

Biochemical composition of zooplankton from the offshore oil fields of Bombay

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Abstract

The proximate composition of mixed and selected group of zooplankton were estimated from collections made between $18^{\circ} - 20^{\circ} 05' N$ and long. $70^{\circ} 25' - 72^{\circ} 40' E$. The dry weight and carbon content of zooplankton varied respectively from 11.95 to 143.42 mg/m^3 (av. 55.06 ± 40.44) and 3.52 to 40.87 mgC/m^3 (av. 15.40 ± 10.92). Mean values for various biochemical constituents as percentage of dry weight were protein 50.1%; carbohydrate 2.6%; lipid 23.8% and carbon 29.4%. Mean caloric content was 21713.7 J/g dry weight. As percentage of organic weight protein amounted to 65.7%; lipid 31.1% and carbohydrate 3.2%. Positive correlation ($P < .001$) was found between dry weight and carbon. Relationship between lipid and calories was significant at 1% level. Zooplankton biomass at zone A in terms of dry weight (av. 17.5 mg/m^3) and carbon (av. 5.67 mgC/m^3) was four times lower than that of zone B (av. 73.72 mg/m^3 equivalent to 20.27 mgC/m^3) whereas the proximate composition showed a reverse trend.

Introduction

Environmental degradation due to oil well operations and its impact on marine life is an aspect of global concern. Considering this, a survey around the oil field of Bombay and Ratnagiri ($18^{\circ} - 20^{\circ} 05' N$ and long $70^{\circ} 25' - 72^{\circ} 40' E$) was under taken by NIO during the 48 Cruise of Sagar Kanya during December 1988 to January 1989. Zooplankton being an integral part of the food chain at the secondary trophic level, samples collected were utilized for evaluation of standing stock and the biochemical composition. The results presented in this communication will be useful for predicting the impact of oil well operations if any of its proximate composition. Though a few earlier studies¹⁻⁴ provide information on the biochemical constituents of zooplankton from off the Central west coast of India, none of these reports cover the levels of different biochemical constituents in individual groups.

Materials and Methods

Zooplankton samples were collected from 12 stations by vertical hauls using an IOS net⁵ from depths ranging from 50 m to surface except at station 12 (Fig. 1). Stations were grouped into two — those within long. $70^{\circ} 25' - 71^{\circ} 2' N$ as zone A (towards offshore and away from oil fields) and those within $71^{\circ} 30' - 72^{\circ} 40' E$ as zone B (around the oil fields). Biomass

determined as displacement volume (Gajbhiya and Nair, unpublished data) was converted to m^2 values based on the sampling depth and to dry weight using the conversion factor $1ml = 85.37$ mg dry weight⁴. Separate samples were collected from 10 stations for estimation of protein⁶, lipid⁷, carbohydrate⁸ and organic carbon⁹ of total zooplankton. Where ever possible major groups were sorted out from the total zooplankton and this pooled sample was used for proximate analysis of important groups. All the analysis was done in duplicate. The carbon value thus obtained for each station was used to convert the biomass (dry weight) into carbon. Caloric content was determined from the major biochemical fractions using Winberg's¹⁰ conversion factors : 9.45; 5.65; and 4.1 for lipid, protein and carbohydrate respectively. Calories thus obtained were converted to J/g dry weight as per Brody¹¹. Ash content was determined by igniting a weighed quantity of the dry powder in a muffle furnace at 450°C for 3-4 h. Zooplankton standing stock (mgC/m^2) was calculated by converting the mean biomass into carbon equivalent on the basis of mean percentage of carbon recorded in the present study.

