

Assessment of biological characteristics on coastal environment of Murud (Maharashtra) during the oil spill (17 May 1993)

S N Gajbhiye, S Mustafa, Pratik Mehta & Vijayalakshmi R Nair
National Institute of Oceanography, Regional Centre, Versova, Bombay-400 061, India

Received 6 October 1994, revised 12 June 1995

A rupture of a feeder riser pipeline resulted in spillage of crude oil estimated to be 3000-8000 tonnes in Bombay High region on 17 May 1993. The treated spill broken down into several patches and drifted south and finally got deposited on the Murud shores and in the Rajpuri creek. The impact of the spill on biota was studied during 27-30 May 1993. Local abnormal concentrations of dissolved dispersed petroleum hydrocarbons (PHC) in the water column exposed pelagic biota to high levels of oil residues. Levels of chlorophyll-*a* and phaeophytin varied widely and were unevenly distributed. Few phytoplankton species like *Nitzschia* sp. were damaged with a coating of black layer of PHC, around the cell. Zooplankton in general were not severely affected though damage restricted to a few species of copepods, *Lucifer*, *Sagitta bedoti* and *S. enflata* showing oily coating on body surfaces or ingestion of PHC into the body leading to death in extreme cases. Drastic reduction in population density of chaetognaths was observed. As the PHC had not sedimented, no adverse impact on macro benthos was evident. Also, there was no evidence of damage to the fish and other marine life. Monitoring of the same area in May 1994 showed normal water quality and biological characteristics indicating the complete recovery of the marine environment off Murud.

The major spills of crude oil and petroleum products occur during their transport by oil tankers, loading and unloading operation, blowouts etc. It has been estimated¹ that approximately 5 million tonnes of oil enters the Arabian Sea each year. In the marine environment the spilled oil goes through a variety of transformations involving physical, chemical and biological processes. Surface oil and tar accumulations and distributions along Indian beaches have been described by Gupta *et al.*² Accordingly, oil slicks are very common in the northern Indian Ocean, mostly from shipping. Although there are a few reports²⁻¹² on oil pollution along the coastal waters of India, nothing is known about the immediate impact of the spill on marine ecosystem. In view of this aspect a case study was undertaken during oil spill off Bombay on 17 May 1993. Observations on the possible impact of the spill on phytoplankton, zooplankton, benthos and fishery form the basis of this communication.

Background of spill

A rupture of a feeder 'riser pipeline' from Bombay High North platform (BHN) resulted in the spilling of 3000-6000 tonnes of crude oil into the sea on 17 May 1993 about 165 km from the shoreline north of Bombay (Fig. 1). Later due to prevailing environ-

mental conditions and use of dispersants, the spill dispersed down into several patches of varying sizes and scattered in the region. Aerial survey conducted on 23 May 1993 indicated large number of brownish patches of degraded crude scattered throughout the Bombay High region¹³. In addition large dark grey patch was sighted drifting in the southerly direction at

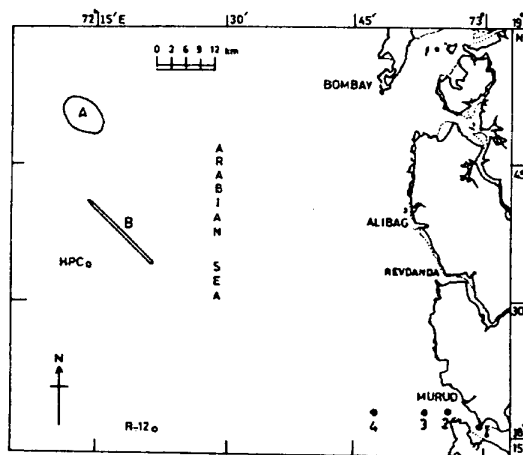


Fig. 1—Position of oil spill in Bombay High along with location of stations off Murud. (A—location of spill on 17 May 1993, B—oil patch noticed on 23 May 1993)

135°. The size of the patch was roughly to be about 20 × 1 km. Although it was late May, premonsoon conditions of strong wind and rough sea were yet to be set. Based on the prevailing mean wind speed of 20 km.h⁻¹, it was anticipated that the floating oil would reach the Konkan coast within 3 to 5 days and the shores of Murud was considered as the most likely landfall location.

