A STUDY OF THE LEVANTINE AND PONTIC HARPACTICOIDA (CRUSTACEA, COPEPODA)

by

FRANCIS DOV POR

Department of Zoology, the Hebrew University, Jerusalem, Israel

INTRODUCTION

Though both are parts of the Mediterranean basin, the eastern Mediterranean and the Black Sea form distinct units from both the hydrographic and the biological points of view. The Levantine basin — delimited by the Anatolian peninsula, the Syrio-Israelian shores and the Egyptian littoral — is the main basin of the eastern Mediterranean.

We studied the Harpacticoida along the Israel coasts. Also we used the data of Brian (1927, 1928) from the Dodecanese, of Gurney (1927) from the Suez Canal zone, and of Steuer (1948) from Alexandria, in order to obtain a comprehensive survey of the levantine Harpacticoida.

In the Black Sea we studied the Harpacticoida of the Rumanian shores and a few samples from the Bulgarian shores and from the pre-bosphoric zone. From our work and the data from the Russian shores (Czerniavski, 1868; Sovinski, 1904; Borutzki, 1960; Mordukhai-Boltovskoi, 1960, etc.), from the Bulgarian shores (Chichkov, 1921; Klie, 1937; Caspers, 1951; Valkanov, 1957) and other data from the Rumanian shores (Jakubisiak, 1938a, 1938b; Serban, 1959; Marcus, 1960, etc.) we are able to give a general survey of the fauna of the northwestern part of this sea — the most interesting from the biological point of view. Unfortunately, nothing is known about the Harpacticoida of the Anatolian coast of the Black Sea and almost nothing about the Caucasian shores.

There are some data from the Sea of Marmara, thanks to the study of Noodt (1955b), but we have no data from the Aegean Sea.

In the zoogeographical analysis and the ecological considerations we referred mainly to the thoroughly studied northern European seas and to the western Mediterranean which — though the number of reported species of Harpacticoida from this part of the Mediterranean is large — is far from being completely known.

As to the more southern seas, we used as references the few available

data from the Red Sea (Gurney, 1927; Nicholls, 1944) and the more complete data existing from the Indian Ocean.

At first glance the Levantine Sea and the Black Sea have very little in common. The two seas are two oceanographic extremes of the Mediterranean. In the Levantine Sea the salinity reaches extreme values of nearly 40 $^0/_{00}$ — a value surpassed only in the Red Sea — while the usual minimal temperatures of the surface layer are 17° C, being nearly 14° C in the greatest depths. In the Black Sea, on the contrary, the salinity never exceeds 18 $^0/_{00}$ and along the northwestern shores even shows a seasonal decrease to 10 $^0/_{00}$, while the surface temperatures frequently reach freezing point and the temperature of the deeper layers does not exceed 7° C.

Since the overwhelming majority of the species which live in these two seas have a common Mediterranean origin, a comparison is very instructive.

From the historical point of view some interesting traits can be found, common to the two seas.

For instance, it was recently shown by Pfannenstiel (1960) that at least twice in its pleistocenic history the eastern Mediterranean passed through „euxinic" periods. In these periods, owing to the eustatic lowering of the sea-level, the contact with the western Mediterranean was nearly interrupted, and the salinity decreased in the surface layer by increased freshwater supply. In the nearly closed basin there appeared a haline zonation, while the deep layers became very poor in oxygen. The conditions which resulted were consequently very similar to those of the recent Black Sea. On the other hand, the settling of the Black Sea by Mediterranean species after the opening of the Bosphorus — a geologically very recent event — has many similarities to the expansion of the Red Sea species into the eastern Mediterranean during the last century, following the opening of the Suez Canal. Tortonese (1951), however, is only partly right in stressing this latter parallelism. It is true that in both cases the immigrants had an advantage over the other inhabitants — in the Black Sea by the increasing marine conditions, and in the Levantine Sea by the high salinity and the subtropical temperatures to which the erythraeic immigrants are much better adapted than the extreme outposts of the Atlantic fauna which are populating it. But on the other hand, the artificial conditions of the Suez Canal are far from similar to those of the Bosphorus.

Extreme autoecological conditions but a similar settling history are thus promising premises for our study. Are the Harpacticoida a group of animals suitable for this purpose?

Up to the present day, zoogeographical and ecological analyses of marine benthos were almost without exception carried out on the basis of echino-

derms, mollusks, decapods and fishes. The so-called meiobenthos — the small Metazoa of the benthos — were not utilised. As well known, the Harpacticoida are, together with the Nematoda, the main animal group forming the omnipresent meiobenthos.

If the faunal groups of the macrobenthos are much more easy to see and to identify — the meiofauna has many advantages for zoogeographical and ecological analyses. Fish and decapods are able to carry out large scale active migrations; the pelagic larvae of the mollusks, decapods and echinoderms considerably increase the motility of these animal groups. Each zoogeographical analysis based on these groups must therefore cope with such problems. As to the ecological aspect, Thorson (1957) who promoted the notion of „isocommunities" in the benthic biocenology, stressed the peculiar problems of the settling down of the pelagic larvae of the macrobenthos. This "settling down" problem may each time modify strongly the composition of the biocenoses owing to the random coincidence of the hydrographic factors or the danger of predation during the pelagic life. Although the fluctuations are greatly avoided by complicated adaptational mechanisms, the problem remains a difficult one. Nothing similar is known among the meiobenthic animals. The larval development always takes place in the substrate, side by side with the adults. The stability of the meiobenthos associations must therefore be very great. The size of the animals and their very reduced capacity for free swimming or creeping makes the migration of the meiobenthos a very slow process. The distributional patterns thus are more constant and reflect better the historic conditions which led to their establishment.

Here we have to oppose strongly the opinion of Gislén (1940). This author apodictically states: "... the smaller the marine forms, the easier the distribution of the species" and "There exist no geographical borders or barriers for the small animals". In our opinion these statements are incorrect, and especially if applied to the Harpacticoida. The data given by Lang (1948) and the facts provided by the present study — especially those showing an almost complete diversity between the Levantine and Red Sea faunae — show the speculative character of Gislén's rule. It is also certainly not applicable to the Ostracods and, notwithstanding some superficial evidence, neither to Nematoda. In the Foraminifera — as quoted by Gislén, the taxonomic problems are rather too unsettled to allow such conclusions.

The following original data are utilised in the present paper:

I. A total number of 63 samples was studied from the Israel coasts. They were obtained at the following localities (see also text-fig. 1):

| 1.	Cesarea	12.7.1960	Eulittoral phytal
2.	Cesarea	12.7.1960	Eulittoral phytal
3.	Cesarea	12.7.1960	Eulittoral phytal
4.	Cesarea	12.7.1960	Eulittoral detritic mud
7.	Gulf of Haifa	3.8.1960	*Dendrophyllia* biocenosis, 5 fathoms
8.	Achzib	1.8.1960	Eulittoral detritic sand
9.	Achzib	1.8.1960	Eulittoral phytal
10.	Cesarea	13.9.1960	Eulittoral phytal
11.	Cesarea	13.9.1960	Eulittoral phytal
12.	Cesarea	13.9.1960	Eulittoral phytal
13.	Cesarea	13.9.1960	Eulittoral phytal
18.	Nakhal Alexander	11.11.1960	Brackish biotope
21.	Cesarea	12.11.1960	Eulittoral phytal
22.	Cesarea	12.11.1960	Eulittoral phytal
24.	Cesarea	12.11.1960	Eulittoral sand
34.	Palmakhim	20.11.1960	Rock pool
36.	Ashod	——	Sandy mud, 5 fathoms
38.	Nakhal Rubin	——	Sandy mud, 5 fathoms
39.	Nakhal Rubin	——	Sandy mud, 5 fathoms
67.	Nakhal Rubin	27.5.1961	Sandy mud, 5 fathoms
68.	Nakhal Rubin	27.5.1961	Sandy mud, 5 fathoms
69.	Nakhal Rubin	27.5.1961	Sandy mud, 5 fathoms
70.	Nakhal Rubin	27.5.1961	Sandy mud, 5 fathoms
71.	Nakhal Rubin	27.5.1961	Sandy mud, 5 fathoms
76.	Cesarea	16.6.1961	Eulittoral sand
77.	Cesarea	16.6.1961	Eulittoral sand
78.	Cesarea	16.6.1961	Eulittoral sand
81.	Cesarea	16.6.1961	Eulittoral sand
84.	Cape Carmel	11.7.1961	Sublittoral mud, 40 fathoms
85.	Gulf of Haifa	10.7.1961	*Dendrophyllia* biocenosis, 12 fathoms
87.	Cape Carmel	11.7.1961	*Dendrophyllia* biocenosis, 25 fathoms (transition)
88.	Nahariya	13.7.1961	Gravel and shells, 10 fathoms
90.	Rosh Hanikra	13.7.1961	Sublittoral mud, 50-55 fathoms
91.	Nahariya	13.7.1961	*Caulerpa* biocenosis, 26 fathoms
92.	Cape Carmel	11.7.1961	Sandy mud, 22 fathoms
93.	Nahariya	13.7.1961	Bathyal mud, 88 fathoms
95.	Gulf of Haifa	10.7.1961	Gravel and mud, 14 fathoms
96.	Rosh Hanikra	13.7.1961	Sublittoral mud, 34 fathoms
97.	Gulf of Haifa	10.7.1961	Sublittoral mud, 20 fathoms
98.	Nahariya	13.7.1961	*Dendrophyllia* biocenosis, 30 fathoms
99.	Gulf of Haifa	11.7.1961	*Caulerpa* biocenosis, 10 fathoms
100.	Gulf of Haifa	10.7.1961	*Caulerpa* biocenosis with gravel, 16 fathoms
101.	Cape Carmel	11.7.1961	Sublittoral mud, 40 fathoms
102.	Cape Carmel	11.7.1961	*Caulerpa* biocenosis, 25 fathoms
103.	Gulf of Haifa	10.7.1961	*Caulerpa* meadows
104.	Rosh Hanikra	13.7.1961	Bathyal mud, 260 fathoms
110.	Palmakhim	15.4.1961	Mixed, sublittoral mud, 5 fathoms
111.	Palmakhim	15.4.1961	Sandy mud, 20 fathoms
126.	Atlith	7.9.1961	Bathyal mud, 75 fathoms
127.	Nakhal Rubin	6.9.1961	Sublittoral mud, 40 fathoms
128.	Nakhal Rubin	6.9.1961	Bathyal mud?, 66 fathoms
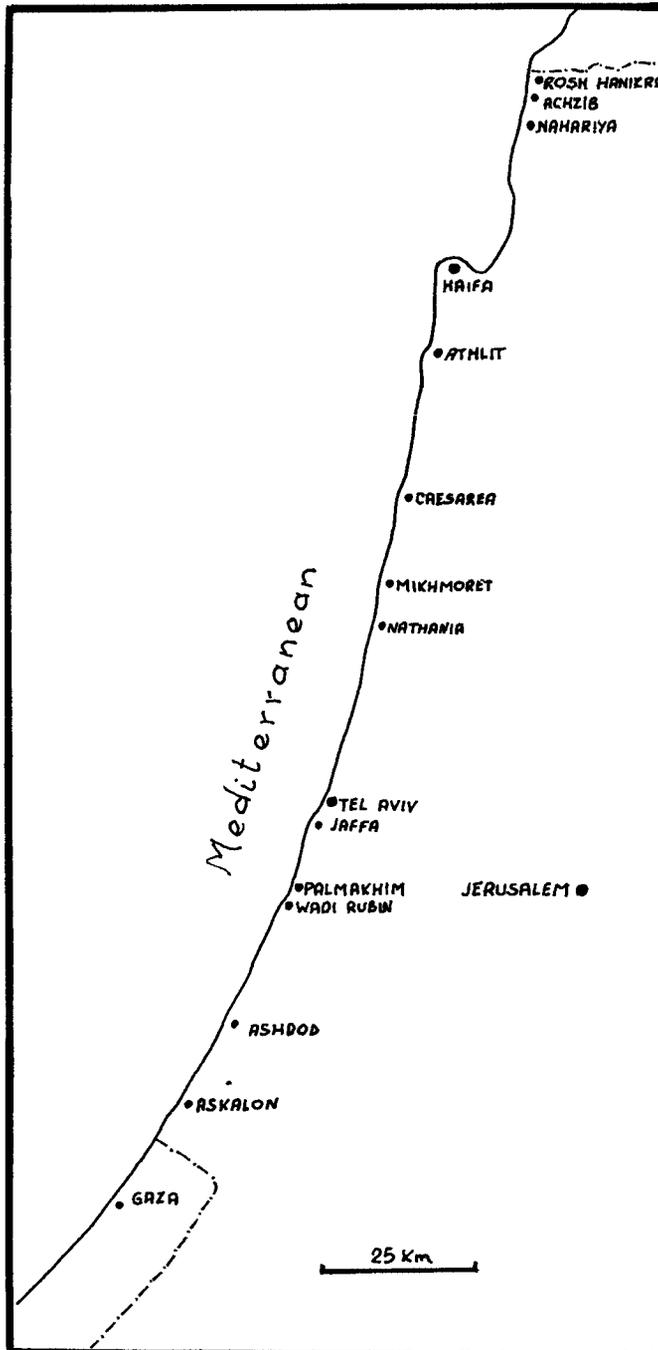
Fig. 1. Map of the Mediterranean shore of Israel.

129.	Nakhal Rubin	6.9.1961	Sandy mud?, 25 fathoms
130.	Nathaniya	7.9.1961	Bathyal mud?, 164 fathoms
132.	Palmakhim	23.9.1961	Eulittoral phytal
136.	Nathaniya	8.10.1961	Muddy phytal, 15 fathoms
137.	Nathaniya	8.10.1961	Sublittoral mud, 25 fathoms
138.	Nathaniya	8.10.1961	Bathyal mud, 75 fathoms
139.	Nathaniya	8.10.1961	Bathyal mud, 160 fathoms
140.	Nakhal Rubin	9.10.1961	Sandy mud, 5 fathoms
141.	Nakhal Rubin	9.10.1961	Sandy mud, 10 fathoms
144.	Nakhal ,Rubin	9.10.1961	Sublittoral mud, 50 fathoms
149.	Ashkelon	10.10.1961	Bathyal mud, 75 fathoms
152.	Ashdod	11.10.1961	Bathyal mud, 75 fathoms

Many samples were collected on the littoral of Cesarea, Achzib and Palmakhim (see list of stations and map of text fig. 1). The samples from greater depths were taken on several profiles: Rosh-Hanikra, Nahariya, Haifa Bay, Atlith, Natanya, Palmakhim, Ashdod, Ashkelon. Thus, both the littoral sampling and the sampling by ship extended over the entire Mediterranean coast of Israel. The maximal depth reached was 260 fathoms; the samples cover the whole range of intermediate depths. There are however comparatively few samples from 50 to 75 fathoms and no samples between 1 and 5 fathoms. For off-shore collecting we used the facilities of the research vessel "Mevoot Yam" of the Israel Fisheries Research Station in Haifa, and we are therefore much indebted to Mr. O. H. Oren, the director of the Station, to the station staff and to the crew of the vessel.

II. For the Black Sea, over 100 samples were studied — the overwhelming majority from the Rumanian shore, but a few also from the Bulgarian shore, from the Crimea and from the pre-bosphoric area of the Black Sea. Apart from the samples collected from the shore, all other samples were supplied by the Hydrological Commission of the Rumanian Academy, and therefore we are very grateful to the chief of the Commission, Dr. M. Bacescu. The deepest sample studied was from a depth of 126 m. The taxonomic descriptions of the Pontic species appeared in a series of papers (Por, 1959, 1960a, 1960b; Marcus & Por, 1960, 1961); the zoogeographical and ecological analysis of this material is presented in the present paper. This analysis, however, suffers from the fact that all the material, as well as the lists of the stations, is no longer available to the author. The specimens are kept in the collections of the Museum of Natural History „Grigore Antipa" in Bucharest. Several new species of Black Sea Harpacticoida were published in one of the above papers (Por, 1959); as the original descriptions were given in Rumanian, it was thought useful to provide here the English translations.

In the samples from the Israel coast we have identified the following 140 species of Harpacticoida:

Name	Stations	Geographical distribution	Ecological preference
Longipedia coronata Claus	84, 91, 98, 99, 100, 137	Cosmopolite?	Sublittoral muds, phytophile?
Longipedia minor T. & A. Scott	3, 4, 76-81, 85, 95	Cosmopolite?	Eulittoral phytal and detritic sands
Canuella perplexa T. &. A. Scott	3, 24, 34, 67, 76-81, 96, 141	Circumeuropean	Mainly eulittoral sands
Canuella furcigera Sars	38, 39, 68, 70	Circumeuropean	Sublittoral sandy muds
Canuella longipes (Thompson & A. Scott)	36, 38, 39, 67, 68, 69, 91, 92, 96, 97, 99, 103, 104, 110, 111, 129, 136, 137, 140, 141	Indopacific-east mediterranean	Mainly sublittoral
Canuella reichi n. sp.	93, 138, 149	——	Bathyal muds
Sunaristes bulbosus n. sp.	137	——	Sublittoral muds?
Brianola stebleri (Monard)	99, 110, 136	Lusitano-mediterranean	Sublittoral muds, phytophile
Cervinia bradyi Norman	3, 104, 139, 149	Boreo-mediterranean	Bathyal muds
Askalonia talpa n. g. n. sp.	93, 138, 139, 145	——	Bathyal muds
Hemicervinia stylifera (I. C. Thompson)	139	Boreo-mediterranean	Bathyal muds
Eucanuella langi n. sp.	93, 149	——	Bathyal muds
Ectinosoma dentatum Steuer	1, 2, 3, 9, 10, 12, 76-81, 85, 95, 99	Erythreo-mediterranean	Eu- and sub-littoral phytal
Ectinosoma diops n. sp.	24, 67, 69, 136, 140	——	Mainly eulittoral sands
Ectinosoma herdmani T. & A. Scott	36, 38, 39, 68, 69, 70, 71, 95, 110, 140	Circumeuropean	Sublittoral sandy muds
Ectinosoma inopinatum n. sp.	99	——	——
Ectinosoma melaniceps Boeck	103	Cosmopolite	——
Ectinosoma canaliculatum n. sp.	39, 67, 68, 95, 140	——	Sublittoral sandy muds
Bradya congenera Sars	127	Boreo-mediterranean	Sublittoral muds?
Pseudobradya aff. *hirsuta* (T. & A. Scott)	127	Boreo-mediterranean	Sublittoral muds?
Halophytophilus fusiformis Brian	2	Mediterranean	Eulittoral phytal
Horsiella marina n. sp.	4	——	Eulittoral phytal?
Danielssenia robusta Sars	104	Boreo-mediterranean	Bathyal muds
Harpacticus flexus Brady & Robertson	24, 136	Circumeuropean	Eulittoral sands, sublittoral?
Harpacticus gracilis Claus	1, 4, 7, 8, 10, 11, 12, 13, 22, 67, 76-81, 88, 110, 132	Circumeuropean, Indian Ocean	Eulittoral and sublittoral phytal
Harpacticus compsonyx Monard	11, 12, 13, 22, 110, 132	Ponto-mediterranean	Eulittoral phytal

Name	Stations	Geographical distribution	Ecological preference
Harpacticus nicaeensis Claus	132	Ponto-mediterranean	Eulittoral phytal
Tisbe furcata (Baird)	10, 11, 12, 76-81, 110	Cosmopolite	Eulittoral phytal
Tisbe tenera (Sars)	1, 4, 9	Circumeuropean, Indian Ocean	Eulittoral phytal
Scutellidium longicauda (Philippi)	2, 12, 13, 22	Cosmopolite	Eulittoral phytal
Scutellidium ligusticum (Brian)	1, 4, 9, 10, 11, 12, 13, 21, 22, 76-81, 110	Mediterranean	Mainly eulittoral phytal
Zosime mediterranea Lang	93, 138	Mediterranean	Sublittoral and bathyal muds
Zosime valida Sars	84	Arctic-mediterranean	Sublittoral muds?
Zosime aff. *incrassata* Sars	149	——	——
Porcellidium viride (Philippi)	2, 12, 13, 110	Circumeuropean	Eulittoral phytal
Porcellidium ovatum Haller	85	Mediterraneo-indopacific	——
Peltidium purpureum Philippi	76-81, 99	Boreo-mediterranean	?
Alteutha typica Czerniavski	1, 2, 9, 10, 11, 12, 21, 22, 67	Ponto-mediterranean	Eulittoral phytal?
Eupelte gracilis Claus	11, 12, 22	Mediterranean	Eulittoral phytal
Tegastes seurati Monard	12	Mediterranean	Eulittoral phytal?
Parategastes sphaericus Claus	2	Cosmopolite?	Eulittoral phytal
Phyllothalestris mysis (Claus)	1, 4, 9, 22	Boreal, circumtropical	Eulittoral phytal
Diarthrodes nobilis (Baird)	103	Arcto-mediterranean Indian Ocean	?
Diarthrodes aegideus (Brian)	7, 12	Mediterranean	Eu- and sub-littoral phytal?
Diarthrodes minutus (Claus)	1, 4, 7, 13, 87, 91	Amphiboreal-circumeuropean	Eu- and sub-littoral phytal
Diarthrodes ponticus (Kričagin)	9, 10, 12	Circumeuropean?	Eulittoral phytal
Dactylopodella flava (Claus)	87, 99	Arctic, circumeuropean	Sublittoral muds
Dactylopodia tisboides (Claus)	1, 2, 3, 4, 7, 9, 10, 11, 12, 22, 24, 34, 76-81, 85, 99, 110, 136	Cosmopolite	Euryekous phytophile
Paradactylopodia brevicornis (Claus)	7, 13, 65, 91, 110	Cosmopolite?	Euryekous?
Eudactylopus spectabilis (Brian)	9, 10	Ponto-mediterranean	Eulittoral phytal
Eudactylopus robustus (Claus)	10, 12, 22	Mediterranean, indopacific	Eulittoral phytal
Eudactylopus aff. *latipes* (T. Scott)	85	——	——

Name	Stations	Geographical distribution	Ecological preference
Idomene aberrans n. sp.	91	——	——
Parastenhelia spinosa (Fischer)	9, 13, 22, 132	Cosmopolite?	Eulittoral phytal
Parastenhelia ornatissima (Monard)	8	Lusitano-mediterranean	Detritic sand?
Stenhelia normani polluta Monard	84, 91	Mediterranean, Indian Ocean	Sublittoral mud, phytophile?
Stenhelia elisabethae Por	1, 2, 3, 12, 22	Ponto-mediterranean	Eulittoral phytal
Stenhelia aff. *minuta* A. Scott	138	——	——
Stenhelia incerta n. sp.	3	——	——
Melima caulerpae n. g. n. sp.	100, 103	——	*Caulerpa* muds?
Diosaccus tenuicornis (Claus)	85, 87, 99	Amphiboreal-mediterranean	Sublittoral muds
Diosaccus truncatus Gurney	127	Mediterranean, Indian Ocean	?
Paradiosaccus variicolor biarticulatus (Monard)	1, 9, 10, 12, 22, 110	Mediterranean	Eulittoral phytal
Paradiosaccus aff. *valens* Gurney	7	——	——
Pseudodiosaccopsis mesogeae n. sp.	99	——	——
Robertsonia knoxi (Thompson & A. Scott)	34, 101	Circumtropical	Rock pools?
Robertsonia angolensis (Monard)	4	Westafrican-mediterranean?	——
Amphiascus varians (Norman & T. Scott)	98	Boreo-mediterranean	——
Amphiascus minutus (Claus)	4, 11, 12, 22	Arctic, amphiboreal, mediterranean	Eulittoral phytal
Amphiascus angustipes Gurney	95	Circumtropical	——
Amphiascopsis thalestroides (Sars)	3, 4, 7, 8, 12, 22, 34, 84, 85, 87, 96, 99	Boreo-mediterranean, erythraeic	Sub- and eulittoral phytal, euryekous?
Amphiascopsis cinctus (Claus)	7, 8, 9, 10, 12, 85, 91, 98	Amphiboreal and circumtropic	Sub- and eulittoral phytal
Amonardia similis (Claus)	22, 24, 87, 99	Mediterranean, Indian Ocean	Euryekous?
Amonardia pelophila n. sp.	138, 149	——	Bathyal muds
Pseudamphiascopsis ismaelensis (Monard)	91, 95, 99, 102, 110, 136	Mediterranean	Sublittoral muds, phytophile?
Metamphiascopsis hirsutus (Thompson & A. Scott)	85, 88	Circumtropical	Gravel and sublittoral muds?
Bulbamphiascus imus (Brady)	88	Cosmopolite?	——
Robertgurneya oligochaeta Noodt	39	Mediterranean	——
Robertgurneya rostrata (Gurney)	7, 85, 99, 102	Circumtropical	Sublittoral muds, phytophile
Robertgurneya similis (A. Scott)	2, 3, 4, 12, 76-81, 99	Boreal, circumtropical?	Eulittoral phytal, detritic sands
Robertgurneya ecaudata (Monard)	99	Mediterranean	Gravel
Robertgurneya ilievecensis (Monard)	88, 91, 95	Lusitano-mediterranean	Gravel

Name	Stations	Geographical distribution	Ecological preference
Typhlamphiascus confusus (T. Scott)	7, 84, 91, 93, 95, 99, 102, 104, 110, 126, 128, 140	Circumeuropean	Sublittoral and bathyal muds
Rhyncholagena pestai (Monard)	88	Lusitano-mediterranean	Gravel
Rhyncholagena levantina n. sp.	88	——	Gravel
Amphiascella brevifurca (Czerniavski)	10	Lusitano-mediterraneo-pontic	Eulittoral phytal
Amphiascella subdebilis (Willey)	2, 7, 102	Temperate Atlantic, Mediterranean	Eu- and sublittoral phytal
Paramphiascella mediterranea Lang	2	Mediterranean	——
Haloschizopera pontarchis Por	84, 91, 96, 102, 127, 141, 147	Ponto-mediterranean	Sublittoral muds
Haloschizopera marmarae Noodt	2, 103	Mediterranean	——
Schizopera neglecta Akatova	18	——	Oligohaline
Metis ignaea Philippi	4, 7, 8, 9, 10, 24, 88	Amphiboreal-circumeuropean	Eu- and sublittoral phytal, euryekous?
Metis holothuriae (Edwards)	34, 85	Amphiboreal, circumtropical	——
Ameira parvula (Claus)	2, 4, 9, 76-81	Amphiboreal, circumeuropean, Indian Ocean	Eulittoral phytal
Ameira scotti Sars	1, 2, 88	Cosmopolite?	Euryekous?
Ameira tenella Sars	95	Circumeuropean	Sublittoral muds?
Proameira dubia (Sars)	149	Boreo-mediterranean	Bathyal muds?
Nitocra lacustris (Schmankevich)	18	——	Oligohaline
Nitocra minor Willey	34	„Bermudo"-mediterranean	Rock pools?
Ameiropsis longicornis Sars	91	Boreo-mediterranean	Sublittoral muds?
Pseudameira crassicornis Sars	102	Boreo-mediterranean	Sublittoral muds?
Pseudameira minutissima Monard	99	Mediterranean	Sublittoral muds?
Sarsameira parva (Boeck)	7	Boreo-mediterranean	——
Stenocopia longicaudata (T. Scott)	7, 91, 99	Boreo-mediterranean	Sublittoral phytal and muds
Anoplosoma sordidum Sars	93	Boreo-mediterranean	Bathyal muds
Anoplosoma stryx n. sp.	93	——	Bathyal muds
Haifameira archibenthoica n. g. n. sp.	104	——	Bathyal muds
Protogoniceps hebraeus n. g. n. sp.	99	——	Gravel? Sublittoral muds?
Phyllopodopsyllus medius n. sp.	99, 102	——	Gravel? Sublittoral muds?

Name	Stations	Geographical distribution	Ecological preference
Phyllopodopsyllus aff. *furcifer* Sars	88	——	Gravel?
Phyllopodopsyllus laticauda n. sp.	76-81	——	Detritic sand?
Willeyella horrida n. g. n. sp.	88	——	Gravel?
Mesochra pygmaea (Claus)	1, 2	Cosmopolite?	Eulittoral phytal
Orthopsyllus linearis (Claus)	2, 4, 7, 9, 22, 85, 95, 99, 102	Cosmopolite	Sub- and eulittoral phytal
Cletodes limicola Brady	7, 84, 90, 91, 95, 99, 102	Cosmopolite?	Sublittoral muds
Enhydrosoma propinquum (Brady)	3	Circumeuropean	Detritic sands?
Rhizothrix curvata Brady & Robertson	4	Boreo-mediterranean	Sublittoral muds?
Mesocletodes monensis (I. C. Thompson)	93, 138	Boreo-mediterranean	Bathyal muds
Mesocletodes bathybia n. sp.	104	——	Bathyal muds
Eurycletodes versimilis Willey	99	Temperate Atlantic, Mediterranean	Sublittoral muds?
Eurycletodes oblongus Sars	84, 93, 104, 130, 152	Boreo-mediterranean	Bathyal, sublittoral
Eurycletodes ephippiger n. sp.	104	——	Bathyal muds
Eurycletodes aculeatus Sars	149	Boreo-mediterranean	Bathyal muds
Hemimesochra derketo n. sp.	96	——	——
Tryphoema porca Monard	68, 70	Lusitano-mediterranean	Sublittoral sandy-muds
Stylicletodes numidicus (Monard)	69	Mediterranean	Sublittoral sandy-muds?
Laophonte cornuta Philippi	7, 10, 22, 85, 87, 95, 102	Cosmopolite	Sub- and eulittoral phytal
Laophonte inornata A. Scott	7, 84, 91, 99	Lusitano-mediterranean Indian Ocean	Sublittoral muds, phytophile
Laophonte elongata Boeck	2	Circumeuropean	Eulittoral phytal?
Laophonte cesareae n. sp.	1, 2	——	Eulittoral phytal
Heterolaophonte uncinata (Czerniavski)	1, 9, 10, 12, 22	Lusitano-mediterranean, pontic	Eulittoral phytal
Heterolaophonte aff. *curvata* (Douwe)	1	——	——
Paralaophonte brevirostris (Claus)	1, 7, 9, 10, 12, 13, 22, 85, 87, 102, 132	Cosmopolite?	Sub- and eulittoral phytal
Paralaophonte aff. *taurina* (Monard)	84	——	——
Paralaophonte quaterspinata (Brian)	4	Mediterranean	——
Asellopsis penicillata n. sp.	39, 68, 69, 70	——	Sublittoral sandy-mud
Esola longicauda Edwards	7, 85, 95, 99	Cosmopolite?	Sublittoral phytal

Esola hirsuta (Thompson & A. Scott)	2, 99	Circumtropical?	——
Onychocamptus armiger (Gurney)	1, 2, 3, 4, 7, 9, 10, 11, 12, 13, 22, 110	Circumtropical?	Mainly eulittoral phytal
Cletopsyllus tertius n. sp.	88, 91	——	Gravel
Laophontodes bicornis A. Scott	2	Cosmopolite?	——

Of these species 26 are new to science (5 being the type species of new genera), while another 27 had not been reported before from the Mediterranean. Together with the 7 species from the Dodecanese mentioned by Brian (1927, 1928) and not yet found on the Israel coast, the 16 species reported by Gurney (1927) from the Suez Canal area (here we consider only the species found in Lake Timsah and farther north) and a species so far reported only from Alexandria (Steuer, 1948), the total number of known species of Harpacticoida in the Levantine Sea is 164. So far some 180 species have been reported from the western Mediterranean. The total number of species of Harpacticoida now known from the Mediterranean (including the present material, but excluding that from the Sea of Marmara dealt with by Noodt, 1955b), is 278.

At present about 121 species of Harpacticoida are known in the Black Sea (not including some uncertain records). The Harpacticoid fauna of the Black Sea thus shows to be less than half as rich as that of the Mediterranean. It also follows that there is no good reason for considering the Harpacticoid fauna of the Levantine Sea as much poorer than that of the western Mediterranean.

GENERAL SECTION

1. Some general oceanographic data on the Levantine and Black Seas

A short outline of the hydrographic and hydrochemical conditions in the Levantine and Pontic basins may be given here. This outline is based chiefly

on the works of Sverdrup, Johnson & Fleming (1957), Oren (1952), Caspers (1957), and Zenkevich (1951).

The contact of the Mediterranean with the Atlantic Ocean through the Strait of Gibraltar is limited by a sill with a depth of 320 m and width of 20 km. The inflow of Atlantic water on the surface exceeds the outflow of the Mediterranean water on the bottom of the strait. The inflowing water has a salinity of less than 37 %.

The Sicilo-Tunisian sill, which delimits the eastern Mediterranean, has a depth of 400 m. Here also, there is an inflowing surface layer of western Mediterranean water with a salinity of 37.20 $^0/_{00}$ and an outflowing deep layer with higher salinities. In the Levantine basin itself, the maximal salinity of the surface waters is 39.58$^0/_{00}$ (south of Cyprus), while 38.66$^0/_{00}$ was measured at depths exceeding 2000 m. The 39$^0/_{00}$ isohaline passes south of Asia Minor. This exceptionally high salinity is lowered along the Levantine coasts during the months September and (partly) October by the Nile flow. At Port Said the fluctuation is from 32 to 26$^0/_{00}$ in the period of the opening of the Nile dams; it reaches the following values along the Levantine coast: from 39.52 to 30.9 $^0/_{00}$ at Gaza, from 39.00 to 36.92 $^0/_{00}$ at Natanya and from 39.58 to 37.75$^0/_{00}$ at Nahariya (Oren, 1952). Tortonese (1951) considered the maximal depth in which this current of low salinity still has influence to be 200 m. It seems, however, that a much lesser depth must be considered as being influenced.

The content of nitrogen and phosphorus is constantly decreasing in the Mediterranean from west to east and reaches very low levels in the Levantine basin. According to Oren (1952), however, the phosphorus content increases steeply during the Nile flow. The sediments carried by the Nile flow reach as far as Jaffa and the broad shelf which characterizes the southern Israel shores is probably the effect of the activity of the Nile throughout the Pleistocene.

The temperatures also are generally high in the Mediterranean. In the Levantine basin they approach tropical levels. The 20° C annual isotherm passes south of Crete and north of Cyprus. The minimal monthly temperature on the Israel coasts is 15.3° C and the maximal temperature measured was 29.5° C (Oren, 1952). At depths of more than 2000 metres there is still a temperature of 13.62° C. This temperature of the abyssal waters is slightly higher than the equally abnormal temperature measured all over the western Mediterranean. We could not find comprehensive data on the oxygen content of the various layers in the Levantine basin, but its decrease from west to east is a well known phenomenon.

The Black Sea is connected with the Mediterranean through the Darda-

nelles, with a sill depth of 70 m, and the Bosphorus, with a sill depth of only 40 m and a maximum width of 700 m. Owing to this narrow contact with the Mediterranean and the great depths of the Black Sea (over 2000 metres) there is an immense area in the Pontic basin in which oxygen is completely lacking and in which great amounts of H_2S are present. Owing to its toxic effect, life in the Black Sea is limited to the shelf zone, down to 150 to 200 metres, below which only desulphurating bacteria can live.

The salinity of the Black Sea is very low, averaging 18 $^0/_{00}$ for the whole sea. In the northwestern part, however, the salinities are even lower, owing to the influence of the Danube and the Ukranian rivers. Here, the 18 $^0/_{00}$ maximum is never attained on the surface, and during the spring flows, and frequently also in the fall, salinity drops to 10 $^0/_{00}$. However, eastwards from the Crimea, along the Caucasian and Anatolian coasts, and also northwards from the Bosphorus to around Sozopol, the surface salinity is more or less constant at 18$^0/_{00}$. Below 20 metres along the northwestern shores the salinity is more or less constant at 18$^0/_{00}$. The Black Sea is thus a brackish-polyhaline basin.

As to the nitrogen and phosphorus content, the rivers provide a permanent and rich supply.

The temperature is also highly variable, especially in the northwestern part, being very much influenced by the continental climate of the Russian plains. Here, the summer temperatures of the surface frequently exceed 20° C, while in the winter the sea often freezes up to a distance of several hundreds of meters from the shore. At depths of about 50 metres a very constant, low temperature of 7.5 to 8.5° C is reached.

The Sea of Azov, which is connected with the Black Sea by the shallow straits of Kerch, is usually considered to be an independent hydrographical unit. If the polyhaline Black Sea is still settled by a majority of marine animals, the Sea of Azov with its mesohaline salinities is already a true brackish sea.

2. The historical background

It is useful to summarize the main phases of the recent history of the Mediterranean and the adjacent basins, in order to try to discern the successive faunal elements which settled them. Our survey is mainly based on the data provided by Zeuner (1959), Pfannenstiel (1944, 1960), Tortonese (1951), Caspers (1957), and Zenkevich (1951).

The Tethys Sea existed as a hydrographical unit till the Miocene. Then the contact with the Indian Ocean through the Hathay-Euphrate area was interrupted and the Mediterranean established as a separate unit. The Sar-

matic basin (including the Ponto-Caspian basins) was also isolated at this time and became brackish. We could not find any indication of the exact chronological relation between these two major events. The Russian authors assume that the isolation of the Sarmatic basin took place in the early Miocene, and that before the end of the Miocene there was a second ephemeral period of renewed contact with the ocean (the so-called Maeotic phase).

It is also accepted that during the Neogene, the Red Sea was a gulf of the Mediterranean — without contact with the Indian Ocean.

The Pliocene is marked in the Mediterranean by the Calabrian phase (at least contemporaneous with the Villefranchien, the Upper Pliocene). This phase was characterized by very high eustatic sea levels (+ 180 m on the Egyptian coast, + 210 m at Gibraltar). The contact with the Atlantic Ocean was thus widely open, and the present sill was probably much lower. This free contact with the ocean and the general decrease of the temperatures determined the dominance of a coldwater fauna, characterized by several boreal elements now extinct in the Mediterranean (*Cyprina islandica*-fauna). The Sarmatic basin probably remained isolated during the whole Calabrian and the subsequent Sicilian phase. It is the Pliocene which is considered to be the main phase in which the peculiar brackish Sarmatic fauna originated.

The Pleistocene started with sea levels as high as in the previous phase. This so called Sicilian phase is marked by a worldwide eustatic level of about + 100 metres. The coldwater *Cyprina islandica*-fauna subsisted also in this phase. It was a period of better circulation in the Mediterranean (like the Calabrian) and the bathyal corals were then richly developed like in the open Atlantic of today (Blanc, Pérès & Picard, 1959).

Concerning the Red Sea, Tortonese (1951) spoke about an early Quaternary simultaneous contact with both the Mediterranean and the Indian Ocean. There is, however, as far as we know no paleontological support for this view.

The period which follows is less well known. There were the so-called Milazzian level of about + 60 m and probably a low level stage during the antepenultimate glaciation. It seems that during this period the modern features of the Strait of Gibraltar were established. During this period, the Ponto-caspian basin passed through the brackish Chaudinskian and Archeuxinic phases.

The great interglacial was marked by a deep and significant discontinuity: the Tyrrhenian phase. Although the level of the sea was only + 32 m the transgressive Mediterranean was then characterized by a distinctly tropical fauna (*Strombus bubonius*-fauna). It seems highly probable that during this phase a contact with the Black Sea was established through the "Sakariya Bos-

phorus" of Pfannenstiel (the Uzunlarian phase of the Russian authors in the Black Sea). For zoogeographic reasons, as shown below, we suppose that this was indeed the period in which a new contact with the Red Sea, and through it with the Indian Ocean was established. Klausewitz (1961) too, supposed such a contact.

What happened during the penultimate glaciation is once again not too clear. Zeuner suggested a faunistically very important regressive sea level of -200 metres during this glacial period. The question must be studied further as to why its influence was not recorded in paleontological material. Perhaps this regression was too short to leave paleontological traces. This phase must, however, have determined a renewed separation of the Black Sea. If Pfannenstiel (1960) is right, then it is indeed in this phase that we must place the "euxinisation" of the eastern Mediterranean, in which the Sicilo-Tunisian strait was only a narrow and shallow "Bosphorus" and the Levantine Sea was strongly influenced by the increased water masses of the pluvial Nile and other rivers and became brackish in its surface layers. As to the Red Sea it probably became an isolated hypersaline lake during this low level period.

Notwithstanding all these vicissitudes, the following interglacial known in the Mediterranean as Tyrrhenian II or Monastirian (with maximal levels of + 18 m) shows the same warmwater *Strombus bubonius*-fauna in the Mediterranean. The Black Sea was in further contact during this so-called Karangatian phase with the Mediterranean. This is namely the period in which *Strombus bubonius* Lam., together with other now extra-Pontic warmwater species such as *Calyptrea sinensis* Desh., *Bittium reticulatum* da Costa, *Echinocyamus pusillus* (O. F. Müller), etc., settled the Black Sea (Caspers, 1957).

The following regression, the -100 m level of the pre-Flandrian phase, contemporary with the last glacial period, marked the end of the *Strombus bubonius*-fauna and the beginning of more or less modern faunal features in the Mediterranean. During this phase the Black Sea was again separated from the Mediterranean and became brackish. The alluvional masses of the isthmus of Suez were deposited marking the most recent possible date for the separation of the Red Sea. Euxinic conditions probably appeared in the eastern Mediterranean also during this period. The Nile, which today succeeds in lowering the salinity of the sea to $32^0/_{00}$ as far as Gaza, had then an undoubtedly much stronger influence and for a much longer period of the year. On the other hand, another hypersaline phase of the Red Sea must be supposed for this period.

The renewed separation of the Black Sea which occurred (the Neoeuxinic phase) was too short to lower the salinity of this sea to oligohaline levels and it remained brackish-polyhaline or mesohaline, i.e., with lower salinities than today. In Würm II the sea already transgressed the Istanbul-Scutari

TABLE I

The pleistocenic past of the Mediterranean basin (modified after Zeuner, 1959; Pfannenstiel, 1944, 1960; Zenkevich, 1951; Caspers, 1957; Tortonese, 1951; Klausewitz, 1961)

Glacial Chronology	Mediterranean Chronology	Pontic Chronology	Eustatic Levels	Black Sea	Western Mediterranean	Eastern Mediterranean	Red Sea	Indian Ocean
Villefranchian	Calabrian	Chaudinskian	+180	Brackish	Cold water period			
First Glaciation	Sicilian		+90—+100		Cyprina islandica fauna]	[Cold water fauna?]		
First Interglacial	Milazzian		+55—+60					
Antepenultimate Glaciation		Archeuxinic	?					
Great Interglacial	Tyrrhenian I	Uzunlarian	+30—+46	Marine Modiolus phaseolinus fauna?]	Tropical period [Strombus bubonius fauna]			
Penultimate Glaciation			−200	?	?	Brackish ?Euxinic conditions	Hypersaline ?	
Last Interglacial	Tyrrhenian II (Monastirian)	Karangatian	+5—+20	Marine [Strombus bubonius fauna?]	Strombus bubonius fauna			
First stade of Last Glaciation	Grimaldi regression?		−100	Brackish		Brackish ?Euxinic conditions	Hypersaline?	
First Interstadial of Last Glaciation	Epimonastirian	Neoeuxinic	0 — +5					
Second and Third stade of Last Glaciation	Preflandrian regression	Palaeopontic	−30 — −70	Modiolus phaseolinus fauna			?	?
Postglacial (Atlantic period)	Flandrian		+3.5	Marine or polyhaline				
Present times		Neopontic	0					

ridge (Caspers, 1957) and the modern Bosphoric contact was established. An euryhaline and coldwater fauna entered the Black Sea during these still glacial conditions (*Cardium edule* L., *Syndosmya ovata* Phil. followed by *Modiolus phaseolinus* Phil.). It is interesting to note that the first two mollusks are also known as immigrants during the Uzunlarian period (see above).

