Report on Zooplankton Samples hauled by Larva-net during the cruise of Bikini-Expedition, with special References to Copepods.※

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Since the Fukuryu-maru No. 5, a tuna long-line boat of about 100 tons, was contaminated by fission products, so-called "ash of the death", of the Hydrogen bomb exploded at Bikini Atoll on March 1, 1954, the fear for the contamination of tuna and many other important fishes by fission products in the neighbouring waters of Bikini Atoll has been increasing in this country. And our tropical tuna fisheries were influenced seriously by this matter.

As the process of the contamination of fishes, two different ways may be expected, —— one is the direct infection through the water and the other is the indirect one through preys. Then, in order to ascertain which of the ways is more reasonable, it is necessary to examine the plankton occurring in the contaminated waters to know how strongly the plankters are contaminated and how they are influenced. Fortunately the authors could have a opportunity to examine the plankton samples collected by the SHUNKOTSU-MARU during her cruise of Bikini-Expedition. In the following, the records of the compositions of plankton samples hauled by larva-net, the horizontal differences of plankton composition according to the latitude and the current and especially the possibility of any morphological or ecological modifications caused by fission products on copepods are given and discussed on the material.

Before entering the subjects, we must express our sincere thanks to Dr. M. FUJINAGA, chair-man of the expedition, and Profs. Y. HIYAMA and Y. MATSUE, members of the advicer group for biological surveys, who afforded to us much facilities for carrying out this work. Also we must record here our hearty thanks to Mr. H. YABE and all other staffs of the survey group, especially to those of the biological party, Capt. K. KOMANO and all other crews of the SHUNKOTSU-MARU for their kindness in helping us extensively during the cruise. Further cordial thanks must be extended to Dr. T. TOKIOKA for his valuable advices. Financial aid granted from the Fisheries Agency of the Ministry of Agriculture for the present investigation is gratefully acknowledged.

I. Material and Method of Collecting Samples.

The material for this study was collected during the period from May 21

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to June 29, 1954 at stations shown in Fig. 1, by the larva-net which is 130cm in diameter of the openning and 450cm in length, stretched with the Japanese minnow net in the anterior 350cm in length and with the silk gauze of 60 meshes in the rest and was equipped with a 3.2 kg lead and the rope of 170m long in use. The net-rope was slacked off by the drift of the ship and the net was hauled at the speed of 24 or 42.5m/min.. Usually the sampling was repeated several times till the sufficient amount of planktons could be secured. Samples were fixed with formalin, divided into the

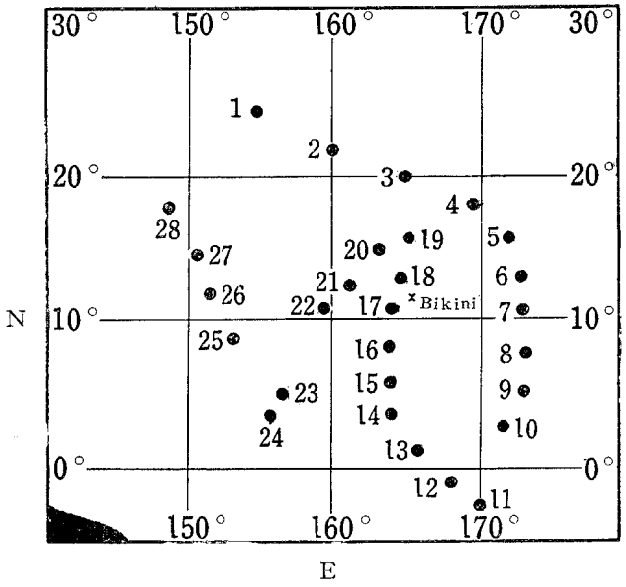

Fig. 1. Map showing the positions of the stations.

Table 1. Stations and their positions.

Station	Date	Lat.	Long.	Time of observation (J. S. T.)
1	21 May	23°— 58' N	154°— 40' E	0500 ~ 0715
2	22	21 — 55	160 — 00	1903 ~ 2046
3	24	19 — 53	161 — 00	0909 ~ 1025
4	29	18 — 12	169 — 43	1000 ~ 1153
5	30	16 — 02	171 — 50	1100 ~ 1232
6	31	13 — 51	172 — 56	0400 ~ 0538
7	1 June	10 — 44	173 — 03	0400 ~ 0600
8	2	8 — 02	173 — 02	0315 ~ 0442
9	3	5 — 03.5	172 — 59	0945 ~ 1400
10	4	3 — 01	171 — 59	0400 ~ 1244
11	6	2 — 21 S	169 — 56	0400 ~ 1740
12	7	1 — 15 S	168 — 05	0400 ~ 0600
13	8	1 — 04 N	165 — 47	0400 ~ 0615
14	9	3 — 55	163 — 52	0400 ~ 1100
15	10	5 — 44	163 — 58	0417 ~ 0730
16	11	8 — 43	164 — 01	0800 ~ 1005
17	12	10 — 55	163 — 51	0400 ~ 0758
18	13	13 — 23	164 — 25	0800 ~ 1039
19	14	15 — 57	165 — 22	0445 ~ 0715
20	19	15 — 03	163 — 15	0400 ~ 0555
21	20	12 — 42	161 — 26	0800 ~ 1030
22	21	10 — 21	159 — 35	0715 ~ 0933
23	23	5 — 03	155 — 53	0747 ~ 1300
24	24	3 — 24.5	155 — 34	0800 ~ 1025
25	26	8 — 59	152 — 51	0535 ~ 0613
26	27	12 — 00	151 — 10	0438 ~ 0530
27	28	14 — 46	149 — 56	0020 ~ 0122
28	29	18 — 00	148 — 38.5	

groups shown in table 8 excepting the sample of the last haul and then the radio activity was measured on respective sub-samples thus classified. The samples obtained by the last haul at each station were brought to our laboratory and used for this study; only the sample from St. 1 was divided

into two halves and one of which was offered to us for examination.

Individual numbers of all identified species were carefully counted in respective samples.

II. Composition of Plankton caught by Larva-net.

The proportions of respective important animal groups are shown in table 2, the most abundant animals were copepods and next came chaetognaths.

Table 2. Composition of chief animal groups at each station.

Station No.	1	2	3	4	5	6	7	8	9	10	11	12
Total number	870	1738	629	147	477	761	456	846	769	2538	2247	2518
Zoo-plankton (%)												
Copepoda	68.6	47.7	78.4	74.8	49.4	58.5	66.2	76.8	48.0	57.3	52.8	54.8
Amphipoda	0.6	1.8	1.0		+	+	+	+	+	+	+	0.5
Schizopoda	4.0	10.8	3.3		+	3.0	+	+	+	0.6	0.9	0.8
Decapoda	+	8.3	+	+	1.9	+		+		+	0.8	+
Phyllopoda		+										
Fish larvae, eggs	1.1	1.4	0.8		1.0	+	1.3	+	+	+	0.8	0.7
Chaetognatha	25.3	18.9	13.4	20.0	41.9	32.9	20.8	17.0	46.0	39.7	38.9	37.7
Medusae		10.9	3.0	4.1	4.6	4.5	11.2	5.0	4.9	1.7	5.7	5.1

13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
2396	2142	271	778	859	336	1504	1998	614	1304	399	692	355	1907	1569
41.1	68.8	78.9	65.2	66.3	92.9	81.5	63.6	57.6	63.6	53.6	68.9	65.1	64.8	66.1
+	0.5		+	1.0	0.9	0.9	+	+	0.8	1.5	+	+	1.6	0.6
0.6	1.0	+	+	+	+	1.0	0.8	1.5	1.7	1.8	+	+	2.1	4.1
+	+	+	+	+		+	+	+	0.9	+			+	3.5
							+							+
	2.4	+	1.4	0.7	+	+	0.8	+	+	+	1.2	0.8	+	0.8
55.3	24.1	13.6	28.3	25.8	3.6	16.3	32.9	30.6	30.3	30.1	21.4	30.7	29.0	8.3
2.4	2.8	6.3	4.1	4.1	1.2	+	1.3	8.3	2.3	12.5	7.7	2.8	1.6	6.7

Values in columns represent the percentages.
+ : less than 0.5%
Ostracods are omitted from the consideration.

Besides them, colonies of *Collozoum* and *Sphaerozoum* of Radiolaria, *Oikopleura*, some Ostracods and *Pyrocystis pseudonoctiluca* of Dinoflagellata were occasionally observed in abundance, but they were not shown in this table.

Abundant species among the above-mentioned animal groups were as follows : Among Schizopoda, most of which were in Furcilian stage, adults of *Euphausia krohnii* were observed abundantly at St. 2, St. 26 and St. 27. Else them, *Siriella thompsonii* (Mysidae), *Thysanopoda tricuspidata* and

Table 3. Occurance of important species.