As expected several patches of floating PHC were noticed on the sea surface up to 15 km from the shoreline of Murud on 28 May 1993. The whole area was also strewn with tarry lumps of varying sizes. The oil patches entered Rajpuri creek on 29 May 1993 and eventually oiled the shores and some mangroves. The fish landing jetty and open spaces often used for sorting of fish, were covered with petroleum hydrocarbon (PHC). Any impact assessment due to contaminant need to be compared with baseline data. The coastal waters of Murud were regularly monitored¹⁴⁻¹⁶ since 1989. These data were used for comparison and prediction of impact.

Materials and Methods

Sampling at Murud coast was done between 27 and 30 May 1993 at four stations (Fig. 1) which are comparable to those for which baseline data are available. Niskin sampler was used to collect water samples from a desired depth for estimation of phytoplankton pigment and cell counts. Oblique hauls for zooplankton were made using a Heron Tranter net (mesh size 0.33 mm, mouth area 0.25 m²) with an attached calibrated TSK flow meter. Sediment samples were collected using a van-Veen grab of 0.04 m² area. Estimation of phytoplankton pigments, cell counts, zooplankton biomass and population, benthic biomass and population were carried out following standard procedures¹².

Results and Discussion

The baseline water quality parameters observed during 1989-93 for the premonsoon (April-May) period¹³⁻¹⁶ are given in Tables 1 and 2. It is evident that the coastal waters including the creeks and bays around Murud were largely free from any environmental stress in the absence of industrialisation and urbanisation and the variabilities are natural occurrences inherent in nearshore water bodies.

Sample collected on 27 May 1993, was relatively clean and there was no evidence of high concentration of PHC in the water column¹³ (Table 3). Several patches of floating PHC were however noticed on the sea surface up to 15 km from the shoreline on 28 May 1993. Consequently, the PHC in the water column varied widely and levels up to 3348 µg.l⁻¹ were

Table 1—Baseline water quality at Murud (1990-1992) (Values are range and average in parentheses) (Data from reference number 14-16)

Parameters	St. 1	St. 2	St. 3	St. 4
Temp (°C)	25.2-30.2 (26.2)	25.0-30.0 (27.7)	25.7-29.8 (27.6)	25.3-29.1 (27.2)
Sal. (× 10 ⁻³)	36.1-36.8 (36.4)	35.6-36.1 (35.9)	35.2-36.2 (35.5)	35.1 (35.1)
pH	7.6-8.1 (7.8)	7.8-8.1 (7.9)	7.9-8.2 (8.0)	7.9-8.3 (8.1)
Susp solids (ml.l ⁻¹)	76-193 (135)	36-112 (77)	17-69 (53)	18-19 (19)
DO (ml.l ⁻¹)	4.2-4.5 (4.4)	3.5-4.6 (4.0)	4.1-4.4 (4.2)	3.8-4.6 (4.2)
BOD (mg.l ⁻¹)	1.0-3.0 (1.8)	0.5-2.2 (1.2)	1.0-2.0 (1.5)	1.0-1.2 (1.1)
NO ₃ ⁻ -N (µg.l ⁻¹)	24-238 (180)	59-328 (193)	35-280 (146)	17-91 (54)
NO ₂ ⁻ -N (µg.l ⁻¹)	7-17 (14)	6-13 (10)	2-15 (6)	1-13 (7)
NH ₄ ⁺ -N (µg.l ⁻¹)	7-17 (13)	6-36 (17)	2-13 (6)	1-2 (1)
PO ₄ ⁻³ -P (µg.l ⁻¹)	45-72 (61)	42-82 (46)	11-64 (45)	8-12 (10)
PHC (µg.l ⁻¹)	0.9-3.9 (2.7)	0.4-0.8 (0.6)	0.6-2.0 (1.4)	ND-0.3 (0.2)

