Zoology 406

Laboratory Zooplankton Atlas for the Strait of Georgia

prepared by

J. D. FULTON

Z O O L O G Y 406

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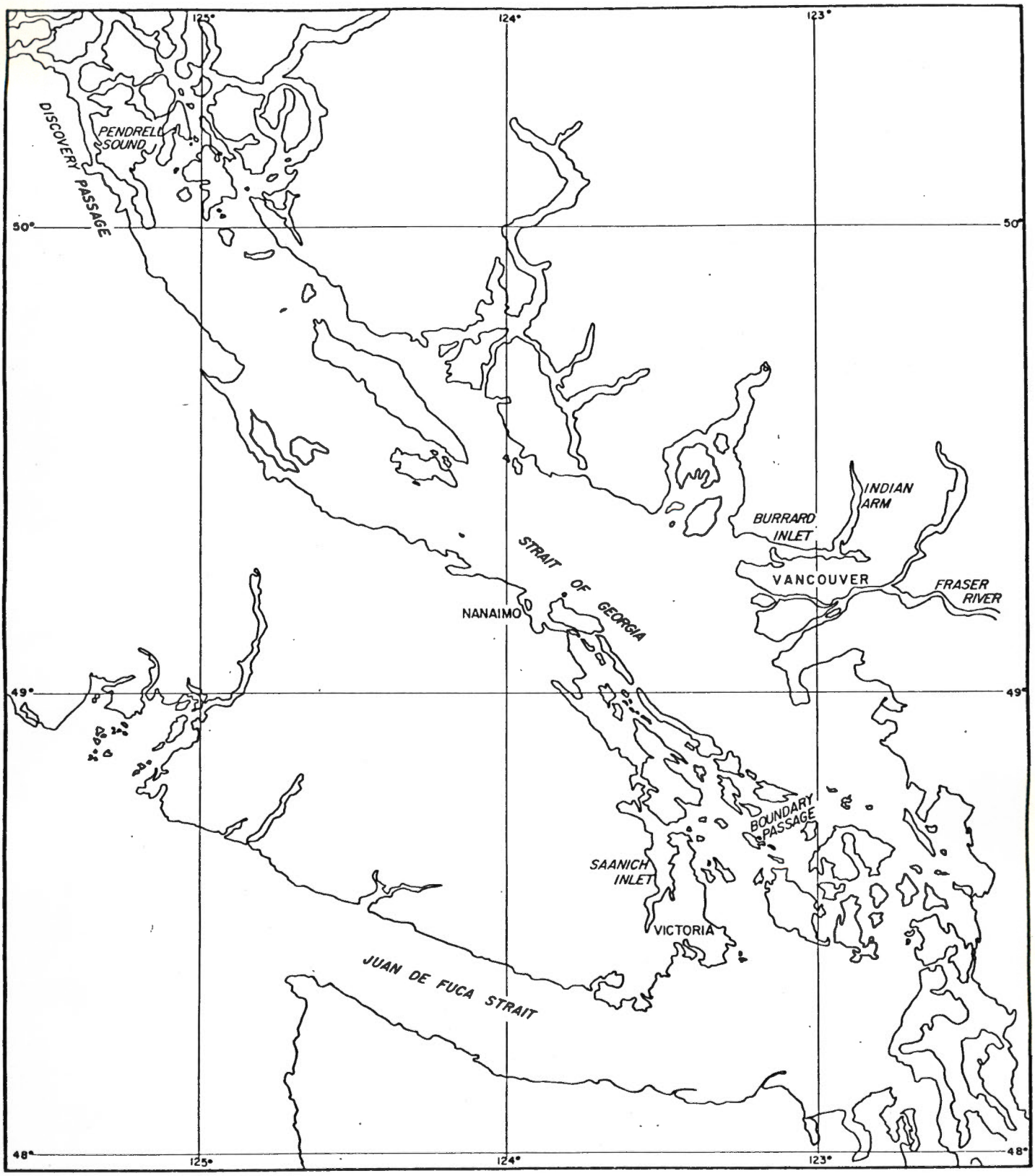
Nanaimo, B.C.



The area studied.

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.

Acknowledgement: Drawings of copepods have been reproduced from Tech. Rept. No. 313, Fisheries Research Board of Canada.

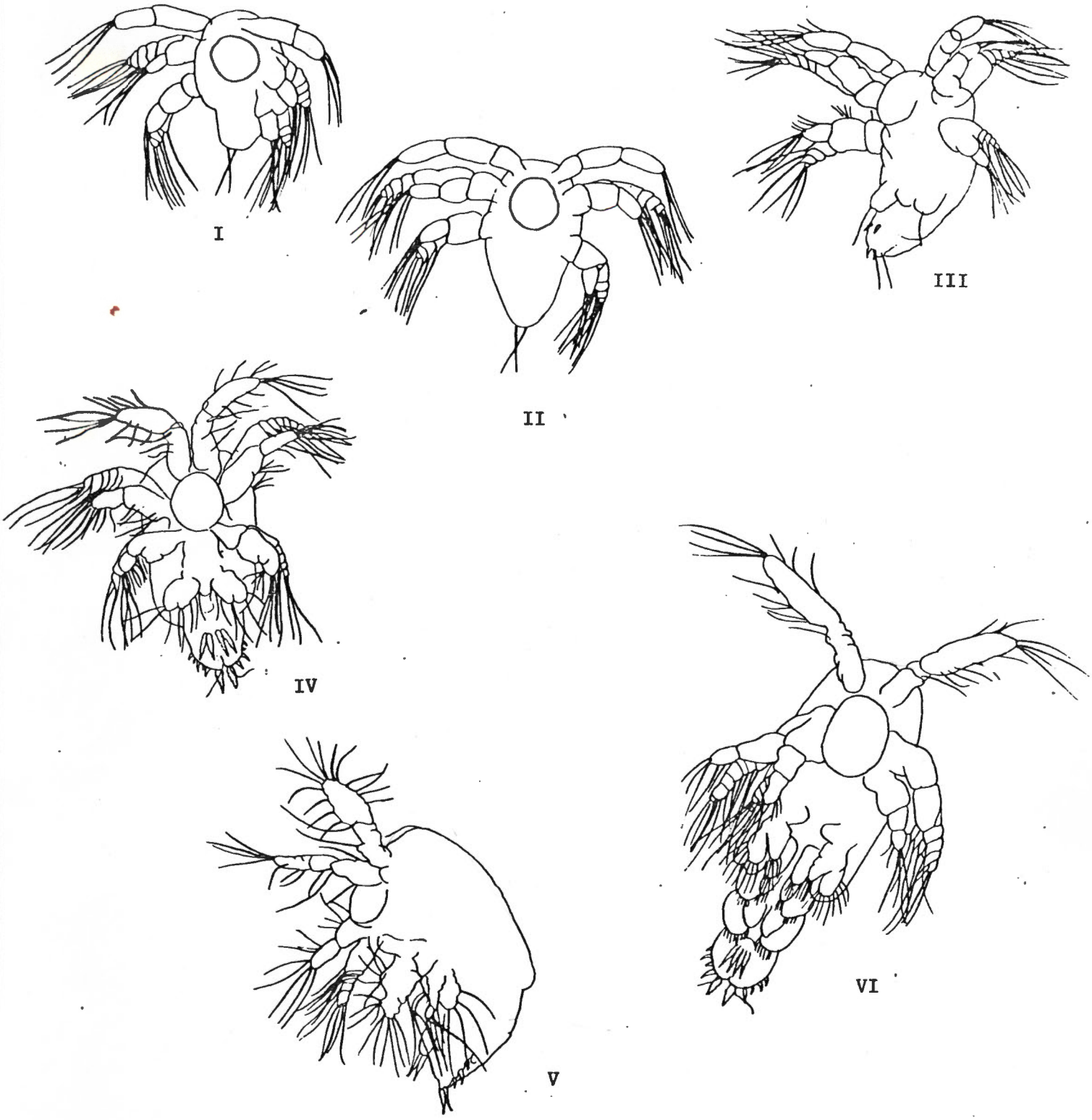


Fig. 1. The nauplii of Calanus plumchrus drawn to the same scale. Stage I is 290 μ long.

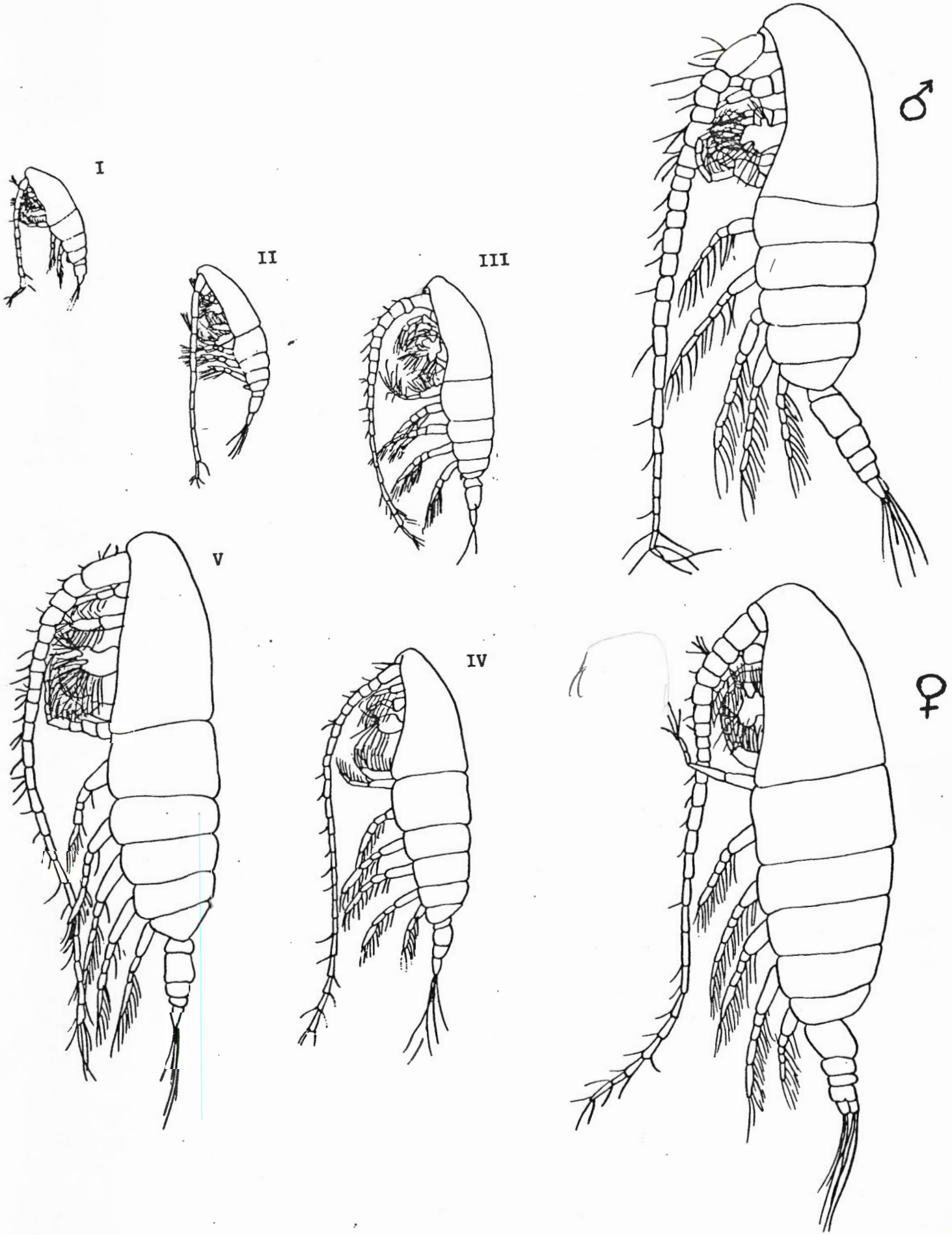
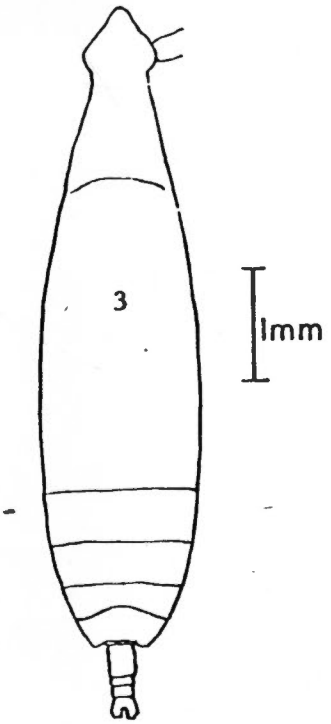
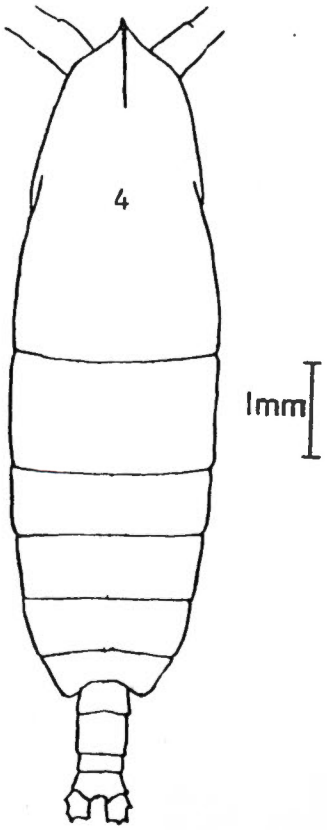
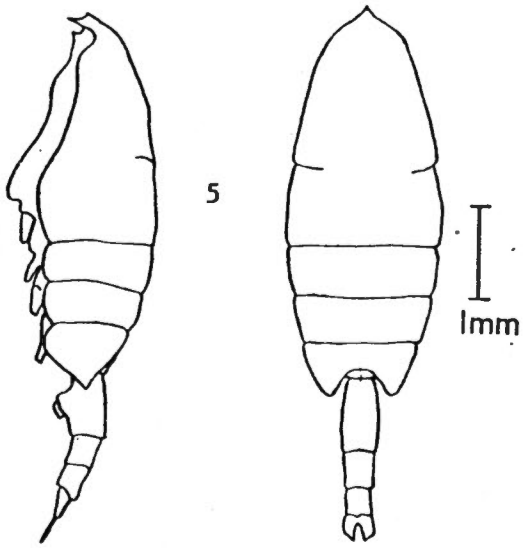


Fig. 2. The copepodid stages of Calanus plumchrus drawn to the same scale. Stage I is one mm long.

