COPEPODS COLLECTED ON THE WHALING GROUNDS OFF NORTHERN JAPAN AND AROUND THE BONIN ISLANDS

Masateru ANRAKU
Faculty of Fisheries, Hokkaido University

Introduction

Since Brady (1883) reported on the pelagic copepods in the western Pacific adjacent to Japan in the Challenger Expedition, 1873–76, copepod fauna in this region has been investigated by several Japanese workers. Sato (1913) made research around Hokkaido, Marukawa (1921) in the northern Pacific near Japan, and Tanaka (1935, 1937, 1938, 1953) in the Izu region. In 1937 Mori published a monograph of copepods from waters neighbouring Japan. Honjo (1951) gave an account of copepods from the Izu Islands region, and Matsue & Komaki (1952) on the materials from the same region. The author has made investigations on plankton copepods off Sanriku (Anraku, 1952), in the Oshoro Bay, west coast of Hokkaido (Anraku, 1953), and in the Okhotsk Sea (Anraku, 1954).

The present paper is a report on the faunistic investigation of plankton copepods collected from the whaling grounds in the northwestern Pacific and around the Bonin Islands in 1951 and 1952 inclusive.

The author wishes to express his hearty thanks to Professor Sigeru Motoda, Faculty of Fisheries, Hokkaido University, for valuable suggestions rendered during the course of his work. He also desires to acknowledge his indebtedness to Dr. Tokiharu Abe, of the Tokai Regional Fisheries Research Laboratory, for providing him facilities of the present investigation. Thanks are also due to the Committee for the Improvement of Equipment of Whaling Vessels for kindly placing materials at his disposal.

Northwestern Pacific

In 1951 the collections were made by the catcher boat, Toshi Maru No. 3, at thirty-four positions (fig. 1) from August 14 to September 2. The net, made of material nearly equal to no. 3 bolting cloth, 45 cm in mouth diameter, was hauled from 150 metre depth to the surface at every station. The collections in 1952, were made by the catcher boat, Konan Maru No. 6, at twenty-nine positions (fig. 1) from August 30 to September 13, and the hauls were made from either 100 or 150 metre depth to the surface.

From the materials more than seventy species of copepods were identified (table 1). Often the warm water type of copepod was represented by such species as *Copilia mirabilis*, *Sapphirina nigromaculata*, *Paracalanus aculeatus*, *Corycaeus*

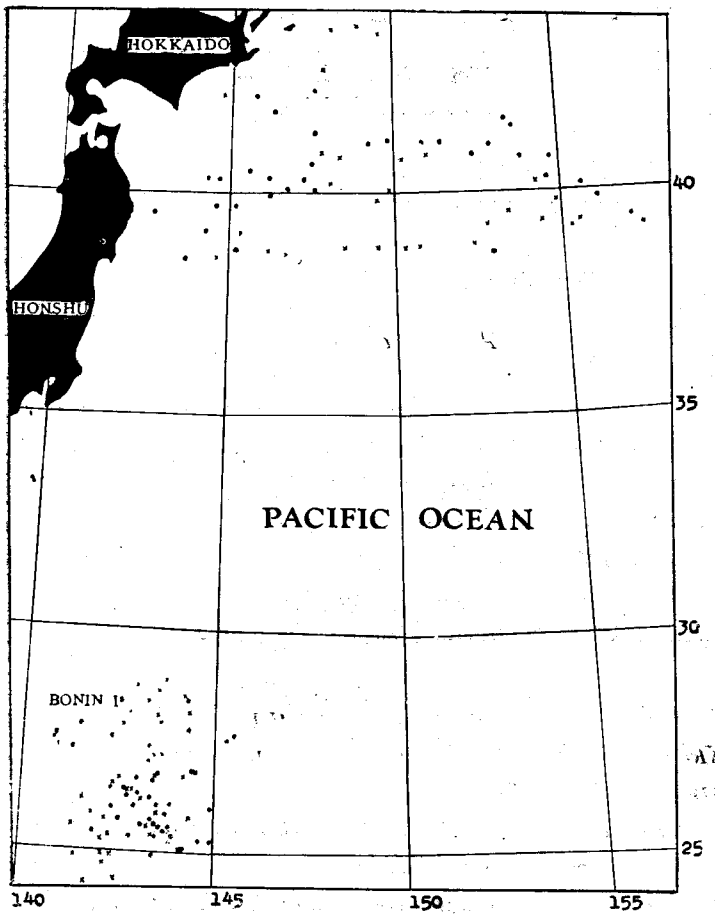

Fig. 1. Chart showing the positions of collection in 1951 (●) and 1952 (×)

speciosus, *Setella gracilis*, *Euterpe acutifrons*, *Labidocera acuta* and *Temora stylifera*, while the cold water type was represented by such species as *Calanus cristatus*, *C. plumchrus*, *Eucalanus bungii bungii*, *Pseudocalanus minutus* and *Candacia columbiae*. The species number of warm water type was comparatively large, though less in individual number, while the species number of cold water type was very small, each species being composed of abundant individuals.

