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SEASONAL VARIATIONS IN SODIUM, POTASSIUM AND MAGNESIUM IN THE COCHIN BACKWATER

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ABSTRACT

Seasonal variations of sodium, potassium and magnesium in the backwater of Cochin were studied during the four seasons of 1973-'74. Na/Cl ratio of the estuarine water closely follows that of sea water through the various seasons. Monsoon rains were found to influence the Mg/Cl ratio of the estuarine water, the general trend being toward an increase in the ratio with lowering chlorinity. The value of K/Cl ratio was always higher for the estuarine water compared to sea water and the ratio increases with decrease in chlorinity. In all seasons the observed amounts of potassium for various samples were found to have a linear relation to chlorinity.

INTRODUCTION

THE COCHIN BACKWATER is situated on the west coast of India between latitudes 09°40′ and 10°10′N and longitudes 76°10′ and 76°25′E. Two large rivers Periyar in the north and Pampa in south, are the major freshwater sources for this backwater system. The small river called Muvattupuzhayar about midway between these two also open in to the lake. A channel, about 450 m wide at Cochin gut, makes permanent connection with the Arabian Sea and transmits the tidal energy and sea salts into the lake. The backwater receives an average rainfall of 33,000 mm, usually from June to September. Except in areas around Willingdon Island the estuarine system has low salinity during this season. The tidal action responsible for salt water upstream in this estuary has been discussed by Josanto (1971) Sankaranarayanan and Qasim (1969).

The present study was undertaken with the view of estimating the major chemical elements of this estuarine system where salinity is subject to continuous variation due to penetration of salt water from the adjacent coastal water and discharge of fresh water by two major rivers. The Cochin backwater system has so far been studied with emphasis mainly on temperature, salinity and seasonal abundance of plankton, pigments, light penetration and nutrient distribution, (Balakrishnan, 1957 ; Ramamirtham and Jayaraman, 1960 ; George and Kartha, 1963 ; George, 1958 ; Josanto, 1971 ; Qasim and Reddy, 1967 ; Qasim *et al.*, 1968 ; Sankaranarayanan and Qasim, 1969). The present investigation is the first one to lay stress on the distribution characteristics of sodium, potassium and magnesium in this backwaters.

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MATERIAL AND METHODS

Fifteen stations were selected in the main body of the estuary (Fig. 1). Water samples were taken only from surface and bottom. Surface samples were taken with a plastic

