

Studies on Hydrobiological Features of the Gulf of Cambay - Part I - Preliminary Account

by

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Introduction

Studies on the hydrography and biology of the west coast of India have received considerable attention due to high productivity and fishery potential of this region (Benerji and Satyanarayana, 1958 and Panikkar and Jayaraman, 1966). The area of investigation, however, has been more or less restricted to the southern part of the west coast. A few attempts (Jayaraman and Gogate, 1957, Jayaraman et al. 1959, and Patil et al. 1964) have been made to study hydrography and biology of the continental shelf from Bombay to Veraval. But these do not include the two important gulfs mainly Gulf of Cambay and Gulf of Kutch. With the findings of oil bearing strata in the nearshore region of the Gulf of Cambay it has become increasingly necessary to know more of the hydrography, bottom sediments and biology of the Gulf of Cambay. A detailed hydrobiological survey in the Gulf of Cambay was therefore undertaken during the cruises of I. N. S. 'Darshak' during the premonsoon period in 1966, 67 and 69. Twenty six stations were selected so as to cover maximum area in the gulf from the interior of the gulf to the mouth in the Arabian Sea (for station locations see Fig. 1). The hydrographic parameters

were recorded mostly at the surface. This paper describes temperature, salinity, depth soundings, direction of wind and currents, plankton, bottom fauna and sediments of the Gulf of Cambay for the first time.

Collection of data and treatment

The hydrographical data were collected and analysed by standard procedures. The temperatures were recorded in degrees centigrade using a surface thermometer. Meteorological data were recorded by suitable meteorological instruments on board I.N.S. 'Darshak'. Plankton samples were collected by a plankton net made of bolting silk XX grade with mesh size 125 per inch (size of aperture 0.119 mm) and with diameter of 45 cms. at the mouth end, length of the net being 94.5 cms. A flowmeter was attached at the mouth end for measuring the flow of water through the net. At almost all the stations the net was towed uniformly for 15 minutes and the revolutions of flowmeter were recorded. The bottom samples were collected by a dredge, grab and snapper. Plankton and benthic samples were preserved in 5% neutralized formalin.

Description of area (Fig. 1)

The Gulf of Cambay lies in the Arabian Sea to the north of Bombay between latitudes $20^{\circ} 30'N$ and $22^{\circ} 20'N$. It is a conical shallow strip of sea with an average depth of 18-27 meters sepa-

rating the peninsula of Kathiawar from the north Bombay coast. The gulf receives two great rivers Tapti and Narbada on the eastern side, the Mahi and Sabarmati on the northern side, and several small rivulets from the peninsula from the west. Most of the smaller

