

A Guide to the Marine Flora and Fauna of the Bay of Fundy: Copepoda: Calanoida

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A GUIDE TO THE MARINE FLORA AND FAUNA OF THE BAY OF FUNDY:
COPEPODA: CALANOIDA

by

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This is the one hundred and thirteenth Technical Report from the
Biological Station, St. Andrews, N.B.

PREFACE

This Technical Report is part of a series originating at the St. Andrews Biological Station entitled "Guide to the Marine Fauna and Flora of the Bay of Fundy." The series will consist of original and/or adapted, illustrated manuals on the identification, distribution and general biology of the estuarine and marine animals and plants occurring within the Bay of Fundy.

The series is a continuation and expansion on "A Preliminary Guide to the Littoral and Sublittoral Marine Invertebrates of Passamaquoddy Bay" and is produced under the auspices of Fisheries and Environmental Sciences to assist in environmental studies concerning the Bay of Fundy. The guide is being prepared in collaboration with systematic specialists and the manuals will be based as much as possible on recent revisionary systematic research. Each manual, concerning major taxon, will include an introduction, illustrated glossary of terms, illustrated keys, alphabetic checklist and available information on distribution, habitat, life-history related biology, and references to the major literature on the group.

The series is intended for use by students and researchers wishing to identify marine organisms found in the Bay of Fundy. They are written as much as possible so that persons without a systematic background may use them, and with the hope they will serve as a guide to additional information concerning a taxon. Since the Bay of Fundy has a wide range of physical habitats and therefore organisms, these manuals will be useful for organism identification throughout the Maritimes and may, in some cases, replace or expand the old series "Canadian Atlantic Fauna." In general this series will be complementary to Natural History Series in progress at the National Museum of Natural Sciences, Ottawa.

Whenever possible representative specimens dealt with in the manuals will be deposited in the reference collection of the Identification Center at the Biological Station, St. Andrews. Researchers in the Bay of Fundy are requested to donate series of specimens to this collection they believe should be available for future examination and reference.

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ABSTRACT

Roff, J. C. 1978. A guide to the marine flora and fauna of the Bay of Fundy: Copepoda:Calanoida. Fish. Mar. Serv. Tech. Rep. 823, iv + 29 p.

A key to thirty-three species belonging to fifteen families of Calanoid copepods from Passamaquoddy Bay and the Bay of Fundy has been compiled.

The classification scheme adopted here is chiefly from Brodski (1967) and Sars (1903), with appropriate modifications of familial characteristics.

Species included here have been confirmed from personal collections and from the literature cited. Ecological notes on depth, regional and seasonal occurrence are included.

Key words: Identification keys, taxonomy, classification systems, ecological distribution, Fundy Bay, Copepoda, Calanoida

RÉSUMÉ

Roff, J. C. 1978. A guide to the marine flora and fauna of the Bay of Fundy: Copepoda:Calanoida. Fish. Mar. Serv. Tech. Rep. 823, iv + 29 p.

L'A. a établi une clef pour identifier 33 espèces de copépodes, groupées en 15 familles du type calanoïde, recensées dans les baies de Passamaquoddy et de Fundy.

La classification adoptée s'inspire principalement de celles de Brodski (1967) et de Sars (1903), auxquelles ont été apportées les modifications appropriées compte tenu des signes distinctifs des familles.

L'existence de ces espèces a été confirmée au moyen de collections personnelles et de la documentation citée. Des notes d'intérêt écologique portent sur les profondeurs, les régions et les saisons qui leur sont spécifiques.

INTRODUCTION

This key to species refers to all species of Calanoid copepods found in and reported from Passamaquoddy Bay, the Bay of Fundy and adjacent estuaries, bays, and brackish waters. It should not be used for regions outside the Bay of Fundy, since other species of Arctic and sub-tropical origin may be encountered. The only species recorded from the Bay of Fundy not included here is *Eucalanus attenuatus* (family Eucalanidae) for which there is apparently only a single record from deep water (Bigelow 1926).

The order (sub-class) Copepoda is usually divided into three free-living sub-orders and a number of parasitic ones. The free-living sub-orders are: the Harpacticoida, which are predominantly benthic and littoral; the Cyclopoida, which contain both benthic and planktonic forms; the Calanoida, which comprise over 90% of all marine copepods, and are virtually all planktonic.

The Harpacticoids are not included here since they are rarely encountered in open water plankton collection. In well-mixed areas of Passamaquoddy Bay, however, they may comprise up to 10% of the catch in samples taken close to the bottom. They can be distinguished in body form from Fig. 1, and their characteristics are listed in Table 1.

Only one species of Cyclopoid is frequently encountered in this area - *Oithona similis*. In addition *Oithona plumifera* has been reported occasionally. The characteristics of the Cyclopoida are shown in Fig. 1 and are listed in Table 1.

The present key refers only to the Calanoida, which can be clearly recognized from their combination of characters (see Fig. 1 and Table 1). A list of families, genera and species is included (Table 2). The Passamaquoddy and Fundy fauna is quite diverse and consists of an admixture of sub-tropical, temperate, and arctic; neritic and oceanic; estuarine, brackish-water, and marine stenohaline forms.

Some species are much more abundant than others, and notes on relative abundance, seasonal occurrence, and day depth have been included in an alphabetized species list with page numbers for assistance in identification (see Table 3). Approximate sizes of species are included with the figure captions. This information, although it may provide confirmatory evidence of identification, cannot substitute for correct recognition from morphological characteristics.

The key is based on characters of adult males (M) and females (F); immature copepodites and even naupliar stages can often be recognized from similarity of body form, coloration, degree of transparency, etc. The immature stages of many of the species listed here have not been

-1-

described or are poorly known. Since correct identification depends heavily on the characteristics of the various appendages these will often need to be dissected off the body for proper examination. Temporary mounts for drawings can be made in water or glycerin-jelly. A glossary of terminology and an anatomical guide have been included.

Although correct identification *de novo* can be a tedious business, once the species is identified it can usually be recognized again by subtle combinations of body proportions, attitudes of appendages, body flexure, coloration, etc., which defy quantitative description. However, recognition in the first instance from such characteristics as body size, form, etc., will certainly lead to misidentification; for this reason a more "classical" taxonomic approach has been followed.

It is hoped that this key will prove useful as an instrument in initial identification, and as a reference for continuing work.

GLOSSARY OF TERMS

- Anal segment - the last urosomal segment bearing the caudal rami
- Antennae - the first, large, metasomal appendages
- Basipodite - the basal segment of an appendage
- Biramous - divided into two rami - or limbs
- Caudal rami - terminal segments of the urosome
- Chelate (Chela) - two segments of a limb forming a pincer
- Digitate - finger-like
- Endopod(ite) - the medial branch of a biramous appendage
- Exopod(ite) - the lateral branch of a biramous appendage
- Genital segment - the first urosomal segment of a female
- Geniculate - bent or bendable like a knee joint
- Lamella - leaf-like
- Metasome - the larger, anterior part of a copepod's body
- Naupliar eye - the single, simple copepod eye
- Phyllopodous - leaf-like, flattened
- Pseudochelate - having the appearance of a chela
- Rostrum - a prominent anterior or antero-ventral projection of the metasome
- Setose - bearing setae
- Sub-chelate - with the terminal segment of an appendage reflexed on the sub-terminal segment to give the appearance of a chela
- Uniramous - with a single ramus or branch
- Urosome - the smaller, posterior part of a copepod's body

BASIC ANATOMICAL FEATURES OF A CALANOID COPEPOD

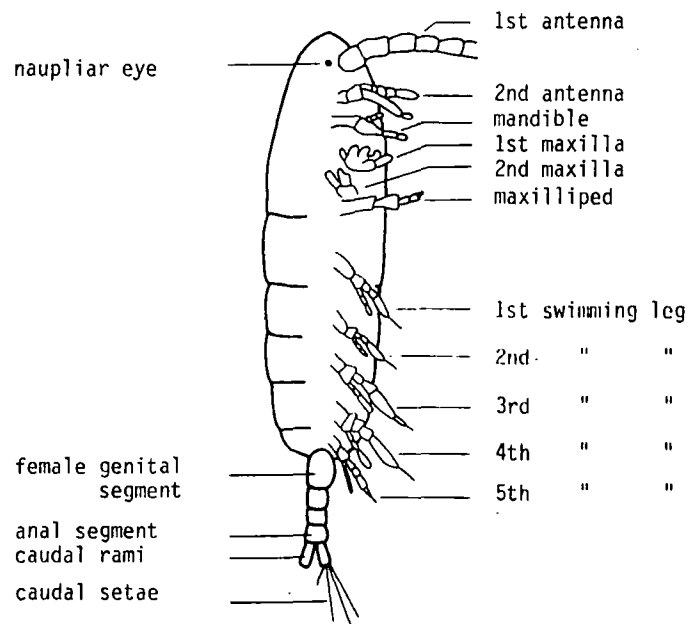


Fig. A1. Composite diagram showing metasome, urosome and appendages.

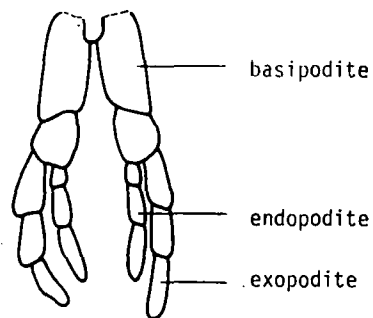


Fig. A2. Major features of an unmodified pair of biramous limbs.

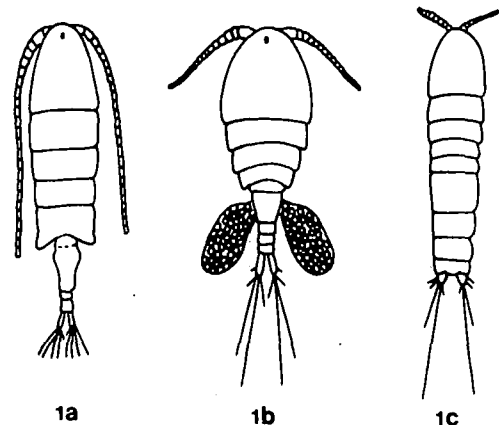
Table 1. Characteristics of the free-living sub-orders of Copepoda

	Calanoida	Cyclopoida	Harpacticoida
Habitat	Virtually all planktonic	A few planktonic mostly littoral or epibenthic	Nearly all littoral or benthic
Body	Metasome much broader than urosome	Metasome narrowing posteriorly, broader than urosome	Metasome and urosome little different in width
Antenna	Reach to end of metasome, more or less	Reach from 1/5 of way, to end of metasome	Very short, usually less than 1/4 length of metasome
Body articulation	Marked constriction between 5th pedigerous segment and urosome	Marked constriction between 4th and 5th pedigerous segments	Slight or no constriction between 4th and 5th pedigerous segments
Egg sac	Single, medial, or none	Two, lateral	Usually one, medial

KEY TO THE ADULT CALANOID COPEPODS

- 1a Body consisting clearly of two parts, the anterior metasome much larger than the posterior urosome. Antennae extend at least to the end of the metasome, or beyond (Fig. 1a) Calanoida 2.
- 1b Body not thus clearly divided or with shorter antennae (Fig. 1b, 1c) Cyclopoida and Harpacticoida . . No key.

