HOKKAIDO UNIVERSITY

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REPORT FROM THE "OSHORO MARU" ON OCEANOGRAPHIC AND BIOLOGICAL INVESTIGATIONS IN THE BERING SEA AND NORTHERN NORTH PACIFIC IN THE SUMMER OF 1955

V. Observations on Copepod Community [1]

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Introduction

Participating in the International Cooperative North Pacific Oceanographic Programme held in the summer of 1955 the training ship "Oshoro Maru" of the Faculty of Fisheries, Hokkaido University, made a cruise to the Bering Sea and northern portion of the North Pacific (Motoda & Fujii, 1956). Prof. S. Motoda was aboard the ship and conducted the research work at sea in this cruise. He placed a part of the plankton materials obtained in this cruise at the disposal of the author. The present studies are undertaken to observe the distribution figure of copepods which might be represented by gross pattern of hydrography.

The collection of zooplankton was made regularly at hydrographic stations by vertical hauls, usually from 150 metre depth to the surface with 45×165 cm net (0.33 mm mesh aperture); hauls were duplicated. A deep haul with 63×300 cm net (0.49 mm mesh aperture) was made at one station (Os 8) by making separate hauls with closing

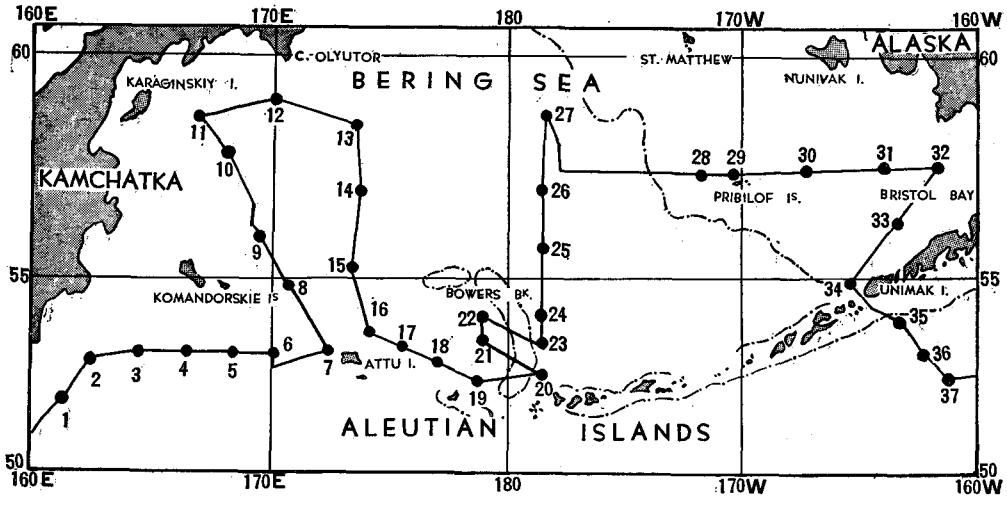

Fig. 1. Approximate location of sampling stations

1) おしよろ丸北洋調査報告 No. 9 (昭和30年度)
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mechanism from 2000 to 1000 metres, from 1000 to 500 metres and 500 to the surface. In addition, deep hauls from usually 1000 metre depth with a couple of rectangular nets, "Twin Net" (10×10 cm at mouth, 50 cm long, 0.28 mm mesh aperture), were performed at every station. Detailed descriptions of the gear and methods of collections and of the exact location of stations are presented in the paper of Motoda and Fujii (1956); only a sketch map showing approximate location of stations is given here (fig. 1).

On this occasion the author wishes to express his sincere gratitude to Prof. S. Motoda not only for his generosity in providing the materials to the author but for his guidance throughout the present studies. He also expresses cordial thanks to Asst. Prof. T. Kawamura and Mr. M. Anraku for their valuable advices during the present studies. The writer is also obliged to the research members and crew of the "Oshoro Maru" in 1955 cruise for their work in sampling the materials at sea.

Results of Observations

The data on quantitative estimation on regular collections with 45×165 cm net are presented in "*Data Record of Oceanographic Observations and Exploratory Fishing*, No. 1, 1957". These data are concerned with wet displacement volume and wet weight of the materials, but in the present studies individual numbers of copepods are counted for each species (tables 1 & 2). As the net was not equipped with a flow-meter, exact filtration coefficient of the net was unknown, but the volume data were converted by assuming that the filtration coefficient of such net would be 0.76 (Motoda *et al.*, 1957). In addition, the error of hauling distance which may have happened in rough weather was corrected (Motoda *et al.*, 1957).

1) Copepod species identified

The copepod species identified from the materials of regular collections with 45×165 cm net are as follows:

* *Calanus finmarchicus* (GUNNERUS)
* *C. plumchrus* MARUKAWA
* *C. cristatus* KRÖYER
* *Eucalanus bungii bungii* JOHNSON
* *Pseudocalanus elongatus* (BOECK)
Microcalanus sp.
Aetideus armatus (BOECK)
Gaetanus armiger GIESBRECHT
* *Gaidius tenuispinus* (SARS)
* *Pareuchaeta japonica* (MARUKAWA)
** *Racovitzanus antarcticus* GIESBRECHT
* *Scolecithricella minor* (BRADY)

*** *Centropages abdominalis* SATO
* *Metridia lucens* BOECK
** *Pleuromamma scutullata* BRODSKY
** *Lucicutia ovaliformis* BRODSKY
* *Candacia columbiae* CAMPBELL
*** *Acartia longiremis* (LILLJEBORG)
*** *Oithona plumifera* BAIRD
*** *O. similis* CLAUS
*** *Microsetella norvegica* (BOECK)
Oncaea conifera GIESBRECHT

A deep haul with 60 × 300 cm net yielded 27 species, of which the follwoing 11 species are never found in the above regular collections from the upper zone.