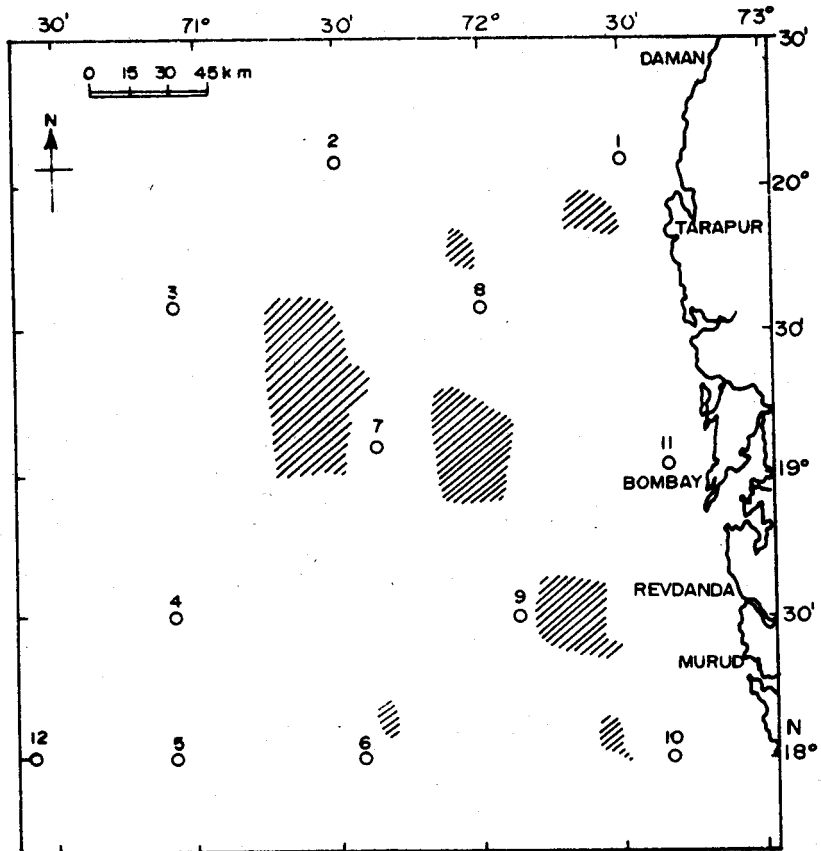


Fig. 1. Station locations. Hatched area indicates oil fields.

Results and Discussion

Biomass ranged from 0.14 to 1.68 ml/m³ (av. 0.65 ± 0.47 ml/m³) and the dry weight from 11.95 to 143.42 mg/m³ (av. 55.06 ± 40.44). The carbon equivalent varied from 3.52 – 40.87 mgC/m³ (av. 15.40 ± 10.92 mg C). Dry weight and carbon indicated significant correlation ($P < 0.001$, $r = 0.99$). The difference in biomass between zones in terms of dry weight and carbon was significant respectively at $P < .05$ ($F = 8.78$ d.f. 1,10); and $P < .05$ ($F = 7.64$ d.f. 1,10). The biomass at zone A (av. 17.5 mg/m³ and 5.67 mgC/m³) was about four times lower than that at zone B (av. 73.72 mg/m³ and 20.27 mg C/m³). However, the mean biomass value recorded was higher than reported earlier for the northern part of the Central Arabian Sea³ and the north eastern Arabian Sea⁴. Maximum biomass at station 10 synchronised with the maximum contribution of chaetognaths. Biomass was relatively high at station 9 when ostracods predominated the zooplankton population.