Fig. 1a-c - Typical adult copepods, dorsal views
a. calanoid
b. cyclopoid
c. harpacticoid

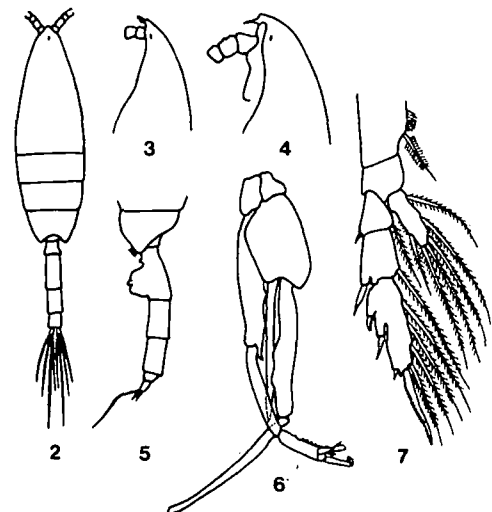


- 2a Eye(s) with one or two pairs of cuticular lenses (Figs. 25, 26, 30). Urosome F with reduced number of segments (2 or 3) (Fig. 30). 5th leg M chelate (Figs. 27, 33) family Pontellidae 16.
- 2b Single median naupliar eye, or absent. No cuticular lenses (except *Pseudodiaptomus*) (Figs. 2, 8, 9) 3.
- 3a First joint of endopodite of 2nd leg with hooks on inner edge (Fig. 39). Swimming legs (except 5th) 3-jointed (Fig. 39). Urosome and caudal rami long (Figs. 34, 35, 38) family Metridiidae 17.
- 3b First joint of endopodite of 2nd leg without hooks on inner edge (Fig. 7) 4.
- 4a Second leg with one-jointed endopodite (Fig. 7). Rostrum acutely pointed (Figs. 3, 4). Genital segment F ventrally protruberant (Fig. 5). 5th leg absent in F. 5th leg extremely elongate in M (Fig. 6) . . family Euchaetidae . . only one species, *Euchaeta norvegica*.

Figs. 2-7 - *Euchaeta norvegica* Boeck 1872
2. M dorsal view
3. F anterior metasome, lateral view
4. M " " " "
5. F urosome, lateral view
6. M 5th leg
7. 2nd swimming leg

Adult size range: M \approx 7mm; F \approx 8 mm.

Distribution: North Atlantic, Norway to United States; Davis Strait south to Chesapeake Bay.

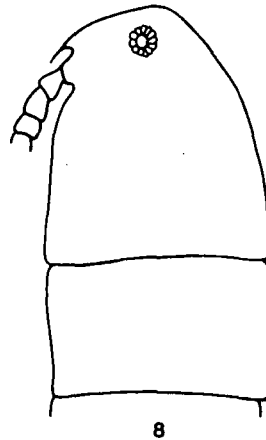


- 4b Endopodite of 2nd leg 2- or 3-jointed (rarely 1-jointed). Head rounded (Figs. 9, 17) (except *Rhincalanus nasutus*) (Fig. 13). Other combination of characters not as above 5.
- 5a Fifth (last) pair of swimming legs basically of the same phyllopodous type as pairs 1-4, modified or largely unmodified but always biramous (Figs. 46, 47, 50, 53, 57, 61) 6.
- 5b Fifth pair of swimming legs greatly modified, not phyllopodous, uniramous, or with weakly developed one-segmented endopodite, may be completely absent in F. (Figs. 14, 16, 19, 20, etc.) 7.
- 6a All swimming legs with 3-jointed branches. 5th leg little modified from legs 1-4, exopodite 5th leg with 2 outer spines on last segment (Figs. 46, 47, 50, 53). Body elongate, oval; posterior of metasome typically rounded; urosome about 1/3 length of metasome (Figs. 44, 45, 48, 49, 51, 52) family Calanidae 19.
- 6b All swimming legs with 3-jointed branches except 5th. 5th leg M exopodites 2-segmented, right exopodite bearing a large chela (Figs. 57, 61). In F 5th leg, second segment of exopodite bears a medial digitate process (Figs. 57b, 61b). End of metasome pointed or with "wings" (Figs. 54, 55, 58, 59). M antenna geniculate (Figs. 55, 59) family Centropagidae only one genus, *Centropages* 21.
- 7a Second, 3rd and 4th pairs of legs with 3-segmented endopodites. Other legs or podites not 3-segmented 8.
- 7b One or all pairs of legs (2nd, 3rd, 4th) with 2-segmented endopodite 11.
- 8a All pairs of swimming legs with 3-segmented podites. 5th legs F uniramous and 3-segmented. 5th leg M with rudimentary 1-segmented endopodites. Eye with a ring of lenses present . . family Pseudodiaptomidae only species, *Pseudodiaptomus coronatus*.

Fig. 8 - *Pseudodiaptomus coronatus* Williams 1906
F anterior metasome, lateral view.

Adult size range: M 1.0-1.2 mm; F 1.2-1.5 mm.

Distribution: North America; Gulf of St. Lawrence south to Nicaragua.



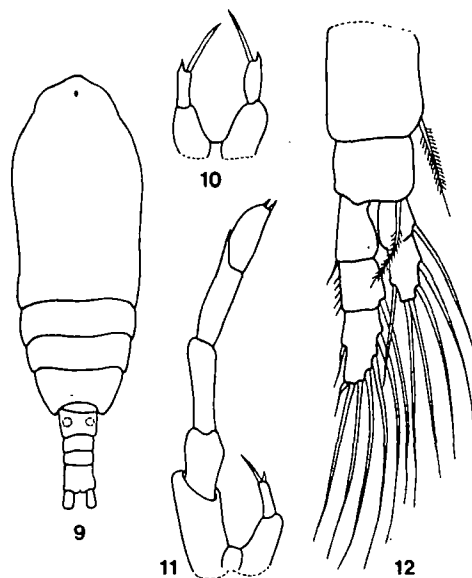
- 8b First pair of legs with 2- or 3-segmented exopodite and 1- or 2-segmented endopodite (e.g., Fig. 12) 9.
- 9a Fifth pair of legs absent in F; or, if present, the metasome is elongate and head triangular and pointed (Figs. 13, 16) 10.
- 9b Fifth pair of legs present in F, bearing hairless distal bristles (Fig. 10). 5th leg of M, left 5-segmented, right 2-segmented (Fig. 11) family Paracalanidae only one species, *Paracalanus parvus*.

Figs. 9-12 - *Paracalanus parvus* (Claus 1863)

- 9. F dorsal view
- 10. F 5th leg
- 11. M 5th leg
- 12. 1st swimming leg

Adult size range: M 0.8-1.4 mm; F 0.7-1.3 mm.

Distribution: Mediterranean, Atlantic and Pacific; Labrador to Chesapeake Bay.



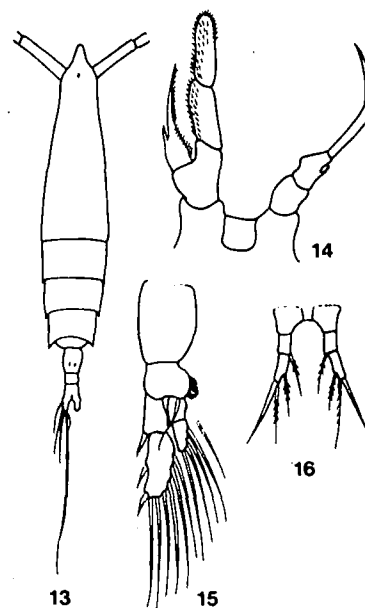
- 10a Fifth pair of legs absent in F. Fifth pair of legs M with rudimentary endopodites or uniramous (Figs. 63, 69, 71). Metasome ovoid, not elongate, posterior corners rounded or pointed (e.g., Fig. 65) family Aetideidae 22.
- 10b Fifth leg F 3-segmented (Fig. 16). Fifth leg M, left is biramous, right is uniramous ending in a large curved spine (Fig. 14). Metasome elongate, head triangular (Fig. 13) family Eucalanidae only one species, *Rhincalanus nasutus*.

Figs. 13-16 - *Rhincalanus nasutus* Giesbrecht 1892

- 13. F dorsal view
- 14. M 5th leg
- 15. 1st swimming leg
- 16. F 5th leg

Adult size range: M 2.7-4.0 mm; F 3.9-5.0+ mm.

Distribution: Atlantic, Pacific, Indian Oceans, Mediterranean Sea; Bay of Fundy to Chesapeake Bay.



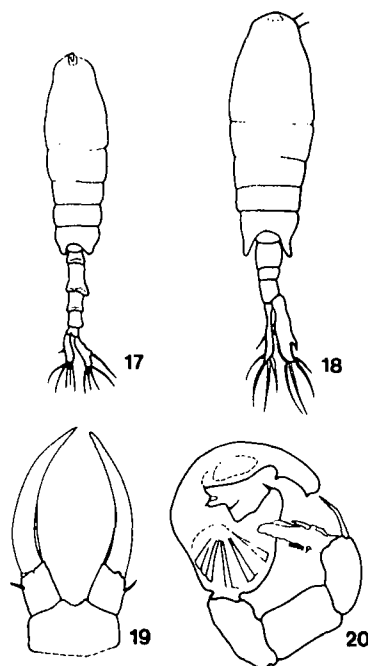
- 11a Endopodite 2-segmented in 2nd pair of legs, 3-segmented in 3rd and 4th pair 12.
 11b Endopodite 2-segmented in 2nd, 3rd and 4th pair of legs (Fig. 102b) 13.
- 12a Fifth pair of legs F absent. Fifth leg M asymmetric, uniramous (Figs. 80, 84)
 family Pseudocalanidae 25.
- 12b Fifth pair of legs F present or absent. If present, minute and one-segmented
 (Fig. 77). If absent then F urosome is less than 1/4 length of metasome, and anal
 segment is much shorter than caudal rami (Fig. 73). Fifth leg M very long, thin,
 with rudimentary endopodite on left side (Figs. 75, 78) family Scolecithricidae 24.
- 13a Urosome in F and M asymmetrical, right caudal ramus thicker than left (Figs. 17,
 18). 5th leg F 2-segmented, distal joint a stout incurved spine (Fig. 19). 5th leg
 M large, chelate (Fig. 20) family Tortanidae . . only one species, *Tortanus discaudatus*.

Figs. 17-20 - *Tortanus discaudatus* (Thompson

- and Scott 1897)
 17. M dorsal view
 18. F " "
 19. F 5th leg
 20. M " "

Adult size range: M 1.3-2.0 mm; F 1.4-2.2 mm.

Distribution: East coast and west coast North
 America, North Sea, James Bay; Labrador to Cape
 Cod.



