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Biochemical Composition of Zooplankton from the Water of Bay of Bengal during Premonsoon Season

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ABSTRACT

Proximate composition and variations in biomass, protein, lipid, carbohydrate, organic carbon and calorific content of mixed zooplankton from the 25 stations in the waters of Bay of Bengal along 88º E longitude (13 stations), and along 11.3º N latitude (12 stations) were estimated. Biomass varied from 1.20 to 11.00 ml.100^{-3} ($\bar{x}$ =4.32±3.70) along 88º E longitude and 2.00 to 20.00 ml.100^{-3} ($\bar{x}$ =7.60±4.48) along 11.3º N latitude in the waters of Bay of Bengal. Copepods, foraminifera, chaetognatha, adult crustaceans, decapods formed the dominant group of total zooplankton (>95.36 and 95% for the respective areas). Of the biochemical fractions of mixed zooplankton, protein formed the major component, varied from 24.00 to 37.20% ($\bar{x}$ =29.88±4.58) and 22.76 to 48.06% ($\bar{x}$ =34.25±5.95) in the respective longitude and latitudes. Lipid varied from 5.06 to 11.50% ($\bar{x}$ =6.79±2.11), and from 5.08 to 14.25 ($\bar{x}$ =7.44±2.50), the carbohydrate content ranged from 3.01 to 6.43% ($\bar{x}$ = 4.261±10), and from 3.02 to 8.08% ($\bar{x}$ =4.82±1.27) for the respective areas. The values of the organic carbon varied from 23.00 to 35.02% ($\bar{x}$ =27.90±4.55), and from 25.48 to 38.03% ($\bar{x}$ =31.47±2.81) for the respective longitudes and latitudes. The calorific potential varied from 1.98 to 3.45 ($\bar{x}$ =2.50±0.48), and from 1.92 to 4.39 ($\bar{x}$ =2.88±0.61) k.cal.g^{-1} for the respective longitude and latitudes. Higher values of the biochemical constituents were observed when the population densities of copepods, foraminifera, chaetognatha, adult crustaceans and decapods were also high. Significant positive correlations observed between total populations, displacement values, dry weight, protein, lipid, carbohydrates, organic carbon and calorific values indicates to certain extent, that these act as metabolic reserve of the zooplankton. Based on the results observed in the present study, zooplankton does not have extensive lipid storage suggesting that protein in addition to the lipid may serve as metabolic reserve. Relatively higher calorific values were attributed to the dominance of copepods in the zooplankton population throughout the study period.

Keywords: Biochemical composition, zooplankton, Bay of Bengal.

INTRODUCTION

An assessment of biomass, biochemical composition and energy content in zooplankton is important to have a better understanding of the organic production, productivity and cycling of biogeochemical elements in the marine biotope. Such information is of much importance in estimating the energy available to higher tropic levels, which in turn, can be used to estimate harvestable fishery resources. Earlier studies

[1-3] on distribution and production of zooplankton have an important bearing on biological resources of the sea. So far very few studies has been done on the biochemical composition and nutritive value of zooplankton from the estuarine, coastal, inshore and Harbor water of India Seas [4-11]. The present study deals with the biomass, biochemical composition, organic carbon and calorific potential of mixed zooplankton collected from the waters of entire Bay of Bengal along 88º E longitude and 11.3º N latitude during the pre-monsoon period.