The adult forms of neither *Calanus cristatus* nor *Calanus plumchrus* were found in these collections, possibly due to the shallow haul. The most part of the above species collected were those of copepodid stage V. Yanagisawa (1942) mentioned that the southern species, such as *Eucalanus subcrassus*, were found even at a staion situated 39°N, 143°E. In the present materials there were many southern forms of copepods additional to *Eucalanus subcrassus* even in the region between 41°N and 42°N.

However, *Gaidius*, *Gaetanus*, *Pleuromamma* and *Heterorhabdus* and *Phyllopus* which were found in the previous collection in this region (Anraku, 1952), were rare or absent in the present materials, probably due to the shallow haul in the present case as compared with the previous work. Among the twenty-eight species of copepods reported by Marukawa (1921) from the northwestern Pacific near Japan, the following twelve species could not be found from the present materials; viz., *Calanus pauper*, *Eucalanus oculanus*, *Euchaeta tonsa*, *Labidocera wollastoni*, *L. pavo*, *Metridia longa*, *Pontella chierchiae*, *Corycaeus danae*, *C. venustus*, *Sapphirina gemma*, *Scolecithrix danae* and *Pseudolovenula magna*. On the other hand, more

Table 1. List of species collected in the northwestern Pacific

Calanus plumchrus MARUKAWA*	*Metridia lucens* BOECK
C. cristatus KRÖYER	*Lucicutia flavicornis* (CLAUS)
C. helgolandicus (CLAUS)	*Heterorhabdus papilliger* (CLAUS)
C. tenuicornis DANA	*Candacia bipinnata* GIESBRECHT
C. minor (CLAUS)	*C. columbiae* CAMPBELL**
C. vulgaris (DANA)	*C.* spp.
C. darwinii (LUBBOCK)	*Acartia negligens* DANA
Eucalanus elongatus (DANA)	*A. danae* GIESBRECHT
E. bungii bungii JOHNSON	*Labidocera japonica* MORI
E. attenuatus (DANA)	*L. acuta* (DANA)
E. subcrassus GIESBRECHT	*L. detruncata* (DANA)
E. sp.	*Oithona plumifera* BAIRD
Rhincalanus nasutus GIESBRECHT	*O. similis* CLAUS
Paracalanus aculeatus GIESBRECHT	*O.* spp.
P. parvus (CLAUS)	*Setella gracilis* DANA
Acrocalanus gracilis GIESBRECHT	*Microsetella norvegica* (EOECK)
Clausocalanus pergens FARRAN	*Clytemnestra rostrata* (BRADY)
C. furcatus (BRADY)	*Oncaea venusta* PHILIPPI
Pseudocalanus minutus (KRÖYER)	*O. media* GIESBRECHT
Bradyidius armatus (BRADY)	*O. conifera* GIESBRECHT
Euchaeta marina (PRESTANDREA)	*O. mediterranea* CLAUS
E. sp.	*O.* sp.
Scolecithricella minor (BRADY)	*Sapphirina nigromaculata* CLAUS
Scolecithrix sp.	*S.* sp.
Phaenna spinifera CLAUS	*Copilia mirabilis* DANA
Centropages bradyi WHEELER	*C. quadrata* DANA
Temora tubinata (DANA)	*Corycaeus anglicus* LUBBOCK
T. discaudata GIESBRECHT	*C. speciosus* DANA
T. stylifera (DANA)	*C.* spp.

*According to the communications of Mr. Z. Nakai and Dr. O. Tanaka *Calanus plumchrus* Marukawa 1921 is quite identical with *C. tonsus* Brady 1883.

**The author is indebted to Dr. O. Tanaka for kindness in informing him that *Candacia pacifica* Mori 1937 was pointed out by Davis (1949, Univ. Wash. Publ. Zool., 14) to be the synonym of *C. columbiae* Campbell 1929.

than thirty species found in the present investigation were not described in the list of Marukawa (1921).

The number of individuals of the principal copepods occurring in 1951 is given in table 4. The samples from stations 10, 19, 21 and 27 were mainly composed of

such cold water species as *Calanus plumchrus*, *C. cristatus* and *Eucalanus bungii bungii*, indicating the prevailing cold Oyashio Current. The warm water species, such as *Sapphirina*, did not appear in those stations. However, the two types of copepods have intermingled at stations 4, 25 and 38. The total number of individuals in the areas eastward from station 32 was very small, there being collected only a few individuals of *Temora* and *Corycaeus*.