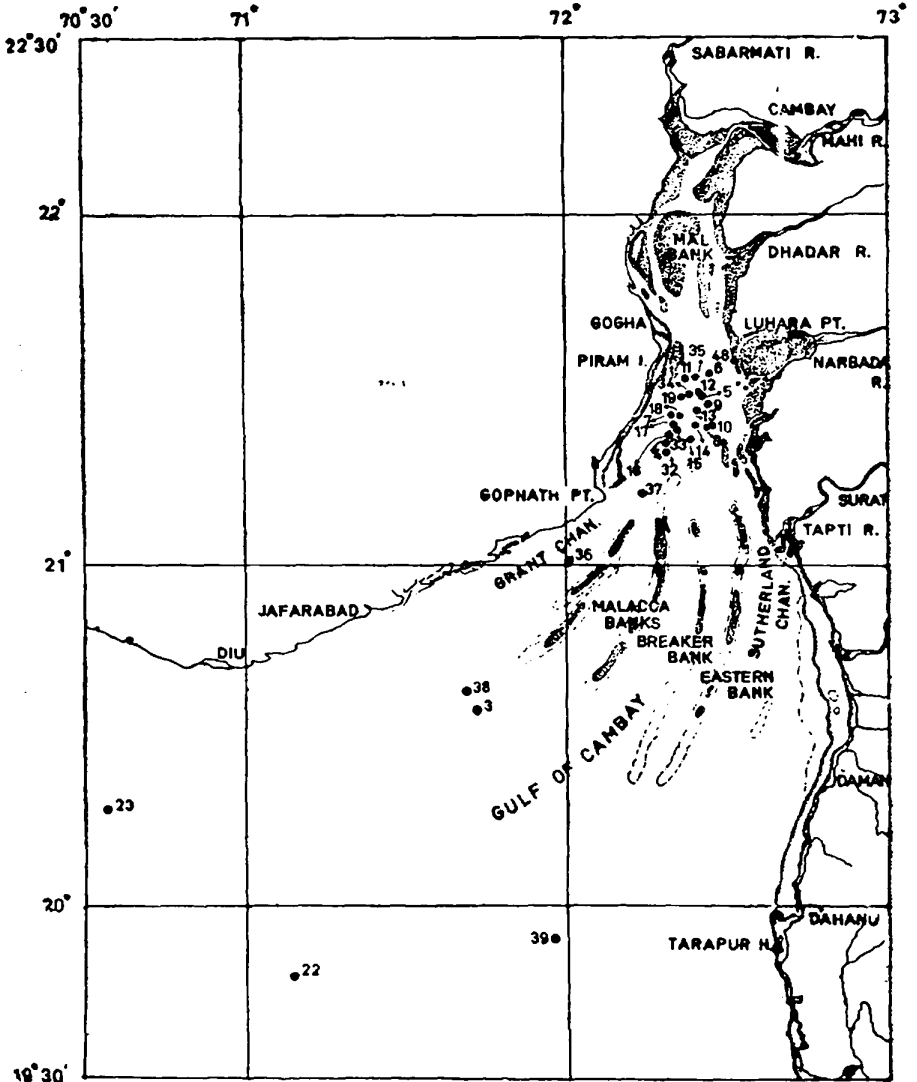


FIG. 1. Map of Gulf of Cambay Showing Location of Stations.

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rivers are dry during summer but become swollen with floods during southwest monsoon season (July-September). There is a series of submerged mud banks running parallel to the coast-line at the mouth of the gulf (Malacca bank). In the interior of the gulf there is a small island (Piram) off Gogha and further north there are large shoals which get exposed during low tide. Considerable shoaling is reported at the entrance of the Gulf of Cambay and mariners are cautioned about the navigational hazards in this region. Silting has made the gulf unsuitable for any major maritime activities, although in the past two famous harbours of Surat and Broach were situated in this area.

Meteorological Observations

Meteorological data were collected from standard instruments on board I. N. S. 'Darshak'. During the first cruise (from 9th to 19th April, 1966) there were no strong winds and the sea was generally calm. There were no large waves on the sea surface but the currents were very strong upto 4-6 knots carrying past the anchored ship large patches of mud. The tidal range in the Gulf of Cambay is the highest in the waters surrounding India. This coupled with the strong currents resulted in a very thorough mixing of waters in the shallow gulf. During the third cruise (from 16th to 19th March, 1967) the winds were quite strong and wind speed of 10-15 knots was observed.

Hydrographical features

Interior region of the gulf is shallow with a depth varying between 18-27 meters, with strong currents running upto 6 knots and wide fluctuations in the tidal range.

Temperature

The water temperatures observed during April, 1966 ranged from 20.67°C to 28.61°C. The temperature structure at any station did not show any vertical gradient. The bathythermograph readings indicated isothermal waters right upto the bottom. During cruise-3, the water temperatures ranged between 24.70°C to 25.86°C but these values were observed during the month of March, 1967 whereas the values of first cruise were taken towards the middle and end of April, 1966 which is quite warm in this part of the country. These values agree with those of Jayaraman and Gogate (1957).

