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LARVAE OF DECAPOD CRUSTACEA FROM THE ADRIATIC SEA

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INTRODUCTION

Benthic animals form an important part of the food of demersal fishes and so a study of their larvae could greatly contribute towards our knowledge of the economy of the sea. Many bottom animals fluctuate in numbers and location and it is perhaps through their larvae that the most immediate explanation of these changes may be found. The larvae themseves are valuable as food of fish, for as S a v a g e (1931) observes, the Decapod larvae sometimes form an important part of the herring food.

Besides helping to find the breeding habits of the different species, the study of the larval forms helps also for systematic classification, as often the classification based on the study of the larval forms is well, founded. As G u r n e y (1940) observes, the adult of *Sergestes* spp. are so similar that even for an expert it is rather difficult to separate the different forms; but the larval forms of these vary so remarkably in structure and form, especially in the early stages that easy separation is possible. Knowledge of the identity of the larvae together with the duration of larval life may contribute also towards the study of the Ocean currents.

Among the early workers, C l a u s (1861—1886) has done the most valuable contributions towards the knowledge of decapod development. C a n o (1891—1892) gave valuable contributions towards the development of the Mediterranean species. M o n t i c e l l i and L o B i a n c o (1900—1902) and H e l d t (1938 and 1955) did excellent work regarding the development of Mediterranean *Penaeids*. During recent years, our knowledge about the decapod larvae has been very much increased by the works of L e b o u r and G u r n e y. But even now as T h o r s o n (1946) observes very little is known from an ecological point of view, namely on the spawning and development of the group all the year round.

within a limited area, in relation to temperature, salinity, food conditions etc. Stephensen (1923) has given valuable notes regarding the occurrence of the different larval forms obtained by the »Thor« expedition from the Mediterranean Sea. But no work has been hitherto done on the seasonal and zonal distribution of the decapod larvae in the Adriatic Sea. In the present paper, an attempt has been made to study the systematics and the occurence of the larvae in the plankton throughout the year to form a picture of the breeding season, zonal distribution, the breeding intensity etc.

The main series collections was taken from the sea near the Island Mljet. But collections taken from lake Mljet and some other stations in the Adriatic Sea are also made use of for the sake of comparison. The collections contain a variety of very interesting forms, and as far as possible the species have been identified.

I take this opportunity to express my deep indebtedness to Dr. S. Stanković, Chairman of the Academic Council, Belgrade, for his valuable suggestions and supervision throughout the period of my work. I am grateful to Dr. T. Šoljan and Dr. O. Karlovac for giving this problem for investigation and for their valuable suggestions. To Dr. M. Buljan I am thankful for the interest he has shown in the work and for furnishing me with the hydrographical data collected from Mljet. To Prof. I. Hoenigman and Prof. T. Vučetić I am thankful for handing over to me the collections from Mljet and to Prof. J. Hure for the valuable collections from the Dubrovnik area.

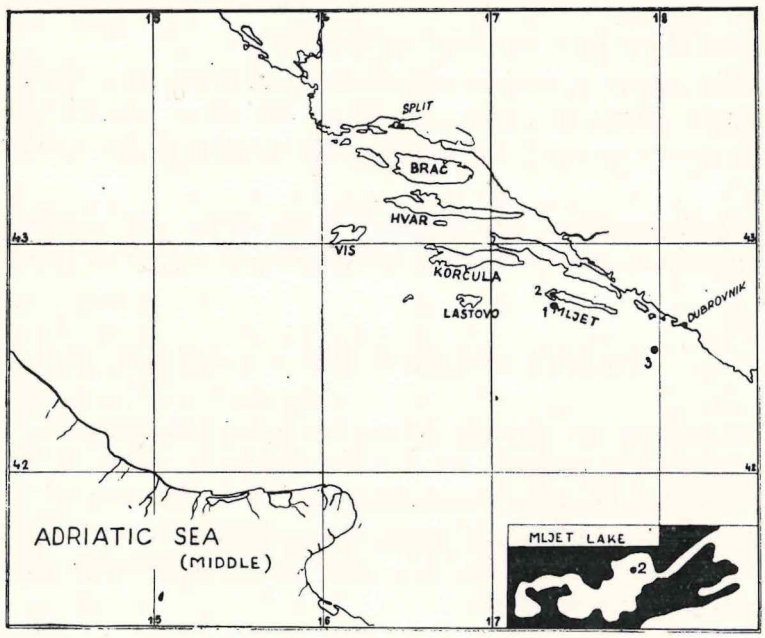
The work was carried out during the tenure of a stipend awarded to me by the Federal People's Republic of Yugoslavia, for which I am indebted to the Commission for the Cultural Relations, Belgrade.

MATERIAL AND METHOD

The main series of collections of larvae has been obtained from the plankton taken one to two miles south of Island Mljet (Gonoturska) in the Adriatic Sea. With a view to study the seasonal intensity, uniform collections were made once in every five weeks during day time, from February 1952 to March 1953, with the same stramin net (2m. diameter, 6m. length, by oblique hauls from a depth of 60m. to surface and the duration of time was kept as 30 minutes in all the cases. In this region the depth of water is about 100m. and the sea bottom is mostly sandy.

A series of collections from the lake Mljet (Vrbovačka), taken during the same period with H e n s e n net (73 cm. diameter) was also analysed to study the probable difference in the seasonal occurrence of the larval forms under the lake conditions.

Regarding the Mljet lake fauna some interesting aspects have been observed and so it will be worthwhile to mention about the topography of the lake. Situated in the Island Mljet, it is 1.69 sq. km. in area, having a greatest depth of 46m., is connected with the Adriatic Sea by a shallow



Map I. Adriatic Sea (middle) showing the stations from where the major collections were made.
St. 1. Mljet (Gonoturska).
St. 2. Mljet Lake (Vrbovačka).
St. 3. Dubrovnik (South of Sv. Andrija).

canal about 4m. broad and 1m. deep, through which there is a free flow of water during the tides. The lake itself is divided into two parts the Great lake and the Little lake, the former being nearer to the sea. The collections referred to here have been taken from the Great lake.

In order to study the diurnal variations in the vertical distribution of the larvae, vertical collections were taken from three different depths

(0—10 m., 10—20 m., and 20—30 m.) in the lake Mljet using Nansen closing net, 73 cm. diameter, during day and night.

A series of horizontal collections taken from a station 6—7 miles south of light house Sv. Andrija (11—12 miles away form the main land) near Dubrovnik, every month from October 1951 to November 1952 in 3 levels: 0—50 m., 50—100 m., and 100—150 m., where the depth of the sea is 160—170 m., using closing stramin net (»Utzor« net Manufactory, Kobenhaven, 1m. diameter) is also made use of, to study the seasonal and zonal distribution of the different species. In this case the collections were taken between 9—10 A.M. in winter and 8—11 A.M. in summer and the duration of the haul was kept as 30 minutes.

Another series of vertical collections from Mljet (Gonoturska) from five levels (0—20 m., 20—40 m., 40—60 m., 60—80 m., and 80—100 m.) is also made use of to study the vertical distribution of the most common species.

The hydrographical data collected from Mljet (Gonoturska), Mljet lake (Vrbovačka) and Dubrovnik (Sv. Andrija) are given in the tables I to III.

DESCRIPTION OF LARVAE

In attempting to identify larvae in preserved material, the only clues to systematic position are our knowledge of larvae of which the identity has already been established and those features of the adult which appear late in larval life. Some of the specimens are hence referred only to their genera, with the hope that future knowledge about them could locate them satisfactorily.

The classification followed is that of Fenner A. Chace Jr. (1951). Only the important and recent references are given under each species as a complete list of the references are given by Gurney (1939 & 1942) in his monographs.

List of species.

Order Decapoda

Sub-order Natantia

Tribe Penaeidea

Family PENAEIDAE

1. *Gennadas elegans* Smith.
2. *Aristaeomorpha foliacea* (Risso).
3. *Solenocera membranacea* (H. M. Edwards).
4. *Penaeus kerathurus* Forskal.
5. *Penaeus* sp.
6. *Sicyonia carinata* Olivier.

Family SERGESTIDAE

7. *Sergestes arcticus* Kroyer.
8. *Sergestes robustus* Smith.
9. *Sergestes corniculum* Kroyer.
10. *Sergestes sargassi* Ortm. Hansen.
11. *Sergestes vigilax* Stimpson.
12. *Lucifer typus* H. M. Edwards.

Tribe Caridea

Family HOPLOPHORIDAE

13. *Acanthephyra purpurea* A. Milne Edwards.

Family PROCESSIDAE

14. *Processa edulis* (Risso).
15. *Processa canaliculata* Leach.

Family PANDALIDAE

16. *Plesionika* sp?

Family ALPHEIDAE

17. *Alpheus ruber* M. Edwards.
18. *Athanas nitescens* Leach.

Family CRANGONIDAE

19. *Philocheras sculptus* (Bell).
20. *Philocheras bispinosus* (Hailstone & Westwood).
21. *Pontophilus spinosus* Leach.
22. *Pontophilus norvegicus* (Sars).

Family HIPPOLYTIDAE

23. *Spirontocaris cranchii* (Leach).
24. *Spirontocaris* sp.
25. *Caridion steveni* Lebour.
26. *Lysmata seticaudata* Risso.
27. *Latreutes* sp.

Family PALAEMONIDAE

28. *Leander serratus* (Pennant).
29. *Leander pacificus* Stimpson.
30. *Periclimenes* sp.
31. *Mesocaris* sp. 1.
32. *Mesocaris* sp. 2.

Tribe Stenopodidea

Family STENOPODIDAE

33. *Stenopus spinosus* Risso.

Sub-order Reptantia

Tribe Palinura

Family PALINURIDAE

34. *Palinurus vulgaris* Latr.

Family SCYLLARIDAE

35. *Scyllarus arctus* Linné.

Tribe Astacura

Family HOMARIDAE

36. *Nephrops norvegicus* (Linné)

Tribe Anomura

Family GALATHEIDAE

37. *Munida bamffica* (Pennant).
38. *Galathea strigosa* (Linnaes).
39. *Galathea squamifera* Leach.
40. *Galathea dispersa* Sp. Bate.
41. *Galathea intermedia* Lilljeborg.

Family PORCELLANIDAE

42. *Porcellana longicornis* (Pennant).

Family AXIIDAE

43. *Axius stirynchus* Leach.

Family LAOMEDIIDAE

44. *Jaxea nocturna* Nardo.
45. *Jaxea* sp.

Family CALLIANASSIIDAE

46. *Upogebia stellata* (Mont.)
47. *Upogebia deltaura* Leach.
48. *Callianassa subterranea* Leach.

Family PAGURIDAE

49. *Anapagurus chiroacanthus* (Lilljeborg).
50. *Eupagurus pubescens* (Kroyer).

Tribe Brachyura

Family DROMIDAE

51. *Dromia vulgaris* Milne Edwards.

Family DORIPPIDAE

52. *Ethusa mascarone* Herbst.

Family LEUCOSIDAE

53. *Ebalia tuberosa* (Pennant).
54. *Ebalia cranchii* Leach.

Family PORTUNIDAE

55. *Portunus depurator* (Linné).
56. *Carcinus maenas* Pennant.

Family ATELECYCLIDAE

57. *Atelecyclus septemdentatus* (Montagu).

Family XANTHIDAE

58. *Xantho incisus* Leach.

Family GONOPLACIDAE

59. *Gonoplax rhomboides* (Linné).

Family MAIIDAE

60. *Maia squinado* (Herbst).

Family PENAEIDAE

GENNADAS ELEGANS Smith (Figs. 1—17).
Stephensen, 1923.
Heldt, 1938.

The stages from protozoea II to the last mysis are represented in the collections. The protozoeae resemble in appearance those of *Penaeus kerathurus,* but differ in the presence of lateral spines on the fourth and dorsal spine on the sixth abdominal somites. Heldt (1938) mentions only 4 mysis stages of this species ranging from 3.73 to 6.0 mm. in length. In the present collections 6 distinct stages may be demarked.

PROTOZOEA II: Length 1.81 mm.

PROTOZOEA III: Length 3.00 mm.

Biramous rudiments of pleopods formed, each tipped with 2 setae. Abdominal somites bear dorsal spines, of which the second is the longest; last 3 somites bear lateral spines also.

MYSIS I: Length of body 2.62 mm. Rostrum 1.00 mm.

Eyes with small stalk. Supra-orbital long and slender, more than half as long as eye. Branchiostegal spine small. Abdominal somites 2 to 6 with

prominent dorsal spines, that of second long and curved. Telson forked for 1/3 its length excluding the apical spines. Six spines present at the apices of each branch and at about the level of the forking the lateral sides of the telson show 2 small spines.

Peduncle of first antenna indistinctly segmented into 3, bears an inner spine at about the middle of the basal segment. Second antenna

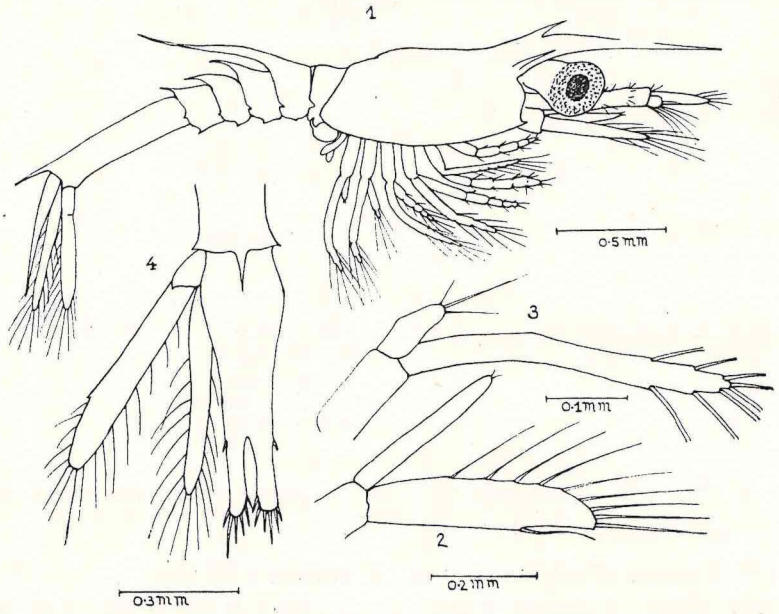


Fig. 1. *Gennadas elegans*, I mysis, profile.
Fig. 2. „ „ , II antenna.
Fig. 3. „ „ , IV peraeopod.
Fig. 4. „ „ , telson & uropod.

with flagellum smaller than scale; scale with a single seta on the outer margin. Endoped of first peraeopod 5-jointed, as long as the exopod; third and fourth peraeopods small; fifth rudimentary. First pleopod appears as a very small bud.

This stage corresponds to Stephensen's specimen 3.5 mm. long and also that described by Claus (1876). But in the present specimen the lateral spines of the telson are situated at about 1/3 the length of the telson from the free end, whereas in Stephensen's specimen these spines are situated »mid way on either side« of the telson.

MYSIS II: Length of body 3.00 to 3.55 mm Rostrum 1.24 to 1.37 mm.

Most of the specimens obtained belong to this and the previous stage, the only remarkable differences are — the supraorbital spines get larger, branchiostegal spine is about 1/2 as long as hepatic, telson forked for slightly more than 1/4 its length, the lateral spines of the telson are seen

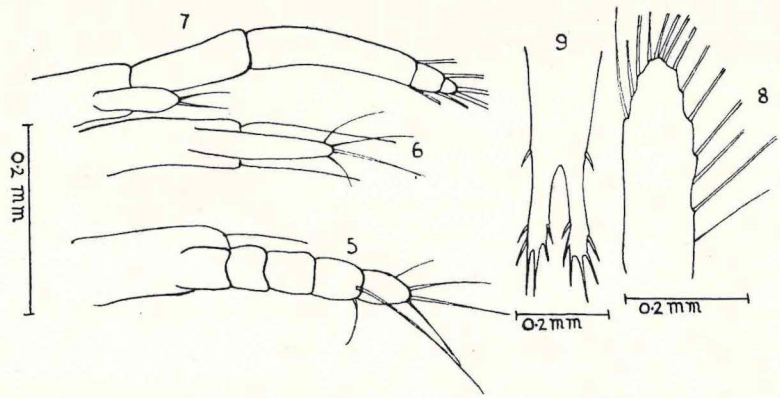


Fig. 5. *Gennadas elegans*, II mysis, endopodite of III peraeopod.
Fig. 6. „ „ , IV peraeopod.
Fig. 7. „ „ , V peraeopod.
Fig. 8. „ „ , tip of II antenna.
Fig. 9. „ „ , telson (distal part).

in front of the fork, endopods of I to III peraepods segmented and all pleopods appear as small buds.

MYSIS III: Length of body 3.72 mm. Rostrum 1.03 mm.

At this stage the telson is forked for slightly less than 1/4 its length, excluding the apical spines. Lateral spines are seen still forward. Endopod

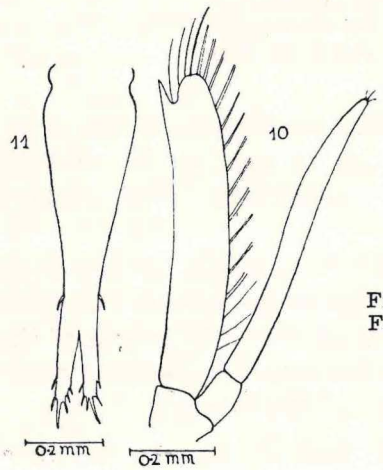


Fig. 10. *Gennadas elegans*, III mysis, II antenna.
Fig. 11. „ „ , telson.

of IV peraeopod shows 5 joints, that of V with 3 joints. Pleopods show minute bifurcation.

MYSIS IV: Length of body 4.13 mm. Rostrum 1.72 mm.

Telson cleft for 1/5 its length. Flagellum of II antenna longer than antennal scale, its distal half shows 11 segments. Apical spine of antennal scale small. Propodus of first 3 peraeopods get enlarged,

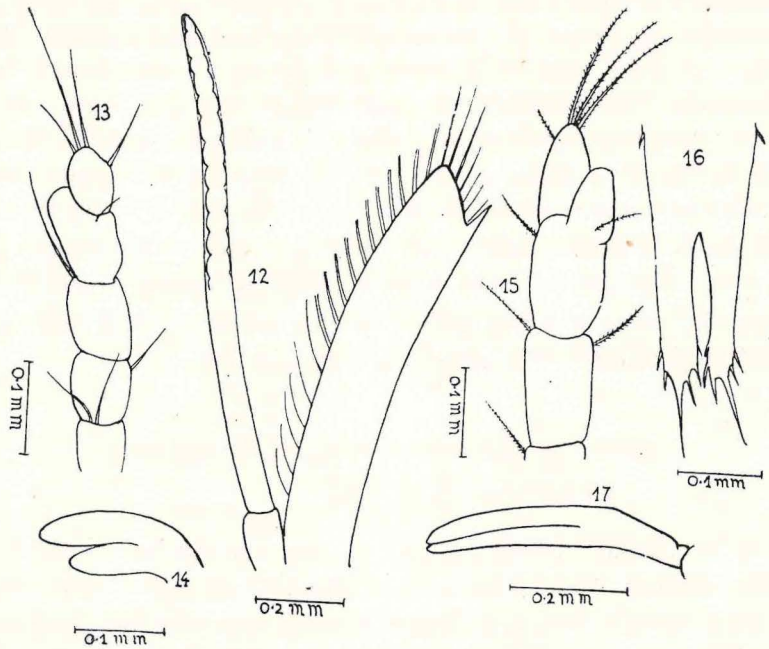


Fig. 12. *Gennadas elegans,* IV mysis, II antenna.
Fig. 13. „ „ , I peraeopod (endopodite).
Fig. 14. „ „ , V pleopod.
Fig. 15. „ V mysis , I peraeopod.
Fig. 16. „ „ , telson.
Fig. 17. „ „ , pleopod.

beginning the formation of chelae. Endopod of V peraeopod with 5 joints. Fifth peraeopod bears 1 branchia, IV peraeopod 3 branchiae and the other peraeopods 2 each.

MYSIS V: Length of body 4.86 mm. Rostrum 1.76 mm.

Supra-orbital spine reduced in size. Peduncle of eye shows a lateral bulging. Telson cleft for slightly less than 1/6 its length. Flagella of I and II antennae very long. Pleopods longer, but without setae.

MYSIS VI: Length of body 5.37 mm. Rostrum 2.00 mm.

This stage resembles the fig. 128 of Heldt (1938). This seems to be the last mysis stage which moults in to the postlarva. Lateral prominences of the eye-stalk more prononuced. Telson cleft for 1/7 its length. Pleopods long, last one 2½ times the segment which bears it. Formation of setae visible under the skin. In the case of pleopod, this stage seems to be more advanced than that figured by Heldt.

Distribution: Stephensen (1923) observes that in the Mediterranean the larvae of this species were taken in December, January to April and June and they were not found in the hotest months. The collections from Gonoturska and Dubrovnik also show the same result- the larvae being most abundant in February and no larva was obtained during the summer months. In the deep water regions the larvae are found to be distributed within 50 m. and only very few specimens were collected from greater depths. At Split also, the early stages of this species were obtained in large numbers during January and February, indicating the main breeding period of this species in the regions under investigation. No larva was obtained from the lake.

ARISTAEOMORPHA FOLIACEA Risso
Stephensen, 1923.

From the Mediterranean, larvae of this species have been recorded from 660—3500 m. (Stephensen *Op. Cit.)* greather than the depth for the adult (400—1300 m.). The species is recorded for the first time from the Adriatic.

The single specimen obtained in the December 1952 collection from Mljet, within 60m. of length 10.0 mm. (from tip of rostrum to end of telson, including the long apical spines) agrees with the discription of Stephensen (1923, pp. 15, 16) and seems to be at the same stage as shown in fig. 6 (Mysis IV?).

Rostrum with 3 teeth dorsally, of which posterior most one very small. Flagellum of II antenna bears 3 small setae at the rounded apex. In Stephensen's figure it is unarmed. First 3 peraeopods chelate though small and not developed. Pleopods about as long as the somites which bear them, formed on the first 5 pleon segments, but without setae. Sixth abdominal somite bears 5 pairs of short spines in the ventral region.

SOLENOCERA MEMBRANACEA (Philippi) Figs. 18—29.

Stephensen, 1923 *(S. siphonocera)*
Heldt, 1938, 1955.

PROTOZOEA II: Length of body 1.37 — 1.65 mm. (without rostrum)
Rostrum 0.31 mm.

Eye with a very small ventral papilla. Dorsal organ large. Body with prominent rostrum and supra-orbital and hepatic spines. Carapace with marginal lappets bearing teeth. Last 5 thoracic somites seen outside carapace. Each arm of the forked telson bears 7 setae. Third maxilliped small and biramous. The 5 peraeopods appear as small lobes on the ventral side of the thoracic somites.

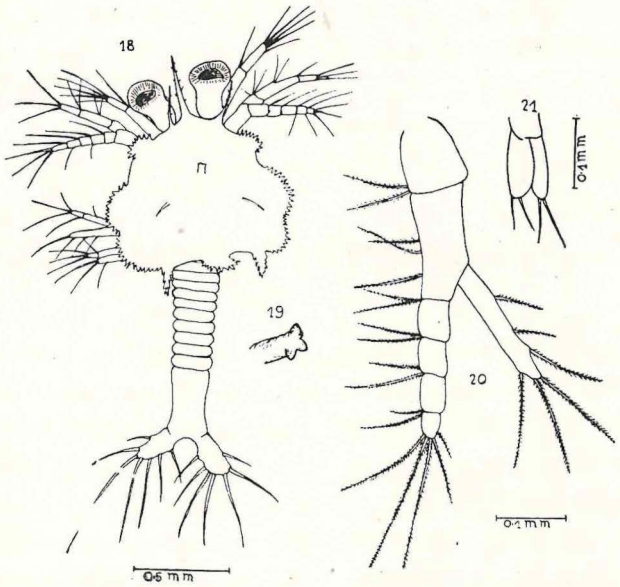


Fig. 18. *Solenocera membranacea*, II protozoea, dorsal view.
Fig. 19. „ „ , dorsal organ.
Fig. 20. „ „ , II maxilliped
Fig. 21. „ „ , III maxilliped.

The present specimens are smaller than those found by Heldt which measure 2 — 2.3 mm. The carapace also shows lesser number of spines than in the Tunisian specimens. Second maxillipeds resemble those of Heldt (1955, p. 36), but III maxilliped is not so developed as shown in her figures. Here the two lobes bear only end setae which are not plumose.

PROTOZOEA III: Length of body 3.41 — 3.75 mm. Rostrum 0.45 mm.

Only last 2 thoracic somites seen outside the carapace. Abdominal somites bear dorsal and lateral spines. Each arm of telson with 8 setae. Third maxilliped larger, but without joints, bears only terminal setae. Five peraeopods present as leaf-like processes having terminal setae. Exopod of uropod with 5 and endopod with 3 setae.

