

**The Seasonal Abundance of the Pelagic Young of
Teleostean Fishes in the Plymouth Area. Part IV.
The Year 1936, with Notes on the Conditions as
shown by the Occurrence of Plankton Indicators.**

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With 4 Figures in the Text.

IN continuation of the three previous reports on the seasonal abundance of the pelagic young of teleostean fishes (Russell, 1930, 1935 and 1936) the corresponding data for the year 1936 can now be given. These are published in the same form as in the previous reports to which reference should be made. The dates on which the collections were taken are given in Table I and the monthly average catches for the young fish in Table II. No observations were available between October 12th and December 16th, but this does not materially affect comparison with other years because normally the young fish present at that time of year are very few in number. As in previous years the results are based on half-hour oblique hauls with the 2-metre ring-trawl. In Fig. 1 is given the curve for the average catches for each fortnight for all young fish, excluding Clupeids, and superimposed upon this the corresponding curve for the average of the period 1930 to 1934 inclusive (see 1935, Fig. 1).

Two features are at once noticeable in this figure for 1936; first, the almost complete absence of the usual peak of the young of spring spawners, and second, the increase in the numbers of the young of summer spawners as compared with those in the years 1934 and 1935. The sum of the monthly average catches of those post-larvae which show maximal abundance in the months June to October inclusive (see 1935, Table II), excluding Clupeids, was 115 in 1936, as against 79 in 1934 and 37 in 1935.

Below are given for the more important species the sums of the average monthly catches for the year 1936 divided by the corresponding average sums for the period 1930 to 1934 (see 1936, p. 601). In the second column are given the figures for the best year divided by the worst year in the period 1930 to 1936 inclusive.

	1936/Av. / 1930-34.	Best / / Worst.
<i>G. merlangus</i>	0.07	23.6 (1932/1936)
<i>G. minutus</i>	0.07	40.3 (1931/1935 & 36)
Onos spp.	0.62	13.0 (1930/1935)
Arnoglossus spp.	0.24	11.5 (1931/1934)
<i>S. norvegicus</i>	0.32	5.4 (1932/1935)
<i>P. limanda</i>	0.33	14.0 (1931/1935)
<i>P. microcephalus</i>	0.13	20.5 (1932/1935)
<i>S. variegata</i>	0.27	5.9 (1932/1936)
Callionymus spp.	0.31	3.4 (1930/1936)
<i>S. scombrus</i>	0.59	11.2 (1930/1935)
Gobiid spp.	0.47	39.7 (1930/1935)

The year 1936 has thus been the worst year recorded for the period 1930 to 1936 for *G. merlangus*, *S. variegata* and *Callionymus* spp.* For *G. merlangus* the best year, 1932, was 23.6 times greater than 1936.

The phosphorus available at the beginning of the year 1936 was still low, deviating -11% from the mean content for the winters 1923-24 to 1934-35 (data kindly supplied by Dr. L. H. N. Cooper).

Figs. 2 and 3 give the data on the occurrence of plankton indicators at Plymouth in 1936 in continuation of those given in the last report (1936, p. 599, Figs. 2, 3). Fig. 2 shows that until August in 1936 there was a distinct preponderance of *Sagitta elegans* over *S. setosa*. This is, however, in no way comparable with the predominance of *S. elegans* in 1930 since the upper half of this figure shows that its numbers were very low. Accompanying *S. elegans* there have also been a few of its associated indicators, e.g. *Aglantha*, Euphausian larvae, and *Themisto gracilipes* (see Fig. 3). *S. setosa* occurred in fair numbers temporarily in February during a period of strong easterly gales. A remarkable feature of the year 1936 has been the return of the siphonophore, *Muggiaea atlantica*. This species disappeared after the year 1924 and was replaced thereafter by *M. kochi* (Russell, 1934). In 1936 *M. kochi* did not appear after January. There have been indications of the occurrence of oceanic water. On March 16th Dr. M. V. Lebour gave me a medusa from the plankton which, while not identifiable for certain, was most likely a young stage of the Laodiceid, *Chromatonema rubra*. This is a deep-sea medusa. On March 26th and 31st specimens of the oceanic scyphomedusa *Pelagia* also appeared in the ring-trawl collections. It is interesting to note that these animals appeared immediately after the sudden decrease of *S. elegans* in March. This appearance of oceanic animals together with the occurrence

* In the corresponding table for 1935 (see 1936, p. 601) *Callionymus* spp. 0.20 should read 0.34; the average for the period 1924-29 had been used in error instead of that for 1930-34.

