ON THE SEASONAL ABUNDANCE OF YOUNG FISH. V. THE YEAR 1937

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(Text-figs. 1–4)

The present report continues the observations on the seasonal abundance of the pelagic young of teleostean fish in the plankton off Plymouth (Russell, 1937) and gives the results for the year 1937. These results are published in the same form as in previous reports. The dates on which collections were made with the 2-metre stramin ringtrawl are given in Table I and the monthly average catches of the young fish per half-hour haul in Table II. In Fig. 1 is given the curve for the average catches for each fortnight of all young fish, excluding clupeids, and superimposed upon this the corresponding curve for the average catches over the period 1930–1934 inclusive.

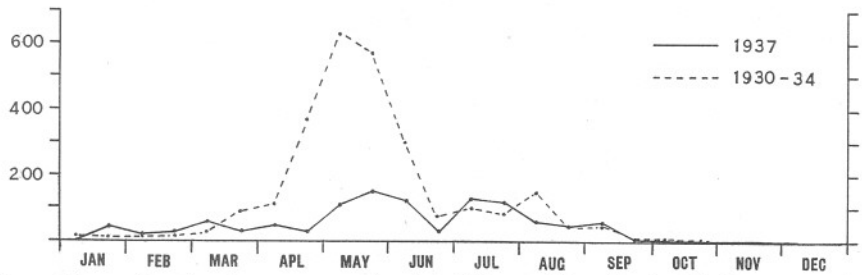

Fig. 1. Curves showing the average catches in half-hour oblique hauls with the 2-metre ringtrawl for each fortnight for all young fish, excluding clupeids, in 1937 (——) and the same averaged over the period 1930–1934 inclusive (-----).

The results for 1937 are almost a repetition of those for 1936. Once more there was an almost complete absence of the usual peak of the young of spring spawners and there were again slightly higher numbers of the young of summer spawners. The sum of the monthly average catches of those post-larvae which show maximal abundance in the months June to October inclusive, excluding clupeids, was 174 in 1937 as against 115 in 1936. These numbers were mainly made up by *Arnoglossus* sp., *C. trachurus*, *C. rupestris*, *S. scombrus*, and *B. gattorugine*. There thus appears to be a gradual swing over to better conditions for summer spawners in contrast to spring spawners the significance of which is not yet apparent.

The sums of the average monthly catches of the more important species for the year 1937 divided by the corresponding average sums for the period

1930–1934 inclusive are given below. In the second column are the figures for the best year divided by the worst year from 1930 to 1937 inclusive.

	1937 / Av. 1930–34	Best / Worst
G. merlangus	0·19	23·6 ('32/'36)
G. minutus	0·15	40·3 ('31/'35 & '36)
Onos spp.	0·40	13·0 ('30/'35)
Arnoglossus spp.	1·09	11·5 ('31/'35)
S. norvegicus	0·14	10·7 ('32/'37)
P. limanda	0·35	14·0 ('31/'35)
P. microcephalus	0·04	41·0 ('32/'37)
S. variegata	0·24	6·5 ('32/'37)
Callionymus spp.	0·28	3·8 ('30/'37)
S. scombrus	1·68	11·2 ('30/'35)
Gobiid spp.	0·02	119·0 ('30/'37)

The year 1937 has been the worst during the period 1930–1937 for *S. norvegicus*, *P. microcephalus*, *S. variegata*, *Callionymus* spp., and Gobiid spp. Except for *Callionymus*, however, the numbers of these species are becoming so low, even in some species reaching unity, that undue significance should no longer be placed on high values for the calculated figures for best divided by worst years.

The numbers of *Callionymus* have fallen from an average of 548 for the period 1930–1934 to only 155 in 1937. This decrease is very noticeable in the catches because young *Callionymus* usually bulk so largely that they are a characteristic feature of Plymouth plankton. But in spite of their decrease in actual numbers their proportionate representation is still 0·28 of the catches of all young fish, excluding clupeids, as compared with 0·38 for the period 1930–1934. The fact that this, the most abundant species, still forms approximately the same proportion of the young fish population indicates that the decrease in the numbers of young fish during the last few years has been due to some factor adverse to all species of fish indiscriminately. Indeed, if this decrease had been due to an overfishing of the reproducing stock it might have been expected that there would have been a corresponding increase in the proportionate numbers of the young of those species of fish which are not taken by the trawl. The gobies for instance might have benefited, whereas actually their numbers have dwindled to insignificance. This adds further support to the argument that it is the decrease in the amount of available phosphorus in the water which is the root cause of the poor survival of young fish.

