THE SEASONAL OCCURRENCE OF MYSIDS OFF PLYMOUTH

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(Text-fig. 1)

In the course of his work on the plankton of the English Channel, Mr F. S. Russell (1928*b*) designed a special townet, made of stramin netting, to fish inside the Agassiz trawl as it was dragged along the bottom. The townet was so fixed as to fish a few inches above the bottom without actually stirring up bottom material. Mr Russell tells me that there was no indication that the net was catching bottom living forms, but that all the animals caught were plankton forms or animals swimming just above the bottom. The hauls, therefore, may be taken to present a picture of the fauna of the bottom layer of water, over a period of a year, and it may not be without interest to analyse the gatherings as far as mysids are concerned in an endeavour to glean information on the biology of the group.

The tow-nettings were taken at three stations in the neighbourhood of Plymouth, from June 1927 to May 1928. The three stations, referred to in the following pages as A, R, and L4, were situated as follows:

A = 2 miles east of Eddystone. Sand.
R = Off Rame Head. Mud.
L4 = Midway between the Breakwater Light and Eddystone. Mud and sand.

The Mysidacea include two groups of forms, those which are permanently planktonic and mostly oceanic, such as *Gnathophausia*, *Eucopia*, *Euchaetomera*, *Caesaromysis*, *Arachnomysis*, certain species of *Anchialina* and *Siriella*, and others, and the remainder which are normally bottom-living. It is to the latter group that the species in this collection belong. The members of this group may leave their bottom-haunting habits and undertake movements into the neighbouring water under the influence of varying stimuli and factors which may be briefly referred to.

In the first place it is almost certain that a large proportion of bottom-living forms spend part of their time in idly swimming just above the bottom. These movements are intermittent and their intensity varies with the operation of various factors in the environment. In shallow water, in suitable locations, I have often observed *Praunus flexuosus*, *P. neglectus* and *Neomysis integer* swimming about gently in 2 or 3 ft. of water in large numbers, especially on calm sunny days. The extent of their activity was seen to vary with such

environmental factors as the intensity of light, the amount of water disturbance, temperature, and so on, but it was quite obvious that such idle swimming movements were a normal feature of their lives. It is not unreasonable to suppose that the majority of bottom-living forms have similar habits, and, in deeper water, where unfavourable conditions are minimized, one may suppose that idle swimming movements just above the bottom are a regular part of the normal life of the species. The fact that the present material includes fourteen out of the twenty-seven species known for the Plymouth fauna would lend support to this view, especially as the stations at which the plankton hauls were made were not suitable localities for most of the missing species, such as *Praunus flexuosus*, *P. neglectus*, *P. inermis*, *Neomysis integer* and the species of *Schistomysis*.

Mysids are also known to undergo diurnal movements in response to light intensity. Russell (1925, 1928*a*, 1931, 1933) has shown that, at Plymouth, certain mysids such as *Anchialina agilis*, *Leptomysis gracilis*, *Neomysis longicornis*, *Schistomysis*, *Erythrops* and *Gastrosaccus normani* move upwards from the bottom with the approach of darkness and may be taken at night in some numbers in mid-water. Some, such as *Anchialina agilis*, actually reach the surface in considerable numbers. I have shown (1936) that the same kind of thing happens in the waters inside the Great Barrier Reef. Fage (1933) suggests that these diurnal movements are dominated by the reproductive cycle and are more marked in the breeding season.

There is, further, evidence that in some Mysidacea at least, for example *Lophogaster typicus* (Tattersall, 1908), the breeding female becomes pelagic and rises to the surface at the time when the young are just ready to be liberated from the brood pouch, thereby ensuring the widest possible distribution for the young. A similar habit may be more generally characteristic of other species of the group, and introduces another factor which may influence movements.

Finally, Russell has called attention (1927) to the occurrence of immature mysids in plankton catches, taken in mid-water, suggesting that in the immature stages mysids are more planktonic in habit than in the adult condition.

A planktonic habit in mysids, therefore, may be either (i) permanent, or (ii) a temporary but normal and intermittent habit in the bottom-living forms, in the layers of water immediately over their haunts, varying in intensity with environmental factors such as light, wave action, temperature, and so on, or (iii) a breeding habit either during the actual processes of mating and egg laying, or to ensure a wide distribution for the young, or (iv) a habit characteristic of the immature phases.

In attempting to analyse the results of a series of tow-nettings such as the present one, it is difficult to assess the precise factor which was operating at the time of the catch or to estimate the degree to which one or more factors have combined to influence the result. Nevertheless some points of interest have emerged from this study.

The Mysids as a Whole

In Fig. 1 the total number of mysids caught in each tow-netting at each of the three stations has been plotted in graph form. The whole of the mysids were picked out and counted, and the figures reduced to 30 min. hauls so as to be strictly comparable.

