Keys and References to the Marine Copepoda of British Columbia

by John Fulton

FISHERIES RESEARCH BOARD OF CANADA

TECHNICAL REPORT NO. 313

1972

FISHERIES RESEARCH BOARD OF CANADA

Technical Reports

FRB Technical Reports are research documents that are of sufficient importance to be preserved, but which for some reason are not appropriate for primary scientific publication. No restriction is placed on subject matter and the series should reflect the broad research interests of FRB.

These Reports can be cited in publications, but care should be taken to indicate their manuscript status. Some of the material in these Reports will eventually appear in the primary scientific literature.

Inquiries concerning any particular Report should be directed to the issuing FRB establishment which is indicated on the title page.

FISHERIES RESEARCH BOARD OF CANADA

TECHNICAL REPORT NO. 313

KEYS AND REFERENCES TO THE MARINE COPEPODA OF BRITISH COLUMBIA

by

John Fulton

FISHERIES RESEARCH BOARD OF CANADA

Pacific Biological Station, Nanaimo, B. C.

MAY 1972

CONTENTS

INTRODUCTION

A food-chain study of the Strait of Georgia began in January 1965. Over the course of the past eight years a relatively large number of zooplankton samples have been collected and analysed. Collections have been made in vertical hauls with a modified Hensen net (2,800 samples), vertical hauls with a cylinder-cone net with a 1/4 m^2 mouth opening (2,600 samples), horizontal hauls with a Miller net (3,000 samples), and horizontal and oblique hauls with a Hardy-Longhurst net (250 samples). All of the nets used in the program were constructed of "Nitex" mesh with 350μ openings. In addition, microzooplankton and larval stages of abundant species were collected from discrete depths in Van Dorn bottles (7 liters) and concentrated by filtration through "Nitex" mesh with 44μ openings (3,000 samples). Quantitative results of zooplankton sampling have been reported by Bishop et al (MS 1966), Stephens et al (MS 1967), Fulton et al (MS 1967, MS 1968, MS 1969a, MS 1969 b). Some of the results have been summarized by Stephens et al (MS 1969). Final interpretation of the results have been reported by LeBrasseur et al, 1969, Parsons et al, 1969a, 1969b, and 1970.

Much of the information which proved useful for rapid sorting of zooplankton appeared in an initial publication (Fulton, MS 1968). In the present MS the keys have been expanded, more illustrations have been included, and suggestions from various users of the previous manual incorporated.

Since these keys were composed for plankton from the Strait of Georgia, they are not particularly suitable for the identification of zooplankton from other geographic locations. For instance, 49 species of copepods identified by the University of Washington from the Columbia River plume have not been identified from the Strait of Georgia samples.

About twenty species account for more than 90% of the standing crop of zooplankton in the area sampled. During the food chain study rapid identification of these species was essential in order that zooplankton data be concurrent with physical, chemical and primary productivity data. The utility of this approach in the study of aquatic ecosystems has been discussed by Parsons (1969).

With speed as a major requirement of plankton sorting, routine identification was based on gross morphology, which is quickly and easily observed with low power magnification. Therefore, the characteristics used in the keys for this manual are usually not the characteristics a taxonomist would use, nor are they intended to be. The intent of the manual is to assist the non-taxonomist with the identification of the more common zooplankton species. It may be argued that the use of the manual might lead to misidentification of rare species. This is undoubtedly true. However, anyone seriously interested in positive identification would have identifications confirmed by an experienced taxonomist. In many cases size proved to be one of the most useful criteria for identification of species. Samples were therefore sorted in a clear plastic Bogarov counting chamber which had a background ruled off in millimeter squares.

Because size proved so useful in the determination of species in samples of low diversity, an optical electronic plankton sizer and counter was developed (Cooke et al, 1970). This machine is capable of counting and sizing (into 7 size categories), ca 12,000 organisms every 6 minutes.

For some species, it has been possible to include brief semi-quantitative remarks on their ecology. The following terms have been used throughout:

X	-	Species observed in the present collection.
A	-	Species observed by previous workers but not in the present collection.
Surface	-	Samples taken from less than 50 m.
Mid-depth	-	Samples taken from deeper than 50 m but less than 200 m.
Deep	-	Samples taken from deeper than 200 m.
Rare	-	Less than one organism per 25 m^3.
Common	-	1 - 25 organisms per 25 m^3.
Abundant	-	More than 25 organisms per 25 m^3.
Very abundant	-	More than 25 organisms and more than 25% of the biomass.

It is to be noted that the above terminology refers to the distribution and abundance most frequently observed and does not seek to delimit or define the absolute limits of a species.

The bibliography has been selected, wherever possible, from systematic work describing species in British Columbia coastal waters. Where there is no local reference or taxonomic description of a species in the present collection, references to taxonomic descriptions from other parts of the world have been included. References which were found most useful for identifications are marked with an asterisk.

ACKNOWLEDGEMENT

The author is grateful to his colleagues and especially to R.J. LeBrasseur for discussion and assistance in the preparation of this manuscript, and to V. Naden, who prepared most of the illustrations.

Copepoda
Order: Calanoida
Calanus pacificus Brodsky, 1948

Calanus finmarchicus (part)	McMurrich, 1916
	Campbell, 1929
	Davis, 1949
	Cameron, 1957
	Légaré, 1957
Calanus pacificus	*Brodsky, 1950
	Brodsky, 1959
Calanus sp.	Shan, 1962

Remarks: X; Surface and mid-depth; Abundant all year; There are two forms of "toothed" Calanus in B.C. coastal waters. Shan (1962) discusses their morphology. The copepodite stages of the 2 forms can be separated by size (Table 2).

Calanus glacialis Jaschnov, 1955

Calanus finmarchicus (part)	McMurrich, 1916
	Campbell, 1929
	Davis, 1949
	Cameron, 1957
	Légaré, 1957
Calanus pacificus (part)	Brodsky, 1950
Calanus "large form"	Shan, 1962

Remarks: X; Surface and mid-depth; Abundant all year; The larger of the two forms of "toothed" Calanus may be this species although Jaschnov (1970) considers records from the Northeastern Pacific to be expatriats from the Bering Sea.

Calanus plumchrus Marukawa, 1921

Calanus plumchrus	Marukawa, 1921
Calanus tonsus	Campbell, 1929
	Campbell, 1930
	*Campbell, 1934
	Davis, 1949
Calanus tonsus var. plumchrus	Brodsky, 1950
Calanus plumchrus	Tanaka, 1956a
Calanus tonsus	Cameron, 1957
	Légaré, 1957

Remarks: X; Egg to Stage V surface; Stage V and VI deep; Very abundant; All year.

Calanus cristatus Krøyer, 1848

Calanus cristatus	Campbell, 1929
	Davis, 1949
	*Brodsky, 1950
	Cameron, 1957
	Légaré, 1957

Remarks: X; Deep; Rare; Spring and summer.

Eucalanus bungii bungii Johnson, 1938

Eucalanus elongatus	Esterly, 1905
	Campbell, 1929
Eucalanus bungii bungii	*Johnson, 1938
	Brodsky, 1950
Eucalanus bungii	Davis, 1949
	Cameron, 1957
	Légaré, 1957

Remarks: X; Mid-depth and deep; Abundant.

Rhincalanus nasutus Giesbrecht, 1888

Rhincalanus nasutus	*Brodsky, 1950
	Cameron, 1957

Remarks: A.

Paracalanus parvus (Claus, 1863)

Paracalanus parvus	McMurrich, 1916
	Campbell, 1929
	Davis, 1949
	*Brodsky, 1950
	Cameron, 1957
	Légaré, 1957

Remarks: X; Surface and mid-depth; Abundant.

Pseudocalanus minutus (Krøyer, 1849)

Pseudocalanus elongatus	McMurrich, 1916
	Campbell, 1929
	*Brodsky, 1950
Pseudocalanus minutus	Davis, 1949
	Tanaka, 1956c
	Cameron, 1957
	Légaré, 1957
	Frolander, 1962

Remarks: X; Surface and mid-depth; Abundant. For a discussion of the taxonomic status of Pseudocalanus see Frolander (1962).

Microcalanus pusillus (Sars, 1903)

Microcalanus pusillus	Campbell, 1929 *Brodsky, 1950 Légaré, 1957

Remarks: X; Surface; Abundant.

Clausocalanus arcuicornis (Dana, 1849)

Clausocalanus arcuicornis	*Brodsky, 1950 Cameron, 1957 Frost and Fleminger, 1968

Remarks: A.

Spinocalanus brevicaudatus Brodsky, 1950

Spinocalanus brevicaudatus	Brodsky, 1950

Remarks: X; Deep; Common in Pendrell Sound.

Aetideus armatus Boeck, 1872

Aetideus armatus	Campbell, 1929 Davis, 1949 *Brodsky, 1950 Cameron, 1957 Légaré, 1957

Remarks: X; Mid-depth and deep; Common.

Aetideus pacificus Brodsky, 1950

Aetideus pacificus	*Brodsky, 1950

Remarks: X; Deep; Rare.

Bradyidius saanichi Park, 1966

Bradyidius saanichi	Park, 1966

Remarks: X; Mid-depth to Deep; Common. Type locality: Saanich Inlet. This species is common in Saanich Inlet. It rarely occurs in the Strait of Georgia.

