BIOMASS AND COMPOSITION OF ZOOPLANKTON IN AND AROUND GULF OF KUTCH

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ABSTRACT

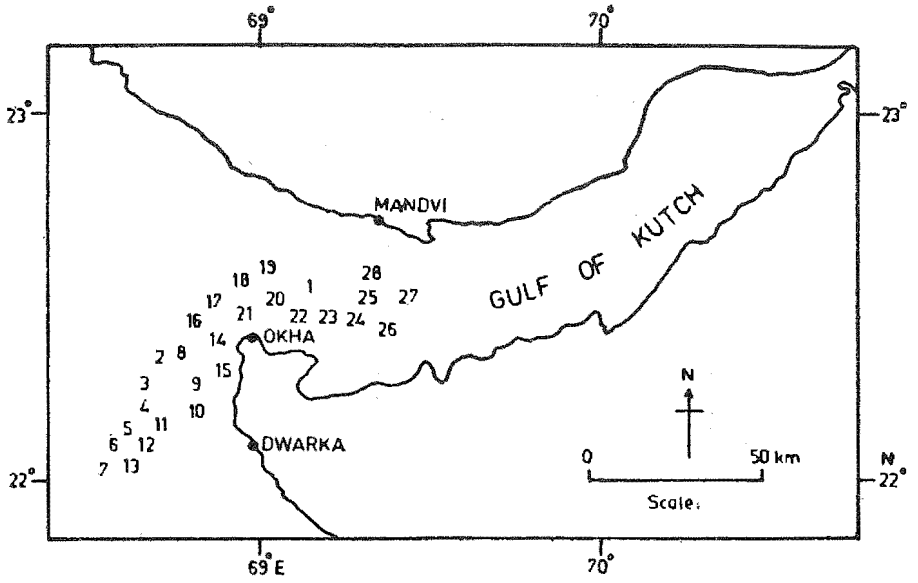
The faunal composition, distribution and abundance of zooplankton from 28 stations in and around the Gulf of Kutch, were studied during INS Darshak cruise in January, 1975. Zooplankton biomass was about 4.5 times more in the outside Gulf region (mean: 50.3 ml/100 m3) than in the inside Gulf (mean: 11.1 ml/100 m3). The mean zooplankton biomass of Dwarka (66.3ml/100 m3) was about 2.5 times more than that off Okha (26.8 ml/100 m3). A rich zooplankton production in the Saurashtra waters corresponded to a rich fishery prevailing in this region.

INTRODUCTION

Studies on plankton distribution and hydrography along the west coast of India have been considerably intensified during the last decade (Panikkar and Rao, 1973). Mostly southern and central part of the coast are subjected to very intensive study. (Prasad 1969; Rao 1973; Qasim 1977; Nair et al 1978). Practically the available information is not much for the Gulfs namely the Gulf of Cambay (IOBC, 1969; NIO, Report, 1979) and the Gulf of Kutch (Ramamurthy and Dhawan, 1963; Bhaskaran and Gopalakrishnan 1971; Dhawan 1972; Paulinose and Aravindakshan, 1977). Hence, the present investigation was undertaken to study the pattern of zooplankton distribution and abundance in the Gulf of Kutch on the north eastern Arabian Sea which sustained a very high fishery potential (Virabhadra Rao, 1973).

MATERIALS AND METHODS

The samples for the present study were collected from 28 stations located in and around the Gulf of Kutch (Fig. 1) during INS Darshak Cruise 1, January, 1975. The vertical hauls covering the entire water column (depth range 18-60m) were made from these stations using an Indian Ocean Standard (IOS) Net (Currie, 1963). Samples were fixed in 5% sea water buffered



formaldehyde. Depths recorded by echo soundings. The environmental data pertaining to salinity, temperature, dissolved oxygen and nutrients (PO_4 & NO3) were obtained from the Indian National Oceanographic Data Centre, National Institute of Oceanography, Goa. Numerical abundance and the displacement volume of the samples are expressed as number/100 m^3 and ml/100 m^3 respectively. Stations 2 to 17 represent outside Gulf region whereas the remaining stations represent inside Gulf region. Stations 3, 4, 5, 6, 7, 10, 11, 12 and 13 represent off Dwarka and similarly stations 2, 8, 9, 14, 15, 16; 17, 18 and 21 represent off Okha.

