

Zonation of Chaetognath Species Along the South-West Coast of India

VIJAYALAKSHMI R. NAIR

National Institute of Oceanography, Dona Paula 403004, Goa

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Zonation of chaetognaths in the pelagic realm was attempted by studying zooplankton samples collected along 3 sections off the south-west coast of India. Fifteen species were encountered in the samples. From inshore waters towards the offshore region species diversity increased from 8 to 14 per station in the oceanic region, even though abundance in terms of total number was more towards the inner shelf region. Concomitant with this, species composition also changed and based on the spatial preference shown by different species, 3 zoogeographic zones could be distinguished within the area under investigation: an inner shelf region of 6 species, an outer shelf region of 3 species and a slope region of 6 species. It is suggested that the prevailing environmental conditions resulted in characteristic association of chaetognath species. Effect of thermocline on the stratification of chaetognaths was studied. The results indicated that thermocline did not affect vertical disposition of most of the species.

BOWMAN¹ while studying the distribution of Calanoid copepods between Cape Hatteras and Southern Florida has observed striking inshore-offshore zonation of species. Even though zonation (applied in the sense of occurrence or distribution of organisms in biogeographic zones) is a general phenomenon associated with intertidal organisms, it is being observed among certain groups of zooplankton to a lesser extent. In the present study attempt is made to interpret whether coastal species association differs from the offshore assemblage and also to assess the progressive changes in species composition from the inshore towards the offshore waters.

Materials and Methods

During the joint programme of NIO and CIFO, 3 cruises (during Feb. to April 1970) were undertaken on board *Bluefin*, a fishing trawler of CIFO. Three sections along the south west coast of India were worked out in the area off Cochin, Alleppey and Quilon in the pelagic realm with 5 stations in each (Fig. 1). Stations were fixed from inshore to offshore waters at depths ranging from 30 to 1000 m and details of these collections were given by Purushan *et al.*². Zooplankton samples were taken by vertical hauls from the bottom to the surface using a HT net (mouth area 0.25 m², length 2.5 m and mesh size 0.2 mm) with a flow meter attached. At stations where a thermocline was observed, an additional haul from thermocline to the surface was made. Numerical values for different species were estimated as number per 100 m³. Mean density for each station was worked out based on the data obtained from 3 cruises and for drawing isolines the values were converted to their logarithms.

Hydrography

Off Cochin the surface salinity varied from 33.2 to 33.45‰ and temperature from 29° to 29.7°C; off

Alleppey salinity varied from 33.45 to 33.65‰ and temperature from 28.5 to 29.1°C and in the Quilon cruise track salinity varied from 33.7 to 34.05‰ and temperature from 28.7° to 29.9°C. The mean values of temperature and salinity for the mixed layer are represented in Fig. 2. Temperature and salinity values gradually increased from the coast towards the sea.