The level of the sea rose steadily, the postglacial, Flandrian transgression began. Modern conditions were then established also in the Black Sea, though the climatic optimum of the contemporaneous postglacial Atlantic period probably marked an increased influence of warm water elements from the Mediterranean. The colder, subboreal period in which we are living now, probably interrupted this influence.

The opening of the Suez Canal, which occurred in 1869, a purely extra-geological event, is, however, the largest oceanographical experiment ever undertaken by man. From the zoogeographical point of view it marks for the eastern Mediterranean a new "Lessepsian" period of renewed contact with the Indo-West Pacific fauna.

The above exposed data are also summarized in table 1.

3. Isocommunities in the Harpacticoida

It was Thorson (1957) who advanced the isocommunity concept in the biocenology of marine bottom organisms. Following this author, the iso-communities are ecological parallels since "The same types of bottom are everywhere inhabited by series of "parallel" animal communities in which different species of the same genera, replace one another as "characterizing species" ".

Until now only the macrobenthal communities were studied in this connection. Ecological work on small benthonic animals was done only in the shallow eulittoral sands. It seems, however, that the homogeneity and the parallelism of these bottom biocenoses are even more pronounced at the level of the meiofauna (animals not exceeding 2 millimetres). As shown above, the problem of the settling does not exist here and the possibility of active migration of such small animals can also be neglected. Since the Harpacticoida are one of the major groups of the meiobenthos, our attempt to establish isocommunities in this group of animals will be the first such attempt at the level of the meiobenthos and may be therefore of a more general interest.

There are almost no studies on the communities of Harpacticoida. Lang (1948) provided some data on the composition of several communities in the Gullmarfjord, Sweden, but he underlined the special conditions existing within that fjord. Noodt (1957) studied the eulittoral level bottom communities of Harpacticoida in the bay of Kiel and the North Sea. Monard (1937) also gave some biocenotic conclusions on the Mediterranean and Lusitanian Harpacticoida. The other data are scattered through the works of Sars (1906-1921) and other authors, and were summarized for the period up to the second World War by Lang (1948).

Knowledge on the communities of Harpacticoida is limited to the littoral phytal and the eulittoral sands. With increasing depths the data become excessively scarce. Perhaps the best studied is the fauna which lives in the interstitial spaces of sandy beaches. This fauna is not included in the present study.

On the basis of our researches in the Black Sea and the Levantine Sea, which extended over a wide range of depths and used all the above quoted

data available, we have tried to establish the leading forms of the Harpacticoid isocommunities of the European seas. The general conclusions may also serve as an introduction to the special chapters on the ecology of the Levantine and Pontic Harpacticoida, in which these conclusions will be discussed more extensively.

The phytal community. — This inhabits the rocky bottoms and the algae of the littoral and sublittoral zone; it is very rich in species. A great number of various niches may be delimited within this biocenosis. Unlike the numerous sessile animals living there or the various algae-feeders, the associations of Harpacticoida are determined here only by physical conditions, and are independent from the composition of the algal association. Out of the great number of phytal species there are several highly characteristic faunal elements, such as *Harpacticus gracilis* Claus and other species of *Harpacticus*, *Phyllothalestris mysis* (Claus), *Scutellidium longicauda* (Philippi), *Parastenhelia spinosa* (Fischer), *Amphiascopsis cinctus* (Claus), *Ectinosoma melaniceps* Boeck, etc. Species of *Alteutha, Peltidium, Porcellidium, Diarthrodes, Heterolaophonte*, and various Tegastids are also very characteristic.

The psammal community. — This community lives specifically in the pure eulittoral sands and is very poor qualitatively, but the few species found are extremely characteristic. They are: *Canuella perplexa* T. & A. Scott, *Harpacticus flexus* Brady & Robertson and *Ectinosoma herdmani* T. & A. Scott [1]). The littoral sands in the seas which have no significant tides, are especially poor in Harpacticoida. Noodt (1957), who observed this in the Baltic sea, considered it an effect of low winter temperatures. The same could possibly be true also for the Black Sea. But the phytal fauna although equally exposed to the cold is fairly rich. On the other hand the same scarcity of the fauna in the eulittoral sands is reported from the Mediterranean. Monard (1935a) found at Salammbô in Tunisia, that "... sandy facies of the nearest littoral is almost uninhabited by Harpacticoids". On the Israel shores we found the same scarcity. It is likely therefore that this phenomenon is due chiefly to the fact that in these closed-in seas the waves are constantly breaking on the same narrow littoral strip. The psammic Harpacticoida are probably not able to resist the wave action and therefore settle the high levels of the eulittoral sand only in periods of calm. So for instance, the only period in which we found a rich association of psammic Harpacticoida in the eulittoral of the Israel coast was in November, i.e., towards the end of the autumnal period of calm.

---

1) As to the proposed synonimisation of *Ectinosoma herdmani* with *E. elongatum* Sars, see Special Section, p. 74.

The eulittoral psammon, however, shelters a very rich fauna of interstitial Harpacticoida.

The sandy mud. — This follows as the highest level of the sublittoral bottoms and has a fauna essentially characterized by species of *Asellopsis* and by *Canuella furcigera* Sars.

The sublittoral muds. — These extend to a depth of some 150 metres, down to the edge of the continental slope, and are inhabited by a large number of species. It can be assumed, however, that the leading forms which are present almost everywhere are species of *Bradya, Stenhelia, Haloschizopera, Enhydrosoma,* and *Cletodes.*

Towards greater depths, there is a transitional fauna — perhaps even an independent community — in which species of *Typhlamphiascus* and *Eurycletodes* are dominant.

The deep sea muds. — These are characterized by the Cerviniidae, species of *Eurycletodes* and *Mesocletodes* and some other Cletodidae. In the Black Sea this association is only partly represented at higher levels, because of the toxic conditions of the greater depths, but we had the occasion to study this community in the bathyal depths of the Levantine Sea. It is still an open question to what extent the transition to the true abyssal fauna is marked by a faunal break.

There is also a little known, but seemingly very specific fauna of the shell bottoms, *Branchiostoma*-sands or gravels. It seems that the characteristic genus of these bottoms is *Rhyncholagena,* together with some species of *Robertgurneya, Bulbamphiascus imus* (Brady) and some of the Tetragonicepsidae. Recent studies showed us, however, that the fauna of such bottoms in the north European seas is quite different.

Positive and negative local differences are found everywhere. For instance *Echinopsyllus normani* Sars is the dominant form of the muds in the Gullmarfjord (Lang, 1948); Monard (1935a) was surprised by the great amounts of *Enhydrosoma propinquum* (Brady) found in the shallow muds of Salammbô; *Paramphiascopsis longirostris* (Claus) is dominant in the deep muds of the Black Sea; on the Israel coasts, *Onychamptus armiger* (Gurney) is a dominant form, while *Heterolaophonte stroemi* (Baird), a species which is dominant elsewhere, is apparently lacking.

Proceeding from north to south, some species disappear; several others survive by submergence, and other species (chiefly of the same genus) fill the gaps. For instance, *Cervinia bradyi* Norman is found in the Gullmarfjord already at depths of 50 m, while along the Israel coasts it lives from at least 120 to 130 metres down. *Typhlamphiascus confusus* (T. Scott) lives in the Gullmarfjord at depths exceeding 40 metres, and is replaced at greater depths

by *Typhlamphiascus typhlops* Sars. In the Mediterranean, the latter species is lacking and *Typhlamphiascus confusus* descends to the greatest depths. Several species of *Eurycletodes* appear in the northern seas already at about 10 m. In the Mediterranean basin they are almost specific for the greatest depths (with the exception of *Eurycletodes versimilis* Willey).

Along the Levantine coasts, several new elements appear in this faunal succession. The indopacific *Canuella longipes* (Thompson & A. Scott) is such an example. It will therefore be of the greatest interest to make such biocenotic studies in the tropical seas too.

Thorson (1957) therefore was more than correct when he considered that " ... The recent work carried out by Remane and his collaborators, on the microbenthos of the shallow water and beaches seems to indicate that the distribution of the microfauna within the macrofauna communities will also show a pronounced uniformity".

The communities of Harpacticoida, which we followed down to bathyal depths present an even greater stability than the communities of the macrobenthos.

4. The biocenology and ecology of the Levantine Harpacticoida

Unfortunately, neither Gurney (1927) nor Brian (1927) furnished any ecological data on their Levantine material. Therefore, while attempting to establish the distribution of the Harpacticoida in the Levantine Sea according to the various biotopes, we are limited to the data we found ourselves along the Israel coasts.

From the ecological point of view, the Israel coasts can be roughly divided into three regions (text-fig. 1).

1. The coastal strip, north of Cape Carmel, including the large Bay of Haifa and reaching the Lebanese border at Rosh Hanikra. Here the coast is rocky (with the exception of some sandy areas within the bay itself), and the rocks and corraligene formations descend to depths of 25 to 30 fathoms. Near Rosh Hanikra, a typical submarine canyon reaches the coastal zone. The Haifa-Rosh Hanikra zone has a great resemblance to the average Mediterranean coast.

2. A transitional zone, along the open coast, from Cape Carmel southwards to Jaffa, shows a more or less interrupted rocky coast. As one proceeds southwards, the patches of rocky coast become more and more isolated, being separated by sandy beaches of increasing length. The rocky facies also descends here to much smaller depths, and the level bottoms are already well represented at very small depths.

3. South of Jaffa, down to the Egyptian coast, the shores are exclusively

sandy, the only exception being the rocks at Palmakhim. Here the influence of the hydrographical changes induced by the Nile flow become more pronounced and the amount of Nile sediments also increases gradually. No bays are found here, and the coast forms an almost perfect straight line.

The Israel coast is thus sufficiently heterogeneous to allow ecological conclusions to be made, which conclusions may also be applied to the whole Levantine basin.

The phytal community of the Harpacticoida is exceptionally rich. We listed a minimal number of 48 species which inhabit specifically or preferentially the algal growths. This number will certainly increase, since we did not include in it those species that were found only a few times. Of course we found in the phytal also species from the neighbouring level bottom communities; these species are only occasional inhabitants of the biocenosis.

The phytal sample with the maximum number of species yielded 25 species. In the Black Sea, in the optimal conditions of the phytal of Yalta (Marcus & Por, 1960) we found only 15 species, while along the Rumanian coasts the maximum number was 12. It seems that the phytal facies of the western Mediterranean is even richer than that of the eastern.

TABLE 2

Characteristic Harpacticoida of the eulittoral phytal. The number of specimens of each species in selected stations is given. Species marked with an asterisk are not restricted to this biotope

Station	2	4	9	10	11	12	13	22
Onychocamptus armiger*	9	3	129	56	67	6	1	5
Harpacticus gracilis	—	22	84	57	7	218	4	6
Scutellidium ligusticum	—	52	6	18	34	34	3	4
Dactylopodia tisboides*	7	11	5	24	1	114	—	—
Altheuta typica	7	—	21	7	—	37	—	1
Orthopsyllus linearis*	9	8	12	—	—	—	—	1
Paralaophonte brevirostris*	—	12	26	9	—	14	1	10
Heterolaophonte uncinata	—	8	23	1	—	3	—	33
Ectinosoma dentatum	7	—	9	8	—	10	—	—
Scutellidium longicauda	1	—	—	—	—	8	8	4
Harpacticus compsonyx	—	—	—	—	4	4	7	1
Paradiosaccus variicolor	—	—	7	2	—	4	—	1

Species found in three samples: *Eudactylopus spectabilis, Stenhelia elisabethae, Parastenhelia spinosa, Phyllothalestris mysis, Robertgurneya similis, Porcellidium viride, Ameira parvula, Metis ignaea*, Tisbe furcata, Diarthrodes ponticus, Eupelte gracilis.*

No preferences for a definite algal substrate were found. If there is a differential repartition among the various species of the phytal Harpacticoida, it is determined only by more or less exposure to wave action. With in-

creasing depths, the amount of the more euryekous phytal species increases, since the amount of sediments among the algae increases too. Table 2 provides a list of species which are quantitatively dominant in the phytal of the eulittoral zone. Of these, six species are seemingly indifferent to water movement: *Onychocamptus armiger* (Gurney), *Harpacticus gracilis* Claus, *Orthopsyllus linearis* (Claus), *Scutellidium ligusticum* Brian, *Ectinosoma dentatum* Steuer, and *Eudactylopus spectabilis* (Brian). Four of these species (the fourth and the last excluded) are also more or less euryekous. All six species which prefer the agitated water conditions are strictly specific to the eulittoral phytal: *Porcellidium viride* (Philippi), *Harpacticus compsonyx* Monard, *Eupelte gracilis* Claus, *Stenhelia elisabethae* Por, *Scutellidium longicauda* (Philippi) and *Parastenhelia spinosa* (Fischer). The phytal species which prefer quiet sheltered places are: *Paralaophonte brevirostris* (Claus), *Phyllothalestris mysis* (Claus) and *Heterolaophonte uncinata* (Czerniavski). Species like *Dactylopodia tisboides* (Claus) are phytophile euryekous species.

The eulittoral phytal fauna referred to above is found all along the Israel coast, but becomes clearly improverished towards the south. At Palmakhim, the phytal biocenosis seems to be very poor (see sample from station 132), composed only of *Harpacticus compsonyx* Monard, *H. nicaeensis* Claus, *Parastenhelia spinosa* (Fischer) and *Paralaophonte brevirostris* (Claus). This association strangely resembles the phytal association found by us (Marcus & Por, 1960) at Yalta in the Black Sea. Perhaps these species belong to the most euryhaline species of the Mediterranean phytal fauna.

The phytal association descends to considerable depths along the northern Israel coast. Here we distinguished two main facies: (1) the "fonds coralligènes" of the French authors (formed of reefs of *Dendrophyllia* and calcarous Rhodophyta) at 10 to 50 metres, and (2) the bottoms covered with *Caulerpa scalpelliformis* (Brown) Agardh generally found only from about 25 metres downwards. The *Dendrophyllia* bottoms are only little influenced

TABLE 3

Characteristic Harpacticoida of the sublittoral *Dendrophyllia* reefs. The number of specimens of each species in selected stations is given. None of the species is restricted to this biotope

Stations	7	85	87
Amphiascopsis thalestroides	51	3	1
Laophonte cornuta	20	9	1
Paralaophonte brevirostris	2	9	1
Amphiascopsis cinctus	54	1	—

Other species found in two of the samples: *Paradactylopodia brevicornis, Diarthrodes minutus, Diosaccus tenuicornis, Esola longicaudata, Robertgurneya rostrata.*

by the nearby muddy bottoms, but the *Caulerpa* beds grow on mud and have a fauna with many pelophile, mud-preferring species.

The undoubtedly dominant species in the *Dendrophyllia* biocenosis (table 3) are the twin species *Amphiascopsis thalestroides* (Sars) and *Amphiascopsis cinctus* (Claus). There are also some other phytal species found here which already prefer a certain amount of sediment: *Laophonte cornuta* Philippi, *Orthopsyllus linearis* (Claus) and *Paralaophonte brevirostris* (Claus). Representatives of mud dwelling species are *Robertgurneya rostrata* (Gurney) (replacing here the purely phytal and eulittoral *Robertgurneya similis* (A. Scott)), *Esola longicauda* Edwards, *Typhlamphiascus confusus* (T. Scott), *Cletodes limicola* Brady, and *Diosaccus tenuicornis* (Claus). It follows that there are no specific "*Dendrophyllia*"-species. As to scattered findings like those of *Sarsameira parva* (Boeck), *Diarthrodes aegideus* (Brian) or *Porcellidium ovatum* Haller, no conclusions can be reached. The interesting species *Stenocopia longicaudata* (T. Scott) has been found by Pesta (1959) in somewhat similar conditions in the submarine caves of the Italian coast. In our material this species was found in both the *Dendrophyllia* and *Caulerpa* communities.

TABLE 4

Characteristic Harpacticoida of the *Caulerpa* muds. The number of specimens of each species in selected stations is given. Species marked with an asterisk are not restricted to this biotope

Station	91	95	99	100	102	103	110	136
Pseudamphiascopsis ismaelensis	6	2	106	—	1	—	13	3
*Canuella longipes**	47	—	23	—	—	1	1	31
*Typhlamphiascus confusus**	5	1	3	—	5	—	1	—
Cletodes limicola	2	18	1	—	6	—	—	—
Brianola stebleri	—	—	13	—	—	—	1	1
Melima caulerpae	—	—	—	4	—	61	—	—
Longipedia coronata	2	—	6	2	—	—	—	—
Esola longicauda	—	1	12	—	—	—	—	—
*Haloschizopera pontarchis**	1	—	—	—	13	—	—	—

Other species found in two samples: *Robertgurneya ilievecensis**, *Stenocopia longicaudata*, *Laophonte inornata*, *Robertgurneya rostrata*.

There are many gradual transitions towards the *Caulerpa* biocenosis. Hence several phytal dwellers can also reach this biotope (table 4); such species are *Amphiascopsis thalestroides*, *A. cinctus*, *Ectinosoma dentatum*, *Paralaophonte brevirostris* and *Laophonte cornuta*. But the bulk of this association is already formed of a number of interesting phytophile mud species, such as *Pseudamphiascopsis ismaelensis* (Monard), *Brianola stebleri* (Monard), *Longipedia coronata* Claus, *Robertgurneya rostrata* (Gurney), *Esola longi-*

cauda Edwards. *Stenhelia normani* T. Scott replaces at these depths the closely related eulittoral *Stenhelia elisabethae* Por. The number of pure level bottom species is also increased here: among others purely aphytal species appear, like *Canuella longipes* (Thompson & A. Scott) and *Cletodes limicola.*

But the most interesting species of the *Caulerpa* association is *Melima caulerpae* belonging to a new genus related to *Stenhelia* which seems to live exclusively among the "leaves" of *Caulerpa scalpelliformis* and which reaches (station 103) an outstanding density. It will be interesting to see in the future, to what extent the linkage of *Melima caulerpae* to this alga is indeed an obligatory one.

Before leaving the biotopes specifically represented along the northern Israel shores, four smaller associations must be referred to.

There is firstly the peculiar biotope of the gravels and shells, the *Branchiostoma*-gravel. Monard (1935a) was the first to underline the specificity of this association. It is true that not all five new species which he described from there are specific to it: *Pseudamphiascopsis ismaelensis* turned out to be a phytophile mud-dweller, and *Robertgurneya ecaudata* seems also to be bound more to a muddy substratum. But the genus *Rhyncholagena* Lang, as shown also by Lang (1948) is a specific indicator of the gravels. At Nahariya we found at 20 metres (station 88) a specific gravel-shell biocenosis in which *Rhyncholagena levantina* n. sp. and *Rhyncholagena pestai* (Monard) were dominant. Associated species were among others, *Robertgurneya ilievecensis* (Monard), *Cletopsyllus tertius* n. sp., *Willeyella horrida* n. g. n. sp., *Bulbamphiascus imus* (Brady) and *Metamphiascopsis hirsutus* (Thompson & A. Scott). It seems that at least some of these species are preferential dwellers of this biotope. It may be added, that at Eilat on the Red Sea, where the only eulittoral sediment is a fine corraline gravel, and undescribed species of *Rhyncholagena* is present everywhere.

The biotope of the rock pools has been insufficiently studied, but it seems that a rock pool at Palmakhim (station 34) had a very specific fauna in which *Robertsonia knoxi* (Thompson & A. Scott) (reported also by Gurney (1927) from rock pools in our area) and *Nitocra minor* Willey are massively dominant.

An eulittoral muddy sand rich in vegetable detritus is found behind the shelters of littoral rocks, as for instance at Cesarea (station 3). This seems to be the preferential biotope of *Enhydrosoma propinquum* (Brady) which has also been found in the northern seas in similar habitats (Lang, 1948).

Finally, the detritic eulittoral sand, found among the rocks in agitated water, forms a natural transition towards the level bottom communities. Many more euryekous phytal species appear in these sands, chiefly *Metis*

ignaea Philippi, *Robertgurneya similis* (A. Scott) and *Longipedia minor* (T. & A. Scott). *Parastenhelia ornatissima* (Monard), which we found only once, was found by Monard (1935b) at Roscoff, also in detritic sand. *Peltidium purpureum* Philippi likewise seems to prefer this biotope. Naturally, *Canuella perplexa* T. & A. Scott, the specific eulittoral sand-dweller, appears too.

If the phytal community is poor along the southern coasts, we find there on the other hand well developed and undisturbed successions of level bottom communities.

The eulittoral sands, as everywhere in seas without considerable tides, are settled by a qualitatively very poor and unstable association of Harpacticoida. As a rule, only the species of the detritic sand are found throughout most of the year in this zone. Most of these are probably gathered here by the waves from the nearby phytal zones. If there is no neighbouring phytal zone, the eulittoral sand can remain uninhabited for most of the year. It seems that the constant breaking of the waves on this littoral strip is responsible for the difficult conditions prevailing. However, at the end of the summer, after a longer period of calm, a specific fauna can be found (station 24) which is dominated by *Harpacticus flexus* Brady & Robertson, the well-known epi-psammal species of the North Sea and the Black Sea. It is interesting to underline that *Harpacticus flexus* becomes the characteristic species of these eulittoral sands only in more southern regions, since on the Scandinavian coast its niche is occupied by *Harpacticus uniremis* Kröyer. The second species which characterizes the shallow sands is *Ectinosoma diops* n. sp.; this species appears to have a southeastern distribution, and replaces in this association *Ectinosoma herdmani,* a species which is usually found in this biotope in the European seas (Gullmarfjord, North and Baltic Seas, western Mediterranean and Black Sea). Finally, *Canuella perplexa* T. & A Scott,

TABLE 5

Characteristic Harpacticoida of the sublittoral sandy muds. The number of specimens of each species in selected stations is given. Species marked with an asterisk are not restricted to this biotope

Station	36	38	39	67	68	69	70	140	141
Canuella longipes*	12	28	6	1	1	12	—	3	30
Ectinosoma herdmani	2	2	16	—	1	2	1	1	—
Canuella furcigera	—	5	1	—	1	—	8	—	—
Asellopsis penicillata	—	—	3	—	4	2	1	—	—
Ectinosoma canaliculatum	—	—	1	1	—	—	—	4	—
Ectinosoma diops*	—	—	—	1	—	1	—	—	9

Species found in two samples: *Canuella perplexa**, *Tryphoema porca.*

the most resistant member of this association (perhaps owing to its large size) is known from everywhere in this biotope. However, it is found also at greater depths.

The sandy mud (table 5) which follows and which we could study thoroughly, since we had many samples from depths of 9 to 10 metres, is characteristically populated by *Canuella longipes* (Thompson & A. Scott), *Asellopsis penicillata* n. sp., *Ectinosoma herdmani*, *Ectinosoma canaliculatum* n. sp., *Canuella furcigera* Sars, and *Tryphoema porca* Monard. *Canuella longipes*, a species described from the Indian Ocean and now found in great numbers in the Levantine basin, is a very common species in this association but not specifially located here: it can be found both in eulittoral sands and in the mud of bathyal depths, and is undoubtedly the most common species of the aphytal bottoms along the Israel coasts. *Canuella furcigera* is a species which probably needs a definite mixture of sand and mud: in the Black Sea it is thus limited to a narrow belt between 10 and 25 metres and only in very rare cases it is found at greater depths. In the Levantine Sea the belt inhabited by this species is even narrower since we found it only in four samples, collected all at 5 fathoms. The cause of this limitation seems to be here also a competitive one, since along the Israel coasts the normal succession *Canuella perplexa-Canuella furcigera* is complicated by the appearance of the very successful competitor *Canuella longipes*. *Asellopsis penicillata* is another species of the group *Asellopsis intermedia* (T. Scott) and *Asellopsis dubosqui* Monard, peculiar to the muddy sublittoral sands. Like these related species, *Asellopsis penicillata* is also closely restricted to a definite amount of mud in the sand, since (like *Canuella furcigera*) it was also found exclusively in the samples from a depth of 5 fathoms.

Another species found on sandy mud is *Ectinosoma herdmani*. This is probably another interesting case in which the appearance of a competitor, in this case *Ectinosoma diops,* but perhaps also the increased temperatures, forced a species out of its usual biotope: *Ectinosoma herdmani* characterizes the shallow sands in the European seas. *Tryphoema porca,* known from Roscoff and the western Mediterranean, is probably a characteristic species of the Lusitano-mediterranean shallow sandy muds. *Ectinosoma canaliculatum* is a new species which along the Israel coasts is strictly limited to this biotope. These sandy muds, our *"Asellopsis"* biocenosis, is characterized at the macrobenthal level by the spatangoid sea urchin *Schizaster canaliferus* (Lamarck) (cf. Gottlieb, 1959).

The sandy mud descends to an average depth of some 50 metres and is followed by the community of the sublittoral muds, designed as the *Brissopsis-Pennatula-Dorippe* association (Gottlieb, 1959). As to the Harpacticoida,

this association is represented at its best between 75 and 120 metres. This is qualitatively and quantitatively a poor association and its only characteristic species found so far are *Haloschizopera pontarchis* Por, *Typhlamphiascus confusus* and *Cletodes limicola*. Several other species like *Rhizothrix curvata* Brady & Robertson, *Brady congenera* Sars, *Pseudobradya* aff. *hirsuta* (T. & A. Scott), *Diosaccus truncatus* Gurney, and *Sunaristes bulbosus* n. sp., though found each only in a single sample, are probably also specific to this biotope. Phytophile species like *Stenhelia normani* T. Scott and *Longipedia coronata* Claus are also found here and probably form the transition towards the *Pseudamphiascopsis ismaelensis-Brianola stebleri* association which characterizes the *Caulerpa* muds. The presence in the sublittoral muds of *Eurycletodes oblongus* Sars, as well as of *Typhlamphiascus confusus* itself, forms the transition to the deeper bathyal muds.

Haloschizopera seems to be the characteristic genus of these sublittoral muds in the Mediterranean and the Black Sea. In the Black Sea, the *Haloschizopera pontarchis* association corresponds to the *Mytilus* and *Modiolus-Amphiura* muds; this biocenosis is there much richer in Harpacticoida than in the Levantine Sea. If for the Black Sea the explanation is found in the fact that this is the deepest inhabited biocenosis and the biotope with the optimal salinity and low constant temperatures, the scarcity of the Harpacticoida in the same biocenosis along our coast constitutes a puzzling fact. It will be thus of great interest to study the density of the meiobenthos in the sublittoral *Haloschizopera* muds of other coasts.

TABLE 6

Characteristic Harpacticoida of the sublittoral bathyal muds. The number of specimens of each species in selected stations is given. Species marked with an asterisk are not restricted to this biotope

Station	93	104	138	139	149
Askalonia talpa	16	—	4	1	28
Cervinia bradyi	2	2	—	1	1
*Typhlamphiascus confusus**	6	27	—	—	4
*Eurycletodes oblongus**	20	3	—	—	—
Amonardia pelophila	—	—	10	—	5
Canuella reichi	1	—	1	—	1
Mesocletodes monensis	4	—	1	—	—
Eucanuella langi	2	—	—	—	1
*Canuella longipes**	1	1	—	—	—

Other species found: *Hemicervinia stylifera*, *Eurycletodes ephippiger*, *Eurycletodes aculeatus*, *Mesocletodes bathybia*, *Anoplosoma stryx*, *A. sordidum*, *Haifameira archibenthoica*, *Danielssenia robusta*, *Zosime incrassata*, *Zosime mediterranea**, *Proameira dubia*, *Stenhelia* aff. *minuta*.

The situation changes suddenly at a depth of about 150 metres. Here a rich and very specific association is found. This association seems to appear near the limit of the continental slope and is found also at the maximum depth which we studied, 460 metres. This association may thus be called the community of the bathyal muds (table 6). It is probable that we reached here the deepest Harpacticoid fauna of the Mediterranean, which as is known, has no specific abyssal fauna but only a bathyal fauna which settles unusual depths.

The Harpacticoida of such depths have never been studied in the Mediterranean and the data from other seas are also very scarce. It is therefore not surprising that, out of the 20 species found here, only two had been previously reported from the Mediterranean and that two new genera and six new species were represented among them.

As already stated, *Eurycletodes oblongus* and *Typhlamphiascus confusus* form the transition between this biocenosis and the sublittoral muds. Both are also dominant species in the bathyal muds. But the real character of this association is determined by the Cerviniidae: *Askalonia talpa* n. g. n. sp., the characteristic species of this community; *Cervinia bradyi* which had been reported once from the Mediterranean, but from an unknown depth (Giesbrecht, 1900); *Eucanuella langi* n. sp., the second species of this genus; and *Hemicervinia stylifera* (I. C. Thompson) [1]), of which so far only three specimens were known, all from northern seas. The second characteristic of this association is the abundance of members of the group *Eurycletodes-Mesocletodes: Eurycletodes oblongus* Sars, *Eurycletodes ephippiger* n. sp., *Eurycletodes aculeatus* Sars, *Mesocletodes monensis* (I. C. Thompson), and *Mesocletodes bathybia* n. sp., and of the Stenocopiinae: *Anoplosoma sordidum* Sars, *Anoplosoma stryx* n. sp. and *Haifameira archibenthoica* n. g. n. sp. Other species, like *Amonardia pelophila* n. sp. which sometimes becomes even dominant here (station 138) and *Canuella reichi* n. sp., a fourth species of the *Canuella* succession, belong to genera which are not characteristic to great depths. *Danielssenia robusta* Sars, *Zosime incrassata* Sars and *Proameira dubia* (Sars) are species reported only from the muds of the northern seas. *Zosime mediterranea* Monard, reported by Monard from lesser depths has also been found by us at 70 metres and is therefore not a specific bathyal species.

Several problems are posed by the discovery of this deep-sea biocenosis of Harpacticoida in the Mediterranean.

The first problem is that of the northern origin of these species. Most of

---

1) *Hemicervinia* Lang is used here to replace the preoccupied name *Herdmania* Thompson (see Special Section).

them show indeed clear northern affinities: *Eucanuella spinifera* T. Scott, the first species of the genus *Eucanella*, lives at 272 metres near the shores of Iceland; *Anoplosoma sordidum* has until now been reported only from the Norwegian coasts at depths of 30 to 350 fathoms. The genus *Daniels-senia* has, according to Lang (1948), two arctic, two arctoboreal and two boreal species (one of which is *Danielssenia robusta* now found in the Me-diterranean). *Cervinia* has a circumpolar range, and *Mesocletodes* was until now also considered to be a purely boreal genus.

It may indeed be assumed that all these species entered the Mediterranean in the cold Calabro-Sicilian period along with other northern immigrants known from the palaeontological record.

But this origin does by no means answer the problem posed by the thermic conditions in which these species now live in the Mediterranean. Lang (1948) indicated a maximal thermopathy of 13° to 14° C for these species. But at 150 metres, the upper limit of this biocenosis in the Mediterranean, the maximum temperatures are 18° to 19° C (Oren, 1952). It seems pro-bable therefore (as shown by Thorson, 1957) that a high degree of thermic adaptability must be responsible for the presence of similar species at similar depths in such different thermic conditions.

It is possible that the main factor here is not the maximum temperature, but the thermic stability itself. It is known from the once warmwater species of the pliocenic European freshwaters that they prefered to withdraw to the cold but still stenothermic conditions of the subterranean waters in order to avoid the great temperature extremes which appeared at the beginning of the glacial periods. It seems that the factor which is decisive in the establish-ment of this bathyal fauna is the more or less constant temperature of these depths, and not the absolute value of the temperatures.

If our assumption is correct, the bathyal fauna of the Levantine Sea is not necessarily of northern origin: it is simply a stenothermic fauna which until now has been reported only from the northern seas.

Further studies in other seas will answer this question. The studies in the Red Sea will of be great importance since the temperatures of the great depths there are even higher.

The fauna found in the Levantine bathyal shows extreme adaptations to life in the deep sea muds. The extremes of two adaptive lines are found here. These two lines sometimes seem to appear convergently within such deep-sea groups as the Cletodidae, the Cerviniidae and the Stenocopiinae.

The first adaptive line is that of the epipelic way of life, which tends to make the small animals able to crawl on the surface of the almost fluid mud, and avoid sinking. It means the gradual elongation of all the limbs including
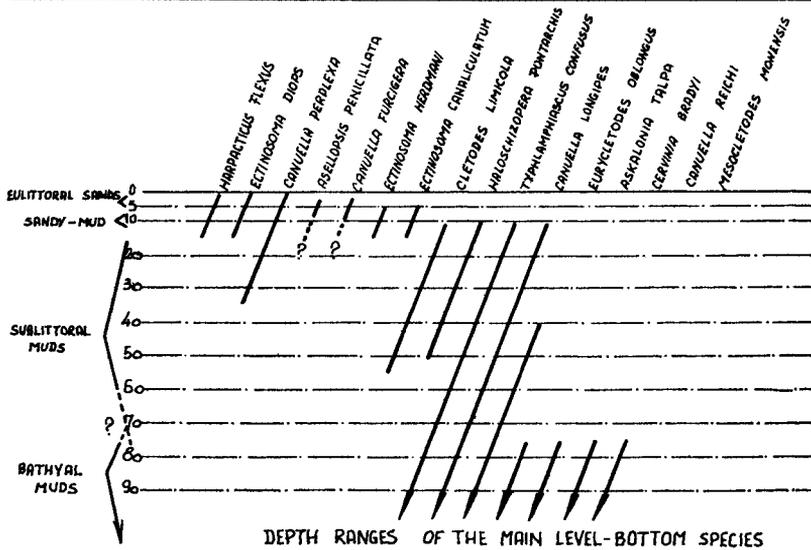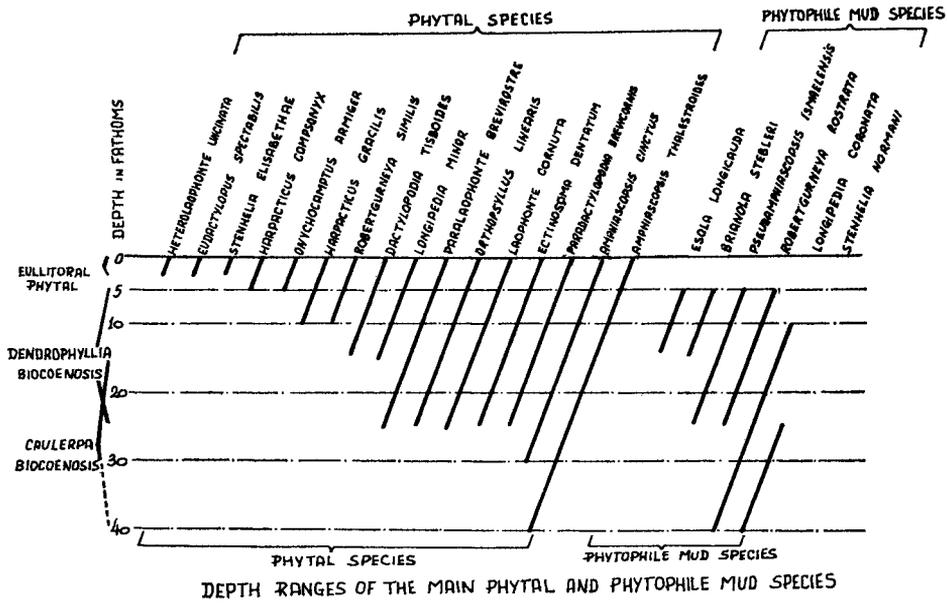
Fig. 2. Depth ranges of several Levantine Harpacticoida.

the furca, so that the animal finally achieves spiderlike features. Similar adaptations are known also among isopod and decapod Crustacea which inhabit the deep muddy bottoms.

This peculiar evolutive tendency is easy to follow along the lines *Eury-*

cletodes-Mesocletodes and *Stenocopia-Haifameira-Anoplosoma*. The elongation of the furca and of the exopodites of the legs reaches a considerable extent in such specialized species as *Mesocletodes abyssicola* (T. & A. Scott), *Mesocletodes inermis* Sars and *Mesocletodes bathybia* n. sp., but this tendency is even more marked in the two species of *Anoplosoma*, in which the antennula is also very long and the exopodites abnormally elongated. In *Anoplosoma stryx* n. sp. we even find a reduction of the number of segments, in order to make this abnormal formation more rigid. In both convergent lines the endopodites of the spider-like animals (see pl. 6 fig. 39) become rudimentary. Similar adaptations are found to a lesser extent also among the Cerviniidae. For instance, in *Hemicervinia stylifera* the furca is extremely elongated. The most evolved link of this line among the Cerviniidae seems to be *Pontostratiotes* Brady in which, instead of elongated legs, there are abnormally elongated spiniform processes on the body.

In the other adaptative line the trend is basically different. Here the adaptations are aimed at an endopelic, burrowing way of life. The body is clumsy, with broad and massive cephalothorax, the antennulae are short, broad and highly chirocerous, the legs are strong, broad, and finally become uni-articulated (pl. 6 fig. 38). The endopodites are again reduced. This process starts among the species of *Cervinia*. Already *Cervinia synarthra* Lang has only a two-segmented exopodite, while in *Askalonia talpa* n. g. n. sp. the exopodites are formed of a single very broad segment only. In this species the legs bear very strong spines, are bent towards the body-axis and have probably a very limited mobility. The Harpacticoida of this type probably plow through the soft mud, actively aided by their short and strong antennulae. Perhaps the fact too that *Askalonia* bears only two eggs is an indication for its endopelic way of life (something similar is known in the interstitial Harpacticoida, cf. Remane, 1940). Among the Cletodidae there are several species which show this adaptative type to a lesser degree. The species of *Zosime*, also owing to such adaptations, have a body form resembling that of the Cerviniidae, although they belong to a quite different family. On the ground of this similitude previous authors placed *Zosime* in the Cerviniidae.

Concluding, we must point to the contrast between the surprising abundance of Harpacticoida in the deep bathyal muds of the Levantine coast and the marked scarcity of them in the sublittoral *Haloschizopera* muds. Although our samples were not quantitative, they were always taken with the same Petersen grab. The rich meiofauna of the archibenthal muds is a fact which must certainly be taken into account in the trophicity problems in the Levantine basin.

5. The zoogeographical relations of the Levantine Harpacticoida

In discussing the zoogeographical relations of the Levantine Harpacti-
coida, several problems may be distinguished.

The first problem is that of the resemblance to the western Mediterranean
and Pontic faunae.

There are several differences between the Levantine and the western Me-
diterranean Harpacticoid faunae. As shown below, the phytal fauna in the
Levantine area is certainly poorer, even if we take into account the few
phytal species which are specific relicts of the eastern basin. As to the level
bottom species, the differences are only of a quantitative character. Many
of the species which we found here for the first time in the Mediterranean
will probably be found also in the western part of this sea, as soon as the
respective biotopes there will be studied. A prognosis in this direction can
be made for *Stenhelia elisabethae* Por and *Haloschizopera pontarchis* Por,
both of which are also found in the Black Sea, and for many of the bathyal
species found together with *Cervinia bradyi* Norman. The scarcity of the
western Mediterranean element in the Levantine Sea is very evident in the
phytal. We found only 19 of the 78 endemic Mediterranean species listed
by Lang (1948), and most of the lacking species are phytal dwellers. For in-
stance, except for *Tegastes seurati* Monard, we did not find any of the spe-
cific Mediterranean Tegastids, though the tropical character of this family
is well known. The same is true for the Peltidiidae. But the scarcity of the
phytal fauna appears also in the lack of such a circumtropical species as
Lourinia armata (Claus), a specific dweller of the phytal zones, widespread
in the western Mediterranean and the Aegean, dominant at Eilat in the Red
Sea and even found in the Suez Canal.

This scarcity of the phytal fauna can be charged to three causes. Firstly,
there are the large fluctuations of salinity during the Nile flow. As shown
in the chapter on the ecology of the Pontic Harpacticoida, the phytal Har-
pacticoida are especially sensitive to oscillations of salinity. If we assume
further, that in the relatively near past, these fluctuations were even more
pronounced along the Israel coasts, we can perhaps take the present situation
to be due also to historical factors. The possibility of a relatively recent im-
poverishment of the phytal communities, which left traces even now, is in-
creased by a third cause: the phytal of the Israel coasts and of the whole
Levantine basin, as one advances southwards has a more and more isolated
distribution along the shores. This patchiness of the littoral phytal increases
greatly south of Haifa. Thus, the phytal biotope along the Levantine coast
can be considered a distant outpost of the rich Mediterranean phytal. If one
admits that the Harpacticoida have a quite reduced motility, it may be assu-

med that the resettlement of these phytal patches after a period of depopulation is not easy. If one considers also that the isolation of the phytal biotopes increases proportionally to the increasing influence of the Nile flow, the combined action of the three above mentioned causes becomes more plausible. In the ecological chapter we underlined the remarkable resemblance between the phytal fauna of Palmakhim, perhaps the last patch of phytal fauna before the Nile delta, and the phytal fauna of Yalta in the Black Sea: in both cases the recent and historic determinants seem to be very similar.

But, in the months which are not influenced by the Nile flow, the salinity of the Levantine coast is unusually high. This is, in our opinion, the cause which has determined the lack on this coast of a number of species found both in the western Mediterranean and the Black Sea. These species seem to be insensitive to lowered salinities or seem even to prefer them. Such are the phytal dwellers *Heterolaophonte stroemi* (Baird) known from the western Mediterranean (but apparently not widespread), which is a dominant species in the phytal of the Black Sea, *Mesochra heldti* Monard, *Mesochra armoricana* Monard and the Lusitanian *Mesochra xenopoda* Monard, which are also fairly tolerant to low salinities. But the high salinities are seemingly impoverishing also the level bottoms in several regards: *Enhydrosoma sordidum* Monard — a Lusitano-Mediterranean species which is dominant in the shallow muds of the Black Sea and also enters there the polyhaline lagoons, is completely lacking on the Israel shores. The excessively high salinities along our coasts are also the most probable cause for the lack of the genera *Tachidius, Microarthridion* and of *Nannopus palustris* Brady in the muds of the Israel coasts: the euryhalinity of these Harpacticoida seems to be efficient only in the direction of lowered salinities and not inversely.

