

Distribution of *Gaussia* (Copepoda, Metridiidae) in the Upper 200 m in the Indian Ocean

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This paper is based on specimens of the genus *Gaussia* sorted during analyses of the 1927 zooplankton samples received at the Indian Ocean Biological Centre (IOBC). The sampling coverage by area and time is given by RAO (1973) this volume. Only

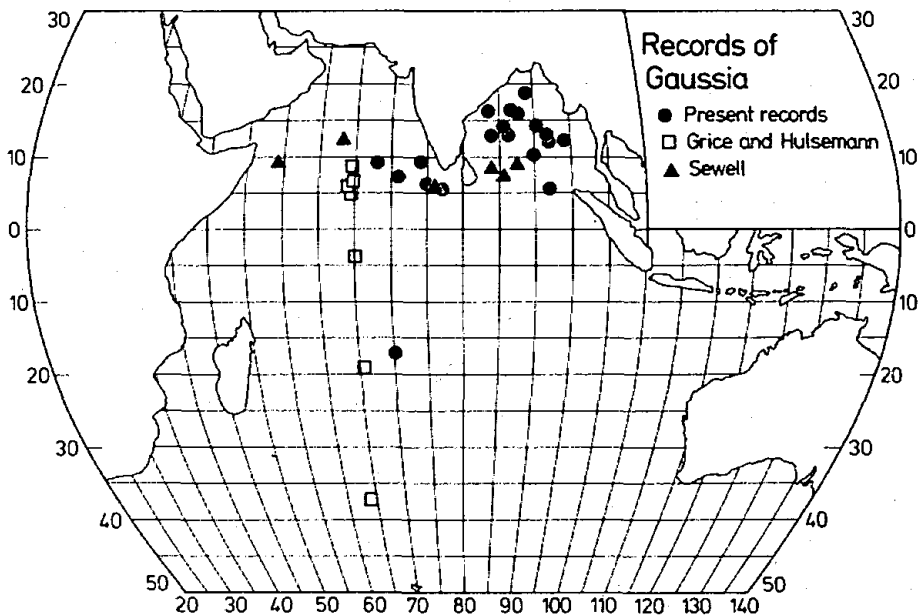


Fig. 1. Available records of *Gaussia* in the Indian Ocean (present records, GRICE and HULSEMANN, 1967; SEWELL, 1932, 1947)

19 revealed the presence of *Gaussia*, all except 1 from stations located north of the Equator: 13 in the Bay of Bengal, and 5 in the Arabian Sea (Fig. 1). Most of these are from the upper 200 m of water, collected in a uniform manner with the Indian Ocean standard net (IOSN) (CURRIE, 1963). Table 1 lists the 19 stations, date and time of collection, depth of haul and number of specimens obtained from each sample.

I. Distribution and Density of the Species

The 66 specimens of *G. princeps* obtained from the samples include males, females and copepodites 5, 4, 3, and 2 (Table 1). About 20% of the specimens, all of them copepodite stages, were collected from the only station in the southern hemisphere at about 17° 18' S, 70° 05' E. The remaining 80% were collected from the 18 stations

Table 1. Collection data (AB, "Anton Bruun"; Di, "Discovery"; Ki, "Kistna"; Pi, "Pioneer"; Vi, "Vintaz")

