Classification and Communities of the Zooplankton in the South-Western Pacific Ocean, with Special Reference to Copepods*

By
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The Kôyô-maru, training vessel of our university, made the oceanographic survey during the period from October, 1969 to January, 1970 in the south-western Pacific Ocean. The present paper deals with the zooplankton samples collected in this cruise.

Many studies on copepods of this region have been carried out by the following researchers: BRADY[1,2], GIESBRECHT and SCHMEIL[3], CLEVE[4], SCOTT[5,6], FARRAN[7,8], SEWELL[9], JOHNSON[10,11], WILSON[12], TANAKA[13], CHIBA *et al.*[14,15], TSURUTA *et al.*[16], SENO[17], TSURUTA[18], VINOGRADOV and VORONINA[19], THE OCEANO. SURVEY COMM. of SHIMONOSEKI UNIV. FISH.[20], HEINRICH[21,22], KOGA *et al.*[23].

KOGA *et al.*[23] have already reported the oceanographic condition and the distribution of zooplankton biomass in this region. In the present paper, therefore, the authors describe some aspects on the difference between the structures of zooplankton communities including species composition and its abundance.

Material and Methods

The zooplankton samples used in this study were collected on board the Kôyô-maru during the period from November 4 to December 29, 1969 at 40 stations (Fig. 1, and Table 1). The samples were taken by the Indian Ocean Standard Net, 113 cm in mouth diameter, 500 cm in length and constructed with gauze having 0.33 mm mesh opening. The net was towed vertically from 200 m depth to the surface at a speed of 1 m/sec. Immediately after the collection, the samples were fixed with 5% formalin solution. The inspection and the measurement of the plankton were conducted in the laboratory on land: after the identification of the species, the composition and relative abundance of each species were recorded. The individual number was also recorded when it was possible. In order to indicate the relative abundance of respective species, the following

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five symbols were used: CC means very common occurrence with the percentage of about 45%; C, common -30%; +, present -15%; R, rare -8%; RR, very rare -2%.

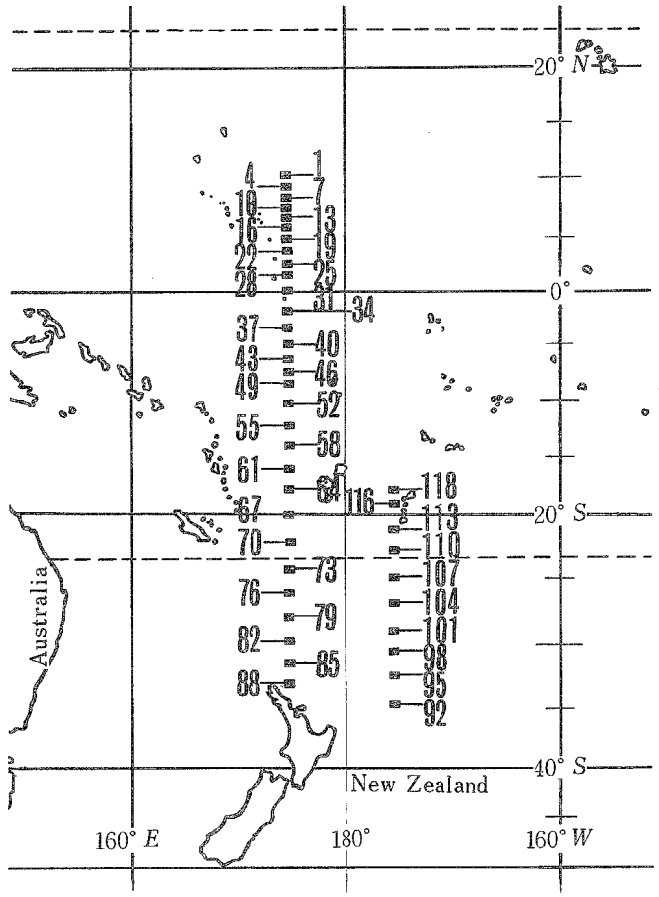

Fig. 1. Map showing the sampling station in the south - western Pacific Ocean.

Results

From the zooplankton specimens collected throughout the present area (St. 1 to 118), the names of the important class or order could be arranged in the following order.

1. Copepoda
2. Chaetognatha
3. Appendicularia
4. Malacostraca (belong to Amphipoda, Decapoda, Euphausiacea)
5. Ostracoda
6. Foraminifera
7. Gastropoda
8. Dinoflagellata
9. Medusa
10. Polychaeta

Table 1. Date and position of each sampling station in the southwestern Pacific Ocean.