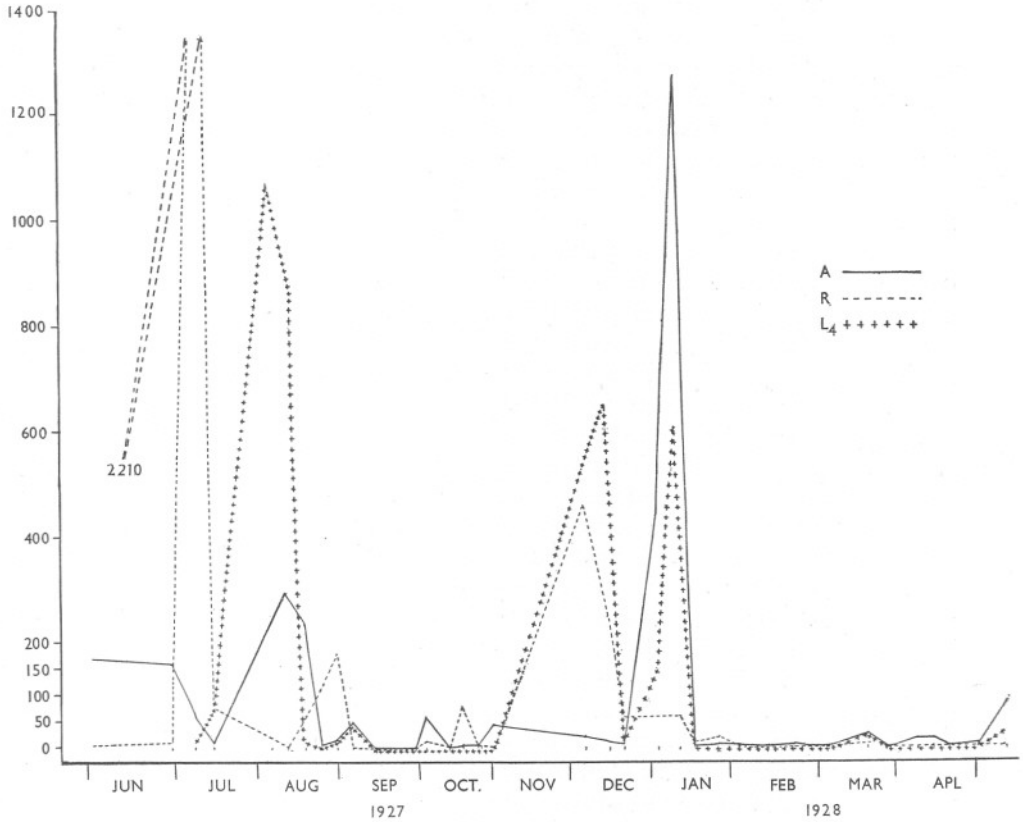

Fig. 1

From this graph it is apparent at once that, during two periods of the year, mysids appeared in the bottom plankton in very large numbers. These two periods are (i) from June to August 1927, and (ii) December 1927 and January 1928. At the other times of the year the number of mysids were small and probably represent a more or less normal picture of the idle and intermittent swimming movements of mysids in the bottom layer. The summer and winter maxima represent unusual activity for which an explanation must be sought. It is to be noted that the maxima did not always appear simultaneously at the three stations, but, taken as a whole, they are well marked.

Further analyses of the maxima show that the summer one is almost completely dominated by *Leptomysis gracilis* and that the high numbers in the catches at this period were almost entirely composed of this species. In the winter maximum, on the contrary, *L. gracilis* played a very insignificant part (negligible but for one haul of 209 specimens on 15. xii. 27) in the swarms of mysids which occurred. The dominant species was *Schistomysis ornata*, while *Anchialina agilis*, the two species of *Gastrosaccus*, and *Neomysis longicornis* also contributed considerably. The difference between the composition of the two maxima is brought out rather strikingly in Table I. In compiling this table I have selected *all* the hauls in which more than 100 specimens of mysids occurred. This is a purely arbitrary number chosen for convenience. There were sixteen such hauls, curiously enough eight in each maximum. I give the total number of mysids in each haul and the numbers of each species represented.

The occurrence of a summer maximum of *Leptomysis gracilis* is not a feature confined to the year 1927–8, but was further indicated in the year 1930 by an examination of the catches in oblique hauls above the bottom recorded by Russell (1933). Mr Russell kindly sent me the samples of the July and August hauls in that year on which the figures given in Table I of his paper are based. All the specimens submitted to me belong to *L. gracilis* except one specimen of *Neomysis longicornis*. Although these results are not strictly comparable with those of the bottom stramin net it is evident that, in 1930, *Leptomysis gracilis* was the most abundant species in the plankton in July and August, and produced a peak of the same nature, though less marked, as in the bottom catches in 1927. There is, however, much less evidence of a winter maximum in the plankton in 1930–1. On February 4 1930, 100 specimens of mysids were caught, and from November 13 1930 to April 16 1931, mysids occurred in only one haul, that on January 15 1931, when ten specimens were found.

