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Biochemical composition of zooplankton from the Andaman Sea

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Abstract

Zooplankton biomass, proximate composition, biochemical constituents and calorific values have been determined from the mixed zooplankton collected from the nearshore and offshore waters around Andaman and Nicobar Islands during north-east monsoon 1996. Biomass varied from 8.20 to 32.80 ml. 100 m^{-3} (x=14.95±6.60) and total zooplankton population ranged from 22950 to 94250 no.100 m^{-3} (x=44465±17778). Copepods contributed maximum at all stations (69.40 - 86.96%). Of the principal biochemical constituents, protein formed the major component. Overall mean values reckoned as percentage of dry weight as 44.84% protein, 19.10% lipid, 4.98% carbohydrate, 38.42% organic carbon and 4.56 k.cal.g^{-1} calorific value. Higher values of these constituents were observed in the nearshore and offshore stations of Nicobar region compared to Andaman region. Significant positive correlations ($P<0.01$) observed between these constituents indicate to certain extent act as a metabolic reserve in the zooplankton. The results revealed that the zooplankton of the Andaman Sea do not have extensive lipid and carbohydrate storage, suggesting that the protein, in addition to lipid and carbohydrate serve as metabolic reserve. The calorific values are high due to the dominance of copepods in the total zooplankton.

Introduction

Information on biochemical composition of zooplankton is of great importance in understanding the nutritive value and energy pathways in pelagic food web. Most of the information is available on these aspects from the west coast of India (Goswami *et al.* 1981; Sumitra Vijayaraghavan *et al.* 1982; Nandakumar *et al.* 1988; Krishna Kumari and Achuthankutty, 1989; Bhat and Wagh, 1992; Krishna Kumari & Goswami 1993; Maruthanayagam and Subramaniam, 1999; Goswami *et al.* 2000) and meagre in the east coast of India (Goswami *et al.* 1981; Sreepada *et. al.* 1992; Krishna Kumari and Goswami; 1993). The present paper deals with biomass, major biochemical constituents, organic carbon and calorific content of the mixed zooplankton from the near and offshore waters around Andaman and Nicobar Islands.

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Material and methods

Zooplankton samples were collected from 16 stations (Fig. 1) of neashore (5) and offshore (11) waters around Andaman and Nicobar Islands during 118th cruise of ORV *Sagar Kanya* (from 15th Oct. to 11th Nov. 1996, north east monsoon) using Bongo plankton net

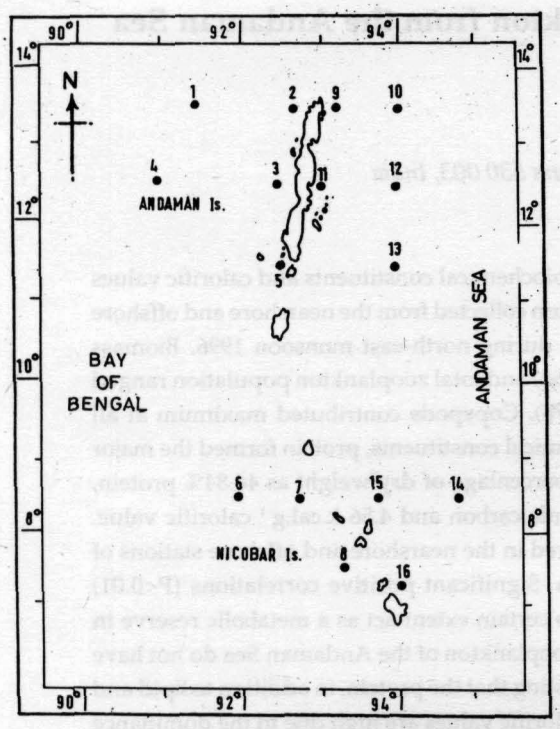

Fig. 1 *Station locations*

(mouth area 0.75 m^2, mesh size 300 µm). After recording biomass (displacement volume), the samples were cleared of debries, washed with distilled water. Half of the each sample was preserved in 5% formaldehyde for groups study and another half was dried at 60°C until constant weight was obtained. The protein content was determined by the method of Lowry *et al.* (1951). The lipid content was estimated by the method of Folch *et al.* (1957) and the total carbohydrate content by the method of Dubuois *et al.* (1956). The organic carbon content was determined by the method of Wakeel and Riley (1957). The calorific content was estimated by using the conversion factors of 5.7, 9.3 and 4 k. cal. g^{-1} (Wineberg, 1971).