* *Microcalanus pygmaeus* (SARS)
** *Spinocalanus spinipes* BRODSKY
** *Gaidius brevispinus* (SARS)
* *Pareuchaeta birostrata* BRODSKY
** *Scaphocalanus magnus* (T. SCOTT)
** *Onchocalanus affinis* WITH
** *Amallothrix inornata* (ESTERLY)
* *Scolecithricella ovata* (ESTERLY)
** *Metridia asymmetrica* BRODSKY
** *Heterorhabdus tanneri* (GIESBRECHT)
* *Oncaea notopus* GIESBRECHT

In addition, deep hauls with a small "Twin Net" yielded the following additions to the above two kinds of collections:

** *Spinocalanus abyssalis* GIESBRECHT
Scaphocalanus sp.
** *Pachyptilus pacificus* JOHNSON
** *Arietellus simplex* SARS

The majority of the above-mentioned species are those which have been reported to be either the boreal (*) or abyssal (**) forms, but a few are forms (***) whose distribution is known to be neritic and world-wide.

Brief mention will be made here on several species whose names have been somewhat confused or whose distribution is especially interesting.

Calanus plumchrus MARUKAWA was first described by Marukawa (1921) as new to science, but the first record in Japanese waters was earlier published by Sato (1913) under the name of *Calanus* sp. They both observed only the immature specimens. The adult forms were found from the deep water (Yamada, 1938; Nakai, 1942; Motoda *et*

al., 1950; Anraku, 1954a, b). Brodsky (1938; 1948; 1950) stated that this species is synonymous to *Calanus tonsus* and he divided it to two forms, *plumchrus* and *typica*. Tanaka maintained the same opinion in his past paper (1954), but after that he (1956) proposed that *Calanus plumchrus* is distinct from *Calanus tonsus*.

According to Johnson (1939), *Eucalanus bungii bungii* JOHNSON is a northern variety of *Eucalanus bungii*, and a southern variety is *Eucalanus bungii californicus*. He stated that the former variety is distributed from the northern area of Japanese waters to the Bering Sea and the latter along the California coast, but var. *californicus* was reported by Tanaka (1953) in the deep water of Sagami Bay.

Pareuchaeta japonica (MARUKAWA) was originally described by Marukawa (1921) as *Euchaeta japonica*. Brodsky (1948; 1950) reported this species from the Japan Sea, Okhotsk Sea, Bering Sea and northern North Pacific. He followed the classification of A. Scott (1909) who divided family Euchaetidae into two genera, *Euchaeta* and *Pareuchaeta*. Mori (1937) stated that the variation between the two genera is obscure and gradual, and Davis (1949) had the same opinion.

Centropages abdominalis SATO was first reported by Sato (1913) near Hokkaido, Kii Channel and Terpeniye Bay of Sakhalin. Later this species was treated as a synonym of *Centropages mcmurrichi* WILLEY 1920 by Brodsky (1948; 1950). However, the publication of Sato (1913) was the earlier, so that *Centropages abdominalis* should be used. This species is distributed in the inland sea of Japan, Okhotsk and Bering Sea, Yellow Sea and southern area of Chukchee Sea (Brodsky, 1950), Arctic Ocean, northern area of Bering Straits, Bering Sea, Grantley Harbour, Alaska, Dixon Entrance and the area adjacent to Vancouver Island (Davis, 1949).

Spinocalanus spinipes, *Pareuchaeta birostrata*, *Metridia asymmetrica*, *Pleuromamma scutullata* and *Lucicutia ovaliformis* were reported by Brodsky (1950) from the northern North Pacific, Bering Sea and Okhotsk Sea. These species are oceanic, bathybic or abyssal.

2) Characteristic distribution of representative copepod species

It is reported that the water which originated from the Gulf of Alaska flows westward and turns northward into the Bering Sea passing through the Aleutian Chain. Some of this water passes out through the Bering Straits and some is flowing as a counterclockwise circulation in the Bering Sea. Along the eastern coast of Kamchatka Peninsula, a part of this current flows still farther southward and finally it is mixed with the water which has poured from the Okhotsk Sea, while another part of the water is thrust into the Subarctic Water and reached the Gulf of Alaska (Fleming, 1955; Mishima & Nishizawa, 1955).

Among the copepods colleted, *Calanus finmarchicus*, *C. plumchrus*, *C. cristatus*,

Eucalanus bungi bungii, *Pseudocalanus elongatus*, *Metridia lucens*, *Acartia longiremis* and *Oithona similis* are numerically important.

