

OIL POLLUTION OF GOA BEACHES, INDIA.

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ABSTRACT

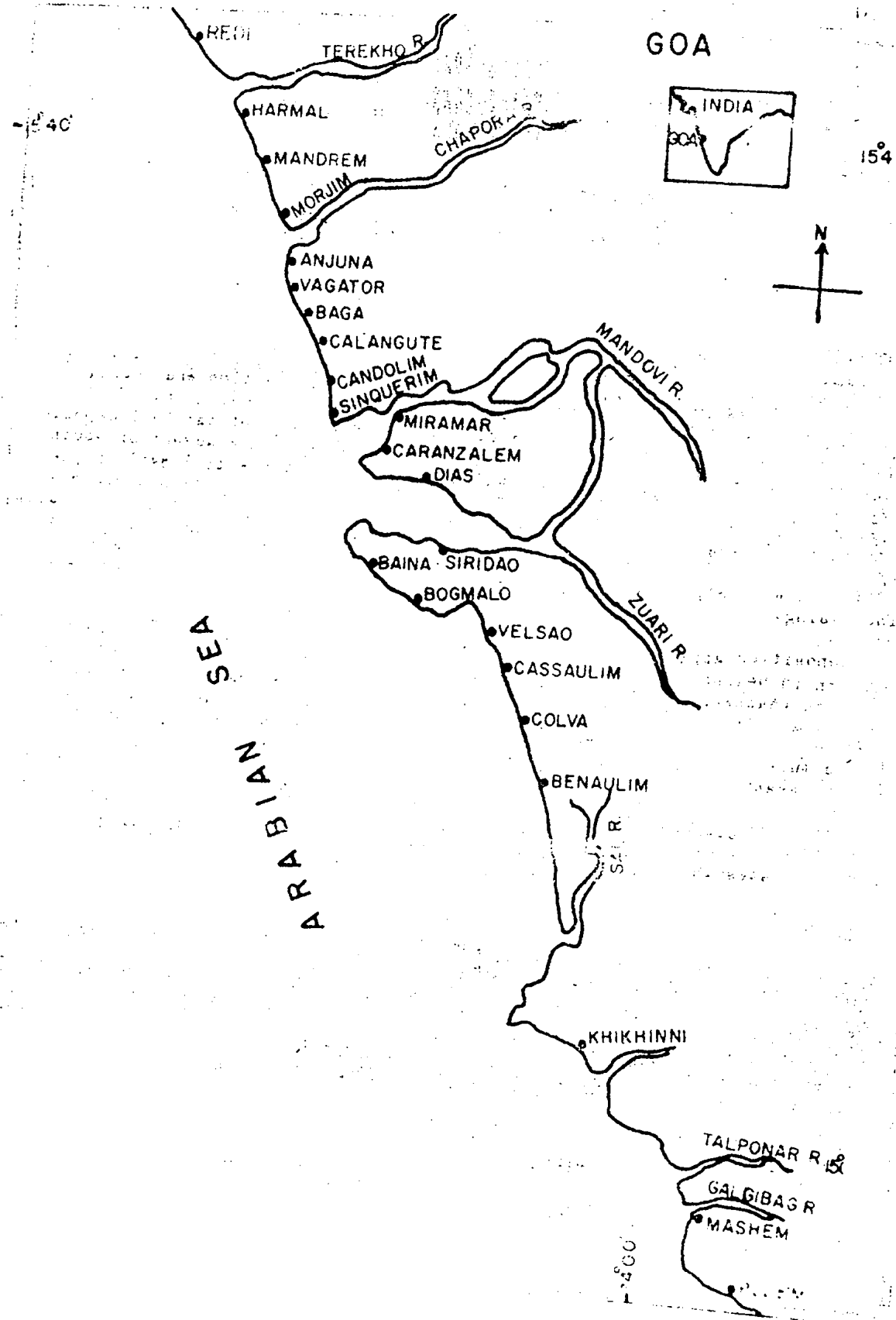
The coast of the Union Territory of Goa located between Lat. $15^{\circ}47'$ and Lat. $14^{\circ}55'$ is about one hundred km. long. Recreational activities and coastal population are simultaneously increasing this results in pollution. The oil pollution was noticed in 1970. The oil pollution in form of tar ball deposition is a seasonal phenomenon and starts every year with the advent of south west monsoon. Earliest deposit occur in April and continue till early September. The process of fresh oil deposition at different tide levels was observed during the years 1972, 1973 and 1974. The deposition of fresh tar balls varied at different tide levels and also from year to year. The mean deposition for the period 1972 - 74 at HTL, MTL and LTL was 190.29, 100.12 and 25.13 g/m², respectively. The studies show that the tar balls deposition had been increasing.

