

PRELIMINARY REPORT ON THE GEOGRAPHICAL DISTRIBUTION OF  
THE SPECIES OF CARINARIIDAE AND PTEROTRACHEIDAE  
(HETEROPODA, MOLLUSCA) FROM THE INTERNATIONAL  
INDIAN OCEAN EXPEDITION

by P. N. ARAVINDAKSHAN

*Indian Ocean Biological Centre, National Institute of Oceanography,  
Cochin-16, S. India*

This is a description of the distribution in the Indian Ocean of species belonging to two families of the Heteropoda, the Carinariidae and Pterotracheidae. The observations are based on plankton collected by *Anton Brunn, Argo, Pioneer* and *Vityaz* during the IIOE. The samples obtained by these vessels provide broad coverage of the Indian Ocean, including the Arabian Sea and Bay of Bengal and southward to 40° S. Beyond 40° S there were only three collections and these contained no specimens. Pterotracheids outnumber the Carinariids in abundance. The four species of the genus *Carinaria*, *Cardiapoda richardi*, *Pterotrachea scutata* and *Pt. minuta* deserve special mention because of their low density in the Indian Ocean. Most abundant and widely distributed are *Firoloida desmaresti* and *Pterotrachea hippocampus*. *Pterosoma planum* and *Cardiapoda placenta* appear to be more restricted to the tropical zone. The identification of the specimens is mainly based upon Tesch (1949).

INTRODUCTION

This paper is the first result of a continuing study of heteropod molluscs sorted out from the plankton collections deposited at the Indian Ocean Biological Centre by the nations that participated in the International Indian Ocean Expedition, 1960-1965. The heteropod molluscs are of particular interest because of their modifications for a pelagic mode of life. The three families, Atlantidae, Carinariidae and Pterotracheidae, are seen to be in a clear phylogenetic line when we take into consideration their shell-structure. In the case of Atlantidae the animal lives encased in the shell, in Carinariids the shell is much reduced, and in Pterotracheids it is absent. The Heteropoda is a small group, but it presents difficulties inasmuch as some forms lack clear diagnostic characters. Though the earliest publications are of limited use now, much knowledge of the group is obtained from the works of Smith (1888); Bonnevie (1920) and Tesch (1906, 1910, 1949). It was Tesch who arranged all the species in a systematic manner and largely solved the problems of identification. Dales (1952) has published a paper on the distribution of Carinariidae and Pterotracheidae off the Pacific coast of North America. Tokioka (1955) and Okutani (1957, 1961) have published a few papers on the heteropods of the Japanese waters.

## MATERIAL STUDIED

The present discussion is limited to a consideration of Carinariidae and Pterotracheidae collected by the research vessels *Anton Brunn*, *Argo*, *Pioneer* and *Vityaz*. The area surveyed included the Arabian Sea, the Bay of Bengal and most of the rest of the Indian Ocean (Fig. 1), the southernmost collections being from a little beyond 40° S. Since only about one-fourth of the total samples on hand at the Indian Ocean Biological Centre have been examined for heteropods thus far the present paper is a preliminary one. The patterns of distribution as they appear at this stage of study will be indicated. From the 535 samples analysed till now, all the twelve species enumerated by Tesch (1949) have been obtained. The list of the species, the total number of stations at which each was represented and the total number of specimens present in all these stations together, are given below :

Species	Total number of stations	Total number of specimens in all stations together
<i>Carinaria lamarcki challengeri</i>	1	2
<i>C. cristata</i>	2	2
<i>C. galea</i>	1	1
<i>C. cithara</i>	6	6
<i>Pterosoma planum</i>	32	45
<i>Cardiapoda placenta</i>	43	143
<i>C. richardi</i>	1	1
<i>Pterotrachea coronata</i>	16	27
<i>Pt. hippocampus</i>	64	155
<i>Pt. scutata</i>	1	1
<i>Pt. minuta</i>	2	2
<i>Firoloida desmaresti</i>	206	1252

## REVIEW OF DISTRIBUTION OF SPECIES

*Family Carinariidae*

This family comprises three genera: *Carinaria*, *Pterosoma* and *Cardiapoda*. Not a single specimen was collected with the shell intact. Though the shell of *Carinaria* is more relied upon for identification characters, the soft parts also give certain clues. Of the three genera in this family, *Pterosoma* and *Cardiapoda* are more frequently represented than *Carinaria*.