All specimens of *Calanus plumchrus* in the samples of 45×165 cm net represent copepodid stages I to V, while the adult forms were usually collected by deep hauls with "Twin Net" and with 63 × 300 cm net. Off the east of Karaginskiy Island (Os 11), and off the southeast of Cape Olyutor (Os 13) and at Os 15, this species occupied the bulk of samples counting more than 200000 individuals per 1000 m^3 of water, while in other stations (Os 2, 8–10, 12, 14, 16, 17, 21, 22, 24 and 26) the number of individuals was 100000 or more. At Os 4 and 5 off the southern part of Komandorskie Islands and at Os 28 and 29 in the shallow eastern Bering Sea, this species occurred to the number of about 5000 individuals per 1000 m^3 of water. In shallow hauls on the continental shelf extending from Alaska (Os 28–30, 33 and 34) this species diminished gradually, but the adult forms were collected there in spite of shallow hauls, probably being brought in with water upwelling from the deep. No specimen of this species was collected at Os 31 and 32 in Bristol Bay.

Calanus finmarchicus appeared in considerable number replacing *C. plumchrus* in Bristol Bay. The number was counted as 3000000 individuals per 1000 m^3 of water in one of the duplicate hauls at Os 31. In the west and central Bering Sea except neighbouring Bower's Bank this species disappeared in the samples of 150 metre vertical hauls as well as deep hauls.

Immature individuals of *Calanus cristatus* occupied the largest bulk of 45×165 cm net samples at Os 11 and 27, counting about 5000 to 9000 individuals per 1000 m^3 of water. The number of individuals was between 100 and 5000 in the west and central Bering sea. In Bristol Bay (Os 30, 31 and 32) this species was not collected. The adult forms were sometimes collected only from the deep layer below 150 metre depth in the west and central Bering Sea.

Eucalanus bungii bungii occurred in extraordinary abundance at Os 16, 17 and 18, about 1500000 individuals per 1000 m^3 of water, and at Os 11 and areas near Bower's Bank (Os 20, 22 to 26) the number was also very large. But no one was collected at Os 30 to 32. The adult forms were included in the samples of 150 metre vertical hauls at every station.

Pseudocalanus elongatus was widely distributed at all stations, the most numerous in Bristol Bay (Os 30 to 32), but comparatively less in number in the off-shore region of the Bering Sea and south of Alaska Peninsula.

Very abundant copepodids of *Metridia lucens* with a few adult forms were collected around Bower's Bank (Os 20 to 26) in 150 metre hauls. At Os 11 only copepodid stages were collected rather abundantly in 150 metre hauls, while many adult forms appeared in the deep "Twin Net" samples. This species become less in the southwestern

Bering Sea, *i. e.*, area south of Komandorskie Islands (Os 2 to 6), at Os 30 and 33. Neither copepodid nor adult occurred at Os 31 and 32.

Oithona similis occurred in the largest number off the eastern coast of Kamchatka (Os 2 and 11) in the 150 metre hauls, and diminished gradually to the offing. In the neighbourhoods of Near Islands, Bower's Bank and Bristol Bay except Os 32, it was comparatively increased in number.

Acartia longiremis was collected near Bower's Bank, Bristol Bay and Alaska Peninsula in 150 metre vertical hauls.

Scolecithricella minor was collected by 150 metre hauls in all stations except Os 29 to 32 in Bristol Bay.

Centropages abdominalis was collected at Os 1 off the east of Kamchatka and Os 33 to Os 36 near Unimak Pass.

Among copepods collected by the deep hauls with "Twin Net" and with 63 × 300 cm net, *Gaetanus armiger*, *Racovitzanus antarcticus*, *Pleuromamma scutullata* and *Lucicutia ovaliformis* were also sometimes collected by 150 metre vertical hauls. From upper 150 metre zone, *Gaetanus armiger* was collected near Bower's Bank (Os 20 and 21) and in the southern portion of Unimak Pass (Os 36), again *Racovitzanus antarcticus* in the west and central Bering Sea, and the southern portion of Unimak Pass, *Pleuromamma scutullata* at Os 10, 14, 20 to 22 and 35, and *Lucicutia ovaliformis*

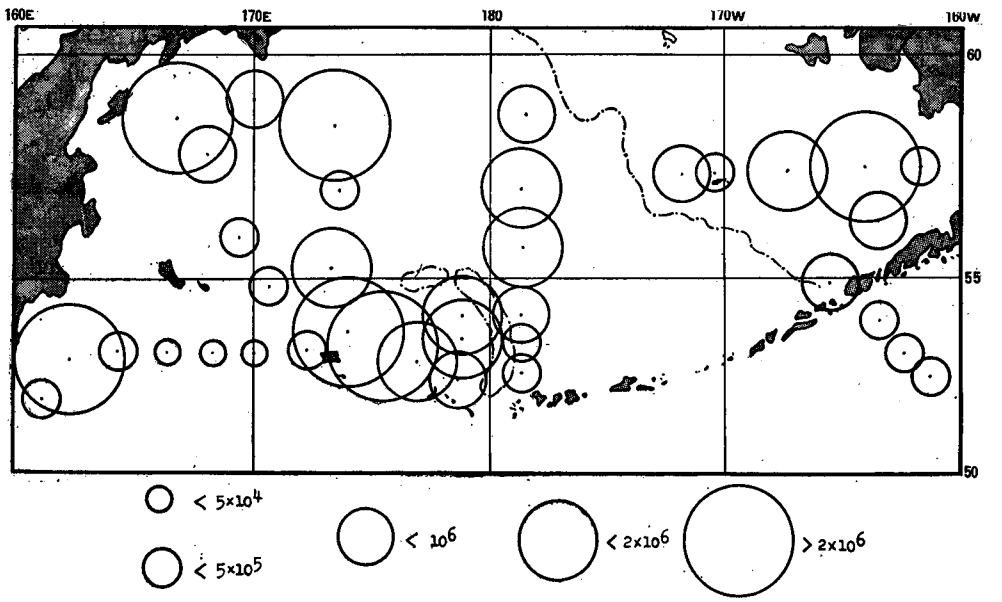

Fig. 2. Number of copepods occurring in upper 150 metre zone
(Individual numbers/1000 m³ of water)

