

Distribution of the Bathypelagic family *Arietellidae* (Copepoda: Calanoida) in the upper 200 m in the Indian Ocean

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Abstract. The calanoid copepods of the family Arietellidae were studied from the International Indian Ocean Expedition collections. The family is represented by three genera and the members usually inhabit deeper layers of the ocean. In the Indian Ocean five species of *Arietellus* were encountered, mostly from southern latitudes. *Paraugaptilus* is reported for the first time from the Indian Ocean. Three species of *Phyllopus* were encountered in the IIOE collections. The members of the genus were concentrated mostly in the equatorial belt.

Introduction

Subsequent to the International Indian Ocean Expedition (1962-65) many publications have come out dealing with the taxonomy and zoogeography of copepods in the Indian Ocean. Kasturirangan *et al.* (1973) have summarised the numerical abundance of copepods collected during the expedition. The distribution of families Centropagidae, Temoridae and Pontellidae was discussed by Fleminger and Hulsemann (1973, 1974). Saraswathy (1973 a, b) has studied the distribution of *Gaussia* in the Indian Ocean. Tanaka (1973) has given an account of Euchaetidae and Gopalakrishnan (1973 & 1974) has dealt with the taxonomy of Scolecithricidae. *Haloptilus* from the Indian Ocean was described by Stephen and Saraladevi (1973) and Saraladevi (1976 & 1977). Lawson (1973, 1977) defined geographical limits for Indian Ocean Candaciidae based on the morphological differences of the species. The family Pontellidae from the Indian Ocean was studied by Silas and Pillae (1967 & 1973). This paper deals with the distribution of Arietellidae, a family of deep water copepods from the surface layers (0-200m) of the Indian Ocean.

Material and methods

The study is based on the copepods obtained from the standard samples collected during the IIOE, and the procedure adopted for the analysis of the samples is given in IOBC, 1969. Copepods being the major group in all the zooplankton samples, a detailed study was made only at stations representative of each 5° Marsden square. Altogether 320 standard samples were examined. The locations from where the family Arietellidae were encountered with their numerical abundance and some hydrographical parameters are given in Table I. The numbers are represented as number per standard haul.

Results and discussion

The family Arietellidae is represented by *Arietellus*, *Paraugaptilus* and *Phyllopus*.

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Table I. Hydrographic parameters of the stations from where *Arietellidae* were identified.

Station Identification	Latitude	Longitude	Date	Time (hrs)	Temperature (°C)		List of Species	No. of specimens per std. haul
					Maximum	Minimum		
1	2	3	4	5	6	7	8	9
AB 137	14°44'S	79°44'E	10-7-63	0650	24.19	19.37	<i>Genus Arietellus</i>	1
AB 316	21°58'S	74°55'E	15-4-64	1238	26.02	16.36	<i>A. aculeatus</i>	1
AB 355	29°38'S	49°23'E	12-7-64	1429	18.83	15.40	<i>A. giesbrechti</i>	1
							<i>A. setosus</i>	1
AR Lu. 86	05°00'S	89°00'E	15-9-62	0317	28.36	13.07	<i>A. simplex</i>	1
Dm 212	25°24'S	109°48'E	13-8-64	1140	26.01	16.60	<i>A. giesbrechti</i>	1
Di 3.5267B	06°44'N	57°59'E	15-3-64	2250	27.7	15.06	<i>A. simplex</i>	1
Ka. 3.24	12°30'S	77°58'E	29-12-63	2020	28.87	20.16	<i>A. plumifer</i>	2
Ka. 3.30	21°32'S	77°58'E	7-1-64	2019	26.06	19.65	<i>A. plumifer</i>	2
Ko. 16.16	15°28'S	99°49'E	5-1-64	1947	27.00	18.55	<i>A. setosus</i>	3
Na. 6.148	32°41'S	35°51'E	13-1-63	0635	23.08	17.15	<i>A. setosus</i>	1
Os. 1.22	16°29'S	107°03'E	2-1-63	0731	27.97	11.72	<i>A. giesbrechti</i>	4
Va. 104.2007	09°00'N	75°20'E	4-11-63	1510	29.25	14.88	<i>A. simplex</i>	3
AB 1.30	12°17'N	93°21'E	28-3-63	0945	28.70	11.85	<i>Genus Phyllopus</i>	1
32	12°52'N	94°13'E	28-3-63	2230	28.64	12.13	<i>P. bidentatus</i>	1
Ar. Lu. 1	00°07'S	96°31'E	1-7-62	2150	29.42	12.18	<i>P. bidentatus</i>	1
Ar. Lu. 3	00°02'S	93°01'E	3-7-62	0032	29.17	12.66	<i>P. bidentatus</i>	3
Ar. Lu. 9	00°00'	80°56'E	8-7-62	0503	28.96	13.04	<i>P. helgae</i>	5
Ar. Lu. 18	00°03'N	62°41'E	15-7-62	0010	28.56	13.74	<i>P. bidentatus</i>	5
Dm. 1.60	08°30'S	76°00'E	11-5-65	2120	23.55	17.42	<i>P. helgae</i>	10