*Genus Carinaria Lamarck 1801*

This includes four species: *Carinaria lamarcki* (with one variety, *Carinaria lamarcki challengeri*), *C. cristata*, *C. galea* and *C. cithara*. Of these *C. cithara* is more common in the Indian Ocean. Figure 2 shows the localities of capture of *Carinaria*.

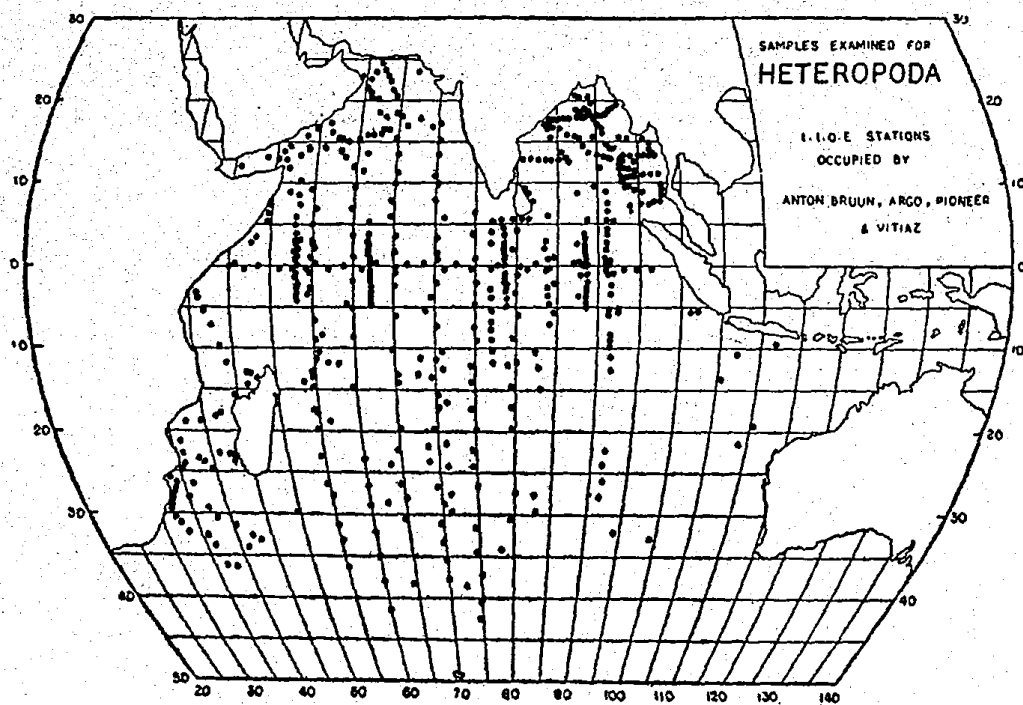


FIG. 1. I.I.O.E. stations occupied by *Anton Bruun*, *Argo Pioneer* and *Vityaz*.