St. No.	Date	Position		St. No.	Date	Position	
		Latitude	Longitude			Latitude	Longitude
1	Nov. 4,'69	09°65′5 N	174°54′0 E	67	Nov.22,'69	20°00′0 S	175°00′0 E
4	4,	08 55 0	175°04 0	73	23,	24 00 0	175 00 0
7	5,	08 00 0	175 59 0	76	23,	26 00 0	175 00 0
10	5,	07 01 8	174 59 8	82	Dec.15,	30 00 0	175 00 0
13	6,	06 00 4	175 04 7	85	16,	32 00 0	175 00 0
16	6,	05 00 0	175 02 9	92	24,	35 00 0	176°00′0 W
22	7,	03 00 0	175 00 0	95	24,	33 00 0	176 00 0
25	7,	02 00 0	175 00 0	98	25,	31 00 0	176 00 0
28	8,	00 58 5	174 56 5	101	25,	29 00 0	176 00 0
31	8,	00 00 0	175 00 0	104	26,	27 00 0	176 00 0
49	11,	08°3′00 S	175 00 0	107	27,	25 00 0	176 00 0
52	12,	10 00 0	175 00 0	110	27,	23 00 0	176 00 0
55	12,	12 00 0	175 00 0	113	28,	21 00 0	176 00 0
61	13,	16 00 0	175 00 0	116	28,	19 00 0	176 00 0
64	21,	18 00 0	175 00 0	118	29,	17 00 0	176 00 0

Ciliata, Cladocera, Radiolaria and Thaliacea were also found, but less abundantly. Fish eggs and larvae, veliger larvae, and young copepods were abundant in numbers and were ranked next of Malacostraca. Although zooplankton in the area investigated included many groups and their communities were very diverse, Copepoda appeared most frequency; viz. it occupied more than 50% of the number of individuals in each station. Copepods of 75 species in 36 genera were identified (Table 2). The abundance of species number could be arranged as follows.

1. Genus *Corycaeus,* including 8 species.
2. Genus *Eucalanus* and *Candacia,* including 4 species, respectively.
3. Genus *Calanus, Euchaeta, Centropages, Pleuromamma, Haloptilus, Acartia, Oithona, Oncaea and Sapphirina,* including 3 species, respectively.
4. Genus *Rhincalanus, Mecynocera, Paracalanus, Acrocalanus, Lubbockia, Pachysoma, Microsetella, Aegisthus* and others, including only one species, respectively.

Although *Corycaeus* showed the maximum number of the species among the genera of Copepoda, the total number of the individuals was few. Therefore, this genus is not considered to be dominant through the all stations in this region. While, genus *Oncaea* contained remarkably abundant individual numbers despite the small number of species.

Suborder Calanoida revealed the maximum number of both species (48 species) and individuals, and suborder Cyclopoida (22 species) followed this. While, suborder Harpacticoida (5 species) was the least in both species and individual numbers.

The small-sized copepods, 0.6 ~ 1.5 mm, such as *Paracalanus aculeatus, Clausocalanus arcuicornis, Mecynocera clausi, Lucicutia flavicornis, Oncaea media, Oncaea venusta* occurred abundantly. They occurred very widely and dominantly in the south-western

Table. 2. List of zooplankton, chiefly Copepoda species, occurred at each station in the south-western Pacific Ocean.

Species \ St. No.	1	4	7	10	13	16	22	25	28	31
COPEPODA										
Calanus helgolandicus	RR	R	R		+			RR	RR	+
Nannocalanus minor		+	R	RR	RR		R	+	+	+
Canthocalanus pauper		RR	R	+			R	RR	R	
Neocalanus robustior	R	+	R	RR	+		+	+	+	+
Neocal. gracilis			RR	R	+		+	+	+	+
Undinula darwini		+	+	R	+		R	R	+	C
Eucalanus attenuatus	RR	RR	R	RR	R		R	+	+	+
Eucal. elongatus										
Eucal. mucronatus				RR	R		RR	R	RR	R
Eucal. crassus								+	+	+
Rhincalanus nasutus								R	RR	
Mecynocera clausi	RR	R	+	RR	+		R	R	R	RR
Paracalanus aculeatus	R	R	+	R	C		C	+	+	+
Acrocalanus gracilis					C		+			
Clausocalanus arcuicornis			+	+	+		C	+	CC	+
Clausocal. sp.				RR	+		+	+	+	+
Aetideus armatus										
Aeti. giesbrechti	RR	RR	R	R						
Calocalanus pavo		RR	RR	RR	RR			R	RR	R
Gaetanus armiger		RR	R	RR						
Euchirella rostrata		R		RR	RR	RR				RR
Euchaeta marina		R	RR	RR	R		RR	C	C	CC
Euch. longicornis		R	RR	R	R		RR	+	+	C
Euch. wolfendeni										
Euch. spp.			RR	R	+				RR	+
Scottocalanus helenae		RR	RR		RR	R				
Scolecithrix danae	RR	R		RR	R			RR	RR	R
Centropages gracilis		—	RR						R	R
Cent. orsini		+			R		R		R	
Cent. elongatus		+							R	
Cent. spp.			+	R	R					
Temora discaudata										
Pleuromamma gracilis		R		R						
Pleuro. xiphius			R	+	RR			R		
Pleuro. abdominalis		RR		R	RR					
Lucicutia flavicornis	CC	CC	+	C	+		+	+	—	R
Heterorhabdus papilliger		RR	R	RR						
Haloptilus ornatus		R	RR	RR			R		RR	
Halo. spinifrons		RR		RR						
Halo. acutifrons				RR						
Candacia aethiopica					R			RR	RR	R
Cand. catula					R				R	R
Cand. truncata	R		R	+	+		R	R		
Cand. pachydactyla	R	R		R				R	R	RR
Calanopia elliptica			R							
Labidocera japonica			RR	RR	RR					
Pontella spinicauda									RR	
Acartia neligens		R	R				+	+	R	+
Acar. danae	RR	RR			RR		RR	R	R	
Acar. longiremis					+		+			
Oithona setigera		R	+		+	R	RR		+	+
Oith. fallax	+	+	+				+	R	+	R
Oith. rigida								R	R	R
Oncaea venusta	+	C	+	C	C	RR	+	C	C	C
On. media	+	+	C	C	+		+	+	C	+
On. conifera		R	R	+	+	+	RR	R	R	R
Lubbockia squillimana										
Sapphirina gemma		RR	RR	RR	RR	RR				
Sapp. opalina	RR	R	RR	R	R	RR		RR	RR	+