The influence of the variable salinities is taken into account also for the lack of other faunal elements in the eastern Mediterranean. In analysing, for instance, the fauna of Ascidians along the Israel coast Pérès (1958) considered that the rarity of the Polyclinidae, still abundant in the Aegean, is due to the influence of the Nile flow.

Certainly some affinities can be found between the faunae of the Levantine basin and the Black Sea. But they can in no way be an argument for the colonisation of the Black Sea from the Levantine basin. As already emphasized, *Stenhelia elisabethae* and *Haloschizopera pontarchis* will probably also be found in the western Mediterranean. The same may be true for the Levantine *Rhizothrix curvata* Brady & Robertson, which is also known from the northern seas, and is closely related to the Pontic *Rhizothrix pubescens* Por, or for the Levantine *Hemimesochra derketo* n. sp., related to

the pontic *Hemimesochra atargatis* Por but also to the northern *Hemimesochra clavularis* Sars. It is also probable that *Haloschizopera marmarae* Noodt and *Robertgurneya oligochaeta* Noodt, at present known only from the Sea of Marmara and our coasts, will be found elsewhere in the Mediterranean. But until concrete data are available, the existence of such Levantino-Pontic or Levantino-Maeotic areals must be taken into account.

A second problem is that of the tropical affinities of the Israel fauna here described, in the context of the general tropical affinities of the Mediterranean and Levantine faunae. Three aspects can be distinguished here on the basis of historical considerations.

Among the tropical species known from the Mediterranean, there are firstly, the circumtropical genera and species, the origin of which evidently goes back to the Tethys. Of the same age must be the faunal affinities with the Westindian fauna (however, only the Harpacticoida of Bermuda have been studied) which also go back to a period in which the Tethys made such an east-west distribution of the meiobenthos across the Atlantic possible. A second category of tropical elements shows affinities with the tropical West-african fauna and with the Indo-West Pacific fauna, and was certainly present in the Mediterranean prior to the opening of the Suez Canal. The origin of this second tropical element must probably be ascribed to the Tyrrhenian period of the Mediterranean, in which a Senegalese fauna entered this sea, and connections with the Indian Ocean through the Red Sea probably existed also. Finally there is the most recent tropical element, which entered the Mediterranean through the Suez Canal.

The well known circumtropic species *Metis holothuriae* (Edwards), *Metamphiascopsis hirsutus* (Thompson & A. Scott), *Robertsonia knoxi* (Thompson & A. Scott) and *Laophonte inornata* A. Scott already reported for the Levantine basin are also found on the Israel coasts. The curious lack of *Lourinia armata* has been discussed above.

We found some new support for the Westindian „Bermudan" affinities. We must especially emphasize the finding on the Israel coast of *Willeyella horrida* n. sp., the second species of a new genus, the type species of which is the Bermudan *Willeyella armata* (Willey), and of *Pseudodiosaccopsis mesogeae* n. sp. (the two other species of this genus *P. rubens* (Brian) and *P. brunneus* (Willey) are known from the Dodekanesos and Bermuda respectively). We also found slightly modified specimens of the Bermudan *Nitocra minor* Willey. Other examples of Bermudan affinities in the Mediterranean are *Onychocamptus armiger* (Gurney), which along the Israel coast is a dominant species of the phytal fauna, and *Robertgurneya rostrata* (Gurney). There are, perhaps, reasons to suppose that the rôle played by

this tropical element in the eastern Mediterranean is greater than in the western Mediterranean.

It is highly possible that these Bermudo-Mediterranean elements are actually circumtropical species, which have not yet been found in the Indo-West Pacific region. The case of *Diarthrodes purpureus* Gurney, known from Ismailia in the Suez Canal and Bermuda, but not yet from the Mediterranean itself, supports this view. At any rate, no special palaeogeographic conditions are known which would facilitate a faunal exchange between both sides of the tropical or subtropical Atlantic fauna after the breakdown of the mesogaeic Tethys.

A group of species found in the Mediterranean and Lusitanian regions as well as in Bermuda, such as *Amphiascella subdebilis* (Willey), *Nannomesochra arupinensis* (Brian), *Scutellidium ligusticum* (Brian) and *Eurycletodes versimilis* Willey (this last species was recently found also on the Irish coast by Roe, 1960) probably belong to a temperate Atlantic fauna and are not Tethys relicts.

In starting the discussion on the Indo-West Pacific relations of the Mediterranean fauna, a few general considerations must be dealt with first.

Much has been written in recent years about the recent immigrants through the Suez Canal. It is difficult to say that the importance of this doubtless highly interesting event was exaggerated. But it somehow overshadowed the existence of older Indo-West Pacific relations, subsequent to the fragmentation of the Tethys, but prior to the opening of the Suez Canal. The cases must be always carefully analysed to avoid superficial conclusions. For instance it is difficult to agree with Fauvel (1955b) who considered the polychaete *Asychis gottoi* Izuka a recent Suez immigrant, although it is found also in the Adriatic Sea.

There are some well known Indo-West Pacific affinities among the Mediterranean Harpacticoida: for example the Mediterraneo-Indo-West Pacific genera *Eudactylopus*, *Syngastes* and *Perissocope*, and species like *Longipedia weberi*, *Porcellidium ovatum*, *Robertsonia irrasa*, etc. In several species one still can assume that their lack in the West Indies is due to insufficient knowledge, but it seems almost sure that the large phytal *Eudactylopus* is lacking on the American coasts, thus being post-Tethysian. On the other hand, the fact that *Eudactylopus spectabilis* (Brian) was found by us at Yalta (Marcus & Por, 1960), shows that by the late pleistocenic opening of the Bosphorus, this genus was already present in the Mediterranean. However, a species of *Eudactylopus* was recently found by Lang (oral communication) on the Californian coast.

Further support to this early exchange with the Indo-West Pacific fauna is furnished by several taxonomic similarities. For instance, in *Robertgur-*

neya similis (A. Scott), the subspecies *erythraea* is found on both sides of the isthmus of Suez, while the typical species is Atlantic. The same applies to the circumtropic *Metamphiascopsis hirsutus*: while the subspecies *bermudensis* lives in Bermuda, the typical subspecies is found in the Mediterranean, on the Levantine coast and in the Red Sea at Eilat. The post-tethysian character of these faunal relations is clear. It is also clear that they can in no way be the product of the 100 years since the opening of the Suez Canal: both the above mentioned species were known from the western Mediterranean more than 30 years ago, when Monard (1928) reported on them.

At a higher systematic level there is the case of *Robertsonia monardi* (Klie) a Mediterraneo-Pontic species which is closely related to *Robertsonia paramonardi* Nicholls from the Australian west coast. *Cletopsyllus tertius* n. sp. found by us on the Israel coasts, is in our opinion the most striking argument for a pleistocene Indo-West Pacific faunal contact: our species is closely related to the West Australian *Cletopsyllus secundus* Nicholls and is morphologically much more distant from the Bermudan *Cletopsyllus papillifer* Willey. It seems thus clear that, though the distance between our species and the Australian is much greater, they belonged to a common population for much more time than with the Bermudan one. On the other hand, the separation between the Levantine and Australian populations cannot be too young and must go back at least to the early or middle Pleistocene in order to permit the segregation of the above twin species.

There are some cases in which the possibility of contact with the tropical West African fauna can also be taken into account: *Robertsonia angolensis* (Monard) is known from West Africa and the entire Mediterranean, and recalls, within the Harpacticoida, the Tyrrhenian expansion of the „Senegalese" elements in the Mediterranean *(Strombus bubonius-*fauna). Though the faunal contact of the tropical West African fauna with the Indo-West Pacific is not an easy one, owing to the cold waters of South Africa, it is possible that some of the tropical species now found in the Mediterranean, in West Africa and in the Indian Ocean, followed this „Senegalese" route. Such are perhaps *Eudactylopus latipes* (T. Scott) and *Esola hirsuta* (Thompson & A. Scott).

Interesting in this connection are two further cases.

Ectinosoma dentatum Steuer was first described from Alexandria and then found successively by Noodt (1955b) in the Sea of Marmara, by Pesta (1959) in the submarine caves of the Bay of Naples, and by us both on the Mediterranean and Red Sea coasts of Israel. This consequently is a species with Indo-West Pacific affinities, since although known only from Eilat, a recent immigration, against the main invasion, from the Mediter-

ranean through the Suez Canal can not be considered. This Mediterraneo-erythraeic species is, however, the dominant *Ectinosoma* of the phytal biotopes on the Israel coast, a species found nearly in every sample and replacing here the well known and widespread *Ectinosoma melaniceps* of the European seas. It even seems that this dominance of *Ectinosoma dentatum* is limited to the eastern Mediterranean except for the somewhat extreme biotope studied by Pesta (1959). It is clear that the ecological predominance of this tropical species is the result of a long process of expansion, impossible in the few decades since the opening of the Suez Canal. But, on the other hand, since there are no differences between the Levantine population and that from Eilat, the separation of these populations cannot be an old one geologically.

A second similar example is that of *Canuella longipes*. This species has been reported from Ceylon, and we found it a dominant species of the shallow muddy bottoms of the Levantine Sea. As shown above it is the third species in the ecological succession with *Canuella perplexa* and *Canuella furcigera*, two species which are found all around the European continent. The southern origin made *Canuella longipes* successful in its competition against *Canuella furcigera*. It appears in such amounts, so typically, and down to such great depths (260 fathoms) that it is quite impossible that a species which has no free larval stages could have been able to reach such an importance and occupy such an area in less than a hundred years.

Both *Ectinosoma dentatum* and *Canuella longipes* must, therefore, be considered the most striking examples of pre- „Lessepsian" faunal exchanges with the Red Sea. Hence, at least these two species must be added to the few species which according to Steinitz (1929) are considered indopacific immigrants prior to the opening of the Suez Canal. Tortonese (1951) after a revision of this list, indicates only as such the gastropod Mollusc *Pirenella conica* (Blv.) the decapod Crustacea *Petrolisthes bosci* (Audouin) and *Thalamita admete* (Herbst) and the fish *Hyporhamphus picarti* (Cuv. & Val.). One may add also the Indopacific polychaete *Eurythoe complanata* (Pallas) a dominant form in the Levantine sands which has been reported from Beyrouth in 1857, twelve years before the opening of the Suez Canal (Fauvel, 1955a). Pérès (1958) who reported a great number of Suez immigrants among the Ascidians of the Israel coast, considered (Pérès & Picard, 1956) that the massive presence of the Indo-West Pacific cormophyte *Halophila stipulacea* (Forskål) in the Aegean can only be explained if it is considered a tropical relict, present before the opening of the Suez Canal. Gohar (1954) too, considered the possibility of pre-"Lessepsian" faunal exchanges even in the early historical times, when the Red Sea reached as far north as the

Bitter Lakes and the remaining distance to Lake Menzaleh was frequently flooded by the Nile.

As to the recent immigrants from the Red Sea, it seems that the span of time which passed since the opening of the Suez Canal is too short to have allowed a large scale immigration of these meiobenthonic animals. The overwhelming majority of the reported cases of recent Red Sea immigrants are fishes, mollusks and decapod Crustacea, which are able to perform large-scale active migrations. In the case of fishes, Kosswig (1942) spoke of a daily advance of as much as some 300 metres. Against that, the immigration of the Harpacticoida through the Suez Canal could only have occurred by a step-by-step advance, using the limited possibilities of these animals to migrate actively. In this way the spread of these small animals is only a very slow one and an areal extension of a few hundred kilometres probably needs at least an equal number of generations. It seems that passive spread by ships, like in the case of some sessile animals, e.g. ascidians, sponges, bryozoans, did neither occur.

It will thus be of great interest to compare our conclusions with those reached from the study of other meiobenthonic animals.

The only cases which possibly can be explained by a recent immigration through the Suez Canal are those of *Diosaccus truncatus* Gurney and *Esola hirsuta* (Thompson & A. Scott).

A third problem must be briefly referred to. It is that of the northern, coldwater element in the fauna of the deep muds. Presumptions are difficult to make here, since almost nothing is known from such depths in the western Mediterranean and the Lusitanian region. We already expressed our opinion about the community of the bathyal bottoms. As to less peculiar species found in the sublittoral muds, which show clear boreal affinities such as *Pseudameira crassicornis* Sars, *Zosime valida* Sars, *Rhizothrix curvata* Brady & Robertson and *Bradya congenera* Sars, here probably the same is true as for the bathyal species. It is, however, possible that all these species used the coldwater conditions of the Calabro-Sicilian period to spread over the Mediterranean and succeeded somehow to hold out in the more stenothermic depths. The fact, however, that a definitely boreal species like *Sarsameira parva* (Boeck) we found in the tropical complex of the shallow *Dendrophyllia* reefs shows the provisory and hypothetic character of many of these zoogeographic speculations.

6. The biocenology and ecology of the Pontic Harpacticoida

The following is a list of all species of Harpacticoida sofar reported from the Black Sea; the interstitial species, however, are not included.

Name	Geographical distribution	Ecological preference	Remarks
Longipedia minor T. & A. Scott	Cosmopolite?	Sublittoral sandy muds	Bulgarian coast
Canuella perplexa T. & A. Scott	Circumeuropean	Mainly eulittoral sands	Euryhaline
Canuella furcigera Sars	Circumeuropean	Sublittoral sandy muds	
Sunaristes paguri Hesse	Cosmopolite?	——	Commensal
Ectinosoma abrau (Kričagin)	——	Oligohaline	
Ectinosoma herdmani T. & A. Scott	Circumeuropean	Eulittoral sands	
Ectinosoma curticorne Boeck	Circumeuropean	——	Euryhaline
Ectinosoma melaniceps Boeck	Cosmopolite	Eulittoral phytal	
Ectinosoma normani T. & A. Scott	Cosmopolite	——	
Ectinosoma brevirostre Sars	Boreo-pontic	Sublittoral, *Mactra* muds	
Microarthridion littorale (Poppe)	Circumeuropean	Muds at various depths	Euryhaline
Harpacticus flexus Brady & Robertson	Circumeuropean	Eulittoral sands	Euryhaline
Harpacticus gracilis Claus	Circumeuropean-Indian	Eulittoral phytal	
Harpacticus obscurus T. Scott	——	Eulittoral phytal?	
Harpacticus littoralis Sars	——	——	
Harpacticus compsonyx Monard	Mediterraneo-pontic	Eulittoral phytal	Crimean coast
Harpacticus nicaeensis Claus	Mediterraneo-pontic	Eulittoral phytal	Crimean coast
Horsiella brevicornis (Douwe)	——	Oligohaline	
Tisbe furcata (Baird)	Cosmopolite	Phytal euryekous	
Tegastes longimanus (Claus)	Boreo-pontic	——	Crimean coast
Parategastes sphaericus (Claus)	Cosmopolite?	——	Crimean coast
Tisbe histriana Marcus & Por	——	Polyhaline lagoons	
Idyella exigua Sars	Circumeuropean	*Mactra* muds	
Scutellidium longicauda (Philippi)	Cosmopolite	Eulittoral phytal	Crimean coast
Porcellidium viride (Philippi)	Circumeuropean	——	Bulgarian coast
Altheuta typica Czerniavski	Mediterraneo-pontic	Eulittoral phytal	Euryhaline
Thalestris longimana Claus	Amphiboreal-circumeuropean	——	
Thalestris rufoviolascens Claus	Circumeuropean	——	
Parathalestris harpactoides (Claus)	Arctic-circumeuropean	Eulittoral sands?	
Phyllothalestris mysis (Claus)	Boreal, circumtropical	Eulittoral phytal	Crimean coast
Rhynchothalestris rufocincta (Brady)	Cosmopolite?	——	
Diarthrodes minutus (Claus)	Amphiboreal-circumeuropean	——	

Name	Geographical distribution	Ecological preference	Remarks
Diarthrodes ponticus (Kričagin)	Circumeuropean	Eulittoral phytal	
Dactylopodia tisboides (Claus)	Cosmopolite	Phytal-euryekous	
Paradactylopodia brevicornis (Claus)	Cosmopolite?	Eulittoral phytal	Also in lagoons
Dactylopodella flava (Claus)	Arctic-circumeuropean	*Mactra* and *Modiolus* muds	
Eudactylopus spectabilis (Brian)	Mediterraneo-pontic	Eulittoral phytal	Crimean coast
Parasthenhelia spinosa (Fischer)	Cosmopolite?	Eulittoral phytal	
Stenhelia palustris Brady	Boreo-pontic	Sublittoral muds	
Stenhelia elisabethae Por	Mediterraneo-pontic	Sublittoral muds	Euryhaline
Stenhelia proxima Sars	Boreo-pontic	*Modiolus* muds	
Stenhelia reflexa Brady & Robertson	Boreo-pontic	*Mactra* muds	
Stenhelia tethysensis Monard	Mediterraneo-pontic	——	Bulgarian coast
Robertsonia monardi (Klie)	Mediterrano-pontic	——	Euryhaline
Amphiascus aff. *caudaespinosus* (Brian)		——	
Amphiascopsis thalestroides (Sars)	Circumeuropean-Indian Ocean	Eulittoral phytal	
Amonardia similis (Claus)	Mediterraneo-indian	——	
Paramphiascopsis longirostris (Claus)	Arctic-circumeuropean	*Mactra* and *Modiolus* muds	
Robergurneya similis A. Scott	Boreal, circumtropical	——	
Amphiascella brevifurca (Czerniavski)	Lusitano-mediterraneo-pontic	Sublittoral muds	
Amphiascella subdebilis (Willey)	Temperate Atlantic, Mediterraneo-pontic	Sublittoral muds	
Bulbamphiascus imus (Brady)	Cosmopolite?	——	
Typhlamphiascus confusus (T. Scott)	Circumeuropean	*Modiolus* muds	
Haloschizopera pontarchis Por	Mediterraneo-pontic	*Mactra* and *Modiolus* muds	
Haloschizopera pauciseta Por	——	——	
Schizopera compacta Lint	Boreo-pontic?	——	Euryhaline
Schizopera grimalschii Jakubisiak	——	——	Lagoons
Metis ignaea Philippi	Amphiboreal-circumeuropean	——	Caucasian coast
Metis ignaea halmyricola Marcus & Por	——	——	Polyhaline lagoons
Ameira parvula (Claus)	Amphiboreal-circumeuropean, Indian Ocean	Muds at various depths	Euryhaline

Name	Geographical distribution	Ecological preference	Remarks
Ameira scotti Sars	Cosmopolite?	*Mactra* muds?	
Ameira tenella Sars	Circumeuropean	——	
Proameira simplex (Norman & T. Scott)	Boreo-pontic	——	
Nitocra fallaciosa Klie	Boreo-pontic?	——	Euryhaline
Nitocra lacustris (Schmankevich)	——	Oligohaline	
Nitocra lacustris sinoi Marcus & Por)	——	——	Polyhaline lagoons
Nitocra hibernica (Brady)	——	Oligohaline	
Nitroca spinipes Boeck	Circumeuropean, amphiboreal, indian	——	
Psyllocamptus minutus Sars	Circumeuropean	Eulittoral phytal	
Mesochra pestai Lang	——	——	
Mesochra pygmaea (Claus)	Cosmopolite?	Eulittoral phytal	
Mesochra rapiens (Schmeil)	Boreo-pontic?	Eulittoral phytal	
Mesochra armoricana Monard	Lusitano-pontic?	——	Euryhaline
Mesochra xenopoda Monard	Mediterraneo-pontic	——	Euryhaline
Mesochra heldti Monard	Mediterraneo-pontic	——	Bulgarian coast
Mesochra aestuarii Gurney	——	Oligohaline	
Nannomesochra arupinensis (Brian)	Temperate Atlantic, Mediterraneo-pontic	Eulittoral phytal	
Itunella muelleri (Gagern)	——	——	
Cletodes tenuipes T. Scott	Boreo-pontic	*Mactra* muds	
Enhydrosoma sordidum Monard	Lusitano-mediterraneo-pontic	Sublittoral muds	Euryhaline
Enhydrosoma propinquum (Brady)	Circumeuropean	——	
Enhydrosoma sarsi (T. Scott)	Boreo-pontic	Mainly *Mactra* muds	
Enhydrosoma curvirostre (T. Scott)	Boreo-pontic	——	
Cletocamptus retrogressus Schmankevich	——	——	Continental salines and lagoons
Cletocamptus confluens (Schmeil)	——	——	Continental salines and lagoons
Rhizothrix pubescens Por	——	——	
Nannopus palustris Brady	——	Eulittoral and sublittoral muds	Euryhaline
Hemimesochra atargatis (Por)	——	*Modiolus* muds	
Heteropsyllus dimorphus Por	——	*Modiolus* muds	
Limnocletodes behningi Borutzky	——	——	Aestuaries
Eurycletodes latus (T. Scott)	Boreo-pontic	*Modiolus* muds	

Name	Geographical distribution	Ecological preference	Remarks
Eurycletodes parasimilis Por	——	*Modiolus* muds	
Stylicletodes longicaudatus (Brady & Robertson)	Boreo-pontic?	*Mactra* muds	
Laophonte cornuta Philippi	Cosmopolite	——	
Laophonte elongata Boeck	Circumeuropean	Eulittoral phytal	
Laophonte longicaudata Boeck	Boreo-pontic	*Mactra* and *Modiolus*(?) muds	
Laophonte borceai Jakubisiak		——	Bulgarian coast
Laophonte setosa Boeck	——	——	Polyhaline lagoon
Heterolaophonte stroemi paraminuta Noodt	Circumeuropean?	Eulittoral phytal	
Heterolaophonte curvata (Douwe)	Mediterraneo-pontic	Eulittoral phytal	
Heterolaophonte uncinata (Czerniavski)	Lusitano-mediterraneo-pontic	Eulittoral phytal	
Paralaophonte brevirostris (Claus)	Cosmopolite?	Phytal-euryekous	
Paronychocamptus leuke Por	——	*Mactra* muds?	
Asellopsis sarmatica Jakubisiak		Sublittoral sandy muds	Euryhaline
Asellopsis bacescui Por	——	*Mactra* muds?	
Onychocamptus mohamed (Blanchard & Richard)	——	Oligohaline	
Esola typhlops pontoica Por		*Mactra*(?) and *Modiolus* muds	
Normanella mucronata Sars	Circumeuropean	Sublittoral, *Mactra* and *Modiolus* muds	
Normanella serrata Por	——	*Mactra* and *Modiolus* muds	

Two facts determine the peculiar characteristics of the Pontic fauna: firstly the polyhaline brackish conditions which have lasted through considerable oscillations, from the late Miocene, and which determined the existence of an abiotic zone below 150 to 200 metres, and secondly the severe climatic conditions with very pronounced temperature peaks in the winter and summer.

The knowledge of the ecology of brackish waters, as summarized by Remane & Schlieper (1958), is essentially based on data from the Baltic Sea. The Black Sea, part of the oldest brackish basin of the world — the Sarmatic or Ponto-Aralo-Caspic basin — can contribute much to the deepening of our knowledge of brackish waters. An attempt is made here for the Harpacticoida.

It is known that, as compared with Atlantic conditions, which may be considered standard oceanic conditions, the Black Sea has hydrologic conditions directly opposed to those of the Mediterranean. Since the fauna of the Black Sea in its overwhelming majority originated from that of the Mediterranean, or at least crossed the Mediterranean, the stress to which these animals were exposed as soon as they settled the Pontic basin, was a very heavy one.

The obstacle of low salinities and highly variable temperatures (see introductory chapter on hydrologic conditions) was insurmountable for many of the Harpacticoida. As already shown by Marcus (1960), none of the worldwide planktonic Harpacticoida is found in the plankton of the Black Sea. Most of these species are adapted to greater depths which, however, in the Black Sea are uninhabitable; but also epipelagic species as *Microsetella rosea* Dana and *Euterpina acutifrons* Dana are lacking. It seems that especially the brackish conditions exerted the heaviest influence on the planktonic world. Of the numerous Calanoida of the Mediterranean, only six or seven species still live in the northwestern Black Sea (Marcus, 1959). The lack or extreme scarcity of many major groups in the Black Sea (Ctenophora, Pteropoda and Heteropoda, Echinodermata, etc.) may be considered the consequence of the great sensitivity of planktonic organisms (or larval stages) to brackish conditions. On the other hand, in his comprehensive study of the Pontic Rotatoria, Rudescu (1961) showed that the overwhelming majority of the 111 species reported from the plankton are brackish or even limnetic species.

In the great majority of the Harpacticoida, which are exclusively benthonic, the situation is different. Although many groups of species are lacking, the general aspect of the fauna remains clearly marine.

Among the groups of Harpacticoida which are lacking, there are many Tegastidae and Peltidiidae, specific phytal species. This scarcity of the phytal biotope will be discussed below. Among the muddwellers, entire families or subfamilies are wanting, such as the Cerviniidae, Ancorabolidae or Stenocopiinae. The group *Bradya-Pseudobradya* is also missing. In all these cases the only limiting factor is, no doubt, the low salinity, since most of the species of these groups are coldwater forms which in the depths of the Black Sea can find more suitable thermic conditions than in the Mediterranean.

On the other hand, however, a positive, enriching influence of the brackish conditions was not found. Only *Microarthridion littorale* (Poppe) and *Nannopus palustris* Brady are found in large numbers in the sea; true brackish water Harpacticoids do not spread beyond the limits of the lagoons or the river-mouths.

Even the fact that along the northwestern shores the salinity periodically drops to 10 to 12 $^0/_{00}$ does not alter the marine feature of the fauna. This is an evident support for Remane's (1958) conclusion that only salinities below 10 $^0/_{00}$ limit the spread of marine animals into the brackish basins. An impoverishment of the fauna of the Harpacticoida occurs only in the Sea of Azov, where the maximum salinities are only 10 to 11 $^0/_{00}$. But here also, surprisingly, some marine species are still present (Mordukhai-Boltovskoi, 1960).

The positive conclusion about the marine features of the Pontic Harpacticoid fauna confirms another statement of Remane, according to which the meiobenthos is less influenced by the brackish conditions than the macrobenthos. The recent study of Ax (1959) on the Ponto-Caspic Turbellaria also confirmed this view: the majority of the Black Sea species are of marine origin, and only very few are brackish or limnetic. As to another meiobenthonic group, the Ostracoda recently studied by Caraion (1959), the fauna is also purely marine even along the north-western coasts, though a great qualitative enrichment is noted in the more "Mediterranean" pre-bosphoric area. In the Harpacticoida even such an increase of the Mediterranean elements in the pre-bosphoric area does not occur. As to the larger animals in the Black Sea, the example of the poor mollusk fauna shows a much deeper influence of the brackish conditions. As to fishes, Slastenenko (1959) showed that in the Black Sea there are some 132 freshwater and brackish species against 115 marine species; while it must be stressed that not all of these marine fishes are actually spawning in the Black Sea.

In a previous paper (Por, 1960a) we made a comparison between the Harpacticoida of the Black Sea and those of the Baltic Sea, based on the data of Noodt (1957) about the salinity tolerance of the Harpacticoida in the Baltic. It was emphasized then that the fauna of the north-western coasts of the Black Sea resembles that of the Bay of Kiel, although the salinity of the latter is higher (20 $^0/_{00}$). Hence, the Harpacticoida in the Black Sea have an increased tolerance to low salinity. This phenomenon is well known, since is has been stated more than once that the adaptation of organisms to brackish conditions is much more easy as one proceeds southwards (see Hesse, Allee & Schmidt, 1951). Examples among the Harpacticoida are several: *Harpacticus flexus* lives in the Black Sea and in the Sea of Azov at salinities below 10 $^0/_{00}$, though it is considered, in northern European seas to be a polyhaline species. Also *Ameira parvula* which is considered by Noodt (1957) to be a polyhaline species, shows a holeuryhaline range in the Black Sea and lives in the almost fresh waters of the lagoon of Sulina. It is also remarkable that *Tegastes longimanus* was able to settle in the meso-

haline Sea of Azov. The clearly northern species *Canuella furcigera* and *Ectinosoma brevirostre* Sars are lacking in the brackish Baltic but present and even widespread in the Black Sea.

Another aspect of life in brackish waters, not yet emphasized is that of the „protective" rôle sometimes played by polyhaline lagoons. We referred to this problem in a previous paper (Marcus & Por, 1961) with regard to the polyhaline lagoons of the Razelm system, Sinoe and Tuzla, in the special case of *Metis ignaea* Philippi. This species does not now live along the Rumanian coasts. The cause may be found in the fact that even if the salinity of the closed lagoons is not higher than that of the open sea, it is at least more stable. If the estuaries of the rivers are refuge areas for the brackish and limnic species, when the sea becomes more saline, the polyhaline lagoons, on the contrary, are able to shelter at a certain degree marine species, when conversely the sea becomes more brackish.

Let us now turn to the communities of Harpacticoida in the various biotopes of the Black Sea.

The phytal biotope is qualitatively very poor in the Black Sea. According to Remane (1958) this phenomenon is a direct consequence of the brackish conditions. On the north-western coasts the phytal fauna consists essentially of *Harpacticus gracilis* and *Heterolaophonte stroemi paraminuta* as dominant species, *Altheuta typica, Diarthrodes ponticus, Parastenhelia spinosa, Tisbe furcata* and *Heterolaophonte curvata*. In the phytal of the Crimean coast, were salinities are more constant, we found (Marcus & Por, 1960) a much richer fauna: *Harpacticus compsonyx* and *Scutellidium longicauda* are the dominant species, accompanied by *Harpacticus nicaeensis* and *Eudactylopus spectabilis*. Three of these species which are not found on the north-western shores of the Black Sea are Mediterranean species. The scarcity of the phytal in the Black Sea is at the same time also a scarcity in endemic Mediterranean species, since most of them are phytal dwellers.

At the other extreme of increasingly brackish conditions, we followed this specific impoverishment of the phytal fauna historically (Marcus & Por, 1961).

In 1934 the salinity in the lagoon of Tuzla was about $30^0/_{00}$. Then there lived a rich phytal fauna composed of *Metis ignaea halmyricola, Harpacticus obscurus, H. gracilis, Paradactylopodia brevicornis, Heterolaophonte stroemi paraminuta, Mesochra xenopoda* and *M. armoricana*. Today, no Harpacticoid is found in the phytal biotope of Tuzla, which now has a salinity of 14 to $16^0/_{00}$. In the nearby Sinoe lagoon, with a salinity of 10 to $14^0/_{00}$ the phytal is already inhabited by such oligohaline species as *Schizopera compacta* Lint, *Nitocra typica* Boeck, *Nitocra lacustris sinoi* Marcus & Por,

Horsiella brevicornis (Douwe) and *Mesochra armoricana* Monard. But, since the salinity of Sinoe was nearly $13^0/_{00}$ in 1951, decreasing from a peak of over $20\,^0/_{00}$ which it reached several years before, such species as *Metis ignaea halmyricola, Mesochra xenopoda* and *Laophonte similis* (Claus) lived there. The salinities in these lagoons, even if they change over periods of several years, are at least not subject to the seasonal fluctuations which so deeply influence the open sea of the Rumanian coast. It may also be anticipated that the low salinity which depopulated completely the phytal biotope of Tuzla, did not alter the purely marine fauna of its soft bottoms where *Enhydrosoma sordidum, Harpacticus flexus, Stenhelia elisabethae* and *Asellopsis sarmatica* live.

Many species which in other, "normal" seas are found also among the phytal fauna, in the Black Sea moved to the soft bottoms and are found there exclusively. Such are *Parathalestris harpactoides* (Claus), *Robertgurneya similis, Amphiascella subdebilis, Stenhelia elisabethae* and *Ameira parvula,* etc.

This change in biotic preferences is a consequence of the fact that the meiofauna of the soft bottoms is less influenced by brackish conditions than that of the phytal. Remane (1958) who reported upon this phenomenon did not explain it. A recent study by Callame (1960), however, gives the possible key to this problem. This author stated that when a sediment containing salt water is covered by fresh water, diffusion is very slow and is carried out only by gradual molecular transport. Callame considered therefore that "...the preservation of the marine environment within the estuarine sediments, enables the burrowing species to advance to stations which are periodically covered with fresh water". The stability of this marine environment within the sediments increases with decreasing grain size.

It seems possible that many of the small meiobenthonic animals are thus able to survive during the relatively short periods of lowered salinity, by burrowing in the sediment. The species bound to the phytal are not able to escape from the influence of low salinity, while a number of more euryekous phytal dwellers left the phytal in the Black Sea to survive within the level bottoms.

The community of the eulittoral sands is composed of the three highly characteristic circumeuropean species of this biotope: *Ectinosoma herdmani, Canuella perplexa,* and *Harpacticus flexus.* As shown in a previous paper (Por, 1960a) *Harpacticus flexus* prefers the quieter, deeper horizons of the eulittoral sands.

A second community, formed of *Canuella furcigera, Asellopsis sarmatica*

and *Enhydrosoma sordidum* is found on the sublittoral sandy muds and corresponds to the circumeuropean *"Asellopsis"* sands.

At some 15 to 18 metres the bottom becomes muddy, and here a third community is found, formed of *Microarthridion littorale, Nannopus palustris, Stenhelia palustris,* and again *Canuella furcigera* and *Enhydrosoma sordidum.* This community has apparently no parallel in the Mediterranean, perhaps only in the northern seas. Here the euryhaline species which can also be found in the lagoons and estuaries are predominant.

Below 20 metres in the *Mactra-Venerupis* muds (Bacescu, 1961) the fauna is basically different; although some of the above species are also found, the community is essentially composed of *Paramphiascopsis longirostris, Haloschizopera pontarchis, Enhydrosoma sordidum, Enhydrosoma sarsi, Normanella mucronata, Normanella serrata* and *Cletodes tenuipes.* At this depth at which the periodical influence of the Danube flow is already insignificant, and as the more important factor, the temperature, is near to a more or less constant 8° C, several other stenohaline and cold water species appear: *Asellopsis bacescui, Rhizothrix pubescens, Stylicletodes longicaudatus, Stenhelia reflexa, Ectinosoma brevirostre, Laophonte longicaudata,* etc. Several of these species have probably a northern origin.

The largest biocenosis of the Black Sea, and also the deepest of all, is the *Modiolus phaseolinus* community, found between 50 and 120 m (Bacescu, 1961), and according to Caspers (1957) down to 185 m. This biocenosis has the most interesting Harpacticoid fauna. Caspers (1957) is evidently wrong in stating that: "... the other animals of this zone [i.e. besides *Modiolus*] are less characteristic; they tend to be euryekous mud-dwelling forms which are present also in the shallow water muds". On the contrary, this biocenosis is characterized by peculiar deep-water harpacticoids such as *Typhlamphiascus confusus, Eurycletodes latus, Eurycletodes parasimilis, Heteropsyllus dimorphus* and *Hemimesochra atargatis,* which are never found in the shallower muds. Some species of the *Mactra-Venerupis* cenosis (but not of the shallow muds) are present here too: such are *Paramphiascopsis longirostris, Haloschizopera pontarchis, Normanella mucronata* and *Stylicletodes longicaudatus.* The limit of the benthic life is reached within this zone. *Paramphiascopsis longirostris,* at 140 m is the deepest recorded Harpacticoid of the Black Sea, while *Eurycletodes latus* has been found at 124 m. It must be stressed, however, that Bacescu (1961) reported Nematoda, Polychaeta and the Tanaidacean *Apseudes* from between 175 and 200 m. It is therefore highly probable that Harpacticoida too, are able to live at such depths which are already very poor in oxygen and heavily infested by H_2S.

Let us deal now with another phenomenon which, according to Remane (1958), characterizes the distribution of marine animals in brackish basins. It is the so called brackish submergence. A comparative table (table 7) gives the depth ranges of some Black Sea species against the depth range of the same species as summarized by Lang (1948). If, again following Remane, we distinguish an upper submergence, a basal submergence and a total submergence, our conclusions on upper submergence must always be more reliable, since the littoral zone is the best known of all.

TABLE 7

Comparative depth ranges of some Pontic Harpacticoida. The data in the last column are taken from Lang, 1948

	Black Sea	Other seas
Stenhelia reflexa	down to 94 m	down to 54 m
Ameira parvula	down to 68 m	"only in shallow water"
Eurycletodes latus	40—124 m	at about 30 m
Canuella perplexa	down to 46 m	down to 15 m
Ameira scotti	below 40 m	below 15 m
Typhlamphiascus confusus	below 60 m	below 15 m
Cletodes tenuipes	below 20 m	below 2 m
Dactylopodella flava	at about 60 m	eurybathic species, also in beach pools
Enhydrosoma sarsi	below 20 m	below 4 m
Bulbamphiascus imus	below 30 m	also in eulittoral algae
Paramphiascopsis longirostris	20—140 m	5—90 m
Amphiascella subdebilis	20—124 m	shallow depths, among algae
Stenhelia elisabethae	below 20 m	eulittoral algae

It seems, however, that many of the cases of submergence in the Black Sea are mainly due to the thermic factor and in a lesser degree to the salinity. *Cletodes tenuipes,* a littoral species of the northern seas which is lacking in the Mediterranean, is found in the Black Sea at a depth of 20 m, it is thus probable that the temperature factor was the determining one for its survival at this depth. On the other hand, in the case of *Typhlamphiascus confusus,* a species facing succesfully the high temperatures of the shallow zones on the Levantine coast, the decisive cause of its submergence in the Black Sea seems more likely to be the salinity factor.

Let us add two peculiar examples at the supraspecific level.

Asellopsis bacescui is found in the Black Sea at unusual depths for a species of *Asellopsis,* viz., between 25 and 45 m in pure mud. The closely related Mediterranean species *Asellopsis dubosqui* Monard and *Asellopsis penicillata* n. sp. as well as the Atlantic *Asellopsis hispida* Brady & Robert-

son are always found in shallow water only, in sandy mud. In the Black Sea this specific "*Asellopsis* community" is settled by an endemic and probably Sarmatic species, *Asellopsis sarmatica* Jakubisiak, which is less sensitive to lowered salinities, while *Asellopsis bacescui* withdrew to greater depths.

Eurycletodes parasimilis Por of the Black Sea is only found at depths below 48 metres, while the very closely related temperate-Atlantic and Mediterranean *E. versimilis* Willey and the North Atlantic *E. similis* (T. Scott) are found close to the shores.

Concluding, we must refer to an interesting phenomenon related to species considered as belonging to the interstitial fauna, although we did not study the sandy beaches, the specific biotope of the interstitial fauna. Surprisingly we found some of these species at unusually great depths and in pure mud. So *Paramesochra herdmani* was repeatedly found at 20, 31 and even 60 metres, and *Leptastacus laticaudatus* Nicholls and *Psammopsyllus operculatus* Nicholls, at 67 metres depth in the pre-bosphoric area (station 686 of the Rumanian Hydrobiological Commission); these were the dominant species. *Leptastacus* was even found at the surprisingly high density of about 2100 specimens per square metre. Otherwise the biocenosis of this pre-bosphoric sample was a typical "*Typhlamphiascus confusus* community".

The only possibility of explaining this phenomenon is the assumption that, in the beach sediment, the interstitial fauna seeks, among other conditions also the brackish one, resulting there from the mingling of the marine with the continental phreatic waters. Such brackish conditions are found everywhere in the Black Sea. On the other hand, the salinity of the interstitial biotope of the Black Sea may be already to low for several worldwide interstitial species (here fresh waters are mingling with already brackish waters) which therefore left for deeper levels. This assumption can perhaps also explain the fact that, until now, very few interstitial species have been reported from the littoral sands of the Black Sea.

7. The zoogeographical relations of the Pontic Harpacticoida

The first problem posed by every Pontic zoogeographical study is that of the Sarmatic (or Caspian) brackish relicts. It is known that in several animal groups, such as Cladocera, Mysidacea, Lamellibranchia, fishes, etc., a rich and peculiar fauna, adapted to the brackish Sarmatic conditions, evolved sometime during the Pliocene or during the successive phases of separation of this basin. This fauna withdrew to the estuaries as soon as the salinity in the Black Sea increased following the opening of the Bosphorus contact.

Among the Harpacticoida the Sarmatic element is surprisingly small.

Only *Limnocletodes behningi* Borutzki, an estuarine species found in both the Black and Caspian Seas, which species also enters the rivers, is such a relict. The only other species of this genus, *Limnocletodes secundus* Sewell is known from brackish waters of the delta of the Ganges. *Limnocletodes* is therefore undoubtedly a genus which once lived in the Tethys, perhaps already in brackish lagoons. Of the other species of the limans of the Black Sea, only *Schizopera grimalschii* Jakubisiak or *Tisbe histriana* Marcus & Por can perhaps be considered sarmatic forms. *Nitocra fallaciosa* Klie and *Robertsonia monardi* (Klie), both described from Pontic estuaries, are known now also from other seas. As shown in the chapter on the ecology of the Pontic Harpacticoida, perhaps *Asellopsis sarmatica* can be considered an autochthonous Sarmatic species. The rest of the species found in the brackish and oligohaline estuaries and lagoons are widespread oligohaline and euryhaline species such as *Ectinosoma abrau, Nannopus palustris, Microarthridion littorale, Nitocra lacustris, Nitocra hibernica* or *Onychocamptus mohamed.* It seems that these species were already present in the past oligohaline phases of the Black Sea. However great their ecological valence, it seems impossible to assume that in so short a period (geologically speaking) as has passed since the withdrawal of the pleistocene glaciers, they succeeded in settling down and eliminating the hypothetical autochthonous Sarmatic forms.

The problem can, presumably, also be posed in the opposite sense — chiefly for *Cletocamptus confluens* (Schmeil) — but also for other species: to what extent could some widespread European oligohaline species such as *Ectinosoma abrau, Nannopus palustris, Nitocra hibernica* etc., be old Sarmatic species which spread out from the Sarmatic basin. Such examples of "more visible" Sarmatic immigrants in Europe, which are even now enlarging their area westwards are *Cordylophora caspia* (Pallas), *Dreissena polymorpha* (Pallas), *Corophium curvispinum* Wundsch and other species listed by Thienemann (1950). This author even considered that a very large percentage of the postglacial fresh water fauna of Europe has a Ponto-Caspic origin.

The Caspian Sea is inhabited by several species which are indeed remnants of the Sarmatic brackish water fauna, such as *Nitocra hibernica incerta* Richard, *Ectinosoma barroisi* Richard, *Ectinosoma concinum* Akatova and *Schizopera neglecta* Akatova. It is interesting to note that the first two species are found also in Lake Tiberias in Israel, while *Schizopera neglecta* also lives in brackish waters along the Israel coast. All these species are definitely members of a tertiary brackish fauna of the Near East which of course also settled in the Caspian Sea.

While the Sarmatic element is very poor among the Harpacticoida, the northern species are well represented as a peculiar relict fauna. In characterizing the fauna of the Black Sea, Ekman (1953) overlooked this element. However, the Russian and Rumanian authors emphasized the presence of this element more than once. Sovinski (1904) stated that "... the Black Sea selected from the Mediterranean fauna those elements which once lived there during the glacial periods". Zenkevich (1951) even considered that "... the fauna of the Black Sea has a relict, psychrostenothermic character". This latter statement may be somewhat exaggerated, the phenomenon itself, however, is a real one and is supported by our findings.

