

Drivers of macrophyte and diatom diversity in a shallow hypertrophic lake

Kateřina Šumberová*, Ondřej Vild, Michal Ducháček, Martina Fabšičová, Jan Potužák, and Markéta Fránková

* Correspondence: katerina.sumberova@ibot.cas.cz

Figures S1–S15. Photographs documenting environment, selected vascular plant species and their assemblages, and fish farming practices in the Dehtář fishpond (Southern Bohemia, Czech Republic).

Dehtář is a fishpond serving mainly for common carp (*Cyprinus carpio*) breeding and, to a lesser extent, also for the breeding of other fish species with similar habitat requirements as the carp (e.g. white amur – *Ctenopharyngodon idella*, spike – *Esox lucius*, spike-perch – *Stizostedion lucioperca*). The fish stock also includes fish species that are not intentionally stocked due to their low economic importance and ability to reproduce naturally in the fishpond system (e.g. roach – *Rutilus rutilus*, perch – *Perca fluviatilis*). In some cases, they even constitute competition for feed with the stocked fish and/or exhibit invasion potential (e.g. bream – *Abramis brama*, Prussian carp – *Carassius gibelio*).

Explanations to photograph captions: For the position of the mapping segments along the fishpond's bank see Figure 1 (Materials and Methods, part 2.1). Vegetation zones: 1st zone (first zone in the main text) – upper littoral with permanent reed and tall sedge beds; 2nd zone (second zone) – lower exposed littoral with vegetation of ruderal grasslands, temporary reed beds and wetland annual vegetation; 3rd zone (third zone) – shallowly flooded lower littoral with vegetation of amphiphytes and (mainly) submerged aquatic plants. For a more detailed description of the vegetation zones see Results, part 3.2.2. If no other author is given, photographs originate from K. Šumberová.



(a)



(b)

Figure S1. The Dehtář fishpond during fish harvesting in November 2016. The water level is substantially lowered already a month before the harvest. Following the harvest, the fishpond is continually filled with water, with the management maximum during the second growing season after the harvest (2nd year of the management cycle): **(a)** Exposed sandy shores below the fishpond dam, with the adjacent zone of wet fishpond mud; **(b)** The deepest part of the Dehtář fishpond where the rest of the water with fish concentrates during the harvesting.



Figure S2. NE corner of the Dehtář fishpond. Segment 2 with *Salix triandra* (1st vegetation zone) and *Bolboschoenus laticarpus* (2nd zone) stands, segment 3 with *Phragmites australis* (1st zone) and a part of segment 4 with *Phalaris arundinacea* beds (1st zone). Both photos are from the 1st year of the management cycle: (a) September of an extremely dry year 2015; (b) June 2019 when the littoral of this fishpond part was shallowly flooded.



Figure S3. NE corner of the Dehtář fishpond, a detail of the narrow bay on the transition of segments 3 and 4: (a) September of an extremely dry year 2015, vegetation predominated by tall wetland annual herbs (*Bidens radiatus*, *Persicaria lapathifolia* and *Rumex maritimus*) on sapropelic mud; (b) June 2016 when the littoral of the bay was deeply flooded (about 30 cm in the 1st vegetation zone with *Phragmites australis* and up to 70 cm in the remnants of the 2nd zone) and large areas of cyanobacterial mats appeared.



Figure S4. Extensive areas of wetland annual vegetation (2nd zone) developed in an extremely dry year 2015 on exposed bottom of the Dehtář fishpond: (a) Vegetation on muddy sediments in the Babický Stream Bay (segment 7) predominated by *Rumex maritimus* and *Bidens radiatus*; (b) Exposed sands and gravels with *Trifolium arvense* community, bordered by tall wetland annual vegetation (*Rumex maritimus*, etc.) in places with a shallow muddy layer and by the vegetation transitional between small wetland annual and amphibious plant communities (*Elatine hydropiper*, etc.) at sites with deeper mud along the south-western shores (segment 11; September 2015).



