

Biochemical Composition of Zooplankton from the Andaman Sea

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Received 15 December 1980; revised received 27 January 1981

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 regions¹⁻⁸, 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 *R V Gveshani* (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

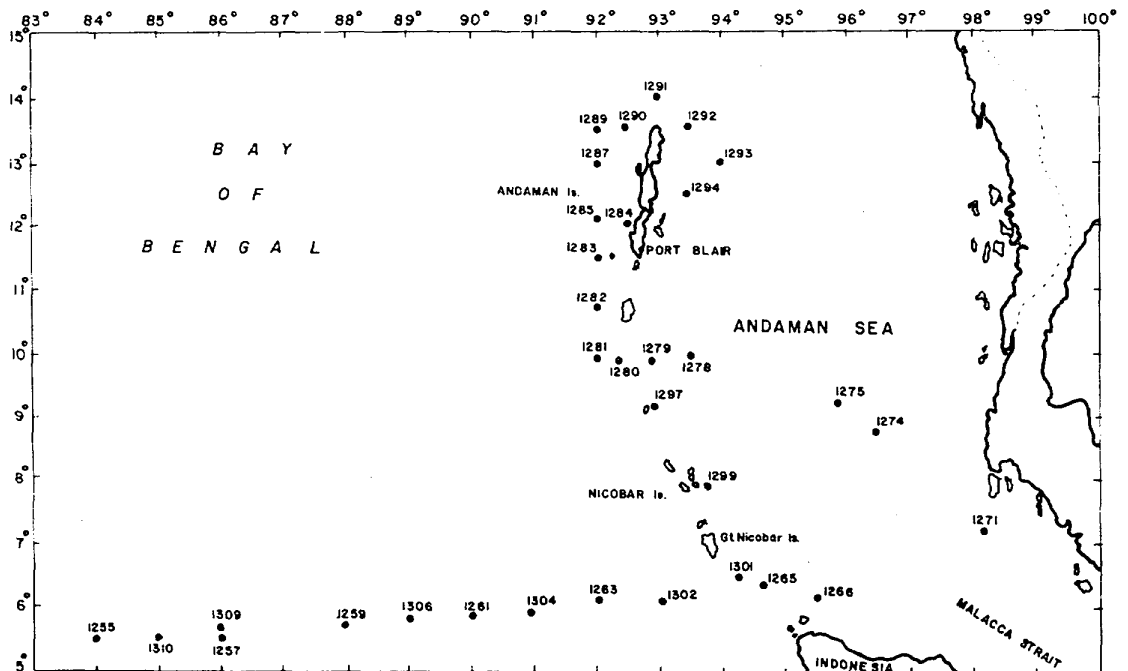


Fig. 1—Location of the sampling stations

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 protein¹¹, lipid¹², carbohydrate¹³, organic carbon¹⁴ and total nitrogen¹⁵ were made. Caloric content was calculated from the values of major biochemical constituents¹⁶.

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 1259, 1290 and 1294. Euphausiids 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 1— Protein, Lipid, Carbohydrate, Organic Carbon and Total Nitrogen Contents, C:N Ratio and Caloric Value of Total Zooplankton

St No	Total dry wt (mg)	%, of dry weight				Total nitrogen %	C:N	Caloric value kcal/g dry wt
		Protein	Lipid	Carbohydrate	Organic carbon			
1255	20	52.64	9.8	4	35	13	2.6:1	3.3
1257	80	51.12	4.7	3	35	12	2.9:1	2.71
1259	137	53.25	8	7	31	9.5	3.2:1	3.28
1261	170	38	13.5	8	40.5	7.7	5.2:1	3.21
1263	180	34.2	6.1	6.1	40.8	8.6	4.7:1	2.28
1265	180	36.51	7.6	10.4	35	4	8.7:1	2.69
1266	140	44.5	7	3.5	32.2	6.8	4.7:1	2.68
1271	87	47.51	15.2	3.5	24.3	11.5	2.1:1	3.58
1274	110	44.61	8.5	5.8	41	6	6.8:1	2.92
1275	30	44.14	8.9	4	39.5	6	6.5:1	2.86
1278	210	35.24	9.2	7.2	42.4	10.2	4.1:1	2.65
1279	150	44.52	8.4	4	42.6	13.1	5.1:1	2.83
1280	98	43.45	12.5	3.3	31.5	5.3	5.9:1	3.08
1281	95	44.5	5	3.5	46.2	12.2	3.7:1	2.49
1282	110	45.4	6.2	3.3	43.4	11.2	3.8:1	2.63
1283	96	43.12	8.5	4.6	40.1	9.8	4.0:1	2.81
1284	112	44.5	7.2	3.1	35.8	7.2	4.9:1	2.68
1285	125	38	17.2	4.5	36.3	6.9	5.2:1	3.41
1287	75	38.45	7.3	6.7	40.5	4.2	9.6:1	2.58
1289	100	44.5	17.2	4.5	40	6.4	6.2:1	3.69
1290	160	53.25	12	8	26	6.6	3.9:1	3.71
1291	30	38	18.2	3.5	41.6	5.4	7.7:1	3.47
1292	75	44.3	9	8.7	38.3	9.5	4.0:1	3.08
1293	75	34.54	3.7	5	40	7.2	5.5:1	2.01
1294	80	53.25	12.5	2.7	32.1	6.5	4.9:1	3.53
1297	115	37.63	7.8	8.2	32.0	4.0	8.0:1	2.66
1299	125	50.71	13.0	8.7	27.0	8.0	3.3:1	3.73
1301	95	42.53	5.4	7.6	40.4	5.5	7.3:1	2.61
1302	150	45.12	12.9	2.0	36.2	7.1	5.0:1	3.20
1304	210	38.13	8.9	4.0	35.0	7.0	5.0:1	2.61
1306	150	48.72	12.0	6.7	25.0	11.4	2.1:1	3.46
1309	90	41.11	11.8	5.3	38.0	7.2	5.2:1	3.06
1310	115	44.50	15.2	3.5	24.5	7.5	3.2:1	3.45
Mean	114	43.63	10.0	5.2	36.0	8.0	5.0:1	2.99

