VIRUS-PROKARYOTE-NANOFLAGELLATE-MICROZOOPLANKTON INTERACTIONS IN SURFACE WATERS OF THE MEDITERRANEAN SEA.

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Abstract

To understand the relative importance of viral shunt *vs* predation of both heterotrophic nanoplankton (HNF) and microzooplankton on autotrophic and hetereotrophic prokaryotes in the pelagic Mediterranean food web, we performed a series of independent incubation experiments along a wide trophic gradient from the Atlantic Ocean to the eastern Mediterranean Sea during a trans-Mediterranean cruise (May-June 2007). Results indicate that nanoflagellates predation, although often strongly controlled by microzooplankton, caused most prokaryotic losses; microzooplankton was more efficient on the autotrophic picoplankton.

Keywords: Bacteria, Predation, Levantine Basin, Western Mediterranean, Plankton

Surface water samples were collected at 9 stations including: 1 station in the Atlantic Sea (station VA), 4 stations in the western Mediterranean Sea and 4 stations in eastern Mediterranean Sea (fig.1).

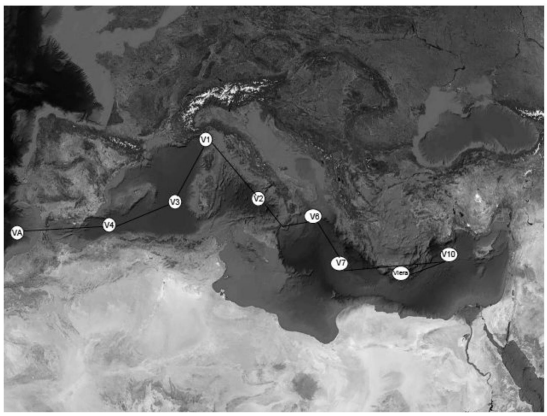

Fig. 1. Position of the 9 stations along the cruise track (VECTOR Project May-June 2007).

The loss of prokaryotic biomass caused by grazing or virus-mediated lysis has different consequences in organic C fluxes and biogeochemical cycles. If the main control of prokaryotic abundance is via protozoan grazing, most of the carbon will be channelled to higher trophic levels in the food web. Conversely, if viral infection accounts for most prokaryotic losses, the flow of carbon and nutrients can be diverted away from larger organisms thus accelerating the transformation of nutrients from particulate to dissolved states. This last process is named "viral shunt". The impact of viruses in pelagic processes depends largely on the significance of the virus-induced prokaryote mortality (VIPM). In the present study VIPM has been estimated on the basis of the viral production and the burst size of viruses (i.e, number of viruses released per infected cell). Viral production rates were measured using the dilution approach, which has been repeatedly applied to several coastal and deep-sea systems [1, 2]. Results reported here indicate that viral abundance was very low and did not significantly vary along the trophic gradient (on average, 6.94×10^4 viruses mL^{-1}). Conversely viral production ranged from $1.16 \pm 0.16 \times 10^3$ viruses $mL^{-1}h^{-1}$, at the station V1, to $2.57 \pm 0.60 \times 10^4$ viruses $mL^{-1}h^{-1}$, at the station V3, in the western Mediterranean Sea. However, on average, no significant differences were observed between viral production in western and eastern Mediterranean Sea. Assuming a burst size of 15, the fraction of prokaryotes killed by viruses per day ranged from ca. 0.3 to ca. 8% d^{-1} (at the stations V1 and V3, in the western Mediterranean Sea) and on average similar values of prokaryotic mortality were observed in both western and eastern sectors of the Mediterranean Sea. Previous studies suggested that higher values of VIPM may be related to the probable absence, or extremely low density, of grazers that compete with viruses for prokaryotic cells [2]. In the present study nanoflagellates (HNF) abundance (range: 3.63 ± 1.18 x10^2 - 1.15 ± 0.05 x10^3 individuals L^{-1}) was on average 2 orders of magnitude lower than viral abundance (fig. 2). A positive relationship (n = 9 R = 0.74) was observed between viruses to HNF abundance ratio and VIPM suggesting a higher contribution of the viral infection to prokaryotic mortality with decreasing HNF abundance. Heterotrophic bacteria abundance (fig.2) ranged from 2.44 ± 7.8 to 6.57 ± 3.45 x10^5 cells L^{-1}, and on average was higher in the western basin. Microzooplankton (MZ) abundance (fig.2) ranged from 7.64 ± 1.36 to 20.08 ± 4.34 x10^2 individuals L^{-1}.

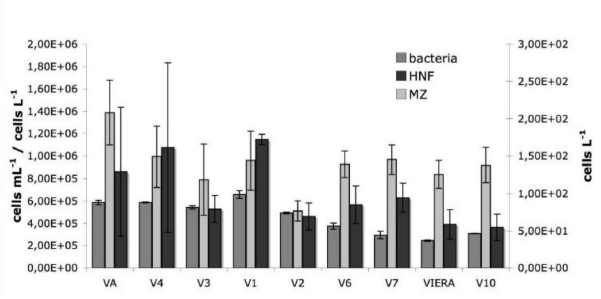

Fig. 2. Abundance of heterotrophic picoplankton and nanoplankton, and microzooplankton in the 9 stations of the trans.Mediterranean cruise.

Grazing impact of HNF and MZ on picoplankton was separately assessed using the classic Landry and Hasset (1982) [3] dilution method. Four models of interaction between HNF and MZ were identified: 1) only HNF fed on picoplankton, no MZ grazing was detected on both picoplankton and HNF, 2) MZ fed directly on picoplankton, no HNF predation was detected, 3) MZ caused an increase in prokaryotic loss compared to the only HNF predation, indicating a direct predation of larger consumers, 4) MZ grazing on HNF reduced prokaryotic biomass loss, indicating a strong top down control of MZ on HNF biomass. The experiments of HNF grazing indicated that most of the prokaryotic mortality in surface waters of the Mediterranean Sea is due to predation by HNF, although in few cases, and particularly on autotrophic fraction, MZ was a more efficient predator than HNF. Results show that in the eastern Mediterranean picoplankton mortality due to both HNF and MZ grazing was always higher than growth rate.

References

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