A further difference between the two maxima must be noted. The summer maximum of *L. gracilis* is composed equally of adults of both sexes and immature forms. The precise details will be found under *L. gracilis* later in this paper, where it will be seen that, broadly speaking, immature specimens were abundant in June, and adults in July and August. Moreover, the adults were actively breeding, females with eggs or embryos in the brood pouch being present in considerable numbers. It would appear that *L. gracilis* becomes markedly planktonic during the breeding season and that the summer maximum of mysids is an expression of this reproductive activity.

On the other hand, the winter maximum of mysids was composed almost entirely of immature specimens, about half-grown or less. A few breeding females of *Schistomysis ornata*, and *Anchialina agilis*, and two breeding females of *Gastrosaccus spinifer* occurred in the winter hauls, but the number of adult specimens was very small and not at all comparable to the numbers of adult *Leptomysis gracilis* in the summer maximum. The winter maximum is obviously correlated with breeding activity among the species which compose

Table I. Composition of Mysid Fauna during Periods of Maximum Abundance

This includes the sixteen tow-nettings during the year in which the total number of mysids caught exceeded 100.

Summer maximum		Total no. of mysids	*Siriella jaltensis*	*S. clausi*	*S. armata*	*Gastrosaccus spinifer*	*G. normani*	*Anchialina agilis*	*Erythrops elegans*	*Mysidopsis angusta*	*M. gibbosa*	*Leptomysis gracilis*	*L. lingvura*	*Schistomysis ornata*	*Neomysis longicornis*
2. vi. 27	A	163	..	..	..	2	..	..	1	..	..	146	..	2	12
29. vi. 27	A	315	..	..	..	..	..	..	2	..	..	306	..	5	2
8. vii. 27	R	2210	..	..	..	..	..	9	2	..	..	2184	..	..	7
5. viii. 27	L4	1063	..	..	..	..	..	3	1	..	..	1011	..	4	44
12. viii. 27	A	294	..	..	..	..	..	..	..	..	..	284	..	3	7
	L4	885	..	..	..	..	..	2	..	1	..	875	..	2	5
19. viii. 27	A	235	..	..	..	..	1	6	1	4	3	166	..	47	7
25. viii. 27	R	108	..	..	..	..	..	2	..	..	..	94	..	6	6
Winter maximum															
6. xii. 27	R	450	2	..	..	..	2	116	1	1	2	3	1	326	1
	L4	527	..	..	..	..	7	195	6	14	7	8	..	285	5
15. xii. 27	R	233	1	..	..	..	4	6	4	3	..	1	3	209	2
	L4	643	1	..	..	18	238	30	2	3	1	209	..	56	85
3. i. 28	A	449	..	..	..	78	79	94	1	1	..	8	..	162	16
	L4	154	2	4	..	16	17	27	1	1	..	4	..	72	9
11. i. 28	A	1268	25	..	..	30	46	195	..	..	1	4	2	867	98
	L4	620	19	..	..	55	68	90	1	1	..	3	..	321	62

it, but these species do not appear to become markedly planktonic in the adult condition for breeding purposes, as does *L. gracilis*. In Table II, I have put together the data showing the months of the year in which the species dealt with in this paper are known to breed. A correlation of the data here presented with the analyses of the bottom plankton hauls will show that no other species of mysids behaves in the same way as *L. gracilis*. There is a suggestion of the same behaviour in *Schistomysis ornata* and *Anchialina agilis* but it is not nearly so definite.

TABLE II. BREEDING OF MYSIDS

Showing the months of the year in which the species dealt with in this paper have been recorded to breed. The table is compiled from data provided by the present material (T), the Plymouth Marine Fauna, 2nd edition, 1931 (P), and Colosi, 1929 for the Mediterranean (C).

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Siriella armata	..	..	..	P	..	P	..	T	..	P	..	..
S. jaltensis	..	..	C	..	..	P	..	..	C	..	..	..
S. clausi	..	..	C	C	..	..	..	C	C	C	..	..
Gastrosaccus spinifer	T	..	..	..	..	..	..	..	..	..	..	..
G. normani	..	..	..	..	..	..	..	T	P	PC	..	..
Anchialina agilis	T	T	TC	..	..	P	..	C	..	TC	..	T
Erythrops elegans	..	..	..	..	..	P	..	..	..	P	..	..
Mysidopsis angusta	..	T	..	..	..	P	P	P	P	PT	..	T
M. gibbosa	..	..	..	P	..	..	P	..	..	..	T	..
Leptomysis gracilis	..	..	..	..	..	PT	T	T	T	T	..	..
L. lingvura	..	..	C	CP	C	C	C	..	C	PC	..	..
Schistomysis ornata	T	P	..	PT	T	..	..	T	T	P	..	T
Neomysis longicornis	..	..	..	..	T	PT	P	PT	P	P	P	..
Heteromysis formosa	..	..	..	..	..	..	..	..	..	P	P	..