Thalassiothrix mediterranea var. *pacifica*, one of the temperate or south temperate species of diatom, was abundantly found in each of the seventeen stations. This species is one which has been reported by Cupp (1943) as a new variety distributed off southern California and in the Gulf of California, sometimes in moderately large numbers.

The individual number of the principal copepods occurring at each position of 1952 is given in table 5. The difference of copepod fauna between 1951 and 1952 was shown by the presence of *Copilia mirabilis* and *Calanus vulgaris*, as well as abundant occurrence of other warm water species, but this may have no significance but that the period and latitude of collection differed in these two years.

Generally, the warm water species occurred in richness in areas southward from 41°N, and in these areas, the cold water species, *Calanus plumchrus* and *Calanus cristatus*, greatly decreased in number. The warm water species entirely disappeared from the northern positions, off Shikotan Island (St. 27, 28, 29, 30 and 32), while a large number of *Calanus plumchrus*, *C. cristatus* and *Eucalanus bungii bungii* were found in these positions.

The monotonous communities of diatoms composed of *Chaetoceros atlanticus* and *Ch. concaviconnis*, which are both cold water species, covered the areas of positions 28 and 32.

Around the Bonin Islands

In 1951 the collections were made by the Shinyo Maru, training ship of the Tokyo University of Fisheries, at forty-nine positions (fig. 1) from April 23 to May 15. The net was hauled from 150 metre depth to the surface, but sometimes from 50 metres. The collections in 1952 were made by the catcher boat, Seki Maru No. 11, on forty positions (fig. 1) from June 27 to July 12. The hauls were made from 100 metre depth to the surface.

About eighty species of copepods were identified (table 2); half of them belonged to the warm water species.

Brady (1883) mentioned sixteen species of copepods gathered from the southern waters of Japan. Among the species which he has listed, *Aetideus giesbrechti*, *Scolecithrix danae*, *Centropages violaceus*, *Pontella plumata* (=*Pontellina plumata*) and *Setella gracilis* were found in the present investigation. The following eleven species did not appear in the present materials though they were listed by Brady (1883): *Calanus propinquus*, *C. tonsus*, *Eucalanus setiger*, *Rhincalanus gigas*, *Euchaeta hessei*, *Leuckartia scapularis*, *Candacia pectinata*, *Pontella detruncata*,

Table 2. List of species collected around the Bonin Islands

Calanus helgolandicus (CLAUS)
C. tenuicornis DANA
C. minor (CLAUS)
C. vulgaris (DANA)
C. darwinii (LUBBOCK)
C. pauper GIESBRECHT
C. gracilis (DANA)
Eucalanus elongatus (DANA)
E. attenuatus (DANA)
E. crassus GIESBRECHT
E. subcrassus GIESBRECHT
E. mucronatus GIESBRECHT
Rhincalanus nasutus GIESBRECHT
R. cornutus DANA
Mecynocera clausi THOMPSON
Paracalanus aculeatus GIESBRECHT
P. parvus (CLAUS)
Acrocalanus gracilis GIESBRECHT
Clausocalanus furcatus (BRADY)
C. arcuicornis (DANA)
C. pergens FARRAN
Ctenocalanus longicornis MORI
Aetideus armatus (BOECK)
A. giesbrechti CLEVE
Gaetanus minor FARRAN
Euchirella sp.
Euchaeta marina (PRESTANDREA)
E. longicornis GIESBRECHT
Scaphocalanus pacificus MORI
Scolecithricella orientalis MORI
S. spp.
Scolecithrix danae (LUBBOCK)
Phaenna spinifera CLAUS
Centropages bradyi WHEELER
C. violaceus (CLAUS)
Temora stylifera (DANA)
T. sp.
Pleuromamma gracilis (CLAUS)
P. abdominalis (LUBBOCK)
P. xiphias (GIESBRECHT)
Lucicutia flavicornis (CLAUS)
L. ovalis WOLFENDEN
Heterorhabdus papilliger (CLAUS)
Haloptilus ornatus (GIESBRECHT)
H. acutifrons (GIESBRECHT)
H. oxycephalus (GIESBRECHT)
Candacia bispinosa CLAUS
C. bipinnata GIESBRECHT
C. longimana CLAUS
C. truncata (DANA)
C. aethiopica DANA
Pontellina plumata (DANA)
Acartia clausi GIESBRECHT
A. negligens DANA
Labidocera acuta (DANA)
L. detruncata (DANA)
Oithona plumifera BAIRD
O. similis CLAUS
O. nana GIESBRECHT
O. fallax FARRAN
O. sp.
Setella gracilis DANA
Microsetella rosea (DANA)
Euterpe acutifrons (DANA)
Clytemnestra rostrata (BRADY)
Oncaea venusta PHILIPPI
O. media GIESBRECHT
O. mediterranea CLAUS
O. sp.
Lubbockia sp.
Sapphirina nigromaculata CLAUS
S. spp.
Copilia mirabilis DANA
C. spp.
Corycaeus speciosus DANA
C. anglicus LUBBOCK
C. curtus FARRAN
C. concinnus DANA
C. spp.