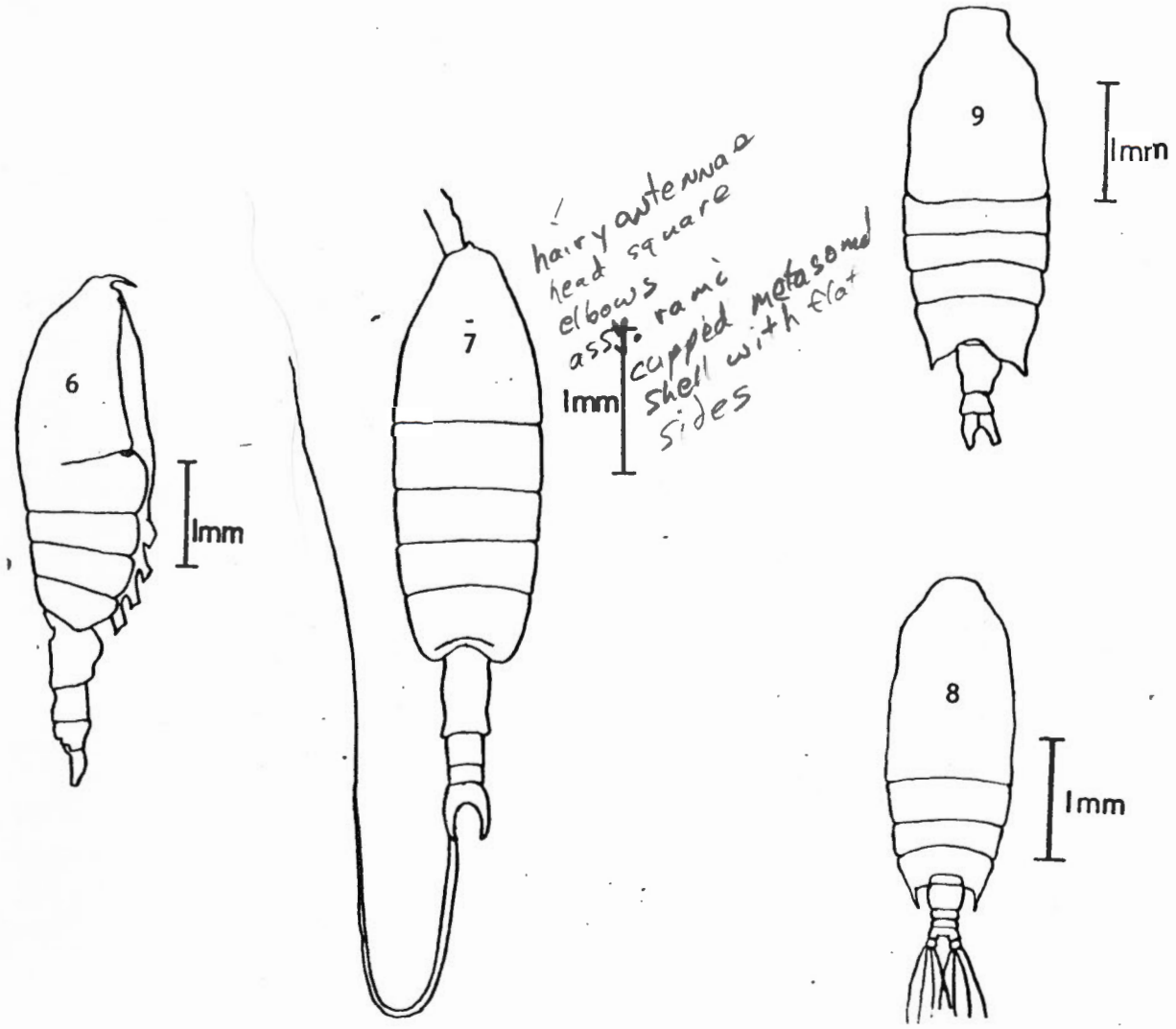






Copepods ≥ 5.5 mm total length

(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)

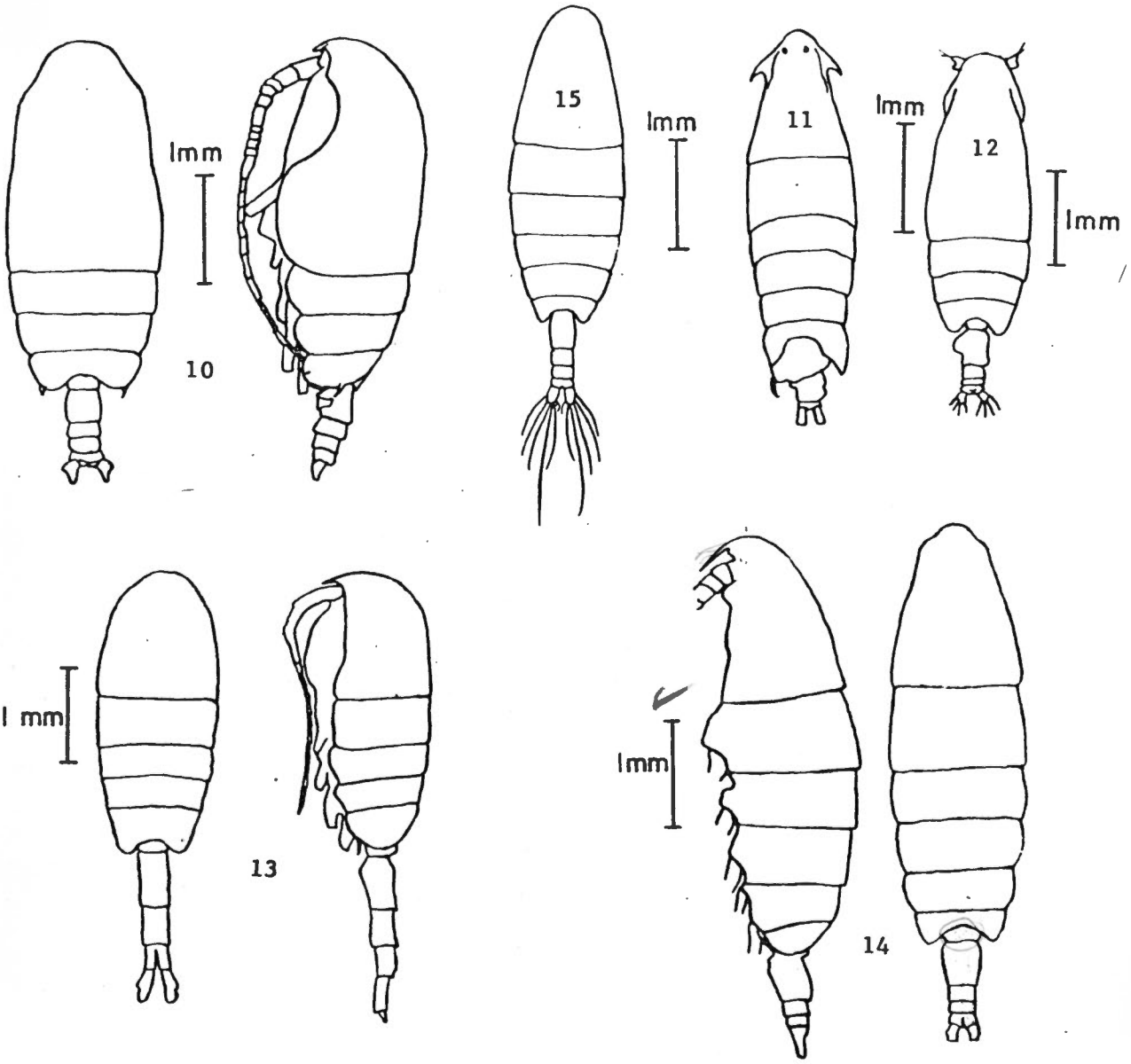


Copepods 3.2 to 5.5 total length

(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)



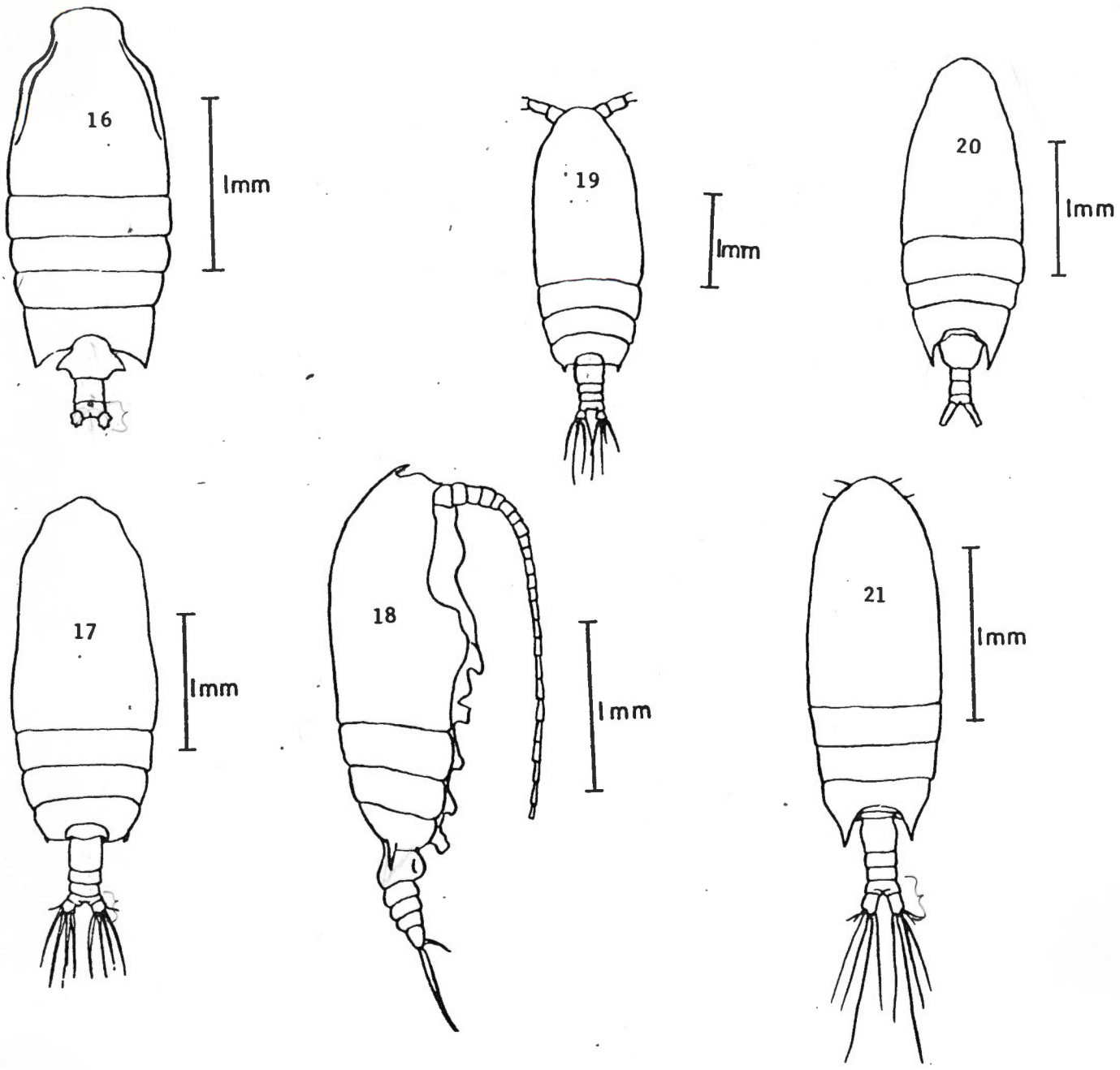
Copepods 3.2 to 5.5 mm total length (cont'd)

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~~ marshallae	3.2-4.2	(Figure 15)



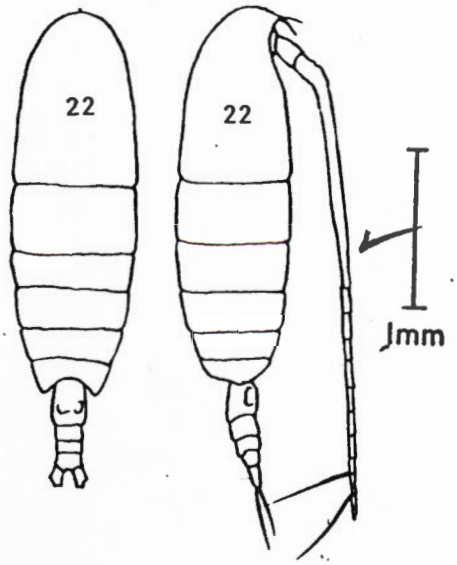
Copepods 2.0 to 3.1 mm total length

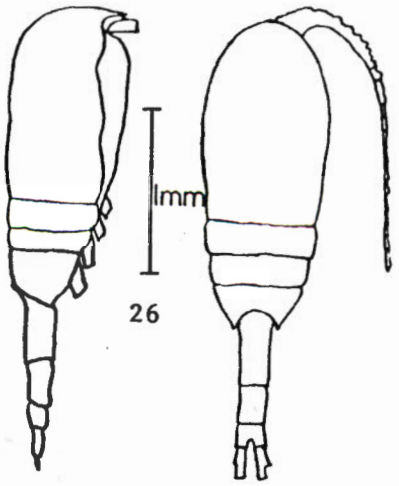
Posterior corners of prosome angular or produced as spines -

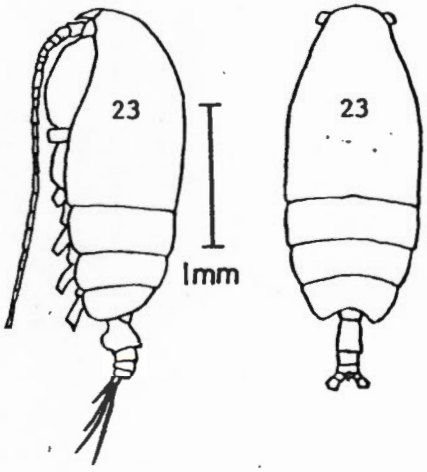
(15)	posterior corners angular, urosome with lateral projections	Candacia bipinnata	2.2-2.5 mm	(Figure 16)
(16)	spines blunt or rounded	Gaidius columbiae	3.0-3.2	(Figure 17)

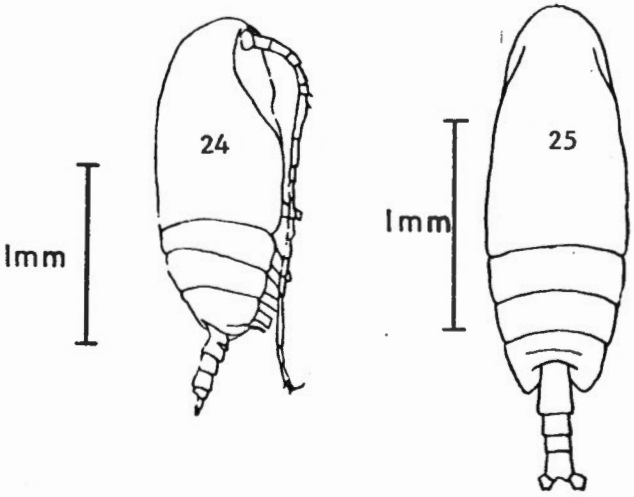
Spines acute -

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





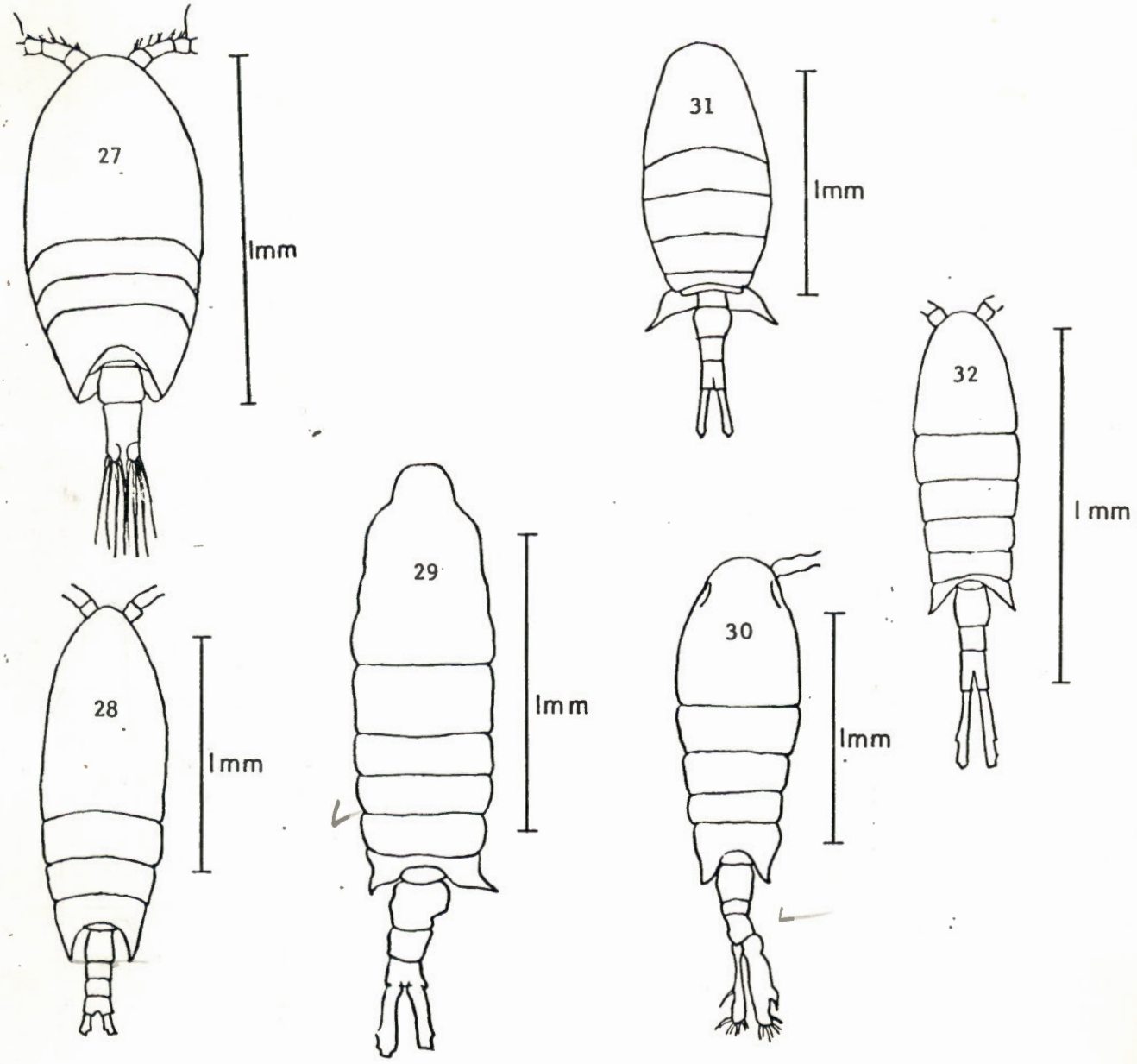




Copepods 2.0 to 3.1 mm total length (cont'd) -

Posterior corners of prosome not angular or produced -

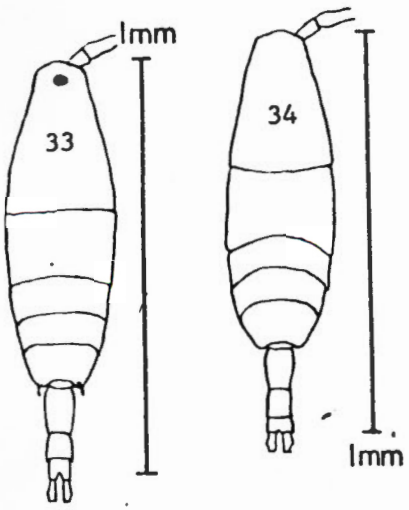
(21)	1st antennae as long or longer than body	Calanus pacificus	2.5-3.5 mm	(Figure 22)
(22)	1st antennae shorter than the body, body robust, urosome relatively short; urosome swollen when viewed laternally	Euchirella rostrata	2.9-3.1	(Figure 23)
(23)	urosome not swollen	Scolecithricella subdentata	2.2	(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)