The further question arises as to why there should be large numbers of immature forms in the bottom plankton during the winter and not at other times. Table II shows that mysids were breeding at other times of the year yet immature specimens were not conspicuously abundant in the bottom plankton hauls. In *Schistomysis ornata*, for instance, one of the dominating species of the winter maximum, adult females carrying eggs or embryos occurred in August, September and October, but there was no corresponding large number of immature forms in the bottom plankton. *Anchialina agilis* was also breeding earlier in the year without any marked accession of immature forms to the plankton. The explanation of these facts is probably to be found in an observation made by Russell (1927). He there notes the appearance of numbers of immature mysids in mid-water tow-nettings in July. This observation suggests that immature forms are more planktonic in habit than the adults, and that for the greater part of the year the young forms are to be sought for higher up in the water than the immediate bottom layer. In winter, conditions (e.g. temperature) are less favourable to a mid-water habit and the young forms are driven into deeper water and become concentrated in the bottom layer. On this assumption the winter maximum in the bottom layer would be an expression of the operation of a different set of factors from

that which brings about the summer maximum. At other times of the year the young forms might be scattered over a much greater range of depth of water. Moreover, the immature forms of the spring, summer and autumn broods rapidly become adult and sink to the bottom to take up their normal bottom-haunting life. The immature forms found in winter represent the overwintering stages of the species concerned and remain in the immature or non-breeding condition for a much longer period than is customary in the summer broods. If, as it appears, immature stages are more planktonic than adults, a greater concentration of young forms is to be expected in the winter months.

The winter of 1927–8 was not abnormal in respect to its winter maximum. Mr Russell has sent me some figures for bottom plankton hauls made in 1932–3 and these show markedly high numbers for December and January. I have not examined the material but the results suggest a winter maximum of the same nature as in the winter 1927–8.

Notes on the Species of Mysids

Fourteen species in all were found in the collection, of which one, *Gastrosaccus spinifer*, has not been recorded previously from the Plymouth area, though known from other parts of Devonshire and Cornwall.

Siriella armata (M.-Ed.).

Cawsand Bay, 12. viii. 27, seven specimens including one adult ♀, carrying embryos. A, 18. x. 27, one immature specimen.

Breeding females have been recorded from the Plymouth area in April, June and October. The occurrence of a breeding female in August fills a gap in this series and suggests that the species has a continuous breeding period at Plymouth lasting at least from April to October. This does not agree with the results of Fage's work at Concarneau where he found that the breeding period of the species extended from September to March.

Siriella jaltensis Czern.

6. xii. 27, R, 2 juv.: 15. xii. 27, R, 1 juv.; L4, 1 juv.: 21. xii. 27, R, 1 ♂: 3. i. 28, A, 3 ♂, 4 juv.; L4, 2 juv.: 11. i. 28, A, 7 ♂, 2 ♀, 16 juv.; R, 2 juv.; L4, 6 ♂, 13 ♀: 26. i. 28, R, 1 ♂, 1 ♀; L4, 1 ♂.

The species only occurred during the time of the winter maximum and then only in small numbers. No breeding specimens were found and none of the specimens is fully mature. This material throws no new light on the breeding season. The only Plymouth records of the breeding season refer to specimens caught in June. Fage (1933) gives the early spring, March and April, and the late summer, August and September, as the breeding times of this species at Concarneau. The only Plymouth record is just midway between these two periods.

Siriella clausi G. O. Sars.

3. i. 28, A, 1 adult ♀; L4, 1 adult ♂, 3 juv.: 17. i. 28, R, 4 juv.; L4, 3 juv.

None of the specimens is breeding and all but two are immature. The species was only met with during the winter maximum. There are no records of breeding females for Plymouth. Fage (1933) gives the same breeding season at Concarneau for this species as for *S. jaltensis*.

Gastrosaccus spinifer (Goës).

2. vi. 27, A, 2 juv.: 15. xii. 27, L4, 18 juv.: 21. xii. 27, A, 1 juv.: 3. i. 28, A, 2 ♀, 78 juv.; L4, 16 juv.: 11. i. 28, A, 30 juv.; R, 5 juv.; L4, 1 ♂, 1 ♀, 51 juv.: 30. iv. 28, A, 1 juv.

This species is new to the Plymouth fauna. It has, however, been recorded from Starcross, the mouth of the R. Exe, and Padstow (Norman & Scott, 1906). The two females caught at St. A in January were carrying eggs in the brood pouch. Fage (1933) states that at Concarneau breeding females were found from February to May.

Gastrosaccus normani (G. O. Sars).