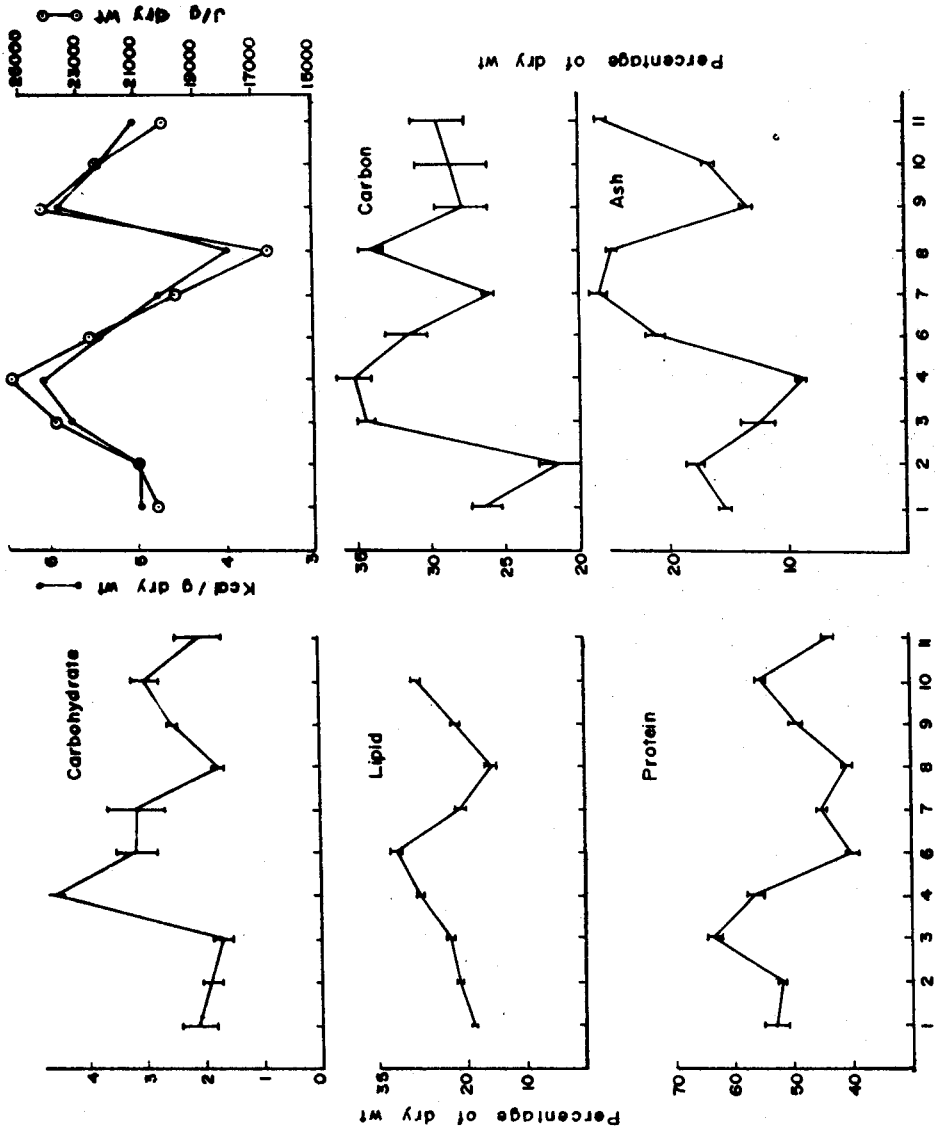
Crustaceans, chaetognaths and fish eggs and larvae formed the major part of the zooplankton community (Table 1). The percentage contribution of major groups of zooplankton ranged from 20–40% for copepods, 5–90% for decapods; 5–30% for chaetognaths, 5–60% for ostracods, 5–25% for fish eggs and larvae and 5–10% for salps. Cladocerans (15%) and heteropods (10%) were recorded as major groups only from station 4, whereas amphipods contributed 6% at station 9.

Variations in proximate composition of total zooplankton alongwith percentage of carbon and calories expressed as kilo calories and J/g dry weight are given in Fig. 2. Carbon ranged from 21.34 to 35.17% (av. 29.44 ± 4.39). On an average it was 34.74 % at zone A and 28.12 % at zone B. Though the mean value corresponds with the earlier reports from central west coast of India^{1,3}, it was higher than reported for northeastern Arabian sea⁴.