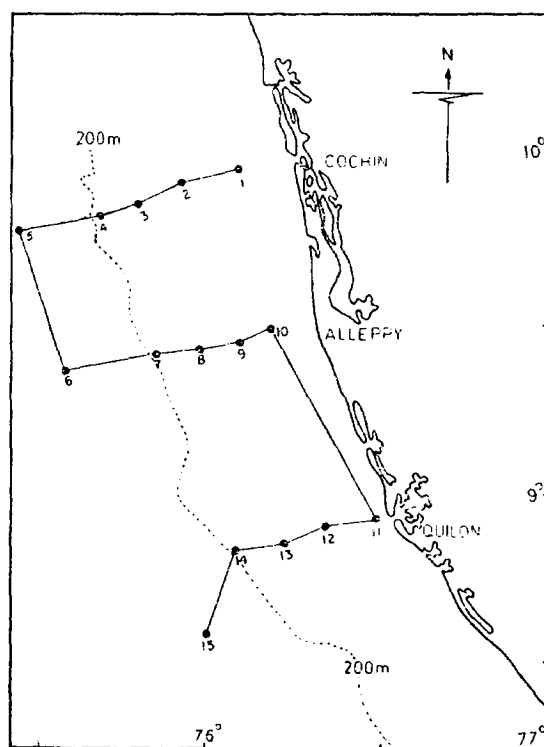


Fig. 1 — Location of stations

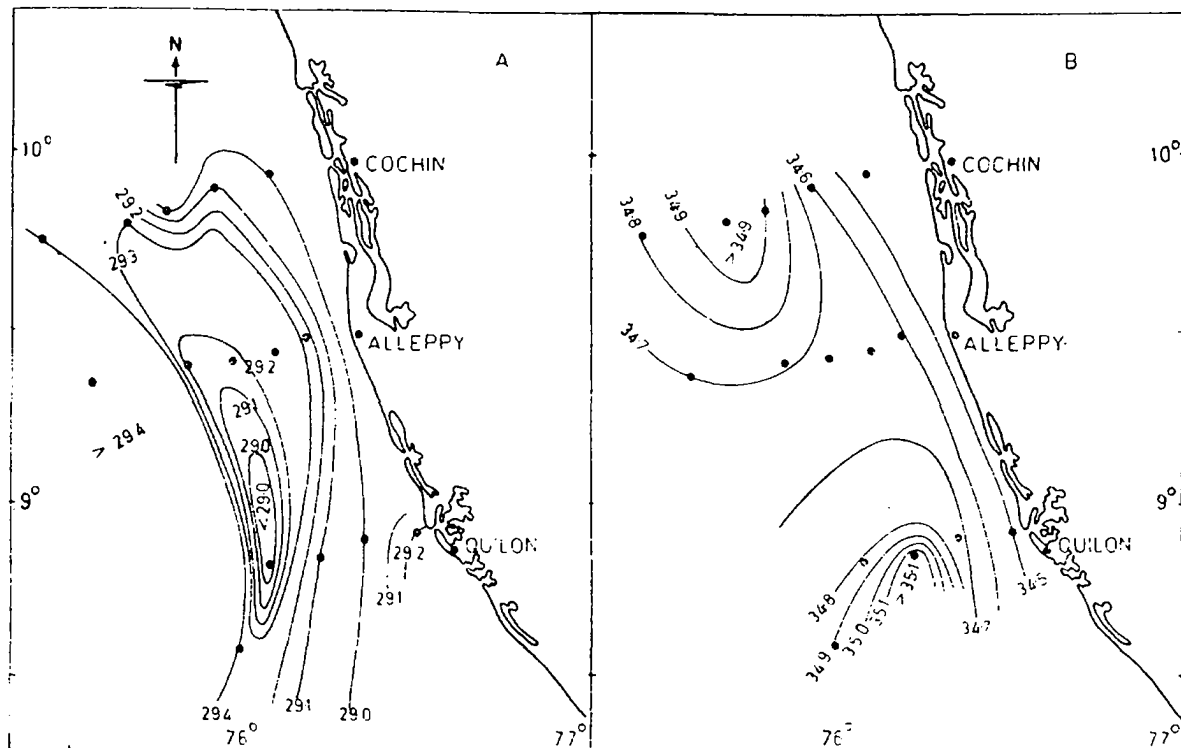


Fig. 2 — Distribution of temperature (A) and salinity (B) for the mixed layer depths [Values represent estimated mean of 3 cruises]

The region under investigation is influenced by 2 different water masses; a low saline coastal water mass and a high saline Arabian Sea water. Presence of high saline water mass in the subsurface layer of the continental shelf of this area has been observed³. The vertical profiles of temperature, salinity and oxygen indicate that upwelling commences in February in these waters. During February to April relatively high salinity waters can be traced up to 40 m at station 2; 35.6‰ at 50 m at station 11 and 35.1‰ at 50 m at station 14.

Results

Species Composition

Fifteen species of chaetognaths were encountered in these samples. They were: *Eukrohnia fowleri*, *Krohnia pacifica*, *K. subtilis*, *Pterosagitta draco*, *Sagitta bedoti*, *S. bipunctata*, *S. decipiens*, *S. enflata*, *S. ferox*, *S. hexaptera*, *S. neglecta*, *S. pacifica*, *S. pulchra*, *S. regularis* and *S. robusta*. Of these, *S. enflata*, *S. bedoti*, *S. neglecta* and *S. regularis* were common species in these collections. The bathypelagic species *E. fowleri* and mesopelagic species *S. decipiens* were found only in 3 samples taken from stations 2, 7 and 8. *K. subtilis* was recorded from a single collection obtained from station 6.

Zonation of Species

The striking feature observed during the analyses was the preference shown by epipelagic species to

particular zones within the region under investigation. The species consistently present in the samples in significant numbers during February to April can be segregated into groups characteristic of particular zones in accordance with their abundance within the neritic/oceanic realm.