Table 2—Baseline biological characteristics at Murud (1990-1992) (Values given are range and averages in parentheses) (Data from reference numbers 14-16)

Parameters	St. 1	St. 2	St. 3	St. 4
Chlorophyll- <i>a</i> (mg.m ⁻³)	0.9-13.4 (5.0)	0.9-11.2 (3.1)	0.5-3.7 (1.8)	1.1-2.1 (1.6)
Phaeophytin (mg.m ⁻³)	0.7-8.1 (2.5)	0.1-1.8 (0.7)	0.2-2.1 (0.9)	0.4-1.7 (0.9)
Zooplankton biomass [ml.(100 m ³)] ⁻¹	1.4-30.7 (9.6)	1.5-35.7 (7.8)	0.5-25.5 (8.7)	3.5-120.3 (48.0)
Zooplankton population [no. × 10 ³ . (100 m ³)] ⁻¹	1.6-150.7 (27.1)	6.3-25.1 (8.9)	3.4-102.2 (40.2)	4.0-55.3 (30.0)
Zooplankton total groups (no.)	9-17 (13)	9-17 (13)	12-19 (15)	16-20 (18)
Macrobenthos biomass (g.m ⁻² , wet wt)	9.8-52.9 (26.4)	0.9-3.1 (1.6)	0.5-4.2 (2.1)	3-24.4 (13.7)
Population (no.m ⁻²)	1715-4252 (2814)	713-1113 (943)	1526-6076 (3105)	3383-4829 (4106)
Total groups (no.)	4-7 (6)	2-6 (4)	3-6 (4)	6-9 (8)
Fishes (catch.h ⁻¹)	—	22.9-29.6 (26.3)	16.5-33.7 (25.1)	14.7-37.5 (26.1)
Total species of fishes (no.)	—	26-29 (28)	13-25 (19)	21-22 (22)

Table 3—Water quality of Murud during May 1993
(Source reference no. 13)

Date	St. no.	Time (hrs)	Sampling level	Temp (°C)		pH	DO (ml.l ⁻¹)	BOD (mg.l ⁻¹) (× 10 ⁻³)	Sal.	Nutrients ((µg.l ⁻¹)				PHC*
				Air	Water					PO ₄ ³⁻ -P	NO ₂ ⁻ -N	NO ₃ ⁻ -N	NH ₄ ⁺ -N	
27 May	1	1900	S	33.1	32.5	8.1	4.8	—	35.7	24	4	60	5	0.5
	2	1730	S	32.8	32.2	8.0	4.9	—	35.0	27	5	46	7	0.6
28 May	2	1630	S	32.5	33.0	8.4	1.8	0.3	35.9	18	2	42	1	6.4
			B	33.0	8.3	1.4	1.4	35.9	52	10	86	4		
	3	1315	S	32.5	31.2	8.4	4.7	5.2	36.4	7	1	7	3	14.0
			B	31.5	8.5	4.6	3.4	35.0	19	2	14	2		
4	1430	S	34.0	32.5	8.3	2.3	0.8	36.2	15	3	20	1	10.5	
		B	32.5	8.3	2.2	0.1	36.0	16	6	53	ND			
29 May	1	1445	S	32.5	33.1	8.1	3.9	—	35.7	35	14	50	2	197
			B	33.3	8.2	3.9	—	35.5	34	13	37	7		
	2	1400	S	32.6	33.0	8.0	4.3	4.2	35.7	17	3	50	3	64.2
			B	33.0	7.9	4.6	6.0	35.7	42	11	78	5		
	3	1300	S	32.5	39.0	8.4	4.9	4.9	35.7	42	3	44	5	3348
			B	33.2	8.3	4.3	—	35.7	41	6	61	4		
4	—	—	—	—	—	—	—	—	—	—	—	—	—	
30 May	1	1000	S	32.0	32.0	8.1	3.9	—	35.7	39	9	59	3	84.2
			B	32.1	8.1	4.5	—	35.7	37	13	47	5		