/cont.

Table I. continued.

Station Identification	Latitude	Longitude	Date	Time (hrs)	Temperature (°C)		List of Species	No. of specimens per sid. haul
					Maximum	Minimum		
1	2	3	4	5	6	7	8	9
<i>Genus Phyllopus</i>								
continued								
Di 1 5038	17°18'N	57°09'E	5-7-63	2239	23.62	15.06	<i>P. muticus</i>	1
Di 3 5412A	02°02'N	56°03'E	2-6-64	0206	29.74	13.67	<i>P. helgae</i>	10
Ka 3 15	00°01'S	78°06'E	12-12-63	2014	28.39	17.34	<i>P. helgae</i>	3
16	01°06'N	78°03'E	4-12-63	2026	28.32	17.62	<i>P. helgae</i>	18
Ki 296	03°00'N	71°38'E	22-7-63	2215	30.00	17.36	<i>P. helgae</i>	13
Ki 301	00°00'	74°00'E	23-8-63	2211	29.30	13.03	<i>P. helgae</i>	10
Ki 304	02°00'N	75°00'E	25-8-63	2100	29.60	13.32	<i>P. muticus</i> 8)	13
							<i>P. bidentatus</i> 5)	
Ko 14 19	13°49'N	94°16'E	28-12-62	1950	27.70	13.11	<i>P. helgae</i>	1
Me 1 137	02°57'N	47°45'E	3-1-65	2105	28.24	13.03	<i>P. helgae</i>	6
1 145	00°48'N	45°23'E	7-1-65	2220	25.43	13.67	<i>P. helgae</i>	12
1 166	04°50'S	41°40'E	24-1-65	0350	27.82	11.33	<i>P. helgae</i>	10
OS 1 7	17°00'S	118°00'E	14-12-62	0029	28.33	12.93	<i>P. bidentatus</i>	3
Va 106 204	14°49'N	74°02'E	10-12-63	—	29.30	28.45	<i>P. bidentatus</i>	1
<i>Genus Parangaptius</i>								
(new to the Indian Ocean)								
OS 1 6	16°00'S	118°00'E	13-12-62	1616	28.03	12.61	<i>P. buchani</i>	2
OS 7 8	09°46'S	110°50'E	20-12-63	2142	28.8	15.09	<i>P. buchani</i>	1

