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ENVIRONMENTAL INVENTORY AND THE DISTRIBUTION OF INORGANIC NUTRIENTS IN A TROPICAL ESTUARY OF THE SOUTH-WEST COAST OF INDIA

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ABSTRACT

Dissolved nutrients (PO_4-P, NO_3-N, NO_2-N and SiO_4-Si estimated in the surface and bottom waters of five selected stations of the Paravur lake during February 1987 to January 1988 revealed distinct seasonal variations. Rainfall and land drainage play significant roles in the nutrient economy, particularly NO_3-N and SiO_4-Si, of this water body. Abnormally high values of PO_4-P indicated extremely polluted condition at the retting zone of the lake during the pre-monsoon season. Sio_4-Si showed signicifant negative relationship with salinity.

INTRODUCTION

Investigation on the distribution and seasonal variations of nutrients is a prerequisite for assessing the biological economy of an estuarine milieu. Studies on this aspect in tropical environments have been made by several workers (Sankaranarayanan and Qasim, 1969; De souza *et al.*, 1981; Saraladevi *et al.*, 1983; Nair *et al.*, 1984; Upadhyay, 1988). The present paper discusses the spatial and temporal distribution of inorganic nutrients at the five selected stations of the Paravur lake, a temporary estuary along the South-west coast of India (Fig. 1).

MATERIAL AND METHODS

Water samples for the analysis of PO_4-P, NO_3-N, NO_2-N and SiO_4-Si were collected at monthly intervals for a period of one year (February'87 - January'88) from two depths, surface and near bottom. The procedures suggested by Strickland and Parsons (1972) were followed for the sample collection and analysis.

RESULTS AND DISCUSSION

Results (Fig. 2) show wide fluctuations in phosphate-phosphorus concentrations with high values during pre-monsoon (February-May). This is in contrast to earlier reports (Sankaranarayanan and Qasim, 1969; De Souza *et al.,* 1981; Nair *et al.,* 1984). As the bar remained closed during this period normal flushing of nutrients from the lake into the sea did not take place. Coupled with this, the high rate of evaporation prevailing at that time might also contribute to the replenishment of phosphate in this system during the pre-monsoon. Even though all the stations, except station 5 showed some increase in phosphate-phosphorus content during early monsoon, higher levels were not maintained for any considerable length of time at any of the stations. So also the distribution of this nutrient in the water column was not uniform in the monsoon season even though vertically homogenous conditions prevailed. Hence it seems that even though some enrichment in this nutrient takes place with the first pulse of the monsoon, no significant contributions are made from the river influx. This is further evidenced by the fact that very low concentrations and even nil values were noted at all the stations during the post-monsoon when there was considerable rainfall and river runoff. This fully agrees with the report of Upadhyay (1988). Ithikkara river carries very high sediment load in the flood waters (Azis, 1978) which might be the reason for phosphate removal by adsorption causing low values during the post-monsoon. The surface and bottom water showed almost the same trend of variation in the phosphate-