- 13b Urosome in F and M symmetrical, (asymmetrical in one species *Candacia armata*, but
 even here the anal segment and caudal rami are symmetrical). 3-segmented (excluding
 caudal rami) in F (Figs. 95, 97) 14.
- 14a Posterior corners of metasome rounded (Figs. 86, 91, 95, etc.). Fifth legs F
 greatly reduced, last joint a long spine, penultimate joint bearing a setose bristle
 (Figs. 90, 93, 94, etc.). 5th leg M weakly chelate (Figs. 88, 92, 96, etc.)
 family Acartiidae only one genus. . . *Acartia* 26.
- 14b Posterior corners of metasome often with single stout spine or "wings" (Figs. 21,
 22, 107, 109). Fifth pair of legs F not so reduced 15.

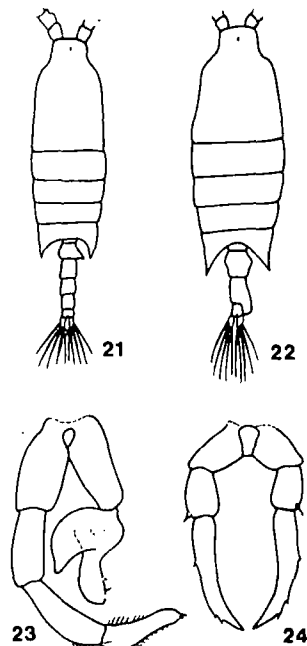
- 15a Urosome asymmetrical (in M, first segment; in F, post-genital segment) (Figs. 21, 22). Right 5th leg M with poorly developed chela (Fig. 23). 5th leg F with stout elongate terminal joint, penultimate joint without inner process (Fig. 24)
 family Candaciidae only one species, *Candacia armata*.

Figs. 21-24 - *Candacia armata* (Boeck 1872)

21. M dorsal view
 22. F " "
 23. M 5th leg
 24. F " "

Adult size range: M and F 2.7 mm.

Distribution: North Atlantic, Mediterranean;
 Gulf of St. Lawrence to Chesapeake Bay.



- 15b Urosome symmetrical. 5th leg M not chelate (may appear to be sub-chelate, e.g., Figs. 105, 110). 5th leg F with short terminal segment and penultimate segment with long inner process; OR with terminal segment longest, bearing four spines, and without spine or basal segment (Figs. 104, 106, 111, 115, 120). Caudal rami very long (Figs. 107, 108, 112, 116) family Temoridae 30.

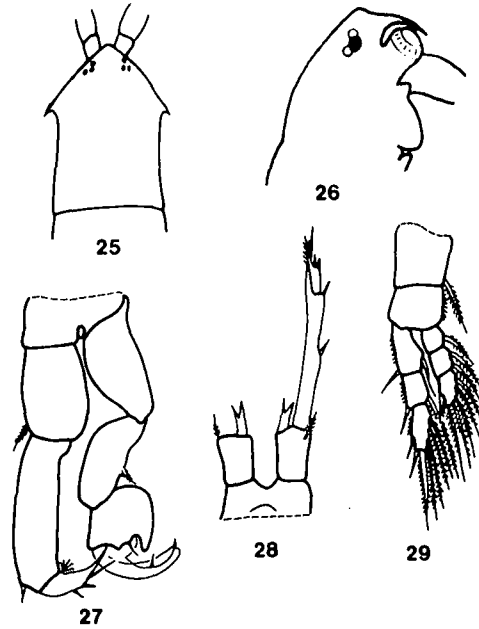
- 16a Two dorsal eyes present each with two cuticular lenses; ventral eye present F and M, enormously developed, club-shaped and directed anteriorly in M (Figs. 25, 26). Endopodite of 1st leg 3-segmented (Fig. 29). 5th leg M uniramous, left leg ending in a spine, and right leg chelate (Fig. 27). 5th leg F with very unequal rami; exopodite slender, 2-segmented about 7x as long as endopodite (Fig. 28)
 genus *Anomalocera* only one species, *A. patersoni*.

Figs. 25-29 - *Anomalocera patersoni* Templeton 1837

- 25. M anterior metasome, dorsal view
- 26. M " " , lateral view
- 27. M 5th leg
- 28. F " "
- 29. 1st swimming leg

Adult size range: M 3.0 mm; F 3.2 mm.

Distribution: Worldwide in temperate seas;
Gulf of St. Lawrence to Chesapeake Bay.



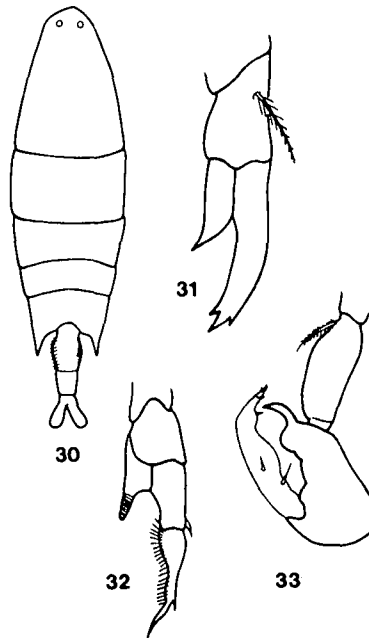
16b Two dorsal eyes each with a single cuticular lens, greatly developed in M; ventral eye present M and F, not developed in M (Fig. 30). Endopodite of first four pairs of legs 2-segmented. Left 5th leg M with rudimentary 1-segmented endopodite; right leg chelate (Fig. 32, 33). 5th leg F with 1-segmented endopodite and exopodite; exopodite about 2x as long as endopodite (Fig. 31)
..... genus *Labidocera* only one species, *L. aestiva*.

Figs. 30-33 - *Labidocera aestiva* Wheeler 1900

- 30. F dorsal view
- 31. F 5th leg
- 32. M " " - left
- 33. M " " - right

Adult size range: M 1.8-2.2 mm; F 1.7-2.0 mm.

Distribution: East coast North America; Gulf of St. Lawrence to Long Island Sound.



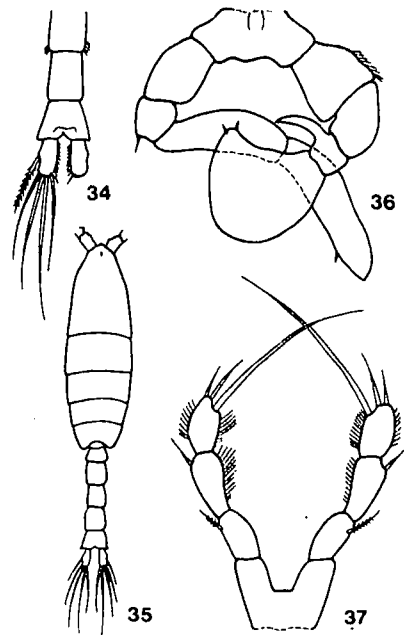
- 17a Metasome with conspicuous dark-colored knob (luminous organ) on right side at base of maxillipeds; anal segment with prominent, angular postero-lateral corners (Figs. 34, 35). 5th leg M right "pseudochelate", with dilated terminal segment (Fig. 36). Distal joint F 5th leg with one very long and two much shorter spines (Fig. 37) genus *Pleuromamma* only one species, *P. robusta*.

Figs. 34-37 - *Pleuromamma robusta* (Dahl 1893)

34. F urosome
35. M dorsal view
36. M 5th leg
37. F " "

Adult size range: M 3.5 mm; F 4.3 mm.

Distribution: North Atlantic, south Atlantic, Indian Ocean, Mediterranean Sea; Grand Banks to Cape Cod.



- 17b Metasome without luminous organ; anal segment without prominent angular corners (Fig. 38). Right 5th leg M with long curved, toothed or setose spine on second segment (Figs. 41, 43). Distal joint F 5th leg with 2 spines of approximately equal length and one shorter or longer (Figs. 40, 42) genus *Metridia* 18.

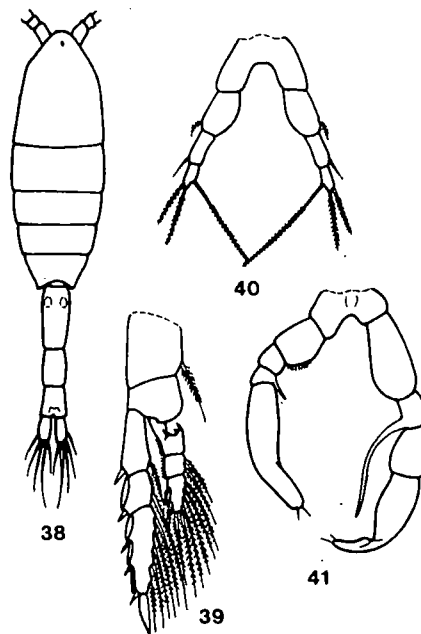
- 18a Fifth leg F 4-segmented; distal segment with one long medial and 2 shorter, terminal spines (Fig. 40). Distal segments of right and left 5th leg M of approximately equal length, but right leg distal segment reduced apically (Fig. 41) *Metridia longa*.

Figs. 38-41 - *Metridia longa* (Lubbock 1854)

38. F dorsal view
39. 2nd swimming leg
40. F 5th leg
41. M " "

Adult size range: M 3.5-3.7 mm; F 4.1-4.5 mm.

Distribution: North Atlantic, Arctic Ocean; Baffin Bay to Long Island Sound.



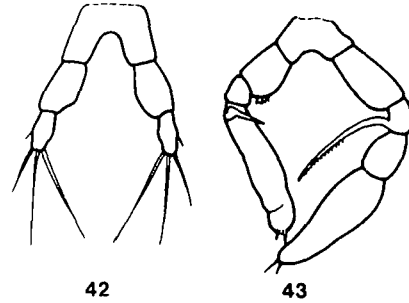
- 18b Fifth leg F 3-segmented (a fourth "joint" may occasionally be apparent); distal segment with two long equal, terminal spines, and one outer shorter spine (Fig. 42).
 Distal joints of right and left 5th leg M approximately equal in length; right leg distal segment stouter and not reduced apically (Fig. 43) *Metridia lucens*.

Figs. 42-43 - *Metridia lucens* Boeck 1864

42. F 5th leg
 43. M " "

Adult size range: M 2.1-2.3 mm; F 2.5-2.8 mm.

Distribution: North Atlantic, north Pacific, South Africa; Labrador to Cape Cod.



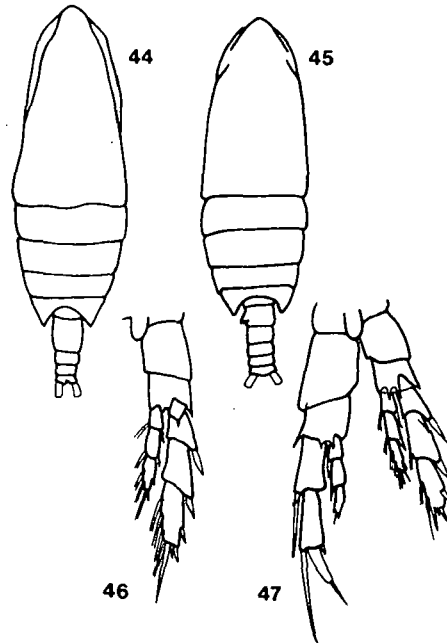
- 19a Head and first thoracic segment separate (6 apparent metasomal segments) (Fig. 48a).
 First antenna extending beyond caudal rami (Fig. 48b) genus *Calanus* 20.
 19b Head and first thoracic segment fused (5 apparent metasomal segments) (Figs. 44, 45).
 First antenna not extending beyond caudal rami
 genus *Nannocalanus* only one species, *N. minor*.