Station		1	2	3	4	5	6	7	8
Copepoda number of individuals in a haul		597	877	493	110	236	445	302	650
COPEPODA (%)									
Calanus	*darwinii*	16.3	15.9	12.6	14.6	9.8	6.8	20.2	8.5
Ca.	*helgolandicus*	8.7	4.8	29.4	26.3	2.1	2.9	+	–
Ca.	*tenuicornis*	9.0	1.4	2.0		2.1	2.3	+	–
Ca.	*robustior*	1.3	1.3	1.2	1.8	11.4	1.8		3.7
Ca.	*tonsus*						2.0	1.3	12.9
Ca.	*gracilis*	1.2	+	+				3.6	
Ca.	*minor*	11.0	6.6	14.8	1.8	25.0	9.0	16.2	23.7
Ca.	*pauper*	4.0	+	+					
Eucalanus	*attenuatus*	+	1.3			+	+		
Eu.	*mucronatus*		+	4.7	11.8		+	1.3	+
Eu.	*crassus*			+	+				
Eu.	*subcrassus*								
Rhincalanus	*cornutus*								+
Acrocalanus	*gracilis*	+	+						
Acro.	*gibber*	+	+						
Acro.	*longicornis*		+						
Acro.	*monachus*								
Paracalanus	*aculeatus*	1.5	+						
Para.	*parvus*	1.2	+						
Clausocalanus	*furcatus*	4.3	+						
Clauso.	*arcuicornis*	+	2.1	+			1.1		
Clauso.	*pergens*	2.7	+			+	+		
Calocalanus	*pavo*								
Pseudocalanus	*elongatus*								
Scaphocalanus	*pacificus*	+	+						
Actidius	*giesbrechii*	1.5	+	+					
Actidius	*armatus*		+						
Scottocalanus	*helenae*		+	+					
Euchirella	*amoena*	+	+	2.0		+			
Euchaeta	*media*	+	+				1.6	1.3	+
Euch.	*flava*	+	+						
Euch.	*wolfendeni*	+	+						
Euch.	*marina*	+	7.6	16.7	31.8	24.1			
Euch.	*plana*	2.0	4.5	+			29.0	23.2	30.3
Euch.	*longicornis*	+	+						
Scolecithricella	*minor*	1.0		+					
Sco.	*bradyi*	+		+					
Sco.	*spinipedata*	+							
Sco.	*abyssalis*								
Sco.	*orientalis*								+
Scolecithrix	*danae*	+	1.6	1.8		6.8	3.6	4.3	3.5
Phaenna	*spinifera*	+							+
Temora	*turbinata*								+
Centropages	*abdominalis*	+	2.1						
Centro.	*bradyi*	+	+						
Centro.	*violaceus*	+	+			+	1.1		+
Centro.	*calaninus*		+	+					
Centro.	*elongatus*		+						
Centro.	*gracilis*						+		+
Centro.	*longicornis*								
Centro.	sp.								
Pleuromamma	*gracilis*	+	24.5	1.0					+
Pleuro.	*robusta*	+	8.8						
Pleuro.	*xiphias*		4.3	+					
Pleuro.	*abdominalis*		+	+					
Lucicutia	*flavicornis*	1.8	+					+	+
Lu.	*ovalis*					+			+
Heterorhabdus	*papilliger*	+	+	+			+	1.3	
Haloptilus	*longicornis*	+	+	+			2.9	+	1.7
Halo.	*mucronatus*	+	+				+	+	
Halo.	*acutifrons*	+	+	+			+		
Halo.	*oxycephalus*	+	+						
Halo.	*ornatus*	+	+						
Candacia	*bradyi*	+	+						
Can.	*discaudata*	+	+						

9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	26	27	28
369	1455	1187	1374	984	1474	214	507	570	312	1226	1270	354	829	214	477	231	1235	1037
20.0	10.2	11.3	10.4	6.4	7.6	13.6	12.0	8.1	8.7	6.1	5.1	1.4	2.3	7.9	15.7	3.0	5.7	4.2
			2.0	3.9	3.7					+	2.8	3.1	2.4				2.9	
			+	+	0.7	2.8	+	2.8	1.9	0.8	1.6		+	+		1.3	0.9	1.9
2.9	+		+		0.9	5.1		+	2.2	0.9	+		+			+	1.4	+
3.5	1.3	1.1	4.9	4.8	0.9	11.2	2.4	7.4	1.9	3.8	5.4	1.4	2.5	+	1.8	5.2	2.8	1.7
+																		
4.1	1.3	20.5	5.9	5.8	2.0	14.5	3.9	13.3	17.3	9.2	6.1	7.5	2.9	2.8	19.3	15.5	1.6	3.9
											1.3					+		
	4.7	23.5	8.3	5.0	0.9		+	+	+	1.1	1.3	+	+	+	+		+	1.2
		+				+											+	
																	1.9	
			1.7															
	3.0	+	+	+	+			+										
	3.0		4.0	1.9	0.7					+							4.6	+
				+	+													+
	0.8																	
	+				+					+	+						1.0	+
		+	+															+
	+											+						
	+												2.5	13.1		1.7		1.3
+	1.0	1.8	3.3	2.6	1.7						3.1	+			2.3		7.6	1.0
			1.5	+	+					+	+		1.4			1.7	1.9	
					+						+							
																		+
	+									+								
		+	+		+	1.4	+		1.9	2.4	2.7	+	+			1.3	+	+
																	1.1	1.4
35.2	58.7	14.5	35.0	59.7	33.4	20.1	46.7	38.4	26.0	49.2	47.6	27.1	40.9	7.9	30.0	42.0	28.7	20.3
										+						+	0.9	1.0
					+					+								
	+				+													
	+			+	+					+						+	+	
18.2	6.5	6.9	11.0	2.4	4.3	9.8	7.9	3.2	3.8	5.1	1.7	1.1	2.5	9.3	4.8	3.9	1.4	1.5
				+			+											
+	+	+	+	+				+			+	1.1	+		2.1	+	+	
			+				+	1.2				+	+	+	+			+
						2.3	+			+		+	+	+	+	+	+	+
+	+	+	+	+		+		+			+		+		+		+	+
	+		+			+												+
							+											
		+											+			+	4.5	6.6
																+		
+											+						10.3	6.2
							+										+	7.7
1.9	+	1.2	+	+	+	+	+	+		+	+		+	+	1.3	+	2.8	1.9
+	+	1.1	+		+	+		+		+	+						+	1.5
					+	+											1.1	+
+					+	2.8		+		+								+
				+									+					
									+									
						+							+					
			+															

Station		1	2	3	4	5	6	7	8
Can.	*catula*	+	+						
Can.	*longimana*	+	+						
Can.	*bipinnata*	+	+				+		
Can.	*truncata*	3.9	+	+	+	3.0	3.6	2.3	+
Can.	*bispinosa*	3.2	+	1.2		+	3.8		1.4
Can.	*aethiopica*	+	+	+	3.6	4.2	2.0	+	+
Can.	*simplex*	1.0	+	+			1.1	2.6	+
Can.	*curta*						+		
Can.	*violaceus*								
Can.	*pachydactyla*								
Arietellus	*armatus*	+							
Labidocera	*deiruncata*		+						
Labido.	*pavo*		+						
Labido.	*tenuicauda*		+						
Labido.	sp.		+						
Pontella	sp.	+	+						
Pontellina	*plumata*	+	+						+
Pontellopsis	*perspicax*								
Pont.	*tenuicauda*								
Acartia	*neligens*	+						2.3	
Acar.	*clausi*	+							
Oithona	*plumifera*	+		+		+	+		1.1
Oith.	*setigera*								
Oith.	*robusta*								
Oncaea	*venusta*	+							
On.	*conifera*		+						
Lubbockia	*squillimana*								
Sapphirina	*darwinii*	–	1.1						+
Sap.	*auronitens*	–	+	+			+		
Sap.	*stellata*	–	+						
Sap.	*gastrica*		+				+		
Sap.	*nigromaculata*		+						
Sap.	*metallina*								+
Sap.	*intestina*								
Sap.	*opalina*								
Sap.	*angusta*								
Sap.	*gemma*								
Sap.	*scarlata*								
Corycaeus	*gibbulus*	+							
Cory.	*lautus*	+	+	1.0		1.7	+		
Cory.	*speciosus*	1.0	+	1.6	3.6	3.0	+		
Cory.	*flaccus*	2.7		+			16.2	8.0	5.4
Cory.	*crassiusculus*					3.8	+		
Cory.	*longistylis*						1.3	+	+
Cory.	*catus*						+	+	
Cory.	*trukicus*								
Cory.	*japonicus*								
Copilia	*mirabilis*	1.0	+		+		+	6.0	1.2
Cop.	*quadrata*	2.0	+		1.8			+	
Cop.	*longistylis*	+	+						
Pachysoma	*dentatum*	+	+						
P.	*punctatum*								
Undeuchaeta	*minor*		+						
AMPHIPODA		Individual number in a haul.							
Oxycephalus	*porcellus* ?								
Phronima	*pacifica*	2	4			1	1		2
Phronima	sp.			1					
Leptocotis	*ambobus*		3						
Parascelus	*zebu*		11	1					
Phronimopsis	*spinifera*		7						
Hyperia	*sibaginis*	2	4			1	3		
Hyperia	sp.		1						
Anchylomera	*blossevillii*		1						

