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GYMNOPLEA COPEPODA COLLECTED IN ALEUTIAN WATERS IN 1953*

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Introduction

The Japanese northern high-sea salmon fishery was reopened in 1952, seven years after cessation of hostilities, making research by Japanese investigators again possible in the far northern Pacific. For the training of cadets in navigational and fishery works as well as researches, T. S. Oshoro Maru, 607 tons motor-ship, of the Faculty of Fisheries, Hokkaido University, Hakodate, made a cruise to the Aleutian waters in May and June, 1953. The plankton samples obtained in this cruise were put at the disposal of the present author. The present report is concerned with *Gymnoplea Copepoda*.

The author wishes to acknowledge his indebtedness to Prof. S. Motoda, Faculty of Fisheries, Hokkaido University, under whose direction the present project was initiated, and to the captain, officers and crew of the Oshoro Maru for affording the facilities for sampling. He is also grateful to Mr. N. Ogawa who worked in obtaining this series of collections.

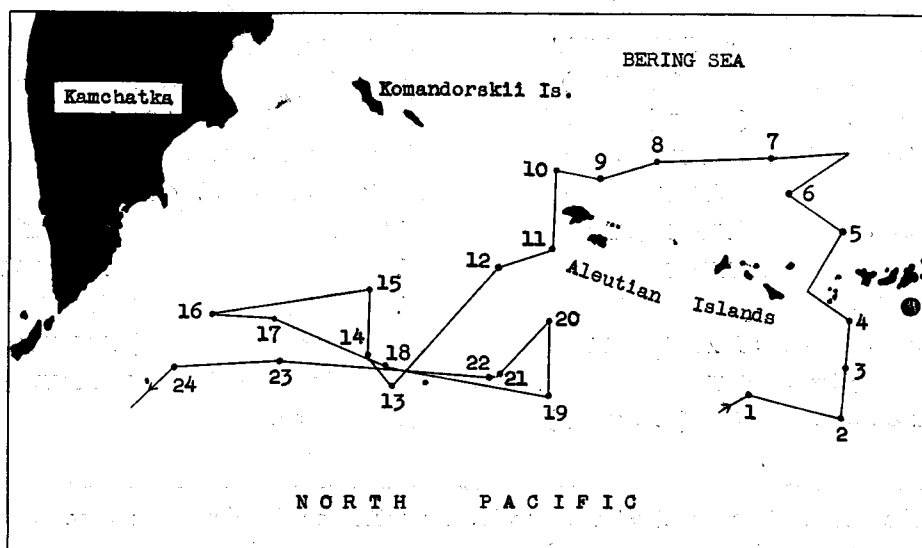


Fig. 1. Track and sampling positions of Oshoro Maru in 1953 cruise

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The approximate locations of the twenty-four positions where samplings were made are shown in figure 1, and more exact positions are given in table 2. The plankton net used was made of coarse bolting silk, no. 40 silk grit gauze (39 meshes a linear inch) and measured 35 cm in mouth diameter by 130 cm in length. The vertical samplings were made sectionally from several different strata, viz., usually 1000-500 m, 500-150 m, 150-50 m, 50-20 m and 20-0 m, sometimes omitting the deeper ones, using an iron cap (Motoda & Anraku, 1954) for closing the net. The sampling time covered various hours, without regard to day or night. In the Aleutian waters the sun rose at about 1:00 a. m. and set at about 5:00 p. m. in early summer.

Species identified

Thirty-one species of Gymnoplea were identified from the materials (table 1). *Calanus plumchrus* * (= *Calanus tonsus* ?), *C. cristatus*, *Eucalanus bungii bungii*, *Metridia lucens* and *M. longa* were the most important constituents numerically among all the species.