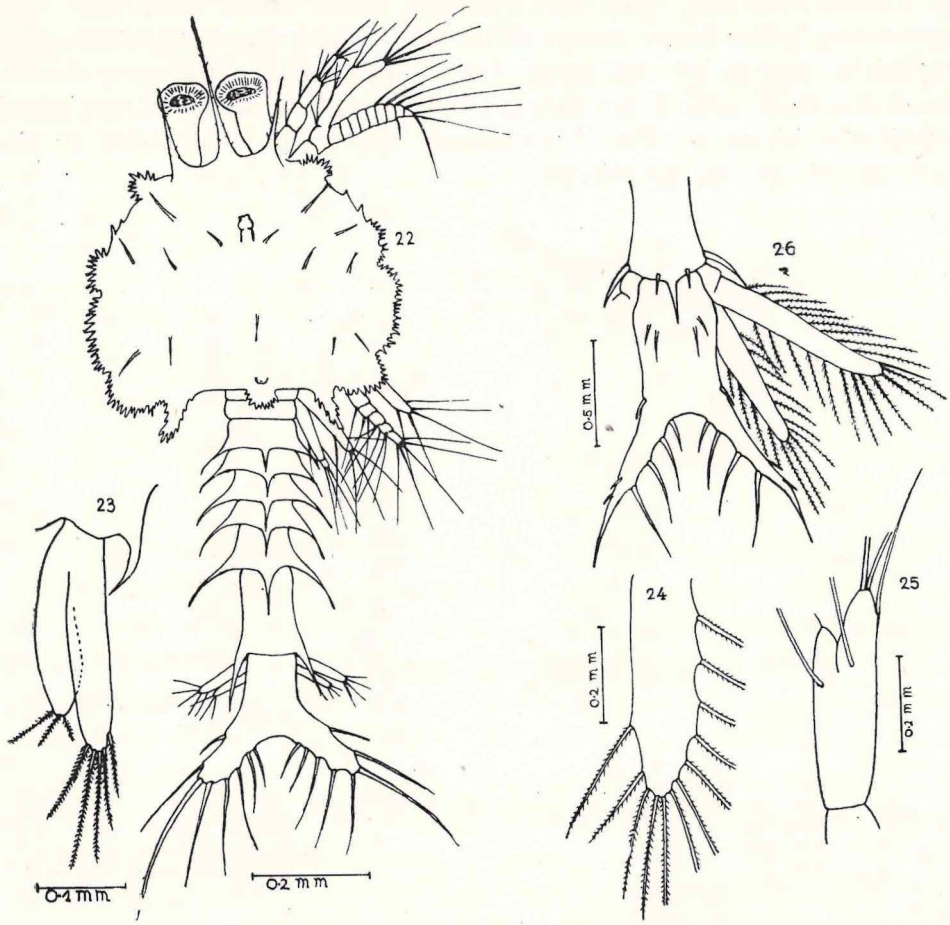


Fig. 22. *Solenocera membranacea,* III protozoea, dorsal view.
Fig. 23. „ „ , uropod (ventral wiew).
Fig. 24. *Solenocera membranacea,* I mysis, antennal scale.
Fig. 25. „ „ , I peraeopod — chela.
Fig. 26. „ „ , telson & uropod.

MYSIS I: Length of body 3.45 — 4.48 mm. Rostrum 0.69 mm.

Dorsal organ small. Carapace with 4 lateral spines anteriorly.

Lappets bearing teeth restricted to the antero-lateral and postero-lateral corners. Abdominal somites with dorsal, lateral and dorso-lateral spines. Flagellum of II antenna almost equal to scale, scale without distal spine. Terminal segments of first to third peraepods show chelae.

MYSIS II: Length of body 6.34 — 6.90 mm. Rostrum 1.55 mm.

Teeth on side of carapace very small, often seen only at the postero-lateral corners. Antennal flagellum more than 1½ times the scale, scale with distal spine. Five pairs of pleopods formed as finger-like processes bearing termina[1] setae. Podobranchiae present on II maxilliped.

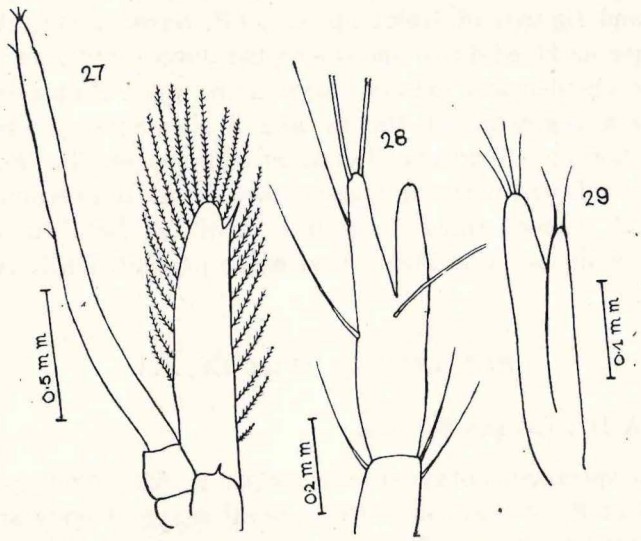


Fig. 27. *Solenocera membranacea*, II mysis, II antenna.
Fig. 28. „ „ , I peraeopod (distal part).
Fig. 29. „ „ , I pleopod.

Distribution: Lo Bianco (1902, 1904) observes that the larvae were found throughout the whole summer upto a depth of 300m. and that at other seasons may also be taken at the surface. Stephensen (1923) says that the »Thor« larvae were mostly taken in June and September and numerous larvae were found at depths much greater than those, where adults are more frequent. (50—70 m.) and that most of the larvae were taken during night. In the Adriatic the larval stages are found almost throughout the year with the maximum abundance in August-September. A second lower peak is also found in January, suggesting the probable existence of 2 breeding seasons. The second protozoea stage is found in large numbers in December and January.

Most of the larvae, particularly the early stages are observed within 100 m., whereas only the first and second mysis stages have been obtained below 100 m. The larval stages of this species are not present in the lake collections.

PENAEUS KERATHURUS Forskal.
Heldt, 1938.

PROTOZOEA II: Length 2.2 mm.

Two specimens obtained from Mljet in January 1953 agree with the description and figures of Heldt op. cit., *(P. trisulcatus),* but these are slightly longer as Heldt's specimens measured only 1.44 — 1.76 mm.

Rostrum slender and extends beyond the eyes. Supra-orbital spines prominent. Six segments of thorax and 5 segments of abdomen seen outside the thoracic shield and distinctly constricted, the last abdominal somite being confluent with the telsonic fork. First and second maxillipeds biramous and setose, third fingerlike, with 2 distal setae. First 4 peraeopods visible as small buds. Anal spine present. Each arm of telson with 7 setae.

PENAEUS sp. (Figs. 30, 31)

PROTOZOEA III: Length 6.7 mm.

A single specimen obtained from Mljet in May 1952 resembles the protozoea III of *P. kerathurus* in the general shape of body and armature of the abdomen, but it is distinctly longer as *P. kerathurus* measures only ca. 2.2 mm.

Rostrum very long, reaching to the extremity of the first antenna. Eyes borne on distinct peduncles, reaching foward to the extremity of exopod of II antenna. No supra-orbital seen. First antenna 3-jointed as in *P. kerathurus,* bears distally 2 long and 3 small setae. Exopod of II antenna shows 10 segments and endopod 2 segments. Last 6 segments of thorax bears more or less similar, biramous leaf-like processes representing the last 6 pairs of thoracic appendages. First 5 abdominal somites bear dorsal spines, fifth has an additional lateral spine on each side and sixth with 2 pairs of lateral spines. Exopod of uropod with 4 distal setae and endopod with a small seta. Each arm of telson with one spine and 7 plumose setae. Pleopods formed as ventral prominences on the first 5 abdominal somites.

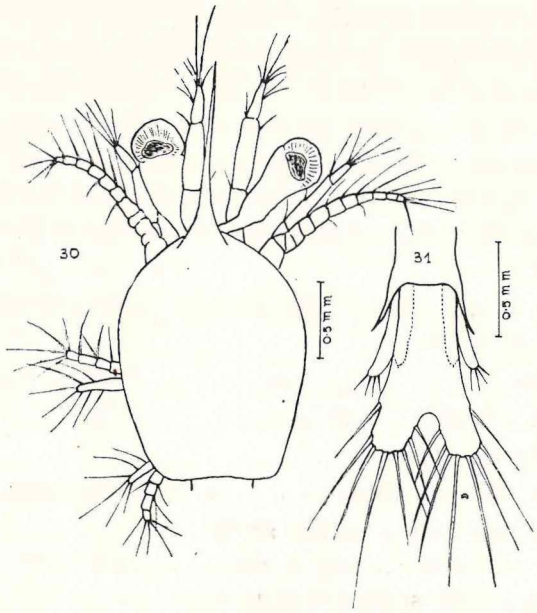


Fig. 30. *Penaeus sp.*, III protozoea, anterior part (dorsal).
Fig. 31. *Penaeus sp.*, III protozoea, telson & uropod.

SICYONIA CARINATA Olivier
Stephensen, 1923.
Heldt, 1938.

MYSIS I: Length 2.3 mm.

Rostrum small and slender, about half as long as first joint of antennular peduncle. Eye with a prominent inner tubercle. Supra-orbital and pterygostomial spines present. Only sixth abdominal somite bears a small median dorsal spine. Telson cleft behind with 6 spines on each lobe at the extremity and 2 marginal spines, one on each side. Uropods as long as telson. First 5 abdominal somites with pleural spines. All peraeopods formed.

Distribution: In the present collection only a single specimen is present, obtained from Mljet in August 1952. Stephensen *op. cit.* observes that the spawning time is from »May to June, perhaps also in Autumn«.

Family SERGESTIDAE

Genus *SERGESTES*

In the present collection larval stages of 5 species of this genus are found, but most of the specimens belong to the 2 species *S. arcticus* and

S. robustus. Generally there are 3 elaphocaris, 2 acanthosoma and a number of mastigopus (the actual number varying according to species) stages, till it attains the adult form.

The first elaphocaris stage is not present in the collections though the second and third stages of the two common species are found in large numbers, probably because the meshes of the coarse stramin net used are too big to trap these small larval forms, or they may be absent in the layers where the net was hauled.

Only acanthosoma stages of all the 5 species are represented and they may be distinguished as follows:

1. Abdominal somites 1 and 2 with ventral spines *S. vigilax*
   Abdominal somites 1 and 2 without ventral spines . . 2.
2. Thorax with posterior dorsal spine . . . . . 3.
   Thorax without posterior dorsal spine . . . . *S. corniculum*
3. Eye, long and slender, eye-ball nearly round. Setose part of exopod less than 1½ times as long as bare . . 4.
   Eye-ball large, asymmetrical, setose part of exopod of uropod about double bare part . . . . . *S. sargassi*
4. Lateral spines of abdominal somite 5 very long, longer than those of fourth . . . . . *S. robustus*
   Lateral spines of abdominal somite 5 very small, smaller than those of fourth . . . . . *S. arcticus*.

SERGESTES ARCTICUS Kroyer (Figs. 32—38)
Hansen, 1922.
Gurney & Lebour, 1940.

ELAPHOCARIS II: Length of body 1.17 mm. (from base of rostrum to fork of telson). Rostrum 0.66 mm.

Rostrum with 3 pairs of long spines, each lateral process with 8 spines and a posterior process with 3 pairs of spines, all spines ending in brush of setae, which is characteristic in this species. Carapace about as long as broad.

ELAPHOCARIS III: Length of body 1.55 mm, Rostrum 1.34 mm.

Supra-orbital process formed with 9 spines and posterior process has 2 more pairs of spines. Eye longer, 8/11 of carapace, eye-ball 1/4 the length of eye.

ACANTHOSOMA I: Length of body 3.0 mm. Rostrum 1.13 mm.

Rostrum with prominent basal spine. Supra-orbital about 5/6 as long as eye. Hepatic, marginal and posterior spines equal and slightly smaller than those of 3 to 5. Eye-ball slightly less than 1/4 the length of eye. Pleopods rudimentary. Exopod of uropod has bare part 5/7 as long as the setose part.

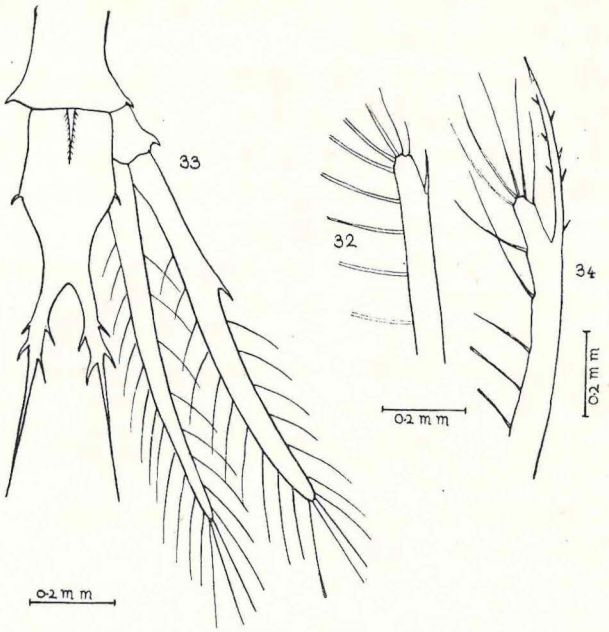


Fig. 32. *Sergestes arcticus*, I acanthosoma, antennal scale.
Fig. 33. „ „ , telson & uropod.
Fig. 34. „ II acanthosoma, antennal scale.

ACANTHOSOMA II: Length of body 3.82 mm. Rostrum 1.0 mm.

Carapace slightly longer than in previous stage. Antennal scale bears an apical spine, which is about 1/3 the length of scale. Pleopods 2 to 5 with rudiments of exopods.

MASTIGOPUS I: Length of body 5.03 mm. Rostrum 0.7 mm.

Rostrum small, reaching to the end of the first segment of antennule, basal spine slender, about 1/4 as long as rostrum. Length of carapace slightly less than twice its width. Posterior dorsal spine very small. Dorsal organ prominent. Pleural spines present on first to fifth abdominal somites. Telson about 2 1/2 times as long as wide.

Eye with long stalk, about $^{2}/_{7}$ length of body. Exopod of uropod with basal part nearly equal to setose part.

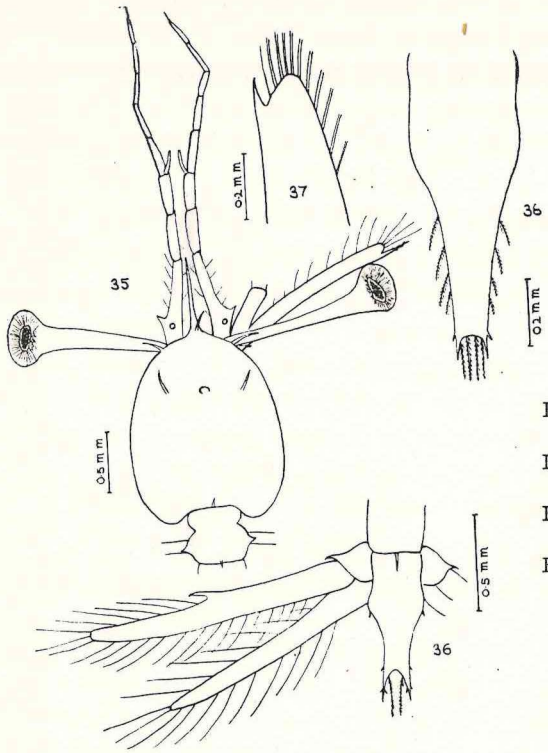


Fig. 35. *Sergestes arcticus*, I mastigopus, anterior part.
Fig. 36. *Sergestes arcticus*, I mastigopus, telson & uropod.
Fig. 37. *Sergestes arcticus*, II mastigopus, antennal scale.
Fig. 38. *Sergestes arcticus*, II mastigopus, telson.

MASTIGOPUS II: Length of body 6.72 mm. Rostrum 0.24 mm.

Basal spine of rostrum very minute. Dorsal organ indistinct. Posterior dorsal spine not present. Abdominal somites 1 to 5 without dorsal spines, sixth with small dorsal spine. Spine at the outher margin of antennal scale reaches only to the level of the end of apical lobe. Telson with marginal and ventral setae. Uropods with bare part $1^{1}/_{2}$ times the setose part. Eye $^{1}/_{5}$ length of body. Last 2 legs rudimentary.

Distribution: Very little is known about the seasonal and zonal distribution of the larvae of this species. Near Mljet and Dubrovnik they are found from January to June, most common from January to March, with maximum in January. The January specimens constitute mostly the second and third elaphocaris stages, probably suggesting the spawning time of the species, whereas during later months acanthosoma and mastigopus stages are common. The larvae are also more common in

slightly deeper water (below 50 m.) than in the surface. Younger stages are seen more numerous between 50 to 100 m. In the lake collections sergestid larvae are not present.

SERGESTES ROBUSTUS Smith (Figs. 39—49)

Hansen, 1922.
Gurney, & Lebour, 1940.

ELAPHOCARIS II: Length of body 1.16 mm. Rostrum 0.76 mm.

Rostral, lateral and posterior processes with long spinules at base and smaller ones distally. A slight swelling characteristic of this species is observed at the base of the lateral processes.

Eye small with a papilla on inner side.

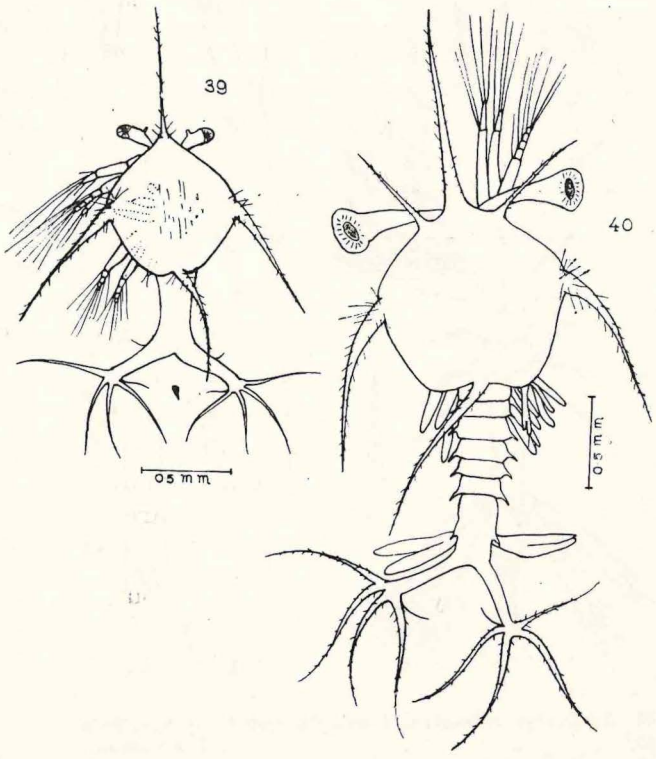


Fig. 39. *Sergestes robustus*, II elaphocaris, dorsal view.
Fig. 40. „ , III elaphocaris, dorsal wiew.

ELAPHOCARIS III: Length of body 2.0 mm. Rostrum 1.03 mm.

Rostrum without spinules at base. Supra-orbital spines longer than eyes. Eye about 1/3 length of body; diameter of eye about 2/5 length of eye.

ACANTHOSOMA I: Length of body 3.27 mm. Rostrum 1.72 mm.

Resembles the form described by Hansen (1922, p. 117, pl. vii, fig. 1d) and slightly differs from that of Gurney and Lebour op. cit. Rostrum slightly longer than thorax. Carapace longer than wide. Supra-orbital nearly as long as eye. Hepatic spines large, without spinules. Posterior dorsal spine nearly as long as posterior lateral spine. Dorsal organ distinct. Lateral spines of abdomen long, those of fifth somite the longest. Telson as described by Gurney & Lebour.

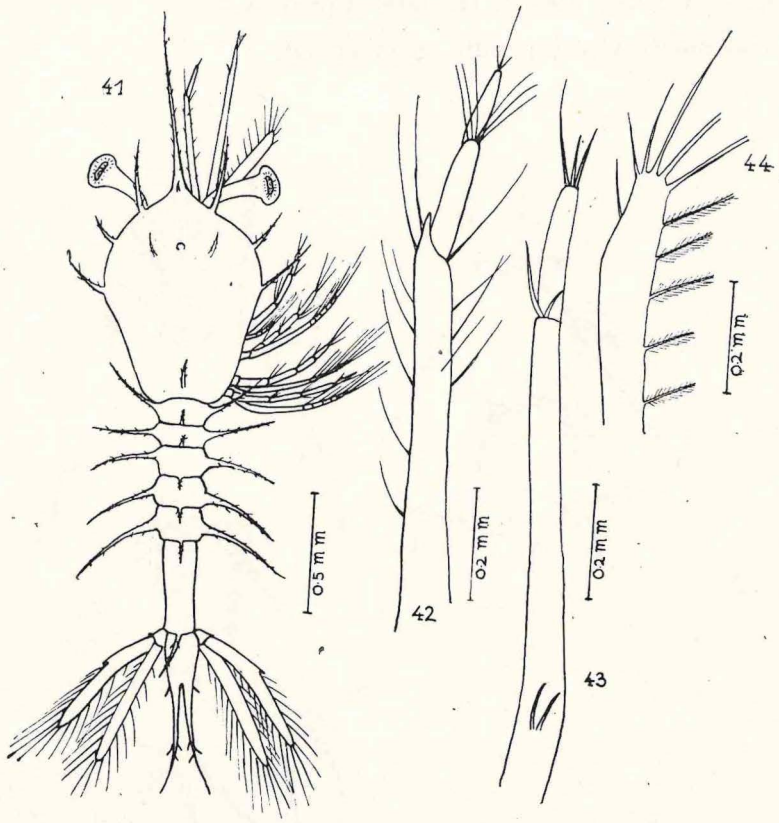


Fig. 41. *Sergestes robustus*, I acanthosoma, dorsal view.
Fig. 42. „ , „ , I antenna.
Fig. 43. „ , „ , antennal flagellum.
Fig. 44. „ , „ , antennal scale.

Antennal scale with 5 apical setae and one smaller outer seta; flagellum about 1⅓ times as long as scale. Eye about ⅛ length of body; eye stalk with a small papilla. Setose part of exopod slightly longer than bare part.

ACANTHOSOMA II: Length of body 4.8 mm. Rostrum 1.72 mm.

General form as in acanthosoma stage I, differs from that figured by G u r n e y and L e b o u r. Carapace as long as rostrum. Supra-orbital spine shorter than eye. Antennal scale with widened distal part having a long spical spine. Telson about equal to uropods. Exopod of uropod has bare part slightly smaller than the distal part. Pleopods long with rudimentary endopods on third to fifth somites.

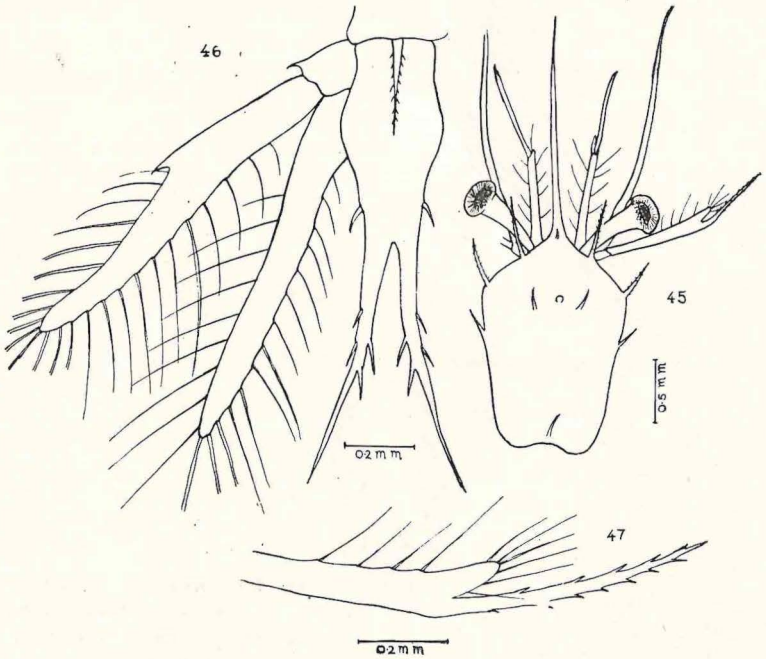


Fig. 45. *Sergestes robustus*, II acanthosoma, anterior part.
Fig. 46. „ „ , telson & uropod.
Fig. 47. „ „ , antennal scale.

MASTIGOPUS I: Length of body 6.31 to 6.51 mm. Rostrum 0.86 to 1.0 mm.

Rostrum reaches to end of second segment of peduncle of first antenna, with a small basal hair. Length of carapace about double the width. Abdominal somites with dorsal and lateral spines as figured by

Gurney and Lebour, but they are simple and untoothed. Legs with small vestiges of exopod. Pleopods long, first without endopod; second to fifth with rudimentary endopods. Exopod of uropod about 4½ times as long as wide, with setose part slightly smaller than bare part.