Figs. 44-47 - *Nannocalanus minor* (Claus 1863)

44. F dorsal view
 45. M " "
 46. F 5th leg
 47. M " "

Adult size range: M and F 1.0 mm.

Distribution: Tropic and subtropic seas of the world; Grand Banks to West Indies, offshore.



20a Body less than 5 mm long (M about 3.6 mm, F about 4.0 mm). Posterior projections of last metasomal segment rounded; caudal rami longer than anal segment (Figs. 48, 49). Endopodite of M left 5th leg extending just over 1/2 way along penultimate segment of exopodite; basipodite concave and toothed (Fig. 50a). 5th leg F similar to M, basipodite concave and toothed (Fig. 50b)

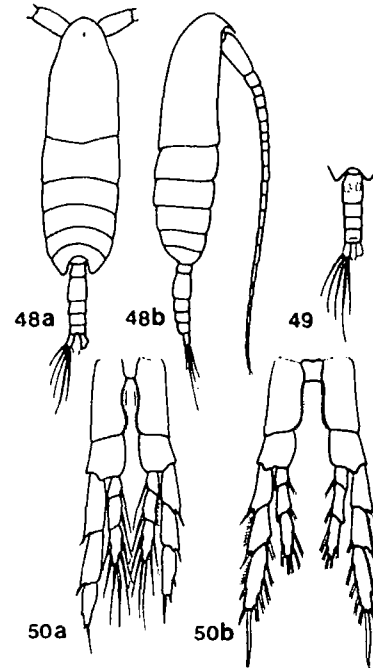
..... *Calanus finmarchicus*.

Figs. 48-50 - *Calanus finmarchicus* (Gunnerus 1765)

- 48a. M dorsal view
- 48b. M lateral view
- 49. F urosome
- 50a. M 5th leg
- 50b. F " "

Adult size range: M 2.3-3.6 mm; F 2.7-5.4 mm.

Distribution: Worldwide in all oceans; Arctic Ocean to West Indies.



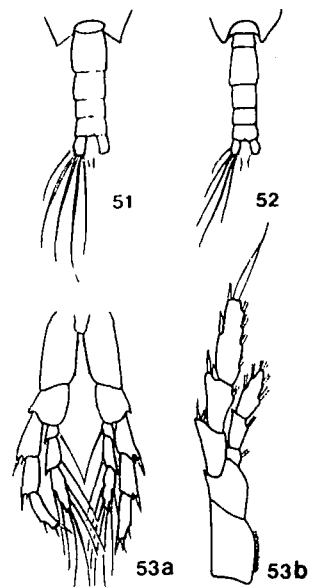
20b Body longer than 5 mm (M about 6 mm, F about 9 mm). Posterior projections of last metasomal segment pointed; caudal rami about same length as anal segment (Figs. 51, 52). Endopodite of M left 5th leg extending beyond 1/2 way along penultimate segment of exopodite; basipodite convex and toothed (Fig. 53a). 5th leg F similar to M, basipodite convex and toothed (Fig. 53b) *Calanus hyperboreus*.

Figs. 51-53 - *Calanus hyperboreus* Kroyer 1838

- 51. F urosome
- 52. M " "
- 53a. M 5th leg
- 53b. F " "

Adult size range: M 5.0-7.0 mm; F 7.0-10.0 mm.

Distribution: Arctic Ocean, north Atlantic, North Sea; Davis Strait to Gulf of Maine.



21a M with spines on antennal segments 2, 3, 6, 17 (Fig. 55). Chela of right 5th leg stout, with branches of nearly equal length (Fig. 57a). F urosome conspicuously asymmetrical, caudal rami about 2x as long as broad, single slender ventral spine at posterior end of genital segment (Figs. 54, 56)

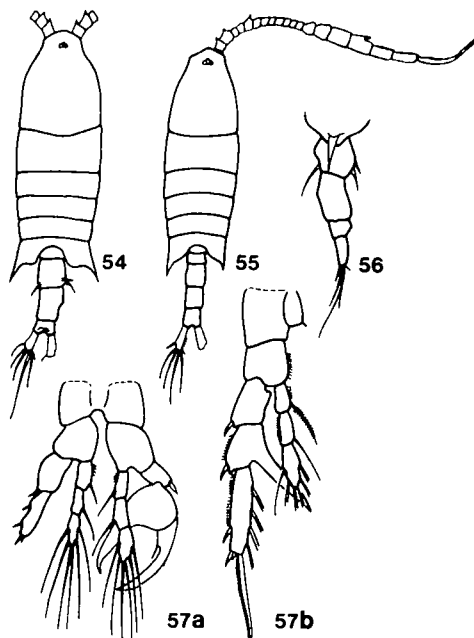
..... *Centropages typicus*.

Figs. 54-57 - *Centropages typicus* Kroyer 1849

- 54. F dorsal view
- 55. M " "
- 56. F urosome, lateral view
- 57a. M 5th leg
- 57b. F " "

Adult size range: M 1.4-1.6 mm; F 1.6-1.8 mm.

Distribution: Tropic and north Atlantic, North Sea; Newfoundland to Chesapeake Bay.



21b M antenna without distinct spines, with setae only (Fig. 59). Chela of right 5th leg slender, outer branch longer than inner (Fig. 61a). F urosome only slightly asymmetrical, caudal rami about 3x as long as broad, single stout spine ventrally at middle of genital segment (Figs. 58, 60)

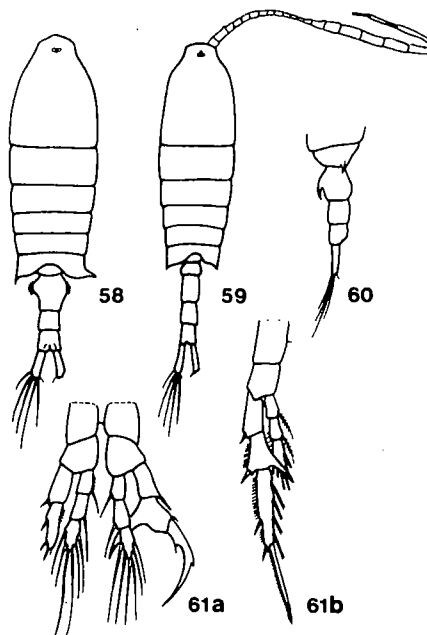
Centropages hamatus.

Figs. 58-61 - *Centropages hamatus* (Lilljeborg 1853)

- 58. F dorsal view
- 59. M " "
- 60. F urosome, lateral view
- 61a. M 5th leg
- 61b. F " "

Adult size range: M 1.3 mm; F 1.4 mm.

Distribution: North Atlantic, North Sea, Black Sea, Baltic Sea; Labrador to Chesapeake Bay.



- 22a Posterior of metasome smoothly rounded, no projections (Fig. 62). Exopodite of first leg 2-segmented; other exopodites 3-segmented. Fifth pair of legs M biramous with endopodites nearly as long as or longer than corresponding exopodite segment (Fig. 63). Basal segment of 4th leg F with 3 short spines and one long setose spine (Fig. 64) genus *Euchirella* only one species, *E. rostrata*.

Figs. 62-64 - *Euchirella rostrata* (Claus 1866)

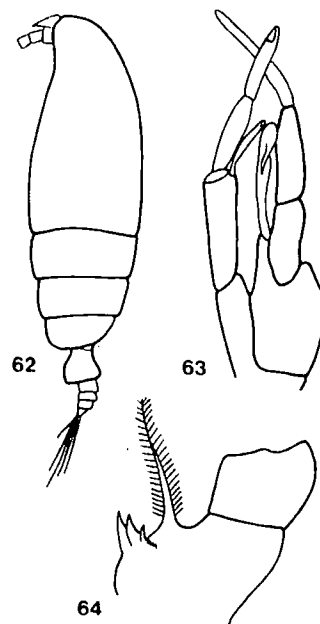
62. F lateral view

63. M 5th leg

64. F 4th leg, basal segment

Adult size range: M 2.5-3.0 mm; F 2.9-3.1 mm.

Distribution: North Atlantic, north and south Pacific, Indian Oceans, Mediterranean Sea; Labrador to Cape Cod.



- 22b Posterior of metasome bearing a large posteriorly directed spine or "wing" at each corner about as long as the genital segment (Figs. 65, 70). Exopodite of first leg 3-segmented, OR 2-segmented with 1st and 2nd joints partially separated. Fifth leg M uniramous, OR with poorly developed endopodites not as long as corresponding exopodite segment (Figs. 69, 71). 4th leg F not as above 23.

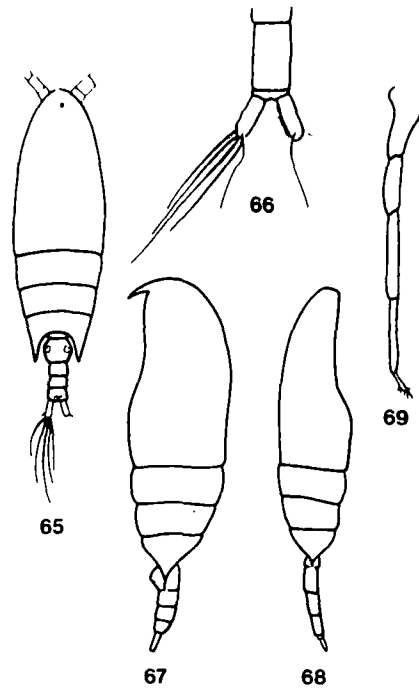
- 23a Rostrum long, basally bifurcated in F; posterior spines of metasome broadly based (Figs. 67, 68). Exopodite of first leg 3-segmented. Caudal rami F about 2x as long as broad, about 1.5x length of anal segment (Fig. 65). Caudal rami M about 3x as long as broad, flared, much longer than anal segment (Fig. 66). Fifth leg M uniramous, present on left side only (Fig. 69)
 genus *Aetideus* only one species, *A. armatus*.

Figs. 65-69 - *Aetideus armatus* (Boeck 1872)

- 65. I dorsal view
- 66. M urosome
- 67. F lateral view
- 68. M " "
- 69. M 5th leg

Adult size range: M 1.4-1.5 mm; F 1.8-2.0 mm.

Distribution: North Atlantic, Pacific, Indian Oceans, Mediterranean Sea; Gulf of St. Lawrence to Gulf of Maine.