In 1937 both *Arnoglossus* and *Scomber* were slightly above the average for 1930–1934, but the latter came nowhere near the high figure of 344 recorded for 1926. A noteworthy feature in 1937 was the unusual abundance of the young of *Serranus cabrilla* of which a catch of 24 was made on September 1.

The results for all species of young fish for the last eight years are summarized in Fig. 2. This figure shows the yearly averages for total young fish (excluding clupeids), for the young of summer spawners, and for total young fish less the young of summer spawners. It shows clearly how the drop in numbers after 1930 occurred first among the young of summer spawners, and that the decrease in the numbers of other species, mainly spring spawners, started later, reaching a very low level in 1935 at which it has remained while the summer spawned fish have slightly improved.

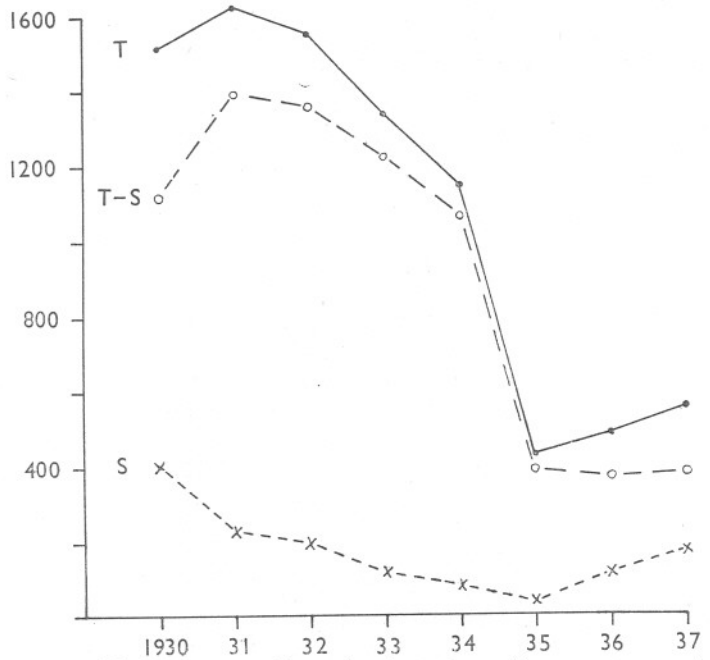

Fig. 2. The sums of the average monthly catches for each year from 1930 to 1937 in half-hour oblique hauls with the 2-metre ringtrawl for: *T*, total young fish (excluding clupeids); *S*, the young of summer spawners; and *T*–*S*, total young fish less the young of summer spawners.

In previous reports it was suggested that we must await a fresh inflow of water from the south of Ireland into the Channel to replenish the supply of phosphorus before there will be a return to conditions for good survival of young fish. It seemed most likely that this replenishment will come from the "elegans" water. So far there are no indications of a return to the conditions of 1930 when "elegans" water predominated off Plymouth. Figs. 3 and 4 give data on the occurrence of plankton indicators in the catches off Plymouth in 1937 in continuation of those given in the last report (1937, Figs. 2 and 3). The year 1937 was very similar to 1936. The numbers of both species of *Sagitta* were extremely low until August, when *S. setosa* became abundant, and

