Living Biomass in the Highly Eutrophic Coastal Environment of Alexandria, Egypt

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ABSTRACT: During the period 1985-1986, the adenosine triphosphate (ATP) method was applied for the first time in EGYPT to assess the living biomass and its components (Bacteria, Phytoplankton and Zooplankton) in one of the heavily polluted basins off the Egyptian coasts, the Eastern Harbour of Alexandria. The ATP levels as well as its spatial and seasonal variations were presented to evaluate the impact of domestic sewage discharged into the harbour on its water quality.

AREA OF STUDY: The Eastern Harbour (E.H) of Alexandria is a relatively shallow semi-closed basin, sheltered from the sea by an artificial break-water, leaving two openings through which the exchange of the harbour water and the neritic Mediterranean water take place. About $35.2X10^6$ m^3 of domestic sewage are discharged into the Eastern Harbour of Alexandria through 11 outfalls, distributed along the coast. This quantity is about 2.3 times the water volume of this basin. Accordingly, the flushing rate would be about 5 months.

MATERIAL AND METHODS: Sampling was carried out at regular bimonthly intervals, throughout the period from May 1985 to May 1986. ATP measurements, for total living ATP and Zooplankton, were carried out according to the method described by Holm-Hansen (1973). Knowing the ATP corresponding to the total living organisms (TATP) and zooplankton (ZATP) as well as that equivalent to phytoplankton (PATP), calculated from phytoplankton biomass carbon (Holm-Hansen, 1973), the bacteria (BATP) could be estimated by subtraction. The ATP equivalent of phytoplankton was computed from the chlorophyll a biomass (determined according to Strickland & Parsons, 1972) using the factor given by (Holm-Hansen, 1973).

RESULTS AND DISCUSSION: During the study period, the annual averages of total ATP (TATP), zooplankton ATP (ZATP), phytoplankton ATP (PATP) and bacteria ATP (BATP) amounted to 6.47±2.06, 3.26±1.28, 1.54±1.41 and 1.83±1.08 µg ATP/l, respectively. Karl (1980) mentioned that elevated ATP concentrations are characteristic to eutrophic zones with values >0.5 µg/l while in regions of moderate productivity, values range between 0.1 and 0.5 µg/l. Both the range and average values observed in the harbour are higher than those recorded in many other localities including the Mississippi bay.

Based on the assumptions of Holm-Hansen and Booth (1966), the estimated number of bacteria/l in the harbour ranged between $0.72X10^8$ and $45X10^8$ Cell/l at the surface and $0.33X10^8$-$58X10^8$ cell/l near the bottom. The annual averages were $12.9X10^8$ and $11.2X10^8$ cell/l, respectively. These values indicate that the bacterial number in the E.H water is exceedingly high compared with oceanic and even coastal waters reflecting the role of organic sewage dumped in this basin (Aboul-Kassim, 1987).

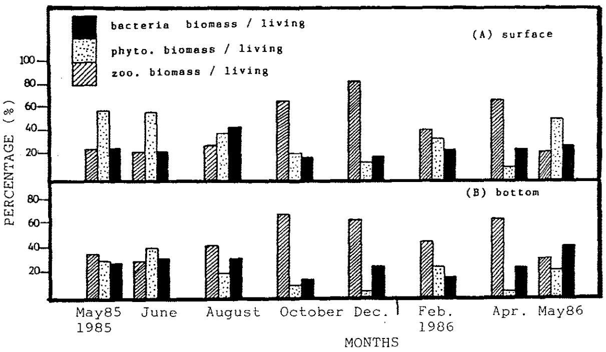

Figure 1: Monthly variations of the percentage composition of zooplankton, phytoplankton and bacteria biomass (mg C/l) in the Eastern Harbour during the period 1985-1986.

In the present study, an attempt was made to obtain the carbon biomass equivalent to that ATP values. The concentrations of living biomass in the harbour water were relatively high. The annual averages of total ATP carbon biomass and that of phytoplankton, zooplankton and bacteria were 1.620, 0.385, 0.820 and 0.450 mg C/l. The zooplankton biomass peak occurred in winter, while those of phytoplankton and bacteria were observed in warm months (Figure 1). An expected significant negative correlation was observed between secchi disk depth (Z_{SD}), measured during sampling, and total living biomass (r=-0.4404, P<0.001). The regression equation relating both variables is:

$$\ln Z_{SD} = 1.2564 - 2.3316 \ln (\text{T.living biomass})$$

Statistically significant positive correlations were also observed between living biomass and that of phytoplankton, zooplankton and bacteria. The empirical regression equations relating these variables are:

T.living biomass = 0.3155 +0.6509 Phytoplankton Biomass
T.living biomass = 0.2388 +0.7946 Zooplankton Biomass
T.living biomass = 0.2704 +1.0053 Bacteria Biomass.