9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	2o	27	28
	3.8		3		+	+				+	+							
4.1	2.0	2.0		+	−	2.3	+	3.7	5.1	2.4	0.8	4.0	1.9	3.7	4.0	1.7	+	4.4
1.4	+	+		+	−			+	+	1.6	+	+	+				0.9	+
+			+	1.4	32.2		2.8	2.8	6.7	+	+	5.9	1.2	11.2	+	+	3.7	1.0
+	1.0	+	+	+		1.4	3.0	1.6	+	1.5	4.6	2.0	1.7	8.4	1.7	3.0	1.1	1.4
		+	+	+								1.1					+	+
	+																	
		+	+	+														
																	+	+
1.1	+	1.2	0.9	+	+				+	+	+		+			+	1.1	+
	+																	
	+																	
			0.9		+		+	+		+	+	3.1	1.1	+		+	1.4	
+	0.8		2.2	+	+					1.1	+	3.1	2.3				2.0	1.4
		3.1				1.9							2.7			+		
		+													+			
		+	1.3	+	+	+	3.2	+	+	+			+	15.4	4.0		+	4.4
																		+
							+						+					
										+	+				+		+	+
+			+		+	+	+	+		+		1.4	+	+				+
	+		+					+	1.3			+	+		+			+
				+														+
	+	1.4	+	+	+										+			
		+																
		+																
		+																
					+		+										+	
																		+
		+	+		0.9			+	4.5	2.3	1.7	7.5	3.7	4.8		1.7	+	+
	11.8	3.9	1.5	+	2.9	2.8	5.7	3.7	3.2	5.5	4.4	4.9	11.3	7.0	3.4	5.2	3.5	3.8
2.4	+	+	+	+	1.4	+		1.1	7.4	2.0	4.2	7.6	4.6	+		+	2.5	+
	+		+					4.4			+							
+		+						1.2	+			+						
+	+		+			+				+			+		+	1.7	+	
							+		1.6			3.1	1.1					
									+									
	+	+	+		0.7		5.1	1.1	1.9	+	+	7.5	2.2	2.8	4.2		+	9.8
			+		+	+	1.2	+					+		+			+
		+					+											
							+											+
		1	1	2										2	1		1	
	4	1	7	1	2			4						1		1		6
					1								1					
			1		1		1	2		7	9		3		1			
								1										
			4		6		2	2	3	3		3	3	2	1		30	4
										3								

Station		1	2	3	4	5	6	7	8
SCHIZOPODA		Individual number in a haul.							
Stylocheiron	*carinatum*	3				2	2	1	
Euphausia	*gracilis*		17	1					
Eu.	*gibba*		3						
Eu.	*krohnii*	1	106						
Thysanopoda	*obtusifrons*								
Thy.	*tricuspidata*		7	1				1	1
Stylocheiron	*suhmii*	10							
Furcilian	stages	21	56	15			20	11	17
Siriella	*thompsoni*		10	4			1		
Siriella	sp.								
Lucifer	*raynaudii*	1	88	1	1	8	1		2
OSTRACODA			75						
Fish larvae		4	15			3	3	5	2
Fish eggs			10	5		2		1	2
Zoea			1						
Veliger									
MEDUSAE (*Muggiaea* etc.)			101	19	6	15	26	36	18
Collozoum and *Sphaerozoum*		R	P		C	P	P		
Pyrocystis	*pseudonoctiluca*	C C	C C	C	C	P			
Chaetognaths	total number	220	347	84	30	200	250	95	144
Chaetognaths	(%)								
Sagitta	*hexapiera*	12.7	+	15.5	16.7	22.5	30.4	49.4	34.0
Sag.	*lyra*	1.8							
Sag.	*enflata*	15.9	6.1	17.9	16.7	24.0	7.6	7.6	20.9
Sag.	*bipunctata*	8.2	12.6		6.6	3.5	3.6	4.2	11.8
Sag.	*feroz*	+							
Sag.	*robusta*		3.6	3.6		2.5	2.4	5.3	+
Sag.	*pulchra*								
Sag.	*serratodentata pacifica*	8.6	70.3	28.6	40.0	17.5	35.6	25.3	15.3
Sag. serr. atlantica f.	*pseudoserratodentata*	+							
Sag.	*neglecta*								
Sag.	*regularis*					+		1.0	+
Sag.	*minima*	7.7							
Pterosag.	*draco*	35.0	+	27.4	20.0	27.0	16.0	4.2	11.8
Krohnitta	*subtilis*	6.4		2.3					
Krohnitta	*pacifica*	1.8	6.9	1.1					
Sag.	*decipiens*								
Sag.	sp.	+	+	3.6		2.5	4.4	1.0	4.8

Copelata	*Oikopleura*	*longicauda*	C	*Oikopleura*	*fusiformis*	C
	Oiko.	*rufescens*	C	*Oiko.*	*parva*	RR
	Oiko.	*cophocersa*	RR	*Oiko.*	sp.	RR
	Megalocercus	*huxleyi*	C	*Siegosoma*	*magnum*	C
	Fritillaria	*pellucida*	RR	*Fritillaria*	*formica*	RR
	Frit.	*venusia*	RR	*Frit.*	*haplostoma*	RR
	Frit.	*megachile*	RR	*Frit. borealis* f.	*sargassi*	RR
	Kowalevskaia	*tenuis*	R	*Pelagopleura*	sp.	R

Abbreviations: *CC···very common* *C···common* *P···present*

Stylocheiron carinatum were observed too, although they were less abundant. Amphipods were represented by *Hyperia sibaginis*, *Parascelus zebu* and *Phronima pacifica*, but the frequencies of their appearance were not so high. Among Crustacean Decapoda, *Lucifer raynaudii* was observed almost at every station, especially abundantly at St. 2, St. 5 and St. 27. Phyllopoda other than a few *Evadne* were not observed in the material. Chaetognaths were the second important animal group and represented by *Sagitta*

9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	26	27	28
2			3							2	1						27 7	6
		3															39	28 2
2					44		2	1			3	2 2	4					5
3	5	8	58	62	5 1	1	14	15		12 3	16 17	5 2	17	4	54	2	38 22 2	82
	10	18	7	12	9 7	4		1 1		1	5 2	3	9	1			3	55 29
3	3	17	5	?	6		4	1			8	2	3		2	3	3	11
1	1 1 1	11	12 1	? 1	45	1	7 1	5 5	2	3	7	1	3 3	1 2	6 1		4	4
11	41	113	78	55	22 R	11 C C R	26	31	2	2	24 C C	51 C C	29 C	17	48	4	19 P P	107 P C
354	1007	873	951	1324	516	37	220	222	12	245	657	188	395	120	148	109	553	277
3.1	5.5	2.2	3.5	2.2	11.1	10.8	6.4	14.4		26.9	18.6	17.5	10.6	+	5.4	16.5	31.8	11.9
69.2	67.9	57.7	57.6	54.2	34.8	37.7	53.6	40.9	66.6	16.7	15.2	25.0	59.4	50.8	37.8	12.8	13.6	28.2
+		+	+	+	+		1.8	1.4	16.7	3.3	+	2.6	1.5	2.5		4.6	4.5	2.2
		1.4	2.2	+			+	+			+	+		+	+		+	
1.4	+	+	2.4	+	2.7	8.2	5.0	2.7		+	+	1	3.0	2.1	8.8 +	2.8	4.7	+
17.5	14.9	20.5	25.1	31.4	32.7	18.9	16.8	15.3		23.3	40.2	1.0	10.9	9.2 +	27.7	43.1	29.1	26.0
							+	+										
+	+	1.6	+	+	+	2.7	+	+				+				+		+
7.9	5.5	11.4	6.0	10.3	11.8 1.1	10.9	6.8	17.6 +		25.3 +	21.6	19.1	8.5	1.0	18.2	12.8	13.2	20.6
	2.3	17.2	1.7	+		2.7 2.7	+								+			7.9
+	2.8	2.1	+	+	4.3	5.4	6.4	4.5	16.7	2.8	3.0	3.3	6.1	4.1		6.4	2.9	2.2

R···rare *RR···very rare* +···<0.5%

serratodentata pacifica, *Sag. hexaptera*, *Sag. enflata* and *Pterosagitta draco*. The abundant species of Copelata (Tunicata) were *Oikopleura longicauda*, *Oik. fusiformis*, *Oik. rufescens*, *Megalocercus huxleyi* and *Stegosoma magnum*. *Muggiaea* and *Diphes* were the chief components of Medusae. Besides these, there were many animals which were out of sphere of our ability of identifying and left out of the table.

