Short Communications

Total Mercury Concentrations in Waters of the Laccadive Sea

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Concentrations of mercury, measured at surface and at different depths in the Laccadive Sea, ranged from 50-204 ng/litre, which agreed with the earlier reported values (11-221 ng/litre) for the Arabian Sea. A few isolated values were higher than the average but these were low enough to show that the Laccadive Sea waters are at present free from mercury pollution.

Dissolved mercury in inorganic form occurs mostly as $HgCl_4^{2-}$ (ref. 1) and its concentration at the surface of the open ocean is in the range 10 to 100 ng/litre[2-4]. Examining the data available from 1934 to 1972, Fitzgerald and Lyons[5] have reported mercury concentrations in the sea water to range between 3 and 364 ng/litre.

Analysing a few samples from different oceans, including the southern Indian Ocean, Chester *et al.*[6] have reported the mercury concentration at the surface to range from 0.5 to 127 ng/litre. From the iceland waters, the range reported is 12-225 ng/litre[7]. Singbal *et al.*[8] have reported a range of 13 to 187 ng/litre for the total mercury in the Arabian Sea based on observations made during the 16th cruise (March 1977) of *R V Gaveshani*.

The present investigation forms a part of the ongoing project of NIO on the protection of marine environment and monitoring of pollutants in the seas around India and is in continuation of the earlier observations in the Arabian Sea[8].

Sea water samples for mercury analysis were collected from the Laccadive Sea (8°-14°N and 71°30′-74°E) in March 1978 during the 31st cruise of *R V Gaveshani*. The surface samples collected were either from 5 or 10 m depth. This was done to have a comparison of mercury with the other heavy metals and to avoid contamination from the 3.5 m metallic hull of the ship. The sampling stations are presented in Fig. 1. Methods of sample collection, storage and analysis were similar to those reported earlier[8].

Four replicate runs of 20 samples and a mixture of equal aliquots of all the samples established a standard deviation for the values. This when expressed as coefficient of variation, was $\pm 4.5\%$.

Before acidification, the samples were neither filtered nor centrifuged on board. Therefore, the concentrations reported here include the contribution of acid leachable mercury associated with particulate material also.

Some of the mercury dissolved by the acid treatment may be in an organically bound form and this quantity will appear in the measurements reported. Burton and Leatherland[9] have found that the acid leachable portions were not > 10% of the total measurable mercury in dissolved form. This method will also estimate methyl mercury, if any, in the samples[7]. The presence of organic mercury is yet to be detected in ocean water and there is considerable doubt whether it remains stable in normal oxygenated sea water[10]. The values are, therefore, expressed as total dissolved mercury concentrations in the samples.

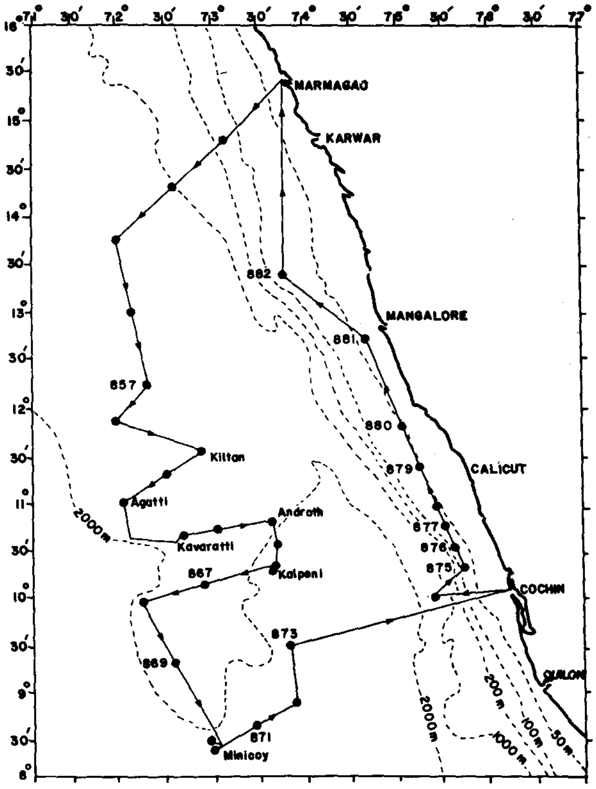

Fig. 1—Station Locations

Table 1—Mercury Concentrations in the Laccadive Sea (Lakshadweep) Part and Indian Coastal Zone of the Arabian Sea from 22 March to 6 April 1978 and Water Masses (Cruise 31)

