

DISTRIBUTION OF PHOSPHORUS IN THE MARINE SEDIMENTS OFF THE EAST COAST OF INDIA

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Sediment samples collected from the shelf and slope regions off the East Coast of India between "Swatch of no ground" in the north and Karaikal in the south, have been analysed for their total phosphorus content and its distribution studied. This study has shown that the shelf sediments in the region between Chilka Lake and "Swatch of no ground" are uniformly rich in their phosphorus content while the sediments in the region between Masulipatam and Pulikkat Lake are uniformly poor with those in the regions between Visakhapatnam and Masulipatam and Pulikkat Lake and Karaikal coming in between. This distribution pattern of phosphorus has been discussed in relation to the phenomenon of upwelling, biological productivity and the influence of river systems.

INTRODUCTION

The productivity in a marine or estuarine environment is related to the concentration and distribution of inorganic nutrients dissolved in water and phosphate is one of these nutrients governing the productivity. The bottom sediments where the regeneration takes place in part due to the diagenetic processes operating within the sediments, act as reservoirs for the overlying waters under favourable conditions. While some work has been done on the distribution of phosphate in the waters of the western Bay of Bengal, practically no information is available on the distribution of phosphorus in the bottom sediments. The present studies have been made to understand the distribution of phosphorus in the sediments of the Bay of Bengal. In these studies the sediment samples collected from the shelf and slope regions off the East Coast of India have been analysed for their total phosphorus content and its distribution studied. The results of this study particularly in relation to upwelling and biological productivity are presented in this paper.

FIELD AND LABORATORY PROCEDURE

Samples of bottom sediments were obtained from the shelf and slope regions off the East Coast of India between "Swatch of no ground" and Karaikal during the 17th, 18th and 26th cruises of I.N.S. KISTNA using Phlegar Corer and LaFond-Dietz Snapper. The locations of the stations are given in Figs. 1A, B. In the region between Chilka Lake and "Swatch of no ground" the shelf is very wide and two major rivers—the Ganges and the Mahanadi—deliver to the sea enormous amounts of sedimentary material. The sediments in this region are mostly clayey in nature and are light ash-grey in colour when they are dry. The shelf between Chilka Lake and Kakinada is not influenced by any major

river discharge and contains a variety of sediments ranging from coarse sands in the nearshore to fine grained clays in the continental slope on the one hand and from highly calcareous to purely clastic on the other. From Kakinada to Pennar confluence the shelf is too narrow and is mostly covered by silty clays. Godavary, Kistna and Pennar rivers supply materials to the shelf in this region. Again from Pennar confluence to Karaikal, except for the Coleroon river in the south, there are no major rivers supplying material to this part of the shelf in appreciable quantities, and the sediments in this region are mainly sandy in nature. The samples collected represent the upper 12' to 28" in the case of the core samples and the upper 4" in the case of the snapper samples.

In the case of the core samples each core was cut into 4" longbits and from each bit silt and clay fraction was separated from the sand fraction by wet sieving through ASTM Sieve No: 230. In the case of the snapper samples, the sample was thoroughly mixed before the silt and clay fraction was separated. The silt and clay fraction thus separated was dried at about 60° C in a hot air oven and then Pulverised. A suitable quantity of the sample was taken and the total phosphorus content determined by the method as described by Rochford (1951). All the measurements were made on the 'Unicam' spectrophotometer at 700 m μ .

RESULTS

Samples collected from 96 stations covering the region between "Swatch of no ground" and Karaikal have been analysed for their total phosphorus content. In the case of the core samples the depth-wise distribution has been studied. The values obtained are given in Table I together with the depths from which the samples were drawn. From an analysis of the data the following generalisations can be made in regard to the distribution of phosphorus in the shelf sediments off the East Coast of India :

1. The sediments in the region between Chilka Lake and "Swatch of no ground" are uniformly rich in their phosphorus content;
2. The sediments in the region between Masulipatam and Pulikkat Lake are uniformly poor in their phosphorus content;
3. The sediments in the region between Visakhapatnam and Masulipatam and between Pulikkat Lake and Karaikal are relatively poor in their phosphorus content when compared with the sediments between Chilka Lake and "Swatch of no ground" but are relatively rich when compared with sediments between Masulipatam and Pulikkat Lake; and
4. The phosphorus content does not show any systematic trend with depth in the core samples.