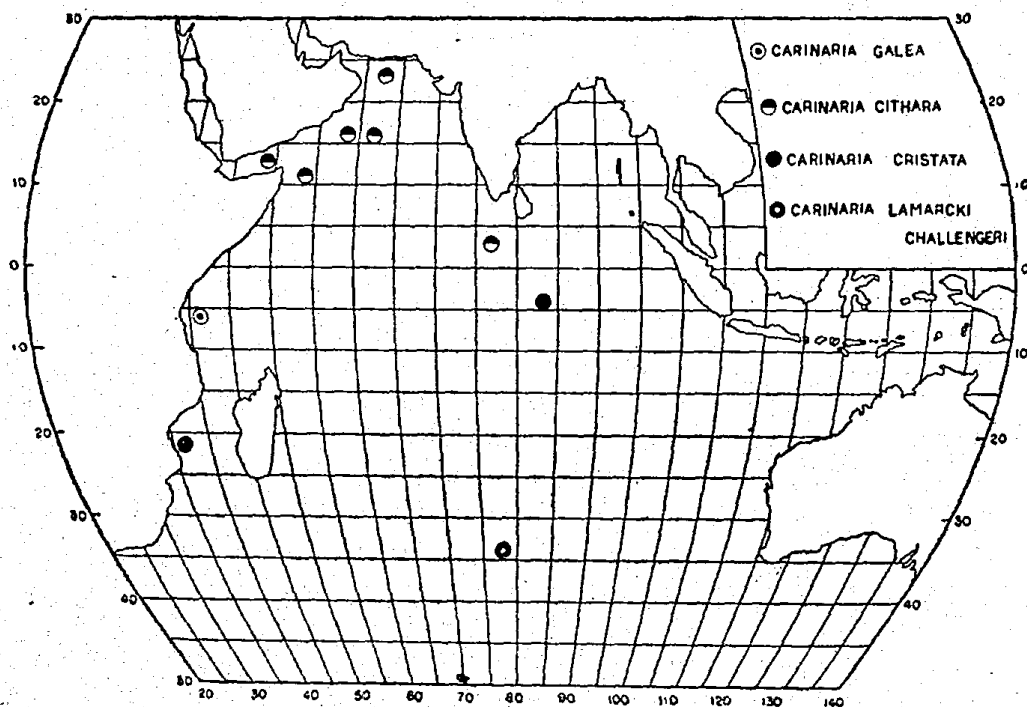


FIG. 2. Distribution of the species of *Carinaria*.

*Carinaria lamarcki challengerii* Bonnevie, 1920

The typical *Carinaria lamarcki* was not obtained. Two specimens of *Carinaria lamarcki challengerii* were collected at Vityaz station 5327 (34°18'S 77°56'E). The distribution of this species is interesting because, as Tesch points out, this is the only heteropod which penetrates into temperate waters. All other ranges are tropical-subtropical. These specimens are considered different from the typical *C. lamarcki* because they possess the "clasper" (Bonnevie 1920) consisting of a pair of folds on the posteroventral side of the body. Okutani (1961) has also not found the "clasper" in the typical specimens of *C. lamarcki*. One of the present specimens is a male (12 mm in length) and the other a female (21 mm). Both cephalic tentacles were present. The right tentacle was smaller than the left. This is contrary to the observations made by Okutani. In his 15 mm specimen the right tentacle was completely absent.

*Carinaria galea* Benson, 1835

Only a 13 mm female specimen was recorded. The locality was off Mombasa. In the Indian Ocean it is distributed from Sumatra to Mombasa, according to Tesch. On the East African coast its distribution extends to Durban. It has not been recorded from the Atlantic and may be considered an Indo-Pacific species.

*Carinaria cristata* (Linne' 1766)

The species is noted for its remarkably large size. In the present material there were only two specimens. The maximum length attained was 28 mm for a female. It was collected between Madagascar and Mozambique. In this species the right tentacle is longer than the left, an anomaly noted by Tesch in his 86 mm specimen. The other specimen was a male, collected north of equator in the eastern Indian Ocean. The distribution of *Carinaria cristata* is known to extend from the south-east coast of Africa northward to Mombasa and also includes the eastern part of the Indian Ocean.

*Carinaria cithara* Benson, 1835

Six specimens were obtained, five of them from the north-west part of the Indian Ocean. The other was from near the equator, south of the tip of India. An important aspect of its distribution is that not a single specimen was present in samples from the Bay of Bengal. Its southernmost record is towards Durban (Tesch). In the present material the maximum length was 52 mm for a female specimen from Vityaz station 5251 (3° 00' N 77° 01' E). The largest *Dana* specimen measured 50 mm. Tesch reported that *Carinaria cithara* was present at each station in the tropical region from Durban to Indo-Malayan waters. Now the distribution is known to extend into the Arabian Sea. There are more records from the Indian Ocean than from the other oceans. The distribution pattern indicates that it is a typical tropical species.