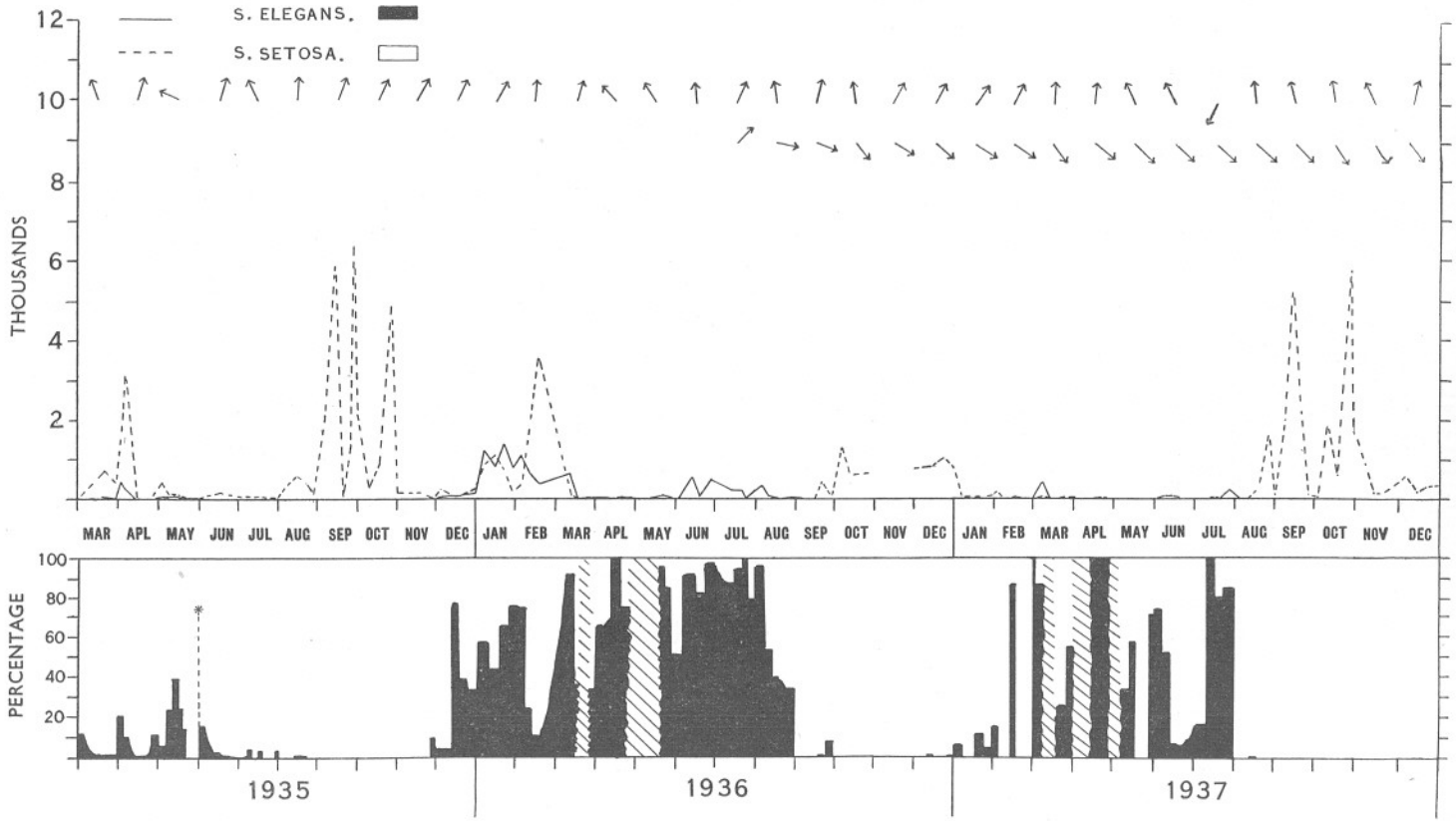

Fig. 3. Above, curves showing the actual abundance of *S. elegans* (——) and *S. setosa* (------) in half-hour oblique hauls with the 2-metre ringtrawl during the period March 1935 to December 1937.

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

At the top of the diagram the arrows indicate the mean directions (true) of the flow of water past the Varne Lightship (above) and the Royal Sovereign Lightship (below) from data kindly supplied by Dr J. N. Carruthers. (Continued from Russell, 1937, p. 681, Fig. 2.)

what *S. elegans* there were were much fewer than in 1936. The siphonophore *Muggiaea atlantica* was again abundant in the later summer and autumn. As in 1936 the low numbers of *S. elegans* in the first half of the year were accompanied by the appearance of unusual species. On February 24 another specimen of the scyphomedusa *Discomedusa lobata* was caught and several *Pelagia*