at Os 9.

In the upper 150 metre zone, *Calanus plumchrus*, *C. cristatus*, *Eucalanus bungii bungii*, *Metridia lucens* and *Oithona similis* were distributed normally and abundantly in the Bering Sea except Bristol Bay. They were as a whole the most abundant at Os 2, 11 and 13 off the east coast of Kamchatka and Os 16 and 17 off the northeast of Attu Island; comparatively abundant in the northern and western portions of Bower's Bank (Os 15, 18, 21, 22, 25 and 26) (fig. 2).

In Bristol Bay, the community of copepods, comprising mainly *Calanus finmarchicus*, *Pseudocalanus elongatus* and *Acartia longiremis*, was the most numerous at Os 31, with Os 30 following (fig. 2).

In the south of Unimak Pass, *Calanus plumchrus*, *C. cristatus*, *Eucalanus bungii bungii* and *Metridia lucens* increased again, while *Calanus finmarchicus* decreased.

Discussion

In the present observation, so far as the upper zone (0–150 metres) is concerned, two divisions of distributional area of copepods are considered, that is, *Calanus plumchrus—Eucalanus bungii* area in the west and east Bering Sea, and *Calanus finmarchicus—Acartia longiremis* area in the eastern shallow Bering Sea (fig. 3).

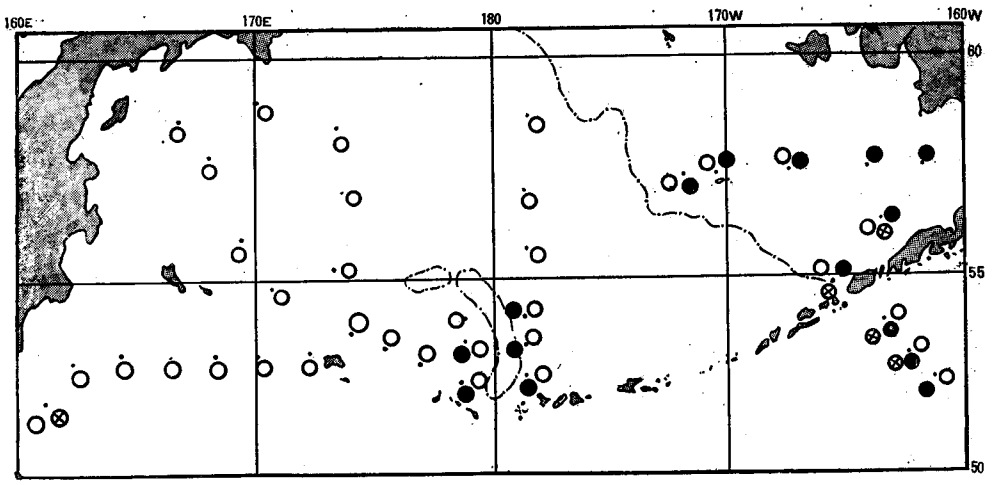

Fig. 3. Distribution figure of three types of copepod populations

○ *Calanus plumchrus—Eucalanus bungii* population

● *Calanus finmarchicus—Acartia longiremis* population

⊗ *Centropages abdominalis*

Calanus plumchrus—Eucalanus bungii population nearly all consisting of copepodids and nauplii usually occurs in company with *Calanus cristatus* and *Metridia*

lucens. They are all oceanic forms. *Oithona similis*, eurythermic and euryhaline copepod form, is also included in these populations. The above population involving these species is widely distributed in the west and central Bering Sea making up the largest group off the east coast of Kamchatka and in western portion of Bower's Bank, but they are rare in the western area of the Near Islands. They are diminishing toward the inshore of Alaska and replaced by *Calanus finmarchicus—Acartia longiremis* population.

In the region to the west of the Pribilof Islands and adjacent to Unimak Pass a mixed population of *Calanus plumchrus—Eucalanus bungii* and *Calanus finmarchicus –Acartia longiremis* is observed.

Calanus finmarchicus—Acartia longiremis population is found only at Os 31 and 32 in Bristol Bay.