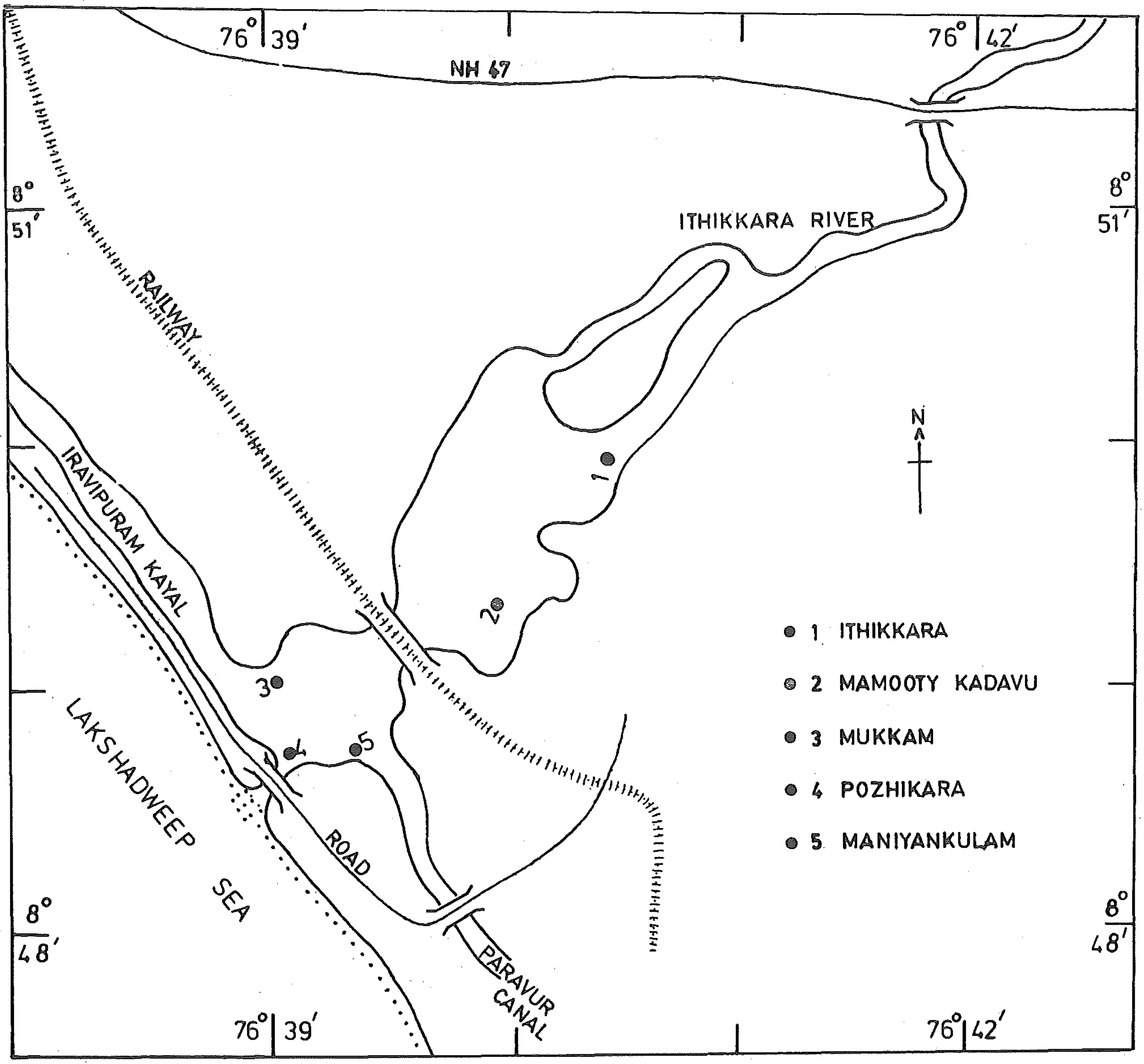

Fig. 1. *Location of sampling stations (Paravur lake).*

phosphorus concentration. On most of the occasions, bottom water values were slightly higher than those of the surface except at station 5, where a reverse condition was discernible.

In general, the phosphate-phosphorus concentration of the medium ranged from nil to 1.46 μg. at. l^{-1}, when stations 1, 2, 3 and 4 are taken into account barring a stray incident at station 4 in February when an unusually high value of 5.07 μg. at. l^{-1} was recorded. The cause of this variation can by all probability be attributable to the incursion of polluted water from the nearby retting zone (station 5). Unlike the other stations, station 5, a retting enclosure highly polluted with the ret liquor and H_2S coupled with anoxic condition, recorded abnormally high phosphate values throughout the pre-monsoon period. Similar results have been reported by earlier workers (Azis, 1978; Nair *et al.*, 1983).

Inorganic phosphate concentration is a useful index of the state of eutrophication of water bodies. Ketchum (1967) held the view that 2.55 μg. at. l^{-1} is the upper limit of phosphate concentration in eutrophication of estuaries. In the present study stations 1,2,3 and 4 had consistantly lower values throughout the year whereas station 5 surpassed this limit during the entire pre-monsoon period.

