <i>Balanus</i> nauplii, larval gastropods, larval bivalves.	
		<i>Clupea sprattus</i>	1	5	Green food remains.	
	Penlee	"	1	5	No food.	
		<i>Clupea harengus</i>	12	8-10.5	<i>Balanus</i> nauplii, larval gastropods, <i>Evadne nordmanni</i> .	
	Cawsand	"	8	10-13.5	<i>Balanus</i> nauplii, larval bivalves, <i>Halosphæra viridis</i> .	
	27	Panther	<i>Clupea harengus</i>	2	8.5-10	<i>Balanus</i> nauplii, green food remains.
			<i>Clupea sprattus</i>	8	3.5-5	Green food remains.
Breakwater		<i>Cottus bubalis</i>	1	5	<i>Balanus</i> nauplii.	
		<i>Clupea sprattus</i>	5	3-5	Green food remains.	
Off White Patch		<i>Ammodytes tobianus</i>	2	4.5	No food.	
		<i>Clupea harengus</i>	1	8.5	"	
March.		Off White Patch	<i>Clupea sprattus</i>	5	3-5	Green food remains.
			<i>Gobius</i> sp.	1	3.5	" " "
1		Off White Patch	<i>Clupea sprattus</i>	1	5	Green food remains.
			"	1	3.5	No food.
	Breakwater	<i>Clupea harengus</i>	1	10	"	
		<i>Clupea sprattus</i>	2	4	"	
	Knap	<i>Ammodytes tobianus</i>	1	4.5	Green food remains.	
		<i>Clupea harengus</i>	1	6	No food.	
	Panther	<i>Clupea sprattus</i>	4	4.5	"	
		"	1	5	Green food remains.	
	Batten Bay	<i>Clupea harengus</i>	1	9	No food.	
		<i>Clupea sprattus</i>	3	5	Green food remains.	
12	Breakwater	<i>Cyclogaster Montagu</i>	1	4 ca.	Crustacea remains.	
		<i>Ammodytes tobianus</i>	2	4.5-5.5	Green food remains.	
	Knap-Penlee	<i>Cottus bubalis</i>	2	4.5	No food.	
		<i>Clupea harengus</i>	1	11	<i>Balanus</i> nauplii, larval bivalve.	
	West Channel	<i>Clupea sprattus</i>	5	3-5.5	Green food remains.	
		<i>Ammodytes tobianus</i>	1	4.5	" " "	
	Off White Patch	"	1	4.5	" " "	
		"	1	5	" " "	
		<i>Cottus bubalis</i>	1	5	" " "	
	15	Panther	<i>Ammodytes tobianus</i>	1	5.5	" " "
<i>Cottus bubalis</i>			1	4.5	" " "	
Knap		<i>Clupea harengus</i>	3	10.5-11	No food.	
		<i>Gobius</i> sp.	2	2.5-3	"	
Knap		<i>Callionymus lyra</i>	1	2 ca.	"	
		<i>Cottus bubalis</i>	3	5	<i>Balanus</i> nauplii.	
		<i>Gobius</i> sp.	5	3-3.5	No food.	
		<i>Ammodytes tobianus</i>	1	5.5	"	
		<i>Clupea sprattus</i>	1	3.6	"	

Date.

March.	Locality.	Fish.	No.	Size in mm.	Food present.
15	Off White Patch	Clupea sprattus	1	4	No food.
		Cottus bubalis	3	5-5.5	<i>Balanus</i> nauplii, Crustacea remains.
		Gobius sp.	1	4	No food.
	Breakwater	Ammodytes tobianus	1	6.5	Green food remains.
		Clupea sprattus	1	9	No food.
19	Off White Patch	"	1	3	"
		Cottus bubalis	1	5 ca.	<i>Balanus</i> nauplii.
	New Grounds	Clupea sprattus	10	3.5-7	Green food remains.
		Callionymus lyra	3	1.5	No food.
		Gadus luscus	7	2-3	Green food remains.
	Breakwater	"	1	2.5	No food.
		Clupea sprattus	1	4.5	"
27	Breakwater	"	5	4.5-7	Green food remains.
		Onos mustela	1	2.5	No food.
30	New Grounds	Clupea sprattus	10	4-6	Green food remains.
		Agonus cataphractus	1	7	<i>Coscinodiscus excentricus</i> .
		Gadus luscus	1	1.5	No food.
		Callionymus lyra	1	2 ca.	<i>Paralia sulcata</i> , <i>Coscinodiscus excentricus</i> .
	Breakwater	Clupea sprattus	19	4-6.5	Green food remains.