Chiridius gracilis Farran, 1908

Chiridius gracilis	*Vervoort, 1952 Cameron, 1957

Remarks: X; Deep; Common.

Pseudoaetideus armatus (Boeck, 1872)

Chiridius armatus	Wailes, 1929
Pseudoaetideus armatus	*Brodsky, 1950

Remarks: A; This species was listed by Wailes (1929), but it seems likely that Wailes, working in the same laboratory as Campbell, mistakenly listed Chiridius armatus instead of Chiridius tenuispinis which was on Campbell's list. C. tenuispinis occurred on Clemens' lists (1933) which Wailes helped to compile, but C. armatus did not.

Gaidius columbiae Park, 1967

Chiridius tenuispinis	Campbell, 1929 ? Légaré, 1957 Park, 1967

Remarks: X; Deep; Abundant; Type locality: Strait of Georgia. Campbell notes that her specimens of C. tenuispinis had shorter spines than was described at that time. It seems likely that she was looking at G. columbiae.

Gaidius pungens Giesbrecht, 1895

Gaidius pungens	Campbell, 1929 Davis, 1949 *Brodsky, 1950 Légaré, 1957

Remarks: X; Deep; Rare.

Gaidius variabilis Brodsky, 1950

Gaidius variabilis	*Brodsky, 1950

Remarks: X; Deep; Common.

Gaetanus intermedius Campbell, 1930

Gaetanus intermedius	Campbell, 1930 Brodsky, 1950
Gaetanus armiger	*Shan, 1962

Remarks: X; Deep; Rare; Type locality: Deep Cove, Indian Arm.

Euchirella pulchra (Lubbock, 1856)

Euchirella pulchra	*Brodsky, 1950

Remarks: X; Deep; Rare.

Euchirella rostrata (Claus, 1866)

Euchirella rostrata	Esterly, 1905 Campbell, 1929 Davis, 1949 *Brodsky, 1950

Remarks: X; Deep; Rare.

Euchaeta japonica Marukawa, 1921

Euchaeta japonica	Marukawa, 1921 Campbell, 1929 *Campbell, 1934
Paraeuchaeta japonica	Brodsky, 1950 Cameron, 1957 Légaré, 1957 Lewis, 1967 Lewis & Ramnarine, 1969

Remarks: X; Deep; Abundant.

Scaphocalanus echinatus Farran, 1905

Scaphocalanus echinatus	Tanaka, 1961

Remarks: X; Deep; Common.

Scaphocalanus brevicornis G.O. Sars, 1900

Scaphocalanus brevicornis	Brodsky, 1950

Remarks: X; Deep; Rare.

Racovitzanus antarcticus Giesbrecht, 1902

Racovitzanus antarcticus	Brodsky, 1950

Remarks: X; Deep; Rare.

Scolecithricella minor (Brady, 1883)

Scolecithricella minor var. occidentalis	*Brodsky, 1950
Scolecithricella minor	Cameron, 1957
	Légaré, 1957

Remarks: X; Mid-depth; Common.

Scolecithricella subdentata (Esterly, 1905)

Scolecithricella subdentata	*Brodsky, 1950
	Cameron, 1957

Remarks: X; Deep; Rare.

Tharybis fultoni Park, 1967

Tharybis fultoni	Park, 1967

Remarks: X; Deep; Rare. Type locality: Strait of Georgia.

Eurytemora americana Williams, 1906

Eurytemora thompsoni	Willey, 1923
Eurytemora transversallis	Campbell, 1930
Eurytemora americana	*Heron, 1964

Remarks: X; Surface; Common.

Eurytemora hirundoides (Nordquist, 1888)

Eurytemora hirundoides	Esterly, 1924
	Campbell, 1929
	Davis, 1949
	*Brodsky, 1950
	Cameron, 1957
	Légaré, 1957

Remarks: X; Surface; Common.

Eurytemora pacifica Sato, 1913

Eurytemora johanseni	Davis, 1949
	Brodsky, 1950
	Légaré, 1957
Eurytemora pacifica	*Heron, 1964

Remarks: A.

Epischura nevadensis Lilljeborg, 1889

Epischura nevadensis	Marsh, 1933

Remarks: X; Surface; Rare. This is a fresh water species caught near the mouth of the Fraser River.

Metridia pacifica Brodsky, 1950

Metridia lucens	Campbell, 1929
	Davis, 1949
	Cameron, 1957
	Légaré, 1957
	Shan, 1962
Metridia pacifica	*Brodsky, 1950

Remarks: X; Surface at night, Mid-depth in daytime; Abundant. For a discussion of *Metridia* from Indian Arm and a comparison of its morphology with the morphology of specimens from other areas see Shan (1962).

Metridia okhotensis Brodsky, 1950

Metridia longa	Campbell, 1929
	Davis, 1949
	Cameron, 1957
	Légaré, 1957
Metridia okhotensis	*Brodsky, 1950

Remarks: X; Deep; Common. The morphology of the specimens in the present collection agrees with Brodsky's description.

Pleuromamma quadrungulata (Dahl, 1893)

Pleuromamma quadrungulata	Davis, 1949

Remarks: X; Deep; Rare.

Centropages abdominalis Sato, 1913

Centropages hamatus	McMurrich, 1916
Centropages mcmurrichi	Willey, 1923
	Campbell, 1929
	Davis, 1949
	*Brodsky, 1950
	Légaré, 1957

Remarks: X; Surface; Abundant.

Diaptomus sp. Westwood, 1836

Diaptomus sp.	Légaré, 1957

Remarks: A; Since this genus is composed exclusively of fresh water forms, it is most likely that Légaré's specimen was found in run-off water.

Heterorhabdus tanneri (Giesbrecht, 1895)

Heterorhabdus tanneri	Brodsky, 1950

Remarks: X; Deep; Rare.

Heterorhabdus proximus Davis, 1949

Heterorhabdus proximus	*Davis, 1949
	Cameron, 1957

Remarks: A; Cameron (1957) lists H. proximus as one of the species of which her identification was uncertain.

Centraugaptilus porcellus Johnson, 1936

Centraugaptilus porcellus	Johnson, 1936
	*Brodsky, 1950
	Légaré, 1957

Remarks: A.

Candacia bipinnata Giesbrecht, 1892

Candacia bipinnata	Brodsky, 1950

Remarks: X; Deep; Rare.

Candacia columbiae Campbell, 1929

Candacia columbiae	Campbell, 1929
	Davis, 1949
	*Brodsky, 1950
	Cameron, 1957
	Légaré, 1957

Remarks: X; Deep; Rare. Type locality: Deserted Bay, Quatsino Sound, Raphael Point (West coast Vancouver Island).

Anomalocera pattersoni Templeton, 1837

Anomalocera pattersoni	Herdman et al (1898)
	Wailes, 1929

Remarks: A; It is most likely that Thompson was looking at Epilabidocera amphitrites when he compiled Herdman's list of species. Clemens (1933), Johnson (1932), and Davis (1949) consider this record as being in error. Wailes omitted A. pattersoni when he helped Clemens compile his list (1933).

Pontella tenuiremis Giesbrecht, 1889

Pontella tenuiremis	Wilson, 1950

Remarks: A; Wilson records this species from Beaver Harbour, Vancouver Island.

Epilabidocera amphitrites McMurrich, 1916

Paralabidocera amphitrites	McMurrich, 1916
	Campbell, 1929
Epilabidocera amphitrites	Davis, 1949
	*Brodsky, 1950
	Cameron, 1957
	Park, 1966
Epilabidocera longipedata	Fleminger, 1967

Remarks: X; Surface; Common; Type locality 3½ miles off Amphitrite Point, West coast of Vancouver Island.

Acartia clausii Giesbrecht, 1889

Acartia clausii	Esterly, 1924 Campbell, 1929 Davis, 1949 *Brodsky, 1950 Cameron, 1957 Légaré, 1957

Remarks: X; Surface; Common; Spring and Summer.

Acartia longiremis (Lilljeborg, 1853)

Acartia longiremis	McMurrich, 1916 Campbell, 1929 Davis, 1949 *Brodsky, 1950 Cameron, 1957 Légaré, 1957 Frolander, 1962

Remarks: X; Surface; Abundant; Spring and Summer.

Tortanus discaudatus (Thompson & Scott, 1897)

Tortanus discaudatus	McMurrich, 1916 Campbell, 1929 Davis, 1949 *Brodsky, 1950 Cameron, 1957 Légaré, 1957

Remarks: X; Surface; Common; Spring and Summer.

Copepoda

Order: Cyclopoida

Oithona spinirostris Claus, 1863

Oithona spinirostris	Campbell, 1929
	Olson, 1949
Oithona plumifera	Davis, 1949
	Cameron, 1957
	Légaré, 1957
Oithona spinirostris	Frolander, 1962

Remarks: X; All depths; Abundant. For a discussion of the morphological differences between O. spinirostris and O. plumifera see Olson (1949) and Frolander (1962).