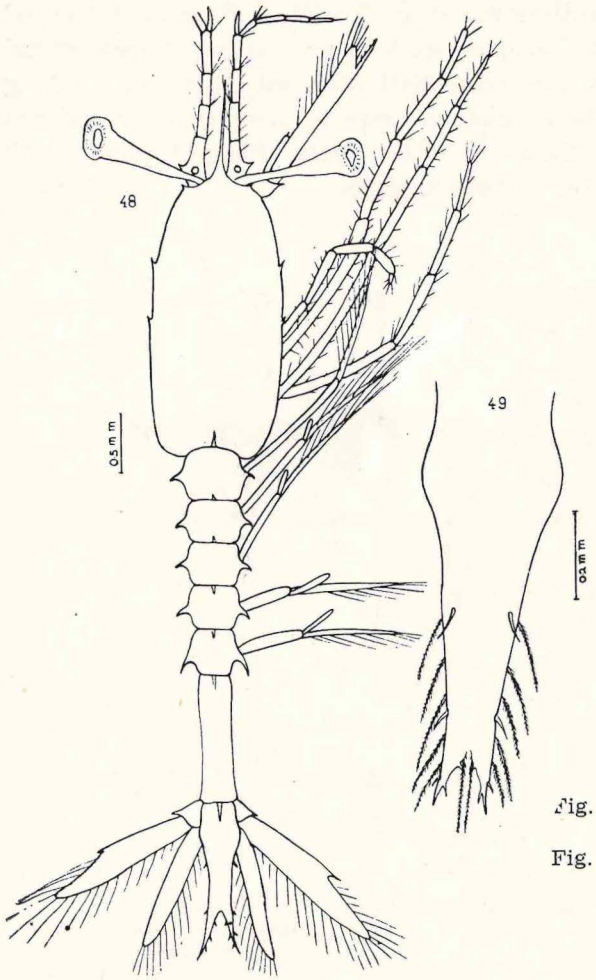


Fig. 48. *Sergestes robustus*, I mastigopus, dorsal view.
Fig. 49. *Sergestes robustus*, II mastigopus, telson.

MASTIGOPUS II: Length of body 7.48 mm. Rostrum 0.51 mm.

Length of carapace about 3 times the greatest width. Dorsal abdominal spines present only on last 3 segments. Telson about 3 times as long as wide, with marginal hairs towards the distal half. Apical fork small, with 3 inner setae and a plumose seta on each arm. Bare part of exopod of uropod more than 1½ times the setose part.

Distribution: This is the second common species of *Sergestidae* in the Adriatic as observed by the larval stages, the seasonal occurrence of which coincides with that of *S. arcticus,* with the maximum in January, when the majoritiy of the specimens are in the II and III elaphocaris stages. Acanthosoma I is also found common from the later half of January, acanthosoma II in large numbers in February and mastigopus stages only from February onwards lasting sometimes till June. Like *S. articus* this species is also found common below 50 m. At Bermuda the larvae of this species were taken from very deep water at depths of about 250 m. In the deep water regions of Adriatic, most of the early stages are found between 50 to 100 m.

SERGESTES CORNICULUM Kroyer (Figs. 50—53).

Hansen, 1922.

Gurney and Lebour, 1940.

ACANTHOSOMA I: Length of body 2.48 mm. Rostrum 0.89 mm.

Different forms of this species are described by Gurney and Lebour. The present specimens resemble *S. corniculum,* acanthosoma

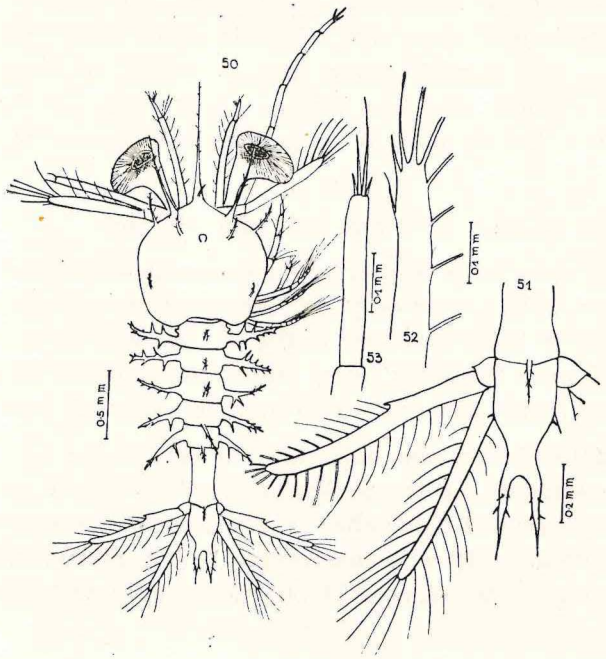


Fig. 50. *Sergestes corniculum,* I acanthosoma, dorsal view.

Fig. 51. *Sergestes corniculum* I acanthosoma, telson & uropod.

Fig. 52. *Sergestes corniculum,* I acanthosoma, antennal scale.

Fig. 53. *Sergestes corniculum,* I acanthosoma, antennal flagelum- tip.

described by Hansen (pl. VII, fig. 3) and acanthosoma II, form B of Gurney and Lebour (op. cit.).

Eye 1/4 lengh of body. Exopod of uropod with bare part 2/3 of setose part. Armature of telson as described by Gurney and Lebour. A very small spinule also is seen anterior to the spine on the inner side of fork.

Distribution: This seems to be a rather rare species in the localitiy under investigation and only 3 specimens in the acanthosoma stage I have been obtained during September from Mljet. The spawning time of this species also seems to be different from that of the previous species.

SERGESTES SARGASSI Ortm. Hansen (Figs. 54—56)

Hansen, 1922.

Gurney and Lebour, 1940.

ACANTHOSOMA I: Length of body 2.3 mm. Rostrum 0.93 mm.

This stage resembles the corresponding stage of *S. corniculum,* from which it may be distinguished by the posterior dorsal spine of carapace.

Rostrum longer than antennule, with long basal spine. Carapace as wide as long. Supra-orbital longer than eye. Hepatic spine long and slender. Dorsal organ large. Eye slightly more than 1/7 length of body, its width slightly more than length of eye, a minute papilla seen on the dorsal side under high power. Setose part of uropod slightly more than double bare part.

ACANTHOSOMA II: Length of body 3.03 mm. Rostrum 0.97 mm.

Carapace slightly wider than long. Posterior dorsal spine about half as long as length of carapace. Telson with only a single spine on each arm of fork. Eye about 1/6 length of body, greatest width of eye-ball, slightly smaller than the length of eye. Pleopods long, but without hairs and rudiments of endopod. Uropod with basal part half as long as setose part.

Distribution: Neither larvae nor adult of this species has been hitherto recorded from the Adriatic. In the present collections larvae are found rare in February, October and November. A few specimens which can be only doubtfully referred to the late mastigopus stage, measuring about 5 mm. in length were also obtained near Dubrovnik in July, October and December.

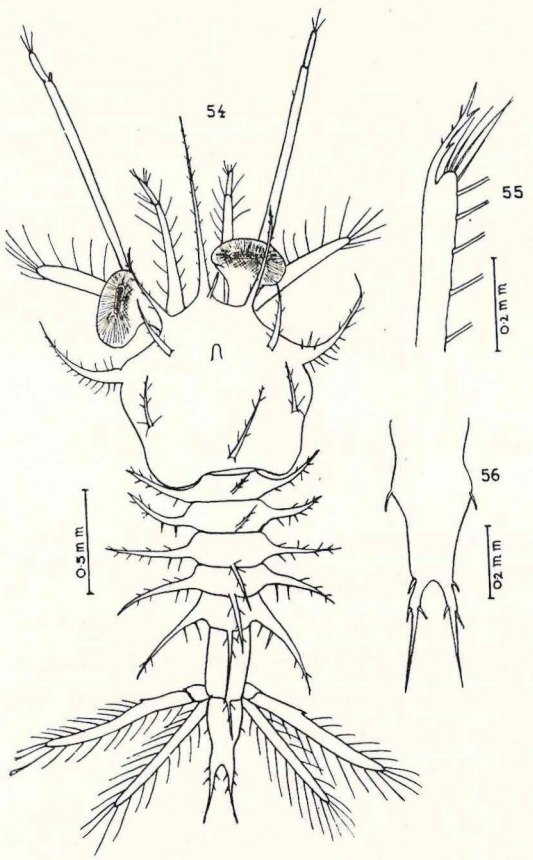


Fig. 54. *Sergestes sargassi*, I acanthosoma, dorsal view.
Fig. 55. *Sergestes sargassi*, II acanthosoma, antennal scale.
Fig. 56. *Sergestes sargassi*, II acanthosoma, telson.

SERGESTES VIGILAX Stimpson (Figs. 57—64).

Hansen, 1922.
Gurney and Lebour, 1940.

ELAPHOCARIS III: Length of body 1.72 mm. Rostrum 1.0 mm.

Rostrum resembles that of figure 45c of Gurney and Lebour (op. cit.) but without serrations, as long as carapace. Supra-orbital process with 15 spines, lateral with 16 and posterior with 5 pairs of spines.

Eye large, asymmetrical. Somites of abdomen with sharp pleural spines.

ACANTHOSOMA I: Length of body 2.59 mm. Rostrum 0.86 mm.

Rostrum as long as antennule, with prominent basal spine. Posterior

dorsal spine large. Lateral spines on first abdominal somite with spinules; those of second small; third pair very large; posterior ones very small.

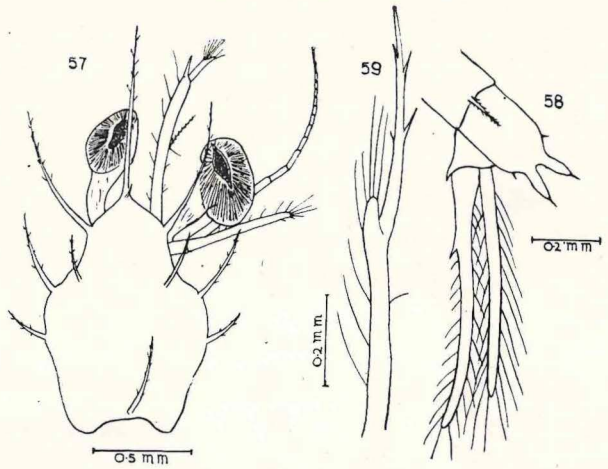


Fig. 57. *Sergestes vigilax*, I acanthosoma, anterior part.
Fig. 58. „ „ , telson & uropod.
Fig. 59. „ II acanthosoma, antennal scale.

ACANTHOSOMA II: Length of body 3.31 mm. Rostrum 1.10 mm.

Dorsal spines of third and fourth abdominal somites longer than rest, with spinules. Third maxilliped stout and long.

MASTIGOPUS II?: Length of body 3.51 mm. Rostrum 0.51 mm.

Rostrum about half as long as first antennular segment. Pleural spines and dorsal spines very small. Eye about 1/3 length of body. Eye-ball more than half length of eye. Exopod of uropod with setose part more than double bare part.

This stage resembles stage I of Gurney and Lebour (op. cit.) in the nature of carapace and antennal scale, but differs in the rostrum which is only half of the first antennular segment. In this respect it resembles stage II, but differs from the second stage in the nature of the antennal scale.

MASTIGOPUS STAGE?: Length 8.5 mm.

Rostrum not extending in front of labrum. Hepatic spines small and simple. Marginal spines not present. Eye-ball slightly less than half the length of eye. Posterior dorsal side of carapace and 3 to 6 abdominal somites with dorsal spines. Exopod of uropod with bare part less than half setose. Telson tapering posteriorly with small apical fork.

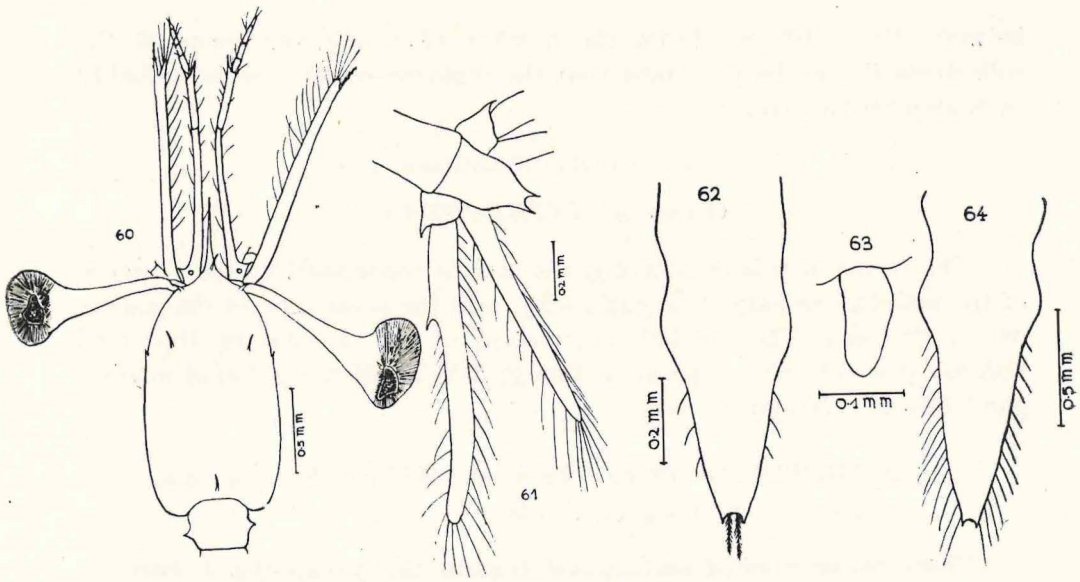


Fig. 60. *Sergestes vigilax*, II mastigopus, anterior part.
Fig. 61. „ „ , telson & uropod.
Fig. 62. *Sergestes vigilax*, mastigopus 8.5 mm, telson.
Fig. 63. „ , „ , petasma.
Fig. 64. „ , mastigopus 12, 65 mm., telson.

MASTIGOPUS STAGE?: Length 12.2 to 12.65 mm.

Eyes still longer. Only sixth abdominal somite bears a very small dorsal spine. Telson with apical fork and setae fringing the sides. Exopod of uropod with setose part 4 times as long as bare part. Pleopods with setose endopodites. Fifth peraeopod small and rudimentary.

Distribution: The larval stages of this species are also not so numerous as those of *S. arcticus* and *S. robustus* and have been observed from autumn to spring. It seems that this species shows two breeding periods — February to May and Semptember to December. Regarding the zonal distribution also, there seems to be some variation, as more specimens were got above 50 m.

LUCIFER TYPUS H. M. Edwards Williamson, 1915.

True larval forms of this species are not represented in the present collections, but young and adult specimens are found from September to May, most of the specimens being obtained within 50 m. and rarely

between 50 to 100 m. From the number of young specimens in the collections it may be presumed that the main breeding time is probably in September-November.

Family HOPLOPHORIDAE

Genus *ACANTHEPHYRA*

The larvae of this primitive genus may be recognized by the presence of the mandibular palp at an early stage and the possession of exopodites on all the legs. The hood-like formation of the dorsum of the third abdominal somite also is peculiar, though this character is found in some pandalids and *Caricyphus* also.

ACANTHEPHYRA PURPUREA A. Milne Edwards.
Gurney & Lebour, 1941.

There has been lot of confusion as regards the two species *A. haeckelii (= multispina)* and *A. purpurea*, the first being the common species in

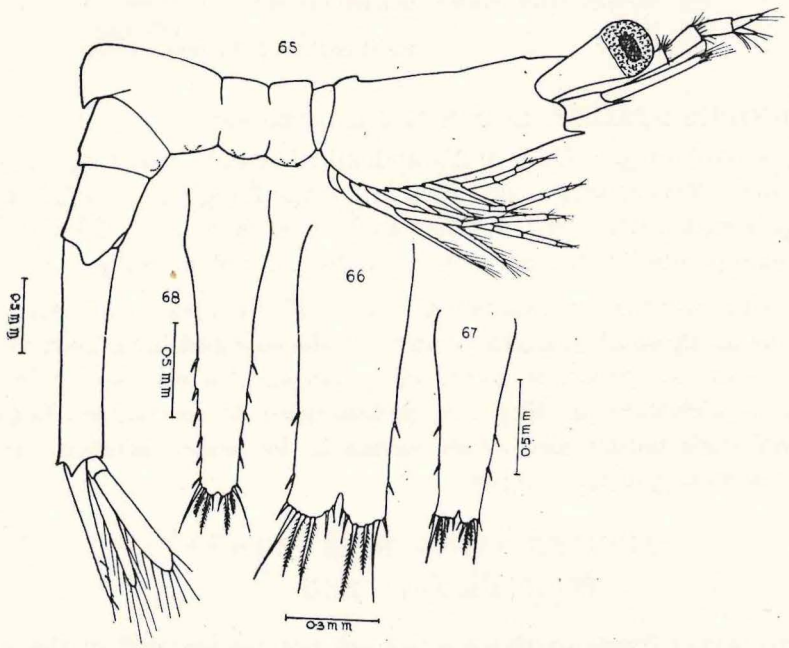


Fig. 65. *Acanthephyra purpurea*, IV stage, profile.
Fig. 66. „ , V stage, telson.
Fig. 67. „ , VII stage, telson.
Fig. 68. „ , IX stage, telson.

the Mediterranean Sea. The two forms are so closely related and so mixed together by early authors, that it is rather difficult to separate them. The main adult character separating the species is only that in *A. purpurea* there are 3 to 5 dorso-lateral spines on the telson, whereas in *A. haeckellii* there are 6 to 11 pairs or even more.

The larva described by Coutiere (1907) to *Hoplocaricyphus similis* is referred by Murray & Hjort (1912) to *A. multispina* and by Gurney & Lebour (1941) to *A. purpurea*. As per diagnostic charaters given by Gurney & Lebour, namely the presence of a large spine on the antennular peduncle and denticulations on the first and second abdominal somites, the specimens in the present collection may be referred to *A. purpurea*. Short descriptions of the different stages are given to note the differences from the Bermuda specimens described by Gurney and Lebour.

STAGE IV: Length 6.0 mm. (from tip of rostrum to end of telson).

Rostrum broad at base, slender distally and without teeth. Anterior and posterior tubercles prominent. Caapace bears pterygostomial spine and 4 small teeth at the posterior lateral margin on each side. Pleura of first abdominal somite also bears a single tooth on each side. Third abdominal somite produced dorsally into a hood covering half the anterior part of the following somite. Telson with almost parallel sides and cleft posteriorly, bearing a single pair of lateral and 7+7 distal spines.

Peduncle of first antenna bears 3 distinct segments. Last 2 peraeopods rudimentary. Pleopods seen as prominences under the skin. Uropod setose.

STAGE V: Length 6.6 mm.

Rostrum develops a small tooth dorsally at about its middle. Pleura of first abdominal somite shows 2 or 3 teeth on each side. Telson bears 2 pairs of lateral and 6+6 posterior spines. Pleopods formed as small buds.

STAGE VI: Length 7.1 mm.

Last 2 peraeodops longer, but still bent under the thorax.

STAGE VII: Length 9.5 mm.

Rostrum bears 1 large and 2 small teeth. Hind lateral border of carapace bears 4—5 serrations on each side. Pleurae of first and second abdominal somites also bear teeth laterally, teeth on first somite being more numerous. Telson broad anteriorly and tapers towards the distal two-thirds, with the same form of armature as in the previous stage. All peraeopods developed with setose exopods. Pleopods biramous.

STAGE VIII: Length 10.0 to 10.9 mm.

Rostrum with 3 or 4 teeth. Telson has 3 pairs of dorso-lateral and 5+5 posterior spines. Mandible with well developed palp. Pleopods biramous, with appendix interna, setae formed only at the tips.

STAGE IX: Length 11.1 mm.

Rostrum bears 4 teeth in front of the anterior dorsal tubercle. Carapace shows small antennal and strong pterygostomial spines. Serrations on the sides of carapace and first and second abdominal pleurae present. Hind lateral borders of pleurae of the fifth abdominal somite produced backwards into long curved spines. Telson bears 5 pairs of dorso-lateral spines in its distal half, and 5+5 terminal spines. Thoracic appendages and pleopods well developed with setae.

Distribution: There is no sharply defined breeding period; it is believed that the eggs are carried by the female for a considerable length of time, but hatch only during a short period when conditions are most favourable. It is a deep water form, and Murray & Hjort (1912) observe that the larvae exceeding 5 mm. are practically confined to deep water. Pesta (1918) observed berried femals in March and May. In the Bermuda plankton (outside) the larvae occur commonly from about 100 to 300 m. (Gurney & Lebour, 1941). Near Dubrovnik the larvae have been sparingly observed almost throughout the year and at Mljet from June to August with maximum in June. From the deep water regions most of the specimens have been collected from 100—150 m., while only a few early stages were obtained above 50 m.

Family PROCESSIDAE

PROCESSA EDULIS (Risso)

Gurney, 1923.
Lebour, 1936, 1941.

STAGE I: Length 1.96 mm.

No rostrum. Scale of antenna not segmented, endopodite a tapering spine. Behind pterygostomial spine 4 small serrations present. Maxillipeds with setose exopodites, each bearing 5 setae. Fourth abdominal somite without spine, fifth with a pair of dorsal spines.

STAGE II: Length 2.2 mm.

First peraeopod well developed.

STAGE III: Length 2.5 mm.

Two pairs of peraeopods well formed, remaining 3 rudimentary. Uropods formed, endopod small. No pleopods.

STAGE IV: Length 2.9 mm.

Third leg also developed.

STAGE V: Length 3.1 mm.

Fourth leg biramous and functional, fifth leg rudimentary. In some specimens pleopods formed as very small buds.

STAGE VI: Length 3.7 mm.

All peraeopods well developed.

STAGE VII: Length 4.8 mm.

Pleopods visible as biramous processes as long as the segments which bear them.

As observed by Lebour (1936) no clear stage as VIII is noticeable. Specimens 4.2 to 5.5 mm. have peraeopods showing end setae.

LAST STAGE: Length 5.5 mm.

All peraeopods and pleopods developed. Telson with a pair of dorsal spines in the proximal region, a pair of marginal spines in the distal 1/3 and 6+6 spines posteriorly. First peraeopod thick with a distal claw, second peraeopod slender with a small chela.

The larval stages of *P. edulius* resemble closely with those of *P. canaliculata*, the only notable difference being that in the latter there is a pair of small dorsal spines on the fourth abdominal somite in all stages, which is absent in the former.

Gurney (1923) observes that the post-larvae emerged from either the eighth or nineth stage. Lebour (1936) states that those from the more open water remain longer in the plankton and grow to stage IX, for more of this stage were present in the collections away from the shore.

Distribution: The larvae were found in the inside waters near Plymouth. Gurney (1923) observes that egg-bearing females have been taken at Plymouth in February and advanced larvae occur in the plankton early in April and continue throughout summer. Risso (1816) states that the eggs are laid several times in the year. In the North Sea the larvae are rare and are found from July to October, mostly in August (Rees, 1952). Graeffe (1900) states that spawning occurs in September and Pesta (1918) as May and June. In the present collections

the larval stages of this species are very common throughout the year, with the maximum abundance from June to October, showing the probability of several broods in an year as observed by R i s s o. The larvae are found more in the surface waters above 50 m. and only in May and August considerable numbers have been collected within 50 to 100 m. near Dubrovnik. Below 100 m. the larvae are only very rarely found. In the lake the larvae are rare, though occur almost throughout the year.

PROCESSA CANALICULATA L e a c h

G u r n e y, 1923.

L e b o u r, 1936, 1941.

STAGE I. Length 2.3 mm.

Longer than L e b o u r ' s specimens which measure only 2 mm. Three pairs of maxillipeds present and their exopods bear 5 setae on each. Fourth and fifth abdominal somites bear very small paired dorsal spines.

STAGE V: Length 4.2 mm.

All peraeopods except last developed. Pleopods appear as small prominences.

STAGE VI: Length 5.1 mm.

All peraeopods formed, pleopods about as long as the segment which bear them.

LAST STAGE: Length 6.2 to 8.0 mm.

Pleopods well developed. Serrations of the anterior margin of carapace distinct. Dorsal spines of fourth and fifth abdominal somites longer.

D i s t r i b u t i o n: The larvae of this species are larger than those of *P. edulis*. At Plymouth they were observed farher away from the shore, and the period of occurrence was found to be almost the same as that of *P. edulis*. R e e s (1952) recorded only 2 larvae of this species from North Sea, one in April and the other in September. It the present collections the larvae of this species are not very cammon and have been obtained only from Mljet (sea), the season of occurrence being from January to June, with maximum in April. This species is recorded from the Adriatic for the first time, the species recorded by P e s t a (1918) as *P. canaliculata* being later on referred as *P. edulis* (Lebour, 1936).

Family PANDALIDAE

Genus *PLESIONIKA* Sp. Bate

The larvae of this genus have not yet been definitely identified and Lebour (1940) suggests that those known as *Icotopus* by Bates (1888), Coutiere (1907) and Gurney (1924, figs. 45, 46) as pandalid may belong to *Plesionika* in pandalidae. It differs from all other genera of pandalids in developing epipods in the late stage. As post-larval stages are not available it is not possible to fix them up definitely. A. complete series of the larval stages are desribed here, for the first time.

PLESIONIKA sp.? (Figs. 69—87)

STAGE I: Length 3.3 mm.

Rostrum slender and pointed, reaching beyond the sessile eyes, upto the extremity of the antennular peduncle. Carapace with 2 or 3 faint antero-lateral denticulations and a small pterygostomial spine. No abdominal spine present. Telson triangular, deeply indented in the centre

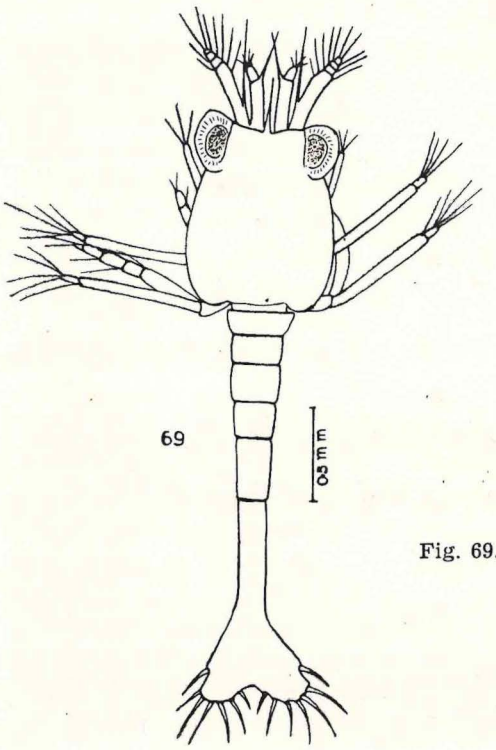


Fig. 69. *Plesionika sp.*, I stage, dorsal view.

of the hind margin and bears 14 setae. Antennule unjointed with a thick seta at the inner distal corner. Antennal scale with 5 small joints distally, bearing 11 setae and a small spine. First three maxillipeds developed with setose exopodites, first with 3 distal setae and the other 2 with 5 each.