RESULTS AND DISCUSSIONS

Environmental features: The results of the environmental parameters such as depth, temperature, salinity, dissolved oxygen and nutrient are given in Table I. As indicated by the results the sampling depths did not vary much between inside (25-50m) and outside (18-60m) stations of the Gulf. But, comparatively a little increase in column temperature of the waters was noticed of the stations outside (20.51-22.72° C) than those of the stations inside (19.70 -20.97° C) the Gulf. Salinity varied between inside (37.45-38.06‰) and outside (36.15-37.74‰) the Gulf stations. In general, the dissolved oxygen values between inside and outside Gulf waters were very much comparable. The very low dissolved oxygen values noticed at inside Gulf

TABLE I :- ENVIRONMENTAL CONDITIONS, ZOOPLANKTON BIOMASS AND POPULATION AT DIFFERENT STATIONS IN GULF OF KUTCH.

Station	Date	Time	Sounding Depth (m)	Sampling Depth (m)	Temp (°C)	Salinity (‰)	Do (ml/1)	Po_4 P. ugat/l	No_3 - N ugat/l	Zooplankton ml/100 m^3	Zooplankton No/ 100 m^3
1.	22.01.75	1620	50	40-0	20.39-20.86	37.74 37.77	5.17-5.42	0.84-1.38	3.4-3.9	5.8	553
2.	23.01-75	0830	29	20-0	21.28-21.29	36.99-37.74	4.96-5.01	0.90-1.14	2.5-2.7	13.3	1504
3.	23.01.75	1006	28	20-0	21.47-21.57	—	4.95-4.97	0.90-0.98	2.2-2.6	76.8	1388
4.	23.01.75	1130	28	20-0	21.70-21.74	—	4.95-4.99	1.07-1.20	3.1-3.4	96.0	1448
5.	23.01.75	1300	35	30-0	21.32-21.74	36.24-36.42	4.77-5.13	0.90-1.66	1.9-3.9	58.5	476
6.	23.01.75	1312	35	30-0	21.89-22.11	—	4.96-5.06	0.96-1.08	2.2-2.4	97.0	2154
7.	23.01.75	1530	68	60-0	21.51-22.27	36.15-36.42	4.82-4.95	1.02-1.27	1.5-3.2	62.2	2472
8.	24.01.75	1700	29	24.0	20.94-20.97	37.25-37.56	4.98-5.03	1.08-1.38	1.8.3.6	26.2	471
9.	24.01.75	2000	32	27-0	21.23-21.48	—	4.27-5.36	0.90-1.32	3.8-4.4	48.5	814
10.	24.01.75	2142	35	30-0	21.32-21.55	—	4.99-5.08	1.14-1.20	3.1-3.2	48.6	466
11.	25.01.75	2348	38	30-0	21.64-21.97	36.14-36.51	4.75-4.87	0.96-1.32	2.1-3.1	47.1	2860
12.	25.01.75	0154	43	37-0	21.34-22.00	—	4.75-4.93	1.04-1.50	2.3-3.6	43.9	788
13.	25.01.75	0442	58	50-0	21.42-21.93	36.15-36.42	4.70-4.87	0.96-1.18	1.7-2.3	66.7	2420
14.	25.01.75	1700	24	18-0	20.81-20.87	36.89-37.01	5.30-5.47	2.06-3.12	3.9-4.2	20.8	527