On copepods, there were 118 species already identified, besides three

speceis, one in each of three genera *Centropages*, *Haloptilus* and *Pontella*, which are perhaps new species and now under close examination. *Euchaeta marina* showed the highest frequency of appearance, occupied 20—50% of all copepods throughout the stations excepting St.1 and was followed by *Calanus darwinii*, *Cal. minor*, *Scolecithrix danae*, *Corycaeus speciosus*, *Candacia truncata* and *Can. aethiopica*.

III. Differences of Plankton Composition according to Currents.

The surveyed area is covering the sea from 30° N to 5° S and from 145° E to 175° E, in which the warning area for Atomic or Hydrogen bombs is included. And the stations where the sampling was carried out are distributed in four oceanic currents, —— South Equatorial Current, Equatorial Counter Current, North Equatorial Current and the northern waters beyond the last named current —— and arranged on four cruise lines named conveniently A, B, C and D from east to west. Thus, we were interested very much in examining how the plankton composition differes according to currents and cruise lines, the biological environmental conditions in the whole area seem apparently indifferent.

In order to examine the differences of plankton composition according to currents and cruise lines, all the stations were classified as shown in table 4.

Table 4. Classification of the stations.

Current \ Observation line	A	B	C	D
the waters north to North Equatorial Current	4	3	1, 2	26
North Equatorial Current	5, 6, 7	17, 18, 19	20, 21, 22	27
Equatorial Counter Current	8, 9	14, 15, 16	23, 24	28
South Equatorial Current	10, 11	12, 13	——	——

Then, the percentages of respective species, shown in table 3, to the total number of Chaetognatha, Schizopoda or Copepoda in respective columns were transformed by angle transformation. Here, the cruise lines A and B cross 4 different currents, while the cruise lines C and D pass through only 3 currents. Consequently we were obliged to examine at first the differences of the above-mentioned values according to 3 currents (Equatorial Counter Current, North Equatorial Current and the northern waters beyond the last-named current) and 4 cruise lines by analysis of variance and then the differences according to 4 currents and two cruise lines (A and B). The results of examinations are shown in table 5 A, B and C. From the results of the former examination, it is cleared that the differences of percentages of *Euphausia krohnii* of Schizopoda and *Scolecithrix danae* of Copepoda

Table 5—A. Results of the examinations (F_0) of the differences of the distribution of respective species according to currents and cruise-lines.

Factor	(1)		(2)	
	current	cruise line	current	cruise line
Calanus darwinii	1.30	2.29	1.76	5.18
Cal. helgolandicus	1.99	1.88	8.39	0.23
Cal. tenuicornis	0.55	0.55	22.40*	0.86
Cal. robustior	0.15	13.84*	9.62	2.38
Cal. tonsus	0.25	0.33	1.46	0.03
Cal. minor	0.65	1.27	1.97	0.07
Eucalanus attenuatus	1.41	5.92	24.36*	0.15
Eucal. mucronatus	0.96	2.03	4.69	0.47
Rhincalanus cornutus	0.50	1.17	2.72	0.35
Acrocalanus gracilis	0.63	1.25	39.34*	0.82
Clausocalanus arcuicornis	1.03	1.97	20.76*	0.97
Clausocal. pergens	1.58	3.50	2.38	0.92
Euchirella amoena	2.16	0.88	2.12	0.24
Euchaeta marina	0.58	1.74	47.78*	8.79
Scolecithrix danae	4.83*	0.28	5.31	0.05
Pleuromamma gracilis	0.92	1.52	6.50	0.00
Pleuro. robusta	0.56	1.31	—	—
Pleuro. xiphias	1.00	1.48	1.50	0.00
Pleuro. abdominalis	0.74	1.46	3.00	1.00
Lucicutia flavicornis	0.62	4.89	4.32	0.52
Luc. ovalis	0.74	0.58	1.77	0.36
Haloptilus longicornis	0.59	3.79	13.54*	0.83
Candacia truncata	0.58	0.28	7.65	0.05
Cand. bispinosa	0.38	1.10	1.91	0.04
Cand. aethiopica	0.92	1.42	2.18	0.31
Cand. simplex	0.44	2.89	1.76	0.10
Pontellina plumata	0.20	0.67	24.86*	0.00
Acartia neligens	1.58	2.29	3.43	0.10
Oithona plumifera	0.15	0.26	1.55	0.07
Oncaea venusta	1.17	1.57	6.45	2.05
Corycaeus lautus	0.57	5.38*	6.80	2.02
Cory. speciosus	0.53	3.03	1.25	0.73
Cory. flaccus	3.08	1.98	7.35	0.43
Copilia mirabilis	0.26	1.17	8.27	0.03
Cop. quadrata	0.48	0.80	1.39	0.11

Table 5—B. continued (1)

Factor	(1)		(2)	
	current	cruise line	current	cruise line
Sagitta hexaptera	3.99	3.40	8.49	0.13
Sag. enflata	3.71	1.07	12.94*	0.00
Sag. bipunctata	2.15	3.38	13.67*	2.12
Sag. serratodentata pacifica	0.73	0.60	1.58	0.02
Pterosagitta draco	3.13	0.93	56.33*	0.31
Krohnitta pacifica	1.86	2.00	10.81*	0.04
	$F^3_6(0.05)$ =4.76	$F^2_6(0.05)$ =5.14	$F^1_3(0.05)$ =10.13	$F^3_3(0.05)$ =9.28

Table 5—C. continued (2)

Factor	(1)		(2)	
	current	cruise line	current	cruise line
Phronima pacifica	0.92	0.68	3.98	0.00
Parascleus zebu	0.86	5.04	3.00	1.27
Hyperia sibaginis	0.35	1.79	29.77*	5.85
Stylocheiron carinatum	0.05	1.54	0.85	0.25
Euphausia gracilis	4.18	1.50	3.00	0.33
Euph. krohnii	5.25*	2.81	3.00	0.33
Thysanopoda tricuspidata	0.72	1.53	4.46	0.19
Furcilian stage of Schizopoda larva	1.34	2.33	0.97	0.04
Siriella thompsonii	2.67	1.23	2.36	0.27
Lucifer raynaudii	0.33	2.35	3.61	0.29
	$F^{3}_{6}(0.05)$ =4.76	$F^{2}_{6}(0.05)$ =5.14	$F^{1}_{3}(0.05)$ =10.13	$F^{3}_{3}(0.05)$ =9.28

Notes : (1) on 3 currents and 4 cruise lines. (2) on 4 currents and 2 cruise lines.
The values which can be regarded to be significant at 0.05 level of significance, are marked with asterisk.

according to currents and that of *Calanus robustior* of Copepoda according to cruise lines are regarded to be significant at 0.05 level of significance. The results of the latter examination show that the differences of percentages of *Sagitta enflata*, *Sag. bipunctata*, *Pterosagitta draco* and *Krohnitta pacifica* of Chaetognatha, *Hyperia sibaginis* of Amphipoda, *Eucalanus attenuatus*, *Acrocalanus gracilis*, *Clausocalanus pergens*, *Euchaeta marina*, *Haloptilus longicornis* and *Pontellina plumata* of Copepoda according to currents are regarded to be significant at 0.05 level of significance. The differences found in other animals can not be regarded to be significant.

All these results, mentioned above, are summarized into table 6, taking table in consideration.

Table 6. Differences of the distribution of various species according to different currents.

species	NN	NEC	ECC	SEC
Sagitta enflata	●		●	●
Sag. bipunctata	●	○		
Pterosagitta draco	●			
Krohnitta pacifica		●		●
Hyperia sibaginis		●		
Euphausia krohnii		●		○
Calanus tenuicornis				
Eucalanus attenuatus				●
Acrocalanus gracilis				●
Clausocalanus arcuicornis				●
Euchaeta marina				○
Scolecithrix danae			●	●
Haloptilus longicornis		●	●	
Pontellina plumata	○			●

Notes : ● much abundant. ○ less abundant *Calanus robustior* and *Corycaeus lautus* were abundant at stations on A and C lines. NN : the waters north to North Equatorial Current. NEC : North Equatorial Current. ECC : Equatorial Counter Current. SEC : South Equatorial Current.