The 18 species which have a discontinuous borneo-pontic range must be considered to be elements which entered the Black Sea in a cold period, at a time when they still lived in the Mediterranean. Since the great majority of these species are dwellers of the sublittoral muds characterized by constant and low temperatures — they must be considered northern elements.

The relict character of such species as *Stenhelia palustris*, *Stenhelia proxima*, *Cletodes tenuipes*, *Eurycletodes latus*, *Enhydrosoma sarsi* and *Laophonte longicaudata* seems highly probable. *Cletodes tenuipes* a species inhabiting also the high Arctic zones, is found in the Black Sea at not too great depths, and so is *Stenhelia palustris* a species which reaches the Arctic circle. Both species are almost certainly lacking in the Mediterranean. As to *Eurycletodes latus*, one of the dominant species of the deep muds in the Black Sea, a species which also reaches Arctic latitudes, it seems to be replaced, at least in the Levantine basin, by two other species of *Eurycletodes*: *E. oblongus* and *E. ephippiger*.

Another interesting case in this connection is that of *Heteropsyllus dimorphus* Por, a Pontic species and one of the dominants of the deep muds there. The genus *Heteropsyllus* was known hitherto only from the boreo-arctic zone. Among the numerous bathyal species which we found in the Levantine Sea, we did not find any species of *Heteropsyllus*. The permanent "subarctic" temperatures of the deep Pontic layers enabled such glacial relicts to survive.

We cannot close the list of the most interesting coldwater forms without adding *Paramphiascopsis longirostris*, a species which Lang (1948) placed in the peculiar Circumpolar-Mediterranean group, and which is found in great numbers in the sublittoral muds of the Black Sea, down to the greatest inhabited depths, but not above the 20 metre limit; this depth already appeared several times in our discussion since it seems to be the upper limit of the cold water species.

As to the time at which the immigration of these cold water relicts into

the Black Sea occurred, there are two possibilities: either the Uzunlarian period or the late Würm glaciation. It is, of course, easier to suppose that this immigration took place during the second phase of this last glaciation, together with that of *Modiolus phaseolinus*, the clam which characterizes the biocenosis in which most of these relicts live. But the possibility of an earlier Uzunlarian immigration must be taken into account, at least for the peculiar Pontic forms like *Heteropsyllus dimorphus*, *Esola typhlops pontoica* and *Hemimesochra atargatis*. Such Uzunlarian immigrants had to endure two heavy oligohaline periods during the penultimate and the last glaciation period and also the warm period during Tyrrhenian II. But perhaps, as supposed by some authors, the abiotic level was then much deeper than it is today and some species could escape to these great depths. At any rate, these difficult conditions and the time which since passed, are perhaps the elements which determined these peculiar Pontic endemisms to be formed.

The small differences observed in the Pontic specimens of *Cletodes tenuipes* and *Eurycletodes latus* (cf. Por, 1959) are of less than subspecific degree and for their appearance did not need a long period of isolation, as did the other cases dealt with above. In such cases a late-Würmian origin is a satisfactory and more probable hypothesis.

The dominant zoogeographic group within the Pontic Harpacticoida is formed by the so called "Atlantic" species with a more or less circumeuropean range. The majority of these species undoubtedly settled in the Black Sea after the breakdown of the Bosphorus isthmus. But there are indications that some of such species entered the Pontic basin at earlier times. Some of the Pontic species belong to peculiar "Artenkreise" in which one of the species is North Atlantic, the other Mediterranean and the third Pontic: in all these cases, the Pontic species is somewhat intermediate between the other two. Such Artenkreise are:

North-Atlantic	Black Sea	Mediterranean
Asellopsis intermedia (T. Scott)	*Asellopsis bacescui* Por	*Asellopsis dubosqui* Monard *Asellopsis penicillata* Por
Normanella minuta Sars	*Normanella serrata* Por	*Normanella semitica* Monard
Haloschizopera junodi (Monard)	*Haloschizopera pauciseta* Por	*Haloschizopera marmarae* Noodt
Eurycletodes similis T. Scott	*Eurycletodes parasimilis* Por	*Eurycletodes versimilis* Willey

In all these cases it seems more probable that the Pontic species originated from the common Atlantic ancestor, before it gave rise to the Mediterranean

species. The other explanation needs the intervention of a phenomenon of convergence.

On an infraspecific level, the case of *Stylicletodes* from the Black Sea is very indicative in this connection. The Pontic specimens were considered by us as belonging to the North Atlantic *Stylicletodes longicaudatus,* but they have also some characters of the Mediterranean *Stylicletodes numidica* Monard, found in the western and eastern Mediterranean. In this case the differentiation of the Pontic population did not reach the specific level.

The above cases are arguments for the hypothesis that the immigration of the Atlantic elements is, at least partly, an older phenomenon, since a post-Würmian immigration seems too late to allow for the formation of local species.

Another phenomenon, interesting to follow in the Atlantic immigrants of the Black Sea, is the so called "Atlanticization" of Sovinski (1904) : species which have normal sizes in the Atlantic show populations with small body sizes in the Mediterranean, and again reach normal dimensions in the Black Sea. Some examples were given from among the Harpacticoida in a previous paper (Por, 1960a). This "Atlanticization" of the body length is perhaps the principal cause owing to which we did not find in the Black Sea a "brackish dwarfism" like that recorded by other authors from the Baltic.

The case of the last zoogeographical group, the Mediterranean species which entered the Black Sea is much clearer. It is a very recent immigration, since in none of the cases did it lead to the appearance of morphologically distinct Pontic populations. The vanguard of this postglacial immigration was probably formed of the Lusitano-Mediterranean species, more adapted to low temperatures: *Amonardia similis, Amphiascella brevifurca, Mesochra xenopoda, Mesochra armoricana, Enhydrosoma sordidum,* and *Heterolaophonte uncinata.*

There are very few true Mediterranean species in the Black Sea: of the 79 Mediterranean endemics listed by Lang (1948), only 8 are now known in the Black Sea. None of the 9 endemic genera of the Mediterranean is found in the Black Sea. If the more stenohaline regions of the Black Sea will be studied, this small percentage will probably increase somewhat. The life conditions in the Black Sea are radically opposed to the Mediterranean conditions which determined the formation of these Mediterranean endemics.

Although very recent, it seems probable that the immigration belongs to the postglacial warm period, and that it has now stopped.

Only very few true Mediterranean species are distributed today over the more brackish north-western part of the Black Sea: such are *Heterolaophonte curvata, Robertsonia monardi, Mesochra heldti,* and the sublittoral *Halo-*

schizopera pontarchis and *Stenhelia elisabethae*. The other Mediterranean species are bound to the more saline Crimean coast and probably to the Caucaso-Anatolian coast.

Since the Crimea is isolated from both sides by regions with low salinity waters, it must be supposed that the Mediterranean species passed these low-salinity regions at a time that the salinity was there higher and more constant.

Since the Mediterranean species of Harpacticoida are mostly bound to the phytal, we did not find any additional Mediterranean species in the deep samples which we had from the pre-bosphoric region, a region influenced by the inflowing deep waters of the Mediterranean. In the Ostracoda Caraion (1959) found here some Mediterranean species which are apparently ready to spread over the whole Black Sea as soon as conditions will become favorable.

SPECIAL SECTION

This section contains the diagnoses and discussions of Levantine genera and species which are either new, imperfectly known, or otherwise interesting. Furthermore, descriptions in English are now provided for eight Pontic species and one subspecies, which were described as new in a previous paper (Por, 1959), and the diagnoses of which were then given in Rumanian.

In the arrangement of the material Lang's (1948) monograph is followed.

Unless otherwise stated, the enlargement of the figures of the accompanying plates is × 100.

CANUELLIDAE

Canuella longipes (Thompson & A. Scott, 1903) (pl. 1 fig. 1-5)

Material examined. — A great number of females and males from stations 36, 38, 39, 67, 68, 69, 91, 92, 96, 97, 99, 103, 104, 110, 111, 129, 136, 137, 140, and 141.

Length. — 0.90-1.40 mm; reported length: 1.50 mm.

Ecological preferences. — Sublittoral muddy-sands and muds; also bathyal.

Remarks. — The male of this species has not yet been described. The sexual dimorphism appears in the male in the fourth leg: the internal seta of the first endopodite segment is modified into a heavy spear-like spine conspiciously ending with a filament. The two external spines of the last endopodite segment are also modified. Sexual dimorphism in the fourth leg is an exception in the Harpacticoida. No dimorphism is found in the legs

of the other known *Canuella* species (but see below under *Canuella reichi*).

The peculiar spine in the basal third of the inner furcal edge is also modified in the male: it is here a seta.

The genital field of the male has well developed structures. The two chitinized filaments which emerge from between the genital opercles almost
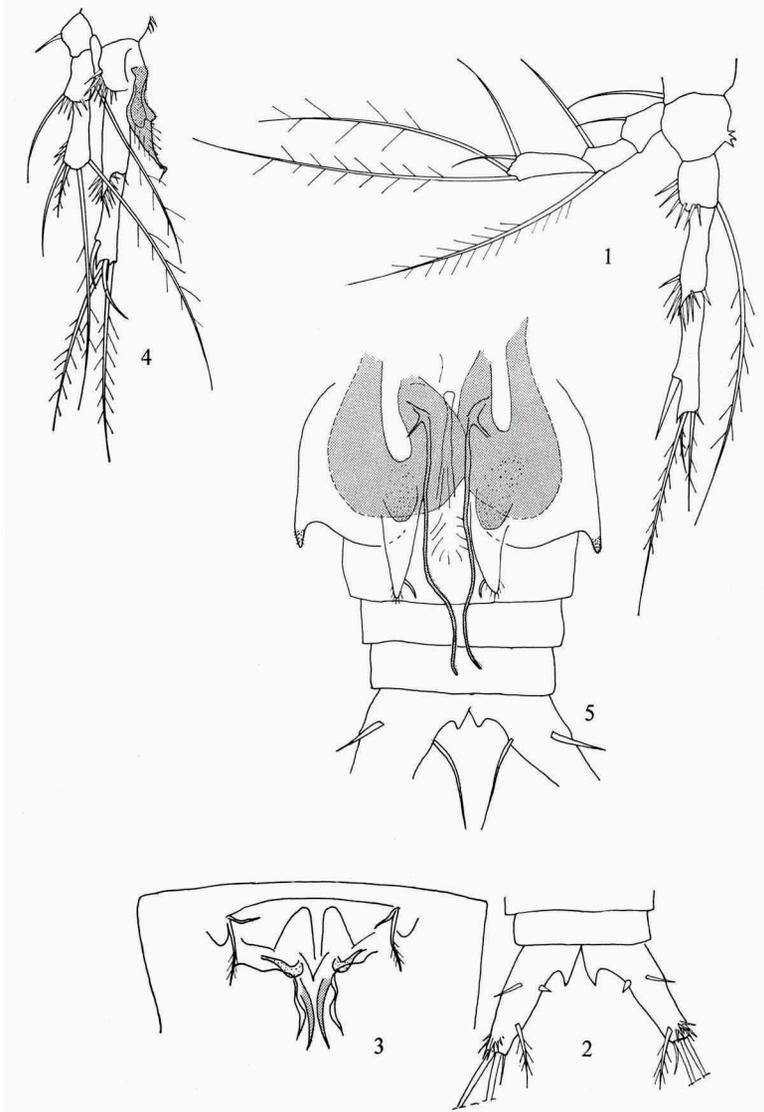
Plate 1, fig. 1-5. *Canuella longipes* (Thompson & A. Scott). 1, P IV of female: 2, furca of female; 3, genital field of female; 4, P IV of male; 5, furca of male.

reach the furca. Otherwise, the structure of the genital field of the male is typical for the genus. The same is true for the female genital field, which has the usual dimensions.

Canuella reichi n. sp. (pl. 2 fig. 6-13)

Material examined. — 2 ♀ and 1 ♂ from stations 93, 138, and 149. The syntypes are preserved in the Zoology Department of the Hebrew University under no. COP. 2.

Length. — ♀, 1.00 mm; ♂, 0.97 mm.

Ecological preferences. — Bathyal muds.

Description. — ♀. Body very slender (width 0.12 mm). First thoracic segment separated from the cephalothorax. The last abdominal segment bears minute marginal setae as well as the operculum. The furcal branches are three times longer than wide and have an obvious longitudinal furrow on the ventral side. In the middle of the length there is a strong, short internal spine.

The antennula seems to be formed of only 5 segments. The exopodite of the maxillula is represented by 2 setae.

The armature of the legs is as follows:

	Exopodite	Endopodite
P I	0.1.022	1.1.212
P II	0.1.121	1.1.112
P III	0.1.121	1.1.022
P IV	0.0.121	1.0.112

The rudimentary fifth leg bears 4 setae. The genital field is as shown in pl. 2 fig. 9.

♂. The armature of the furca shows the dimorphism already mentioned for *Canuella longipes*: the internal spines of the female furca are replaced by simple setae in the male. The seven-segmented antennula is shown in pl. 2 fig. 11. The dimorphism of the second leg is remarkable: here the internal setae of the median endopodite segment of each side form a peculiar pincer.

The male and female genital fields have very reduced dimensions, but are clearly of the *Canuella* type. The colour of both females and males is a dark brown.

Discussion. — In our opinion the separation of the genera within the Canuellidae, as it appears at present is not yet a definitive one. According to the armature of the legs, our species should be placed in the genus *Brianola* Monard; but the armature of the PI exopodite is even more reduced. In
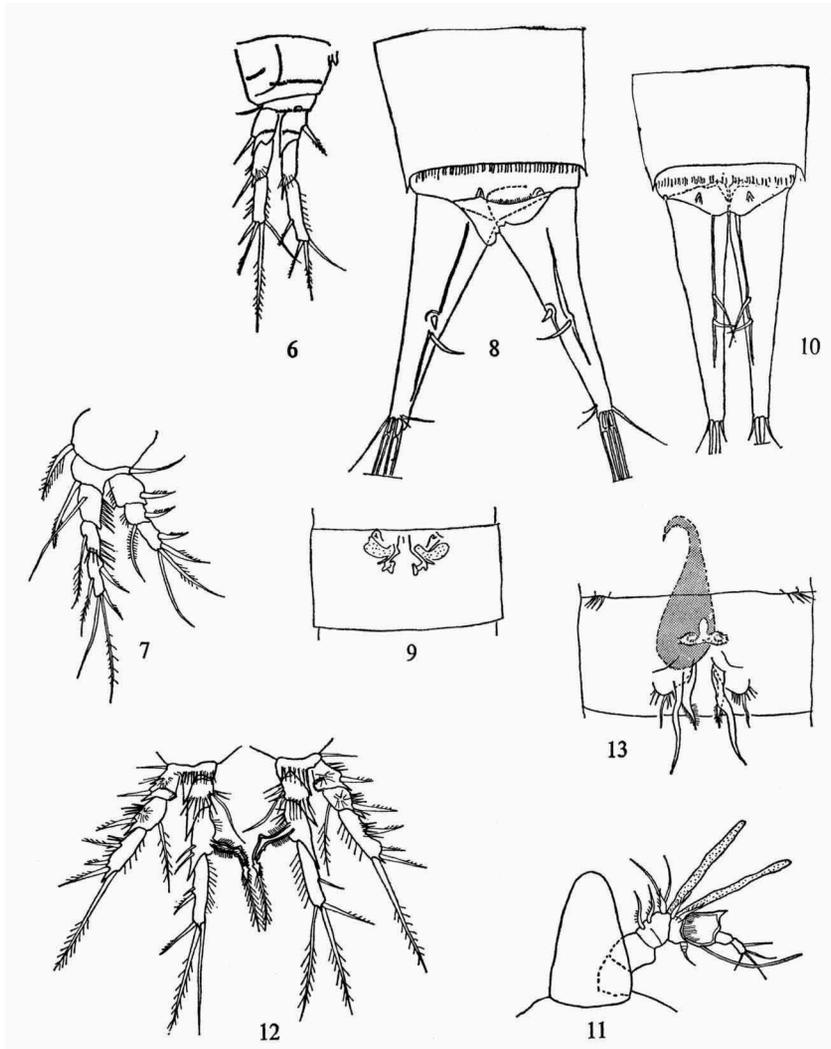
Plate 2, fig. 6-13. *Canuella reichi* n. sp. 6, P IV of female; 7, P I of female; 8, furca of female; 9, genital field of female; 10, furca of male; 11, A I of male; 12, P II of male; 13, genital field of male.

Brianola, a monotypic genus, the first thoracic segment is fused to the head and there are also other differences from our new species (the antennal exopodite is seven-segmented, the epipodite of the maxillulae is represented by 3 setae, etc.). The affinities of the new species with *Canuella* are supported by the shape of the genital fields, the presence of the knob-like spine on the furca of the female (and its dimorphic feature in the male; see *Ca-*

nuella longipes) and by other characters, e.g., the separate first thoracic segment. The dimorphism of PII points towards *Sunaristes* Hesse. It would be perhaps more correct to consider *Canuella reichi* a transitional species between *Canuella inopinata* and *Brianola*.

Brianola stebleri (Monard, 1926) (pl. 3 fig. 14-16)

Material examined. — 12 ♀ and 3 ♂ from stations 99, 110 and 136.

Length. — ♀, 0.95-1.04 mm; ♂, 0.75 mm; reported length: ♀, 0.9-1.05 mm.

Previous records. — France (Roscoff, Cette), Algeria (Castiglione), Tunisia (Salammbo).

Ecological preferences. — A phytophile mud species of the sublittoral.

Remarks. — The male has not been reported upon before, therefore we present here the features of its genital field, which is quite different from the genital field of species of *Canuella*. The antennulae are very short, with short and clumsy aesthetasks. No dimorphism in the structure of the legs could be observed. It must, however, be stressed that in the males examined PV had only four setae instead of five.

Sunaristes bulbosus n. sp. (pl. 3 fig. 17-21, pl. 4 fig. 22-26)

Material examined. — 2 ♀ and 2 ♂ from station 37. The syntypes are preserved in the Zoology Department of the Hebrew University under no. COP. 3.

Length. — ♀ and ♂, 0.89-0.90 mm.

Description. — ♀. The rostrum is very broad and prominent. The first thoracic segment is fused to the cephalothorax. The suture of the genital segment is well developed. The edges of the abdominal segments and of the operculum bear no setae. The furcal branches are only 1.5 times longer than broad and bear two peculiar bulbose superficial setae near the inner distal corner.

The antennula is formed of six vaguely delimited segments, the first of which shows an external distal spur. The exopodite of the antenna is formed of 7 segments. The exopodite of the mandible is composed of two segments. The epipodite of the maxillula is represented by 2 setae.

The armature of the swimming legs is a follows:

	Exopodite	Endopodite
P I	0.1.223	1.1.023
P II	0.1.223	1.1.212
P III	0.1.122	1.1.121
P IV	0.1.121	1.0.112
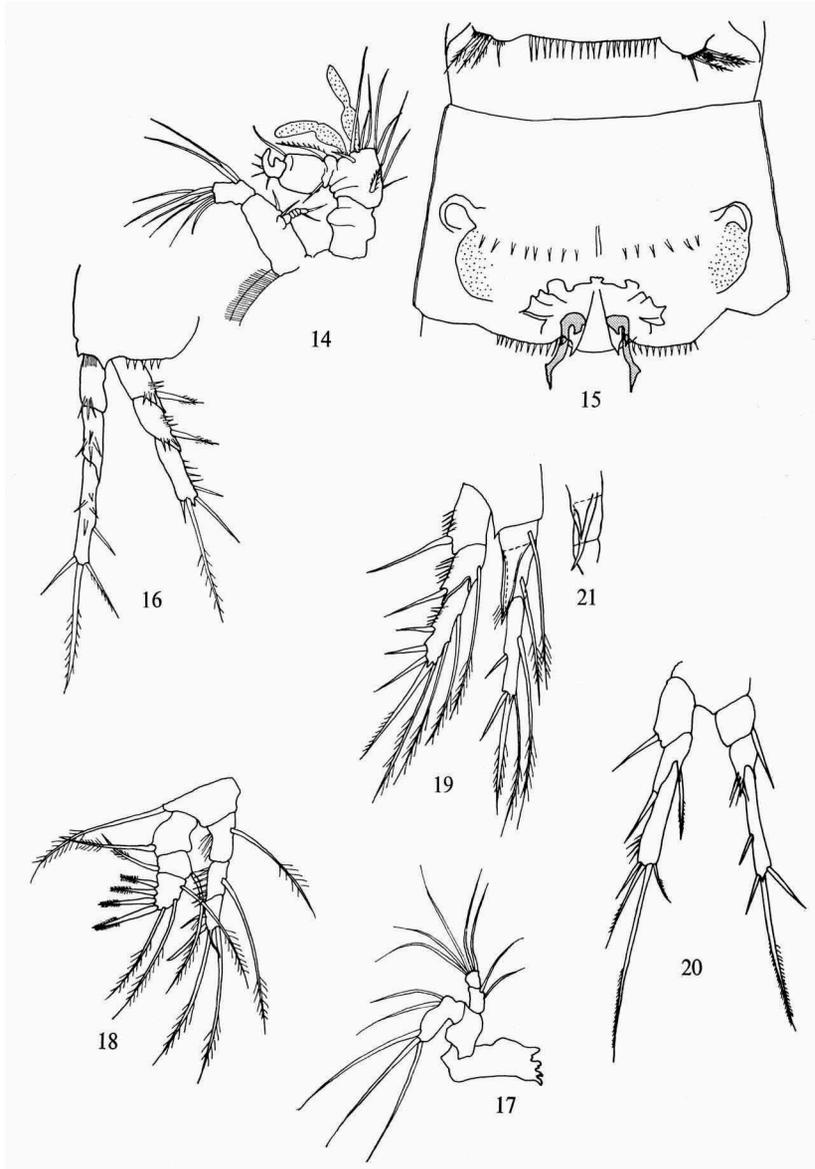
Plate 3, fig. 14-16. *Brianola stebleri* (Monard). 14, A I and A II of male; 15, genital field of male (× 50); 16, P IV of female.
Fig. 17-21. *Sunaristes bulbosus* n. sp. 17, mandible; 18, P I of female; 19, P II of female; 20, P IV of female; 21, spine of P II of male.

The first segment of the endopodite of PII forms a strong inner spine. PV bears four setae.

The genital field has a structure resembling that of *Canuella*, being almost similar to that of *Canuellina insignis* Gurney.

♂. The inner spine of the endopodite of PII is more slender and curved than in the female. No other dimorphic character was found in the legs. The peculiar structure of the last claw-like segment of the antennulae (pl. 4 fig. 23) must be emphasized. The genital field is very similar to that of *Sunaristes*.

Discussion. — The close relation to *Sunaristes paguri* Hesse is evident if we consider the armature of the swimming legs (though the terminal segments of the endopodites of PIII and PIV bear four setae instead of three) and the genital field of the male. But there are also some affinities with *Canuellina insignis* Gurney (the shape of the segments of the legs, the female genital field, the seven-segmented exopodite of the antenna). Specific characters are, apart from the armature of the legs, the spine on the first antennular segment, the three-segmented mandibular exopodite and the bulb-like setae on the exceptionally short furcal branches. It is thus difficult to decide the generic status of our species, but the relationship to *Sunaristes* seems to be closer.

Both egg-bearing females and ripe males were found living free in the muddy bottom.

CERVINIIDAE
Cervinia bradyi Norman, 1878 (pl. 4 fig. 27-29)

Material examined. — 3 ♀, 1 ♂ and 2 copepodites from stations 93, 104, 139 and 149.

Length. — ♀, 1.08-1.20 mm; ♂, 0.85 mm; reported length: ♀, 1.40-1.50 mm; ♂, 1.20 mm.

Previous reports. — Faroes, Norway, Sweden, Scotland, Naples.

Ecological preferences. — Bathyal muds.

Remarks. — No differences could be observed in our females when compared with the descriptions given by Sars and Lang. We add an illustration of the female genital field of this species, which as far we know has not yet been figured.

The peculiar dimorphic hair cover of the male abdomen is noteworthy. This pubescence appears on the figures provided by Sars but was not mentioned in the diagnosis given by Lang. In the female the abdomen is smooth while the furca is hairy. The dimorphism of the maxilla is treated below.

It is interesting that in our male — though showing a ripe spermatophore
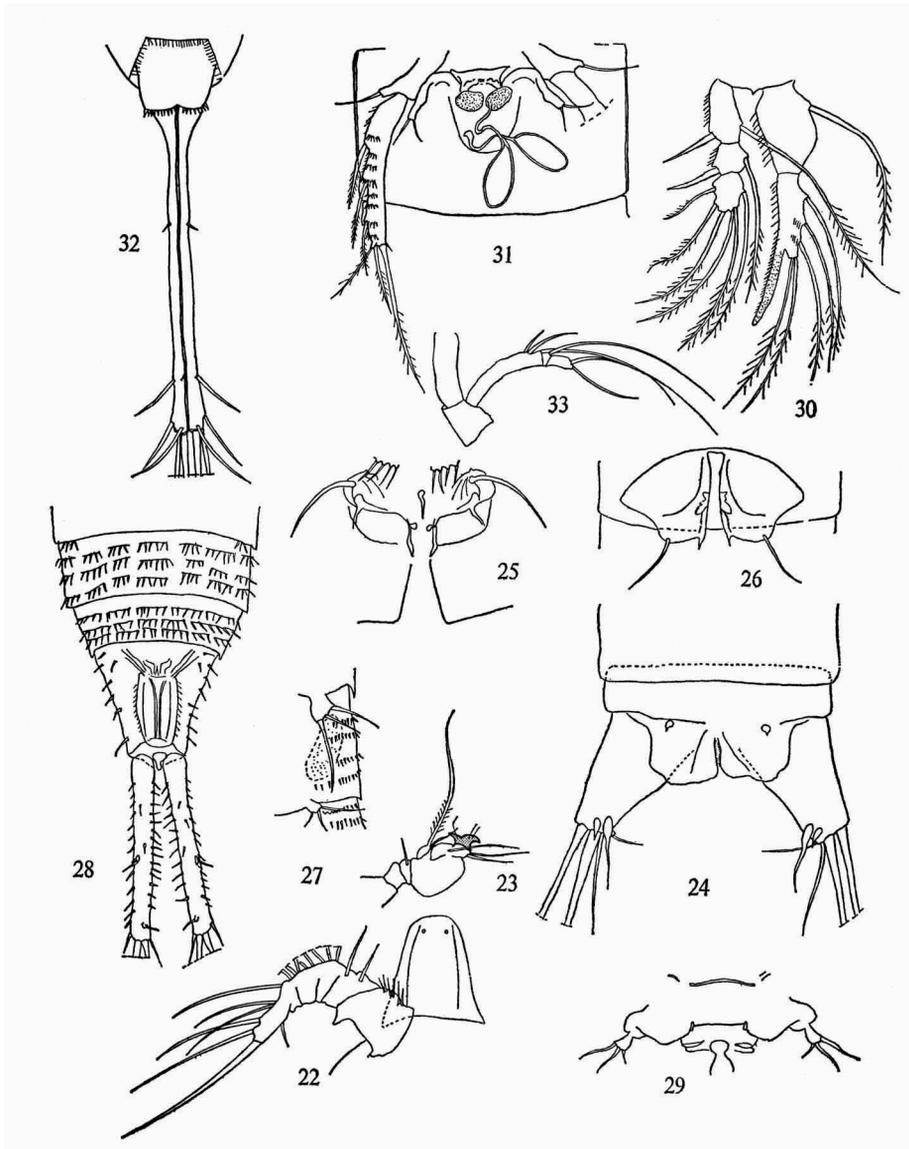
Plate 4, fig. 22-26. *Sunaristes bulbosus* n. sp. 22, A I of female; 23, A I of male; 24, furca of female; 25, genital field of female; 26, genital field of male.

Fig. 27-29. *Cervinia bradyi* Norman. 27, P V and P VI of male; 28, furca and last abdominal segment of male; 29, genital field of female (× 200).

Fig. 30-33. *Hemicervinia stylifera* (I. C. Thompson). 30, P I of female; 31, genital field of female; 32, furca of female; 33, exopodite of A II.

— the fifth leg is reduced and only uni-articulated. In the typical males, this leg is bi-articulated and the basal segment bears a hair.

Discussion. Giesbrecht (1900) reported this species from Naples. In this connection Lang (1948) wrote: "...der Fund Giesbrechts aus dem Mittelmeer stammt ganz sicher aus einer Tiefe wo die Temperatur nicht $13°-14°$ übersteigt". — Such depths are difficult to find in the Mediterranean. The lowest temperature in the Levantine basin at depths exceeding 2000 metres is still $13.60°$. At a depth of 75 fathoms at which we already found *Cervinia bradyi*, the temperatures sometimes come close to $20°$.

Hence *Cervinia bradyi*, despite the increased temperature, keeps in the Mediterranean to the depth range which it occupies in the northern seas. We found it between 140 and 500 metres; reports from the northern seas show a depth range between 40 and 286 m. Some physiological adaptation against an increased metabolic rhythm in the sense shown by Thorson (1957) must therefore exist. The smaller size of our mature specimens and perhaps the rudimentary fifth leg of the male possibly show the effects of a more accelerated development.

Hemicervinia stylifera (I.C. Thompson, 1893) (pl. 4 fig. 30-33)

Material examined. — 1 ♀ from station 139.

Length. — 0.94 mm; reported length: ♀, 1.20 mm (Lang), 0.6 mm? (Thompson).

Previous reports. — Irish Sea (Isle of Man), Sweden (Gullmarfjord).

Remarks. — The present species is best known as *Herdmania stylifera* I. C. Thompson. As, however, the generic name *Herdmania* I. C. Thompson, 1893, is preoccupied by *Herdmania* Lahille, 1888 (Tunicata), the oldest available synonym of *Herdmania* I. C. Thompson, viz. *Hemicervinia* Lang, 1935, has to be used for the present genus.

Though we only have a single female at our disposal, it is possible to add some data to the recent description of the species by Lang (1948), which description was also based on a single specimen. The differences from the type description shown by our specimen are perhaps due to the incompleteness of the former.

The rostrum is like that described by Lang; also the furcal rami agree quite well with his description. The fringe of spines on the last abdominal segment and the minute setae on the operculum, found in our specimens, are quite characteristic.

The antennula is 8-segmented and actually shows a small spur-like prominence on the first joint. The allobasis of the antenna bears the two setae referred to by Lang. The exopodite, however, is formed by 3 segments only,

5

instead of by 4 segments which according to Lang is characteristic for the Cerviniidae. In a northern specimen of the present species in Lang's collection, however, I found also a specimen with a tri-articulated exopodite. This point in the diagnosis of the family ought therefore to be modified. The epipodite of the maxillula is actually represented by two setae.

The first leg closely agrees with the existing descriptions — among other things it shows the peculiar digitiform processus of the second segment of the endopodite. The inner setae of the first exopodite and endopodite segments are much longer than in Lang's specimen, though it seems that the seta of the endopodite was either copied by him from Thompson or is hypothetical — since it was torn in his specimen.

The armature of the other legs is identical with the formula given by Lang, with the only difference that the median segment of the endopodite of PIV bears a single seta instead of two. The doubts of Lang as to whether there are five or six setae on PV are answered by the fact that our specimen actually has six setae on this leg. A peculiar feature of this leg in our specimen is the fact that it bears 8 transverse rows of spines.

We also figure the female genital field (with two spermatophores attached) as this has so far not been figured.

Eucanuella langi n. sp. (pl. 5 fig. 34-37)

Material examined. — 3 ♂ from stations 93 and 149. The syntypes are preserved in the collection of the Zoology Department of the Hebrew University under no. COP. 4.

Length. — ♂, 0.92-0.96 mm.

Ecological preferences. — Apparently bathyal muds.

Description. — Our species is closely related to *Eucanuella spinifera* T. Scott, 1900, the only species so far known of this genus. The differences are as follows. The thoracic epimera are very prominent and the edges of the segments are strongly denticulated. The denticulation increases progressively towards the furca, since the edge of the cephalothorax is only slightly sinuous. No such denticulation is found in *Eucanuella spinifera*. The furcal rami of the present species closely resemble those of *E. spinifera,* though in our specimen we did not find the inequality between the length of the right and the left ramus. The two external setae of the furca are very distant from each other. The rostrum is a simple triangular prominence, and in one of the specimens (pl. 5 fig. 36) it has a denticulated tip.

The antennulae is formed of 9 segments instead of 8 and it bears three long, moniliform aesthetasks, and one much shorter supplementary terminal one.
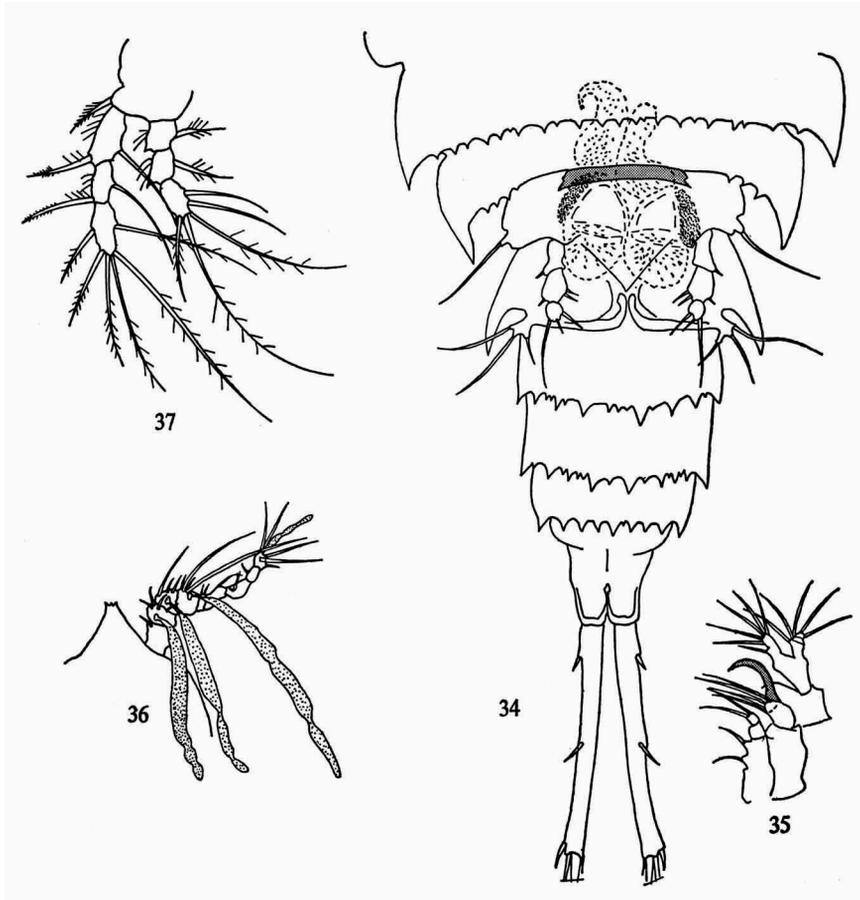
Plate 5, fig. 34-37. *Eucanuella langi* n. sp., male. 34, abdomen and furca; 35, mouthparts; 36, A I; 37, P I.

A peculiar structure of the mouth complex is noteworthy. The mandible is normal, with a tri-articulated exopodite. The maxillula is normal, while the maxilla shows a strong, curved claw on the penultimate segment. After the present description was written I had the opportunity to study the maxilla in specimens of *Eucanuella spinifera* from Dr. Lang's collection. It appears that the claw-like modification of the maxilla is dimorphic in the males only; the maxilla of the female being normal. I found a similar, though much less pronounced dimorphism in males of *Cervinia bradyi* from both the Gullmarfjord and the Israel coast. Nothing similar could be found in the males of *Cerviniopsis clavicornis* Sars.

The armature of the legs is peculiar, as shown by the following comparison of the armature of PI to PIV of the two species:

	P I		P II		P III		P IV	
	Ex.	End.	Ex.	End.	Ex.	End.	Ex.	End.
E. *spinifera*	1.1.123	1.1.111	1.1.223	1.2.221	1.1.223	1.2.321	1.1.223	1.1.221
E. *langi*	1.1.123	1.1.221	1.1.223	1.2.221	1.1.223	1.2.221	1.1.223	1.2.221

As shown here differences are found only in the endopodite of the first, third and fourth legs.

The fifth legs differ considerably from those of *Eucanuella spinifera* as figured by Sars. The basipodite adheres broadly to the segment and is hardly delimited. The last segment has only three weak setae — not four strong spines. The second segment, however, bears three very short appendices instead of the two spines in the nordic species.

The female is unknown.

Discussion. — *Eucanuella spinifera* T. Scott is known from Iceland (63° 56′ N), Norway, Sweden (Gullmarfjord, Väderö, Koster), the Shetland Islands (59° 36′ N) and Scotland (58° 09′ N). Jespersen (1940) found it in Iceland at a depth of 272 m and Lang (1948) reported it from Sweden at a depth of 45 to 240 m. Our species was found at 140 and 170 m, thus at similar depths, though the temperature at these depths off the southern Israel coasts is quite different from that off the subarctic coast of Iceland. The small dimensions of our species are noteworthy (0.92 to 0.96 mm against about 1.30 mm in the northern species).

Askalonia talpa n.g., n. sp. (pl. 6 fig. 38, pl. 7 fig. 40-49)

Material examined. — 27 ♀ and 18 copepodites from stations 93, 138, 139 and 145. The syntypes are preserved in the collection of the Zoology Department of the Hebrew University under no. COP. 5.

Length. — ♀, 0.78-1.06 mm.

Ecological preferences. — Bathyal muds.

Askalonia talpa is the type species of the new genus *Askalonia* and therefore the diagnosis below is both generic and specific.

The aspect of the body is *Cerviniopsis*-like, but the first thoracic segment is completely fused with the cephalothorax (incompletely fused in *Cerviniopsis* Sars, distinct in *Cervinia* Norman). The genital segment shows only a dorsal suture and prominent lateral spines. The abdominal segments have denticulated edges, both dorsally and ventrally. The operculum is smooth. The furcal rami have a variable length but at least slightly exceed the length of the last two abdominal segments. The rami are rather close together.
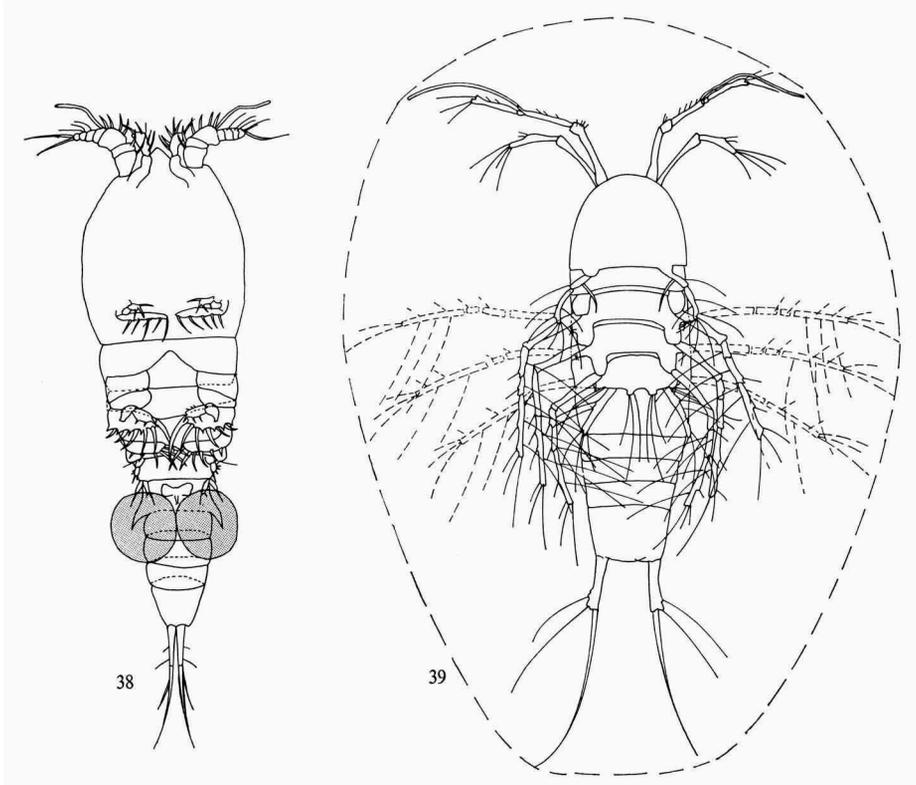
Plate 6. Comparison of the body forms of *Askalonia talpa* n. sp. (fig. 38) and *Anoplosoma stryx* n. sp. (fig. 39); × 50.

The antennula is very robust, like in *Cerviniopsis*, but is formed of 7 segments instead of 6. The third segment is very large and bears together with the much shorter second segment a number of strong spines. The allobasis of the antenna bears only one very long seta; a second seta could not be observed in any specimen, though something like an insertion exists. The exopodite is four-segmented. There are strong claw-like paragnaths. The epipodite of the maxillula is replaced by a small hair.