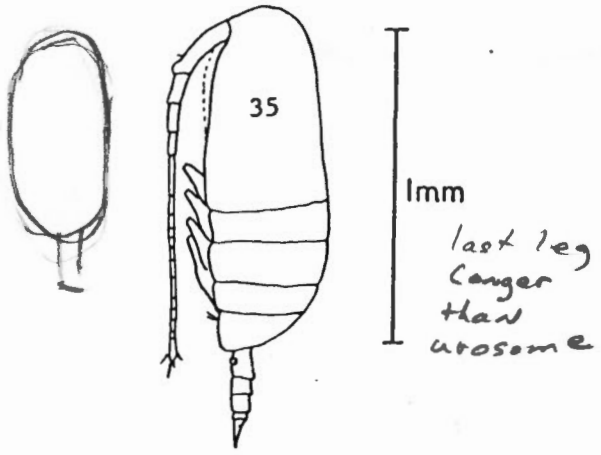


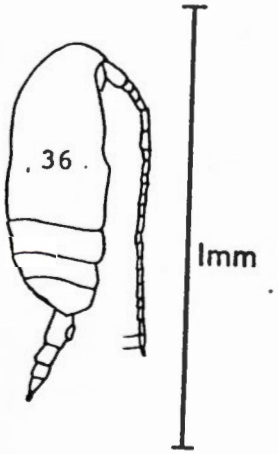
Copepods ≤2 mm total length

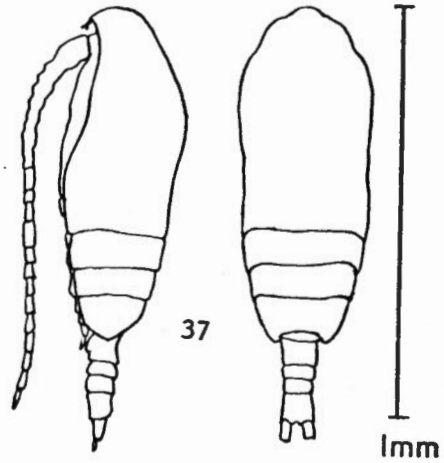
Posterior corners of prosome angular or produced as spines or wings -

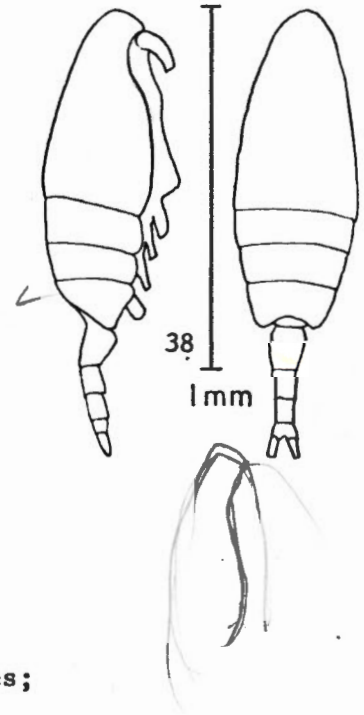
(26) body robust, urosome relatively short	Tharybis fultoni	1.2-1.3 mm	(Figure 27)
(27) posterior corners produced as symmetrical spines	Aetideus armatus	1.3-2.0	(Figure 28)
(28) posterior corners produced as asymmetrical spines, urosome asymmetrical	Centropages abdominalis	1.6-2.1	(Figure 29)
(29) posterior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











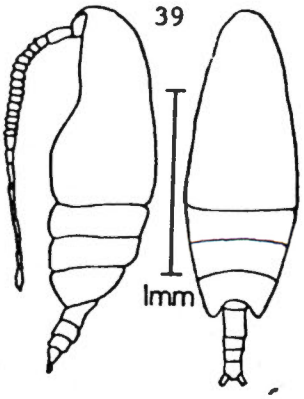
Copepods ≤2 mm total length (cont'd) -

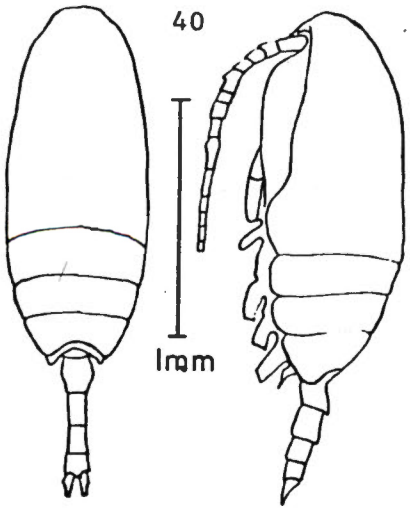
Posterior corners of prosome not angular or produced as spines; urosome of three segments -

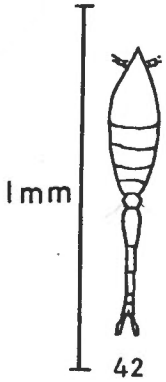
(32)	last segment of metasome rounded, with two short stiff setae	Acartia longiremis	0.98-1.25 mm (Figure 33)
(33)	last segment of metasome rounded, with 3-5 marginal spinules	Acartia clausi	0.91-1.22 (Figure 34)

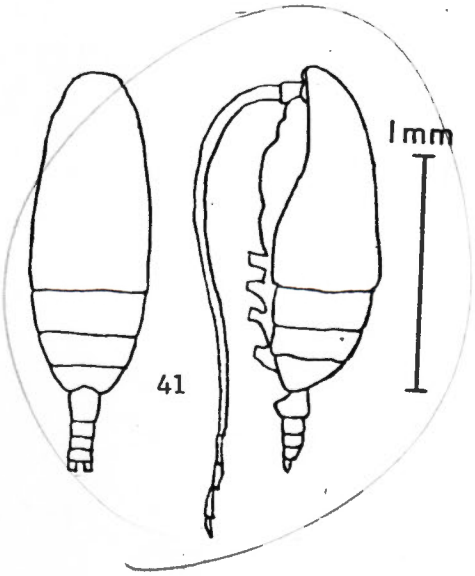
Urosome of four segments -

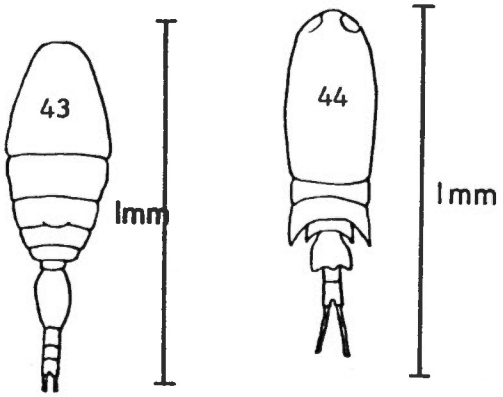
(34)	body robust, urosome relatively short	Scolecithricella minor	1.25-1.4 (Figure 35)
(35)	total length less than 1 mm	Microcalanus pygmaeus pusillus	0.7-0.9 (Figure 36)
(36)	5th leg present but reduced, urosome relatively thick	Paracalanus parvus	0.7-1.3 (Figure 37)
(37)	no 5th leg, genital segment 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)

cyclopoids

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

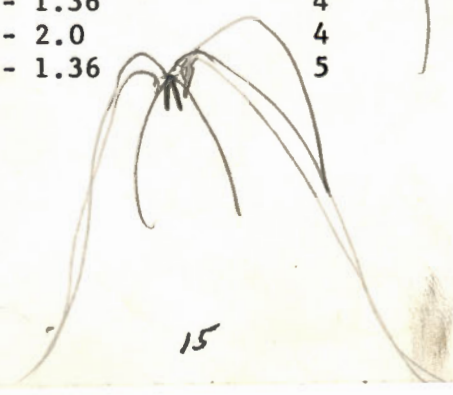
Species	Stage	Length in mm I	II	III	IV	V	VI	For a detailed account see Reference
Acartia longiremis		0.12	0.14	0.16	0.19	0.23	0.27	Oberg, 1906
Oithona spinirostris		0.13	0.15	0.17	0.20	0.24	0.27	Gibbons & Ogilvie, 1933
Pseudocalanus minutus		0.18	0.18	0.26	0.33	0.38	0.44	Ogilvie, 1953
Metridia lucens		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
Centropages 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.

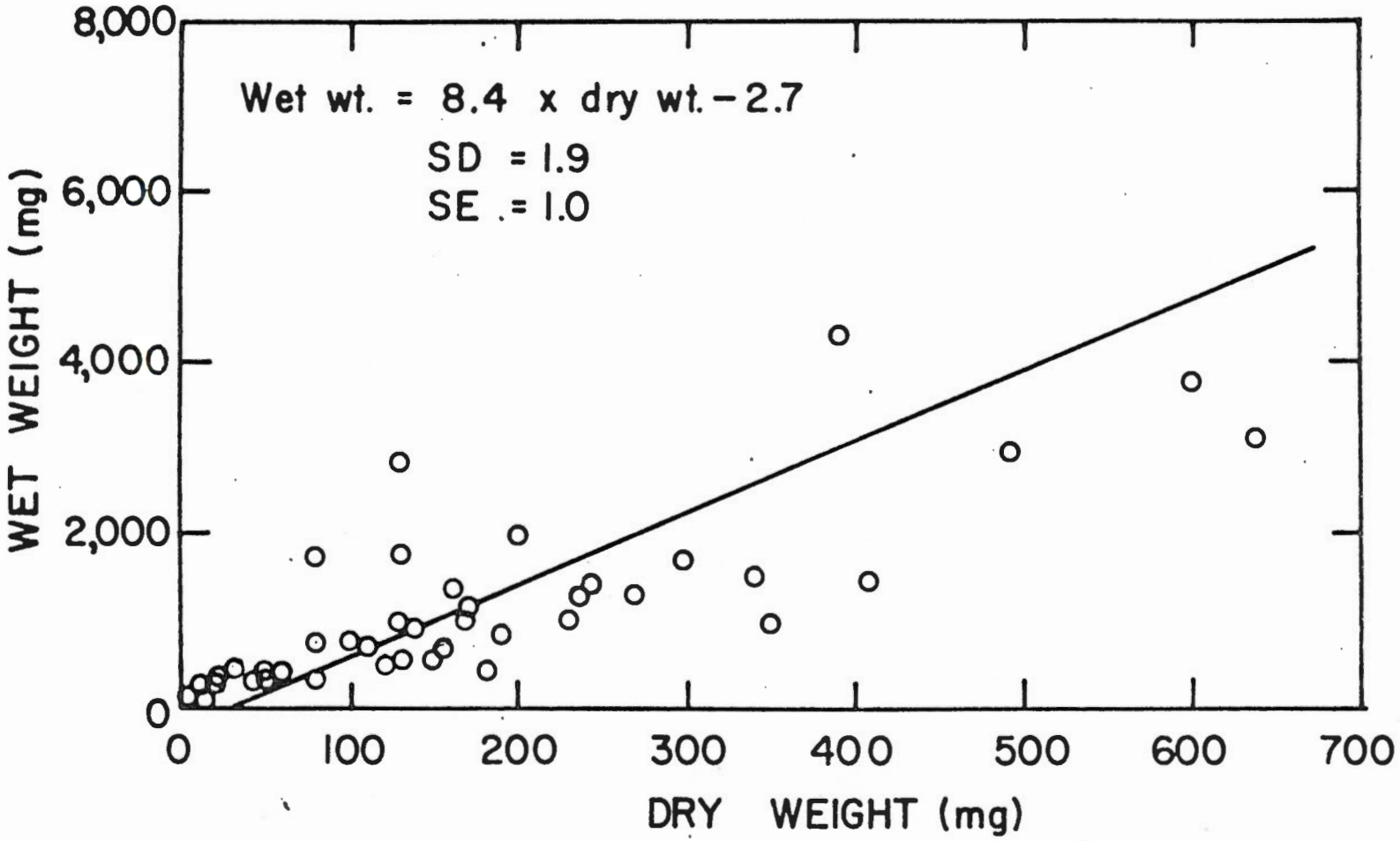
		Total body length (mm)	No. of abdominal segments	Pairs of legs
Calanus plumchrus				
	I	0.9 - 1.3	1	2
	II	1.2 - 1.5	2	3
	III	1.8 - 2.4	2	4
	IV	2.8 - 3.4	3	5
	V	4.1 - 5.2	4	5
	VI♀	4.5 - 5.2	4	5
	VI♂	4.6	5	5
Calanus pacificus				
	I	0.5	2	2
	II	1.2	2	3
	III	1.5	2	4
	IV	1.8	3	5
	V	2.5 - 2.8	4	5
	VI♀	2.8 - 3.0	4	5
	VI♂	2.5	5	5
Calanus ~~glacialis~~ marshalae				
	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



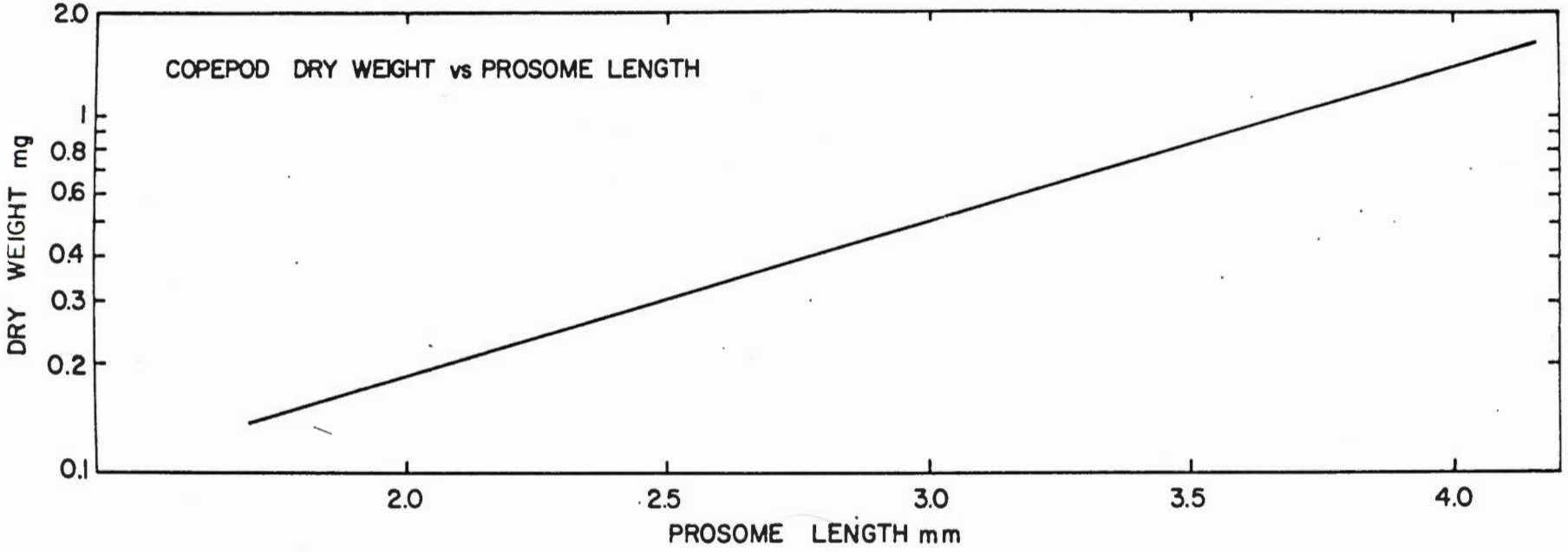
(Cont'd)