Figure S5. Zonation of the littoral in the northern part of the Dehtář fishpond (segment 4). From the bank: 1st zone – narrow strip predominated by *Phalaris arundinacea*, 2nd zone with several sub-zones, i.e. grassland with *Trifolium hybridum*, narrow strip predominated by annual *Bidens radiatus* and a stand of *Bolboschoenus* sp. Aquatic and amphibious plant assemblages (3rd zone) develop on the watered margin of *Bolboschoenus* stand and in shallow lagoons bordered by sandy deposits (August 2019).



Figure S6. Zonation of the littoral in the north-western part of the Dehtář fishpond (segment 6). From the bank: 1st zone – narrow strip predominated by *Phalaris arundinacea* and disturbed stands of *Carex acuta*, and 2nd zone with scarce vegetation of wetland annuals with low moisture demands. The shallow water zone is not yet vegetated (June 2019).



Figure S7. Detail of the vegetation in the Babický Stream Bay (segment 7; see also Figure S12): transitional plant assemblages on moist sand with a shallow muddy layer. *Coleanthus subtilis*, *Ranunculus sceleratus* and *Juncus bufonius* are the dominants (April 2015).



Figure S8. Detail of the vegetation on the south-western shore of the Dehtář fishpond (see also Figure S4a): transitional plant assemblages on moist sand with a shallow muddy layer. *Elatine hydropiper* (red-coloured under extremely dry conditions) and *Limosella aquatica* are the dominants, seedlings of *Veronica anagallis-aquatica* and *Spergularia kurkae* also occur frequently. These stands appeared at the end of the growing season in 2015 on newly exposed substrates, following continual water table decrease (April 2015).



Figure S9. *Montia arvensis*, one of the rarest wetland annual species of the Czech Republic. In the Dehtář fishpond it grows over a variety of substrata, preferentially on sand or between stones in the upper part of the 2nd vegetation zone or its transition to *Carex acuta* or *Phalaris arundinacea* beds in about 50% of mapping segments. As a winter annual it flowers already in early spring and usually disappears by mid-May (March 2016).



Figure S10. *Myosurus minimus* on the shore disturbed by wave action near the fishpond dam (segment 1), accompanied by *Myosotis* spp. and other wetland and weedy annual species (photo by M. Ducháček, May 2014).



Figure S11. The Babický Stream Bay (segment 7) in the 2nd year of the management cycle. Due to continually low water levels, atypical for the 2nd management year, a part of the bottom is covered with wet disturbed grassland predominated by *Agrostis stolonifera* (the situation was similar at BSB before the flooding in 2016, see Figure S13). Its left margin was temporarily flooded and after a new exposure colonised by wetland annuals (July 2014).



Figure S12. Large areas of exposed pond bottom in the Babický Stream Bay (segment 7) with the mosaic of wetland annual plant communities on sandy (e.g. *Juncus bufonius*) and muddy substrates (*Coleanthus subtilis*, *Ranunculus sceleratus*; April 2015). Vegetation development started already after the fish harvesting in 2014 and continued in spring of the 1st year of the management cycle.



Figure S13. The Babický Stream Bay in July 2016 (segment 7). The uninterrupted succession in 2015/2016 resulted in vegetation of wet disturbed grasslands with e.g. *Agrostis stolonifera*, *Poa palustris* and *Persicaria amphibia*. At the end of May 2016 (2nd management year) the stands started to be gradually overflooded and in July only remnants of vegetation, from a large part flooded, occurred at the site. The stands were grazed by aquatic birds (mainly various Anseriformes) and by white carp (*Ctenopharyngodon idella*).



Figure S14. A windy day on the Dehtář fishpond. Wave-mediated disturbances on sandy shores near the fishpond dam (photo by M. Ducháček, May 2014).



Figure S15. In 2019, strong winds occurred only scarcely at the Dehtář fishpond. The glassy water table was often covered by cyanobacterial mats during summer months (June 2019).