As revealed from the present study, the average relative abundance of the different components of living biomass in the harbour water could be expressed as follows:
Zooplankton: 50.02%, Bacteria: 28.18%, Phytoplankton: 21.8%.

REFERENCES:
Aboul-Kassim, T.A. (1987). M.Sc. Thesis, Faculty of Science, Alexandria University, Egypt.
Holm-Hansen, O. (1973). In: Estuarine Microbial Ecology. Stevenson, H.L. and R.R. Colwell (Ed.). Univ. of South Carolina press, Columbia, S.C., pp.73-89.
Holm-Hansen, O. and C.R. Booth (1966). Limnol. Oceanogr., 11 :510-519.
Karl, D.M. (1980). Microbiological Reviews, Vol.44 : 739-796.
Strickland, J.D.H and T.R.Parsons (1972). Fish.Res.Bd.Canada, Bull.167.

Impact of Sewage Discharge on the Phosphorus Species and Dynamics in the Eastern Harbour of Alexandria, Egypt

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Phosphorus is one of the most important nutrient elements which control the growth and reproduction of phytoplankton. Mean while, when present in huge concentrations it may cause eutrophication and is considered as a potential pollutant.

This work assesses the importance of land based sources on the phosphorus species and budget in a heavily polluted basin off Alexandria coast.

The annual mean of dissolved inorganic phosphorus (DIP) in the Eastern Harbour (E.H) amounted to 0.44 ± 0.223 ug at/l. Generally, statistically significant correlations were found between DIP with particulate organic matter (POM) (P< 0.001) and dissolved oxygen (P< 0.001), indicating the importance of oxidation of organic matter as a source of DIP. The importance of the allochthonous source of DIP was demonstrated by the significant inverse correction found between DIP and salinity (r=- 0.318, P< 0.001).

Dissolved organic phosphorus (DOP) constitutes between 55-60% of total dissolved phosphorus (TDP) in the harbour water. The average value of DOP concentrations for surface and bottom water layers were 0.677±0.491 and 0.436±0.262 ug at/l, respectively. Significant corrections were observed between DOP and chlorophyll a (P< 0.001) as well as total living biomass (P<0.001), underscoring the important role of living organisms as a source of DOP in the harbour water.

Particulate phosphorus (PP) in the E.H was remarkably higher than that of TDP, constituting more than 58% of total phosphorus (TP). The overall average amounted to 1.394± 0.754 ug at/l. The high significant corrections between PP with POM (P< 0.001) and salinity (r= - 0.5399, P< 0.001) indicated that the concentration of PP is directly proportional to the amount of run-off. The regression equation being : POM = 1.767 + 0.670 PP.

The overall average values of inorganic phosphorus, organic phosphorus and total phosphorus of the surficial sediments of the harbour basin amounted to 0.086%, 0.02% and 0.106%, respectively.

The annual inputs of DIP to the harbour basin during 1985-1986 from land sources, precipitation as well as flux from sediments were 567 kg, 6.5 kg and 520 kg, respectively. About 400 kg/yr of DIP reaches the harbour from the neritic Mediterranean waters through the eastern outlet. On the other hand, the total phosphorus input to the bay via precipitation amounted to 6.5 kg/yr. Laboratory experiments indicated that maximum phosphorus released from sediments was attained during the first five days. A total 520 kg DIP was estimated to be released to the overlying water from sediments. This amount is about 52% of the total DIP input to the harbour.

The annual rate of phytoplankton uptake of DIP was experimentally determined and amounted to 860 kg/yr. The present day standing stock of phosphorus in the harbour amounted to 209 kg. Following the circulation pattern in the bay, he outflowing water from the bay carries about 190 kg of DIP annually to the coastal water of Alexandria region. The rest of the inflowing phosphorus is either adsorbed on settling particles or sediments.