Oncaea obtusa and *Phyllopus bidentatus*.

The composition of the copepod community of the two years as studied by the present author does not show any striking difference. Individual number occurring at each position of 1951 and 1952 is listed in tables 6 and 7 respectively.

Considerations of the occurrence of warm water copepods at various latitudes

The distribution of the warm water copepods has often been studied from the viewpoint of zoogeography (Ekman, 1953, pp. 324-332). Three genera, *Sapphirina*, *Copilia* and *Corycaeus*, have been considered to be those which are mainly distributed in the warmer latitudes.

The number of the positions where the above genera have occurred is tabulated against the total number of positions of net haul divided into various latitudes (table 3).

Table 3. Number of positions at which three most common grnera of warm water copepods were present in 1951—52 inclusive. Figures in parentheses are total number of positions where net haul was made.

Latitude (N)	*Corycaeus*	*Sapphirina*	*Copilia*
43-44	0 (3)	0 (3)	0 (3)
42-43	0 (4)	0 (4)	0 (4)
41-42	0 (7)	0 (7)	0 (7)
40-41	9 (19)	0 (19)	0 (19)
39-40	13 (18)	1 (18)	1 (18)
38-39	8 (11)	2 (11)	4 (11)
28-29	8 (9)	6 (9)	7 (9)
27-28	17 (17)	9 (17)	6 (17)
26-27	23 (24)	9 (24)	12 (24)
25-26	31 (31)	16 (31)	15 (31)
24-25	8 (8)	0 (8)	6 (8)

It may be clearly seen from this table that the above warm water genera were distributed at almost every position situated in the southern latitudes whilst the occurrences were few in the positions of northern latitudes. *Corycaeus* was the most numerous in number of individuals among the three and it did not occur in the area on the north of 41°N, while it appeared all stations on the south of 28°N. The number of individuals of both *Sapphirina* and *Copilia* was smaller than that of *Corycaeus* throughout the observations. These two had entirely disappeared in the region northwards of 40°N, though they occurred often in the southern latitudes.

The distribution area of the above copepods is possibly responsible to the

flowing up of the warm Kuroshio Current in the North Pacific.

Summary

1. More than one-hundred species of pelagic copepods were identified from the materials sampled off northern Japan and around the Bonin Islands in 1951 and 1952.
2. Typical cold water copepods (*Calanus cristatus, C. plumchrus, Eucalanus bungii bungii, Pseudocalanus minutus* and *Candacia columbiae*) occurred richly in the region northward from 38°N, while typical warm water copepods (*Copilia* spp., *Sapphirina* spp., *Corycaeus* spp., *Calanus minor, C. vulgaris, C. darwinii, C. pauper, Eucalanus elongatus, E. crassus, E. subcrassus, Mecynocera clausi, Paracalanus aculeatus, Aetideus giesbrechti, Temora stylifera, T. tubinata, T. discaudata, Labidocera acuta, L. detruncata, Setella gracilis, Euterpe acutifrons*) were commonly found in the southern region, having not occurred northward from 42°N.
3. The number of positions at which three genera of the typical warm water copepods (*Copilia, Sapphirina* and *Corycaeus*) have occurred was decreased northward, these copepods having occurred at nearly all positions of southern latitudes.

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).

.....(1953). Seasonal distribution of pelagic copepods at Oshoro Bay, west coast of Hokkaido. *Ibid.* **3** (3), 187—192.

.....(1954). Distribution of plankton copepods off Kitami, Hokkaido, in Okhotsk Sea in summer, 1949 and 1950. *Ibid.* **4** (4), 249—254.

Brady, G. S. (1883). Report on the copepoda collected by H. M. S. Challenger during the years 1873—76. *Rep. Sci. Result Voyage H. M. S. Challenger.* Zool. **8**, 1—142.

Cupp, E. E. (1943). Marine plankton diatoms of the west coast of north America. *Bull. Scripps Inst. Oceanogr., Univ. Cali.* **5** (1), 1—138.

Ekman, S. (1953). Zoogeography of the sea. 417p. London, Sidgwick and Jackson Ltd.

Honjo, Y. (1951). Distribution of copepoda in the adjacent seas of the Izu Islands during winter and spring. *Jour. Oceanogr. Soc. Jap.* **8** (3—4), 77—87, (in Japanese).

Marukawa, H. (1921). Plankton list and some new species of copepods from the northern waters of Japan. *Bull. l' Inst. Oceanogr. Monaco* **384**, 1—15.

Matsue, Y. & Komaki Y. (1953). The feature of the plankton found in the surrounding area of Myojin-sho. Report on the submarine eruption of Myojin-sho. *Jour. Tokyo Univ. Fish.* **40** (special number 2), 22—25.