		Gadus luscus	2	1.5-2	No food.
		Gobius sp.	5	2-3	Green food remains, larval bivalve, <i>Coscinodiscus</i> sp.
		Cottus bubalis	5	4.5-5	<i>Balanus</i> nauplii, <i>Biddulphia regia</i> , <i>Biddulphia</i> sp., <i>Coscinodiscus Granii</i> , larval gastropods, <i>Coscinodiscus radiatus</i> , <i>Thalassiosira gravida</i> , Copepod remains.
		Callionymus lyra	1	1.5	<i>Coscinodiscus</i> sp.
		Onos mustela	1	2.5	No food.
April.		Clupea sprattus	2	4.5-5	Green food remains.
2	Knap	Callionymus lyra	2	2.5	Green food remains, <i>Navicula</i> sp., <i>Pleurosigma</i> sp., <i>Coscinodiscus</i> sp.
		Cyclogaster Montagu	1	4.5	No food.
		Gadus merlangus	1	4	"
		Gadus luscus	1	3	<i>Coccosphaera</i> sp. (cf. <i>atlantica</i> ), <i>Coscinodiscus</i> sp.
4	Breakwater	Clupea sprattus	9	4.5-6	Green food remains.
		Gadus merlangus	1	4 ca.	Nauplii of <i>Calanus finmarchicus</i> , <i>Coscinodiscus Granii</i> .
		Cyclogaster Montagu	1	3.5	No food.
12	Queen's Grounds	Gobius sp.	2	3.5-4	<i>Balanus</i> nauplii.
		Clupea sprattus	1	5.5	Green food remains.
		Callionymus lyra	1	2.5	No food.
		Zeugopterus (?) sp.	1	7	"
	Duke's Rock	Gobius sp.	3	2.5-3.5	Green food remains.
		Gadus merlangus	2	2.5-5	<i>Pseudocalanus elongatus</i> .
		Callionymus lyra	1	1.5 ca.	No food.
		Cyclogaster Montagu	1	4	Brownish food remains.
18	N.E. of Drake's Island	Callionymus lyra	1	3.6	No food.
		Clupea sprattus	1	7	"



Date.	Locality.	Fish.	No.	Size in mm.	Food present.
April 23	Breakwater	<i>Gadus merlangus</i>	3	7.5-9	<i>Pseudocalanus elongatus</i> and eggs.
	Duke's Rock	<i>Cottus bubalis</i>	1	10	Nothing.
		<i>Callionymus lyra</i>	4	3.5-5	Copepod nauplii.
		<i>Gadus merlangus</i>	3	8-8.5	<i>Paracalanus parvus</i> .
		<i>Onos mustela</i>	1	4.5	Copepod nauplii remains.
	West Channel	<i>Cottus bubalis</i>	1	7	<i>Temora longicornis</i> .
		<i>Pleuronectes microcephalus</i>	1	4	No food.
25	Knap	<i>Onos mustela</i>	1	3.5	"
		<i>Gadus merlangus</i>	1	7.5	<i>Pseudocalanus elongatus</i> and eggs.
30	Knap	<i>Callionymus lyra</i>	2	3-4	No food.
	S. of Knap	"	1	4.5	"
May 4	West of Breakwater	<i>Gadus merlangus</i>	2	10-11	<i>Pseudocalanus elongatus</i> .
10	Cawsand Bay	"	2	6-12	"
		<i>Gobius</i> sp.	1	2.5	No food.
		<i>Callionymus lyra</i>	4	2-3.5	Copepod remains.
	Inner Knap	"	5	2.5-5.5	"
		<i>Gadus merlangus</i>	7	3-14	<i>Pseudocalanus elongatus</i> , Copepod remains.
		<i>Pleuronectes flesus</i>	1	8.5	No food.
24	Breakwater	<i>Clupea sprattus</i>	1	24.5	"
		<i>Gadus morrhua</i>	1	19	<i>Calanus finmarchicus</i> , <i>Temora longicornis</i> .
		<i>Gadus merlangus</i>	3	6-7.5	Copepod remains.
		<i>Onos mustela</i>	3	5-11	Copepod remains, ova.
		<i>Callionymus lyra</i>	2	3	No food.
	West Channel	"	2	4	"
31	Breakwater	<i>Pleuronectes flesus</i>	1	10.5	<i>Phæocystis</i> spores.
	Knap	<i>Gobius</i> sp.	1	4	No food.
June 7	Off Reny Rocks	<i>Callionymus lyra</i>	1	5	No food.
