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VERTICAL DISTRIBUTION OF PHOSPHATE, NITRATE AND NITRITE OF LAKSHADWEEP WATERS IN THE ARABIAN SEA

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ABSTRACT

The paper presents the estimation of physico-chemical parameters of seawater samples collected from 28 stations between 07°50' and 13 ° 00' N and between 70°00' and 75°00' E onboard FORV *Sagar Sampada* in February, 1987. Water samples drawn from selected depths of 0, 100, 200, 300, and 500m were analysed for dissolved oxygen and nutrients (phosphate, nitrate and nitrite). In general, lower concentration of nutrients was recorded at surface and 100m depth at all stations. Higher concentrations of nutrient components were encountered at deeper depths with low values of dissolved oxygen. Lowest nutrient values at surface and highest at bottom (500 m) recorded, in microgram-at/l, were PO_4-P: 0.14-7.17; NO_3-NO. 08-27.35 and NO_2-N: Trace - 1.48 except with 1.65 microgram-at/l at 300 m. Probable factors governing the distribution of analysed parameters in Lakshadweep waters are discussed.

INTRODUCTION

Detailed studies dealing with the distribution, cycles, and inter-relationship of the nutrients in the Indian seas have been carried out by many workers viz., Ryther *et al.* (1966), Sankaranarayanan and Reddy (1968), Viswanathan and Ganguly (1968), Reddy and Sankaranarayanan (1968a and 1968b), Sankaranarayanan (1973), Sen Gupta *et al.* (1975, 1976, 1977, 1979), Deuser *et al.* (1978), Devassy *et al.* (1978), Naqvi and Qasim (1983), Sankaranarayanan *et al.* (1983), Sen Gupta and Naqvi (1984) and De and Singbal (1986).

It is understood from the available literature that only limited information is available on the distribution of nutrients in the Lakshadweep Sea. In the present study an attempt has been made to investigate the pattern of distribution of the nutrients such as PO_4, NO_2 & NO_3 in relation to temperature and dissolved oxygen in the Lakshadweep waters based on samples collected onboard FORV *Sagar Sampada.*

MATERIAL AND METHODS

A total of 28 stations covering an area between 08° and 13° N and between 70° and 75°E near to the Lakshadweep Islands were selected and divided into six transects (I to VI) each transect 1° apart covering 4 to 5 stations. Transects and station positions are given in Figure 1.

Water samples were collected by using Rosette sampler from standard depths of 0, 100, 200, 300 and 500m for nutrients estimation. Water samples were analysed immediately after collection onboard the vessel using the Digital Spectrophotometer GS: 5600 (ECIL make) for nutrients following standard methods of Strickland and Parson (1968) for dissolved oxygen. Temperature values were recorded by automatic temperature recorder attached with the rosette sampler. Mean value of each parameter for each transect and each depth was calculated (Tables 1 and 2).

RESULTS AND DISCUSSION

Hydrographic factors

Temperature and dissolved oxygen showed significant variation with depth and little variation among transects.

From the composite average values (Table 1) it was found that waters in southern transects were warmer than that of the northern. Vertical temperature values (Table 2) ranged between 27.9 and 10.20°C with an average of 18.0°C.

Dissolved oxygen

Oxygen concentration (Table 2) ranged from 5.0 to 0.1 ml/l (Ave. 1.5) Vertical distribution of dissolved oxygen showed a sharp decrease from surface down to 200 m and thereafter values remained almost constant. Composite average values with respect to south and north transects revealed that Lakshadweep waters of southern area were