IV. Reproduction of Copepoda.

We reported already on the composition and the distribution of plankton in a part of this region in 1954. Consequently we were much interested in examining how the plankton-composition in this region was affected and changed by a series of experiences of Atomic and Hydrogen bomb. In spite of our careful morphological and ecological observations on plankton, we could not recognize any significant effects of bombs on copepods; they were living and thriving in the surveyed waters as before. We think that the plankton was contaminated indirectly by sea water containing the fission products, but was not affected by the explosion itself of bomb. The degree of the radio-active contamination of sea water is shown in table 7.

Tab e 7. Comparison of the radio-activities of sea water and macroplankton.

Station	5	6	7	8	9	12	15
Date	29/May	30/May	1/June	2/June	3/June	7	10
Radio-activity of surface water	150	450	25	11	3	0	3
Radio-activity of the water at 50 m deep			36				
Maximum radio-activity observed from surface to 200m deep.		(0 m) 450	(50m) 36				
Radio-activity of Copelata	190	490	50	4	0	0	0
Radio-activity of Copepoda		1850	64	29	5	0	5

16	17(1)	17(7)	18	19	20	21	22	23	24	26	27
11	12	12	13	14	19	20	21	23	24	27	28
10	84	5540	70	650	480	1300	210	16	1	10	350
	5800	920	84	420	410	330	730	9	5	9	180
	(50m) 5800	(20m) 6050	(50m) 84	(0 m) 650	(0 m) 480	(0 m) 1300	(50m) 780	(0 m) 16	(75m) 9	(75m) 70	(0 m) 350
0	3800		280	640	410	930	680	14	0	45	170
34	6400		190	980	1300	4100	1940	11	5	78	280

Note : The radio-activity of sea water was estimated by Fe—Ba method and represented by count per minute per litter. The radio-activity of plankton is represented by the value obtained from the dried up sample of 1g. wet weight count per minute. (The values obtained from the samples the weight of which are less than 1g. are converted into the values per one gramme).

The macroplanktons distributed in this region were infected also with radio-activity through the contaminated sea water. The degrees of the radio-activity of macro-planktons at each station are shown in table 8. It is

Table 8. Radio-activities of macroplankton.

Station	Date	Radiolaria				Medusae				Pteropoda			
		Wet		Dry		Wet		Dry		Wet		Dry	
		g.	cpm.	g.	cpm.	g.	cpm.	g.	cpm.	g.	cpm.	g.	cpm.
1	21 May												
2	22												
3	24												
4	29												
5	30	0.3	10	0.05	64	2.7	50	0.1	250				
6	31												
7	1 June												
8	2	0.05	0	<0.05	2	0.55	0	0.1	0	0.45	12	0.1	13
9	3					0.32	0	<0.05	0	0.4	6	0.1	6
10	4									0.1	5	<0.1	7
11	6									0.8	10	0.2	5
12	7					1.75	0	0.15	0	0.4	3	0.15	0
13	8					2.0	2	0.15	0				
14	9					1.1	0	0.1	0				
15	10					0.2	9	<0.05	9	0.05	0	<0.05	0
16	11	0.05	0	0.05	10	0.3	0	<0.05	0				
17	12					0.3	516	0.05	820	0.05	80	<0.05	135
18	13					0.6	80	<0.05	170				
19	14												
20	19					0.2	33	<0.05	50	<0.05	170	<0.05	190
21	20					0.3	230	0.05	284	<0.05	47	<0.05	52
22	21					0.9	87	0.1	140	<0.05	5	<0.05	7
23	23	0.05	0	<0.05	0	1.00	0	0.05	0				
24	24					1.00	0	0.05	6				
25	27												
26	28					1.0	0	<0.05	0	0.05	25	<0.05	43
27	29					1.0	15	0.05	50	0.15	0	0.05	0
28	29												

Copelata				Thaliacea				Copepoda				Other Crustacea			
Wet		Dry		Wet		Dry		Wet		Dry		Wet		Dry	
g.	cpm.	g.	cpm.	g.	cpm.	g.	cpm.	g.	cpm.	g.	cpm.	g.	cpm.	g.	cpm.
0.2	0	<0.1	0												
1.5	0	0.05	0									1.8	0	0.1	9
1.6	0	0.15	0									1.9	0	0.15	0
1.1	12	0.15	28												
1.3	56	0.1	250	3.35	370	0.15	2180								
0.65	154	0.05	320					0.45	460	0.05	830				
0.45	14	0.05	22	2.0	35	0.1	162	1.1	26	0.1	70				
1.00	5	0.1	4					1.6	15	0.2	46				
1.60	0	0.1	0					1.1	2	0.2	5				
2.0	0	.015	1					2.0	0	0.15	4				
1.5	0	0.25	0					1.0	0	0.15	0	0.15	0	0.05	0
2.0	0	0.25	0					2.0	0	0.3	0				
2.0	2	0.2	0	6.4	3	0.05	0	1.5	5	0.25	0				
2.0	2	0.15	7					2.05	0	0.3	13	0.2	5 ?	<0.05	0
0.5	0	0.1	0					0.95	21	0.15	25				
0.6	0	0.05	0					0.65	10	0.05	22				
1.0	2120	0.1	3830	0.2	393	<0.05	725	1.0	3400	0.15	6400	0.15	170	0.05	450
0.25	50	<0.05	70	0.25	140	<0.05	215	1.0	130	0.1	185				
0.7	278	0.1	446					1.0	489	0.1	975	0.25	439	0.05	634
2.0	356	0.15	810					0.8	553	0.05	1000				
0.55	175	0.05	507	1.0	396	<0.05	720	0.25	875	0.05	1022				
1.0	386	0.1	675					1.0	1024	0.1	1935				
1.0	6	0.05	14					1.0	0	0.15	11	1.0	0	0.05	0
1.0	0	0.05	0	0.5	10	<0.05	22	0.95	0	0.05	5	1.0	0	0.05	12
0.85	24	0.1	39	0.8	64	0.05	128	1.0	40	0.1	78	0.75	24	0.05	50
1.0	73	0.1	170					0.95	150	0.1	270	1.0	166	0.05	250
0.5	5	0.05	0	0.7	0	0.05	8	0.55	0	0.1	0	0.7	0	0.1	5

a matter of course that the radio-activity of the dried plankton was much stronger than that of the wet plankton.

Although there may be opinions to define the reproductive period of various animals by morphological characteristics, we prefer the following characteristics as the standard of deciding the reproductive period of copepods:

in female
1. with one or two egg sacs hanging at the genital pore,
2. with eggs or egg masses attached to feet,
3. with uterus or oviduct packed with eggs or egg-masses,
4. with spermatophore hanging at the gential pore or at the dorsal side;

in male
1. with spermatophore attached to the 5th foot,
2. with spermatophore hanging at the genital pore,
3. with spermatophore in the body,
4. with spermatophore attached to the 1st antenna.

Besides these, copepods in coitus are considered to be in the reproductive period, although such a case is scarcely observable in the oceanic species.

The species found in the reproductive period throughout the stations were the following 37 ones:

Calanus darwinii, Cal. helgolandicus, Cal. tenuicornis, Cal. robustior, Cal. gracilis, Cal. minor, Eucalanus attenuatus, Acrocalanus gracilis, Clausocalanus arcuicornis, Clausocal. pergens, Euchaeta marina, Eu. wolfendeni, Euchirella amoena, Lucicutia flavicornis, Lu. ovalis, Heterorhabdus papilliger, Scottocalanus helenae, Scolecithricella danae, Candacia catula, Ca. bispinosa, Ca. aethiopica, Ca. truncata, Ca. curta, Labidocera pavo, La. detruncata, Pleuromamma xiphias, Pleuro. abdominalis, Pleuro. gracilis, Centropages violaceus, Cent. elongatus Cent. calaninus, Pontellopsis perspicax, Corycaeus flaccus, Cory. speciosus, Cory. lautus, Oncaea venusta, Sapphirina stellata.

There were found many individuals in the reproductive period even at highly contaminated stations (Sts. 5, 6, 17—21 and 27) as well as in non-contaminated region.

V. Larval stages of Copepoda.

The body form of Copepoda may be modified remarkably in the period of metamorphosis through copepodite stages. And there are many species, in which the adult and the larva differ so much from each other as if they were belonging to quite different species. Such developmental modifications are clearly seen in the external form of the body, especially in the 1st antenna,

last angles of thoracic segment, genital segment, caudal furca, the 5th pair of feet and furcal setae. The larva of Copepoda undergoes 2—5 moultings and then passes 1—6 copepodite stages before it develops to the adult. Usually the copepodite stages, especially the 5th one, resemble the adult, but in some cases the last stage may differ strongly from the adult. For this reason, larvae of some known copepods have often been recorded as new species, for instances *Calanus plumchrus*, *Temora stylifera*, *Haloptilus mucronatus*, etc. Recently, TANAKA (1954) cleared that *Calanus plumchrus* is nothing but an immature form of *Calanus tonsus*. Thus the insufficiency of the study of the copepod larvae causes frequently some confusions in the identification of species. Here, we are aware of the necessity of studying the copepod larvae. The following described immature form of copepoda means the stages from I to VI of the copepodite stage.

