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Nutrient intrusion by the River Rhine in the Dutch Coastal waters.

by

F. Vegter (Delta Institute for Hydrobiological Research, Yerseke, the Netherlands.)

The river Rhine contains large quantities of nutrients from domestic and industrial sources. These nutrients are carried to the North Sea by the river water. This water mass forms a plume in the coastal waters with the fresh water extending over the salt water. Peelen (1970) described the form and situation of this plume. The distance into the North Sea reached by this plume depends on the discharge of the Rhine. In order to obtain an insight into the significance of these nutrients in the Dutch coastal waters, surface samples were taken at ten localities (Fig. 1). In the Delta Institute for Hydrobiological Research these water samples have been analyzed i.e. for ammonia, nitrite, nitrate, and chloride content. We want to present some results of the investigations during 1970.

It was possible to demonstrate a relation between river discharge and nutrient intrusion. The isolines for the various nutrients correspond very well with the isohalines, as shown in the figures 2-5. Moreover, they also show a close relationship with the lines of equal potential primary production drawn by de Kroon for the Dutch coastal waters in 1968, (de Kroon + Gieskes 1971 in press). Especially the area where the potential primary production is maximal corresponds very well with the form of the plume. It may be concluded that the intrusion of nutrients increases the primary production along the Dutch coastal waters.

A better insight into the behaviour of the nutrients on their way to the sea may be obtained when the nutrient values are plotted against the chloride values. For two months, viz. February and July, the results are shown. The figures 6 through 9 deal with the results in February. A linear relationship is found for the nitrate values, hence the nitrate behaved at this time as a conservative parameter. The ammonia, however, shows a

maximal value at $4^{o}/oo$ Cl', that is $7.2^{o}/oo$ total salt. This is caused by the fact that -due to the tidal movements- the river water remains within the estuary -the Haringvliet and Hollands Diep- for a considerable period. The length of this period depends on the river discharge. The organic matter in the water will be partly mineralised during this period. The formation of ammonia and phosphate is the first result of this process. However, the sojourn in the estuary was not long enough for the oxydation of ammonia to nitrate, although the figure for nitrite points on some nitrite formation. The oxygen values in the tidal area therefore are even lower than in the main river.

Another example is shown in the figures 10 through 13. These figures represent the data collected on the 7th of July 1970. All nitrogen curves show a maximum in the brackish region and they decrease rapidly towards the marine region. This is due to the river discharge.

The discharge was low enough to give the river water the opportunity to stay for a sufficiently long time in the tidal region. In this time, not only the organic matter in the water was mineralized, but also the ammonia was oxydized to nitrate.

Fig. 13 shows the data of phosphate concentrations in the brackish and saline regions. The phosphate concentration in the river was very high; over 20 µgat $P\text{-}PO_4/l$ and could not be shown in the figure. On its way to the brackish region a lot of this phosphate disappears, probably by adsorption to silt.

To gain an insight into the extend of the eutrofication, we computed mean values for the concentration of each component in the coastal water.

Water with a salinity over $15^{o}/oo$ Cl', or a salt content over $27^{o}/oo$ total salt has been arbitrarily chosen as coastal water. This has been done to prevent that a sample station with river influence would bias the average.

The results are shown in the figures 14 through 17. The values show large fluctuation. For instance, the ammonia values vary from 50 to 10 µgat/l. The maximal nitrate values are lower, but they are of the same order of magnitude. Nitrite and phosphate data are both a factor 10 lower than those for ammonia and nitrate.

Literature.

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C.M./L: 15.