Results

Zooplankton biomass (ml./100 m^{-3}) and total zooplankton population densities (no. 100 m^{-3}) observed in the each station is given in the Table 1. Biomass varied from 8.20 (St. 3, inshore) to 32.80 ml. 100 m^{-3} (St. 14, offshore, x = 14.94±6.7). Total population densitities ranged from 22950 (St. 3) to 94250 no. 100 m^{-3} (St. 14, x = 44465 ± 17778). Higher values of biomass and total population were observed in the offshore waters than that of inshore waters. Eighteen groups of zooplankton were identified during the study period (Table 2), copepods formed dominant group (with an average of 78.9%), followed by decapods (4.7%), chaetognaths (3.8%), oikopleura (3.2%), amphipods (1.7%), siphonophores (1.5%), fish eggs and larvae (1%), Lucifers (0.8%), doliolids (0.7%), gastropod larvae (0.7%), salps (0.6%), pteropods (0.6%), bivalves (0.5%) cladocerans (0.4%), ostracods (0.3%) and miscellaneous groups (0.4%) constituted by polychaetae larvae, mysids and medusae. Variation of zooplankton biomass depends upon the occurrence of dominant group of zooplankton in the total population.

Biochemical components

Protein, lipid, carbohydrate, organic carbon and calorific value (% dry weight) of the mixed zooplankton in the inshore and offshore waters around Andaman and Nicobar Islands are shown in Fig. 2. Protein formed the major biochemical fraction and ranged from 34.65 (St. 3, inshore) to 55.07% (St. 14, offshore, x =

Table 1. *Biomass, total population and dominant groups of zooplankton in the Andaman Sea during October - November 1996*

St. No.	Depth (m)	Biomass (ml./ 100 m^{-3})	Total population (no. 100 m^{-3})	Dominant groups of zooplankton
1	2900	10.80	35900	Cope, Deca, Oiko, Chae
2	65	12.70	43750	Cope, Chae, Deca, Oiko
3	75	8.20	22950	Cope, Deca, Pter, Oiko
4	3100	10.50	32650	Cope, Chae, Deca, Oiko
5	65	8.60	26100	Cope, Chae, Deca, Siph
6	2500	25.20	64550	Cope, Deca, Chae, Clado
7	900	16.10	49500	Cope, Chae, Deca, Oiko
8	580	18.90	50850	Cope, Chae, Deca, Oiko
9	630	12.40	37200	Cope, Deca, Oiko, Chae
10	960	13.80	45200	Cope, Deca, Chae, Doli
11	58	9.60	33350	Cope, Oiko, Chae, Deca
12	2200	12.50	36200	Cope, Amphi, Deca, Chae
13	2350	8.80	29100	Cope, Chae, Oiko, Deca
14	1750	32.80	94250	Cope, Deca, Luci, Chae
15	70	15.40	48700	Cope, Deca, Chae, Oiko
16	1650	22.80	61200	Cope, Siph, Deca, Chae
X	14.94±6.66	44465 ± 17778		

Cope - Copepods; Deca - Decapods; Chae - Chaetognaths; Oiko - Oikopleura; Doli - Doliolids; Siph - Siphonophores; Luci - Lucifers, Pter - Pteropods, Amphi - Amphipods, Clado - Cladocerans

44.84±5.81). Lipid content varied from 10.80 to 27.35% (x = 19.10 ±5.25), carbohydrate ranged from 4.04 to 6.70% (x = 4.98 ± 0.68) in these waters. Organic carbon in the mixed zooplankton varied from 32.02 to 45.51% (x=38.42±3.93) and the calorific value varied from 3.17 to 5.97 k.cal.g-1 dry weight (x=4.56±0.83). The dry weight of the zooplankton varied from 105.30 to 879.60 mg. 100m^{-3} (x=438.91± 238.3). In the present study high values of dry weight, biochemical constituents, organic carbon and calorific values were observed in the offshore stations (6,7,8,14 & 15) and lower values were observed in the inshore stations (3,5,11). Higher values of these constituents in these stations were due to the occurrence of larger number of copepods, decapods, chaetognaths, oikopleura, amphipods, lucifers and fish eggs and larvae in the total zooplankton. Significant positive correlations ($P<0.01$) were observed between total population, displacement volume, dry weight, biochemical constituents, organic carbon and calorific value (Table 3) implying that biochemical constituents play an important role in energy metabolism.

