Chemical studies in Southern Aegean Sea

by

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Introduction

Description of the hydrological conditions of the Southern Aegean Sea as well as the water movements between the Aegean and Mediterranean Seas has been given sporadically by several investigators [POLLAK, 1951; LACOMBE *et al.*, 1958; MILLER, 1963; MCGILL, 1965].

In this paper the general features of seasonal and regional distribution of P-PO_4, N-NO_3 and Si-SiO_2 in the Southern Aegean Sea will be examined. Attention will be drawn to the N : P and Si : P ratios and their possible deviations from the normal values.

Materials and methods

The data examined here were collected from R/V *Ariadny* during the expedition of the Royal Greek Navy to the Southern Aegean Sea in August-September 1966 and March-April, June-July and October-November 1967. The stations which were occupied in the area are given in fig. 1.

Aliquots of the samples taken from surface and 100 m depths were kept frozen in 500 ml plastic bottles until the day of analysis. Calorimetric determinations were made with a DK Beckman spectrophotometer according to the methods of STRICKLAND & PARSONS [1965]. Temperatures and salinities were recorded at all stations.

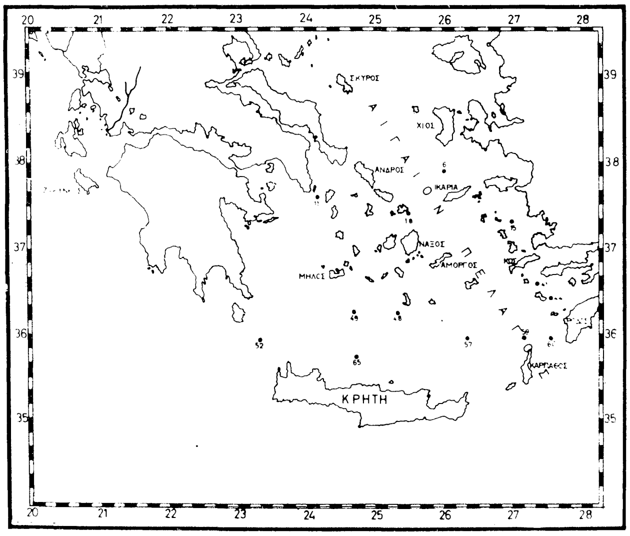

FIG. 1. — Position of station sampling in Southern Aegean Sea.

Rapp. Comm. int. Mer Médit., **21**, 7, pp. 321-323, 2 fig. (1973).

Results and discussion

The variations in concentrations were for $P\text{-}PO_4$ 0.0-0.7 µg at/l, for $N\text{-}NO_3$ 0.0-1.7 µg at/l and for $Si\text{-}SiO_2$ 0.2-6.0 µg at/l (table 1). These values generally agree with the results on the nutrient salts of the Central Aegean Sea presented by McGill [1965].

TABLE I. Nutrient relationships

Component	Number of observations	Minimum and maximum values	Mean concentration (µg at/l)	Mean concentration ratio (by atoms)	Ratio of change	Correlation coefficient
P	92	0.0-0.7	0.056	N:P = 6.04	$\Delta N : \Delta P = 1.01$	0.27
N	92	0.0-1.7	0.360	Si: P = 42.8	$\Delta Si : \Delta P = 0.44$	0.04
Si	95	0.2-6.0	2.400			

$P\text{-}PO_4$ concentrations (Fig.2) appeared to have been considerably higher at almost all stations in the spring samples (March-April), than in these found in other seasons. Variations between surface and 100 m samples were generally insignificant at this period. In summer (June-July), early autumn (August-September) and early winter (October-November) a deficiancy of $P\text{-}PO_4$ was observed in most stations. Only on a few occasions abnormally high values (up to 0.7 µg at/l) were encountered in surface and 100 m samples. It is remarkable that station 44 appeared to be rich in $P\text{-}PO_4$ at all seasons.

The $N\text{-}NO_3$ samples (Fig. 2) showed somewhat different situations during the four seasons. This nutrient was uniformly distributed in surface and 100 m samples during spring (March-April). The summer (June-July) samples were marked by general deficiency (except St. 6) in $N\text{-}NO_3$. During the early autumn period remarkably higher concentrations were recorded on surface samples at a few stations (18, 41, 59); while in early winter (October-November) an increase of $N\text{-}NO_3$ mainly in the 100 m samples of most stations was observed.

Seasonal and regional changes in the concentrations of $Si\text{-}SiO_2$ were not important. Although the values of this nutrient seemed to be somewhat lower during the spring period in relation to other seasons, it was never exhausted. Variations in $Si\text{-}SiO_2$ concentrations between the surface and 100 m depth were also insignificant.