49	52	55	61	64	67	73	76	82	85	92	95	98	101	104	107	110	113	116	118
		+	+	+	R	+	RR							R		RR		+	+
		R	+	+	+	+	+							R		+		+	R
			R	R	+	+	+							+		+		R	R
			+			C	C		R		+			+		+		C	
	RR			−	C	+	+		−					+		+		R	RR
+	R			R	RR	R	+		R					R		C	+	+	R
R	RR	+	R	RR		+	+		R					+		RR	R	RR	RR
					RR	R	RR							RR					
		RR			RR	RR	R											RR	RR
		RR		RR	R	RR	R											RR	R
R			+	+	RR														
		R																	
		R	+	+	C	C	+		RR	R				C		CC	CC	+	+
R	RR	RR	+	+		+	C		C		C	R		R		+		+	
			+	C	+	+	+							+		RR	+	+	+
+	R	R	+	C	C	+	+		C					+			R	RR	R
				R	R		RR		+									RR	+
						R										R			
					RR	RR	RR												
R	R	R	RR	+	R	RR	RR							R			+	R	R
					RR	RR	RR												
+	+	R		RR	RR	RR	R					RR						RR	R
	+	+	R	R	R	R	RR				R	R					RR	RR	R
		R	R	−	R	+	R							R		RR	RR	+	R
				R	R	+	+					RR	RR						
R	+		R	R			RR							RR				RR	RR
													RR						
RR	RR			R	R	RR	R							R			RR	+	R
				R	+		R									R		RR	
					R		R				RR			R				RR	
			R				R												
																	RR	RR	RR
																		RR	RR
				R	C	R	+				C							C	
	R				+	RR	RR				R	RR	C					RR	RR
					R		+											R	RR
RR		R	C	R	C	C	+		R		R	+		C		+	C	C	C
											R	RR							
RR		R	RR	RR	RR	R	+	R					RR	R		R	R	R	RR
											RR							RR	RR
			R						RR					R			RR	RR	RR
				+										+					
	RR				R			RR								R		RR	R
R		R	+	+	+	R	RR							R		+	+	+	R
		RR	RR		R						R			R			RR	RR	
														RR			RR	RR	
				+					+		+	+	+	+			R		R
		R	RR	+		+	+	+	+	+	+	+	R	+		+	+	R	R
							+	+	−	RR	R							R	RR
				R	RR	+	R				RR	+		+		+	+	+	RR
		RR	R	R	R	+	R	RR						+		+	+	R	
				R	RR	+	R										RR	RR	RR
CC	+	+	+	+	+	+	+		+		+	+	C	C		C			C
C	+	R	+	+	R	R	+		−	R	+	+	+	+			R	+	C
		R	RR	RR	R	R	RR					+	C	+					
		+	+	+	+									R		R	C	R	+
				RR	R	R	RR							R			R	RR	
		RR	RR	RR	RR	RR	RR							R		R	R	RR	RR

Table 2. — (Cont'd)

Species \ St. No.	1	4	7	10	13	16	22	25	28	31
Sapp. nigromaculata				RR						R
Sapp. spp.				RR						RR
Copilia mirabilis		RR								
Cop. quardata		R	R	RR			RR	RR	RR	RR
Pachysoma dentatum										
Corycaeus speciosus	RR	R	RR	R	RR		RR	R	+	R
Cory. clausi	+	+	R	RR	RR		+	+	+	+
Cory. crassiusculus		RR	RR	RR	R			RR	R	RR
Cory. longistylis	R	R	R	RR	+		RR	RR	+	RR
Cory. lautus	+	R	R	R	R				R	R
Cory. dahli	+									
Cory. agilis					+				R	
Cory. gibbulus	+	−	+	R	+		+	+	+	+
Cory. concinnus	+	−	+					+	+	R
Cory. spp.	R			RR	RR			R	R	
Microsetella rosea	RR									
Mieroset. gracilis										
Clytemnestra rostrata										
Cly. scutellata										
Aegisthus mucronatus		RR	RR							
DINOFLAGELLATA										
Pyrocystis noctiluca	RR	RR	RR		RR	RR	RR		RR	R
Ceratum macroseros var. *gallicum*		R	R		RR				RR	RR
Cera. sumatranum										
Cera. spp.		+	R	RR	RR				RR	RR
CILIATA										
FORAMINIFERA										
Globigerina bulloides			R		RR		C			
Globi. spp.				R		RR		R	RR	RR
Orbubina universa										
RADIOLARIA										
Collozum inerme				RR						
MEDUSA										
Muggiaea spp.	RR				RR	RR	R	RR	R	R
Abyla spp.						RR	RR		R	
MALACOSTRACA		R	RR				R			R
GASTROPODA										
Atlanta spp.	RR	R	R	RR	RR	RR	RR	R	RR	
APPENDICULARIA										
Oikopleura spp.		R			R		RR		R	
THALIACEA										
Doliolum spp.		RR	RR				RR	RR	RR	RR
Salpa spp.			RR							
POLYCHAETA	RR	R	RR	RR	R	RR	RR	RR	RR	
OSTRACODA										
Conchoecia magna		R	R	+						
Concho. spp.		RR	RR	R						
Cypridina notiluca	R	RR	R				RR			
Cypridina spp.										
CLADOCERA	RR						RR			
CHAETOGNATHA										
Sagitta spp.		+	+	+	C		C	C	CC	
PLANKTONIC LARVAE										
Fish eggs & larvae	R	R	R	RR	R			RR		R
Cyphonautes larvae						RR				
Malacostraca larvae		R	RR	R	RR		R		R	R
Veliger larvae		RR	RR		RR		R			
Polychaeta larvae		RR	R	RR						
Copepoda youngs		RR	RR	RR	RR	RR	RR			