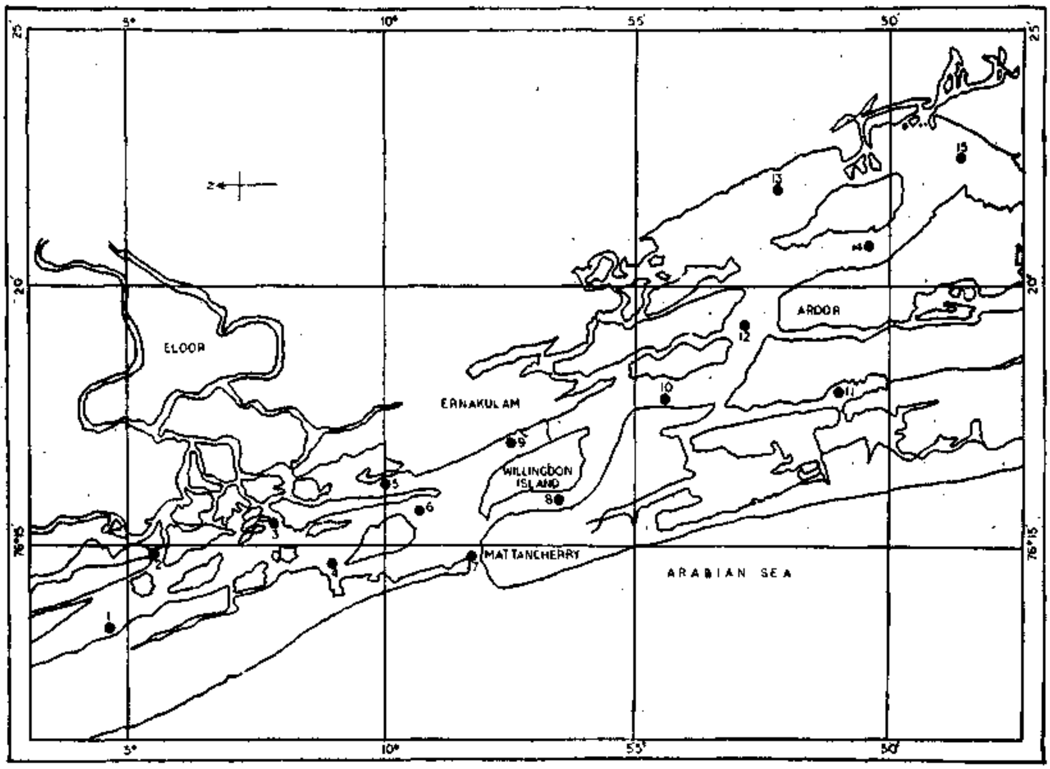

Fig. 1. Vembanad Lake and adjoining regions with station positions.

bucket and bottom samples with a non-metallic bottom sampler. All samples were stored in polythene containers and kept cold until they could be analysed. The majority of stations have a depth of 2-4 m while stations around Willingdon Island have depths of 10-12 m. Sodium, potassium and magnesium were estimated by the method of Culkin and Cox (1966) and chlorinity by the Kundsen's method. The mean values were calculated from the data obtained for surface and bottom samples at each station.

For testing the significance of difference between mean values of sodium, potassium and magnesium for various seasons t test was employed as applied by Croxton and Cowden (1950).

X_A and X are the mea n values obtained for N_A and N_B (N_A and N_B are the number of samples of two different months) respectively. Var A and Var B are respectively the values $[(N_A - 1) \times$ Variance of I Group$]$ and $[(N_B - 1) \times$ Variance for other group$]$. Standard error of the difference between means is given by (S.E.) $X_{(A-B)}$ =

$$\sqrt{\frac{(N_A + N_B)\ (\text{Var A} + \text{Var B})}{N_A\ N_B\ (N_A - 1 + N_B - 1)}}$$

$$T\ \text{cal} = \frac{X_A \sim X_B}{(\text{S.E.})\ X_{A-B}}$$

Results and Discussion

Distribution of Chlorinity in the Cochin Backwater system is the effect of the combined action of water movement induced by fresh-water discharge, tidal variation and mixing between fresh water and salt water. Depending on the degree of mixing, salinity varies from a well mixed type to a stratified type, the former indicating the predominance of the tidal forces over fresh water flow and latter that of fresh-water over weak tidal flow. The land run off, induced by monsoon rain was found to influence the concentration of nutrients in this back-water system (Sankaranarayanan and Qasim, 1969). Similar effects were found to smaller extent on the ionic distribution also.

Magnesium: The results of the present observations and statistical analysis of seasonal differences are given in Tables 1 and 2. The mean value of Mg/Cl ratio in July was 0.06697 for the 12 stations with a standard deviation of 0.0003. The value was comparatively higher than for other months and is approximately 0.3 % greater than that of March. The influence of land run off during rainy season possibly contribute to excess magnesium found in July. Chlorinity values at majority of stations were comparatively low in July (Fig. 2).

TABLE 1

Month	Mg (g/kg) Cl‰	Standard deviation	No. of stations	No. of samples
July 1973	0.06697	0.0003	12	24
October 1973	0.06679	0.0002	14	28
January 1974	0.06677	0.0002	14	28
March 1974	0.06670	0.0002	15	30

TABLE 2. *Results of tests of significance between mean values of Mg/Cl ratio*

Group	t calculated	t table	Significance
July-October	.. 12.693	1.96	Highly significant
July-January	.. 14.104	1.96	Highly significant
July-March	.. 19.708	1.96	Highly significant
October-January	.. 1.95	1.96	Significant
October-March	.. 9.063	1.96	Highly significant
January-March	.. 7.07	1.96	Highly significant