STAGE II: Length 3.45 mm.

Rostrum extend to half the length of the antennular peduncle. Eyes long and stalked. Supra-orbital small. Abdomen without spines. Antennal flagellum extends beyond the scale, with an accessory seta springing from its basal 1/3. First maxilliped small, exopod with 4 end setae and a small seta on outer side. Exopods of other maxillipeds long, each with 6 long setae. First peraeopod seen as a small unsegmented biramous process. Telson with 8+8 setae.

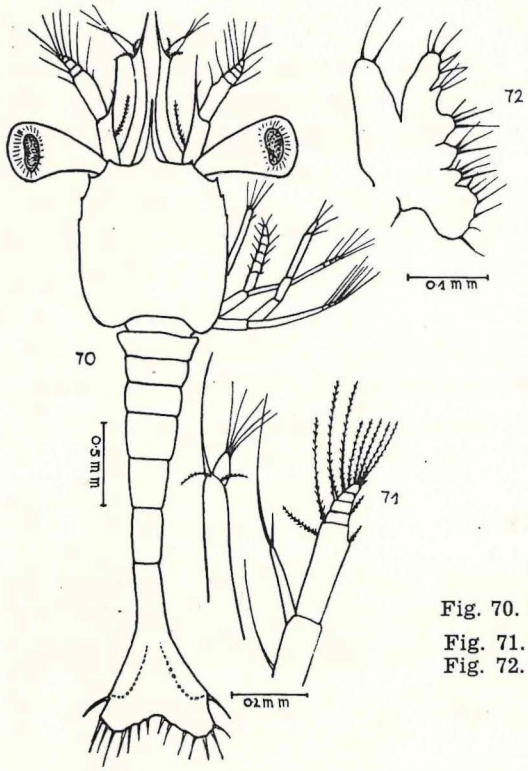


Fig. 70. *Plesionika sp.*, II stage, dorsal view.
Fig. 71. „ , I & II antenna.
Fig. 72. „ , II maxilla.

STAGE III: Length 4.0 mm.

Rostrum as in previous stage. Antennular peduncle concave on its outer margin. Antennal flagellum short and thicker at base, slightly less

than half the length of scale. First peraeopod longer, second appears as small rudiment. Teeth on the margin of carapace better developed. Telson triangular with 8+8 spines. Uropods formed, outer with 6, and inner with 2 setae.

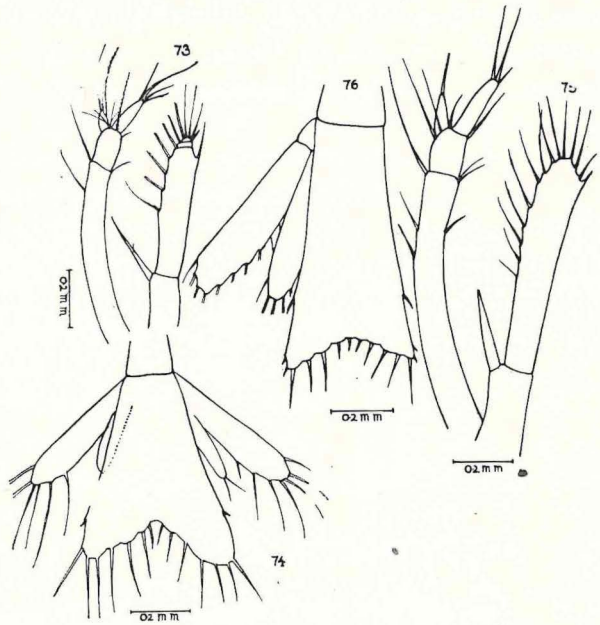


Fig. 73. *Plesionika sp.*, III stage, I & II antenna.
Fig. 74. „ „ , telson & uropod.
Fig. 75. „ , IV stage, I & II antenna.
Fig. 76. „ „ , telson & uropod.

STAGE IV: Length 4.4 mm.

Inner flagellum of antennule longer, basal joint bears 2 setae on the inner margin. Antennal flagellum short and stout, without accessory hair, about 1/3 as long as scale. Scale with a marginal spine. First peraeopod long and segmented. Uropods well formed.

STAGE V: Length 5.5 mm.

Marginal teeth of carapace better developed. Eyes long, extending to the extremity of the first joint of antennular peduncle. Sides of telson almost parallel, with 3 pairs of marginal and 5+5 end spines. Second peraeopod developed, last 3 peraeopods rudimentary.

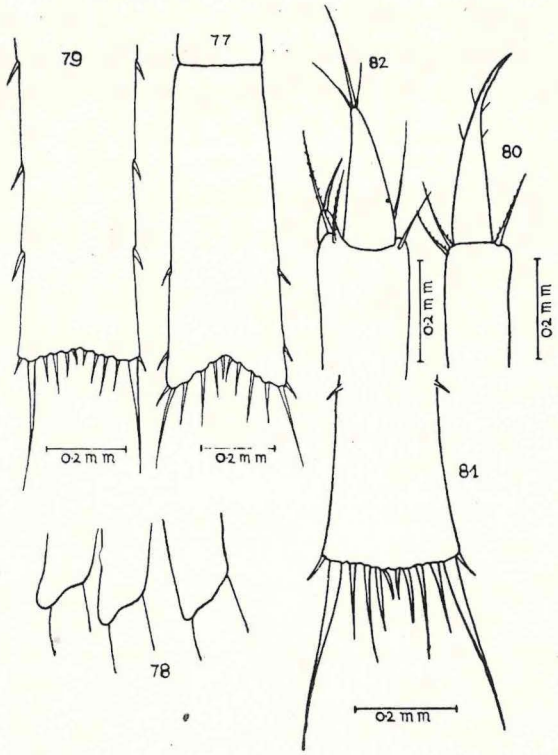


Fig. 77. *Plesionika sp.*, V stage ,telson.
Fig. 78. „ , VIII stage, epipods of last 3 peraeopods.
Fig. 79. „ , „ , telson.
Fig. 80. „ , X stage, II peraeopod-tip.
Fig. 81. „ , „ , telson.
Fig. 82. „ , XI stage, II peraeopod-tip.

STAGE VI: Length 5.7 mm.

Rostrum as in previous stage. Margins of carapace with 4 teeth, pterygostomial spine large, supra-orbital small. Third peraeopod functional. Epipods distinct on the maxillipeds and the first 3 peraeopods. Telson narrow, outer margin with 2 slender spines situated in the distal half, sometimes an additional small spine also seen in between.

STAGE VII: Length 6.4 mm.

Rostrum reaches to more than half the length of the antennular peduncle, bears 8—9 teeth dorsally in front of the small dorsal organ. Antennal flagellum more than half the length of the antennal scale. Fourth peraeopod biramous. Uropods reach the end of telson.

STAGE VIII: Length 8.5 mm.

Rostrum reaches the end of the antennular peduncle, with 9 teeth dorsally and 2 teeth ventrally. Lateral side of carapace bears 6 teeth. Antennular flagellum longer; antennal flagellum unsegmented, as long as scale. Proximal region of telson wider than the distal, margin with 3 spines and the concave terminal end with 12 spines. All peraeopods developed, fifth without exopod. Pleopods formed as small rudiments.

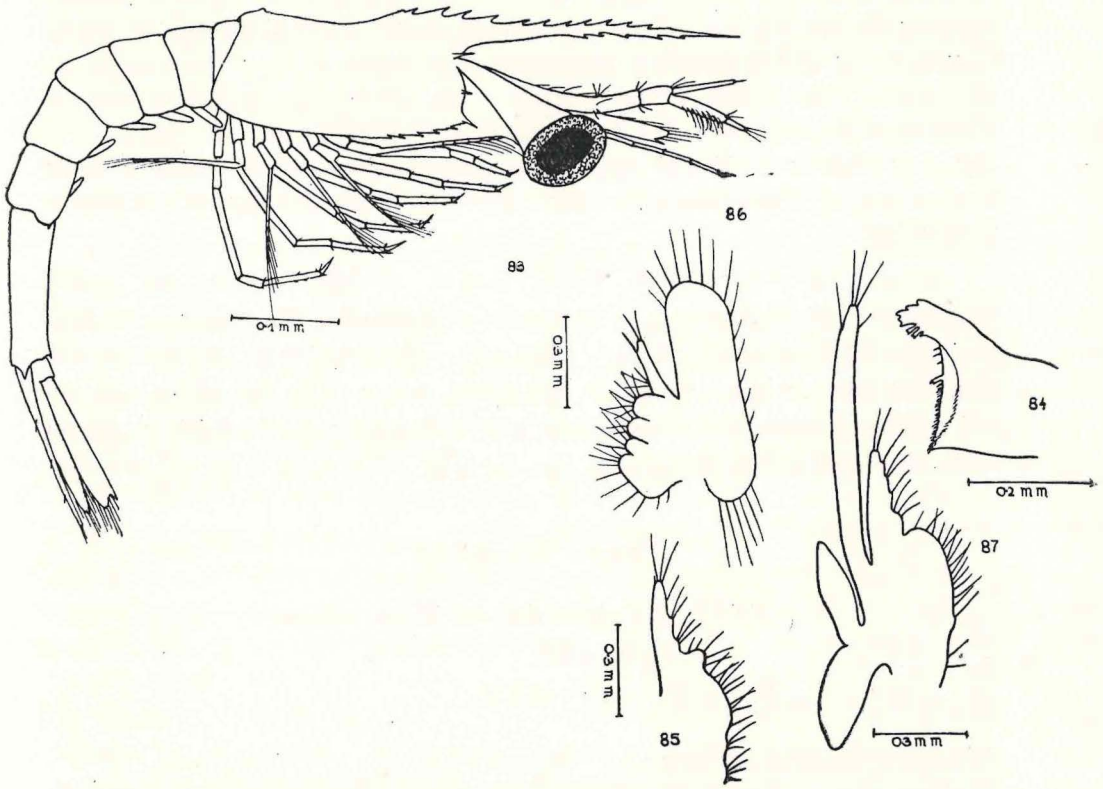


Fig. 83. *Plesionika sp.*, IX stage, profile.
Fig. 84. „ „ , mandible
Fig. 85. „ „ , I maxilla.
Fig. 86. „ „ , II maxilla.
Fig. 87. „ „ , I maxilliped.

STAGE IX: Length 9.0—9.7 mm.

Rostrum with 11—12 teeth dorsally and 4—5 ventrally. Antennal flagellum bears an end segment. Lateral margins of the posteriod part of telson almost straight.

STAGE X: Length 10.2 mm.

Rostrum with 13 dorsal and 6 ventral teeth. Second peraeopod shows the formation of chela. Pleopods bear rudiments of setae at the tips.

STAGE XI: Length 14—15 mm.

Rostrum long, with 14 upper teeth and 7 lower ones. Supra-orbital, antennal and branchiostegal spines long and pointed. Lateral side of carapace with 6 marginal and 3 dors-lateral teeth. Eyes shorter, though keeping the same shape as in the previous stage. Antennular and antennal flagella long and segmented. Antennal scale bears a long stout spine at the outer distal corner. Basal portion of the antennular peduncle bears a stout curved process on its outer margin. Proximal part of telson $2^{1}/_{2}$ times as wide as the distal part. Distal end of telson slightly convex, with 6+6 spines, of which second is long and stout. Pleopods long and biramous with setae.

Distribution: The larval stages of this species are found throughout the year with a peak period in November-December. A second peak has been observed in the Dubrovnik region in May. The larvae are observed more in the mid-water collections away from the shore regions (50—100 m.) than in shallow water. But in January considerable numbers were obtained within 50 m. also. In the lake collections it is not present.

Family ALPHEIDAE

ALPHEUS RUBER M. Edwards

Webb, 1921.

Lebour, 1932a.

STAGE I: Length 3.1 mm.

Telson with 7+7 spines. Rudiment of only first peraeopod visible as a small prominence.

STAGE II: Length 3.37 mm.

Endopod of third maxilliped with very long spine. Rudiments of first two pairs of thoracic legs long and directed forwards, third pair appears as small buds. Fifth peraeopod prematurely developed, reaching as far as the extremity of the endopod of second maxilliped. Exopod of uropod indicated.

STAGE III: Length 4.0 mm.

Second and third pairs of peraepodos rudimentary. Dorsal organ visible.

STAGE IV: Length 4.89 mm.

Fourth leg bigger. First 2 peraeopods bear setose exopodites, though their endopodites are small and undivided.

STAGE V: Length 5.58 mm.

First and second peraeopods show the formation of chelae. Pleopods appear as buds. Setose exopodites on first 3 peraeopods.

STAGE VI: Length 6.89 mm.

First 4 peraeopods bear setose exopodites. Pleopods biramous.

STAGE VII: Length 7.72 mm.

Pleopods longer, first pleopod about as long as the first abdominal somite.

STAGE VIII: Length 8.27 mm.

All peraeopods distinctly segmented and chelae of first and second peraeopods well formed.

STAGE IX: Length 8.8—9.0 mm.

Pleopods bear setae in their distal half.

Distribution: Graffe (1900) states that spawning was observed in the Gulf of Trieste in May and September. By the »Thor« expedition numerous larvae were taken from the Mediterranean »over great depths to bottom (upto over 3000 m), but most of the stations were comparatively close to the land«. There the larvae were found generally from June to August. Pesta (1918) recorded female with ova from the Adriatic in May and September. From the Plymouth region berried females were recorded from June to August and the larvae commonly in the plankton in the late summer and early autumn, chiefly in the waters away from the shore (Lebour, 1932). In the present collections the larvae are found throughout the year, with maximum in December in the Mljet region and July at Dubrovnik. Most of the specimens were obtained within 50 m., while only from August to October considerable numbers were collected below 50 m. It is also found that the larvae are more numerous in the shore collections than in the off-shore waters. In the lake, the larvae are rather rare and found only fom July to November.

ATHANAS NITESCENS Leach.

Sars, 1906.
Webb, 1921.
Lebour, 1932a.

STAGE II: Length 1.7 mm.

Third maxilliped with a long jointed endopodite, terminating in a serrated spine.

STAGE III: Length 2.0 mm.

Endopodite of third maxilliped short. Fifth peraeopod with long spine. Uropods formed, inner without setae.

STAGE IV: Length 2.3 mm.

First two and fifth peraeopods developed, third and fourth appear as rudiments.

STAGE V: Length 2.5 mm.

STAGE VI: Length 2.8 mm.

Pleopods appear as small rudiments. All legs formed, third and fourth still rudimentary.

STAGE VII: Length 2.9 mm.

All peraeopods well developed, last 3 without exopods.

STAGE IX: Length 3.1 mm.

First and second peraeopods bear chelae. Pleopods large and biramous, without setae.

The larval stages of *A. nitescens* may be distinguished from those of *A. ruber* by its smaller size, the absence of exopods on third and fourth peraeopods and the roundness of the eyes.

Distribution: In the Plymouth plankton all the stages were found common in summer and early autumn, usually in inshore waters. At Roscoff the breeding season is observed to be from late May to the middle of August (Nouvel, 1935, 1937). Pesta (1918) observed berried females in June. In the Adriatic Sea, the larvae are found from June to November, the season of occurrence more or less coinciding with the previous records. In the lake they have been observed in May also. Unlike *A. ruber* the larvae of this species are found more restricted in deeper waters below 50 m.

Family CRANGONIDAE

PHILOCHERAS SCULPTUS (Bell) Figs. 88, 89.

Lebour, 1931a.

Only the first stage larva of this species has been described by Lebour. In the present collections the first and last stages are present.

STAGE I: Length ca. 2.1 mm.

Eyes sessile with anterior tubercle. Rostrum small and simple, about half as long as antennular peduncle. Anterior lateral margin of carapace denticulated. Abdomen with paired dorso-lateral spines on third to fifth segments. Telson triangular, indented at the middle with 7+7 setae. First peraoepod biramous, second and third rudiments.

This stage resembles the corresponding stage of *P. bispinosus,* described by Sars (1890), from which it may be distinguished by the larger size (in *P. bispinosus,* I stage is only 1.3 mm. long) and the longer rostrum.

STAGE V: Length ca. 4.0 mm.

Rostrum reaches the extremity of the basal segment of the antennular peduncle, broad at base and pointed distally, not curved as in *P. bispinosus.* Carapace with strong pterygostomial and 11 teeth in the anterior lateral margin. Spines on abdominal somites 3 to 4 prominent. Hind margin of telson less indented than in the related species *P. bispinosus,* with one pair of marginal and 7+7 distal spines. Inner flagellum of first antenna

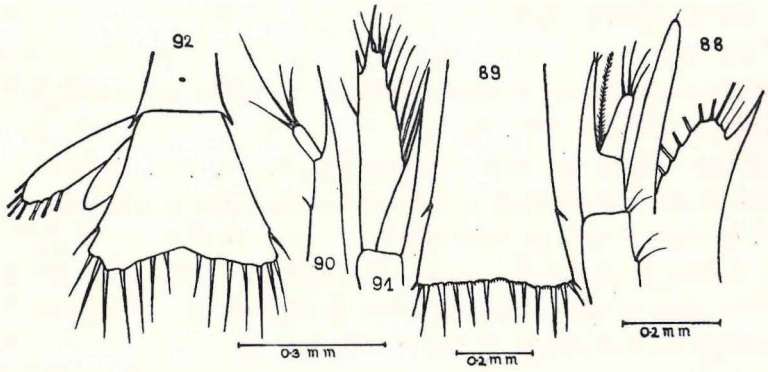


Fig. 88. *Philocheras sculptus,* V stage, I & II antenna.
Fig. 89. „ „ , telson.
Fig. 90. *Philocheras bispinosus,* III stage, I antenna.
Fig. 91 „ , „ , II antenna.
Fig. 91 „ , „ , telson & uropod.

stout and pointed, outer with 4 end-setae. Antennal scale with long, stout, distal marginal spine, which reaches beyond the extremity of the antennal lobe. Peraeopods well developed, only first two bear exopod. Pleopods large and biramous, but without setae. Uropods well developed.

The length of the last larva also is greater than that of *P. bispinosus*, the recorded maximum length in that species being only 3.5 mm.

Distribution: The first larva of this species was hatched at Plymouth in July. Pesta (1918) observes that the spawning occurs in May and June. In the persent collection the larvae of this species are not very common, but have been observed almost throughout the year with maximum in January.

PHILOCHERAS BISPINOSUS (Hailstone & Westwood)
Figs. 90—92.

Sars, 1890.
Lebour, 1931a.

The larval stages of this species have been dealt with by Sars under *Ceraphilus nanus* and by Lebour as *P. bispinosus*.

STAGE III: Length ca. 2.2 mm.

Inner flagellum of first antenna a stout spine, outer with 4 end-setae. Endopod of second antenna a stout spine; scale with a distal spine, 1 marginal spine and 11 setae. Three pairs of peraeopods functional. Endopod of uropod without setae.

STAGE IV: Length 2.7 mm.

Paired spines on third to fifth abdominal somites large. All peraeopods present, last 3 without exopods. Pleopods appear as small buds.
STAGE V: Length ca. 3.0 mm.

Rostrum broad at base, distinctly curved and pointed distally. Flagellum of second antenna stout, almost as long as the scale. Pleopods long and biramous, but without setae.

The larvae of this species are very similar to that of *P. sculptus*, from which they may be distinguished chiefly by the smaller size, and in the last stage by the antennal scale (vide infra).

Distribution: At Plymouth, the adult of this species is common in the inshore regions, breeding in spring and summer, larvae in the plankton fairly common in spring and summer. At Mljet in the open sea the larvae are present almost throughout the year in small numbers, with

maximum in January. In the lake and at Dubrovnik it is rarely found during winter and early spring. The species has not yet been recorded from the Adriatic Sea.

PONTOPHILUS SPINOSUS Leach (Fig. 93).

Sars, 1890.
Gurney, 1903.
Williamson, 1915.
Lebour, 1931.

STAGE II: Length 6.24 mm. (including rostrum 1.0 mm.).

Eye globular with an internal bulging. Lateral margin of carapace with 4 small spines in its anterior half. Posterior dorsal margins of abdominal somites without spinules. Dorsal spine of third abdominal somite extends beyond the extremity of the fourth somite. Sixth somite not separated from the telson. Inner flagellum of first antenna with small distal spinules. Scale of second antenna unsegmented with 13 setae. Third maxilliped and first peraeopod with setose exopodites, following peraeopods rudimentary.

Distribution: Paolucci (1909) observed berried females in March. Off Northumberland Coast the larvae have been observed in May and July and at Kattegat in April (Thorson, 1946). Rees (1952) observed a single specimen in May 1948 off the Aberdeenshire Coast. In the present collection only a solitary specimen is present, obtained from Dubrovnik in February 1952.

PONTOPHILUS NORVEGICUS (Sars) Fig. 94.

Sars, 1890.
Gurney, 1903.
Williamson, 1915.

STAGE I: Length 8.15 mm. (including rostrum 1.45 mm.)

The larvae of this species closely resemble the corresponding stage of *P. spinosus,* the main differences being the presence of numerous small spines on the posterior dorsal and ventral margins of the abdominal segments and the absence of a deeply incised telson.

Pterygostomial spine short and stout, anterior lateral margin of carapace bears 6 short teeth. Telson with 6+6 plumose setae and one spine on each of the outer margins. Inner flagellum of first antenna bears

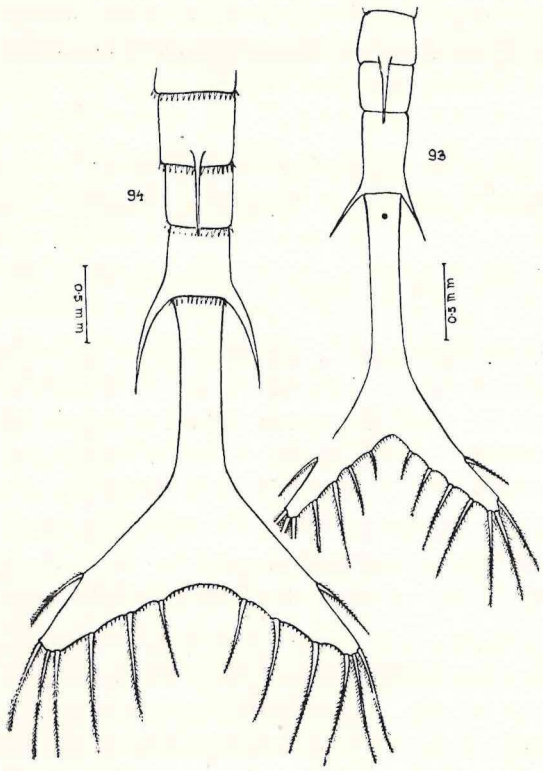


Fig. 93. *Pontophilus spinosus*, II stage, distal part of abdomen and telson.
Fig. 94. *Pontophilus norvegicus*, I stage, distal part of abdomen and telson.

numerous long spines. First peraeopod with setose exopodite, following pairs rudimentary.

Distribution: In the present collection only 2 specimens are present, being obtained from Dubrovnik area on 27th February 1952; but it is the first record of the species from the Adriatic Sea.

Family HIPPOLYTIDAE

SPIRONTOCARIS CRANCHII (Leach)
Lebour, 1932, 1936.

STAGE I: Length 1.5 mm.

No rostral spine, antennal scale segmented at tip. Side of carapace with 3 denticulations. Rudiment of first leg visible. Anal spine present. Fifth abdominal somite with a pair of small lateral spines.

STAGE II: Length 1.5 mm.

Rostrum and supra-orbital spine formed. Eyes stalked. Rudiments of second legs present.

STAGE III: Length 2.1 mm.

Antennal scale with 2 small end-segments. First and second peraeopods with setose exopodites, following 2 pairs rudimentary.

STAGE IV: Length 2.3 mm.

Third peraeopod bilobed, fourth rudimentary.

STAGE V: Length 2.5 mm.

First 3 peraeopods with setose exopodites, each with 6 setae. Pleopods not formed.

STAGE VI: Length 2.8 mm.

Pleopods formed as small buds. Last 2 peraepods rudimentary.

STAGE VII: Length 3.0 mm.

Chelae begin to form on first and second peraeopods.

STAGE VIII: Length 3.3 mm.

Last 2 peraeopods without exopods. Pleopods long, but without setae. Lateral spines of fifth abdominal somite large.

STAGE IX: Length 3.6 mm.

Rostrum small, broad at base. Third abdominal somite large, covers an anterior portion of the following segment. Dorsal organ prominent. Telson narrow with 2 pairs of marginal spines and 6+6 end-setae.

Distribution: In the Plymouth region ripe males and females were observed in May and June and found to breed from March, continuing till autumn; the larvae being observed in the plankton during summer and early autumn. (Lebour, 1932). In the present collections, the larvae are found almost troughout the year in the open sea as well as in the lake. In the sea it is found in large numbers from June to September, with maximum in June-July, whereas 2 peak periods — one in May and another in September are observed in the lake. In the deep water regions, it is observed mostly in the surface waters above 50 m. and scarcely below 100 m.