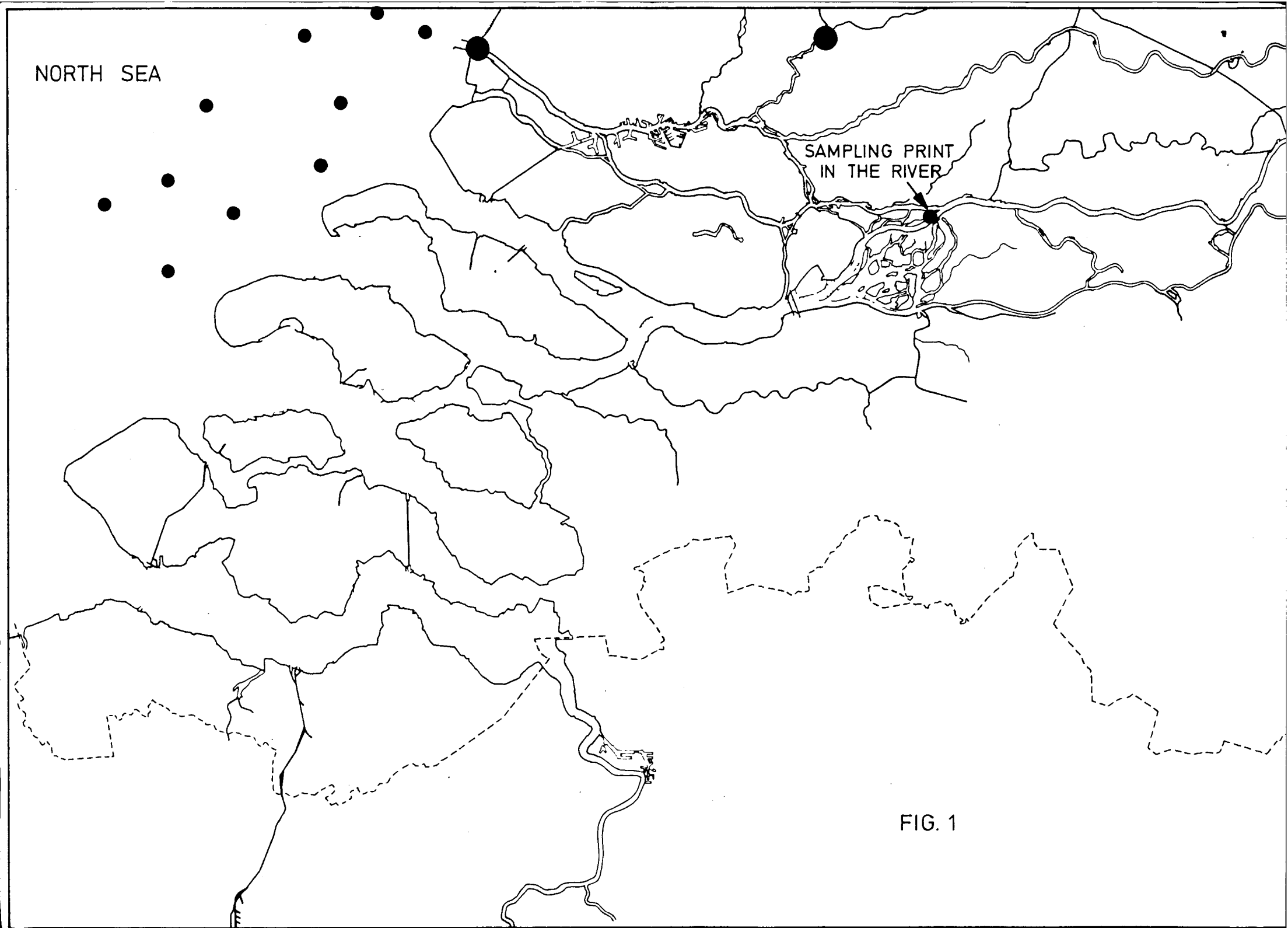


FIG. 1

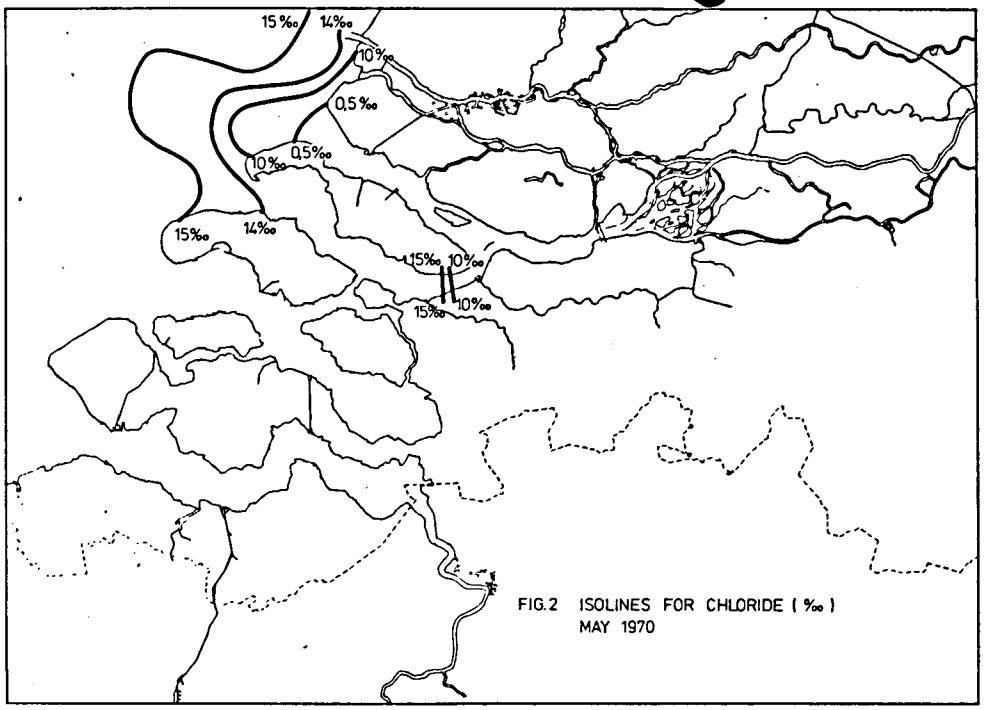


FIG.2 ISOLINES FOR CHLORIDE (‰)
MAY 1970

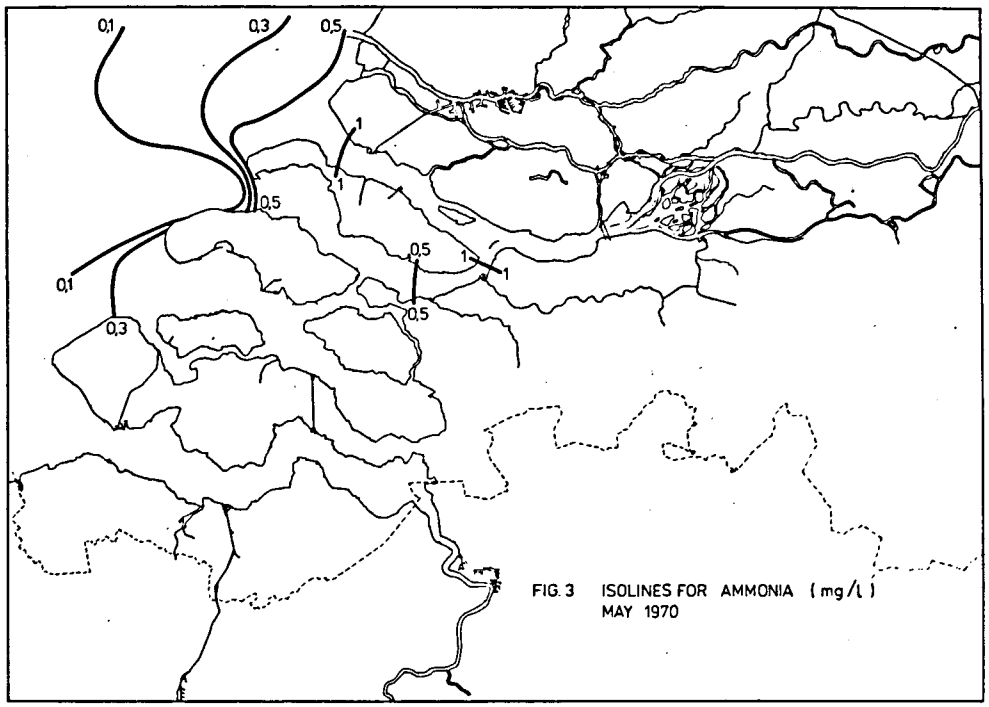


FIG. 3 ISOLINES FOR AMMONIA (mg/l)
MAY 1970

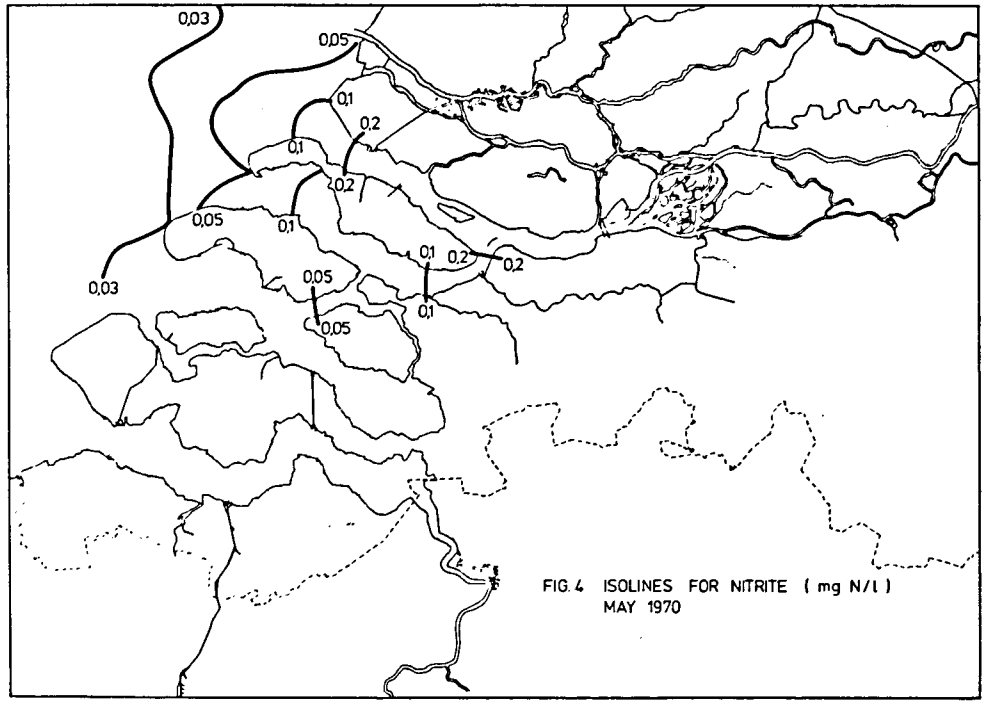


FIG. 4 ISOLINES FOR NITRITE (mg N/l)
MAY 1970