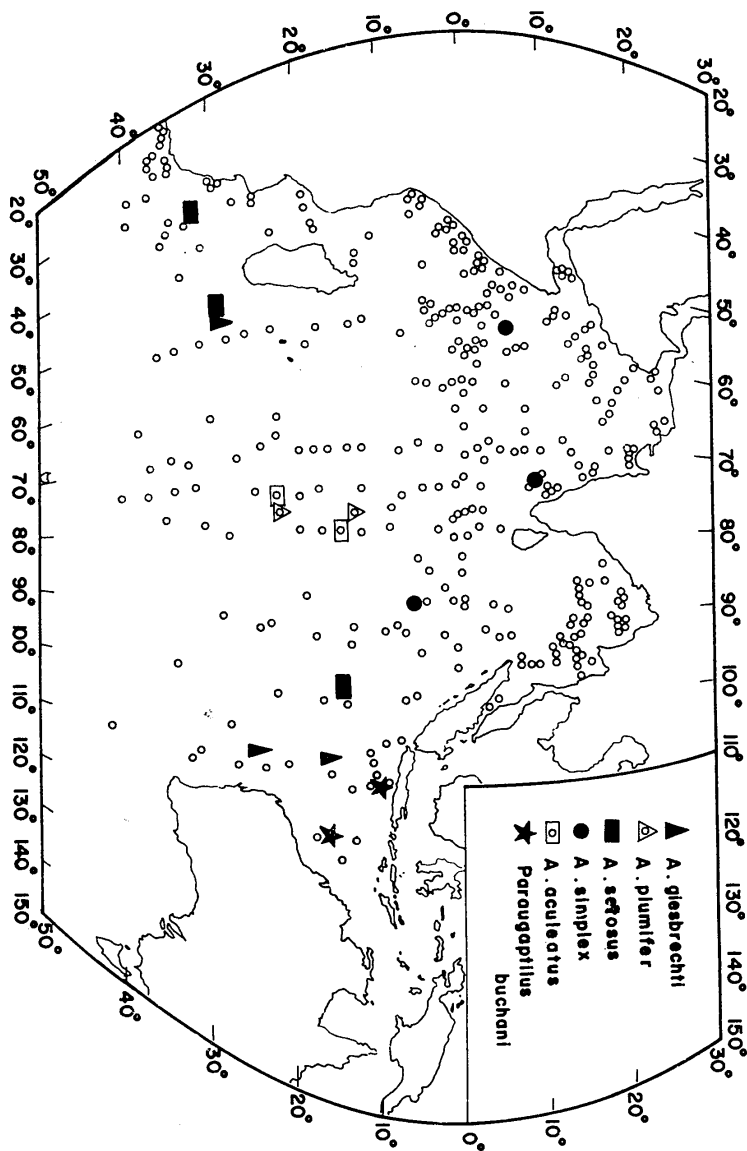


Fig.1 Distribution of *Arietellus* and *Paraugaptilus* in the Indian Ocean (open circles indicate the stations selected for the study).

Figs. 1 and 2 show the distribution of these three genera in the Indian Ocean.

Genus — *Arietellus* (Fig. 1)

Five species of *Arietellus* are encountered in the IIOE collections.

A. aculeatus is present at two stations located between latitudes 14°S and 21°S

and 70°E and 80°E in the central Indian Ocean.

A. giesbrechti is recorded at two stations along 107°E and 109°E at latitudes 16°S and 25°S, and at one south of Madagascar.

A. plumifer is found in two stations in the central Indian Ocean along 77°E.

A. setosus is present in three stations, two near South Africa and the third in the eastern Indian Ocean between Indonesia and Australia.

A. simplex is restricted to the northern Indian Ocean. The 3 positive stations are widely scattered, one near the southwest coast of India, one in the central Indian Ocean and the third off Somalia.

In the previous study Sewell (1947) reports *A. giesbrechti*, *A. plumifer* and *A. simplex* from the Arabian Sea. De Decker and Mombeck (1965) list three more species, *A. aculeatus*, *A. pavoninus* and *A. setosus*, from the Agulhas Bank. Since *A. pavoninus* is not reported from deeper collections from other parts of the Indian Ocean (Sewell, 1947 and Grice & Hulsemann, 1967) it is probable that the species is a migrant to the Agulhas Bank from the Atlantic.

The most striking aspect of the distribution of this genus is the preference of the species to the southern latitudes (south of 10°S) of the Indian Ocean and its total absence in the Bay of Bengal. Only *A. simplex* is observed in northern region from the upper 200 m. However, other species are recorded from the same area in deeper layers (Table II). The avoidance of the surface waters may be due to the presence of Arabian Sea surface water (Gallagher, 1966) which is characterised by high salinity and high temperature.