SPIRONTOCARIS sp. (Fig. 95 — 99)

STAGE I: Length 2.2 mm.

Antennule with long, stout, plumose seta and aesthetes as in *S. cranchii*. Antennal scale segmented at tip, flagellum represented by a long

spine. No rostral spine. Pterygostomial spine and 3 serrations present on each side of carapace. Anal spine present. This stage resembles closely with the corresponding stage of *S. cranchii,* the notable difference being only the larges size. In *S. cranchii* the first stage is only 1.5 mm. in length.

STAGE III: Length 2.9 mm.

Antennuale with base of 2 segments. Antennal scale without clear segmentation, outer margin with single seta. Supra-orbital and pterygostomial spines present. First and second peraeopods bilobed, last 3 seen as small rudiments. Inner branch of uropod bears 2 setae.

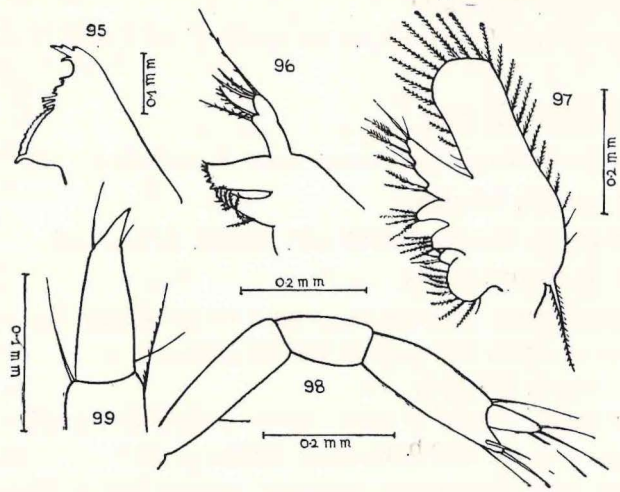


Fig. 95. *Spirontocaris sp.,* IX stage, mandible.
Fig. 96. „ „ , I maxilla.
Fig. 97. „ „ , II maxilla.
Fig. 98. „ „ , I peraeopod.
Fig. 99. „ „ , III peraeopod- tip.

STAGE V: Length 4.2 mm.

Rostrum broad at base and pointed distally. Third abdominal somite hood-like. Four peraeopods with exopods, fifth rudimentary.

STAGE VI: Length 4.5 mm.

This stage shows only a further stage in the development of the appendages. Fifth peraeopod shows indistinct segmentation.

STAGE VII: Length 5.0 mm.

Pterygostomial spine and the teeth behind stronger. All peraeopods developed, fifth without exopod. First and second legs show the formation of chelae. Pleopods formed as bifurcated processes. Telson with 2 pairs of marginal and 12 distal spines.

STAGE VIII: Length 5.1 mm.

Peraeopods longer and better developed. Pleopods 2-jointed.

STAGE IX: Length 5.4 mm.

Supra-orbital and denticulations of carapace still present. Antennal flagellum shows incipient segmentation. Telson narrowing, distal end rounded, showing 12 spines as in *S. cranchii*. Pleopods bear setae at the ends.

The stages described above closely resemble those of *S. cranchii* and *S. occulta*. From the former they chiefly differ in the absence of lateral spines on the fifth abdominal somite and presence of exopod on fourth peraeopod, and from the latter in the absence of denticles on the fifth abdominal somite and in having the dactylus of third leg straight. The larva differs from the first stage of *S. pusiola* described by Bull (1938) in the absence of rostral spine.

Distribution: The larvae of this species are present in the sea almost throughout the year with maximum in June at Gonoturska.

In the lake the larvae of this species have been observed only in July.

CARIDION STEVENI Lebour

Sars, 1900 (= Pandalus bonnieri)
Lebour, 1930a

The chief peculiarities of this larvae are the presence of 2 curved horns on the dorsal side of the carapace, which may be corresponding to the supra-orbital spines and the enormous length of the antennal flagella.

STAGE III:

Rostrum slender, pointed, and curved downwards, reaching almost to the end of the basal joint of the antennular peduncle. Two dorsal curved processes prominent on carapace at about 1/3 distance from its anterior end. Antennal scale with distal segments and two outer setae. First peraeopod developed with an oar-shaped endopodite, second and third rudiments. Uropods present, inner with only 2 setae.

STAGE V: Length ca. 5.5 mm.

First 3 legs functional, fourth biramous, fifth rudimentary. Antennal scale with distal spine, antennal flagellum about twice as long as scale. In Lebour's specimens it is nearly 3 times as long as scale. Telson with 2 pairs of lateral and 3 pairs of posterior spines.

STAGE VIII: Length 6.7 mm.

This is smaller than the corresponding stage of Lebour which is 7.0 to 7.5 mm. long.

Peduncle of first antenna 3-jointed. Flagellum of second antenna very long. Endopodites of peraeopods slender. Pleopods present as biramous processes, without setae.

STAGE IX: Length ca. 7.3 mm.

Rostrum long, withou teeth, reaching to the extremity of the second joint of peduncle of first antenna. Horns on carapace broad at base, sharply curved and situated a little more back on the carapace than in the previous stage, but they are not so big as figured by Sars.

Antennal flagellum about as long as length of body. Exopods present on first four peraeopods. Pleopods long with end-setae. Telson with second pair of posterior spines long and stout.

Distribution: It is a shore species found near Plymouth in the rocky pools; females in berry having been observed during January to May and larvae in the plankton from March to early August, occurs from mid-water to near the bottom (Lebour op. cit.). In the present collections larvae are sparingly represented from May to November. Neither larva nor adult of this species has been hitherto recorded from the Mediterranean region.

LYSMATA SETICAUDATA Risso (Figs. 100—106).

Caroli, 1918.
Gurney, 1937.

The larvae of *L. seticaudata* is characterised by the great elongation of the eye stalk (in the first stage eye is sessile) and the precocious development of leg 5 before the appearence of legs 3 & 4 into a long appendage with a paddle-like enlargement of the propodus.

Caroli (1918) has described the first 6 and last 2 stages in the development of this species. In the present collections stage VII is also found.

STAGE I: Length 3.34 mm. Rostrum 0.24 mm.

Larva larger than that recorded by Caroli. Carapace with 2 dorsal tubercles. Margin of carapace serrated. Telson with 7+7 plumose setae. Antennal scale with 5 small distal segments. First 2 peraeopods with segmented endopods, fifth a small prominence.

STAGE II: Length 3.27 mm. Rostrum 0.24 mm.

Eyes stalked. Telson with 8 pairs of setae. Fifth peraeopod long, reaching beyond the tip of telson, propodus flattened.

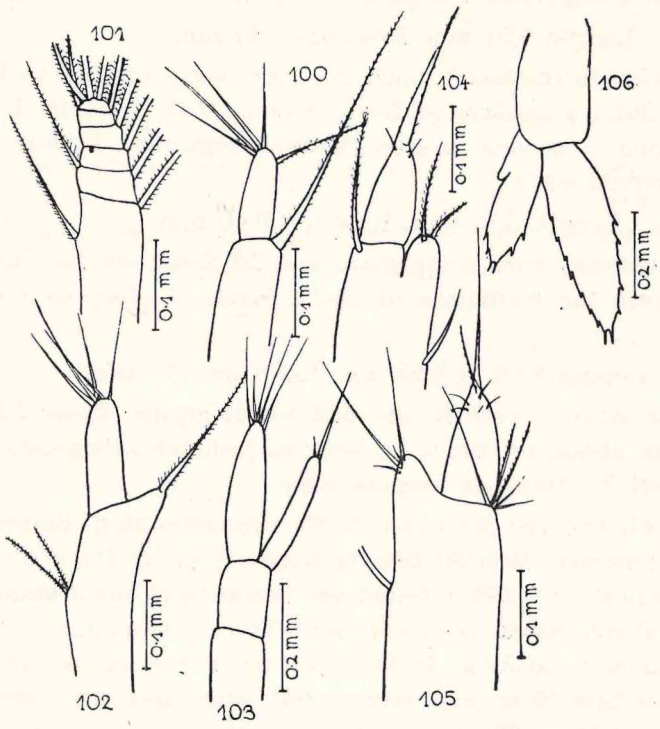


Fig. 100. *Lysmata seticaudata*, I stage, I antenna.
Fig. 101. „ „ , antennal scale.
Fig. 102. „ II stage, I antenna- tip.
Fig. 103. „ IV stage, I antenna- tip.
Fig. 104. „ VIII stage, I peraepod- tip.
Fig. 105. „ IX stage, I peraeopod- tip.
Fig. 106. „ „ , II pleopod.

STAGE IV: Length 3.41 mm. Rostrum 0.17 mm.

Dorsal organ prominent. A minute spine also present in front of dorsal organ in some specimens. Margin of carapace faintly serrated. Exopod of uropod setose, endopod small.

STAGE V: Length 4.17 mm. Rostrum 0.31 mm.

Rostrum long and doubly curved, Flagellum of first antenna segmented into two. Inner and outer uropods with setae.

STAGE VI: Length 5.07 mm. Rostrum 0.3 mm.

Marginal teeth of carapace disappeared. Telson with 2 marginal spines and 5 pairs of plumose setae distally. Outer flagellum of first antenna with 3 segments. Pleopods visible as biramous rudiments.

STAGE VII: Length 5.51 mm. Rostrum 0.44 mm.

In addition to the basal tooth, rostrum bears another tooth at about its middle. Outer flagellum of first antenna with 4 joints, flagellum of second antenna 1/2 as long as scale, without segments. Endopod of fourth leg with terminal setae.

STAGE VIII: Length 5.81 mm. Rostrum 0.40 mm.

Telson narrow, with 2 marginal and 10 distal spines. Distal end of first leg shows the formation of chela. Rami of pleopods end in short spines.

STAGE IX: Length 6.40 to 6.89 mm. Rostrum 0.72 mm.

Rostrum with 2 teeth in the mid-dorsal region. Inner flagellum of first antenna about 1 1/2 times as long as peduncle. Flagellum of second antenna about 2 1/2 times as long as scale.

Distribution: Stalio (1877) observes that spawning occurs throughout summer. Berried femals were found by Paolucci (1909) in June. Gamulin (1948) found the second and third stages in June. In the present collections, the larvae are observed from June to November, with the maximum in June. In the deep water regions larvae have been found more within 50 m. and only in July some specimens were collected within 50 to 100 m. The larval stages of this species seems to be more common away from the shore regions.

LATREUTES sp.? (Figs. 107—109)

Only the first stage larva of this genus is known with certainty (Gurney, 1937).

STAGE IV: Length 3.6 mm.

Rostrum small and simple. Prominent supra-orbital and pterygostomial spines present. Margin of carapace bears anteriorly 5 small teeth. Third abdominal somite large, bears a curved median dorsal spine, in front of the posterior margin, fifth bears a pair of long dorso-lateral spines and sixth with a median dorsal spine springing from the hind margin. No anal spine observed. Telson about 3 times as long as wide,

sides parallel, with 2 pairs of small marginal and 6 pairs of posterior setae.

Antennular peduncle with 2 segments, basal joint curved at the middle. Antennal scale broadening towards the end with large apical spine. Maxilla very broad in front with large proximal setae. Maxilliped I, epipod large, exopod with 6 setae. Maxilliped II, exopod with 6 setae. Exopod of III maxilliped with 8 setae. Endopod of II leg small, exopod with 8 setae. Endopod of III leg large, exopod with 6 setae. Fourth leg with large segmented endopod, without exopod. Fifth leg rudimentary.

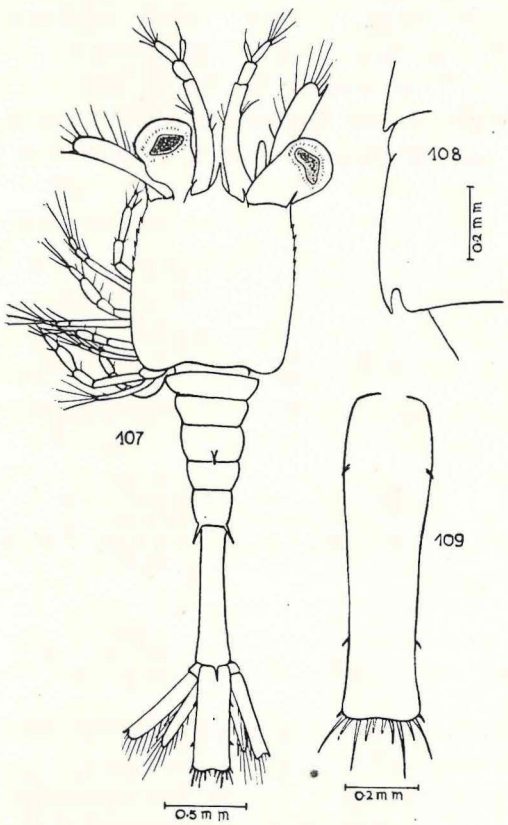


Fig. 107. *Latreutes sp.*, IV stage, dorsal view.
Fig. 108. *Latreutes sp.*, IV stage, Lateral view of III abdominal somite.
Fig. 109. *Latreutes sp.*, IV stage, telson.

LAST STAGE: Length 8.7 mm.

Rostrum and spines of carapace and abdomen as in stage 4. Anterior dorsal papilla prominent, posterior very small. Antennular peduncle with 2 segments. Antennal flagellum slightly longer than scale, unsegmented. All peraeopods well developed, first shows the formation of chela, last

2 without exopods. Pleopods biramous, but without setae. Telson broad at base, narrowing distally, gets broader towards the end.

Distribution: The larvae are rare in the December collections from Mljet (sea).

Family PALAEMONIDAE

LEANDER SERRATUS (Pennant).

STAGE II: Length 3.31 mm.

Rostrum long and slender, reaching slightly beyond the first joint of antennular peduncle. Antennal scale shows 4 small distal segments. Carapace with serrated dorsal tooth situated slightly in front of the middle. Supra-orbital spine prominent. Abdominal somite 5, with long lateral spines. Exopod of uropod indicated on the ventral side of telson. Exopods on second maxilliped to third peraeopod with 6, 8, 8, 8 and 6 setae respectively.

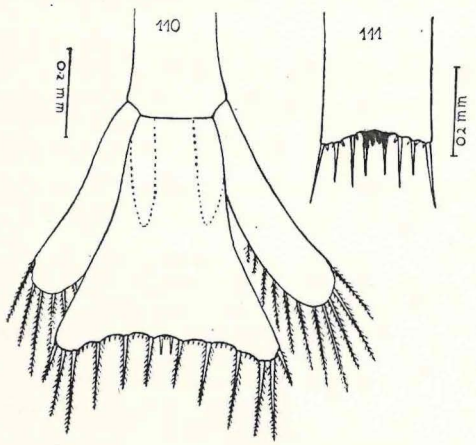


Fig. 110. *Leander serratus*, IV stage, telson & uropods.
Fig. 111. *Leander serratus*, V stage, telson- tip.

STAGE IV: Length 4.39 mm.

Rostrum reaches the distal end of the last segment of first antenna. Carapace dorsally with 2 large barbed teeth. A small spine appears just above and close to the pterygostomial, which forms the branchiostegal spine. Fourth peraeopod with setose exopodite, fifth rudimentary.

STAGE V: Length 5.50 mm.

Carapace bears one more tooth dorsally, behind the second one. Telson with almost parallel sides, no marginal spines, distal end with 5 pairs of setae. All peraeopods formed, fifth without exopod. Pleopods formed as biramous rudiments.

Distribution: Graeffe (1900) observes that the spawning occurs in May, June, August and September. Lebour (1947) found the larvae in the inshore waters from January to October, with maximum in June, July and August. In the collections brom Mljet the larval stages of this species are found rare during June and July 1952.

LEANDER PACIFICUS Stimpson
Gurney, 1938.

STAGE I: Length 2.90 mm.

The specimen agrees with the description of Gurney. Rostrum about as long as the antennular peduncle and bears minute serrations distally. Fifth abdominal somite without spines — in this respect it discriminates from *L. squilla,* which has a pair of lateral spines even in the first stage. Hind margin of telson with undulations, bearing 14 plumose setae and small hairs in between. Exopods of 3 maxillipeds with 6, 8, 8 setae respectively.

Distribution: The larvae of this species have been recorded at Gardaqa in March (Gurney, 1938). In the collection from Mljet only a single specimen is present, caught in July 1952.

PERICLIMENES sp. (Figs. 112—119).

A series of stages resembling very much the »larva of an unknown genus« (Gurney & Lebour, 1941) and *Periclimenes* sp. (Lebour, 1954 pp. 225—226) have been observed in the collections from Mljet and Dubrovnik during August to October 1952. These transparent larvae are very peculiar in having a long slender body, with slightly elongated head region, long exopodites on the third maxilliped and first two peraeopods, very long antennular flagellum and a small dorsal spine on the dorsum of the third abdominal somite from first to last stage.

Lebour *op. cit.* observes that the larvae described by Gurney & Lebour (1941) and that of Lebour (1954) »are apparently the only known instances of such a phenomenon« as the unusual elongation of the antennular flagellum and suggests that these two forms may possibly belong to separate genera.

The present larvae agree with that described by Lebour in the nature of the telson, absence of exopods on the last 3 peraeopods and in having small pleural points. But it is distinct from that of Lebour, in

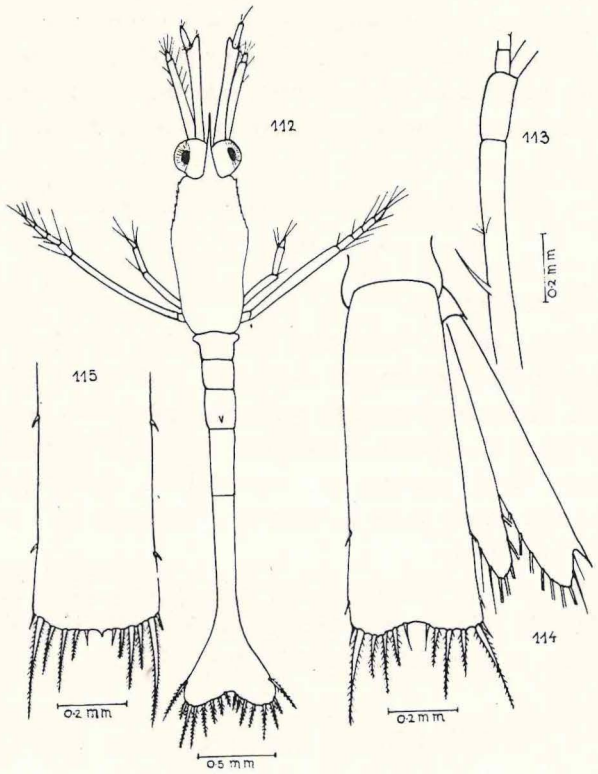


Fig. 112. *Periclimenes sp.*, I stage, dorsal view.
Fig. 113. „ , IV stage, I antenna.
Fig. 114. „ , V stage, telson & uropod.
Fig. 115. „ , IX stage, telson.

having only one large median dorsal tooth on the third abdominal somite, instead of two small teeth in L e b o u r ' s specimen and in having longer last 3 peraeopods and stronger pleural points on the first 5 abdominal somites.

STAGE I/II: Length 3,86 mm.

Eyes globular. Rostrum simple and pointed, broad at base, gradually tapering distally, reaches slightly benyond the eyes. Pterygostomial spine present, behind which the carapace bears 7 small teeth on each side. Supra-orbital and antennal spines absent. Telson not separated from the sixth abdominal somite, deeply indented behind with one pair of marginal and 7 pairs of distal spines. Peduncle of first antenna long, with an inner

distal lobe. Scale of second antenna as long as peduncle of first antenna, with a single distal segment, 2 marginal setae and 10 setae fringing the inner margin and free end. Exopod of third maxilliped long. First peraeopod a biramous rudiment. Dorsum of third abdominal segment enlarged and bears a small spine. Minute pleural points noticeable on the fourth abdominal somite.

STAGE IV: Length 4.93 mm.

Body bent at right angle at the third abdominal somite. Head region more elongated. Spine on third abdominal somite larger. Telson with the same armature as before. Peduncle of first antenna shows 2 segments, basal one with a large internal spine at about its middle. Inner flagellum of first antenna long and segmented, outer small with a few setae. First peraeopod with setose exopodite, following pairs rudimentary. Uropods well formed.

STAGE V: Length 6.34 mm.

Eyes slightly elongated, eye-ball with a little bulging on the inner side. Mandible with strong cutting edge. First maxilla with a 2-jointed palp. Endopod of second maxilla with 8 lobes. Inner flagellum of first antenna 1¼ times as long as the length of body. Scale of antenna with a distal marginal spine. First 2 peraeopods with setose exopodites, last 3

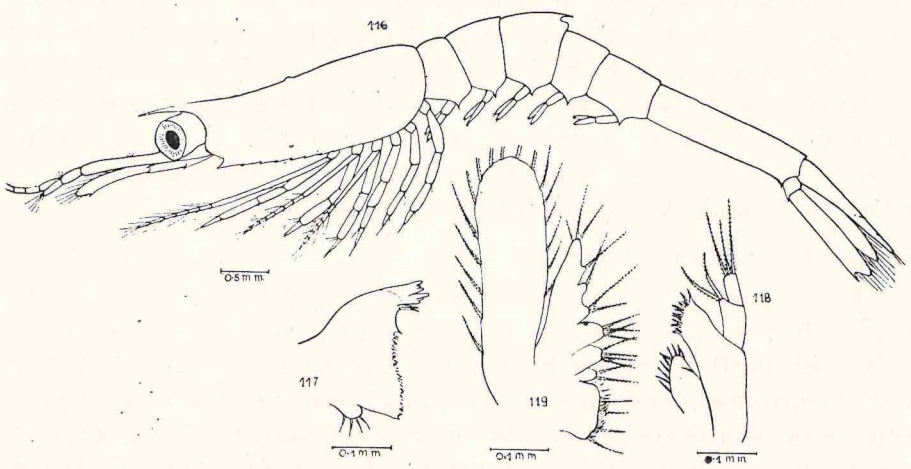


Fig. 116. *Periclimenes sp.*, VIII stage, profile.
Fig. 117. „ , V stage, right mandiable.
Fig. 118. „ , „ , I maxilla.
Fig. 119. „ , „ , II maxilla.

rudimentary. Pleural spines distinct on first 5 abdominal somites. Pleopods appear as small buds.

STAGE VII: Length 8.45 mm.

Flagellum of second antenna slightly longer than scale. Last 3 peraeopods jointed, without exopods. Pleopods small, but biramous with small end-setae. Pleural spines and the dorsal spine of third abdominal somite larger. Anal spine present.

STAGE VIII: Length 8.76 mm.

Flagellum of second antenna 1½ times the scale. Last 3 peraeopods and pleopods longer.

STAGE IX: Length 9.13 mm.

Almost as previous stage. Antennular flagellum 1½ times the length of body.

MESOCARIS Ortman sp. I. (Figs. 120—123).

Gurney, 1936, 1938.
Gurney & Lebour, 1941.

A series of larval stages with the striking feature whith characterises this larval genus, namely the acute double flexure of the depressed body have been observed in the collections from Mljet and Dubrovnik during June and August. Though it is not possible to fix them up to some particular species, short descriptions of the different stages are given in the hope that future additional knowledge would help in ascertaining them to definite species. Stage VI in the present collection seems to agree with »Palaemonid B.R.V« of Gurney (1938, pp. 30, 31).

STAGE IV: Length 3.3 mm.

Body sharply bent at thorax and third abdominal somite. Rostrum more than half as long as the first segment of the antennular peduncle, with very small dorsal tooth. Supra-orbital long and barbed. Antennule with 2 segments. Antennal scale with small terminal spine and 11 plumose setae. First and second peraeopods with setose exopods, each exopod with 4 terminal setae and 2 minute marginal hairs. Last 3 peraeopods appear as rudiments. Pleopods formed as ventral prominences. No anal spine. Endopod of uropod without setae, exopod with 6 setae. Telson spatulate, indented behind, with a pair of marginal and 7 pairs of posterior spines.

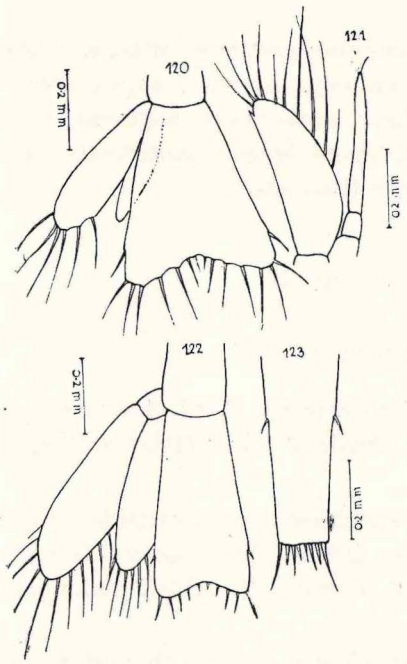


Fig. 120. *Mesocaris sp.*, I, IV stage, telson & uropod.
Fig. 121. *Mesocaris sp.*, I, IV stage, II antenna.
Fig. 122. *Mesocaris sp.*, I, V stage, telson & uropod.
Fig. 123. *Mesocaris sp.*, I, VIII stage, telson

STAGE V: Length 3.7 mm.

Prominent barbed supra-orbital and small antennal spines present. First 3 peraeopods bear exopods, last 2 rudimentary. Telson slightly broader distally, indented posteriorly with one pair of marginal and 5 pairs of posterior spines.

STAGE VI: Length 4.6 mm.