MATERIALS AND METHODS

Surface zooplankton samples were collected from 25 stations along 88º E longitude (13 stations) and along 11.3º N latitude (12 stations.) during 113th cruise of ORV Sagar Kanya is shown in fig.1. Zooplankton samples were sampled using a Bongo net (mouth area 0.25 m^2, mesh width 300 µm) with a calibrated flow meter fixed at the center point of the net mouth. At each station horizontal hauls were made for 10 min duration. Immediately after collection, the samples were cleaned of debris, placed in a small nylon sieve and thoroughly rinsed with Milli-Q Water to remove salts. Water adhering to the samples was removed by placing the sieve on good quality filter paper without any contamination and measured the biomass by displacement volume method. After measuring the biomass, one half of the sample was preserved with 5% formaldehyde for taxonomical studies and the other half of the sample was freeze dried. The freeze-dried samples were again dried at 50°C until constant weight was obtained at shore laboratory. The dried samples were used for estimation of different biochemical constituents. Protein was estimated by the method of Lowry *et al*., 1951[12], lipid by Folch *et al*., 1957 [13], carbohydrate by Dubiou et al., 1956 [14] and organic carbon by El Wakeel and Riley, 1957 [15]. Calorific potential was estimated using the conversion factors of 5.7; 9.3 and 4 $k.cal.g^{-1}$ respectively for protein, lipid and carbohydrate by the method of Winberg, 1971 [16].

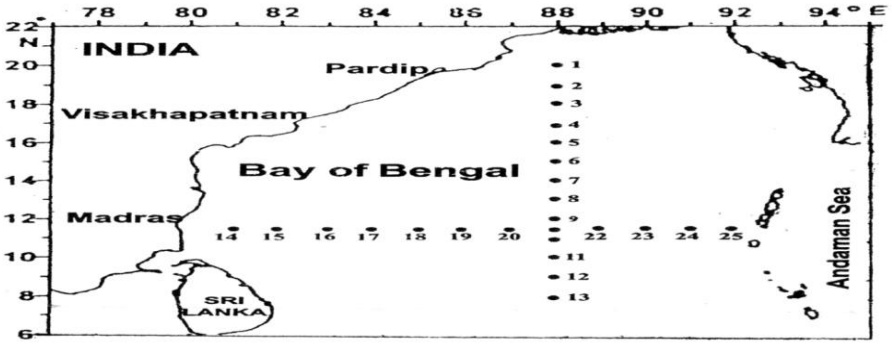


Fig.1. Station locations in the water of Bay of Bengal

RESULTS AND DISCUSSION

Biomass, dry weight and population density: Zooplankton biomass, dry weight, total population densities and dominant groups of zooplankton along 88º E longitude and 11.3º N latitude from the water of Bay of Bengal are given in the table 1. Biomass and dry weight along 88º E longitude, varied from 1.20 to 11.00 ml.100 m^{-3} ($\bar{x}$ =4.32±3.70) and 0.380 to 1.430 gr.100 m^{-3} ($\bar{x}$ =0.757±0.354). Along 11.3º N latitude, they ranged from 2.00 to 20.00 ml.100 m^{-3} ($\bar{x}$ =7.60±4.48) and 0.240 to 2.260 gr.100 m^{-3} ($\bar{x}$ =0.88±0.51). Total zooplankton in the respective waters varied from 4240 to 28840 no.100 m^{-3} ($\bar{x}$ =12087±8515) and from 4630 to 50490 no.100 m^{-3}($\bar{x}$ =17780±11737). Higher biomass, dry weight and total population densities are observed in the stations 1-3, 11 and along 88º E and 16,17, 20 and 25 along 11.3º N (Table 1) were attributed to the higher number zooplankton are may be associated with the productivity during the study period [17-18]. Low vales of these were observed in the stations when the productivity and zooplankton densities are usually low [19-21]. The present values are comparable with the values reported from the offshore waters of the Arabian Sea [3] and Harbor water of Bombay [20], from the waters of

northern part of central Arabian Sea [6] , from the waters of Bombay High (oil platform) area in the Arabian Sea [7] and from the waters of the Bay of Bengal [8].