Genus *Pterosoma* Lesson, 1827

*Pterosoma planum* is the only species in the genus *Pterosoma*. It is Indo-Pacific and wholly confined to tropical waters. In the eastern Indian Ocean its northern most record is at 18° N in the Bay of Bengal (Fig. 3). There were numerous records

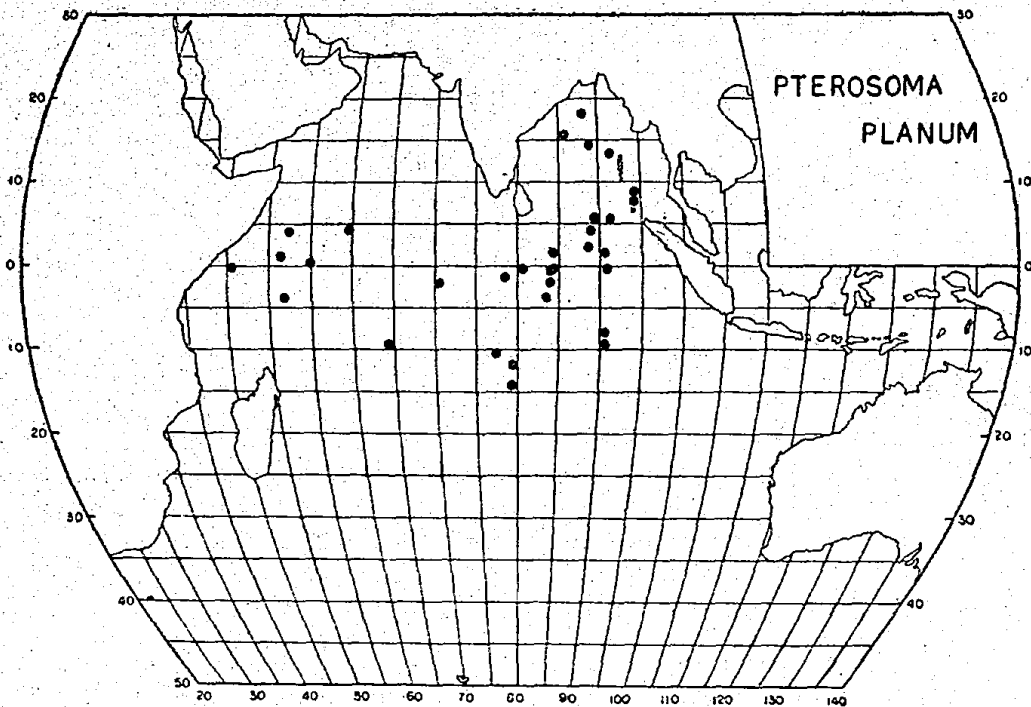


FIG. 3. Distribution of *Pterosoma planum*.

