Alteration in the summer phytoplankton abundance from medium to low water level conditions in the River Danube.

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Introduction

Phytoplankton investigations on the River Danube at Göd (riv. km. 1669) have been carried out with a weekly frequency by Kiss for more than twenty years (Kiss 1985, 1986, 1994). As a general tendency in the River Danube, low water level in the spring and summer period (from early March to the end of September) leads to the development of large phytoplankton abundances (20 000 – 100 000 ind ml^{-1}). The reason for this is two-fold: on one hand, the Danube is rich in inorganic nutrients (potentially hypertrophic, the PO_4-P concentration is about 5 times higher as the limitation level), on the other hand, during low water periods, up to 70-90 percent of the water-spout falls within the euphotic zone (Kiss 1994). Normally, the high phytoplankton abundance decreases dramatically after a flood, however, during the spring and summer periods, it regenerates quickly afterwards (Kiss 1996). From the middle of September on, this regeneration is slower or might not happen at all due to the decreased light availability.

The years 2003 and 2005 were exceptional in the sense that phytoplankton abundance did not show the usual correlation with water level in these two years in August. Both years were characterized by low water level during certain periods of the summer while the water level in 2004 was not especially low. In this paper, the analysis of the phytoplankton samples from April to October 2003-2005 will be outlined. In these periods, several physicochemical parameters of the water such as conductivity, phosphorus and nitrogen content, O_2 content and saturation, suspended matter content and chemical oxygen demand were also monitored beside phytoplankton abundance, species composition, chlorophyll-a content, and protozoa abundance and species composition.

Material and Methods

Sampling methodology, analysis of phytoplankton and protozoa samples, and water chemistry analysis were carried out as described earlier (Kiss 1994, Kiss et al. 1996, Ács et al 2006).

Results and Discussion

Phytoplankton flora of the Danube was mostly dominated by centric diatoms, especially by *Cyclostephanos*, *Cyclotella*, *Skeletonema*, *Stephanodiscus*, *Thalassiosira* species during the whole year (Fig. 1., Kiss 1986, 1987, Kiss & Genkal, 1993, Kiss & Nausch 1988).

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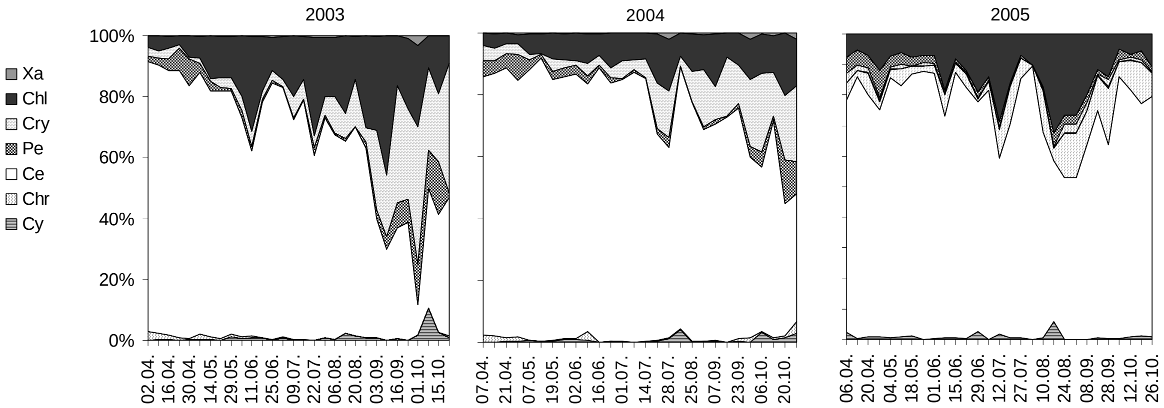

Figure 1: The contribution of algal groups to phytoplankton in the three years of our study. Values are relative abundances given as %. (Xa = Xantophyceae, Dinophyta, Euglenophyta, Chl = Chlorophyceae, Cry = Cryptophyta, Pe = Pennales, Ce = Centrales, Chr = Chrysophyceae, Cy = Cyanobacteria).