Table 1. List of species collected

<i>Calanus plumchrus</i> MARUKAWA	<i>Scolecithricella minor</i> (BRADY)
<i>C. cristatus</i> KRÖYER	<i>S. obtusifrons</i> (SARS)
<i>C. helgolandicus</i> (CLAUS)	<i>S. ovata</i> (FARRAN)
<i>Eucalanus bungii bungii</i> JOHNSON	<i>S. sp.</i>
<i>Rhincalanus nasutus</i> GIESBRECHT	<i>Phaenna spinifera</i> CLAUS
<i>Pseudocalanus minutus</i> (KRÖYER)	<i>Metridia lucens</i> BOECK
<i>Aetideus armatus</i> (BOECK)	<i>M. longa</i> LUBBOCK
<i>Gaidius tenuispinus</i> SARS	<i>Pleuromamma robusta</i> (DAHL)
<i>G. brevispinus</i> SARS	<i>Lucicutia magna</i> WOLFENDEN
<i>Gaetanus armiger</i> GIESBRECHT	<i>Heterorhabdus papilliger</i> (CLAUS)
<i>G. minor</i> FARRAN	<i>H. abyssalis</i> GIESBRECHT
<i>Euchirella</i> sp.	<i>H. sp.</i>
<i>Euchaeta japonica</i> MARUKAWA	<i>Haloptilus oxycephalus</i> (GIESBRECHT)
<i>E. plana</i> MORI	<i>Candacia columbiae</i> CAMPBELL
<i>Scaphocalanus magnus</i> (T. SCOTT)	<i>C. sp.</i>
<i>S. sp.</i>	

The former three species have also been reported as the dominant species from the upper layer (above 150 metres) in the same region (Tsuruta & Chiba, 1954). *Rhincalanus nasutus*, *Aetideus armatus*, *Gaetanus minor*, *Euchirella* sp.,

* Tanaka (1954) placed *Calanus plumchrus* with *C. tonsus*. However, Mr. Z. Nakai has informed the author that he was lead to the opinion that both were quite different on the basis of his recent study, although he had not been sure as to whether these two were really different.

Scolecithricella obtusifrons, *S. ovata*, *Phaenna spinifera* and *Haloptilus oxycephalus* occurred rather rarely. The above species belong to the cold water or abyssal forms, the warm water forms being entirely absent.

Scolecithricella obtusifrons (SARS) has been reported from the North Atlantic and southern Pacific Ocean. In the present samples only females were found, which agree fairly well with Breemen's (1908) description, and also with the description and figures given by Scott (1909). The rostrum is furnished with long and moderately stout filaments as in the Siboga's form (Scott, 1909). The apex of each filament is distinctly bifurcate (fig. 2). Body length 3.5 mm.

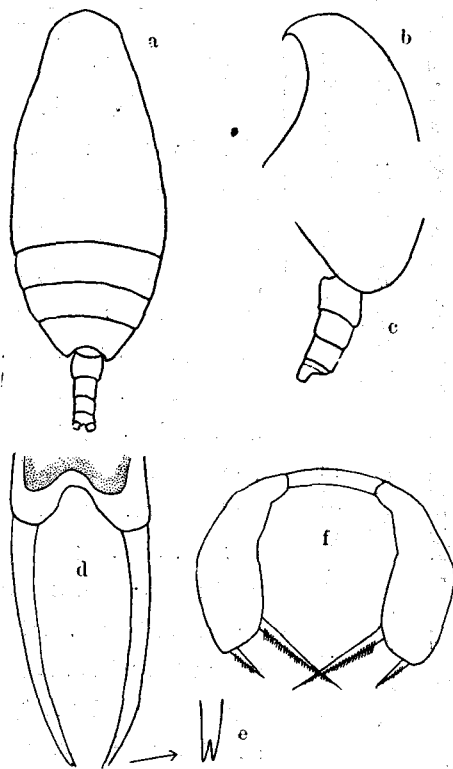


Fig. 2. *Scolecithricella obtusifrons* (♀)

a: dorsal	× 16
b: head, lateral	× 30
c: abdomen, lateral	× 30
d: rostral filament	× 195
e: apex of rostral filament	× 410
f: 5th feet	× 195