Coastal zone or inner shelf region (Fig. 3) — These species showed maximum population density in the inshore waters and gradually decreased in abundance towards the middle and outer zone. Six species come under this group. Maximum abundance for *S. bedoti*, *S. ferox* and *S. neglecta* was off Cochin, for *S. enflata* off Cochin, and Alleppey, for *K. pacifica* off Alleppey and Quilon and for *S. regularis* off Alleppey.

Middle zone or outer shelf region (Fig. 3) — A few species showed relatively low values towards the inner shelf region, higher densities in the middle zone and density again decreasing towards the outer zone. The species showing this pattern of abundance are *S. pacifica* and *S. robusta* along the three transects and *S. pulchra* found only off Quilon.

Outer zone or slope region (Fig. 3) — *P. draco*, *S. bipunctata* and *S. hexaptera* were practically absent along the coastal region and gradually appeared in the middle zone and increased towards the offshore waters. The sparsely represented species *K. subtilis*, *S. decipiens* and *E. fowleri* were also restricted to this zone.

For assessing the progressive change in species abundance, the stations were segregated into 5

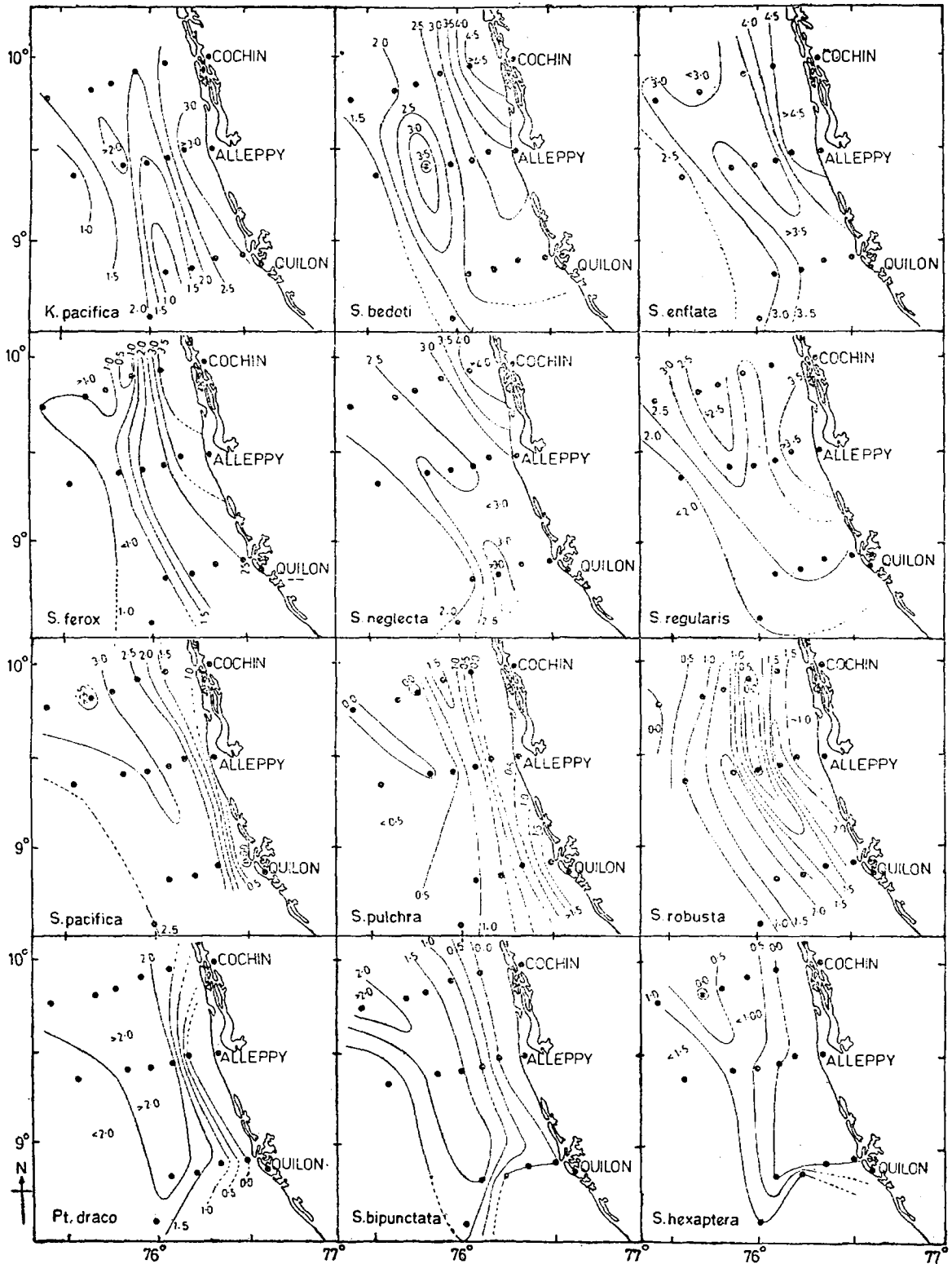


Fig. 3 — Population densities of chaetognath species showing preference to inner shelf region (*K. pacifica*, *S. bedoti*, *S. enfata*, *S. ferox*, *S. neglecta* and *S. regularis*), outer shelf region (*S. pacifica*, *S. pulchra*, *S. robusta*) and slope region (*Pt. draco*, *S. bipunctata* and *S. hexaptera*) [Numbers represent log values of estimated mean density per 100 m²]