The inverse correlation between water level and phytoplankton abundance was very clear in the early summer periods of all three years (Fig. 2. - see periods marked by dotted circle, also Fig. 3). This was well in accordance with previous findings (Vörös et al. 2000). However, the years 2003 and 2005 deviated from the general pattern in the late-summer period.

The year 2003 was characterized by a rather low water discharge and hence, the phytoplankton abundances were accordingly high until midsummer (Ács et al. 2006). In August, phytoplankton abundance dropped to a very low value and throughout the autumn it stayed lower than it has been observed before. The content of suspended matter was also very low, with values under 10 mg l^{-1}. In spite of the low water level, warm temperature and surplus inorganic nutrients, the phytoplankton and protozoa abundance remained extremely low in the late summer and autumn. The same phenomenon was repeated again in 2005: we experienced low water level and low phytoplankton and protozoa abundance values. Contrary to this, the year 2004 was characterized by medium water level and higher phytoplankton abundance values (Fig. 2).

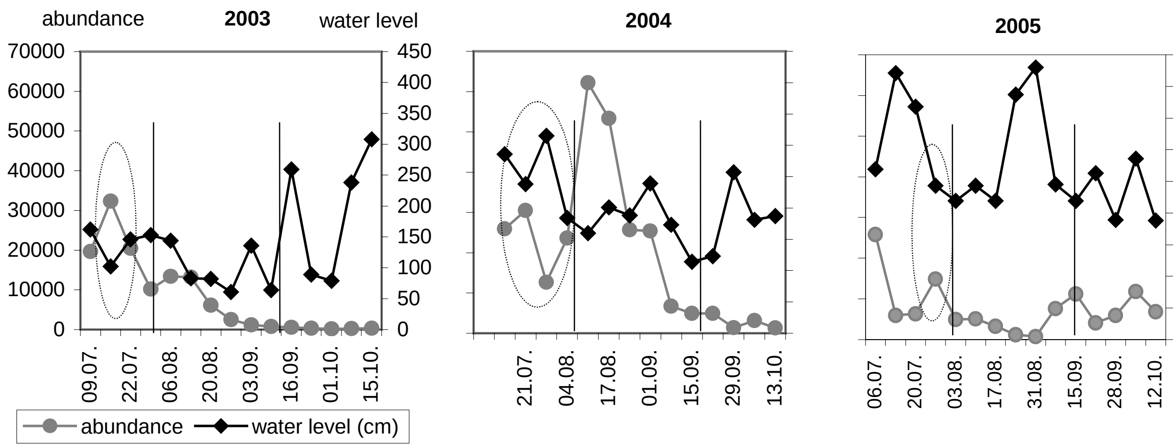

Figure 2: Phytoplankton abundance (ind ml^{-1}) in the late summer period of 2003-2005. Dotted circle indicates the periods that followed the regular pattern of water level (cm) and phytoplankton abundance correlation, two vertical lines mark the periods that deviated from the regular pattern.

In order to find the possible causes of this phenomena, toxicity tests (with *Sinopis alba* and *Scenedesmus capricornutum*) were carried out, furthermore, the element content of the periphyton was measured in 2003. These tests did not reveal the presence of toxins or enhanced amounts of heavy metals. The abundance of grazing protozoa was also determined, but this value was not extraordinarily high, furthermore, protozoa assemblages were mostly composed of small species that are primarily not alga-consumers (Ács et al 2006). The concentration of dissolved oxygen was also within the usual boundaries in all three years (Fig. 4). Both the years 2003 and 2005 were characterised by a prolonged low water period during the whole of August and between 27th July and 17th August, respectively (Fig. 3). A prolonged, 3-4 weeks long low water period was not present in 2004.