The deposition appears to be influenced by topography of shore and current pattern in nearshore areas. Tar ball deposition is generally high along the open sea beaches with steep gradient, and maximum concentration occurs at high tide mark. The estuaries influence the pattern of tar ball deposition near their embouchures. The presence of tar balls along with plastic beads, polychaete tubes, empty pteropod shells also indicate that with the approach of the monsoon season, the material normally found at the sea bottom is stirred up and washed ashore. It is also evident that before reaching the coast oil undergoes various stages of degradation. It is necessary to undertake base line studies and suggest suitable preventive measures for regulating discharge of oil and oil wastes in the coastal areas.

INTRODUCTION

The oil pollution is an increasing phenomenon, its effects are beginning to be seen in the developing countries also. In India oil pollution was first observed in 1970 and from 1972 a detailed study has been undertaken to determine the areas of pollution and other related aspects. The work was started along the West Coast from Saurashtra in north to Kerala in south. The oil pollution is seen along the beaches in the form of accumulation of oil wastes and deposition of tar balls (Dwivedi and Parulekar, 1974). In the present communication

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deposition of tar balls, seasonal variation and distribution at different tide levels has been studied along the Goa coast.

The coastline of the Union Territory of Goa, is approximately 100 km. long and is situated between Lat. $15^{\circ}47'$ and Lat. $14^{\circ}55'$. This territory is undergoing rapid development and Vasco Harbour has become one of the major ore-handling ports along the West coast of India. The other related industries in this area are coastal shipping, fisheries and an agrochemical industry. The coastal population is also increasing and this results in larger discharge of domestic waste and sewage. The tourism is also being developed in this area, as a result, the coastal areas are receiving greater attention for recreation and protection of the environment.

Along the Goa coast oil pollution was observed during 1970 (Nair et al 1974). Fresh oil was seen at the supra-high tide level at Vagator. Subsequent investigations in the same areas showed the presence of oil patches and tar balls between tide levels. Later near the confluence of the river at Baga, tar balls as big as 3" in diameter were found. As a result regular investigation were undertaken along Goa beaches (Fig.1) from 1972 to 1974 and 24 different stations were studied. During 1972, 73, 74 respectively 15, 20 and 22 stations were observed. Care was taken that stations observed during earlier years were also repeated.

MATERIAL AND METHODS

A series of beaches were selected to cover representative sampling of the coast line of Goa. At each of these stations total beach expanse, beach gradient and particle size of sand was studied. At each beach three different transects were observed and all the tide levels were sampled. Samples were collected from 0.1 m^2 and the data from all these samples was pooled to calculate mean deposit in g/m^2 . At other beaches where tar ball deposition was sparse, it has been noted accordingly. The other material deposited along with the tar balls and the nearness of openings of estuaries and islands were also noted. Each beach was observed repeatedly during the same year to study the period of commencement, duration and intensity of tar ball deposition. The physico-chemical conditions (Reddy and Singhal, 1973) grain size, density and freshness of balls were also studied and a few samples were identified by the thin layer chromatography (Dwivedi et al, in press).

RESULTS AND DISCUSSION

The 24 beaches studied during a period of three years provide very good coverage of the coast line of Goa. Repeated observations at the same beaches and during different periods provide reasonably accurate data to determine the geographical area affected, season and magnitude of pollution due to washing ashore of tar balls. They also indicate areas where pollution does not occur or its magnitude and duration is negligible. The deposition of tar balls at different tide levels on a few selected beaches are shown in Table 1.