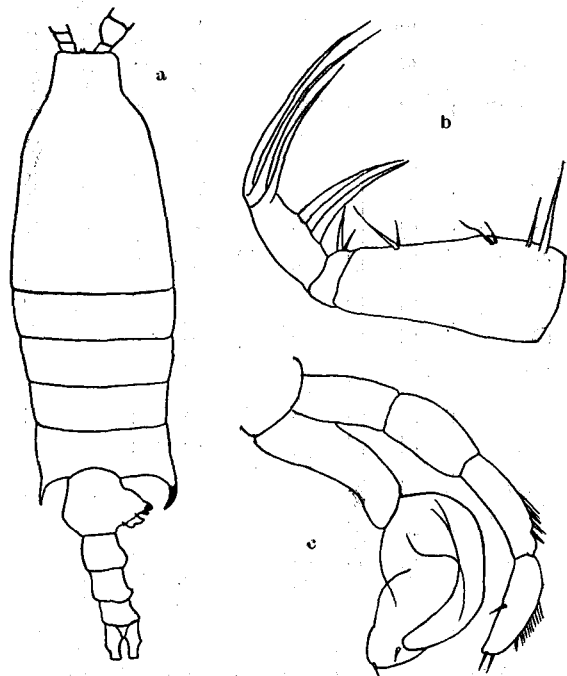


Fig. 3. *Candacia columbiae* (♂)

a: dorsal	× 28
b: 1st maxilliped	× 33
c: 5th feet	× 55

Candacia columbiae CAMPBELL has been reported by Campbell (1929), and by Davis (1949) from off the west coast of Vancouver Island and northern Japan. The female of this species was described by Mori (1937) under the name of *Candacia*

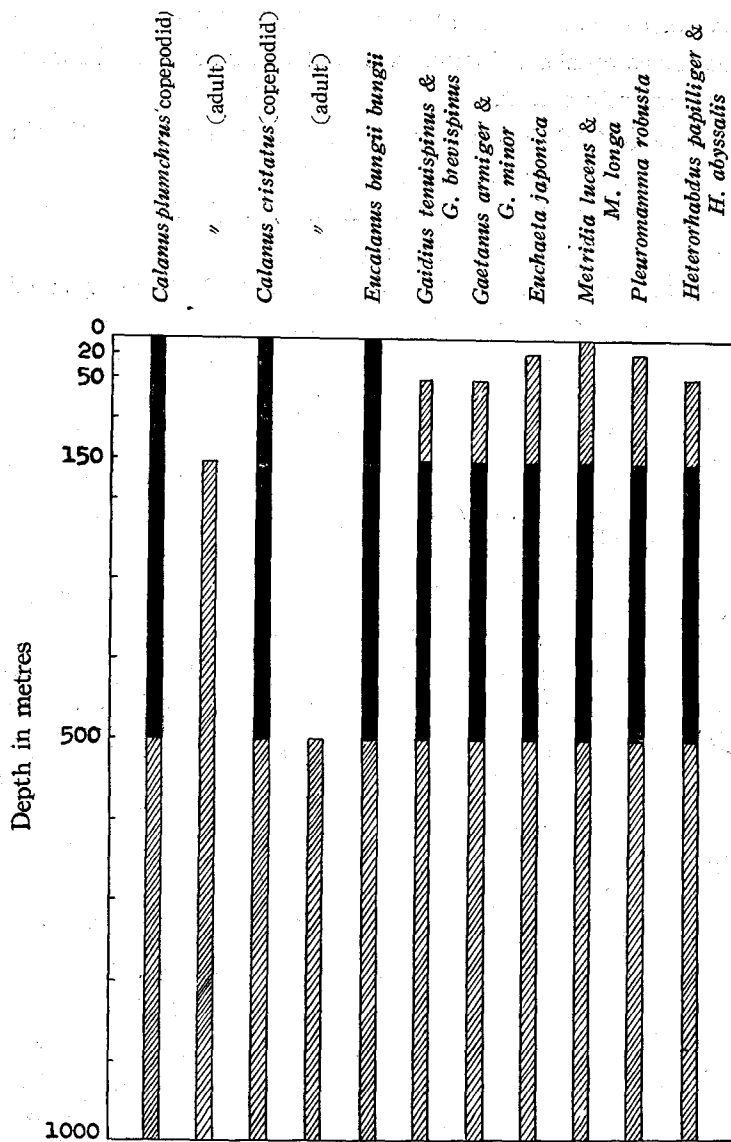


Fig. 4. Diagrammatic figure of vertical distribution of copepods

somewhat ventrally, is an ear-shaped lobe; the second, third, and fourth segments of abdomen are also slightly asymmetrical, being produced slightly on the right. The right fifth foot bears a chela. Body length 2.8 mm.

