Biochemical Composition of Zooplankton from the Andaman Sea

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Protein was the dominant constituent in mixed zooplankton, major planktonic groups and some common species collected from the Andaman Sea. Overall mean values, calculated as a percentage of dry weight, were 45.14 protein, 10.6 lipid, 4.2 carbohydrate, 33.5 organic carbon and 7.2 total nitrogen. Biochemical constituent values were low in forms with a high water content. No reciprocal relationship was found between protein and lipid fractions. Organisms with lower C:N gave a higher caloric value indicating the role of protein as a metabolic reserve in tropical zooplankton with low lipid content.

Biochemical studies are important for understanding the nutritive value and flow of energy at different trophic levels. Compared to studies on the biochemistry of zooplankton from the colder regions\(^1\)\(^{-8}\), little work has been done on the zooplankton from the tropical areas\(^9\),\(^10\). Bogorov et al.\(^9\) and Stephen et al.\(^10\) have described the biochemical composition of zooplankton from the Indian Ocean and Laccadive Sea (Lakshadweep) respectively dealing only with a few species or groups. Biochemical constituents, C:N ratio and caloric value of mixed zooplankton, major planktonic groups and their common species collected mainly from the Andaman Sea during 66 to 68 cruises of RV *Gaveshani* (Dec. 1979 to Feb. 1980) are given here.

Materials and Methods

Zooplankton were collected from 33 stations (Fig. 1) by vertical hauls (200 m to surface) using the Indian Ocean Standard Net. The samples were frozen immediately in a deepfreeze. For biochemical analyses these were thawed, cleaned and divided into 2 parts, one was utilized for the determination of biochemical constituents in mixed zooplankton and the other for the determination in major groups and common species, sorted rapidly in distilled water. The material...

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Fig. 1—Location of the sampling stations
was dried to constant weight in an oven at 60°C. Owing to paucity of dried material, 1 proximate biochemical analysis was done for each sample. Estimations of protein, lipid, carbohydrate, organic carbon and total nitrogen were made. Caloric content was calculated from the values of major biochemical constituents.

Results
The results are presented in Tables 1 and 2.
Protein formed the major biochemical constituent in all samples analysed. Highest protein value for the mixed zooplankton was recorded at sts 1269, 1290 and 1294. Euphausids were the major planktonic component at the 1st station whereas fish larvae were dominant in the remaining 2 stations. The lowest value at st 1263 was due to the abundance of gelatinous forms such as medusae, siphonophores, salps and doliolids. Protein content was uniformly high in different zooplankton groups except for organisms with high water content (Hydromedusae, Coelenterata, Pyrosomidae and Thaliacea) where the protein fraction varied from 21.36 to 33.3% (mean 28.84%). Crustaceans, particularly copepods showed high protein with the maximum value (61.34%) in Undinula vulgaris. Lipid fraction was usually low in mixed zooplankton but a slightly higher lipid content was observed in different groups and species. Carbohydrate content was generally poor. The values were low (0.8%) in gelatinous organisms especially in the colonial forms (Pyrosomidae). Organic carbon fraction varied from 24.3 to 46.2% in terms of dry weight for total zooplankton and from 18.5 to 48.5% for groups and species. Highest total nitrogen value (13.1%) was obtained for the mixed zooplankton collected at st 1279. The values were also high in the carnivorous copepod Euchaeta marina. The mean C:N was around 5:1 for the zooplankton population from

<table>
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Table 2—Protein, Lipid, Carbohydrate, Organic Carbon and Total Nitrogen Contents, C:N Ratio and Caloric Value
of Major Zooplanktonic Groups and Common Species

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the Andaman Sea (Tables 1 and 2). Organisms with lower C:N gave higher caloric values and the highest value (4.23 k cal/g dry weight) was obtained for the fish larvae (Table 2).