A. *Euchaeta marina* immature male and female. Figs. 2. 3 and 4

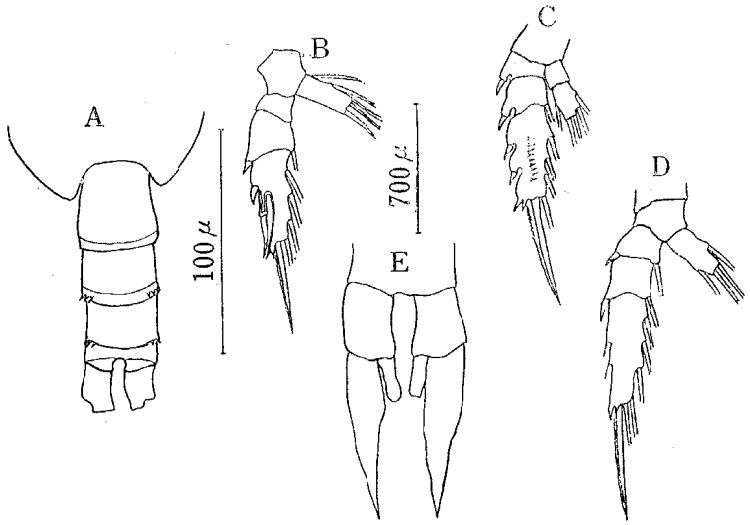

Fig .2 *Euchaeta marina* male.
A. Abdomen, dorsal view. B. 2nd foot.
C. 3rd foot. D. 4th foot. E. 5th pair of feet.

Male. Both the anterior and the posterior divisions consist each of 5 segments; the ratio of length is 21 : 10. The minute spinules on the body surface are not remarkable in larval stages. The exopodite of the 2nd foot consists of 3 segments as in adult; the middle one of the 3 marginal spines on the 3rd segment of exopodite of the 2nd foot is longest reaching to the tip of the terminal spine. The endopodite of the 2nd foot is 1-jointed. The exopodite of the 3rd foot consists of 3 segments and the endopodite consists of 2 segments jointed indistinctly. The exopodite of the 4th foot consists of 3 segments and the endopodite consists of 2 segments. There are many small spines at the middle of the terminal segment of the exopodite. The 5th pair

of feet are nearly symmetrical and bifurcated to long exopodite and short endopodite, the latter is ¼ as long and ⅓ as wide as the former. The proportional length of each segment of the anterior and the posterior divisions are as follows.

Segments of the anterior division

1	2	3	4	5	
50	21	15	17	7	= 100

Segments of the posterior division

1	2	3	4	furca	
24	24	20	17	15	= 100

There are several small spines at the lateral margins of the 2nd and 3rd segments of the posterior division. The 1st antenna consists of 22 segments, of which the 3, 7, 12, 19 and 22 ones are furnished each with long seta.

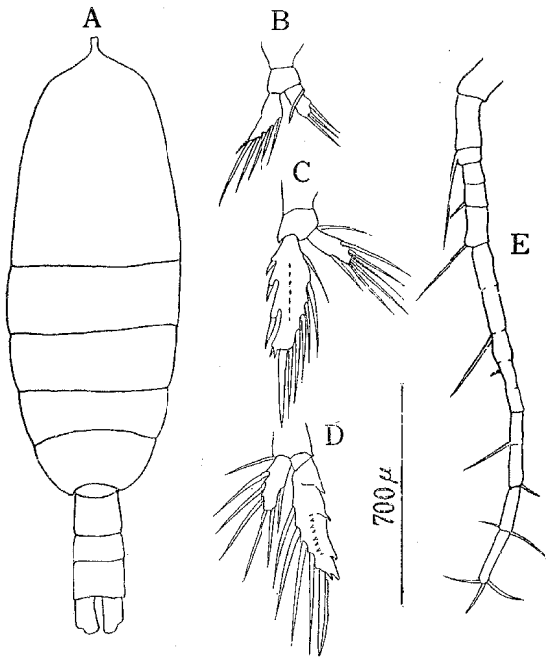

Fig. 3 *Euchaeta marina* female (5th copepodite stage).
A. dorsal view B. 1st foot C. 2nd foot
D. 4th foot E. 1st anttenna

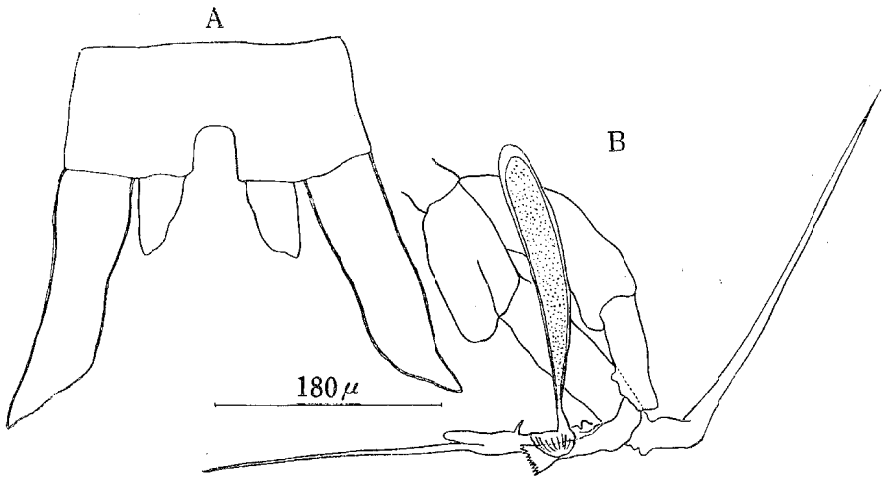

Fig. 4 5th pair of feet of *Euchaeta marina* male.
A. Copepodite stage B. Adult, with spermatophore.

Female. The anterior division consists of 5 segments and the posterior of 4 segments. The proportion of the former to the latter is 21 : 10. The proportional length of each segment is :

Segments of the anterior division

1	2	3	4	5	
52	13	13	8	14	= 100

Segments of the posterior division

1	2	3	furca	
54	12	17	17	= 100

The minute spinules on the body surface are inconspicuous. The exopodite and the endopodite are 1-segmented in both the 1st and the 2nd feet. The exopodite of the 2nd foot has a small spine at the middle. The 4th foot consists of 1-segmented endopodite and 3-segmented exopodite, jointed incompletely. The basal segment and terminal ones of the 1st antenna are distinctly segmented, while the middle part is not yet segmented.

Length. Male 2.8—3.2mm, Female 2.7—3.0mm.

Distribution. This species occurred at the following stations as a dominant one: St. 3,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,26,27,28,

B. *Euchirella amoena* immature male. Fig. 5.

The anterior division consists of 4 segments and the posterior of 6 segments. The ratio of the former to the latter is 17 : 5. The proportional length of each segment is :

Segments of the anterior division

1	2	3	4	
62	15	10	13	= 100

Segments of the posterior division

1	2	3	4	5	furca	
25	12	15	16	15	17	= 100

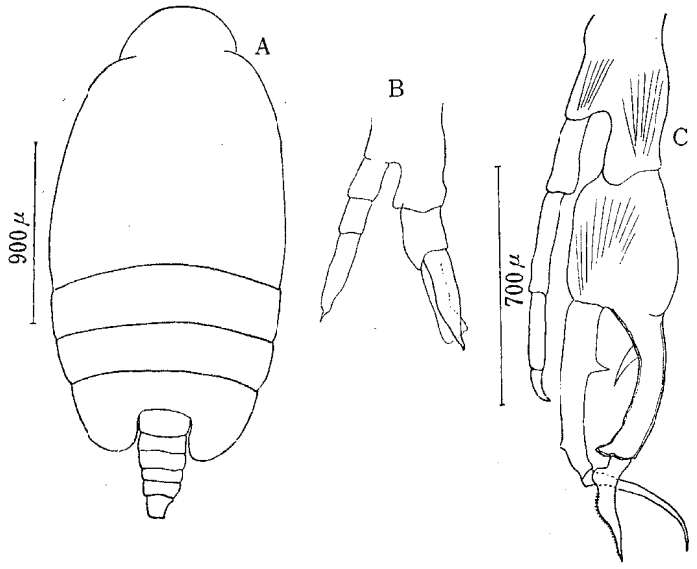

Fig. 5 *Euchirella amoena*.
A. Male, 5th copepodite stage.
B. ♂, 5th pair of feet of larva.
C. ♂, 5th pair of feet of adult.