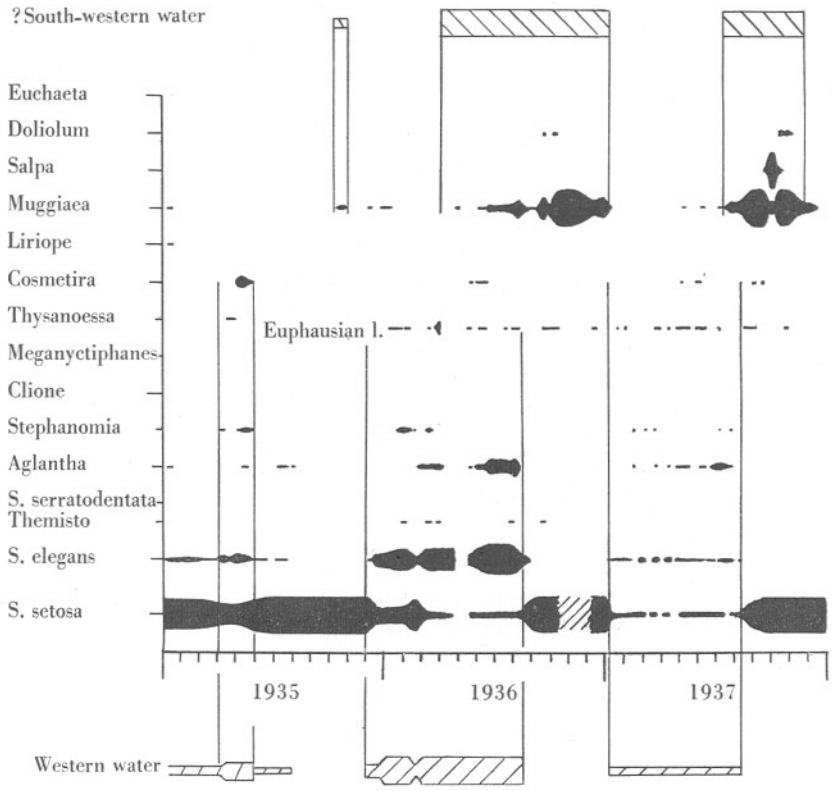

Fig. 4. Diagram showing the occurrence of the various plankton indicators in the collections off Plymouth during the years 1935, 1936 and 1937. (Continued from Russell, 1937, p. 682, Fig. 3.)

The *Muggiaea* species were *M. kochi* up to January 1937, and thereafter *M. atlantica*, the salps were *S. fusiformis*, and the doliolids *D. nationalis*.

were present in April. These two species were recorded in 1936 for the first time off Plymouth. In addition, in 1937 one specimen of the copepod *Rhincalanus nasutus* was taken on February 9; this is the first time the species has been recorded off Plymouth. It is perhaps also of interest that on February 23 the *Salpa* landed a catch with many small hake.

On September 20 *Salpa fusiformis* appeared in the catches and had disappeared by October 19. Although the salps were not found off Plymouth on

September 13 they were present on the next day off Looe. This is the first appearance of salps off Plymouth since 1932.

As in 1936 also, pilchard eggs were a distinct feature in the plankton in 1937. They were present continuously from April to December, the approximate numbers on the different dates being as follows: April 14 (280), 26 (2320); May 3 (2360), 10 (37, 300), 19 (1000), 24 (2800), 31 (4200); June 6 (480), 14 (30,000), 18 (19,220); July 5 (14,960), 13 (7920), 19 (few), 26 (few); August 4 (1220), 11 (880); September 1 (1000), 7 (few), 13 (few), 20 (few), 27 (90); October 4 (100), 11 (320), 26 (few); November 1 (2420), 8 (300), 15 (670), 19 (20); December 6 (4), 13 (1), 31 (11).

The continuous appearance of such large numbers of pilchard eggs under conditions when the numbers of both *S. elegans* and *S. setosa* are conspicuously low deserves special mention, as it appears possible that we have here a body of water distinct from either of those characterized by the presence of *S. elegans* or *S. setosa*. If this be so, or whatever be the origin of this water, it is proposed that it should for the time being be called "pilchard" water, since it is evident that it is well worth watching in the future for the conditions that favour this great production of pilchard eggs off Plymouth.

In spite of the large number of eggs there are no indications in the ring-trawl catches that the young were abnormally abundant. The possibility that the low numbers of *S. setosa* may also be owing to their poor survival must not be lost sight of, but we do not know how abundant they were in the eastern half of the Channel.

REFERENCE

RUSSELL, F. S., 1937. 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. *Journ. Mar. Biol. Assoc.*, Vol. XXI, pp. 679–86.

TABLE I. DATES ON WHICH COLLECTIONS WERE MADE, 1937

All 2 miles east of Eddystone unless otherwise stated

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
6*	2	1	6	3	6	5	4	1	4	1	6
12*	9	8	14	10	14	13	11	7	11	8	13
20	16	19‡	19§	18	18	19	18	13‖	19	15	20
27†	24	23	26	24		26	25	20	26	19¶	31
		30		31				27			

* L4–L5.
† Bolt E × S: Stoke Pt. N.
‡ L3–L4.
§ Off Revelstoke, 25 fathoms.
‖ 4–5 miles south of Breakwater.
¶ 3 miles west of Rame.