As reported by several workers, the prime

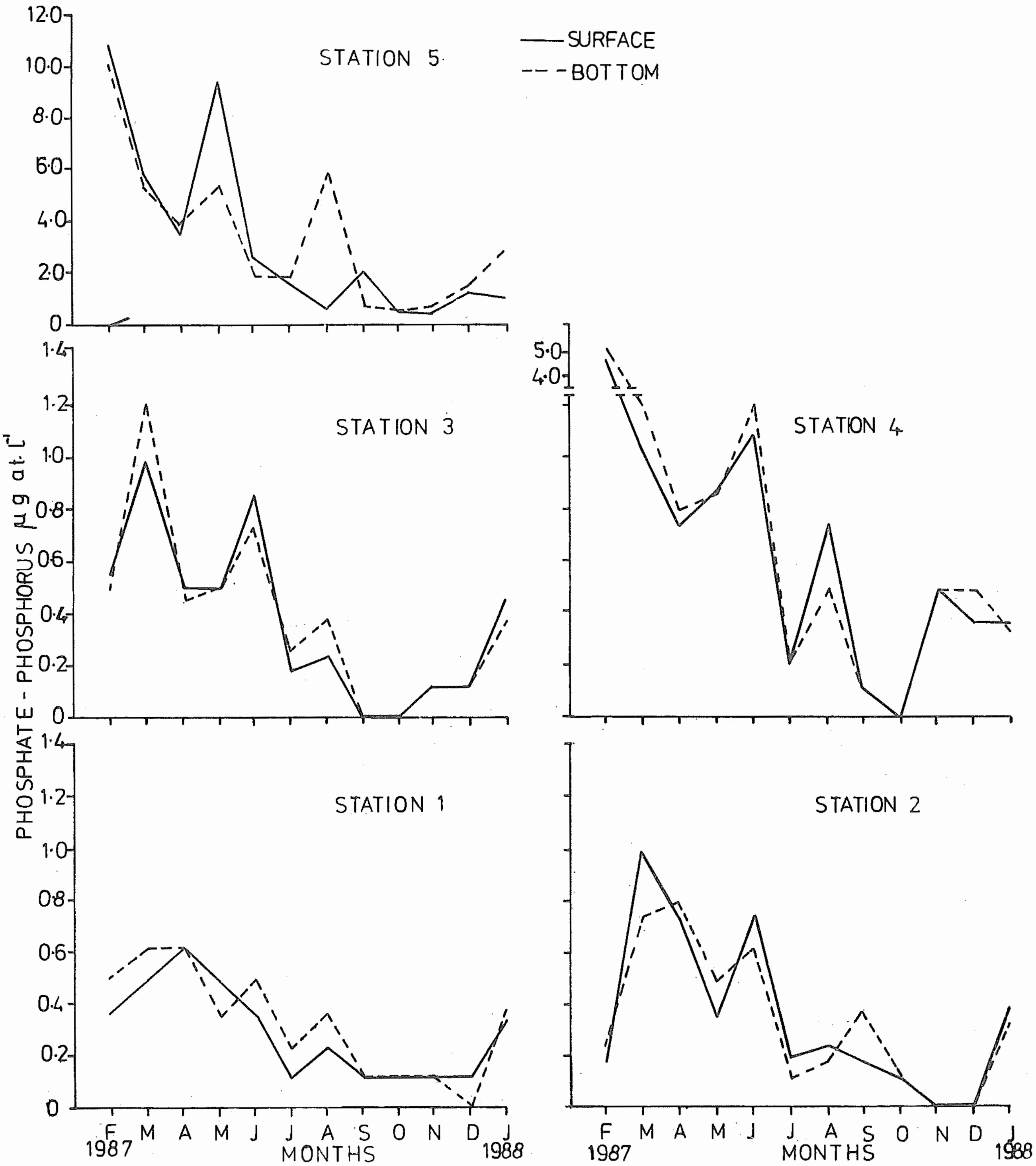

Fig. 2. *Seasonal variations in Phosphate-phosphorus*

source of nitrogeneous nutrients in an estuary are from the river run off during the monsoon rains and also from *in situ* fixation. In the present study also the nitrate-nitrogen concentration registered a sharp increase during the onset of the monsoon and a decrease as the season progresses (Fig. 3). After the peak in May-June, the nitrate-nitrogen values dropped during the following months prior to another increase in October with the advent of the north-east monsoon. Influence of nitrate rich fresh rainwater could explain for the higher values recorded. This agrees fairly well with the earlier reports (Azis, 1978; Saraladevi *et al.*, 1983; Gopinathan, 1985). Nitrate concentrations were fairly good in the medium during February to April (pre-monsoon). The high rate of evaporation and the decomposition of dead organic matter account for this (Zafar, 1964).