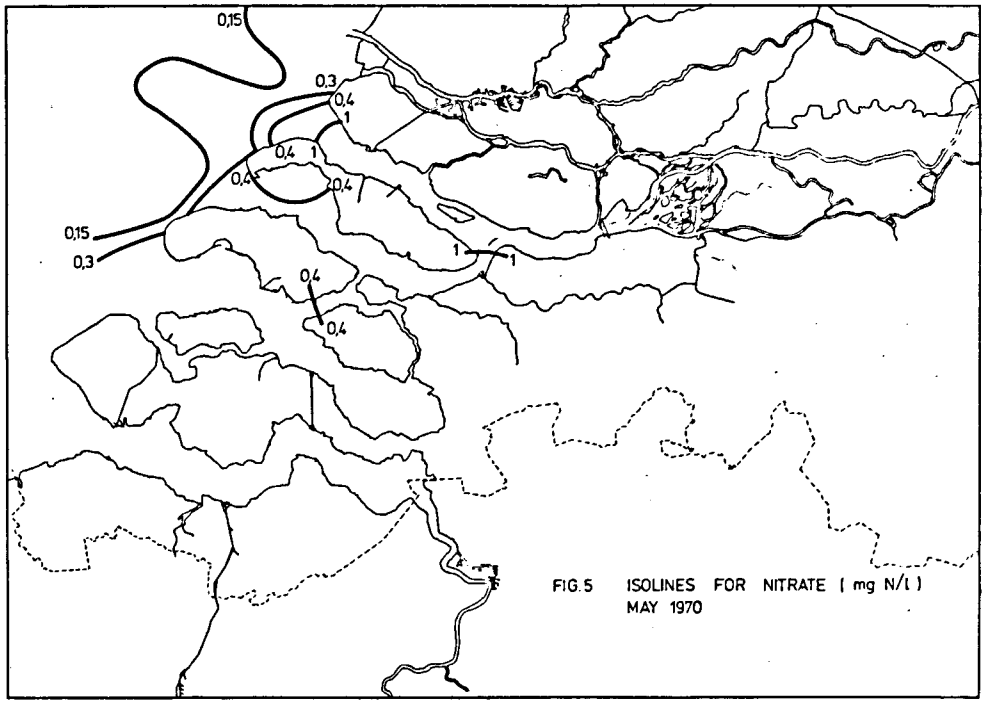


FIG.5 ISOLINES FOR NITRATE (mg N/l)
MAY 1970

NORTH SEA 26 - 2 - 1970

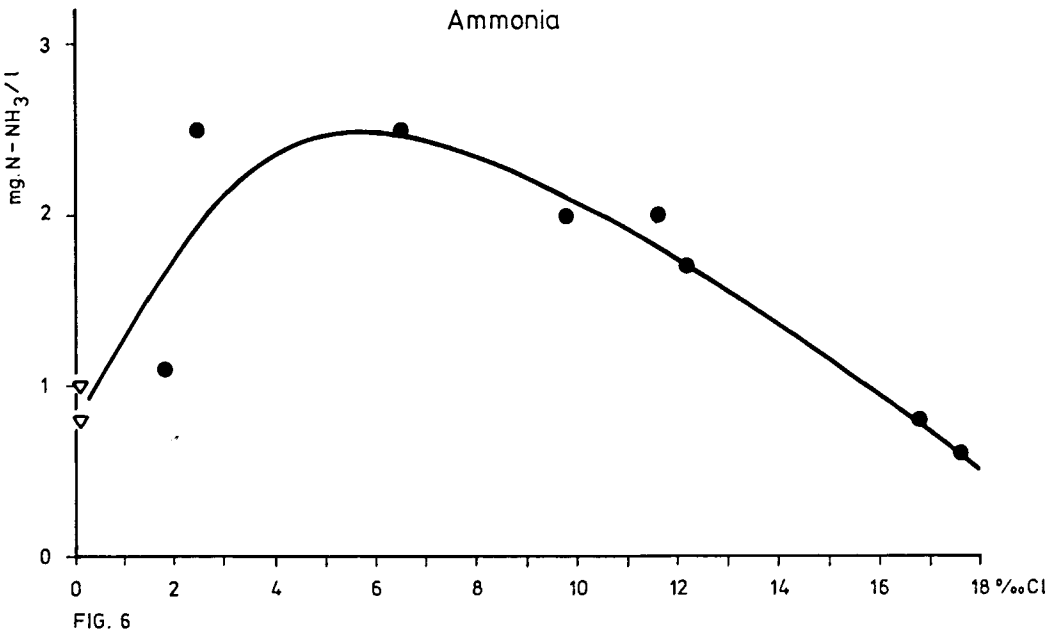


FIG. 6

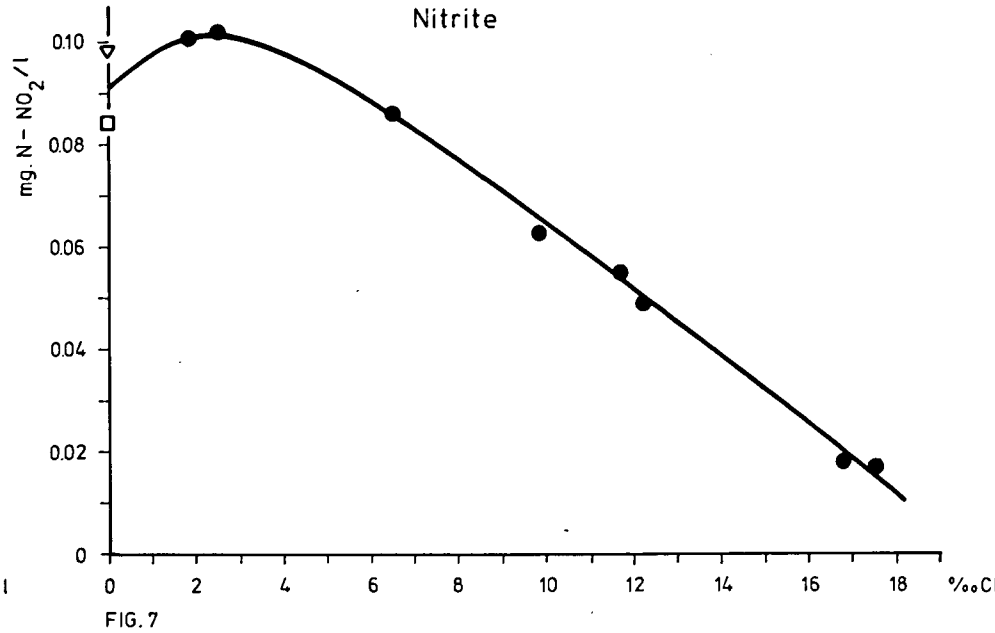


FIG. 7

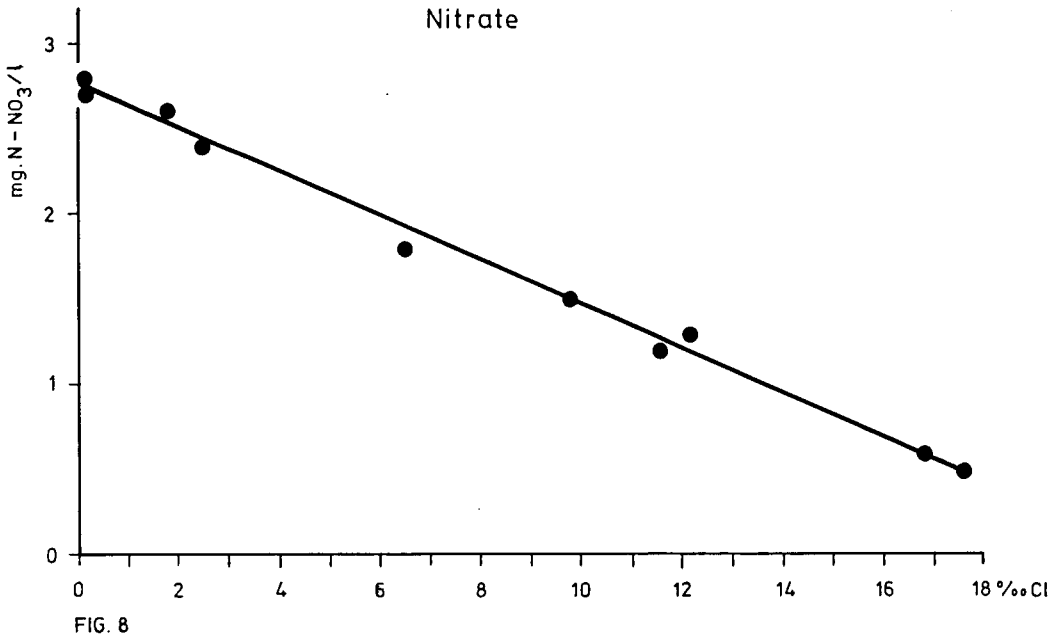


FIG. 8

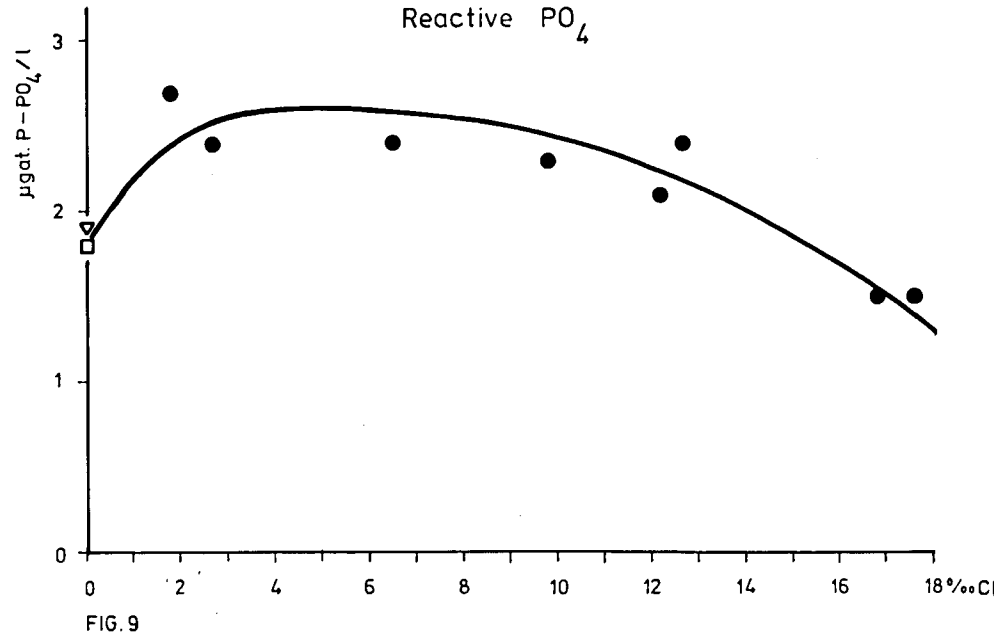


FIG. 9