Protein ranged from 40.27 to 63.24% (av. 50.14 ± 7.33). Zone wise it was 59.87% at zone A and 47.17% at zone B and the difference was significant at $P < .05$ ($F = 7.66$ d.f. 1, 8). Variation in protein evaluation due to the application of different techniques has been reported¹². The protein content in the present study appears to be higher than reported earlier³ for zooplankton from the same area. This may be due to the analytical technique adopted by the earlier workers and also the species composition. Maximum percentage contribution of decapods with dominance of *Acetes* sp. at station 3 probably resulted in the highest value of protein at this station.

The percentage of carbohydrate, the principal metabolite in marine organisms varied from 1.68 to 4.55 (station 4) with a mean value of 2.59%. Area-wise it was 3.12 % at zone A and 2.46 at zone B.

Lipid fluctuated from 16.23 to 32.09 (av. 23.82%). The highest contribution of lipid at station 6 coincided with maximum percentage incidence of fish eggs and larvae. It was 25.02% at zone A and 23.52% at zone B. Positive correlation ($P < .01$, $r = 0.72$) was observed between lipid and calorific values. Among the various biochemical components, lipid in the present study appears to be high as compared to the values from west coast. Inhibition of lipid



STATIONS

Fig. 2. Station-wise variation in protein, carbohydrate, lipid, ash, carbon (as percentage of dry weight) and caloric content (kcal and J/g dry weight) of mixed zooplankton.

Table 1 - Biomass and percentage contribution of major groups of zooplankton at different stations.

Station nos.	ml/m ³	mg/m ³	mgC/m ³	Major groups
1.	0.72	61.47	16.22	copepods (40%), chaetognaths (15%) decapods (10%), fish eggs and larvae (5%), ostracods (5%).
2.	0.88	75.13	16.03	copepods (20%), decapods (20%), chaetognaths (15%), ostracods (10%).
3.	0.22	18.78	6.44	decapods (90%), copepods (6%).
4.	0.24	20.49	7.21	copepods (30%), decapods (15%), cladocerans (15%), chaetognaths (15%) fish eggs & larvae (10%), heteropod (10%), salps (5%).
5.	0.22	18.78	5.52	copepods (30%), fish eggs & larvae (10%), decapods (15%), chaetognaths (10%), salps (5%).
6.	0.54	46.10	14.62	copepods (35%), fish eggs & larvae (25%), decapods (10%), chaetognaths (5%).
7.	0.88	75.15	19.57	ostracods (60%), copepods (30%), decapods (5%).
8.	0.24	20.49	6.98	decapods (50%), copepods (30%), ostracods (15%), chaetognaths (5%).
9.	1.20	102.44	28.46	ostracods (35%), copepods (35%), gastropods (6%), amphipods (6%), decapods (7%).
10.	1.68	143.42	40.87	copepods (40%), decapods (20%), chaetognaths (30%).
11.	0.78	66.59	19.37	copepods (35%), chaetognaths (20%), ostracods (15%), decapods (10%).
12.	0.14	11.95	3.52	copepods (30%), decapods (25%), chaetognaths (10%), salps (10%).
Mean	0.65	55.06	15.40	
SD	± 0.47	± 40.44	± 10.92	

deposition due to high temperature and primary production greater than the consumption by zooplankton at tropical and subtropical waters has been reported^{12,13}. Average temperature recorded in the present study was 23.37° C. Lipid functions as a source of energy during starvation for the developing embryos and also as a source of buoyancy for larvae and adults to minimize energy requirements. In temperate zooplankton lipid forms the major source of energy whereas in tropical and subtropical zooplankton lipid and protein function as major metabolic substrates.

Ash content varied from 8.77 to 25.79% with an average value of 18.1%.