	A			R			L4		
	♂	♀	juv.	♂	♀	juv.	♂	♀	juv.
15. vii. 27	..	..	..	..	..	..	..	..	1
19. viii. 27	..	1	..	..	..	..	..	..	..
6. ix. 27	..	1	1	..	..	..	..	..	..
4. x. 27	2	1	..	..	..	..	..	..	..
1. xi. 27	..	..	1	..	..	..	..	..	..
6. xii. 27	..	..	2	..	..	2	..	..	7
15 xii. 27	..	..	2	..	..	4	..	..	238
21. xii. 27	..	..	3	..	..	2	..	..	..
3. i. 28	..	..	79	..	..	..	..	..	17
11. i. 28	..	..	46	..	..	8	..	..	68
26. i. 28	..	..	..	4	4	..	..	..	..
23. iii. 28	..	..	..	1	..	..	..	..	..

Only one female carrying eggs appears in the collection and that was taken at St. A in August. Fage (1933) notes that the species is more abundant in the night plankton from the end of the summer to the end of the autumn and that this is its breeding season. In the present collection large numbers of immature specimens appeared in the bottom plankton in December and January. Previous Plymouth records show that breeding females have been found in September and October. The Plymouth observations, therefore, support Fage's conclusions that the summer and autumn are the breeding season for this species. The large number of immature specimens found in December and January represent the last of the autumn broods which are overwintering in the immature condition and will probably breed early in the spring.

One further point should be mentioned. Some of the specimens caught on January 11 and all those caught on January 26 and March 23 1928, had forwardly directed lobes on the carapace exactly as is found in *G. sanctus*, but the pleopods of the males of such lobed specimens were clearly of the *G. normani*

type. I have already called attention (1908) to the occurrence of lobed specimens captured by the "Huxley" in the Bay of Biscay in August 1906. I have never been able to solve this problem, but it does appear that the presence or absence of such lobes on the carapace is not infallible as a specific character.

Anchialina agilis (G. O. Sars).

	A			R			L4		
	♂	♀	juv.	♂	♀	juv.	♂	♀	juv.
8. vii. 27	..	..	..	..	..	18	..	..	..
5. viii. 27	..	..	..	..	..	..	3	..	..
12. viii. 27	..	..	..	..	..	..	2	..	..
19. viii. 27	2	4	..	..	..	..	..	..	..
25. viii. 27	..	..	..	1	1	..	1	..	..
31. viii. 27	..	..	..	4	1	..	..	..	..
6. ix. 27	..	2	..	..	..	..	..	..	..
15. ix. 27	..	..	..	1	..	..	..	..	..
4. x. 27	2	1	..	..	2	..	..	..	..
18. x. 27	2	..	..	..	..	..	..	..	..
25. x. 27	1	..	..	..	..	..	..	..	..
1. xi. 27	7	5	7	..	..	..	..	..	..
6. xii. 27	..	..	14	20	5	91	23	28	144
15. xii. 27	..	..	—	..	1	5	..	1	29
21. xii. 27	..	..	—	2	4	25	..	..	5
3. i. 28	21	24	51	..	..	..	3	2	22
11. i. 28	18	17	160	..	..	11	9	17	64
17. i. 28	..	..	..	..	1	3	..	..	..
26. i. 28	..	..	1	1	..	..	..	1	..
24. ii. 28	..	..	3	..	..	..	..	..	..
23. iii. 28	4	1	..	2	..	..	..	1	..

This species occurred sparingly in the adult condition during most of the year, but in December 1927 and January 1928 large numbers of immature specimens, accompanied by a good many adults contributed to the winter maximum. Breeding females occurred in October and December 1927, and January, February and March 1928. The large number of immature specimens in the winter is clearly correlated with active reproduction during the winter months. The increased number of adults in the winter also suggests that *Anchialina agilis*, like *Leptomysis gracilis*, becomes more planktonic and active in its movements during the breeding season. This reproductive planktonic phase in the adult is not so marked as in *L. gracilis*, but is perhaps more emphatic than in *Schistomysis ornata*. Other Plymouth records show that breeding females have been taken there in June. None of the specimens caught between July and October 1927 were actually carrying eggs or embryos, though some of them looked as if they had recently shed their brood.

Erythrops elegans (G. O. Sars).

2. vi. 27, A, 1 ♀; R, 1 ♂: 29. vi. 27, A, 2 ♀: 8. vii. 27, R, 3 ♀: 5. viii. 27, L4, 1 ♂: 19. viii. 27, A, 1 ♂: 18. x. 27, A, 1 ♀; R, 1 ♂: 1. xi. 27, A, 1 ♂: 6. xii. 27, R, 1 ♂; L4, 1 ♂, 5 ♀: 15. xii. 27, R, 1 ♂, 3 ♀; L4, 2 juv.: 3. i. 28, A, 1 ♂; L4, 1 ♀: 11. i. 28, L4, 1 ♀: 23. iii. 28, A, 2 ♀: 18. iv. 28, A, 2 ♂, 2 juv.

No breeding females occurred in the plankton, and the species made no contribution either to the summer or winter maximum.

Mysidopsis angusta G. O. Sars.