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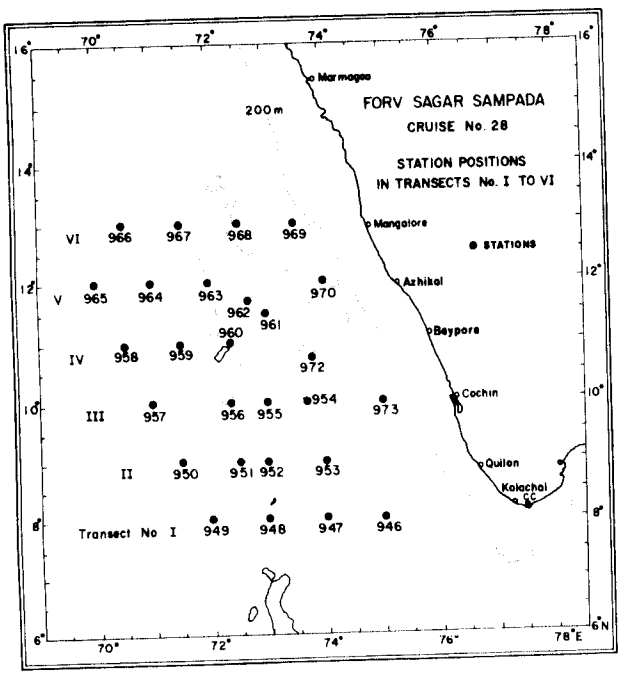

Fig. 1. The positions of stations and transects chosen for the study in the Lakshadweep Sea.

higher in oxygen level than that of the northern region (Table 1).

Nutrient distributions

The possible reasons for the depthwise and regional variation of nutrients content in the Arabian Sea and in Lakshadweep waters particularly have been discussed by Red Field *et al.* (1963), Reddy and Sankaranarayanan(1968 a, 1968 b), Sankaranarayanan (1973), Sen Gupta *et al* . (1975, 1979), Devassy *et al.* (1978) and De and Singbal (1986). It is assumed that the distribution of nutrients and hydrographic parameters in Lakshadweep waters appeared to be more dependent on the dilution, general current pattern and source of origin of water masses.

Phosphate

The lowest and highest values observed were 0.76 µg-at/l at surface and 5.76 µg-at/l at 300 m in transects V and VI respectively. PO_4 values showed an increasing trend from surface to bottom in transects I, IV & V whereas in transects II, III and VI the values increased upto 300 m and then gradually decreased down to 500 m. The observed mean (3.78 µg-at/l)

TABLE 1. *Transectwise mean and composite average values of nutrient and hydrographic parameters of Lakshadweep waters during February , 1987*

Regions		Parameters				
		Phosphate (µg-at/l)	Nitrate (µg-at/l)	Nitrite (µg-at/l)	Temp. (°C)	Dissolved oxygen (ml/l)
Southern region	I	4.11	13.17	0.11	17.6	1.56
	II	3.63	14.28	0.21	18.3	1.74
	III	3.56	11.62	0.14	18.3	1.54
Composite average	(I - III)	3.76	13.02	0.15	18.1	1.61
Northern region	IV	3.76	12.03	0.14	17.9	1.44
	V	3.58	11.08	0.12	18.0	1.60
	VI	4.14	12.68	0.42	15.4	1.36
Composite average	(IV - VI)	3.87	11.93	0.23	17.4	1.47
Range of average values	(I - IV)	0.76 - 5.76	0.57 - 21.66	0.03 - 0.70	27.4 - 10.7	4.30 - 0.40
Mean values		3.78	12.45	0.19	18.0	1.5