S — surface; B — bottom

*Sample for PHC collected at 1 m below the sea surface.

observed. Sampling from PHC in the water column was undertaken at 1 m depth from the surface as per UNESCO procedure¹⁷. The advantage of sampling below the water surface is that the results are not adversely biased due to patchiness of water insoluble PHC floating on the surface. The decrease in DO to 1.4 ml.l⁻¹ at some locations and its high variability was associated with the enhanced level of PHC in the water column. The water quality however improved on the following day (29 May 1993) at a few stations and the patches moved to nearshore areas.

Although PHC had entered the creek, the mangrove areas were not seriously affected, though the oyster beds at the entrance of Rajpuri creek were coated with PHC in patches. The bottom sediment data indicates that floating PHC had not settled on the bottom when the collections were made¹³.

Prevailing biological characteristics of the coastal zone off Murud were evaluated based on the qualitative and quantitative data on organisms representing different trophic levels including phytoplankton, zooplankton, benthos, fishery, intertidal fauna, mangroves etc. Capuzzo¹⁸ reported that the biological effects of PHC on marine organisms are a function of factors like persistence and bioavailability of the hydrocarbons, ability of the organisms to accumulate and metabolize them and the amount of contaminants interfering with normal metabolism.

The levels of chl-*a* varied from 0.5 to 5.3 mg.m⁻³ during 27-30 May and this fell within the range of the baseline (Table 4). Values of chl-*a* were relatively low on 29 May the day of high contamination by PHC. A petroleum spill can cause immediate adverse impact on phytoplankton by retarding photosynthesis.

Phaeophytin also varied widely and was unevenly distributed. The concentration frequently exceeded that of chl-*a* indicating environmental stress, perhaps also due to PHC contamination. On an average at st. 2 there was reduction in phytoplankton cell counts and levels of chl-*a* with enhancement in the levels of phaeophytin. However, species diversity remained the same (Table 4).

Sixtyseven species of phytoplankton belonging to 5 classes are identified from the collections. In the order of dominance, Bacillariophyceae was followed by Cyanophyceae, Dinophyceae, Chlorophyceae and Euglenophyceae. The cell counts varied widely between 7.7 and 280 × 10³.l⁻¹. Cells count was generally high in the surface water. Highest cell count was recorded at st. 3 on 29 May when the diatoms *Ditylum brightwelli* and *Asterionella japonica* were predominant. Diatoms dominated the phytoplankton community and were represented mainly by *Nitzschia* sp., *N. pungens*, *Navicula* sp. and *Rhizosolenia* sp. Phytoplankton species diversity was generally higher at sts 2 and 3 as compared to st. 1. Phytoplanktons are sensitive to oil spill and it varies

Table 4—Distribution of phytoplankton pigments and population off Murud
(Values in parentheses indicate mean values)