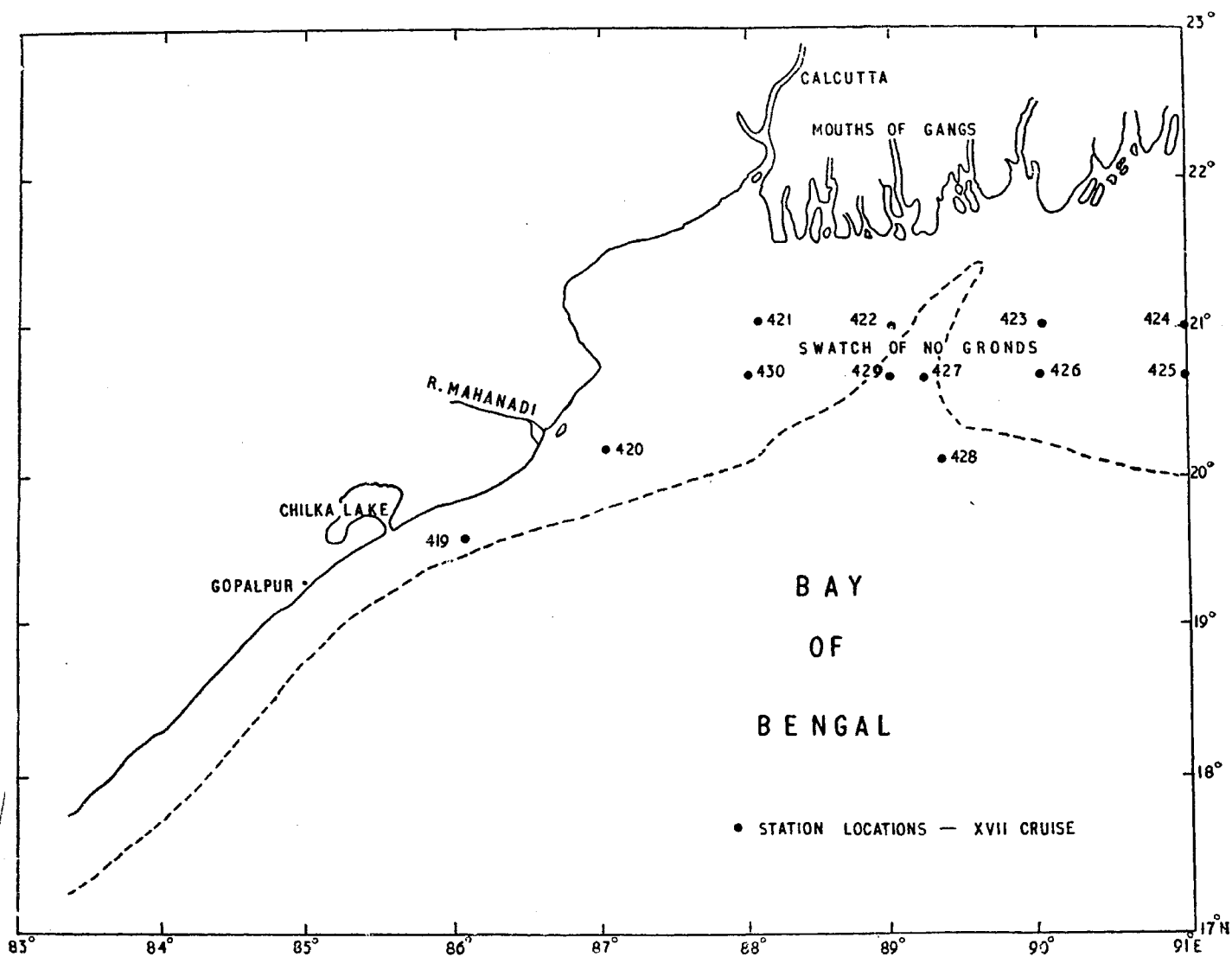


FIG. 1A.