Vertical distribution of main species

A diagrammatic figure of the vertical distribution of main species is shown in figure 4.

pacifica from Kushiro Harbor, southeast Hokkaido, and was also found from the northern Pacific and the Okhotsk Sea near Japan (Tanaka, 1953; Anraku, 1952, 1954a, 1954b), while the male has scarcely been found from Japanese waters. The male (fig. 3) of the present material agrees closely with the description and figures of Davis 1949, viz., the last thoracic segment is asymmetrical and furnished with the right side projection, which has pigmented point and is bent in towards the abdomen; the genital segment is produced into a large projection which is bifurcated and pigmented at the tip; on the posterior surface of the projection, and

Calanus plumchrus was distributed from the surface to 1000 metre depth (lower limit of the present hauls), though the number of individuals was rather rare at depths below 500 metres. The adults of both sexes were found only in the five collections from 1000 to 500 metre layer and in the three collections from 500 to 150 metre layer. It is assumed that their occurrence is generally limited to below 150 metres. The distribution of adult males was usually deeper than in the females. The present result has confirmed the previous findings of the adults of this species from the deep water of the Japan Sea, Okhotsk Sea and North Pacific Ocean (Yamada, 1938; Nakai, 1942a, 1942b; Motoda, Iizuka & Anraku, 1950; Anraku, 1952, 1954a; Furuhashi, 1953).

A large number of *Calanus cristatus* were found above 500 metres, occurring rather small in number below 500 metres as in the former species, and being scarcely found above 20 metres except at station 19. However, both sexes of adult *C. cristatus* have been reported from the deep water, at least deeper than about several hundred metres, of the Japan Sea and the Pacific (Tanaka, 1938; Nakai, 1942a; Anraku, 1952).

Eucalanus bungii bungii was found through the range from the surface to 1000 metres, though the majority occurred between 20 and 500 metre layers.

Both *Metridia lucens* and *M. longa* have been mentioned by many workers (Esterly, 1912; Clarke, 1933, 1934; Bogorov, 1946; Motoda & Anraku, 1951, 1952) as a species making conspicuous vertical diurnal migration. This was confirmed by the present investigation finding that an abundance of individuals were in the shallow layer at night, while in rather deep layer in the daytime.

A single species, *Pleuromamma robusta*, was identified from genus *Pleuromamma*. The distribution of this genus was commonly restricted within the middle layer of the sea, and the present specimens were also found below 50 metres, being not collected above 20 metres.

Euchaeta japonica was found in the layers from 20 to 1000 metres, especially abundant in 150 to 500 metres, and entirely absent above 20 metres. This species was described (Brodsky, 1938) as an abyssal copepod in the Japan Sea, and also reported from the deeper layer of the northern Pacific near Japan and Okhotsk Sea (Anraku, 1952, 1954a).

Gaetanus armiger and *Heterorhabdus* were found only below 50 metres.

Genus *Gaidius*, one of the abyssal copepods, has been reported by several workers from the deep waters in the Japan Sea and the Pacific Ocean (Brodsky, 1938; Motoda, Iizuka & Anraku, 1950; Tanaka, 1953). In the present investigation several individuals of both *Gaidius brevispinus* and *G. tenuispinus* were collected below 50 metres.

A few individuals of *Euchirella* sp. occurred only below 150 metres.