TABLE 1. TAR BALL DEPOSITION ALONG SOME BEACHES OF GOA AT VARIOUS TIDE LEVELS
(EHWS) - (HTL) - (MPL) and - (LTL)

Stations	Date	Deposition (gm/m ²)				Associations and remarks
		EHWS	HTL	MPL	LTL	
1	2	3	4	5	6	7
YEAR - 1972						
1. ANJUNA	25/7	-	33.6	5.1	-	-
2. BAGA	25/7	918.7	12.4	12.1	-	-
3. CALANGUTE	25/7	1547.0	40.8	8.0	1.3	-
YEAR - 1973						
1. ARAMBOL	31/5	93.3 (Random)	-	-	-	Stray, fresh soft lumps at supra litoral region only.
2. MANDREM	31/5	42.0	-	-	-	-
3. VAGATOR	31/5	-	143.0	-	-	-
4. BAGA	31/5	-	548.5	-	-	-
5. CALANGUTE	31/5	-	73.5	-	-	-
6. CAVELOSSIM	29/5	59.3	-	-	-	-
YEAR - 1974						
1. BOJMALO	16/5	-	-	-	-	Scattered fresh deposition in granular form. No association.
2. VELSÃO	16/5	-	-	-	-	-do-
3. COLVA	16/5	-	3.6	-	-	Fresh deposition with bigger granules mixed with sand.
4. BANULIM	16/5	-	2.4	-	-	-do-

1	2	3	4	5	6	7	
5. CARANZALEM	20/3 17/4 4/7	-	233.2 1361.0 225.6	8.8 -	-	-	Fresh deposition at high and mid tide levels, spherical balls of diameter 5 to 10 mm. Present throughout the beach.
6. BOOMALO	25/6	37.2	93.6	168.0	44.0	-	Fresh-Assn. polychaete tubes, plastic beads, porpita, Petropoda shells, Lepas, Sepia bones etc.
7. POLEM	2/7	18.4	18.0	20.4	-	-	Fresh. Assn., polychaete tubes, plastic beads etc.
8. CALGIBAG	2/7	-	0.8	-	-	-	No association.
9. BAGA	4/7	56.9	-	133.2	100.4	-	Assn., polychaete tubes, beads etc.
10. CANDOLIM	4/7	266.3	-	257.6	76.8	-	Diameter of balls 2 to 3". Assn., polychaete tubes, plastic beads <u>Physalia physalia</u> , <u>Lepas</u> etc.
11. ANJUNA	4/7	84.6	-	355.2	234.8	-	Dia. of balls 2 to 3". Assn., polychaete tubes, plastic beads, <u>Physalia physalia</u> , <u>Lepas</u> etc.
12. VAGATOR	4/7	-	-	308.4	327.2	-	-do-
13. MORJIM	4/7	352.4	-	203.2	-	-	-do-
14. CALANGUTE	4/7	132.3	-	94.8	24.4	-	-do-
15. MANDREM	4/7	90.1	62.8	-	-	-	-do-
16. SINQUERIM	4/7	-	-	1873.6	734.8	-	Tar balls ranging from 3 to 4" dia. Assn., polychaete tubes, plastic beads, <u>Physalia</u> , gastropod shells, <u>Lepas</u> etc.
17. SIRIDAO	8/8	5.3	-	-	-	-	Stray deposition, tar mixed with shells and sand.

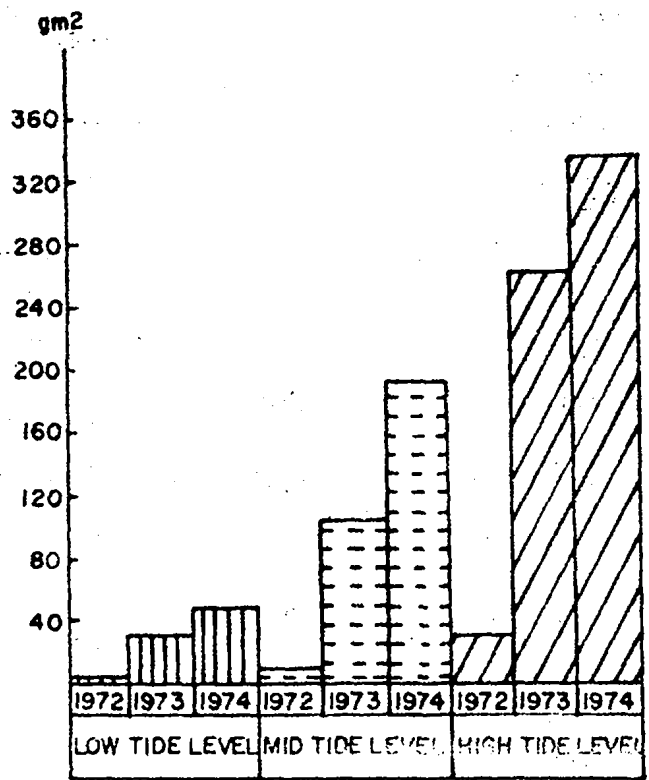


Fig.2. Tar ball deposition at various tide levels along Goa beaches; mean values for the years 1972 to 74 expressed in g/m².