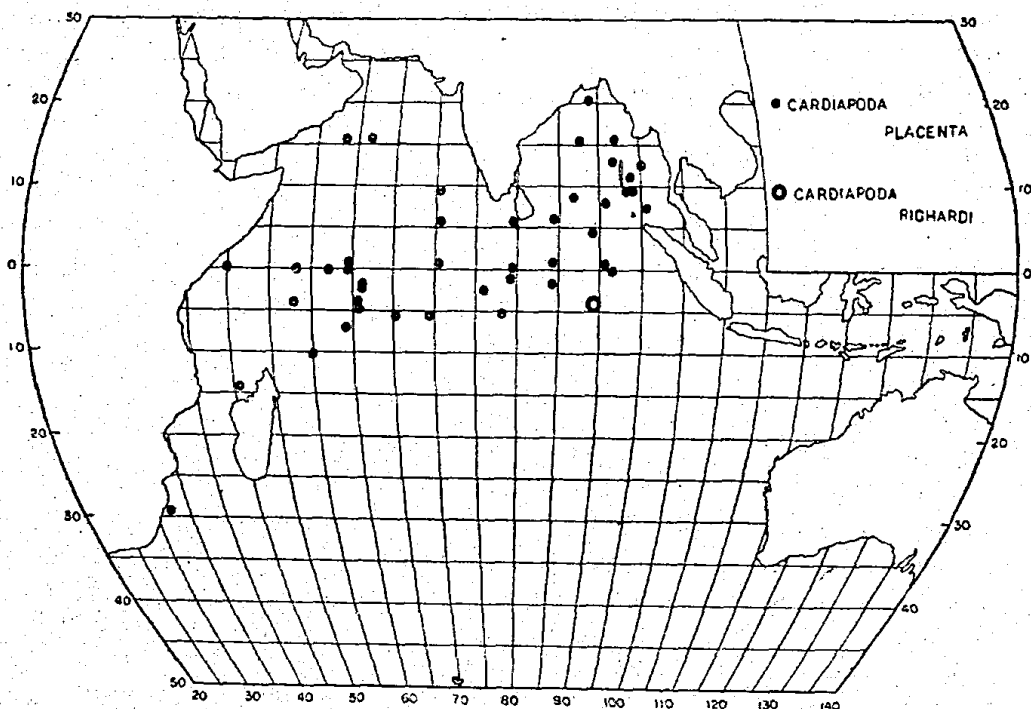


FIG. 4. Distribution of *Cardiopoda placenta* and *Cardiopoda richardi*.

from the eastern Indian Ocean. To the west, it was found off the Somali coast with the northernmost records near 5° N. Thus, it was not found in the Arabian Sea. According to the *Dana* investigations, the southernmost record is 35° 49' S. The present records extend only to 15° S. In the present collection the largest specimen measured 35 mm in length (excluding the tail). Both cephalic tentacles were present, the right one being very small. However, in small specimens the right tentacle is absent. Lesson (1830) described a specimen of 80 mm length, while the largest specimens reported by Hedley (*cited from* Tesch) and Tesch measured only 30 mm.

*Genus* *Cardiapoda* d' Orbigny, 1836

The two species, *Cardiapoda placenta* and *C. richardi* are strikingly different morphologically, as well as in their distributional ranges. *Cardiapoda placenta* is common in the Indo-Pacific whereas *C. richardi* is more abundant in the Atlantic, particularly the Sargasso Sea. There are numerous records of *C. placenta* from the Caribbean Sea, but none for *C. richardi*. In turn, *C. placenta* is rare in the Sargasso Sea. The present records are shown in figure 4.

*Cardiapoda placenta* (Lesson 1830)

Most records for this species are from equatorial waters. There were also several records from the Bay of Bengal, but few from the Arabian Sea. They were present in large numbers in the eastern Indian Ocean. In the present investigation there were only three records south of 10°S. Previous records showed that *C. placenta* is abundant in Indo-Malayan waters. On the east African coast it was found near Madagascar and Mombasa. Its most southern *Dana* record was at 35° 49'S, 23° 09'E off the eastern edge of the Agulhas Bank. In the present study it was found to be only about 30°S.

*Cardiapoda richardi* Vayssiere, 1904

*Cardiapoda richardi* was present at only one locality, "Lusiad" Stn 85 (04° 01'S, 80° 00' E). It was a small and damaged female specimen. Formerly the species was recorded between Ceylon and Seychelles and between Madagascar and east Africa. Now the distribution is known to extend to the eastern Indian Ocean. It is, clearly, rare and scattered in occurrence.

*Family Pterotracheidae*

All the known species of *Pterotrachea* were present. *Pterotrachea coronata* and *Pt. hippocampus* show wide distribution. *Pterotrachea scutata* and *Pt. minuta* are of special interest because of their rare occurrence. *Firoloida desmaresti* is the most abundant among all the species mentioned here. Figures 5 and 6 show the distribution of *Pterotrachea* species and figure 7 shows the distribution of *Firoloida desmaresti*.

*Pterotrachea coronata* : Forskal, 1775

This is one of the largest heteropods. It is widely distributed in the Indian Ocean, though the numbers caught are not as large as the catches reported from

other oceans. In the present collection the largest specimen obtained measured 100 mm length (75 mm excluding the tail). It was a female and there was no sucker on the fin. Tesch could not find a single female with a sucker, but cited Fewkes (1883, 1888) and Paneth (1885) who concluded that this is not always the case, and that the sucker may occur in *Pt. coronata* females as well as in males. But the present author has not found any female specimen with sucker.

