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Influence of environmental variation on the bacterioplankton community and its loss to viral lysis in the Curonian Lagoon

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ABSTRACT

Coastal lagoons are continuously exposed to strong environmental gradients that determine the distribution and trophic interactions of microbial communities. Therefore, in this study we assessed whether and how environmental changes influence the bacterial community and its vulnerability to viral infection and lysis along the major environmental gradient in the Curonian Lagoon. We found significant differences in bacterial community profiles, their richness and evenness between the riverine, freshwater southern part and the Baltic Sea water intrusion-influenced northern part of the lagoon, suggesting strong environmental control of the structure of bacterial communities. Viruses were found to be play an important role in bacterial mortality in the Curonian Lagoon, being responsible for the removal of 20–50% of the bacterial standing stock. We observed differences in virioplankton decay rates and virus burst sizes between the northern and southern parts of the lagoon. However, no relationships were found between viral activity and bacterial communities within the lagoon ecosystem. The frequency of infected cells and virus-mediated bacterial mortality (VMBM) remained constant among the sampling sites irrespective of differences in bacteria community assemblages and environmental conditions. The results indicate that factors determining changes in bacterial diversity are different from the factors limiting their vulnerability to viral infection and lysis. This study also suggests that under changing environmental conditions, virus-bacteria interactions are more stable than the interacting viral and bacterial communities themselves. These findings are important for understanding the functioning of the coastal ecosystems under the rapidly changing local (spatial and temporal) and global (e.g. eutrophication, climate change) conditions.

1. Introduction

Coastal lagoons are water bodies characterized by their pronounced environmental gradients that emerge along the river - sea transition creating spatially and temporally heterogeneous habitats to which planktonic organisms are challenged to adapt (Moeseneder and Herndl, 1995; Bergstedt et al., 2004; Malits et al., 2004). The mixing of river flow and seawater, among other factors, can determine shifts in the salinity regime, nutrient concentration and availability of dissolved organic matter. Differences in water turbulence and water residence time arising along the major environmental gradient of the lagoon ecosystems are associated with variation in physical and chemical disturbance level, changes in shear forces, light penetration, concentration of dissolved gases, distribution of suspended particles and many other changes. Such environmental perturbations have a major impact on the structure (species richness, evenness, cell size distribution, etc.), abundance and activity (growth, production, respiration etc.) of microbial communities (Peters and Marrase, 2000; Peters et al., 2002; Crump et al., 2004; Barrera-Alba et al., 2009; Hitchcock et al., 2010; Simonato et al., 2010; Chen et al., 2011). Thus, one would expect it to also change their vulnerability and loss to predation and viral lysis (Petersen et al., 1998; Marine et al., 2013). Changes in bacterioplankton mortality can cascade throughout the entire pelagic food web and affect ecosystem productivity and water quality. It is, therefore, important to understand how microbial communities and their loss to biotic factors are related to the environmental

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gradients of lagoon ecosystems.

The Curonian Lagoon (55°14′N, 21°05′E) is a large (area – ~1584 km^2, volume – ~6.3 km^3) and shallow (mean depth ~3.7 m) coastal ecosystem occurring in the south-eastern Baltic Sea (Fig. 1). The northern part of the lagoon is a transitory riverine-like system having complex water circulation patterns influenced by Nemūnas River discharge and irregular seawater intrusions (Ferrarin et al., 2008). This part is characterized by relatively short water residence time and non-stable salinity fluctuations, ranging from 0 to 7 (Ferrarin et al., 2008). The lentic-like southern part of the lagoon exhibits closed water circulation patterns, relatively low current velocities and poor water renewal (Ferrarin et al., 2008). It is suggested that hydrodynamics-associated differences in environmental conditions (e.g. salinity, nutrient distribution) that emerge

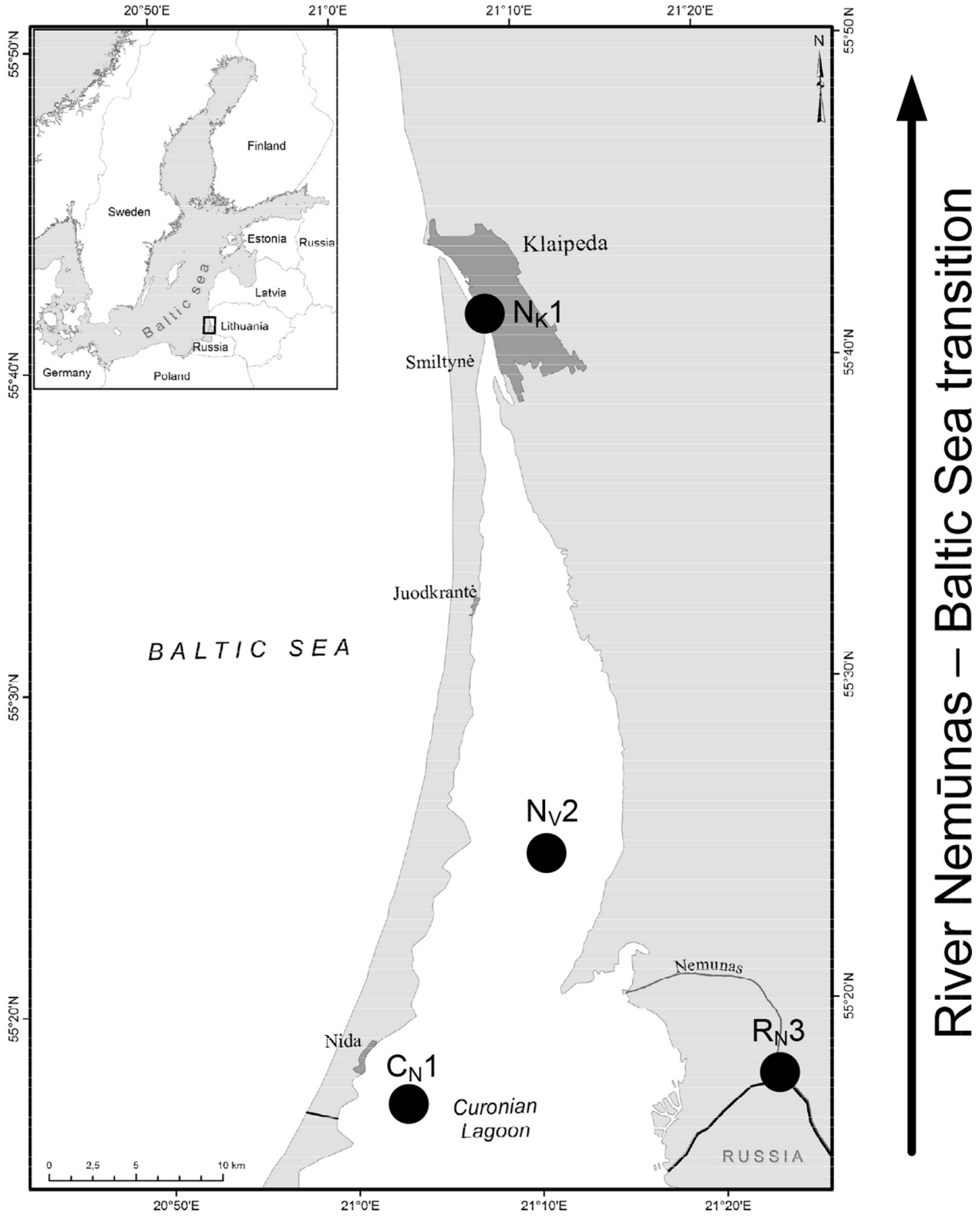

Fig. 1. The location of the sampling sites in the Curonian Lagoon.