12	Knap	"	1	7	"
	Breakwater	"	1	5.5	"
	West Channel	<i>Trigla gurnardus</i>	1	8	<i>Podon intermedius</i> .
		<i>Gobius</i> sp.	1	5	No food.
		<i>Labrus bergylta</i>	2	2.5	"
July 2	Knap	<i>Callionymus lyra</i>	1	3	<i>Euterpina acutifrons</i> .
		<i>Clupea sprattus</i>	1	5	No food.
	Panther	<i>Lophius piscatorius</i>	1	8.5	"
4	W. End of Breakwater	<i>Clupea sprattus</i>	1	7	"
9	Off White Patch	<i>Gobius minutus</i>	10	3.5-8	Nauplius of <i>Temora longicornis</i> .
		<i>Callionymus lyra</i>	2	2.5-4	No food.
		<i>Ammodytes lanceolatus</i>	1	10	Copepod nauplii, <i>Rhizosolenia shrubsolei</i> .
	West end of Breakwater	"	1	7.5	No food.
	Knap	<i>Gobius minutus</i>	1	6	Copepod remains.
		"	2	6-6.5	<i>Pseudocalanus elongatus</i> , Copepod remains.
11	White Patch	<i>Callionymus lyra</i>	1	3	No food.

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6 fish.

Date.	Locality.	Fish.	No.	Size in mm.	Food present.
July 11	White Patch	Labrus bergylta	1	6	<i>Cittarocyclus denticulata</i> , <i>Temora longicornis</i> , <i>Euterpina acutifrons</i> , Copepod indet., <i>Pro-</i> <i>rocentrum micans</i> , <i>Peridinium</i> sp., <i>Litho-</i> <i>melissa setosa</i> , <i>Tintin-</i> <i>nopsis beroidea</i> .
	Knap	Callionymus lyra	2	7	<i>Balanus</i> nauplii.
23	Breakwater	Rhombus lævis	1	18	<i>Temora longicornis</i> , <i>Centropages typicus</i> . <i>Brachyura zoëa</i> , <i>Hip-</i> <i>polyte</i> larvæ.
		Rhamphistoma belone	13	10-28	Green and brown food remains, <i>Harpacticus</i> <i>uniremis</i> , <i>Pleurosigma</i> sp. ova.
	Off White Patch	Onos mustela	3	15-26	Copepod remains.
	Panther	Gadus merlangus	1	34	" "
		Rhamphistoma belone	2	12-17	Green food remains, <i>Harpacticus uniremis</i> .
		Cyclopterus lumpus	1	15	Amphipod remains, <i>Harpacticus uniremis</i> .
25	Panther	Clupea sprattus	1	5	No food.
		Gobius minutus	1	6	<i>Calanus</i> nauplii.
		Labrus bergylta	1	4.5	<i>Temora</i> nauplii, <i>Navic-</i> <i>ula</i> sp. Peridinian remains.
27	Knap	Lophius piscatorius	5	4-5	Copepod remains.
		Labrus bergylta	1	3	Green food remains.
		Onos mustela	1	3 ca.	<i>Temora</i> nauplii.
	Off White Patch	Scomber scomber	3	3.5-4.5	Green food remains.
		Labrus bergylta	3	2.5-4	<i>Temora</i> nauplii.
		Callionymus lyra	2	3-8	No food.
		Gobius minutus	1	4	Copepod nauplius re- mains.
	Breakwater	Labrus bergylta	2	2.5	Green food remains.
		Lepadogaster Candollei	1	4	No food.
30	Knap	"	2	4.5-6	Copepod remains.
		Labrus bergylta	14	4-6	Green food remains, Copepod and Copepod nauplii remains.
		Callionymus lyra	1	8	Copepod remains.
		Onos mustela	1	6.5	" "
		Scomber scomber	3	5-7	Brown and green food remains, Copepod nauplii.
	Panther	Scomber scomber	2	3-5	Brown and green food remains, Copepod nauplii.
		Labrus bergylta	7	4-6	Green food and Copepod nauplii remains.
		Onos mustela	1	6.5	Copepod remains.
		Callionymus lyra	1	7	" "
August.					
1	Knap	Labrus bergylta	2	5	Copepod nauplii.
	Panther	"	2	4-6	Young <i>Temora longi-</i> <i>cornis</i> and <i>Temora</i> nauplii.
		Scomber scomber	1	7	<i>Temora</i> nauplii.
7	Panther	Onos mustela	1	5.5	Young <i>Temora longi-</i> <i>cornis</i> .

Date.	Locality.	Fish.	No.	Size in mm.	Food present.