Oithona helgolandica Claus, 1863

Oithona similis	McMurrich, 1916
Oithona helgolandica	Campbell, 1929
	Davis, 1949
	Cameron, 1957
	Légaré, 1957

Remarks: X; All depths; Common.

Oithona plumifera Baird, 1843

Oithona plumifera	Davis, 1949
	Cameron, 1957
	Légaré, 1957

Remarks: X; Deep; Rare.

Oncaea borealis Sars, 1918

Oncaea borealis	Campbell, 1929
	*Rose, 1933

Remarks: X; Mid-depths and Deep; Common.

Oncaea conifera Giesbrecht, 1891

Oncaea conifera	*Rose, 1933
	Davis, 1949
	Cameron, 1957
	Légaré, 1957

Remarks: X; Mid-depths; Rare.

Oncaea subtilis Giesbrecht, 1892

Oncaea subtilis	Campbell, 1929
	*Rose, 1933

Remarks: A.

Corycaeus anglicus Lubbock, 1855

Corycaeus affinis	McMurrich, 1916
	Campbell, 1929
Corycaeus anglicus	*Rose, 1933
Corycaeus affinis	Davis, 1949
	Cameron, 1957
	Légaré, 1957

Remarks: X; Mid-depth; Common.

Corycaeus catus F. Dahl, 1894

Corycaeus obtusus	Herdman, Thompson and Scott, 1898
Corycaeus catus	Wilson, 1950
	*Mori, 1964

Remarks: A.

Ascomyzon rubrum Campbell, 1929

Ascomyzon rubrum	*Campbell, 1929
	Légaré, 1957

Remarks: A; Type locality: Departure Bay, Horsewell Rocks.

Macrocheiron sargassi Sars, 1916

Macrocheiron sargassi	Campbell, 1930

Remarks: A.

Copepoda

Order: Harpacticoida

Tigriopus californicus (Baker, 1912)

Tigriopus triangulus	Campbell, 1930 Monk, 1941 *Lang, 1948

Remarks: X; Normal habitat is tide pools.

Amphiascus phyllopus (Sars, 1906)

Amphiascus phyllopus	Campbell, 1929 *Lang, 1948

Remarks: A; Lang, 1948 lists Campbell's reference to this species as an uncertain identification. The species has been described from European and Mediterranean coastal waters.

Diosaccus spinatus Campbell, 1929

Diosaccus spinatus	Campbell, 1929 Légaré, 1957 *Lang, 1965

Remarks: A; Type locality: Departure Bay.

Tisbe furcata (Baird, 1837)

Idya furcata	McMurrich, 1916? Campbell, 1929 Légaré, 1957
Tisbe furcata	*Lang, 1948

Remarks: A.

Zaus aurelii Poppe, 1884

Zaus caeruleus	Campbell, 1929
Zaus aurelii	*Lang, 1948

Remarks: A.

Harpacticus chelifer (Müller, 1776)

Harpacticus chelifer	Wilson, 1950

Remarks: A; Wilson records this species from Beaver Harbour, Vancouver Island.

Harpacticus uniremis Krøyer, 1842

Harpacticus uniremis	Campbell, 1929 *Lang, 1948 Légaré, 1957

Remarks: A.

Microsetella norvegica (Boeck, 1864)

Microsetella norvegica	*Lang, 1948 Davis, 1949 Cameron, 1957

Remarks: A.

Microsetella rosea (Dana, 1848)

Microsetella rosea	Esterly, 1905 Campbell, 1929 *Lang, 1948 Davis, 1949 Cameron, 1957

Remarks: X; Mid-depth; Common.

Copepoda

Order: Monstrilloida

Monstrilla helgolandica Claus, 1863

Monstrilla helgolandica — Rose, 1933; *Park, 1967

Remarks: X; Rare.

Monstrilla longiremis Giesbrecht, 1892

Monstrilla longiremis — Rose, 1933; *Park, 1967

Remarks: X; Rare.

Monstrilla spinosa Park, 1967

Monstrilla spinosa — *Park, 1967

Remarks: X; Rare; Type locality: Saanich Inlet.

Monstrilla wandelii Stephenson, 1913

Monstrilla wandelii — *Park, 1967

Remarks: X; Rare.

SELECTED REFERENCES TO ADULT COPEPODA

Bishop, S.O., J.D. Fulton, O.D. Kennedy, and K. Stephens. MS 1966. Data Record: Physical, chemical and biological data, Strait of Georgia, 1965. Fish. Res. Board Can. MS Rep. Oceanog. Limnol. 211: 171 p.

Brodsky, K.A. 1950. Calanoida of the far eastern seas and polar basin of the USSR. Opred. po Faune SSR 35: 1-442. (In Russian).

1959. On the phylogenetic relationships of certain species of Calanus (copepoda) from the northern and southern hemispheres. Zoological Journal Academy of Sciences of the USSR 38(10): 1537-1553. (Transl. by Mr. D. Ward, Scottish Marine Biological Association, Oceanographic Laboratory, Edinburgh.)

Cameron, F.E. 1957. Some factors influencing the distribution of pelagic copepods in the Queen Charlotte Island area. J. Fish. Res. Bd. Canada 14(2): 165-202.

Campbell, M.H. 1929a. A preliminary quantitative study of the zooplankton in the Strait of Georgia. Trans. Roy. Soc. Can. 23(5): 1-28.

1929b. Some free-swimming copepods of the Vancouver Island region. Trans. Roy. Soc. Can. 23(5): 303-332.

1930. Some free-swimming copepods of the Vancouver Island region. II. Trans. Roy. Soc. Can. 24(5): 177-182.

1934. The life history and post embryonic development of the copepods, Calanus tonsus Brady and Euchaeta japonica Marukawa. J. Biol. Board Canada 1(1): 1-65.

Clemens, M.A. 1933. A check-list of the marine fauna and flora of the Canadian Pacific coast. Nat. Res. Counc. Can., Ottawa, Ontario. (Mimeo)

Cook, R.A., L.D.B. Terhune, J.S. Ford, and W.H. Bell. MS 1970. An opto-electronic plankton sizer. Fish. Res. Board Can. Tech. Rep. 172: 40 p.

Davis, C.C. 1943. The larval stages of the calanoid copepod Eurytemora hirundoides (Nordquist). Chesapeake Biol. Lab. Publ. No. 58: 1-20.

1949. The pelagic copepods of the northeastern Pacific Ocean. Univ. Wash. Publ. Biol. 14: 1-117.

Esterly, C.O. 1905. The pelagic copepoda of the San Diego Region. Univ. Calif. Publ. Zool. 2(4): 113-233.

1906. Additions to the copepod fauna of the San Diego Region. Univ. Calif. Publ. Zool. 3(5): 53-92.

1908. The light recipient organs of the copepod, Eucalanus elongatus. Bull. Mus. Comp. Zool. Harvard Univ. 53: 1-55.

1911. Third report on the copepod fauna of the San Diego Region. Univ. Calif. Publ. Zool. 6(14): 313-352.

1913. Fourth taxonomic report of the copepoda of the San Diego Region. Univ. Calif. Publ. Zool. 11(10): 81-196.

1924. Free-swimming copepoda of San Francisco Bay. Univ. Calif. Publ. Zool. 26(5): 81-129.

Fleminger, A. 1967. Taxonomy, distribution and polymorphism in the Labidocera jollae group with remarks on evolution within the group (Copepoda: Calanoida). Proc. U.S. Nat. Mus. 120(3567): 1-61.

Frolander, H.F. 1962. Quantitative estimations of temporal variations of zooplankton off the coast of Washington and British Columbia. J. Fish. Res. Bd. Canada 19(4): 657-675.

Frost, B., and A. Fleminger. 1968. A revision of the genus Clausocalanus (Copepoda: Calanoida) with remarks on distributional patterns in diagnostic characters. Bull. Scripps Inst. Oceanogr. Univ. Calif. 12: 1-235.

Fulton, J.D. MS 1968. A laboratory manual for the identification of British Columbia marine zooplankton. Fish. Res. Board Can. Tech. Rep. 55: 141 p.

Fulton, J.D., O.D. Kennedy, K. Stephens, and J. Skelding. MS 1967. Data Record: Physical, chemical and biological data, Strait of Georgia, 1966. Fish. Res. Board Can. MS Rep 915: 145 p.

MS 1968. Data Record: Physical, chemical and biological data, Strait of Georgia, 1967. Fish. Res. Board Can. MS Rep. 968: 197 p.

Fulton, J.D., O.D. Kennedy, H. Seki, and K. Stephens. MS 1969a. Biological, chemical and physical observations in Saanich Inlet, Vancouver Island, British Columbia, 1968. Fish. Res. Board Can. MS Rep. 1018: 109 p.

Fulton, J.D., O.D. Kennedy, J. Skelding, and K. Stephens. MS 1969b. Data Record: Physical, chemical and biological data Strait of Georgia, 1968. Fish. Res. Board Can. MS Rep. Oceanogr. Limnol. 1049: 34 p.

Gibbons, S.G., and H.S. Ogilvie. 1933. Developmental stages of Oithona helgolandica and O. spinirpstris with a note on the occurrence of body spines cyclopoid nauplii. J. Mar. Biol. Ass. U.K. 18(2): 529-550.