A comparative study between station 5, a highly polluted zone, and the other stations revealed that in the former nitrate values were much lower than those in the latter throughout the period of study. The low values for the polluted region could be due to low rate of replenishment during the degradation of organic matter and also possibly due to reduction as suggested by Nair *et al.* (1984).

The concentration of nitrite-nitrogen was generally found to be much lower than that of nitrate. Nitrite-nitrogen exhibited a bimodal annual cycle with peaks during the pre- and post-monsoons (Fig. 4). In the present study the nitrite-nitrogen concentration was higher during the post-monsoon with the peak in October except at station 5 where seasonal averages showed more or less similar pattern during all the seasons. This increase in nitrite levels in the water column during the post-monsoon period is probably related to the north-east monsoon showers. Nonetheless, a clear relationship with the seasons as in the case of nitrate is not apparent. Similar observations were made by different workers in various waters (Saraladevi *et al.*, 1983; Nair *et al.*, 1984; Kahar, 1988). During the pre-monsoon period moderate concentrations of this nutrient detected in the present study might be due to the oxidation of ammonia, reduction process of nitrate, excretion of phytoplankton and by the recycling of nitrogen (Sankaranarayanan and Qasim, 1969; Rajendran, 1974). The seasonal variation observed in the nitrite-nitrogen concentration may thus be due to the predominance of any one of these processes depending upon the biological activity prevailing in the area.

In estuaries the mixing of the silicon-rich freshwater with silicon-poor saline water plays an important role in governing the dissolved silicon distribution. In the present study when the salinity was low during the monsoon and post-monsoon periods the concentration of silicate-silicon was found to be high (Fig. 5). This inverse relationship between salinity and silicate concentration agrees well with earlier reports (Nair *et al.*, 1983; Gopinathan, 1985). Seasonal averages have indicated low concentration of silicate-silicon in the medium during pre-monsoon when the salinity was high confirming the views referred to above. An abrupt increase in this nutrient was evident at all stations early in the monsoon season (June). Higher levels were maintained for a longer period i.e., till December with a peak in October during which time rainfall in this area was intense. The data of the present study clearly indicate the riverine input of silica into the estuary. The influence of oceanic contribution of dissolved silicon seems to be insignificant compared to that from the riverine source.

Variations in salinity (Table 1) and SiO_4-Si (Fig. 5) show the inverse relationship between these two factors. Higher values of SiO_4-Si during the rainy season can be attributed to the heavy river discharge during the monsoon. Pre-monsoon showed the reverse condition coupled with higher salinity values. These observations indicate the riverine input of silica into this estuary.