Station identification	Location Lat.	Long. E.	Date	Time	Collection depth	wire angle	Adults		Copepodites					Total Specimens
							Male	Female	5	4	3	2	1	
AB. 1. 32	12° 52' N	94° 13'	28- 3-63	2 230	200	-	1	-	1	-	-	-	-	2
AB. 1. 58	18° 11' N	88° 04'	9- 4-63	0 012	200	-	-	-	2	-	1	-	-	3
AB. 1. 70	15° 17' N	87° 50'	16- 4-63	2 129	200	-	2	-	2	-	2	-	-	7
AB. 1. 73	14° 02' N	90° 08'	17- 4-63	2 233	200	-	2	3	1	-	1	-	-	8
AB. 1. 76	12° 56' N	92° 10'	18- 4-63	2 304	200	-	-	-	1	-	1	-	-	2
AB. 1. 92	16° 40' N	83° 58'	29- 4-63	0 249	200	-	-	-	3	-	2	-	-	5
AB. 1. 95	14° 22' N	85° 20'	30- 4-63	0 144	200	-	-	-	1	-	-	-	-	1
AB. 1. 97	13° 08' N	86° 12'	1- 5-63	0 450	200	-	-	3	-	-	-	-	-	3
AB. 1. 99	13° 02' N	84° 22'	1- 5-63	2 229	200	-	-	1	-	-	-	-	-	1
AB. 2. 123	17° 18' S	70° 05'	10- 6-63	0 635	200	-	-	-	6	-	2	-	2	12
Di. 5 381 B	09° 57' N	74° 27'	19- 5-64	2 255	200	-	1	-	2	-	2	-	-	5
Di. 5 383 A	09° 58' N	67° 32'	21- 5-64	2 055	200	-	-	-	1	-	-	-	-	1
Ki. 7. 189	16° 30' N	87° 15'	16- 3-63	2 330	200	-	-	1	-	-	-	-	-	1
Ki. 13. 294	07° 00' N	71° 30'	20- 8-63	2 235	200	-	1	1	-	-	-	-	-	2
Ki. 13. 308	06° 00' N	75° 00'	26- 8-63	0 035	200	-	-	1	-	-	-	-	1	2
Ki. 14. 352	13° 00' N	92° 00'	15- 9-63	2 232	200	-	2	1	1	-	-	-	-	4
Ki. 15. 362	10° 00' N	90° 00'	13- 6-64	0 835	200	40°	-	1	-	-	-	-	-	1
Pi. 35	05° 02' N	92° 00'	13- 6-64	2 030	200	45°	-	-	-	-	1	-	2	3
Vi. 5 249	05° 05' N	77° 07'	1-10-62	0 229	283	45°	1-	1	1	-	-	-	-	3

located between 5° – 19° N and 67° – 95° E (Table 1). The Indian Ocean north of the Equator comprises the monsoon region, characterized by seasonal reversal of the surface currents. Most of the specimens of *Gaussia* were collected during the SW monsoon period. Even typical upwelling areas have not shown the presence of the species in the upper layer.

II. Discussion

The fact that 20% of the total number of specimens was collected from the single positive station south of the Equator may indicate that the species occurred in this

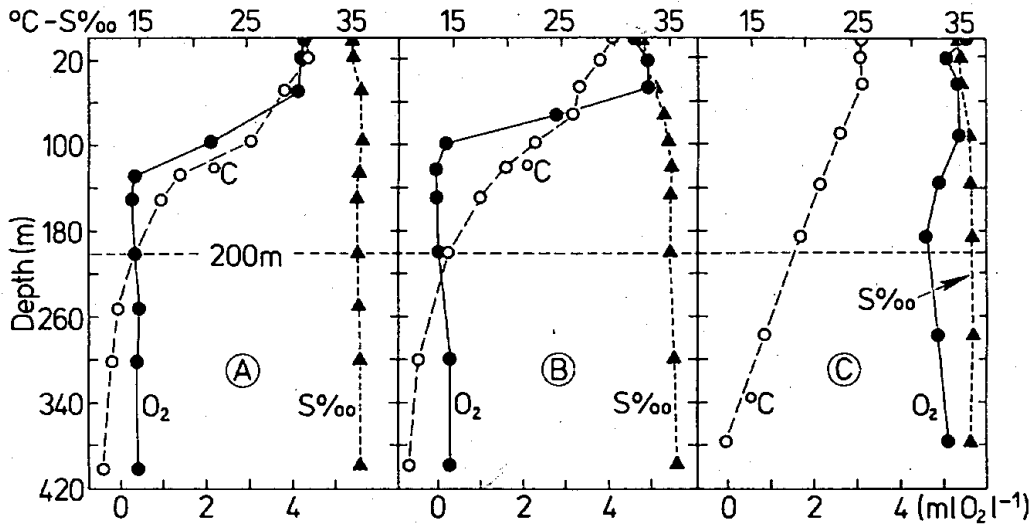


Fig. 2. Hydrographic data at selected stations in the Arabian Sea (A); Bay of Bengal (B); and southern Indian Ocean (C)