The highest concentrations of $P\text{-}PO_4$, $N\text{-}NO_3$ and $Si\text{-}SiO_2$ were recorded at the following stations :
— $P\text{-}PO_4$: 6, 41, 44, 52, and 59.
— $N\text{-}NO_3$: 6, 15, 18, 41, and 59.
— $Si\text{-}SiO_2$: 6, 15, 44, 49, 52, 59, and 65.

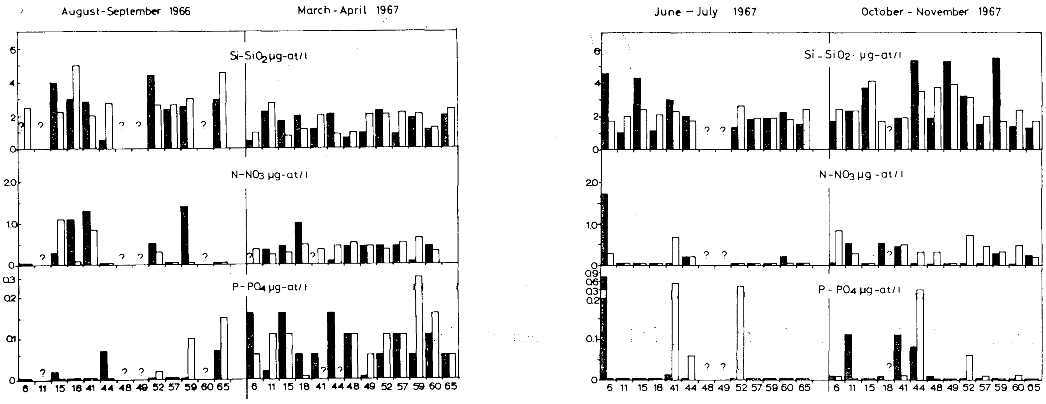

FIG. 2. — Distribution of values obtained for $P\text{-}PO_4$, N-ÇO_3, and $Si\text{-}SiO_2$ (µg at/l) in the different stations occupied in Southern Aegean Sea. ▬ surface samples, ▭ 100 m samples.

Station 6 is located in the northern part of the Southern Aegean Sea (fig. 1) and its relative richness in all three nutrients during summer might be influenced by water originating from the Black Sea [LACOMBE *et al.*, 1958]. The higher values which were recorded in the south east passage between Rhodes and Asia-Minor (St. 41, 44) are in agreement with results reported by MCGILL [1965] who suggested that the influx of Levantine water through this strait increases the amount of nutrients.

Relatively low values of P-PO_4 (0.0-0.15 μg at/l) and N-NO_3 (0.0-0.50 μg at/l) were recorded in the central part of the region (St. 48, 49, 57, and 65).

On the basis of the mean concentration values of P-PO_4 N-NO_3 and Si-SiO_2 measurements of the N:P and Si:P atomic ratios were made (table 1). The ratio N:P = 6.04 is far below the normal value 16:1 proposed by STEFANSSON & RICHARDS [1963] and others.

An evaluation of the ratio of change ΔN:ΔP and ΔSi:ΔP was also made from the present data (table 1). The results showed that extremely low (ΔN:ΔP = 1.01 and ΔSi:ΔP = 0.44) ratios exist. These values as well as the fact that there is no correlation between the nitrate-phosphate and silicate-phosphate concentrations are consistent with report of MCGILL [1965].

KETSCHUM *et al.* [1958] suggested that the ΔN : ΔP expresses the ratio by which biological populations modify the concentrations of phosphorus and nitrogen. He indicated that in New England waters the biological populations although they are exposed to an abnormally low N:P ratio, they are assimilating and regenarating nitrogen and phosphorus in the normal ratio ΔN :ΔP = 15:1. STEFANSSON & RICHARDS [1963] on the other hand showed that the assimilation ratio ΔN:ΔP approaches zero when the nitrate is exhausted and the phosphate appears at very low concentrations. The results obtained during the present investigation showed that in Southern Aegean Sea the Biological populations are exposed to a low N:P ratio, but their ΔN:ΔP = 1.01 assimilation ratio remains still smaller and far below the normal ratio suggested by KETCHUM and his colaborators. It can be assumed that the poverty of the Southern Aegean Sea in these two nutrients might account for the low N:P and ΔN:ΔP ratios.

As far as the phosphate-silicate relationships are concerned, the results are quite obscure. The Si:P ratio approached the rather high value of 42.8 : 1 (table 1) but the ratio of change ΔSi : ΔP remained extremely small. The analysis of the biological factors which are responsible for the fractionation of silicate might add greatly to our understanding the biological cycle in this area.

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