23b Rostrum short, not basally bifurcated but notched in F; posterior spines of metasome narrowly based (Fig. 70). Exopodite of first leg sometimes with partially separated 1st and 2nd segments (apparently 2-segmented). Caudal rami M and F less than 2x as long as broad; about same length as anal segment in F, shorter than anal segment in M (Figs. 70-72). Fifth legs M biramous, endopodites not as long as corresponding exopodite segment (Fig. 71)

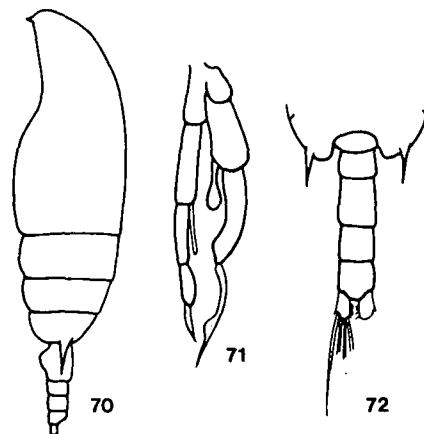
..... genus *Gaidius* only one species, *G. tenuispinus*.

Figs. 70-72 - *Gaidius tenuispinus* (G.O. Sars 1900)

- 70. F lateral view
- 71. M 5th leg
- 72. M urosome

Adult size range: M 2.0 mm; F 3.5-3.8 mm.

Distribution: Polar Seas, north Atlantic, eastern Pacific, North Sea; Davis Strait to Cape Cod.



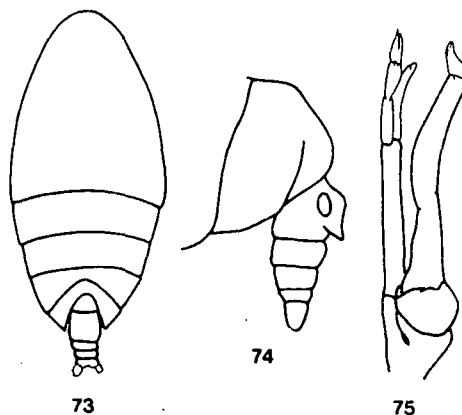
- 24a Genital segment F with ventral projection directed posteriorly (Fig. 74).
Antennae, when reflected, extending past metasome. Fifth leg absent or vestigial
in F. Fifth leg M biramous on left side, uniramous on right; right and left legs
sub-equal in length (Fig. 75) genus *Scolecithrix* only one species, *S. danae*.

Figs. 73-75 - *Scolecithrix danae* (Lubbock 1856)

73. F dorsal view
74. F urosome, lateral view
75. M 5th leg

Adult size range: M 1.4 mm; F 1.25 mm.

Distribution: Tropical and north Atlantic and
Pacific Oceans, Mediterranean Sea; Gulf of
Maine to Carribean.



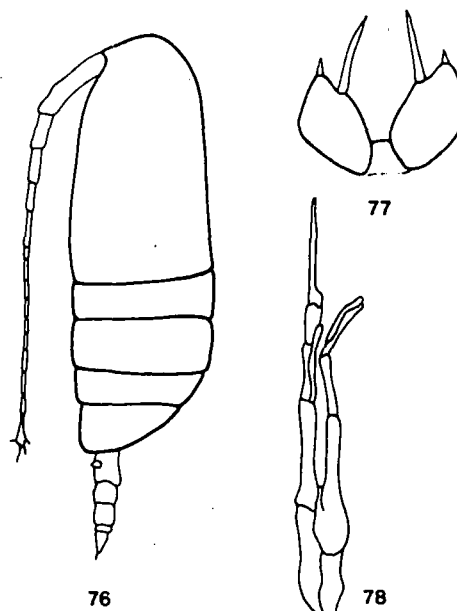
- 24b Genital segment F without projection (Fig. 76). Antennae when reflected, extending
as far as end of metasome (Fig. 76). 5th leg F present, consisting of a single
lamella segment (Fig. 77). 5th leg M very long, extending beyond caudal rami;
right leg longer than left, distal segment much larger than penultimate; with a
styliform appendage on 2nd joint; first joint of left leg dilated distally
(Fig. 78) genus *Scolecithricella* only one species *S. minor*.

Figs. 76-78 - *Scolecithricella minor* (Brody 1883)

76. F lateral view
77. F 5th leg
78. M " "

Adult size range: M and F 1.4 mm.

Distribution: Arctic Ocean, Indian Ocean, north
Atlantic; Labrador to Georges Bank.



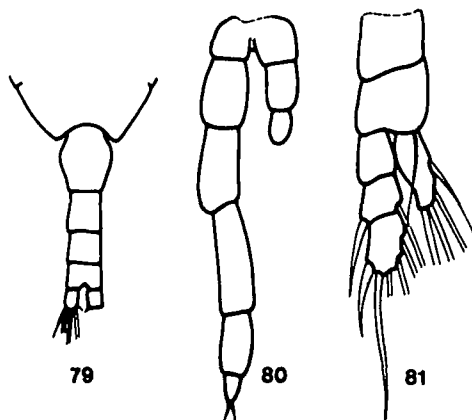
25a No eyespot present. M and F very small - about 0.7 mm total length. Caudal rami about as long as broad, equal to, in length, or shorter than anal segment (Fig. 79). Proximal joint of exopodite of 1st pair of legs without outer spine; endopodite of 1st pair bearing 4 bristles (Fig. 81). 5th leg absent in F. Right 5th leg of M about 1/3 length of left and ending in a small rounded segment (Fig. 80) genus *Microcalanus* only one species, *M. pusillus*.

Figs. 79-81 - *Microcalanus pusillus* G.O. Sars 1903

- 79. F urosome
- 80. M 5th leg
- 81. 1st swimming leg

Adult size range: M and F 0.7 mm.

Distribution: North Atlantic; Grand Banks to Bay of Fundy.



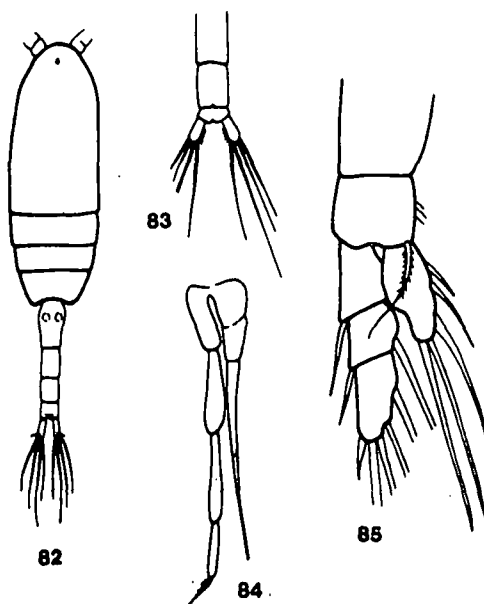
25b Simple naupliar eye present. M about 1.1 mm, F about 1.5 mm long (quite variable). Caudal rami about 2.5x as long as broad, in F just longer, and in male much longer than anal segment (Figs. 82, 83). Proximal joint of exopodite of 1st pair of legs with outer spine; endopodite of first pair with 5 bristles (Fig. 85). 5th leg absent in F. Left leg of M longer than right; 2nd and 3rd joints of left leg dilated distally, terminal joint very small; right leg very slender ending in long straight point (Fig. 84) . . genus *Pseudocalanus* only species, *P. minutus* (=elongatus).

Figs. 82-85 - *Pseudocalanus minutus* (Kroyer 1849)

- 82. F dorsal view
- 83. M urosome
- 84. M 5th leg
- 85. 1st swimming leg

Adult size range: M 1.1-1.4 mm; F 1.2-2.0 mm, variable.

Distribution: North Atlantic, North and Mediterranean Seas; Baffin Island to Chesapeake Bay.



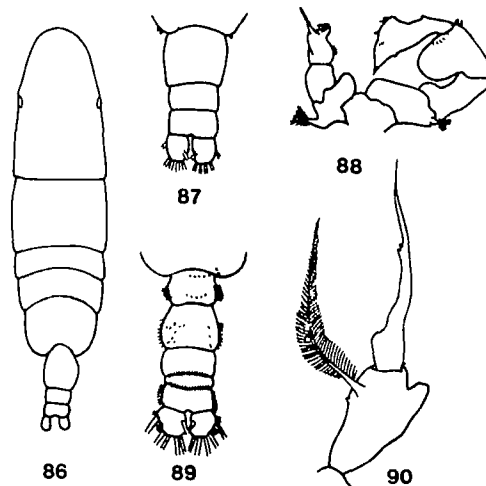
- 26a Urosome of F short, including caudal rami, only about 1/4 length of metasome (Fig. 86). Caudal rami about as wide as long and about same length as last urosomal segment in M and F (Figs. 87, 89). Lateral parts of M genital segment with tufts of bristles (Fig. 89) *Acartia tonsa*.

Figs. 86-90 - *Acartia tonsa* Dana 1848

86. F dorsal view
87. F urosome
88. M 5th leg
89. M urosome
90. F 5th leg

Adult size range: M 1.0-1.3 mm; F 1.3-1.5 mm.

Distribution: Tropical and north Pacific, tropical and north Atlantic; Gulf of St. Lawrence to Central America.



- 26b Urosome (including caudal rami) at least 1/3 length of metasome (e.g., Fig. 95). Caudal rami at least 1.5x as long as wide (e.g., Fig. 97) 27.

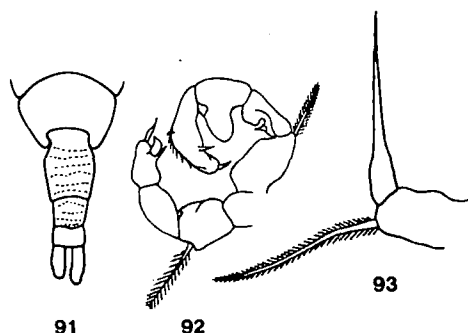
- 27a Genital and post-genital segment of F urosome bearing many dorsal rows short spines (Fig. 91). Distal joint of M left 5th leg bearing short thick medial appendage (Fig. 92) *Acartia bifilosa*.

Figs. 91-93 - *Acartia bifilosa* (Giesbrecht 1881)

91. F urosome
92. M 5th leg
93. F " "

Adult size range: M 1.0-1.1 mm; F 1.1 mm.

Distribution: Tropical and north Atlantic, North Sea, Baltic Sea, Mediterranean Sea; Bay of Fundy to Vineyard Sound.



- 27b Genital and post-genital segment of F urosome without such dorsal spines. Left leg distal joint M without such an appendage. (N.B. short spines are present) 28.

28a Genital segment of F very swollen anteriorly, caudal rami flared (Fig. 95).

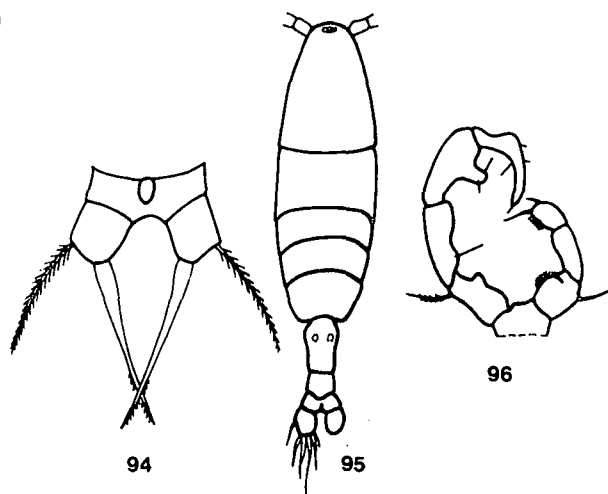
Right 5th leg M 2x as long as left (Fig. 96) *Acartia discaudata*.