49	52	55	61	64	67	73	76	82	85	92	95	98	101	104	107	110	113	116	118
				R		R								+		RR	RR	RR	
				RR		RR	R							+		RR			RR
			RR														RR	RR	RR
																RR	RR		
RR	RR		R	RR	RR	R								RR		RR	RR	RR	RR
R			R	R	RR									+		+	R	R	+
RR		RR	R	RR	R	+										R	R	RR	
		R	R	RR							RR	+	RR	R		R	RR	RR	R
R			R	RR	RR	RR			RR								RR	RR	RR
			+	+	RR	R	RR							RR			RR	R	R
		RR	R																
RR	R	+	+	+	R	RR										R	R	RR	R
RR	R	+	R	+	RR	RR	R		R			R		R		+	+	+	+
			R	R	R	+						+							
													R	RR					
						RR			RR				RR	RR	RR	R	RR	RR	
												+	RR	R					
						R			RR			R	RR	R		RR			
			RR	RR	R	RR										RR	R	RR	R
		RR	R	RR	RR	RR								RR					RR
			RR			RR											RR		RR
			+	RR	RR									RR					
			RR		+														
				RR		+	+							RR		RR	R		
							RR		RR		RR			RR					
																	RR		
	RR	RR				RR	RR		RR		RR		RR	R		RR	R	RR	RR
RR			RR	RR		RR	RR		RR		RR			RR	RR				
		RR	RR		RR	R	+	RR	RR		RR			RR		R	R	R	
RR			R	RR	RR		RR									R	R	RR	
		R	R			R	R				RR			R		RR	+	R	RR
							RR										RR		
				RR		RR													
			RR	R	RR	RR	RR				RR			RR		RR	RR		RR
RR			R	RR		R	+				RR	RR		R				R	
														RR		R	RR		
		RR			R		R		RR					RR		R	R	RR	R
											R			R					
				RR						RR									
		+	C	C	+	+	+			+	RR	RR		+		C	CC	+	C
			R	RR	R	R	R		RR			R	RR	R	RR	RR	RR	RR	R
																RR			R
RR			RR	RR	RR	R	R				RR		R	RR		R	RR	RR	RR
R				RR	RR	RR	+									+	R	R	
																	RR	RR	
	RR	C	R		RR		C	CC			RR	C	C			R	RR	RR	RR

Pacific Ocean. On the other hand, the large-sized species, 2.6 ~ 5.5 mm, such as *Eucalanus elongatus, Rhincalanus nasutus, Pontella spinicauda, Euchaeta marina, Euchaeta longicornis* were rare and few in the number of individuals. In addition, the species of intermediate size, 1.6 ~ 2.5 mm, were also found at some stations. These species were *Calanus helgolandicus, Nannocalanus minor, Neocalanus gracilis,* and *Undinula darwini.*