NORTH SEA 7-7-1970

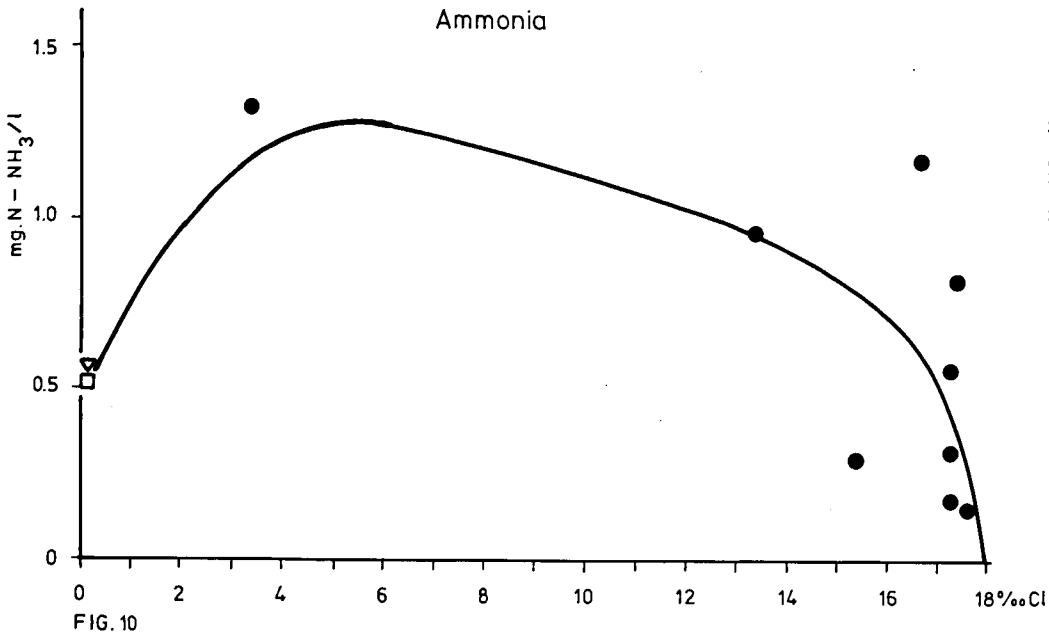


FIG. 10

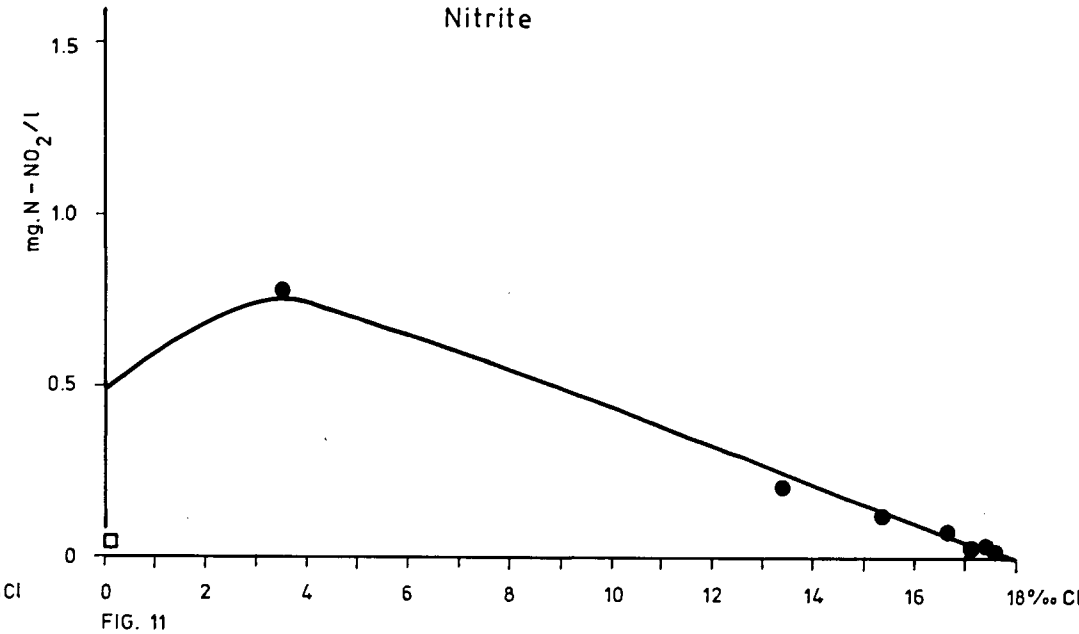


FIG. 11

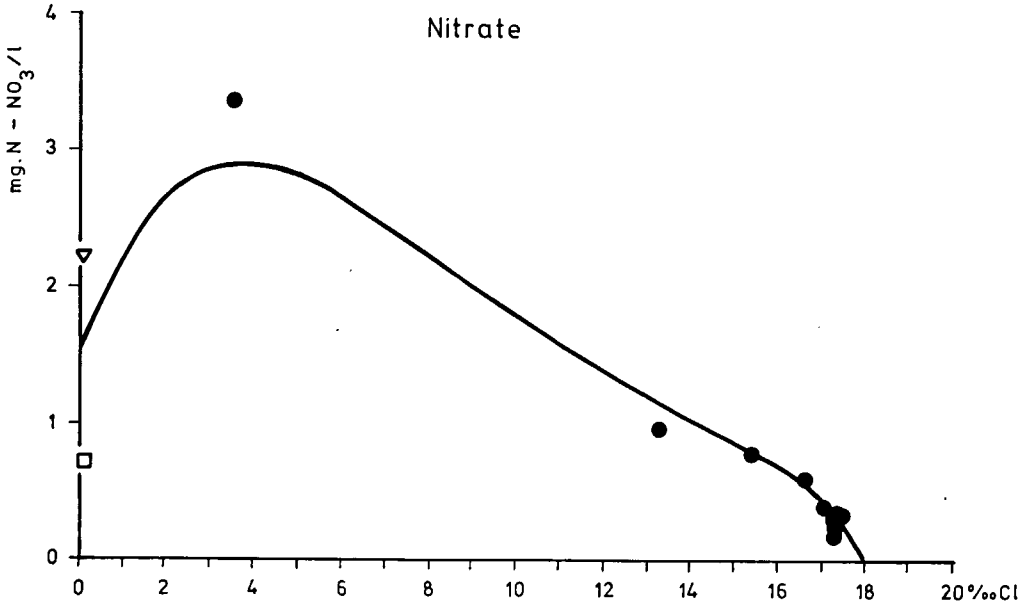


FIG. 12

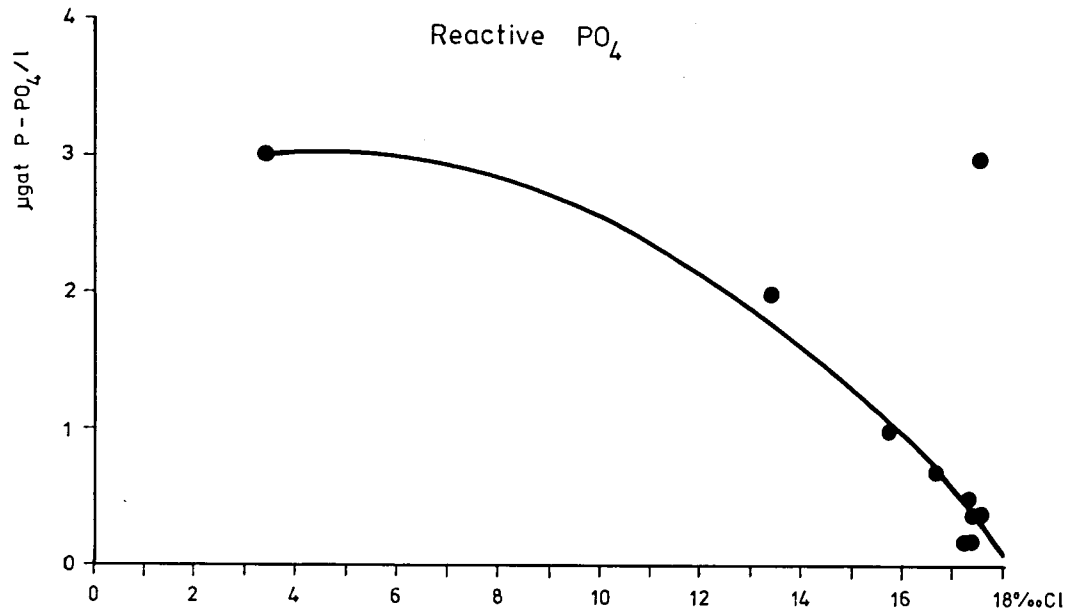


FIG. 13

Fig. 14 Ammonia 1970

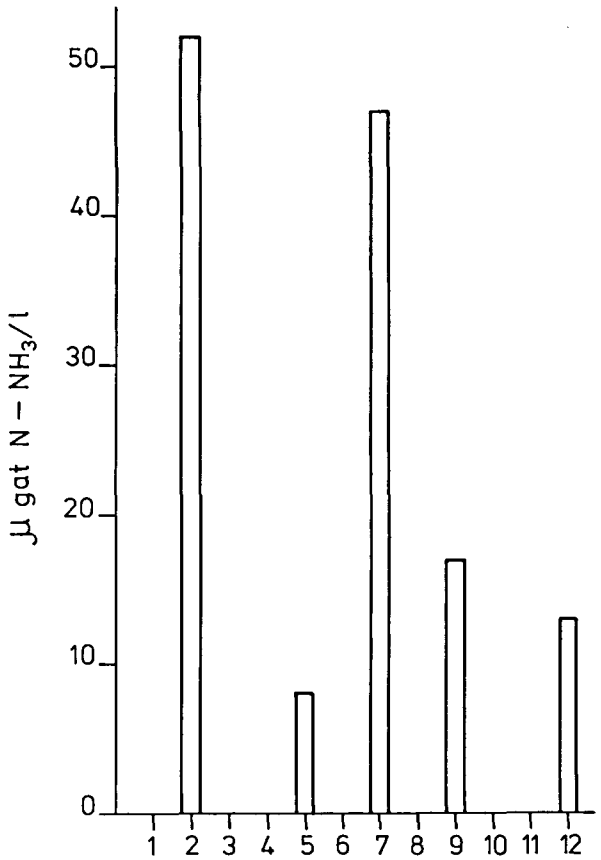


Fig. 15 Nitrate 1970