Very similar to Gurney's »Palaemonid B.R.V. Stage« (1938), but smaller in size. Dorsal tooth of rostrum better developed and serrated. Flagellum of second antenna longer than scale, bears 3 small setae. First peraeopod with propodus enlarged, showing the formation of chela. Setose exopods on first 4 peraeopods. Pleopods small, but biramous. Fifth peraeopod slightly longer than fourth.

STAGE VII: Length 5.1 mm.

Antennal flagellum longer than scale by the 2 end segments. Exopods of third and fourth peraeopods very small, with minute marginal setae. Telson with one pair of marginal spines inserted at about the middle and 4 pairs of terminal spines.

STAGE VIII: Length ca. 6.0 mm.

Rostrum as long as the 3-jointed antennular peduncle, with a single dorsal serrated tooth. Carapace with prominent serrated supra-orbital and antennal spines. No anal spine. First antennular segment with stylocerite better formed and the ventral spine larger. Antennal scale with distal marginal spine, flagellum longer than scale.

MESOCARIS Ortman sp. II.

Gurney, 1936.
Gurney & Lebour, 1941.

Two specimens closely resembling *Mesocaris* sp. B of Gurney & Lebour (1941, p. 159, figs. J. K) were obtained from Mljet and Split during June.

Gurney & Lebour obtained the specimens from outside Castle Harbour (Bermuda) in depths from 100 to 300 m. This species is very peculiar in having an extreme case of body flexure, the third abdominal somite coming near the head region.

The present specimens measure about 10 mm. in length and seems to belong to the penultimate or last stage.

Rostrum longer than eye with a high crest bearing 4 teeth. Small supra-orbital spines present. Abdomen without spines. Telson narrow with 2 pairs of lateral and 3 pairs of terminal spines. Peraeopods 1—4 with exopods, first and second chelate. Pleopods large and biramous, without setae.

STENOPUS SPINOSUS Risso

Cano, 1892.
Gurney, 1924.

Though a number of unidentified larvae of *Stenopus* have been recorded (Gurney & Lebour 1941) the larvae of only the 2 species *Stenopus hispidus* and *S. spinosus* have been identified, the former having been recorded by Brook & Herrick(1891) and the latter by Cano (op. cit.). The species recorded from the Mediterranean region is *S. spinosus* whereas *S. hispidus* has been found only from the Indo-Pacific and tropical east American seas. As per diagnostic character given by Gurney (1924) namely the presence of a long dorsal spine on the third

abdominal somite in first stage, the larvae in the present collections belong to the common Mediterranean species *S. spinosus*.

STAGE I: Length of body 2.75 to 3.37 mm. Rostrum 1.41 mm.

Rostrum bears small anterior denticles and small spines dorsally in the basal region. Supra-orbital absent. Third abdominal somite bears a curved dorsal spine which reaches slightly beyond the extremity of the fifth abdominal somite. Lateral spine of first abdominal somite longer than the third abdominal spine. In *s. hispidus* the dorsal spine of the third abdominal somite is shorter than the combined length of the fourth and fifth abdominal somites. Telson with 5 teeth on the outer margin and 6 plumose setae on each lobe, of which the outer most one is very small.

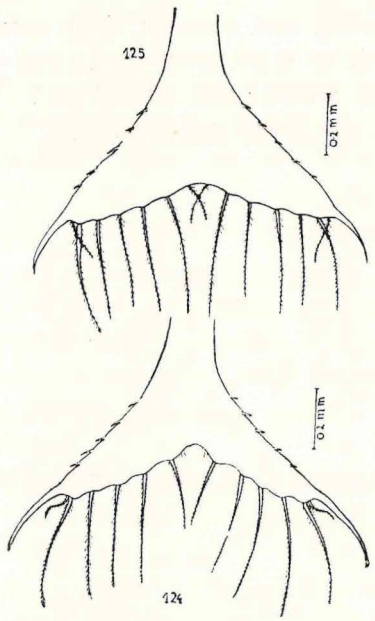


Fig. 124. *Stenopus spinosus*, I stage, telson.
Fig. 125. „ , II stage, telson.

STAGE II: Length of body 3.62 mm. Rostrum 2.41 mm.

This stage resembles the previous stage, but the eyes become stalked and long supra-orbitals as long as 3/5 the length of eye are formed. Dorsal spine of third abdominal somite about double as long as the combined length of fourth and fifth abdominal somites. Each lobe of telson with 7 plumose setae, of which 2 are small and slender. Endopod of first leg still small and single jointed, second leg appears as a small rudiment. No pleopods present.

Distribution: The larvae of this species are sparingly obtained from June to December, with maximum in August. It is not present it the lake collections.

Family PALINURIDAE

PALINURUS VULGARIS Latr. (Fig. 126).
Cunningham, 1891.
Bouvier, 1914.
Gamulin, 1955.

Ten stages of this species were described by Bouvier.

PHYLLOSOMA I: Length 3.24 to 3.44.

First antenna slightly longer than second and smaller than eyes. Third maxilliped with setose exopod. Exopod of third peraeopod finger-like. Fourth and fifth peraepods appear as small buds. Distal end of abdomen truncated, with 3 setae at each of the distal outer corners.

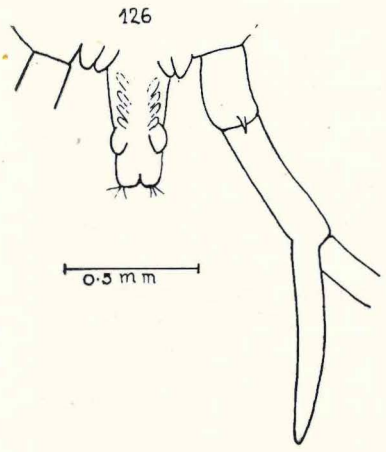


Fig. 126. *Palinurus vulgaris*, I phyllosoma, distal part.

Distribution: In the N. Atlantic, phyllosoma is found from the later half of June to September (Cunnigham & Bouvier), the last stages being common about the end of July and during August. In the Mediterranean Stephensen (1923) observed the larvae in the winter and summer months. Pesta (1918) gives the spawning time of this species as spring and also August. Gamulin (1955) found the first larval stage of this species in the middle and N. Adriatic from December to March, with the peak period in January and February. In the present

collections also, the first stage larvae are present in January and February, showing that this species has an earlier spawning time in the Adriatic than in the N. Atlantic.

Family SCYLLARIDAE

SCYLLARUS ARCTUS Linne. (Figs. 127—139).

Pesta, 1918.

Stephensen, 1923.

Only the first and third stages are represented in the present collections, being obtained from June to January. But in an earlier collection taken near Split in the later half of August 1948 almost all stages are represented.

STAGE I: Length 1.2 mm.

Resembles closely with the figure of Williamson (1915) and the description of Stephensen (1923), but slightly smaller. The differen-

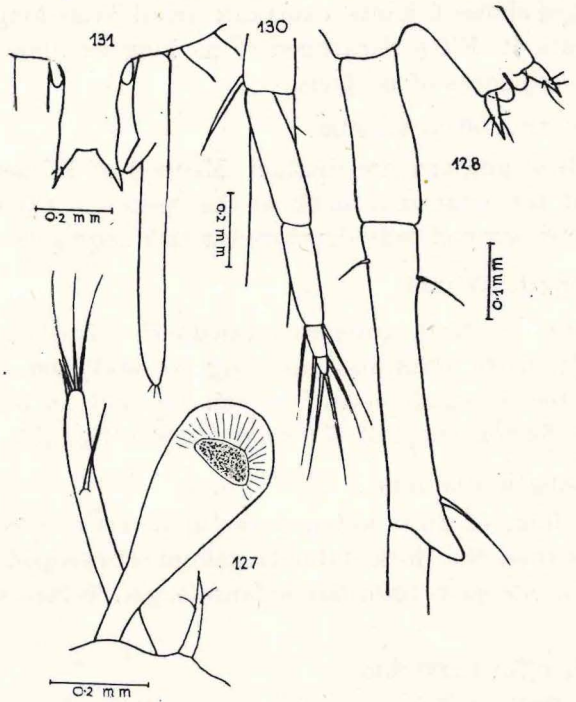


Fig. 127. *Scyllarus arctus*, I phyllosoma, eye & antennae.
Fig. 128. „ „ , distal part & III peraeopod.
Fig. 130. „ , III phyllosoma, exopodite of III peraeopod.
Fig. 131. „ , III phyllosoma, distal part & IV peraeopod.

ces from Stephensen's description are — antenna I as long as eye, distal extremity with a short spine and 3 plumose setae and the sides of the abdomen drawn into sharp spines.

STAGE II: Length 1.51 to 1.68 mm.

Exopodite on third peraeopod about 3/5 as long as the second joint of the leg. In a specimen 1.51 mm. long, the exopod is only 2/7 as long as the second joint which bears it. Peraeopod IV only half as long as the abdomen.

STAGE III: Length 2.58 mm.

The process at the distal 1/3 of first antenna large. Exopod of third peraeopod with 3 joints, but not so developed as shown by Stephensen. Peraeopod 4, 3 1/2 times as long as the abdomen excluding the fork.

STAGE IV: Length 2.41 to 3.00 mm.

Third peraeopod with well developed exopodite bearing long setae. Fourth peraeopod shows 6 joints, exopodite small, 2/3 as long as the second joint which bears it. Fifth peraeopod 2/7 as long as abdomen. Abdomen with lateral prominences of uropods.

STAGE V: Length 4.00 to 4.1 mm.

Joints of first antenna not distinct. Exopod of IV peraeopod shows 5 segments, but the setae still small in the specimen 4.0 mm long. In a specimen 4.41 mm. exopod fully developed with 8 segments and long setae.

STAGE VI: Length 9.2 mm.

Three joints of first antennular peduncle distinct. Peraeopod 5 slender, slightly more than half as long as abdomen. Four pairs of pleopods indicated as small buds. Uropods distinct as bifid lobes. This stage resembles *Scyllarus sp.* of Gurney (1936, fig. 33).

STAGE VII: Length 10.9 mm.

Inner flagellum of first antenna distincly articulated at base, but slightly smaller than the thick outer flagellum. Peraeopod 5, about 3/4 as long as abdomen. Pleopods bifid, inner limb larger. Telson separated from abdomen.

STAGE VIII: Length 12.96 mm.

Inner flagellum of first antenna curved. Second antenna stout, as long as first, spine at the proximal 1/3 smaller. Posterior end of telson convex.

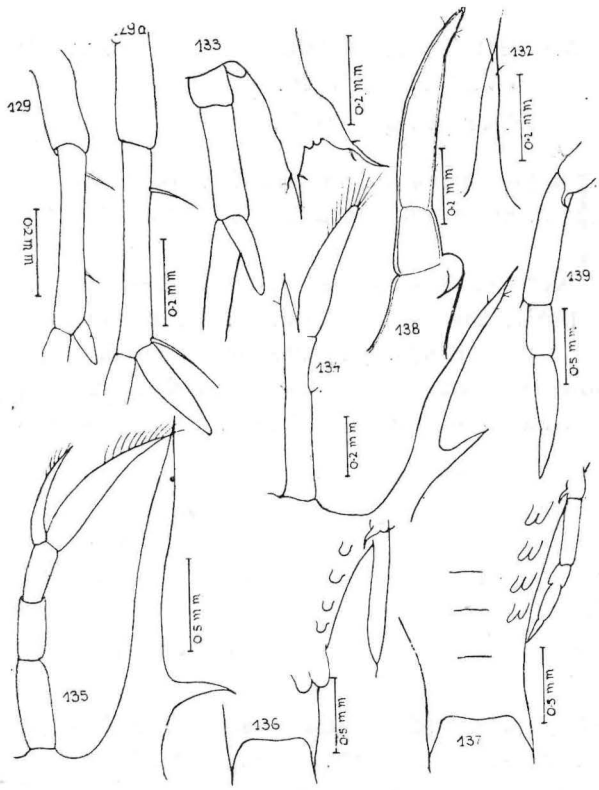


Fig. 129. *Scyllarus arctus*, II phyllosoma, III peraeopod of specimen 1.51 mm.
Fig, 129a. „ „ , III peraeopod of specimen 1.68 mm.
Fig. 132. „ , IV phyllosoma, II antenna.
Fig, 133. „ , „ , distal part & IV peraeopod.
Fig, 134. „ , „ , V phyllosoma, I & II antenna.
Fig, 135. „ , „ , VI phyllosoma, I & II antenna.
Fig, 136. „ , „ , „ , distal part.
Fig, 137. „ , „ , VII phyllosoma, distal part.
Fig, 138. „ , „ , VIII phyllosoma, I antenna (ventral)
Fig, 139. „ , „ , „ , V peraeopod.

Distribution: Stephensen (1923) observes that the larvae are found in the Mediterranean from December to September, the summer hauls yielding more specimens, with the maximum in August. Pesta (1918) gives the spawning season as July. In the present collections the maximum number of larvae is present in August, agreeing with Stephensen's observations.

Family HOMARIDAE

NEPHROPS NORVEGICUS (L.) Fig. 40.
Santucci, 1926.
Karlovac, 1953.

STAGE I: A single specimen in the February collection from Mljet measures 6.51 mm. in length (from tip of rostrum to the angle of caudal fork).

The larva more or less agrees with the description and figures of Santucci (1926). But the rostrum in the present specimen is more pronounced, having a length of 0.96 mm., which is about 1/3 of the carapace without rostrum. It is doubly curved as in Stage II and has a dorsal groove basally, but without teeth. Plueral spines present, their

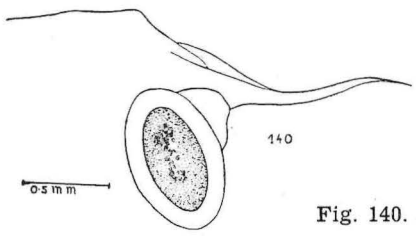


Fig. 140. *Nephrops norvegicus*, I stage, rostrum- profile.

length increasing backwards, fourth pair being the longest. Pleopods visible as small buds. Caudal fork about 3/4 the length of body, with 10 sharp spines on the outer and numerous plumose setae on the inner edge of each arm.

Distribution: In the North Sea the larvae are found throughout summer (Havinga, 1929), in the Danish waters in April, May and August (Jorgensen, 1923). In the High Adriatic, larvae are observed from January to April, the duration of the 3 larval stages apparently going beyond 2 to 3 weeks; it generally takes 3 months for eggs to hatch, the peak showing in January (Karlovac, 1953). This species also shows an earlier hatching period here, than in the N. Atlantic.

Family GALATHEIDAE

Munida and *Galathea* are known to have 4 larval stages, except in *Galathea dispersa*, in which 5 are said to have been observed (Lebour, 1930).

The larvae of the 5 species found in the Adriatic may be distinguished by the following key adapted from Lebour (1930).

1. Antennal scale long and tapering . . . . . *Munida bamffica*
   Antennal scale broad and short . . . . . 2.
2. Spines present on fourth and fifth abdominal segments . . . . . 3.
   Spines present on fifth abdominal segment only . . 4.
3. Larvae large, first larva ca. 3.6 mm and last ca. 8.2 mm. . . . . *G. strigosa*
   Larvae smaller, first larva ca. 2.5 mm. and last ca. 4.2 mm. . . . . *G. squamifera*
4. Larvae of moderate size, first larva ca. 2.4 mm. and last ca. 5.1 mm. . . . . *G. dispersa*
   Larvae very small, first larva ca. 2.1 mm and last larva ca 4.2 mm. . . . . *G. intermedia*

MUNIDA BAMFFICA (Penant).

Sars, 1890.
Lebour, 1930.

The larval stages of this species have been described by Sars as *M. rugosa* and Lebour as *M. bamffica.*

STAGE I: Length 6.0 mm. (from tip of rostrum to end of telson).

STAGE II: Length 6.9 mm.

Third pair of maxillipeds formed.

STAGE IV: Length 10.0 mm.

Uropods well developed, telson with 10 pairs of spines, of which the second a minute hair.

Distribution: Stalio (1877) found berried females in the summer months. Lebour (op. cit.) observes that berried femals were found along with *Galathea spp.* from autumn to spring. In the Norway Coast berried femals were found from February to April. Larvae were observed off Norway from May to July, in the Irish Sea in April and off Plymouth from January to June (Thorson, 1946). In the Adriatic the larvae are found common from January to April, with the maximum during January-February, which shows that the breeding time of this species more or less agrees with that in the Plymouth area. But, contrary

to the observations at Plymouth, the larvae are found here not far away from the shore.

GALATHEA STRIGOSA (Linnaeus).
Lebour, 1930, 1931b.

STAGE I: Length 3.6 mm. (from tip of rostrum to end of telson excluding the spines).

STAGE II: Length 4.2 mm.

STAGE III: Length 5.6 mm.

STAGE IV: Length 8.2 mm.

Both pairs of abdominal spines very large.

Distribution: Pesta (1918) observes that the spawning of this species varies with locality; Stalio (1877) found it in march and Graeffe (1900) from January to May. Lebour (1930) observes that the larvae of this species are common in the inside and outside waters near Plymouth. Rees (1952) says that he has found larvae during July and August. In the present collections larvae are common from December to June with maximum in March in the sea and May in the lake.

GALATHEA SQUAMIFERA Leach.
Lebour, 1931b.

STAGE I: Length 2.5 mm. (from tip of rostrum to end of telson excluding the setae).

STAGE II: Length 2.6 mm.

STAGE III: Length 3.5 mm.

STAGE IV: Length 4.2 mm.

Distribution: At Plymouth, female in berry were observed from February onwards, and larvae common in the inshore regions in spring, summer and less common in autumn and winter (Lebour, op. cit.) Rees (1952) observed the larvae from March to October, with maximum in July. In the present collections the larvae are not very common, having been obtained in considerable numbers only in January, when all the stages are present.

GALATHEA DISPERSA Sp. Bate
Lebour, 1930, 1931b.

STAGE I: Length 2.4 mm. (from tip of rostrum to end of telson excluding the setae).

STAGE II: Length 2.9 mm.

STAGE III: Length 4.0 mm.

STAGE IV: Length 5.1 mm.

Inner uropod with 9 plumose setae.

Distribution: Graeffe (1900) observed the spawning in the Gulf of Trieste and S. Andriatic in February, March, September and October. Berried femals were observed near Plymouth all the year round and the larvae were abundant in the plankton in the outside waters (Lebour, 1930). Rees (1952) observed the larvae from February to November, with peak in July and August. In the present collections the larvae are very common from December to June, with maximum in May-June. In the lake the larvae are found only from May to July, with maximum in June. So, it may be presumed that the breeding period of this species is restricted here to a few months, unlike in the Plymouth area. Also, the larvae are seen more in the inshore waters than in the off-shore regions.

GALATHEA INTERMEDIA Lilljeborg.
Lebour, 1930, 1931b.

STAGE I: Length 2.1 mm. (from tip of rostrum to end of telson, excluding the setae).

STAGE II: Length 3.0 mm.

STAGE III: Length 3.6 mm.

Second seta of telson very slender and hair-like, but distinct and longer than the first spine.

STAGE IV: Length 4.2 mm.

Inner uropod bears 5 plumose setae fringing the extremity.

Post-larva: Length 3.4 mm.

Distribution: This is not a common species in the Plymouth area and the larvae were observed both inside and outside waters chiefly in spring and summer (Lebour, 1931b). In the Danish waters the larvae were frequently observed from late July to late October

(Thorson, 1946), and in the North Sea from March to November with peak in July and August (Rees, 1952). In the present collections the larvae of this species are very common and are found almost throughout the year with the maximum in the sea in June-July. From the lake also, considerable numbers of larvae were collected, but here the maximum occurs in May. Like *G. dispersa,* the larvae of this species are found more common in the inshore waters, and only very few specimens were obtained from the off-shore station. In deep water regions, the larvae of this as well as those of *G. dispersa* are found most common in the surface waters within 50 m. and rarely between 50 and 100 m.

Family PORCELLANIDAE

PORCELLANA LONGICORNIS (Pennant).
Williamson, 1915.
Lebour, 1943.

The larvae of *Porcellana* are easily distinguished by the very long rostrum, which is about twice as long as the body.

STAGE I: Length of body 1.59 mm. (from base of rostrum to the end of telson). Length from spine to spine 7.30 mm.

Telson with 5 pairs of plumose setae, the third seta bearing hooks distally, which character distinguishes it from *P. platycheles.*

STAGE II: Length of body 1.89 mm. Length from spine to spine 9.0 mm.

Telson with 6 pairs of plumose setae. Anal spine prominent. Three pairs of pleopods present.

Distribution: Lebour (1943) observed the larvae in the inshore plankton in every month except December and most common in summer. Rees (1952) found the larvae near to the coast mostly around August and Thorson (1946) recorded them during late July. Here the larvae are found in May, August, November, December and January, with maximum in May.

Family AXIIDAE

AXIUS STIRYNCHUS Leach (Fig. 141).
Webb, 1921.
Caroli, 1921.

Only 2 larval stages are found in this species, the eggs being very large measuring 2.5×1.2 mm. and the larva possesses all its appendages except the uropods on hatching.

STAGE I?: Length 9.1 mm. Rostrum 1.9 mm.

The specimen is longer than the stage I of Webb (op. cit.) and about as long as her stage II. But it differs from stage II as the setae on the exopods of the first 3 peraepodos are not yet formed. The telson also resembles that of stage II and excluding the long lateral prolongations there are 14 spines and 1 slender hair on each side of the middle spine.

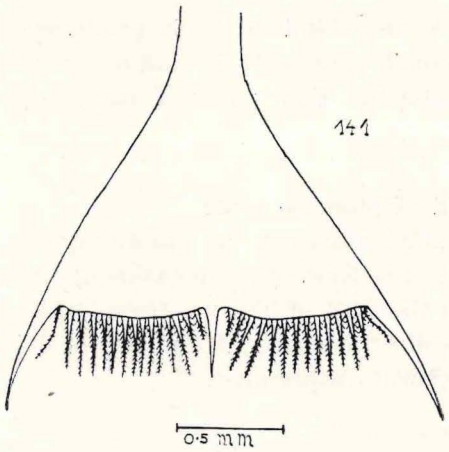


Fig. 141. *Axius stirynchus*, I stage, telson.

Distribution: Webb (1921) obtained the larva of this species towards the end of August and Lebour (1947) found from May to October. In the present collection only a single I stage larva is present, obtained in May 1952 from Mljet. This species has not yet been recorded from the Adriatic.

Family LAOMEDIIDAE

This family is of special interest in view of the extreme rarity of the species and specimens. In the collections at hand, larvae of 2 species are present, of which one is referred to *Jaxea nocturna*.

JAXEA NOCTURNA Nardo (Figs. 142, 143).

Williamson, 1915.
Caroli, 1924.
Gurney, 1924.

This is the only species of *Jaxea* recorded from the Adriatic Sea and stages 2 to 4 are represented in the collection.

STAGE II: Length 5.44 to 5.68 mm.

The specimens closely resemble the descriptions and figures of Caroli. Inner flagellum of first antenna ends in a spine; outer distinctly segmented from the peduncle, bears a thick seta and 4 smaller setae at the extremity. Lateral borders of telson terminate in very sharp, curved spines, and in between these there are 10 pairs of plumose setae.

STAGE III: Length 7.69 mm.

Dorsal organ visible as a rounded knob behind the neck. peduncle of first antenna bears 6 setae. Uropods formed, outer with 11 and inner with 4 setae. Telson with 12 pairs of plumose setae. Four pairs of appendages formed.

STAGE IV: Length 11.68 mm.

Telson with serrated spines instead of plumose setae.

Distribution: Graeffe (1909) observed the spawning time of this species as September. Larvae in the first stage measuring from 3.5 to 4.5 mm. have been collected from the Gulf of Trieste, from October to December (Pesta, 1918). In the collections from Mljet stages 2 to 4 are present in small numbers from April to September.

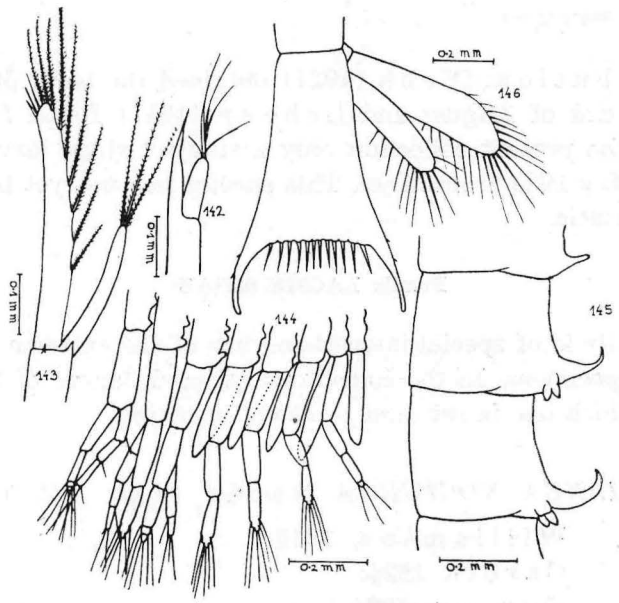


Fig. 142. *Jaxea nocturna*, II stage, I antenna.
Fig. 143. „ „ , II antenna.
Fig. 144. *Jaxea sp.*, VI stage, profile- peraeopods & maxillipeds.
Fig. 145. „ „ , pleural spines and pleopods.
Fig. 146. „ „ „ , telson & uropod.

JAXEA sp. (Figs. 144—146).