**Discussion**

Earlier studies on proximate composition of zooplankton and selected common species clearly indicated that protein constituted the major fraction in terms of dry weight\(^1\).\(^6\).\(^7\). Raymont et al.\(^1\) quoted mean value of 70.9% in mysid *Neomysis integer*, 60% in several planktonic decapods\(^4\) and 57% in the euphausid *Meganyctiphanes norvegica*\(^5\). Ferguson and Raymont\(^1\)\(^7\) gave protein content of 37 to 56.3% for another euphausid *Euphausia superba*. Protein content of Euphausiacea and *Euphausia diomedeae* determined...
in the present investigation (Table 2) was within the range reported for other euphausid species. However, the protein content for the chaetognath *Sagitta enflata* was less than the values reported for the other species.\(^7,18,19\) High variability in protein content was reported in the copepod species.\(^18,20,21\) Stephen *et al.*\(^19\) obtained protein content of 53.33% for *Euchaeta marina* from the Laccadive Sea and the value compared well with the protein content of the same species collected from the Andaman Sea (Table 2). Fluctuations in the percentage of protein in planktonic organisms were explained on the basis of seasonal variations in *Meganyctiphanes norvegica*\(^4\) and *Sagitta hispida*\(^7\), utility as metabolic substrate\(^22\) and difference in environmental salinity\(^23\).

No reciprocal relationship was discernible between protein and lipid fractions. Lipid content was low with mean values of 10.0, 9.9 and 11.9% in terms of dry weight in mixed zooplankton, major groups and common species respectively. Spatial variations were noticed in the lipid content of zooplankton collected at stations located on the north and south of 10° lat. (Fig. 1). Lipid content was more at the northern stations (mean 8.1%) than at the southern stations (mean 7.8%). Lipid content was poor compared to the value reported for this species (31.77%) from the Laccadive Sea\(^10\) but the value was within the low range (9 to 15%) given for the mysid *Neomysis integer*\(^1\). Lipid fraction was lowest for organisms with high water content. However, the value obtained for these animals in the present study were higher than those reported from Cochin backwaters.\(^27\) Variations in total lipid were attributed to variations in storage and utilization in colder regions.\(^4\) In warm water environments, the rate of primary production far exceeds the rate of consumption by zooplankton.\(^28\) The continuous supply of phytoplankton food would render lipid reserve unnecessary which might account for the low lipid content in the tropical zooplankton.

All the zooplankton species examined so far were reported to be low in carbohydrate content.\(^5,6,29\) as in the present study. Carbohydrate content of the decapod species studied compared well with the reported values for 3 decapod species collected from the Gulf of Aden.\(^7\) Copepods such as *Undinula vulgaris* and *Pontellina plumata* which could obtain carbohydrate directly by feeding on phytoplankton showed slightly higher values than that observed for other planktonic groups, viz. Amphipoda, Isopoda, Mysidacea, but still, the mean value was around 4% in terms of dry weight. Low carbohydrate content suggested that glycogen, the usual storage carbohydrate in many marine animals might not contribute substantially towards the body reserve and energy flow.

The amount of food available was reported to influence the carbon content of zooplankton.\(^30\) Cushing *et al.*\(^31\) reported the average carbon content of oceanic zooplankton to be 60% of the total zooplankton dry weight. Omori\(^30\) gave 45% as the average carbon value of zooplankton for the north Pacific. The overall mean value of organic carbon of zooplankton collected from the Andaman Sea was 33.5%, comparable to the average carbon value (33.7%) of zooplankton of Cochin waters\(^32\). The C:N was 5:1 for the planktonic organisms. The animals with lower C:N had higher calorific values. However, Qasim *et al.*\(^33\) reported the maximum calorific content for *Halobates* sp. (6.46 k cal/g dry weight) collected from the coastal region extending from Dabhol to Tuticorin.

The present study shows that protein serves as a metabolic reserve. The tropical zooplankton do not have extensive lipid and carbohydrate storages owing to constant supply of phytoplankton food. This is very much in contrast to the conditions obtained in temperate plankton.

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