regions (Table 1). Zonal distribution of different species among the 5 regions is represented in Fig. 4. The species characteristic of the inner shelf region *K. pacifica*, *S. bedoti*, *S. cnflata*, *S. ferox*, *S. neglecta* and *S. regularis* (Fig. 4A) sustained maximum density along region I and gradually decreased in abundance towards region V suggesting an inshore preference. *S. pacifica*, *S. pulchra*, and *S. robusta* form an intermediate group and these species were more abundant in the outer shelf region. The typical oceanic species (Fig. 4B) dominate region V and are very rarely represented in other regions.

Another interesting feature observed is the progressive increase in absolute number of species encountered in the sample from inshore waters towards the offshore waters (Fig. 5), the number of species increasing from 8/station to 14/station. Maximum number of species was encountered in samples taken from stations located at oceanic region. However, abundance in terms of total number per m³ is more towards the shelf

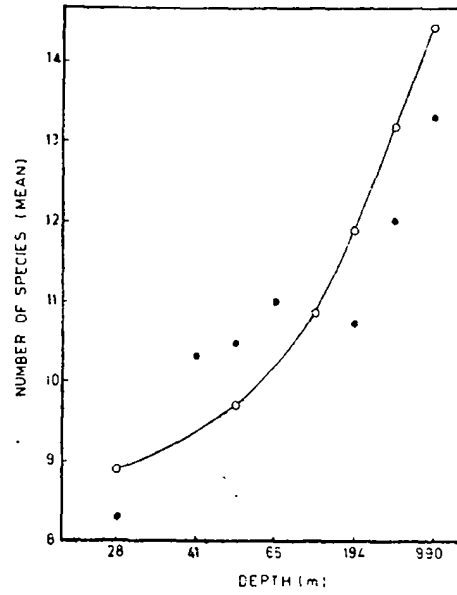


Fig. 5 — Increase in the number of chaetognath species from inshore towards the offshore waters

TABLE 1 — STATIONS IN DIFFERENT REGIONS AND MEAN NUMBER OF CHAETOGNATHS FROM THE RESPECTIVE AREAS

Region	Stations	Chaetognaths No./m ³
I	1, 10, 11	528
II	2, 9, 12	115
III	3, 8, 13	56
IV	4, 7, 14	64
V	5, 6, 15	28

region. The average number of chaetognaths for the 5 different regions are given in Table 1.

Abundance in Relation to Thermocline

Effect of thermocline on the vertical disposition of chaetognath species was assessed based on the samples collected from above and below the