A single specimen obtained in the July collection from Mljet, probably belonging to stage VI differs from all published larval stages of *Jaxea spp.* Hitherto, the complete stages of only 2 species of this genus, viz. *Jaxea nocturna* and *Jaxea sp.* Gurney, are known. But the present specimen differs from both, mainly in the absence of lateral spines on the last abdominal somite and in having only 12 strong spines in the hollowed posterior margin.

Length 5.7 mm. (from tip of rostrum to the end of telson, excluding the lateral prolongations).

Rostrum with a double curve, end of which does not reach the extremity of the eye. Endopodite of first antenna slightly longer than the 2-jointed exopodite, flagella 2-jointed. Endopodite of second antenna without segments, longer than antennal scale, with a small distal seta, basipodite with 2 inner distal spines as in *Jaxea sp.* Gurney. First 3 maxillipeds well developed with exopods. Exopods of first 3 peraeopods bear 5 distal setae, while those of fourth pair with only 3 small setae. Endopodites of all the peraeopods rudimentary and similar. Telson rectangular in shape, with the posterior corners drawn into curved processes. In the hollowed posterior margin there are 12 strong ciliated spines, of which those at the centre are small. On the outer side of each of the lateral prolongations 2 small hairs may be noticed. No teeth on the inner side of the lateral prolongations of the telson as seen in *J. nocturna* Nardo and *Jaxea sp.* Gurney. Both branches of uropods bear setae; exopod without tooth on its outer margin. At the base of uropods a pair of small, blunt spines noticed on the ventral side. First abdominal somite with a pair of blunt spines, whereas the following 4 somites have hooked spines, the size of which increase backwards. Sixth abdominal somite without spines. In *J. nocturna* and *Jaxea sp.* Gurney, there are long and curved spines on this segment. Pleopods appear as biramous rudiments on somites 3 to 5, their size also increasing backwards.

Family CALLIANASSIDAE

UPOGEBIA STELLATA (Montagu)
Webb, 1919, 1921.
Gurney, 1938.

The larvae of Upogebia may be distinguished by the small rounded rostrum, telson with small median spine in all except first stage, legs 1

to 3 with exopodites, pleopod absent from first abdominal somite and endopod of third maxilliped rudimentary.

As per diagnostic characters given by Webb (1921) the common form found in the collections may be identified as *U. stellata.*

STAGE I: Length 2.74 mm.

STAGE II: Length 3.45 mm.

As Gurney (1924) observes a hair present in between the first and second spines of telson on each side.

STAGE III: Length 4.55 mm.

Inner uropod without setae.

STAGE IV: Length 4.72 mm.

Distribution: Pesta (1918) observed spawning in June and July. At Plymouth the larvae were observed common in the tow-net collections, most abundant in early summer, only small numbers in July and rare after the middle of August. In the North Sea larvae were found from July to November (Rees, 1952). In the present collections larvae are observed from February to July, most abundant from May to July, with peak in June, more or less coinciding with the observations in the Plymouth area. The larvae are found more in the surface waters above 50 m. and only very few specimens were caught within 50 to 100 m. No larva was collected from the lake.

UPOGEBIA DELTAURA Leach.

Webb, 1919, 1921.

STAGE II: Length 2.4 mm.

It closely resembles that of *U. stellata,* the only notable difference being the absence of a seta on the second joint of the endopod of first maxilliped.

STAGE III: Length 3.55 mm.

Pleopods formed, and are about 3/4 the length of the somites which bear them. Last 2 peraeopods without exopods.

STAGE IV: Length 4.50 mm.

The larva at this stage is very similar to that of *U. stellata,* the only notable difference being the absence of seta on the second joint of the endopod of second maxilliped.

Distribution: Lebour (1947) found the larvae from April to November, with maximum from July to September. In the North Sea it has almost the same period of occurence as that of *U. stellata* (Rees, 1952). In the present collections larvae of this species are present only in small numbers from August to January. From the lake only a single third stage larva was obtained in December.

CALLIANASSA SUBTERRANEA (Montagu).

Sars, 1884.
Webb, 1921.
Gurney, 1938.
Caroli, 1947.

STAGE I: Length 3.37 mm. (including rostrum).

Closely resembles the stage I described by Sars op. cit. Telson with 7+1+7 spines, of which the second one is a very small hair.

STAGE II: Length 4.07 mm.

All peraeopods formed, last 3 unsegmented. Telson with 8+1+8 spines. No pleopods.

STAGE III: Length 5.0 mm.

First 4 peraeopods well developed. Pleopods biramous on third to fifth somites.

STAGE V: Length 5.69 mm.

Peraeopods and pleopods well developed. Dorsal side of third, fourth and fifth abdominal somites well carinated.

Distribution: Lebour (1947) observed the larvae in summer and early autumn. From the North Sea the larvae were collected in August and September (Rees, 1952). In the Adriatic the larval stages are found almost throughout the year, most common from May to July with peak in June at Mljet and July at Dubrovnik. In the lake it is rather rare and only in May it has been observed. The larval stages of this species are found more common within 50 to 100 m.

Family PAGURIDAE

In paguridae the broad and short carapace terminates posterolaterally into a sharp point, but without fringes of spines as in Galatheidae.

The pagurid larvae with 3 pairs of pleopods in stage IV are referred to *Anapagurus,* the larvae of *Eupagurus* having 4 pairs of pleopods.

ANAPAGURUS CHIROACANTHUS (Lilljeborg).
Sars, 1889.
Williamson, 1915.

STAGE I: Length 2.48 mm.

Telson with 7 pairs of spines, the second one a very small hair, seen only in ventral view.

STAGE II: Length 3.4 mm.

Prominences of the pleopods formed. Caudal plate with 8 pairs of spines.

STAGE III: Length 3.7 mm.

STAGE IV: Length 5.0 mm.

Postero-lateral spines of carapace short. Uropods well developed, exopod with 6 setae on the inner side and a terminal spine, endopod a small lobe with an end seta. Second spine of telson slender, fourth stout, fused with the telson, not much longer than fifth, sixth and seventh, eighth smaller. A pair of ventro-lateral spines prominent on the fifth segment of abdomen.

Post-larva (Glaücothoe stage): Length 2.68 to 3.00 mm.

Resembles fig. 296 of Williamson (op. cit.). All appendages incuding the pleopods and uropods well developed. Posterior margins of exopod and endopod of uropod bear 6 and 5 blunt teeth respectively.

Distribution: Thorson (1946) and Rees (1952) observed the larvae common from July to October, with maximum in October. Here, it is found in large numbers from February to August, with the maximum during June-July. In the deep water regions the larvae are found to be distributed at all depths, but are most common within 50 to 100 m. This species has not yet been recoded from the Adriatic.

EUPAGURUS PUBESCENS (Kroyer).
Sars, 1889.
Williamson, 1915.

STAGE III: Length 3.6 mm.

Rostrum reaches slightly in front of antennule. Flagelium of second antenna stout and pointed, about as long as scale. Posterior borders of

abdominal somites with small, dorsal spines. Penultimate segment of abdomen bears 2 large lateral spines. Pleopods formed. Last 3 peraeopods rudimentary.

STAGE IV: Length 4.1 mm.

Flagellum of second antenna slightly longer than scale. Biramous pleopods (4 pairs) formed, but without setae, the outer terminates into a long stout spine.

Distribution: Rees (1952) observed the larvae from February to May. Thorson (1946) found that off northern Norway, the breeding peirod is probably from October to April. In the present collections the larvae are rare and have been observed during the same period as in the North Sea. This species is recorded from the Adriatic Sea for the first time.

Tribe Brachyura

The crab zoeae constitute an important part of the decapod larvae, sometimes occupying as much as 25% of the total larvae of this group. As they frequent the surface layers, they also play a considerable role as food of shoal fishes.

In the open sea the larval crabs occur at all depths, though they are more in the surface layers than in depths. Russell (1927) observes that the zoeae, though they avoid the actual surface layers, were frequently numerous within 5 m. of the surface.

The crab zoeae are present here throughout the year with a maximum intensity in January. In the regions below 50 m. the zoeae are very rare. The megalopa stage is also seen throughout the year, with maximum in February and March, but is found more numerous at depths and only very rarely observed in the collections above 50 m.

Family DROMIDAE

DROMIA VULGARIS Milne Edwards.

Cano, 1894.

Lebour, 1934.

There are 5 zoeae and 1 megalopa stages in this species.

STAGE I: Length 3.1 mm.

The specimens in the present collection agree with the description and figures of Cano (op. cit.). It is however longer than the first stage recorded at Plymouth which is only 2.9 mm. and is further advanced in development.

First leg bilobed with endopodite having 2 end-setae (in the Plymouth specimens these setae are not present). Rudiments of legs 2 to 4 are also seen.

Distribution: Pesta (1918) observed mature specimens from May to June. Lebour (1934) found berried female in July and last zoeae in September. In the July collections from Dubrovnik area the first stage larvae of this species are found in small numbers between 50 to 100 m.

Family DORIPPIDAE

ETHUSA MASCARONE (Herbst.)
Cano, 1891.
Williamson, 1915.

A series of 3 larval stages very similar to that of *E. mascarone* as described by Cano have been obtained in the collections.

STAGE I: Length of body 2.58 mm. (from base of rostrum to cleft of telson). Rostrum 2.0 mm.

First and second maxillipeds well developed and biramous. Third indicated as a small prominence. Carapace bears small lateral spines, in addition to the dorsal spine, which is as long as the rostrum. The presence of these lateral spines distinguishes it from its ally *Dorippe lanatus,* which is also found in the Adriatic. Five abdominal somites free from the carapace, second with a pair of lateral teeth and a ventral prominence. Telson not distinctly separated from the last abdominal somite.

STAGE II: Length of body 4.8 mm. Rostrum 4.0 mm.

Third maxilliped small and biramous, without setae, bears a single gill at the base. First peraeopod with 2 gills and the following 3 pairs with one each. All except first somite of abdomen show ventral prominences. Telson with a thick cover of fur-like hairs.

STAGE III: Length of body 6.0 mm. Rostrum 5.0 mm.

First peraeopod chelate. No exopods on peraeopods. Two pairs of long hairs present on the dorsal side of first abdominal somite. Pleopods formed on second to fifth abdominal somites.

Distribution: Herbst (1782—1804) gives the spawning time as early part of the year. In the Mljet region larvae are common from May to November with maximum in May. In the lake it is rather rare and only in May it has been collected sparingly. The larvae are found more in the surface collections.

Family LEUCOSIDAE

EBALIA TUBEROSA (Pennant).

Lebour, 1928, 1928a.

Four larval stages present. No dorsal spine, rostral and lateral spines rudimentary.

STAGE I: Length about 1.3 mm.

Carapace covers the rudimentary limbs. Distal margins of telson end in small points.

STAGE IV: Length 2.3 to 2.5 mm.

Eight setae present on maxillipeds. First leg large with strong chela. Four pairs of long pleopods (without setae) present, fifth visible as 2 buds under the telson. Telson bears posteriorly 6 setae, of which the central 2 are large.

MEGALOPA: Length 1.4 mm. Breadth of carapace 1.18 mm. Six setae present on the last pleopod.

Distribution: Berried crabs were observed in the Plymouth area from March to July and larvae in the plankton from January to October (Lebour, 1928). In the North Sea, the peak number was found in August (Rees, 1952). In the Adriatic the larval stages of this species are observed in the open sea collections during February to April, with maximum in April. The early stages of this species are found even in the surface collections, where as the last stage is more numerous in the lower water layers.

EBALIA CRANCHII Leach.

Cano, 1891.

Lebour, 1928.

The zoeae of this species agree with Cano's *Plagusia sp.* which he later on referred as *Ebalia sp.* and differ from *E. tuberosa* chiefly in the presence of 3 teeth at each of the distal lateral corners of the telson. A small hair is also seen between the second and the third teeth in the last stage.

STAGE II: Length ca. 1.3 mm.

No pleopods.

STAGE III: Length ca. 1.5 mm.

First and second maxillipeds with setose exopodites. Four pairs of pleopods appear as small buds. Telson with 3 teeth at the distal outer corner and 6 setae posteriorly.

STAGE IV: Length 2.1 mm.

All thoracic appendages formed. A pair of small buds, about 1/3 the size of the fourth pleopod visible on the ventral side of telson.

MEGALOPA: Smaller than that of *E. tuberosa*. Length of carapace 1.0 mm., breadth 0.74 mm.

Last pleopod with 4 setae.

Distribution: Near Plymouth berried crabs were found in April and larvae in summer and autumn, chiefly from July to September (Lebour, op. cit.). Rees (1952) observes that *E. cranchii* has the peak period in October and that it occurs more in shallower water than at depths. Here at Mljet the larvae are found from April to November, with maximum intensity in September and no difference in zonal distribution is seen from that of *E. tuberosa*.

Family PORTUNIDAE

Regarding this group Lebour (1928a) observes that it is difficult to recognize the later zoea of any of this species and that unless these are reared or taken alive in the plankton, it is not worthwhile to separate them. Six species of *Portunus* have been recorded from the Adriatic Sea (Pesta, 1918) and the majority of the crab zoeae obtained in the present collections belong to members of this family.

PORTUNUS DEPURATOR (Linne).

Williamson, 1915.
Lebour, 1928a.

LAST STAGE: Length ca. 5 mm. From spine to spine 3.4 mm.

MEGALOPA: Carapace with rostrum 1.8 mm.

Last pleopod with 9 setae.

Distribution: Near Plymouth berried crabs were observed in spring, summer and autumn, rare in winter, chiefly in spring and zoeae in plankton most of the year, especially in spring and early summer (Lebour, op. cit.). Planktonic larvae were observed at Sound mainly

in September and October, from Irish Sea in April and Kattegat in early October (Thorson, 1946). In the Adriatic berried females were observed from January to July and October to December (Pesta, 1918). In the present collections zoeae were found in the plankton throughout the year, with maximum intensity in January-February and megalopa in June-July.

CARCINUS MAENAS (Pennant).

Four zoeal stages found in this species.

STAGE II: Length ca. 1.8 mm. (from tip of rostrum to end of telson).

STAGE III: Length ca. 2.5 mm.

STAGE IV: Length ca. 3.3 mm.

MEGALOPA: Length of carapace 1.4 mm. (with rostral spine).

Last pleopod with 5 setae.

Distribution: Pesta (1918) observed berried females in the early part of the year. Near Plymouth berried crabs were found throughout the year, chiefly in February and March and the larvae all they year round, with maximum in spring and early summer (Lebour, op. cit.). Larvae were found off Scotland from March to late July; off Northumberland from May to August; off west Norway in summer with megalopa in August; in the Sound from July to October and in the North Sea June and July (Thorson, 1946). In the present collections from the open sea, zoeae are commonly present from April to September with maximum in May and megalopa from June to November.

Family ATELECYCLIDAE

ATELECYCLUS SEPTEMDENTATUS (Montagu). Lebour, 1928a.

MEGALOPA: This larva is peculiar in having a long rostrum and a backwardly directed spine on the carapace. Last pleopod bears 11 setae.

Distribution: At Plymouth the larva is common in spring and rare in summer (Lebour, op. cit.). In the Adriatic, it has been observed only sparingly during April, November and December.

Family XANTHIDAE

XANTHO INCISUS Leach.
Lebour, 1928a.

MEGALOPA: Length of carapace 1.7 mm.; breadth 1.1 mm.

Closely resenbles the specimen described by Lebour (op. cit.). Carapace with a square rostrum, with a short bifid tooth at the centre. Last pleopod with 10 setae. This species is recorded here for the first time.

Family GONOPLACIDAE

GONOPLAX RHOMBOIDES (L.)
Williamson, 1915.
Pesta, 1918 (= *G. angulatus)*
Lebour, 1928a.

Four zoeal stages are present in this species. The larvae are peculiar in having the exopodite of the antenna as long as the spinous process and knobs on second to fifth abdominal somites.

STAGE II: Length 2.9 mm (from tip of rostrum to end of telson). Length from spine to spine 2.27 mm.

Tubercles of second segment prominent, those of third to fifth very small.

STAGE III: Length 4.6 mm. Length from spine to spine 3.3 mm.

Dorsal spine longer than rostral. Pleopods appear as buds. Telson with an extra pair of internal setae.

STAGE IV: Length 5.3 mm. Length from spine to spine 3.3 mm.

All peraeopods and pleopods formed. Telson with one more pair of additional setae.

MEGALOPA: Length of carapace 2.17 mm. Breadth of carapace 1.94 mm.

Distribution: Pesta (1918) observed berried female in the early part of the year and during summer. At Plymouth berried crab was observed in June and larvae fairly common in the plankton from June to September and early autumn (Lebour, op. cit.). In the present collections the zoeae were obtained from December to April, with maximum in February and megalopa from December to February.

Family MAIIDAE

MAIA SQUINADO (Herbst.).
Lebour, 1927, 1928a.

STAGE I: Length ca. 3.1 mm.

Both rostral and dorsal spines slightly curved. Telson with 3 pairs of plumose setae inside the fork and one large spine covering 2 smaller ones on either side at the base of the telson fork.

Distribution: Pesta (1918) gives the spawning time as March, April, July and August. At Plymouth berried crabs were found from May to October, chiefly in July and August and larvae in the plankton in summer and autumn, abundant in late summer (Lebour, op. cit.). At Mljet the larvae of this species are rarely observed in May and June.

DISCUSSION

BREEDING SEASONS AND THE DISTRIBUTION OF LARVAE.

The larva is a free-swimming phase in the cycle of the individual, which differs in form and habit from the adult. In some species, metamorphosis from the young to adult is sudden, whereas in others it is gradual. We know very little about the environment of the larval forms and in many cases the young and adult live at very different depths. As Russell (1927) observes, even different stages of the same species may sometimes occupy different zones. As the breeding season is the most critical time during the life of most marine invertebrates, the conditions prevailing during the spawning and larval development will mostly be decisive of the occurrence of the species in the locality. Orton (1920) observes that the species able to vegetate at rather low temperatures require very definite and normally much higher temperatures to ripen their sexual products and to spawn them. Besides temperature, salinity and pH, the phyto plankton intensity also seems to influence the starting or retarding of the spawning of marine invertebrates, as the amount of food required by the larvae of bottom invertebrates is proportionately larger than that of their parents (Thorson, 1946). According to the occurrence of decapod larvae in the collections, they may be classified

into »abundant«, »common« and »rare« forms. In the first category comes 11 species: — *Sergestes arcticus, S. robustus, Processa edulis, Alpheus ruber, Spirontocaris cranchii, Galathea dispersa, G. intermedia, Porcellana longicornis, Upogebia stellata, Anapagurus chiroacantus* and *Portunus depurator*. The rare forms are usually represented by a sigle or a few specimens and in this category comes 20 species: — *Aristaeomorpha foliacea, Penaeus spp., Sicyonia carinata, Sergestes corniculum, Sergestes sargassi, Pontophilus spp., Leander spp., Mesocaris spp., Latreutes sp., Nephrops norvegicus, Axius stirynchus, Jaxea spp., Eupagurus pubescens, Dromia vulgaris,* and *Mai squinado*. The remaining 29 forms may be referred as cammon.

Pesta (1918) in his monograph has recorded 143 species of decapods, of which 43 belong to Natantia and the rest to Reptantia. In the present collections, though the Natantia is well represented by 33 species, Reptaintia is rather rare, mainly because of the scarcity of the crab larvae. Out of the 52 species of larvae identified, only 41 have been hitherto recorded from the Adriatic Sea.

As the fauna of the coast is of varied nature, the plankton of the coastal waters is also rich in larval forms than that of the open sea. Ortmann (1893) and Gurney (1924) observe that there is a very close relation between the number of decapod larvae and the proximity of land, indicating that the larvae of the littoral species are not generally carried into the open sea. A comparison of the collections from Mljet and Sv. Andrija (Dubrovnik) confirm this observation in the Adriatic also. The greatest numbers of individuals and species were obtained in the collections from Mljet, which station is nearer to the shore than that near Dubrovnik. Among the 60 forms dealt with in the present paper, 57 have been obtained in the collections from Mljet, whereas only 32 were got from Dubrovnik area. Three species not present in the Mljet collections viz. *Pontophilus spinosus, P. norvegicus* and *Dromia vulgaris* are however present in the Dubrovnik collections; but they are represented by only very few specimens, showing the rarity of the species in the locality under investigation.

It may be observed that the number of species of decapod larvae in the plankton from the Adriatic Sea is rather high, when compared to those from the North Sea and other cold water regions. Besides the 60 species dealt with in the present paper, collected mainly from 2 stations, atleast 10 more species are present in the collections, though not in large numbers. In the plankton collections from the North Sea taken during

nearly 3 years (1947—1949) the number of species present is 41 and only »less than 1% of the larvae was left unidentified« (Rees, 1952); and from the Danish waters, larvae of only 35 out of 37 species recorded have been found (Thorson, 1946). Thirty species of larvae recorded from the Plymouth region, 18 by the Recorder Survey of the North Sea and 10 from the Danish Sound are represented in the present collections.

Though the swimming powers of some larvae are considerable, they are sometimes at the mercy of the ocean currents and may at times be carried to very long distances. Fraser (1936) has worked out the relation of the ocean currents in the case of *Euphausia superba* and found that the larval life may be even as long as 10 months, during which time a lengthy migration is effected. (Euphausiacea is not included in the present classification of Decapoda). But, generally the larvae of the shore species have mostly the same distribution as the adults. Usually, swarms of larvae of one species in different stages of development may be observed together, which seems to indicate a tendency of keeping together from hatching onwards, or of collecting together in a suitable locality. The occurrence of different stages of *Gennadas elegans, Solenocera membranacea, Sergestes spp., Processa edulis, Plesionika sp., Alpheus ruber, Spirontocaris cranchii, Galathea spp.,* and crab zoeae during definite periods and at particular places may be quoted as examples illustrating this phenomenon.

The length of the breeding season varies considerably from species to species. Some species have very short, while others have a very long breeding season. According to the breeding habit of the species they may be divided into »perennial« and »seasonal« breeders, the larvae of the perennial breeders being found in the plankton almost throughout the year, while the larvae of the seasonal breeders have their restricted periods of appearance. Eleven species viz. *Solenocera membranacea, Processa edulis, Plesionika sp., Alpheur ruber, Philocheras spp., Spirontocaris spp., Galathea intermedia, Callianassa subterranea* and *Portunus depurator* have larvae in the plankton collections from the sea almost throughout the year. The maximum abundance of larvae of five among these are found in the summer months June to September, whereas the maxima of the remaining six species occur in the winter months December to February. It may also be noted that throughout the period of occurence, the early stages of almost all the species in question are also found with the later stages, showing the extended breeding season.

Among the seasonal breeders, the majority breed during summer and winter as evinced by the presence of larvae in the plankton. Near Mljet, the maximum abundance larvae of 16 species is during June-July, 11 species in August-September, 8 species in November-December, 12 species in January-February, 3 species in March-April and 7 species in May. Thus, greater numbers of species have their maximum abundance during June-July (summer) and January-February (winter). From the occurrence of larvae in the plankton, it may be observed that most of the species common to Adriatic and N. Atlantic have a more extended breeding season here than in the colder regions and the summer spawners like *Philocheras bispinosus, Munida bamffica, Galathea strigosa* and *G. squamifera* in the N. Atlantic have their main breeding season here in winter.

Larvae of no endemic species are observed in the lake. All the 18 species found viz. *Processa edulis, Alpheus ruber, Athanas nitescens, Philocheras bispinosus, Spirontocaris cranchii, Spirontocaris sp., Lysmata seticaudata, Galathea strigosa, G. dispersa, G. intermedia, Callianassa subterranea, Upogebia deltaura, Ethusa mascarone, Anapagurus chiroacantus, Portunus depurator, Carcinus maenas, Ebalia cranchii,* and *Gonoplax rhomboides* are found common in the sea out side the lake. Though the seasonal occurrence of the larvae of these species in the lake almost coincides with that in the sea, their maxima is generally reached slightly earlier. Out of the 18 species, 11 have their maximum abundance of larvae in May, the maximum for 9 of these having been reached in the sea only in June or later. The maximum number of species viz. 14 and the maximum number of specimens are also observed in the lake during May. No winter maximum is observed and the poorest collection is in December. This is mainly because of the total absence of the group Penaeidea in the lake collections, which pronounce the winter maximum at Gonoturska. The absence of penaeid larvae in the lake may be due to the shallower water and much variable changes of temperature. Even though the larvae of *Sregestes spp.* are abundant in the sea during January, they are not seen in the lake. It is also probable that the lake species which require some particular optimum temperature, salinity etc. for breeding, migrate to the sea in search of these conditions as observed by Gurney (1923 & 1942) in the case of *Leander longirostris* and *Penaeus* & *Metapenaeus spp.*

During April and May the climatic conditions change and the first indication of a new spawn can be observed. The outcome of larvae are mostly from *Spirontocaris spp., Alpheus ruber, Caridion steveni, Jaxea nocturna, Upogebia stellata, Porcellana longicornis, Callianassa subter-*

ranea, Ethusa mascarone, Ebalia spp., and *Maia squinado*. The minimum temperature at the surface of the sea is reached during February and March (12.0° C in the sea and 8.16° C in the lake) and by May the temperature increses to 19.2° C in the sea and 19.8° C in the lake. This rise in temperature over the minimum of the year seems to induce spawning in some species. In the lake, this change is more pronounced than in the sea and the larval maximum occurs during May. But in the sea out side the lake, though larvae come to appear in large numbers in May, the height of the summer spawing is reached only in June, when the temperature is still higher. This is about 4 to 6 weeks earlier than observed in the cold waters of North Sea and Danish Coasts. T h o r s o n (1946) observed that in the Danish Sound the summer spawning occurs rather late owing to the considerable current and water movements which retard the heating of the water, and that in the Danish fjords, where the water is shallow and rise of temperature takes place earlier, summer spawning also occurs earlier.