*Pterotrachea hippocampus* Philippi, 1836

According to Tesch *Pt. coronata* is more abundant than *Pt. hippocampus*. But the present observations show that *Pt. hippocampus* was obtained from 64 stations (Fig. 6) as against 16 stations for *Pt. coronata* (Fig. 5). In the Indian Ocean *Pt. hippocampus* was found to be most abundant between 5°S and 5°N. However, the southernmost record is at 28°00'S, on the African coast. In the Bay of Bengal it was not found north of the Andamans, as was the case with *Pt. coronata* (Fig. 5). No specimens were caught in the Arabian Sea.

*Pterotrachea scutata* Gegenbaur, 1855

Only one specimen was obtained, from Vityaz Stn 5199 (26° 02' S, 91° 38' E). The total length of the specimen was 39 mm. It was in a damaged condition. Evidently, this is not a common species in the Indian Ocean but in the Atlantic and Pacific it is known to have been caught in large numbers.

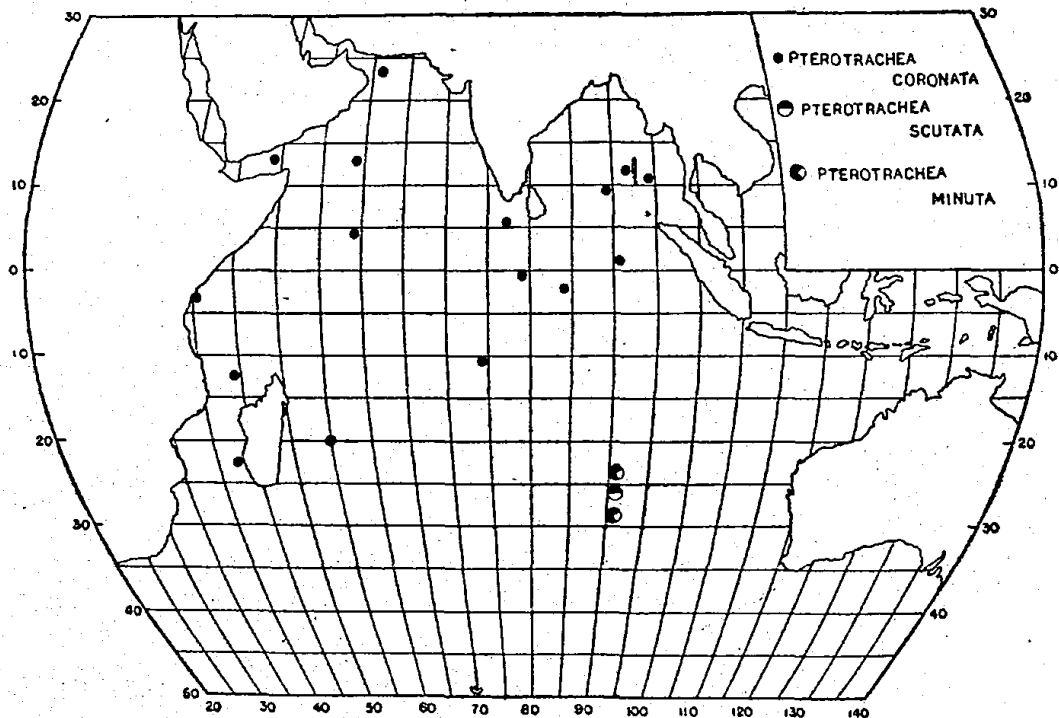
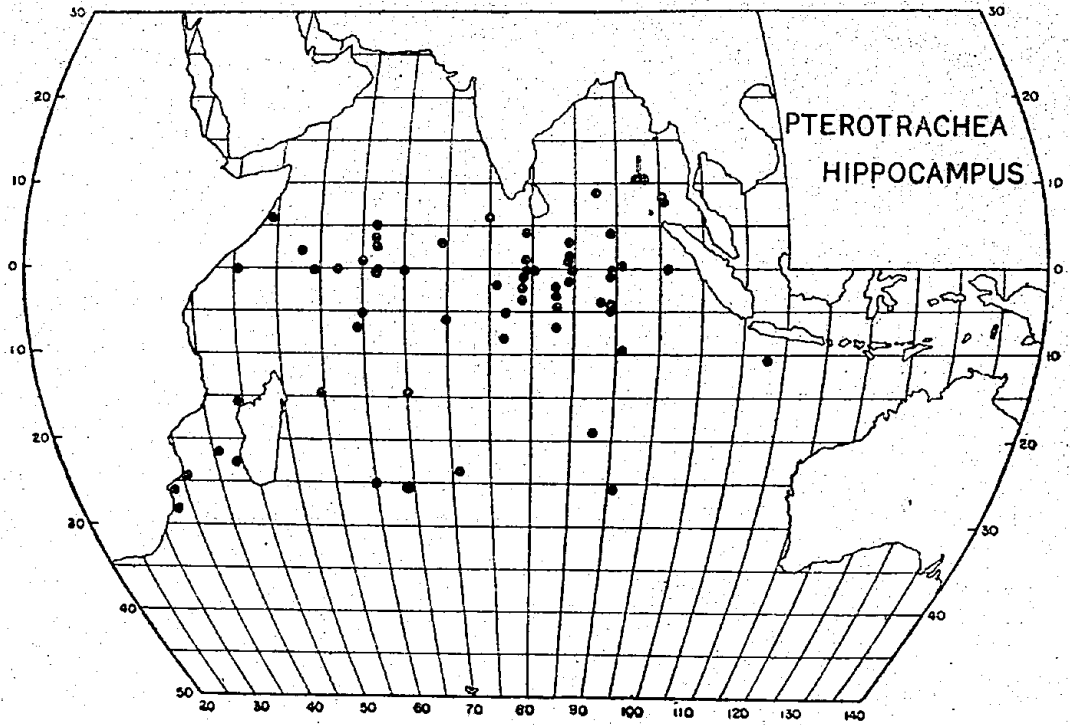
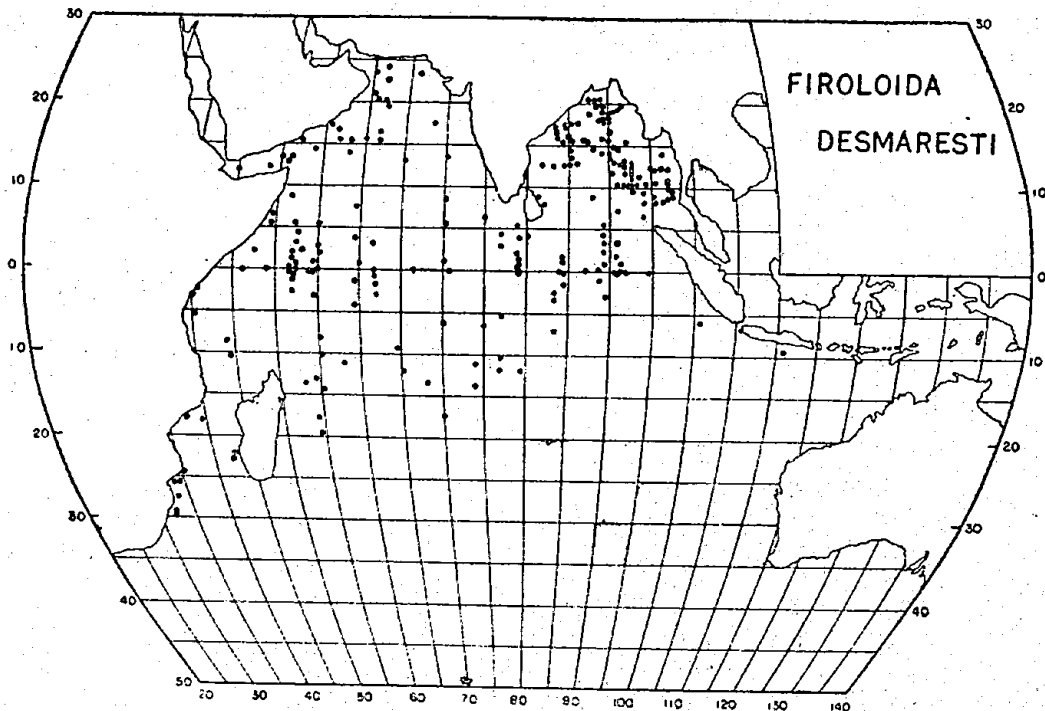


FIG. 5. Distribution of *Pterotrachea coronata*, *Pt. scutata* and *Pt. minuta*.