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

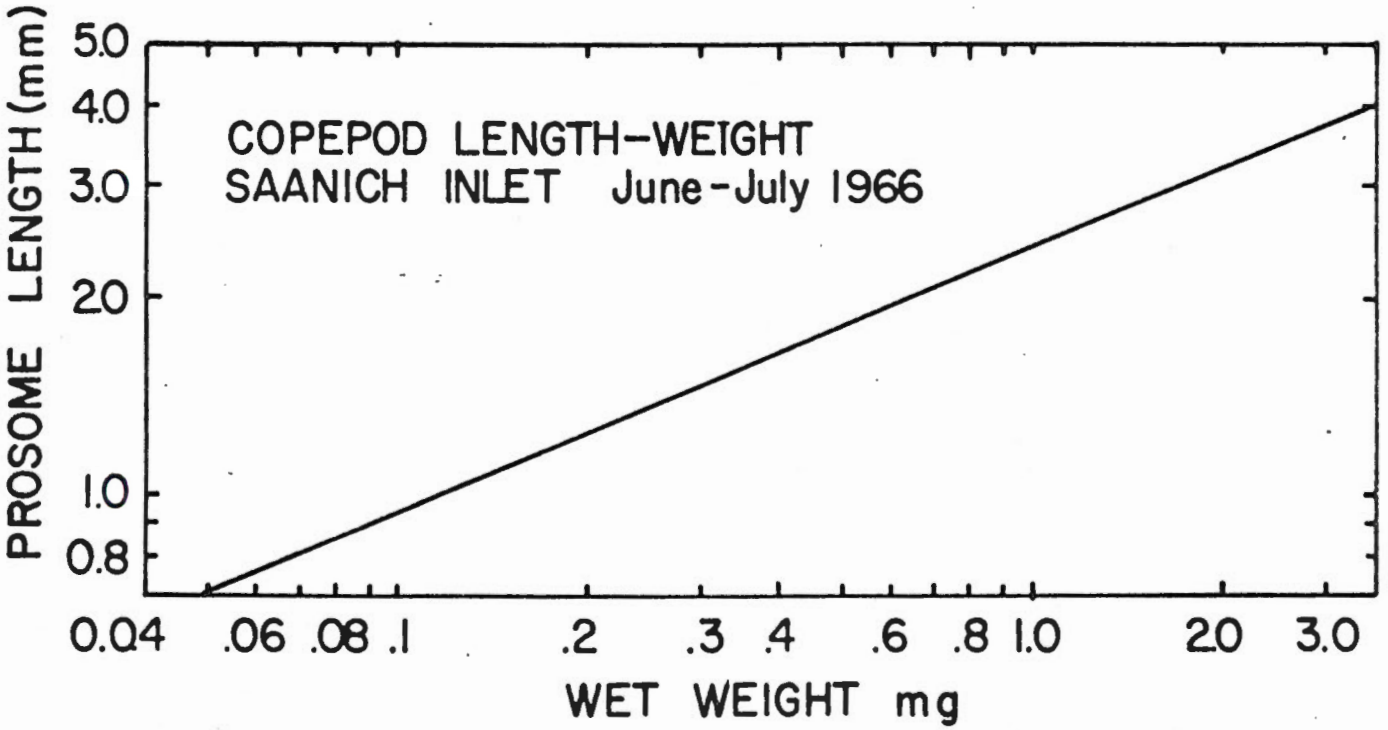
		Total body length (mm)	No. of abdominal segments	Pairs of legs
Metridia pacifica				
	I	0.53	1	2
	II	0.74	1	3
	III	1.08	2	4
	IV	1.28	3	4
	V♀	1.8 - 2.1	3	5
	V♂	1.8 - 1.5	4	5
	VI♀	2.5 - 2.9	3	5
	VI♂	2.0 - 2.3	5	5
Eucalanus bungii bungii (from Johnson, 1937)				
	I	1.3 - 1.6	1	2
	II	2.0 - 1.6	1	3
	III	2.9 - 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



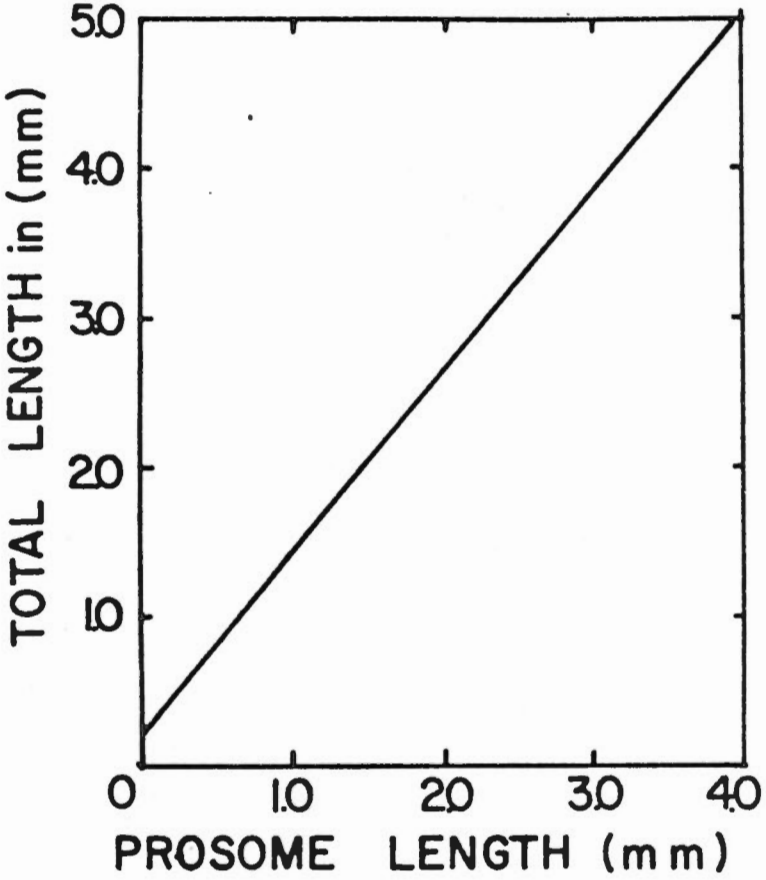
Relationship of wet weight to dry weight for copepods.



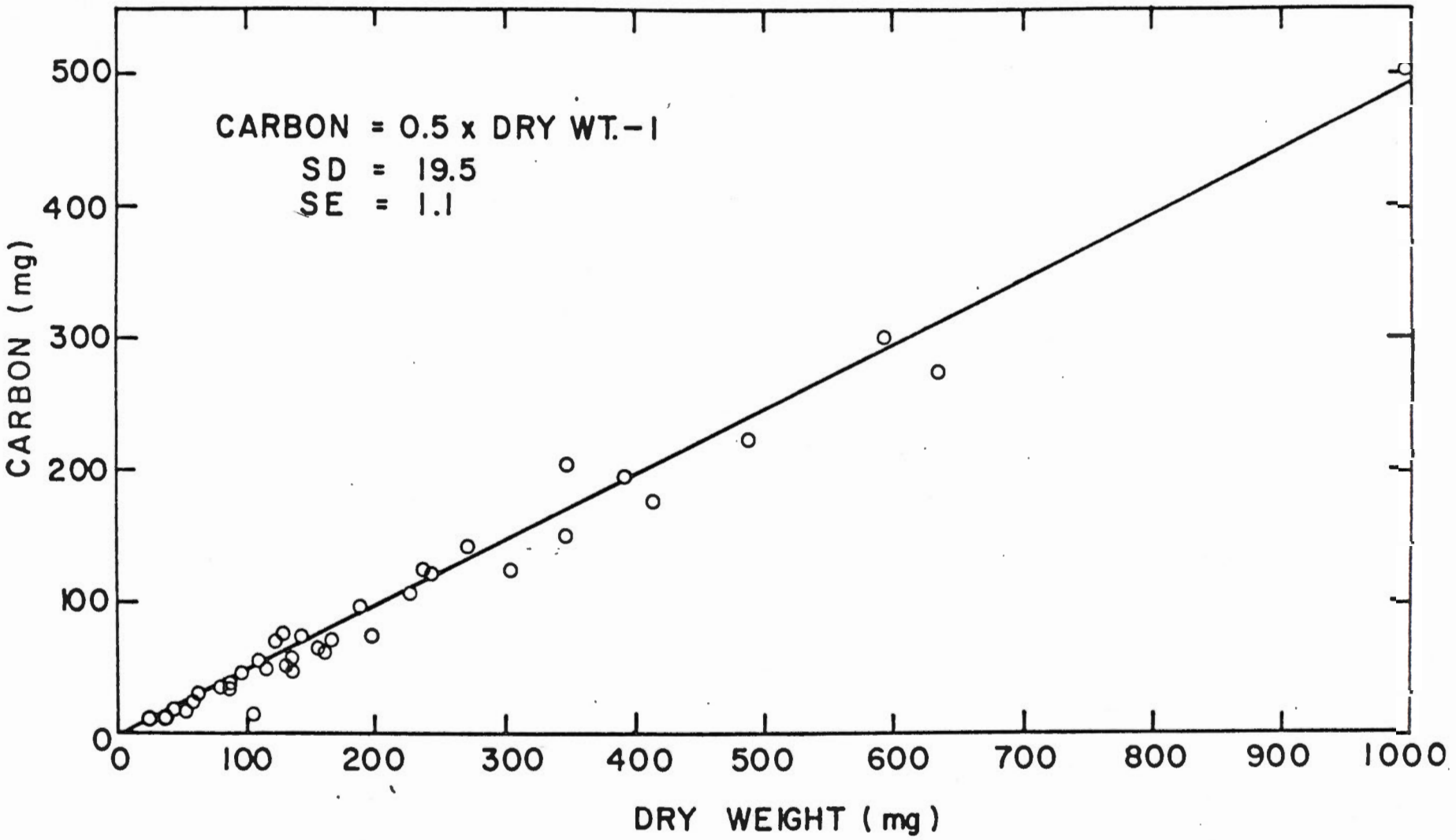
Relationship of dry weight to prosome length for copepods.



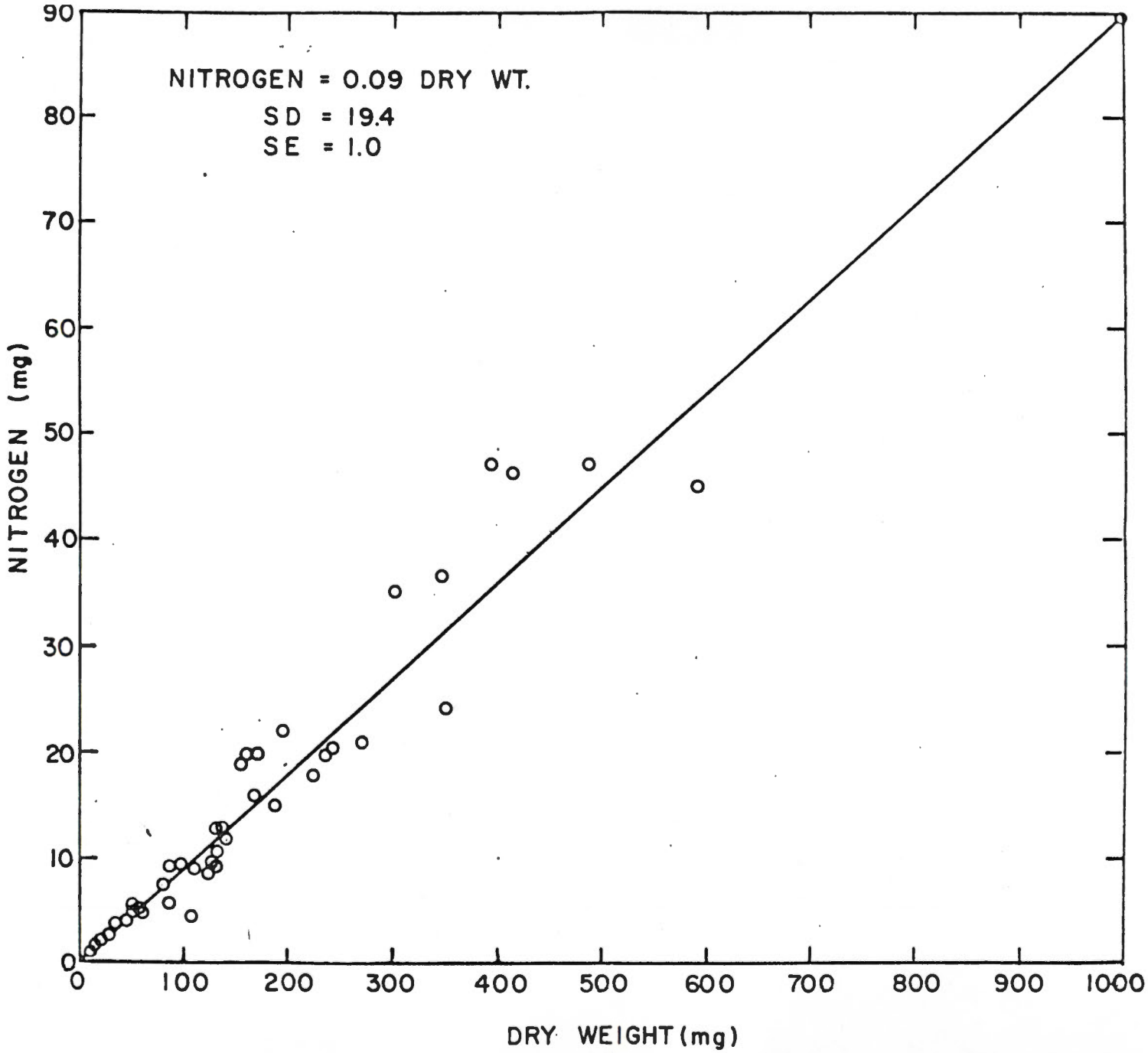
Relationship of wet weight to prosome length for copepods.



Relationship of total length to prosome length for copepods.

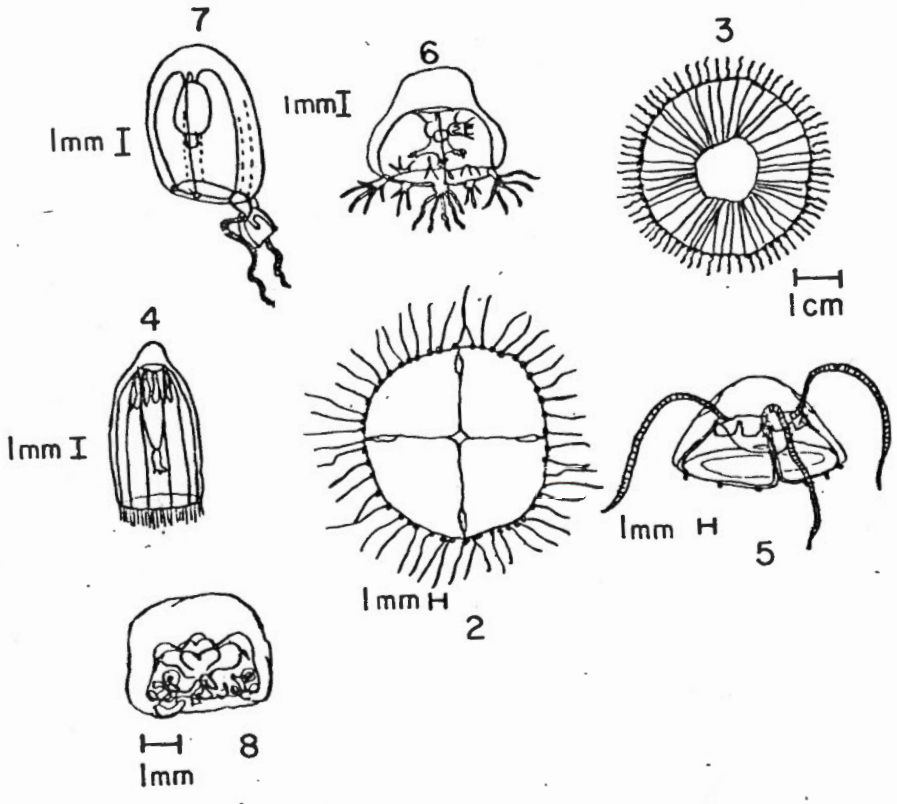


Relationship of dry weight to carbon for copepods.