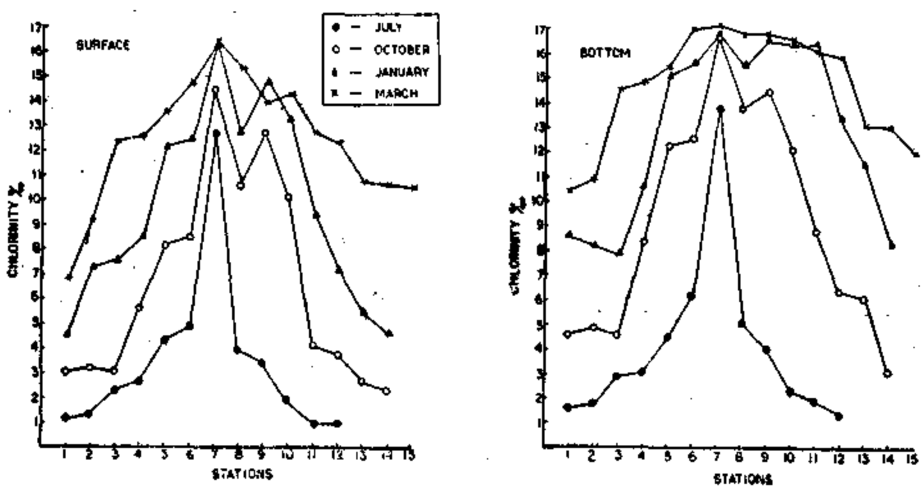

Fig. 2. Seasonal variations in chlorinity values of surface and bottom samples at different stations.

Sodium : The results of estimation of sodium in the estuarine water during different seasons are summarised in Table 3. A slight increase observed in the Na/Cl ratio in July is possibly sodium from land run off. Results of the tests of significance of the mean values of Na/Cl ratio during various months (Table 4) indicate that the differences in mean values between different months are significant.

TABLE 3

Month	Na (g/kg) Cl‰	Standard deviation	No. of stations	No. of samples
July 1973	0.5573	0.0015	12	24
October 1973	0.5567	0.0012	14	28
January 1974	0.5561	0.0012	14	28
March 1974	0.5559	0.0010	15	30

TABLE 4. *Results of the tests of significance between mean values of Na/Cl ratio*

Group	t calculated	t table	Significance
July-October ..	7.948	1.96	Highly significant
July-January ..	15.844	1.96	Highly significant
July-March ..	20.449	1.96	Highly significant
October-January ..	9.740	1.96	Highly significant
October-March ..	14.598	1.96	Highly significant
January-March ..	3.646	1.96	Significant

Potassium : The distribution characteristics of potassium was found to differ from those of sodium and magnesium. An examination of the K/Cl values reveal the following : (1) K/Cl ratio for each station depends on the chlorinity and season (2) The ratio increases with decrease in chlorinity. This differs from the pattern observed in sea water (Culkin and Cox, 1966 ; Fukai and Shiokawa, 1955).

In July the maximum value of K/Cl obtained was 0.02496 at station 1 with a chlorinity of 1.2‰ and the minimum was 0.02074 for a chlorinity of 13.8‰ at station 7. A plot of the observed amount of potassium against chlorinity was found to be a straight line with a slope of 0.02065 (Fig. 3 a). It makes an intercept on the y axis at 0.00628. The values were computed by least square method (Mether, 1966) for 12 stations (24 samples). A linear equation for the observed line can be represented by the relation.

$$K = 0.020653 \ Cl + 0.00628$$

Where K is the amount of potassium (g/kg) and Cl. is the chlorinity (‰). Deviation from the above relation was less than ± 0.5%

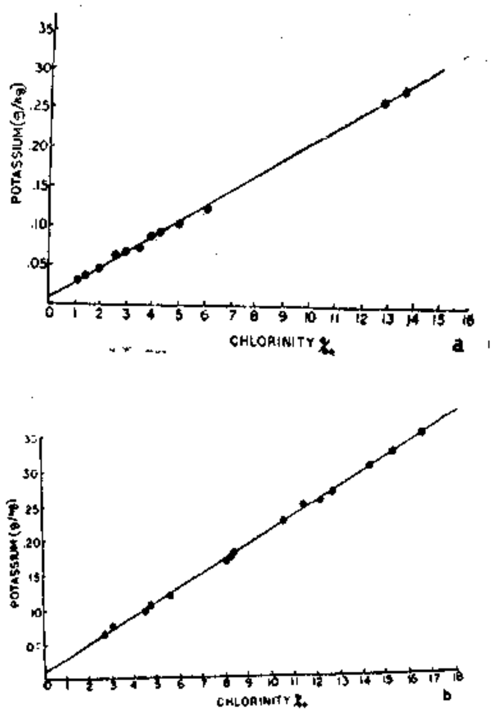

Fig. 3. Distribution of potassium during a. July and b. October 1973.