2. vi. 27, R, 1 ♂: 12. viii. 27, L4, 1 ♂: 19. viii. 27, A, 2 ♂, 2 ♀: 4. x. 27, A, 2 ♂, 1 ♀: 18. x. 27, A, 1 ♀: 25. x. 27, A, 1 ♂: 1. xi. 27, A, 1 ♂: 6. xii. 27, R, 1 ♂; L4, 3 ♂, 4 ♀, 7 juv.: 15. xii. 27, R, 1 ♂, 1 ♀, 1 juv.; L4, 1 ♂, 2 juv.: 21. xii. 27, R, 1 ♀, 4 juv.; L4, 1 juv.: 3. i. 28, A, 1 ♀; L4, 1 ♂: 11. i. 28, L4, 1 juv.: 23. ii. 28, A, 2 ♀: 23. iii. 28, L4, 2 ♂, 1 ♀: 23. iv. 28, A, 1 ♂; L4, 1 juv.: 30. iv. 28, A, 1 juv.: 11. v. 28, A, 1 ♀.

Breeding females occurred in October, December and February. The Plymouth records show a more or less continuous breeding season from June to February. The species contributes nothing to either the summer or winter maximum, but occurs as isolated specimens or in very small numbers all the year round in the bottom plankton.

Mysidopsis gibbosa G. O. Sars.

19. viii. 27, A, 3 ♀: 1. xi. 27, A, 1 ♀: 6. xii. 27, R, 2 juv.; L4, 1 juv.: 15. xii. 27, L4, 1 juv.: 11. i. 28, A, 1 ♀: 23. ii. 28, A, 1 ♂, 1 ♀.

The single specimen caught on November 1 1927, was a breeding female with embryos. Previous Plymouth records refer to breeding females caught in April and July. This suggests that the species has a continuous breeding season extending from April to November. The species is apparently a casual member of the bottom plankton fauna.

Leptomysis gracilis (G. O. Sars).

	A			R			L4		
	♂	♀	juv.	♂	♀	juv.	♂	♀	juv.
2. vi. 27	70	60	16	2	..	3	..	..	..
29. vi. 27	14	26	266	1	..	19	..	..	..
8. vii. 27	12	9	38	2180 (not sexed)			6	2	9
15. vii. 27	..	..	15	13	6	7	4	1	60
5. viii. 27	..	..	..	..	..	..	467	544	..
12. viii. 27	163	121	..	..	2	..	415	460	..
19. viii. 27	50	116	..	25	26	..	4	6	..
25. viii. 27	1	..	5	36	58	..	..	..	..
31. viii. 27	4	1	..	42	44	..	..	..	..
6. ix. 27	21	20	..	..	..	..	22	20	..
15. ix. 27	..	..	..	..	..	..	..	1	..
4. x. 27	28	15	3	5	1	..	2	..	1
18. x. 27	..	..	2	4	4	..	..	..	..
25. x. 27	2	..	..	..	..	..	..	..	..
1. xi. 27	4	5	..	2	..	..	..	..	..
6. xii. 27	..	..	2	..	..	3	2	..	6
15. xii. 27	..	..	7	..	..	1	..	1	208
21. xii. 27	..	..	..	..	..	2	..	..	..
3. i. 28	7	1	..	..	..	..	..	..	4
11. i. 28	..	..	4	..	..	8	1	..	2
17. i. 28	..	..	..	..	..	..	1	..	..
14. ii. 28	..	1	..	..	..	..	1	1	..
24. ii. 28	1	..	..	..	..	..	..	..	..
23. iii. 28	..	..	2	..	..	..	..	3	..
12. iv. 28	..	..	14	..	..	..	..	..	..
18. iv. 28	..	1	1	..	..	1	1	1	..
23. iv. 28	..	..	..	..	..	..	..	3	..
30. iv. 28	..	..	..	..	1	1	1	..	..
11. v. 28	25	55	..	..	..	..	11	13	..

This species is entirely responsible for the summer maximum of mysids in the bottom layer of water. Plymouth records, based mainly on the evidence of this collection, show that the species is actively breeding from June to October, females carrying eggs or embryos appearing in considerable numbers throughout that period. No breeding females were found after October and the numbers of specimens of the species in the bottom layers fell considerably for the remainder of the year from November to May. The only exception occurred on December 15 1927 at L4, when 208 immature specimens were caught. Adults again became numerous in the plankton in May and indicate that the species was again preparing for the breeding season.

The present material seems to suggest that *L. gracilis* becomes very active in the adult breeding condition, and leaves the actual bottom for a planktonic life at that time. They remain, however, in the bottom layer of water and here the young are liberated. It will be noticed from the table that during the breeding season the number of immature specimens in the bottom layer is not very large. The evidence supplied by Russell (1927) suggests that the immature forms at this time are to be found in the higher layers of water, about midway between the surface and bottom. In the winter months the immature stages are driven into deeper water, and the occurrence of 208 specimens at L4 in December 1927 seems to be explained on these grounds. In other words the depth position of the larvae in the plankton is influenced by environmental factors, probably by the temperature of the water.