Sato, T. (1913). The pelagic copepoda. Suisan-Chosa-Hokoku (*Rep. Hokkaido Fish. Exp. Sta.*), **1**, 1—79, (in Japanese).

Tanaka, O. (1935). Copepods in Sagami Bay. II. Fam. Candacidae. *Suisangakkaiho* **6** (4), 210—227, (in Japanese).

……(1937). Copepods from the deep water of Suruga Bay. *Jap. Jour. Zool.* **7** (2), 251—271.

……(1938). Note on *Calanus cristatus* Krŏyer. *Ibid.* **7** (4), 599—601.

……(1953). The pelagic copepods of the Izu region. *Rec. Oceanogr. Wks. Japan*, N. S. **1** (1), 126—137.

Yanagisawa, T. (1942). Plankton in the vicinity of Kurile Islands. *Jour. Oceanogr. Kobe* **13** (3), 250—258.

Table 4. Result of collection from northwestern Pacific in 1951

station	1	2	4	6	7	8	10	12	13	14	15	16	17	18	19	20	21	23	24	25	26	27	28	29	30	32	33	34	35	36	37	38	39	40
date	Aug. 14	15	16	16	17	17	19	19	20	20	20	21	21	22	22	22	23	27	27	28	28	29	29	29	30	30	31	31	Sept. 1	1	1	2	2	2
time	7:30 p.m.	12:30 p.m.	8:00 a.m.	6:00 p.m.	7:00 a.m.	12:30 p.m.	8:00 a.m.	7:00 p.m.	8:00 a.m.	12:30 p.m.	7:00 p.m.	12:30 p.m.	7:00 p.m.	8:00 a.m.	12:00 m.	7:00 p.m.	2:00 p.m.	1:00 p.m.	7:00 p.m.	8:45 a.m.	4:00 p.m.	10:00 a.m.	1:00 p.m.	7:00 p.m.	8:00 a.m.	6:00 p.m.	8:00 a.m.	3:30 p.m.	7:00 a.m.	12:30 p.m.	4:00 p.m.	6:30 a.m.	12:30 p.m.	5:30 p.m.
depth (m)	0～150	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	0～100	〃	0～150	0～100	0～150	〃	0～100	0～150	〃	〃	〃	〃	〃	〃	〃	〃	〃
Calanus plumchrus		2	3	16			7				2				18	5	48	4			4	35												
C. cristatus				3	2			1			3	5		1	5	5		1			4												
C. helgolandicus	6	9	15	24	30	11	39	120		20	44	160	12	14	10	2	30	16	2		6	2											1
C. tenuicornis	2	10		8		1	1			1			1			2		2	1	3	1												
C. minor																																		1
Eucalanus bungii bungii		10	32	8	15		39			2	4	6	3		8	9	20	16	3	4	6	15	1				7		2			6		1
E. attenuatus						5																												
E. sp.														12											2	2								
Rhincalanus nasutus																																		1
Bradyidius armatus													1																					
Euchaeta sp.	1	1				1	1	1																		1								
Scolecithricella minor				16	5						5															2								
Temora spp.																				2							1				2			
Metridia lucens		3		24	32			16			15	1		6	17																		1
Candacia bipinnata	3					2																												
C. columbiae																										1								
Labidocera spp.	2	1																																
other microcalanoida	rr	r	cc	cc	+	rr		r	r	r	rr	r	r	r	cc	+	c	r	r	+	r	rr	rr	rr	rr	+	c	r	rr	rr	rr	+		+
Oithona spp.	rr	+	cc	cc	+	rr		r	r	r	r	r	r	r	cc	+	c	r	r	+	r	rr	rr	rr	rr	r	c	r	rr	rr	rr	+		+
Sapphirina spp.													1																				
Corycaeus spp.	5		8			1		8	4	1																	3	1					