With the increase of chlorinity the value of K/Cl ratio was found to alter at each station in the preceeding months. The highest and lowest values of K/Cl ratio observed during October was 0.02203 and 0.0209 at stations 7 and 14 respectively. By the method of least squares the linear equation obtained for 28 samples was $K = 0.020614\ Cl + 0.00413$. Deviation from the general behaviour was less than 0.3% (Fig. 3 b). Similar behaviour was found in January and March and the observed results can be represented by the equations $K = 0.020614\ Cl + 0.003116$ and $K = 0.02061\ Cl + 0.0030$ respectively.

From the above results it is seen that the total amount of potassium for a given chlorinity at different seasons follow a general linear relationship of the form $K = X\ Cl + c$—Eq. (1) Statistical analysis using least square method has shown that the difference between the values of X is negligible so that the value of K/Cl for various seasons depends on the variations in the contents c. For a given chlorinity therefore the general equation reduces to

$$K = K' + c \text{ — (2) where } K' = X\ Cl.$$

$$\text{So that } \frac{K}{Cl} = \frac{K' + C}{Cl}$$

From the above relation it can be seen that- for a given value of e, the influence of c is prominent at low chlorinity. Statistical analysis of the general behaviour showed that the difference in value of c are rather negligible. From the general equation (1), when c is negligible, the value of K is given by the relation.

$$K = X\ Cl. \text{ So that } \frac{K}{Cl} = X.$$

The value of X is taken to be 0.02061 which closely follow the relative ratio for sea water and agrees with the observations of Culkin and Cox (1966). Hence the value of c may be considered on the excess potassium contributed to the estuarine system mainly by fresh water discharge.

References

BALAKRISHNAN, A. 1957. Variation of salinity and temperature in Ernakulam channel. *Bull. cent. Res. Inst. Univ. Kerala*, **5** : 7-9.

CROXTON, F. E. AND D. J. COWDEN 1950. *Applied General Statistics*. Pitman, London. pp. 1-330.

CULKIN, F. AND R. A. COX 1966. Sodium, potassium, magnesium, calcium and strontium in sea water. *Deep-Sea Res.*, **13** : 789-804.

FUKAI, R. AND F. SHIOKAWA 1955. On the main Chemical components dissolved in adjacent waters to Aleutian Islands in the North Pacific. *Bull. Chem. Soc. Japan*, **28** : 636-640.

GEORGE, M. J. 1958. Observation on the plankton of Cochin Backwaters. *Indian J. Fish.*, **5** : 375-401.

——— AND K. N. KARTHA 1963. Surface salinity of Cochin Backwater with reference to tide. *J. mar. biol. Ass. India*, **5** : 178-184.

JOSANTO, V. 1971. Bottom salinity characteristics and factors which influence the salt water penetration in the Vembanad Lake. *Bull. Dept. mar. Biol. Oceangr. Uni. Cochin*, **5** : 1-16.

MATHER, K. 1966. Statistical Analysis in Biology. Matheens and Co. Ltd. London.

QASIM, S. Z. AND C. V. G. REDDY 1967. The estimation of plant pigments of Cochin Backwater during monsoon months. *Bull. mar. Sci. Gulf. Caribb.*, **17** : 95-110.

———, P. M. A. BHATTATHIRI AND S. A. H. ABIDI 1968. Solar radiation and its penetration in a tropical estuary. *J. exp. mar. Biol. Ecol.*, **2** : 87-103.

RAMAMIRTHAM, C. P. AND R. JAYARAMAN 1960. Hydrographical features of the continental shelf waters off Cochin during the years 1958 and 1959. *J. mar. biol. Ass. India*, **2** : 199-207.

SANKARANARAYANAN, V. N. AND S. Z. QASIM 1969. Nutrients of Cochin Backwater in relation to environmental characteristics. *Marine Biol.*, **2** : 236-247.