TABLE : I Continued

15.	25.01.75	2112	43	35-0	21.06-21.12	—	5.16-5.33	1.50-1.20	3.3-4.2	45.3	648
16.	26.01.75	0648	35	50.0	20.51-20.55	37 25-37.43	5.07-5.32	0.82-1.51	3.8-4.1	22.5	558
17.	26.01.75	0806	55	30-0	20.36-20.42	—	5.16-5.26	0.70-1.24	2.2-2.3	32.0	397
18.	26.01.75	0942	35	30-0	20.22-20.27		5.23-5.45	0.80-1.44	2.4-2.9	17.8	650
19.	26.01.75	1106	38	50-0	20.50-20.97	37.62-35.75	5.22-5.41	1.02-1.40	2.3-2.4	16.0	510
20.	26.01.75	1500	56	30-0	20.57-20.64	—	5.13-5.42	0.49-1.38	3.2-3.9	8.7	194
21.	26.01.75	1636	36	30-0	20.56-20.60	—	5.17-5.31	0.84-1.73	2.9-3.4	14.6	363
22.	26.01.75	1848	30	25-0	20.14-20.18	37.41-37.63	2.70-3.75	1.08-1.50	1.8-3.4	16.0	480
23.	27.01.75	0742	35	30-0	19.94-19.98	—	1.44-5.55	0.94-1.20	1.8-1.9	7.1	209
24.	27.01.75	0912	32	25-0	19.76-20.13	—	5.12-5.35	1.57-1.94	2.4-2.7	8.6	171
25.	27.01.75	1018	40	35-0	19.82-19.98	37.45-37.72	5.13-5.34	1.08-1.30	2.1-2.2	13.7	304
26.	27.01.75	1136	62	50-0	19.81-19.97	—	5.13-5.29	1.56-1.72	1.9-2.3	5.3	248
27.	27.01.75	1300	30	25-0	19.85-19.93	—	5.27-5.38	0.88-0.94	1.9-2.1	12.8	174
28.	28.01.75	0748	40	30-0	19.70-19.73	37.72-38.06	5.08-5.15	0.56-1.20	2.1-2.2	6.7	41

were mainly due to oxygen depletion encountered at the bottom waters especially of sations 22 and 23. The waters outside Gulf regions, in general, had more nutrients as compared to the waters inside the Gulf.

Biomass: The zooplankton biomass values are given in Table 1. Total biomass varied from 5.3 to 97.0 ml/100 m^3 for the 28 stations. The gelatinous animals (medusae, doliolids etc.) had contributed between 1 and 38 ml/100 m^3 of the total biomass. Biomass for the inside and outside stations of the Gulf varied from 5.3 to 17.8 ml/100 m^3 and 13.3 to 97.7 ml/100 m^3 respectively. Highest biomass of 97.0 ml/100 m was obtained at station 6 located off Dwarka. Lowest biomass of 5.3 ml/100 m^3 was recorded at station 26 in the inside Gulf region. Comparatively higher biomass values were recorded off Dwarka (43.0 to 97.0 ml/100 m^3) than Okha (13.3 to 48.5 ml|100 m^3). The mean biomass off Dwarka (66.3 ml|100 m^3) was about 2.5 times more than that off Okha (26.8 ml/100 m^3). The mean biomass (50.3 ml/100 m^3) of the stations outside the Gulf was about 4.5 times more than that of inside stations (11.1 ml/100 m^3). It would appear that the difference in salinity and nutrients contributed to higher biomass from sea side.

Population density: Variations in zooplankton population are given in Table I. Numerical density varied from 41|m^3 (Stn. 28) to 2860|m^3 (Stn. 11). The mean density of zooplankton for the outside Gulf region (1212|m^3) was about 4 times more than that of inside Gulf region (325/m^3). The mean values did not show significant variation between the stations near and fa.ther off the shore at Dwarka. Mean population density off Dwarka (1608|m^3) was 2.5 times more than off Okha (659/m^3).