In general the nutrient budget particularly

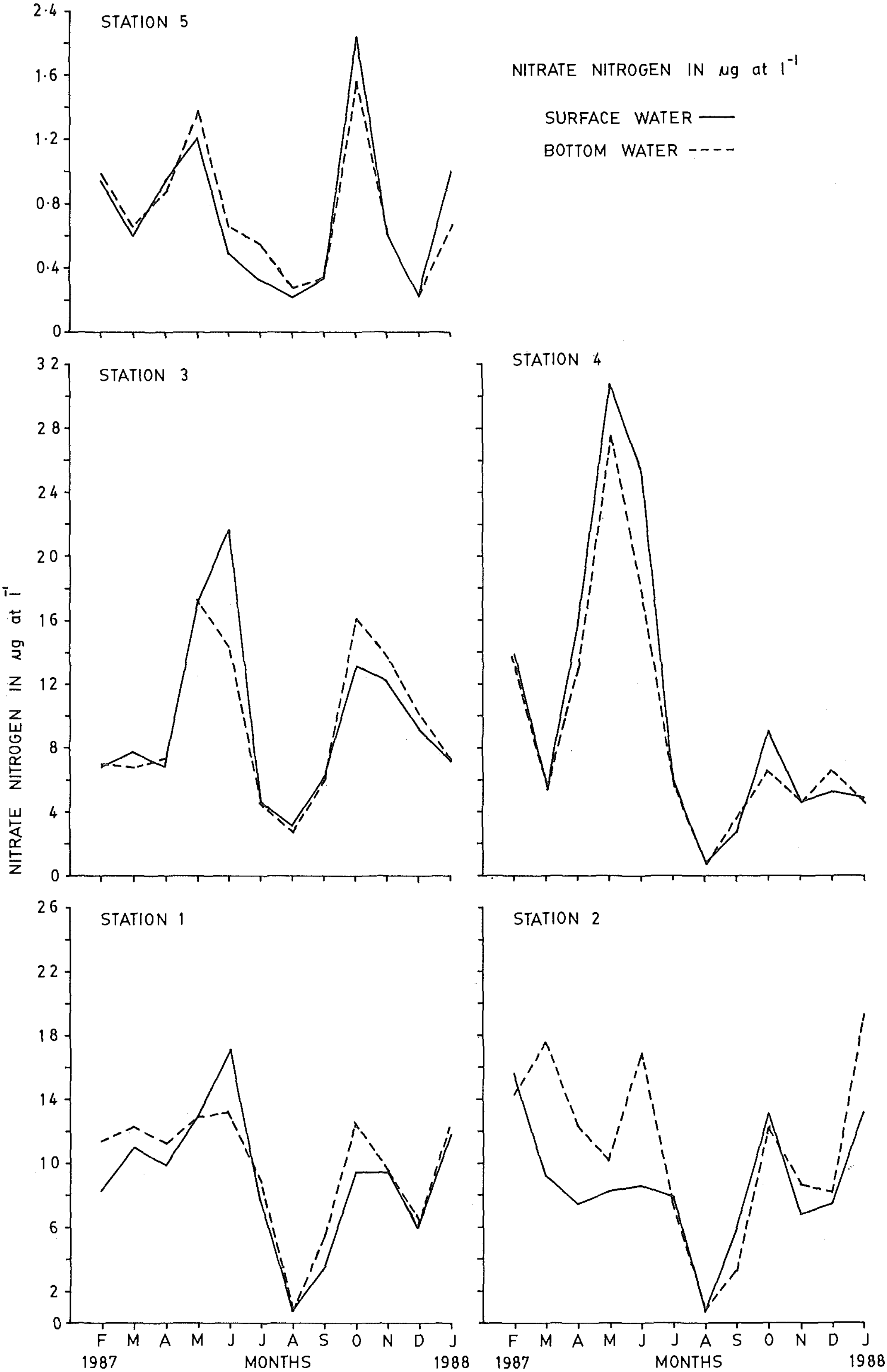

Fig. 3. *Seasonal variations in Nitrate-Nitrogen concentration*

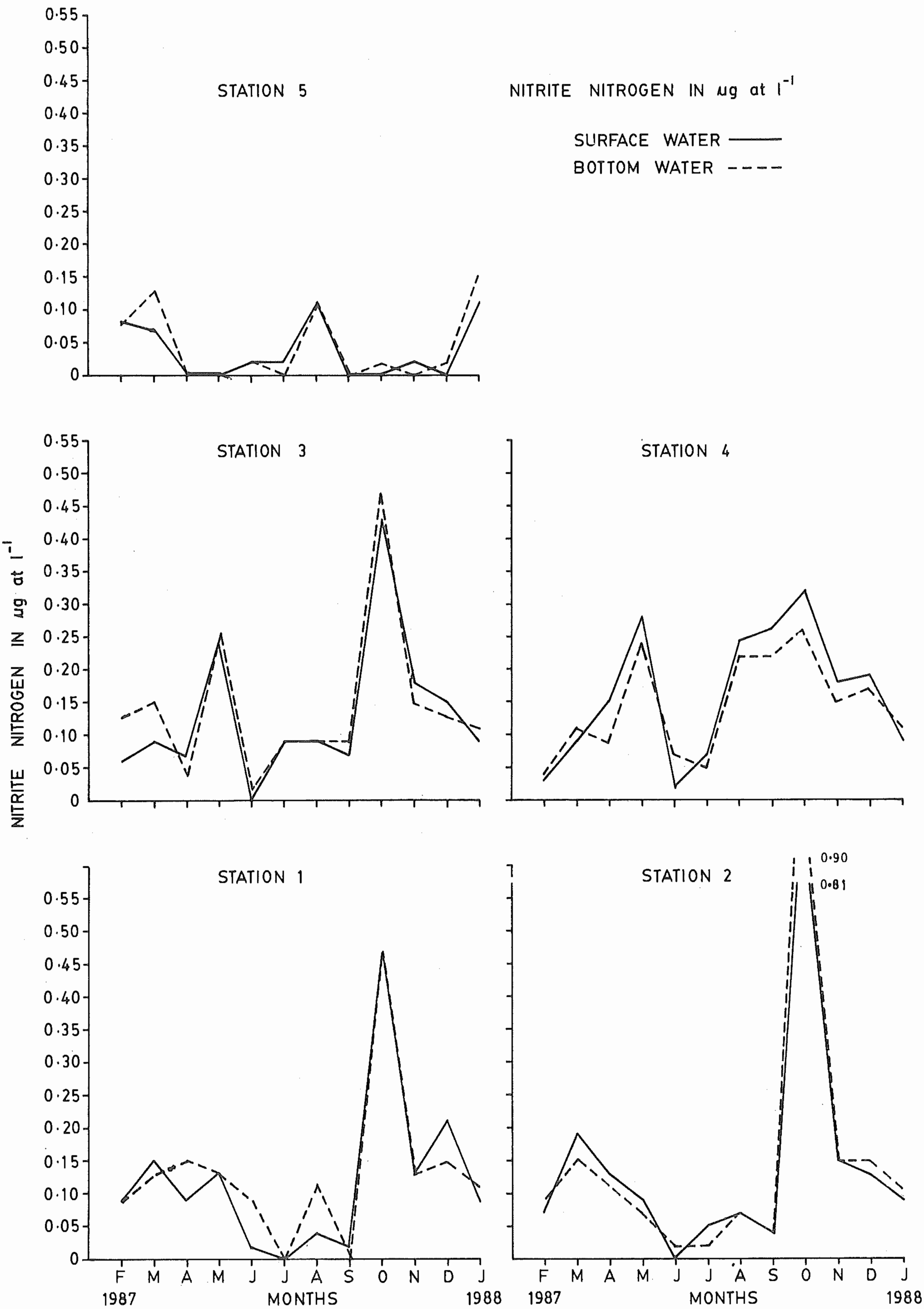

Fig. 4. *Seasonal variations in Nitrite-Nitrogen*

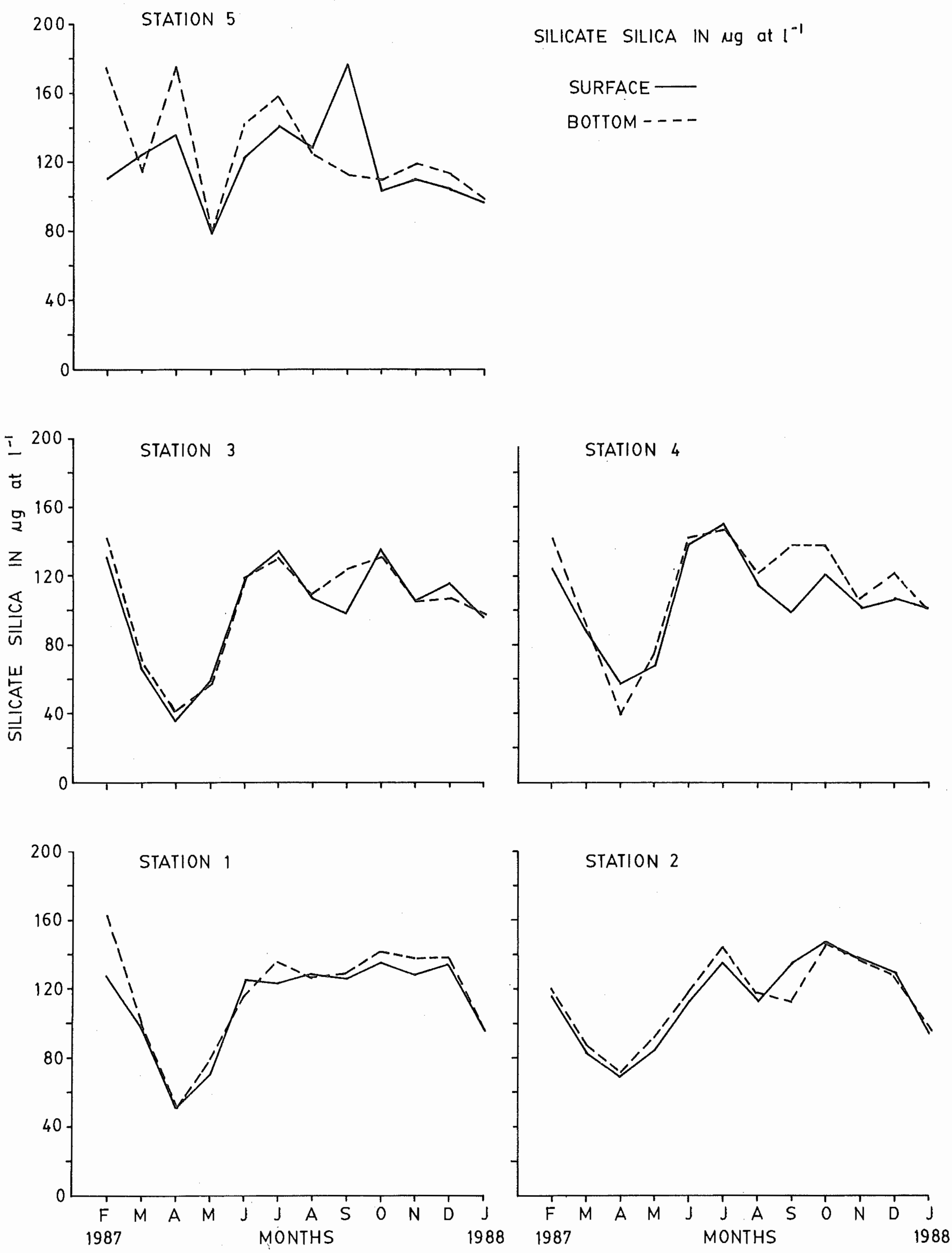

Fig. 5. *Seasonal variations in silicate-silicon*

Table I. *Monthly variations of salinity %o at the five stations during 1987-88.*

Month	SALINITY									
	Station 1		Station 2		Station 3		Station 4		Station 5	
	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW
