CENTRO, Vol. 1, No. 4, 1989, pp. 1 – 7.


# A survey of the nitrate and phosphate levels of inshore marine waters from Malta (Central Mediterranean)

C. AGIUS[1] and V. JACCARINI[2]

*(1. Department of Biology, Faculty of Science, University of Malta; 2. Department of Zoology, University of Nairobi, Kenya)*

*(Received 15th April, 1988)*

ABSTRACT

The nitrate and phosphate levels were monitored over a one-year period in three inshore localities in Malta. There were recorded no seasonal variations in nutrient levels at Marsaxlokk bay. At Mistra bay a slight decrease in nitrate-nitrogen was recorded during the autumn and winter periods. At both these locations, however the nitrate-nitrogen was generally below 1/μg-at/l and phosphate-phosphorus always less than 0.2 /μg-at/l. The values are typical of most areas in the Mediterranean. The concentrations of nutrients at Rinella creek were consistently manifold higher and peaked during the winter months. This, very probably, reflects the combined effects of organic pollution and rainfall on this very enclosed creek. Occasionally, short-lived high levels of nitrates were recorded at Marsaxlokk and Mistra bays. These seem to originate from agitation of bottom sediments.

## Introduction

The scarcity of nitrates and phosphates in the Mediterranean was first described by Thomsen (1931) and subsequently confirmed by numerous workers. There is no published information on the distribution of nutrients in the inshore marine waters of Malta and thus this study presents the first observations on the occurrence of these nutrients that play such a vital role in primary production. The nutrient analyses described in this study were performed in connection with oyster growth trials. The results of these trials as well as a description of the hydrological conditions of the areas under study have been described elsewhere (Agius *et al.*, 1978). A preliminary survey of the phytoplankton populations of the areas under study has been carried out by Jaccarini *et al.* (1978).

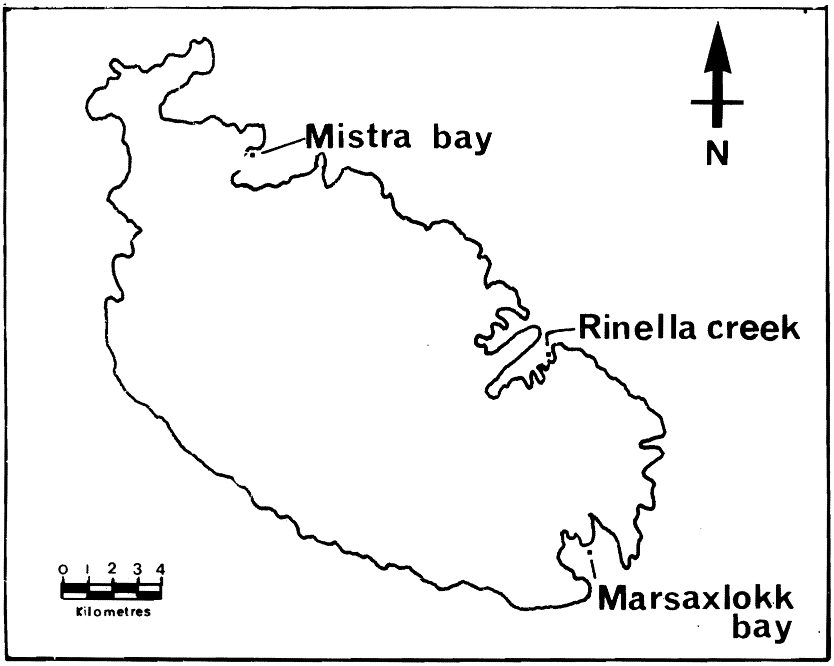



*Fig. 1. Map of Malta showing sites from where samples for nutrient analysis were taken.*

## Materials and Methods

### *Sampling*

Water samples were taken from Marsaxlokk bay, Mistra bay and Rinella creek (Fig. 1). Sampling was carried out at roughly two-weekly intervals. From February 1975 to March 1976 samples were taken from a depth of 3m from each location. From September 1975 to March 1976 samples were also taken from a depth of 8m from each location. Water samples were collected by means of a 3-litre capacity Van Dorn bottle and were transported to the laboratory in polyethylene bottles at 0 - 5°C in a thermos flask. Care was taken not to trap any air bubbles with the water samples. All samples were analysed for their nitrate and phosphate content. While in about 50% of the cases analyses were performed within three hours, at other times delays were unavoidable and samples were deep-frozen in a domestic-type freezer at its lowest temperature setting.