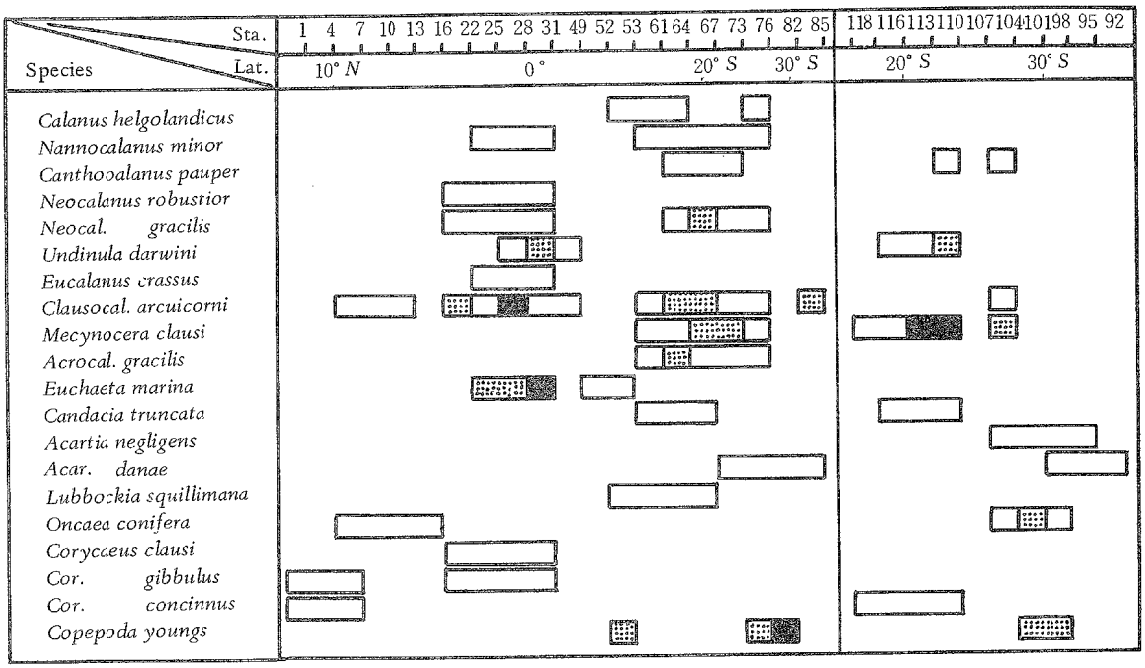

Fig. 2. Showing the distributional patterns of some copepods in the south-western Pacific Ocean. Solid dotted, and open correspond with the Symbols of CC, C, and + in the abundance of the plankton, respectively.

A great abundance of the plankton in the northern part of the equatorial area between 03°N and 0° lat. was found as was reported by Heinrich[21] (Fig. 2). Five species of Copepoda, *Neocalanus robustior, Eucalanus crussus, Euchaeta marina, Corycaeus gibbulus,* and *Corycaeus clausi* occurred there. There is also a great abundance of copepods in the southern part of the equatorial area, between 12°S and 26°S lat., where *Calanus helgolandicus, Canthocalanus pauper, Candacia truncata, Acrocalanus gracilis, Mecynocera clausi,* and *Lubbockia squillimana* were seen abundantly. Five species, which are *Nannocalanus minor, Neocalanus gracilis, Undinula darwini, Clausocalanus arcuicornis,* and *Corycaeus concinnus,* were found to be abundant in both parts of the equatorial area mentioned above. Three copepods, *Acartia negligens, A. danae* and *Oncaea conifera,* however, did not follow the previous three pattern of distribution. The first species was found abundantly in the area from 27°S to 33°S lat., the second one from 24°S to 35°S lat., and the third one from 07°N to 05°N lat. and from 27°S to 31°S lat., respectively.

The following species were rare and found locally. *Aetideus armatus* was apparently restricted to Sts. 73 (24°S lat.) and 110 (23°S lat.), *Calanopia elliptica* to St. 7 (08°N

lat.), *Pontella spinicauda* to St. 28 (0°58'N lat.), *Copilia mirabilis* to St. 113 (21°S lat.), *Aegisthus mucronatus* to Sts. 4 (8°55'N lat.) and 7 (08°N lat.). Further, young copepods were dominant in the southern part of the equatorial area between 12°S and 31°S lat. No species besides copepods indicated distinct latitudinal distribution.

The planktonic animals identified other than copepods were 7 species. Among these species, *Sagitta* spp. were most numerous in numbers. The following species occurred very rarely: *Muggiaea* spp., *Atlanta* spp., *Cypridina noctiluca, Conchoecia magna.*

A NOTE ON THE SPECIES DISTRIBUTION NEW TO AREA:

Aegisthus mucronatus GIESBRECHT 1891 (Fig. 3)