Table 5. Result of collection from northwestern Pacific in 1952

station	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	24	25	26	27	28	29	30	32
date	Aug. 30	30	30	31	31	Sept. 1	1	2	2	3	3	3	4	4	5	5	5	6	6	7	7	8	8	8	9	11	11	12	13
time	9:30 a.m.	1:00 p.m.	5:30 p.m.	9:00 a.m.	5:30 p.m.	1:00 p.m.	5:30 p.m.	9:00 a.m.	1:10 p.m.	9:00 a.m.	1:00 p.m.	5:30 p.m.	1:00 p.m.	5:30 p.m.	7:00 a.m.	12:40 p.m.	5:00 p.m.	1:00 p.m.	5:00 p.m.	8:30 a.m.	1:00 p.m.	9:00 a.m.	1:00 p.m.	5:30 p.m.	9:00 a.m.	9:00 a.m.	6:00 p.m.	1:30 p.m.	9:30 a.m.
depth (m)	0~150	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	0~100	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃
Calanus plumchrus			51	2																		1			65		5	440	320
C. cristatus	3		5	6	1							2								15	8		24	1	16	8		18	40
C. helgolandicus	72	144		240	18		15		16		60	4	8	4					20	44	12	68	640	7		8		24	210
C. tenuicornis	5	16				16		17					10				1				4			2					
C. minor	3																												
C. vulgaris							64	1																					
Eucalanus elongatus										11							11	3	8										
E. bungii buugii	4			128	6			2												28	8	20	100	6	48	160	16	24	220
E. attenuatus		2					1		24																				
E. subcrassus		3											3																
E. sp.						3				88	16	3		24	16	4													
Rhincalanus nasutus										6																			
Euchaeta marina													70																
E. sp.			1	1			1			4														1					
Scolecithricella minor	5			10																									
Scolecithrix sp.							20	10																					
Phaenna spinifera							1	20	16	5				16															
Temora spp.							1	1	10	6	8	1		5	1	4	1		24	4									
Metridia lucens			90	15	60		10			4		12	8								1	4		6			160		
Lucicutia flavicornis								15		4																			
Heterorhabdus papilliger						10				2			2																
Candacia bipinnata									1		3		2	1					5	8		1							
C. columbiae			1																										
C. sp.						1				2																			
Labidocera spp.							2		8							1													
other microcalanoida	c	rr	r	rr	r	r	rr	r	c	r	c	rr	r	r	r	r	rr	+	+	+	r	r	rr	rr	rr	+	+	r	cc
Oithona spp.	+	rr	r	rr	r	r	rr	r	c	r	c	rr	r	r	r	r	rr	+	+	+	r	r	rr	rr	rr	c	c	r	cc
Setella gracilis		1				1	2						2	1															
Sapphirina spp.	4	5																											
Copilia spp.		1				2	1			2												1							
Corycaeus spp.	3	10				32	10	5	10	4	16	2	8			3				12	4	10							