Hebard, J.F. MS 1956. The seasonal variations of zooplankton in Puget Sound. MS Thesis Univ. Washington, Seattle, Wash.

Herdman, W.A., I.C. Thompson, and A. Scott. 1898. On the plankton collected continuously during two traverses of the North Atlantic in the summer of 1897; with descriptions of new species of copepoda; and an appendix on dredging in Puget Sound. Trans. Liverpool Biol. Soc. 12: 33-90.

Heron, G.A. 1964. Seven species of Eurytemora (Copepoda) from Northwestern North America. Crustaceana 7(3): 199-211.

Jaschnov, W.A. 1955. Morphology, distribution and systematics of Calanus finmarchicus S.L. Zool. Zh., Acad. of Sc. of the USSR 34(6): 1201-1223.

1970. Distribution of Calanus species in the seas of the Northern Hemisphere. Int. Revue ges. Hydrobiol 55(2): 197-212.

Johnson, M.W. 1932. Seasonal distribution of plankton at Friday Harbour, Washington. Univ. Wash. Publ. Oceanogr. 1(1): 1-38.

1934. The life history of the copepod Tortanus discaudatus (Thompson and Scott). Biol. Bull. (Woods Hole) 67(1): 182-200.

1934b. The developmental stages of the copepod Epilabidocera amphitrites McMurrich. Biol. Bull (Woods Hole) 67(3): 466-483.

1936. Pachyptilus pacificus and Centraugaptilus porcellus, two new copepods from the North Pacific. Bull. Scripps Inst. Oceanogr. Univ. Calif. Tech. Ser. 4(8): 65-70.

1938. Concerning the copepod Eucalanus elongatus Dana and its varieties in the Northeast Pacific. Bull. Scripps Inst. Oceanogr. Univ. Calif. Tech. Ser. 4(6): 165-180.

1939. The study of species formation in certain Eucalanus copepods in the North Pacific. 6th Pac. Sci. Congr. Proc., Oceanogr. Mar. Biol. 3: 565-568.

Lang, K. 1948. Monographie der Harpacticiden. Hakan Ohlssons Boktryckeri, Lund. 1682 p.

1965. Copepoda harpacticoidea from the Californian Pacific coast. Kungl. Svenska Vetenskapskademiens Handlingar, Fjarde Serien. Band 10, No. 2.

LeBrasseur, R.J., W.E. Barraclough, O.D. Kennedy, and T.R. Parsons. 1969. Production studies in the Strait of Georgia. Part III. Observations on the food of larval and juvenile fish in the Fraser River plume, February to May, 1967. J. Exp. Mar. Biol. Ecol. 3: 51-61.

Légaré, J.E.H. 1957. The qualitative and quantitative distribution of plankton in the Strait of Georgia in relation to certain oceanographic factors. J. Fish. Res. Bd. Canada 14(4): 521-552.

McMurrich, J.P. 1916. Notes on the plankton of the British Columbia coast. Trans. Roy. Soc. Can. Vol. 10, Ser. 3, Sec. 4: 75-89.

Marsh, C.D. 1929. Distribution and key to the North American copepods of the genus Diaptomus, with the description of a new species. Proc. U.S. Nat. Mus. 75(2785): 1-27.

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(2959): 1-58.

Marukawa, Hisatosi. 1921. Plankton list and some new species of copepoda from the northern waters of Japan. Bull. Inst. Oceanogr. (Monaco) 384: 1-15.

Monk, C.R. 1941. Marine harpacticoid copepods from California. Trans. Amer. Microsc. Soc. 69(1): 75-99.

Mori, T. 1964. The pelagic copepoda from the neighbouring waters of Japan 2nd Ed. The Soyo Co. Inc., Tokyo. 310 p.

Murphy, H.E. 1923. The life cycle of Oithona nana, reared experimentally. Univ. Calif. Publ. Zool. 22: 449-454.

Olson, J.B. 1949. The pelagic cyclopoid copepods of the coastal waters of Oregon, California and Lower California. Ph.D. Thesis. Univ. of Calif., Los Angeles, Calif. 208 p.

Park, T.S. 1965. The biology of a calanoid copepod, Epilabidocera amphitrites McMurrich. Diss. Abstr. Vol. 26(5): 1-320.

1966. A new species of Bradyidius (Copepoda: Calanoida) from the Pacific Coast of North America. J. Fish. Res. Bd. Canada 23(6): 805-811

1967a. Two species of copepods from the Strait of Georgia, British Columbia, Canada. J. Fish. Res. Bd. Canada 24(2): 231-241.

1967b. Two unreported species and one new species of Monstrilla (Copepoda: Monstrilloida) from the Strait of Georgia. Trans. Amer. Microsc. Soc. 86(2): 144-152.

Parsons, T.R. 1969. The use of particle size spectra in determining the structure of a plankton community. J. Oceanogr. Soc. Jap. 25(4): 172-181.

Parsons, T.R., K. Stephens, and R.J. LeBrasseur. 1969a. Production studies in the Strait of Georgia. I. Primary production under the Fraser River plume, February to May 1967. J. Exp. Mar. Biol. Ecol. 3: 27-38.

Parsons, T.R., R.J. LeBrasseur, J.D. Fulton, and O.D. Kennedy. 1969b. Production studies in the Strait of Georgia. Part II. Secondary production under the Fraser River plume, February to May 1967. J. Exp. Mar. Biol. Ecol. 3: 39-50.

Parsons, T.R., R.J. LeBrasseur, and W.E. Barraclough. 1970. Levels of production in the pelagic environment of the Strait of Georgia, British Columbia. J. Fish. Res. Bd. Canada 27(7): 1251-1264.

Rose, M. 1933. Copepodes Pelagiques. Faune Fr. 26: 374 p.

Shan, Kuo-cheng. MS 1962. Systematic and ecological studies on Copepoda in Indian Arm, British Columbia. M.Sc. Thesis. Univ. British Columbia, Vancouver, B.C. 185 p.

Sharpe, R.W. 1911. Notes on the Marine Copepoda and Cladocera of Woods Hole and adjacent regions, including a synopsis of the Genera of Harpacticoida. Proc. U.S. Nat. Mus. 38: 405-436.

Stephens, K., J.D. Fulton, and O.D. Kennedy. 1969. Summary of biological oceanographic observations in the Strait of Georgia, 1965 to 1968. Fish. Res. Board Can. Tech. Rep. 110: 86 p.

Stephens, K., J.D. Fulton, O.D. Kennedy, and A.K. Pease. MS 1967. Biological, chemical and physical observations in Saanich Inlet, Vancouver Island, British Columbia. Fish. Res. Board Can. MS Rep. 912: 119 p.

Tanaka, O. 1936. On some new species of copepoda from Sagami Bay. Jap. J. Zool. 7: 31-36.

1938. Notes on Calanus cristatus Kroyer. Jap. J. Zool. 7: 599-601.

1954. Note on Calanus tonsus Brady in Japanese waters. J. Oceanogr. Soc. Jap. 10(1): 31-39.

1956a. Further note on Calanus tonsus Brady in Japanese waters. J. Oceanogr. Soc. Jap. 12(2): 49-52.

1956b. The pelagic copepods of the Izu Region, Middle Japan. Systematic Account I. Publ. Seto Mar. Biol. Lab. 5(2): 251-272.

1956c. The pelagic copepods of the Izu Region, Middle Japan. Systematic Account II. Publ. Seto Mar. Biol. Lab. 5(3): 367-406.

1957a. The pelagic copepods of the Izu Region, Middle Japan. Systematic Account III. Publ. Seto Mar. Biol. Lab. 6(1): 31-68.

1957b. The pelagic copepods of the Izu Region, Middle Japan. Systematic Account IV. Publ. Seto Mar. Biol. Lab. 6(2): 169-207.

1958. The pelagic copepods of the Izu Region, Middle Japan. Systematic Account V. Publ. Seto Mar. Biol. Lab. 6(3): 327-367.

1960. The pelagic copepods of the Izu Region, Middle Japan. Systematic Account VI. Publ. Seto Mar. Biol. Lab. 8(1): 85-135.

1961. The pelagic copepods of the Izu Region, Middle Japan. Systematic Account VII. Publ. Seto Mar. Biol. Lab. 9(1): 139-190.

1962. The pelagic copepods of the Izu Region, Middle Japan. Systematic Account VIII. Publ. Seto Mar. Biol. Lab. 10(1): 35-90.

1963. The pelagic copepods of the Izu Region, Middle Japan. Systematic Account IX. Publ. Seto Mar. Biol. Lab. 11(1): 7-55.

1964a. The pelagic copepods of the Izu Region, Middle Japan. Systematic Account X. Publ. Seto Mar. Biol. Lab. 12(1): 1-37.

1964b. The pelagic copepods of the Izu Region, Middle Japan. Systematic Account XI. Publ. Seto Mar. Biol. Lab. 12(1): 39-91.

1964c. The pelagic copepods of the Izu Region, Middle Japan. Systematic Account XII. Publ. Seto Mar. Biol. Lab. 12(3): 231-271.

Thompson, I.S., and A. Scott. 1903. Supplementary report on the copepods to the government of Ceylon on the pearl oyster fisheries of the Gulf of Manaar. Royal Soc.: 227-307.