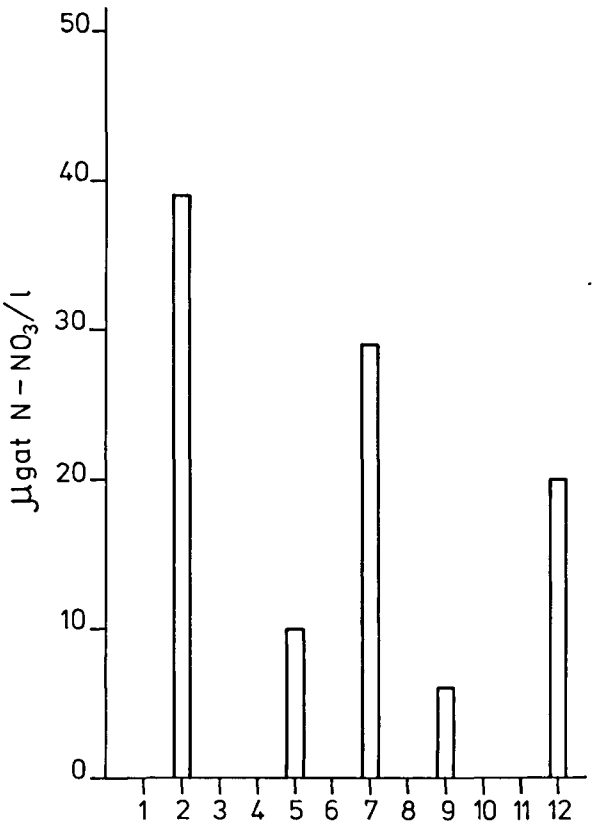


Fig. 16 Nitrite 1970

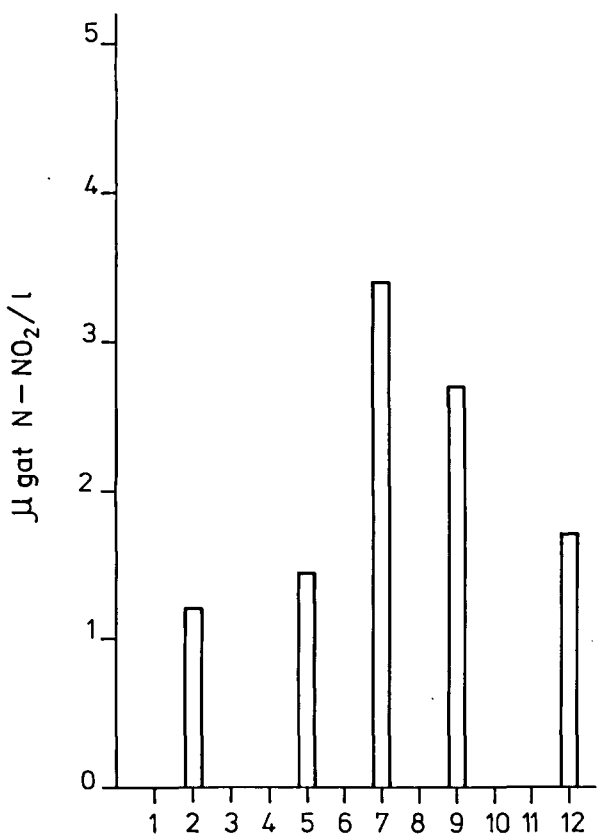
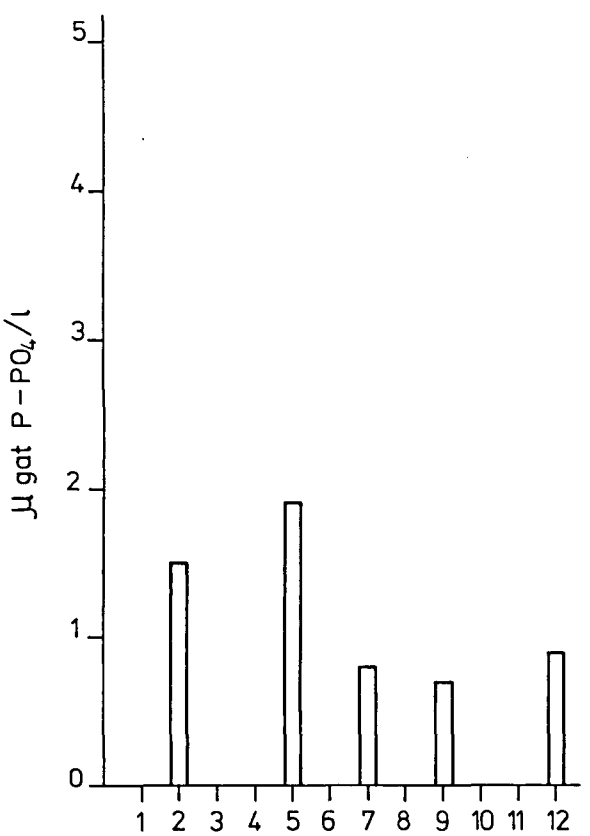


Fig. 17 Reactive Fosfate



K. POPP MADSEN
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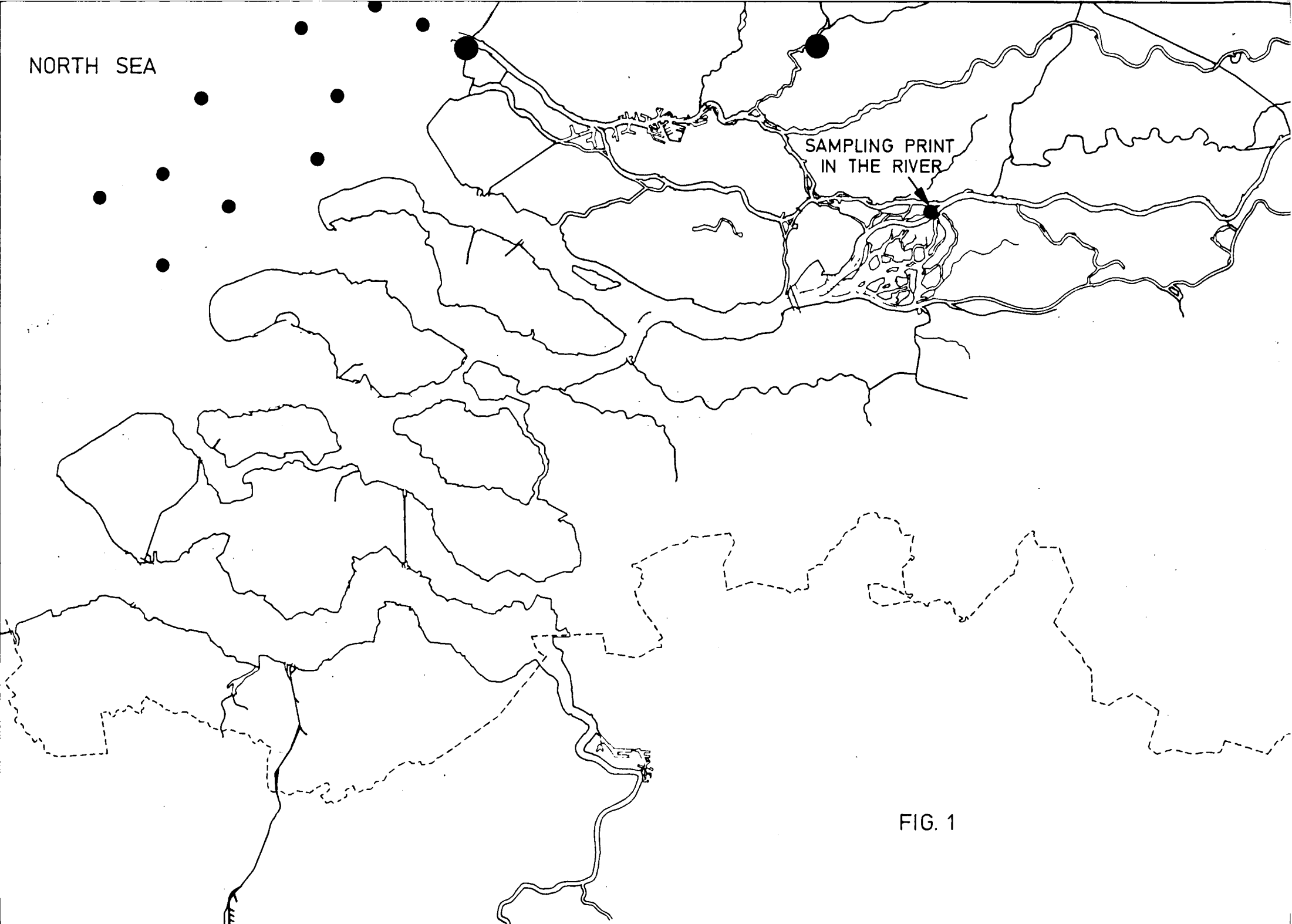
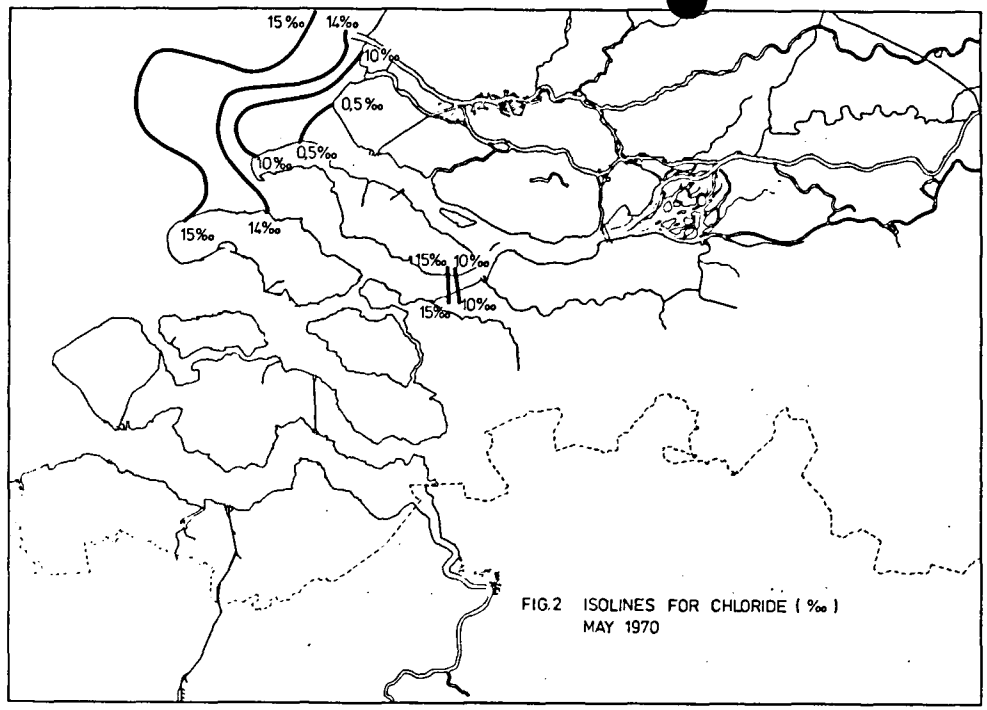