St. no.	Date	Chl- <i>a</i> (mg.m ⁻³)	Phaeophytin (mg.m ⁻³)	Phytoplankton (no. × 10 ³) ⁻¹	Total species (no.)	Major species	Tainted species
1	27.5.93 (Before spill) (Normal)	3.7	1.5	68	6	<i>Nitzschia</i> sp., <i>Rhizosolenia</i> sp., <i>Pleurosigma</i> sp.	
1	29.5.93 30.5.93 (After spill)	2.1-3.2 (2.7)	ND-5.6 (2.9)	8-80 (35)	9-18 (4)	<i>Nitzschia</i> sp., <i>N. pungens</i> , <i>Skeletonema costatum</i> , <i>Rhizosolenia</i> sp., <i>Pleurosigma</i> sp., <i>Coscinodiscus</i> sp., <i>Thalassiosira</i> sp., <i>Oscillatoria</i> sp.	<i>Nitzschia</i> sp., <i>Nitzschia closterium</i> , <i>Pleurosigma</i> sp., <i>Rhizosolenia</i> sp. and <i>Ditylum brightwelli</i>
2	27.5.93 28.5.93 (Before spill)	0.5-2.1 (1.8)	1.1-2.3 (1.8)	190-196 (193)	22-23 (23)	<i>Nitzschia</i> sp., <i>Navicula</i> sp., <i>Nitzschia pungens</i> , <i>Thalassiosira decipiens</i> , <i>Chaetoceros</i> sp.	—
2	29.5.93 30.5.93 (After spill)	0.5-2.7 (1.4)	ND-6.3 (4.1)	65-152 (108.5)	22-25 (23)	<i>Nitzschia</i> sp., <i>N. pungens</i> , <i>Rhizosolenia</i> sp., <i>R. stouterfoitii</i> , <i>R. setigera</i> , <i>Coscinodiscus</i> sp., <i>Chaetoceros</i> sp., <i>Thalassionema nitzschoides</i> , <i>Navicula</i> sp.	<i>Nitzschia</i> sp.
3	28.5.93 29.5.93 (During & after spill)	1.0-5.3 (2.3)	ND-1.2 (1.0)	14-280 (87.3)	15-42 (24)	<i>Nitzschia</i> sp., <i>N. pungens</i> , <i>Trichodesmium</i> sp., <i>Ditylum brightwelli</i> , <i>Rhizosolenia</i> sp., <i>R. setigera</i> , <i>Thalassionema nitzschoides</i> , <i>Chaetoceros</i> sp., <i>Asterionella japonica</i>	<i>Ditylum brightwelli</i> , <i>Trichodesmium</i> sp., <i>Rhizosolenia</i> sp., <i>Surirella</i> sp., <i>Chaetoceros</i> sp., <i>Nitzschia closterium</i> , <i>Biddulphia sinensis</i>
4	28.5.93	3.7	—	6.4	21	<i>Nitzschia</i> sp., <i>N. pungens</i> , <i>Trichodesmium</i> sp., <i>Synedra</i> sp., <i>Coscinodiscus</i> sp.	

among major groups and sometimes within species. Green algae are more sensitive to hydrocarbons than diatoms, blue-green algae and flagellates¹⁹. A few species particularly *Nitzschia* sp. were damaged with a coating of black layer presumably of PHC, around the cell. Some species of *Ditylum brightwelli*, *Trichodesmium* sp., *Rhizosolenia* sp., *Surirella* sp., *Chaetoceros* sp., *Nitzschia closterium* and *Biddulphia sinensis* from collections at st. 3 were also in damaged condition (Table 5). The maximum damage to phytoplankton cells was noticed at sts 2 and 3. As per available reports damage to plants can occur during acute phases of spills. Such effects have been recorded for phytoplankton¹⁹ and attached algae²⁰.

It is unlikely that weathered oil residue from a small spill like the one under discussion in the open ocean will cause any measurable and long-term damage to phytoplankton. It is expected that whatever marginal

damage caused by the impact, will be quickly ephemeral.

The observed zooplankton biomass, total population, total groups and faunal composition agreed well with the baseline (Table 2, 5). The highest biomass recorded at st. 1 was due to the predominance of *Lucifer* (27.2%), mysids (8.6%) and ctenophores (3.4%). The average zooplankton biomass drastically decreased from st. 1 to 4 and the respective values were 38.2, 8.4, 5.6 and 4.7 ml (100 m³)⁻¹. At st. 1 observed reduction in zooplankton standing stock just after the spill was by a factor of 2.5 while at st. 2 the reduction was to the extent of 2.3 times. The total population at st. 1 which was maximum among all the stations was represented by 11 groups. The most dominant group was copepods (41.9%). The minimum population which was observed at st. 2 also consisted of 11 groups with the dominance of copepods (48.7%) followed by *Lucifer*, (21.9%),

Table 5—Distribution of zooplankton and macrobenthos off Murud
(Values in parentheses indicate mean values)