Faunal composition: Percentage compositions of zooplankton are given in Table II. Thirteen important faunal groups were recognized in the samples from 28 stations. Rest of the faunal groups were repo ted under miscellaneous category. Some of the very important faunal groups encountered in the samples were Copepoda. Chaetognatha, Medusae, Decapoda, Polychaeta, Siphonophora, and fish larvae. The groups such as Gastropoda, Pteropoda, Ostracoda, Oikopleura, Salpidae and Dol olidae were of secondary importance. Miscellaneous group consisted of fish eggs, bivalve larvae, echinoderms larvae, euphausiids, amphipods, isopods, caladocerans, cirripedes etc. had contributed a very insignificant percentage (0.2%) of the total plankton.

An increase in the mean percentage of copepods from outside (68%) to inside (84%) Gulf region was evident (Table II). *Eucalanus subcrassus, Acrocalanus, gracilis, Temora turbinata, Paracalanus aculeatus, Oithona plumifera, Corycaeus* sp : *Euchaeta wolfendeni, Centropages orsinii, Undinula vulgaris,* and *Candacia* sp. *Euterpina acutifrons, Acartia* sp., *Oncaea* sp. and *Longipedia* sp were common in the samples. Chaetognaths were noticed in abundance at Dwarka and Okha areas. The present investigation clearly indicated a higher percentage of chaetognaths in the open sea (14-15%) as compared to the inner Gulf region (7-8%). Species like *Sagitta enflata, S. bedoti, S. bipunctata* and *S. pacifica* reported to be abundant off Dwarka and Okha coast than the inner Gulf regions. Salps and doliolids contributed major part of gelatinous animals besides medusae.

Decapods were mainly represented by penaeid larvae, anomuran larvae and zoea and megalopa stages of crab. In general, the mean percentage composition of decapods showed an increase from outside (4.1%) to inside Gulf region (5.6%). On the other hand, the mean percentage composition of pelagic polychaetes gradually decreased from Dwarka (3%) to Okha (1.5%). Groups like Siphonophora, Oikopleura and Pteropoda showed their preference to open sea. Pteropod species viz; *Creseis acicula, C. virgula* and *Cavolinia* sp. observed in the present collections, had already been recorded in the Indian Ocean by Tesch (1948) and Sakthivel (1967). Ostracods formed a minor component of zooplankton in the Gulf of Kutch. *Cypridina dentata* was the common ostracod recorded. Fish larvae (viz; *Trichurus* sp; *Cynoglossus* sp. etc) were seen in common, although they contributed very less percentage of the total plankton.

The results (Table III) of the present investigation clearly indicated relatively a higher zooplankton productivity for the stations off Gulf than the stations inside the Gulf. Further, the stations off Dwarka sustained rich biomass as compared to the stations off Okha. Zooplankton biomass of about 4 to 5 times more than the average biomass of the entire Indian Ocean has been reported for the northern and northeastern Arabian Sea (Prasad 1969). Again zooplankton biomass of 560 ml/200 m^3 recorded (Paulinose and Aravindakshan 1977) in the area of Kutch is the highest for the entire Indian Ocean. A comparative account of zooplankton biomass off Gulf of Kutch (Table III) reveals, in general ,a rich biomass for the stations off Gulf of Kutch (Range 20-80 ml/100 m^3) especially in the regions off Dwarka (80 ml/100 m^3) as

TABLE — II: PERCENTAGE COMPOSITION OF ZOOPLANKTON AT DIFFERENT STATIONS IN GULF OF KUTCH.