Figs. 94-96 - *Acartia discaudata* (Giesbrecht 1882)

- 94. F 5th leg
- 95. F dorsal view
- 96. M 5th leg

Adult size range: M 1.1 mm; F 1.2 mm.

Distribution: Mid-Atlantic Ocean, Baltic Sea, North Sea; Bay of Fundy to Buzzards Bay.



28b Genital segment F not as swollen, OR swollen more centrally in segment; caudal rami not flared. Right 5th leg M only about 1.5x length of left. (Figs. 98, 102)

. 29.

29a Posterior metasomal segment with two dorso-lateral spines, one each side (Fig. 97).

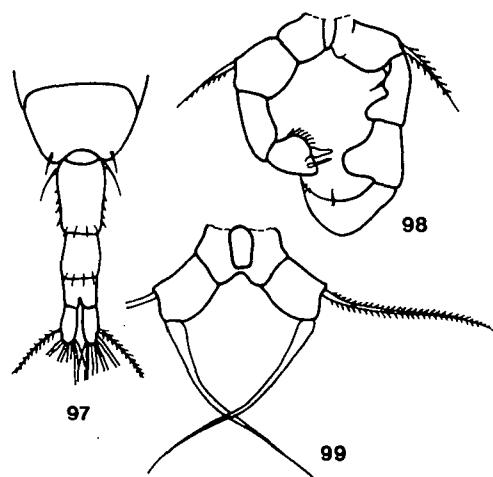
5th leg F with long thin terminal spine (Fig. 99). Right 5th leg M terminal segment without lateral spines (Fig. 98) *Acartia longiremis*.

Figs. 97-99 - *Acartia longiremis* (Lilljeborg 1853)

- 97. F urosome
- 98. M 5th leg
- 99. F 5th leg

Adult size range: M 0.9-1.0 mm; F 1.0-1.3 mm.

Distribution: North Atlantic, Arctic Ocean, Baltic Sea, North Sea, Hudson Bay; Baffin Island to Chesapeake Bay.



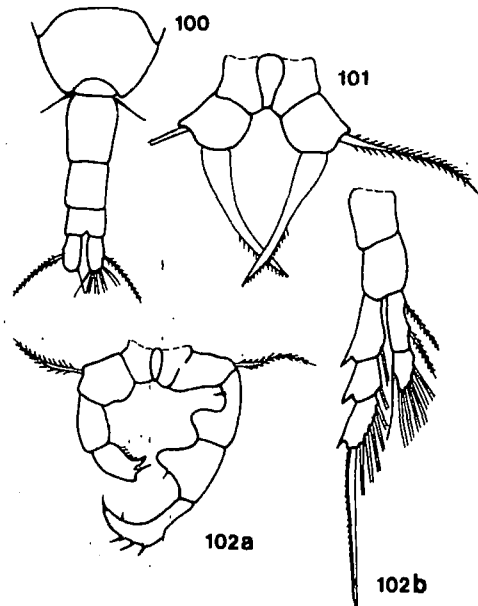
29b Posterior metasomal segment without dorso-lateral spines (Fig. 100) (N.B. do not confuse with lateral spines of genital segment). 5th leg F ending in thick serrate terminal spine (Fig. 101). Right 5th leg M terminal segment bearing 4 lateral spines (Fig. 102a) *Acartia clausi*.

Figs. 100-102 - *Acartia clausi* Giesbrecht 1889

- 100. F urosome
- 101. F 5th leg
- 102a. M " "
- 102b. 3rd swimming leg

Adult size range: M 0.85-1.1 mm; F 0.9-1.2 mm.

Distribution: North Atlantic, North Sea, Baltic Sea, Mediterranean Sea, Hudson Bay; Labrador to Chesapeake Bay.



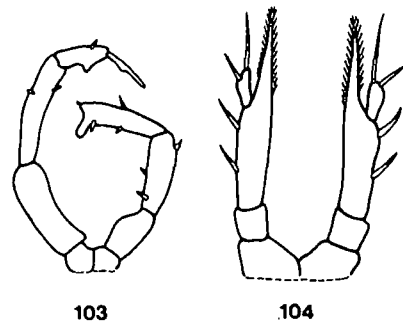
- 30a Antenna, when reflected reaches more or less only to end of metasome (Fig. 109). Metasome elongate, not narrowing noticeably to the posterior (Fig. 107). Endopodite of first leg with a single segment. 5th leg M without chela, left and right legs of similar form (Fig. 103). 5th leg F with a number of spines, distal segment smallest (Fig. 104) genus *Eurytemora* 31.
- 30b Antenna, when reflected, reaches to anal segment (Fig. 113). Metasome widest just behind "head" in region of mouth parts, narrowing posteriorly (Fig. 112). Endopodite of first leg with 2 segments. 5th leg M left "chelate" (Fig. 114). 5th leg F simple, without spines except on last segment which is the longest (Fig. 115) genus *Temora* 33.
- 31a Anal segment and caudal rami F covered with small spines (Fig. 108). Distal joint F 5th leg short, rounded; process of penultimate joint directed obliquely medially (Fig. 106b). 5th pair of legs M 4- or 5-jointed, if 5-jointed then distal joint of left leg is short and acutely angular; second segment of left leg swollen at middle (Fig. 105) 32.
- 32b Anal segment and caudal rami of F smooth, without small spines. Process on penultimate joint of 5th legs F much longer (2.5x) than distal joint of leg, and pointing parallel to long axis of body (Fig. 104). Right 5th leg M 5-jointed, third joint longer and narrower than second, distal joint thin, filiform; third joint of left and right legs bearing 3 spines (Fig. 103) *Eurytemora herdmani*.

Figs. 103-104 - *Eurytemora herdmani* Thompson

- and Scott 1898
- 103. M 5th leg
- 104. F " "

Adult size range: M 1.2-1.5 mm; F 1.3-1.6 mm.

Distribution: Eastern North America, Alaska, Hudson and James Bays; Labrador to Cape Cod.



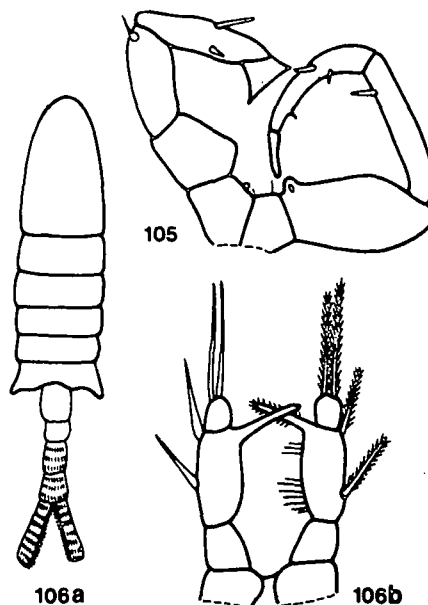
32a Distal joint of 5th leg F bearing 2 long setose bristles; medial process of penultimate joint serrate; penultimate and distal joints with hairy inner margins (Fig. 106b). 5th pair of legs M 5-jointed; distal joint of left leg short, acutely angular (Fig. 105) *Eurytemora americana* (=thompsoni).

Figs. 105-106 - *Eurytemora americana* Williams 1906

- 105. M 5th leg
- 106a. F dorsal view
- 106b. F 5th leg

Adult size range: M 1.0-1.5 mm; F 1.1-1.6 mm.

Distribution: In estuaries eastern North America; Ogac Lake, Baffin Island to Narragansett Bay.



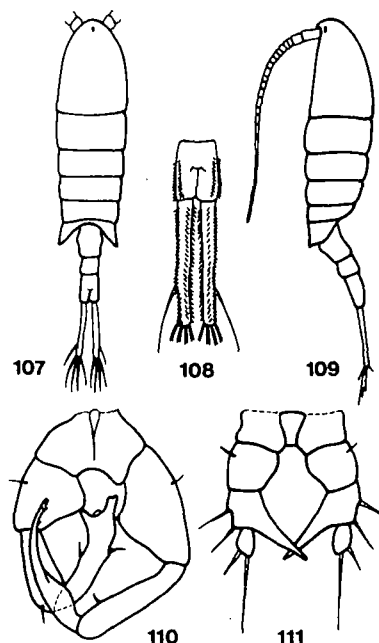
32b Distal joint of 5th leg F bearing a smooth apical spine, which is 2-3x longer than the sub-apical spine; penultimate segment with smooth outer spines and smooth medial process (Fig. 111). 5th pair of legs M 4-jointed; distal joint of left leg broadened apically, with 2 blunt processes (Fig. 110) *Eurytemora hirundoides*.

Figs. 107-111 - *Eurytemora hirundoides* (Nordquist 1888)

- 107. F dorsal view
- 108. F caudal rami and anal segment
- 109. F lateral view
- 110. M 5th leg
- 111. F " "

Adult size range: M 1.9-2.2 mm; F 1.0-1.5 mm.

Distribution: Inshore north Atlantic, Baltic Sea; Labrador to Chesapeake Bay.



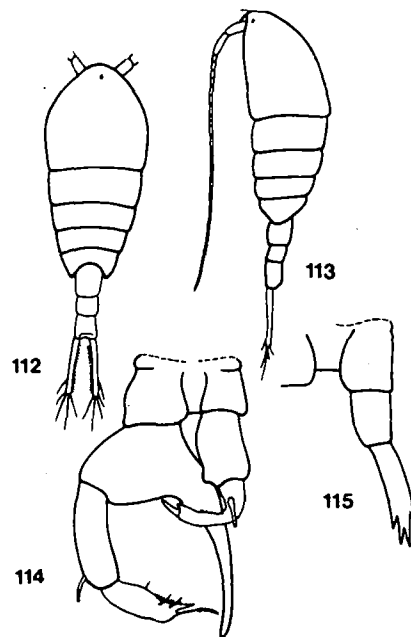
- 33a M and F posterior edges of metasome bluntly rounded (Figs. 112, 113). Last segment of 5th leg F ending in 2 short terminal spines and 2 short sub-terminal spines, one lateral and one medial (Fig. 115). M 5th leg chelate, terminal segment of left 5th leg shorter and thinner than penultimate, produced into an acute tip, and bearing a fine setose spine sub-apically (Fig. 114) *Temora longicornis*.

Figs. 112-115 - *Temora longicornis* (Müller 1785)

- 112. F dorsal view
- 113. F lateral view
- 114. M 5th leg
- 115. F " "

Adult size range: M and F 1.5 mm.

Distribution: North Atlantic, Baltic Sea;
Labrador to Chesapeake Bay.