Relationship of dry weight to nitrogen for copepods.

Key to pelagic medusae - Strait of Georgia

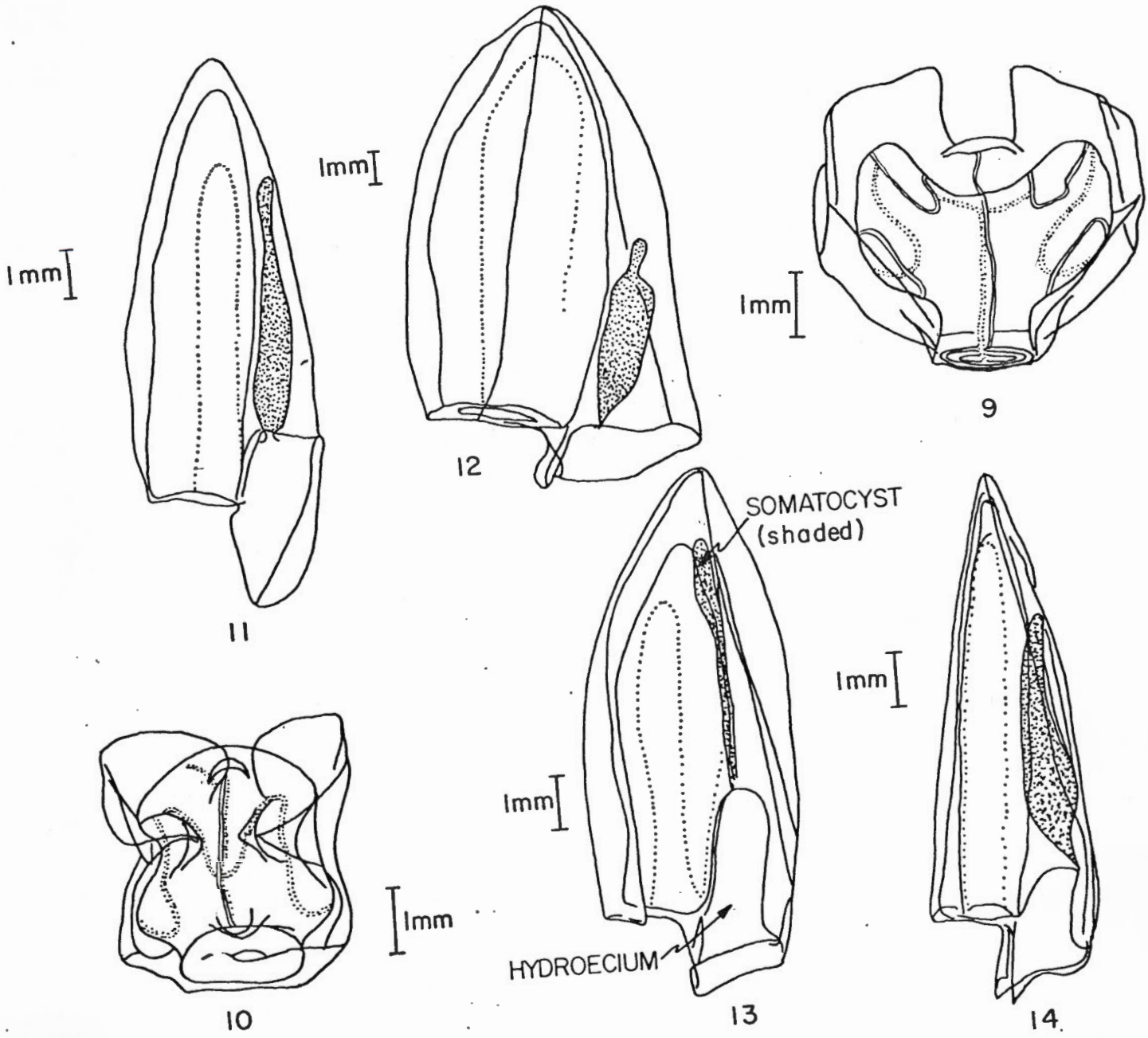


Body disc shaped

(1) four radiating canals — Phialidium gregarium (Figure 2)
(2) many radiating canals — Aequorea aequorea (Figure 3)

Body bell shaped

(3) many small tentacles on margin of bell — Aglantha digitale (Figure 4)
(4) four tentacles through the upper surface of the bell — Aegina (Figure 5)
(5) tentacles arranged symmetrically in eight clumps on margin of the bell — Rathkea (Figure 6)
(6) four clumps of tentacles on margin of bell, one clump larger than others — Hybocodon (Figure 7)
(7) tentacles usually curled up inside bell in preserved specimens — Proboscidactyla (Figure 8)



(a) Many nectophores clustered around a central stem with a pneumatophore at the top.

(1) nectophore "Y" shaped	Nanomia cara	(Figure 9)
(2) nectophore irregular in shape	Nanomia bijuga	(Figure 10)

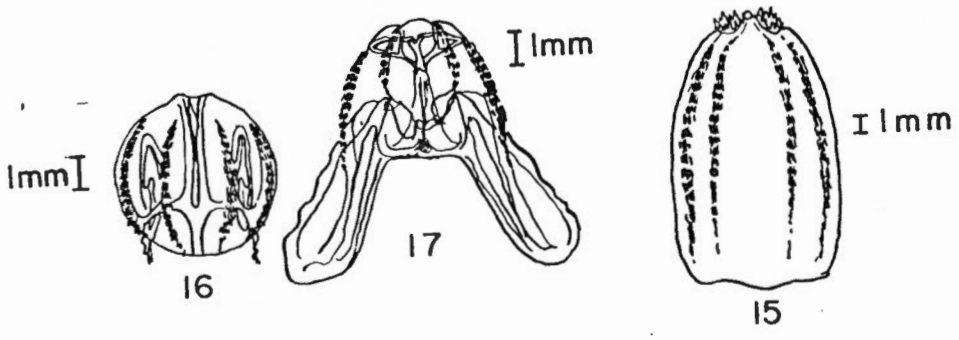
(b) A single nectophore with no pneumatophore.

(c) No ridges on the bell of the nectophore	Dimophyes arctica	(Figure 11)

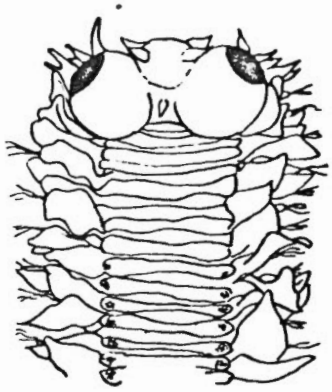
(d) Ridges on the bell of the nectophore

(1) hydroecium shallow	Lensia baryi	(Figure 12)
(2) hydroecium deep, somatocyst long and slender	Muggiaea atlantica	(Figure 13)
(3) hydroecium deep, somatocyst large and fusiform	Chelophyes appendiculata	(Figure 14)

Key to the Ctenophora



(1) Body oval in shape, usually a deep red	Beroe cucumis	(Figure 15)
(2) Body nearly spherical	Pleurobrachia pileus	(Figure 16)
(3) Posterior of body composed of two large lobes	Bolinopsis infundibulum	(Figure 17)



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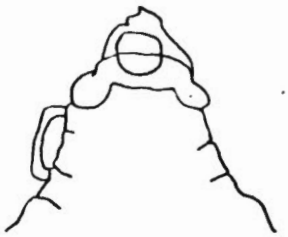
Key to the Polychaeta



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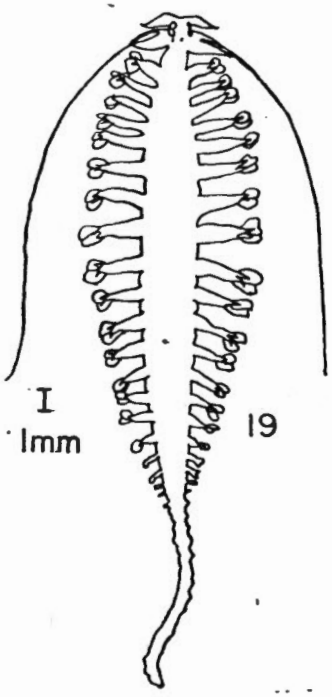
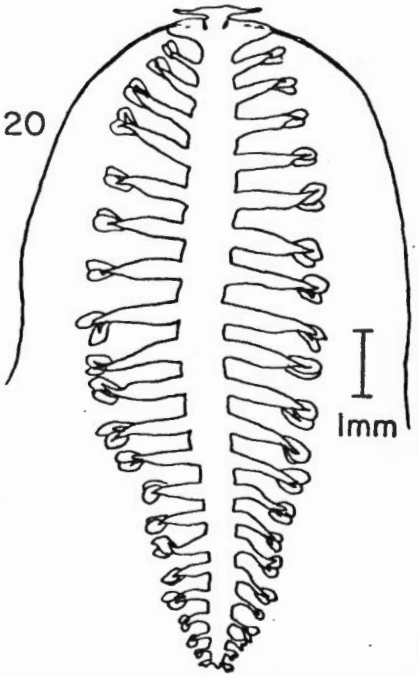




A) Body pigmented, up to 15 cm long

(1) Rhynchonerella angelini (Figure 18)

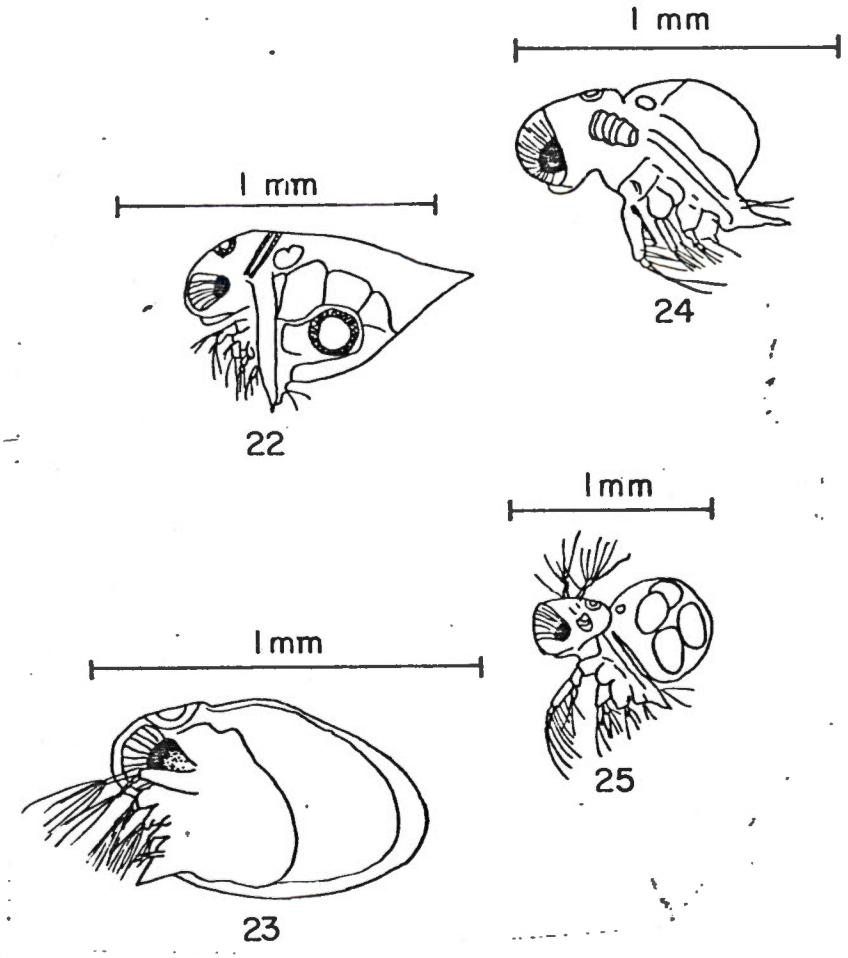
B) Body transparent

Parapodia and antenna, prominant

(2) with tail — Tomopteris renata (Figure 19)
(3) without tail — Tomopteris septentrionalis (Figure 20)

Parapodia not prominant, no antenna

(4) Typhloscolex mulleri (Figure 21)



A. constriction between head and body

(1) 1 setae on expodite of legs 1-3 - Podon leuckartii (fig. 24)

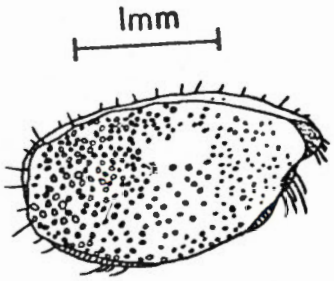
(2) 3 setae on expodite of legs 1-3 - Podon polyphemoides (fig. 25)

B. No constriction between head and body

(1) 1 setae on expodite of 3rd leg - Evadne nordmanni (fig. 22)

(2) 3 setae on exopodite of 3rd leg - Evadne tergestina (fig. 23)

Key to the Ostracoda



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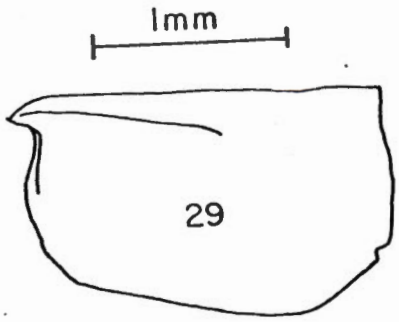
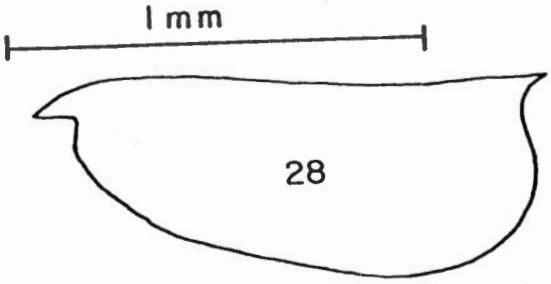
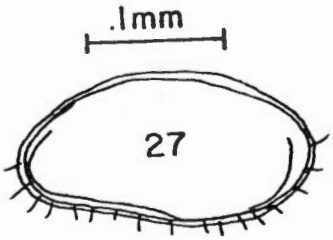
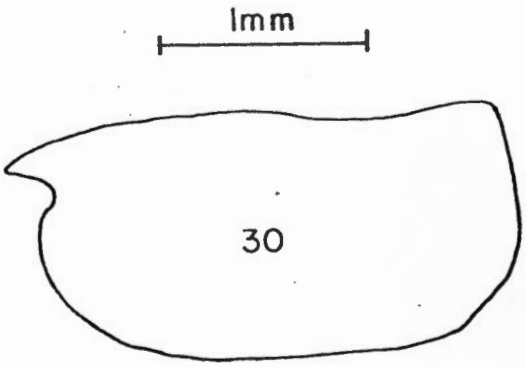








A) Shell surface heavily pitted — Philomedes sp. (Figure 26)

B) Shell smooth

1) shell more or less oval — Paradoxostoma striungulum (Figure 27)