This species therefore provides evidence of two types of movement, (i) a movement from a bottom living to a planktonic life in the adult condition for breeding purposes, and (ii) a migration of the immature forms to greater or lesser depths according to the season of the year, movements which are presumably influenced by temperature.

Leptomysis lingvura (G. O. Sars).

1. xi. 27, A, 1 ♂: 6. xii. 27, R, 1 juv.: 15. xii. 27, R, 3 juv.: 21. xii. 27, A, 2 juv.; R, 1 juv.: 11. i. 28, A, 2 juv.: 23. iii. 28, A, 1 juv.

All the specimens but one are immature and no breeding females were taken. Plymouth records refer to breeding females caught in April and October, but in the Mediterranean the breeding season appears to be a continuous one from March to October (Colosi, 1929).

Schistomysis ornata (G. O. Sars).

	A			R			L4		
	♂	♀	juv.	♂	♀	juv.	♂	♀	juv.
2. vi. 27	..	..	2	..	..	..	..	..	..
29. vi. 27	1	2	2	..	..	..	..	..	..
5. viii. 27	..	..	..	..	..	..	1	..	3
12. viii. 27	1	1	1	..	..	..	..	..	..
19. viii. 27	18	23	6	1	1	..	..	..	..
25. viii. 27	..	1	..	1	3	2	..	..	..

Schistomysis ornata (G. O. Sars) (*cont.*)

	A			R			L4		
31. viii. 27	6	1	..	..	..	..	..	..	..
30. ix. 27	..	..	..	..	1	..	..	..	..
4. x. 27	1	1	4	1	2	..	..	..	..
18. x. 27	..	..	..	1	3	2	..	..	..
1. xi. 27	2	3	9	..	..	..	..	..	1
6. xii. 27	..	..	1	..	..	326	..	..	285
15. xii. 27	..	..	1	8	17	184	1	1	54
21. xii. 27	..	..	..	1	3	6	1	..	..
3. i. 28	..	1	161	..	..	..	..	2	70
11. i. 28	..	..	867	..	..	20	..	..	321
26. i. 28	..	1	..	4	3	..	..	..	..
3. ii. 28	..	..	..	..	..	2	..	..	..
29. ii. 28	..	..	..	..	..	..	..	2	..
23. iii. 28	2	1	2	..	1	..	3	3	7
12. iv. 28	..	1	..	..	..	..	..	..	..
18. iv. 28	1	1	8	..	..	..	..	..	..
23. iv. 28	..	..	1	..	..	..	..	..	..
11. v. 28	..	1	1	..	..	..	..	..	..

The numbers of adult specimens in the bottom layer of water was never very large and may, for the most part, be accounted for as the result of a normal habit of swimming about idly near their bottom haunts. There is a faint suggestion that when breeding these movements are more marked, for on August 19 1927, when forty-one adults were caught at St. A, and on December 15 1927, when twenty-five adults were caught at St. R, the females in both hauls were carrying eggs or embryos. Such breeding movements are not nearly so well marked and definite as in *Leptomysis gracilis*, or in *Anchialina agilis*. On the other hand, immature specimens were largely responsible for the winter maximum of mysids in the bottom layer of water. The evidence from adult specimens shows that there was considerable breeding activity during December and January. From Table II, however, this species would appear to be breeding practically all the year round. In the present material breeding females occurred in January, April, May, August, September and December, and other Plymouth records show that breeding females have occurred in February and October. The question naturally arises as to what happens to the immature forms at other seasons of the year except the winter. The table of the occurrence of this species during 1927–8 shows no marked accession of immature forms to the bottom plankton at these times and there is no other evidence available. Russell (1927) does not mention this species when observing that immature mysids are to be found in mid-water hauls in considerable numbers. His remarks refer mainly to *Leptomysis gracilis*. It is possible, however, that at seasons of the year, other than winter, the immature forms may inhabit layers of water higher up than the bottom layer and that this may account for their absence in the bottom water at times other than winter when the adults are actively breeding.

To sum up, *Schistomysis ornata* does show some slight movements from its bottom living haunts to the bottom water for breeding purposes, but the

movement is not nearly so marked or so definite as in *Leptomysis gracilis*. Large numbers of immature forms occur in the bottom layer of the plankton in the winter, but there is no evidence of what happens to these immature forms at other seasons of the year.

Neomysis longicornis (M.-Ed.).