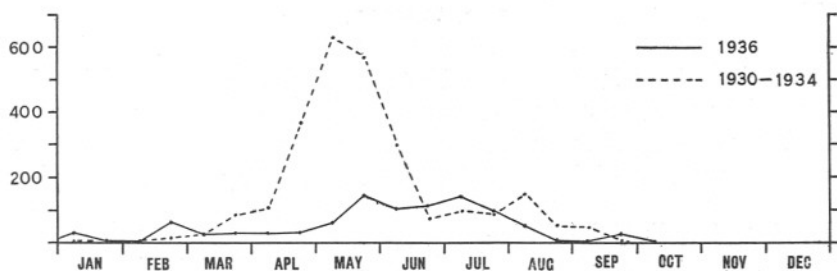


FIG. 1.—Curves showing the average catches in half-hour oblique hauls with the 2-metre ring-trawl for each fortnight for all young fish, excluding Clupeids, in 1936 (—) and the same averaged over the period 1930 to 1934 inclusive (---).

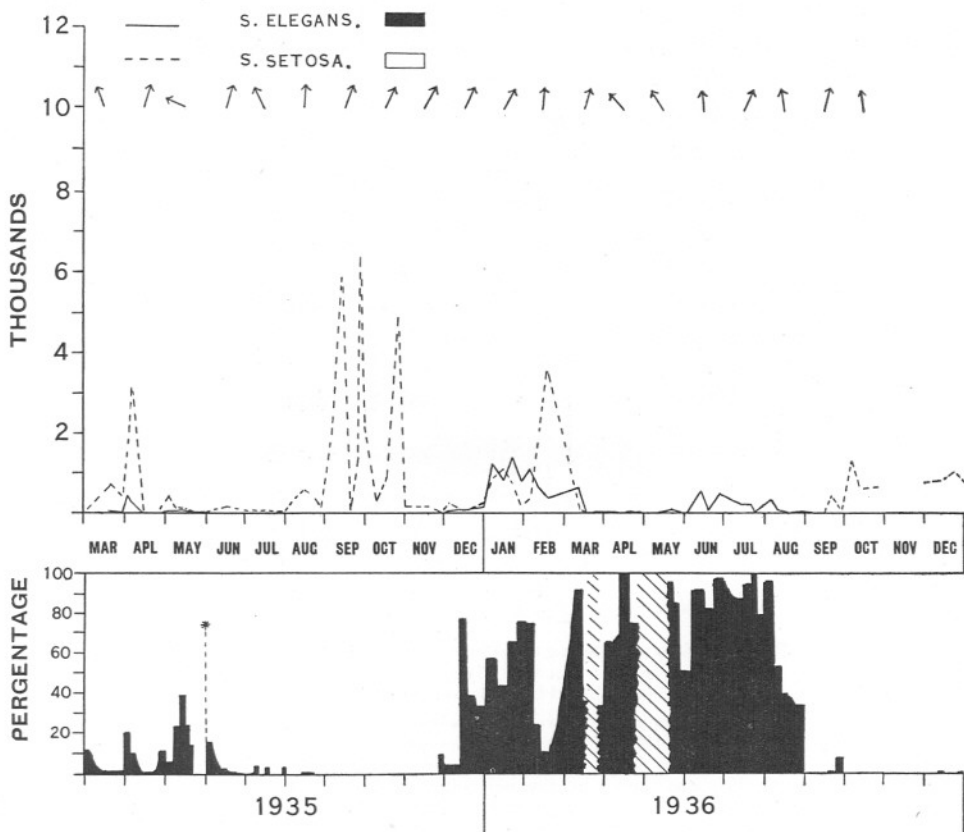


FIG. 2.—Above, curves showing the actual abundance of *S. elegans* (—) and *S. setosa* (---) in half-hour oblique hauls with the 2-metre ring-trawl during the period March, 1935, to December, 1936.

Below, the percentage composition of the Sagitta populations during the same period; *S. elegans*, black; *S. setosa*, white; no Sagitta, cross-hatched.