The earliest deposition starts in March or April which coincides with the start of winds in coastal direction before the commencement of the monsoon season. At first small tar balls appear at the coastline, sometimes these are seen floating in the water. The tar balls are of different sizes and shapes. They were approximately 1 to 8 mm in diameter. At the low tide level small size tar balls occur. The quantity deposited is also less. In a few instances only they have been observed in the process of deposition. Towards mid tide level the frequency of occurrence and the size of tar balls increase. Invariably whenever deposition was observed at low and mid tide level it was fresh. It appears that deposition at low and mid tide level is a transitory phenomenon and ultimately tar balls concentrate at high tide level. During 1974 amongst the polluted beaches, the occurrence of tar balls was 100% at HTL, 60% at MTL and 7% at LTL. At HTL they were seen in fresh semidried and dried condition. Sometimes tar balls contained large amounts of sand. Thus indicating that the tar balls accumulate at HTL where they remain for long times. Similarly old deposition of tar was observed earlier at Calicut beach in Kerala.

The pooled data for the three years (Fig. 2) shows comparative incidence of oil pollution at different levels. Throughout this period frequency of occurrence and density of deposition was higher at HTL. The other more important and damaging fact is that oil pollution has increased (Table 2).

TABLE 2. TAR BALL DEPOSITION ALONG BEACHES OF GOA FROM 1972 to 1974

(MEAN WEIGHT IN g/m^2)

Beach	1972	1973	1974	Remarks
1. HARMAL	x	93.2	188.3	Starts end May. Heavy in June - July.
2. MANDREM	x	42.0	76.4	-do-
3. MORJIM	x	110.4	277.8	-do-
4. ANJUNA	19.3	250.0	337.3	-do-
5. VAGATOR	43.7	143.0	317.8	-do-
6. BAGA	315.4	548.5	96.8	Intense in June
7. CALANGUTE	532.1	78.5	83.8	-do-
8. CANDOLIM	150.0	165.7	200.2	June-July heavy
9. SINQUERIM	875.0	1045.0	1304.2	July heavy
10. MIRAMAR	75.5	90.0	105.2	May-June heavy
11. CAHANZALEM	552.7	500.0	534.3	April heavy

Beach	1972	1973	1974	Remarks
12. DIAS	x	33.1	45.0	Starts in June
13. SIRIDAO	40.2	63.7	50.3	Intense in June
14. VASCO	x	x	35.0	Starts late June
15. BAINA	100.7	135.0	200.4	-do-
16. BOOMALO	x	41.8	85.7	Intense in June end.
17. VELSAO	x	x	100.0	Starts in April intense in June
18. CASAULIM	40.0	92.6	123.0	-do-
19. COLVA	10.1	15.7	14.8	Starts in May
20. BENAULIM	60.3	x	2.4	-do-
21. CAVELOSSIM	45.2	59.2	x	-do-
22. KHAINKHINNI	x	10.5	x	-do-
23. MASHEM	x	x	3.4	Starts late June
24. POLEM	12.2	9.6	18.9	-do-

The tar deposition occurs along a large part of the coastline but all the beaches are not affected and the rate of deposition is also variable. Variation in deposition and accumulation of tar balls is due to many factors like coastal circulation, beach gradient, and the topography of the coastline. It has been seen that near the embouchures of estuaries the tar ball deposition is more. The example in Goa region are Sinqueris, Candolim and Vagator where during the year 1974 average deposits were respectively of 1304, 200 and 316 grammes per square meter. In these areas tar is found mixed with other materials of estuarine origin like the leaves and the fruits of mangroves. It appears that the discharge of water from the estuaries influences the coastal circulation pattern and the suspended and the floating material of the near shore area is washed ashore. Similar phenomenon has been reported from other areas of the Indian coast also (Dwivedi and Parulakar, 1974). Apart from the material of estuarine origin, polychaete tubes in varying quantities and in some cases Turritella shells were also found along with the tar balls. In some areas tar balls washed ashore were coated with algae and some of them had large goose barnacles, growing on them (Nair et al, 1972). This occurred every year. Apparently tar balls had remained floating in water for long periods and provided a substratum for algae and other animals life. The presence of these shells along with polychaete tubes and Turritella shells indicate that they

originate at certain distance away from the shore and most probably in the vicinity of the coastal shipping route. With the approach of monsoon winds the coastal waters are agitated and the material normally found near the sea bottom and in the water column are stirred and are washed ashore. The washing ashore of tar balls is a repetitive process initially they deposit at different levels and ultimately accumulate in large quantities at high tide mark or get spread over supra tide levels.