GROUPS	STATIONS													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Copepoda	78.8	84.0	79.0	56.1	50.2	62.5	72.8	54.9	62.8	50.3	73.2	67.2	37.9	98.1
Chaetognatha	13.3	06.8	....	15.3	13.3	11.1	10.1	34.8	15.9	29.0	10.1	20.3	14.9	04.0
Polychaeta	00.6	00.8	01.5	01.8	....	03.5	01.4	02.1	00.7	00.7	08.5	04.5	06.1	02.3
Medusae	....	01.9	00.8	00.4	02.5	04.0	....	....	01.0	02.3	00.4	....	....	00.2
Gastropoda (veligers)	....	....	01.0	01.6	....	00.3	00.2	00.4	04.8	00.7	01.5	01.0	00.8	00.1
Oikopleura	00.1	00.5	01.2	10.4	....	04.2	03.6	00.4	00.4	....	00.4	....	....	....
Siphonophora	....	....	01.1	....	....	04.0	00.8	....	....	02.3	00.6	....	10.3	....
Decapoda	06.6	04.3	01.5	04.0	00.4	02.3	04.4	02.5	03.6	08.5	01.2	03.0	08.7	02.2
Peteropoda	....	....	....	06.3	28.4	03.7	03.4	01.7	05.3	03.4	02.4	03.8	09.2	00.3
Salpidae	....	00.5	08.0	03.7	04.5	02.7	01.2	02.5	02.4	01.5	01.2	....	....	....
Doliolidae	....	00.1	04.0	....	....	00.6	01.3	....	00.2	....	00.1	....	01.7	....
Fish larvae	....	00.3	01.6	....	00.6	01.0	00.3	00.4	02.6	00.7	00.2	....	10.7	01.2
Ostracoda	00.2	00.5	00.2	00.2	....	....	....	....	....	....	....	00.1	....	00.3
Misc. Groups	00.4	00.3	00.1	00.2	00.1	00.1	00.5	00.3	00.3	00.6	00.2	00.1	00.1	00.3

Table (11) Contd.

GROUPS	STATIONS													
	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Copepoda	70.9	62.7	46.0	73.8	88.6	91.0	90.5	84.1	87.9	72.7	80.7	80.7	88.3	90.4
Chaetognatha	12.9	28.7	18.0	18.9	08.7	01.5	03.8	12.4	10.0	10.1	06.5	03.8	04.5	02.2
Polychaeta	01.5	00.8	....	....	....	....	....	....	....	....	....	....	....	....
Medusae	00.4	04.5	....	02.7	00.7	....	00.3	....	....	00.6	....	....	....	....
Gastropoda (veligers)	03.3	....	....	....	....	04.0	..	....	....	04.0	06.5	04.2	02.0	....
Oikopleura	01.5	00.8	....	....	....	....	....	....	....	....	....	....	....	....
Siphonophora	02.1	00.2	01.7	....	....	....	....	00.8	....	....	....	....	....	....
Decapoda	01.3	00.8	25.0	01.3	01.1	03.0	04.4	02.0	01.0	11.0	02.9	07.6	05.1	07.2
Pteropoda	01.8	00.3	03.0	02.1	....	....	....	....	....	....	....	....	....	....
Salpidae	02.2	01.0	01.0	00.7	00.1	....	....	....	....	....	....	....	....	....
Doliolidae	00.4	....	....	....	....	....	....	....	....	....	....	....	....	....
Fish larvae	00.9	00.1	01.0	00.3	00.3	....	....	00.2	....	....	....	....	....	....
Ostracoda	00.4	....	04.0	00.1	00.2	00.3	00.5	00.2	....	02.3	01.2	03.3	....	00.1
Misc. Groups	00.4	00.1	00.3	00.1	00.3	00 2	00.5	00.3	00.1	00.3	00.2	00.4	00 1	00 1

reported by Paulinose and Aravindakshan. The present study is in agreement with the above report. IOBC Report (1969), showed relatively less mean biomass of zooplankton for this region, which, however, can be attributed to the difference in the sampling period and also to the limitation in the area of sampling.

