

# Plankton community structure during an ecosystem disruptive algal bloom of *Prymnesium parvum*

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*The purpose of this paper was to study the plankton food web structure in Lake Koronia during an extremely dense bloom of Prymnesium parvum. The Prymnesium bloom fulfilled the main criteria of an ecosystem disruptive algal bloom, since it was a massive persistent, monospecific bloom which disrupted the dynamics of the plankton community. It appeared after an N-fixing cyanobacterial bloom, when a decrease in temperature and low nitrogen conditions may have caused a positive feedback, which allowed the replacement of cyanobacteria by the invasive Prymnesium. The initiation of the bloom was further facilitated by the disruption of zooplankton grazing, with the biomass of the primary grazers, rotifers and cladocerans, dropping to undetectable levels. Furthermore, the rest of the phytoplankton responded to the onset of the bloom by an 82% decrease. Cyanobacteria and diatoms exhibited the highest decrease in biomass (95 and 99%, respectively) followed by chlorophytes (55% decrease). This enabled the uncontrolled increase of the P. parvum population to numbers close to the highest abundance ever recorded. At that point, the grazing community was reinstated and the system became replete with nutrients with an N:P ratio of 10:1. This coincided with the beginning of the bloom termination, which was followed by an increase in the biomass of competing phytoplankton.*

## INTRODUCTION

Harmful algal blooms (HABs) are being recorded with increasing frequency in coastal and inland waters due to enhanced eutrophication and global climate change (Anderson *et al.*, 2002). Apart from the obvious harm to humans, HABs may disrupt ecosystem structure and function. In such cases, they are referred to as ecosystem disruptive algal blooms (EDABs) (Sunda *et al.*, 2006).

The haptophyte *Prymnesium parvum* is included among the species considered to cause EDABs (Sunda *et al.*, 2006). Its blooms are usually accompanied by massive deaths of fish in coastal aquaculture areas leading to great financial loss (e.g. Kaartvedt *et al.*, 1991; Lindholm *et al.*, 1999). This has led to extensive research in an

attempt to elucidate the factors leading to the formation of such blooms and regulating their toxicity. Nevertheless, very little has been published regarding field data, especially in the Mediterranean limnosystems (Lindholm *et al.*, 1999; Mattioli and Simoni, 1999). These may represent the “future” of the temperate cold systems under the influence of climate change (Alvarez-Cobelas *et al.*, 2005).

In August–September 2004, an extremely dense bloom of the haptophyte *P. parvum* was observed in Lake Koronia, the present status of which is a current example of unsustainable water resources management and weather adverse effects (Michaloudi and Kostecka, 2004). This bloom coincided with a mass bird (thousands) and fish (hundreds) kill (Moustaka-Gouni *et al.*, 2004). Avian deaths have not been previously

were completely suppressed in the laboratory bioassays performed by Fistarol *et al.* (Fistarol *et al.*, 2003). The group least affected during the *Prymnesium* bloom in Lake Koronia were chlorophytes. The largest decrease in chlorophyte biomass was observed on 17 September by the end of the bloom. This decrease is possibly related to increased grazing rates by rotifers. The cryptophytes represented by *Cryptomonas* sp. exhibited a peak population on 11 September but declined rapidly a week later. Cryptophytes have been found to be affected through both the release of allelopathic compounds and predation of *Prymnesium* (Barreiro *et al.*, 2005). Predation by *Prymnesium* was not observed in our live samples.

In conclusion, the *P. parvum* bloom recorded in Lake Koronia constituted an EDAB since it was a massive persistent, monospecific bloom, which disrupted the dynamics of the plankton food web components. The conditions leading to the initiation of the bloom involved an N-fixing cyanobacterial pre-bloom and low nitrogen concentrations. Limited grazing during bloom initiation, with rotifers and cladocerans reaching undetectable numbers constituted a positive feedback for the establishment of the EDAB (Sunda *et al.*, 2006). This feedback was further facilitated by the large decrease in the biomass of other phytoplankton which competed with *P. parvum* for nutrients and light. The *Prymnesium* bloom was most probably terminated by the continuous positive feedback which triggered the formation of cysts.

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