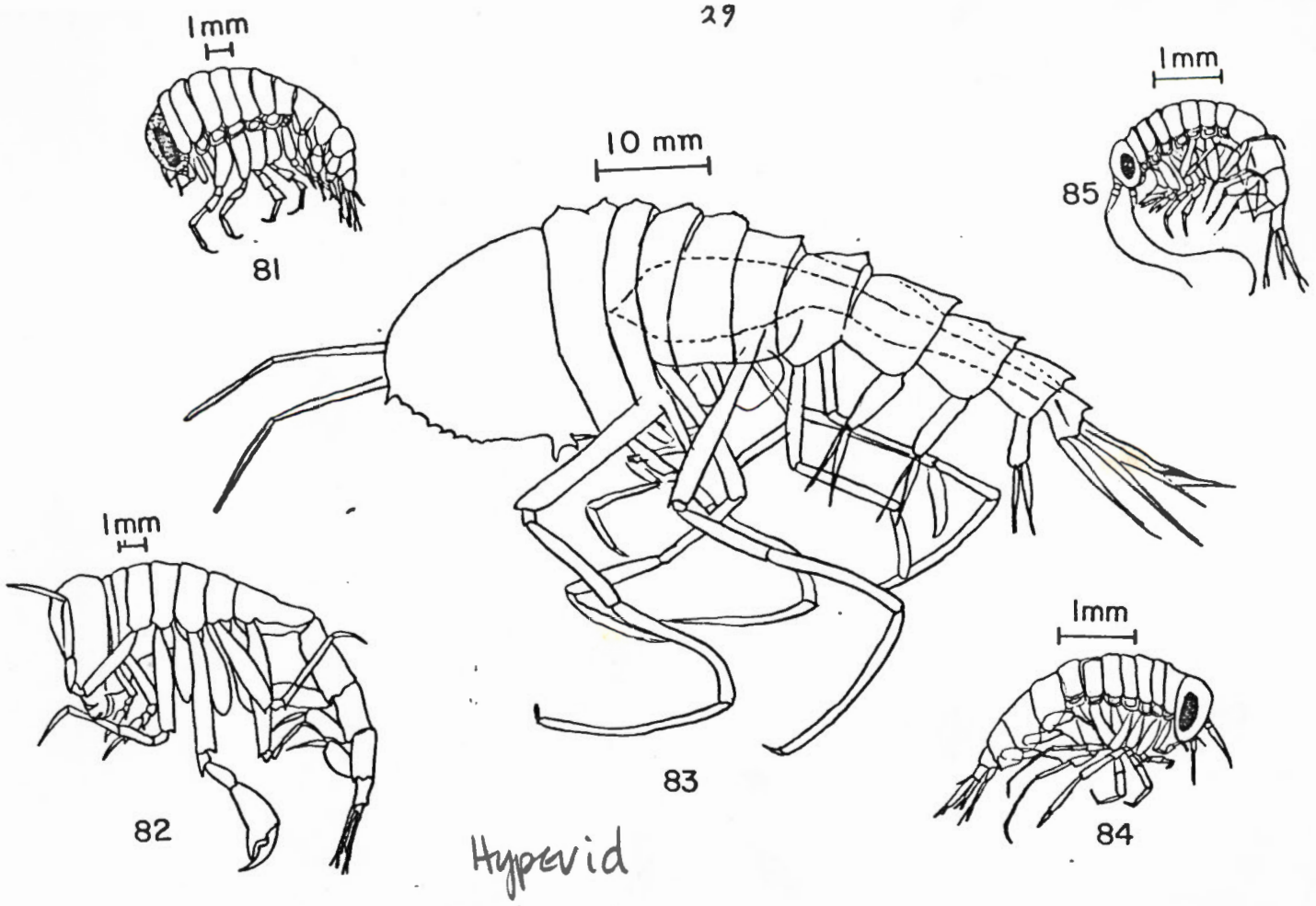
2) hinge of shell flat, ventral edge of shell rounded

(a) less than 1.8 mm long — Conchoecia elegans (Figure 28)

(b) greater than 1.8 mm long

(i) notch in posterior ventral edge of shell — Conchoecia alata minor (Figure 29)

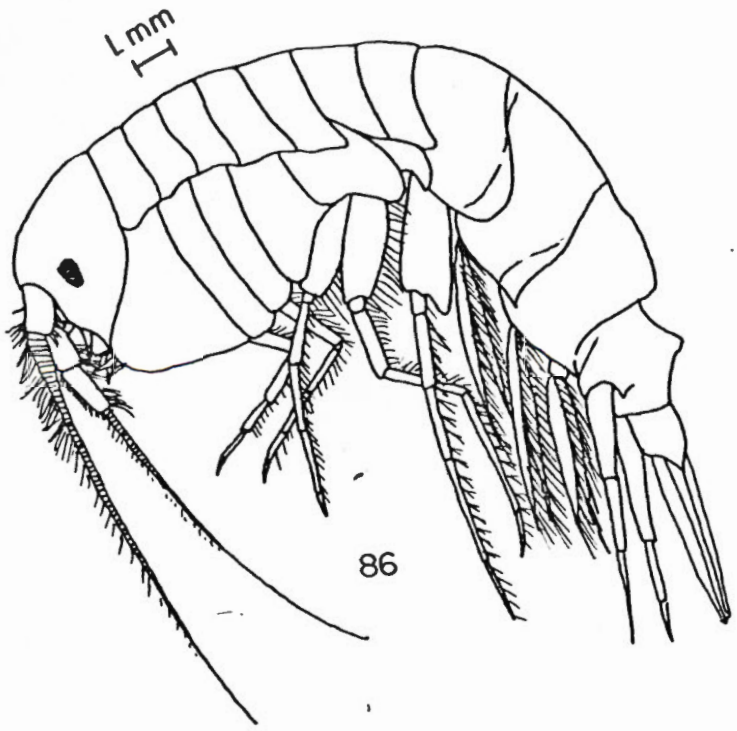
(ii) ventral edge of shell smooth — Conchoecia spinirostris (Figure 30)

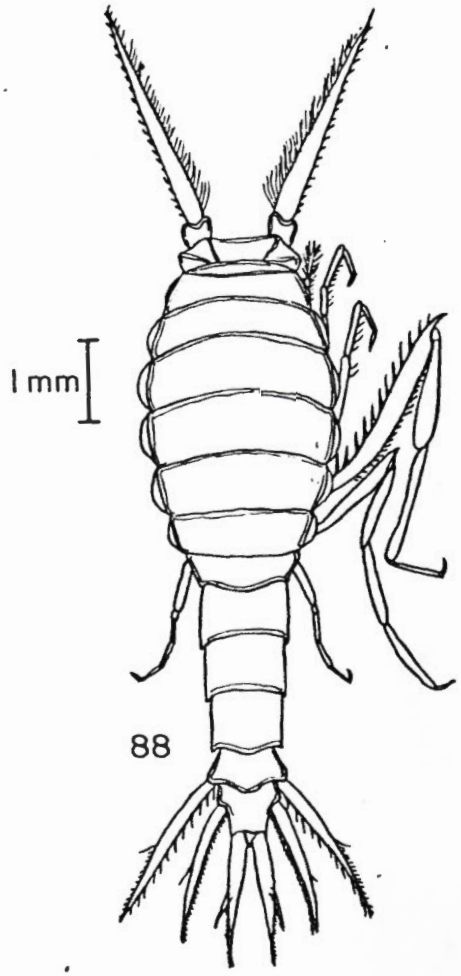


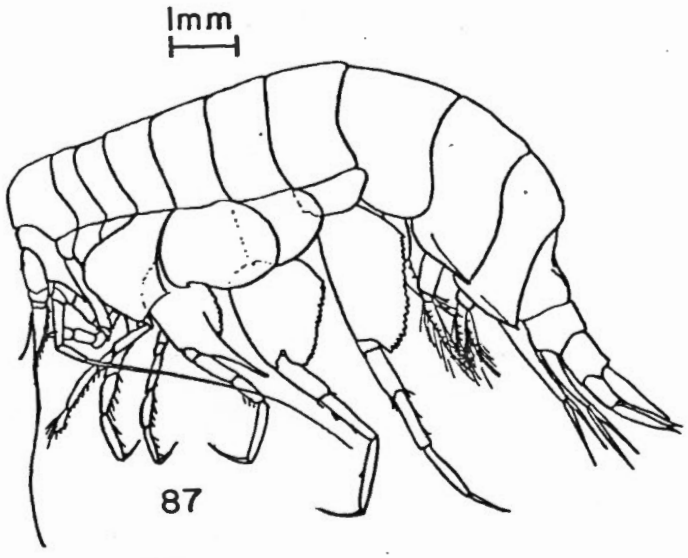
Hyperid

Key to the pelagic amphipods - Strait of Georgia

		Figure
1) Compound eye usually covering the entire head region. Head segment usually as large or larger than first body segment.		
(A) Longer than 7 mm, body pigmented or opaque		
(a) fifth leg prominently chelate	Euprimno sp.	
adult longer than 10 mm	E. abyssalis	
adult shorter than 10 mm	E. macropa	
(b) fifth leg not chelate, first and second legs subchelate	Hyperia	81
(B) Longer than 7 mm, body transparent		
(a) fifth leg prominently chelate	Phronima	82
(b) legs not chelate	Cystisoma	83
(C) Smaller than 7 mm, body pigmented or opaque		
(a) fifth leg prominently chelate	Euprimno	
(b) fifth leg not chelate; legs 5-7 longer than 3 and 4	Parathemisto	84
(c) fifth leg not chelate; legs 5-7 not longer than 3 and 4; first 2 legs chelate	Hyperoche	85



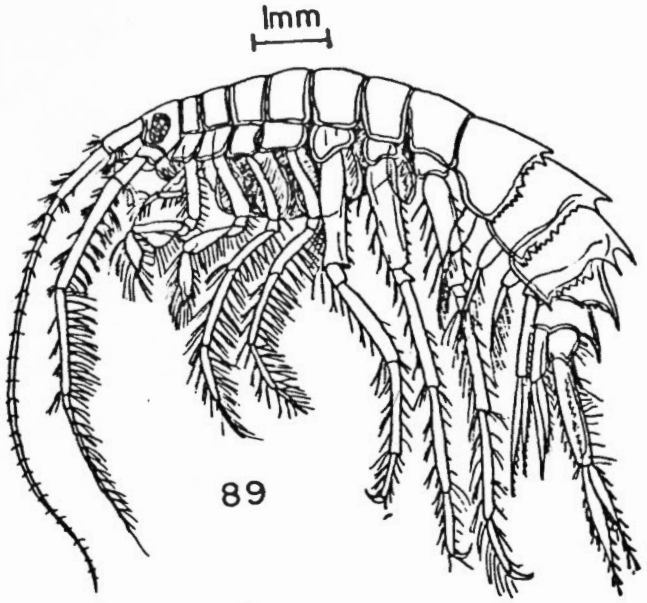


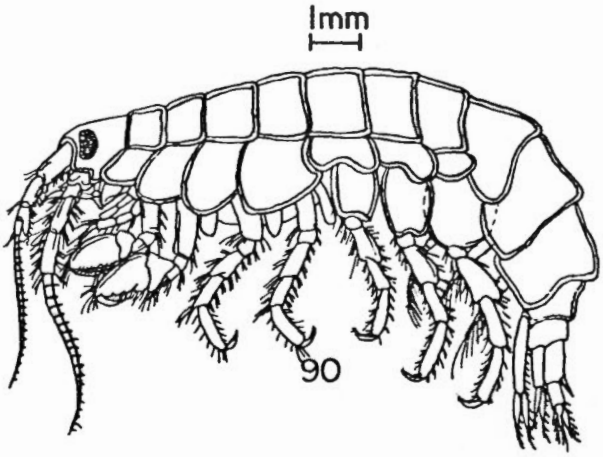


2) Compound eyes not covering the entire head region.

(A) Head segment as large or larger than first body segment.

(a)	longer than 15 mm, head bulbous	Stilipes	86
(b)	shorter than 15 mm, vaulted forehead when viewed laterally	Cyphocaris	87
(c)	antennae projecting like "horns" when viewed dorsally	Scina	88





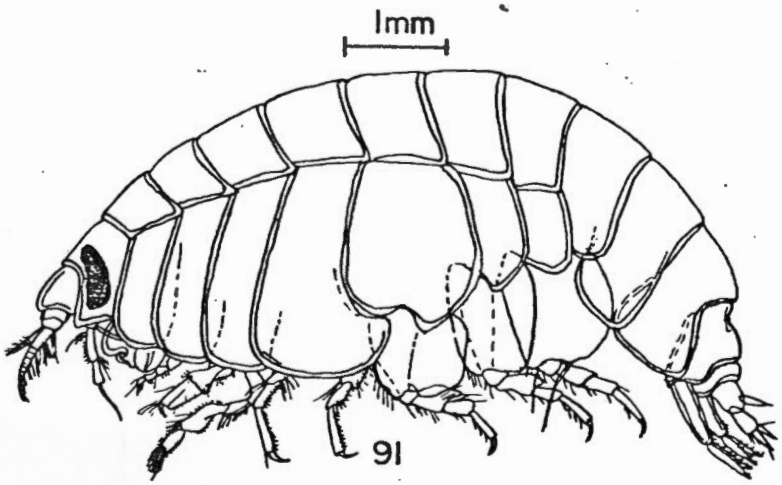
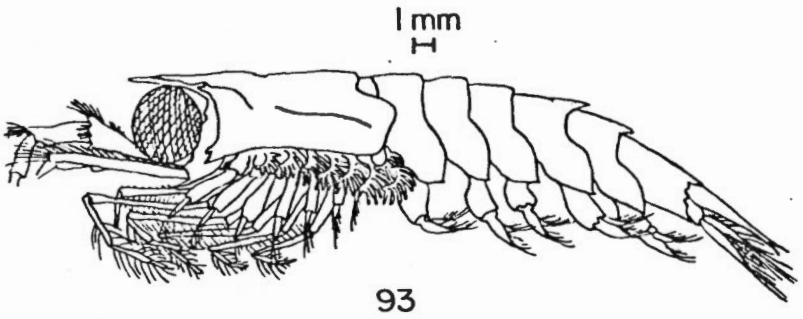


		Figure
(B) Head segment smaller than first body segment		
(a) first two legs chelate, last five segments of body produced as dorsal spines	Melphidippa	89
(b) first two legs chelate, no dorsal spines	Calliopius	90
(c) first two legs subchelate, body usually bright orange	Orchomenella	91



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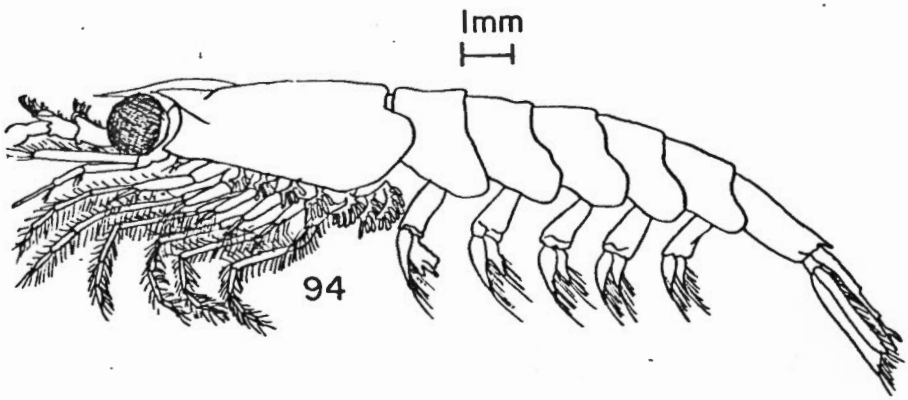