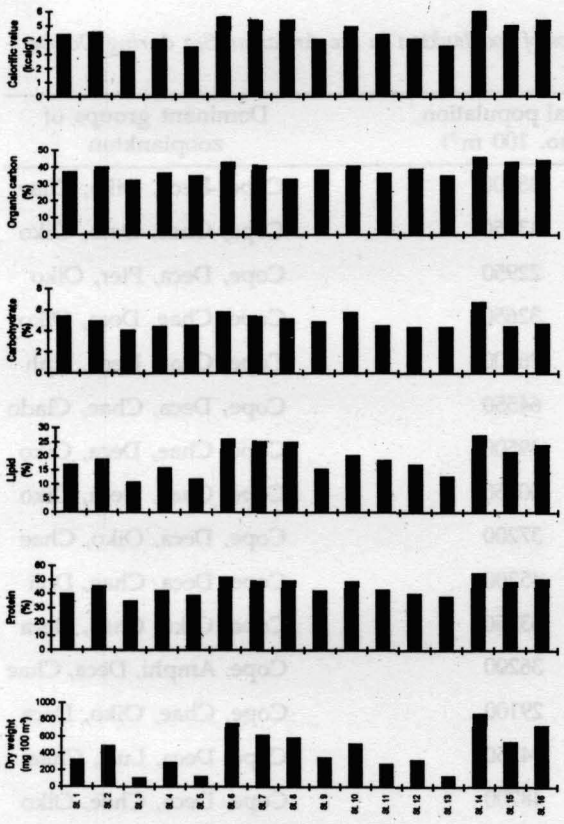

Fig. 2. *Variation of dry weight, biochemical constituents, organic carbon and calorific value in the mixed zooplankton of Andaman Sea.*

Table 2. *Proximate composition of zooplankton in the Andaman Sea*

Groups	Percent composition (Range)		
Copepods	69.40	-	86.96
Decapods	2.25	-	15.80
Oikopleura	1.01	-	14.24
Amphipods	0.62	-	11.88
Chaetognaths	1.93	-	6.44
Siphonophores	0.69	-	5.96
Lucifers	0.16	-	3.21
Fish Eggs & Larvae	0.15	-	2.55
Gastropods	0.30	-	2.42
Pteropods	0.20	-	2.40
Cladocerans	0.24	-	2.16
Salps	0.16	-	2.14
Bivalve larvae	0.31	-	1.41
Doliolids	0.31	-	1.37
Mysids	0.27	-	1.28
Polychaetes	0.27	-	0.93
Ostracods	0.19	-	0.67
Medusae	0.37	-	0.51

Table 3. *Correlation matrix of total population, biomass, biochemical constituents, organic carbon and calorific value of zooplankton in the Andaman Sea*

	TP	DV	DW	PRT	LP	CHO	OC
DV	0.98						
DW	0.94	0.94					
PRT	0.91	0.90	0.97				
LP	0.88	0.90	0.96	0.96			
Cho	0.76*	0.73*	0.70*	0.64*	0.63*		
OC	0.80	0.74*	0.81	0.77*	0.70*	0.50*	
CV	0.90	0.90	0.97	0.97	0.99	0.68*	0.73*

* $p < 0.05$

TP : Total population;DV : Displacement volume; DW : Dry weight; PRT : Protein; CHO : Carbohydrate; OC : Organic carbon; CV : Calorific value

Discussion

High values of biomass, dry weight and total population were observed in the inshore and offshore waters of southern stations (Nicobar area) compared to the northern stations (Andaman area) may be attributed to the high productivity of the former associated with the occurrence of large number of copepods, decapods, chaetognaths, oikopleura, amphipods siphonophores, lucifers, fish eggs and larvae in the total zooplankton and low productivity associated with low population density of zooplankton in the latter. The values reported in the present study comparable with those reported for northern part of central Arabian Sea (Nandakumar *et al.* 1988), northeastern Arabian Sea (Krishna Kumari and Achuthankutty, 1989), Bay of Bengal (Sreepada *et al.* 1992; Krishna Kumari and Goswami, 1993).

Protein formed the major biochemical component in the mixed zooplankton of Andaman Sea (Fig. 2). Protein values observed in the present study are comparable with the values reported earlier for the northeastern Arabian Sea (Krishna Kumari and Achuthankutty, 1989), northwest Bay of Bengal (Sreepada *et al.* 1992; Krishna Kumari and Goswami, 1993) but higher than those in Arabian Sea of the south-central, west coast of India (Sumitra-Vijayaraghavan *et al.* 1982) and northern part of central Arabian Sea (Nandakumar *et al.* 1988). Protein values were higher in the inshore and offshore stations of southern region (Nicobar area) when compared to nearshore and offshore stations of northern region (Andaman area) due to the occurrence of relatively higher number of copepods, decapods, chaetognaths, oikopleura, lucifers and fish eggs and larvae in the total zooplankton that are associated with high productivity of these stations (Krupanidhi, 1998). Compared to lipid and carbohydrate (Fig. 2), protein formed the major fraction, indicating its usefulness as energy reserve (Conover, 1964; Conover and Corner, 1968) The variation of protein in the present study may be either due to its utilization as a metabolic substrate or due to seasonal change, age of organism at the time of collection and salinity of the waters (Raymont, 1972).