At the top of the diagram the arrows indicate the mean direction (true) of the flow of water through the Straits of Dover for each month as indicated by the Carruthers Current Meter working from the Varne Lightship, kindly supplied by Dr. J. N. Carruthers. (Continued from Russell, 1936, p. 599, Fig. 2.) (*=*S. setosa*, 1; *S. elegans*, 2.)

of *Muggiaea* throughout the second half of the year possibly explains the preponderance of *S. elegans* and also its low numbers. Such water as has filled the western end of the English Channel has not come from the west, where the water is rich in *elegans*, but from the south-west and has carried

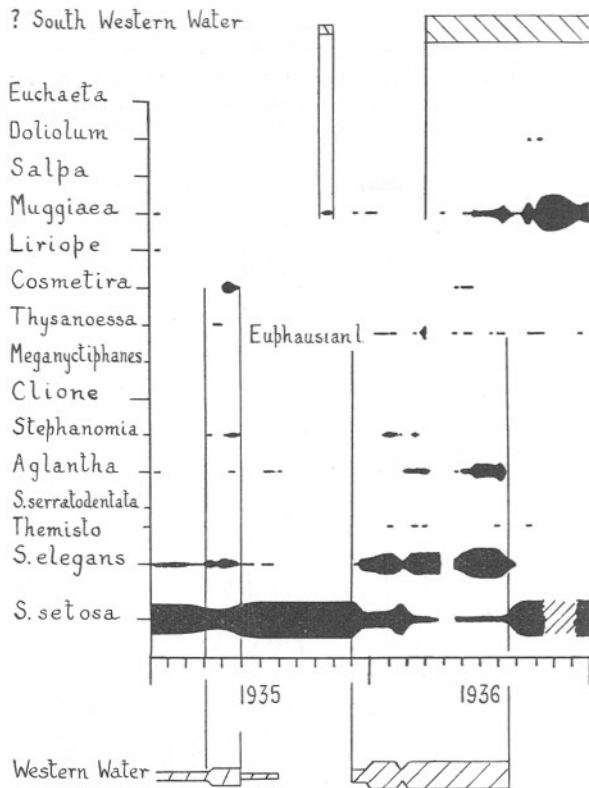


FIG. 3.—Diagram showing the occurrence of the various plankton indicators in collections off Plymouth during the years 1935 and 1936. (Continued from Russell, 1936, p. 599, Fig. 3.)

The *Muggiaea* species were *M. kochi* up to January, 1936, and thereafter in 1936 *M. atlantica*. The cross-hatching indicates a period during which no standard collections were made. *M. atlantica* was shown by tow-net collections to be numerous off Plymouth during that period. The *Doliolum* species was *D. nationalis*.

away with it small quantities from the boundary of the *elegans* water proper. I am indebted to Dr. H. W. Harvey for the information that the western end of the English Channel filled with water of low salinity early in the year. This appears at first in conflict with the occurrence of oceanic plankton animals, but it must be realized that along the French coast whence this water probably comes the steep-to coast will allow the

occurrence of oceanic plankton animals well inshore. It is possible that the improvement in the numbers of the young of summer spawning fish may bear some relation to these water movements.

From September until the end of the year *S. elegans* was almost completely replaced by *S. setosa*, while the presence of some south-western water was also indicated by the persistence of *Muggiaea*. An unusual record on December 31st, 1936, was that of the Scyphomedusan, *Discomedusa lobata* Claus, which has never before been recorded in these waters.

In Fig. 4 are shown the temperatures at L5 (surface) and E1 (bottom) in the early months of the year. Compared with other years 1936 was a late year, and the occurrence of such of the young of spring spawners

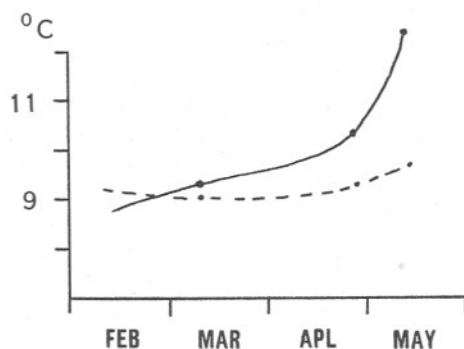


FIG. 4.—Temperatures in February, March, April and May for the year 1936. — surface at L5; - - - bottom at E1.

as were taken was in agreement with this. It can, however, hardly have been the cause of the disappearance of the usual peak of young of spring spawners. Neither can their disappearance be accounted for by the depredations of ctenophores as was suggested for 1929 (1935, p. 166, Fig. 7). Ctenophores were very scarce in 1936 until September, when there was a sudden invasion, chiefly of *Pleurobrachia*, whose numbers were as follows:—September 15th, 3; 22nd, 2940; 29th, 14,020; October 6th, 1740; 12th, 3. Mr. P. G. Corbin has told me that *Pleurobrachia* were present in large numbers at E1 on September 18th, apparently already moving in towards the Eddystone.

We can thus at present only account for the failure of the production of the young of spring spawners as being due to the prolonged period of poverty in nutrient salts that has continued since 1932. In 1935 the spring peak was already considerably smaller than normal. If a renewed total annual abundance of young fish is to take place it must presumably await an influx into the English Channel of water rich in nutrient matter from the west in the winter months.