The 5th foot is asymmetrical; the right foot consists of 2 segments and, of which the distal one is bifurcated. The exopodite is tapering directly to a pointed end. The endopodite is uniform and truncated distally. The left foot consists of 3 segments, the terminal one of which is longest, rearly as long as other two segments, and furnished with a small spine at the distal end. In adult the right 5th foot is modified into the forceps and the left one consists of 4 segments. Length 2.7—4.5mm.

Distribution. This species occured abundantly at the following stations; St. 6, 8, 11, 15, 27, 28.

C. *Scolecithrix danae* immature male. Fig. 6.

The anterior end of head is rounded. The anterior division consists of 5 segments and the posterior of 6 segments. The proportion of the former to the later is 4 : 1. The proportional length of each segment is :

Segments of the anterior division

1	2	3	4	5	
55	17	15	7	6	= 100

Segments of the posterior division

1	2	3	4	5	furca	
24	16	15	15	22	8	= 100

The 5th pair of feet are nearly symmetrical consist each of 2 segments, the distal segments are bifurcated. Endopodite is shorter than exopodite and about ½ as wide as the latter. The ratio of the anterior division to the posterior one is 3.5 : 1 in adult.

The proportional length of each segment in adult is as follows :

Segments of the anterior division

1	2	3	4	5	
70	13	12	3	2	= 100

Segments of the posterior division

1	2	3	4	5	furca	
28	28	18	10	6	10	= 100

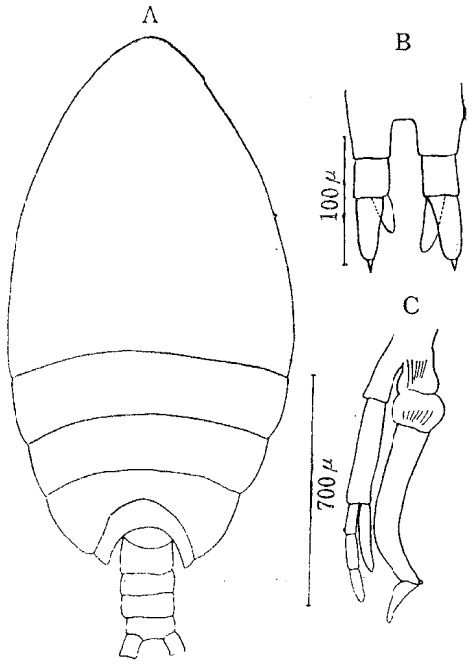

Fig. 6 *Scolecithrix danae.*
A. 5th copepodite stage.
B. 5th pair of feet of larva.
C. 5th pair of feet of adult.

Both 5th feet are elongated and modified; now the right foot is uniramous and the left one is biramous, exopodite being 3-segmented and endopodite 1-segmented.

Length. Larva 1.9—2.7mm, Adult 2.3—3.0mm.

Distribution. This species, especially larval forms, occurred at the following stations: St. 6, 8, 9, 10, 11, 13, 14, 23, as a dominant species next to *Euchaeta*.

D. *Pleuromamma xiphias* immature female. Fig. 7.

The anterior division consists of 4 segments and the posterior of 3 segments. The proportion of the former to the latter is 3 : 1. There is a darkly pigmented knob on the left side of the cephalothorax. The proportional length of each segment is as follows :

Segments of the anterior division

1	2	3	4	
67	10	8	15	= 100

Segments of the posterior division

1	2	furca	
21	48	31	= 100

The basal segment of the 1st antenna is already provided along both the anterior and posterior margins with curved small spines as in adult. The 5th feet are symmetrical and consist each of 2 incompletely jointed segments, and are furnished with a spine at the distal end, but devoid of fine spines at the inner margin, which are found in adult. The same feet of adult are

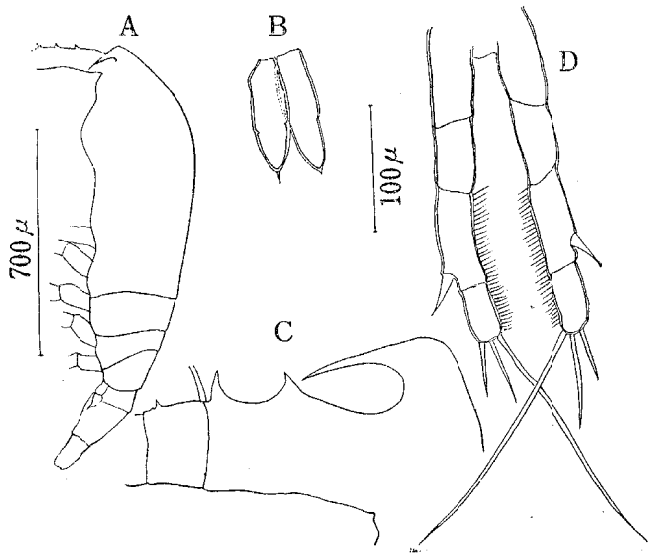

Fig. 7 *Pleuromamma xiphias*.
A. Lateral view, copepodite stage.
B. 5th pair of feet, copepodite stage.
C. Basal segment of 1st antenna, copepodite stage.
D. 5th pair of feet of adult.

also symmetrical and consist each of 4 segments, the outer margin of the 3rd segment has a spine and the terminal segment has 3 apical setae, of which the inner-most one is longer than the rest.

Length. 1.2—1.8mm.

Distribution. This species was obtained abundantly at Sts. 27 and 28.

E. *Centropages violaceus* immature male. Fig. 8

The anterior division consists of 5 segments and the posterior of 6 segments. The proportional length of segments are as follows :

Segments of the anterior division

1	2	3	4	5	
51	16	12	11	10	= 100

Segments of the posterior division

1	2	3	4	5	furca	
21	19	19	14	6	21	= 100

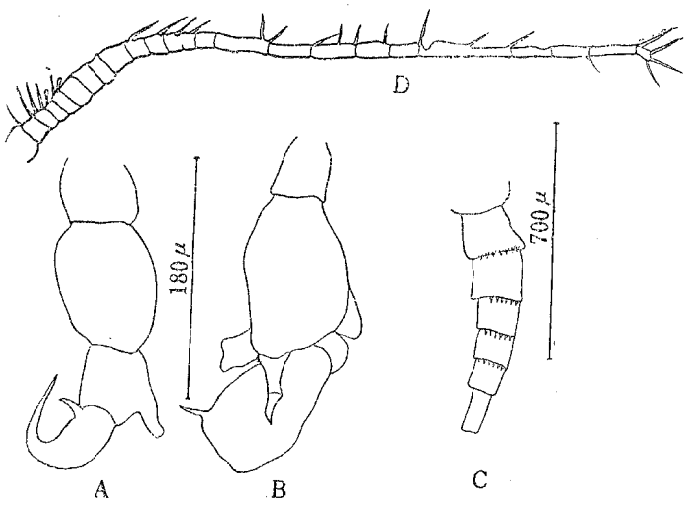

Fig. 8 Copepodite stage of *Centropages violaceus* male.
A. Right 5th foot. B. Left 5th foot.
C. Abdomen, lateral view. D. 1st antenna.

The most remarkable difference between the larva and the adult lies in that the posterior margin of the abdominal segments excepting the anal one are denticulate conspicuously. This denticulation is much reduced in adult. The exopodite of the right 5th foot is furnished on the terminal segment with 2 spines, both curved inwards. The terminal segment of the left foot is swelled and furnished with a spine. The right antenna consists of 24 segments and is slightly modified to the grasping antenna. The 19th segment is the longest of all.

The proportional length of each segment in adult is as follows :

Segments of the anterior division	1	2	3	4	5	6	
	44	20	10	11	10	5	= 100

Segments of the posterior division	1	2	3	4	5	furca	
	20	20	16	12	12	20	= 100

The 5th pair of feet are asymmetrical, the 2nd segment of the left exopodite is furnished with 2 long and staut spines on the outer margin. The right exopodite is furnished with 2 spines, one of which is protruded and curved inwards, while the other is modified to a club-like spine. There are 2 spermatophors in the thorax of adult, they are 600—700 μ in length.

Length. Larva 1—1.5mm, Adult 1.5—2.0mm.

Distribution. This species was recorded at St. 6; immature individuals were rare.