Table 1. Station wise variation in biomass, total population and dominant groups of zooplankton in the offshore water of Bay of Bengal during Pre-monsoon season

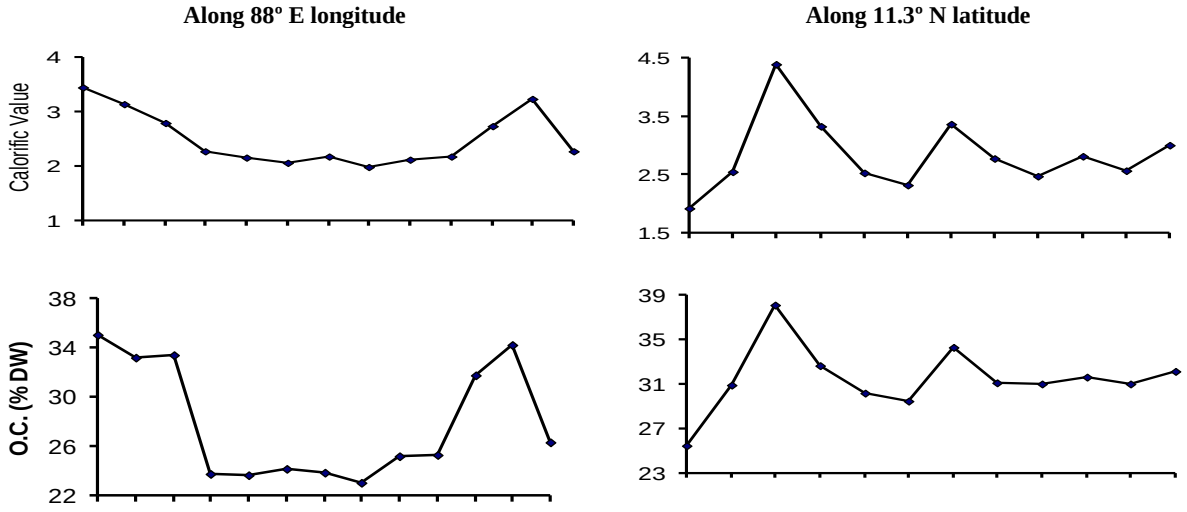
Along 88^0 E Longitude					Along 11.3^0 N Longitude				
St. No.	Biomass (ml.100 m^{-3})	Dry weight (mg.100 $^{-3}$)	Total Population (no.100 m^{-3})	Dominant groups	St. No.	Biomass (ml.100 m^{-3})	Dry weight (mg.100 $^{-3}$)	Total Population (no.100 m^{-3})	Dominant groups
1	11.00	1430	28,840	Cope, chaet, mysid, amph	14	2.00	240	4,630	Cope, amph, chaet, gast
2	9.00	1210	21,180	Cope, foram, chaet, ostro	15	5.00	580	11,960	Cope, foram, chaet, gast
3	8.00	980	21,310	Cope, chaet, mysid, amph	16	20.00	2260	50,490	Cope, foram, chaet, lucif
4	1.60	490	5,860	Cope, foram, chaet, gast	17	10.00	1280	22,340	Cope, foram, ostro, F & L
5	1.50	480	5,800	Cope, chaet, amph, gast	18	5.00	630	12,380	Cope, chaet, gast, deca
6	1.50	476	5,720	Foram, cope, chaet, F & L	19	4.50	510	6,680	Cope, foram, ostro, F & L
7	1.50	471	9,720	Cope, chaet, foram, F & L	20	11.00	1310	27,880	Cope, chaet, foram, ostro
8	1.20	380	4,280	Cope, chaet, foram, deca	21	6.20	710	15,220	Cope, chaet, foram, deca
9	1.40	414	7,540	Lucif, cope, chaet, foram	22	5.30	620	12,720	Cope, chaet, ostro, gast
10	1.50	610	5,480	Cope, foram, chaet, deca	23	6.80	760	17,080	Cope, deca, chaet, lucif
11	6.00	821	11,560	Cope, foram, chaet, ostro	24	5.80	680	13,000	Cope, chaet, gast, ostro
12	10.00	1310	25,600	Cope, foram, chaet, ostro	25	9.60	1010	21,960	Cope, chaet,gast, deca
13	2.00	760	4,240	Cope, chaet, foram, ostro					