FIG. 1



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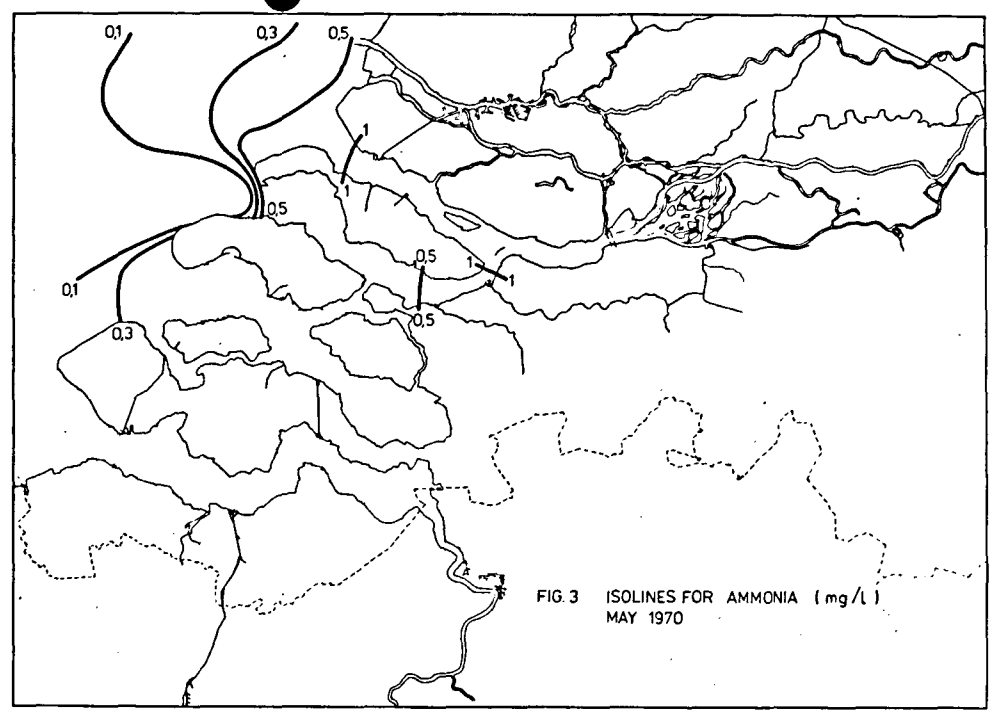

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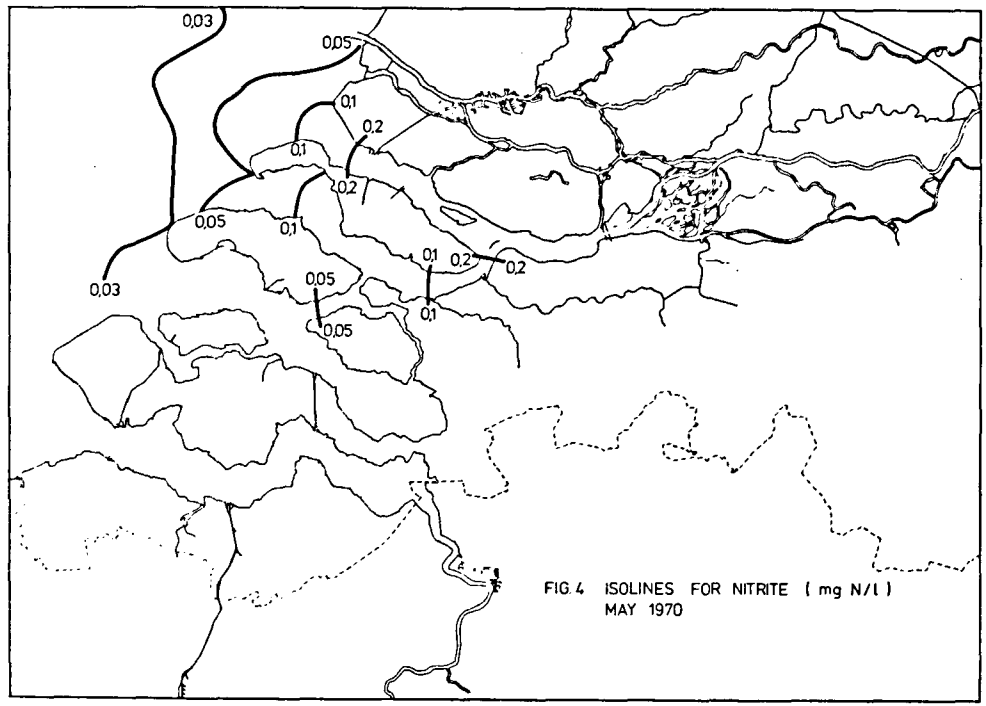

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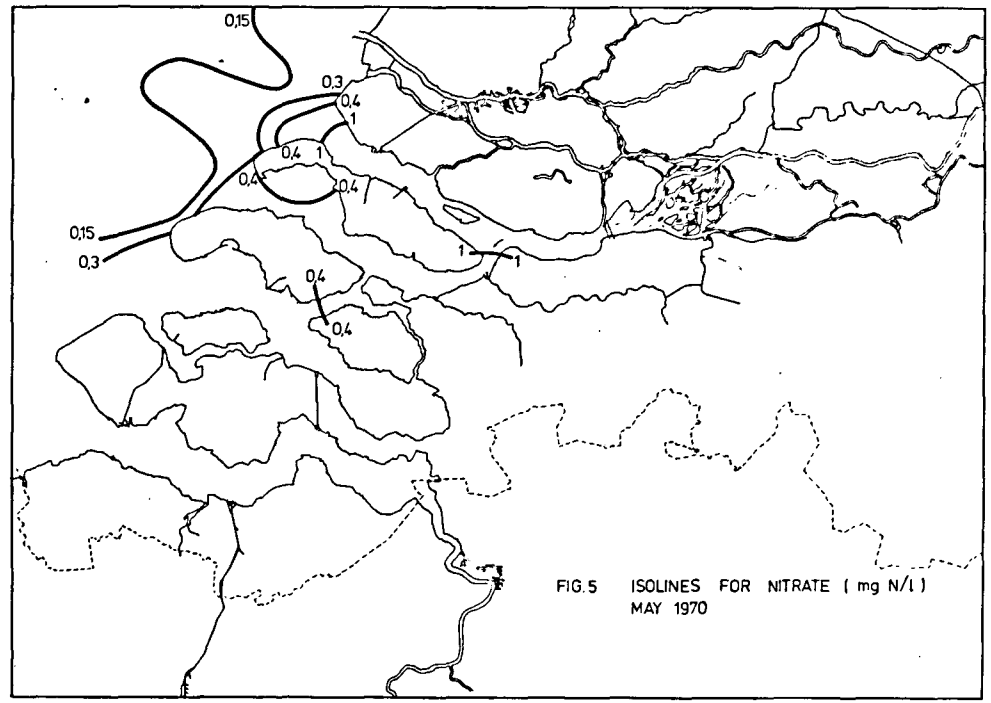

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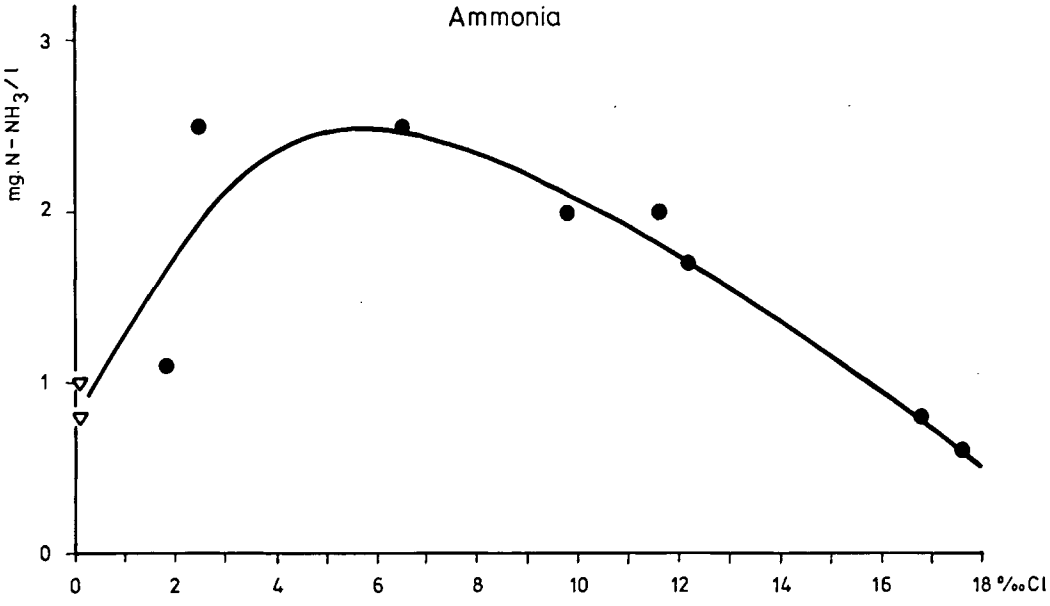
MAY 1970