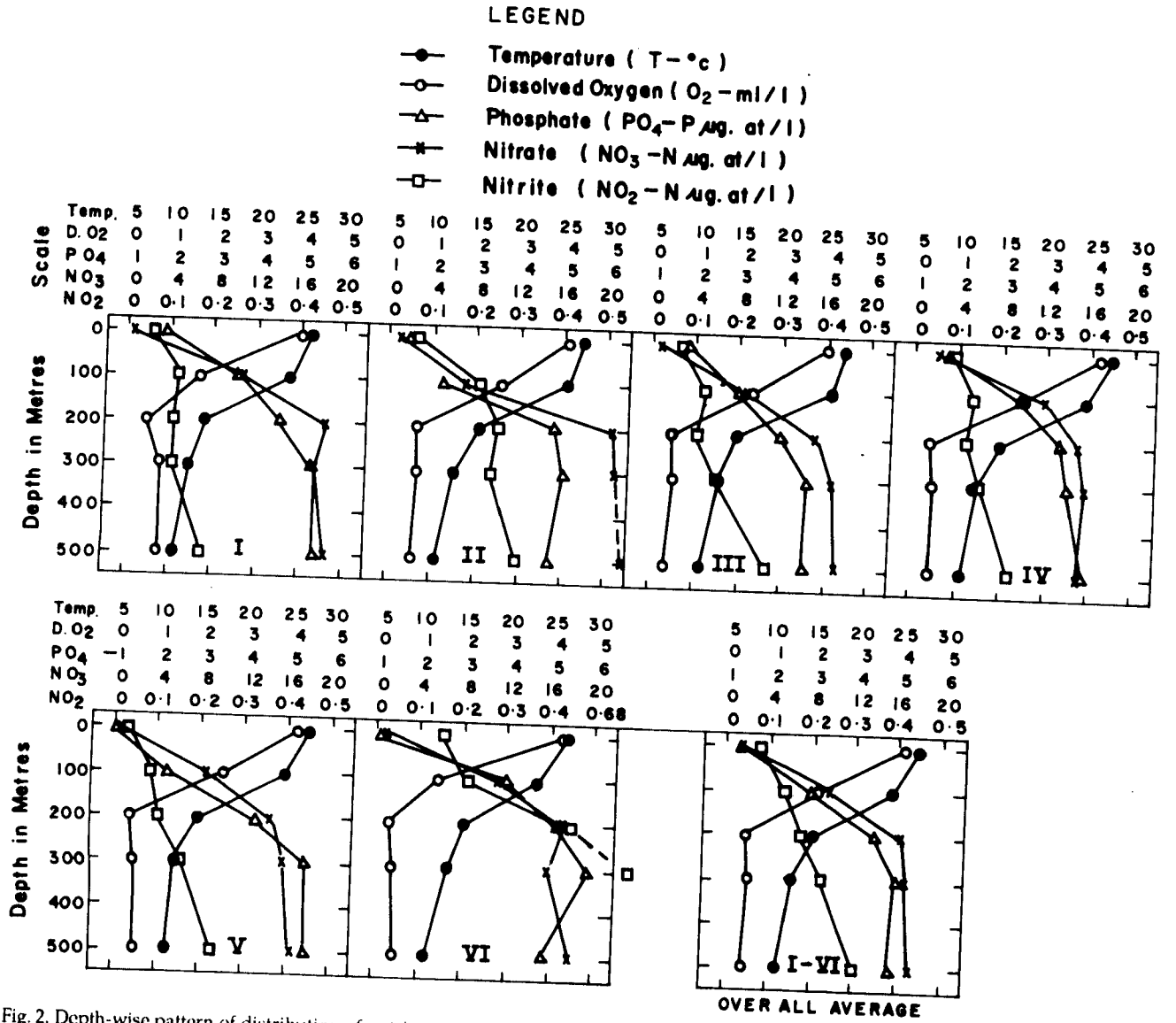

Fig. 2. Depth-wise pattern of distribution of nutrients and hydrographic parameters in the Lakshadweep waters.

was almost similar to those reported earlier by Viswanathan *et al.* (1967) in west coast of northern Indian Ocean and by Sen Gupta *et al.* (1976a and 1979) in the Arabian Sea. Later Devassy *et al.* (1978) reported higher PO_4 range (2.00-13.15 µg-at/l) from oceanic waters in the presence of bloom conditions than those of normal oceanic waters. Composite average values observed were 3.76 and 3.87 µg-at/l in south and north transects respectively. This revealed that PO_4 content was higher in waters of northern transects and hence an increasing trend from south to north was noticed (Fig. 2 and Table 1). High amount of phosphate content in deeper waters may be due to absence of photosynthetic activity.

Another reason for depth-wise increase of PO_4 in oceanic conditions may be that due to oxidation of organic matter in intermediate depths, depletion of oxygen takes place with concomitant release and increase of PO_4 (Red Field *et al.*, 1963).