Genus — *Paraugaptilus* (Fig. 1)

Paraugaptilus buchani is recorded for the first time from the Indian Ocean, at two stations between Java and Australia. Earlier records of the species from the Indo-Pacific are confined to the Izu region (Tanaka, 1964) and the Indonesian Archipelago (Wilson, 1950). The occurrence of this species in the eastern Indian Ocean may be attributed to the incursion of Pacific water through the Banda and Timor Seas (Gallagher, 1966). The extent of migration of *P. buchani* in the Indian Ocean can be fully explained only after examining deep water collections from the Indian Ocean. However the presence of the species in the upper 200 metres may be related to upwelling in the Java Sea (Wyrтки, 1973).

Genus — *Phyllopus* (Fig. 2)

In the IIOE collections only 3 species of *Phyllopus* are recorded. Of these *P. helgae* is observed from 11 stations, *P. bidentatus* from eight stations and *P. muticus* from two stations. The present study shows that *P. helgae* and *P. bidentatus* are distributed mainly in equatorial belt especially between 0° to 5°N (Fig. 2), but *P. bidentatus* extends to the Arabian Sea, Bay of Bengal and Australian coast. *P. muticus* is observed from one station off the Arabian coast and another in the central equatorial region. The earlier reports of this genus from the Indian Ocean (Table II) show that the present observation is the first report of the genus from Bay of Bengal. The species belonging to this genus are well known for their extensive vertical migration. In the IIOE collections also their presence is noticed in the night hauls except at one station. Roe (1972)

Table II. Records of the family *Arietellidae* from the Indian Ocean.

List of species	Authors	Locality	Depth	Year	Observation	Present observation				
<i>Arietellus oculatus</i>	Sewell, 1947	Arabian Sea (Deep water collections)	Southwest Indian Ocean (mid water collections)	1965	De Decker & Mombeck	1967	Grice & Hulsemann	Western Indian Ocean (mid water and deep water collections)	Indian Ocean (200-0 m)	Central Indian Ocean
<i>Arietellus giesbrechti</i>	—	—	—	—	—	—	—	—	—	—
		Southern and Central Arabian Sea	1000-100 m	—	—	—	—	—	—	Southeast Indian Ocean
		500-0 m, 200-0 m, 400-0 m	—	—	—	—	—	—	—	—
<i>A. pavoninus</i>	—	—	Below 300 m	—	—	—	—	—	—	—
<i>A. plumifer</i>	—	Central Arabian Sea	Below 300 m	—	—	—	—	—	—	Central Indian Ocean
		645-400 m	—	—	—	—	—	—	—	—
<i>A. setosus</i>	—	—	250-100 m	—	—	—	—	—	—	Southern Indian Ocean
<i>A. simplex</i>	—	Central Arabian Sea	Below 300 m	—	—	—	—	—	—	North of 10°S
		850-0 m, 645-400 m	—	—	—	—	—	—	—	—
<i>Parangapitius buchani</i>	—	—	—	—	—	—	—	—	—	New record from Southeast Indian Ocean
<i>Phyllopus aequalis</i>	—	—	1000-750 m	—	—	—	—	—	—	—
<i>P. bidentatus</i>	—	—	—	—	—	—	—	—	—	Equatorial and southern area
<i>P. helgae</i>	—	—	750-500 m	—	—	—	—	—	—	Equatorial and eastern Indian Ocean
<i>P. impar</i>	—	Gulf of Oman	—	—	—	—	—	—	—	—
		1500-0 m	—	—	—	—	—	—	—	—
<i>P. muticus</i>	—	Northern Arabian Sea	—	—	—	—	—	—	—	Arabian coast
		1500-0 m	—	—	—	—	—	—	—	Central Indian Ocean