Salinity

Salinity also did not show any vertical gradient which is due to a very thorough mixing of the water mass. The salinity in the interior of the gulf at the stations near the mouths of the major rivers—Narbada, Tapi, Mahi and Sabarmati ranged from 24.87‰ to 27.57‰ with an average value of 26.14‰. It can be seen from the data that the values recorded are not very uniform since they were taken at different times on different days with varying conditions of flood and ebb tide. The stations at the mouth of the gulf, 23, 32, 36, 37 and 38 all showed typical marine environment, the salinity being around 34.5‰. This compares very favourably with the values obtained by Jayaraman and Gogate (1957) who took two stations in the Gulf of Cambay. The location of the first station being 21°00'N, 72°00'E and the second station at 21°25'N, 72°15'E comparable to our stations 36 and 37.

Turbidity

The gulf waters are muddy throughout its extent. Large number of floa-

Table I
OCEANOGRAPHIC LOG DATA
I. N. S. Darshak Cruises in Gulf of Cambay

Station No.	Date	Time	Geographic Position		Air Temperature Wet (°C)	Air Temperature Dry (°C)	Barometer reading	Wind Direction of & Force (Knots)	State of Tide	Depth (m)	Salinity ‰	Temperature
			Lat. N	Long. E								
4	9-4-'66	0900-0925	21° 21.5'	72° 19'	21.4	24.2	1013.5	3 NW	ebb	29.3	27.01	25.28
5	10-4-'66	1140-1205	21° 29.5'	72° 25.4'	24.7	27.8	1011.0	3 NE	ebb	31.1	26.02	26.67
6	10-4-'66	1920-2000	21° 33.5'	72° 26.9'	25.3	29.2	1012.5	2 NE	flood	31.1	24.87	25.56
7	11-4-'66	1030-1103	21° 26.3'	72° 19.6'	23.1	27.2	1015.5	4 NE	ebb	25.6	25.48	26.39
8	13-4-'66	1110-1200	21° 24.2'	72° 26.7'	24.4	28.1	1015.0	3 NE	ebb	27.4	25.39	26.67
9	13-4-'66	1700	21° 28.2'	72° 26.9'	25.6	27.8	1011.0	3 NE	ebb	25.6	25.48	27.22
10	15-5-'66	1120-1145	21° 24.3'	72° 27.2'	24.2	26.2	1014.0	4 NW	flood	29.3	26.02	26.11
11	17-4-'66	1230-1300	21° 32.6'	72° 22.4'	25.6	27.8	1014.0	2 SW	flood	25.6	25.30	26.67
12	17-4-'66	1320-1350	21° 30.6'	72° 24.7'	26.0	29.2	1012.0	3 SW	flood	31.1	26.29	28.06
13	17-4-'66	1419-1440	21° 27.0'	72° 24.8'	26.9	30.3	1010.5	2 SW	flood	31.1	27.38	27.28
14	17-4-'66	1455	21° 21.6'	72° 24.1'	20.9	30.3	1010.5	2 SW	flood	32.9	27.57	27.39
15	17-4-'66	1525-1542	21° 22.1'	72° 23.4'	26.4	29.0	1011.0	2 SW	flood	25.6	25.84	28.61
16	19-4-'66	0947	21° 22.7'	72° 19.3'	24.4	27.5	1012.0	5 NW	ebb	23.8	25.57	26.94
17	19-4-'66	1025	21° 24.5'	72° 20.12'	25.6	28.3	1013.0	4 NE	ebb	25.6	27.11	26.44
18	19-4-'66	1048-1109	21° 26.9'	72° 21.2'	25.6	28.3	1013.0	4 NE	ebb	27.4	26.65	27.78
19	19-4-'66	1120	21° 23.5'	72° 21.8'	25.6	28.3	1013.0	3 NE	flood	23.8	26.29	26.78
23	28-1-'67	0805	20° 16.7'	70° 34.5'	18.3	21.7	1014.5	15 NNW	—	77.0	35.08	23.89
32	16-3-'67	1540	21° 20.0'	72° 18.9'	24.4	26.7	—	—	—	21.95	34.81	25.82
33	17-3-'67	0935	21° 24.0'	72° 21.0'	23.6	25.6	—	10-15	—	25.00	34.67	24.70
34	17-3-'67	1135	21° 30.0'	72° 23.0'	22.8	24.7	—	10-15	—	24.00	34.54	25.20
35	17-3-'67	1335	21° 33.0'	72° 24.7'	23.1	25.8	—	10	—	32.00	34.58	24.70
36	18-3-'67	1130	21° 09.5'	72° 07.5'	22.2	25.3	—	10-15	—	21.95	34.72	25.00
37	18-3-'67	1530	21° 12.5'	72° 14.5'	23.9	26.4	—	10-15	—	25.60	34.81	25.29
38	19-3-'67	1115	20° 37.7'	71° 41.4'	22.8	26.9	—	7-8	—	18.00	34.99	25.75
39	19-3-'67	1630	19° 54.5'	71° 58.2'	22.8	26.7	—	8-9	—	32.00	35.48	25.86
48	1-2-'69	2000-2145	21° 35.5'	72° 30.2'	22.22	23.88	1014.0	10 NNW	—	21.00	32.03	21.44