### *Determination of nitrate*

This was carried out following the procedure described in Strickland and Parsons (1965) whereby the nitrate in sea water is reduced to nitrite when a sample is run through a column containing amalgamated cadmium filings. The nitrite thus produced is determined by diazotising with sulphanilamide and coupling with N-(l-naphthyl)-ethylenediamine to form a highly coloured azo dye, the extinction of which is measured at 543 nm. No correction was made for any nitrite initially present in the sample so that the results of the estimations actually represent the sum total of the nitrate and nitrite content. However, the latter is known to be normally much lower than the former.

*Determination of phosphate*

This was carried out employing the method for reactive phosphorus (low levels) described in Strickland and Parsons (1972). The water sample is allowed to react with a composite reagent containing molybdic acid, ascorbic acid and trivalent antimony. The resulting blue-coloured complex is extracted with isobutanol and its extinction measured at 690nm.

**Results**

The seasonal variations in nutrient levels in the three localities under investigation are shown in Fig. A. & B. The nitrate levels are expressed as µ/g-at/N/l and the phosphates as µ/g-a/t P/1.

As the plots show there were no consistent differences in nitrate or phosphate levels between the two depths at any of the sites tested. The nitrate-nitrogen levels were in most instances much higher than those of phosphate-phosphorus. The only consistent differences that could be detected between the nutrient levels at Marsaxlokk and Mistra was a slightly lower level of nitrate-nitrogen at Mistra during autumn and winter. The nutrient levels at Rinella were consistently much higher than those at the other two sites.

There were no marked seasonal variations in nutrient levels at Marsaxlokk bay. At Mistra bay a slight decrease in nitrate-nitrogen was recorded during autumn and winter. At both these locations, however, the nutrient levels recorded were very low throughout the year ($NO_3$-N generally below l/µg-at/1 and $PO_4$-P always less than 0.2 µ/g-at/1) except for some occasionally very high nitrate values which appeared to be of short duration. The levels of nutrients in Rinella waters showed significant increases during the winter months. In fact while the nitrate levels were persistently higher from November to February, the phosphate levels were significantly higher in January-February. Throughout the remaining part of the year the nutrient levels at this site were more or less constant ($NO_3$-N mainly between 1 and 3 µ/g-at/1 and $PO_4$-P mainly between 0.1 and 0.4µ/g-at/1).

**Discussion**

The levels of nitrates and phosphates recorded in this study support the now well-established contention that nitrates and especially phosphates are severely depleted in Mediterranean waters (for review of the pertinent literature see Agius and Jaccarini, 1982). Regions under the influence of fresh water or sewage outfalls are exceptions.

The consistently low values of nitrates and phosphates at Marsaxlokk and Mistra bays mean that these nutrients are consumed as fast as they are made available. On the other hand, the data for Rinella creek indicate that some factor other than nitrates or phosphates is normally limiting. The consistently higher nutrient levels at Rinella very probably reflect a high degree of organic pollution. Sewage effluent contains generous amounts of plant nutrients. Moreover, the possibility of fresh water outflows from the lower water table of Malta contributing to the nutrient levels must not be overlooked. Although several such outflows have been located below sea-level in various coastal areas, their contribution to nutrient availability for our coastal waters remains to be investigated.

The levels of nutrients recorded in this study were, to a large extent, reflected in the standing crop levels; these latter have been published elsewhere (Agius *et al.*, 1978;