We suggest that light inhibition and other, presently unknown causes are in the background of the 2003 and 2005 phenomena. The effect of light limitation could be observed on epilithic algae at Göd during the same period in 2003. The epilithic algae produced a thick mucilage cover to protect themselves against the high radiation effect (Ács et al. 2006). In the future, we will investigate the possible food-chain between phytoplankton and mussels, which are effective filters in large rivers. Thus, the unusual phenomenon can eventually occur that the phytoplankton abundance is extremely low in the River Danube in hot, sunny summer periods if the water level is low for a prolonged period of time.

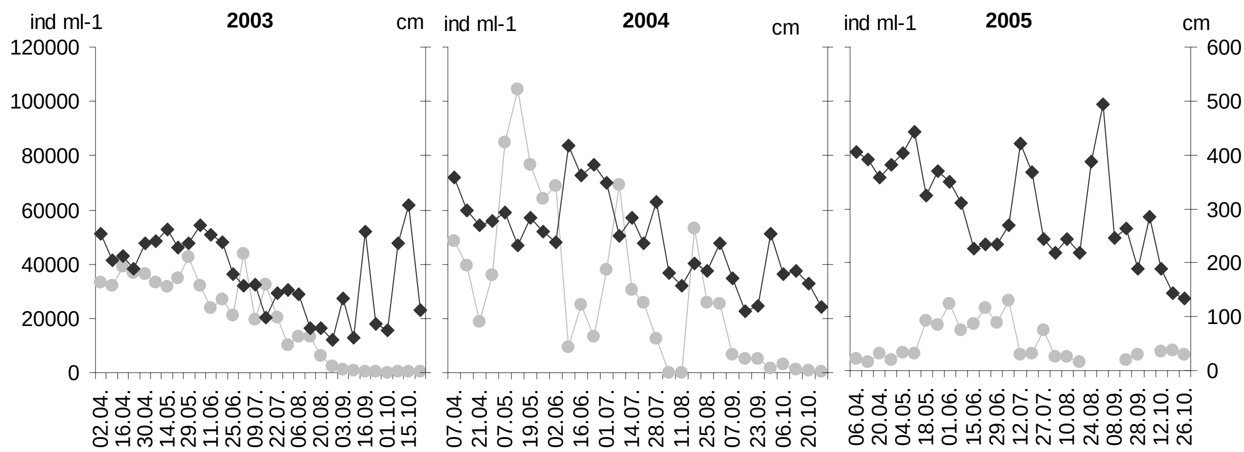

Figure 3: Phytoplankton abundance (ind ml^{-1}) and water level (cm) in the April-October periods of 2003-2005. -●- indicates phytoplankton abundance, -♦- indicates water level.

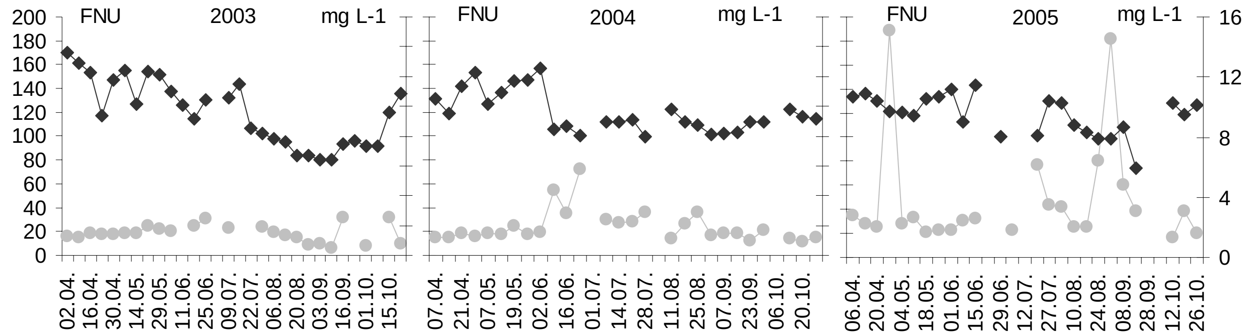

Figure 4 a, b, c.: Turbidity and dissolved oxygen content in the Danube during the study periods. -●- indicates turbidity (FNU), -♦- indicates dissolved oxygen (mg L^{-1}).

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