TABLE II. AVERAGE MONTHLY CATCHES OF POST-LARVAE PER HALF-HOUR

Oblique hauls with 2-metre Ringtrawl, 1937

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Σ
Total Young Fish	37	116	430	56	182	150	207	60	40	40	9	1	1328
Ditto, less Clupeids	21	22	39	36	132	89	124	53	36	2	2	1	557
All Clupeid spp.	17	94	391	20	50	58	83	7	5	39	6	1	771
Clupea harengus	3	1	1	..	..	..	..	..	..	..	..	..	5
Gadus pollachius	..	..	+	1	+	+	..	..	..	..	..	..	1
Gadus merlangus	..	..	2	5	21	7	2	..	..	..	..	..	37
Gadus minutus	..	..	10	2	1	1	+	..	..	..	..	..	14
Gadus luscus	..	+	+	..	1	+	+	+	..	+	1	1	3
Gadus callarius	..	+	..	..	..	..	..	..	..	..	..	..	+
Onos spp.	..	..	1	1	13	3	2	1	..	..	..	..	21
Molva molva	..	..	..	..	+	..	..	..	..	..	..	..	+
Merluccius merluccius	..	..	..	..	..	..	..	+	..	+	..	..	+
Raniceps raninus	..	..	..	..	..	..	+	..	..	..	..	..	+
Capros aper	..	..	..	..	..	..	..	1	+	..	..	..	1
Zeus faber	..	..	..	..	..	..	..	..	..	+	..	..	+
Arnoglossus spp.	..	..	..	..	..	+	17	9	10	+	..	..	36
Rhombus spp.	..	..	..	..	..	+	2	3	2	..	..	..	7
Scophthalmus norvegicus	..	..	..	..	3	4	1	..	..	..	..	..	8
Zeugopterus punctatus	..	..	..	+	1	..	..	..	..	..	..	..	1
Zeugopterus unimaculatus	..	..	..	..	..	..	..	..	..	..	..	..	..
Pleuronectes limanda	..	..	+	6	9	4	..	..	..	..	..	..	19
Pleuronectes flesus	..	..	+	1	..	..	..	..	..	..	..	..	1
Pleuronectes microcephalus	..	..	..	..	+	1	..	..	..	..	..	..	1
Solea vulgaris	..	..	1	2	..	..	..	..	..	..	..	..	3
Solea variegata	..	..	..	3	7	8	1	1	..	..	..	..	20
Solea lascaris	..	..	..	..	..	..	..	..	+	..	..	..	+
Solea lutea	..	..	..	..	+	..	+	..	..	..	..	..	+
Serranus cabrilla	..	..	..	..	..	..	..	+	5	..	..	..	5
Caranx trachurus	..	..	..	..	..	..	3	8	6	+	..	..	17
Mullus surmuletus	..	..	..	..	..	..	..	+	..	..	..	..	+
Morone labrax	..	..	..	..	..	..	..	..	..	..	..	..	..
Ammodytes sp.	21	21	23	4	..	..	3	3	1	..	1	..	77
Ammodytes lanceolatus	..	..	..	1	4	3	1	1	..	..	..	..	10
Cepola rubescens	..	..	..	..	..	..	1	..	1	..	..	..	2
Callionymus spp.	..	..	..	10	69	46	12	15	2	+	1	..	155
Labrus bergylta	..	..	..	..	..	+	..	..	..	..	..	..	+
Labrus mixtus	..	..	..	..	..	+	..	..	..	..	..	..	+
Ctenolabrus rupestris	..	..	..	..	..	3	17	1	..	..	..	..	21
Crenilabrus melops	..	..	..	..	..	..	2	..	..	..	..	..	2
Centrolabrus exoletus	..	..	..	..	..	..	..	..	..	..	..	..	..
Trachinus vipera	..	..	..	..	..	..	2	2	2	..	..	..	6
Scomber scombrus	..	..	..	..	5	24	5	3	..	..	..	..	37
Gobius spp.	..	..	..	..	+	+	1	..	+	..	..	..	1
Lebetus scorpioides	..	..	..	..	..	..	..	..	..	..	..	..	..
Blennius ocellaris	..	..	..	..	..	..	..	..	..	..	..	..	..
Blennius pholis	..	..	..	..	..	1	2	..	..	..	..	..	3
Blennius gattorugine	..	..	..	..	..	3	33	+	+	..	+	..	36
Chirolophis galerita	..	1	..	..	..	..	..	..	..	..	..	..	1
Agonus cataphractus	..	..	..	..	..	..	..	..	..	..	..	..	..
Trigla spp.	..	..	..	..	..	+	+	..	..	..	..	..	+
Cottus sp.	+	+	2	1	..	+	..	..	..	..	..	..	3
Liparis montagui	..	..	..	..	..	..	..	..	..	..	..	..	..
Lepadogaster bimaculatus	..	..	..	..	..	..	..	..	..	..	..	..	..
Lophius piscatorius	..	..	..	+	..	+	..	..	..	..	..	..	+