Caloric content ranged from 16503.49 to 25311.51 J/g dry weight (av. 21713.7 ± 2512.37 J/g dry weight). On an ash free dry weight basis the value was 28360 J/g dry weight. Since the calorific coefficient to lipid is nearly twice as much as that of both protein and carbohydrate, lipid : protein (L : P) ratio provides a good indication of the calorific value of zooplankton organic weight¹². In the present investigation L : P ratio ranged from 0.34 - 0.88 averaging 0.49 ± 14. Low calorific value has been reported¹². The L : P ratio is < 0.4, and

Table 2 - Proximate composition (% of dry weight), carbon and caloric content (cal/g dry wt) of major groups of zooplankton.

Major groups	Protein	Lipid	Carbo- hydrate	Carbon	Caloric content	Ash
Crab eggs	67.64	18.46	4.84	37.49	5766.0	7.7
Fish larvae	66.02	15.34	1.16	44.16	5236.2	15.23
Copepods	62.79	19.46	2.53	31.68	5435.21	14.48
Ostracods	45.65	21.70	2.16	20.76	4706.55	28.88
Stomatopods	49.53	18.74	2.38	18.00	4611.23	-
Chaetognaths	62.15	15.68	2.16	24.66	5087.19	-
Decapods	63.44	19.19	2.48	39.95	5499.95	11.80
Cephalopods	64.15	15.79	1.31	-	5177.42	10.14
Pteropods	31.74	12.84	1.17	9.77	3050.10	-
Medusae	35.38	9.08	1.86	-	2935.50	35.75
Acetes	62.22	19.58	1.06	41.56	5409.88	15.64
Anchovi larvae	63.42	15.10	1.04	29.92	5060.84	17.35

high, if it is, > 0.7. However, mean calorific content in the present study was greater than reported for zooplankton from west coast of India^{2,4,14,15}. Mean organic weight of zooplankton in the present study was 33.89 mg/m³ corresponding to 77.14% of dry weight. Lipid as percentage of organic weight ranged from 25.08 to 42.47% (av. 30.82%), protein 53.26 to 72.97% (av. 65.75%) and carbohydrate 1.95 to 5.12% (av. 3.41%). Calorific content as a function of organic weight fluctuated from 6572.82 to 7198.09 (av. 6768.43) and calories in terms of organic weight/m³ varied from 58.64 to 554.05 (av. 229.10 cal ow/m³).

Table 2 represents proximate composition of 12 major groups of zooplankton. Protein was maximum in crab eggs (67.64%) and minimum in pteropods (31.74%). The difference in various biochemical components between shelled organisms, gelatinous organisms, other crustaceans and fish eggs and larvae were found significant - Protein $P < .001$ (F 33.5 d.f. 2, 9); lipid $P < .05$ (F 42 d.f. 2, 9) and carbon and calories $P < .01$ (F 14.49 d.f. 2, 9). Protein recorded for chaetognaths agrees with that of earlier reports^{16,17}, whereas pteropod values were higher than the report of Beer¹⁸. Calorific content in general agrees with that of Morris and Hopkins¹⁹.

Present results on lipid, carbohydrate etc. show that lipid was maximum in ostracods, and minimum in medusae. Carbohydrate value fluctuated marginally between groups except for the relatively high value (4.84%) recorded in crab eggs. The very low organic carbon (9.77%) in pteropods led to a proportionate low calorific value. The low caloric content in medusae shows the poor contribution of this group in energy transfer as secondary producer.

The reliability of using dry weight and carbon equivalent in the estimation of standing stock for selected areas has been reported². The average standing stock in the present study has been estimated as 618 mgC/m². Considering the entire study area as 5.3×10^4 km², the standing stock amounted to 3.3×10^4 tonnes of carbon. The zooplankton production at zone A (459.69 mgC/m²) was about 1.5 times low as compared to zone B (699.28 mgC/m²), whereas the biochemical constituents were at the higher side at zone A. Ratios recorded for protein, lipid and carbohydrate between the zones (A & B) were respectively 1.3 : 1; 1.1 : 1 and 1.3 : 1. The difference between the zones suggests possibility of some changes in the proximate composition of zooplankton collected from stations around the oil field.

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