Suborder HARPACTICOIDA

Family PONTOSTRATIONTIDAE

Genus *Aegisthus* GIESBRECHT

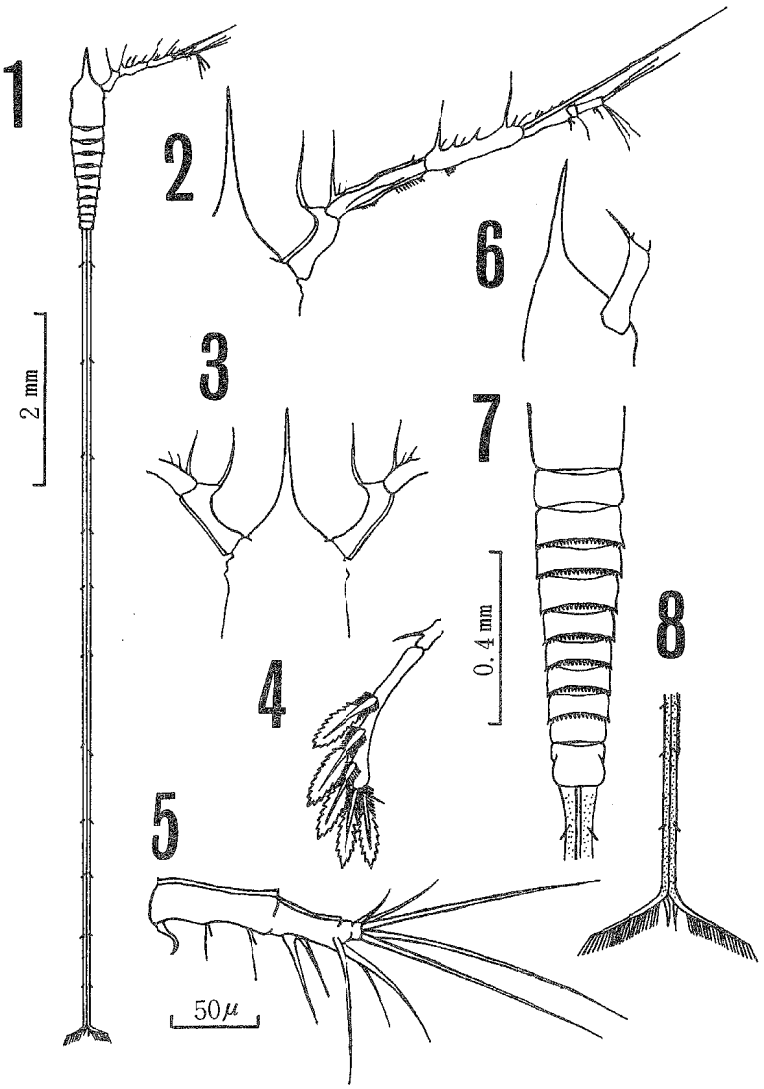

Fig. 3. *Aegisthus muoronatus* Giesbrecht (juvenile female, copepodite stage V). 1, dorsal view; 2, lst antenna; 3, head, dorsal view; 4, 5th leg; 5, second maxilla; 6, head, lateral view; 7, posterior portion of body; 8, end of furcal setae. Scales; 2 mm bar for 1; 50μ, for 5; 0.4 mm, for all the others.

The present species occurred at the Sts. 4 and 7. They agreed with the females in the copepodite stage V described by JOHNSON.[10] Body length of female stage V is 1.9～2.0 mm. The body consists of 10 segments including 6 cephalothrax segments, 3 abdomen proper segments and an anal segment. The anal segment is confluent with the short caudal rami. In both right and left, the first antennae, whose length is about 1.0 mm, consist of 7 segments. The longest seta of the furca is about 9.0 mm and prominent as spine. The serratures occurring on the posterior margins of the 2nd – 6th thoracic and the 1st – 2nd abdominal segments are retained, but the single spine of each posterior lateral margine of the head is lost. The end of the longest caudal seta is forked, and one of them bears many fine and short bristles.

Occurrence: St. 4 (08°55'N lat., 175°04'E long.)
St. 7 (08°00'N lat., 175°59'E long.)

Temperatuer and Salinity:
The range of mean water temperature, 21.39°C (St. 7) – 22.00°C (St. 4)
The range of mean salinity, 34.32% (St. 4) – 34.38% (St. 7)

Distribution: This species described first by GIESBRECHT in 1891, has never been reported on any paper published by TANAKA,[13] CHIBA *et al.*,[14,15] TSURUTA *et al.*,[16] THE OCEANO. SURVEY COMM. OF SHIMONOSEKI UNIV. FISH.[20] in the south-western Pacific Ocean and Indian Ocean. In this region, therefore, the present finding is the first record. JOHNSON[24] reported that this species has a very wide distribution and occurs in the tropical Pacific, Gulf of Guninea, North Atlantic, North Sea, Malay Archipelago, Gulf of Maine nad Gulf of Gascogne. TANAKA[25] also reported this species in the Kuroshio Basin in the Izu region.

Discussion

The present results may be compared with those reported by HEINRICH,[22] who made the survey in the same region, west of 170°W long., in the south-western Pacific Ocean.

Undinula darwini LUBBOCK HEINRICH[22] reported that this species revealed the maximum abundance in the equatorial area between 10°N lat. and 10°S lat. We found that it was more dominant in the water between 03°N and 0° lat. than in the other area. Therefore, it seems that the distribution of this species extends to the water adjacent to the equator.

Mecynocera clause THOMPSON and *Calanus helgolandicus* DANA. In this study, these species appeared most abundantly in the area between 12°S and 26°S lat. HEINRICH[22] found the former species in the area between 20°S and 30°S lat., and the latter in the area between 10°S and 20°S lat. These species seem to be dominant in

the southern part from the equator.

Acartia danae GIESBRECHT and *Acartia negligens* DANA HEINRICH[22] reported that the bands of the maximum abundance of the former species was found only in the south of 30°S lat. The results of the present study indicated apparently that there was a distributional zone of the maximum abundance in the southern area between 24°S and 35°S lat. Although she reported that the latter species was found numerously in the area between 10°S and 20°S lat. and the area between 10°S and 30°S lat. in addition to the area of the equator, the authors observed that this showed the maximum abundance not in the equatorial area but in the further southern area between 27°S and 33°S lat. As to these species, therefore, it seems that they can be abundantly found in the water around 30°S lat.