Cope = Copepods, Chaet = Chaetognaths, Deca = Decapods, Foram = Foramenifera, Ostro = Ostrocards, Gast = Gastropods, Ptero = Pteropods, Lucif = Lucifers, F & L = Fish eggs and Larvae, amph = Ampipods, Mysid = Mysids

Eighteen zooplankton groups were identified in the waters of Bay of Bengal throughout the study period and total number of populations were higher along 11.3º N latitude then compared to the 88º E longitude due to the available productivity. Copepods contributed maximum (with a mean of 56.76%, 68.93%,), followed by foraminifera (15.11%, 8.99%), chaetognatha (11.85% and 8.46%), adult crustaceans (8.21%, 4.96%), decapod larvae (3.43%, 3.65%), molluscans (2.73% , 3.36%), and miscellaneous groups (3.86%, 3.32%) including fish eggs & larvae, hydromedusae, siphonophores, oikopleura, doliolids and polychaetes in the respective waters of the Bay of Bengal, during the study period.

Biochemical Components: Station wise variation of protein, lipid, carbohydrate, organic carbon and calorific values in the mixed zooplankton of the offshore waters of the Bay of Bengal are given in fig. 2. Protein formed the major biochemical component and ranged from 24.00 to 37.20% ($\bar{x}$ =29.88±4.58) along 88º E longitude and 22.76 to 48.06% ($\bar{x}$ =34.25±5.95) along 11.3º N latitude of the Bay of Bengal. Protein values observed in the present study are comparable to the values earlier reported for the zooplankton of west coast of India [4], Arabian Sea off the south central west coast of India [5], northwest Bay of Bengal [9], but higher than those of northern part of central Arabian Sea [6] Bombay High (oil platform) area in the Arabian Sea [7]. Protein values were high when higher numbers of copepods, decapods, chaetognatha, foraminifera, bivalves, adult crustaceans, molluscans of total zooplankton populations are associated with the productivity of the offshore water of Bay of Bengal during premonsoon season. Compared to carbohydrate and lipid, protein formed the major fractions (Fig.2), indicating the usefulness as energy reserve [21]. Zooplankton utilizes the protein as an additional source of energy at times of stress [22].

The lipid content in the present study showed wide variations from 5.08 to 11.50% ($\bar{x}$ =6.79±2.10) along 88º E and from 5.08 to 14.25% ($\bar{x}$ =7.44±2.50) along the 11.3º N latitude of the Bay of Bengal. The values recorded in the present study agree with the values reported earlier [4, 9] but lower than those reported for zooplankton from northern parts of central Arabian Sea [6] and Bay of Bengal [8]. The lipid content is more in zooplankton due to the occurrence of high lipid containing groups like copepods, decapods, chaetognatha, adult crustaceans and foraminifera. However, lipid values observed in the present study are high when compared to earlier values reported from higher latitudes [23], which may be attributed to the availability of food throughout the study period [1-2]. Fluctuations in the lipid content at different stations were attributed to their storage and utilization during starved period, when it serves as an effective reserve.