Johnson (1953) reported two communities in the eastern Bering Sea and in the Chukchee Sea; (1) a western community characterized by offshore deep-water species extends somewhat eastward just north of the Aleutian Islands, and northward through the Bering Straits on the Siberian side, (2) an eastern neritic community characterized by neritic or estuarine forms exists in the Pribilofs, Nunivak Island and off the Alaskan coast. According to Brodsky (1955), the population in the offshore of the southern Bering Sea is similar to the northern North Pacific population consisting of *Calanus tonsus, C. cristatus, Eucalanus bungii, Scolecithricella minor, Pareuchaeta japonica* and *Metridia pacifica*, extending to the Gulf of Alaska, to near southeastern Hokkaido and to the central Okhotsk Sea. The neritic population of eastern Bering Sea is extending along the Aleutian Chain to Near Islands. Vinogradov (1956) reported that the copepod population in the offshore of southern Bering Sea extends far to the Bering Straits and the population of the coastal region of west Bering Sea occurring abundantly in the Gulf of Anadir is extending far to the region adjacent to the Pribilof Islands; moreover, *Calanus tonsus* and *Eucalanus bungii* constitute characteristic southern population, and *Calanus finmarchicus* occurs in the population in the Gulf of Anadir.

In the area adjacent to Bower's Bank, copepods collected are only oceanic and bathybic forms (Anraku, 1954b), while diatom population is occupied by neritic forms (Motoda & Kawarada, 1955).

In the present cruise, it is considered that the water from the Pacific pouring into the Bering Sea is characterized by *Calanus plumchrus—Eucalanus bungii* population which are oceanic and bathybic forms, and the water in the eastern shallow Bering Sea is characterized by presence of *Calanus finmarchicus—Acartia longiremis* population which are boreal or neritic forms. The water in Bower's Bank, around the Pribilof Islands and in Unimak Pass are inhabited by the mixed populations of the above forms.

Summary

Regular samplings were made by 150 metre vertical hauls with 45 × 165 cm net and by 1000 metres or more deep hauls with a couple of 100 cm^2 × 50 cm "Twin Net". A deep haul extending to 2000 metres was made with 63 × 300 cm net at one station. Thirty-seven species of copepods were identified from such collections.

So far as the upper 150 metre zone is concerned, *Calanus plumchrus*, *C. cristatus*, *Eucalanus bungii bungii*, *Scolecithricella minor* and *Metridia lucens* which are oceanic forms, are commonly distributed in the west and central Bering Sea, and in the southern offshore region of the Alaska Peninsula. *Calanus finmarchicus* and *Acartia longiremis* are distributed around Bower's Bank and in the eastern shallow Bering Sea. *Pseudocalanus elongatus* and *Oithona similis* are widely distributed in the Bering Sea and in the southern offshore region of the Alaska Peninsula. The distribution of *Centropages abdominalis* is restricted to the southern side of Kamchatka and waters adjacent to Unimak Pass.

In the upper zone of the Bering Sea, three areas are distinguished with respect to the copepod populations; that is, (1) *Calanus plumchrus*—*Eucalanus bungii* area in the west and central Bering Sea, (2) *Calanus finmarchicus*—*Acartia longiremis* area in the eastern shallow Bering Sea, (3) Mixed area of these forms around Bower's Bank, the Pribilof Islands and Unimak Pass.

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Table 1. Number of individuals (per 1000 m³ of water) of each species of copepoda collected by duplicate hauls covering upper 150 metre zone
(The number is converted by correcting the errors of hauling distance in rough weather and assuming that filtration coefficient of the net is 0.76)