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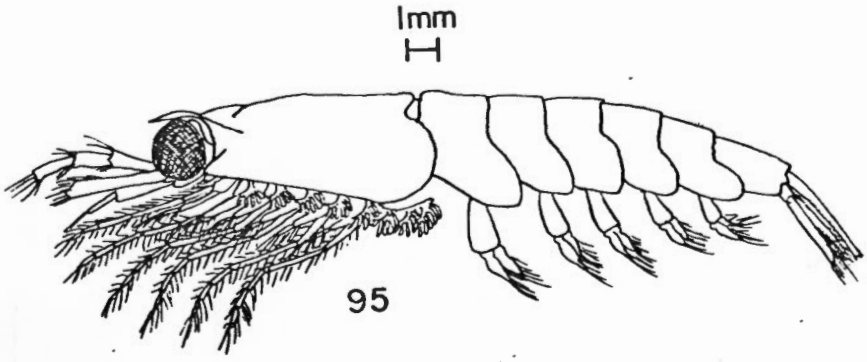
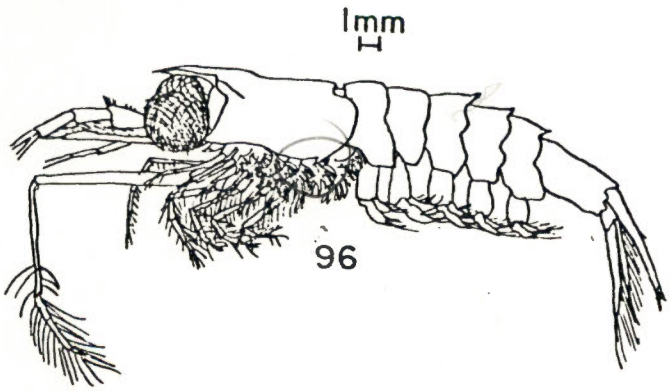
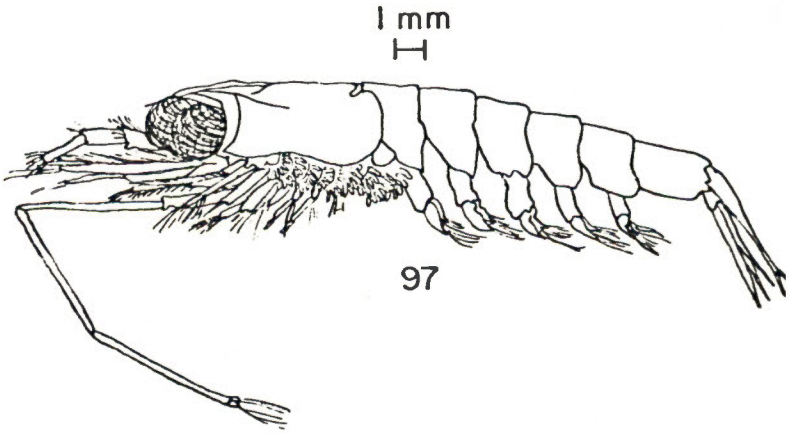


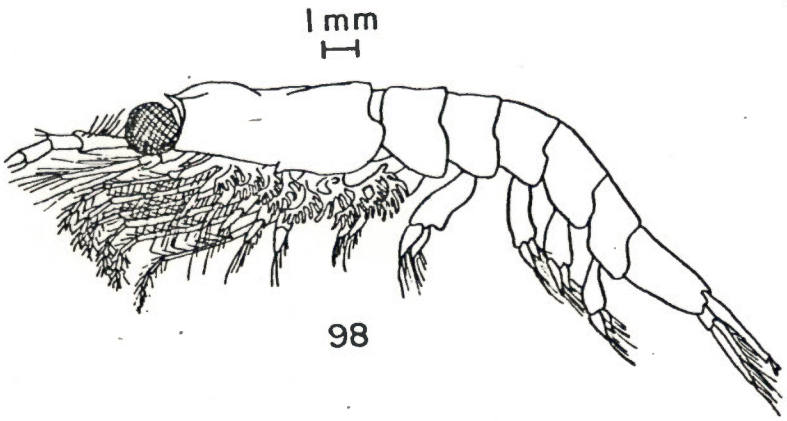
95

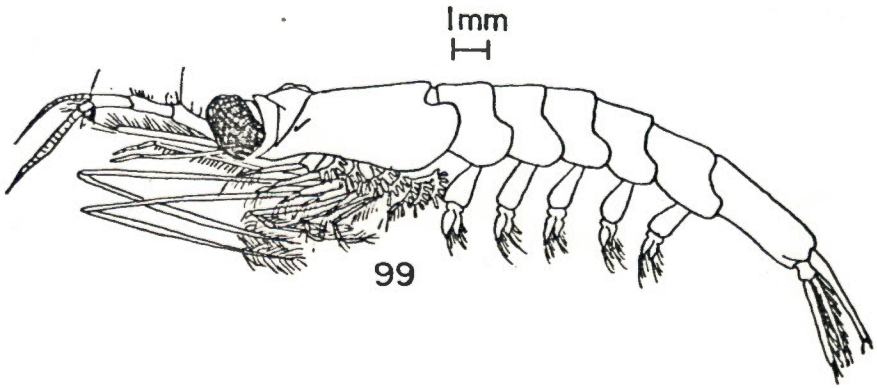
Key to the euphausiids - Strait of Georgia

		Figure
1) Rostral spine		
(A) Eyes round or oval		
(a) Dorsal abdominal spines, largest on 4th segment; maximum length to 38 mm	Thysanoessa spinifera	93
(b) Dorsal abdominal spine on last segment only; maximum length to 16 mm	Thysanoessa inermis	94
(c) No abdominal spines; maximum length to 25 mm	Thysanoessa raschii	95









(B) Eyes constricted

(a) Dorsal abdominal spines, largest on 3rd segment; maximum length to 30 mm — Thysanoessa longipes — 96

(b) No abdominal spines; maximum length to 25 mm — Nematoscelis difficilis — 97

(disregard spine, see picture)
(ie. Spine on carapace)

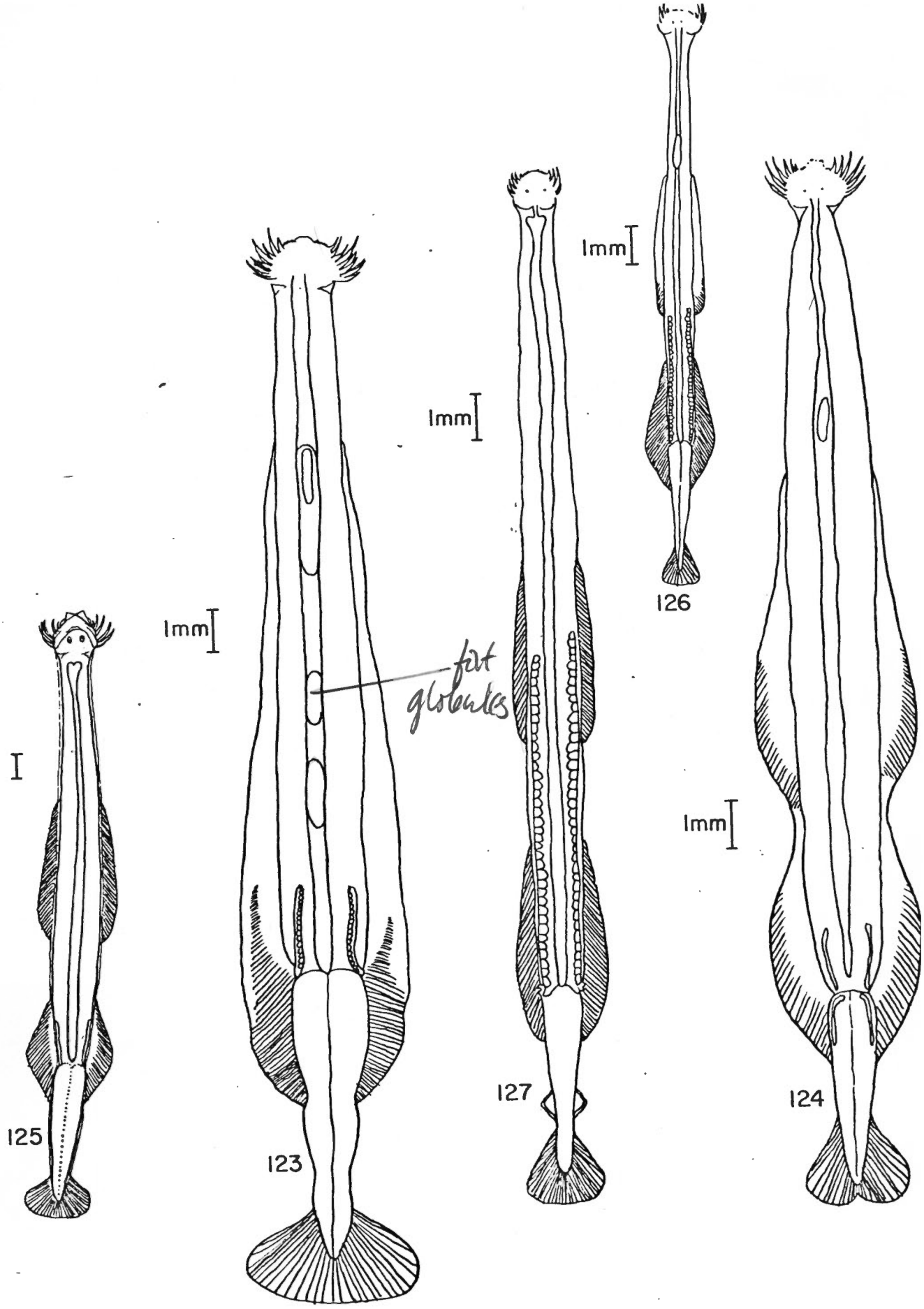
2) No rostral spine

(A) Eyes round or nearly round; maximum length to 25 mm — Euphausia pacifica — 98

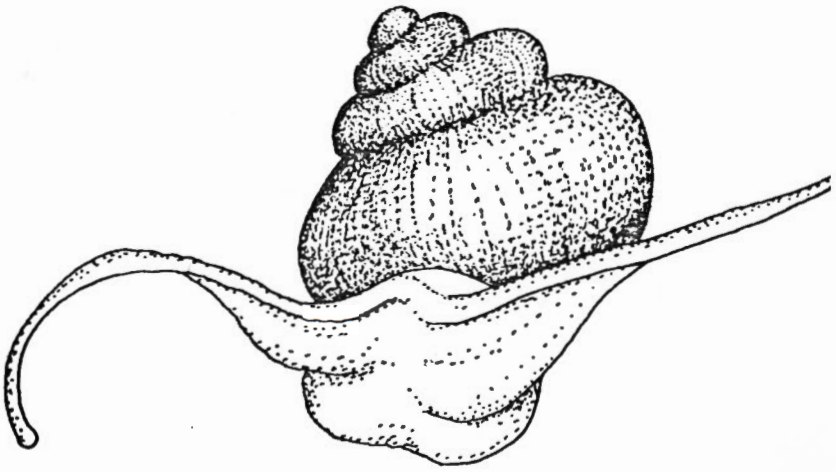
(B) Eyes constricted, rostral keel; maximum length to 26 mm — Tessarabrachion oculatus — 99

Key to the Chaetognatha - Strait of Georgia

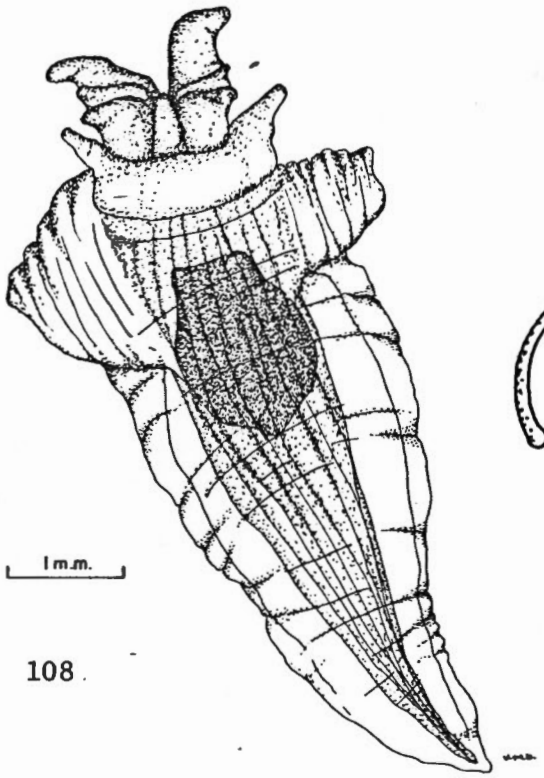
		Figure
1) Anal opening anterior to tail septum -	*Sagitta scrippsae*	124
2) Anal opening at tail septum		
A) No pigment in eyes -	*Eukrohnia hamata*	123
B) Eyes pigmented		
(a) collarette extending from head to ventral ganglion -	*Sagitta planktonis*	125
(b) no collarette		
(i) hooks 5-7	*Sagitta decipiens*	126
(ii) hooks 8-13	*Sagitta elegans*	127


1mm
1mm
1mm
1mm
fat globules
125
123
127
126
124

Key to the Pteropoda



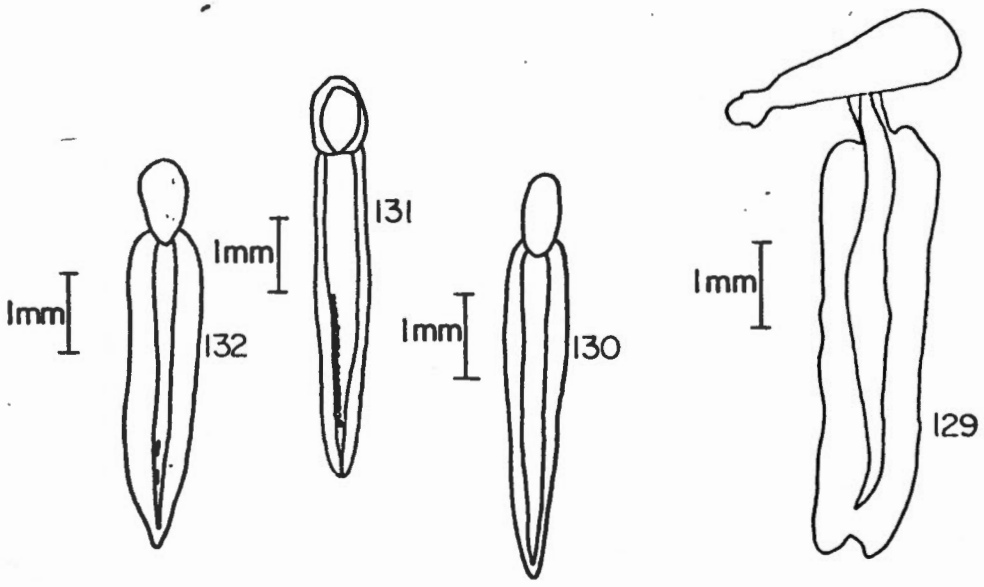
107



108

(1) Shell present	Limacina helicina	107
(2) Shell absent	Clione limacina	108

Key to the Larvacea



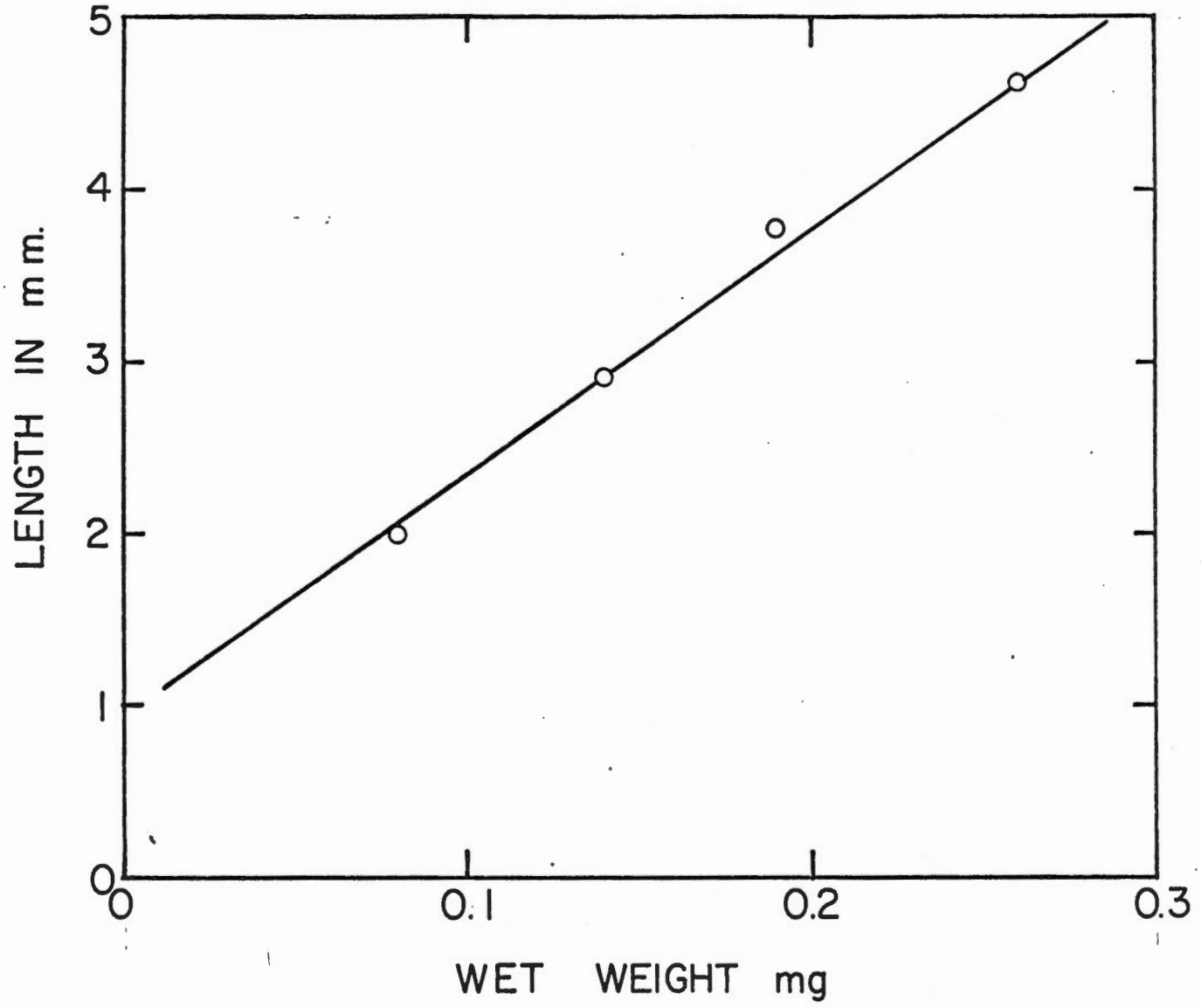
(1) Tail paddle shaped — Fritillaria borealis f. typica (Figure 129)

