

Biochemical composition of zooplankton of Bombay High (oil platform) area in the Arabian Sea

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Received 10 February 1992; revised 6 July 1992

Variations in the biochemical constituents and calorific values of zooplankton from an off-shore oil processing platform were estimated. Mean value of biomass was 0.35 ml. m^{-3} with relatively higher values during post-monsoon period. Copepods formed the major component ($> 80\%$) of zooplankton throughout the year. Of the proximate principals, protein formed the major component. Overall mean values, calculated as percentages of dry weight were 16.65 protein, 4.33 carbohydrate, 2.51 lipid and 23.43 organic carbon. The results revealed that the zooplankton of Bombay High area do not have extensive lipid and carbohydrate storage, suggesting that the protein, in addition to lipid may serve as a metabolic reserve. The calorific value was very low ($1.35 \text{ k cal.g}^{-1}$ dry wt) which indicates that the energy available for plankton feeders such as marine foulers is comparatively less.

Studies on biochemical composition and calorific values of zooplankton help to assess the energy available to plankton feeders like foulers in a marine ecosystem. Such studies are relatively few and restricted to isolated localities off the Indian coast¹⁻⁷. However, no detailed information from Bombay High area is available. Furthermore, no data to this date seems to be available from a fixed oceanic station over a period of one year. This should augment the knowledge of energy cycle in the open sea. The present study aims at understanding seasonal variations in biochemical composition of mixed zooplankton of Bombay High area, located 170 km WNW off Bombay ($19^{\circ} 20'N$, $17^{\circ} 21'E$).

Zooplankton samples were collected at monthly intervals (March 1985 to February 1986) through vertical hauls (water column - 80m) with a HT net (mouth area - 0.25 m^2 ; meshsize - $100 \mu\text{m}$). Two samples were collected each time, one for biomass and taxonomical studies and the other for biochemical analysis. Biomass was determined by volume displacement method while proximate principals - protein⁸, lipid^{9,10} and carbohydrate¹¹ - and organic carbon¹² were estimated using standard methods. Calorific values were computed using the conversion factors of 5.7, 9.3 and 4 K cal.g^{-1} respectively for protein, lipid and carbohydrate¹³.

Zooplankton biomass (Table 1) varied from 0.17 to 0.65 ml.m^{-3} with relatively high values in postmonsoon months (Nov.-Jan.). Protein was the major component forming 11.3 to 26.7% of the dry weight with relatively high values in late monsoon months (Aug. and Sept.) and premonsoon (March). Percentage of lipid was low throughout.

Carbohydrate ranged from 1.08 to 9.62% and organic carbon varied from 9.75 to 33.16% (Fig. 1). While a significant correlation was observed between the values of organic carbon and protein ($r=0.73$; $P < 0.001$), a similar trend is not perceptible with the lipid and carbohydrate. The calorific content of zooplankton varied from 0.92 to $1.95 \text{ k cal. g}^{-1}$ of dry weight. The values show significant correlation with protein ($r=0.927$, $P < 0.001$) and organic carbon ($r=0.715$, $P > 0.001$) and moderate correlation with lipid ($r = 0.465$, $P < 0.05$) and carbohydrate ($r = 0.4$, $P < 0.05$).

The dry weight equivalent of zooplankton were calculated by using the relationship³, $1 \text{ ml displaced volume} = 81.7 \text{ mg dry wt}$. Based on these values and carbon values obtained in this study, the standing crop of the zooplankton was calculated and the average was found to be 6.77 mg C.m^{-3} . Since copepods formed the major component of the zooplankton, in computing secondary production the equation $D = 71.72 t^{-1.22}$ given by Cushing¹⁴ was used, where D is the copepod generation time in days and t is the temperature. Using data on temperature collected along with zooplankton samples the average secondary production was found to be $47.47 \text{ mg C.m}^{-3} \cdot \text{d}^{-1}$.

Seasonal variations in biochemical composition of zooplankton are due to variable species composition and their population. Because of short life span¹⁵, plankton of tropics have a number of generations in a year. This is reflected in marked seasonal variations in the biochemical composition of mixed zooplankton.

Table 1—Monthly variations of different parameters of zooplankton

Month	Biomass (ml.m ⁻³)	Dry wt (mg.m ⁻³)	Organic carbon (mg C.m ⁻³)	Sec. Prod. (mg C.m ⁻³ .d ⁻¹)	Major groups	(no.m ⁻³)
March '85	0.36	29.41	8.40	21.66	Copepoda Chaetognatha	(1780) (47)
April	0.23	19.20	4.22	14.76	Copepoda Appendicularia	(720) (35)
May	0.24	19.61	4.23	166.74	Copepoda Appendicularia	(564) (41)
June	NS	NS	NS	NS	NS	
July	0.23	19.20	4.51	154.96	Copepoda Chaetognatha	(892) (119)
Aug.	0.30	24.51	6.87	18.51	Copepoda Gastropod larvae Chaetognatha Appendicularia	(1440) (160) (75) (74)
Sept.	0.21	17.16	5.69	12.78	Copepoda Appendicularia Chaetognatha	(1200) (170) (45)
Oct.	0.17	13.48	1.31	10.07	Copepoda Chaetognatha	(520) (36)
Nov.	0.58	46.98	11.23	31.76	Copepoda Polychaeta Appendicularia Chaetognatha	(520) (240) (57) (52)
Dec.	0.65	52.70	9.89	37.45	Copepoda Chaetognatha Ostracoda	(1536) (87) (40)
Jan. '86	0.50	40.85	11.12	29.99	Copepoda Appendicularia Thaliaceae	(640) (128) (60)
Feb.	0.40	32.68	6.96	23.49	Copepoda Cladocera Appendicularia	(1200) (81) (80)