Number of Station	Os 1		Os 2		Os 3		Os 4		Os 5		Os 6		Os 7		Os 8		Os 9		Os 10		Os 11		Os 12		Os 13		Os 14		Os 15		Cs 16		Os 17		Os 18		Os 19	
Date	June 26		27		28		29		29		30		July 1		2		3		4		4		5		6		7		7		8		8		9		9	
Latitude & Longitude	51-43 N ; 160-30 E		52-52 N ; 161-50 E		53-00 N ; 164-00 E		53-01 N ; 166-00 E		53-00 N ; 168-00 E		53-02 N ; 170-00 E		53-02 N ; 172-00 E		54-30 N ; 170-33 E		55-58 N ; 169-11 E		57-41 N ; 167-59 E		58-29 N ; 166-32 E		59-00 N ; 170-00 E		58-30 N ; 173-15 E		56-54 N ; 173-17 E		55-10 N ; 173-17 E		53-25 N ; 173-38 E		53-10 N ; 175-04 E		52-50 N ; 176-56 E		52-28 N ; 178-40 E	
Hour	1910	2100	1423	1620	1045	1135	0725	0824	1725	1818	1352	1448	1408	1456	0338	0448	0535	0630	0940	1027	1915	2007	1405	1510	1330	1440	0550	0640	1948	2030	0535	1027	1725	1815	0300	0355	1217	1305
Number of Haul	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Calanus finmarchicus adult ♂♀																																						
V																																						
IV																																						
III																																						
II																																						
I																																						
Total																																						
Calanus plumchrus adult ♂♀																																						
V	17100	14000	3970	2620	6530	6320	320	610	1770	340	220	340	280	670	2850	5010	1270	2120	12000	8040	34500	16720	14930	9680	8440	9630	2900	5580	9440	3220	10650	4360	35200	39200	1550	5370	360	610
IV	23400	28000	64600	57000	4840	9160	2170	4260	1690	300	670	560	6260	2240	11000	19200	3500	1770	19300	9630	175300	120000	18750	14680	24530	8040	19500	25920	10300	6220	34100	43600	61000	68500	16480	38230	14260	11900
III	10600	24500	94900	52500	3370	8550	2030	6280	1870	640	1170	1850	16900	6940	12050	19200	14120	14000	28680	12030	82300	102900	14930	11420	70600	61000	30100	57580	155100	7300	36950	34900	25650	15550	14400	64500	9080	5650
II	1960	1860	37000	22200	1260	3250	510	1830	840	510	560	890	18800	11330	31800	51950	136900	119200	26900	18000	26530	53000	18750	9680	86600	161300	29450	33200	193200	129300	25600	14530	19200	4900	2050	14330	5180	3860
I	2220	1590	10600	10480	840	200									8000	41400	17050	24900	1680	3210	10600	33400	3400	3380	27650	32150	10600	10080	27400	15470	11380	8730	3210	2410			650	1250
Total	55280	69950	211070	144900	16840	27380	5030	12980	6170	1790	2620	3640	42240	21180	65700	136760	172840	161990	88560	50910	329230	326020	70760	48840	217820	272120	92550	132360	395440	161510	118680	106120	144260	130560	34480	122430	29530	23270
Calanus cristatus copepodid st.	280	550	4420	3720	630	560	560	2320	90	40	170	450	340	900	2850	3050	1720	2480	1840	2020	5140	9140	3400	2480	3120	4610	1560	7200	3920	2460	1950	3450	2410	2130	710	600	160	160
Eucalanus bungii bungii adult	3120	9500	660	5300	8730	10330	7150	7100	6100	2460	3240	3730	1170	4700	29350	31100	22000	30200	10080	14470	13280	25050	16100	15850	10930	2820	7220	8820	7730	7950	39100	28350	154000	72500	12350	78900	11650	9450
copepodid st.	37000	23700	366000	416000	31300	16700	7630	23300	7040	3490	4250	4260	45600	20400	18700	56300	3630	4600	292000	220200	818000	700000	390000	274200	323800	338800	1450	1440	37850	20600	2133000	1085000	2719000	1855000	1000400	1684000	549000	448000
Total	40120	33200	366660	421300	40030	27030	14780	30900	13140	5950	7490	7950	46770	25100	48050	87900	25630	34800	302080	234670	831280	725050	406100	290050	334730	361620	8670	10260	45580	28550	2172100	1113350	2873000	1927500	1012750	1762900	560650	457450
Pseudocalanus elongatus adult	21900	33300	63600	74000	4640	4340	1130	760	710	550	610	560	10730	5270	12130	10360	5600	6180	38800	42600	65300	41800	18750	17590	12260	38500	8300	9370	6860	5140	8540	8730	19250	4900	38800	9550	4540	3400
copepodid st.	29600	14500	56000	68800	8210	5100	400	8300	1250	430	670	530	11620	12500	7100	7200	2380	5800	10100	12700	108800	105000	61300	38800	29200	41750	23050	15880	44650	25700	48220	33500	73800	83200	18520	45600	2600	3760
Total	51500	47800	119600	142800	12850	9440	1530	9060	1960	980	1280	1090	22350	17770	19230	17560	7980	11980	48900	55300	174100	147800	80050	56390	41460	80250	31350	25250	51510	30840	56760	42230	93050	88100	57320	55150	7140	7140
Microcalanus sp.																																						
Aetideus armatus																																						
Gaetanus armiger																											210	180										160
Gaidius tenuispinus																																						
Pareuchaeta japonica		50																																				
Racovitzanus antarcticus							160	200	90	40			3580	900	190		420	350	840					1760														
Scolecithricella minor	9500	4310	7270	7940	1260	1430	480	460	340	90	1010	670	5270	10730	2620	1600	3220	3700	5890	4820	2650		2540	3520	3840	9640	1670	720	1720	220		190						
Centropages abdominalis	280	870																									2320	5750		640	2840	5680	12850	2460	2050	4760	1950	2510
Metridia lucens adult	1120	2580	660			610							900	3140	560	800	1400	1240		1600			3400	880	3080		2940	1440	3440	1290	2840							
copepodid st.	1960		3980			2020	1080	2020	530	40	110		17900	12000	33700	39200	18650	24220	15200	22000	50400	67000	48500	24600	23350	75300	34300	70580	116500	74600	88000	168700	38500	75800	24620	2330		
Total	3080	2580	4640			2630	1080	2020	530	40	110		18800	15140	34260	40000	20050	25460	15200	23600	50400	67000	51900	25480	26430	75300	36790	72020	119940	75890	90840	168700	38500	75800	18500	14320	14940	15100
Pleuromamma scutullata																																						
Lucicutia ovaliformis																				1600							210										
Candacia columbiae	60																140																					
Acartia longiremis																													110	50								
Oithona similis	1120	12900	843000	640000	16300	12700	120	900	23440	7560	9860	16670	90500	11350	30800	53800	5460	14320	32790	44500	357500	426000	41600	73500	33000	32150	85300	57800	61900	73000	51200	55200	22450	17120	20500	26320	31820	47600
O. plumifera		430																																				
Microsetella norvegica																											420			860				2450				610
Oncaea conifera	280			660						40						1600		710		1600								720		860	710			2450				
Copepod nauplii	20150	9950	835000	194500	4000	5100	760	1820	310	470			57300	69000	10650	24000	7420	12200	208700	346500	204500	312000	602500	364200	453000	182200	7560	5750	262000	191200	184800	201200	625000	368000	222000	281800	26600	32000
Total	181650	182590	2442660	1555820	91910	86270	24500	60660	46380	17000	22540	30510	287150	172070	214350	366270	244880	268340	704806	765520	1954800	2013010	1258850	866220	1114400	1017890	263610	318010	942120	566080	2679880	1696120	3811520	2619020	1392930	2272450	673420	586020

