On the role of mesozooplankton in the regeneration of nutrients on the Saronikos Gulf (Greece)

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Among zooplankton excretions, special interest has been given to ammonia and inorganic phosphorus because of their importance as nutrients for phytoplankton. It is also well documented that ammonia is the major form of dissolved nitrogen excreted by zooplankton; in most cases the inorganic fraction of the dissolved phosphorus compounds dominates especially during low food conditions. Investigations of the mechanisms for nutrient regeneration are of primary importance in the study of productivity in the oligotrophic waters of Eastern Mediterranean.

This study was carried out fortnightly from January 1989 to January 1990. Living zooplankton were collected by oblique net (200 µm) tows from a shallow coastal area of the Inner Saronikos Gulf where the dominant species are the copepod *Acartia clausi* during winter and spring and the cladoceran *Penilia avirostris* during the warm period (CHRISTOU, 1992). Within two hours from the collection 7-8 subsamples of concentrated mixed zooplankton were introduced into 600ml beakers filled with filtered (GF/C glass fiber filters) sea water collected from the same area. For every two bottles there was one control (without animals) whereas all bottles (the controls and these with the incubated animals) were placed at *in situ* temperature and in darkness for 20-24 hours. Ammonia was determined after LIDDICOAT *et al.* (1975) and phosphates according to STRICKLAND and PARSONS (1972). Excretion rates (µg-at· µgdrwt^{-1} d^{-1}) were calculated from the difference between concentrations of test and control bottles. The daily zooplankton contribution to the nutrients was estimated taking into account the *in situ* zooplankton biomass (excretion rate x biomass).

The nutrient measurements in the study area showed that ammonia concentrations ranged from 0.16 to 1.25 µg-at· l^{-1} whereas the phosphate concentrations - fluctuated between 0 and 0.38 µg-at· l^{-1} were low for a coastal area especially during the summer months (Fig. 1 a). The daily ammonia excretion was calculated to range from negligible amounts to 0.049 µg-at· l^{-1} while the daily phosphates excretion was calculated to fluctuate from negligible levels just to µg-at· l^{-1} (Fig. 1 b). The excretion rates corresponding to ammonia and phosphates showed similar trends. The latter has also been found in the Western Mediterranean by ALCARAZ (1988). The higher values were recorded from June to October with a maximum in July while in the rest of the year extremely low values prevailed.

Estimates by many workers have shown that ammonia and phosphate excretions by zooplankton meet 40-90% of the nitrogen and 52-140% of the phosphorus demands of phytoplankton in various marine waters (IKEDA *et al.*, 1982). Thus zooplankton not only reduce phytoplankton biomass through their grazing activity but also contribute to phytoplankton growth. The nutrient cycling between phytoplankton and zooplankton is a possible mechanism for maintaining a high growth rate of phytoplankton in nutrient-poor waters (GOLDMAN *et al.*, 1979).

For the present study the daily zooplankton excretions seem to contribute a considerable amount for nutrients in the sea only during the warm period (Fig. 1). The daily ammonia excretion supplies 6.6% to the water column concentrations in July.

In this month, when phosphates were almost depleted from the sea, the phosphate excretion of zooplankton seems to be the only available source for phytoplankton.

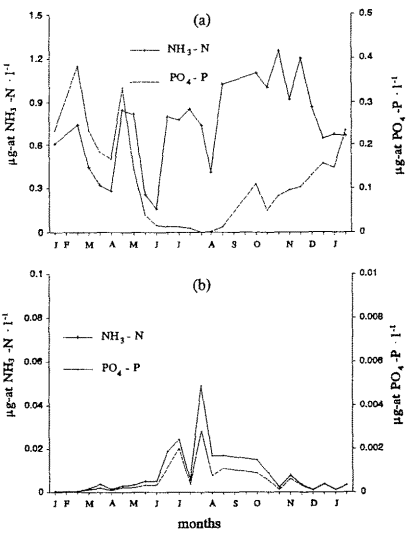

Figure 1. (a) Nutrient (ammonia, phosphates) fluctuations in the sampling area. (b) Daily mesozooplankton contribution to the nutrients through excretions for each sampling date.

In a Mediterranean lagoon (near Marseilles) the nitrogen excretion of zooplankton, attained higher va-lues in summer, represented a large percentage of the total water column stock and the nitrogen regeneration was considered as an important phenomenon (GAUDY, 1989).

Apparently the importance of zooplankton excretion as a nutrient regeneration mechanism varies from one system to another depending on the environmental conditions and contributions of other biological and non-biological nutrient supply mechanisms.

Although the study area is coastal with external nutrient enrichment sources, the phosphate excretion of zooplankton, particularly in summer, seems to be a significant nutrient regeneration process in the area. This point supports the hypothesis that in the Saronikos Gulf mainly phosphates limit the phytoplankton growth.

However for an overall consideration of the regenerated primary production in the area, the regeneration due to the bacterial activity upon faecal pellets and corpses as well as the microzooplankton contri-bution should be taken into account.

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