The occurrence of tar in the water column was also supported by observations in February 1972. Towards the southern extremity of Goa during vertical Zooplankton haul at 10 m depth the plankton net got contaminated with oil. It was thus seen that oil is found in coastal zone and it is therefore necessary to monitor levels of oil pollution in sea water to establish beachline parameters. The use of methane, ethane and propane to establish base line data of oil pollution could be useful, (Swinnerton and Lamontagne, 1974).

The data indicates that pollution increased (Fig. 2) at all tide levels. Along the Indian coast the shipping activities have also increased. The Indian Merchant Fleet in 1947 had in operation 59 ships with gross tonnage of 1.92 lakh tons. This increased to 259 ships with 26.17 lakh tons in 1973 (Srivatava, 1973). Increase in merchant fleet has resulted in considerable increase in coastal shipping activities. As a result during the last few years accidental oil spills have also occurred. In 1974 one case of oil spill had occurred in Vasco harbour itself. In other cases discharge of oil water in coastal waters has been observed, (Ramamurthy, 1974). It is thus clear that coastal areas have greater threat of oil pollution.

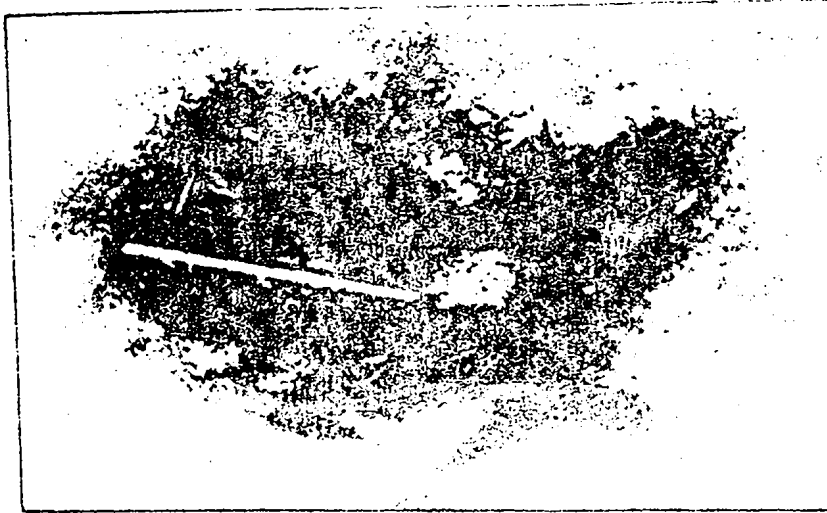
Oil and oil products are the polluting substances which affect many parts of the world oceans. The ocean is fundamentally a fluid and what happens in one place in the oceans affects other places. Therefore it is necessary to know about concentration of oil pollutants and the manner in which the oceans disperse or concentrate the oil derivatives. The Baltic, the North sea, the Irish sea, and the Bay of Biscay have extensive oil pollution. The concentration of pollution in these relatively enclosed seas decreases with distance from the shore but they can be detected many kilometers away from the shore (White 1974). Various sources estimate that 10 to 15 million tons of oil are dumped into the oceans annually and this is likely to increase as major part of the production is moved from the land to the continental shelf and farther out to sea (Simonon, 1974). In India also successful drilling of oil has begun along the west coast off Maharashtra and at Bombay high. Therefore pollution studies are necessary to establish baseline data.

The three year study indicates that oil pollution along the Goa Coast is increasing and urgent measures are required to regulate the disposal of oil wastes in coastal areas. In some parts tarball deposition along the beaches is negligible, these areas may be useful for development of recreational complexes. The oil pollution also occurs in near shore waters and in addition threat of accidents from oil wells located on the continental shelf also exists. Therefore, an extensive study following standard and inter-calibrated methods (Bierie et al, 1974, Lacey and Everhart, 1974, Thompson and Grumfield, 1974) is necessary to determine the baseline concentrations of oil in water and the concentration of tar balls along the beaches.

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Tar Ball deposition at High Tide Level (HTL)
Sinqueria Beach 1973.



Tar Ball deposition at High Tide Level (HTL)
Caranzalem April, 1974.



OIL FILM AT BAINA BEACH, JOA.