- 33b M and F metasome posterior edges produced into acutely pointed "wings" (Figs. 116, 117). Last segment of 5th leg F ending in 2 short spines and one long, sub-apical medial spine, with 1 short spine laterally 1/2 way down last segment (Fig. 120). Terminal segment of left fifth leg M greatly enlarged, subspherical in shape *Temora stylifera*.

Figs. 116-120 - *Temora stylifera* Dana 1849

- 116. F dorsal view
- 117. M urosome
- 118. M 5th leg - right
- 119. M " " - left
- 120. F " "

Adult size range: M and F 1.0 mm.

Distribution: Tropical Pacific and Atlantic
Oceans, Red Sea, Mediterranean Sea; Gulf of St.
Lawrence to Caribbean.

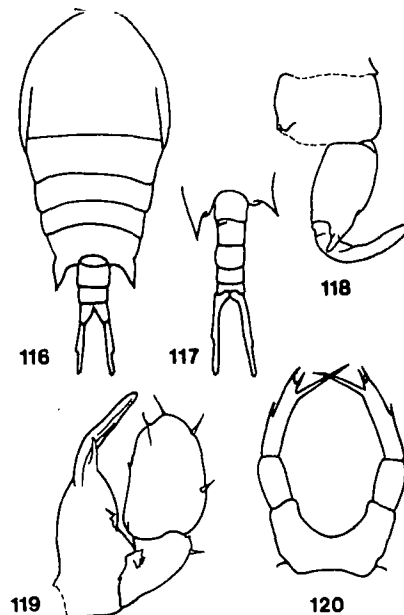


Table 2. List of families, genera and species

Family	Genus	Species and Author
Acartiidae	Acartia	<i>bifilosa</i> (Giesbrecht 1881) <i>discaudata</i> (Giesbrecht 1882) <i>clausi</i> Giesbrecht 1889 <i>longiremis</i> (Lilljeborg 1853) <i>tonsa</i> Dana 1848
Aetideidae (all outside Passamaquoddy Bay)	<i>Aetideus</i> <i>Euchirella</i> <i>Gaidius</i>	<i>armatus</i> (Boeck 1872) <i>rostrata</i> (Claus 1866) <i>tenuispinus</i> (G.O. Sars 1900)
Calanidae	<i>Calanus</i> <i>Nannocalanus</i>	<i>finmarchicus</i> (Gunnerus 1765) <i>hyperboreus</i> Kroyer 1838 N.B. no <i>helgolandicus</i> <i>minor</i> (Claus 1863)
Candaciidae	<i>Candacia</i>	<i>armata</i> (Boeck 1872)
Centropagidae	<i>Centropages</i>	<i>hamatus</i> (Lilljeborg 1853) <i>typicus</i> Kroyer 1849
Eucalanidae	<i>Rhincalanus</i>	<i>nasutus</i> Giesbrecht 1892
Euchaetidae	<i>Euchaeta</i>	<i>norvegica</i> Boeck 1872
Metrididae	<i>Metridia</i> <i>Pleuromamma</i>	<i>longa</i> (Lubbock 1854) <i>lucens</i> Boeck 1864 <i>robusta</i> (Dahl 1893)
Paracalanidae	<i>Paracalanus</i>	<i>parvus</i> (Claus 1863)
Pontellidae	<i>Anomalocera</i> <i>Labidocera</i>	<i>paterstoni</i> Templeton 1837 <i>aestiva</i> Wheeler 1900
Pseudocalanidae	<i>Microcalanus</i> <i>Pseudocalanus</i>	<i>pusillus</i> G. O. Sars 1903 <i>minutus</i> (Kroyer 1849)
Pseudodiaptomidae (Bay of Fundy only)	<i>Pseudodiaptomus</i>	<i>coronatus</i> Williams 1906
Scolecithricidae	<i>Scolecithricella</i> <i>Scolecithrix</i>	<i>minor</i> (Brady 1883) <i>danae</i> (Lubbock 1856)
Temoridae	<i>Eurytemora</i> <i>Temora</i>	<i>americana</i> Williams, 1906 (= <i>thompsoni</i>) (Willey, 1923) <i>herdmani</i> Thompson and Scott 1898 <i>hirundoides</i> (Nordquist 1888) <i>longicornis</i> (Müller 1785) <i>stylifera</i> (Dana 1849)
Tortanidae	<i>Tortanus</i>	<i>discaudatus</i> (Thompson and Scott 1897)

Table 3. Alphabetical list of species with ecological notes and page numbers

Species	Depth/Region Encountered	Abundance/Seasonal Occurrence	Page
<i>Acartia bilfilosa</i>	Surface; neritic estuarine	Locally abundant, "swarms"; summer, fall	19
<i>Acartia clausi</i>	Surface; neritic	Dominant species; summer, fall	21
<i>Acartia discaudata</i>	Surface; neritic (estuarine?)	Not reported for the immediate area	20
<i>Acartia longiremis</i>	Surface; neritic, oceanic	Common, occurs with <i>A. clausi</i> ; spring to fall	20
<i>Acartia tonsa</i>	Surface, neritic, estuarine, low salinity waters	Locally abundant, estuaries, bays	19
<i>Aetideus armatus</i>	Subsurface to 500 m (+?); oceanic, tropical, sub-tropical	Rare; summer	16
<i>Anomalocera patersoni</i>	Surface, neustonic; neritic, oceanic	Common + abundant "swarms"; summer	10
<i>Calanus finmarchicus</i>	Subsurface; oceanic	Occurs year round; very common	13
<i>Calanus hyperboreus</i>	Subsurface; oceanic	Rare + common; year round	13
<i>Candacia armata</i>	Surface subsurface; oceanic	Rare	9
<i>Centropages hamatus</i>	Surface; neritic, oceanic	Common; summer, fall	14
<i>Centropages typicus</i>	Surface; neritic, oceanic	Common; year round	14
<i>Euchaeta norvegica</i>	Deep-water, subsurface, surface; neritic, oceanic	Rare + common; year round	5
<i>Euchirella rostrata</i>	Deep-water, subsurface; oceanic	Rare	15
<i>Eurytemora americana</i> (= <i>thompsoni</i>)	Surface; neritic, estuarine, low salinity waters	Locally common? Summer?	22
<i>Eurytemora herdmani</i>	Surface; neritic, littoral, estuarine, low salinity waters	Locally abundant; spring, summer, fall	21

Table 3. Continued

Species	Depth/Region Encountered	Abundance/Seasonal Occurrence	Page
<i>Eurytemora hirundoides</i>	Surface; neritic, littoral, low salinity	Locally abundant; spring, summer, fall	22
<i>Gaidius tenuispinus</i>	Deep water; oceanic	Rare	16
<i>Labidocera aestiva</i>	Subsurface; neritic (?)	Rare	10
<i>Metridia longa</i>	Subsurface, deep water; oceanic	Rare + common; year round?	11
<i>Metridia lucens</i>	Surface; oceanic	Common + abundant; year round	12
<i>Microcalanus pusillus</i>	Subsurface; deep water, oceanic	?	18
<i>Nannocalanus minor</i>	Subsurface, surface	?	12
<i>Paracalanus parvus</i>	Surface, neritic, oceanic	Common; year round?	7
<i>Pleuromamma robusta</i>	Subsurface, deep water; oceanic	Rare	11
<i>Pseudocalanus minutus</i>	Surface, subsurface; neritic, oceanic	Common + abundant; year round	18
<i>Pseudodiaptomus coronatus</i>	Surface; neritic, littoral, bays, estuaries, low salinity waters	Locally abundant	6
<i>Rhincalanus nasutus</i>	Subsurface; oceanic	Rare; summer, winter	8
<i>Scolecithricella minor</i>	Surface, subsurface; oceanic	Rare; fall, winter?	17
<i>Scolecithrix danae</i>	Surface, subsurface; oceanic	Rare	17
<i>Temora longicornis</i>	Surface; neritic, oceanic	Common + abundant; year round	23
<i>Temora stylifera</i>	Surface, subsurface; oceanic	Rare; fall	23
<i>Tortanus discaudatus</i>	Surface; neritic, estuarine	Common + abundant	8

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SELECTED BIBLIOGRAPHY

- Battle, H. I., A. G. Huntsman, A. M. Jeffers, G. W. Jeffers, W. H. Johnson, and N. A. McNairn. 1939. Fatness, digestion and food of Passamaquoddy young herring. J. Biol. Board Can. 2: 401-429.
- Bigelow, H. B. 1926. Plankton of the offshore waters of the Gulf of Maine. Bull. U.S. Bur. Fish. 40: 1-509.
- Brady, G. S. 1876. A monograph of the free and semi-parasitic copepoda of the British Islands. Publ. Roy. Soc., London, Vols. I, II, III.
- Brodski, K. A. 1967. Calanoida of the far eastern seas and polar basin of the U.S.S.R. Keys to the fauna of the U.S.S.R. publ. Zool. Inst., Acad. Sci. U.S.S.R. No. 35.
- Conover, R. J. 1956. The biology of *Acartia clausi* and *Acartia tonsa*. Bull. Bingham Oceanogr. Collect. Yale Univ. 15: 156-233.
- Cowie, J. J. 1929. Report on the work of the Biological Board for 1928-29. Fish. Res. Board Can. Ann. Rep. 62: 121-138.
- Currie, M. E. 1919. Exuviation and variation of plankton copepods with special reference to *Calanus finmarchicus*. Trans. Roy. Soc. Can. 12(3): (Sect. 4): 207-233.
- Davis, C. C. 1943. The larval stages of the calanoid copepod *Eurytemora hirundoides* (Nordquist). Chesapeake Biol. Lab. Publ. No. 58: 1-20.
1955. The marine and freshwater plankton. Michigan State University Press.
- Farran, G. P. 1948a. Copepoda. Calanoida. Fam. Centropagidae. Gen. *Centropages*. Fich. Ident. Zoopl. Cons. Int. Explor. Mer, 11.
- 1948b. Copepoda. Calanoida. Fam. Acartiidae. Gen. *Acartia*. Fich. Ident. Zoopl. Cons. Int. Explor. Mer, 12.
- 1948c. Copepoda. Calanoida. Fam. Candaciidae. Gen. *Candacia*. Fich. Ident. Zoopl. Cons. Int. Explor. Mer, 13.
- 1948d. Copepoda. Calanoida. Fam. Metridiidae. Gen. *Metridia*. Fich. Ident. Zoopl. Cons. Int. Explor. Mer, 14.
- 1948e. Copepoda. Calanoida. Fam. Metridiidae. Gen. *Platromamma*. Fich. Ident. Zoopl. Cons. Int. Explor. Mer, 17.
- Farran, G. P., and W. Vervoort. 1951a. Copepoda. Calanoida. Fam. Calanidae. Fich. Ident. Zoopl. Cons. Int. Explor. Mer, 32.
- 1951b. Copepoda. Calanoida. Fam. Eucalanidae. Fich. Ident. Zoopl. Cons. Int. Explor. Mer, 34.
- 1951c. Copepoda. Calanoida. Fam. Paracalanidae. Gen. *Paracalanus*. Fich. Ident. Zoopl. Cons. Int. Explor. Mer, 35.
- 1951d. Copepoda. Calanoida. Fam. Pseudocalanidae. Gen. *Pseudocalanus*, *Microcalanus*. Fich. Ident. Zoopl. Cons. Int. Explor. Mer, 37.
- Fish, C. J. 1936a. The biology of *Calanus finmarchicus* in the Gulf of Maine and Bay of Fundy. Biol. Bull. (Woods Hole) 70: 118-141.
- 1936b. The biology of *Pseudocalanus minutus* in the Gulf of Maine and Bay of Fundy. Biol. Bull. (Woods Hole) 70: 193-216.
- 1936c. The biology of *Oithona similis* in the Gulf of Maine and Bay of Fundy. Biol. Bull. (Woods Hole) 71: 169-187.
- Fish, C. J., and M. W. Johnson. 1937. The biology of the plankton population in the Bay of Fundy and Gulf of Maine with special reference to production and distribution. J. Biol. Board Can. 3: 189-322.
- Fontaine, M. 1955. The planktonic copepods (Calanoida, Cyclopoida, Monstrilloidea) of Ungava Bay, with special reference to the biology of *Pseudocalanus minutus* and *Calanus finmarchicus*. J. Fish. Res. Board Can. 12: 858-898.
- Fulton, J. 1972. Keys and references to the marine copepoda of British Columbia. Fish. Res. Board Can. Tech. Rep. 313, 63 p.
- Gibbons, S. G. 1938. Early developmental stages of copepoda: II. *Metridia lucens* Boeck. Ann. Mag. Natur. Hist. 11: 493-497.
- Glover, R. S., and G. A. Robinson. 1968. Continuous plankton records during the NORTHWESTLANT Surveys, 1963 -- Zooplankton. Int. Comm. Northwest Atl. Fish. Spec. Publ. 7: 123-126.
- Grainger, E. H. 1963. Copepods of the genus *Calanus* as indicators of eastern Canadian waters. In M.J. Dunbar (ed.) Marine Distributions. Roy. Soc. Can. Spec. Publ. 5: 68-94.