St No.	Position	Water mass	Sampling depth (m)	Temp. °C	Salinity ‰	Mercury conc. ng/l
857	12°13.5′N	Arabian Sea surface	10	28.31	35.63	60
	72°22′E	do	100	27.69	36.29	50
		Red Sea	500	11.82	35.39	ND
		N. Indian Ocean Deep	1000	8.47	35.24	25
867	19°05′N	Arabian Sea surface	10	29.06	34.90	75
	72°56′E	do	100	27.27	35.89	25
		Red Sea	500	12.83	35.23	ND
		N. Indian Ocean Deep	1000	9.56	35.19	ND
869	09°16.5′N	Arabian Sea surface	10	29.05	34.41	100
	72°35′E	do	100	27.72	35.41	ND
		Red Sea	500	11.77	35.34	50
		N. Indian Ocean Deep	1000	8.54	35.16	50
871	08°32′N	Arabian Sea surface	10	29.49	35.21	100
	73°26.5′E	do	100	26.01	36.03	50
		Red Sea	500	10.83	35.27	ND
		N. Indian Ocean Deep	1000	7.66	35.1	ND
		do	1500	5.27	35.02	25
873	09°26′N	Arabian Sea surface	10	29.9	34.55	120
	73°45′E	do	100	27.19	36.10	50
		Red Sea	500	10.35	35.25	60
		N. Indian Ocean Deep	1000	7.14	35.04	25
		do	1500	4.93	34.90	ND
		do	2000	—	—	25
875	10°14.6′N		10	30.13	34.61	204
	75°44′E		50	28.92	34.91	100
876	10°28′N		10	—	—	180
	75°38.4′E		50	—	—	120
877	10°40′N		10	—	—	175
	75°34′E		50	—	—	100
879	11°20′N		10	29.33	34.99	160
	75°16.2′E		45	29.20	35.12	60
880	11°47′N		10	29.21	35.05	100
	75°04.1′E		45	28.75	35.15	45
881	12°40.2′N		5	29.58	35.35	120
	74°40.8′E		30	28.95	—	100
882	13°24′N		5	29.11	35.36	50
	73°45′E		30	28.93	35.35	50

ND = Non-detectable

The results are presented in Table 1 and results of a few stations away from the Laccadive Sea, are also given for comparison. The area investigated has several water masses. Some attempt has been made to determine whether there is any relation between the concentration of mercury and the different water masses. For this purpose, the water masses from which the samples are drawn have been identified using the classification of Rochford[11] for the Indian Ocean. The data in Table 1 provide very little evidence for any correlation between mercury concentration and a particular water mass. However, it can be seen from the Table that the Red Sea and the North Indian Ocean Deep Water masses contain very little or no mercury.

Analysing a few surface samples, collected between 26° and 28°S in the Indian Ocean, Chester *et al.*[6] have reported values varying from 9-52 ng/litre. This area being somewhat north of the subtropical convergence in the Indian Ocean, lies close to the sources of origin of the north Indian Ocean Deep Water. Values between non-detectable limit and 60 ng/litre are observed in the present study from the area 8° to 12°N at depths having a similar water mass (Table 1). This agreement is interesting and the slight variation obtained between the 2 sets of values may be due to some mixing with overlying and underlying water masses. This is only a conjecture as the values are too few to draw any definite conclusions.

Variations of mercury with depth have been studied at st 873 where sampling has been done up to 2000 m. Concentrations decrease with depth. This is attributable to different characteristics of the water masses as noted above or to the general cycle of mercury in the marine environment.

In the Laccadive Sea, mercury values in general at the surface increase from north to south. A similar trend has been observed in the coastal regions of the Arabian Sea in the same season (premonsoon)[8].

In general, the surface mercury concentrations decrease as we move offshore. This is in agreement with the observations in the Arabian Sea made earlier[8].

A high mercury concentration at the surface was observed during the 16th cruise at st 326. This solitary high value was left out for further confirmation as it was suspected that this might be the effect of some contamination[8]. Mercury deposits were observed in crustal rocks of the hinterland between Calicut and Karwar[12]. This might affect the surface concentration of mercury in this area due to weathering and atmospheric flux. To test this idea further, close sampling was made during the 31st cruise in that area at about 50 m isobath (sts 875-881). Surface concentrations ranged from 100-204 ng/litre (av. 156 ng/litre). The values, excluding one, were not higher than those from the other stations. Hence, the leaching of the mercury from the hinterland did not appear to be very significant. The existence of one isolated high value, however, remains unexplained.

Average surface mercury concentration in the Laccadive Sea was 91 ng/litre (range 60-120 ng/litre). In the coastal waters of the Arabian Sea the average surface value was 136 ng/litre[8] and for the entire Arabian Sea the average value at the surface was 120 ng/litre. Pooling the observations of all the cruises the average concentration at the surface for the northern Indian Ocean would be 106 ng/litre.

There are very few observations on the mercury concentrations from the surface waters of the open ocean. The reported range values (ng/litre) are: Atlantic[6,7], 0.5-225; Pacific[5], 12-153; Southern Indian Ocean, 9-74; China and Japan Seas[6], 6-51; and northern Indian Ocean, 0-221.

Kureishy *et al.*[13] have analysed a few edible fishes from the Indian Ocean and obtained a concentration of 0.09-0.21 ppm (wet weight basis) of mercury. This range is far below the limit of acceptability (0.5 ppm). Combining present observations for the water, with their data, for the edible fishes, it can be concluded that the Indian Ocean is almost free from mercury pollution.

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Trace Metals in the Laccadive Sea

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Concentrations of Cu, Fe, Mn, Zn, Co and Ni, measured both in dissolved and particulate forms at 5 stations in the Laccadive Sea, were within the range reported for other areas of the world ocean. Only one station away from the islands, showed somewhat higher values for most of the metals. Dissolved Cu showed a decrease with depth. Dissolved Fe and Mn, on the other hand, showed a marked increase at a depth of 500 m.

The metals Cu, Fe, Mn, Zn, Co, Ni occur in sea water in different forms. These metals can become toxic to marine life when they exceed certain levels of concentration. To predict the trace metals acting as pollutants, it is necessary to have data of their baseline concentrations. Metals in particulate forms occur in