NORTH SEA 26 - 2 - 1970



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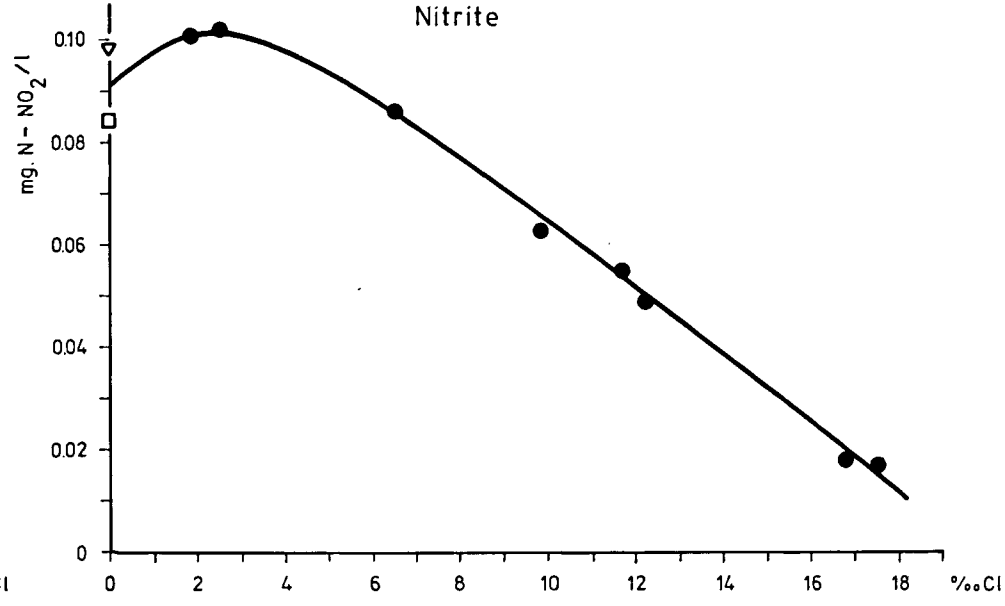

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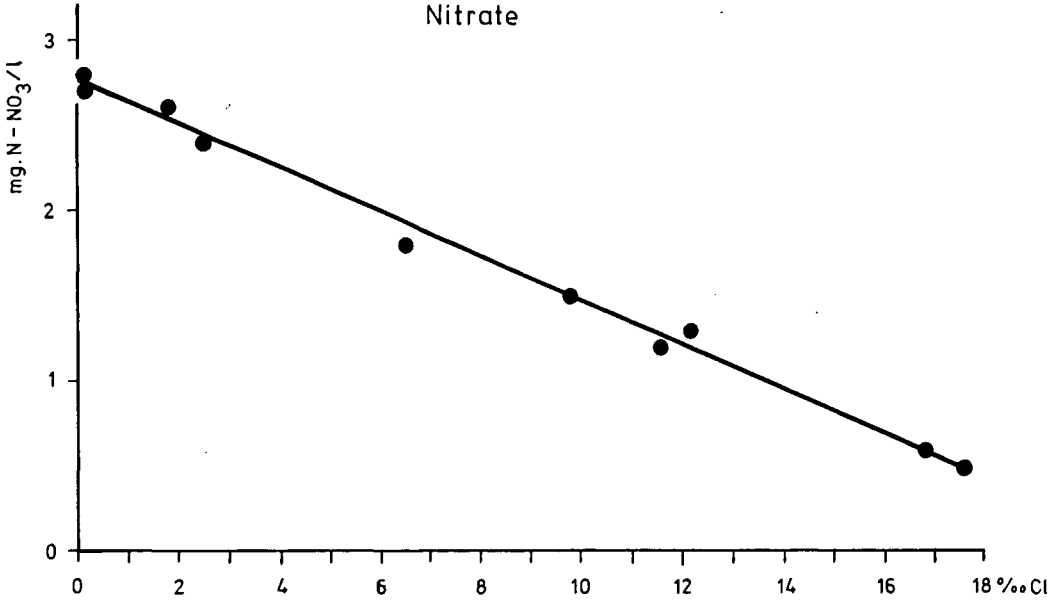