Table II
PLANKTON REPORT

St. No.	Date	Time of haul	Flow meter revolution	Plankton Volume (Wet in cc.)	Predominant	Frequent	Few
4	9.4.1966	0910-0925	7282	54	Phytoplankton	Copepods	Coelenterates and fish larvae
5	10.4.1966	1150-1205	2210	3	---	---	---
6	10.4.1966	1938-1953	1100	47.5	Phytoplankton and Chaetognaths	---	Young fish and Copepods
7	11.4.1966	1048-1103	4690	6	Phytoplankton	---	---
8	13.4.1966	1115-1130	1150	%	---	Chaetognaths	Copepods and Crustacean larvae
9	15.4.1966	1125-1145	---	90	---	Chaetognaths	Copepods and Prawn larvae
10	17.4.1966	1243-1257	2990	75	Phytoplankton	Chaetognaths	Fish larvae
11	17.4.1966	1334-1349	6952	75	Phytoplankton	Copepods	Chaetognaths
12	17.4.1966	1423-1438	830	25	---	Copepods and fish eggs	Copepods of Galanoida sp.
23	28.1.1967	0805	---	1.5	Siphonophores, Cephalopod eggs, Salps, Oikopleura sp.	Pteropod shells, Copepods	Acartia sp. Oithona sp. and Fish larvae
32	16.3.1967	1540	---	7	Coscinodiscus sp. Copepod nauplii and Fish Larvae	Acrocalanus sp. Temora sp. and Corycaeus sp.	Amphipods, Magalopa of crab, Decapod larvae and Fish eggs
33	17.3.1967	0935	---	3	Sand particles, Organic debris and Cirripede nauplii	Siphonophores (Diphyys sp.) Polychaete larvae, Gastropod shells, Cirripede nauplii and Copepods-- Labidocera sp., Oithona sp. & Euterpinna sp	Coscinodiscus sp.
34	17.3.1967	1135	---	3	---	Copepod nauplii and Copepods---Oithona sp.	Mt nusae, Chaetognaths and Decapod larvae
35	17.3.1967	1335	---	1.5	Sand particles and Organic debris	Copepods Microsetella sp. and Fish larvae	Copepod nauplii
36	18.3.1967	1530	---	5	Coscinodiscus sp. Copepods --Paracalanus sp. Oithona sp. Euterpinna sp. and Copepod nauplii	Cirripede larvae and Copepods--Oithona sp.	Fish larvae
37	18.3.1967	1530	---	2	Coscinodiscus sp. Polychaete	---	---
38	19.3.1967	1115	---	1	Phytoplankton--mostly Coscinodiscus sp. Copepods--Paracalanus sp. and Oithona sp. Copepod nauplii	Copepod nauplii	Siphonophores, Copepods--Paracalanus sp. Oithona sp. Euterpinna sp. and Oikopleura sp
39	19.3.1967	1630	---	1	---	Copepods--Paracalanus sp. Oithona sp. Microsetella sp. Euterpinna sp. and Corycaeus sp., Euphausiids, Fish eggs	Medusae and Cirripede nauplii

ting and mud patches were observed. Secchi disk disappeared as soon as it was lowered in the water suggesting a very high turbid water mass. The Plankton net collected a large amount of mud particles in the interior of the gulf and many times the net was clogged.