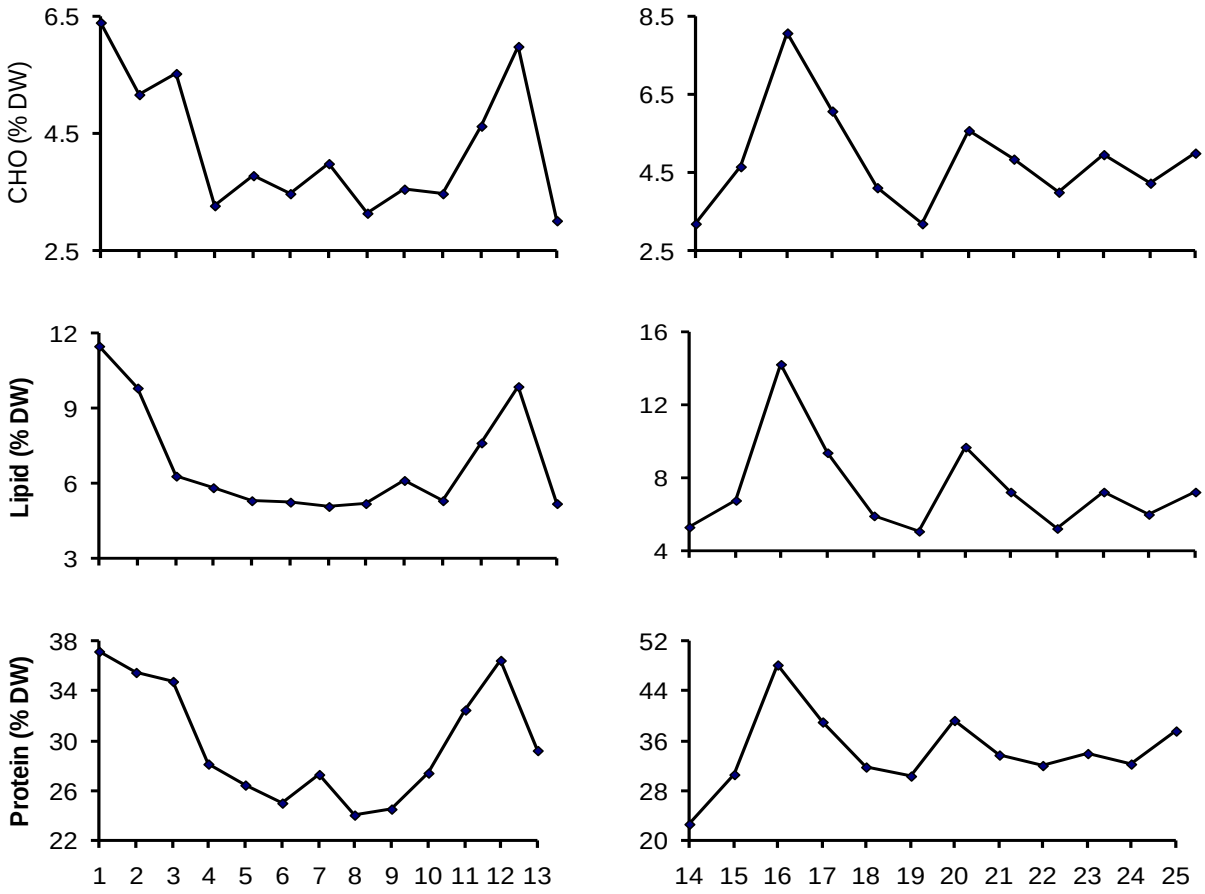


Fig. 2. Station wise variation of biochemical constituents of zooplankton from the waters of Bay of Bengal during premonsoon season.

The values of carbohydrate in the present study are relatively high ranging from 3.01 to 6.43% ($\bar{x}$ =4.36±1.10) along 88º E and 3.20 to 8.08% ($\bar{x}$ =4.82±1.27) along 11.3º N of the Bay of Bengal, which is in agreement with reported values of Indian waters [5-6] Carbohydrate content in zooplankton depends upon its composition, decreasing with increase of gelatinous organisms and increasing with copepod population. In the present study copepods are the dominant group throughout study period, and may be responsible for the higher carbohydrate content. Low carbohydrate content reflects the short-term variations in glycogen storage of the marine organisms, which in turn, depends upon their feeding activities.

Based on the above observations, we are of the opinion that although lipid and carbohydrate could function as important food reserve, protein may also be utilized and function as a reserve food [21-22]. Studies on the mysid *Neomysis integer* [24] indicate that on starvation amino acids from protein appear to be mobilized and subsequently deaminated with a rapid rise in ammonia excretion. Loss of protein in zooplankton during starved condition indicating its utilization has been well documented [22]. Mobilization of protein for metabolic requirements is believed to be essential in tropical zooplankton where lipid reserves are low as has been shown by earlier observation in zooplankton off the India coasts [4-6].