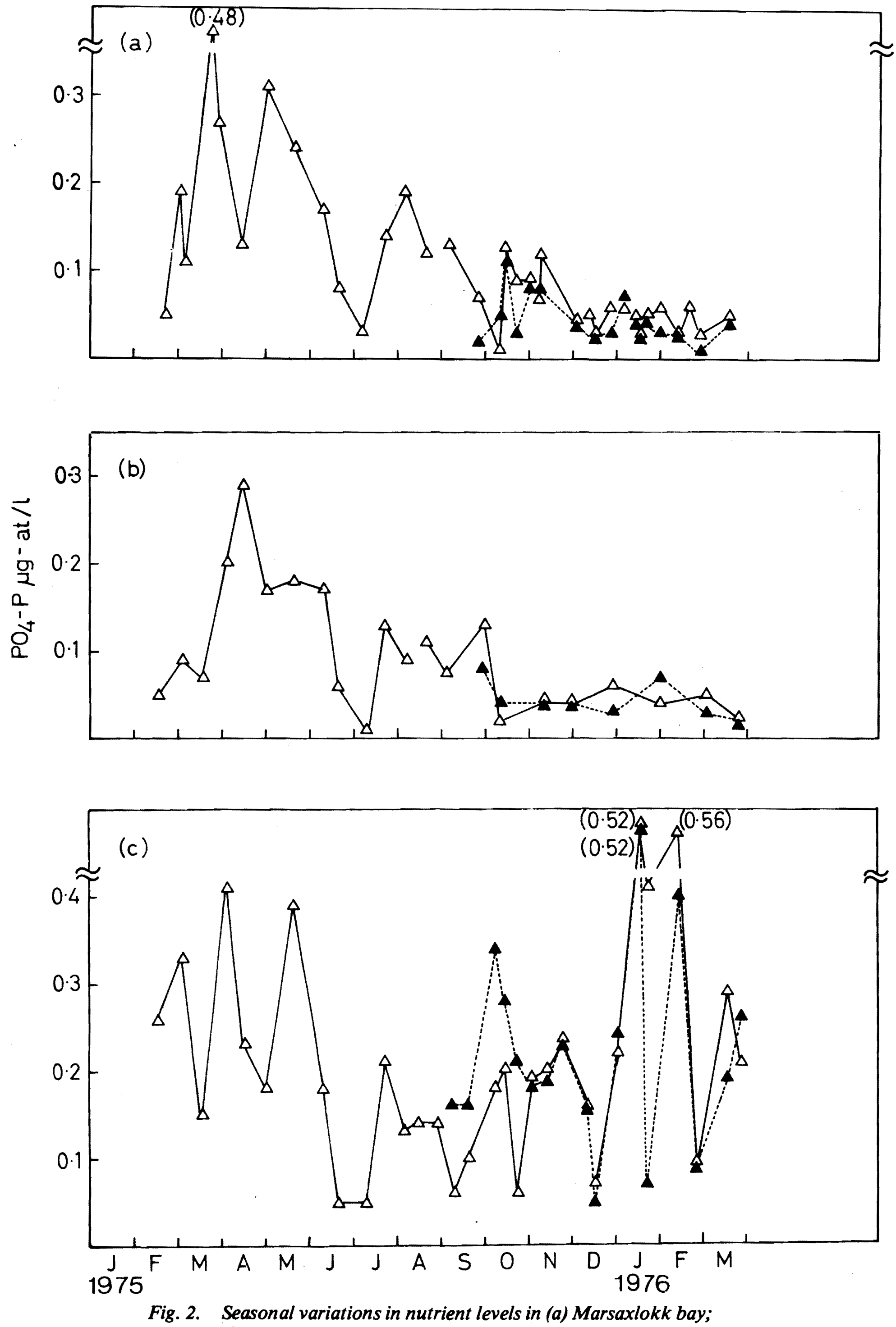
