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Standing stock and biochemical composition of zooplankton in the northeastern Arabian Sea

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Zooplankton standing stock and biochemical composition were estimated for the coastal and oceanic regions of the northeastern Arabian Sea during November-December 1985. Biomass in terms of dry weight only showed significant difference between the coastal and oceanic waters. Ostracods were the predominant component (> 47%) in the coastal zone whereas copepods generally dominated (> 64%) in the oceanic zone. Protein was the principal biochemical component with an average value of 44.49% in the coastal zooplankton and 38.1% in the oceanic zooplankton suggesting that protein, in addition to lipid, may function as a reserve food in tropical zooplankton. Lipid, carbohydrate, ash, carbon and calorific content did not show much variation. Standing crop was estimated as 352.13 mgC. m^{-2} for the upper 50m column of the coastal region, 716.82 mgC. m^{-2} for the upper 200 m column of the oceanic region and 3.44×10^5 tonnes carbon for the entire study area. The study indicated that coastal region is more productive than the oceanic region.

Information on standing stock and biochemical composition of zooplankton is important in evaluating the secondary production and the energy transfer in the secondary trophic level. Literature pertaining to these aspects from Indian waters[1-10] is mostly from easturies or neritic waters and very little is known from the oceanic region especially beyond the continental shelf. In this paper, biomass, carbon content, proximate composition and calorific value of coastal and oceanic zooplankton in the northeastern Arabian Sea are presented.

Materials and Methods

Zooplankton samples were collected from 8 oceanic (sts 3716-3723, depth > 2800 m) and 8 coastal (sts 3724-3752, depth < 100 m) stations in the northeastern Arabian Sea during the 160 cruise of *R V Gaveshani* between 24 November and 9 December 1985 (Fig. 1). Vertical hauls in the oceanic (200m depth) and coastal (50m depth) regions were made with a H T net (mouth area 0.25 m^2, mesh width 0.3 mm). Biomass was determined as displacement volume. One half of each sample was preserved for taxonomical studies and the other half was fresh dried in the oven for analyses of protein[11], carbohydrate[12], lipid[13] an cabron content[14]. Ash content was determined by igniting a weighed quantity of the dry powder in a muffle furnace at 450°C for 3-4 h. Calorific value was estimated as described by Platt *et al.*[15].

Results and Discussion

Biomass (Table 1) in the coastal waters ranged from 0.15 to 0.53 $ml.m^{-3}$ (av. 0.35 $ml.m^{-3}$) and the dry weight from 12.94-47.48 $mg.m^{-3}$ (av. 29.89 $mg.m^{-3}$). In the oceanic waters the range observed was between 0.02 and 0.72 $ml.m^{-3}$ (av. 0.22 $ml.m^{-3}$) and the dry weight range was between 5.47 and 41.81 $mg.m^{-3}$ (av 15.2 $mg.m^{-3}$). The carbon equiva-

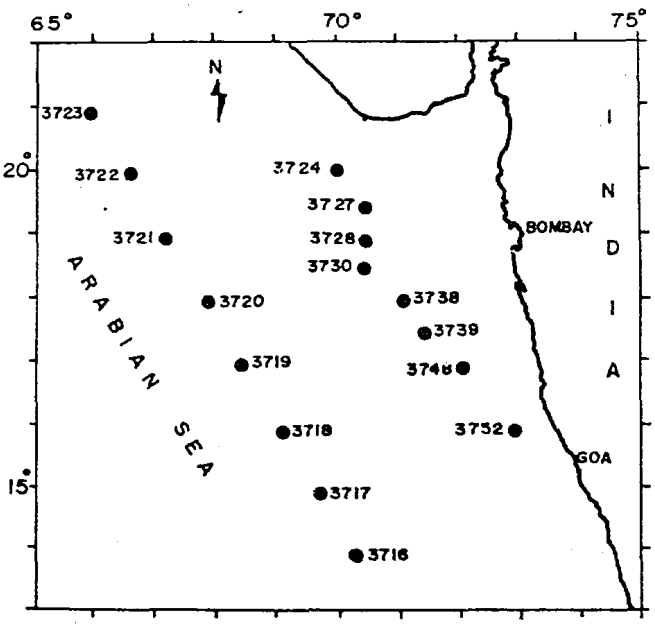

Fig. 1—Station locations

Table 1—Biomass and contribution of major groups (> 10% of total counts) at different stations