Table 6. Result of collection around the Bonin Islands in 1951

station	1	2	3	4	5	6	7	9	10	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
date	Apr. 23	24	24	24	25	25	25	26	29	29	30	30	30	May 1	1	1	1	2	2	3	3	5	5	5	6	6	7	7	7	8	8	8	9	10	10	10	10	12	12	12	13	13	13	13	14	14	14	14	15
time	12:00 m.	5:00 a.m.	12:00 m.	6:00 p.m.	7:00 a.m.	12:00 m.	6:00 p.m.	12:00 m.	11:00 a.m.	6:00 p.m.	7:30 a.m.	10:45 a.m.	3:00 p.m.	5:00 a.m.	9:00 a.m.	12:15 p.m.	6:00 p.m.	8:45 a.m.	6:30 p.m.	9:45 a.m.	2:00 p.m.	8:30 a.m.	1:30 p.m.	6:00 p.m.	9:30 a.m.	5:30 p.m.	8:20 a.m.	12:10 p.m.	5:30 p.m.	8:00 a.m.	11:30 a.m.	5:00 p.m.	4:00 p.m.	7:00 a.m.	12:00 m.	1:00 p.m.	6:00 p.m.	9:10 a.m.	12:13 p.m.	5:30 p.m.	8:00 a.m.	12:00 m.	5:30 p.m.	8:30 p.m.	8:00 a.m.	12:00 m.	6:30 p.m.	8:30 p.m.	7:00 p.m.
depth (m)	0~50	〃	〃	〃	〃	〃	〃	〃	0~150	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃
Calanus helgolandicus														1																										1									
C. darwinii	8	8	16				16		40	16	32			32		96	64	32		16	32		16	8				16					32	48				16					40	24		72			
C. minor	12	8	4	32	40	16		4	32	64	32	64	64	32	64	80	16	32	32	48	32	32	64	32	96	80	72	56	16	16	32		40	64	144	8	8	16	64	40	16	72	88	120	64	96	88		8
C. pauper															4				4									1																		1	4	8
C. tenuicornis			16			2							4	16	32	48	16	16	32		64	64	16	4	16	32	16	16	24	16	8	16	16		32		16		32		4	4					8	4
C. gracilis		8	8	8	4				16	8	16	32		16	32	32	8	16	16		16	16	8	4	16	32	16	8	4	8	8	4	16	16	32		16	24	32	8	4	2	32	40	16	16	32	8	
Eucalanus elongatus																																		2															
E. attenuatus									4					4	16		8					2			2			2				2		2						1	1	1			8			
E. crassus											4				4						4																								16	8		
E. subcrassus																																		4														
E. mucronatus																	4		4	8																														
Rhincalanus nasutus									4				2		8																			1															
R. cornutus											8																												1									
Mecynocera clausi	8	32	16			16	16	2	32	32	32	256	32	64	32	32	64	64	32			64	16	24	16	16	8	64	64	72		8	90		16		8	96	80	96	16	56	16		24	72	40	80	80
Aetideus armatus																			16									8	8																				
A. giesbrechti									16								16	16			16				16		16		16		8	8	16									16	16		16	16	16		16
Euchirella sp.																		2																1												1		
Euchaeta marina			4			8		8	24	8	8	64	4		16	16		80	64	16	16	16	8	4	32	16	24	16	8	16	24	48	32	40	32	4	2	24	48	4	4	2	16	16		24	16	16	16
E. longicornis	4				4		16																																										
Scaphocalanus pacificus																																															1	1
Scolecithricella sp.																							16																											
Scolecithrix danae	1							2		8										2	4			2				2	2	8												4			1	1		1	
Phaenna spinifera								4		2			2					8		4	32			8																										
Centropages bradyi	8					8			16		8			32	32									8			8							16	32														
C. violaceus							16																																										
Temora spp.			1											16									2									1		2	2		1			1								
Pleuromamma gracilis				8			16		24	32	48	128	40										16				32	32		40	8		16				40	48	8	8		16	16	8	16		16	16
P. abdominalis																			4													8											24					
Lucicutia flavicornis		32					16		24	16	32	128		32			32		16		32	48	32	16	32	24	32	24	16	24	48	16		16	32		16	40	48	24	8	8	40	32	16	32	16	16	16
L. ovalis				8	16		8		8	16			32							8	16	16	16	8			16	16				16	16					8				4				16			
Heterorhabdus papilliger																				8																				16						8	8		8
Haloptilus ornatus																							1		2	8		2			1							1						4				
H. oxycephalus																												1						1							1							
Candacia bispinosa									24																																							
C. bipinnata		4		4		4		1		4	8	32		16				4	4						16			8	8	16	8									4	4	4	4	8	4	24		2	2
C. longimana			4		8		8								16	16	16	4	4		8	16										4	8	8	8							4					16		
C. truncata													4										4																										
C. aethiopica	8														4					4			2	4															1	4								
Pontellina plumata											1					16												2				2		2													
Acartia spp.	40	64	32	80	32	48	80	32	80				32				80			16		80	80	40	40	48	32	32	40	16	16	16	90	40	48	16	24		64	48	40	40	40	80	64	64	64	40	40
Oithona spp.	40	32	24	40	16	32	32	8	40	32	128	32	40	190	180	90	64	64	16	80	80	190	80	40	40	40	32	40	40	80	40	16	90	40	128	32	8	160	240	72	96	88	80	80	80	320	96	80	80
other microcalanoida	70	240	128	640	360	160	480	56	800	320	640	1840	240	1280	480	240	640	480	960	128	1280	480	240	400	440	400	800	400	480	400	560	160	400	400	1280	240	80	400	1120	400	54	360	320	480	160	440	240	480	480
Setella gracilis																	8				4					16		2			4			24	16	1							1					
Microsetella rosea																	8				64	32			24	16			24	32								16	8	4		8		16				
Oncaea spp.	32	24	24	88	320	24	160	8	640	40	480	1600	80	320	960	90	880	190	500	80	640	400	174	480	400	560	720	720	360	400	120	104	640	240	1280	40	40	320	1280	120	96	400	640	320	200	480	240	320	280
Lubbockia sp.															16											2			2																4	4		
Sapphirina spp.	1		1			2	1		2		4				8				8		16			2	16	8	8	4	4	2	4	8	4		4				2	2		1				1		2
Copilia spp.	2					5								4					8	4	8	4	2		8	4	4	4	2	2				8	2	3					1	2	1			1		
Corycaeus spp.	188	24	24		96	48	32	8	64	48	16	64	24	48	64	64	190	102	144	84	320	160	56	120	80	180	96	120	72	90	64	16	80	160	160	16	32	80	80	40	48	80	120	64	64	80	64	80	80