The results (Table II) clearly indicated the abundance of crustaceans like copepods and decapods in the inner Gulf region as compared to the outside Gulf On the other hand, the abundance of chaetognaths, polychaets, medusae, oikopleurans and siphonophores were more in the outside Gulf accounting for relatively high biomass in the area. Thus, the investigation revealed an increase in group diversity of zooplankton towards offshore region.....The present study has reported only very less number of ostracods in the Gulf of Kutch.....But, according to Paulinose and Aravindakshan (1977) most of their collections off Gulf of Kutch dominated by ostracods and also the samples collected during night were reported to contain highest number of ostracods. Eventhough, dissolved oxygen values were comparable between inside and outside stations of Gulf groups like Siphonophora, Pteropoda, Oikopleura etc. having preference to open ocean were confined mostly to the open ocean.

The reported values on total zooplankton from Kandala creek in the interior Gulf of Kutch (Ramamurthy and Dhawan 1963 and Dhawan 1972) are not comparable for reasons such as that (a) the samples were of horizontal haul in nature and (b) they were collected from a creek. However, a poor primary production in the waters at the interior Gulf regions as indicated by these reports was chiefly attributed to the very poor visibility prevailed due to high turbid nature of the water column.....Latter, a report on plankton (Bhaskaran and Gopalakrishnan, 1971) from port Okha in the Gulf of Kutch, reveals a rich phytoplankton and zooplankton of considerable quantity and diversity comparable with any other part of the west coast of India. Even-though the reported biomass values of zooplankton for Port Okha 11.9 ml/haul Jan '69 and 5.4 ml/haul-Jan '70) are close to the present results, they are not comparable since they did not quantify the volume of filtered water.

Nutrient values (Table 1) of the surface water off Gulf of Kutch are very much comparable to the IIOE data. The reported mean values of chloro-

TABLE III: COMPARATIVE ACCOUNT OF ZOOPLANKTON BIOMASS* FOR THE GULF OF KUTCH REGION OF THE NORTH EASTERN ARABIAN SEA (1969-1981)

Source	Region	Period	Biomass ml/100m³
IOBC (1969)	20°19′ — 22°02′ N and 67°03′ — 68°23′ E	March	Mean 20.6
Paulinose and Aravindakshan (1977)	a) 20-23° N and 66-70° E (In general, off Gulf of Kutch)	Dec.-May	Range 20—80
	b) 22-22.5° N and 66.5° — 67° E	—do—	280 (Highest record for the entire Indian Ocean)
	c) 22-23.5° N and 66.5°-68° E (Off Gulf of Kutch)	—do—	80
	d) 20°-22° N and 69-70° E (Off Dwarka)	—do—	80
Present Study	22°05′ — 22°43′ and 68°32′ — 69°20′ E (Entire region)	January	Range: 5.3—97.0
	a) Inside the Gulf	—do—	Mean — 11.1
	b) Outside the Gulf	—do—	Mean — 50.3
	c) Off Dwarka	—do—	Mean — 66.3

* All the samples were collected by using IOSN.

phyll A and primary production for the water column (O-50M) off Gulf of Kutch region are > .50 mg|m³ and > .50 mg C|m³|hour respectively (Krey and Babenerd, 1976). Thus, the sea off Gulf of Kutch contributes a rich secondary production since it sustained high nutrients and rich primary prodution. In addition to these biological productivity, a very rich benthic productivity (Parulekar and Wagh, 1975 Kasinathan et. al, 1973) and high fishery potential (Virabhadra Rao 1973) have already been reportial for this region.

A rich fishery of diverse forms chiefly contributed by crustaceans, elasmobranchs, clupeiods, catfishes, polynemids, scianids, mackerals, soles, and ribbon fishes exists in this area (Virabhadra Rao 1973). These forms mainly feed on zooplankton either directly or indirectly. Subramanyan (1973); Prasad (1969) and Nair et al (1978) have correllated a rich fishery with rich plankton production of south west coast of India. A very similar trend is existing in the Saurashtra waters where high plankton production and rich fishery are recorded.

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