Continued

Number of Station	Os 20		Os 21		Os 22		Os 23		Os 24		Os 25		Os 26		Os 27		Os 28		Os 29		Os 30		Os 31		Os 32		Os 33		Os 34		Os 35		Os 36		Os 37	
Date	July 9-10		10		10′		10′		10′		11		11		12		14		14		15		15		16		19		20		20		21		21	
Latitude & Longitude	52-30N ; 178-54W		53-14N ; 178-40E		53-54N ; 178-40E		53-03N ; 178-52W		53-54N ; 178-52W		55-34N ; 178-48W		57-00N ; 178-58W		58-49N ; 178-43W		57-16N ; 171-50W		57-27N ; 170-11W		57-26N ; 167-05W		57-23N ; 163-58W		57-16N ; 161-40W		56-04N ; 163-15W		54-46N ; 165-19W		53-40N ; 163-31W		52-58N ; 162-19W		52-15N ; 161-09W	
Hour	2340	0030	1700	1750	0025	0100	1230	1340	1940	2030	0835	0935	1920	2015	0810	1000	1003	1038	1655	1700	0520	0527	1755	1758	0500	0550	1952	1956	0945	0955	2225	2310	0630	0740	1435	1550
Number of Haul	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Calanus finmarchicus adult ♂♀	♂ 690	♂ 550	♂ 1130 ♀ 2280	♀ 410			♀ 5000	♀ 160		♀ 1810							♀ 150	♀ 970	♀ 490	♀ 590	♂ 1000 ♀ 1710	♀ 2200	♀ 1600	♂ 2300 ♀ 12000	♀ 480	♀ 2400	♀ 1010	♀ 290	♀ 1650	♀ 1530	♀ 890	♀ 1790	♀ 50			♀ 430
V		180					1460	160	890								3120	3900	26650	85200	457800	33700	537000	574000	15900	63300	94200	146800	6110	3070	3130	11620	210			210
IV		370		810													8660	25400	98600	251500	1312000	379000	860900	1796000	28400	120500	33600	35600	14920	3970	2010		210			
III																	5160	18500	88600	118300	97600	22000	307500	610000	13850	4180	11400	21800	4960	12270	890					
II																	610	10720	25600	44900	21750	4400	59700	37800	10000	4180	12090	30800	4960	6140	670					
I																		2930	3940	118300			34100		14780	31050	2680	7070	4130	3060						
Total	690	1100	3410	1220			6460	320	890	1810							17700	62420	243880	618750	1891860	441300	1800800	3032100	83410	225610	154980	242360	41730	30040	7590	13410	470			640
Calanus plumchrus adult ♂♀																	♀ 3220	♀ 9520	♀ 5460	♀ 1190	♀ 680	♀ 550					♀ 1680		♀ 210							
V	12200	1640	27300	11800	4730	6340	17600	21980	24300	40000	16880	68400	18520	39200	11000	8220	1850	3410	2500	2360								150	830	12280	450	4530	7680	19850	2530	2770
IV	15280	8930	54600	26050	28400	11890	5600	7600	19700	16400	36900	32950	25600	18000	13450	7630													630	6140	3360	16500	16260	12100	6710	5320
III	1230	5840	16050	4890	50450	6340	4210	5940	10730	14520	5180	7330	4850	10600	13080	4110													830		450	3580	5970	2900	5860	4480
II	1820	5840	20920	1630	18920	5500	9860	5090	14280	10000	7780	6110	30920	9000	1630	1170													4130				4480	2240	5160	5110
I	3120	5840	13680			3170	9860	4370	3590	2720	10400	1230	1550	1640	810	1170																	2130	1120	2580	1280
Total	33650	28090	132550	44370	102500	33240	46770	44980	72600	83640	77140	116020	81440	78440	39970	22300	5070	12930	7960	3550	680	550					1680	150	6630	18420	4260	24610	36520	38210	22840	18960
Calanus cristatus copepodid st.	3080	580	1490	870	4290	4740	3050	1640	1570	570	3740	760	2130	6330	5400	6010	240	490	490	150								150	210	50		2680	1200	560	410	1170
Eucalanus bungii bungii adult	4880	6200			22100	4740	79500	23700	10730	19200	1950	4880	6190	1640	7600	2640	460	1960	1490	750							4710	2360	2580	630	610	6260	640	1570	6700	6820
copepodid st.	78300	87400	1118000	781000	771000	405000	195100	98300	472000	568500	852000	946000	535000	508000	531000	279000	7100	46900	8950	4400							2010	8870	13880	62100	15200	6000	22000	18510	35300	15380
Total	83180	93600	1118000	781000	793100	409740	274600	122000	482730	587700	853950	950880	541190	509640	538600	281640	7560	48860	10440	5150							6720	11230	16460	62730	15810	12260	22640	20080	42000	22200
Pseudocalanus elongatus adult	3000	11680	10210	10460	1570	6340	16000	21200	12520	9090	15600	15720	11600	8170	2450	5860	16500	45800	89600	37800	1180000	193500	435200	729000	56800	126600	21450	11820	120000	171900	8930	14280	1710	890	4200	2980
copepodid st.	13420	17450	17050	10460	22150	17450	36900	18400	10730	16400	62200	40300	44900	45750	10600	17600	39600	142000	197100	189200	1083000	392000	491400	582000	66400	121900	26780	39700	193800	312500	16110	25050	2560	6660	12580	6600
Total	16420	29130	27260	20920	23720	23790	52900	39600	23250	25490	77800	56020	56500	53920	13050	23460	56100	187800	280700	227000	2263000	585500	929600	1311000	123200	248500	48230	51520	313800	484400	25040	39330	4270	7550	16780	9580
Microcalanus sp.																	460	13670	1980	2370																
Aetideus armatus																																			840	
Gaetanus armiger	150	140			3140	400																														
Gaidius tenuispinus					200																												450			
Pareuchaeta japonica	160	140			250	150			1790	60	2600		50	50		590																				
Racovitzanus antarcticus							1600	210						1640	6460	1170																	110	210		
Scolecithricella minor	1230	4640		1650	9460	730	17600	76000	1790	1810	5200	6110	480	3280	1630	4110	460	970																	840	210
Centropages abdominalis																													830	1530	450	1790	1070	890	2520	1280
Metridia lucens adult	14020	4560	110		2370	6340	6420	5940	5930	7260	1950	3670	770	2450	1630	1760	2000	10800	11920							1350	2360	26380	21410	1790	3580	210			
copepodid st.	34400	92200	271800	201800	143800	55300	155200	84400	157500	294500	321500	184200	123700	109500	30150	35700	26240	158000	35800	4730		2200							830	150	2460	8050				
Total	46420	96760	271910	201800	146170	61640	161620	90340	163430	301760	323450	187870	124470	111950	31780	37460	28240	168800	47720	4730		2200					2010	2360	79250	80000	9590	18800	2100	1350	28600	35600
Pleuromamma scutullata	150	550		100	3740	450																					2010	2360	80080	80150	12050	26850	2100	1350	28600	35600
Lucicutia ovaliformis																															450					
Candacia columbiae		90			100					60																						890				
Acartia longiremis	2920	6840					4810	110									19300	39100	218100	386000	302000	115200	350000	340000	5320	3580	258000	255000	86000	92000	10100	12510	9380	15460	8400	3600
Oithona similis	41800	12250	55800	231100	167000	76200	196800	106000	748000	257200	22800	11200	40300	52400	22800	49600	6500	2640	218100	45000	249000	105400	51150	67700			8080	47300	126500	24500	1570	10720	20720	21750		
O. plumifera	1230							850				1230		810	1630	2340	620														230		430	450		
Microsetella norvegica			3410											810																						
Oncaea conifera	190	140							1790	910		40		810	3260																					
Copepod nauplii	25020	14600	126100	62400	368000	138800	62900	60500	130200	5000	142700	23200	30230	54800	169100	200000	770			590					10000	15580			4930	18400			850		24200	7680
Total	253370	284730	1746770	1345430	1621670	749880	829110	542550	1628040	1266010	1509380	1353330	876790	874880	833680	628680	143020	537680	1035370	1293330	4706540	1250150	3131550	4750800	221930	493270	481050	612430	703550	833630	79900	148840	100060	106300	147430	100920