NS = Not sampled

In the present study the protein values are relatively lower than those observed elsewhere and are comparable to similar findings recorded from the northern part of the central Arabian Sea¹⁶. In general, protein values were high when the copepods dominated zooplankton (>90%) as in January, March, August and September. Reciprocal relationship between protein and lipid fractions

observed in March and May might indicate their possible role as substrates for energy production during premonsoon months, as both are capable of entering the same metabolic cycle¹⁷.

Relatively low values of lipid observed at present compare well with those of the northern part of central Arabian Sea¹⁶. Seasonal fluctuations in lipids were attributed to their storage and utilisation in

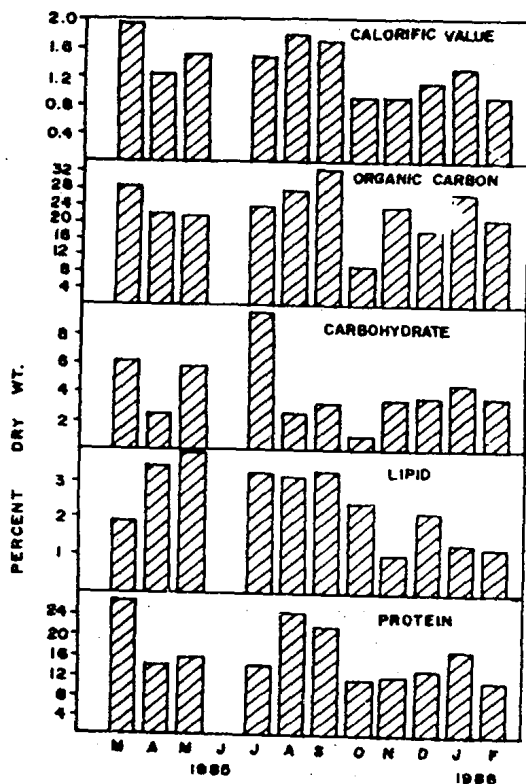


Fig. 1—Variations in concentration of biochemical components (% dry wt) and calorific values (K cal. g⁻¹ dry wt) of mixed zooplankton

colder regions, where it serves as an effective energy reserve to tide over formidable winter. In tropics with continuous supply of phytoplankton round the year and primary production far exceeding the rate of consumption by zooplankton¹⁸, the importance of fat is very much reduced as is reflected in its low value. The values of carbohydrate were relatively low (av. 43.5 mg.g⁻¹) as is the case of a number of studies elsewhere^{4-7,15,16}. Goswami *et al.*⁴ have shown that carbohydrate content of zooplankton is dependent upon its composition, declining with gelatinous forms and those with calcareous shells and increasing with copepods. Similar observations were also recorded in this study in October and March with siphonophores, medusae and copepods dominating the plankton in October and March respectively. The highest value observed in July might be attributed to large quantities of phytoplankton which could not be separated from zooplankton. The fluctuations during the rest of the months reflect short-term variations in glycogen store of the animals, depending upon their feeding activities.

Studies in higher latitudes have shown that zooplankton normally derive energy from the oxidation of carbohydrate and lipid, and use protein

when subjected to starvation¹⁹⁻²¹. Mobilising protein for metabolic requirements is essential in tropical zooplankton where lipid reserves are decidedly low, as has been shown by earlier observation in zooplankton off the Indian coast^{4,5,7,15,16,22}. Present study substantiates this assumption.

Organic carbon of zooplankton is a reliable measure of energy equivalent of the secondary producers. It is largely dependent upon the species composition, the size of the different populations, availability of food in general and physiological state of the individual organism. In the present study it varied from 97.53 to 331.57 mg C.g⁻¹ with peak value in September; coinciding with rich population of copepods, appendicularians, decapods and veliger larvae.

The calorific values are relatively low than those recorded from areas off Indian coast by earlier workers^{2,5,7}. The relationship between organic carbon content and calorific value is significant with an increase in one reflected in that of the others. In the present study, high calorific values were associated with zooplankton dominated by copepods.

To sum up, the present study substantiates the observations of others elsewhere that protein serves as the main metabolic reserve in tropical zooplankton. The zooplankton of Bombay High area do not have extensive lipid and carbohydrate storage which might be due to availability of phytoplankton food round the year. The average calorific value of zooplankton was found to be low suggesting that the energy available for plankton feeders such as marine fouling organisms of Bombay High area is comparatively less.

Funds and facilities provided by Oil and Natural Gas Commission, Bombay are gratefully acknowledged.

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