The legs are highly aberrant. In all four legs the exopodites are formed of a single segment; the endopodite of the first leg is uni-articulated, that of the following two legs is two-segmented, while the fourth endopodite is lacking altogether. The position of the legs is more or less perpendicular to the median line of the body and the surface of the segments is in turn perpendicular to the ventral surface of the body. The two branches of the legs are overlapping at least in the first and second legs. The short and robust
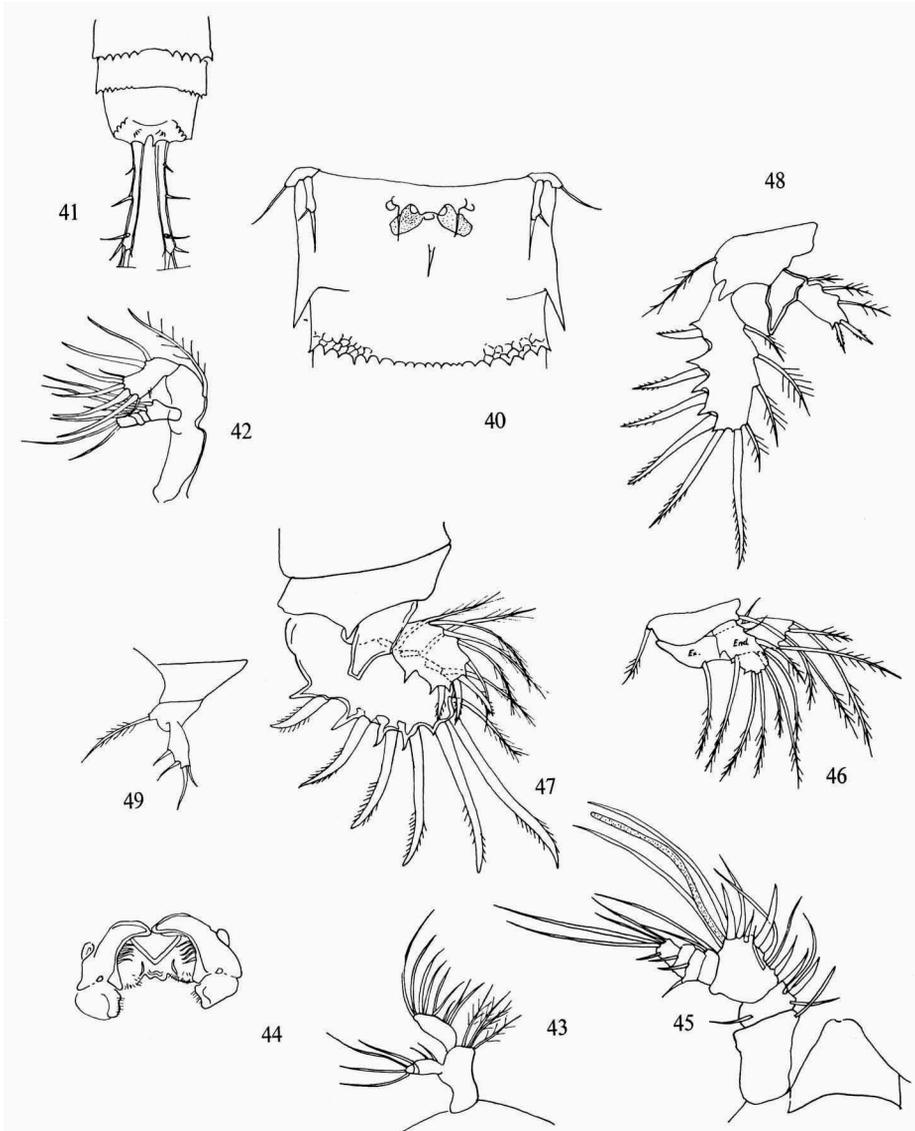
Plate 7, fig. 40-49. *Askalonia talpa* n. sp., female. 40, genital segment and P V; 41, furca; 42, A II; 43, mandibular palp; 44, paragnaths; 45, A I; 46, P I; 47, P II; 48, P III; 49, P IV.

appendages are probably able to carry out digging movements. The external edge of the second and third exopodites (and chiefly of the second) bear strong spines. The external side of the first segments of the respective endopodites are produced into strong spurs, while the external appendices of

the second segments are also strong spines. The fourth leg is rudimentary; it consists of a uni-articulated exopodite without endopodite.

The distal segment of the fifth leg is very elongated and bears two setae. The genital field of the female is shown in pl. 7 fig. 40. The females carried usually only two eggs.

The male is unknown.

Discussion. — There can be little doubt that our new genus is closely related to *Cerviniopsis* Sars. Though there are also other differences which justify the creation of an independent genus, the main feature is the combination of the rudimentary and the highly specialized characters of the legs. We are also tempted to suppose that *Askalonia* derived from *Cerviniopsis* through neotenic mechanisms. On the other hand, however, the uni-articulated exopodites are also highly specialized digging devices. The neoteny could be the result of the influence of unusually high temperatures in the specific habitat (*Cerviniopsis intermedia* Lang and *C. stylicaudata* Lang were found at Spitzbergen at 2700 m depth, *C. clavicornis* Sars was found near the Lofoten and off the coast of Norway at fairly great depths and so was *C. longicaudata* Sars off the Norway coast). As pointed out in the general part of this paper, we suppose that the antennulae and the legs of *Askalonia talpa* present extreme adaptations for "digging-swimming" in the almost liquid deep-sea mud.

ECTINOSOMIDAE

Ectinosoma diops n. sp. (pl. 8 fig. 50-53)

Material examined. — 5 ♀ from stations 24, 67, 69, 136 and 140. The syntypes are preserved in the collection of the Zoology Department of the Hebrew University under no. COP. 6.

Length. — 0.59-0.75 mm.

Ecological preferences. — Eulittoral sands.

Description. — ♀. The rostrum is quadrangular. Between the bases of the first and second antennae there are two distinct red pigment spots, somewhat similar to those found in *Ectinosoma normani* T. & A. Scott. The posterior edge bears denticles. The abdominal segments too show a rich armature of denticles. The dorsal surface of the last abdominal segment shows also rows of long and slender setae. The operculum is broadly triangular with a denticulated tip. The furcal branches are quadrangular, with a slightly granulated cuticula; they show a shield-like projection.

The last segment of the exopodite of PIV has 3 spines. The formula of the other legs is also like that of *Ectinosoma sarsi*. The exopodite of PV slightly exceeds the basiendopodite and both branches bear a transverse row
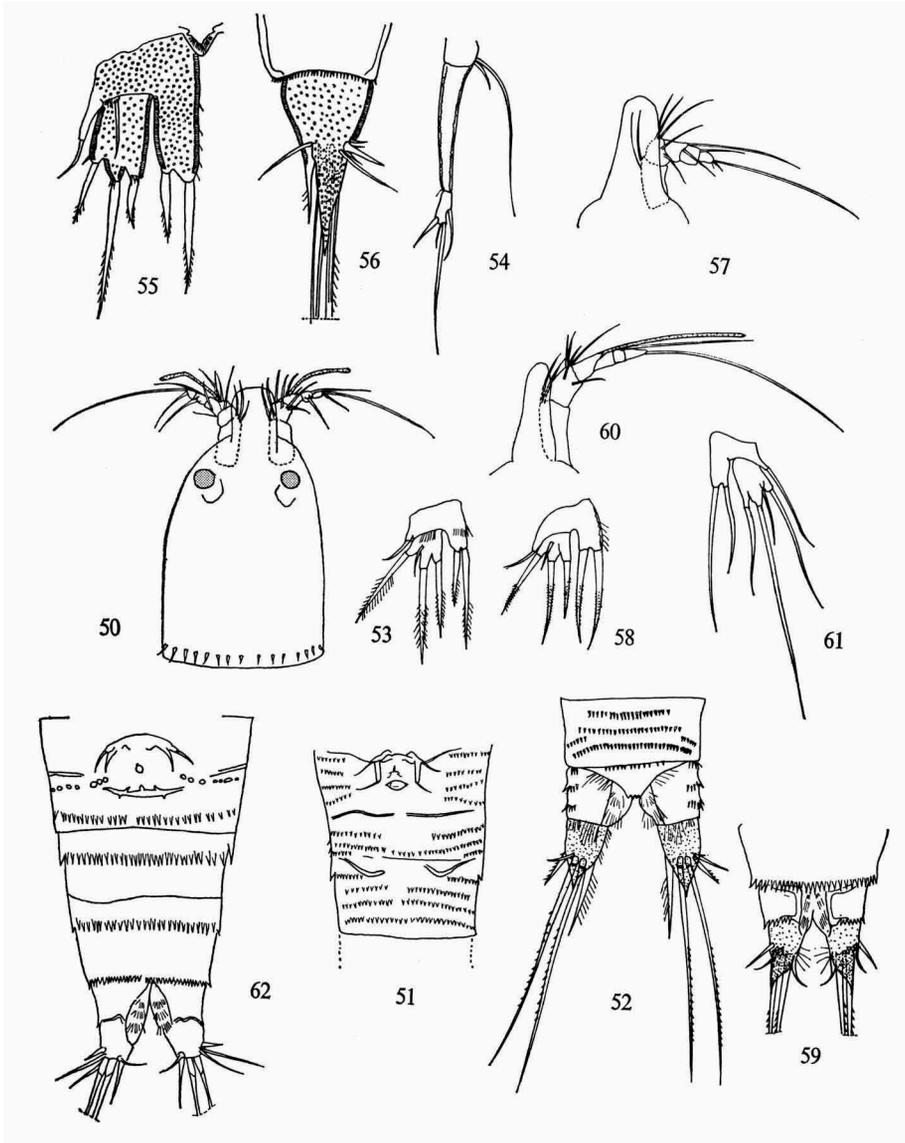
Plate 8, fig. 50-53. *Ectinosoma diops* n. sp., female. 50, cephalothorax; 51, genital
segment; 52, furca; 53, P V.
Fig. 54-56. *Ectinosoma canaliculatum* n. sp., female. 54, maxillipede; 55, P V; 56, furca.
Fig. 57-59. *Ectinosoma herdmani* T. & A. Scott, female. 57, rostrum and A I;
58, P V; 59, furca.
Fig. 60-62. *Ectinosoma inopinatum* n. sp., female. 60, rostrum and A I; 61, P V;
62, abdomen and furca.

of slender hairs. The external seta of the basiendopodite is twice as short as the inner.

The colour is whitish translucent.

The male is unknown.

Discussion. — *Ectinosoma diops,* though belonging to the subgenus *Halectinosoma* shows on the edge of the cephalothorax the denticles found also in *Ectinosoma dentatum* Steuer [1]), and the two red pigment spots known only in *E. normani,* both species belonging to the subgenus *Ectinosoma.* Among the species of *Halectinosoma,* the nearest relation found is that to *E. elongatum* Sars.

Ectinosoma canaliculatum n. sp. (pl. 8 fig. 54-56)

Material examined. — 10 ♀ from stations 39, 67, 88, 95 and 140. The syntypes are preserved in the collection of the Zoology Department of the Hebrew University under no. COP. 7.

Length. — 0.92-1.15 mm.

Ecological preference. — Sublittoral sandy muds.

Description. — ♀. This species is very closely related to *Ectinosoma sarsi* Boeck. Like in that species, the first antenna is five-segmented.

The body is dark yellowish-brown; the rostrum is like in *E. sarsi.* The furcal rami are very short, the breadth slightly exceeding the length. The cuticula of the whole body is perforated by a great number of small canaliculae.

The armature of the legs is identical to that of *E. sarsi.* The maxillipede is much longer and more slender. The shape and the armature of PV also differ. The branches are much more elongated: the length of the exopodite exceeds 1.5 to 1.6 times its width and the length of the basiendopodite exceeds 1.3 times the width. The basiendopodite reaches and even slightly exceeds the exopodite; the setae on both branches are long and the median seta of the exopodite almost reaches the end of the genital segment.

The male is unknown.

Discussion. — It is beyond any doubt that this species is very closely related to *Ectinosoma sarsi* — a species living in the sandy-muds and the muds of the northern seas. The area of *E. sarsi* extends from the extreme north ("Siebeninsel" 81° 14′ N) to the northern shores of France. Our species, which differs from *E. sarsi* chiefly by the structure of the maxillipede and of PV, is probably its vicariant in the warm water conditions of the Levantine Sea. It is difficult to make out the identity of the specimen described

---

1) Professor Lang recently found such a denticulation in other species of *Ectinosoma* (verbal communication).

by Monard (1928) from Banyuls as *E. sarsi,* but its PV seems to be quite different from that of Boeck's species.

Ectinosoma herdmani T. & A. Scott, 1894 (pl. 8 fig. 57-59)

Material examined. — 28 ♀ from stations 36, 38, 39, 68, 69, 70, 71, 95, 110 and 140.

Length. — ♀, 0.65-0.75 mm; reported length: 0.60-0.80 mm.

Previous records. — Norway, Sweden, Scotland, England, France (Roscoff, Banyuls), Algeria, Tunisia (Salammbo), Black Sea.

Ecological preference. — Sublittoral sandy muds (at least in the Levantine Sea).

Remarks. — There seems to be a breakless transition between *Ectinosoma herdmani* T. & A. Scott and *Ectinosoma elongatum* Sars. Our levantine specimens are closer to the first while those of the Black Sea show more characters of the second species. It is thus possible that *E. elongatum* has, in fact, no independent status. In our specimens the shape of the setae on PV is intermediate between the two species and the somewhat longer furca also points more to *E. elongatum.* But the other characters, including the rostrum agree with those of *E. herdmani.*

Ectinosoma inopinatum n. sp. (pl. 9 fig. 60-62)

Material examined. — 4 ♀ from station 99. The syntypes are preserved in the collection of the Zoology Department of the Hebrew University under no. COP. 8.

Length. — 0.71 mm.

Description. — ♀. The shape of the rostrum is shown in pl. 9 fig. 60. The posterior edges of the abdominal segments are denticulated, and the ventral side of the genital segment shows a peculiar transverse row of chitinous knobs. The furcal rami are slightly conical and their length does not exceed their width.

The antennulae are six-segmented. The armature of the legs has a formula of the *sarsi*-type. PV is of a peculiar type: the length of the basiendopodite exceeds its width and the exopodite too is longer than broad. The setae of both rami are very long. The superficial seta is situated near the edge of the exopodite.

The male is not known.

Discussion. — The resemblance to *Ectinosoma finmarchicum* T. Scott is very great. The differences are not too important and consist chiefly of the ornamentation of the genital segment and some small structural details in PV. Since, however, *Ectinosoma finmarchicum* is a circumpolar species,
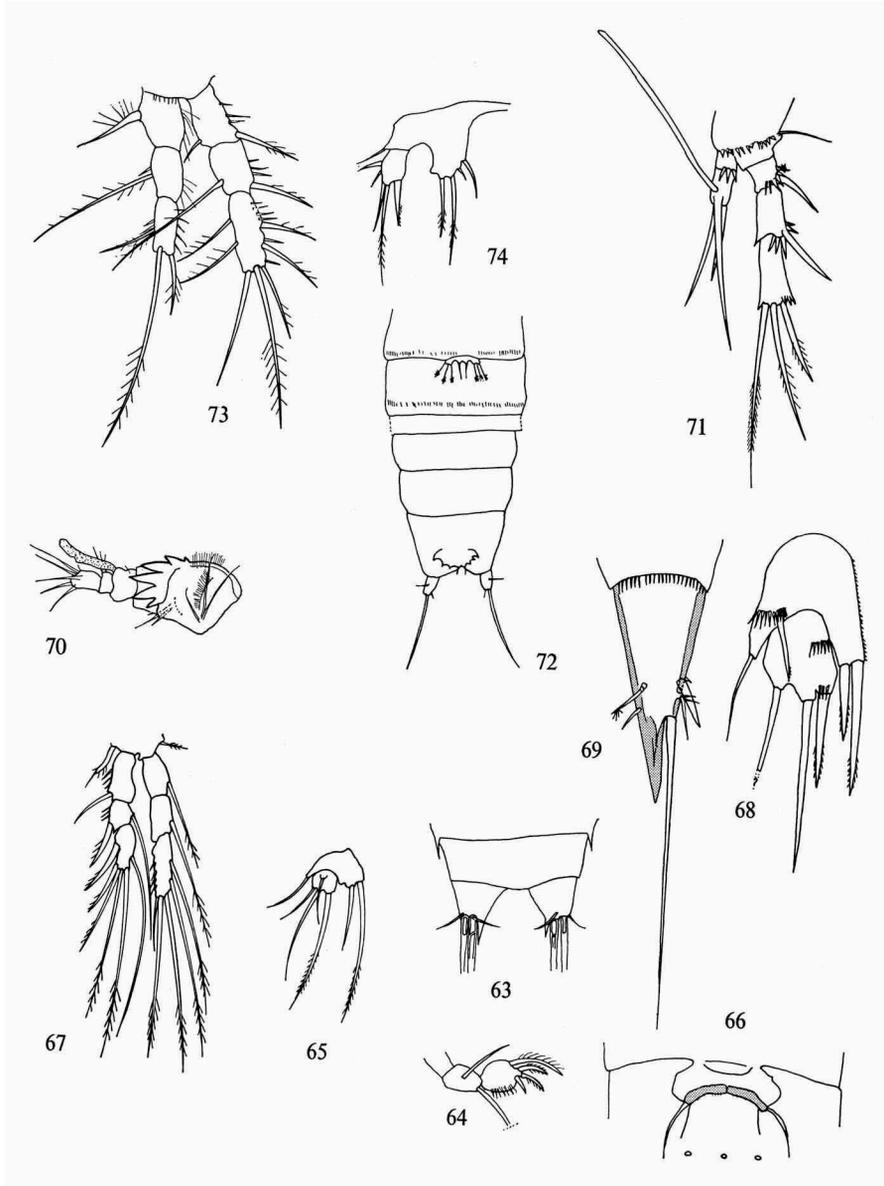
Plate 9, fig. 63-65. *Bradya congenera* Sars, female. 63, furca; 64, maxillipede; 65, P V.
Fig. 66-69. *Pseudobradya* aff. *hirsuta* (T. & A. Scott), female. 66, genital field; 67, P I;
68, P V; 69, furca.
Fig. 70-72. *Horsiella marina* n. sp., female. 70, A I (× 300); 71, P I (× 300);
72, abdomen.
Fig. 73, 74. *Danielssenia robusta* Sars. 73, P I; 74, P V.

not found south of Greenland, it seems to us sufficiently clear that our specimens belong to a different species.

Bradya congenera Sars, 1920 (pl. 9 fig. 63-65)

Material examined. — 1 ♀ from station 127.

Length. — ♀, 0.54 mm; reported length: ♀, 0.60-0.70 mm.

Previous records. — Norway (Risör), Sweden (Gullmarfjord).

Ecological preference. — Found at 40 fathoms in mud.

Remarks. — Our specimen shows almost no differences from typical material — as shown by our figures. Only the setae of PV are longer and reach far beyond the edge of the genital segment, the middle of the penultimate abdominal segment.

Discussion. — Lang (1948) reported *Bradya congenera* from muddy bottoms of Gullmarfjord between 40 and 120 metres and considered that it has a maximal thermopathy of 13° to 14° C. Our specimen lived at 73 metres — i.e. at the same depths as the northern specimens. The limit of its thermopathy must therefore be much higher here.

Pseudobradya aff. hirsuta (T. & A. Scott, 1894) (pl. 9 fig. 66-69)

Material examined. — 1 ♀ from station 127.

Length. — ♀, 0.94 mm; reported length: 0.89-1.00 mm.

Previous records. — Norway (Farsund), Sweden (Gullmarfjord), southern England.

Ecological preference. — Found at 40 fathoms in mud.

Remarks. — Our material shows some slight differences from typical specimens from the north. The furca has a more pointed inner apical processus and is not hirsute. The fifth leg shows no transverse rows of setae on the basiendopodite and the setae of this branch are more spine-like. The colour of the body is brown. The genital field is figured here (pl. 9 fig. 66).

DARCYTHOMPSONIIDAE

Horsiella marina n. sp. (pl. 9 fig. 70-72)

Material examined. — 1 ♀ from station 4. The holotype is preserved in the collection of the Zoology Department of the Hebrew University under no. COP. 9.

Length. — 0.55 mm.

Description. — ♀. The body is elongate like in the other species of the genus. The last thoracic segment and the genital segment show a fringe of small setae on their posterior edge. The operculum is cut out in 7 prominent denticles. The furcal rami are extremely small and short.

The antennnula is five-segmented, the first segment ends in heavy spines. The antenna has no exopodite. The mandible also lacks a palp. The palp of the maxillula consists of a single segment. The maxillipede is lacking.

The armature of the legs is as follows:

	Exopodite	Endopodite
P I	0.0.021	1.111
P II	0.0.021	0.111
P III	0.0.021	0.111
P IV	0.0.022	1.011

A reduced armature of the exopodites is thus characteristic for our species. The first segment of P IV bears the peculiar modified seta known also from other species of the genus.

The fifth leg bears four pennate setae.

Discussion. — Our species is the fourth species of the genus to be found in the sea (others are: *Horsiella gurneyi* Nicholls, *Horsiella ignava* Noodt and *Horsiella biscayensis* Noodt). The last two species, however, are dwellers of the interstitial biotope, while *Horsiella marina* is probably a phytal species. The small dimensions of our species are met only in *Horsiella brevicornis* (Douwe).

TACHIDIIDAE

Danielssenia robusta Sars, 1921 (pl. 9 fig. 73, 74)

Material examined. — 1 ♀ from station 104.

Length. — ♀, 0.89 mm; reported length: about 1.00 mm.

Previous records. — Norway (Risör), Sweden (Gullmarfjord).

Ecological preference. — Bathyal muds?

Remarks. — Our specimen is identical with the typical specimens from the northern seas: the width of the furca considerably exceeds its length, the antennula is four-segmented, the armature of the legs is identical and the small PV bears 4 setae on the basiendopodite. The long seta of the coxa of the maxillipede has not been observed. The abdomen shows lateral and ventral rows of spinules on the segmental edges.

Discussion. — Our specimen was found at 470 metres, while the northern specimens were found at lesser depths. We have here perhaps a case of thermic-submergence.

Zosime aff. incrassata Sars, 1910 (pl. 10 fig. 75-79)

Material examined. — 1 ♀ from station 149.

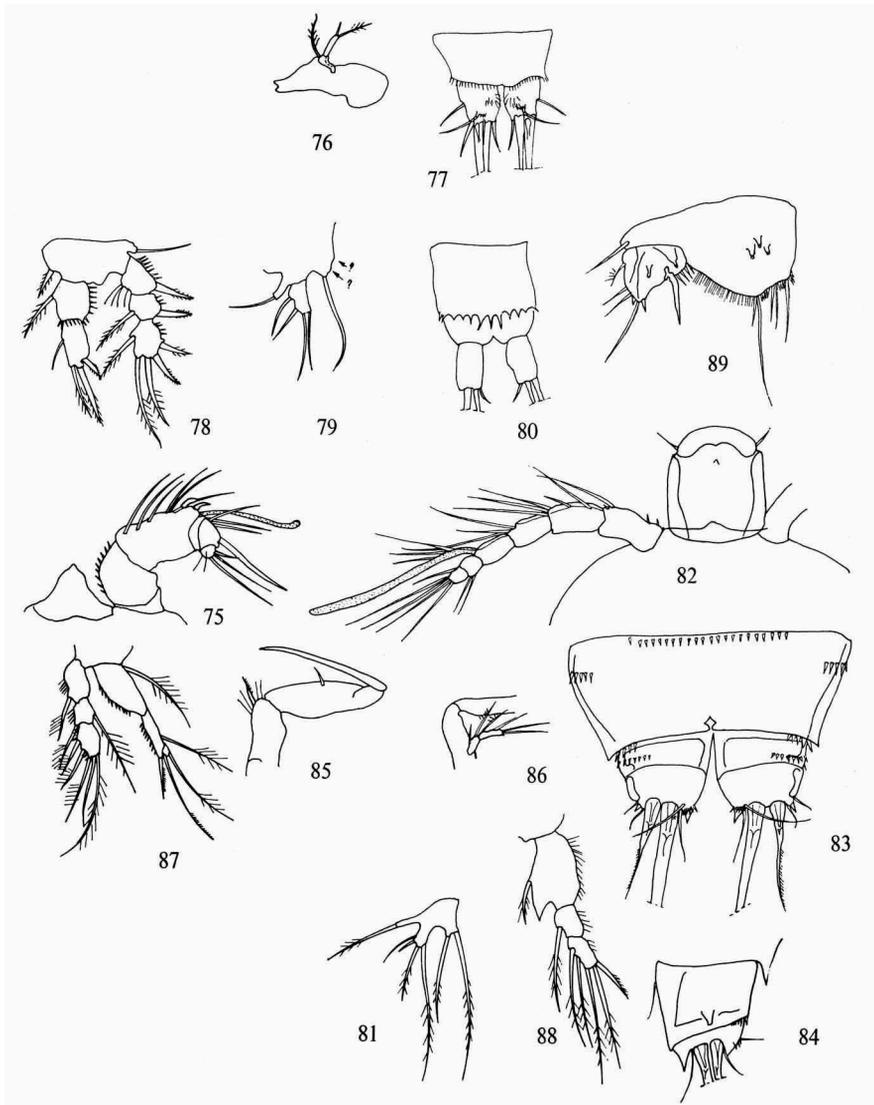Length. — 0.56 mm.

Ecological preference. — Bathyal muds?

Plate 10, fig. 75-79. *Zosime* aff. *incrassata* Sars, female. 75, A I; 76, mandible; 77, furca; 78, P I; 79, P V.
Fig. 80, 81. *Zosime valida* Sars, female. 80, furca; 81, P V.
Fig. 82-89. *Idomene aberrans* n. sp., female. 82, rostrum and A I; 83, furca in ventral view; 84, furcal branch in dorsal view; 85, maxillipede; 86, exopodite of A II; 87, P I; 88, endopodite of P II; 89, P V.

Remarks. — In some features this deep-sea specimen quite closely resembles *Zosime incrassata*. The genital segment has only short lateral sutures

and the length of the furcal branches is equal to their width. The armature of the legs shows also the specific characters found in *Z. incrassata*.

There are, however, also characters which require perhaps a separation from *Zosime incrassata*. The antennula is short, stout and composed only of 6 segments, instead of 7, and the third segment is much larger than the preceding one. The exopodite of the mandible which is reported to be reduced to a single seta in *Z. incrassata* is formed in our specimen of two distinct segments which bear three setae. As to the incomplete PV, the exopodite and the basiendopodite are respectively longer and shorter than in *Zosime incrassata*.

Zosime valida Sars, 1919 (pl. 10 fig. 80, 81)

Material examined. — 2 ♀ from station 84.

Length. — ♀, 0.63 and 0.64 mm; reported length: 0.7 mm.

Previous records. — Franz Joseph Land, Spitzbergen, Faroe Islands, Norway, Sweden, Bay of Kiel, Scotland, England.

Ecological preference. — "*Typhlamphiascus* muds"?

Remarks. — Our specimens agree almost entirely with the typical specimens. The slightly different PV and the last abdominal segment of our specimens are figured here.

THALESTRIDAE
Idomene aberrans n. sp. (pl. 10 fig. 82-89)

Material examined. — 1 ♀ from station 91. The holotype is preserved in the collection of the Zoology Department of the Hebrew University under no. COP. 10.

Length. — ♀, 0.70 mm.

Description. — ♀. The body has the usual flattened form of the genus. The rostrum is large, it has the form of an equilateral rectangle and is clearly articulated. The abdominal segments bear ventral and lateral rows of short spines. The furcal branches are conspicuously broader than long. The external apical furcal seta is short and suddenly tapers in its distal half.

The antennula is formed of six segments and shows no pectination. The exopodite of A II is bi-articulated and bears six setae. Both exopodite and endopodite of the mandible are uni-articulated and bear long and slender setae. The claw of the maxillipede is not pectinated.

The first leg has a peculiar form shown in pl. 10 fig. 87. The highly reduced condition of the last segment of the endopodite must be underlined. The first endopodite segments of the following legs are broadened, oval,

and produced in an inner spine-like terminal apophysis. The armature of the legs is as follows:

	Exopodite	Endopodite
P II	1.1.223	1.1.221
P III	1.1.323	1.1.221
P IV	1.1.323	1.1.221

As to PV this limb is highly specialized and somewhat resembles the specialized legs of *Idomene laticauda* (Thompson & A. Scott) and *I. aemula* (Thompson & A. Scott). The exopodite hardly exceeds the broadened basiendopodite and bears besides a strong inner spine, five setae and two marginal spinules. The basiendopodite bears five setae and two groups of marginal spinules.

Discussion. — Our species is undoubtedly related to *Idomene australis* Brady and perhaps also to other Indopacific species like *I. laticauda* and *I. aemula*. Unfortunately only the male of *I. australis* is known and therefore PV is not comparable. The swimming legs have a highly peculiar structure.

Eudactylopus sp. (pl. 11 fig. 90-94)

Material examined. — 1 ♂ from station 85.

Length. — 0.80 mm.

Remarks. — From this specimen of *Eudactylopus*, which seems to be very different from the known males of this genus, we present only the figures. A revision of the genus *Eudactylopus* is very necessary and special attention should be given to tropical material. Until then the status of our present specimen should be left undecided.

PARASTENHELIIDAE

Parastenhelia ornatissima (Monard, 1937) (pl. 11 fig. 95, 96)

Material examined. — 7 ♀ from station 8.

Length. — about 0.40 mm; reported length: 0.40 mm.

Previous record. — France (Roscoff).

Ecological preference. — Eulittoral detritic sands?

Remarks. — This is the first record of the species from the Mediterranean. Our specimens differ very little from Monard's: only the operculum has fewer (7) and larger spines, and the setae on PV (chiefly on the basiendopodite) are slightly shorter. Antennae, mouthparts and swimming legs are typical.
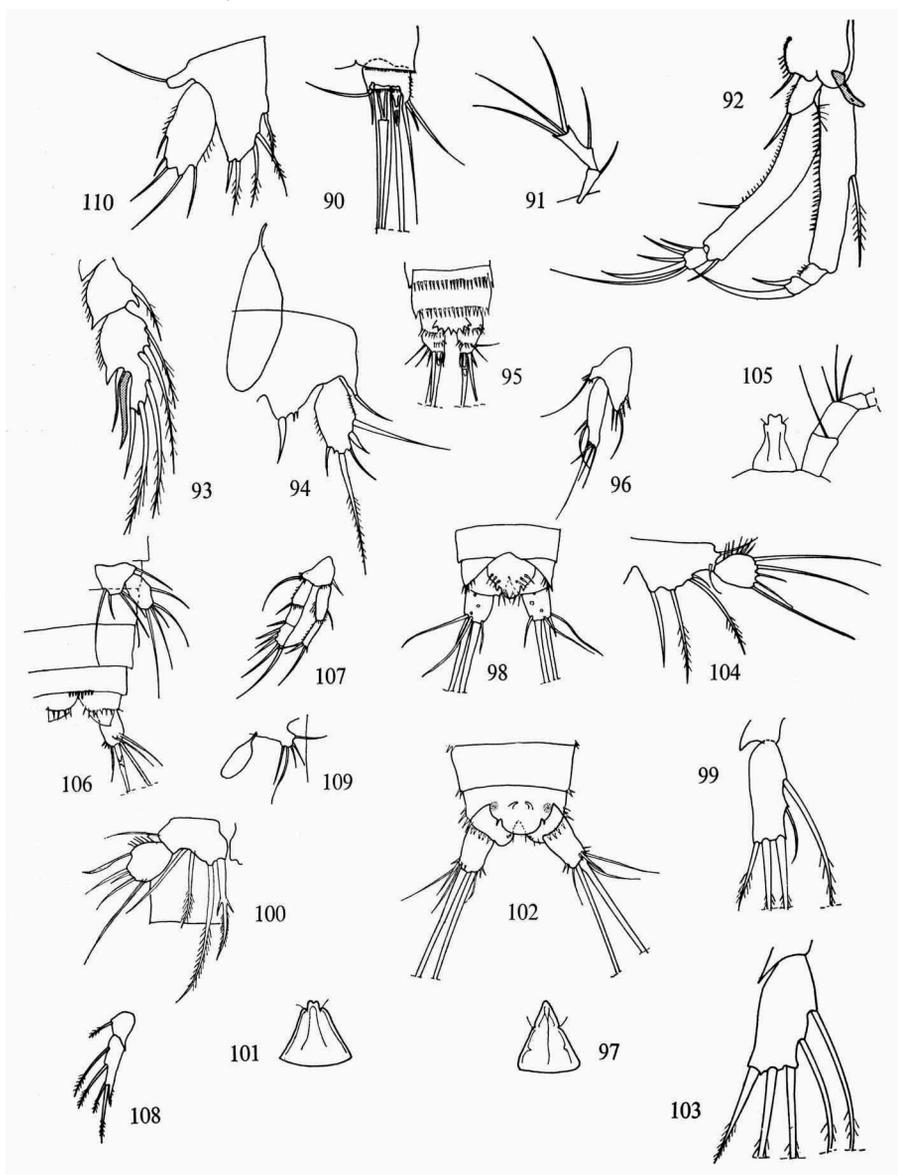
Plate 11, fig. 90-94. *Eudactylopus* sp., male. 90, furca; 91, exopodite of A II; 92, P I; 93, endopodite of P II; 94, P V.

Fig. 95, 96. *Parastenhelia ornatissima* Monard, female. 95, furca and operculum; 96, P V.

Fig. 97-100. *Stenhelia elisabethae* Por, female. 97, rostrum; 98, furca; 99, last segment of endopodite of P IV (× 300); 100, P V.

Fig. 101-104. *Stenhelia normani polluta* Monard, female. 101, rostrum; 102, furca; 103, last segment of endopodite of P IV (× 300); 104, P V.

Fig. 105-109. *Stenhelia incerta* n. sp. 105, rostrum and A II of female; 106, furca and P V of female; 107, P I of female; 108, P II of male; 109, P V of male.

Fig. 110. *Amphiascus varians* (Norman & T. Scott), P V of female.

DIOSACCIDAE

Stenhelia (Delavalia) elisabethae Por, 1960 (pl. 11 fig. 97-100)

and

Stenhelia (D.) normani polluta Monard, 1928 (pl. 11 fig. 101-104)

Material examined. — *Stenhelia elisabethae*: 23 ♀ and 9 ♂ from stations 1, 2, 3, 12, and 22. *Stenhelia normani polluta*: 2 ♀ from stations 84 and 91.

Remarks. — It seems that these two forms, together with *Stenhelia n. normani* T. Scott from the northern seas and *Stenhelia normani acutirostris* Willey from Bermuda, are forming a clear "Formenkreis".

Stenhelia elisabethae described by us from the Black Sea, seems to be a very constant species: the specimens from the Israel coast are remarkable in their resemblance to the pontic ones and even such intimate features as the form of the operculum and the ornamentation of the furcal branches are identical. The fifth leg shows also an identical armature.

Stenhelia normani polluta is a much more difficult case. We considered our specimens as belonging to this subspecies since the external seta on the basiendopodite of PV has a clear tendency to become reduced. The lack of this seta is the only distinguishing character of this subspecies given by Monard (1928) and Sewell (1940). The latter author even considered this only character sufficient to justify a status of independent species. A common trait of our *S. n. polluta* specimens with *S. elisabethae* and at the same time a clear difference from the typical *S. normani* is the lack of the inner seta on the first endopodite segment of P II and the supplementary seta on the last endopodite segment of P IV. On the other hand, there are clear differences between the two forms, as shown by our figures. The presence of a small seta at the base of the exopodite of P V in our *S. n. polluta* specimens is especially noteworthy.

As to the fourth member of this Formenkreis, *S. normani acutirostris*, although the form of the rostrum is identical to that of *S. elisabethae*, and the supplementary seta on P IV is also present, the reduced armature of the endopodites of P III and P IV and the normal feature of the setae of P V probably affords to *S. n. acutirostris* the status of an independent species.

The following table gives a comparison of the armature of the swimming legs of the four forms:

	P II		P III		P IV	
	Ex.	End.	Ex.	End.	Ex.	End.
S. n. normani	1.1.223	1.2.121	1.1.323	1.1.321	1.1.223	1.1.221
S. elisabethae	0.1.223	1.2.121	1.1.323	1.1.321	1.1.223	1.1.221
S. n. polluta	0.1.223	1.2.121	1.1.323	1.1.321	1.1.323	1.1.221
S. n. acutirostris	1.1.223	1.2.121	1.1.323	1.1.221	1.1.323	1.1.121

On the Israel coast, *Stenhelia elisabethae* is a stenotypic phytal species (in the Black Sea it lives in mud) while *S. normani polluta* prefers shallow muds.

Stenhelia incerta n. sp. (pl. 11 fig. 105-109)

Material examined. — 1 ♀ and 1 ♂ from station 3. The syntypes are preserved in the collection of the Zoology Department of the Hebrew University under no. COP. 11.

Length. — ♀, 0.48 mm; ♂, 0.48 mm.

Description. — ♀. The rostrum is prominent and bears a bifid apex. The length of the furcal branches exceeds their width about 1.5 times, and the furcal setae are normal. The antennulae are formed of 8 segments.

The exopodite of P I bears 5 setae on the last segment, while the last segment of the endopodite bears only 3 setae. The armature of the other legs is as follows:

	Exopodite	Endopodite
P II	1.1.223	1.1.220
P III	1.1.323	1.1.420
P IV	1.1.322	1.1.320

The setae on P III and P IV are normal, and none shows peculiar dimensions. The exopodite of P V bears 5 setae while the basiendopodite bears 4 fairly well developed setae.

♂. The endopodite of P II is figured here (pl. 11 fig. 108); the spiniform apophysis of the last segment bears no small setae. P V has the form of a single plate with 5 setae.

Discussion. — The general shape of the rostrum and the armature of the exopodite of P I show close resemblance to those of *Stenhelia (D.) reflexa* Brady & Robertson. The specific characters are the bifid rostrum, the short furca, the reduced armature of the last endopodite segment of P I and that of the median segment of the P II endopodite, etc.

Stenhelia aff. minuta A. Scott, 1902 (pl. 12 fig. 111,112)

Material examined. — 1 ♀ from station 138.

Length. — ♀, 0.51 mm; reported length: ♀, 0.46-0.48 mm.

Previous records. — Egypt (Ismailia, Gulf of Suez), Indian Ocean.

Remarks. — The differences shown by our specimen from the very closely related *Stenhelia minuta* are: a) the much longer furcal branches (5 times longer than wide, against 3 times in *S. minuta*); b) the second segment of the exopodite of P I shows no seta; c) there is only one highly reduced inner seta on the basiendopodite of P V.

The antenna is formed of seven segments. The maxillipede, not described in *Stenhelia minuta*, was obscure also in our specimen.
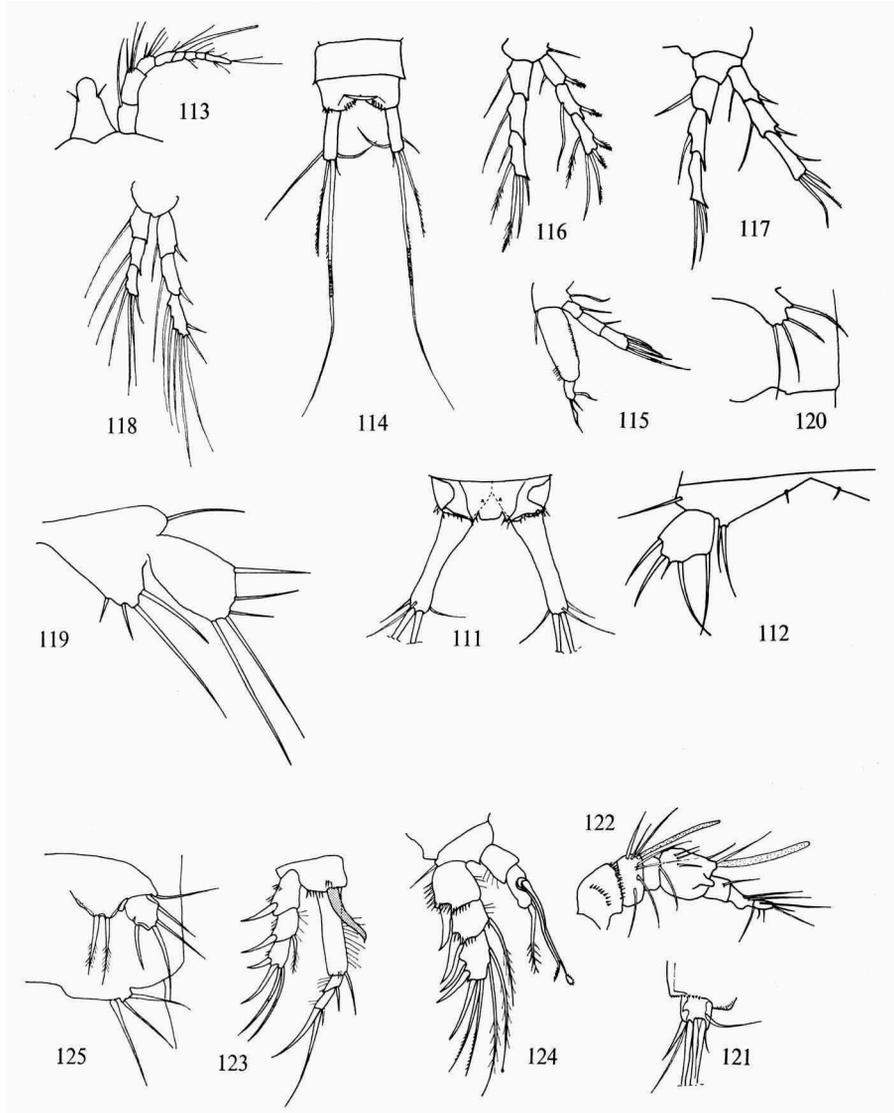

Plate 12, fig. 111, 112. *Stenhelia* aff. *minuta* A. Scott, female. 111, furca; 112, P V. Fig. 113-120. *Melima caulerpae* n. sp. 113, rostrum and A I of female; 114, furca of female; 115, P I of female; 116, P III of female; 117, P II of female; 118, P IV of female; 119, P V of female (× 300); 120, P V of male (× 300).
Fig. 121-125. *Pseudodiosaccopsis mesogeae* n. sp., male. 121, furcal branch; 122, A I; 123, P I; 124, P II; 125, P V.

Melima caulerpae n. gen., n. sp. (pl. 12 fig. 113-120)

Material examined. — 59 ♀ and 3 ♂ from stations 100, 103. The syntypes are preserved in the collection of the Zoology Department of the Hebrew University under no. COP. 12.

Length. — ♀, 0.39-0.40 mm; ♂, 0.33 mm.

Ecological preference. — *Caulerpa* meadows?

Remarks. — *Melima caulerpae* is the type species of the new genus *Melima* and therefore the generic diagnosis coincides with that of its unique species.

Description. — ♀. Body *Stenhelia*-like. Rostrum prominent, with rounded tip. Abdominal segments with smooth edges. The furcal branches are about 3.5 times longer than broad. The furcal setae are normal, the inner is characteristically curved forwards.

The antenna is eight-segmented. The exopodite of A II is formed, like in *Stenhelia*, of three segments; the first two bear a seta each, the last has three setae. The mouthparts are also like those of *Stenhelia*: the mandible shows the typically elongated basis and exo- and endopodite branches; the maxillipede has a very reduced apical armature.

P I is highly aberrant and specialized. The first endopodite segment is very long and broad, while the second segment is reduced and bears 3 setae, two of which have a peculiar structure (pl. 12 fig. 115). The median segment of the exopodite bears no inner setae. The armature of the swimming legs is as follows:

	Exopodite	Endopodite
P II	1.1.022	1.1.021
P III	1.1.122	1.1.230
P IV	1.1.322	1.1.230

The following characters are noteworthy: the armature of the last exopodite segments of P II and P III is reduced to 4, respectively 5 setae; the median segment of the endopodite of P II bears a single seta, while the last segment bears only 3 setae.

P V is shown in pl. 12 fig. 119: the exopodite bears 5 setae, and the basiendopodite 4 setae, which are concentrated on the tip of this segment. The genital field shows nothing peculiar.

♂. The most striking feature of the male is the lack of dimorphic structures in P II or even P III. P V is a single plate with 4 setae.