St No	Dis. vol. ($ml.m^{-3}$)	Dry wt ($mg.m^{-3}$)	Carbon ($mg\ C.m^{-3}$)	Major groups ($no.m^{-3}$)	
Oceanic stations					
3716	2.31*	463.90*	119.50*	Ostracoda	(1474)
				Pelecypoda	(771)
3717	0.15	12.14	2.63	Copepoda	(80)
				Ostracoda	(27)
				Cladocera	(38)
3718	0.12	6.45	1.03	Copepoda	(76)
				Chaetognatha	(11)
				Tunicata	(9)
3719	0.25	15.39	3.60	Copepoda	(57)
3720	0.07	5.47	1.18	Copepoda	(17)
				Chaetognatha	(3)
				Tunicata	(3)
3721	0.72	41.81	12.50	Copepoda	(90)
				Mysids	(143)
				Tunicata	(67)
3722	0.02	1.54*	0.41*	Copepoda	(179)
3723	1.81	9.94	2.35	Copepoda	(88)
				Mysids	(21)
Coastal stations					
3724	0.37	17.09	4.07	Copepoda	(107)
				Chaetognatha	(27)
3727	0.53	45.16	14.27	Copepoda	(139)
				Ostracoda	(211)
3728	0.38	31.87	7.66	Copepoda	(80)
				Amphipoda	(53)
3730	0.36	12.94	2.11	Copepoda	(15)
				Tunicata	(10)
3738	0.04*	1.88*	0.44*	Copepoda	(33)
3739	0.15	19.25	5.09	Copepoda	(16)
				Ostracoda	(58)
3748	0.30	47.48	8.95	Copepoda	(62)
				Ostracoda	(130)
3752	0.39	35.41	8.57	Copepoda	(88)
				Ostracoda	(327)

*Values not considered for averaging

Table 2—Biochemical composition (% dry wt) and calorific value ($k\ cal.g^{-1}$ dry wt) of mixed zooplankton from different stations

St.No.	Carbon	Protein	Carbohydrate	Lipid	Ash	Calories
Oceanic stations						
3716	25.76	25.28	2.83	4.27	38.31	3.69
3717	21.69	29.47	2.54	16.11	31.30	3.07
3718	16.02	38.85	2.40	14.50	30.39	2.21
3719	23.38	42.03	2.86	13.25	29.49	3.33
3720	21.66	40.06	1.48	11.48	38.08	3.07
3721	29.89	40.67	1.79	10.15	23.90	4.32
3722	26.64	32.47	2.45	7.30	20.53	3.82
3723	23.67	56.00	1.14	20.22	17.15	3.37
Coastal stations						
3724	23.48	53.77	1.38	17.85	25.13	3.34
3727	31.60	32.57	2.29	10.79	28.75	4.58
3728	24.04	56.29	3.21	14.84	24.55	3.43
3730	16.32	42.61	3.13	19.41	26.37	2.25
3738	23.62	43.79	2.47	15.51	27.37	3.36
3739	26.45	54.06	1.27	10.44	28.37	3.79
3748	18.86	36.42	3.21	22.56	26.22	2.64
3752	24.21	36.44	2.24	9.05	33.66	3.45

lent ranged from 1.03 to 12.5 mg $C.m^{-3}$ (av. 3.88 mg $C.m^{-3}$) and from 2.11 to 14.27 mg $C.m^{-3}$ (av. 7.25 mg $C.m^{-3}$) respectively for the oceanic and coastal stations. Only dry weight values indicated significant difference ($P<0.01$) between the zones. The average biomass for the study area was 0.29 $ml.m^{-3}$ which was equivalent to 31 $ml.m^{-2}$.

In the coastal waters, ostracods had an overall dominance (47.2%) and copepods followed next (35.1%). In the oceanic waters, other than st 3716, where aggregations of ostracods and juvenile pelecypods occurred, copepods were dominant at most of the stations (>64%; Table 1). It appears that abundance of ostracods and mysids was responsible for the high dry weight values observed at some stations.

Carbon—The recorded range was 16.02-29.89% (av. 23.58%) for the oceanic region and 16.32-31.60%(av. 23.57%) for the coastal region (Table 2). These values, however, were lower than those previously reported for zooplankton of the Arabian Sea[4,8,9]. Although differences were known to occur in carbon content in zooplankton from different regions either due to variation in composition or food availability[16,17], no such difference was discernible between coastal and oceanic zooplankton in the present study. Nontheless, high degree of correlation ($P<0.001$) as reported earlier[15] was observed between carbon and calorific content.

Protein—This was the principal biochemical component which had the lowest value (25.28%) at st 3716 and highest (56.29%) at st 3728 (Table 2). As compared to oceanic zooplankton (av. 38.1%) protein content in coastal zooplankton was high (av. 44.49%).

Lipid—Large variations(range 4.27-22.56%) occurred in lipid content (Table 2). The average values obtained were 12.16 and 15.06% respectively for oceanic and coastal zones. Positive correlation ($P<0.01$) was observed between lipid and calorific values. In temperate forms lipid is the main food reserve and hence high lipid content is generally encountered in zooplankton also[18–20]. In contrast,

tropical zooplankton has comparatively low lipid content where protein is the major component[3,6–9].