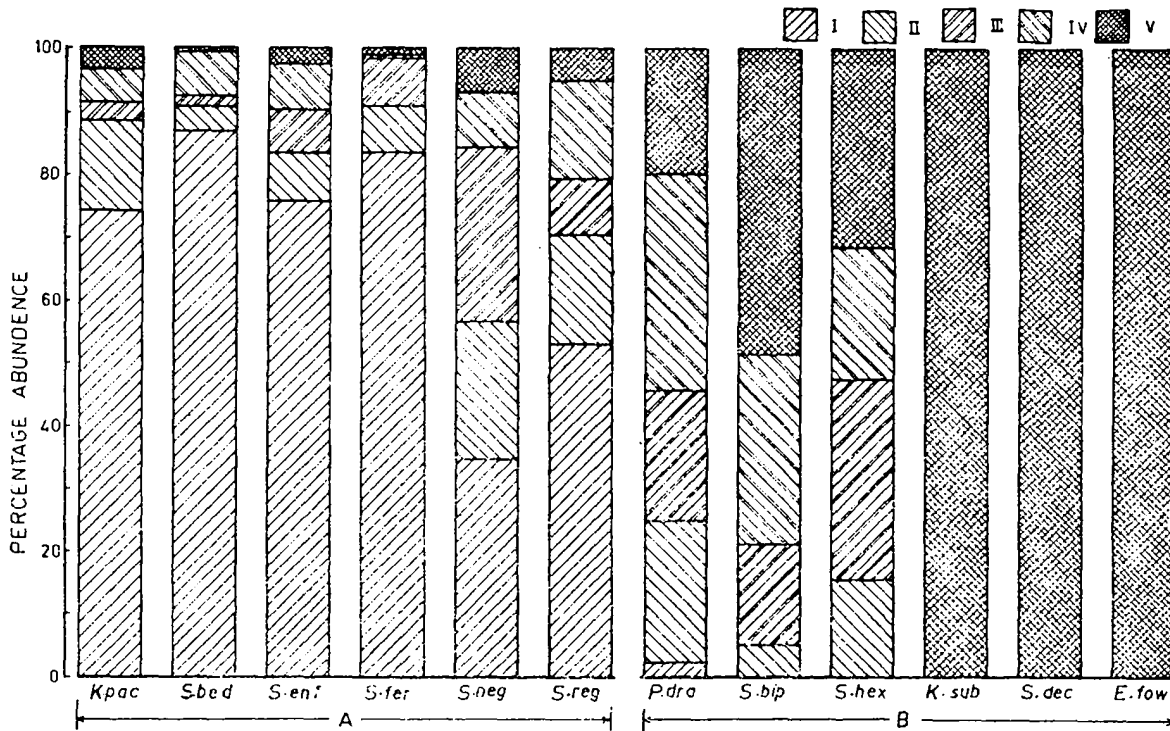


Fig. 4 — Relative abundance of different chaetognath species in the 5 regions [Species of the inner shelf region (A) and slope region (B)]

TABLE 2 — DENSITY OF CHAETOGNATHS IN RELATION TO MIXED LAYER

Station	Depth of mixed layer m	Chaetognaths No./m ²
7	100	218
4	100	61
14	85	40
15	75	44
5	75	31
6	75	12

thermocline. It was noted that thermocline was not influencing the stratification of most of the chaetognath species, since they were encountered in hauls above the thermocline as well as in samples taken from bottom to surface. *K. subtilis* and *S. hexaptera* were the only two species which had restricted distribution below the thermocline. The depth of the mixed layer seemed to be affecting the abundance of chaetognath population and maximum chaetognaths were obtained from stations where discontinuity layer extended down to 100 m (Table 2).

Discussion

From the study on the zonal characteristics of different chaetognath species it would appear that they have environmental preference either for inshore or offshore waters. The species distributional range exhibited overlapping and clear cut demarcation could be made only for the typical oceanic species. The species predominant in the coastal and middle zones are typical Indo-Pacific species and the offshore zone is dominated by cosmopolitan species of Atlantic, Pacific and Indian Oceans⁴.

Srinivasan⁵ has given an account on the chaetognaths along the west coast of India, the region just north of the present area of investigation. The present findings corroborate his observation in the preference shown by *S. bedoti*, *S. ferox* and *S. enflata* for the shelf waters and of *P. draco* and *S. hexaptera* for the oceanic region.

The present concept of decreasing number of species towards the inshore waters is supported by earlier studies on the group from oceanic, coastal and estuarine waters^{6,7}. The oceanic realm, the relatively less saline waters of the shelf region and the estuarine waters of fluctuating salinity conditions result in 3 distinct environments. Off Cochin, in the oceanic area, 14 species were found, in the shelf region 8-10 species and in the estuarine habitat 4-5 species. The available data indicate that the prevailing environmental conditions at the time of sampling sustained different associations of chaetognath species according to water mass, distance from the coast and depth of mixed layer.

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