Discussion. — The specialized structure of P I, the advanced reduction of the armature on the swimming legs and the lack of dimorphism in the male P II, justify in our opinion the creation of the new genus. From among the species of *Stenhelia*, *S. longifurca* Sewell shows some resemblance to

the new genus: the armature (but not the structure) of P I and the begin-
ning reduction of the setae on several legs (the endopodite of P II bears,
however, 5 setae, more than any other species of *Stenhelia*).

The creation of the genus *Melima,* placed next to *Stenhelia* with its two
subgenera, bring us closer to the necessary separation of the highly peculiar
Stenhelia-like Harpacticoida from the other Diosaccidae.

Pseudodiosaccopsis mesogeae n. sp. (pl. 12 fig. 122-125)

Material examined. — 1 ♂ from station 99. The holotype is preserved in
the collection of the Zoology Department of the Hebrew University under
no. COP. 13.

Length. — ♂, 0.53 mm.

Description. — ♂. The body is pyriform and of a bright red colour. The
dorsal surface of the abdomen as well as the operculum are smooth; ven-
trally the edges bear short setae. The furcal rami are slightly broader than
long; the external furcal seta is modified to a strong spine.

The antennula is seven-segmented; the antenna and the mouthparts have
the structure typical for the genus.

The first segment of the three-segmented endopodite of P I slightly ex-
ceeds the exopodite. The modified endopodite of P II bears only a single
apical seta. The seta of the inner edge has a strongly broadened base and
towards the tip is divided into two branches. The armature of P III and
P IV is the one typical for the genus. The exopodite of P V is short,
rounded and the basiendopodite hardly reaches the middle of the exopodite.

The female is not known.

Discussion. — Although it is possible that Brian's description of *Pseudo-
diosaccopsis rufescens* is not too accurate, our species is clearly different
from it and shows some resemblance to *Pseudodiosaccopsis brunneus*
(Willey).

Amphiascus varians (Norman & T. Scott, 1905) (pl. 11 fig. 110)

Material examined. — 1 ♀ from station 98.

Length. — ♀, 0.56 mm; reported length: ♀, 0.70-0.77 mm.

Previous records. — Norway, Germany (Heligoland), Great Britain
(Cornwall), France (Roscoff).

Remarks. — Our specimen shows the typical features of the northern spe-
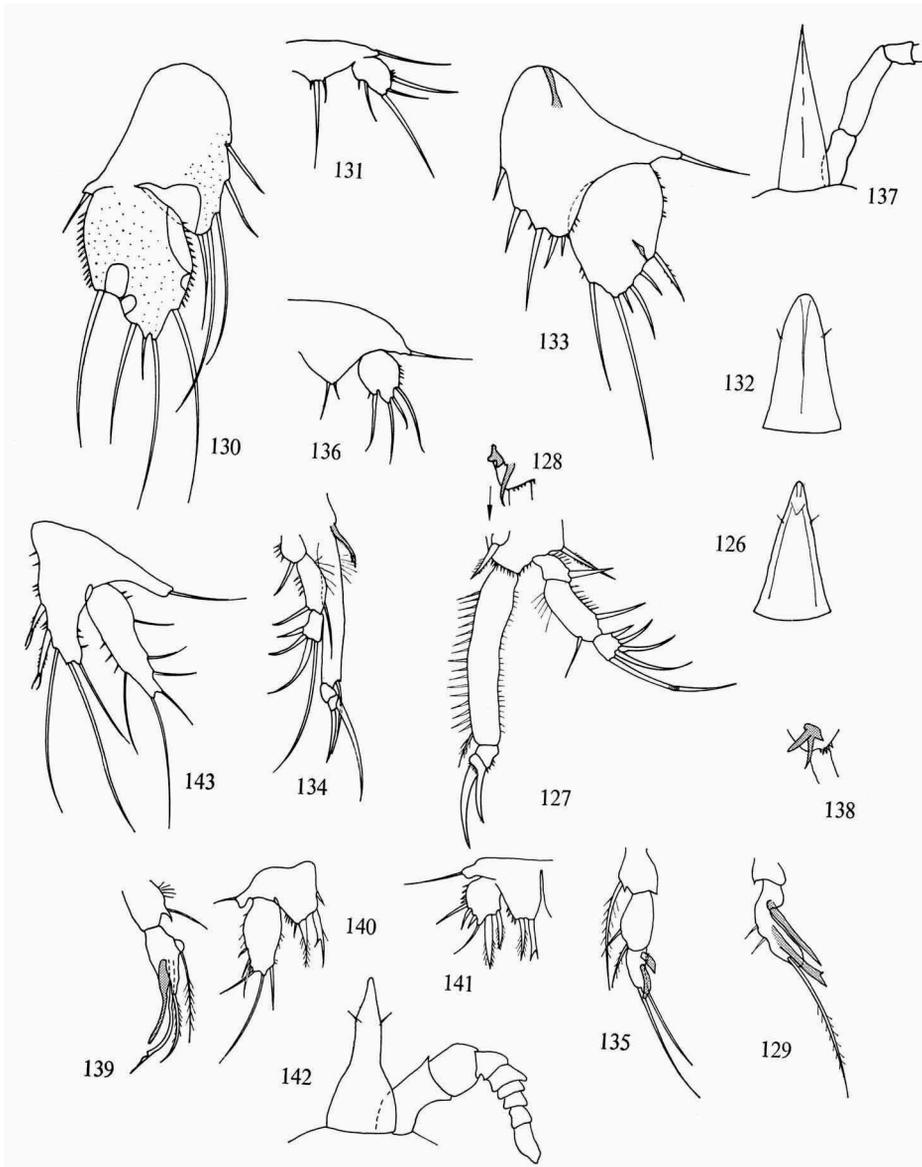cimens. Only the apical setae of the short furcal rami are not swollen at
their base.

Plate 13, fig. 126-131. *Amonardia similis* (Claus). 126, rostrum; 127, P I of female; 128, spine of P I of male; 129, endopodite of P II of male; 130, P V of female; 131, P V of male.

Fig. 132-136. *Amonardia pelophila* n. sp. 132, rostrum; 133, P V of female; 134, P I of male; 135, endopodite of P II of male; 136, P V of male.

Fig. 137-141. *Robertgurneya ilievecensis* (Monard). 137, rostrum of female; 138, spine on P I of male; 139, endopodite of P II of male; 140, P V of female; 141, P V of male.

Fig. 142, 143. *Typhlamphiascus confusus* (T. Scott), female. 142, rostrum and A I; 143, P V.

Amonardia similis (Claus, 1866) (pl. 13 fig. 126-131)

Material examined. — 58 ♀ and 3 ♂ from stations 22, 24, 87 and 99.

Length. — ♀, 0.66-1.20 mm; ♂, 0.53-0.55 mm; reported length: ♀, 0.70-1.30 mm.

Previous records. — Western Mediterranean, Canary Islands, Adriatic Sea, Algeria, Greece (Dodekanesos), Suez Canal (Ismailia).

Ecologic preference. — More or less euryekous.

Remarks. — This species seems to be very variable. We give therefore some characteristic features of our specimens, while furthermore the first description of the male of this species is provided.

The variability of the general size of our specimens is a very interesting phenomenon, but it does not exceed the limits given in the literature. The armature of the abdomen generally corresponds to that of the typical form (cf. Lang, 1948), but the penultimate segment shows a ventral row of spines, while the operculum (like in *Amonardia normani* (Brady)) bears 1 or 2 rows of small spinules or hairs. As to the armature of the last segment of the exopodite of P IV, in our specimens it always bears two inner setae as described by Lang (1948), Brian (1928) and Jakubisiak (1936) and not three, like in the specimens of Monard (1928).

P V shows hyaline spots on the exopodite and also on the basiendopodite; in previous descriptions of the species these spots are not mentioned. This character clearly recalls *A. phyllopus* (Sars), but in the latter species there is no hyaline spot on the basiendopodite, while the very short basiendopodite is still like that of the "typical" *A. similis*.

The dimorphic features of the male are shown in pl. 13 fig. 128, 129, and 131. The spine on the basipodite of P I is peculiar, differing from the almost unmodified spine of P I of *A. phyllopus*. The endopodite of P II is also much more markedly modified and somewhat resembles that of *A. normani*.

It is possible that the morphological differences between the females of *A. similis* and *A. phyllopus* are not clearly defined, at least in their overlapping Mediterranean area. The males, however, are clearly different.

Amonardia pelophila n. sp. (pl. 13 fig. 132-136)

Material examined. — 14 ♀ and 1 ♂ from stations 138 and 149. The syntypes are preserved in the collection of the Zoology Department of the Hebrew University under no. COP. 14.

Length. — About 1.00 mm in both sexes.

Ecological preference. — Bathyal muds.

Description. — ♀. The body shows a transverse orange-red stripe on each

segment and is filled with oil droplets. The rostrum is broad and blunt. The abdominal segments bear only a few lateral spines and are smooth both dorsally and ventrally; only on the last segment there are some dorsal spines, above the furca. The operculum bears small spinules. The furcal rami have — as in all the species of the genus — a length more or less equal to their width.

The antennula is eight-segmented. Antenna and mouth parts are of the normal type. The last segment of the endopodite of P I bears 4 setae. The armature of the swimming legs is like that of the other species. The last segment of the exopodite of P IV bears two inner setae. P V somewhat resembles that of *Amonardia normani*, but both segments bear a conspicuous reddish chitinous trabeculum; the length of the exopodite exceeds its width only about 1.2 to 1.3 times; the armature of the basiendopodite is formed of short reduced spines.

♂. In our males, the basipodite spine of P I is long and curved downward. The endopodite of P II is formed of three segments, with two modified lateral spines. The armature of P V is reduced to 4 setae on the exopodite and 2 on the basiendopodite.

Discussion. — *Amonardia pelophila* is obviously related to *Amonardia normani*. It seems, however, to have a very clearly delimited position both systematically and ecologically.

Robertgurneya ilievecensis (Monard, 1935) (pl. 13 fig. 137-141)
Material examined. — 3 ♀ and 2 ♂ from stations 88, 91 and 95.
Length. — ♀, 0.64-0.74 mm; ♂, 0.71-0.74 mm; reported length: ♀, 0.46 mm.
Previous reports. — France (Roscoff).
Ecological preference. — Sublittoral gravel and muds.
Remarks. — Our female specimens show some differences from Monard's description. The size is much greater. Ventrally the antepenultimate abdominal segment shows the typical armature, but the spines form two rows instead of one. The branches of P I are typical but the median segment of the endopodite bears a seta which is lacking in Monard's specimens. The exopodite of P V is shorter and rounder than in the type specimens and the external seta is very reduced.

Until now the male was unknown. Our figures show the dimorphic inner spine of the basipodite of P I, the modified endopodite of P II and P V.

Typhlamphiascus confusus (T. Scott, 1902) (pl. 13 fig. 142, 143)
Material examined. — 29 ♀ and 15 ♂ from station 7, 84, 91, 93, 96, 99, 102, 104, 110, 126, 128 and 149.

Length. — ♀, 0.78 (-1.14) mm; ♂, 0.74 (-1.04) mm; reported length: ♀, 0.80-0.98 mm; ♂, 0.75-0.85 mm.

Previous records. — Norway, Sweden (Gullmarfjord), Great Britain (Scotland, Northumberland), France (Roscoff), Black Sea.

Ecological preference. — Characteristic for sublittoral muds, but sometimes also in smaller depths.

Remarks. — Our material on the whole agrees well with the typical specimens. P V has the armature characteristic of this species; the length of the exopodite, however, is variable. The furcal rami are straight. This is true chiefly for the population of very large specimens, found in station 91, in which the rostrum is also much more pointed than usual. Although size seems to be variable in this species, it is possible that this population, with a length exceeding 1.00 mm, belongs to a separate taxonomic unit.

Rhyncholagena aff. pestai (Monard, 1935) (pl. 14 fig. 144, 145)

Material examined. — 1♀ from station 88.

Length. — ♀, 0.81 mm; reported length: ♀, 0.75-0.80 mm; ♂, 0.62 mm.

Previous records. — France (Roscoff), Algeria (Castiglione).

Remarks. — For the moment our only specimen must be considered to belong to *Rhyncholagena pestai* as it has many features in common with that species. However, the following differences are worthy of notice. The rostrum is much less tapering. The armature of the abdominal segment is typical, but the body, including the furcal rami is not hairy; only on the penultimate abdominal segment there is a row of hairs above the marginal spines. The furcal rami have no convex edges. The armature of the swimming legs is similar to that of typical specimens, only the median segment of the endopodite of P III bears 1 seta instead of 2. P V is also quite similar, but the median external seta of the exopodite is very reduced and the disposition of the hyaline areas on both rami is different.

Rhyncholagena levantina n. sp. (pl. 14 fig. 146-151)

Material examined. — 5 ♀ and 2 ♂ from station 88. The syntypes are preserved in the collection of the Zoology Department of the Hebrew University under no. COP. 15.

Length. — ♀, 0.81 mm; ♂, 0.78 mm.

Description. — ♀. The rostrum is strongly convex and its tip is only slightly produced. Only the last three abdominal segments have ventral rows of spines; on the penultimate segment the row is interrupted (not so in the males). The furcal rami are slightly longer than broad. The operculum is figured here (pl. 14 fig. 148).
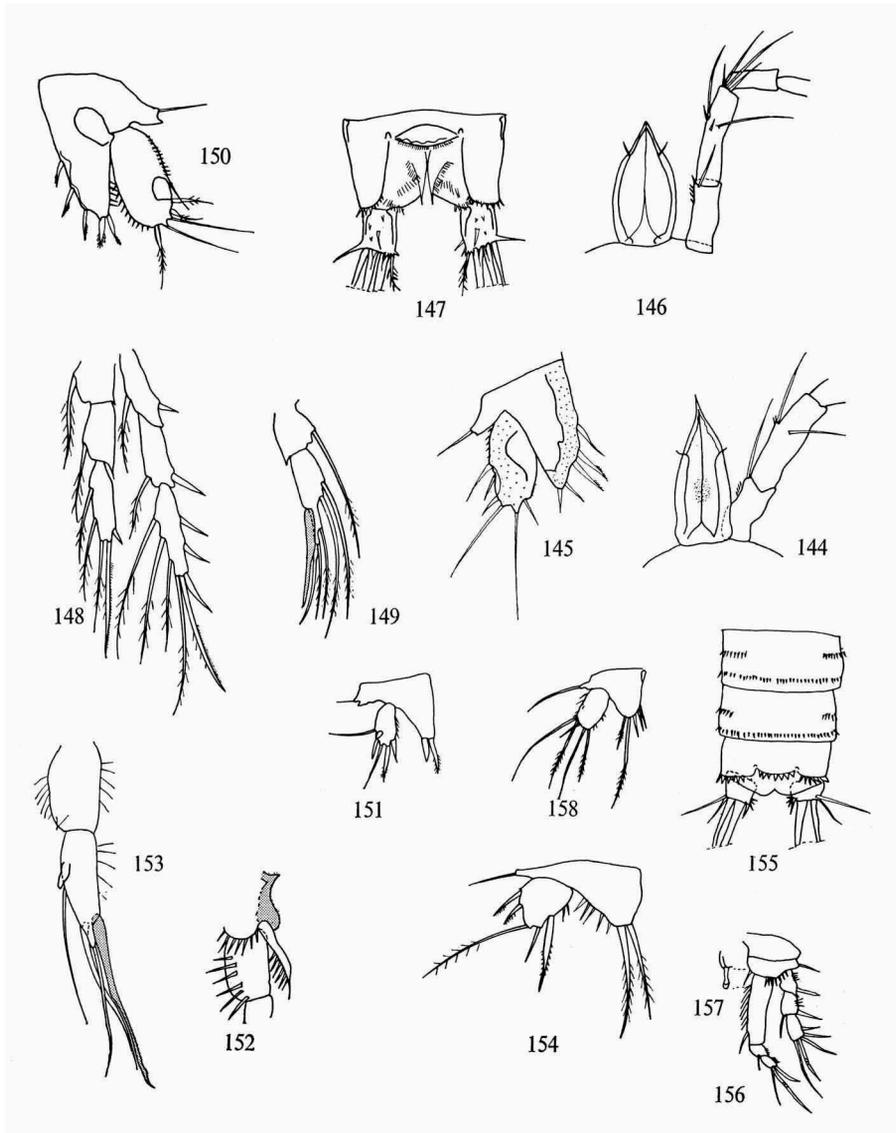
Plate 14, fig. 144, 145. *Rhyncholagena* aff. *pestai* (Monard). 144, rostrum; 145, P V of female.

Fig. 146-151. *Rhyncholagena levantina* n. sp. 146, rostrum and A I of female; 147, furca; 148, P IV of female; 149, P II of male; 150, P V of female; 151, P V of male.

Fig. 152-154. *Haloschizopera marmarae* Noodt, male. 152, spine on P I; 153, endopodite of P II; 154, P V (152-154, × 300).

Fig. 155-158. *Nitocra minor* Willey. 155, abdomen; 156, P I of female; 157, spine on P I of male; 158, P V of female.

The antenna is eight-segmented, without a spur on the second segment. The antenna and mouthparts are like in the other species of the genus. P I has also the shape typical for the whole genus. The armature of the swimming legs is as follows:

	Exopodite	Endopodite
P II	1.1.123	1.1.121
P III	1.1.123	1.1.321
P IV	1.1.323	1.1.221

P V has a blunt and rounded exopodite, with five small setae; the basiendopodite bears also five stout and short setae. Two hyaline spots are present.

♂. The basipodite of P I shows an upper blunt tooth and a downcurved spine. The endopodite of P II is shown in pl. 14 fig. 149. The exopodite of P V bears 5 setae and shows a small hyaline locus; the elongated basiendopodite bears two setae, the internal being spiniform.

Discussion. — While the rostrum and P V are very peculiar in our species, the armature of the legs stands in between the formulae of *Rhyncholagena lagenirostris* (Sars) and *R. pestai*.

Haloschizopera pontarchis Por, 1959

Material examined. — The syntypes are preserved in the Museum "Grigore Antipa", Bucharest, under no. 27.

Description. — ♀. Length 0.70 to 0.75 mm. The antennula is composed of eight segments. The last segment of the endopodite of P I (Por, 1959, pl. 1 fig. 1) is one and a half times longer than the penultimate one. The endopodite of P II has no inner seta on the first segment (Por, 1959, pl. 1 fig. 3). Besides this difference the armature of the legs is identical with those of other species of the genus. P V, however, has a peculiar structure: the exopodite is about one and a half times longer than broad and bears 5 setae, of which the innermost is outstandingly long and strong, while the apical one is very slender and short. The basiendopodite exceeds the middle of the exopodite and has a quadrangular shape. It bears four setae. A large hyaline spot is found at the base of the basiendopodite (Por, 1959, pl. 1 fig. 5). The abdominal segments bear strong marginal spines ventrally. On the operculum a group of 4 strong spines is found. The furca (Por, 1959, pl. 1 fig. 7) is longer than broad.

♂. Length 0.45 to 0.50 mm. Besides the prehensile antennula the male shows the following dimorphic characters: the inner spine of the basipodite of P I shows a chitinous tooth of a peculiar shape (Por, 1959, pl. 1 fig. 2). The endopodite of P II (Por, 1959, pl. 1 fig. 4) shows a great resemblance to that of the males of the genus *Schizopera* and is specifically different

from that of *Haloschizopera mathoi* Monard. The exopodite of P V has an oblique insertion (Por, 1959, pl. 1 fig. 6) ; the innermost seta is here also very strong but the apical one is stronger than in the female.

Haloschizopera pauciseta Por, 1959

Material examined. — The holotype is preserved in the Museum "Grigore Antipa", Bucharest, under no. 28.

Description. — ♀. Length 0.40 to 0.48 mm. The antennula is eight-segmented. The last segment of the endopodite of P I is elongate (Por, 1959, pl. 1 fig. 9). The first segment of the endopodite of P I does not bear the usual inner seta. The same seta is lacking also on the first segment of the en-dopodite of P II (Por, 1959, pl. 1 fig. 10). The armature of the exopodites of P III and P IV is reduced too. The last segment of the exopodite of P III has no inner seta while that of P IV possesses only one. The exopodite of P V is 2.5 times longer than broad and bears 5 setae (Por, 1959, pl. 1 fig. 11). The basiendopodite reaches the middle of the exopodite and bears four setae. On their ventral edges the abdominal segments bear groups of small spines (Por, 1959, pl. 1 fig. 12) while they show slender hairs on the dorsal edges. The furca is broader than long (Por, 1959, pl. 1 fig. 12).

No male has been found.

Haloschizopera marmarae Noodt, 1955 (pl. 14 fig. 152-154)

Material examined. — 5 ♀ and 4 ♂ from stations 2 and 103.

Length. — ♀, 0.39-0.40 mm; ♂, 0.38 mm; reported length: ♀, 0.48 mm.

Previous record. — Sea of Marmara.

Remarks. — The male of this recently described species has not yet been reported upon. We present here the figures of the three dimorphic appendages of the male.

It is interesting that, both in the Mediterranean and in the Black Sea, in species of this genus the males are not at all rare (Klie, 1942; Por, 1959), while in northern European seas no males were ever found.

Schizopera neglecta Akatova, 1935 (pl. 15 fig. 160-163)

Material examined. — 15 ♀ and 4 ♂ from station 18.

Length. — ♀, 0.50-0.55 mm; ♂, 0.38-0.40 mm; reported length: ♀, 0.58 mm; ♂, 0.51 mm.

Previous record. — Caspian Sea.

Ecological preference. — Brackish estuaries.

Remarks. — Our specimens are almost exactly like those from the Caspian Sea. Only P V shows a small hyaline locus on the basiendopodite and P V of the male has a more prominent basiendopodite.
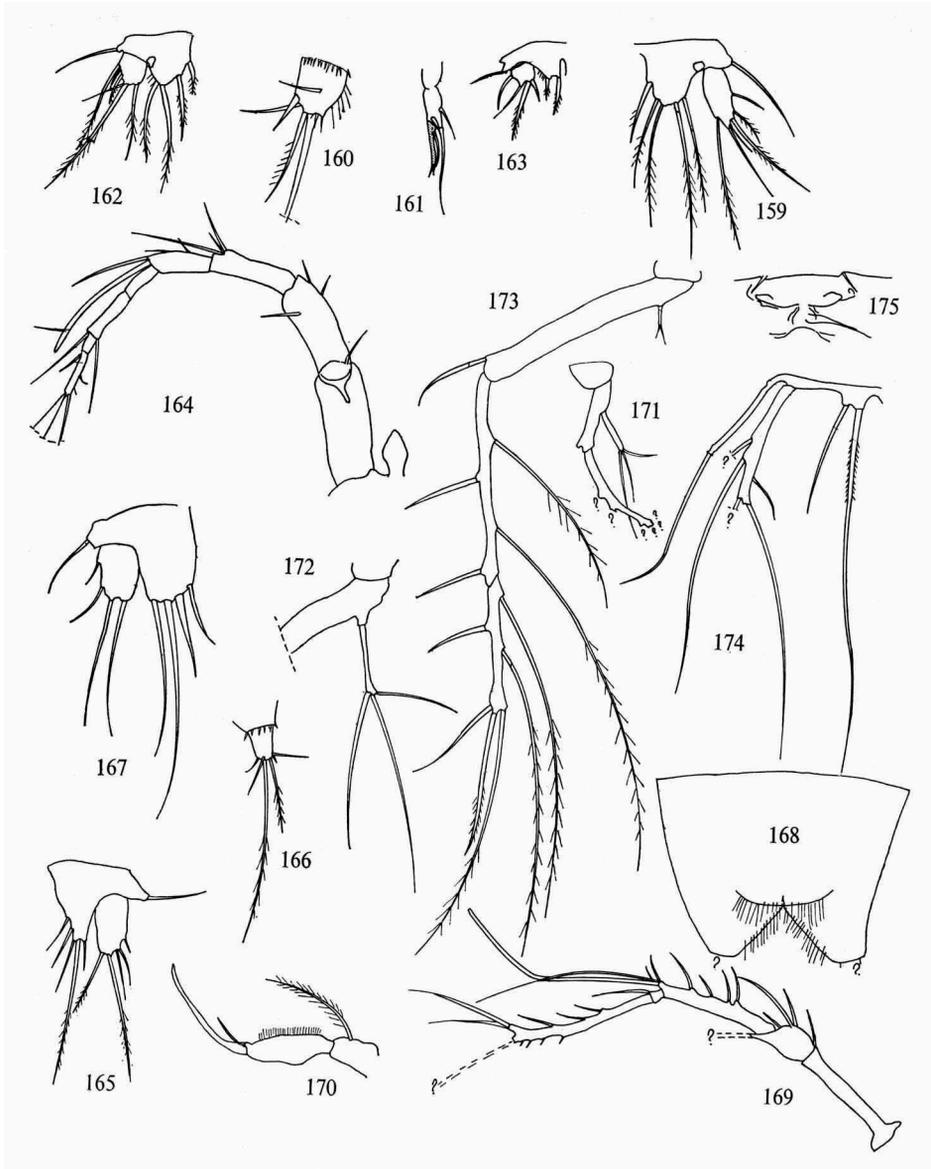
Plate 15, fig. 159. *Proameira dubia* (Sars), P V of female.
Fig. 160-163. *Schizopera neglecta* Akatova. 160, furca; 161, endopodite of P II of male; 162, P V of female; 163, P V of male.
Fig. 164, 165. *Ameiropsis longicornis* Sars, female. 164, rostrum and A I; 165, P V.
Fig. 166, 167. *Pseudameira crassicornis* Sars. 166, furca; 167, P V of female (× 300).
Fig. 168-175. *Anoplosoma sordidum* Sars, female. 168, furca; 169, A I; 170, maxillipede; 171, P I; 172, endopodite of P II; 173, P IV; 174, P V; 175, genital field.

AMEIRIDAE

Proameira dubia Sars, 1920 (pl. 15 fig. 159)

Material examined. — 1 ♀ from station 149.

Length. — ♀, 0.78 mm; reported length: 0.90 mm.

Previous records. — Norway, Sweden.

Remarks. — Our specimen strongly resembles those from northern waters. The only noteworthy difference is the presence of a small hyaline spot on the basiendopodite of P V, resembling that found in *Proameira simplex* (Norman & T. Scott).

Nitocra minor Willey, 1930 (pl. 14 fig. 155-158)

Material examined. — 16 ♀ and 8 ♂ from station 34.

Length. — ♀, 0.45 mm; ♂, 0.40 mm; reported length: ♀, 0.56 mm; ♂, 0.35 mm.

Previous record. — Bermuda.

Ecological preference. — Rock pools?

Remarks. — Our specimens must be considered to belong to *Nitocra minor*: the highly peculiar characters like the spine armature of the abdominal segment and the operculum, the armature of the swimming legs, the armature of P V and the shape of the modified spine on the basipodite of P I of the male support such an identification. A few characters, like the presence of a hyaline spot on the basiendopodite of P V and also the different P V of the male, indicate perhaps some relation to *Nitocra mediterranea* (Brian). In some points the present material resembles *Nitocra affinis* Gurney.

Ameiropsis longicornis Sars, 1907 (pl. 15 fig. 164, 165)

Material examined. — 1 ♀ from station 91.

Length. — ♀, 0.67 mm; reported length: 0.60 mm.

Previous records. — Norway, Ireland.

Remarks. — Our specimen on the whole resembles the type specimens. The shape of the rostrum, however, is noteworthy. The exopodite of P V is broader and the basiendopodite is longer than in northern specimens.

Pseudameira crassicornis Sars, 1911 (pl. 15 fig. 166, 167)

Material examined. — 1 ♀ from station 102.

Length. — ♀, 0.30 mm(!); reported length: ♀, 0.52 mm.

Previous records. — Norway, Sweden, Scotland.

Remarks. — In our specimen which is almost typical, only two aberrant features were noted: the fact that the median seta on the exopodite of A II is slightly longer, and that the furcal rami are shorter than in the type.
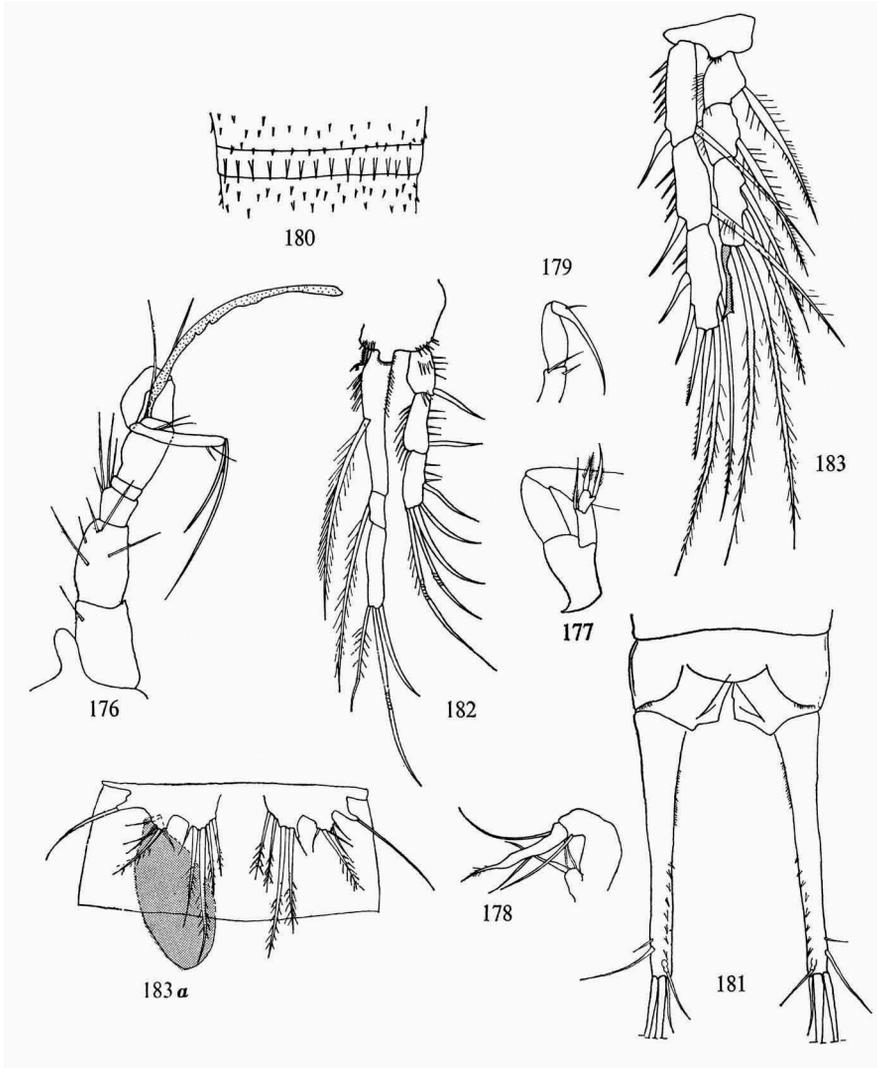
Plate 16, fig. 176-183a. *Haifameira archibenthoica* n. sp., male. 176, rostrum and A I; 177, exopodite of A II; 178, maxillula; 179, maxillipede; 180, abdominal segment in ventral view; 181, furca in dorsal view; 182, P I; 183, P III; 183a, P V.

Haifameira archibenthoica n. gen., n. sp. (pl. 16 fig. 176-183a)

Material examined. — 1 ♂ from station 104. The holotype is preserved

in the collection of the Zoology Department of the Hebrew University under
no. COP. 16.

Length. — ♂, 1.04 mm.

Ecological preference. — Bathyal muds?

Remarks. — The diagnosis of the only male is used also for a preliminary
diagnosis of the new genus.

Description. — The eye is present. The body is elongate, the rostrum
short, and tongue-like. The abdominal segments are ventrally covered with
scattered hairs, their edges bear a row of long setae. The furcal branches
are very long, almost 6 times longer than broad and are provided with a
row of small spinules along the inner edges. The operculum is rounded and
smooth.

The antennula is eight-segmented and forms a strong clasping organ. The
antenna has a basis and a bi-articulated exopodite which bears three strong
hairs. The mandible and the maxilla were not observed. The palp of the
maxillula is shown in pl. 16 fig. 178.

The endopodite of P I has its first segment slightly shorter than the exo-
podite; the last segment is almost three times longer than the second; the
first two segments bear a long and strong interior hair each, the last seg-
ments ends in three setae. The exopodite bears 5 setae on the last segment
and has no inner seta. The inner spine of the basipodite is modified (see
pl. 16 fig. 182).

The swimming legs have three-segmented branches and their armature is
as follows:

	Exopodite	Endopodite
P II	1.1.123	1.1.130
P III	1.1.123	1.1.230
P IV	1.1.223	1.1.230

The modified spine on the endopodite of P III resembles a similar for-
mation in species of the genus *Psyllocamptus*.

The two P V are fused to a single plate. The exopodite part bears 5 setae,
while the basiendopodite part bears also 5 setae, of which the innermost is
very small and starts from a prominence.

Discussion. — The exact position of this very large Ameirid within the
family is not clear. As shown above, the modified P III resembles that of
a *Psyllocamptus*. The armature of the legs somewhat recalls that of *Pro-
ameira*, *Pseudameira* or *Ameiropsis*. Although *Haifameira* has a strongly
elongated body, antennae and furca like the Stenocopiinae and also lives in
deep sea muds, it is possible that it should rather be placed in the Ameirinae.

Anoplosoma sordidum Sars, 1911 (pl. 15 fig. 168-175)

Material examined. — 1 ♀ from station 93.

Length. — ♀, 1.00 mm; reported length: ♀, 0.84 mm.

Previous record. — Norway (found only once).

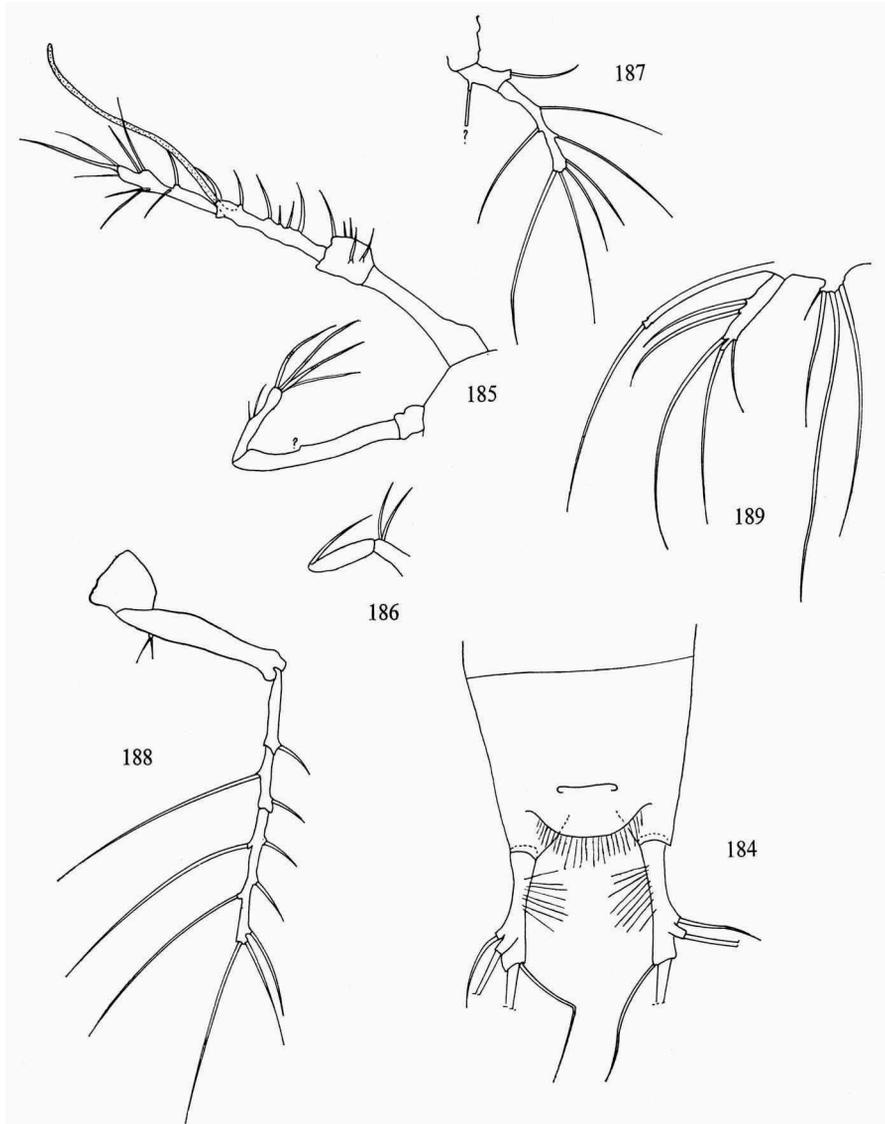Ecological preference. — Bathyal muds.

Plate 17, fig. 184-189. *Anoplosoma stryx* n. sp., female. 184, furca in dorsal view; 185, A I and A II; 186, maxillipede; 187, P I; 188, P IV; 189, P V.

Remarks. — Our somewhat damaged specimen undoubtedly belongs to this species. The differences from the original description are as follows. The furcal rami — although possibly damaged — seem to be unusually short. The endopodities of the legs are more elongate, as well as the exopodite of P V. The basis of the maxillipede bears only one seta, although the second was possibly torn off.

The armature of the legs is typical. The exopodites of the swimming legs are bi-articulated. The genital field is shown in pl. 15 fig. 175.

Anoplosoma stryx n. sp. (pl. 6 fig. 39, pl. 17 fig. 184-189)

Material examined. — 2 ♀ from station 93. The syntypes are preserved in the collection of the Zoology Department of the Hebrew University under no. COP. 17.

Length. — ♀, 0.82 and 0.85 mm.

Ecological preference. — Bathyal muds?

Remarks. — This is the second species of the genus *Anoplosoma*. A whole series of features of this species alter the original diagnosis of the genus.

Description. — ♀. The peculiar form of the body is shown in pl. 6 fig. 39. The operculum and the inner edge of the furcal branches bear long hairs. The furcal branches have the usual form of that of the Stenocopiinae, with lateral and superficial setae inserted on large prominences.

The antennula is six-segmented; the antenna has a small basis and its exopodite is reduced to a smooth insignificant knob. P I is similar to that of *Anoplosoma sordidum*.

The swimming legs have tri-articulated exopodites. The endopodites are more reduced than in *A. sordidum*. The exopodite of P V bears 5 setae, the basiendopodite 4 setae.

The male of this species is not known.

Discussion. — *Anoplosoma stryx* seems to be a more primitive species than *A. sordidum* since its antennula is six-segmented and the exopodites still three-segmented. The richer armature of the basiendopodite of P V is an additional indication in this direction.

The meaning of the adaptative line *Stenocopia-Malacopsyllus-Anoplosoma* has already been discussed in the general part.

Tetragonicepsidae

Phyllopodopsyllus medius n. sp. (pl. 18 fig. 190-195)

Material examined. — 3 ♀ and 2 ♂ from stations 99 and 102. The syn-
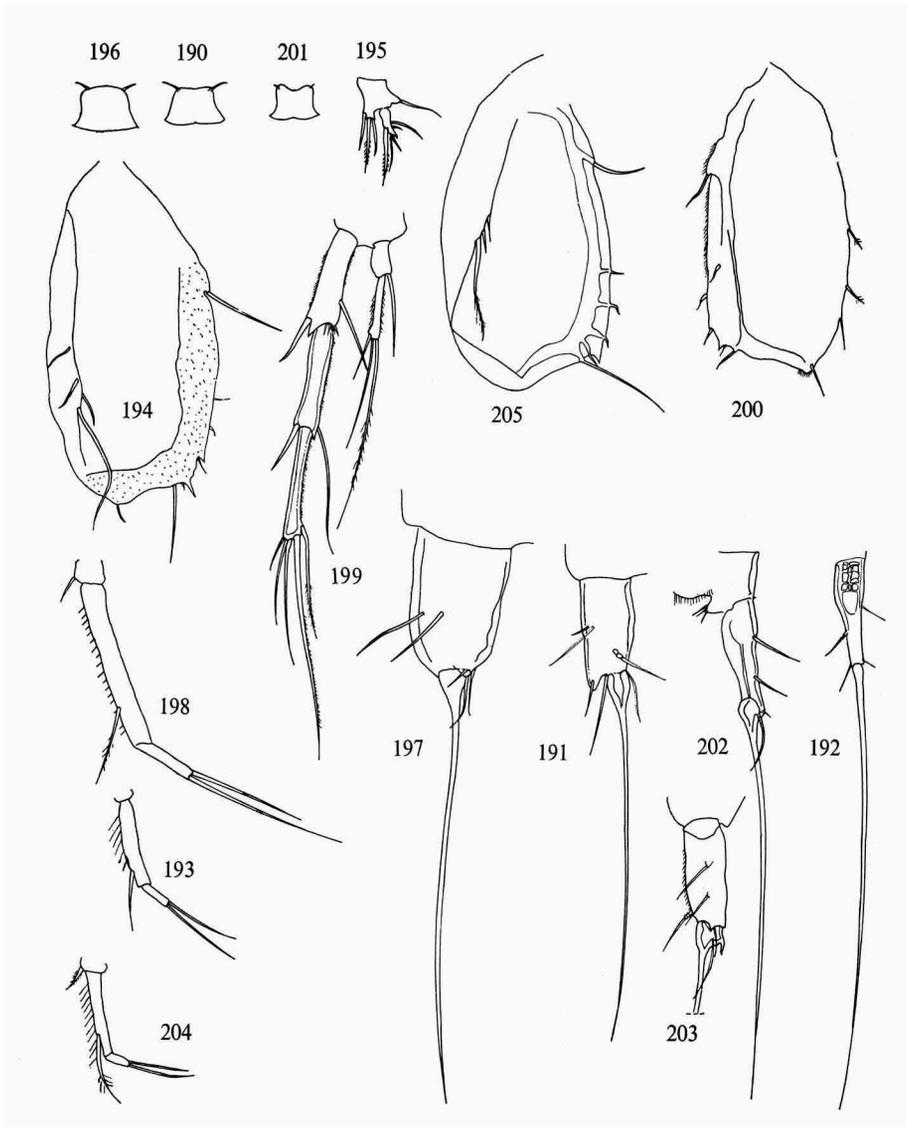
Plate 18, fig. 190-195. *Phyllopodopsyllus medius* n. sp. 190, rostrum; 191, furca of female; 192, furca of male; 193, endopodite of P I; 194, P V of female; 195, P V of male.

Fig. 196-200. *Phyllopodopsyllus laticauda* n. sp., female. 196, rostrum; 197, furca; 198, endopodite of P I; 199, P IV; 200, P V (× 50).

Fig. 201-205. *Phyllopodopsyllus* aff. *furciger* Sars, female. 201, rostrum; 202, furca in dorsal view; 203, furca in lateral view; 204, endopodite of P I; 205, P V of female.

types are preserved in the collection of the Zoology Department of the Hebrew University under no. COP. 18.

Length. — ♀, 0.65-0.82 mm; ♂, 0.65 mm.