Table 2. Number of individuals (per 1000 m^3 of water) of each species of copepoda occurring in separate vertical zone at station Os 8

(Error of filtration coefficient of the net is not corrected)

Species	500–0m	1000–500m	2000–1000m
Calanus plumchrus (adult)	928	13	13
〃 (copepodid)	3377	96	22
C. cristatus (adult)	19	58	10
〃 (copepodid)	600	232	
Eucalanus bungii bungii (adult)	2858	426	3
〃 (copepodid)	1109	84	6
Pseudocalanus elongatus (adult)	671	26	3
〃 (copepodid)	103	45	
Microcalanus pygmaeus		19	16
Spinocalanus spinipes	52	19	
Gaidius tenuispinus	52	45	13
G. brevispinus	103	71	10
Gaidins 〃 copepodid	103		
Gaetanus armiger	180	32	3
Pareuchaeta japonica	19		3
P. birostrata	32	13	3
Pareuchaeta 〃 copepodid	491	129	6
Scaphocalanus magnus	52	6	3
Onchocalanus affinis		13	
Amallothrix inornata	103	45	
Racovitzanus antarcticus	129		
Scolecithricella minor	516	32	6
S. ovata		19	
Scolecithricella 〃 copepodid	77	142	
Metridia lucens	129	174	3
M. asymmetrica		206	16
Metridia 〃 copepodid	2476	123	6
Pleuromamma scutullata	439	13	
Lucicutia ovalifromis	181	497	23
Heterorhabdus tanneri	52	581	
Oithona similis	491	194	61
O. plumifera		6	
Microsetella norvegica	26		
Oncaea conifera	491	155	6
O. notopus			10
Other copepodid stages	774	271	16
Copepod nauplii	155	45	6
Total	16788	3930	267