Table 7. Result of collection around the Bonin Islands in 1952

station	1	3	4	5	6	7	8	9	10	11	12	14	15	16	17	18	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
date	Jun. 27	27	28	28	28	29	29	30	30	30	Jul. 1	1	2	2	2	3	4	4	4	5	5	6	6	6	7	7	8	8	8	9	9	9	10	10	10	11	11	11	12	12
time	8:00 a.m.	7:00 p.m.	8:00 a.m.	2:00 p.m.	7:00 p.m.	10:00 a.m.	7:00 p.m.	8:00 a.m.	2:00 p.m.	6:30 p.m.	9:30 a.m.	6:30 p.m.	8:00 a.m	2:00 p.m.	6:30 p.m.	2:00 p.m.	8:00 a.m.	2:00 p.m.	6:30 p.m.	8:00 a.m.	4:30 p.m.	8:00 a.m.	2:00 p.m.	6:30 p.m.	2:00 p.m.	6:30 p.m.	8:00 a.m.	2:00 p.m.	6:30 p.m.	8:00 a.m.	2:00 p.m.	6:30 p.m.	8:10 a.m.	2:00 p.m.	6:30 p.m.	8:00 a.m.	2:00 p.m.	6:30 p.m.	8:00 a.m.	4:30 p.m.
Calanus helgolandicus															1																									
C. darwinii				16			64			40	64			40	16	24	32	24	16		24			24		4	8	32		24		32		40			24		32	24
C. minor	16	24	32	16	16	8	16	2	12	40	80	8	16	16	8			96		56	16	40	80	16	16	4	4	16	24	32	32	16	24	40	24	4	32	24	40	16
C. tenuicornis	16	8	4	8	8	8	8	8		32	32	16	8	16	16	8	16	16			8		16	16	24		8	8	8		16	16	8	16	24	4	24	16		4
C. gracilis		8	2		8	2			1	16	16		8	8				8	2	2	4	16	8	8	8		4	8	32	16		8	8			4	16	4		4
Eucalanus elongatus											8																				16	24	8	64	40					
E. attenuatus	4	2	16		8		4	4		2						4		40	32		4	16	8	8	4	4			16	16	8						16	16	16	8
E. crassus											16																													
E. mucronatus																	4																							
Rhincalanus nasutus											16				16			16	16			16		24	4														16	8
Mecynocera clausi	160	16	64	32	48	40	64	16	24	80	90	16	48	32	4	96	120	72	80	40	24	56	81	64	24	24	16	24	24	48	16	24	30	328	200	24	120	40	80	16
Aetideus armatus														8																									
A. giesbrechti		8			2			2												4	16								8	8	4								
Euchirella sp.																																				1				
Euchaeta marina		4	16	8	8	4	32	4	4	32	40	16	16	24	16	4	4	16	4		16	8	4	16	4			16	16	16	16	8	8	16	24	4	8	4	4	4
E. longicornis										8																	4													
Scaphocalanus pacificus			1																																				
Scolecithrix danae			2		1	2	2				8						1									1	4	8		2						2				
Phaenna spinifera																														2						1				
Centropages bradyi						8	16	8						8		24						8					4								24	8		8	16		
Temora spp.	2					1											4						1																	
Pleuromamma gracilis		4			8		16		4	24								24						8					8	8		24	8		32					
Lucicutia flavicornis		8			8			8	4	24	40	16	24	32	8			24						16						8	16	16	16	32			24			16
L. ovalis	4						16			16	32	16				8	8		16	16	16	16							16	8				16	40		16	24	24	
Heterorhabdus papilliger													8	16	8		4	16	16				8	16				16	8		8	8					8		8	
Haloptilus ornatus				1					1		2		1											1			1	2		1	1							1	1
H. acutifrons																																								1
Candacia bipinnata			32						4	16	16	4	8		4	16	8		8	8			4			4								32	24	4	4			
C. longimana	2			8	4	4	8	4						8										16			4	16	8	4		4	8				4	8	16
C. truncata		4																16				4																	
Pontellina plumata																																				1				1
Acartia spp.	90	24	160	56	80	120	72	56	64	90	64	90	24	36	200	80	120	80	80	160	80	64	200	96	72	36	56	36	56	32	240	96	56	178	160	32	136	56	40	40
Labidocera spp.	1				2		2								3																		1							
other micrcalanoida	160	160	480	360	240	200	168	56	96	342	80	80	56	40	32	64	80	50	80	40	40	32	40	80	42	36	56	36	32	80	160	120	56	204	160	32	160	80	120	120
Oithona spp.	90	24	160	160	120	120	1280	16	48	80	640	176	400	200	288	90	200	400	400	240	240	240	208	320	64	120	80	480	800	800	1008	720	200	440	992	120	400	400	560	264
Setella gracilis		2												1		1				1		1				1	1		4	2		1			1			1		
Microsetella rosea										8																					8							8		8
Oncaea spp.	32	240	1040	700	368	140	256	40	96	400	960	160	72	160	200	90	120	400	320	416	280	336	240	160	400	120	80	368	440	432	816	352	368	560	568	120	424	400	1160	264
Lubbockia sp.			8	8			8					8		16										8						8			4					16	
Sapphirina spp.	2						1				4			1	1	4	4	8	4	4	1						2							4	2		2	2		2
Copilia spp.	1			4	1				1			2	2		1	4			4	2		8	1		2	1	4	4			2	4		4	4		2	4	4	4
Corycaeus spp.	48	56	176	64	80	64	320	24	48	640	40	80	56	160	200	48	16	72	32	90	32	160	90	80	72	88		200	108	144	528	256	160	126	120	30	120	72	128	80