

solely attributed to river input, since the concentration in sea water ranges from 1-50 $\mu\text{g}/\text{litre}^4$.

Concentrations of dissolved Co were very low. Dissolved Ni concentrations vary between non-detectable levels to 12.2 $\mu\text{g}/\text{litre}$, the trend of variation does not show any definite order. However, deeper waters were slightly richer in dissolved Ni than surface (Table 1). Probably Ni taken up by the organisms in the photic zone is released in the lower layers¹².

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Distribution of Petroleum Hydrocarbons in Goa Coastal Waters

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Average hydrocarbon concentrations in water, plankton and sediment samples collected from the central west coast of India between 14°40'N and 15°50'N were 30.9 $\mu\text{g}/\text{litre}$, 46.9 $\mu\text{g}/\text{g}$ dry wt and 7.1 $\mu\text{g}/\text{g}$ dry wt respectively. The data suggest that marine plankton are useful indicators of oil pollution in this region.

Coastal zone receives a considerable amount of oil from shipping which includes dumping of bilge, accidental discharge of oil from tankers, exhaust discharge from small craft, runoff of oil via sewage, land waste and industrial effluents¹. Chemical and biological studies have shown that petroleum hydrocarbons from an oil spill can persist in marine sediments for at least 2 yr (ref. 2) and that the spilled oil has an adverse effect on marine organisms³⁻⁵.

As a part of an ongoing project on the origin, role and fate of hydrocarbons in the sea, a survey has been

carried out to estimate the amount of petroleum hydrocarbons present in the coastal waters of Goa. Such a study would provide a base to determine any changes that might occur in the future.

Water (24), plankton (6) and sediment (9) samples were collected during the 46th cruise of *RV Gaveshani* in Dec. 1978 (Fig. 1), for the analysis of petroleum derived hydrocarbons.

Sampling and preservation—Collection and preservation of water samples was done as described previously⁶. Plankton samples were collected with the help of a Neuston net (mesh size – 500 μm) while the ship was running dead slow. Samples were then wrapped in clean aluminium foil, placed in glass jars and frozen till analysed. Sediment samples were obtained by La Fond Dietz Snapper which sampled the upper 5 cm of the sediment. The samples were kept frozen in glass jars till analysed.

Extraction and analysis—On reaching the shore laboratory, water samples were thawed and shaken again before they were transferred to a separating funnel. After separation, the sample was extracted with hexane for a 2nd time. The combined hexane extract was freed from the residual water by treatment with anhydrous sodium sulphate. It was then concentrated to about 20 ml by evaporation at 50°C on a controlled water bath. The hexane extract was then passed through a column of silica gel (60-120 mesh) which had been treated and deactivated before use. The column was then washed with 30-40 ml hexane. The combined hexane extract was evaporated and final volume made up to 10 ml. Hexane was used as a blank and a Saudi Arabian crude oil was taken as a standard. Both these were treated by the same way as the samples. Petroleum hydrocarbon concentrations were measured with a Beckman ACTA-C-III double beam recording spectrophotometer⁶.

Plankton and sediment samples were thawed and the former were checked for tar particles and paint chips, and whenever they were found contaminated the samples were discarded.

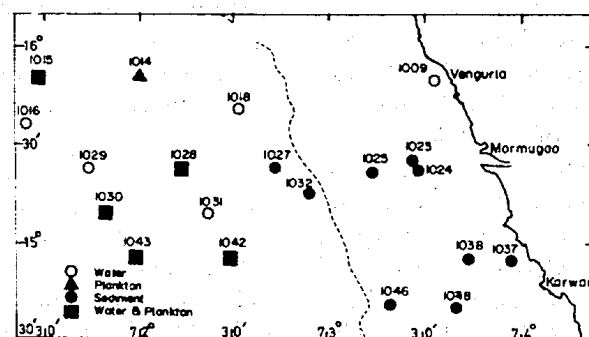


Fig. 1—Station locations

SHORT COMMUNICATIONS

The following procedure was adopted for the determination of petroleum hydrocarbons. Dried material (2-5 g) was Soxhlet extracted for 72 hr using a quaternary solvent mixture (hexane-methanol-acetone-chloroform in 1:1:1:1) prepared fresh every 24 hr. The combined extract was diluted to a known volume. A 25 ml aliquot of the sample solution was evaporated to about 5 ml. This was then subjected to separation on a chromatographic column. The column (1 cm diam. and 60 cm length) was packed with 14 cm height of silica gel (60-120 mesh size activated at 120°C for about 10 hr and then deactivated with 3% of water by weight) and 14 cm height of alumina (neutral, activated at 250°C for 10 hr and then deactivated with 3% of water by weight). The silica gel was packed first as an even layer and the alumina was packed over it as a separate top layer. Copper powder (2 cm height) was packed over the alumina layer as a separate top layer for the removal of elemental sulphur. The column was then eluted with hexane. The first 6 ml were discarded as they come off the column. The next 40 ml were collected and concentrated to 25 ml.

The absorbance of the aliquots was measured using the scanning mode of a Beckman ACTA-C-III double beam spectrophotometer in the UV region 350 to 190 nm. The maximum absorbance was observed at 213 nm.

The efficiency of the chromatographic separation is seen in Figs. 2 and 3. Fig. 2 shows the difference between the UV absorbance of samples before and after passing through the columns; the peak at 256 nm due to the absorbance of non-petroleum material is

reduced after passing through the column. IR spectra (Fig. 3) show clearly the column chromatographic separation of the hydrocarbon fractions from non-hydrocarbons.

Saudi Arabian oil was used as a reference standard. The procedural blanks showed no contribution of hydrocarbons from reagents and solvents. With the instrument and the reagents available for the analysis, a standard deviation of $\pm 0.6\%$ was obtained from replicate analyses.