HEINRICH[22] and BEKLEMISHEV[26] have reported that the most important ecological boundary among the areas of maximum abundance of the various species was found approximately in the area between 10°N and 10°S lat., which is also the boundary among three main communities. In this study, we recognized such boundaries as mentioned above in the area between 03°N and 0° lat. or between 12°S and 26°S lat. in nearly the same region, west of 176°W long. The numbers of species and individuals were more abundant in the northern (03°N ~ 0° lat.) and southern (12°S ~ 26°S lat.) parts of the equatorial area sourrounded by these boundaries than in the area at the north of 05°N lat. or the area at the south of 30°S lat. Therefore, the species diversity seems to be higher in this equatorial area than in the other water.

KOGA *et al.*[23] divided this region into four different area based on the water mass analysis. They reported that *Oncaea venusta* and *Oncaea media* were found dominantly in all areas, while *Mecynocena clausi* was abundant only in the water south of 16°S lat. These results were clearly confirmed by the present study.

Concerning the occurrence of zooplankton other than copepods, the similar phenomena were noticed in chaetognaths and euphausiids in the Pacific Ocean [27,28]. In the present study, however, we could not be able to recognize the apparent latitudinal occurrence of these groups.

The occurrence of *Aegisthus mucronatus* GIESBRECHT in the deep layers was previously reported as follows: vertical hauls from 1800 m (GIESBRECHT, 1891a,b, 1892), 382 and 620 fathoms (PEARSON, 1907), 120 fathoms (FARRAN, 1904), 400 ~ 700 fathoms (FARRAN, 1909), 300 fathoms (WOLFENDEN, 1904), and 1000 ~ 3000 m (WOLFENDEN, 1911). The horizontal distribution of this species in the Pacific and the Atlantic Oceans was reported as the following: the Atlantic Ocean – Faroer canal (WOLFENDEN, 1904), Biscay Bay (FARRAN, 1926), Sargasso Sea (SARS, 1916), Gulf of Guniea (CLEVE, 1904); the Pacific Ocean – southern California, Juan de Fuca, and Cape Mendocino (JOHNSON, 1937), 06°07'N lat. -121°44'E long., 04°27'N lat. -125°25'E long., 03°01'N lat. -122°02'E long., *etc.* (SCOTT, 1909). From descriptions of these observations, it seems that the young stages of this species occur generally in the surface waters shallower than 200 m, while the adult stage occurs most abundantly in the waters deeper than 200 m. Despite the present species has the wide spread distribution both in the

Pacific and the Atlantic Oceans as mentioned above, only little apperance (two individuals) in the south-western Pacific Ocean was observed in this study. This suggests that this species occurs sparsely in the surface waters, and the adult should occur in quantity in the deep water below 200 m.

The species showing local occurrence, *Aetideus armatus, Calanopia elliptica, Pontella spinicauda, Copilia mirabilis,* and *Pachysoma dentatum,* seem to have the same ecological habits as *Aegisthus mucronatus.*

Summary

1) The species composition and its abundance of zooplankton was studied on the materials obtained during the oceanographic survey of the Kôyô-maru in the south-western Pacific Ocean.

2) The most abundant forms were copepods occuping 50% or more of the total individual number of zooplankton examined. The species number identified reached up to 75 (48 species of Calanoida, 22 species of Cyclopoida and 5 species of Harpacticoida) in 36 genera.

3) The small-sized copepods such as *Paracalanus aculeatus, Clausocalanus arcuicornis, Mecynocera clausi, Lucicutia flavicornis, Oncaea media,* and *Oncaea venusta* were dominant in the present water. While, the large-sized copepods such as *Eucalanus elongatus, Rhincalanus nasutus, Pontella spinicauda, Euchaeta marina,* and *Euchaeta longicornis* occurred very rarely.

4) The occurrence, new to area, of the juvenile female of *Aegisthus mucronatus* in the 5th copepodite stage was only confined to the surface waters (0 – ca. 200 m) of the Sts. 4 and 7.

5) The latitudinal distribution of copepods species showed three distributional patterns as presented diagrammatically in Fig. 2.

6) *Neocalanus robustior, Eucalanus crussus, Euchaeta marina, Corycaeus gibbulus,* and *Corycaeus clausi* were more abundant in the northern area from the equator (03°N ~ 0° lat.). While, *Calanus tenuicornis, Canthocalanus pauper, Mecynocera clausi, Acrocalanus gracilis, Candacia truncata,* and *Lubbockia squillimana* were abundant in the southern water from the equator (12°S ~ 26°S lat.). The other species such as *Calanus minor, Neocalanus gracilis, Undinula darwini, Clausocalanus pergens,* and *Corycaeus concinnus* revealed no distinct distribtuion pattern and were found in either areas.