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

Groups	Total dry wt (mg)	% of dry weight				Total nitrogen %	C:N	Caloric value k cal/g dry wt
		Protein	Lipid	Carbo- hydrate	Organic carbon			
GROUPS								
Hydromedusae	25	32.31	5.8	2.0	24.6	4.1	6.0:1	1.98
Coelenterata	20	33.30	6.4	3.5	31.0	3.7	8.3:1	2.15
Polychaeta	65	41.23	13.7	5.2	40.0	9.5	4.2:1	3.25
Copepoda	180	61.21	14.4	4.4	21.4	7.3	2.9:1	4.11
Decapoda	70	49.34	11.5	6.2	33.0	8.1	4.0:1	3.42
Amphipoda	58	44.32	9.5	5.3	38.7	6.4	6.0:1	2.97
Isopoda	20	52.33	8.8	4.5	34.9	8.4	4.1:1	3.22
Ostracoda	96	48.21	9.7	6.0	35.8	8.1	4.4:1	3.19
Mysidacea	60	43.24	12.4	4.0	30.2	8.6	3.5:1	3.16
Euphausiacea	80	52.15	10.8	5.1	32.9	9.1	3.6:1	3.34
Pteropoda	92	42.14	8.5	2.0	24.7	3.5	7.0:1	2.65
Pyrosomidae	24	21.36	4.7	0.8	18.5	2.4	7.7:1	1.37
Thaliacea	20	28.41	4.6	1.0	21.5	2.7	7.9:1	1.67
Fish larvae	112	54.21	19.1	3.6	23.0	8.9	2.6:1	4.23
Mean	65	43.12	9.9	3.7	29.3	6.5	5.1:1	2.91
COMMON SPECIES								
Copepoda								
<i>Undinula vulgaris</i>	25	61.34	9.4	3.8	26.2	8.0	3.2:1	3.58
<i>Euchaeta marina</i>	34	53.12	10.5	4.6	30.0	9.6	3.1:1	3.40
<i>Pontella spinipes</i>	78	60.32	13.5	3.0	22.0	6.8	3.2:1	3.98
<i>Pontellina plumata</i>	35	53.54	17.8	3.3	25.2	9.2	2.7:1	4.07
<i>Euchirella</i> spp	42	45.14	12.2	4.2	39.0	6.5	6.0:1	3.14
Decapoda								
<i>Acanthephyra sanguinea</i>	110	51.32	13.5	2.2	31.8	5.9	5.4:1	3.52
<i>Gennadas</i> sp.	80	41.63	11.2	2.5	44.2	6.6	6.7:1	2.90
<i>Alpheus</i> sp.	65	38.13	12.6	2.0	46.8	5.3	8.8:1	2.98
Mysidacea								
<i>Sirella</i> sp	70	45.92	10.5	4.2	39.2	7.5	5.2:1	3.10
Euphausiacea								
<i>Euphausia diomedea</i>	100	56.50	12.8	3.2	27.9	6.0	4.6:1	3.72
Chaetognatha								
<i>Sagitta enflata</i>	85	36.80	8.0	4.6	48.5	6.2	7.8:1	2.49
Ostracoda								
<i>Cypridina dentata</i>	115	40.48	11.2	5.9	42.1	8.8	4.8:1	3.01
Mean	70	48.68	11.9	3.6	35.2	7.2	5.1:1	3.32

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 decapods⁴ and 57% in the euphausid *Meganctiphanes norvegica*⁵. Ferguson and Raymont¹⁷ gave protein content of 37 to 56.3% for another euphausid *Euphausia superba*. Protein content of Euphausiacea and *Euphausia diomedea* determined

in the present investigation (Table 2) was within the range reported for other euphausiid 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.*¹⁰ 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 substrate²² and difference in environmental salinity²³.

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 reported values from colder regions^{4, 22, 24-26}. Lipid fraction of *Euphausia diomedea* was low (12.8%) compared to the value reported for this species (31.77%) from the Laccadive Sea¹⁰ 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 backwaters²⁷. Variations in total lipid were attributed to variations in storage and utilization in colder regions⁴. In warm water environments, the rate of primary production far exceeds the rate of consumption by zooplankton²⁸. 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 Aden⁷. 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 zooplankton³⁰. Cushing *et al.*³¹ reported the average carbon content of oceanic zooplankton to be 60% of the total zooplankton dry weight. Omori³⁰ 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 waters³². The C:N was 5:1 for the planktonic organisms. The animals with lower C:N had higher caloric value. The caloric content of mixed zooplankton varied from 2.01 to 3.73 k cal/g dry weight (Table 1). Values for the zooplankton of Cochin waters³² were reported to fluctuate from 1.06 to 4.95 k cal/g dry weight. Variations in calorific content were noticed between groups and species also. The crustaceans, particularly copepod species showed high caloric values. However, Qasim *et al.*³³ reported the maximum caloric 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.

Acknowledgement

The authors express their gratitude to Dr S.Z. Qasim, Director, for help and encouragement. Thanks are also due to Dr Sumitra Vijayaraghavan for comments on the manuscript.

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