August 10	Knap	Syngnathus acus	1	25	<i>Temora</i> nauplius remains, <i>Pseudocalanus elongatus</i> .
		<i>Scomber scomber</i>	4	3-4	Green food remains, Copepod nauplii, larval gastropods.
		<i>Labrus bergylta</i>	1	7	<i>Pseudocalanus elongatus</i> .
		<i>Lepadogaster gouani</i>	4	4-5.5	Copepod nauplii, Harpacticids indet.
		<i>Lepadogaster Candollei</i>	3	5-6.5	Young <i>Temora longicornis</i> , Copepod nauplius remains, Harpacticids indet.
	Panther	<i>Labrus bergylta</i>	1	7	<i>Temora longicornis</i> .
		<i>Cyclopterus lumpus</i>	1	18	Larval <i>Eupagurus</i> , Decapod larvæ remains.
13	West Channel	<i>Lepadogaster Candollei</i>	1	7.5	Copepod remains.
		<i>Gobius</i> sp.	1	11	Remains of diatoms, <i>Skeletonema costatum</i> .
	Breakwater	"	3	12-13	Green food remains.
14	West End of Breakwater	"	2	12	<i>Temora longicornis</i> , <i>Balanus</i> nauplius.
		<i>Lepadogaster Candollei</i>	1	8	Copepod remains.
		<i>Blennius gattorugine</i>	1	22	Remains of crab zoëa and Crangon larvæ.
15	Breakwater	<i>Gobius</i> sp.	1	11	No food.
		<i>Gobius minutus</i>	1	7	<i>Pseudocalanus elongatus</i> .
20	Breakwater	<i>Labrax bergylta</i>	1	7.5	<i>Podon intermedius</i> , young <i>Temora longicornis</i> , <i>Temora</i> nauplii.
		<i>Lepadogaster Candollei</i>	1	4	Young <i>Temora longicornis</i> .
		<i>Scomber scomber</i>	6	3.5-8.5	<i>Temora</i> nauplii, Copepod remains.
		<i>Nerophis lumbriciformis</i>	1	10.5	Young Copepods, Copepod nauplii.
	Panther	<i>Rhamphistoma belone</i>	1	29	No food.
		<i>Syngnathus rostellatus</i>	1	105	Decapod larvæ remains.
		<i>Rhombus lævis</i>	1	14	Copepod remains.
		<i>Gobius</i> sp.	1	13	" "
		<i>Labrus bergylta</i>	1	10	" "
	Off White Patch	<i>Scomber scomber</i>	1	5.5	<i>Temora</i> nauplii, remains of young Copepods.
22	Breakwater	<i>Rhombus maximus</i>	1	14	<i>Balanus</i> nauplii, <i>Centropages typicus</i> .
		<i>Syngnathus acus</i>	1	31	No food.
		<i>Gasterosteus spinachia</i>	2	75-79	Amphipod and Harpacticid remains.
	Knap	<i>Rhombus maximus</i>	1	11.5	<i>Temora longicornis</i> .
		<i>Nerophis lumbriciformis</i>	1	10	No food.
		<i>Gobius</i> sp.	1	12	Young <i>Temora</i> and <i>Temora</i> nauplii.
30	Breakwater	<i>Syngnathus rostellatus</i>	1	45	Crab zoëa, <i>Acartia</i> sp. <i>Pseudocalanus elongatus</i> , other Crustacea remains.
	Knap	<i>Onos mustela</i>	1	2	No food.
Sept. 3	Off White Patch	<i>Gobius minutus</i>	1	2	No food.

Date. Sept.	Locality.	Fish.	No.	Size in mm.	Food present.
4	Inside Breakwater	Gobius minutus	2	14	<i>Temora longicornis</i> , <i>Pseudocalanus elongatus</i> , <i>Acartia</i> sp.
	Breakwater	Syngnathus rostellatus	1	105	Larval decapod remains.
		Gobius minutus	1	8	No food.
		Clupea sprattus	1	11	"
		Ammodytes lanceolatus	1	11	Copepod remains.
	Knap	Caranx trachurus	1	30	<i>Calanus finmarchicus</i> , <i>Porcellana</i> larva, Crustacea remains.
6	Breakwater	Clupea sprattus	1	23	No food.
	Outside Breakwater	Labrus bergylta	1	11	<i>Pseudocalanus elongatus</i> .