- Grice, G. D. 1963a. A revision of the genus *Candacia* (Copepoda: Calanoida) with an annotated list of the species and a key for their identification. Zool. Meded. 38: 171-194.
- 1963b. Deep water copepods from the western North Atlantic with notes on five species. Bull. Mar. Sci. Gulf and Carib. 13: 493-501.
- Heron, G. A. 1964. Seven species of *Eurytemora* (Copepoda) from northwestern North America. Crustaceana 7: 199-211.
- Huntsman, A. G. 1924. Limiting factors for marine animals. I. The lethal effect of sunlight. Contrib. Can. Biol. N.S. 2: 81-88.
1955. Effect of freshets on Passamaquoddy plankton. Deep-sea Res. 3(Suppl.): 321-330.
- Jaschnov, W. A. 1955. Morphology, distribution and systematics of *Calanus finmarchicus* S.L. Zool. Zh., Acad. Sci. U.S.S.R. 34: 1201-1223.
- Jermolajev, E. G. 1958. Zooplankton of the inner Bay of Fundy. J. Fish. Res. Board Can. 15: 1219-1228.
- Johnson, M. W. 1934. The life history of the copepod *Tortanus discaudatus* (Thompson and Scott). Biol. Bull. (Woods Hole) 67: 182-200.
1935. The developmental stages of *Labidocera*. Biol. Bull., (Woods Hole) 68: 397-421.
- Johnson, W. H. 1934. Herring food in Passamaquoddy Bay. Biol. Board Can. Ann. Rep. (1933): p. 24.
1935. The food and feeding of the herring (*Clupea harengus* L.). Biol. Board Can. MS Rep. 195, 60 p.
1938. The effect of light on the vertical movements of *Acartia clausi* (Giesbrecht). Biol. Bull. (Woods Hole) 75: 106-118.
1939. Changes in the vertical distribution of the common free swimming copepods of Passamaquoddy Bay, New Brunswick. Fish. Res. Board Can. MS Rep. 137, 24 p.
1942. Effect of light on copepods as food for Passamaquoddy herring. J. Fish. Res. Board Can. 5: 365-376.
- LaCroix, G., and L. Legendre. 1964. Le zooplancton et l'estuaire de la Rivière Restigouche (Baie des Chaleurs): quantités et composition en août 1962. Natur. Can. 91: 21-40.
- Lebour, M. V. 1916. Stages in the life history of *Calanus finmarchicus* (Gunnerus), experimentally reared by Mr. L. R. Crawshaw in the Plymouth Laboratory. J. Mar. Biol. Assoc. U.K. 11: 1-17.
- Légare, J. E. H. 1961. The zooplankton of the Passamaquoddy region. Fish. Res. Board Can. MS Rep. 77, 37 p.
- Légare, J. E. H., and D. C. MacLellan. 1960. A qualitative and quantitative study of the plankton of the Quoddy region in 1957 and 1958 with special reference to the food of the herring. J. Fish. Res. Board Can. 17: 409-448.
- Lowndes, A. 1931. *Eurytemora thompsoni*. A Willey, a New European Record. Ann. Mag. Nat. Hist. 8(10).
- MacDonald, D. L. 1912. On a collection of crustacea made at St. Andrews. N.B. Contrib. Can. Biol. 1906-1910: 83-84.
- March, C. D. 1933. Synopsis of the calanoid crustaceans, exclusive of the Diaptomidae, found in fresh and brackish waters, chiefly of North America. Proc. U.S. Nat. Mus. 82: 1-58.
- Marshall, S. M., and A. P. Orr. 1955. The biology of a marine copepod. Publ. Oliver and Boyd, Reprint, Springer-Verlag.
- Matthews, J. B. L. 1967. *Calanus finmarchicus* s.l. in the North Atlantic. The relationships between *Calanus finmarchicus* s. str., *C. glacialis* and *C. helgolandicus*. Bull. Mar. Ecol. 6: 159-179.
- McMurrich, J. P. 1917a. The winter plankton in the neighbourhood of St. Andrews. Contrib. Can. Biol., 1915-1916: 1-10.
- 1917b. Notes on some crustacean forms occurring in the plankton of Passamaquoddy Bay. Trans. Roy. Soc. Can. 11 (Sect. 4): 47-61.
- Murphy, H. E. 1923. The life cycle of *Oithona nana*, reared experimentally. Univ. Calif. Publ. Zool. 22: 449-454.
- Newell, G. E., and R. C. Newell. 1963. Marine plankton - a practical guide. Hutchinson Educational.
- Odell, E. C. 1926. The correlation between light intensity and the bathymetric distribution of marine copepods. Biol. Board Can. MS Rep. 89, 23 p.
- Ogilvie, H. S. 1953. Copepod nauplii (I) Fich Ident. Zool. Cons. Int. Explor. Mer, 50.
- Owre, H. B., and M. Foyo. 1967. Copepods of the Florida Current. Fauna Caribaea No. 1. Crustacea, Part I: Copepoda. Publ. Inst. Mar. Sci. Univ. Miami.

- Raymont, J. E. G. 1963. Plankton and productivity in the oceans. Pergamon Press.
- Rose, M. 1933. Copépodes pélagiques. Faune Fr. 26: 1-374.
1942. Les Scolecithricidae (copépodes pélagiques) de la Baie d'Alger. Ann. Inst. Océanogr. Monaco 21: 113-170.
- Sars, G. O. 1903. An account of the crustacea of Norway with short descriptions and figures of all the species. Vol. IV. Copepoda, Calanoida. Publ. Bergen Museum.
- Sherman, K. 1965. Seasonal and areal distribution of Gulf of Maine coastal zooplankton, 1963. Int. Comm. Northwest Atl. Fish. Spec. Publ. 6: 611-623.
- 1966a. Seasonal and areal distribution of zooplankton in coastal waters of the Gulf of Maine, 1964. U.S. Fish Wildl. Serv. Spec. Sci. Rep. Fish. 530, 11 p.
- 1966b. Copepods of Gulf of Maine coastal waters. Maine Field Natur. 22: 94-97.
1968. Seasonal and areal distribution of zooplankton in coastal waters of the Gulf of Maine, 1965 and 1966. U.S. Fish Wildl. Serv. Spec. Sci. Rep. Fish. 562, 11 p.
- Shih, C. T., A. J. G. Figueira, and E. H. Grainger. 1971. A synopsis of Canadian marine zooplankton. Fish. Res. Board Can. Bull. 176.
- Vervoort, W. 1952a. Copepoda. Calanoida. Fam. Aetideidae. Key to the genera and references. Fich. Ident. Zoopl. Cons. Int. Explor. Mer, 41.
- 1952b. Copepoda. Calanoida. Fam. Aetideida. Gen. *Aetideus*, *Euaetideus*, *Aetideopsis*. Fich. Ident. Zoopl. Cons. Int. Explor. Mer, 42.
- 1952c. Copepoda. Calanoida. Fam. Aetideidae. Gen. *Gaidius*. Fich. Ident. Zoopl. Cons. Int. Explor. Mer, 45.
- 1952d. Copepoda. Calanoida. Fam. Aetideidae. Gen. *Euchirella*. Fich. Ident. Zoopl. Cons. Int. Explor. Mer, 47.
- Vinogradov, M. E. 1970. Vertical distribution of the oceanic zooplankton. Acad. Sci. U.S.S.R. Inst. Oceanogr.
- Wheeler, W. M. 1901. The free-swimming copepods of the Woods Hole region. Bull. U.S. Fish. Comm. 19(1899): 157-192.
- Willey, A. 1913. Notes on plankton collected across the mouth of the St. Croix River opposite to the Biological Station at St. Andrews, New Brunswick, in July and August 1912. Proc. Zool. Soc. London, 1913: 283-292.
1915. The plankton in St. Andrews Bay. Contrib. Can. Biol., 1911-1914, 1: 1-9.
- 1919a. Report on the Copepoda obtained in the Gulf of St. Lawrence and adjacent waters, 1915. Contr. Can. Biol. 12: 173-220.
- 1919b. Report on the Copepoda obtained in the Gulf of St. Lawrence and adjacent waters, 1915. In J. Hjort (ed.) Canadian fisheries expedition, 1914-1915. Dept. Nav. Ser., Ottawa, p. 173-220.
1920. Report of the Canadian Arctic Expedition, 1913-1918, Vol. 7, Crustacea, p.K. Marine Copepoda, 1-46.
1921. Arctic Copepoda in Passamaquoddy Bay. Proc. Amer. Acad. Arts and Sci. 56: 183-196.
1923. Notes on the distribution of free-living Copepoda in Canadian waters. Contrib. Can. Biol. N.S. 1: 303-334.
- Wilson, C. B. 1932. The copepods of the Woods Hole region, Massachusetts. Bull. U.S. Nat. Mus. 158: XIX + 635 p.
- Wimpenny, R. S. 1966. The plankton of the sea. American Elsevier.
- Wright, N. E. 1925-26. The Copepod food cycle. Biol. Board Can. MS Rep. 87, 33 p.