Nitrate

NO_3 content showed an increasing trend with depths in all transects except I & VI where it decreased at 300 m and then increased down to 500 m depth (Fig. 2). Lowest and highest values (Table 2) recorded were 0.57 µg-at/l at surface and 21.66 µg-at/l at 500 m in respect of transects V and II. Composite average values (Table 1) were 13.02 and 11.93

TABLE 2. *Depth-wise analysis for nutrients and hydrographic parameters for Lakshadweep waters during February, 1987*

Depth (m)	Parameters				
	Phosphate (µg-at/l)	Nitrate (µg-at/l)	Nitrite (µg-at/l)	Temp. (°C)	Dissolved oxygen (ml/l)
0	0.76 - 1.87 (1.41)	0.57 - 2.36 (1.00)	0.03 - 0.15 (0.07)	26.3 - 27.4 (27.1)	4.0 - 4.3 (4.1)
100	2.18 - 3.96 (2.98)	7.12 - 11.77 (9.55)	0.08 - 0.22 (0.13)	23.3 - 26.8 (24.2)	1.4 - 2.6 (2.1)
200	4.00 - 5.09 (4.45)	14.26 - 20.56 (16.55)	0.10 - 0.44 (0.17)	14.4 - 15.5 (15.0)	0.3 - 0.7 (0.5)
300	4.47 - 5.78 (5.00)	15.55 - 20.90 (16.95)	0.10 - 0.58 (0.22)	12.3 - 13.0 (12.6)	0.25 - 0.8 (0.5)
500	4.49 - 5.37 (4.90)	15.24 - 21.66 (17.52)	0.17 - 0.70 (0.30)	10.5 - 10.8 (10.8)	0.4 - 0.8 (0.49)
Range (0 - 500)	0.14 - 7.17 (3.78)	0.08 - 27.35 (12.45)	Trace - 1.48 (0.19)	27.9 - 10.2 (18.0)	5.0 - 0.1 (1.5)

µg-at/l in southern and northern transects which revealed a decreasing trend from south to north. Observed average values in the present study were slightly lower than those reported by Sen Gupta *et al.* (1976) for the same depth range along 9° -14° N Lat. in northwestern Indian Ocean. Overall average (12.45 µg-at/l) was also lower (16 µg-at/l) than that reported earlier by Sen Gupta *et al.* (1976a) from northeastern basin of the Arabian Sea. Low NO_3 values may arise first from a high rate of denitrification and secondly due to the net effect of the bio-chemical processes (Deuser *et al.*, 1978).

Nitrite

Figure 2 shows that NO_2 content has an irregular trend of increasing and decreasing with depth in all transects though the values increased gradually from surface to lower layers in transects V & VI. The composite values recorded (0.15 and 0.23 µg-at /l) (Table 1) for south and north transects revealed an increasing trend from south to north. Nitrite values were very low at surface and found to increase gradually with intermediate depths. Observed average values varied from 0.03 to 0.70 µg-at/l with an overall average of 0.19 µg-at/l (Table 1). Sen Gupta *et al.* (1976a) observed a range of 0.38 to 1.56 µg-at/l of NO_2 for the waters from surface to 900 m depth of the eastern Arabian Sea. Sen Gupta *et al.* (1979) found a range of NO_2 values (0.16-0.20 µg-at/l) for the surface layers of the Lakshadweep waters which are comparable to the values of the present study (0.03-0.22). Since the concentrations and differences of nitrite values were of low orders, no special emphasis could be made on the factors governing nitrite content variation. Increase in nitrite content at surface layers results from denitrification as well as by air-sea interaction of exchange of chemical elements. It is interesting to note that below the depth of about 200 m the nitrates were steady whereas nitrite content increased with depth (Fig. 2). The increase of nitrite in the deeper layers (200 m) may be attributed to the presence of bacteria favourable for the denitrification. The release of oxygen in the process of denitrification might have been used by bacteria for their survival, reducing the oxygen content very much (De and Singbal, 1986). The process of denitrification involves the use of NO_3 ions as the next source of energy when all oxygen from the system has been utilized. During this process NO_2 ions are formed as the intermediate product and gaseous nitrogen as the end product.

Conclusions

In general, phosphate and nitrate showed a regular trend of distribution whereas nitrite showed an irregular pattern of distribution with depth. The intensity of their depth-wise increase was in the order as NO_3, PO_4, NO_2. The distribution of PO_4 and NO_2 showed an increasing trend whereas NO_3 indicated a decreasing trend from south to north. The low nutrient, might be related to the denitrification process and diffusion of currents contributing to the nutrient depleted waters. And also high level of nutrients could be resulted from the mineralization of organic material through bacterial oxidation and chemical decomposition.

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