As a whole, the total quantity of copepods occurring in the strata from 500 to

Table 2. Relative abundance of each species collected near the Aleutian Islands

Position	1					2				3				
	49°22'N, 178°18'E					48°57'N, 178°49'W				50°00'N, 178°44'W				
Time	May14, 21:00~23:00					May15, 11:40~14:00				May15, 22:00~24:00				
Depth (m)	20	50	150	500	1000	20	50	150	500	20	50	150	500	1000
	0	20	50	150	500	0	20	50	150	0	20	50	150	500
<i>Calanus plumchrus</i> (copepodid)	2	4	60			32	128	16		8	2			
" (adult)				16										
<i>Calanus cristatus</i> (copepodid)		8	12	1		80	8	8		2	88	18	4	3
" (adult)				11										5
<i>C. helgolandicus</i>				12		6	32			2	2			
<i>Eucalanus bungii bungii</i>	8	64	48				8	8		56	160			
<i>Rhincalanus nasutus</i>													1	
<i>Aetideus armatus</i>														
<i>Gaideus tenuispinus</i>			1	1									4	
<i>G. brevispinus</i>														
<i>Gaetanus armiger</i>		16	16				4	16						
<i>G. minor</i>														
<i>Euchirella</i> sp.									1					
<i>Euchaeta japonica</i>		1	1	4	4				2	2		23		
<i>E. plana</i>														
<i>Scaphocalanus magnus</i>														
<i>S.</i> sp.														
<i>Scolecithricella minor</i>											4			
<i>S. obtusifrons</i>													3	
<i>S. ovata</i>									4					
<i>S.</i> sp.							1	16						
<i>Phaenna spinifera</i>														1
<i>Metridia lucens</i> & <i>M. longa</i>	112	32	32	32		2	16	80		8	48	32	16	
<i>Pleuromamma robusta</i>		8	40	24	24			16				24	48	2
<i>Lucicutia magna</i>														
<i>Heterorhabdus papilliger</i>			1	4	1				2	1		2		
<i>H. abyssalis</i>				2									6	
<i>H.</i> sp.														
<i>Haloptilus oxycephalus</i>														
<i>Candacia columbiae</i>	1	1							1					
<i>C.</i> sp.														

in 1953 (Individual number in a haul)

4	5	6	7	8	9
50°58'N, 178°40.5'W	52°36'N, 178°46'W	53°22'N, 179°27'E	54°00'N, 178°57'E	53°50.5'N, 175°24.5'E	53°35'N, 173°43'E
May16, 6:30~8:30	May16~17, 23:20~1:00	May17, 11:20~12:45	May18, 11:30~12:30	May19, 7:30~10:30	May19, 5:30~6:30
20 50 150 500 1000 0 20 50 150 500	20 50 150 500 1000 0 20 50 150 500	20 50 150 500 0 20 50 150	50 150 0 50	50 0	20 50 150 0 20 50
776 380 2 156 12 12 60 4 24 1 7 24 4	418 80 168 80 4 16 32 4	160 56 4 10 10 12 30	134 24 40	224	9 22 10 2 42
240 520 4 72	24 320 16 40 4 16 4	50 120 50 12 4 4	240 54	120	9 62
32 8 3 1 16	8 56 2 2 24	18 1 16			4
		8 1			
104 104 8 48 16	88 64 360 8 56	2 10 46 2 38	20 16		
2 1 2	3 4 5 4 1	2 1 1 2			

Position	10					11				12		
	53°42'N, 172°09'E					52°15'N, 172°07'E				51°53'N, 170°23'E		
Time	May 20, 3:00~5:00					May 20, 5:30~6:30				May 21, 4:00~5:00		
Depth (m)	20	50	150	500	1000	20	50	150	500	20	50	150
	0	20	50	150	500	0	20	50	150	0	20	50
<i>Calanus plumchrus</i> (copepodid)	8	24	8	32	12	8	8	16	2		1	5
" (adult)									12			
<i>Calanus cristatus</i> (copepodid)		4	32	40	4			4	10	74	4	
" (adult)												
<i>C. helgolandicus</i>												
<i>Eucalanus bungii bungii</i>		15	40	104				42	70			17
<i>Rhincalanus nasutus</i>												
<i>Aelideus armatus</i>												
<i>Gaidius tenuispinus</i>				32	4				6			
<i>G. brevispinus</i>												
<i>Gaetanus armiger</i>				24					10			
<i>G. minor</i>												
<i>Euchirella</i> sp.												
<i>Euchaeta japonica</i>				32	8			5	10			1
<i>E. plana</i>												
<i>Scaphocalanus magnus</i>				4				4				
<i>S.</i> sp.												
<i>Scolecithricella minor</i>												
<i>S. obtusifrons</i>												
<i>S. ovata</i>												
<i>S.</i> sp.												
<i>Phaenna spinifera</i>												
<i>Metridia lucens</i> & <i>M. longa</i>				56	32			8	186			
<i>Pleuromamma robusta</i>				56	8				24			
<i>Lucicutia magna</i>												
<i>Heterorhabdus papilliger</i>				6				1	3			
<i>H. abyssalis</i>				10					7			
<i>H.</i> sp.												
<i>Haloptilus oxycephalus</i>												
<i>Candacia columbiae</i>								1	3			
<i>C.</i> sp.												