(2) Tail fusiform

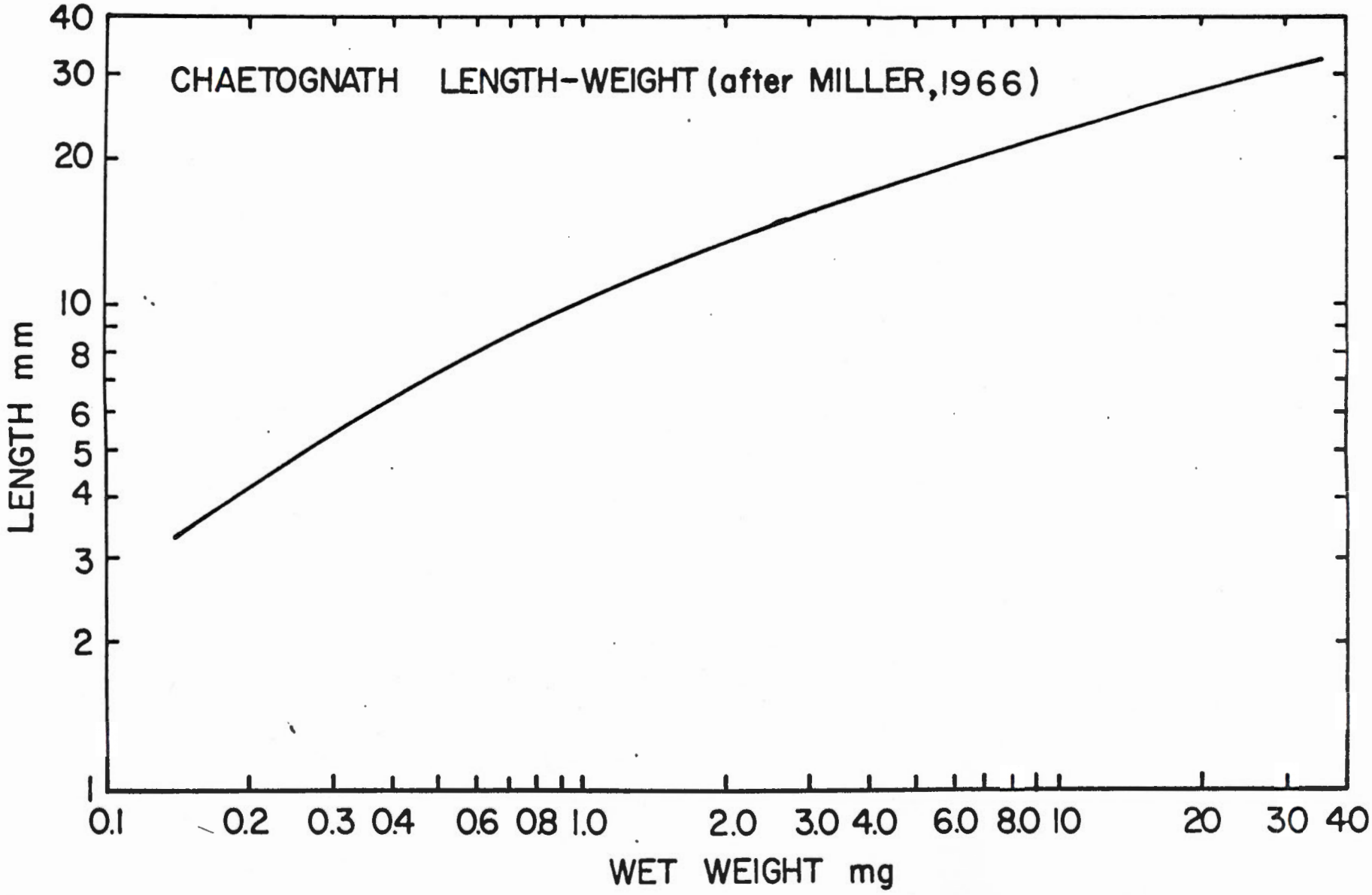
(a) Tail with no subchordal cells — Oikopleura vanhoffeni (Figure 130)

(b) Tail with 17-25 subchordal cells — Oikopleura labradoriensis (Figure 131)

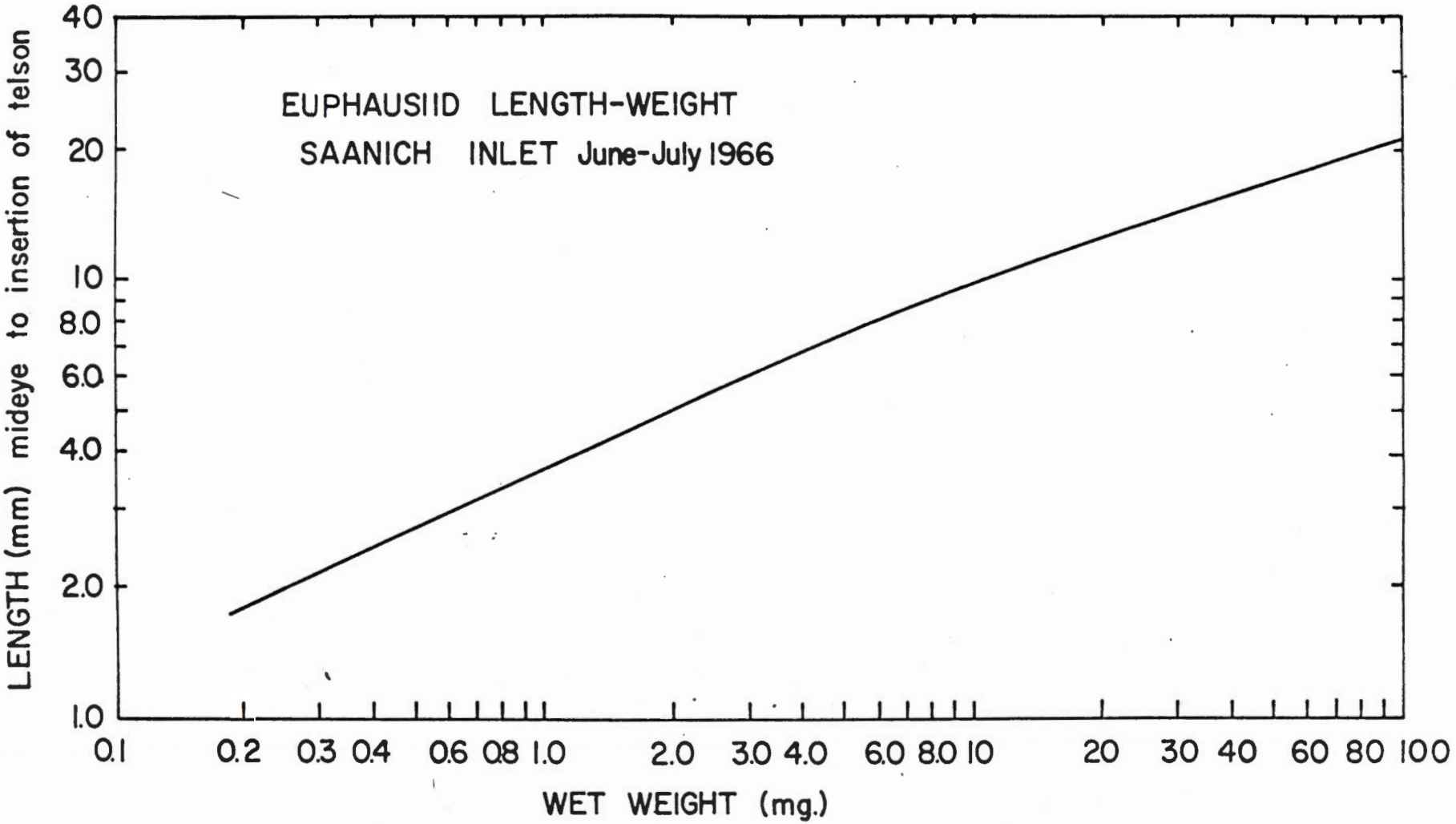
(c) Tail with 2 subchordal cells — Oikopleura dioica (Figure 132)



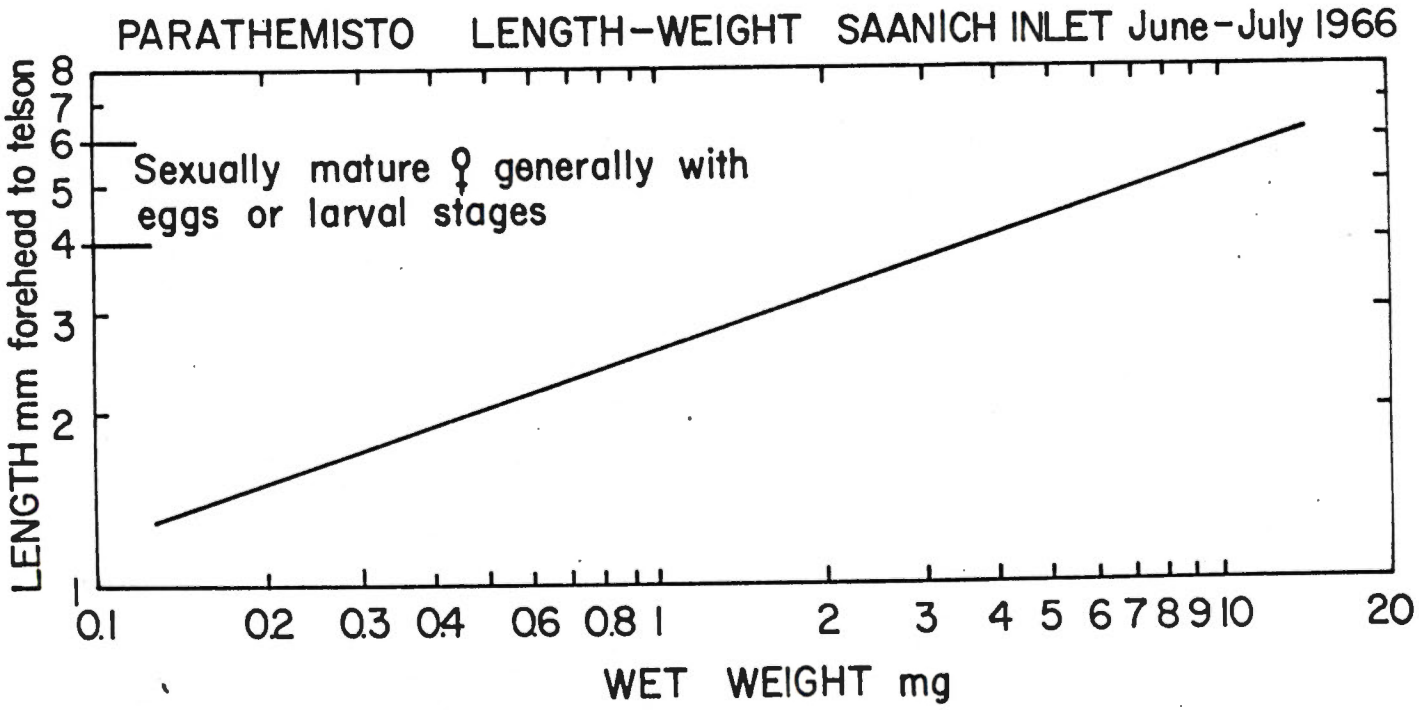
Relationship of length to weight for larvacea.



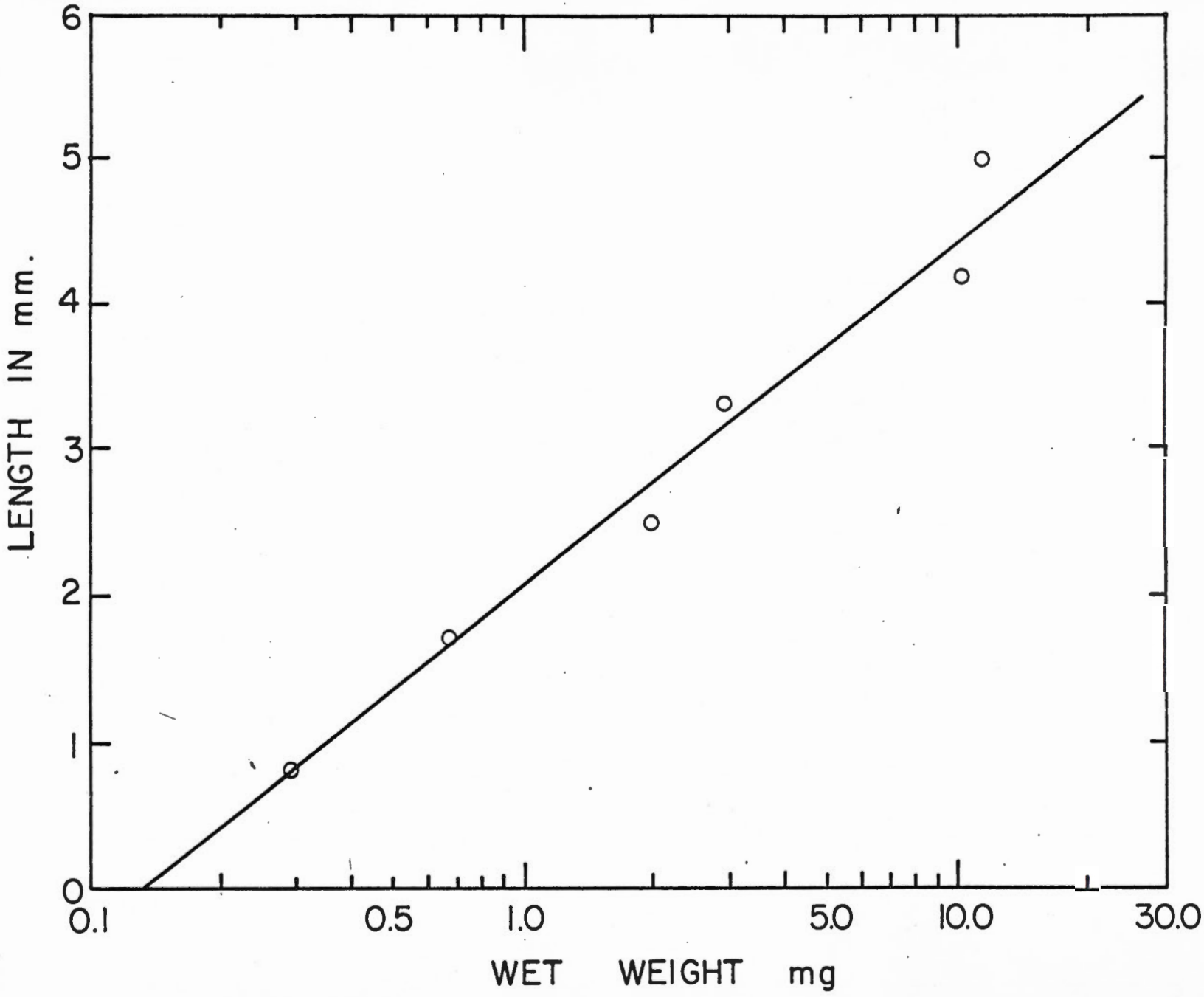
Relationship of length to weight for Chaetognaths.



Relationship of length to weight for euphausiids.



Relationship of length to weight for Parathemisto.



Relationship of length to weight for ostracods.