Ecological preference. — Gravels and sublittoral mud?

Description. — ♀. The shape of the rostrum is shown in pl. 18 fig. 190. The furcal rami are quadrangular, their length exceeds about twice their width and their inner angle is produced; the inner apical seta of the furca has an inflated base.

The antennula bears a typical spur on the second segment. The last segment of the endopodite of P I exceeds its width more than 4 times.

The armature of the swimming legs is shown here in comparison with that of the other species of the genus:

	P II		P III		P IV	
	Exop.	Endop.	Exop.	Endop.	Exop.	Endop.
P. medius n. sp.	1.0.022	0.12	1.0.022	0.12	1.0.230	1.12
P. laticauda n. sp.	1.0.022	0.12	1.0.022	0.12	1.1.230	1.12
P. furciger Sars	1.0.122	0.12	1.0.222	1.12	1.1.230	1.12
P. bradyi Scott	1.0.122	0.12	1.0.222	0-1.2-3	1.1.2(-3)22	1.2-3
P. aegyptiacus Nicholls	1.0.122	0.12	1.0.222	0.12	1.1.321	1.12
P. xenus (Kunz)	1.0.112	0.02	1.0.112	0.02	1.0.321	0.12
P. trichophorus (Kunz)	1.0.112	1.12	1.0.112	1.12	1.0.322	1.12

Phyllopodopsyllus medius shows a reduction of the armature of the last segments of the exopodites of P II and P III, as well as a reduction of the seta on the median exopodite segment of P IV. The lack of these setae somewhat reminds one of the formulae of species of the genus *Pteropsyllus*.

P V has a spiniform prominence on the external angle; the inner angle bears a seta. The setae of the external side are short and small; the lowest setae of the inner side are very long.

♂. The furca is bulbiform and much narrower than in the female; the apical seta occupies the whole distal edge, but is not inflated at its base like in the female. P V has distinct segments; the exopodite bears 5 setae and the basiendopodite 3.

Discussion. — The systematics of the Tetragonicepsidae, the genus *Phyllopodopsyllus* included, are far from clear. The amount of newly discovered species, chiefly from tropical areas is also steadily increasing. Unfortunately, however, the armature of the swimming legs is not known in all species. It is clear that diagnoses of the species of *Phyllopodopsyllus* cannot be based exclusively on the shape of the furca. *P. medius* shows, as far as the armature of the legs is concerned, some resemblance to the West-African species described by Kunz (1961).

Phyllopodopsyllus laticauda n. sp. (pl. 18 fig. 196-200)

Material examined. — 1 ♀ from station 76-81. The holotype is preserved in the collection of the Zoology Department of the Hebrew University, under no. COP. 19.

Length. — ♀, 1.14 mm.

Description. — The large dimensions are the most striking character of this species. The rostrum, however, is relatively small, with a rounded outline. The furcal branches are quadrangular and slightly tapering, with the length exceeding the width by only 1.40 times. The apical seta of the furca has a broadened base, but is not bulbiform.

The length of the last segment of the endopodite of P I, exceeds 5 times its width. The armature of the swimming legs is very much like that of *Phyllopodopsyllus medius* (see the comparative table under that species), with the only difference that the median segment of the exopodite of P IV bears a seta. P V is also very much like that of the previous species, but is at least twice as large.

Discussion. — This species, found in detritic sands, is very similar to *Phyllopodopsyllus medius*, but size, shape of the furca and the small difference in the armature, in our opinion justifies its recognition as a different species.

Phyllopodopsyllus aff. **furciger** Sars, 1907 (pl. 18 fig. 201-205)

Material examined. — 1 ♀ from station 88.

Length. — ♀, 0.65 mm; reported length: ♀, 0.73 mm.

Previous record. — Norway (a single female specimen found by Sars).

Remarks. — Since this species has been described after a single specimen, the small differences shown by our specimen may well fall within the limits of interspecific variation, the more so since such important characters like furca and P V are identical.

The rostrum is shown in pl. 18 fig. 201. The last segment of the endopodite of P I is much shorter than in the northern specimen and its length exceeds its width by only 2.5 times. The formula of the armature of the swimming legs is shown in the comparative table on p. 101. In our specimen, the formula of the exopodite of P IV is different from that of *P. bradyi* Scott, and not identical as stated by Sars for his specimen.

Protogoniceps hebraeus n. gen., n. sp. (pl. 19 fig. 206-216)

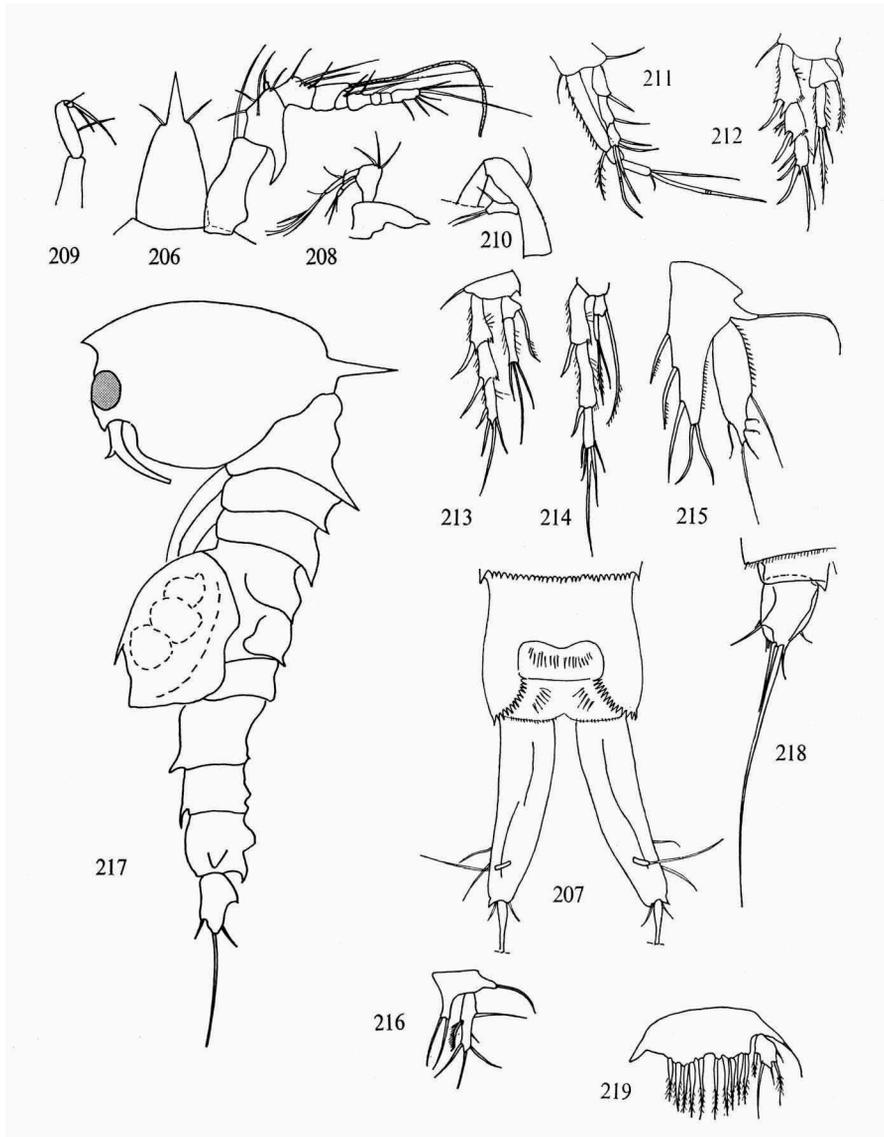Material examined. — 1 ♀, 2 ♂ and 2 copepodites from station 99. The

Plate 19, fig. 206-216. *Protogoniceps hebraeus* n. sp. 206, rostrum and A I of female; 207, furca; 208, mandible; 209, maxillipede; 210, exopodite of A II; 211, P I of female; 212, P II of female; 213, P III of female; 214, P IV of female; 215, P V of female; 216, P V of male.

Fig. 217. *Willeyella horrida* n. sp., habitus of female.

Fig. 218, 219. *Rhizothrix curvata* Brady & Robertson. 218, furca; 219, P V of female.

syntypes are in the collection of the Zoology Department of the Hebrew University under no. COP. 20.

Length. — ♀, 0.83 mm; ♂, 0.79 mm.

Ecological preference. — Gravels?

Remarks. — The diagnosis of the species, which is the type species of the genus *Protogoniceps*, is also the provisional diagnosis of this new genus.

Description. — ♀. The rostrum is pointed. The operculum is a non-denticulated, straight-edged plate, with a row of superficial hairs. The length of the furcal rami exceeds about 4 times their width; a longitudinal furrow can be observed.

The antennula is nine-segmented, with a strong and curved spur on the second segment. A II has a fairly large and uni-articulated exopodite which bears 3 setae. The mandible is shown in pl. 19 fig. 208. The maxillula has a small exopodite and inconspicuous endopodite. The maxilla has 5 endites. The maxillipede is shown in pl. 19 fig. 209.

The endopodite of P I is formed of two segments; the last segment of the exopodite bears 5 setae. The armature of the swimming legs is shown in the following comparative table of the genera of Tetragonicepsidae:

	P II		P III		P IV	
	Ex.	End.	Ex.	End.	Ex.	End.
Pteropsyllus	0.0.022	1.03	0.0.022	1.02(-3)	0.0.022	1.02(-3)
Paraphyllopodopsyllus	1.0.022	1.03	1.0.022	1.03	0.0.022	1.02(-3)
Willeyella	0.1.222	1.03	0.1.222	1.03	0.1.0(-1)12	1.01
Diagoniceps	0.1.122	1.03	0.1.122	1.03	0.1.2(-3)22	1.121
Tetragoniceps	?	?	1. ?	1.03	1. ?	1.02(-3)
Protogoniceps	0.0.023	1.03	0.0.022	1.03	0.0.131	1.02

For *Phyllopodopsyllus*, see comparative table on page 101.

P V is clearly bi-articulated, primitive, not foliaceous. The exopodite bears 6 setae and the basiendopodite 5.

♂. P V of the male has an exopodite which bears 6 setae like in the female, but the setae are comparatively much larger. The basiendopodite bears 2 setae.

Discussion. — The new genus shows a mixture of the characters of other genera of Tetragonicepsidae. A revision of this family is much needed. The rostrum and the armature of the swimming legs, for instance, show affinities to *Pteropsyllus*. The primitive feature of P V and the nine-segmented A I resemble those of *Tetragoniceps*, while the spur on the second antennular segment is a character proper to *Phyllopodopsyllus*. In the meanwhile, *Protogoniceps* may be considered as something like a collective ancestor of the various genera of Tetragonicepsidae.

Willeyella nov. gen.

Two species are placed here in this new genus, viz., *Willeyella armata* (Willey, 1935) (= *Phyllopodopsyllus armatus* Willey, 1935; a species considered by Lang, 1948, as incertae sedis) and *Willeyella horrida* n. sp. from our Levantine material. The generic diagnosis is based on the characters common to the females of the two species, while in the diagnosis of the male characters only those of the first species could be used. The type species of the new genus is *Phyllopodopsyllus armatus* Willey, 1935.

Diagnosis. — ♀. The rostrum is reduced, not articulated. The cephalothorax shows two pointed posterolateral processes, while on the abdominal segments there are pointed ventral spurs.

A I bears a strong process or spur on the first segment. A II with a basis, and a uni-articulated exopodite bearing a long, strong and modified apical seta. Mandible with a well developed exopodite and endopodite. Maxillula also with both exopodite and endopodite present. Maxilla with 5 endites, 2 of these being more or less fused. The maxillipede is slender and prehensile.

P I with a three-segmented exopodite and a two-segmented endopodite. The exopodite bears no inner setae and has 4 apical setae. The endopodite has 2 apical setae. The swimming legs have tri-articulated exopodites and bi-articulated endopodites: the segments of the first endopodite are conspicuously broadened in their distal part. The formula of the armature of the swimming legs is shown in the comparative table under *Protogoniceps hebraeus*. P V is modified, with a single foliaceous limb. The genital area (of *Willeyella horrida*) is shown in pl. 20 fig. 229.

♂ — The endopodites are strongly modified. P V is bi-articulated.

Willeyella horrida n. sp. (pl. 19 fig. 217; pl. 20 fig. 220-230)

Material examined. — 1 ♀, and 1 nauplius(?) from station 99. The female holotype is preserved in the collection of the Zoology Department of the Hebrew University under no. COP. 21.

Length. — ♀, 1.20 mm.

Ecological preference. — Gravel?

Description. — Only the points in which the present new species differs from *Willeyella armata* are listed. The body is hairy; there seems to be no operculum, but there are two strong interfurcal spines. The furcal branches are elliptical, with a strong spiniform lateral process. A I is formed of 8 segments; the second segment bears an articulated spur of the shape usual in the Tetragonicepsidae. The apical seta of the exopodite of A II is only slightly modified. The 5 endites of the maxilla are distinctly separated. The segments of the endopodite of P I are longer. The exopodite of P IV has

an aberrant armature: its last segment bears only four setae, of which three are strongly reduced, the inner one being very long and strong, with a peculiar penicillated tip; the inner seta on the median segment is also strongly reduced.
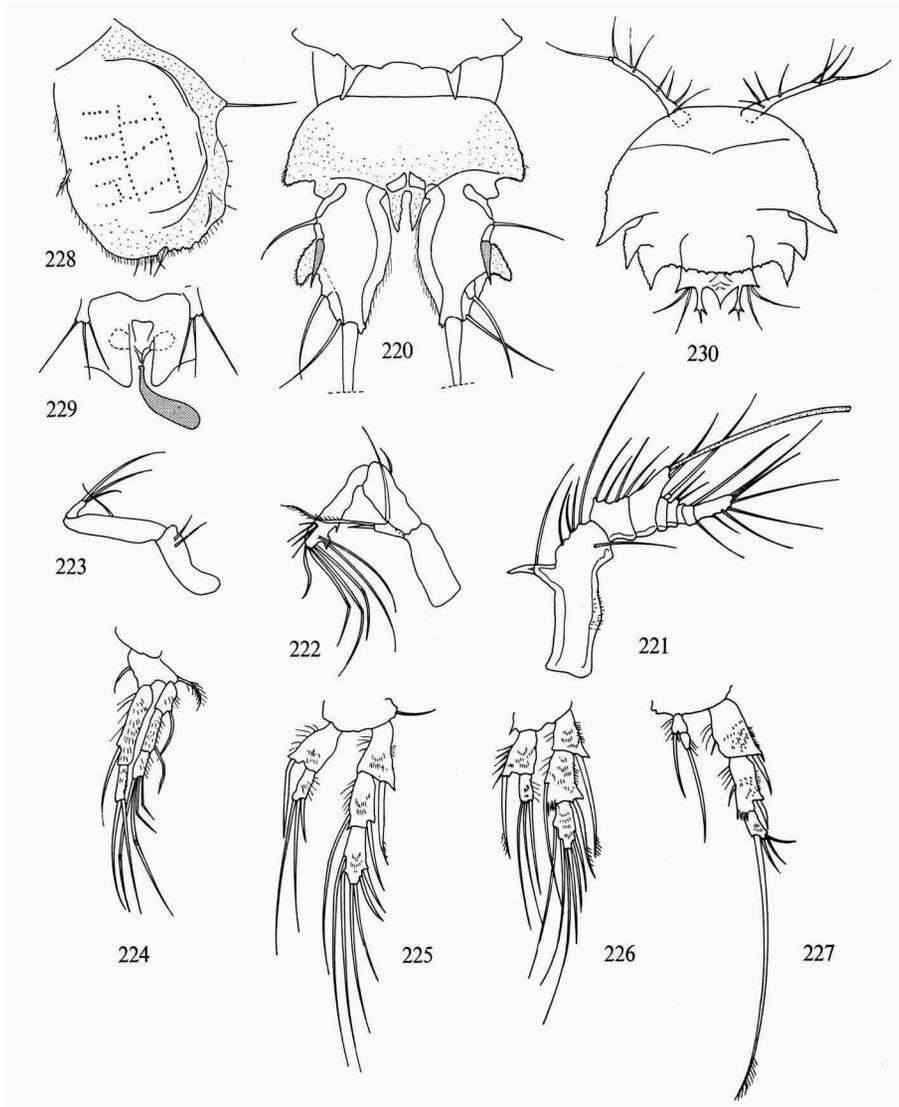

Plate 20, fig. 220-230. *Willeyella horrida* n. sp., female. 220, furca; 221, A I; 222, A II; 223, maxillipede; 224, P I; 225, P II; 226, P III; 227, P IV; 228, P V (× 50); 229, genital field; 230, nauplius (× 50).

P V cannot be compared with that of *W. armata* since the figure of that leg of the Bermudan species is not very clear. The dimensions of our specimen (1.20 mm) against the 0.80 mm of the female of Willey's species also is noteworthy.

CLETODIDAE

Cletodes limicola Brady, 1872 (pl. 21 fig. 231-241)

Material examined. — 20 ♀ and 11 ♂ from stations 7, 84, 90, 91, 95, 99 and 102.

Length. — ♀, 0.56-0.62 mm; ♂, 0.54-0.59 mm; reported length: ♀, 0.55-0.65 mm; ♂, somewhat smaller.

Previous records. — Norway, Sweden, Scotland, England, Ireland, Algeria, Red Sea, Indian Ocean.

Ecological preference. — Sublittoral muds mainly.

Discussion. — A very interesting phenomenon observed in our specimens is the variability of the shape of the furcal branches in the females. In the males the furcal branches seem to be always of the narrow type which apparently predominates also among the females.

A similar phenomenon was studied by Mrs. A. Marcus and the author several years ago in *Enhydrosoma sordidum* Monard in the Black Sea. Hundreds of specimens from various biotopes and different seasons were then studied and it was found that the phenomenon of the swollen furcal branches appears only in females, being apparently unrelated to external factors. Now, since the same phenomenon is found also in the morphologically quite different *Cletodes limicola* and apparently in an identical manner as in *E. sordidum* it seems that its explanation must be found on a generic level in the two genera *Cletodes* and *Enhydrosoma*. The easiest explanation, that of a phenomenon of gynandromorphism in several females, must be rejected since the females with a male-type furca in both cases are in the majority.

Rhizothrix curvata Brady & Robertson, 1880 (pl. 19 fig. 218, 219)

Material examined. — 1 ♀ from station 84.

Length. — ♀, 0.55 mm; reported length: ♀, 0.55-0.60 mm.

Previous records. — Norway, Scotland, England, Ireland, France (Roscoff).

Remarks. — This is the first record of this species and also of the genus *Rhizothrix* from the Mediterranean. A related species, *Rhizothrix pubescens* Por has recently been described by us from the Black Sea (see below).

Our Levantine specimen corresponds exactly with northern specimens of the species, as illustrated by our two figures.
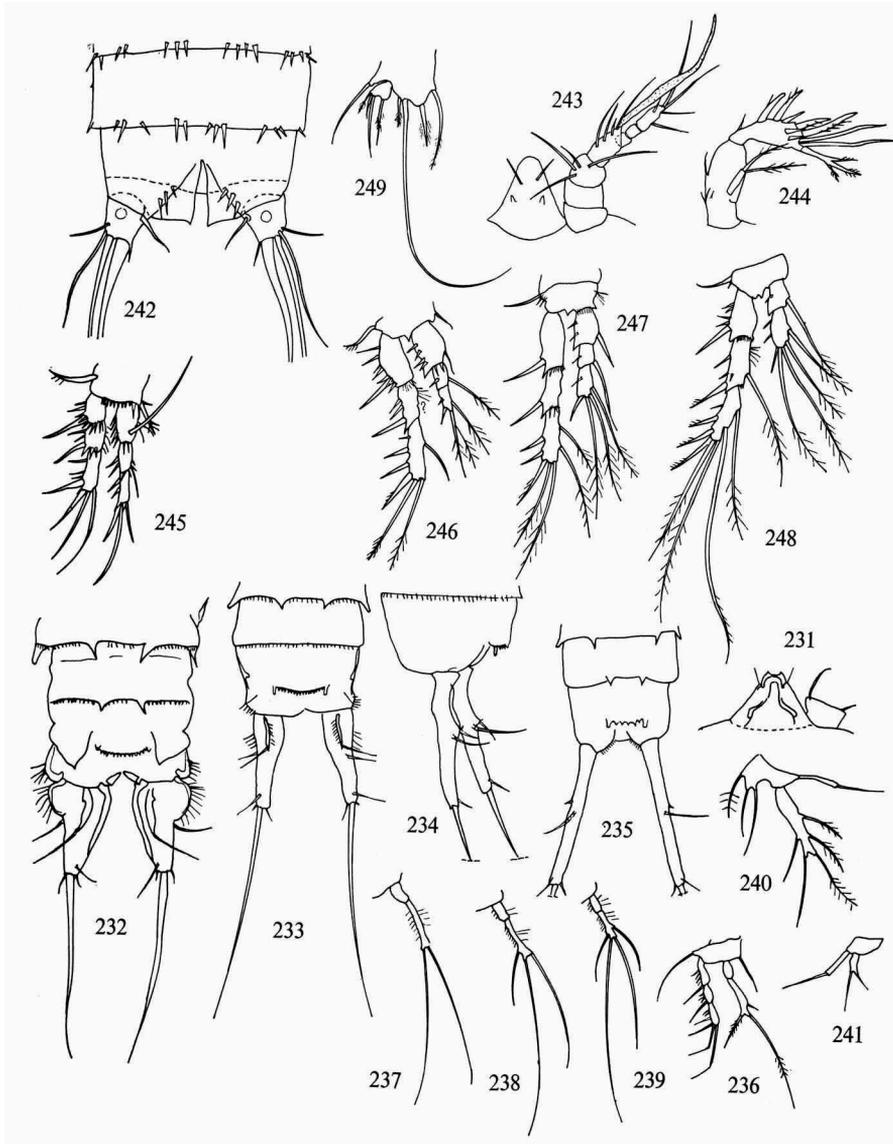
Plate 21, fig. 231-241. *Cletodes limicola* Brady. 231, rostrum; 232, 233, furca of female; 234, furca of female in lateral view; 235, furca of male; 236, P I of female; 237, endopodite of P II of female; 238, endopodite of P III of female; 239, endopodite of P IV of female; 240, P V of female; 241, P V of male.
Fig. 242-249. *Hemimesochra derketo* n. sp., female. 242, furca and last abdominal segment; 243, rostrum and A I; 244, A II; 245, P I; 246, P II; 247, P III; 248, P IV; 249, P V.

Rhizothrix pubescens Por, 1959

Material examined. — The syntypes are preserved in the Museum "Grigore Antipa", Bucharest, under no. 31.

Description. — ♀. Length 0.65 mm. The antennula is like that of *R. curvata* Brady & Robertson with the only difference that the second segment, instead of a simple seta, bears two spinulated setae which are directed backward like spurs (Por, 1959, pl. 2 fig. 19). The exopodite of the antennna has 4 setae, the apical of which is strong and spiniform (Por, 1959, pl. 2 fig. 20). The armature of the legs shows nothing remarkable except for the armature of the endopodite of P IV which is formed of 4 instead of 3 setae (Por, 1959, pl. 2 fig. 23). The exopodite of P V is rounded; its length does not exceed its width (Por, 1959, pl. 2 fig. 24). The armature of the basiendopodite consists, like in the exopodite, of 5 setae (the specimen shown in our figure is asymmetrical in this respect). The peculiarity of our species is the fact that the whole body is thickly covered with hair, the antennae and the legs included. The furca is similar to that of *R. curvata* (see Por, 1959, pl. 2 fig. 26).

♂. Same length as the female. Only P V shows dimorphic characters (Por, 1959, pl. 2 fig. 25), its basiendopoditic part bears two setae.

Mesocletodes monensis (I. C. Thompson, 1893) (pl. 22 fig. 250-252)

Material examined. — 5 ♀ from stations 93 and 138.

Length. — ♀, 0.75-0.80 mm; reported length: ♀, 0.90 mm.

Previous records. — Norway, Sweden, Scotland, England (Port Erin).

Ecological preference. — Bathyal muds.

Remarks. — Our specimens closely resemble the type specimens of the species. The dorsal edges of the abdominal segments bear denticles; such denticles are also found on the last segment above the furcal branches. The last segment also bears superficial denticles ventrally. The operculum is slightly hairy. The furcal branches are long, but somewhat shorter than in the type specimens. There is a spine on the cephalothorax but the spine on the last abdominal segment is simple, and thus unlike that of northern specimens.

A I is eight-segmented, the second segment is qudrangular and broadened. The exopodite of A II bears a very long and a short seta. The mandibular palp is uni-ramous and uni-articulated. P I, the swimming legs and P V are as in the northern specimens.

Discussion. — The genus *Mesocletodes* had so far not been reported from the Mediterranean. *Mesocletodes monensis* and the following new species
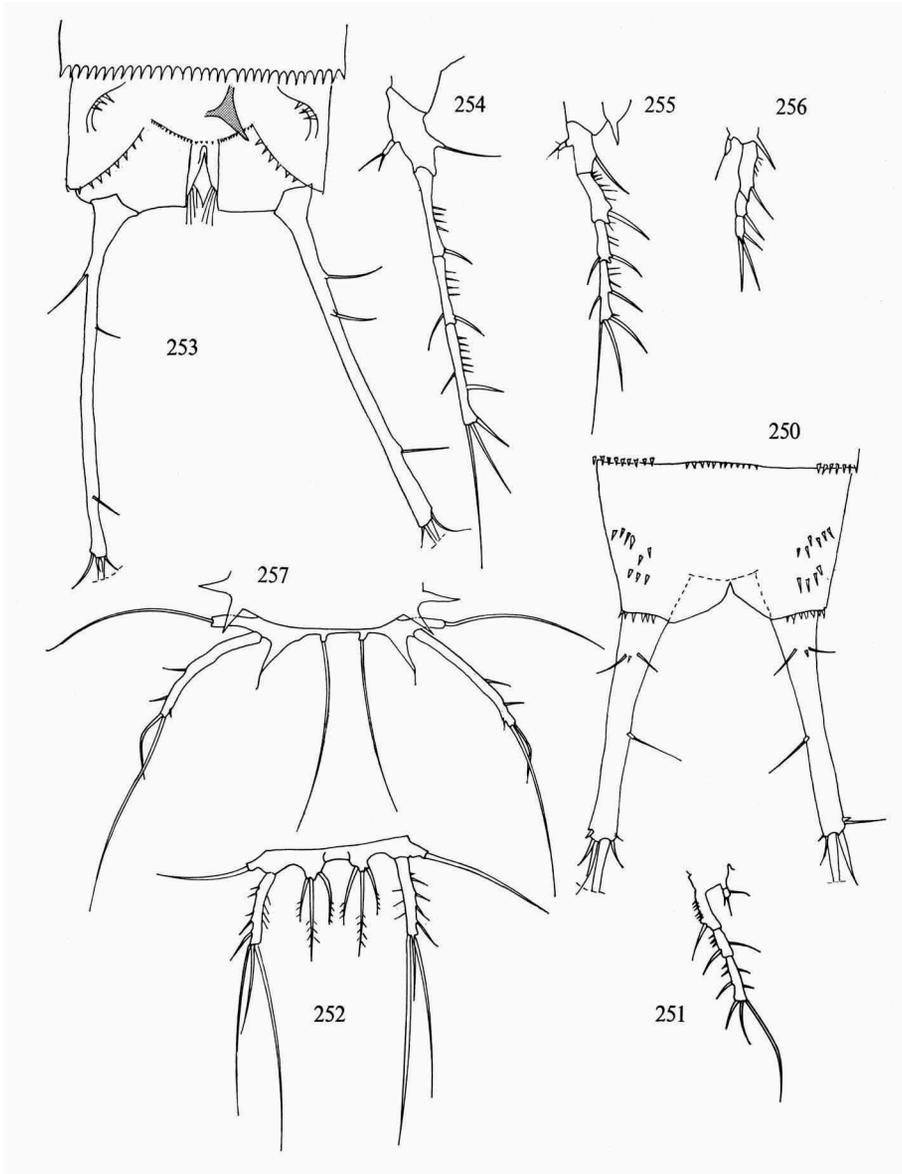
Plate 22, fig. 250-252. *Mesocletodes monensis* (I. C. Thompson), female. 250, furca in
ventral view; 251, P II; 252, P V.
Fig. 253-257. *Mesocletodes bathybia* n. sp., female. 253, furca in dorsal view; 254, P IV;
255, P II; 256, P I; 257, P V.

Mesocletodes bathybia are found in deep-sea muds as are also the northern representatives of this genus.

Mesocletodes bathybia n. sp. (pl. 22 fig. 253-257)

Material examined. — 3 ♀ from station 104. The syntypes are preserved in the collection of the Zoology Department of the Hebrew University under no. COP. 22.

Length. — ♀, 0.85-0.89 mm.

Ecological preference. — Bathyal muds?

Description. — ♀. All the thoracic segments (the cephalothorax included) have both dorsal and ventral edges cut out in the form of a strong denticulation (in pl. 22 fig. 253 the denticulation of the last thoracic segment is shown). These tooth-like serrations are found also on the lateral edges of the cephalothorax. The abdominal segments (the last segment included) show a somewhat smaller denticulation dorsally. The operculum bears only a fringe of minute hairs. The furcal rami are extremely long and slender, with the lateral seta in the proximal quarter. There is a medio-dorsal spine on the cephalothorax and a single or double one on the last abdominal segment.

The antennula is six-segmented, with the second segment broad. The exopodite of the antenna is represented by two setae. The mandible has a uniramous and uni-articulated palp.

The endopodite of P I bears only one seta. The exopodite has a strongly reduced inner seta. The first segment of the exopodite of all the swimming legs is almost as long as the following two segments. The armature of the legs is like in *Mesocletodes abyssicola* (T. & A. Scott). The endopodites of the swimming legs are reduced, uni-articulated, with two setae and sometimes a rudimental third one. The endopodite of P IV is articulated to the basis.

P V shows a conspicuous spine on the basiendopodite (similar to those of the thoracic edges). The exopodite bears 5 setae, the internal of which is strongly reduced: the basiendopodite bears a single long seta.

The male is unknown.

Discussion. — The differences from the nearly related *Mesocletodes abyssicola* are found in the armature of the thoracic and abdominal edges, the shorter A I, the reduced armature of the endopodite of P I, the short exopodites of the swimming legs and chiefly the structure and armature of P V.

Eurycletodes (Oligocletodes) parasimilis Por, 1959

Material examined. — The syntypes are preserved in the Museum "Grigore Antipa", Bucharest, under no. 30.

Description. — ♀. Length 0.55 to 0.60 mm. The rostrum, antennula and antenna like in *E. (O.) similis* (T. Scott). P I has the same armature as that species, the endopodite, however, being much shorter and even failing to reach the middle of the second segment of the exopodite (Por, 1959, pl. 4 fig. 39). The endopodites of the other legs are likewise characterized by their shortness (Por, 1959, pl. 4 figs. 40-42). The armature of the last segments of the endopodite of P II, P III, and P IV is peculiar and formed of 3, 4 and 4 setae. In *E. (O.) similis* the respective formula is 4, 5, 4 while in *E. (O.) versimilis* it is 3, 3, 3. It must be noted, however, that in one of our specimens the last segment of the endopodite of P III showed only 3 setae on one side.

The exopodite of P V (Por, 1959, pl. 4 fig. 43) is 3.5 times longer than broad. It bears 4 setae. The basiendopodite bears 2 setae. The abdominal segments are ornamented with small dimples. Dorsally they bear spinules while ventrally there are only small setae. The last abdominal segment has an additional transverse row of ventral setae across its middle. The operculum bears fairly strong spinules. The furca is short, triangular, with equal sides (Por, 1959, pl. 4 fig. 45).

♂. Length 0.52 to 0.58 mm. The endopodites are slightly longer than in the female. P V is like in the specimens of *E. (O.) similis* dealt with by T. Scott (1895) and Klie (1950) and not like those treated by Sars (1909) and Lang (1948), since it bears 2 setae on the basiendopodite part (Por, 1959, pl. 4 fig. 44).

Eurycletodes ephippiger n. sp. (pl. 23 fig. 258-262)

Material examined. — 3 ♀ from station 104. The syntypes are preserved in the collection of the Zoology Department of the Hebrew University under no. COP. 23.

Length. — ♀, 0.63 mm.

Ecological preference. — Bathyal muds?

Description. — ♀. The dorsal edges of the body segments are strongly denticulated; the epimera are produced. The rostrum is prominent and pointed. The operculum as well as its lateral sides are strongly denticulated. Dorsally the penultimate abdominal segment shows a smooth saddle-like chitinuous formation, with spinulated posterior and postero-lateral edges. The furcal branches are quadrangular and twice longer than broad.

The antennnula is six-segmented. The exopodite of A II is completely lacking. The mandible has a palp.

The endopodite of P I is as long as the exopodite, and bears 4 setae on the last segment. The exopodite bears an inner seta on the median segment
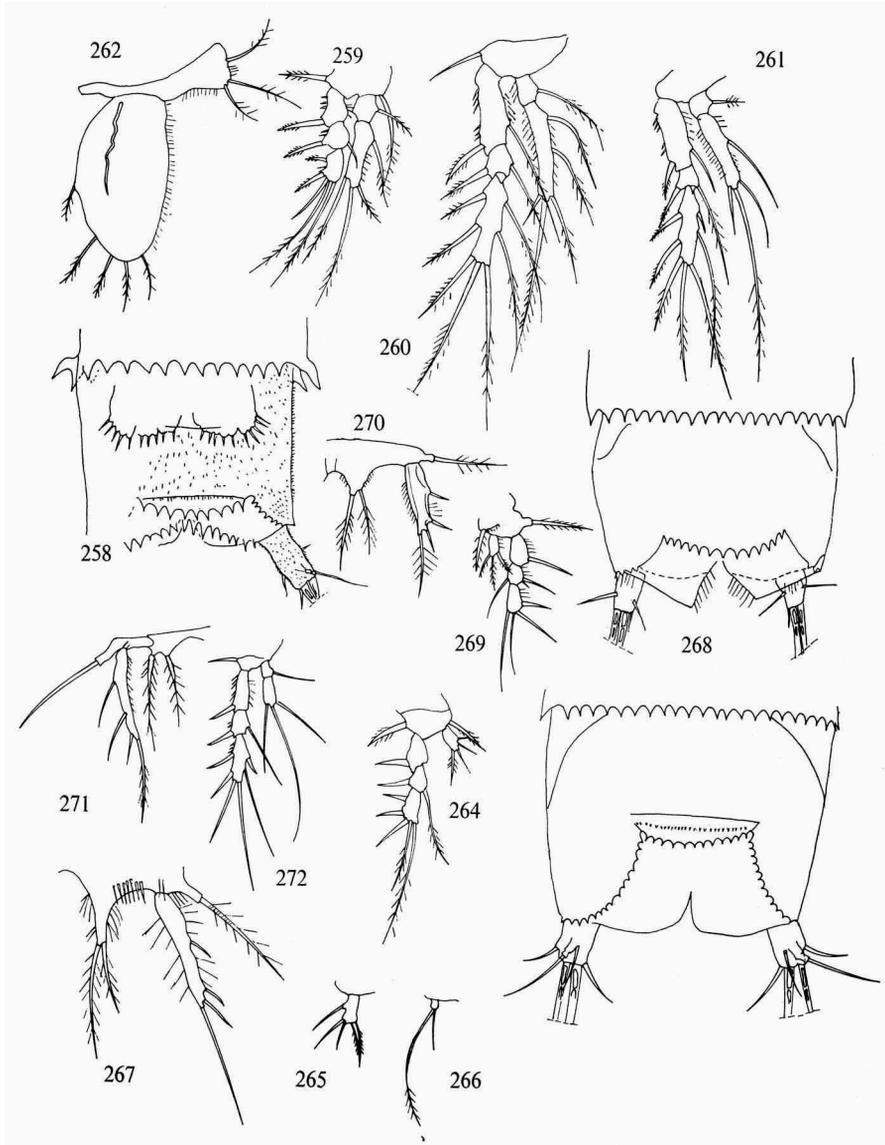
Plate 23, fig. 258-262. *Eurycletodes ephippiger* n. sp., female. 258, furca in dorsal view; 259, P I; 260, P II; 261, P IV; 262, P V.

Fig. 263-267. *Eurycletodes oblongus* Sars, female. 263, furca in dorsal view; 264, P I; 265, endopodite of P II; 266, endopodite of P IV; 267, P V.

Fig. 268-270. *Eurycletodes aculeatus* Sars, female. 268, furca in dorsal view; 269, P I; 270, P V.

Fig. 271, 272. *Eurycletodes versimilis* Willey, female. 271, P V; 272, P IV.

and five on the last one. The armature of the swimming legs is as follows:

	Exopodite	Endopodite
P II	1.1.223	1.221
P III	1.1.223	1.221
P IV	1.1.223	1.121

P V has a strongly broadened exopodite (less than twice as long as broad), bearing five fairly reduced setae. The basiendopodite is only slightly prominent and bears 3 setae.

The male has not been found.

Discussion. — This new species is undoubtedly closely related to *Eurycletodes laticauda* (Boeck) and *Eurycletodes serratus* (Sars) (perhaps more to the latter than to the former), two species living in the deep muds of northern seas. The specific traits of our species are found in the saddle-like dorsal formation, the armature of P I and P II, the shape of the furca and the phylliform exopodite of P V.

Eurycletodes oblongus Sars, 1920 (pl. 23 fig. 263-267)

Material examined. — 27 ♀ from stations 84, 93, 104, 130 and 152.

Length. — ♀, 0.67-0.75 mm; reported length: ♀, 0.80 mm.

Previous records. — Norway, Sweden, Denmark.

Ecological preference. — Deep, mainly bathyal muds.

Remarks. — As shown in the few figures added, our specimens agree perfectly with the type description. The only difference found is the different length relation of the setae on the various legs.

Eurycletodes aculeatus Sars, 1920 (pl. 23 fig. 268-270)

Material examined. — 1 ♀ from station 149.

Length. — ♀, 0.56 mm; reported length: 0.70-0.75 mm.

Previous records. — Norway, Sweden, Denmark.

Remarks. — Our specimen belongs undoubtedly to this species, as shown by its typical furca, reduced armature on the endopodites of P I and P II, and the short basiendopodite of P V. The endopodite of P V, however, is broader than in the type description.

Discussion. — It is of an outstanding interest that the twin species, *E. oblongus* and *E. aculeatus* which were found together in the northern seas, often in exactly the same localities and at similar depths, are also found together in an area so distant from their type localities. It is also worth while to note that in Lang's (1948) catches *E. aculeatus* is dominant and *E. oblongus* rare, while in our material the opposite is true.

Heteropsyllus dimorphus Por, 1959

Material examined. — The syntypes are deposited in the Museum "Grigore Antipa", Bucharest, under no. 29.

Description. — ♀. Length 0.44 to 0.53 mm. The rostrum is pointed. The antennula is five-segmented, with a structure typical for the whole genus (Por, 1959, pl. 3 fig. 27). The exopodite of the antenna bears three terminal setae. The last segment of the endopodite of P I (Por, 1959, pl. 3 fig. 28) is elongate and bears 3 setae. The exopodite does not reach the middle of the last segment of the endopodite. The endopodites of P II and P III (Por, 1959, pl. 3 fig. 29, 32) bear five setae on the last segments, while the last segment of P IV has only four. P V has a fairly elongate exopodite with 5 setae. The basiendopodite which likewise bears five setae does not reach the tip of the exopodite. There is a small hyaline spot at the base of the basiendopodite (Por, 1959, pl. 3 fig. 34). The abdominal segments bear short lateral rows of spinules while the operculum shows only a fringe of fine setae. The furca is about 1.5 times longer than broad (Por, 1959, pl. 3 fig. 36).

♂. Length 0.40 to 0.45 mm. The endopodite of P III is modified and formed of three segments; the last two segments bear a total of 4 setae instead of the 5 found on the last segment of the endopodite of P III of the female. From the penultimate segment arises a digitiform process which is sickle-shaped and extends beyond the last segment to a length equal to the length of this last segment (Por, 1959, pl. 3 fig. 30, 31). P V is formed of a slightly elongate exopodite bearing 4 setae (Por, 1959, pl. 3 fig. 35) and a basiendopodite, well separated, which bears 3 setae and reaches slightly beyond the middle of the exopodite. The ornamentation of the abdominal segments is formed here by a whole row of unequal small ventral spines. Dorsally they show only slender hairs. The furca seems to be shorter in the male than in the female.

Hemimesochra Sars, 1920

The genus is restricted here to the species *Hemimesochra clavularis* Sars, 1920, *Hemimesochra atargatis* (Por, 1961) (= *Mesopsyllus atargatis* Por) and *Hemimesochra derketo* n. sp. Though the differences between these three species are considerable, the identity of their mouthparts and of the structure of their P V justifies the creation, in a heterogenous family like the Cletodidae, of a comprehensive genus rather than that of three distinct monotypic genera. The proposed diagnosis of this genus is as follows.

Mesochra-like body. Triangular, short rostrum. Antennula 5- or 6-seg-

mented. Antenna with or without exopodite. Mandibular palp uni-ramous. Maxillula without separated exo- and endopodite. Maxilla with three endites. Maxillipede of the usual form. Endopodite segments of the swimming legs variable in number. Exopodite of P V much smaller than the large shield-like basiendopodite. Males unknown.

Hemimesochra derketo n. sp. (pl. 21 fig. 242-249)

Material examined. — 1 ♀ from station 96. The holotype is deposited in the collection of the Zoology Department of the Hebrew University under no. COP. 24.

Length. — ♀, 0.77 mm.

Description. — ♀. Ventrally the abdominal segments bear scattered groups of spinules. The furcal branches are trapezoidal, with their length equal to their width. The antennula is six-segmented. The antenna has a basis and an uni-articulated exopodite which bears 2 setae. The endopodite of P I is formed of three segments and so are the endopodites of P II and P III. Only the endopodite of P IV is two-segmented. The comparative formula of the leg armature in the three species of the genus is as follows:

	P I		P II		P III		P IV	
	Ex.	End.	Ex.	End.	Ex.	End.	Ex.	End.
H. clavularis	0.0.022	1.021	0.1.123	1.221	0.1.223	1.321	0.1.223	1.221
H. atargatis	0.1.121	1.1.120	0.1.123	0.111	0.1.223	1.121	0.1.223	1.121
H. derketo	0.0.121	1.1.120	0.1.123	1.1.120	0.1.223	1.1.220	0.1.223	1.221

Notable is the peculiar form and orientation of the inner seta on the first segment of the endopodite of P I.

P V has a small exopodite with 4 short and slender hairs. The basiendopodite bears also 4 setae, of which the second from the exterior is strong and very long, while the third is strong, short and pennate.

The male is unknown.

Discussion. — The new species *Hemimesochra derketo* is no doubt the most primitive of the three species of the genus, as shown among other things by the tri-articulated branches of the first three legs.