13	14	15	16	17
49°33'N, 167°01'E	50°09'N, 166°14'E	51°28'N, 166°24'E	50°55.5'N, 161°23'E	50°52'N, 163°18'E
May 24, 0:30~2:30	May25, 14:00~16:00	May27, 12:30~15:00	Jun. 1, 6:00~8:00	Jun. 1, 14:00~
20 50 150 500 0 20 50 150	20 50 150 500 1000 0 20 50 150 500	20 50 150 500 1000 0 20 50 150 500	20 50 150 500 1000 0 20 50 150 500	20 50 150 0 20 50
7 96 102 4 10 1 20 4 8 40	6 24 252 32 6 24 4 8 4 6 16	2 54 32 16 26 4 8 2	24 54 2 82 14 2 2 2 12 1 11 8 2 16	28 40 10 32 4
2 20 108 8 6	184 112	32 96 8	1 56 56 1 1 4 16 5	5 154 88
8 2 14	1 4	16 8	40 40 2	4
6 2		4	12	
4 4 46 27 8	8 8 16	32 40	280 16 96	4
4	1	1 1	2 3 2	

Position	18					19					20				
	49°50.8'N, 166°46.2'E					49°24'N, 172°00'E					50°51.5'N, 172°00E				
Time	Jun. 2, 18:00~20:00					Jun. 5, 12:00~14:00					Jun. 6, 11:00~13:00				
Depth (m)	20	50	150	500	1000	20	50	150	500	1000	20	50	150	500	1000
	0	20	50	150	500	0	20	50	150	500	0	20	50	150	500
<i>Calanus plumchrus</i> (copepodid)	32	8	3			94	16				48	40	32	12	
" (adult)				4										8	8
<i>Calanus cristatus</i> (copepodid)	1	24	8			280	18	2	16	4	8	1	12	3	
" (adult)				8											5
<i>C. helgolandicus</i>	4	2				12	2				8	8			
<i>Eucalanus bungii bungii</i>		4	1				8	200	1		198	120	16	8	
<i>Rhincalanus nasutus</i>															
<i>Aetideus armatus</i>															
<i>Gaidius tenuispinus</i>							4							8	
<i>G. brevispinus</i>														1	
<i>Gaetanus armiger</i>							16							16	
<i>G. minor</i>															
<i>Euchirella</i> sp.															
<i>Euchaeta japonica</i>			1	4			16	4				8	8	8	
<i>E. plana</i>															2
<i>Scaphocalanus magnus</i>							4							4	
<i>S. sp.</i>							2								6
<i>Scolecithricella minor</i>															
<i>S. obtusifrons</i>															
<i>S. ovata</i>															
<i>S. sp.</i>															
<i>Phaenna spinifera</i>															
<i>Metridia lucens</i> & <i>M. longa</i>		4		32			2	32	16			32	64		
<i>Pleuromamma robusta</i>								24					88		
<i>Lucicutia magna</i>							4	4							4
<i>Heterorhabdus papilliger</i>															
<i>H. abyssalis</i>															4
<i>H. sp.</i>														1	
<i>Haloptilus oxycephalus</i>															
<i>Candacia columbiae</i>												1	4		
<i>C. sp.</i>															1

21	22	23	24
49°48'N, 170°22'E	49°45'N, 170°15'E	50°03'N, 163°32'E	49°55'N, 160°15'E
Jun. 10, 17:30~	Jun. 11, 17:00~	Jun. 16, 17:00~	Jun. 17, 17:00~
20 0	20 0	20 0	20 0
50 20		50 20	50 20
150 50		150 50	150 50
1 9 34	150	1 34 4	6 14 10
12 3	73	12	4 10
22		1 42 14	12 116 10
1 8		1	1
		6	2
14			

1000 metres was rather less than in the layers above 500 metres. However, the species number was large between 150 and 500 metre layers comparing with other strata both above and below.

Body weight and body length of *Calanus cristatus* and *Calanus plumchrus*

Almost all individuals of both *Calanus plumchrus* and *C. cristatus* of the present specimens belonged to the copepodid stage V. The body length of both species occurring in the 1000 metre vertical haul is shown in the following table.

