FATE OF PHYTOPLANKTON PRODUCTION IN A RESTRICTED MEDITERRANEAN LAGOON

A. Sakka Hlaili [1] *, B. Grami [1], H. Hadj Mabrouk [1], M. Gosselin [2], D. Hamel [2]

[1] Laboratoire de Cytologie végétale et de Phytoplanctonologie, Faculté des Sciences de Bizerte, 7021 Zarzouna, Bizerte, Tunisie. - asma_sakka@yahoo.fr

[2] Institut des Sciences de la Mer de Rimouski (ISMER), Université du Québec à Rimouski, 310 allée des Ursulines, Rimouski, Québec G5L 3A1, Canada

Abstract

The fate of phytoplankton production was assessed in summer 2005 in the Bizerte Lagoon. Four stations were sampled for particulate organic carbon (POC), biomass, composition, growth rate and production of phytoplankton, microzooplankton grazing and vertical sinking of organic carbon. POC concentrations and algal biomasses exhibited significant spatial and vertical heterogeneity. The phytoplankton production (511- 851 mg C m^{-2} d^{-1}) was mainly grazed by microzooplankton (63 - 83%) and then channelled to the higher consumers, while sinking flow corresponded to 31- 36% of the carbon produced which was exported to the benthic food web.

Keywords : Lagoons, Phytoplankton, Carbon.

Introduction

Bizerte Lagoon, which supports intensive fishery activities and several aquaculture farms, is experiencing increasing anthropogenic of pollutants loading from expanding urban, agricultural and industrial development along its shores. This affected the productivity which in turn may lead to the dystrophy of planktonic and/or benthic communities. Hence, in order to assess the actual trophic status of the lagoon, it is urgent to understand and determine the carbon cycle within the lagoon. The focus of this study was to investigate the phytoplankton production and its export to the higher planktonic levels, *via* microzooplankton grazing, and to the benthic food web, through sedimentation.

Material and Methods

The sampling was carried out in summer 2005 at four stations (MA, MB, MJ and R), which are impacted by different human activities. Each station was sampled at three depths (2, 4/5 and 7.5/8.5 m) for particulate organic carbon (POC), abundance, composition, growth rate and production of phytoplankton (<2 μm, 2-10 μm, >10 μm) and microzooplankton grazing. In the four stations, the sedimentation of organic carbon was assessed using particular interceptor traps, which were installed at 9 m depth. POC was analysed on pre-combusted GF/F (21 mm) filters with a Perkin-Elmer 2400 CHN elemental analyzer. Picophytoplankton (<2 μm) was counted using epifluorescence microscope (x100 Fluotar objective). Identification and enumeration of 2-10 μm and >10 μm algae were determined under the inverted microscope (100 x objective) on 50-100 ml settled volumes. Phytoplankton abundances were converted to carbon biomass by measuring the biovolumes of species and converting them to cell carbon using conversion factors from literature. Phytoplankton production rate was estimated by the ^{14}C method. Rates of algal growth and microzooplankton grazing were determined using the dilution protocol [2]. A two-ways ANOVA analysis was performed to test spatial and vertical heterogeneity on different estimated variables.

Results and discussion

Particular organic carbon (POC) exhibited no significant difference among stations (P>0.05) but showed vertical heterogeneity (218-400 mg C m^{-3}, P<0.05). At station MA, POC concentrations increased with depth, while they decreased in the other stations. The carbon biomasses for different size fractions of phytoplankton exhibited significant spatial variations (P<0.001). The >10 μm phytoplankton had higher biomass at station MA, with value increased from 2 m (225.6 mg C m^{-3}) to 7.5 m (308 mg C m^{-3}). In contrast, in the other stations, >10 μm algal biomass (111.5-231 mg Cm^{-3}) decreased with depth. The >10 μm, which constituted the main fraction of total phytoplankton carbon, were mainly represented by diatoms. These algae were dominated by several species of *Cerataulina, Chaetoceros*, *Navicula*, *Rhizosolenia* and *Nitzschia*. The biomasses of picophytoplankton (4.5-18.9 mg C m^{-3}) and 2-10 μm phytoplankton (3.7-10.5 mg C m^{-3}) showed vertical heterogeneity in all stations, higher concentrations being in stations MJ and MB, respectively. In most stations, total phytoplankton carbon contributed 49-80% of POC. This indicates that autotrophs were the main components of the planktonic system, since heterotrophs and detritus represent 20-50% of the POC.

In stations MJ and R the production rate was maximal at 2 m and decreased with depth. Obviously, the vertical distribution of algal production is related to the vertical profile of light in the water column [3]. Algal biomasses in both stations were almost similar, but production rate was higher at station R (36-84 mg C m^{-3} d^{-1}) than that measured at station MJ (48-132 mg C m^{-3} d^{-1}). This may be due to the higher growth rate estimated at station R (0.42 d^{-1}) than that at station MJ (0.26 d^{-1}). The picophytoplankton contributed the main fraction (75-82%) of the production. The 2-10 μm and >10 μm phytoplankton represented 11-20 and 6% of produced carbon, respectively. The areal production rates, calculated by vertically integrating the values from the three sampling depths, were 511 and 851 mg C m^{-2} d^{-1} at stations MJ and R respectively. These rates were higher than those found in Open Ocean but similar to those measured in nearshore environments [4, 5].

Rates of microzooplankton gazing varied significantly (P<0.01) among stations, the higher rate (0.27 d^{-1}) was at station MB and the lower (0.15 d^{-1}) at station MJ. Grazing coefficients corresponded to consumption rates of 42-102.5 mg C m^{-3} d^{-1}. In station MJ and R, the levels of grazing were equivalent to daily losses of 63-83% of the phytoplankton production. The vertical flow of organic carbon exhibited spatial heterogeneity (P<0.01), higher and lower values was observed at station MA (561 mg C m^{-2} d^{-1}) and MJ (187 mg C m^{-2} d^{-1}), respectively. In station MJ and R, the sinking rates corresponded to 31-36% of the carbon produced which was exported to the benthic food wed. This stresses that the main flow of organic carbon was through microzooplankton grazing that play a key role in the carbon transfer to the higher pelagic consumers.

References

1 - MacIsaac E.A. and Stockner J.G., 1993. Enumeration of phototrophic picoplankton by autofluorescence microscopy. *In*: Kemp P.K. Sherr B.F. Sherr E.B. and Cole J.J (eds.), Handbook of methodology in aquatic microbial ecology. Lewis Publischers, Boca Raton, FL, pp 187-197.

2 - Landry M.R. and Hassett R.P., 1982. Estimating the grazing impact of marine micro-zooplankton. *Mar. Biol.*, 67: 283-288.

3 - Gocke K. and Lenz J., 2004. A new turbulence incubator for measuring primary production in non-stratified waters. *J. Plankton Res.*, 26: 357-369.

4 - Froneman P.W., McQuaid C.D. and Laubscher R.K., 1999. Size-fractionated primary production studies in the vicinity of the subtropical front and an adjacent warm-core eddy south of Africa in austral winter. *J. Plankton Res.*, 21: 2019-2035.

5 - Froneman P.W., Laubscher R.K. and McQuaid C.D., 2001. Sizefractionated primary production in the south Atlantic and Atlantic sectors of the southern Ocean. *J. Plankton Res.*, 23: 611-622.