

weed pollution during late postmonsoon and premonsoon months. It may be noted that the environment is free of biological pollutant during late postmonsoon and premonsoon months which coincided with 'unobjectionable' months referred for faecal contamination. Total absence of macrofaeces, disappearance of salvinia and improvement in the physico-chemical conditions of the environment during the late postmonsoon and premonsoon months offered a presentable status to this beach above the 'objectionable levels' of pollution.

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Trace Metals in Zooplankton from the Bay of Bengal

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Zooplankton samples, collected during the 20th and 21st cruises of *RV Gaveshani* in the Bay of Bengal, were analysed for their trace element concentrations. The concentrations were comparable to the values obtained by other workers in different areas.

Determination of heavy metals in biological material of the sea has attained practical importance with the increased awareness of the dangers of marine pollution. So far little work¹⁻⁶ has been done on the multi-element determination in bulk collections of zooplankton.

Zooplankton are of much importance in the cycling process of elements in the oceans. Though the concentrations of metals in zooplankton vary because of many reasons, they do indicate possible environmental characteristics of a particular region. Moreover, being a major source of food for larger animals, their role in the transfer of metals to higher trophic levels is of much importance. The present study deals with the determination of Cu, Fe, Co, Ni, Pb, Mn and Zn in zooplankton from the Bay of Bengal. This work forms a part of the programme on monitoring different pollutants in the biological material from the Indian waters.

All collections were made during the 20th and 21st cruises of *RV Gaveshani*. Zooplankton samples were collected using an HT Net (mesh size 0.2 mm) from the stations shown in Fig. 1. The net was towed for 15 min while the ship was moving dead slow. The metal frame of the net was covered by a canvass sheet and a PVC bucket was used. On completion of the tow, the net was not washed with the ship's sea water supply⁷. The plankton cake was transferred to polythene bags directly from the bucket, with the help of a precleaned glass rod, after draining the water out. All samples were frozen at -5° to -10°C on board.

On reaching the shore laboratory, the samples were thawed and dried at 60°C in petri dishes. Dried material (1-2 g) was weighed accurately and then transferred to a 100 ml conical flask. The material was digested in conc. HNO_3 (15-25 ml) followed by concentrated perchloric acid until a clean solution was obtained. Blanks were run along with the samples. The acid volume, reduced to 1-2 ml, was transferred to a 10 ml flask and made up to the mark with glass distilled water. The solutions were examined for trace metals

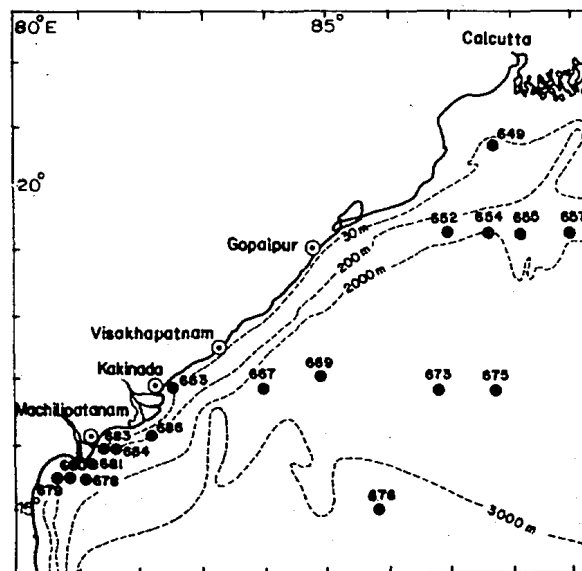


Fig. 1—Location of stations (Numbers refer to oceanographic station starting with cruise 1 of *RV Gaveshani*)

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using standard atomic absorption techniques⁵. Calibration curves were prepared for each metal using the standards.

The accuracy of the method used was checked by analysing the reference sample of the fish flour used in the 1975 ICES trace metal intercalibration exercise. The results (Table 1) are in agreement with those of other laboratories⁸. Coefficient of variation, except for Pb, was between 5 and 10% (Table 1).

Table 2 gives the results of the analysis. Average concentrations were computed for all the samples analysed and the values compared with those obtained by other workers.

A preliminary analysis on species composition of zooplankton samples, based on the other sub-samples revealed that copepods were most dominant in all the samples. Chaetognaths were next in abundance followed by euphausiids⁹. It is felt that the small change in the composition may not contribute significantly to the wide variation of values as observed here.

Table 1—Result of Standard ICES Fish Flour Analysis (ppm)

	Cu	Co	Ni	Pb	Fe	Mn	Zn
Mean value	4.92	1.82	0.256	2.41	745.73	15.85	46.54
SD	0.4	0.18	0.24	0.51	47.56	0.79	2.7
Coefft. of variation	8.13	9.89	9.38	21.16	6.38	4.98	5.8

The most interesting observation is that the zooplankton from the offshore areas showed high values as compared to zooplankton from the coastal stations. St 649 off Hooghly estuary shows low values as compared to st 652 and 654 far off the Hooghly estuary for most of the metals. This is not as significant as the difference in between the other coastal and offshore stations (Table 2). On a comparative basis all the coastal stations, barring st 663 which is at the mouth of a tributary of river Godavari, show lower values for all the metals than the offshore stations. Since there are no data on the concentrations of trace metals in sea water and particulate matter from the Bay of Bengal, at each of these stations, it is rather difficult to assign any reason for the occurrence of high values in offshore samples. The peculiar gyral circulation pattern in the Bay of Bengal may be an important factor for the high concentration in the offshore samples. Since the coastal areas have a large amount of solid particles, the metals are adsorbed on these particles and are probably removed more quickly by sinking to the bottom than in the open ocean which has very little particulate matter. This has been shown to be true in the case of chlorinated hydrocarbons¹⁰. However, more information is needed to support the above assumption. Significantly high concentrations of Pb are found in the offshore samples. High concentration of Pb has been reported from different

