Impact of sewage pollution on nutrients uptake rate by Phytoplankton in a South-Eastern Mediterranean Basin

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Phosphorus and nitrogen compounds play key roles in plant photosynthesis. Phytoplankton normally satisfy their nutrient requirements by their direct assimilation. Phosphorus and nitrogen uptakes are virtually confined to the euphotic layer of the sea, since they are a photosynthetic processes. Although all forms of nitrogen and phosphorus can be assimilated by most species of phytoplankton, nitrate, ammonia and orthophosphate are usually used preferentially (GLIBERT *et al.*, 1991; KROM *et al.*, 1991). According to GARSIDE (1981), autotrophic bacteria are also able to assimilate nitrogen. These resemble green plants in their ability to build carbohydrates and proteins. Some of these, known as photosynthetic, possess coloring material, or bacteriochlorin and use radiant energy in building up protoplasm, while others, known as chemosynthetic, derive their energy from the oxidation of various inorganic compounds.

Anthropogenic nutrients input plays an important role in the high productivity and biomass of the coastal zone of Alexandria (Egypt) relative to its continental shelf. The amount of production depends on the external supply of nutrients (allochthonous input) and the internal nutrient regeneration rate (ABOUL-KASSIM, 1987). The relationship between variable nutrient supply, the capacity for its utilization by different classes of phytoplankton, and ultimately the amount of recycling and export of nutrients from Alexandria coastal waters are not well understood. Our objective in this paper is to study carefully the nutrient uptake rates of phytoplankton (light and dark uptakes) in the sewage-impacted water of the Eastern Harbor (E.H), Alexandria.

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The study area is a semi-circular shallow bay, surrounded by Alexandria city, connected to the Mediterranean through two openings. The basin is subjected annually to about $35x10^6$ m^3 of unprocessed sewage, rendering its flushing time to be 5 months. The uptake rates of orthophosphate, nitrate and ammonia by phytoplankton were determined according to EPPLY *et al.* (1969). Five liters of the harbor water were collected and divided into 5 portions, each of one liter. These portions were enriched with increasing concentrations of:

(1)- phosphorus (2.5, 5, 10, 15, 30 ug at/l) using an A.R. standard KH_2PO_4,
(2)- nitrate (2.5, 5, 10, 15, 30 ug at/l) using an A.R. standard KNO_3, and
(3)- ammonia (5, 10, 20, 30, 40 ug at/l) using NH_4SO_4.

Aliquots of 300 ml from each sample were placed in dark and light stoppered bottles and incubated *in situ* for 4 hours at about 25 cm below the surface. After incubation, the initial and final nutrients concentrations in each sample were determined and the rate of uptake rate/hour was calculated.

Results showed that the light and dark uptake rates of orthophosphate (Figure 1) increased gradually by increasing phosphorus concentrations, reaching maximum at 17.5 ug at/l after which they decreased. The annual rate of phosphorus (light) uptake by phytoplankton was calculated to be 860 kg/year.

The annual rate of ammonia and nitrate light uptake rates were found to be 83.0 and 41.5 Tons/km^2 or about 210 and 105 Tons/year, respectively. However, the greater part of these amounts is probably due to bacterial uptake (ABOUL-KASSIM, 1987). MAHMOUD (1985) gave a value of 43.4 and 30.7 Tons/Km^2 for ammonia and nitrate uptake in El-Mex Bay of Alexandria (affected by agricultural run-off, i.e. $2.57x10^6$ m^3/yr from Umom drain, ABOUL-KASSIM, 1990). This might indicate the enhancement effect of sewage disposed in the harbor basin on the uptake rates by phytoplankton. The difference of ammonia uptake in dark and light bottles is less significant than that of nitrate and phosphate (Figure 1). Likewise, a dark and light uptake was also observed in the case of nitrate. These high uptake rates are mostly due to the high bacterial biomass (measured by the adenosine triphosphate method) in the Eastern Harbor; i.e. average 0.46 mg C/l (ABOUL-KASSIM *et al.*, 1992). Statistically, high significant correlations occurred between both light and dark nutrients uptake rates, and the regression equations relating these variables are:

1- for orthophosphate: Light uptake = - 0.12653 + 2.2449 Dark uptake (r^2= 0.800).
2- for nitrate: Light uptake = 0.86835 + 1.1433 Dark uptake (r^2= 0.964).
3- for ammonia: Light uptake = 0.57913 + 1.0010 Dark uptake (r^2= 0.996).

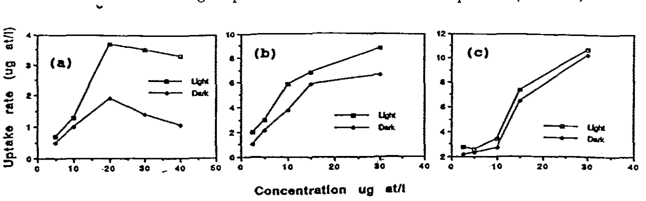

Figure 1: Uptake of a)- orthophosphate, b)- nitrate and c)- ammonia by phytoplankton at both light and dark bottles.

In conclusion, the high light and dark uptake rates of nutrients in the E.H. of Alexandria compared with other polluted areas in the Mediterranean area (ABOUL-KASSIM, 1987) is undoubtedly due to the high standing stock of phytoplankton (i.e. 5.14±2.71 mg chl a/l) and bacterial biomass (i.e. 52% of living biomass). These high living biomass is due to the continuous supply of nutrients (allochthonous source) in the harbor, i.e. 420 tons N/yr (EL-NADY *et al.*, 1990) and 1.094 tons P/l (DOWIDAR *et al.*, 1990).

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