<i>Calanus cristatus</i>		<i>Calanus plumchrus</i>	
Body length(mm)	Number of individuals measured	Body length(mm)	Number of individuals measured
8.00-8.49	6	4.00-4.49	5
8.50-8.99	13	4.50-4.99	10
9.00-9.49	1	5.00-5.49	5

The mean body length of *Calanus cristatus* (8.53 mm) was about twice that of *Calanus plumchrus* (4.58 mm), while the wet body weight of the former species (0.325 gr per 20 individuals) was about 6.4 times that of the latter (0.051 gr). The body length of *Calanus cristatus* of the present specimens is comparatively smaller than that reported by Nakai (1942a; about 9.4 mm) based on the specimens obtained around and near Japan. The range of the body length of *Calanus plumchrus* of the present specimens is 4.17-5.00 mm, whilst it is 4.21-5.03 mm in the Nakai's specimens. Although the ratio of the total number of individuals of *Calanus plumchrus* to *C. cristatus* through the whole collections is about 3.4 : 1, the body weight of *C. plumchrus* in whole collections is far less than that of *C. cristatus*. From this, *Calanus cristatus* may be of great importance in these waters from the viewpoint of nutritive value for salmon and other plankton-feeding fishes. This was also noticed by Nakai (1952) on the materials from the Aleutians in 1952.

The mean body length of immature *C. cristatus* (stage V) occurring in the upper layer (50 - 20 m) is 8.08 mm, while that of the lower layer (500 - 150 m) is 8.21 mm. The body length of the adult forms, occurring always below 500 metres, is about 8.33 mm in female and about 8.17 mm in the male, being sometimes slightly shorter than that of the last copepodid stage. The present specimens of adult *Calanus cristatus* are rather smaller than those collected in the deep water of Sagami Bay by Tanaka (1938; ♀ : 8.4-9.3 mm, ♂ : 7.4-8.6 mm). Present specimens in copepodid stage IV are about 5 mm in body length.

Summary

1. The present investigation deals with Gymnoplea Copepoda collected in Aleutian

- waters in May and June, 1952.
2. Thirty-one species were identified. Among them, *Calanus plumchrus*, *C. cristatus*, *Eucalanus bungii bungii*, *Metridia lucens* and *M. longa* were found to be the main constituents of the large copepod community.
 3. *Metridia lucens* and *M. longa* were abundant above 500 metre layer, and *Pleuromamma robusta*, *Heterorhabdus papilliger*, *H. abyssalis*, *Euchaeta japonica*, *Gaetanus armiger*, *Gaidius brevispinus* and *G. tenuispinus* inhabited mainly 500 - 150 metre layers.
 4. *Calanus cristatus* was of most importance in quantity, being about 6.4 times *Calanus plumchrus* in wet weight.
 5. The majority of *Calanus cristatus* and *C. plumchrus* belonged to copepodid stage V, and were distributed between 1000 metre depth and the surface, particularly predominantly above 500 metres.
 6. The adults of both sexes of *Calanus plumchrus* were found in the collection from 500 to 150 metres and also from 1000 to 500 metres, while those of *Calanus cristatus* were found only in the collection from 1000 to 500 metres.