St. no.	Date	Zooplankton (biomass) ml.(100 m ³) ⁻¹	Zooplankton (population) [no. × 10 ³ (100 m ³) ⁻¹]	Total groups (no.)	Benthic biomass (mg.m ⁻²) wet wt	Benthic population (no. m ⁻²)	Total groups (no.)	Remarks
1	27.5.93 (Before spill)	52.9	41.7	11	—	—	—	Normal
	29.5.93	4.2-14.4 (33.3)	14.2-52.9 (30.3)	10-11 (11)	—	—	—	Swarming of ctenophores
	30.5.93 (After spill)							
2	27.5.93 (Before spill)	6.9	31.5	16	—	—	—	Normal
	28.5.93	2.9-17.5	7.3-46.7	10-11	19.2	5600	4	Damaged chaetognaths, copepods and <i>Lucifer</i> sp. with black residue in gut
	29.5.93	(8.8)	(30.0)	(11)				
	30.5.93 (During and after spill)							
3	28.5.93	4.2-6.9	33.1-38.4	9-10	3.7	10600	6	Damaged chaetognaths, <i>Lucifer</i> sp. and <i>Acetes</i> sp. with black residue
	29.5.93 (During and after spill)	(5.6)	(35.8)	(9)				
4	28.5.93 (During spill)	4.7	48.1	9	11.3	11475	7	Damaged chaetognaths, <i>Lucifer</i> sp., fish larvae with oil residue

gastropods (14.6%) and decapods (9.7%). Invariably copepods dominated contributing over 70% of the total population. Copepods were followed by *Lucifer* sp. (6.2%), decapods (5.9%), ctenophores (2.6%) and chaetognaths (1.5%). The other groups present in the collection were siphonophores, medusae, fish eggs, lamellibranchiata, mysids, gastropods, polychaetes, isopods, *Acetes* sp, appendicularians, stomatopod larvae and cephalopods.

The faunal diversity varied between 9 to 16 with the highest diversity 16 at st. 2 on 27 May before the oil spill reached Murud. Microscopic examination of zooplankton revealed black residue presumably of PHC in gut of some species of copepods and chaetognaths. However, PHC was noticed in the gut of *L. pectinata*, *Canthocalanus pauper* and *Acartia* sp.

Chaetognaths are very sensitive to pollution impact²¹ and a detailed analysis of the group confirmed this assumption. Two species namely *S. bedoti* and *S. enflata* were found in the collections. *S. bedoti* dominated the area. *S. enflata* being an oceanic species was more abundant towards

offshore. Before the spill chaetognaths were fairly abundant in the area. The adverse effect was observed from 28 May onwards. The total population of chaetognaths suddenly decreased by a factor of 3 and 4.9 times respectively at sts 1 and 2 (Table 6). The species *S. enflata* almost disappeared from sts 1 and 2. The effect on the organism was at varying degree and 5.56% of the chaetognaths were observed in damaged conditions. Some were tainted with oil giving a brownish colour and others with oil within the digestive track. Some of them were shrunk and others were flattened. At sts 1 and 2 the effect was marginal and it increased towards sts 3 and 4. Maximum damage to the extent of 56% was seen at st. 3. Laboratory studies on plankton species demonstrate that water soluble extracts of oils can kill planktonic organisms²² especially those which primarily occupy surface waters due to immediate exposure to lethal concentrations. Parker²³ also demonstrated the presence of oil in the guts of copepods and barnacle larvae.