F. *Candacia truncata* immature male. Fig. 9

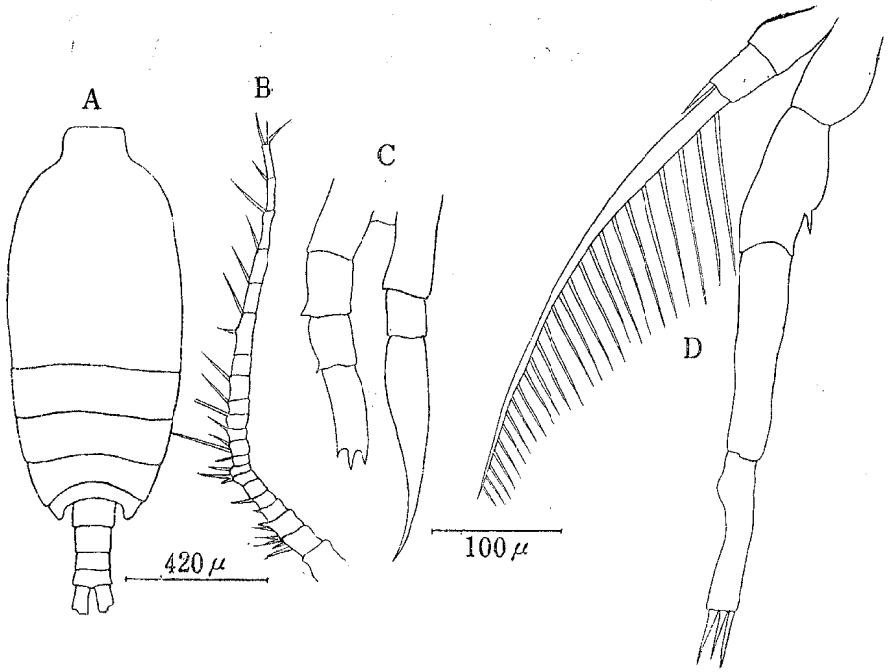

Fig. 9 *Candacia truncata*
A. Copepodite stage, dorsal view.
B. 〃 , 1st antenna.
C. 〃 , 5th pair of feet.
D. 5th pair of feet, adult.

Both the anterior and posterior divisions consist of 5 segments, the proportion of the former to the latter is 3 : 1. The proportional lengths of respective segments are as follows :

Segments of the anterior division	1	2	3	4	5	
	72	9	10	6	3	= 100

Segments of the posterior division	1	2	3	4	furca	
	20	30	20	17	13	= 100

The 1st antenna consists of 22 segments, but it is far from a grasping antenna, the knee-like articulation being not yet formed. The left 5th foot consists of 4 segments and is furnished with 3 small spines on the terminal segment, the right foot consists of 3 segments, the dictal one of which is elongated to a seta, but not yet modified to a plumous one.

Length. 1.2—1.6mm.

Distribution. This species was obtained at the following stations : Sts. 6, 7, 10, 11, 17, 19, 24, 27, common but not abundant.

G. *Candacia bipinnata* immature male. Fig. 10

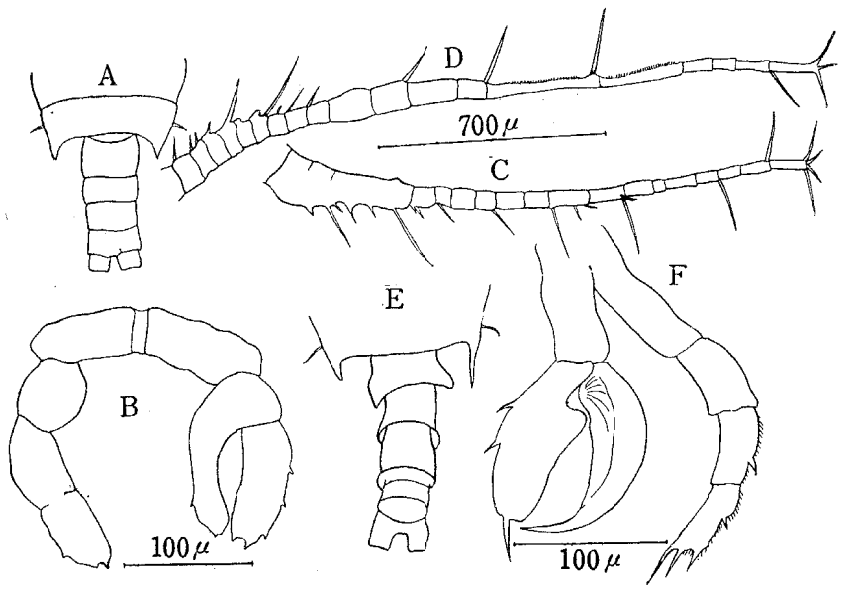

Fig. 10 *Candacia bipinnata.*
A. Abdomen, copepodite stage. B. 5th pair of feet, copepodite stage.
C. 1st antenna, copepodite stage. D. 1st antenna, adult.
E. Abdomen, adult. F. 5th pair of feet, adult.

Both the anterior and posterior divisions consist of 5 segments. The proportional length of respective segments are as follows :

Segments of the anterior division	1	2	3	4	5	
	38	20	15	15	12	= 100

Segments of the posterior division	1	2	3	4	furca	
	38	20	15	15	12	= 100

The 1st antenna is not yet modified to a grasping organs ; the 6 basal segments are fused one another and their articulations are indistinct. The postero-lateral angles of the last thoracic segment differ from those of the adult, being arranged symmetrically and with a spinule on each lateral side of the segment.. The posterior division of body consists of 5 segments instead of 6 ones in adult, the anal segment is separated incompletely. The 1st to 4th feet resemble those of adult. The 5th foot, however, differs much

from that of adult, being asymmetrical and consisting of 2 segments. The right foot forms a simple forceps, while the left one consists of 4 segments and is devoid of fine hair on two distal segments, which are found distinctly in adult.

Length. Larva 1.8—2.0 mm, Adult 2.1—2.6mm.

Distribution. Both immature and adult forms were obtained at Sts. 6 and 21.

H. *Candacia curta* immature male. Fig. 11.

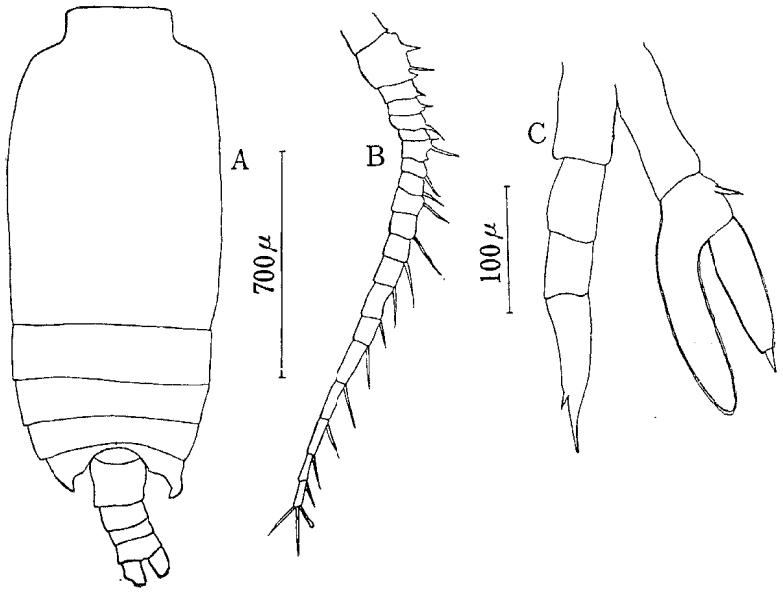

Fig. 11 *Candacia curta*. copepodite stage.
A. Cephalothorax, dorsal view.
B. 1st antenna.
C. 5th pair of feet.

Both the anterior and posterior divisions consist of 5 segments. The ratio of the former to the latter is 3.5 : 1. The proportional lengths of respective segments are as follows :

Segments of the anterior division	1	2	3	4	5	
	70	12	9	7	2	= 100

Segments of the posterior division	1	2	3	4	furca	
	39	19	17	11	14	= 100

The 1st antenna is not yet modified to a grasping organ, the knee-like articulation being indiscernible. The right postero-lateral angle of the last thoracic segment is slightly protruded asymmetrically and curved inward. The genital segment is also asymmetrical in form. The right 5th foot consists of 2 segments, forms a forceps and is furnished with a small spine at distal end of the endopodite. The left foot consists of 4 segments, of which the terminal one is bifurcated and devoid of setae along the outer margin.

Length. 1.5—2.0mm.

Distribution. Occurred sparsely at St. 11.

VI. Conclusion.

Samples of macro-zooplankton hauled by larva-net in the waters around Bikini Atoll during the period from May to June 1954 are treated here. It is a noteworthy fact that 118 species of copepods, including 19 genera and 38 species in the reproductive period, were found in the material besides many other animals, although they were contaminated by fission products more strongly than the water or fishes collected at the same stations. Results of the careful examination upon the plankton composition reveal that there is no species, the distribution of which was affected seriously by the contamination of water due to fission products, while there are several species, the distributions of which were different in accordance with the oceanic currents. On the larval stages of Copepoda, we cleared such as *Euchaeta marina*, *Euchirella amoena*, *Scolecithrix danae*, *Pleuromamma xiphias*, *Centropages violaceus*, *Candacia truncata*, *Cand. bipinnata* and *Cand. curta*.

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