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References

1) BRADY, G. S., 1883: Report on the Copepoda obtained by H. M. S. Challenger during the year 1875–1876. *Rep. Sci. Res. Voy. H. M. S. Challenger, Zool.*, 8, 1–140.
2) BRADY, G. S., 1889: On the marine Copepoda of New Zealand. *Trans. Zool., Soc. London*, 15.
3) GIESBRECHT, W. and O. SCHMEIL, 1898: Copepoda 1. Gymnoplea. Das Tierreich, 6, Crustacea, 1–165.
4) CLEVE, P. T., 1901: Plankton from the Indian Ocean and Malay Archipelago. *Kongl. Svenska Vet-Akad. Handl.*, 35 (5). 1–55.
5) SCOTT, A., 1902: On some Red Sea and Indian Ocean Copepoda. *Trans. Liverpool Biol. Soc.*, 16, 397–425.
6) SCOTT, A., 1909: The Copepoda of the Siboga Expedition—Part 1, Free-swimming, littoral, and semi-parasitic Copepoda. *Siboga Exp. Monogr.*, 29, 5–320.
7) FARRAN, G. P., 1911: Plankton from Christmas Island, Indian Ocean, 1, On Copepoda of the family Corycaedae. *Zool. Soc. London*, 1913, 285–296.
8) FARRAN, G. P., 1913: Plankton from Christmas Island, Indian Ocean 2, On Copepoda of the genera Oithona and Paroithona. *Zool. Soc. London*, 1913, 181–193.
9) SWELL, R. B., 1929: The Copepoda of Indian Seas. Calanoidae. *Mem. Indian Mus.*, 10, 1–221
10) JOHNSON, M. W., 1949: Zooplankton as an index of water exchange between Bikini Lagon and the open sea. *Trans. Amer. Geophys. Union*, 30, 234–244.
11) JOHNSON, M. W., 1954: Plankton of the Northern Marshall Island. *U. S. Geol. Surv. Profess. Papers*, 260, 301–304.
12) WILSON, C. B., 1950: Contribution to the biology of the Philippine Archipelago and adjacent region. Copepods gathered by the United States—Fisheries Steamer "Albatros" from 1887 to 1909, chiefly in the Pacific Ocean. Uni. Sta. Gov. Pri. Off. Wash., 141–441.
13) TANAKA, O., 1954: Pelagic Copepoda. Biological results of the Japanese Antarctic Research Expedition 10.
14) CHIBA, T., A. TSURUTA and H. MAĖDA, 1955: Report on Zooplankton sample hauled by larva-net during the cruise of Bikini-Expedition, with special references to Copepoda. *This Jour.*, 5 (3), 31–55.
15) CHIBA, T., T. SATOW, A. TURUTA, O. HIRONO and S. TAGAWA, 1967: Oceanographical and planktological studies of the tunafishing grounds in the middle part of the North Indian Ocean. *Ibid.*, 6 (3), 7–29.
16) TSURUTA, A., T. SATOW, K. HAYAMA, and T. CHIBA, 1957: Oceanographical and planktological studies of tuna-fishing ground in the eastern part of the Indian Ocean. *This Jour.*, 7 (1), 1–17.
17) SENO, J., 1962: Plankton collected by the "Umitaka Maru" in the Indian Ocean. *Inform. Bull. Planktol. Japan*, 8, 12–14.
18) TSURUTA, A., 1963: Distribution of plankton and its characteristics in the oceanic fishing ground, with special reference to their relation to fishing. *Ibid.*, 12 (1), 42–53.
19) VINOGRADOV, M. E. and N. M. VORONINA, 1963: Quantative distribution of plankton in the upper layers of the Pacific equatorial currents, 1. The distribution of the standing crop and the horizontal distribution of some species. *Trudy Inst. Okeanol.*, 71, 22–59.
20) The Oceano. Survey Comm. of Shimonoseki Univ. Fish., 1965: Data of oceano-

graphic observation and exploratory fishing, No. 1, International Indian Ocean Expedition 1962–63 and 1963–64.
21) HEINRICH, A. K., 1968: Quantitative distribution of the plankton animals in the West Pacific. In the plankton of the Pacific Ocean., Ed. by H. J. SEMINA, 87–102. Nauka, Moscow.
22) HEINRICH, A. K., 1969: On the tropical plankton communities in the western Pacific. *J. Cons. int. Explor. Mer.*, 33 (1), 45–52.
23) KOGA, S., S. TAWARA and A. TSURUTA, 1971: Oceanic condition relevant to distribution of zooplankton biomass in the central south Pacific. *This Jour.*, 20 (2), 15–23.
24) JOHNSON, M. W., 1937: Notes on final metamorphosis of the male *Aegisthus mucronatus* Giesbrecht, and its bearing on the status of some uncertain species. *Trans. Amer. Microscop. Soc.*, 56 (4), 505–509.
25) TANAKA, O., 1965: The pelagic copepods of the surrounding waters of Japan. *Inform. Bull. Planktol. Japan*, 12, 16–24.
26) BEKLEMISCHEV, C. W., 1967: Biogeographical division of the Pacific Ocean within surface and intermediate waters. In the Pacific Ocean, 7; Biology of the Pacific Ocean, Book 1, Plankton, 98–169, Nauka, Moscow.
27) BIERI, R., 1959: The distribution of the plankton Chaetognatha in the Pacific and their relationship to the water masses. *Limonol. Oceanogr.*, 4, 1–28.
28) BRINTON, E., 1962: The distribution of Pacific euphausiids. *Bull. Scripps Inst. Oceanogr.*, 8, 51–269.