LAOPHONTIDAE

Laophonte cesareae n. sp. (pl. 24 fig. 273-281)

Material examined. — 21 ♀ and 9 ♂ from stations 1 and 2. The syntypes are deposited in the collection of the Zoology Department of the Hebrew University under no. COP. 25.

Length. — ♀, 0.50-0.55 mm; ♂, 0.52 mm.

Ecological preference. — Eulittoral phytal.

Description. — ♀. The rostrum is very short and blunt. The abdominal segments have no lateral expansions. Dorsally the abdominal segments have marginal denticles. Ventrally they bear marginal spinules. The operculum shows small denticles. The furca is nearly 3 times longer than broad. The inner side of the furcal branches has a proximal tuft of hairs.

The antennula is six-segmented; the fifth segment is very short. The antenna has a basis and an exopodite.

The branches of P I are bi-articulate. The endopodite has a strong terminal claw and a short slender terminal hair. The endopodites of P II and P III are bi-articulate, while the endopodite of P IV is formed of a single segment. The spine formula of these legs is as follows:

	Exopodite	Endopodite
P II	0.0.023	0.110
P III	0.1.023	0.210
P IV	0.0.023	1.—

P V has a prominent exopodite which bears 5 setae. The basiendopodite bears 4 setae.

♂. The last segment of the endopodite of P III bears, besides a normal seta, a strong, broadened and spiniform process, with a saw-like inner distal edge. P V has no basiendopodite; there are 5 spines on the exopodite; the internal of these is particularly strong.

Discussion. — Our species clearly belongs to the *"inopinata* group" of *Laophonte* (cf. Lang, 1948) but it is difficult to decide whether it is nearer to the nordic *Laophonte inopinata* T. Scott or to the Bermudan *L. longistylata* Willey.

Paronychocamptus leuke Por, 1959

Material examined. — The syntypes of the species are preserved in the Museum "Grigore Antipa" in Bucharest under no. 32.

Description. — ♀. Length 0.65 to 0.70 mm. The rostrum is triangular and prominent with a rounded tip (Por, 1959, pl. 5 fig. 57). The antennula is formed of 7 segments. The exopodite of A II bears 4 setae. The exopodite of P I is tri-articulate. The endopodite of P II bears 4 setae on the last segment (Por, 1959, pl. 5 fig. 59). The exopodite of P III bears a single inner seta on its last segment. The endopodite of P III has 5 setae (Por, 1959, pl. 5 fig. 61). P IV has the same reduced armature as in *P. exiguus* Sars (Por, 1959, pl. 5 fig. 62). The exopodite bears 3 setae. The exopodite of P V is 1.5 times longer than broad, with 5 setae. The basiendopodite has 4 setae, only 3 of which are inserted apically (Por, 1959, pl. 5 fig. 63). The
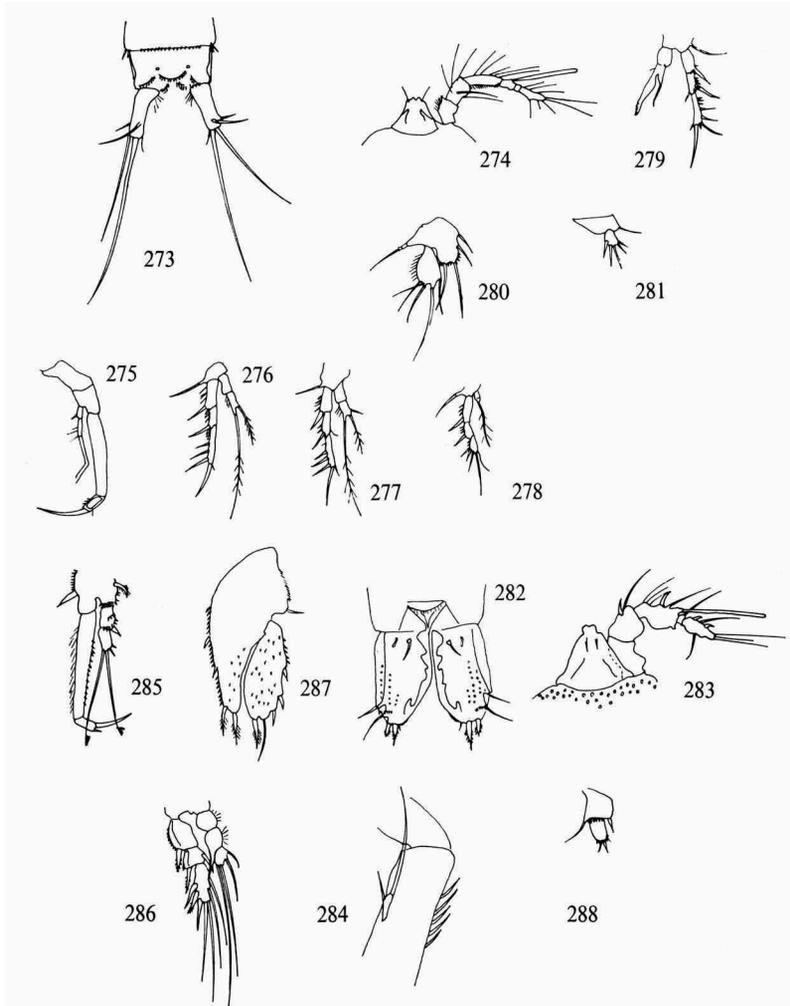
Plate 24, fig. 273-281. *Laophonte cesareae* n. sp. 273, furca in dorsal view; 274, rostrum and A I of female; 275, P I of female; 276, P II of female; 277, P III of female; 278, P IV of female; 279, P III of male; 280, P V of female; 281, P V of male. Fig. 282-288. *Asellopsis penicillata* n. sp. 282, furca in dorsal view; 283, rostrum and A I of female; 284, expodite of A II; 285, P I of female; 286, P II of male; 287, P V of female; 288, P V of male.

prominence on which the external seta of the basiendopodite (the basal seta) is inserted, is very long. In one of the specimens the basiendopodite of one side has only 4 setae. The furca is short, i.e., only 1.3 times longer than broad (Por, 1959, pl. 6 fig. 65).

♂. Length 0.51 mm. The exopodites of the swimming legs are only slight-

ly modified. The exopodite of P III, which ought to show the strongest dimorphism has only stronger spines than in the female. The shape of the segments, however, is similar. The endopodite of P III is tri-articulate. The second segment bears a tooth-like prominence which has a basal incision and a curved shape. The exopodite of P V (Por, 1959, pl. 5 fig. 64) is very short and broad and bears 5 setae. The basiendopodite portion has 2 setae.

Asellopsis penicillata n. sp. (pl. 24 fig. 282-288)

Material examined. — 9 ♀ and 2 ♂ from stations 39, 68, 69 and 70. The syntypes are preserved in the collection of the Zoology Department of the Hebrew University under no. COP. 26.

Length. — ♀, 0.50-0.59 mm; ♂, 0.49 mm.

Ecological preference. — Sublittoral sandy muds.

Description. — ♀. The rostrum is triangular with a bifid tip. The epimera of the abdominal segments are produced. The furcal branches are more than 1.5 to 2 times as long as wide. The apical furcal setae are very short. The internal chitinous ornamentation of the furcal branches is shown in pl. 24 fig. 282.

The antennula is formed of five segments (3 + 2). The antenna has a small, uni-articulated exopodite which bears two setae.

The endopodite of P I has two relatively short segments. The two apical setae are very long and bear apical tufts. The endopodites of P II and P IV bear 3 setae, the endopodite of P III bears 6 setae.

P V has a broad and oval exopodite, which slightly exceeds the basiendopodite. The 3 external setae of the exopodite are modified into very short spines, the two terminal ones (a spine and a seta) are also relatively short. In the same way, on the basiendopodite there are two strongly reduced internal spines and two longer apical spiniform setae.

♂. The endopodite of P III shows the typical spiniform external process on the second segment. The third segment bears only 4 setae. P V is shown in pl. 24 fig. 288 and bears 3 strongly reduced setae on the exopodite.

Discussion. — Our new species clearly belongs to the "Artenkreis" of *Asellopsis hispida* Brady & Robertson, *A. dubosqui* Monard and *A. bacescui* Por and obviously represents this group on the Levantine coasts. The striking specific features of our species are the penicillated setae of the endopodite of P I and the excessive shortness of the setae on P V and the furca.

Asellopsis bacescui Por, 1959

Material examined. — The syntypes are preserved in the Museum "Grigore Antipa", Bucharest, under no. 33.

Description. — ♀. Length 0.62 to 0.71 mm. The rostrum is shown in pl.
6 fig. 66 of our 1959 paper. The antennula is formed of four segments (Por,
1959, pl. 6 fig. 66). The exopodite of the antenna is reduced and bears only
2 setae (Por, 1959, pl. 6 fig. 67). The exopodite of P I is characterized by
its elongated second segment, which is 1.5 times longer than the first. The
first segment has a strong spiniform inner seta. The exopodites of P II to
P IV have 2 external spines on the last segments. The spine formula of the
last segments of the endopodite is respectively for P II: 1.2.0., for P III:
2.2.1., and for P IV: 1.1.1. The basiendopodite of P V is much shorter than
the exopodite and reaches only ¾ of its length. It bears 4 setae, the inner
of which are spiniform and relatively long. The exopodite has 5 setae, the
apical one being longest, the inner is also fairly long while the three exter-
nal setae are short (Por, 1959, pl. 6 fig. 72).

The abdomen is fairly flattened, the last two segments have no prominent
epimera (Por, 1959, pl. 6 fig. 77). The abdomen and the furca are covered
with minute dimples. The operculum has a fringe of minute spines. The
furca is only slightly longer than broad and with an almost quadrangular
outline. On the inner side of the furcal branches there is a chitinous orna-
mentation formed of 4 trabeculae on each side (Por, 1959, pl. 6 fig. 77).
The proximal three are more or less perpendicular to the edge of the furca,
the distal one is curved. A similar formation is figured for *Asellopsis du-
bosqui* by Monard. The apical setae of the furca are inserted in the middle
of the distal edge like in *Asellopsis hispida* Brady & Robertson.

♂. Length 0.47 to 0.50 mm. The antennula is modified. The endopodite
of P III has a produced median segment like in all species of this genus.
P V is highly variable as to its form but it is always provided with 3 setae.
The basiendopodite portion bears a seta (Por, 1959, pl. 6 figs. 73-76).

Esola typhlops pontoica Por, 1959

Material examined. — The syntypes are preserved in the Museum "Gri-
gore Antipa" in Bucharest under no. 34.

Description. — ♀. Length 0.67 to 0.69 mm. The antennula (Por, 1959,
pl. 7 fig. 80) resembles those of *Esola longiremis* (T. Scott) and *E. t. typh-
lops* (Sars). The exopodite of P I is generally bi-articulated, but we found
a specimen in which it was slightly tri-articulated on one side (Por, 1959,
pl. 7 fig. 82). The armature of the swimming legs resembles that of the
other species of the genus (*E. spelea* (Chappuis) excepted).

The armature of P V is specific: the exopodite bears 6 setae while the
basiendopodite has 5. The edges of the abdominal segments show both dor-
sal and ventral rows of spinules. The operculum has a complicate arma-

ture (Por, 1959, pl. 8 fig. 83). The furca is three times longer than broad.

Normanella serrata Por, 1959

Material examined. — The syntypes are preserved in the Museum "Grigore Antipa", Bucharest, under no. 34.

Description. — ♀. Length 0.48 to 0.60 mm. The antennula is formed of six segments. The rostrum is triangular with a blunt tip, surmounted by a pointed prominence (Por, 1959, pl. 7 fig. 84). P I to P IV have a structure and armature like in the other species of the genus. The exopodite of P V has a variable length: it is between 3.0 and 5.2 times longer than broad (Por, 1959, pl. 7 fig. 85). The basiendopodite is relatively short and reaches constantly only the middle of the exopodite. The posterior edges of all the segments, the cephalothorax included, are deeply cut-out, serrulated (Por, 1959, pl. 7 fig. 88). The lateral edges of the cephalothorax are also serrulated over a certain distance. The edges of the abdominal segments bear ventrally a row of setae increasing in length laterally (Por, 1959, pl. 7 fig. 87). The length of the furca is also highly variable: it is from 2.0 to 3.7 times longer than broad.

♂. Length 0.43 to 0.46 mm. One of the three males studied has the furca 4.8 times longer than broad. P V is like in the other species of the genus: it bears 4 setae on the longer exopodite and 2 on the basiendopodite. The exopodite is three times longer than broad (Por, 1959, pl. 7 fig. 86).

Cletopsyllus tertius n. sp. (pl. 25 fig. 289-293, pl. 26 fig. 294-298)

Material examined. — 1 ♀ and 1 ♂ from stations 88 and 91. The syntypes are preserved in the collection of the Zoology Department of the Hebrew University under no. COP. 27.

Length. — ♀, 1.52 mm; ♂, 1.30 mm.

Ecological preference. — Gravels?

Description. — ♀. The very large body bears a high, triangular rostrum with a slightly trifid tip. The edges of the body segments are deeply denticulated. The length of the denticles decreases from the cephalothorax towards the last abdominal segment. The operculum is rounded and setigerous. The anal segment bears dorsally two peculiar processes. The furcal branches are long, almost straight, their length exceeding their width nearly six times. Only a few basal setae are found on the internal edges of the branches.

The antennula is five-segmented as shown in pl. 26 fig. 294. The second segment bears a huge spur and the third segment bears 7 external setae. The antenna has an allobasis and a short exopodite bearing 2 setae. The mandible has a short exopodite bearing one seta. The maxillula has a clearly biramous palp. The maxilla has one terminal and two very small other endites.
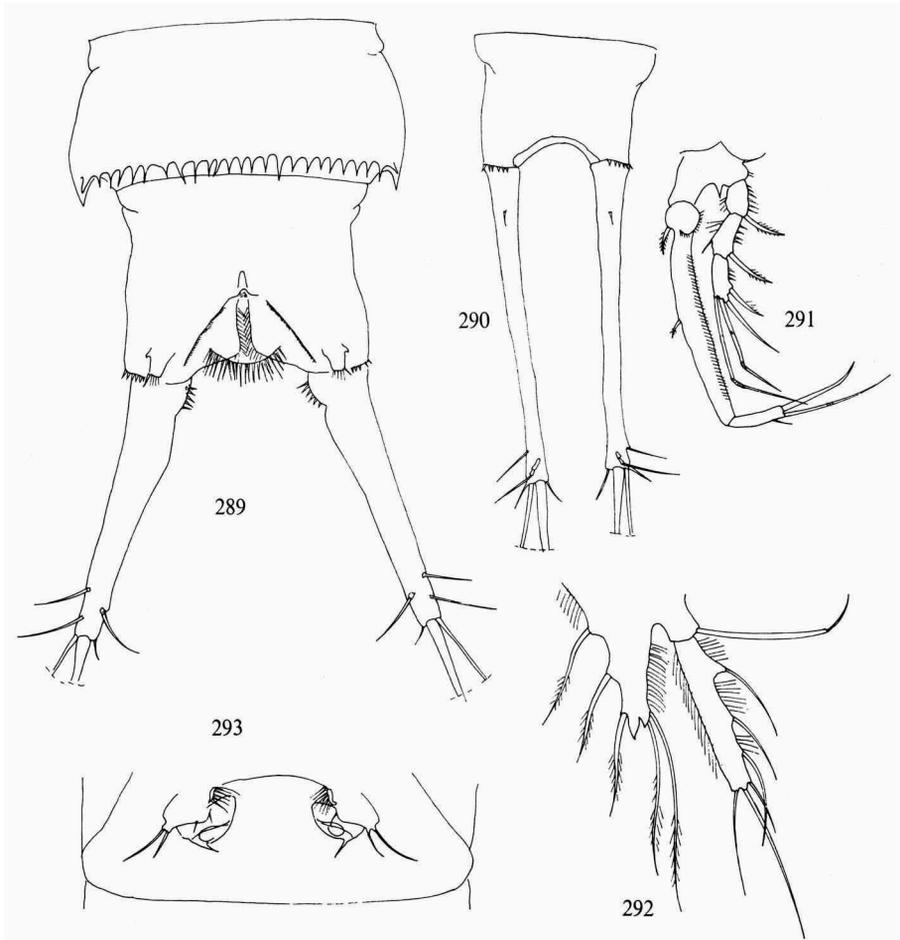
Plate 25, fig. 289-293. *Cletopsyllus tertius* n. sp. 289, furca of female in dorsal view; 290, furca of male; 291, P I of female; 292, P V of female; 293, genital field of female.

P I has 3 terminal setae on the endopodite and 4 terminal setae on the exopodite. The exopodite does not reach the middle of the first segment of the endopodite. The armature of the swimming legs is as follows:

	Exopodite	Endopodite
P II	0.1.123	1.421
P III	1.1.223	1.321
P IV	1.1.223	1.321

The exopodite of P V is elongate, with 4 external and 2 apical setae. The basiendopodite hardly reaches the middle of the exopodite and bears 5 setae. The genital field is shown in pl. 25 fig. 293.

♂. This is the first description of a male of *Cletopsyllus*. A I is a strong clasping organ as shown in pl. 26 fig. 296. The external spines of the expodite of P IV are conspicuously serrate. The length of the furca exceeds its width twelve times — being thus much longer than in the female. The exopodite of P V bears 5 setae while the basiendopodite has only 3 setae and does not show the apical process found in the female.

Discussion. — Our specimens has very large dimensions as compared to *Cletopsyllus papillifer* Willey from Bermuda (0.96 mm) and *C. secundus* Nicholls from Western Australia (0.98 mm). The new species is closely related to the Western Australian. Differences are found in the number of setae on the third segment of A I, in the presence of an exopodite on A II, in the reduction of one of the endites of the maxilla. The most important difference is the increased length of the furca. The sexual dimorphism of this character is noteworthy.
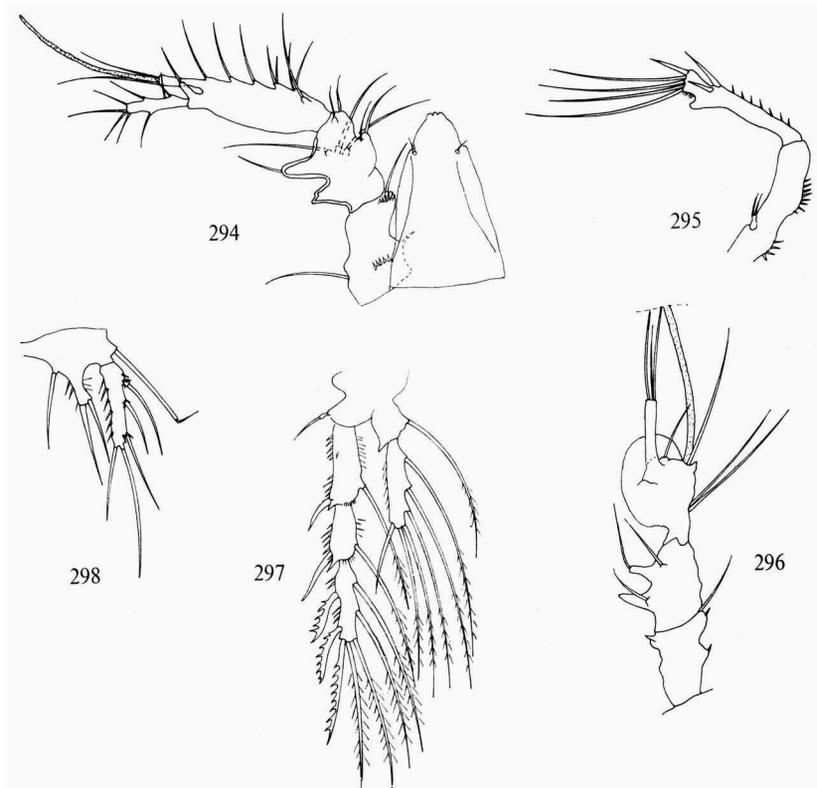

Plate 26, fig. 294-298. *Cletopsyllus tertius* n. sp. 294, rostrum and A I; 295, A II; 296, A I of male; 297, P IV of male; 298, P V of male.

REFERENCES

AGUESSE, P. C. & B. H. DUSSART, 1957. Sur quelques crustacés de Camargue et leur écologie. — Vie et Milieu, **7**: 481-520, fig. 1-13.

AKATOVA, N., 1935. Drei neue Copepoden-Arten aus dem Kaspi-See. — Zool. Anz., **111**: 319-326, fig. 1-18.

AVNIMELECH, M., 1960. The latest history of the Mediterranean coast of Israel. — Rapp. Proc. Verb. Comm. Int. Mer Médit., **15** (3): 331-341, fig. 1-4.

AX, P., 1959. Zur Systematik, Ökologie und Tiergeographie der Turbellarienfauna in den ponto-kaspischen Brackwassermeeren. — Zool. Jahrb. Syst., **87** (1, 2): 43-184.

BĂCESCU, M., 1940. Les Mysidacés des eaux roumaines. — Ann. Sci. Univ. Jassy, **26** (2): 453-804.

——, 1961. Cercetari fizicochimice si biologice romînesti la Marea Neagra, efectuate in perioada 1954-1959. — Hidrobiologia, **3**: 17-46.

BĂCESCU, M., H. DUMITRESCU, V. MANEA, F. PÓR & R. MAYER, 1957. Les sables à Corbulomya (Aloidis) maeotica Mil — base trophique de premier ordre pour les poissons de la Mer Noire. — Trav. Mus. Gr. Antipa, **1**: 305-374, fig. 1-18.

BLANC, J. J., J. M. PÉRÈS & J. PICARD, 1959. Coraux profonds et thanatocoenoses quaternaires en Méditerranée. Topographie et géologie des profondeurs océaniques. — Colloques Int. Centre Nat. Rech. Sci., **83**.

BORUTZKY, E. V., 1952. Harpacticoida presynkh vod. — Fauna SSSR, **3** (4): 1-424, fig. 1-116.

BOŽIĆ, B., 1953. Sur quelques Copépodes Harpacticoides des sables de Roscoff. Description de Rhizothrix (Adelopoda) bocqueti n. sp. — Arch. Zool. expér. gén., **91** (Notes et Revue): 17-24.

——, 1955. Copépodes Harpacticoides des sables des environs de Roscoff. Description de quelques formes nouvelles. —Arch. Zool. expér. gén., **92** (Notes et Revue): 1-12.

BRADY, G. S., 1878. A monograph of the free and semi-parasitic Copepoda of the British Islands, **1**: 1-148, pl. 1-33.

BRIAN, A., 1928. Descrizione di specie nuovi o poco conosciute di copepodi bentonici del mare Egeo. — Boll. Mus. Zool. Anat. comp. Univ. Genova, **7** (18): 1-37, fig. 1-151.

——, 1928a. I Copepodi bentonici marini. Richerche faunistiche nelle isole Italiane dell'Egeo. — Arch. Zool. Ital., **12**: 293-343, fig. 1-59.

BRODSKY, V. A., 1959. Deep-Sea Harpacticoida. Part I. A revision of the genus Pontostratiotes Brady, 1883. — Zool. Zh. Moscow, **38** (12): 1785-1789, fig. 1, 2.

CALLAME, B., 1960. Étude sur la diffusion des sels entre les eaux surnageantes et les eaux d'imbibition dans les sédiments marins littoraux. — Bull. Inst. océanogr. Monaco, **1181**: 1-18, fig. 1-4.

CARAION, F. E., 1959. Ostracode noi in Marea Neagra (Apele bosforice). — Com. Acad. Rep. Popul. Romina, **9** (3): 5-273.

CASPERS, H., 1951. Quantitative Untersuchungen über die Bodentierwelt des Schwarzen Meeres im bulgarischen Küstenbereich. — Arch. Hydrobiol. Hydrogr., **45**: 1-192, text-fig. 1-66, pl. 1-7.

———, 1957. Black Sea and Sea of Azov. In: J.W. HEDGPETH (ed.), Treatise on Marine Ecology and Paleoecology I. — Mem. geol. Soc. America, **67**: 801-889, fig. 1-37.

CHAPPUIS, P. A., 1954. Harpacticides psammiques récoltés par Cl. Delamare Deboutteville en Méditerrannée. — Vie et Milieu, **4**: 254-276, fig. 1-71.

CHAPPUIS, P. A. & M. SERBAN, 1953. Copépodes cavernicoles de la nappe phréatique de la plage d'Agigea près Constanza. — Notes biospéol., **8**: 91-102.

CHICHKOFF, G., 1912. Contribution à l'étude de la faune de la Mer Noire. Animaux récoltés sur les côtes bulgares. — Arch. Zool. expér. gén., (5) **10** (Notes et Revue): xxix-xxxix.

CZERNIAVSKI, V., 1868. Materialia ad zoographiam ponticam comparatam. — Trud.

pervago sjezda Russk. estest. Zoolog. Str., **1868**: 17-136, pl. 1-8.

DOUWE, C. VAN, 1929. Marine Litoral-Copepoden: Zur Verbreitung des Genus Laophonte Philippi im Mittelmeer. — Zool. Anz., **83**: 283-294, fig. 1-22.

EKMAN, S., 1953. Zoogeography of the sea: i-xiv, 1-417, fig. 1-121.

FAUVEL, P., 1955. Contribution à la faune des Annélides Polychètes des côtes d'Israel. — Bull. Sea Fish. Res. Sta. Haifa, **10**: 3-12.

——, 1955a. Contribution à la faune des Annélides Polychètes des côtes d'Israel. II. — Bull. Res. Council Israel, (B) **6** (3, 4): 213-219.

FURON, R., 1958. Causes de la répartition des êtres vivants. Paléographie, biogéographie dynamique. — Evolution des Sciences, **10**: 1-164.

GIESBRECHT, W., 1900. Mitteilungen über Copepoden, 12-14. — Mitt. Zool. Stat. Neapel, **14**: 39-82, pl. 2-5.

GISLÉN, T., 1940. The number of animal species in Sweden, with remarks on some rules of distribution, especially of the microfauna. — Lunds Univ. Årsskr., (2) **36** (2): 1-23.

GOHAR, H. A. F., 1954. The place of the Red Sea between the Indian Ocean and the Mediterranean. — Publ. Inst. Rech. hydrobiol. Fac. Sci. Univ. Istanbul, (B) **2**: 47-82, map 1.

GOTTLIEB, E., 1959. Study of the benthos in Haifa Bay. Ecology and zoogeography of Invertebrates: 1-131, fig. 1-4, maps. (Thesis, Hebrew University, Jerusalem).

GURNEY, R., 1927. Report on the Crustacea-Copepoda (litoral and semi-parasitic). Zoological results of the Cambridge Expedition to the Suez Canal, 1924. No. 35. — Trans. Zool. Soc. London, **22**: 451-577, fig. 108-168.

——, 1931. British fresh-water Copepoda, **1**: i-lii, 1-238, fig. 1-344.

HAAS, G., 1948. Sur l'immigration de mollusques indopacifiques dans les eaux côtières de la Palestine. — J. Conch., **88**: 141-144.

——, 1951. Preliminary report on the Molluscs of the Palestine coastal shelf. — **Bull.** Sea Fish. Res. Sta. Haifa, **1**: 1-20.

HESSE, R., W. C. ALLEE & K. P. SCHMIDT, 1951. Ecological animal geography: i-xiv, 1-597, fig. 1-135.

JAKOBI, H., 1954. Especies novas de Harpacticoida (Copepoda-Crustacea) encontrados em algas marinhas do litoral Paraná-Santa Catarina. — Bol. Inst. oceanogr. São Paulo, **5** (1): 189-211, pl. 1-6.

JAKUBISIAK, S., 1936. Matériaux à la faune des Harpacticoides de Roscoff (côtes bretonnes, France). — Fragm. faun. Mus. zool. Polon., **2** (28): 315-321.

——, 1938. Les Harpacticoides de la Mer Noire (côtes roumaines). — Ann. Sci. Univ. Jassy, **24** (2): 387-402, pl. 1, 2.

——, 1938a. Sur les Harpacticoides des limans de la Mer Noire. — Arch. Hydrobiol. Ichthyol. Suwalki, **11**: 289-292, fig. 1-8.

JESPERSEN, P., 1940. Non-parasitic Copepoda. — In: A. FRIDRIKSSON & S. L. TUXEN (ed.), The Zoology of Iceland, **3** (33): 1-116, fig. 1-8.

KLAUSEWITZ, W., 1960. Systematisch-evolutive Untersuchungen über die Abstammung einiger Fische des Roten Meeres. — Verh. Deutsch. zool. Ges., **1959**: 175-182, fig. 1-5.

KLIE, W., 1937. Ostracoden und Harpacticoiden aus brackigen Gewässern an der bulgarischen Küste des Schwarzen Meeres. — Bull. Inst. Roy. Hist. nat. Sophia, **10**: 1-42, fig. 1-70.

——, 1941. Laophonte-Arten (Cop. Harp.) aus dem Mittelmeer mit verkümmertem Nebenast der zweiten Antenne. — Arch. Naturgesch., (n. ser.) **10**: 259-277, fig. 1-18.

——, 1941a. Adriatische Harpacticoiden I. Zur Kenntnis einiger Laophonte-Arten. — Zool. Anz., **135**: 89-93, fig. 1, 2.

——, 1942. Die Gattung Amphiascus G. O. Sars, 1911 (Cop. Harp.) im Mittelmeer. — Arch. Naturgesch., (n. ser.) **10**: 443-475, fig. 1-15.

——, 1949. Harpacticoida (Cop.) aus dem Bereich von Helgoland und der Kieler Bucht. I. — Kieler Meeresforsch., **6**: 90-128, fig. 1-52.

——, 1950. Harpacticoida (Cop.) aus dem Bereich von Helgoland und der Kieler Bucht (Fortsetzung). — Kieler Meeresforsch., **7** (1): 76-128, fig. 53-160.

KOSSWIG, C., 1942. Die Faunengeschichte des Mittel- und Schwarzen Meeres. — C. R. Soc. Turque Sci. phys. nat., **9**: 37-52.

——, 1954. Beitrag zur Zoogeographie der Seen im Marmaragebiet. — Publ. Inst. Rech. hydrobiol. Fac. Sci. Univ. Istanbul, **1** (4): 276-283.

KUNZ, H., 1961. Beitrag zur Kenntnis der D'Arcythompsonidae (Copepoda, Harpacticoidea). — Zool. Anz., **167**: 275-280.

LANG, K., 1948. Monographie der Harpacticiden, **1**: 1-896, fig. 1-361; **2**: 897-1682, fig. 362-607, map 1-378.

MARCUS, A., 1959. Unele consideratii generale asupra faunei de Copepode planctonice a litoralului rominesc. — Com. Acad. Rep. Popul. Romina, **9** (10): 1041-1047.

——, 1960. Harpacticoiden im Plankton der rumänischen Küsten des Schwarzen Meeres vorgefunden. — Trav. Mus. Gr. Antipa, **2**: 165-176, fig. 1, 2.

MARCUS, A. & F. PÓR, 1960. Die Copepoden einer Probe aus dem Felsbiotop von Yalta (Krimhalbinsel). — Trav. Mus. Gr. Antipa, **2**: 145-163, fig. 1-7.

—— & ——, 1961. Die Copepoden der polyhalinen Lagunen Sinoe (Schwarze Meerrumänische Küsten). — Acta Mus. Maced. Sci. nat., **7** (6): 105-126, pl. 1-3.

MONARD, A., 1928. Les Harpacticoides marins de Banyuls. — Arch. Zool. expér. gén., **67**: 259-443, fig. 1-48.

——, 1935. Les Harpacticoides marins de la région de Salammbo. — Bull. Sta. océanogr. Salammbo, **34**: 1-94, fig. 1-145.

——, 1935a. Étude sur la faune des Harpacticoides marins de Roscoff. — Trav. Sta. biol. Roscoff, **13**: 5-88, fig. 1-235.

——, 1937. Les Harpacticoïdes marins de la région d'Alger et de Castiglione. — Bull. Trav. Sta. Aquicult. Pêche Castiglione, **1935** (2): 9-93, fig. 1-5.

MORDUKHAI-BOLTOVSKOI, F. D., 1960. Catalogue of the free living invertebrate fauna of the Sea of Azov. — Zool. Zh. Moscow, **39** (10): 1454-1466, fig. 1. [In Russian].

NICHOLLS, A. G., 1941. Littoral Copepoda from South Australia. (1) Harpacticoida. — Rec. South Austr. Mus., **6** (4): 381-427, fig. 1-23.

——, 1944. Littoral Copepoda from the Red Sea. — Ann. Mag. nat. Hist., (11) **11**: 487-503, fig. 1-9.

——, 1945. Marine Copepoda from Western Australia. III. Littoral Harpacticoids from Port Denison. — J. Roy. Soc. West. Austr., **29**: 1-16, fig. 1-8.

NOODT, W., 1953. Bemerkenswerte Copepoda Harpacticoidea aus dem Eulittoral der deutschen Meeresküste. — Zool. Anz., **151**: 6-20, fig. 1-43.

——, 1955. Harpacticiden (Crust. Cop.) aus dem Sandstrand der französischen Biscayaküste. — Kieler Meeresforsch., **11**: 86-109, fig. 1-113.

——, 1955a. Marine Harpacticoiden (Crust. Cop.) aus dem Marmara Meer. — Rev. Fac. Sci. Univ. Istanbul, (B) **20** (1, 2): 49-94, fig. 1-103.

——, 1956. Verzeichnis der im Eulitoral der schleswig-holsteinischen Küsten angetroffenen Copepoda Harpacticoidea. — Schr. naturwiss. Ver. Schleswig-Holstein, **28**: 42-64.

——, 1957. Zur Ökologie der Harpacticoiden (Crust. Cop.) des Eulitorals der deutschen Meeresküste und der angrenzenden Brackgewässer. — Z. Morphol. Oekol. Tiere, **46**: 149-242, fig. 1-13.

OREN, O. H., 1952. Some hydrographical features observed off the coast of Israel. — Bull. Inst. océanogr. Monaco, **1017**: 1-9, fig. 1-4.

PÉRÈS, J. M., 1958. Ascidies de la Baie de Haife collectées par E. Gottlieb. — Bull. Res. Council Israel, (B) **7** (3, 4): 151-164.

——, 1961. Océanographie biologique et biologe marine, **1**: i-viii, 1-541, fig. 1-35.

Pérès, J. M. & J. Picard, 1955. Biotopes et biocenoses de la Méditerranée occidentale, comparés à ceux de la Manche et de l'Atlantique nord-oriental. — Arch. Zool. expér. gén., **92** (1): 1-70.

——— & ———, 1956. Notes préliminaires sur les résultats de la campagne de recherches benthiques de la Calypso dans la Méditerranée nord-orientale. — Rev. Trav. Sta. mar. Endoume, **18**.

——— & ———, 1958. Manuel de bionomie benthique de la Méditerranée. — Rev. Sta. mar. Endoume, **23** (14): 1-122.

Pesta, O., 1920. Die Planctoncopepoden der Adria. — Zool. Jb. Syst., **43**: 471-660, text-fig. 1-17, pl. 8, map 1.

———, 1926. Carcinologische Mitteilungen. Wissenschaftliche Forschungsberichte aus dem Gebiete der unteren Donau und des Schwarzen Meeres. III. — Arch Hydrobiol., **16**: 605-643, fig. 1-34.

———, 1959. Harpacticoiden (Crust. Cop.) aus submarinen Höhlen und den benachbarten Littoralbezirken am Kap von Sorrent (Neapel). — Publ. Staz. zool. Napoli, (suppl.) **30**: 95-177, fig. 1-149.

Pfannenstiel, M., 1944. Die diluviale Entwicklungsstadien und die Urgeschichte von Dardanellen, Marmarameer und Bosporus. — Geol. Rundschau, **34** (7, 8).

———, 1960. Erläuterungen zu den bathymetrischen Karten des östlichen Mittelmeeres. — Bull. Inst. océanogr. Monaco, **1192**: 1-60, chart 1-9.

Por, F., 1959. Harpacticoide noi (Crustacea, Copepoda) din milurile Mării Negre. — Studii Cercetari Biol. Acad. Rep. Popul. Romîne, (Biol. Anim.) **4** (11): 347-368, fig. 1-7.

———, 1960. Littorale Harpacticoiden der Nordwest-Küsten des Schwarzen Meeres. — Trav. Mus. Gr. Antipa, **2**: 97-143, fig. 1-17.

———, 1960a. Mesopsyllus atargatis n.g., n. sp., ein neuer Harpacticoide (Crustacea Copepoda) aus dem Schwarzen Meere. — Trav. Mus. Gr. Antipa, **2**: 177-182, fig. 1-9.

Prokudina, L. A., 1952. Catalogue of the fauna and flora of the Black Sea in the region of the Karadag Biological Station. — Trud. Karadag Biol. Sta., **12**. [In Russian].

Remane, A., 1940. Einführung in die zoologische Ökologie der Nord- und Ostsee. In: G. Grimpe & E. Wagler (ed.), Die Tierwelt der Nord- und Ostsee, **1** (a): 1-238, fig. 1-76.

———, 1958. Ökologie des Brackwassers. In: A. Remane & C. Schlieper, Die Biologie des Brackwassers. — Die Binnengewässer, **22**: 1-216, fig. 1-81.

Roe, K. M., 1959. The littoral Harpacticids of the Dalkey (Co. Dublin) area with descriptions of six new species. — Proc. Roy Irish Acad., (B) **59** (12): 221-255, fig. 1-150.

———, 1960. Some Harpacticoids from Lough Ine, with descriptions of two new species. — Proc. Roy. Irish Acad., (B) **60** (8): 277-289, fig. 1-44.

Rudescu,, L., 1961. Rotiferii din Marea Neagra. — Hidrobiologia, **3**: 283-329.

Sars, G. O., 1903-1911. Copepoda Harpacticoida. An Account of the Crustacea of Norway, **5**: i-xiv, 1-449, pl. 1-230, suppl. pl. 1-54.

———, 1919-1921. Copepoda Supplement. An Account of the Crustacea of Norway, **7**: 1-121, pl. 1-76.

Scott, A., 1902. On some Red Sea and Indian Ocean Copepoda. — Proc. Liverpool biol. Soc., **16**: 397-428, pl. 1-3.

Serban, M., 1959. Les Copépodes de la Mer Noire. Note préliminaire sur les Harpacticides de la côte roumaine. — Lucrar. Stat. zool. marit. Agigea, vol. festiv., **1956**: 259-302.

Sewell, R. B. Seymour, 1940. Copepoda Harpacticoida. — Sci. Rep. John Murray Exped., **7** (2): 117-382, fig. 1-88, chart 1.

——, 1948. The free-swimming planktonic Copepoda. Geographical distribution. — Sci. Rep. John Murray Exped., **8** (3): 317-592, fig. 72-95, chart 1, 2.

SLASTENENKO, E. P., 1959. Zoogeographical review of the Black Sea fish fauna. — Hidrobiologia, **14** (2): 177-189.

SOVINSKI, V., 1904. Introduction à l'étude de la faune du bassin marin ponto-aralo-kaspien. — Zapiski Kiev. Obshch. Est., **18**: i-xiii, 1-48, 1-216, i-iv, pl. 1-4. [In Russian].

STEINITZ, W., 1929. Die Wanderung indopazifischer Arten ins Mittelmeer seit Beginn der Quartärperiode. — Int. Rev. Hydrobiol. Hydrogr., **22**: 1-90, fig. 1-9.

STEUER, A., 1941. Die mediterrane Harpacticoiden-Gattung Bradyellopsis Brian. — Note Ist. Biol. mar. Rovigno, **2** (19): 1-16, fig. 1-25.

——, 1948. Variabilität und Verbreitung einiger Copepoda Harpacticoida der Gattungen Ameira und Mesochra aus dem östlichen Mittelmeer (Alexandrien). — Thalassia, **6**: 1-19.

SVERDRUP, H. U., M. W. JOHNSON & R. H. FLEMING, 1946. The Oceans, their physics, chemistry, and general biology: i-x, 1-1087, fig. 1-265, chart 1-7.

THOMPSON, I. C. & A. SCOTT, 1903. Report on the Copepoda collected by Professor Herdman, at Ceylon, in 1902. — Rep. Ceylon Pearl Oyster Fish., **1** (suppl. 7): 227-307, text-fig. 1, pl. 1-20.

THIENEMANN, A., 1950. Verbreitungsgeschichte der Süsswassertierwelt Europas. — Die Binnengewässer, **18**: i-xvi, 1-809, text-fig. 1-249, pl. 1-11.

THORSON, G., 1957. Bottom Communities (sublittoral or shallow shelf). In: J. W. HEDGPETH (ed.), Treatise on Marine Ecology and Paleoecology, volume I. — Mem. geol. Soc. America, **67**: 461-534, fig. 1-20.

TORTONESE, E., 1951. I caratteri biologici del Mediterraneo orientale e i problemi relativi. — Arch. zool. Ital., (suppl.) **7**: 207-251.

——, 1960. Modern views on the distribution of the marine benthos. — Publ. Inst. Rech. hydrobiol. Fac. Sci. Univ. Istanbul, (B) **5** (1, 2): 35-42, fig. 1, 2.

——, 1960a. The relations between the Mediterranean and Atlantic fauna. — Publ. Inst. Rech. hydrobiol. Fac. Sci. Univ. Istanbul, (B) **5** (1, 2): 30-34, fig. 1.

VALKANOV, A., 1957. Katalog unserer Schwarzmeerfauna. — Arb. biol. Meeressta. Varna, **19**: 1-62.

VINOGRADOV, K. A., 1961. Results of the hydrobiological studies carried out by the USSR in the Black Sea and mostly in its northwestern part, between 1954 and 1959. — Hidrobiologia, **3**: 67-68.

WIESER, W., 1959. The effect of grain size on the distribution of small invertebrates inhabiting the beaches of Puget Sound. — Limnol. Oceanogr., **4**: 181-194.

——, 1959a. Free-living Nematodes and other small invertebrates of Puget Sound beaches. — Univ. Washington Publ. Biol., **19**: 1-179, text-fig. 1-109, pl. 1-46.

——, 1960. Benthic studies in Buzzards Bay II. Limnol. Oceanogr., **5**: 121-137.

WILLEY, A., 1930. Harpacticoid Copepoda from Bermuda. Part I. — Ann. Mag. nat. Hist., (10) **6**: 81-113.

——, 1935. Harpacticoid Copepoda from Bermuda. Part II. — Ann. Mag. nat. Hist., (10) **15**: 50-100, fig. 1-188.

WILSON, C. B., 1932. The Copepoda of the Woods Hole region, Massachusetts. — Bull. U.S. Nat. Mus., **158**: 1-635, text-fig. 1-316, pl. 1-41.

ZENKEVICH, L. A., 1951. The seas of the USSR, their Fauna and Flora: 1-366, fig. 1-285. [In Russian].

ZEUNER, E. F., 1959. The Pleistocene period: 1-447.