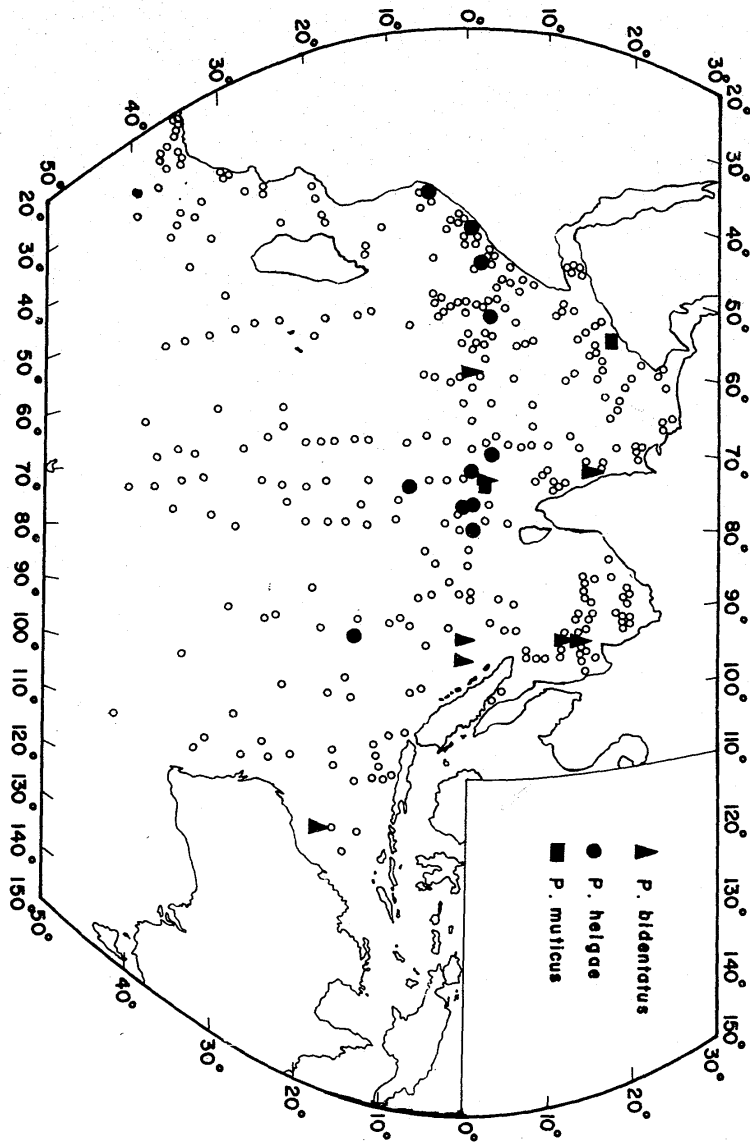


Fig.2 Distribution of *Phyllopus*. (Open circles indicate the stations selected for the study).

reports that *P. helgae* occupies a restricted depth range (625-700 m) during day and at night exhibits extensive vertical migration with much of the population rising to a depth of 100 m.

Previous records of the family Arietellidae from the Indian Ocean are from deep and midwater hauls. Only Sewell (1947) studied samples from the entire Indian Ocean. The other two observations are restricted to the Agulhas Bank and

western Indian Ocean. The gradual decrease in the number of deep water copepods in the northern part of the Indian Ocean with a minimum number of species in Bay of Bengal is shown by Sewell (1948). This he attributed to the lesser influence of Atlantic water in the northern region of the Indian Ocean. De Decker and Mombeck (1965) have also noticed the paucity of bathypelagic copepods towards the north and east. But this view of a "falling off" of deep sea species is opposed by Grice and Hulsemann (1967) who suggest that bathypelagic species are extremely widespread. In the study of the genus *Gaussia*, another bathypelagic copepod, Saraswathy (1973 b) has found that of the two species of the genus, *G. sewelli* is restricted to the northern Indian Ocean whereas *G. scotti* is present in the southern Indian Ocean, as well as in the Pacific and Atlantic Oceans. The tendency of bathy- and mesoplanktonic species to occupy deeper strata in the tropical part of the ocean and their emergence in the upper layers in subtropical region has been noticed for other planktonic organisms like chaetognaths (Nair, 1978).

The present data of Arietellidae from the surface waters of Indian Ocean provide only limited information on the distribution trends of bathypelagic copepods. A detailed study of the family from deep water collections would effectively improve our knowledge on the behaviour and preferences of the bathypelagic species.

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Distribution of Arietellidae in the Indian Ocean

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