	A			R			L4		
	♂	♀	juv.	♂	♀	juv.	♂	♀	juv.
2. vi. 27	6	4	2	..	..	..	..	..	..
29. vi. 27	1	1	..	..	..	..	..	..	..
8. vii. 27	..	..	..	8	6	..	..	..	..
15. vii. 27	1	1	..	..	..	..	..	..	..
5. viii. 27	..	..	..	..	..	..	15	29	..
12. viii. 27	6	1	..	..	..	..	1	2	1
19. viii. 27	5	1	1	4	2	..	..	..	..
25. viii. 27	..	..	..	4	2	..	..	..	..
31. viii. 27	2	2	1	..	..	..	..	..	..
6. ix. 27	6	..	..	..	..	..	..	..	..
4. x. 27	..	1	..	..	..	..	..	..	..
6. xii. 27	..	..	..	..	1	..	..	5	..
15. xii. 27	..	..	..	1	..	1	5	1	79
3. i. 28	6	2	8	..	..	..	6	1	2
11. i. 28	21	19	48	..	..	..	29	34	4
24. ii. 28	..	3	..	..	..	..	..	..	..
23. iii. 28	..	..	..	1	..	..	..	..	..
11. v. 28	..	3	..	..	..	..	..	..	..

This species appears to behave very much as *Schistomysis ornata*. It occurred in small numbers fairly regularly throughout the year. Breeding females were captured in May, June and August, and the Plymouth records indicate a continuous period of breeding activity from May to November. The species took part in the winter maximum of mysids, there being a small accession of immature and young forms to the bottom layer of water in December and January.

Heteromysis formosa S. J. Smith.

23. iii. 28, L4, 1 adult ♂.

Summary

An analysis is made of the mysids which occurred in a series of bottom stramin net plankton hauls made at three stations in the Plymouth area in 1927–8.

There were two marked maxima in numbers of mysids, a summer one in July and August, and a winter one in December and January.

The summer maximum was due entirely to *Leptomysis gracilis*.

The winter maximum was due mainly to *Schistomysis ornata* and *Anchialina agilis*, but the two species of *Gastrosaccus*, and *Neomysis longicornis* also contributed to a lesser degree.

The summer maximum was composed mainly of adult males and breeding females of *Leptomysis gracilis* which appear to become markedly

planktonic in habit at the breeding season though keeping to the deeper layers. Immature specimens were present but the majority were probably higher up in the water (mid-water).

There is a suggestion that a similar planktonic habit is to be found in *Schistomysis ornata* and *Anchialina agilis* during their breeding period in the winter, but it is not nearly so marked as in *Leptomysis gracilis*.

The winter maximum is mainly due to large numbers of immature forms and it is suggested that environmental factors, probably temperature, cause a concentration of immature stages in the bottom water during winter. At other times of the year these immature forms are distributed over a much greater depth range of water.

Idle swimming movements just over the bottom are a normal habit of bottom living mysids.

The collection provides evidence of three types of movements in mysids: (i) idle swimming just over the bottom, (ii) definite and marked movements into the plankton in the adult condition during the breeding season, and (iii) movements of the immature forms to greater or lesser depths according to environmental conditions, probably temperature.

REFERENCES

COLOSI, G., 1929. I Misidacei del Golfo di Napoli. *Pub. Stat. Zool. Nap.*, Vol. IX, fasc. 3, pp. 405–41.

FAGE, L., 1933. Pêches planctoniques à la lumière effectuées à Banyulis-sur-Mer et à Concarneau. III. Crustacés. *Arch. Zool. Expér. Gén.*, Tome 76, pp. 105–248.

NORMAN, A. M. & SCOTT, A., 1906. *The Crustacea of Devon and Cornwall.* London.

RUSSELL, F. S., 1925. The vertical distribution of marine macroplankton. I. An observation on diurnal changes. *Journ. Mar. Biol. Assoc.*, Vol. XIII, pp. 769–809.

—— 1927. *Ibid.* V. The distribution of animals caught in the ring trawl in the daytime in the Plymouth area. *Journ. Mar. Biol. Assoc.*, Vol. XIV, pp. 557–608.

—— 1928*a*. *Ibid.* VI. Further observations on diurnal changes. *Journ. Mar. Biol. Assoc.*, Vol. XV, pp. 81–104.

—— 1928*b*. A net for catching plankton near the bottom. *Journ. Mar. Biol. Assoc.* Vol. XV, pp. 105–8.

—— 1931. The vertical distribution of marine macroplankton. XI. Further observations on diurnal changes. *Journ. Mar. Biol. Assoc.*, Vol. XVII, pp. 767–84.

—— 1933. The seasonal distribution of macroplankton as shown by catches in the 2-metre stramin ring trawl in offshore waters off Plymouth. *Journ. Mar. Biol. Assoc.*, Vol. XIX, pp. 73–82.

TATTERSALL, W. M., 1908. The Schizopoda and Isopoda collected by the "Huxley" from the north side of the Bay of Biscay in August 1906. *Journ. Mar. Biol. Assoc.*, Vol. VII, pp. 189–96.

—— 1936. The Zooplankton. V. The occurrence and seasonal distribution of the Mysidacea and Euphausiacea. *Great Barrier Reef Exped.* 1928–29. *Sci. Rep.* (*Brit. Mus.*), Vol. II, No. 8, pp. 277–89.