FIG. 6. Distribution of *Pterotrachea hippocampus*.FIG. 7. Distribution of *Firoloida desmaresti*.



*Pterotrachea minuta* Bonnevie, 1920

Two specimens were obtained near the locality at which *Pt. scutata* was obtained. One specimen measured 13 mm and the other 29 mm in length. Bonnevie's specimen measured 13 mm and Tesch's was 25 mm. This species is rare in all oceans. Tesch reported it from near Mombasa and the present observation extends its distribution to the eastern Indian Ocean.

*Firoloida desmaresti* Lesueur, 1817

As has already been stated this is the most abundant species among the Carinariidae and Pterotracheidae. It is typically a tropical species, and Okutani did not find it in Japanese waters. In the Indian Ocean its southerly range extends to 30° S, along the African coast. East of the Agulhas Stream it is not found south of 20° S. The records are numerous from the Bay of Bengal, the Arabian Sea and the equatorial zone.

To summarise the above review of distribution, it may be said that all the species enumerated by Tesch were present in the material examined. *Carinaria cithara* was obtained from the Arabian Sea but not a single specimen was found in the Bay of Bengal. *Carinaria cristata*, *C. galea* and *C. lamarcki challengerii* were collected; but it is to be noted that not a single specimen was observed from the Arabian Sea or the Bay of Bengal. *Pterosoma planum* appears to be absent from the Arabian Sea. There were numerous records of *Cardiapoda placenta* from the Bay of Bengal but only scattered distribution in the Arabian Sea. Among the Pterotracheidae *Firoloida desmaresti* had the widest distribution. It seems to be rare beyond 20° S except on the African coast. Of the *Pterotrachea* species, *Pt. hippocampus* and *Pt. coronata* were relatively common. But the former was not obtained from the Arabian Sea. *Pt. scutata* and *Pt. minuta* were noted to be rare. Only one specimen of *Pt. scutata* and two of *Pt. minuta* were collected.

## ACKNOWLEDGEMENT

The author is greatly indebted to Dr. N. K. Panikkar, the Director of the National Institute of Oceanography, for giving him permission to present this paper for the "Symposium on the Indian Ocean" and Dr. Edward Brinton, the Curator of the Indian Ocean Biological Centre, for his help and guidance. He is grateful to Mr. L. R. Kasturirangan, the Associate Curator, for his helpful criticisms of the manuscript.

## REFERENCES

- Bonnevie, K. (1920). Heteropoda. *Rep. Sci. Res. "Michael Sars" N. Atl. Deep Sea Exped.*, 1910, 3, 1-17.
- Coan, E. (1965). Generic units in the Heteropoda. *Veliger*, 8, 36-41.
- Dales, R. P. (1952). The distribution of some heteropod molluscs off the Pacific coast of North America. *Proc. zool. Soc. Lond.*, 122, 1007-1015.
- Okutani, T. (1957). On Pterotrachean Fauna in Japanese waters. *Bull. Tokai reg. Fish. Res. Lab.*, 16, 15-21.
- (1961). Notes on the genus *Carinaria* (Heteropoda) from Japanese and adjacent waters. *Publ. Seto mar. biol. Lab.*, 9, 333-352.
- Sebastian, M. J. (1963). On the occurrence of the pelagic mollusc, *Cardiapoda placenta* (Lesson) in the Arabian sea. *J. mar. biol. Ass. India*, 5, 140-142.

- Smith, E. A. (1888). Report on the Heteropoda collected by the H. M. S. Challenger during the years 1873-1876. *Sci. Rep. Voy. Challenger, Zool.*, 23, 1-47.
- Tesch, J. J. (1906). Die Heteropoden der Siboga—Expedite. *Siboga Exped.*, 51, 1-112.
- (1910). Pterop. a. Heterop. Percy Sladen Trust exp. to the Indian Ocean in 1905. *Trans. Linn. Soc. Lond.*, 14, 170-189.
- (1949). Heteropoda. *Dana Rep.*, 34, 1-53.