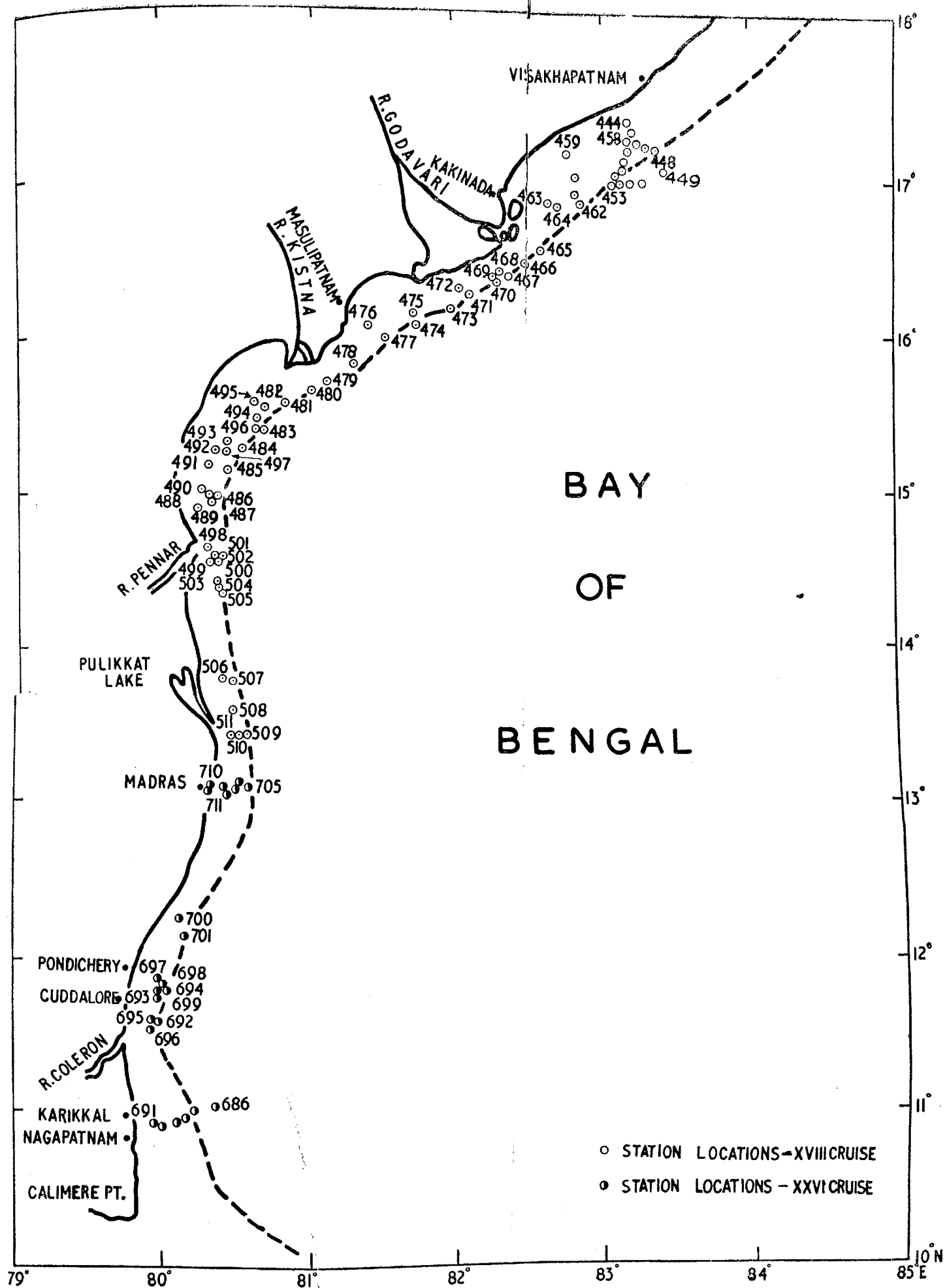


FIG. 1B.