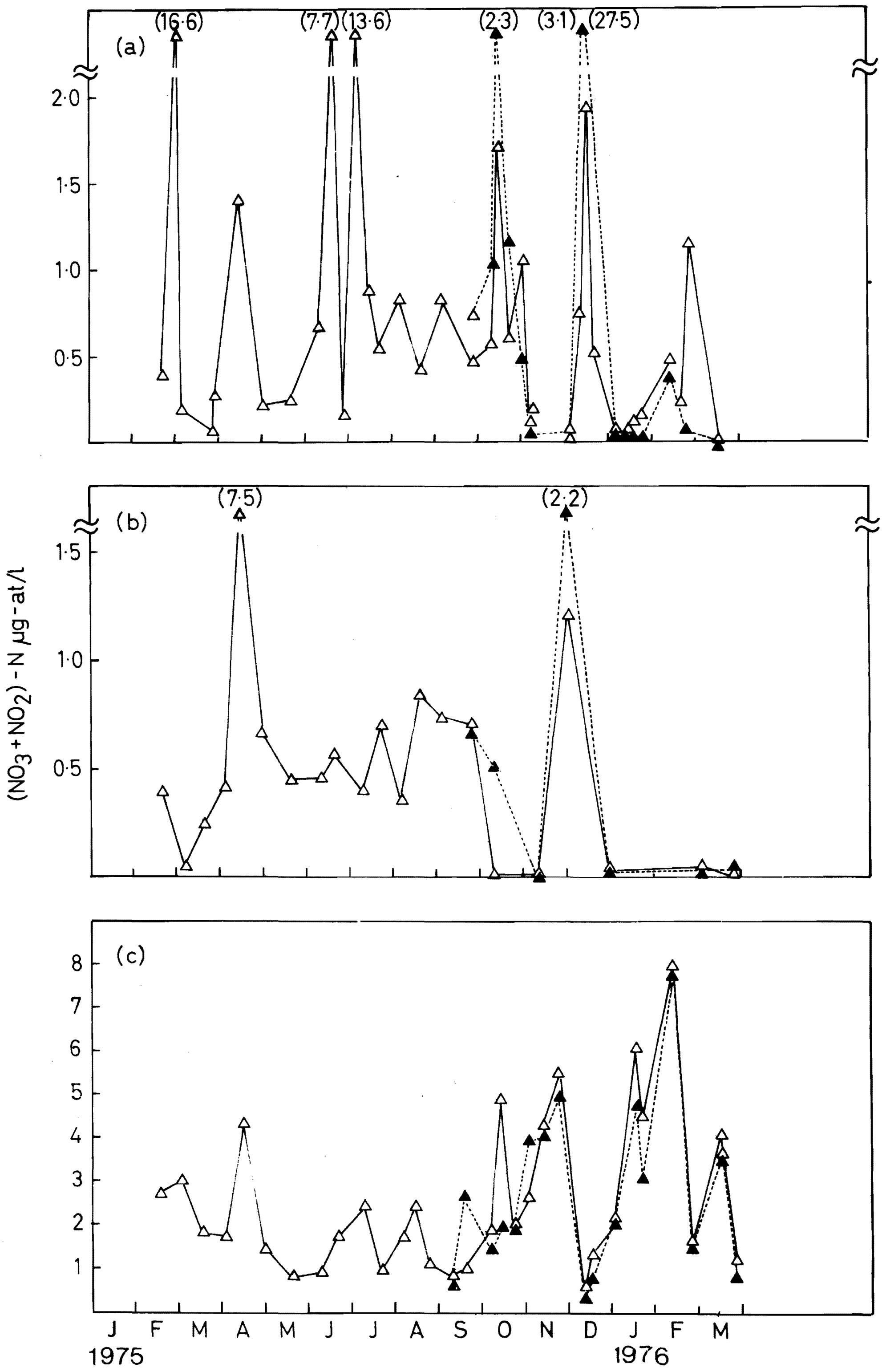