Plankton

Table 2 gives details of wet volume of the plankton and the major groups of planktonic forms observed. These are classified into 3 categories: predominant, frequent and few. It can be observed from the table that the stations nearer the mouth of the gulf contained higher representation of planktonic forms than those of the interior of the gulf. Phytoplankton, mainly diatoms were present in large numbers with chaetognaths and copepods occurring more frequently. At station No. 32 a large number of fish larvae were observed. Relatively large number of chaetognaths were collected between 8th April, 1966 to 17th April, 1966. *Sagitta neglecta* is the most abundant species. The other species occurring are *S. bombayensis*, *S. pulchra* and *S. robusta*.

Benthos

Several grab and snapper samples were collected for the study of both micro and macro bottom fauna. Analysis of these samples revealed that Foraminifera form the major constituent of the bottom fauna in this area. About 85 species belonging to 34 genera and fifteen families viz Astrorhizidae, Textulariidae, Valvulinidae, Miliolidae, Ophthalmidiidae, Trochamminidae, Lagenidae, Nonionidae, Camerinidae, Peneroplidae, Buliminidae, Rotaliidae, Globigerinidae, Globorotaliidae, and Anomalinidae have been collected and reported. Foraminiferal species (1)

Quinqueloculina candeiana d'Orbigny, (2) *Spiroloculina antillarum* d'Orbigny *aequa* Cushman, (3) *Sp. depressa* var. *rotundata* Williamson, (4) *Biloculina lucernula* Schwager, (5) *Nonion depressula* (Walker and Jacob), (6) *Bolivina nitida* Brady, (7) *Bolivina aenariensis* (Costa), (8) *Rotalia venusta* Brady, (9) *Pulvinulina concamerata* (Montagu) (10) *Lamarckina scabra* (Brady), (11) *Anomalina coronata* Parker and Jones have been reported for the first time from the Indian coasts. The abundance of Foraminifera appears to be related to the type of bottom deposits. The muddy sand deposits have greater concentration of Foraminifera than the sandy mud or muddy deposits. It has been observed that muddy sediments are very poor in concentration of Foraminifera.

Similarly the size of foraminiferal tests has shown a definite relationship with the texture of the deposits. When the deposits consist of coarser particles, larger foraminiferal tests were present whereas in the presence of finer particulate size, the Foraminifera were smaller in size.

It can be concluded that the foraminiferal ensemble in the Gulf of Cambay is typical of shallow tropical warm waters of Indo Pacific region. All the grab and snapper samples have shown almost total absence of macrofauna such as annelids, lamellibranches and gastropods etc. Only two specimens of shrimp were once collected from the bottom. The total absence of macrofauna in this area is perhaps due to very high turbidity and strong currents prevailing in the region.

Bottom Sediments

The sediments in the Gulf of Cambay are mainly composed of mud with mixed sand. In the interior of the gulf

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the floor is composed of mud or sandy mud whereas at the stations towards the mouth, the sand fraction progressively increases with the lowering of mud fraction.

Summary

A hydrographic and biological survey was carried out in the Gulf of Cambay during April, 1966. March, 1967 and February, 1969. Hydrographical parameters investigated were salinity and temperature. The stations nearer the mouths of the rivers have shown estuarine conditions whereas the stations located at the mouth of the gulf show a clear influence of the open sea during the periods of investigations. The gulf waters are highly turbid because of the

presence of large quantities of mud brought down by the major rivers — Narbada and Tapti. The plankton is rich towards the mouth of the gulf and very poor in the interior region. A study of benthos of the gulf revealed almost total absence of macrofauna. The microfauna is mainly represented by Foraminifera.

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