FIG. 8

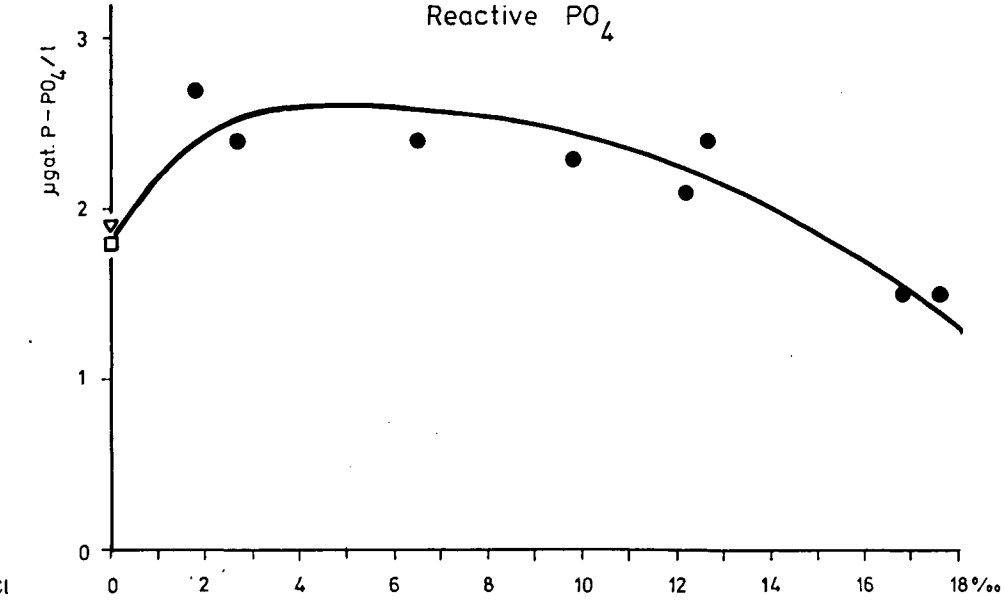


FIG. 9

NORTH SEA 7-7-19

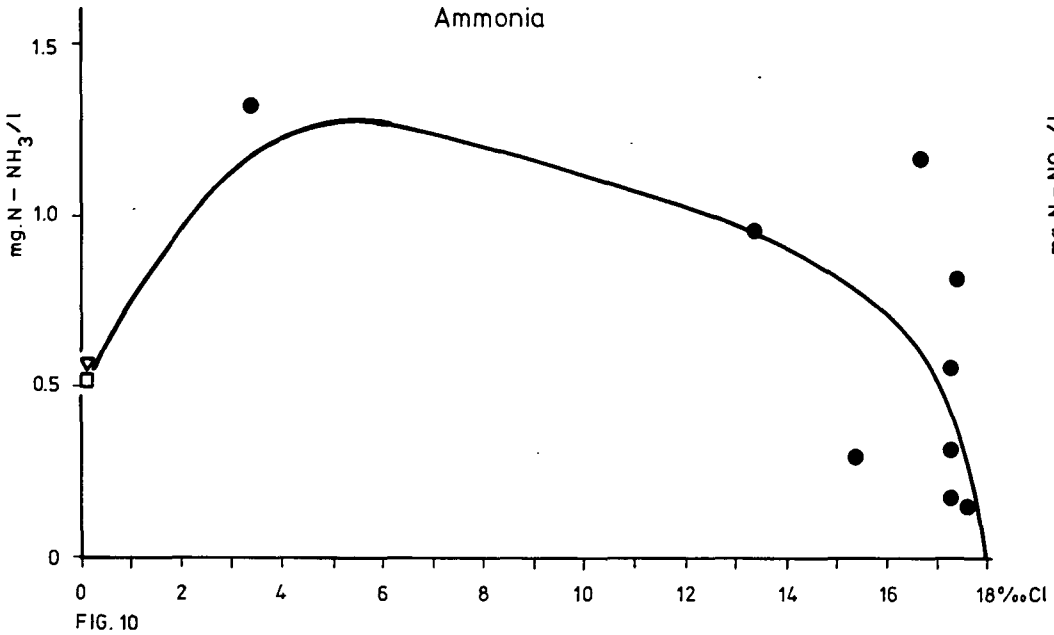


FIG. 10

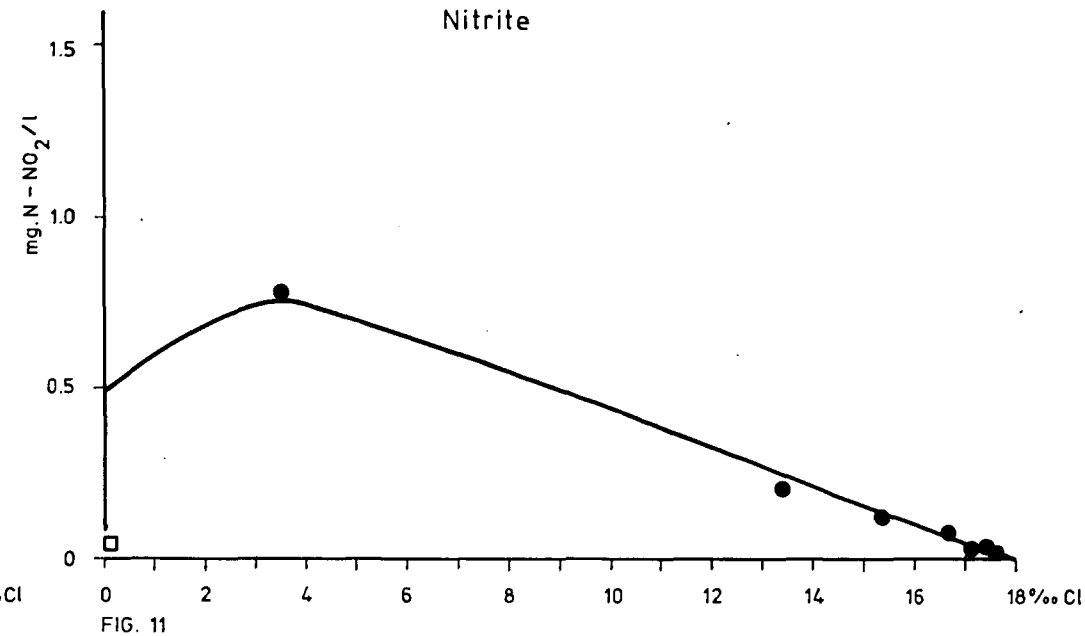


FIG. 11

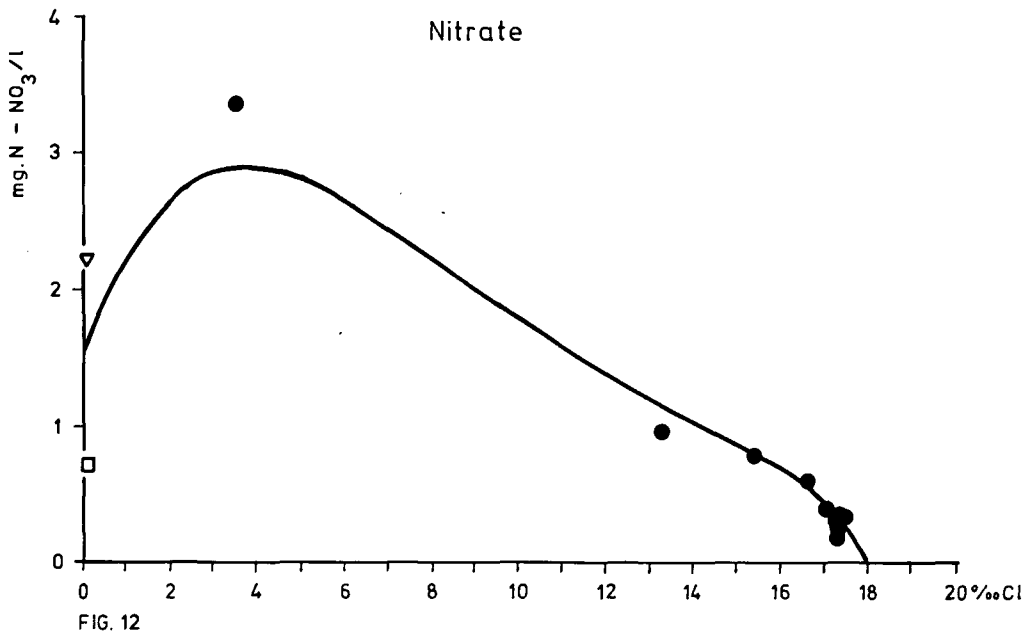


FIG. 12

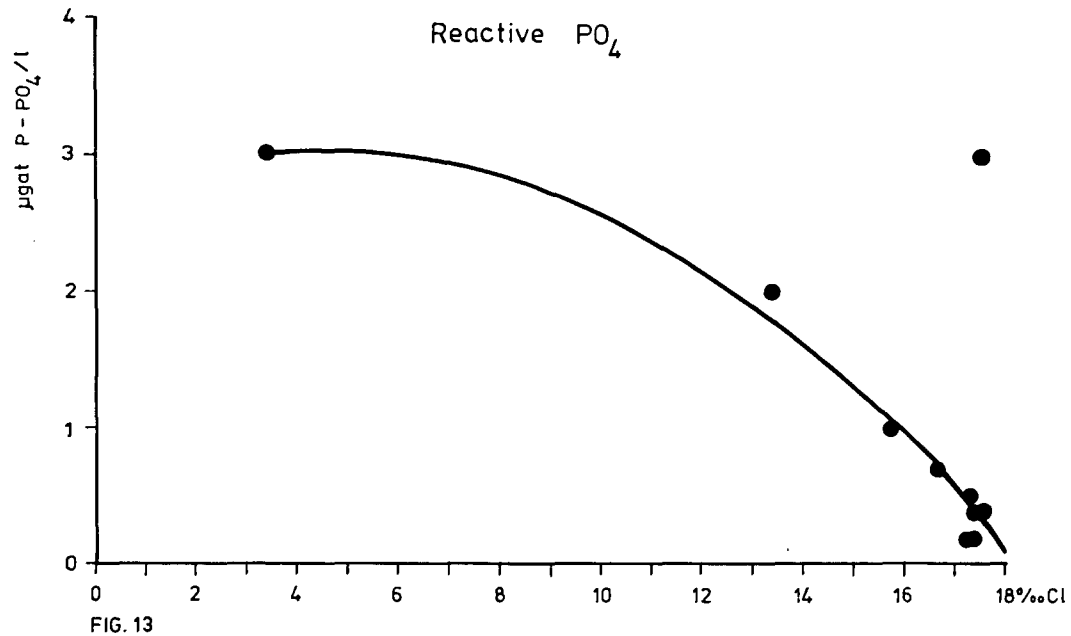
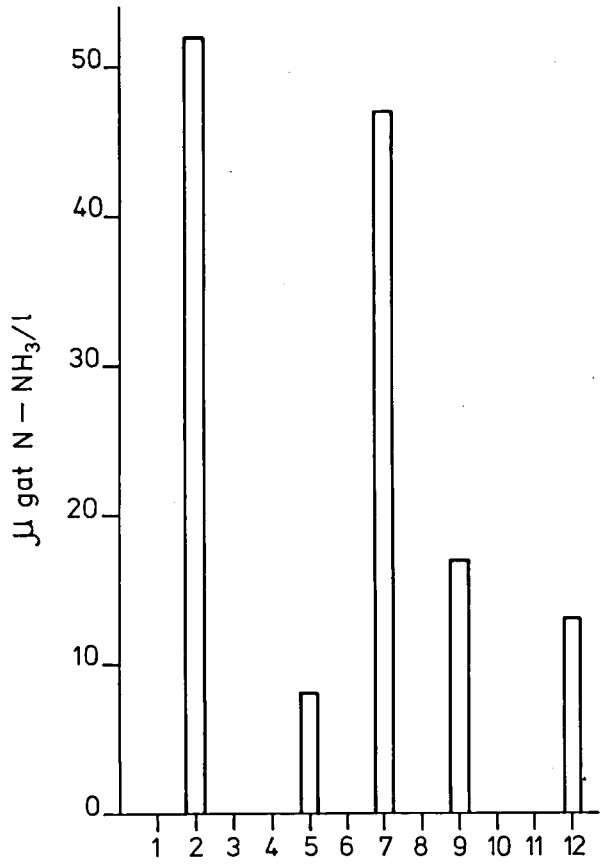


FIG. 13

Fig. 14 Ammonia 1970



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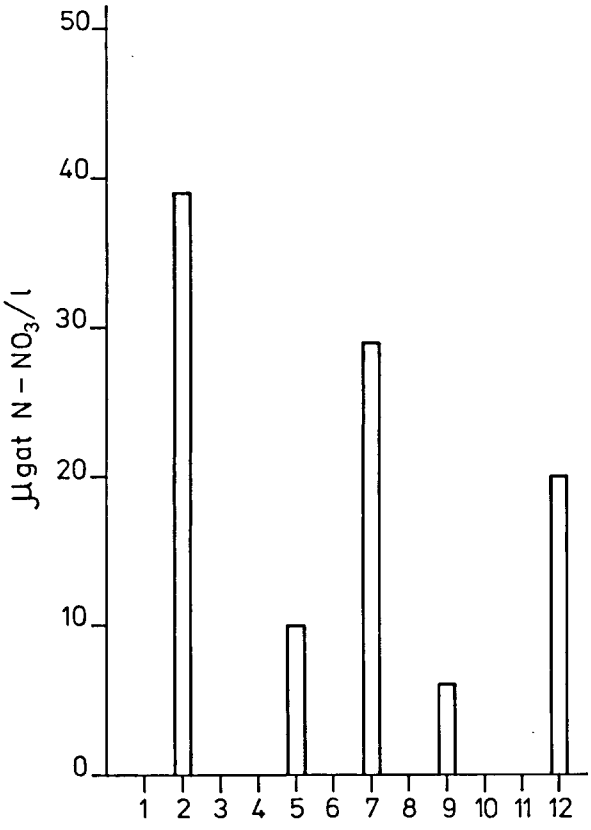

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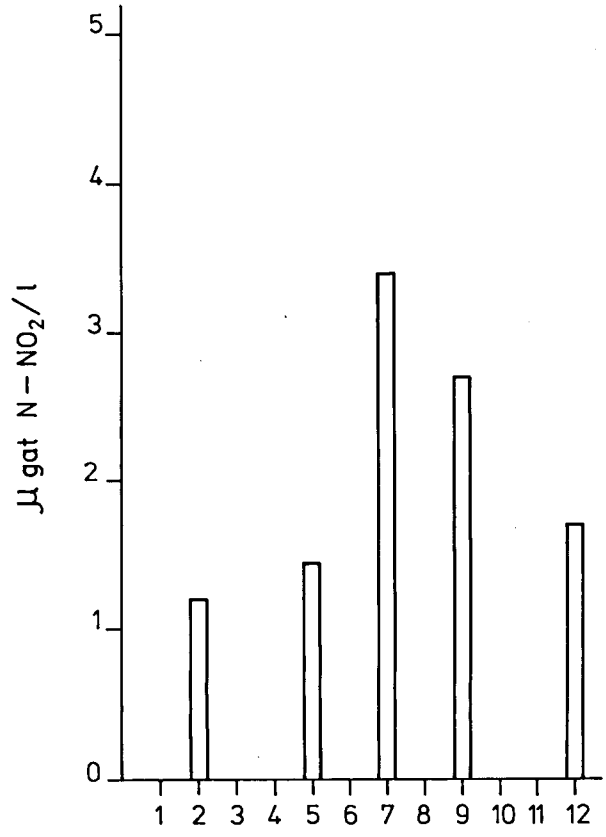

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