10	Off White Patch	Gobius minutus	1	10	Copepod remains.
12	Panther	Gobius minutus	1	4.5	No food.
		Gasterosteus spinachia	1	85	"
	Off White Patch	Gobius minutus	1	7	"
17	West Channel	Trachinus vipera	1	22	Copepod and other Crustacea remains.
	Breakwater	Ammodytes lanceolatus	20	7-14	<i>Acartia</i> sp. other Copepod remains.
		Scomber scomber	3	7-16	<i>Temora longicornis</i> Copepod remains.
20	Inside Breakwater	Gobius minutus	1	3	No food.
21	Breakwater	Syngnathus acus	1	7.5	<i>Centropages typicus</i> .
		Ammodytes lanceolatus	3	9-12	<i>Acartia clausi</i> <i>Pseudocalanus elongatus</i> , Copepod remains.
	Knap	Trachinus vipera	1	22	<i>Pseudocalanus elongatus</i> , <i>Anomalocera Patter-soni</i> .
		Caranx trachurus	1	30	<i>Centropages typicus</i> , <i>Temora longicornis</i> .
26	Off White Patch	Blennius galerita	1	17	<i>Temora longicornis</i> .
28	Breakwater	Caranx trachurus	1	30	Copepod remains.
		Syngnathus acus	1	85	<i>Pseudocalanus elongatus</i> , <i>Temora longicornis</i> , <i>Acartia clausi</i> , <i>Corycaeus anglicus</i> , <i>Centropages typicus</i> .
Oct. 3	Panther	Trachinus vipera	1	5	<i>Pseudocalanus elongatus</i> , <i>Temora nauplius</i> .
	Breakwater	Gadus luscus	1	4	<i>Pseudocalanus elongatus</i> .
		Ammodytes lanceolatus	3	8-9	Green food remains, <i>Oithona</i> sp. Copepod remains.
	Knap	Clupea sprattus	1	27	<i>Pseudocalanus elongatus</i> .
5	Knap	Ammodytes lanceolatus	1	10	Copepod remains.
15	Knap	Lepadogaster Gouani	1	6 ca.	<i>Centropages typicus</i> , <i>Pseudocalanus elongatus</i> .
	Panther	Syngnathus acus	1	60	<i>Temora longicornis</i> , <i>Centropages typicus</i> , <i>Pseudocalanus elongatus</i> , <i>Paracalanus parvus</i> .
		Nerophis lumbriciformis	1	40	No food.
17	West Channel	Clupea harengus	1	9	"

Date.	Locality.	Fish.	No.	Size in mm.	Food present.
Oct. 19	Knap	<i>Gadus luscus</i>	1	7	<i>Pseudocalanus elongatus</i> , <i>Acartia clausi</i> , <i>Calanus finmarchicus</i> .
	Panther	<i>Callionymus lyra</i>	1	2	No food.
22	Knap	<i>Clupea sprattus</i>	1	6	Green food remains.
	Breakwater	"	1	5	<i>Tintinnopsis ventricosa</i> .
23	Cawsand	<i>Caranx trachurus</i>	1	40	<i>Idya furcata</i> , Harpacticids indet. <i>Temora longicornis</i> , crab zoëa.
26	Breakwater	<i>Clupea harengus</i>	1	8.5	No food.
Nov. 1	Breakwater	<i>Callionymus lyra</i>	1	2	No food.
5	Off White Patch	<i>Clupea harengus</i>	4	11-18	"
		<i>Clupea sprattus</i>	1	6	"
		<i>Syngnathus rostellatus</i>	1	45	<i>Pseudocalanus elongatus</i> , Copepod remains, ova.
	Panther	<i>Crystallogobius Nilssoni</i>	1	21	No food.
6	West End of Breakwater	<i>Clupea sprattus</i>	1	5.5	"
	Breakwater	<i>Ammodytes tobianus</i>	1	5	Copepod nauplii.
		"	1	5	No food.
		<i>Clupea harengus</i>	2	8-13	"
		<i>Clupea sprattus</i>	1	5	"
19	Off White Patch	<i>Ammodytes tobianus</i>	1	4	"
20	Off White Patch	<i>Clupea sprattus</i>	1	6	"
	Panther	"	1	5	<i>Thalassiothrix nitzschoides</i> .
		<i>Clupea harengus</i>	1	6	No food.
	Breakwater	<i>Gadus luscus</i>	1	4	"
		<i>Clupea sprattus</i>	7	6-8.5	Green food remains, Copepod nauplii remains, <i>Pleurosigma</i> sp.
23	Off White Patch	<i>Clupea harengus</i>	6	6.5-9	No food.
	Panther	"	1	6	"
26	Panther	"	1	9	"
Dec. 11	Off White Patch	"	1	7	"