*Fig. 2. Seasonal variations in nutrient levels in (a) Marsaxlokk bay; (b) Mistra bay and (c) Rinella creek.*

△ – *A represents the nutrient levels at 3m. depth*

▲ – *A represents the nutrient levels at 8m. depth.*

**(A)**



(a)
(16·6)
(7·7)
(13·6)
(2·3)
(3·1)
(27·5)
2·0
1·5
1·0
0·5
(b)
(7·5)
(2·2)
1·5
1·0
0·5
(NO3 + NO2) - N µg-at/l
(c)
8
7
6
5
4
3
2
1
J F M A M J J A S O N D J F M
1975
1976


**(B)**

Jaccarini *et al.*, 1978), Particularly striking is the remarkable correspondence between standing crop increase and nutrient concentration decrease recorded during a phytoplankton bloom that occurred at Rinella in February 1976.

Throughout this study some attempt was made to monitor the sensitivity of nutrient levels to rainfall. It was observed that while rainfall does not significantly affect the waters of Marsaxlokk and Mistra bays, heavy rains considerably raised the nutrient levels at Rinella. Thus the high nutrient levels in January-February 1976 followed closely upon heavy rains and it seems that the higher winter nutrient values at this location are associated with the rainy season. This is probably a reflection of the more enclosed nature of Rinella creek enabling the retention of a much larger volume of rain water. Significantly, the salinity of the waters in this creek has been observed to drop, even if marginally following upon rainfalls. The salinities at the other two sites remain unaltered.

The occasional and short-lived high nitrate values observed at Marsaxlokk and Mistra are difficult to interpret. It was noted that on some of the instances when such high levels of nitrate were recorded, the water was rather turbid. Although the exact origin and nature of the suspended matter are still unknown it seems most likely that they originated from bottom sediments. What forces bring them into suspension and their lifetime in this state also remain to be thoroughly investigated. The possibilty of sediments acting as potential stores of nutrients in the sea has been identified by various workers (see for example Hood, 1974). It thus became apparent that the sediments in the areas under study may be potential stores of nutrients which are released when agitated into suspension. This hypothesis was tested by collecting samples of sediment from Marsaxlokk bay in October 1975 and mixing 200 ml portions of this sediment with 600 ml portions of synthetic sea water prepared using Analytical Grade reagents. These were stirred vigorously, allowed to settle and after thirty minutes had their nitrate and phosphate levels monitored. Mixing and nutrient analysis was repeated at 30 min intervals for two hours. The results are tabulated in Table 1.

**Table 1.** Changes in the levels of nitrate and phosphate in artificial sea water after mixing with sediment.

| **Time (hrs)** | **$(NO_3 + NO_2) - N$.conc.** **μ/g-at/l** | **$PO_4$-P.conc.** **μ/g-at/l** |
|---|---|---|
| 0* | 0.31 | 0.12 |
| ½ | 5.37 | 2.73 |
| 1 | 5.60 | 3.50 |
| 2 | 5.60 | 5.23 |

*synthetic sea water only

Nitrates and phosphates were released in large amounts on mixing with sediment. Thus, mixing processes involving sediments could well explain the occasional high nitrate values recorded. Why the increase in nitrate levels is not accompanied in nature by an increase in phosphates could be explained on the basis of the marked differences in the solubility of these two classes of compounds. Nitrates are very soluble and thus liable to go into solution and remain so for a long time. Phosphates are much less soluble and on agitation of the sediments may exist only temporarily in a finely suspended state before they resettle on the bottom. Thus while in raw sea water samples phosphates are not likely to be detected they could have been detected in the mixing experiment because of the periodic agitation, the relatively small volumes of the water, and the relatively short time given for it to settle.

Needless to say other phenomena such as some form of upwelling or man-made perturbations may be responsible. Various physical, chemical and biological parameters of the areas described here have subsequently been monitored in an attempt to clarify this problem. This will be published separately.

## REFERENCES

Agius C. and Jaccarini, V. (1982) The effects of nitrate and phosphate enrichmetns on the phytoplankton from Marsaxlokk Bay, Malta (Central Mediterranean) *Hydrobiologia*, 87: 89-96.

Agius C., Jaccarini V. and Ritz D.A. (1978) Growth tirals of *Crassostrea gigas* and *Ostrea edulis* in inshore waters of Malta (Central Mediterranean). *Aquaculture*, 15: 195-218.

Hood D.W. (1974) Chemical cycles in the sea. In: Oceanography, The Last Frontier. Voice of America, Forum Series.

Jaccarini V., Agius C. and Leger G. (1978) A preliminary survey of the phytoplankton of inshore marine waters from Malta (Central Mediterranean). *Mem. Biol. Marine e Oceangr.* 8(1): 1-12.

Strickland J.D.H. and Parsons T.R. (1965) A manual of sea water analysis. *Fish. Res. Board Can. Bull.* (2nd edition, revised) **125**: 203.

Strickland J.D.H. and Parsons T.R. (1972) A practical handbook of sea water analysis. *Fish. Res. Board Can. Bull.* (2nd edition) **167**: 310.

Thomsen H. (1931) Nitrate and phosphate contents of Mediterranean water. Reports of the Danish Oceanographic Expedition 1908-1910 to the Mediterranean and adjacent seas, **3**(6): 1-14.