locality in maximum number at the time of sampling. The absence of any adult specimen in the catch from this apparently rich area may be due to vertical migration or may be the result of different environmental preferences by adults and young. CUSHING (1951), reviewing the vertical migrations of planktonic *Crustacea*, observed that migration can be modified by weather, sunlight, temperature and phytoplankton density, and further masked by differences in behaviour of groups of animals. On the basis of previous work on the distribution of juveniles and adults of different species of copepods, he concluded that surface-living species have younger stages which prefer greater depths while deep-water species have the juveniles towards the surface.

From Fig. 1 it can be seen that, though the typical upwelling areas were well sampled during the IIOE, specimens of *Gaussia* were usually absent from these regions. In connection with these negative results, it may be interesting to recall the observations on the distribution of bathypelagic copepods in the equatorial Pacific by GUERDRAT (1969). He recorded a difference in behaviour according to the structure of the water column, with a wider vertical migration in areas where upwelling is weak, and more restricted migration in regions of intense upwelling. Dealing with latitudinal distribution in the

area 20° S to 4° N along 170° E, GUEREDRAT found an equatorial increase of the species in upwelling areas where there is enrichment of the upper layer. The pattern of distribution in the Indian Ocean is seen to be different from that noted in the Pacific, the positive stations being located mostly north of 5° N and south of 4° S (Fig. 1).

Our findings on the distribution pattern of the species in the Indian Ocean are not inconsistent with the observations of SEWELL (1948). There may well be a population of *Gaussia* in the southern areas of the Indian Ocean at deeper levels than towards the north. This speculation is supported by records of the species at 3 stations south of the Equator, the southernmost at 37° 59' S (GRICE and HULSEMANN, 1967). Samples at all these stations were taken with the Isaacs-Kidd mid-water trawl from 350–2 394 m depth at the southernmost station. The actual number of specimens collected from these stations is not given. Further, as quoted by GRICE and HULSEMANN (1967), IVANENKOS and GUBIN (1960) observed that “in the area between 10° and 16° S, the upper part of the southward flowing North Indian Deep Water mixes with northward flowing Sub-Antarctic Intermediate Water and the lower part of the North Indian Deep Water mixes with the Antarctic Bottom Water. This mixing results in the formation of two water masses: the South Indian Deep Water (1 500–3 500 m) which flows southward and North Indian Bottom Water (a layer of 200–700 m) which flows northward. The North Indian Deep Water, formed in the northern Arabian Sea, is centered between 400 and 1 500 m north of the Equator and between 800 and 2 000 m south of the Equator”. This supports the view that cold water is encountered nearer the surface in the northern Indian Ocean than in the southern.

It can be seen from Table 1 that at 2 stations the net had fished only above 200 m depth, as evidenced by the wire angle; Fig. 2 shows water of 19° C temperature or lower in the Bay of Bengal at approximately 130 m.

The hydrographic data available for water depths at every one of the stations from which *G. princeps* was collected, indicate the presence of cold water at subsurface levels. This, considered along with time of collection and the inherent tendency of the species to diurnal vertical migration, would explain the presence of this bathypelagic species at depths of only 200 m. Moreover, latitudinal differences in temperature are insignificant in deep-water layers as compared to the surface; hence bathypelagic fauna commonly have a more extensive distribution than epipelagic fauna (EKMAN, 1953). Speciation declines with increase in depth; it is, therefore, of interest that only 1 species of *Gaussia* is known from all the oceans.