Vervoort, W. 1952. Copepoda, Sub-order, Calanoida. Fish. Indent. Zoopl. 44.

Wailes, G.H. 1929. The marine-zooplankton of British Columbia. Museum and Art Notes (Vancouver) 4(4).

Willey, A. 1923. Notes on the distribution of free-living copepoda in Canadian waters. Part I. Contrib. Can. Biol. N.S. I: 303-334.

Wilson, C.B. 1950. Copepods gathered by the U.S. Fisheries Steamer Albatross from 1887 to 1909, chiefly in the Pacific Ocean. U.S. Nat. Mus. Bull 199(4): 141-441.

SELECTED REFERENCES TO THE NAUPLII AND COPEPODID STAGES OF THE COPEPODA

Campbell, M.H. 1934. The life history and post embryonic development of the copepods, Calanus tonsus Brady and Euchaeta japonica Marukawa. J. Biol. Bd. Canada 1(1): 1-65.

Conover, R.J. 1956. The biology of Acartia clausi and Acartia tonsa. Bull. Bingham Oceanogr. Collect. Yale Univ. 15: 156-233.

Davis, C.C. 1943. The larval stages of the calanoid copepod Eurytemora hirundoides (Nordquist). Chesapeake Biol. Lab. Publ. No. 58: 1-20.

Faber, D.J. 1966. Seasonal occurrence and abundance of free-swimming copepod nauplii in Narragansett Bay. J. Fish Res. Bd. Canada 23(3): 189-205.

Gibbons, S.G. 1938. Early developmental stages of copepoda: II. Metridia lucens Boeck. Ann. Mag. Natur. Hist. 11(2): 493-497.

Gibbons, S.G., and H.S. Ogilvie. 1933. Developmental stages of Oithona helgolandica and O. spinirostris with a note on the occurrence of body spines in cyclopoid nauplii. J. Mar. Biol. Ass. U.K. 18(2): 529-550.

Johnson, M.W. 1934. The life history of the copepod Tortanus discaudatus (Thompson and Scott). Biol. Bull. (Woods Hole) 67(1): 182-200.

1934b. The developmental stages of the copepod Epilabidocera amphitrites McMurrich. Biol. Bull. (Woods Hole) 67(3): 466-483.

1938. Concerning the copepod Eucalanus elongatus Dana and its varieties in the Northeast Pacific. Bull. Scripps Inst. Oceanogr. Univ. Calif. Tech. Ser. 4(6): 165-180.

Kogo, F. 1960. The nauplius larvae of Centropages abdominalis Sato. Bull. Japan Soc. Sc. Fish. 26(9): 877-882.

Lebour, M.V. 1916. Stages in the life history of Calanus finmarchicus (Gunnerus), experimentally reared by Mr. L.R. Crawshay in the Plymouth Laboratory. J. Mar. Biol. Ass. U.K. 11(1): 1-17.

Lewis, A.G. 1967. An enrichment solution for culturing the early developmental stages of the planktonic marine copepod Euchaeta japonica Marukawa. Limnol. Oceanogr. 12: 147-148.

Lewis, A.G., and A. Ramnarine. 1969. Some chemical factors affecting the early developmental stages of Euchaeta japonica (Crustacea: Copepoda: Calanoida) in the laboratory. J. Fish. Res. Bd. Canada 26: 1347-1362.

Murphy, H.E. 1923. The life cycle of Oithona nana, reared experimentally. Univ. Calif. Publ. Zool. 22: 449-454.

Oberg, M. 1906. Die Metamorphose der Plankton Copepoden der Kieler Bucht. Wiss. Meer. Abt. Kiel 9: 37-175.

Ogilvie, H.S. 1953. Copepod nauplii (I) Fich. Ident. Zoopl. 50.

Shan, K. 1962. Systematic and ecological studies on copepoda in Indian Arm, British Columbia. M.Sc. Thesis, Univ. of British Columbia, Vancouver, B.C. 185 p.

Wiborg, K.F. 1948. Experiments with the Clarke-Bumpus Plankton Sampler and with a plankton pump in the Lofoten area in Northern Norway. Rep. Norw. Fish. Invest. 9(2): 1-22.

COPEPODA

Campbell (1929, 1930) was first to make an intensive study of the copepod fauna of the coastal waters of British Columbia. Prior to her monographs, there were isolated observations by Thompson and Scott (in Herdman et al. 1898), McMurrich (1916) and Willey (1923). Since Campbell's work, Davis (1949) has published a monograph on the pelagic copepoda of the northeastern Pacific Ocean; Cameron (1957) has listed and discussed the distribution of copepods in the Queen Charlotte Island region; and Légaré (1957) has listed and discussed the copepods of the Strait of Georgia region. More recently, Park (1966, 1967a, 1967b) has described four new species which occur in the Strait of Georgia. Brodsky's monograph (1950), although it does not deal with the same geographic area, was the most useful reference for the calanoid copepods and has been followed here unless otherwise indicated.

For some time now there has been discussion as to the status of such series as Calanus finmarchicus, C. glacialis, C. helgolandicus, and C. pacificus (see Jaschnov, 1970). In the Strait of Georgia there are two distinct forms of "toothed" Calanus. I have called them C. pacificus and C. glacialis. A world specialist might well find them to be two distinct species, quite separate from C. pacificus Brodsky. Shan (1962) has compared the two forms of "toothed" Calanus from Indian Arm with C. finmarchicus from the North Atlantic.

KEY TO THE ADULT COPEPODA

This key is designed for the rapid identification of adult female copepods. For an appreciation of the development stages of copepods, the six nauplii stages (Fig. 1) and the six copepodid stages (Fig. 2) of Calanus plumchrus are shown. Lengths of the nauplius stages (Table 1) and lengths of the copepodid stages (Table 2) of the more common species of copepods are taken from specimens from the Strait of Georgia preserved in formalin.

COPEPODA

Gurney (1913-1930) was first [illegible] of the [illegible] of the coastal waters of Hudson Bay [illegible] Ontario [illegible]

Further [illegible] to the [illegible] [illegible]

KEY TO THE ADULT COPEPODA

This key is [illegible] needed for the [illegible] [illegible]

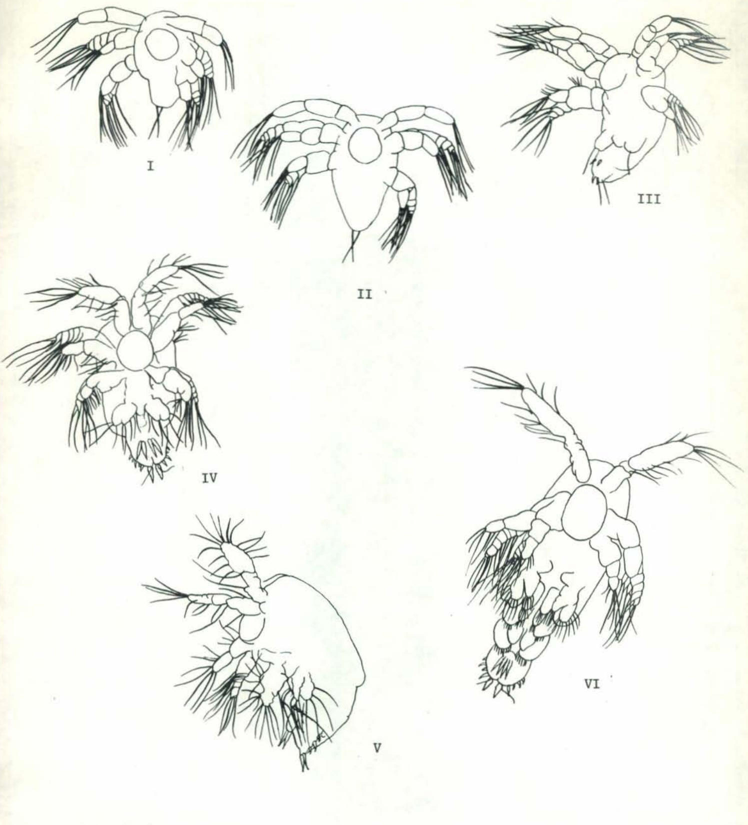


Fig. 1. The nauplii of Calanus plumchrus drawn to the same scale. Stage I is 290 μ long.