TABLE I

Serial Number	Station Number	Depth in Fathoms	Type of Sample	Total phosphorus in mg/gm of silt						
				0-4"	4-8"	8-12"	12-16"	16-20"	20-24"	24-28"
1	2	3	4	5	6	7	8	9	10	11
<i>Chilka Lake-Swatch of no ground region</i>										
1	419	50	Core	1940	980	980				
2	420	26	"	620	1200	510				
3	421	10	Snapper	860						
4	422	45	"	1030						
5	423	45	"	1210						
6	424	30	"	1160						
7	425	43	"	700						
8	426	50	"	1300						
9	427	200	Core	1030	900	990	720	940		
10	428	400	"	570	740	1180	550	380		
11	429	90	"	680	680	780	1030	1000		
12	430	50	"	530	180	650	360	710		
<i>Visakhapatnam—Masulipatam region</i>										
13	444	19	Core	230	660	290	90	290	290	
14	445	30	"	620	630	330	310			
15	446	42	"	350	180	230	580	100	880	
16	447	58	Snapper	1370						
17	448	73	"	1080						
18	450	120	Core	630	560	350	560	340	410	
19	451	115	"	600	550	400	520	300		
20	452	115	"	500	560	850	650	550		
21	453	110	Core	650	1040	500	270	1090	1390	
22	454	90	"	300	450	80	400			
23	455	70	Snapper	260						
24	456	50	"	200						
25	457	40	Core	70	430	70	290	490	150	
26	458	26	"	300	300	210	200	640	570	490
27	459	19	"	80	280	190	260	100	310	
28	460	41	"	70	270	70	90	510	140	
29	461	70	"	120	85	75	290	85		
30	462	100	"	640	450	80	400			
31	463	40	"	70	110	350	530	85	38	160
32	464	69	"	230	360	120	75	90		
33	465	130	"	270	200	170	410	300		
34	466	110	"	270	200	170	410	300		
35	467	110	"	60	50	260	150	440	340	
36	468	20	"	220	470	80	620	70	620	
37	469	20	"	290	260	540	260			
38	470	80	"	250	90	450	310	290	120	
39	471	75	"	570	380	510	110			
40	472	20	"	650	500	170	89	210	320	
41	473	81	"	670	600	190	90	470		
42	474	138	"	670	600	190	80	470		
43	475	17	"	66	50	170	90	210	320	
44	476	267	Core	100	100	90	30	100		
45	477	82	"	40	40	30	80			
<i>Masulipatam—Pulikkat Lake region</i>										
46	478	80	Core	30	67	37	30	43		
47	479	180	"	34	255	323	196			
48	480	80	"	86	30	129	54	244		
49	481	85	"	43	40	16	20	40		
50	482	20	"	260	340	60	330	30		
51	483	95	"	150	100	70	170			
52	484	80	"	50	126	22	50			
53	485	95	"	35	19	99	90	30		(Contd.)

TABLE I—(Contd)

1	2	3	4	5	6	7	8	9	10	11
54	486	91	„	19	27	3	70			
55	487	70	„	27	35	73	27			
56	488	43	„	37	40	73	27	19	27	
57	489	26	„	81	69	153	76	370	199	
58	490	20	„	162	46	139	109			
59	493	19	„	51	40	123	84	123		
60	494	17	Snapper	371						
61	497	26	Core	70	72	53	53			
62	498	23	Snapper	139						
63	499	30	Core	51	70	52	53			
64	501	70	„	88	32	51	72			
65	502	170	„	90	89	349	81	328		
66	503	90	Core	91	91	397	89	329		
67	504	305	„	332	67	65	65	90		
68	505	150	„	193	530	257	176	171	85	
69	506	23	Snapper	170						
70	507	80	„	169						
71	508	35	„	100						
72	509	105	Core	375	106	125	352			
73	510	63	Snapper	280						
74	511	35	„	370						
<i>Karaiikal Pulikkat Lake region</i>										
75	686	588	Snapper	251						
76	687	180	„	1164						
77	688	50	„	92						
78	689	30	„	763						
79	690	16	Core	215	211	243				
80	691	8	Snapper	334						
81	692	96	Core	335	240	289				
82	693	264	„	277	69	73				
83	694		„	52	183	90				
84	695	150	Snapper	280						
85	697	186	Core	103	90	92				
86	698	288	„	110	90	92				
87	699	39	Snapper	92						
88	700	24	„	414						
89	701	50	Core	427	112	94				
90	705	09	„	427	94	108				
91	706	55	„	492	430	231				
92	707	38	„	93	69	139				
93	708	25	„	158	120	146				
94	709	15	Snapper	20						
95	710	9	„	995						
96	711	7	„	160						