Subtidal macrofaunal standing stock in terms of biomass varied widely from 0.1 to 52.9 mg.m⁻² (wet wt), and population 713-11500.m⁻². The earlier

Table 6—Details of chaetognaths obtained from different stations off Murud

Date	Total population (no. (100 m ³) ⁻¹)	Percentage of total zooplankton population	<i>Sagitta bedoti</i> (%)	<i>Sagitta enflata</i> (%)
Station 1				
27.5.93	1346	3.2	98	2
29.5.93	450	1.96	99	1
30.5.93	120	0.23	100	—
30.5.93	296	2.08	100	—
Station 2				
27.5.93	1497	4.76	98	2
28.5.93	307	1.56	100	—
29.5.93	672	1.4	100	—
30.5.93	71	0.97	100	—
Station 3				
28.5.93	121	0.32	73	27
29.5.93	6	0.1	100	—
Station 4				
28.5.93	344	0.72	95.6	4.4

studies¹²⁻¹⁴ indicated average macrofaunal biomass and population at sts 1, 2, 3 and 4 as 26.4, 1.3, 1.7 and 9.5 mg.m⁻² and 2810, 776, 2620 and 3330.m⁻² respectively. Maximum faunal groups (av. 8) was observed at st. 4 whereas lowest (av. 3) was recorded at st. 3. Thus, the earlier studies (Table 2) showed higher biomass and population density at sts 1 and 4 respectively.

During the present investigation it was observed that faunal group diversity and composition were comparable to the baseline¹⁴⁻¹⁶, within the general variability inherent in the distribution of benthos. The higher benthic biomass (3 to 7 times more) and numerical abundance (2 to 15 times more) observed during the present study could probably be due to seasonal variability in the faunal abundance. These studies did not reveal any gross adverse impact on benthic organisms. This was expected since the collections were made during the period when PHC was floating/dispersed in the water column and had not deposited on the sediment.

A large number of dead organisms (5 to 9.m⁻²) belonging to *Propita* sp. were washed ashore and strewn on the beach along with oil residue.

The intertidal fauna could not be studied as the shores were heavily contaminated by PHC on 28 May. Moreover baseline for intertidal fauna is not available for comparison. The team had opportunity to visit affected spots. The physical verification revealed that the intertidal area was under the heavy deposition of PHC on the shores and subsequent percolation in the sediment.

Most of the intertidal region has a rocky and sandy shore. It is expected that the intertidal fauna will be severely affected. Reports^{24,25} on such area indicate that intertidal fauna of heavily oiled shores will be severely damaged, leading to changes in species composition and recovery is often slow. Also, considerable additional damage was incurred during clean-up. It is necessary that long-term studies of recovery of intertidal fauna of sandy beaches and rocky shores should be undertaken forthwith. In this respect the study of commercially important oyster populations at the mouth of Rajpuri creek will be significant.

The trawl catch of commercially operating fishing trawler was examined on 28 May. There was neither any evidence of oil coating to the fish caught nor there were tar lumps, in the catch. On the impact of fishery, Baker²⁶ reported that there is no evidence so far that any oil spill has significantly affected adult fish populations in the open sea. The catch rate was 65 kg.h⁻¹. The haul examined showed 11 species of fishes and 4 species of prawns, the catch composition was comparable to the earlier data¹⁴⁻¹⁶. The most common species were *Coilia dussumieri*, *Johmiu glaucus*, *Thryssa mystax*, *Lepturacanthus savala* *Parapenaeopsis stylifera* and *Metapenaeus affinis*.

The present observations are based on a restricted field observations and pertain to the environmental conditions prevailing during an oil spill and hence should be considered indicative of gross trend of probable damage to ecology due to immediate impact. In general, the immediate impact was on plankton which showed some damage to the sensitive species of phytoplankton and zooplankton by rupturing, coating cells and killing and tainting species like *Lucifer* and *Sagitta*. The effect can be rated as marginal. As noticed in oil spills such damages are only transient and normal populations are restored quickly as plankton in general have high replacement capacity. Subsequent study of May 1994 for the Murud coastal water indicated normal distribution of phytoplankton, zooplankton, benthos and fishery suggesting recovery of the ecosystem.

Acknowledgement

Authors are grateful to Director and Dr M D Zingde, Scientist-in-Charge, RC of NIO, Bombay for encouragement. Thanks are also due to Mr A V Mandalia and Mr P Sharma for technical help.

References

- Hinrichsen D. *Our common seas. Coasts in crisis.* (Earthscan Publications, London) 1990, pp.184.