The year 1936 has been outstanding for the prolonged abundance of the eggs of the pilchard. These appeared first in numbers on March 31st and were last seen on October 12th, after which collections ceased until the middle of December. Their occurrences were as follows (approximate numbers, when counted, in brackets):—March 31st, many (2500); April 7th, few; 15th, few; 22nd, many (1750); May 4th, many (1430); 13th, very many; 20th, many; June 2nd, many (2000); 12th, many; 16th, very many (8000); 26th, many (3300); July 13th, very many (17,400); 24th, very many (5750); 29th, few; August 17th, present; 28th, present; September 1st, present; 9th, few; 15th, many (1500); October 6th, present; 12th, many (3160). The numbers of surviving young, however, do not appear to have been high.

It can now be stated that as in previous years the curve of the abundance of young whiting in the plankton still follows that for the landings of whiting (cf. 1935, p. 169, Fig. 8; 1936, p. 602). The landings of whiting by British sailing trawlers in area VII, d-e, in the English Channel fell in 1935 to 2.0 cwt. per 100 hours' fishing, and the sum of the average monthly catches of young whiting dropped to 13. This is excessively low when compared with 308 in 1932.

My thanks are due to Capt. V. Lord and the crew of the S.S. *Salpa* for their continued care in making these collections.

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- RUSSELL, F. S. 1930. The Seasonal Abundance and Distribution of the Pelagic Young of Teleostean Fishes Caught in the Ring-trawl in Offshore Waters in the Plymouth Area. *Journ. Mar. Biol. Assoc., N.S.*, Vol. XVI, No. 3, pp. 707-722.
- 1934. On the Occurrence of the Siphonophores *Muggiaea atlantica* Cunningham and *Muggiaea kochi* (Will) in the English Channel. *Ibid.* Vol. XIX, No. 2, pp. 555-558.
- 1935. The Seasonal Abundance and Distribution of the Pelagic Young of Teleostean Fishes Caught in the Ring-Trawl in Offshore Waters in the Plymouth Area. Part II. *Ibid.* Vol. XX, No. 2, pp. 147-180.
- 1936. *Idem.* Part III. The Year 1935, with a Note on the Conditions as Shown by the Occurrence of Plankton Indicators. *Ibid.* Vol. XX, No. 3, pp. 595-604.

TABLE I.

DATES ON WHICH COLLECTIONS WERE MADE, 1936.

All 2 miles east of Eddystone unless otherwise stated.

(No observations between October 12th and December 16th.)

Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5	12	7	4	2	13	5	1	6‡		16
7	12*	16	15	13	12	22†	11	9	12		21*
14	18*	23	22	20	16	24	17	15			31
21		31	28	27	26	29	28	22			
29								29			

* Haul taken at L4-L5.

† Haul taken 4 mi. S.S.E. of Mewstone.

‡ Haul taken 4 mi. E.×S. of Prawle Point.

TABLE II.

AVERAGE MONTHLY CATCHES OF POST-LARVAE PER HALF-HOUR
Oblique Haul with 2-metre Ring-trawl, 1936.

(No observations between October 12th and December 16th.)