DISCUSSION

The most important conditions favourable for the formation of marine sediments rich in phosphorus are (1) a high content of dissolved phosphates in the overlying waters, (2) the concentration of phosphorus by the organisms and their sinking to the bottom after death, and (3) the concentration of phosphorus in the muds as a result of the decomposition of the dead organisms at the bottom. The waters rich in phosphates essential for the intense development of organic life may come either from land through rivers or from the deeper parts of the sea

through upwelling (Bushinski 1964). The sediments rich in phosphorus found on the continental shelf off the coasts of Peru, Chile, south-west coast of Africa and north America have been attributed to the phenomenon of dominant upwelling followed by slow rate of deposition of detrital material (Dietz, Emery and Shepard 1942).

The existence of upwelling along the East Coast of India off Visakhapatnam and Madras has been brought to light by investigations of several workers (Ganapathy, LaFond and Bhavanarayana 1956; Bhavanarayana and LaFond 1957; LaFond 1957; Varadachari 1958; Varma and Reddy 1959). A comparison of the physical characteristics of the shelf waters off Visakhapatnam, Madras and Karaikal has shown that upwelling is more pronounced off Visakhapatnam than off Madras and Karaikal both during the premonsoon and monsoon periods (Murty and Varadachari 1967).

The present investigations reveal that the sediments in the region between Chilka Lake and "Swatch of no ground" are uniformly rich in their phosphorus content while the sediments in the region between Masulipatam and Pulikkat Lake are uniformly poor with those in the region between Visakhapatnam and Masulipatam and Pulikkat Lake and Karaikal coming in between. An examination of the nutrient data (unpublished) in the waters has revealed similar differences in the distribution of phosphates in the waters. Further, a consideration of the biological productivity in general, has revealed similar differences in all the regions except that between Chilka Lake and "Swatch of no ground". In this region the heavy influx of fresh water from the Ganges and Brahmaputra rivers charged with heavy suspended terrigenous matter prevents the development of organic life. The high content of phosphorus in the sediments without much organic life in the overlying waters may perhaps be attributed to the adsorption of the dissolved phosphates in the waters by the silt and clay particles suspended in the waters and their subsequent settling down to the bottom and partly due to the decomposition of the terrigenous organic matter deposited at the bottom. The reason for the absence or almost negligible amount of the biogenous matter in the waters in this region has been explained as due to the high quantity of suspended terrigenous matter and the turbid waters carried to the Bay by the mighty rivers from the Himalayan region (Lisitsyn 1960). Thus the phosphate content in the sediments in the region between Chilka Lake and "Swatch of no ground" may perhaps be attributed to the contribution by the rivers. The low content of the phosphates in the sediments of the Kakinada Bay (10 to 50 mg/gm of silt) and the overlying waters has been traced to the insignificant contribution by the Godavari waters (Shenoy 1960). The same may be the case in regard to the other rivers also in view of the generally low values observed in the sediments in the vicinity of the river systems.

SUMMARY

Studies on the distribution of phosphorus in the shelf sediments off the East Coast of India have revealed that the shelf sediments in the region between

Chilka Lake and "Swatch of no ground" are uniformly rich in their phosphorus content while the sediments in the region between Masulipatam and Pulikkat Lake are uniformly poor in their phosphorus content with those in the regions between Visakhapatnam and Masulipatam and Pulikkat Lake and Karaikal coming in between. While the high concentration of phosphorus found in the region between Chilka Lake and "Swatch of no ground" has been explained as due to the contribution by the rivers from the north, the differences found in the different regions between Visakhapatnam and Karaikal have been attributed to the differences in upwelling and the corresponding differences in the levels of biological productivity.

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