Feb.'87	2.05	2.15	4.75	4.85	7.00	8.45	5.65	5.70	4.55	4.35
Mar.	3.40	3.70	7.15	7.25	8.70	10.65	8.60	8.65	7.90	7.70
Apr.	4.33	4.35	11.00	10.97	12.60	14.75	12.17	12.10	11.90	11.90
May	5.10	5.15	11.90	11.90	15.70	15.85	14.30	14.40	14.80	14.80
June	0.20	0.23	0.77	0.80	2.02	4.22	0.70	1.77	6.30	7.70
July	0.95	0.90	1.32	1.37	2.30	2.52	1.97	1.80	2.80	2.80
Aug.	1.90	1.95	2.00	2.00	0.90	0.95	3.55	3.60	3.40	3.40
Sept.	0.55	0.70	0.50	0.60	0.95	0.97	3.15	2.20	2.00	2.25
Oct.	0.20	0.18	0.17	0.17	0.57	0.62	0.82	0.82	1.72	1.70
Nov.	0.60	0.57	0.45	0.47	1.62	1.75	1.35	1.57	1.80	1.80
Dec.	1.50	1.47	1.55	1.55	3.00	3.75	3.05	3.20	2.90	2.90
Jan.'88	2.70	2.85	2.95	3.05	4.50	6.60	4.45	4.55	3.55	3.55

SW- Surface water, BW- Bottom water

those of nitrate and silicate are considerably affected by the magnitude of rainfall and land drainage. Even though variation in the concentrations are seldom common to the water column, absolute values at the surface and bottom did not differ much during most of the time probably on account of the shallow nature of the water body.

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