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Ph.D. Thesis Review

submitted to: University of South Bohemia
Faculty of Science, Department of Ecosystem Biology

Title: Aquatic insect assemblages in littoral zones of ponds and other man-made habitats

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Dissertation results

Chapter I is dedicated to changes in the status of littoral habitat in South Bohemian fishponds and their effective conservation. The study reveals a decline of the littoral habitat during the second half of the 20th century, irrespective of the protection status. This is an important finding, since the littoral zones are a vital habitat for pond macroinvertebrate biodiversity. The study also indicates that this process can be reverted.

Chapter II provides results of investigations on habitat selection by the endangered diving beetle *Graphoderus bilineatus* in habitats largely modified by humans. The data show that the species occurs in various natural habitats and extensively managed fishponds but avoids intensively managed fishponds.

Chapter III describes the variation in odonate communities among different types of man-made lentic water bodies which provide habitats in different successional stages. All studied habitats were complementary with respect to odonate species composition. Environmental characteristics of each habitat and management practices were considered in the analyses.

Chapter IV is focused on the differences between spontaneous succession and technical reclamation of post-mining sites with regard to protection of two newt species of conservation concern in Central Europe, *Lissotriton vulgaris* and *Triturus cristatus*. Both species were largely absent from the artificially established post-mining pools, as well as from adjacent fishponds, while the spontaneously developed post-mining pools proved more suitable as breeding habitats.

Chapter V deals with the problem of suitability of lignite spoil heaps as habitats for aquatic insects. The study provides original field data on aquatic beetles and hemipterans and synthesises available datasets on freshwater communities of invertebrates and vertebrates at post-mining habitats. The studied insect communities as well as some other insect groups and amphibians (based on the reviewed studies) were richer in spontaneously and semi-spontaneously developed pools. However, 'technically created' pools could be suitable habitats for aquatic plants, odonates and macrozoobenthos. The study also provides some

information on morphological and environmental characteristics of the post-mining pools that enjoyed high biodiversity.

General comments

The Dissertation (five main chapters) is well structured and correctly presented. The text is written in a concise manner. The applied field and statistical methods are adequate. The figures and tables are presented properly. References are exhaustive and correspond to the present state of knowledge.

The Dissertation deserves a broader title; the present one *Aquatic insect assemblages in littoral zones of ponds and other man-made habitats* is somewhat misleading, because Chapter I documents changes in the status of pond littoral habitats which are important for a broader range of taxa than aquatic insects only, Chapter IV deals with newts, and Chapter V provides a literature synthesis on the relevance of restoration approaches at post-mining sites for freshwater biodiversity, including plants and amphibians. Chapter I and V are particularly outstanding parts of the Dissertation, since they tackle the problem of long-term changes in fishpond habitats and summarize the effects of post-mining restoration practices.

Chapter I. The merit of this chapter is that it shows that the conservation status of the fishponds did not affect the decline trends of the littoral zones indicating that habitat protection in the ponds that were nature reserves was insufficient to stop the long-term decrease of the littoral habitat. I am missing a more detailed description of what conservation measures are adopted when fishponds have a 'reserve' status (it is only mentioned in the Discussion that the reserves are privately owned) and am also missing a more thorough discussion of how the effectiveness of the protection of littoral habitat could be practically improved without risking a serious conflict with the economic interests of pond owners. A point which could be more thoroughly examined are the ultimate causes of the littoral habitat decline: were macrophyte beds actively destroyed for the sake of larger fish yields or did the decline occur due to indirect consequences of fish culture practices (e.g. increasing fish stocks)? Also, it would be good to know some estimates for the relationship between the extent of the littoral zone (e.g. in terms of proportion of pond surface area) and macroinvertebrate (also amphibian) diversity. Pond biodiversity does not necessarily need to be linearly related to the area of littoral zone - rich biodiversity may be associated with open water habitats as well, as indicated in Chapter V for post-mining freshwater pools.

Since fishponds usually occur in clusters operated by individual fish farms, I would consider including fish farm identity in the generalised linear mixed models (as a random term); in this way local differences in farming practices could be accounted for (admittedly, pond management could have changed within individual farms from the 1950s).

Chapter II provides interesting insights into the *Graphoderus bilineatus* preferences on the macro- and microhabitat scale. The species may be considered an umbrella species as it is frequently found in habitats characterised by high species richness of large-bodied aquatic beetles. It is a pity that fish status (total biomass, size structure) was omitted from the analyses because fish is known to have a strong impact on dytiscid occurrence. Many natural and man-made habitats can be to a varying degree colonised by fish, so fish status could be a factor better explaining *Graphoderus bilineatus* distribution among habitats than locality type.

Chapter III presents in a fine manner the complexity of habitat selection by odonates in response to habitat features, including avoidance of and adverse trophic interactions with fish. My only consideration are the relatively small sample sizes (6 early-succession sandpit ponds,

7 late-succession sandpit ponds and 7 fishponds). Given the large variability in management of the ponds, especially of aquaculture ponds, a larger pond sample could provide a more complete picture of factors driving odonate assemblages.

Chapter IV. This paper shows that costly technical reclamation of lignite spoil heaps is not more effective in creation of breeding habitats for newts than their natural succession. This finding is important due to the economic burdens involved in technical reclamation. It is a little unclear why other amphibian species (i.e. anurans) were not investigated. I see - based on references in Chapter V -that the potential of post-mining areas as habitats for amphibians has been investigated by other researchers (Vojar et al. *Ecological Engineering* 2016), so considering these data would (as has been in Chapter V) shed additional light on which strategies for habitat restoration are optimal for amphibian diversity. The other question would be whether the occurrence of fish in the lignite heaps was dependent on the way the pools were established - for a reader not familiar with Bohemian post-mining areas it may be unclear to what extent fish invade the post-mining pools. As in Chapter II, fish presence (and status) might have been an important predictor in the analyses and it should have been investigated as indicated by the virtual absence of newts from the local fishponds.

Chapter V demonstrates opposite patterns of habitat value of post-mining pools for different taxa with respect to the pool origin (natural vs. technical). These findings are of high scientific and conservation importance as they show that uniform habitat reclamation approaches are insufficient for a complete conservation of post-mining pool communities. Also, the synthesis of the role of land surroundings (including land use) of post-mining freshwaters is highly valuable since it provides a base for well-grounded recommendations for restoration approaches.

Conclusions

The Thesis addresses the important topics of management of human-made freshwaters for animal diversity and represents a high-level scientific achievement. The Author has made a substantial theoretical and empirical contribution to the field of freshwater biodiversity conservation.

The Thesis meets the international requirements imposed on a Ph.D. dissertation in Hydrobiology and I recommend it for acceptance to be defended in front of the Ph.D. committee.

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