Table 2—Trace Metal Concentration in Zooplankton (ppm dry weight)

St No.	Cu	Co	Ni	Pb	Fe	Mn	Zn
649	25	5	61	173*	2803	143	1378*
652 ^a	153	16	17	—	4873	110	1700*
654 ^a	12	8	14	208*	3161	172	938
655 ^a	10	2	1	11	127	7	109
657 ^a	31	8	10	5	1255	62	680
663	—	26	26	—	4121	249	1390*
667 ^a	24	11	21	119	961	27	490
669 ^a	97	31	6	63	684	17	592
673 ^a	228	32	81	—	2443	66	1530*
675 ^a	—	17	50	—	6930	133	—
676 ^a	81	5	11	54	2424	45	1237*
678	—	ND	29	58	1363	19	—
679	52	16	17	170*	1411	37	816
680	4	6	5	8	134	7	105
681	3	2	2	7	145	6	46
683	20	3	2	5	82	5	107
684	—	9	12	—	1162	34	514
686	—	ND	30	185*	4011	95	1701*
Mean(18) ^f	33	11	21	37	1139	31	440
Martin ³ (22)	41	13.33	42	49	1200	28	428
Szabo ² (5)	30	1	19	—	1133.3	11.3	266.6

*Not included for calculating the average

^fValues in parentheses indicate number of samples analysed

ND=Not detectable

^aOffshore stations and the rest coastal

areas¹⁻³. However, present results suggest a possible build-up of this 'non-essential' element in the biota of Bay of Bengal, for reasons still unknown.

The concentration factor for each metal, except Pb, was calculated. The concentration factor was highest for Fe (15638) followed by Co (1955), Zn (1042), Ni (442), Mn (358) and Cu (228). According to Bowen¹¹, among cations, the affinity for living matter is in the order tetravalent and trivalent elements > divalent transition metals > divalent group II A metals > univalent group I metals. When the concentration factor was arranged in the decreasing order, the above statement was found to hold good for all elements except Zn.

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Energy Value of Suspended Detritus from Some Stations along the West Coast of India

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Energy content of suspended detritus was determined from the coastal waters of the west coast of India during the 31st cruise (March-April 1978) of *RV Gaveshani*. Percentage contribution of energy by phytoplankton, zooplankton and detritus in total suspended matter amounted to 5.05, 13.8 and 81 respectively. The caloric value of the detritus ranged from 490 to 5094 cal/g dry weight. The results indicated the predominance of detritus over living matter.

Detrital particles generally form the major component of suspended matter in the sea and play an important role in physical, chemical and biological processes¹.

The importance of detritus in the food web has been indicated²⁻⁶. However, information on nutritive value of detritus during its formation in the tropical waters is very limited^{7,8}. The present communication deals with some aspects of the caloric content of suspended detritus.

Water samples were collected from different depths using van Dorn sampler from 7 stations (lat 13° 30' N to lat 10° N) during the 31st cruise of *RV Gaveshani* (March-April 1978) in the Arabian Sea. To quantify the amount of total suspended matter, 4 to 9 l of water sample was filtered through GF/C Whatman filter paper and dried in an oven at 70°C. Chlorophyll *a* was estimated fluorometrically and converted to phytoplankton carbon using the conversion factor given by Tranter⁹. Zooplankton biomass data available as displacement volume/m², collected during the 17th cruise of *RV Gaveshani* (March 1977) from the same area, were used for computing zooplankton carbon values following the conversion factor of Tranter⁹.

Phytoplankton calories were derived from the carbon values using the conversion factor given by Platt and Irwin¹⁰. Zooplankton carbon was converted to caloric value using the conversion factor 1 mg C = 10 calories¹¹. Energy content of total suspended matter was determined by combustion of the dried material in a Parr adiabatic microbomb calorimeter. Detrital calories were obtained by the difference between the total suspended matter calories and phyto- and zooplankton calories. The results given here represent the integrated column production values.

Integrated values of phytoplankton, zooplankton and detrital calories are given in Table 1. On an unit weight basis, the caloric value ranged from 490 to 5094 cal/g dry weight (av. 1601 cal/g dry weight). The mean detrital caloric value recorded in the present study appears to be lower than that reported for Red Sea, Gulf of Aden, Equatorial Atlantic, Gulf of Mexico¹², Menai Straits¹³ and the Laccadive Sea⁸ but higher than that reported for Cochin backwaters⁶ and Zuari estuary⁷.

Table 1—Integrated Energy Values of Phytoplankton, Zooplankton and Suspended Detritus at Different Stations in the West Coast of India

Station No.	Depth range (m)	Energy kcal/m ²		
		Phytoplankton	Zooplankton	Detrital
875	0-50	0.654	2.4	78.646
877	0-50	0.599	1.8	71.851
878	0-50	1.642	9.6	5.858
879	0-45	3.061	1.8	79.188
880	0-45	1.271	1.8	27.383
881	0-37	1.602	2.4	6.765
882	0-30	0.358	1.2	23.75