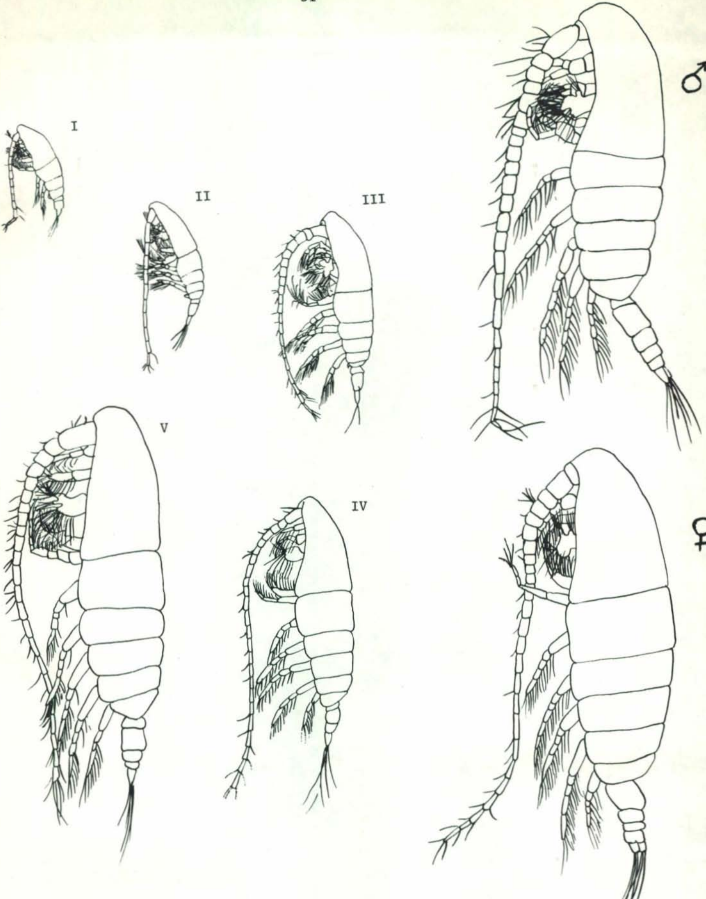
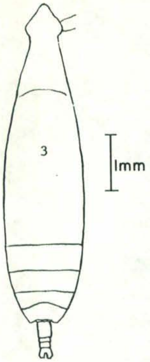
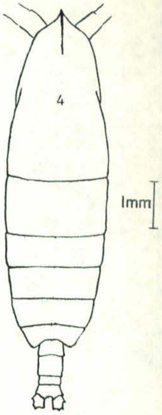
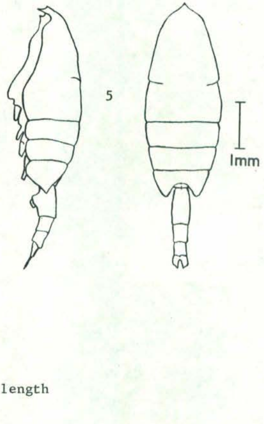


Fig. 2. The copepodid stages of <u>Calanus</u> <u>plumchrus</u> drawn to the same scale. Stage I is one mm long.

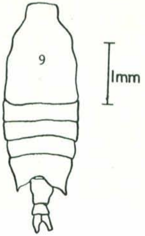


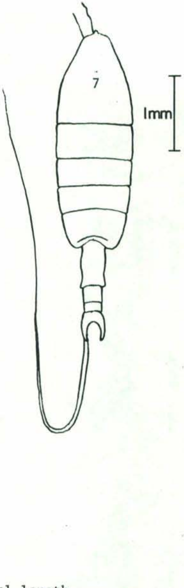


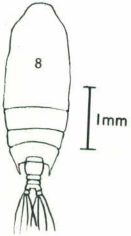


Copepods ≥ 5.5 mm total length

(1)	body transparent head triangular shaped	Eucalanus bungii bungii	6.6-8.0 mm	(Figure 3)
(2)	body not transparent head with medial crest or keel	Calanus cristatus	8.6-10.4	(Figure 4)
(3)	prominent mouth parts genital segment enlarged	Euchaeta japonica	6.3-6.5	(Figure 5)





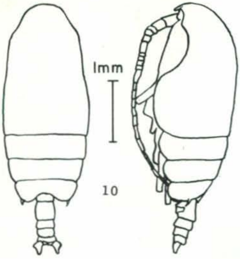


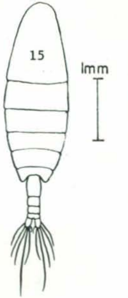
Copepods 3.2 to 5.5 total length

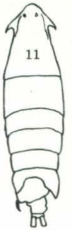
(4)	prominent black photophore on the side of the body	*Pleuromamma quadrungulata*	3.3-5.0 mm	(Figure 6)
(5)	one of the seta of the urosome enlarged and longer than the body	*Heterorhabdus tanneri*	3.8-4.2	(Figure 7)

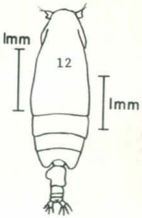
Posterior corners of prosome angular or produced as spines -

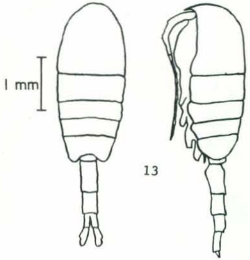
(6)	spines pointed and symmetrical	*Gaidius pungens*	3.0-3.5	(Figure 8)
(7)	spines rounded and asymmetrical	*Candacia columbiae*	3.5-4.1	(Figure 9)

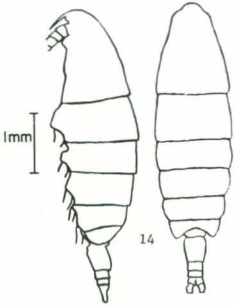












Copepods 3.2 to 5.5 mm total length (cont'd)

Posterior corners of prosome angular or produced as spines (cont'd) -

(9)	spines variable, sometimes rounded and sometimes pointed	Gaidius variabilis	4.0-4.1 mm	(Figure 10)
(10)	prominent eyes, lateral edges of head produced as hooks	Epilabidocera amphitrites	3.2-4.0	(Figure 11)

Posterior corners of prosome not angular or produced as spines -

(11)	urosome asymmetrical	Euchirella pulchra	3.4-4.0	(Figure 12)
(12)	urosome more than 1/3 the length of the body	Metridia okhotensis	4.1-4.5	(Figure 13)
(13)	urosome less than 1/3 the length of the body	Calanus plumchrus	4.0-5.4	(Figure 14)
(14)	urosome less than 1/3 the lengh of the body, inner margin of 5th leg with serrated plate	Calanus glacialis	3.2-4.2	(Figure 15)

[illegible]

[illegible] angular [illegible]

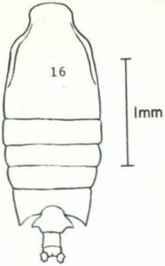
[illegible]

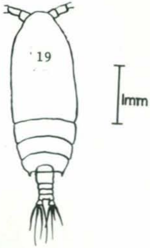
[illegible]

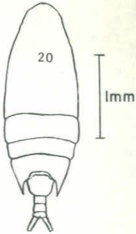
Metridia [illegible]

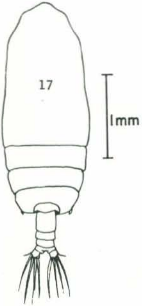
Calanus [illegible]

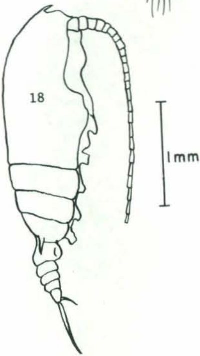
[illegible]

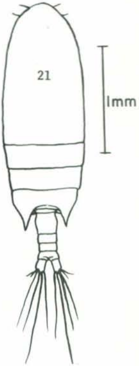












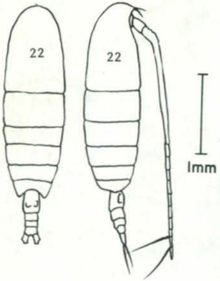
Copepods 2.0 to 3.1 mm total length

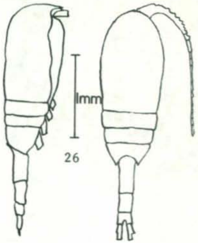
Posterior corners of prosome angular or produced as spines -

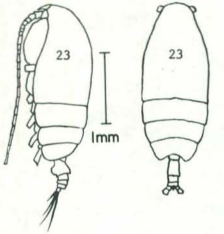
(15)	posterior corners angular, urosome with lateral projections	<u>Candacia</u> <u>bipinnata</u>	2.2-2.5 mm	(Figure 16)
(16)	spines blunt or rounded	<u>Gaidius</u> <u>columbiae</u>	3.0-3.2	(Figure 17)

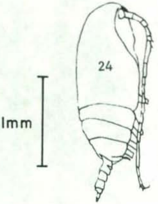
Spines acute -

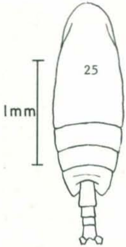
(17)	cephalic spine	<u>Gaetanus</u> <u>intermedius</u>	2.1	(Figure 18)
(18)	spines extend less than 1/2 the length of the genital segment.	<u>Chiridius</u> <u>gracilis</u>	2.4-4.8	(Figure 19)
(19)	genital segment nearly round	<u>Aetideus</u> <u>pacificus</u>	2.2-3.0	(Figure 20)
(20)	genital segment rectangular	<u>Bradyidius</u> <u>saanichi</u>	2.3-2.6	(Figure 21)
(6)	spines curving inwards towards genital segment	<u>Gaidius</u> <u>pungens</u>	3.0-3.5	(Figure 8)