Organic carbon of zooplankton is a reliable source of energy equivalent of secondary production for any season [25]. It is mainly dependent upon the species composition, the size of the different populations, and

availability of food in general and physiological state of the individual organisms [6]. In the present study, the values varied from 23.00 to 35.02% ($\bar{x}$ = 27.90±4.55) along 88º E and from 25.48 to 38.03% ($\bar{x}$ =31.47±2.81) along 11.3º N of the Bay of Bengal, with high values st. 22 coinciding with high population densities of copepods, decapods, chaetognatha, adult crustaceans and molluscans. These values however are higher than those reported earlier for zooplankton of Arabian Sea and Bay of Bengal.

Calorific value: The calorific values observed in the present study ranged from 1.98 to 3.45 k.cal.g^{-1} ($\bar{x}$ =2.50±0.48) along 88º E and 1.92 to 4.39 k.cal.g^{-1} ($\bar{x}$ =2.83±0.61) along 11.3º N in the waters of Bay of Bengal. The mean values observed in the present study are comparable to those reported for the Arabian sea [5] and the Bay of Bengal [8-9]. Differences in calorific values in the zooplankton from these water may be attributed to the species composition, time of collection and physiological state of zooplankton. High calorific values in the present study were associated with zooplankton dominated by copepods, decapods, chaetognatha, foraminifera, adult crustaceans and fish eggs and larvae in the total zooplankton. Significant correlations were observed between biomass and copepods in the waters of Bay of Bengal.

However, biomass significantly correlated with chaetognatha (r=0.77), molluscans (r=0.50) in the water along 88º E longitude. The biomass also correlated significantly with foraminifera (r=0.75), adult crustaceans (r=0.63) in the waters along 11.3º N latitude of Bay of Bengal. Protein was significantly correlated with copepods (r=0.92, 0.96) in the waters of Bay of Bengal, it significantly correlated with chaetognatha (r=0.67) along 88º E longitude and foraminifera (r=0.73) along 11.3º N latitude, indicating that major fraction of biochemical components are derived from these groups of zooplankton.
Significant positive correlations (p <0.01) were observed between biomass, dry weight, total population, biochemical components and calorific values are given in the table 2 indicates that biochemical components play an important role in energy metabolism.

It is therefore evident from the present study that the variations in 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 other areas. The zooplankton in the waters of Bay of Bengal does not appear to have an extensive storage of lipid and carbohydrate and this might be due to availability food. Higher calorific values observed in the present study may be attributed to the dominance of copepods in the total zooplankton throughout the study period.

Table 2. Correlation matrix of total population, biomass, dry weight and biochemical constituents of zooplankton in the water of Bay of Bengal during premonsoon season (n=25; p<0.01)

Along 88º E longitude

	TP	DV	DW	PRT	LP	CHO	OC	CV
TP		0.97	0.93	0.92	0.90	0.98	0.93	0.95
DV	0.99		0.97	0.96	0.92	0.96	0.98	0.98
DW	0.99	0.99		0.96	0.91	0.90	0.95	0.98
PRT	0.95	0.96	0.96			0.91	0.96	0.97
LP	0.97	0.96	0.97	0.90		0.88	0.87	0.95
CHO	0.96	0.95	0.96	0.93	0.97		0.93	0.94
OC	0.94	0.94	0.94	0.97	0.88	0.92		0.96
CV	0.98	0.98	0.99	0.98	0.97	0.98	0.96	

Along 11.3º latitude

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

APPLICATIONS

Zooplanktons are the secondary producers in the ocean and are inter-linked between primary and ternary producers in the marine food chain. Zooplanktons are important micro organisms to identify the fishery source of particular area. Protein content in the zooplankton is high and also pure. We can use the zooplankton protein as food supplement for the human being.

CONCLUSIONS

It is therefore evident from the present study that the variations in 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 other areas. The zooplankton in the waters of Bay of Bengal does not appear to have an extensive storage of lipid and carbohydrate and this might be due to availability food. Higher calorific values observed in the present study may be attributed to the dominance of copepods in the total zooplankton throughout the study period.

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