- 2 Gupta R S, Naik S & Varadachari V V R, in *SCOPE 38. Ecotoxicology and climate*, edited by P Bourdeau *et al.* (John Wiley, Chichester) 1989, 235.
- 3 Nair S A, Devassy V P, Dwivedi S N & Selvakumar R A, *Curr Sci.* 41 (1972) 766.
- 4 Dwivedi S N & Parulekar A H, in *Proc Symp and workshop on marine pollution monitoring*, edited by R C Junghans, (National Bureau of Standards, Gaithersburg, USA) 1974, 101.
- 5 Dwivedi S N, Parulekar A H & Devassy V P, *3rd International Ocean Development Conference*, August 5-8, 1975 Tokyo, Japan (1975).
- 6 Dwivedi S N, Desai B N, Parulekar A H, Josanto V & George M D, *Mahasagar - Bull Natn Inst Oceanogr.* 7 (1974) 91.
- 7 Unnithan R V, Gore P S, Ravindaran O, Venugopal P, Sarla Devi K & Remani K N, *Indian J Mar Sci.* 10 (1981) 371.
- 8 Kadam A N & Zingde M D, *Mahasagar - Bull Natn Inst Oceanogr.* 18 (1985) 511.
- 9 Sen Gupta R, Qasim S Z, Fondecak S P & Topgi R S, *Mar Poll Bull.* 11 (1980) 65.
- 10 Sood V J & Raju G R K, in *Seminar on marine pollution prevention, control and response*, International Maritime Organisation, Bombay, Oct 8-13, 1984.
- 11 Qasim S Z, *J Inst Mar Technol.* 19 (1975) 5.
- 12 Rokade M A, Kadam A N, Bhosle N B & Zingde M D, *Indian J Mar Sci.* 15 (1986) 250.
- 13 Anon, *A report on assessment of oil spill of 17th May, 1993 on coastal environment of Murud*, (National Institute of Oceanography, Regional Centre, Bombay) 1993, pp.29.
- 14 Anon, *A report on marine environmental studies: Environmental quality along the north-west coast of India*, (National Institute of Oceanography, Regional Centre, Bombay) 1990, pp.135.
- 15 Anon, *A report on marine environmental studies: Environmental quality along the north-west coast of India*, (National Institute of Oceanography, Regional Centre, Bombay) 1991, pp.139.
- 16 Anon, *A report on marine environmental studies: Environmental quality along the north-west coast of India*, (National Institute of Oceanography, Regional Centre, Bombay) 1992, pp.101.
- 17 UNESCO, *Manual for monitoring oil and dissolved/dispersed petroleum hydrocarbons in marine waters and on beaches*, Manual and Guides, No.13 (IOC-UNESCO, Paris) 1987, pp.35.
- 18 Capuzzo J M, in *Long-term environmental effects of offshore oil and gas development*, edited by D Boesch & N Rabalais, (Elsevier Applied Science, London) 1987, 343.
- 19 Mironov O G, in *Proc. FAO conference on marine pollution and its effect on living resources and fish*, (FAO, Rome) 1970, E-92.
- 20 North W J, Neushul M & Clentening K A, in *Pollution marines par les produits petroliers*, Symposium de Monaco, (1969) 335.
- 21 Nair V R, Gajbhiye S N & Desai B N, *Indian J Mar Sci.* 20 (1991) 43.
- 22 Davenport J, *Phil Trans R Soc Lond B*, 297 (1982) 369.
- 23 Parker C A, *AMI Report*, (1970) B 198 CMS.
- 24 Baker J M, in *Proc. joint conference on prevention and control of oil spills*, (American Petroleum Institute, Washington, DC) 1973, 715.
- 25 Bacu B J, Landford T E & Gundlach E R, in *Proceedings 1987 international oil spill conference*, (American Petroleum Institute, Washington, DC) 1987, 459.
- 26 Baker J M, *Oikos*, 22 (1971) 106.