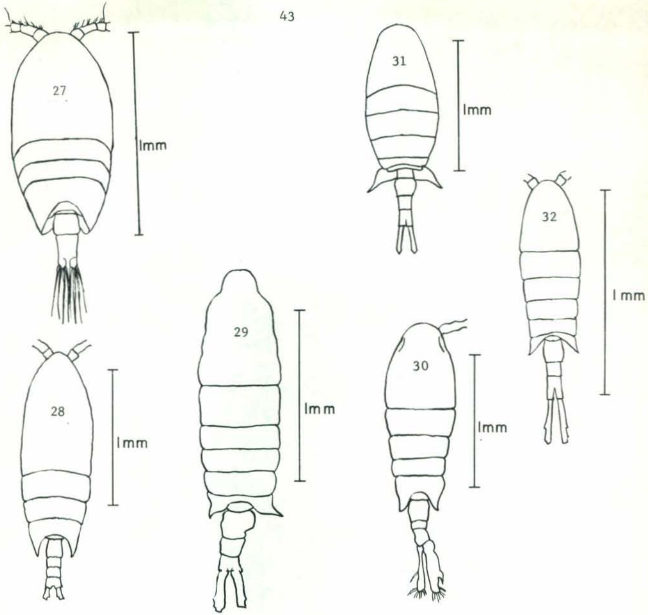




Copepods 2.0 to 3.1 mm total length (cont'd) -

Posterior corners of prosome not angular or produced -

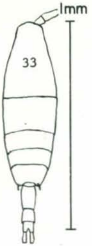
(21)	1st antennae as long or longer than body	Calanus pacificus	2.5-3.5 mm	(Figure 22)
(22)	1st antennae shorter than the body, body robust, urosome relatively short; urosome swollen when viewed laterally	Euchirella rostrata	2.9-3.1	(Figure 23)
(23)	urosome not swollen	Scolecithricella subdentata	2.2	(Figure 24)
(24)	body not particularly robust; urosome medium (less than 1/3 body length)	Racovitzanus antarcticus	2.1-2.4	(Figure 25)
(25)	urosome long (more than 1/3 body length)	Metridia pacifica	2.5-2.9	(Figure 26)

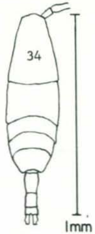


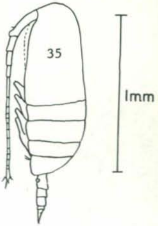
Copepods ≤2 mm total length

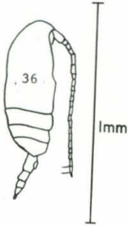
Posterior corners of prosome angular or produced as spines or wings -

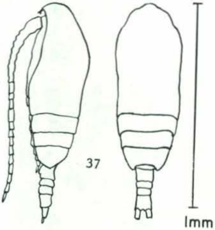
(26)	body robust, urosome relatively short	<u>Tharybis fultoni</u>	1.2-1.3 mm	(Figure 27)
(27)	posterior corners produced as symmetrical spines	<u>Aetideus armatus</u>	1.3-2.0	(Figure 28)
(28)	posterior corners produced as asymmetrical spines, urosome asymmetrical	<u>Centropages abdominalis</u>	1.6-2.1	(Figure 29)
(29)	posterior corners produced as symmetrical rounded spines, urosome asymmetrical	<u>Tortanus discaudatus</u>	1.4-2.3	(Figure 30)
(30)	posterior corners produced as "wings", last segment of urosome covered with spinules	<u>Eurytemora americana</u>	1.6-1.8	(Figure 31)
(31)	posterior corners produced as "wings', last segment of urosome smooth	<u>Eurytemora hirundoides</u>	1.0-1.6	(Figure 32)

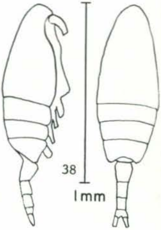








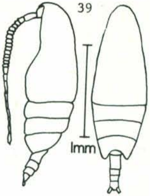


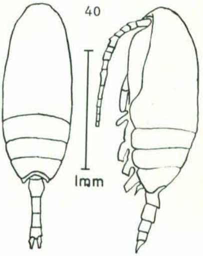


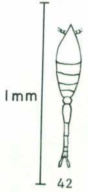
Copepods ≤2 mm total length (cont'd) -

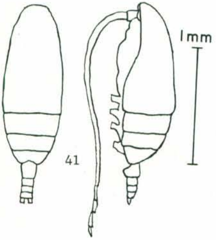
Posterior corners of prosome not angular or produced as spines; urosome of three segments -

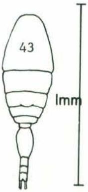
(32)	last segment of metasome rounded, with two short stiff setae	Acartia longiremis	0.98-1.25 mm	(Figure 33)
(33)	last segment of metasome rounded, with 3-5 marginal spinules	Acartia clausi	0.91-1.22	(Figure 34)
	Urosome of four segments -			
(34)	body robust, urosome relatively short	Scolecithricella minor	1.25-1.4	(Figure 35)
(35)	total length less than 1 mm	Microcalanus pygmaeus pusillus	0.7-0.9	(Figure 36)
(36)	5th leg present but reduced, urosome relatively thick	Paracalanus parvus	0.7-1.3	(Figure 37)
(37)	no 5th leg, genital segment swollen	Pseudocalanus minutus	1.2-2.0	(Figure 38)

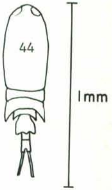












Copepods ≤2 mm total length (cont'd) -

Posterior corners of prosome not angular or produced as spines; urosome of four segments -

(38)	segments 5-15 of 1st antennae wider than long	Scaphocalanus echinatus	1.7-2.0 mm	(Figure 39)
(39)	5th leg present but reduced, urosome relatively slender	Scaphocalanus brevicornis	1.9-2.1	(Figure 40)
(40)	no 5th leg, 1st antennae longer than body	Spinocalanus brevicaudatus	1.6-1.8	(Figure 41)

Urosome of five segments or more; 5th leg on 1st segment of urosome -

(41)	head pointed when viewed dorsally	Oithona spinirostris	0.7-1.2	(Figure 42)
(42)	head rounded	Oithona helgolandica	0.7-0.96	
(43)	1st antennae short	Oncaea borealis	0.7-1.4	(Figure 43)
(44)	head provided with cuticular lenses	Corycaeus anglicus	0.8-1.1	(Figure 44)

Table 1. Size of some copepod nauplii preserved in formalin.

Species	Stage	Length in mm						For a detailed account see Reference
		I	II	III	IV	V	VI	
Acartia longiremis		0.12	0.14	0.16	0.19	0.23	0.27	Oberg, 1906
Oithona spinirostris		0.13	0.15	0.17	0.20	0.24	0.27	Gibbons & Ogilvie, 1933
Pseudocalanus minutus		0.18	0.18	0.26	0.33	0.38	0.44	Ogilvie, 1953
Metridia lucens		0.19	0.21	0.27	0.34	0.41	0.46	Ogilvie, 1953
Calanus pacificus		0.22	0.27	0.40	0.48	0.55	0.61	Ogilvie, 1953
Calanus plumchrus		0.29	0.30	0.35	0.46	0.56	0.70	Campbell, 1934
Eucalanus bungii bungii		0.22	0.30	0.49	0.66	0.82	0.97	Johnson, 1937
Euchaeta japonica		0.59	0.64	0.66	0.69	0.80	0.87	Campbell, 1934

Species	Stage	Length in mm						
		Egg	I	II	III	IV	V	VI
Tortanus discaudatus		0.11	0.13	0.19	0.24	0.30	0.33	-
Microcalanus pusillus		-	0.08	0.09	0.13	0.16	0.18	0.21
Centropagès abdominalis		0.08	0.10	0.14	0.19	0.22	0.26	0.28
Epilabidocera amphitrites			0.18	0.26	0.34	0.40	0.46	0.56

Remarks: Measurements are taken from preserved samples. Specimens may shrink as much as 10% during preservation. Our experience suggests that there is little or no size difference between North Pacific and North Atlantic representatives of the same species.

Table 2. Size of copepodid stages preserved in formalin.