Carbohydrate—Low carbohydrate content appears to be characteristic of zooplankton[3,6–9]. Carbohydrate accounting to <1% has also been reported[21]. In this study also, it was found to be minimal (range 1.14-3.21%; Table 2). The low carbohydrate content in zooplankton which is considered as one of the important metabolic substrates and the high level of protein suggest that protein, in addition to lipid, may function as a food reserve[18,19,22,23]

Ash—The average values did not show much variation between oceanic (28.6%) and coastal (27.55%) region. Except for a few values, the variation was within 20-32% (Table 2).

Calorific value—Variations between the stations was negligible (range 2.21-4.58 k cal.g^{-1} dry wt) and incidentally the average was 3.36 k cal.g^{-1} dry wt for both coastal and oceanic waters (Table 2). This however differed slightly from the earlier reported values for the Arabian Sea[7,9].

Standing crop—Converting displacement volume to its dry weight equivalent and to carbon equivalent is probably a more direct and reliable method of estimating the standing crop. This method has yielded dry weight equivalent of 1 ml of zooplankton as ranging between 61.9 and 81.7 mg for the coastal water of Goa[4] and between 68.7 and 82.2 mg for the Andaman Sea[5]. In the present study the estimated dry weight for 1 ml of zooplankton was 85.37 mg for the coastal waters and 69.09 mg for the oceanic waters with an average of 79.7 mg. Substituting these values for their carbon equivalents, based on the average carbon values obtained in this study, the standing crop was estimated as 352.13 mg C.m^{-2} for the upper 50 m column of the coastal waters and 716.82 mg C. m^{-2} for the upper 200 m column of the oceanic waters. When extrapolated for the entire study area of 5.9×10^5 km^2, the zooplankton standing crop was found to be equivalent to 3.44×10^5 tonnes carbon.

Thus, it could be deduced from this study that although there was no appreciable variations in the biochemical composition between the coastal and oceanic zooplankton, the standing crop estimates clearly indicated that the coastal region is more productive than the oceanic region.

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References

1 Qasim S Z, Wafar M V M, Sumitra-Vijayaraghavan, Royan J P & Krishna Kumari L, *Indian J Mar Sci*, 7 (1978) 84.
2 Stephen R, Panampunnayil S U, Gopalakrishnan T C & Sankaranarayanan V N, *Indian J Mar Sci*, 8 (1979) 257.
3 Madhupratap M, Venugopal P & Haridas P, *Indian J Mar Sci*, 8 (1979) 155.
4 Nair V R, *Indian J Mar Sci*, 9 (1980) 114.
5 Madhupratap M, Achuthankutty C T, Nair S R S & Nair V R, *Indian J Mar Sci*, 10 (1981) 258.
6 Goswami S C, Rao T S S & Matondkar S G P, *Indian J Mar Sci*, 10 (1981) 296.
7 Goswami S C, Rao T S S & Matondkar S G P, *Mahasagar—Bull Natn Inst Oceanogr*, 14 (1981) 313.
8 Sumitra-Vijayaraghavan, Selvakumar R A & Rao T S S, *Indian J Mar Sci*, 11 (1982) 70.
9 Nandakumar K, Bhat L K & Wagh A B, *Indian J Mar Sci*, 17 (1988) 48.
10 Krishna Kumari L & Nair V R, *Indian J Mar Sci*, 17 (1988) 78.
11 Raymont J E G, Austin J & Linford E, *J Cons Perm Int Explor Mer*, 28 (1964) 354.
12 Dubois M, Gillas K A, Hamilton J K, Rebus R A & Smith F, *Anal Chem*, 28 (1956) 350.
13 Folch J, Lees M & Solane-Stanley G H, *J Biol Chem*, 226 (1957) 497.
14 El Wakeel S K & Riley J P, *J Cons Perm Int Explor Mer*, 22 (1957) 180.
15 Platt T, Brawn V M & Irwin B, *J Fish Res Board Can*, 26 (1969) 2345.
16 Platt T & Irwin B, *Limnol Oceanogr*, 18 (1973) 306.
17 Omori M, *Mar Biol*, 3 (1969) 4.
18 Conover R J, in *Food relations and nutrition of zooplankton* (Univ Rhode Island, USA) 1964, 81.
19 Conover R J & Corner E D S, *J Mar Biol Assoc, UK*, 48 (1968) 49.
20 Lee F R & Hirota K, *Limnol Oceanogr*, 18 (1972) 227.
21 Beers J R, *Limnol Oceanogr*, 11 (1966) 520.
22 Raymont J E G, Sreenivasayam R T & Raymont J K B, *Deep-Sea Res*, 16 (1969) 141.
23 Reeve M R, Ravmont J E G & Raymont J K B, *Mar Biol*, 6 (1970) 357.