Thus the temperature of the sea water is regarded as the most essential factor in starting the breeding season. O r t o n (1920) observes »that most animals under normal conditions begin to breed either at a definite temperature, which is a physiological constant for the species, or at a definite temperature change, namely either the maximum or minimum temperatures of the locality«. He also considers that the changes in salinity have very little value as a spawning stimulus.

Taking total larvae into consideration, at Mljet sea there are 2 maxima, one in June 1952 and the other in January 1953. But it may be noted that the January maximum is formed by the sporadic occurrence of crab zoeae and early stages of *Sergestes robustus*, and *Sergestes arcticus*. Excluding these 3 forms, the total decapod larvae in this month is very low and is only of the same level as seen during the previous 2 months. So, it is justifiable to consider June as the main maximum for the total decapod larvae in the Mljet region. In the Dubrovnik area also, two maxima are observed, one in winter and the other in summer, the winter maximum being much enhanced by the presence of crab zoeae and *Sergestes* larvae, and the summer miximum occurring a little late.

LARVAL LIFE.

From a systematic study of the larvae in the collections it may be observed that the larval stages of many species found in the warm Adriatic are larger than the corresponding stages of the same species

collected from the cold waters, like North Sea, Danish coasts and Plymouth area. They are also found to be further advanced in development even from the time of hatching from the egg. This progress in development is very much evinced in the case of *Processa edulis, Alpheus ruber, Athanas nitescens, Philocheras spp., Axius stirynchus, Upogebia spp., Callianassa subterranea* and *Dromia vulgaris*. The open sea forms like *Spirontocaris cranchii, Processa edulis, Acanthephyra purpurea, Plesionika sp.,* and *Lysmata seticaudata* have more variable larval forms than the inshore species.

The length of the pelagic larval life as well as the number of pelagic stages, vary from species to species. The number of stages in any species is probably a fixed one in most cases, but it can be correctly ascertained only by following the moults in natural surroundings. Generally the number of pelagic stages is largest in Natantia varying from 5 to 9, whereas, there may be only even 2 stages in some Reptantia. In a few oceanic larvae, more than 9 stages may also be found, if each moult is counted to be a stage, with very little changes taking place within moults. The 11 stages of *Plesionika sp.* may from an example of this lengthy larval life. In the case of some penaeids like *P. kerathurus* and *Sicyonia carinata,* H e l d t (1938) has observed even as much a 8 nauplius stages, 3 protozoeae and 4 zoeae (mysis) giving a total of 15 stages. The size of the egg in proportion to the size of the adult is suggested by G u r n e y (1942) as giving some indication of the length of larval life and that where larval life is normal the eggs are about $^{1}/_{100}$ of the parent's length; but they may be even as big as $^{1}/_{9}$ of the length of the adult. He also observes that the size of the larvae bears very little relation to that of the adult.

The larvae of some species are found almost throughout the year, while the larvae of others are found only during restricted periods as discussed above. But the time spent by the individual larva in the plankton may be presumed to be rather short. From the literature, it may be gathered that the larval life varies from 3 weeks to 2 months. T h o r s o n (1946) observes that in nature, the pelagic life of most species of decapod larvae in the N. Atlantic seems normally to last for about 4 weeks. Though no direct evidence is available in the present investigation, a computation of the different stages in the collections seems to show that in the warm waters of the Adriatic, the larval life may be shorter.

VERTICAL DISTRIBUTION.

Though decapod larvae are found at all depths, most of them have a depth preference, concentrating in the region of optimum conditions. As transformation takes place, the larvae of the shore species are found to seek the habitat of their parents. In the present observations, though the larvae are found to avoid the actual surface layers during day time, the maximum abundance occurs within 50 m. and the least number near the bottom. The zoeae of crabs are found more in the surface layers, while megalopa and pagurids, though come to the surface occasionally are frequently seen near the bottom. Larvae of *Gennadas elegans, Philocheras bispinosus, Spirontocaris cranchii, Lysmata seticaudata, Latreutes sp., Mesocaris spp., Stenopus spinosus, Galathea spp., Upogebia stellata* and *Portunus depurator* are found more abundant within 50 m. *Sergestes spp., Acanthephyra purpurea, Solenocera membranacea* and *Plesionika sp.* are seen between 50 to 150 m., with the maximum at 50 to 100 m. *Athanas nitescens, Spirontocaris sp.* and *Callianassa subterranea* occur most common within 50 to 100 m.; *Processa edulis* and *Caridion steveni* are evenly distributed within 100 m. and *Alpheus ruber* though it occurs at all depths has its maximum within 50 m.

The young stages of the different species are found to be aggregated at the regions of optimum conditions for the species, whereas older larvae are found more scattered in the different layers. Here the second and third elaphocaris stages of *Sergestes robustus* and *Sergestes arcticus* are seen restricted within 50 to 100 m., while acanthosoma and mastigopus stages are found scattered in the different layers. Russell (1927) observes that even within the same species, there may be changes in the vertical distribution, in accordance with the varying temperature in the sea water.

DIURNAL MIGRATION.

Russell (1927 & 1928) has shown that the decapod larvae have a pronounced diurnal, vertical movement. But his work mostly deals with the littoral species and little is known about the deep sea forms like *Sergestes* and *Acanthephyra*. Russell (1927a) observes that each species has an optimum intensity of light, which it follows upwards as the light fails and as the light falls below the optimum, the animal tends to sink to lower levels of better temperature or salinity. At dawn they

rise again to seek the increasing light and again follow the optimum intensity downwards.

In the present investigation, the diurnal changes occurring in the vertical distribution of the decapod larvae have been studied mainly by a series of collections taken from the Mljet lake in June 1952, and the observations more or less agree with those of Russell.

Alpheids represented by *Alpheus ruber* and *Athanas nitescens* occur in small numbers in the surface layers during day, but swarms were observed in the night collections from the surface.

Spirontocaris spp. are observed at all depths during day and night, but have a maximum intensity within 20 m. during night.

Galathea represented by *G. strigosa, G. dispersa* and *G. intermedia* are more numerous in the upper layer (0—10 m.) in the evening and at night (10 P. M.) found to be more abundant within 20—30 m. This is in any way different from Russell's (1928) observations that »in the dark (10.35 P. M., June) the surface layers were filled up«.

Upogebia stellata is found restricted to deeper layers during day, while at night it is seen only at the surface as observed by Russell.

According to Russell (1928) pagurid larvae come to surface layers only when it is very dark, and that in day light they are very near the bottom. Though in the sea collections here also, the pagurid larvae are found most abundant near the bottom during day, in the lake a different trend is seen, the larvae being caught in the surface layer within 10 m. in the evening as well as at night.

The crab zoeae occur at all depths during day and night, but have their maximum at 20—30 m. in the night collections. During day, megalopa are observed only within 20—30 m., but at night they are seen in large numbers at the surface.

SUMMARY

A preliminary study of the larvae of decapod crustacea from the Adriatic Sea is made on the basis of a series of collections from Mljet (Gonoturska) from February 1952 to March 1953. Almost simultaneous collections taken from the lake Mljet (Vrbovačka) and Dubrovnik (Sv. Andrija) and some other stations in the Adriatic Sea are also made use of for the sake of comparison.

The systematics, seasonal and zonal distribution of 60 species of decapod larvae are given.

From a systematic study of the larval stages, it may be observed that the larval stages of some species recorded from the warm Adriatic Sea are larger than the corresponding stages of the same species collected from the cold waters of the North Sea, Danish coasts and Plymouth area and are found to be further advanced in development, even from the time of hatching from the egg.

The number of species of decapod larvae is greater than found in similar collections from the cold waters of the North Sea and Danish coasts.

The number of species as well as the number of individuals of decapod larvae is greater in the collections nearer the shore than at the stations away from the shore.

The maximum number of larvae occurs within 50 m.

Judging from the occurrence of larvae in the collections, two main breeding seasons are observed in the sea — one in summer and the other in winter, the winter maximum being formed by the sporadic occurrence of crab zoeae and early larval stages of *Sergestes spp.*

The hatching period of most larvae seems to agree with that in the Mediterranean Sea and is earlier by 4—6 weeks, than in the North Atlantic.

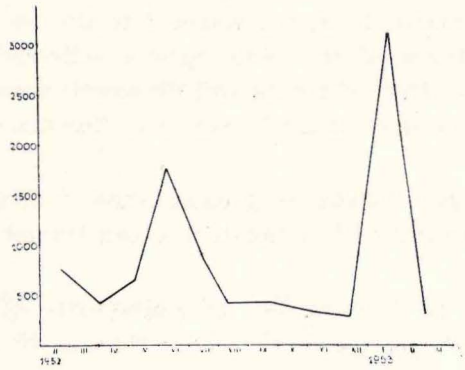
The occurrence of the larvae in the lake Mljet almost coincides with that in the sea outside, but the larval maximum (the number of species as well as individuals) in the lake is found to be earlier than in the sea by about one month, probably because of the quick heating of the water by the onset of spring, which induces the spawning of the species.

Larvae of no endemic species are found in the lake.

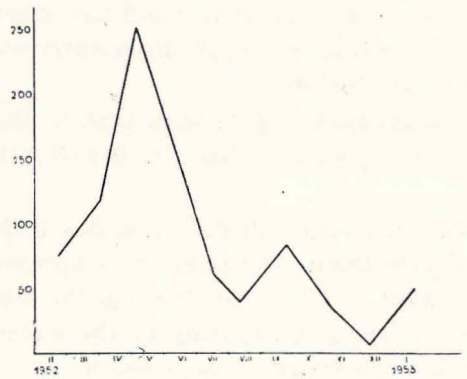
Only a single maximum of larvae (May) is found in the lake, mainly because of the absence of the larvae of Penaeidea, which are found to breed in the sea during the winter months.

The larvae of each species has a depth preference.

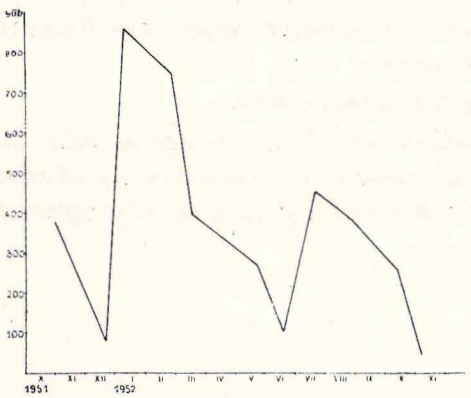
The general trend in diurnal migration of larvae agrees with the accepted views on vertical distribution namely the concentrating of most species near the surface during dusk and travelling back to their optimum intensity of light during day time.



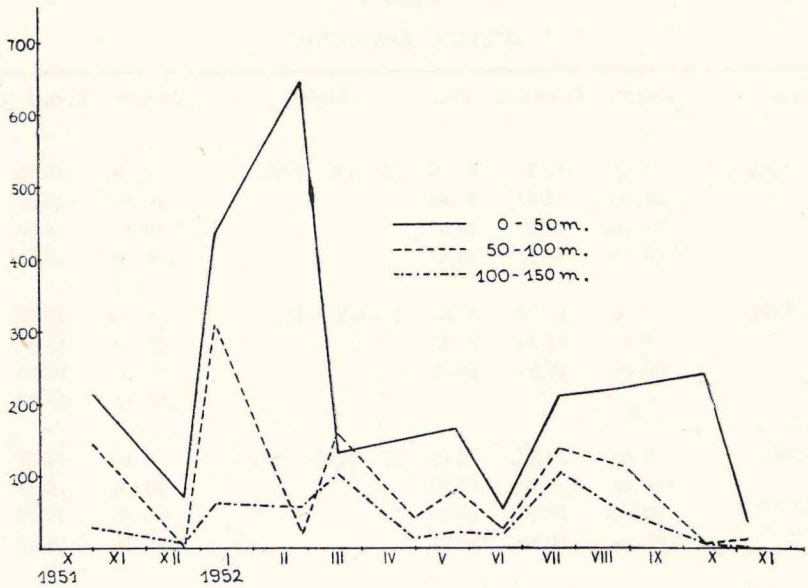
Graph I. Total decapod larvae at Gonoturska (Mljet, St. 1) from February 1952 — March 1953.



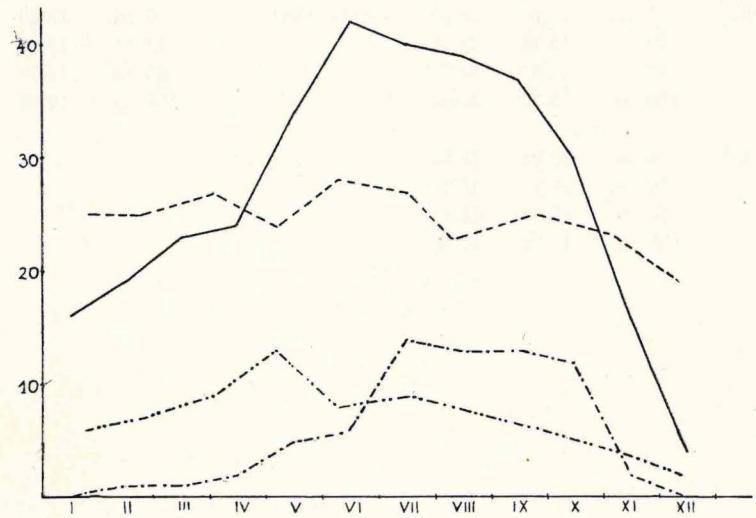
Graph II. Total decapod larvae at Vrbovačka (Mljet Lake, St. 2) from February 1952 — January 1953.



Graph III. Total decapod larvae near Sv. Andrija (Dubrovnik, St. 3) from October 1951 — November 1952.



Graph IV. Decapod larvae at St. 3 (three levels); from October 1951 — November 1952.



Graph V. Number of species of larval decapod Crustacea

——————— Plymouth (Lebour, 1947).
— — — — — Gonoturska (St. 1) 1952—1952.
— . — . — . — Danish Sound (Thorson, 1946).
— .. — .. — .. — Mljet Lake (St. 2) 1952—1953.

Table I.

Mljet — Gonoturska

Date	Depth	Temp. °C	S‰	Date	Depth	Temp. °C	S‰
21—II—1952.	0 m.	12.50	37.48	25—IX—1952.	0 m.	22.95	38.26
	20 m.	12.28	37.67		20 m.	22.88	38.73
	60 m.	13.25	38.03		60 m.	15.30	38.68
	76 m.	13.42	38.07		100 m.	14.25	38.71
3—IV—1952.	0 m.	13.70	37.83	6—XI—1952.	0. m.	17.60	38.46
	30 m.	13.05	37.84		20 m.	17.80	38.42
	60 m.	12.90	38.07		60 m.	15.95	38.44
					100 m.	15.90	38.51
8—V—1952.	0 m.	19.20	38.15	11—XII—1952.	0 m.	16.00	37.34
	30 m.	15.00	37.74		20 m.	15.95	37.54
	60 m.	14.40	38.21		60 m.	16.25	38.15
	100 m.	14.80	38.31		100 m.	15.45	38.33
8—VI—1952.	0 m.	19.22	37.84	22—I—1953	0 m.	13.48	38.22
	20 m.	16.90	38.01		20 m.	13.48	38.22
	60 m.	13.64	38.37		60 m.	13.55	38.21
					100 m.	13.62	38.21
17—VII—1952.	0 m.	21.80	38.13	3—III—1953.	0 m.	12.80	37.84
	20 m.	15.75	38.13		20 m.	13.15	38.06
	60 m.	14.60	38.33		60 m.	13.30	38.28
	100 m.	15.00	38.03		100 m.	14.28	38.66
19—VIII—1952.	0 m.	22.95	38.30				
	20 m.	16.85	38.35				
	60 m.	17.68	38.49				
	100 m.	17.25	38.60				

Table II.

Mljet lake — Vrbovačka

Date	Depth	Temp. °C	S‰	Date	Depth	Temp. °C	S‰
22—II—1952.	0 m.	8.16	34.95	26—IX—1952.	0 m.	23.06	37.29
	20 m.	9.35	35.70		20 m.	21.38	37.56
	41 m.	9.20	35.75		40 m.	13.67	35.82
2—IV—1952.	0 m.	11.90	35.34	7—XI—1952.	0 m.	16.32	36.96
	20 m.	10.71	35.59		20 m.	16.25	36.94
	42 m.	9.45	35.62		40 m.	12.64	36.94
6—V—1952.	0 m.	19.80	35.75	12—XII—1952.	0 m.	11.85	35.14
	20 m.	11.17	35.71		20 m.	14.95	36.71
	40 m.	9.72	36.68		41 m.	13.60	36.78
9—VI—1952.	0 m.	21.45	36.24	23—I—1953.	0 m.	10.07	35.70
	20 m.	12.00	35.73		20 m.	10.05	35.77
	42 m.	9.92	35.93		40 m.	10.70	35.93
16—VII—1952.	0 m.	26.60	36.87	4—III—1953.	0 m.	9.60	35.66
	20 m.	13.34	35.66		20 m.	9.30	35.77
	42 m.	10.22	35.62		40 m.	9.38	35.79
20—VIII—1952.	0 m.	26.85	36.16				
	20 m.	13.33	36.04				
	40 m.	10.71	35.68				

Table III.

Dubrovnik — Sv. Andrija

Date	Depth	Temp. °C	S‰	Date	Depth	Temp. °C	S‰
30—X—1951.	0 m.	19.6	37.3	23—V—1952.	0 m.	17.5	37.8
	20 m.		38.1		20 m.	13.9	38.0
	50 m.		38.1		50 m.	13.9	38.3
	100 m.		38.1		100 m.	13.8	38.6
	150 m.		38.1		150 m.	13.8	
21—XII—1951.	0 m.	15.5	37.8	19—VI—1952.	0 m.	23.4	37.9
	20 m.	15.2	38.2		20 m.	19.5	38.4
	50 m.	13.9	38.2		50 m.	14.8	38.6
	100 m.	13.9	38.3		100 m.	14.2	38.7
	150 m.	13.9	38.4		150 m.	14.0	38.6
27—II—1952.	0 m.	13.1	38.2	21—VII—1952.	0 m.	23.7	38.3
	20 m.	13.1	38.2		20 m.	17.4	38.4
	50 m.	13.5	38.3		50 m.	14.5	38.4
	100 m.	13.5	38.4		100 m.	14.0	38.8
	150 m.	13.7	38.5		150 m.		
17—III—1952.	0 m.	13.0	38.3	27—VIII—1952.	0 m.	25.6	38.5
	20 m.	12.9	38.3		20 m.	17.0	38.7
	50 m.	12.9	38.3		50 m.	14.6	38.7
	100 m.	12.9			100 m.	14.0	38.7
	150 m.	13.0			150 m.	14.0	38.7
29—IV—1952.	0 m.		37.6	13—X—1952.	0 m.	24.6	38.3
	20 m.	14.4	38.0		20 m.		38.3
	50 m.	13.4	38.2		50 m.	14.9	38.4
	100 m.	13.5	38.2		100 m.	14.6	38.7
	150 m.				150 m.		
				6—XI—1952.	0 m.	17.8	38.2
					20 m.	17.7	38.5
					50 m.	15.2	38.6
					100 m.	14.4	38.7
					150 m.	14.4	38.7

Table IV.

Seasonal occurrence of Decapod Larvae at Gonoturska (Mljet, St. I) from Feb. 1952 — March 1953.

Species	1952									1953	
	II 22	IV 2	V 6	VI 9	VII 16	VIII 10	IX 25	XI 7	XII 12	I 23	III 3
Gennadas elegans	78	4	1							12	28
Aristaeomorpha foliacea									1		
Solenocera membranacea	9	15		1		2	37	4	4	20	
Penaeus kerathurus										2	
Penaeus sp.			1								
Sicyonia carinata						1					
Sergestes arcticus	40	5	1	1						1125	6
Sergestes robustus	46	1		1						588	59
Sergestes corniculum							3				
Sergestes sargassi	1							2			
Sergestes vigilax	1		4				1	18	2		
Lucifer typus	15	22	18				45	25	10	15	12
Acanthephyra purpurea				37	1	14					
Processa edulis	43	42	11	162	70	163	103	44	10	25	22
Processa canaliculata	5	7		4						3	
Plesionika sp.	13	14	16	17	7	11	13	22	36	17	10
Alpheus ruber	47	143	13	104	5	110	81	129	162	37	14
Athanas nitescens				3	7	8	8	2			
Philocheras sculptus	1	2	2		8		6		1	12	
Philocheras bispinosus	3	1			2	1	3	1		10	
Spirontocaris cranchii		6		101	66	27	25	3	3	4	
Spirontocaris sp.		28	20	47	18	17	2	6		3	
Caridion steveni			3	5	1		1	1			
Lysmata seticaudata				12	2	8	6	2		1	
Latreutes sp.									4		
Leander serratus				1	3						
Leander pacificus					1						
Periclimenes sp.						5	8				
Mesocaris sp. 1				5							
Mesocaris sp. 2					2						
Stenopus spinosus				2	4	6	2		1		

Species	1952									1953	
	II 22	IV 2	V 6	VI 9	VII 16	VIII 10	IX 25	XI 7	XII 12	I 23	III 3
Palinurus vulgaris										6	4
Scyllarus arctus				2		4	1	3	1	3	
Nephrops norvegicus	1										
Munida bamffica	23	1								33	
Galathea strigosa	2	10		3					1		25
Galathea squamifera				1						29	
Galathea dispersa	13	15	207	151					7	39	16
Galathea intermedia	36	6	69	311	331	1	35			53	22
Porcellana longicornis			105			1		2	1	1	
Axius stirynchus			1								
Jaxea nocturna		1	2		1		1				
Jaxea sp.					1						
Upogebia stellata	1		30	448	51						
Upogebia deltaura						2	4	4		1	
Callianassa subterranea	1		10	26	1	1		1	1		
Anapagurus chiroacanthus	120	20	13	130	142	5					20
Eupagurus pubescens	3	1	1								
Ethusa mascarone			55		4	9	1	4			
Ebalia tuberosa	10	14									4
Ebalia cranchii		16			7		21	1			
Portunus depurator	198	31	34	38	12	15	20	15	12	340	54
Carcinus maenas		3	15	10	6	3	4	4			
Atelecyclus septemdentatus		2						8	6		
Xantho incisus		2			10	5	1	3			
Gonoplax rhomboides	5	2							8	7	4
Maia squinado			1	3							
Total	715	414	633	152-	758	419	432	304	271	2386	300
Unidentified	49	4	12	205	97	6	6	31	14	730	10
Grand total	764	418	645	1731	855	425	438	335	285	3116	310

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LARVE DEKAPODNIH RAKOVA JADRANSKOG MORA

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Kratak sadržaj

Izvršen je preliminaran studij o larvama dekapodnih Crustacea Jadranskog mora na bazi niza lovina iz Mljeta (Gonoturska) dobivenih od februara 1952. g. do marta 1953. g.

Gotovo simultano uzete lovine u Mljetskom jezeru (Vrbovačka), kod Dubrovnika (Sv. Andrija) i na nekim drugim stanicama u Jadranskom moru, također su korištene za upoređenje rezultata.

Data je sistematika te sezonska i vertikalna rasprostranjenost 60 vrsta dekapodnih larva.

Iz sistematskog studija larvalnih stadija može se primijetiti, da su općenito različiti stadiji zabilježeni u toplom Jadranu veći od odgovarajućih stadija istih vrsta, sakupljenih u hladnim vodama Sjevernog mora, danskih obala i Plymoutskog područja, i da su razvijeniji već u vrijeme kada se izlegu iz jaja.

Nađeno je, da je broj vrsta dekapodnih larva veći od onoga u sličnim lovinama iz hladnijih voda Sjevernog mora i danskih obala.

Broj vrsta, isto kao i broj primjeraka dekapodnih larva, veći je na stanicama bližih obali, nego na onima koje su udaljene od obale.

Maksimalan broj larva se pojavljuje do 50 m.

Prosuđujući po pojavljivanju larva u materijalu, primijećene su 2 glavne sezone mriješčenja u moru — jedna ljeti i druga zimi — a zimski je maksimum oblikovan sporadičkim pojavljivanjem zoea stadija brahiurnih rakova i ranih larvalnih stadija *Sergestes* spp.

Period izleganja najvećega broja larva, izgleda, slaže se s onim u Mediteranu, a raniji je za 4—6 tjedana nego u hladnim vodama Sjevernog Atlantika.

Pojavljivanje larva u Mljetskom jezeru gotovo koincidira s onim u moru izvan jezera, ali je maksimum larva (broj vrsta isto kao i broj primjeraka) u jezeru nađen za oko mjesec dana ranije nego u moru, vjerojatno zbog brzine zagrijavanja vode nadolaskom proljeća, što pospješuje mriješćenje i izleganje larvi.

U jezeru nisu nađene larve nikakovih endemičkih vrsta.

U jezeru je nađen samo jedan maksimum larva (maj), uglavnom zbog odsutnosti larva grupe *Peneidea*, za koje je nađeno da se u moru mrijeste tokom zimskih mjeseci.

Larve svake vrste daju prednost izvjesnoj dubini.

Općeniti način gibanja kod dnevne migracije larva slaže se s usvojenim pogledima na vertikalnu rasprostranjenost, naime, da se kod zalaza sunca larve većine vrsta koncentriraju uz površinu, i da se kreću natrag prema svojem optimumu intenziteta svijetla tokom dana.

CONTENTS

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