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Σ
Total Young Fish	67	654	75	38	167	375	251	65	14	63		94	1863
Ditto, less Clupeids	21	27	30	31	104	111	112	29	14	6		2	487
All Clupeid spp.	46	627	45	7	63	264	139	36	+	58		92*	1377
<i>Clupea harengus</i>	-	-	-	-	-	-	-	-	-	-		-	92
<i>Gadus pollachius</i>	-	-	1	1	-	+	-	-	-	-		-	2
<i>Gadus merlangus</i>	-	-	3	1	7	2	-	-	-	-		-	13
<i>Gadus minutus</i>	-	+	1	1	1	4	-	-	-	-		-	7
<i>Gadus luscus</i>	12	1	2	-	-	+	+	-	-	1		+	16
<i>Gadus callarius</i>	-	-	-	-	-	-	-	-	-	-		-	-
Onos spp.	-	-	12	5	12	2	1	-	+	-		-	32
<i>Molva molva</i>	-	-	-	-	-	-	-	-	-	-		-	-
<i>Merluccius merluccius</i>	-	-	-	-	-	-	+	-	-	1		-	1
<i>Raniceps raninus</i>	-	-	-	-	-	-	1	-	-	-		-	1
<i>Capros aper</i>	-	-	-	-	-	-	-	-	-	-		-	-
<i>Zeus faber</i>	-	-	-	-	-	-	-	-	-	-		-	-
<i>Arnoglossus</i> sp.	-	-	-	-	-	3	2	2	1	-		-	8
<i>Rhombus laevis</i>	-	-	-	-	-	-	-	-	-	-		-	-
<i>Rhombus maximus</i>	-	-	-	-	-	-	+	+	-	-		-	+
<i>Scophthalmus norvegicus</i>	-	-	+	1	8	9	1	-	-	-		-	19
<i>Zeugopterus punctatus</i>	-	-	+	1	2	3	1	-	-	-		-	7
<i>Zeugopterus unimaculatus</i>	-	-	-	-	+	-	+	-	-	-		-	+
<i>Pleuronectes limanda</i>	-	+	+	2	12	4	-	-	-	-		-	18
<i>Pleuronectes flesus</i>	-	-	-	+	1	-	-	-	-	-		-	1
<i>Pleuronectes microcephalus</i>	-	-	-	-	1	2	-	-	-	-		-	3
<i>Solea vulgaris</i>	-	-	-	-	1	+	-	-	-	-		-	1
<i>Solea variegata</i>	-	-	-	1	6	12	3	-	-	-		-	22
<i>Solea tascaris</i>	-	-	-	-	-	-	-	-	+	-		-	+
<i>Solea lutea</i>	-	-	-	-	-	1	+	-	-	-		-	1
<i>Serranus cabrilla</i>	-	-	-	-	-	-	-	-	-	-		-	-
<i>Caranz trachurus</i>	-	-	-	-	-	-	+	1	8	1		-	10
<i>Mullus surmuletus</i>	-	-	-	-	-	-	-	-	-	-		-	-
<i>Morone labrax</i>	-	-	-	-	-	-	-	-	-	-		-	-
<i>Ammodytes</i> sp.	7	22	5	2	-	-	-	3	1	-		-	40
<i>Ammodytes lanceolatus</i>	-	-	1	4	2	4	4	2	-	1		-	18
<i>Cepola rubescens</i>	-	-	-	-	-	-	-	+	-	-		-	+
<i>Callionymus</i> spp.	-	-	3	12	50	52	49	2	1	1		-	170
<i>Labrus berylla</i>	-	-	-	-	1	1	-	-	-	-		-	2
<i>Labrus mixtus</i>	-	-	-	-	+	1	+	-	-	-		-	1
<i>Ctenolabrus rupestris</i>	-	-	-	-	-	1	9	8	-	-		-	18
<i>Crenilabrus melops</i>	-	-	-	-	-	2	2	1	-	-		-	5
<i>Centrolabrus exoletus</i>	-	-	-	-	-	-	-	-	-	-		-	-
<i>Trachinus vipera</i>	-	-	-	-	-	-	+	1	+	-		-	1
<i>Scomber scombrus</i>	-	-	-	-	-	1	8	4	-	-		-	13
Gobiid spp.	2	1	-	-	1	4	10	1	-	1		1	21
<i>Lebetus scorpioides</i>	-	-	-	-	-	+	+	-	-	-		-	+
<i>Blennius ocellaris</i>	-	-	-	-	-	-	-	1	+	-		-	1
<i>Blennius pholis</i>	-	-	-	-	-	-	2	18	5	+		-	25
<i>Blennius gattorugine</i>	-	-	-	-	-	-	-	-	-	-		-	2
<i>Chirolophus galerita</i>	+	1	1	-	-	-	-	-	-	-		-	1
<i>Agonus cataphractus</i>	-	1	-	-	-	-	-	-	-	-		-	1
<i>Trigla</i> spp.	-	-	-	-	-	1	1	-	1	2		-	5
<i>Cottus</i> sp.†	-	+	2	1	-	-	-	-	-	-		-	3
<i>Liparis montagu</i>	-	-	-	-	-	-	-	-	-	-		-	-
<i>Lepadogaster bimaculatus</i>	-	-	-	-	-	1	+	-	-	-		-	1
<i>Lophius piscatorius</i>	-	-	+	-	-	+	1	-	-	-		-	1
Young Pipe-fish	-	-	-	-	-	1	-	-	1	-		-	2

* On Dec. 16th there was a catch of 274; this was immediately after a heavy gale and the contents of the catch were typical of a night haul. This average may therefore be unduly weighted.

† While I was in Copenhagen last year Dr. A. Fr. Bruun kindly drew my attention to a paper in which he described the young stages of what he presumed to be *Cottus liljeborgi* (Public. Circ. No. 88, 1925). A re-examination of a number of specimens in my collections has shown that they agree with Bruun's figures for *C. liljeborgi*, although the adult has not yet been recorded here. These post-larvae had previously been included under the name *C. bubalis*.