		Total body length (mm)	No. of abdoninal segments	Pairs of legs
Calanus plumchrus				
	I	0.9 - 1.3	1	2
	II	1.2 - 1.5	2	3
	III	1.8 - 2.4	2	4
	IV	2.8 - 3.4	3	5
	V	4.1 - 5.2	4	5
	VI♀	4.5 - 5.2	4	5
	VI♂	4.6	5	5
Calanus pacificus				
	I	0.5	2	2
	II	1.2	2	3
	III	1.5	2	4
	IV	1.8	3	5
	V	2.5 - 2.8	4	5
	VI♀	2.8 - 3.0	4	5
	VI♂	2.5	5	5
Calanus glacialis				
	I	0.5 - 0.7	1	2
	II	1.2 - 1.5	2	3
	III	1.6 - 2.3	2	4
	IV	2.3 - 2.6	3	5
	V	2.8 - 3.8	4	5
	VI♀	3.2 - 4.2	4	5
	VI♂	3.5 - 4.0	5	5
Calanus cristatus				
	I	1.20	2	2
	II	2.0	2	3
	III	3.24	2	4
	IV	4.90 - 5.3	3	5
	V	7.1 - 8.9	4	5
	VI♀	8.5 - 10.4	4	5
	VI♂	9.0 - 9.8	5	5
Pseudocalanus minutus				
	I	0.55 - .62	2	2
	II	0.58 - .73	2	3
	III	0.78 - .90	2	4
	IV	1.05 - 1.10	3	4
	V	1.10 - 1.36	4	4
	VI♀	1.12 - 2.0	4	4
	VI♂	1.1 - 1.36	5	5

(Cont'd)

Table 2. Size of copepodid stages preserved in formalin. (Cont'd)

		Total body length (mm)	No. of abdominal segments	Pairs of legs
Metridia pacifica				
	I	0.53	1	2
	II	0.74	1	3
	III	1.08	2	4
	IV	1.28	3	4
	V♀	1.8 - 2.1	3	5
	V♂	1.8 - 1.5	4	5
	VI♀	2.5 - 2.9	3	5
	VI♂	2.0 - 2.3	5	5
Eucalanus bungii bungii (from Johnson, 1937)				
	I	1.3 - 1.6	1	2
	II	2.0 - 1.6	1	3
	III	2.9 - 3.0	1	4
	IV♀	3.6 - 3.8	2	4
	IV♂	3.4 - 3.7	2	5
	V♀	4.9 - 5.2	2	4
	V♂	4.5 - 4.8	3	5
	VI♀	6.5 - 8.0	4	5
	VI♂	4.8 - 5.4	4	5
Euchaeta japonica (from Campbell, 1934)				
	I	1.3	2	2
	II	1.8	2	3
	III	2.3	2	4
	IV♀	3.3	3	4
	IV♂	3.3	3	5
	V♀	4.8	4	4
	V♂	4.8	4	5
	VI♀	5.5	4	4
	VI♂	5.0	4	5
Gaetanus intermedius (from Shan, 1962)				
	I	0.85	2	2
	II	1.15	2	3
	III	1.55	2	4
	IV♀	2.00	3	4
	IV♂	2.00	3	5
	V♀	2.70	4	4
	V♂	2.65	4	5
	VI♀	2.90 - 3.2	4	5
	VI♂	2.80 - 3.1	4	5

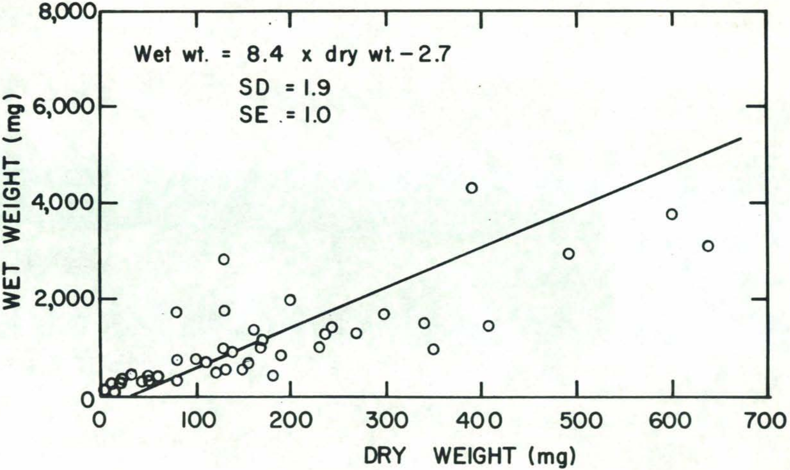


Fig. 45. Relationship of wet weight to dry weight for copepods.

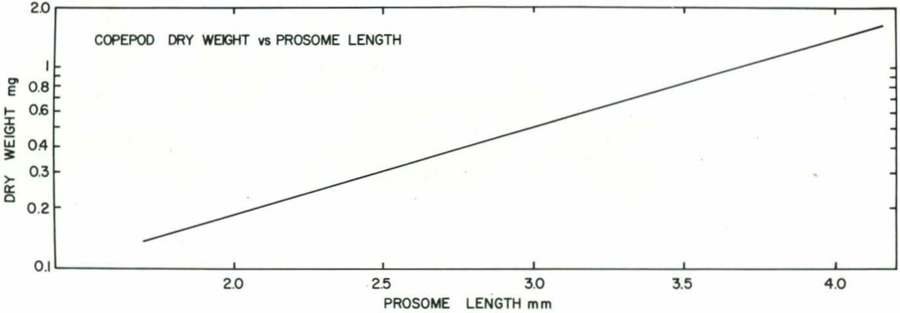


Fig. 46. Relationship of dry weight to prosome length for copepods.

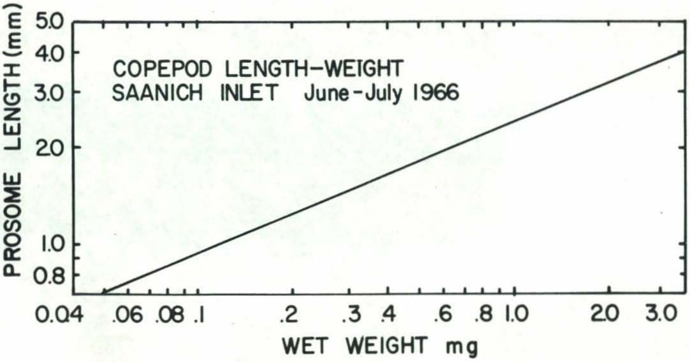


Fig. 47. Relationship of wet weight to prosome length for copepods.

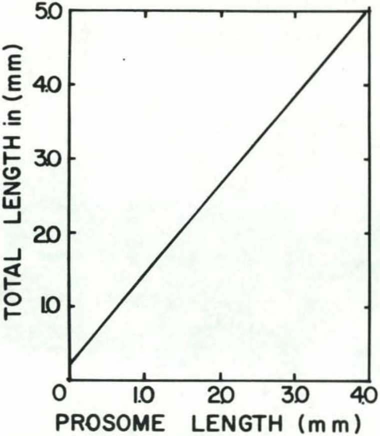


Fig. 48. Relationship of total length to prosome length for copepods.

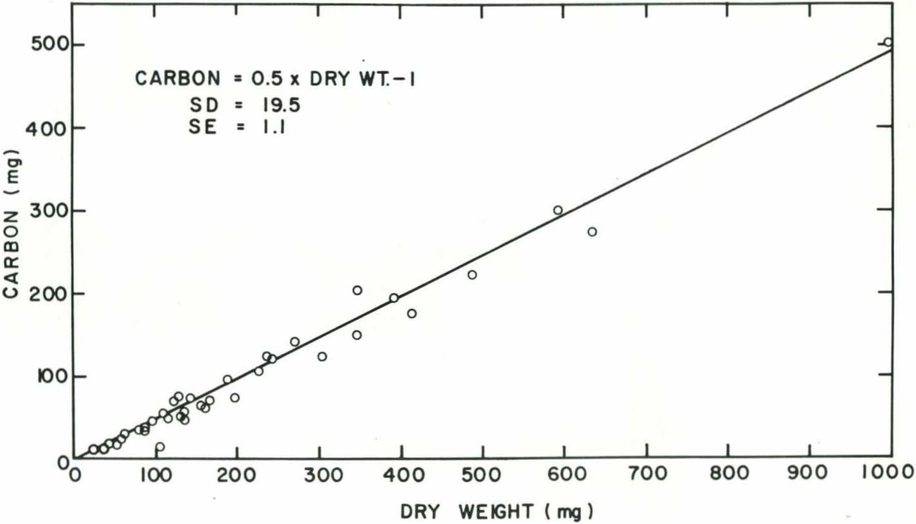


Fig. 49 . Relationship of dry weight to carbon for copepods.

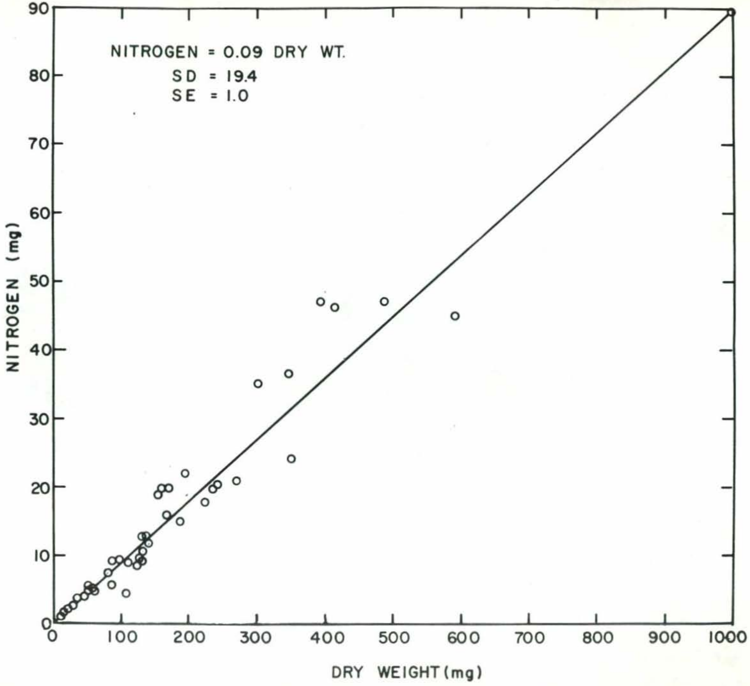


Fig. 50. Relationship of dry weight to nitrogen for copepods.