Literature cited

- Anraku, M. (1952). Plankton copepods collected by R. S. "Yushiwo-maru" in Pacific waters to the east of northern Japan during her cruise in November 1948. *Bull. Fac. Fish., Hokkaido Univ.* 3 (1), 31-39. (in Japanese).
- (1954a). Distribution of plankton copepods off Kitami, Hokkaido, in Okhotsk Sea in summer, 1949 and 1950. *Ibid.* 4 (4), 49-55.
- (1954b). Copepods collected on the whaling grounds off northern Japan and around the Bonin Islands. *Ibid.* 4 (5), 1-8.
- Bogorov, B. G. (1946). Peculiarities of diurnal vertical migrations of zooplankton in Polar Seas. *Jour. Mar. Res.* 6 (1-3), 25-32.
- Breemen, P. G. (1908). Nordisches Plankton. VIII. Copepoden, 1-264.
- Brodsky, K. A. (1938). Plankton investigation in the northeastern part of the Japan Sea. *Bull. Pacific Sci. Inst. Fish. Oceanogr.* (Vladiostok) 10, 159-182. (in Russian. with English summary).
- Campbell, M. H. (1929). Some freeswimming copepods of the Vancouver Island region. *Trans. Roy. Soc. Canada* 23 (5), 303-322.
- Clarke, G. L. (1933). Diurnal migration of plankton in the Gulf of Maine and its correlation with changes in submarine irradiation. *Biol. Bull.* 65 (3), 402-436.
- (1934). Further observations on the diurnal migration of copepods in the Gulf of Maine. *Ibid.* 67 (3), 432-455.
- Davis, C. C. (1949). The pelagic copepoda of the northeastern Pacific Ocean. *Univ. Washington Publ. Biol.* 14, 1-118.
- Esterly, C. O. (1912). The occurrence and vertical distribution of the copepoda of the San Diego region, with particular reference to nineteen species. *Univ. Calif. Publ. Zool.* 9 (6), 253-340.
- Furuhashi, K. (1953). On the vertical distribution of animal plankton in the sea of Japan off San'in-District in summer of 1952. *Publ. Seto Mar. Biol. Lab.* 3 (1), 61-74.

- Mori, T. (1937). *The pelagic copepoda from the neighbouring waters of Japan*. 149p. Tokyo; Yokendo.
- Motoda, S. & Anraku, M. (1951). An observation on the vertical distribution of plankton at Ishikari Bay, Hokkaido. *Jour. Oceanogr. Soc. Jap.* 6 (4), 194-201. (in Japanese).
- & ————— (1952). Observation on the plankton of Funka-Bay, Hokkaido. I. Vertical distribution of plankton at the mouth of the bay in August, 1950. *Bull. Hokkaido Reg. Fish. Res. Lab.* 5, 17-20. (in Japanese).
- & ————— (1954). Daily change of vertical distribution of plankton animals near western entrance to the Tsugaru Strait, northern Japan. *Bull. Fac. Fish., Hokkaido Univ.* 4 (5), 15-19.
- Motoda, S., Iizuka, A. & Anraku, M. (1950). Distribution of plankton in the waters northwest of Hokkaido in summer of 1949. *Hokubunihonkai Shinkai Gyoden Chosahokoku* (Rep. Res. Deep Sea Fishery in northern Japan Sea), summer 1949, Otaru, 79-109. (in Japanese).
- Nakai, Z. (1942a). The chemical composition, volume, weight and the size of the important marine plankton. *Jour. Oceanogr. Soc. Jap.* 1 (1-2), 45-55. (in Japanese).
- (1942b). [Sardine in Korea]. *Kaiyo-no-kagaku*. Oceanogr. Soc. Jap. 2 (3), 198-204. (in Japanese).
- (1952). On quantitative distribution of plankton reproduced in the Northern Pacific. *Special Pub. Tokai Reg. Fish. Res. Lab.* 2, 1-6.
- Scott, A. (1909). The copepoda of the Siboga expedition. Pt. I. Free-swimming, littoral and semi-parasitic copepoda. 323p. Leyden.
- Tanaka, O. (1938). Note on *Calanus cristatus* KRÖYER. *Jap. Jour. Zool.* 7 (4), 599-610.
- (1953). The pelagic copepods of the Izu region. *Rec. Oceanogr. Wks. Japan*, N. S. 1 (1), 126-137.
- (1954). Note on *Calanus tonsus* BRADY in Japanese waters. *Jour. Oceanogr. Soc. Jap.*, 10 (1), 29-39.
- Tsuruta, A. & Chiba, T. (1954). On the distribution of plankton at the fishing ground of salmon in the North Pacific Ocean 1952. *Jour. Shimonoseki Coll. Fish.* 3 (3), 239-245. (in Japanese).
- Yamada, T. (1938). Supplementary note on the classification of some species of copepoda. *Suisan-gakkai-ho* 7 (4), 183-188. (in Japanese).

Although there is Martin W. Johnson's report on the plankton of the Bering Sea, "The production and distribution of zooplankton in the surface waters of Bering Sea and Bering Strait. Part II(B), Rec. Oceanogr. Cruise U. S. Coast Guard Cutter Chelan 1934 (mimeo. rept.)", this report is inaccessible to the present author.