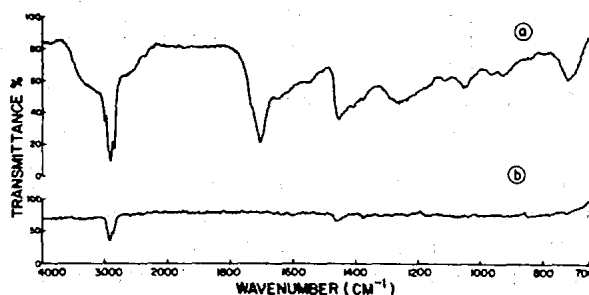


Fig. 3—IR-Spectrum of water sample before (a) and after (b) column chromatography

Table 1—Petroleum Hydrocarbon Concentrations (PHC) in Waters

St No.	Depth (m)	Sampling depth (m)	PHC ($\mu\text{g/litre}$)
1009	20	0	36.5
		10	24.8
		20	28.0
1015	2500	0	28.8
		10	24.3
1016	1700	0	26.5
		10	22.8
1018	1300	0	27.0
		10	27.0
1027	300	0	21.5
		10	16.8
1028	2050	0	25.5
		10	23.3
1029	2300	0	26.0
		10	24.8
1030	2200	0	41.5
		10	33.8
1031	2150	0	42.5
		10	38.3
1042	1900	0	42.0
		10	39.8
		20	36.8
1043	2200	0	42.8
		10	42.5

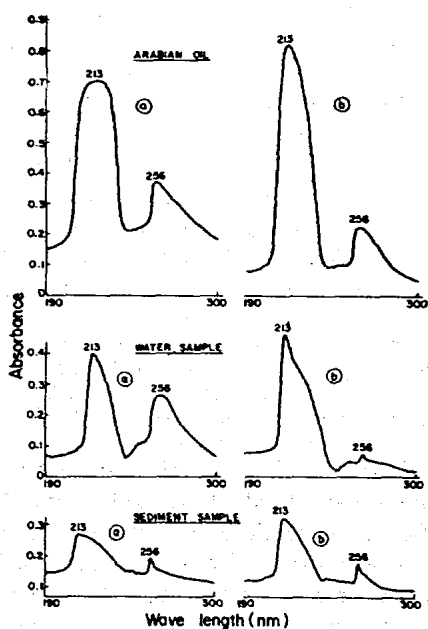


Fig. 2—UV-Spectrum before (a) and after (b) column chromatography of samples

Table 2—Petroleum Hydrocarbon Concentrations (PHC) in Sediments

St No.	Depth (m)	Sediment characteristics*				PHC $\mu\text{g/g}$ dry wt
		Texture	Silt (%)	Clay (%)	Sand (%)	
1023	20	Sandy-silt	43.2	14.5	42.3	7.6
1024	56	Sand	8.1	4.9	87.0	6.7
1025	82	Sand	7.0	4.2	88.8	6.9
1027	300	Sand-silt-clay	20.9	53.6	25.5	6.4
1032	240	—	—	—	—	6.3
1037	20	Sandy-clay	19.2	40.8	40.0	9.4
1038	52	Sand	12.6	6.5	80.9	4.8
1046	107	Sand	16.4	3.8	79.8	8.1
1048	54	Sand	2.1	0.3	97.6	8.5

*Ansari, Z.A. (personal communication).

The average petroleum hydrocarbon concentrations (PHC) at surface and 10 m depths do not differ significantly in sea water samples (Table 1). These values are higher than those reported by Sen Gupta *et al.*⁶ for coastal Arabian Sea and coastal Bay of Bengal. PHC was more (av. 40 $\mu\text{g/litre}$) in waters south of Goa region (sts 1030, 1031, 1042, 1043) while it was less (av. 27.3 $\mu\text{g/litre}$) in waters north of Goa (sts 1009, 1015, 1016, 1018). The values along the Goa track (sts 1027, 1028, 1029) were more or less equal to those in the northern region (av. 22.9 $\mu\text{g/litre}$). Thus the higher values in the south region indicate that the input of oil is more in this region.

The marine plankton consisted mainly of ostracods, copepods, decapods and chaetognaths. PHC in plankton at sts 1014, 1015, 1028, 1030, 1042 and 1043 was 19.5, 33.7, 83.3, 37.8, 46.3 and 60.8 $\mu\text{g/g}$ dry wt respectively. The measured levels of *n*-alkanes of mixed plankton varied between 0.3 and 263 $\mu\text{g/g}$ in open sea and 1.4 and 1586 $\mu\text{g/g}$ in coastal waters⁷. Organisms absorb hydrocarbons either from the sediment directly, from settling particles which also supply hydrocarbons to the sediments or through intermediate solution or suspension in the bottom waters⁸. Data from sts 1014, 1015, 1030, 1042 and 1043 indicate a positive relationship between PHC levels in plankton and sea water; this can be used with advantage in detecting oil pollution in the sea.

Table 2 presents PHC values in sediments along with sediment characteristics. PHC averages of 12.63 and 14.68 $\mu\text{g/g}$ dry wt respectively, were reported for sediments from the Mediterranean Sea⁹ and Western North Atlantic¹⁰.

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Recent Foraminifera from Beach Sands of Malabar Coast

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Study of Recent foraminifera from 3 sandy beaches, viz. Cochin, Chellanam and Purakkad, of Malabar coast, Western India, reveals the presence of 25 species. Their distribution pattern indicates that it is mainly controlled by ecology in which salinity is the chief factor.

Foraminiferal fauna from beach sands of the east as well as west coasts of India have been described but no information is available on the Recent foraminifera from the beach sands of Malabar coast, facing the Arabian Sea. In view of this, a study of the Recent

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