The lipid content in the present study showed wide variations (Fig. 2). Spatial variations were also observed in the lipid content of mixed zooplankton in the Andaman Sea. Lipid content was more at the southern stations (mean 24.78%) than at northern stations (mean 15.71%) due to the occurrence of high lipid containing groups like copepods, decapods, chaetognaths, lucifers and fish eggs and larvae (Krishna Kumari and Goswami 1993). Lipid content in the present study agree with values reported earlier (Krishna Kumari and Achuthankutty, 1989; Krishna Kumari and Goswami, 1993) but higher than those reported for zooplankton of northern part of central Arabian Sea (Nandakumar *et al.* 1988). Variations in the lipid content attributed is to its storage and utilization during starved period when it serves as an effective

energy reserve. Lipid values observed in the present study are lower when compared to the reported values from colder regions (Fisher, 1962; Littlepage, 1964; Vinogradova, 1964). In tropical environments, the rate of primary production far exceeds the rate of consumption of zooplankton and the continuous supply of phytoplankton food would render lipid reserve unnecessary which might account for the low lipid content in the tropical zooplankton.

The values of carbohydrate in the present study are low and comparable with earlier reports (Goswami *et al.* 1981; Sumitra Vijayaraghavan *et al.* 1982; Krishna Kumari and Achuthankutty, 1989; Krishna Kumari and Goswami, 1993). In general, carbohydrate content is very low in the mixed zooplankton as compared to protein and lipid. Low carbohydrate content in the zooplankton suggested that glycogen, the usual storage carbohydrate in many marine animals might not contribute substantially towards the body reserve and energy flow.

Organic carbon of zooplankton is a reliable source of energy equivalent of secondary production for any season and it is also mainly dependent upon the species composition, the size of the different population, availability of food and physiological state of the individual organisms (Omori, 1969; Nair *et al.* 1983). Higher values of organic carbon observed in the nearshore and offshore stations of the southern region (Nicobar area) than to northern region (Andaman area) may be attributed to higher population densities of copepods, decapods, chaetognaths, oikopleura, lucifers in the total zooplankton. These values, however, were higher than those reported in earlier studies of zooplankton in the Arabian Sea (Nandakumar *et al.* 1988) and Bay of Bengal (Sreepada *et al.* 1992).

The mean calorific value observed in the present study is relatively higher than those reported for zooplankton of Arabian Sea (Sumitra Vijayaraghavan *et al.* 1982) and compared with Bay of Bengal (Krishna Kumari and Goswami, 1993). The differences in calorific values observed for zooplankton in the present study may be attributed to season of collection, varying species composition and maturity of zooplankton. Higher calorific values in the present study were associated with zooplankton dominated by copepods, decapods, chaetognaths, oikopleura and lucifers in the total zooplankton.

Biomass significantly correlated with copepods (r=0.95), decapods (r=0.75), chaetognaths (r=0.75), and adult crustaceans (r=0.65). Protein is significantly correlated with copepods (r=0.89), decapods (r=0.87) and chaetognaths (r=0.78), lipid with copepods (r=0.83), decapods (r=0.72) and chaetognaths (r=0.70) where as carbohydrate and organic carbon correlated well with copepods (r=0.74; 0.79) and organic carbon correlated with copepods (r=0.77) only. Calorific values correlated significantly with copepods (r=0.86), decapods (r=0.73) and chaetognaths (r=0.70), indicating that major fractions of biochemical

constituents are derived from these group of zooplankton.

Total zooplankton, biomass, biochemical constituents, organic carbon and calorific value (Table 3) indicate significant positive ($P < 0.01$) correlations among them in the Andaman Sea implying that biochemical components play an important role in the energy metabolism.

The above observations in the present study, indicate that variations in biomass, total population and biochemical constituents are influenced by the species composition of zooplankton. Protein formed a major component and may serve as the main metabolic reserve as reported from the other areas. High values of all these constituents observed in the mixed zooplankton of Nicobar region might to be due to high productivity of these waters when compared to Andaman region. So also the higher calorific values observed may be due to the dominance of copepod in the total zooplankton.

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