

THESES OF THE DOCTORAL (PHD) DISSERTATION

**THE EFFECTS OF WETLAND MANAGEMENT AND
RESTORATION TECHNIQUES ON AQUATIC BEETLE
ASSEMBLAGES**

ÁKOS MOLNÁR

Supervisor:

Dr. Árpád Szentesi, DSc, associate professor

Consultant:

Dr. Zoltán Csabai, PhD, associate professor

Doctoral School of Biology

Head of the Doctoral School: Dr. Anna Erdei, DSc, professor

Doctoral programme of Zootaxonomy, Animal Ecology, Hydrobiology

Head of Doctoral Programme: Dr. János Török, DSc, professor

Loránd Eötvös University

Department of Systematic Zoology and Ecology

Budapest

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1. Introduction and aims

Over the last few centuries, Europe and Hungary have lost an estimated 90 and 97 percent of their natural wetlands due to human activities (Lájer 1998, Mitsch & Gosselink 2000). Therefore, similarly to terrestrial and aquatic habitats, not only species-level conservation but even the protection of the existing nature conservation areas is insufficient to prevent the loss of wetland biodiversity. The restoration of the lost, degraded or altered habitats is also necessary. As the ecological systems are opened and their long-term stability cannot be guaranteed (Simberloff 1982), specific management is necessary to keep the habitat in the planned status or to canalize natural changes. Habitat management and traditional land use forms are often similar, as lots of valuable habitats formed as a result of traditional human land use like mowing or grazing (Ausden 2007).

To achieve a successful restoration, evidence-based planning is necessary (Sutherland *et al.* 2004), which assumes the investigation of the evidence (i.e. studies about the success of former restorations). In my dissertation, I intended to join this process with the investigation of the effects of wetland management techniques on aquatic beetle assemblages.

Aquatic beetles are suitable for this type of studies for many reasons. Practically, water beetle assemblages are good indicators of the environmental changes, and water beetles inhabit most wetlands in considerable abundance (Foster 1987, Ribera & Foster 1992, Sánchez-Fernández *et al.* 2006). Furthermore, water beetles are easy to collect and identify. Our scientific knowledge about water beetles is rather scarce, thus information about their ecology and responses to human activities can be valuable e.g. for developing wetland-qualifying methods based on water beetles, but also at planning restorations specifically for aquatic macroinvertebrates.

I addressed the question of whether and how water beetle assemblages are influenced by wetland management techniques. I investigated the effect of the following management techniques on the composition and abundance of water beetle assemblages:

(1) Planting of native aquatic plants. This method is used to facilitate the development of the vegetation of the restored habitat. Studies about the correlation of aquatic invertebrates and aquatic plants revealed that planted habitats provided better circumstances for aquatic beetles. Therefore planted habitats could support more diverse and abundant water beetle assemblages.

(2) Different methods of inundation. Surface flow and subsurface flow wetlands are different in their water quality, resulting in different water beetle assemblages. I hypothesized that subsurface flow wetlands with low nutrient concentration support more diverse and abundant water beetle assemblages.

(3) Mowing of emergent vegetation, more specifically cattail (*Typha*) species. Mowing of dense *Typha* stands may result in better physico-chemical conditions for water beetles and opens water surface which may be easier to detect visually for water beetles colonizing the water from the air.

(4) Ecologically intensive grazing (0.9-1.3 animal unit/ha) by native livestock. Former studies suggest that intensive grazing has negative effects on the diversity and abundance of water beetle assemblages.

2. Materials and methods

Data collection

The effects of the wetland management practices were studied at three different wetlands of Hungary. Planting of aquatic plants and different methods of inundation were studied in the Nyirkai-Hany habitat restoration area in the Hanság, Northwest Hungary. The effect of mowing was studied in a field experiment on the Nyík-rét II reservoir near the village Farnos, on the northern part of the Danube-Tisza Plain. The effect of grazing by native livestock was tested at the habitat-restoration area of the Nagy-Vókonya Puszta, in the Hortobágy (northeastern part of the Great Hungarian Plain). Water beetles were collected by sweeping with a hand-net at standardized parameters (number of sweeps, duration, area). The number of the collected water beetle imagos was used to compare the abundance and species composition of the managed and control areas. Environmental data (plant cover, water temperature, depth, pH, conductivity, sediment thickness) was also registered to get a closer insight into the possible mechanisms.

Data analysis

Repeated-measures ANOVA models were used to analyse the data collected in the Nyirkai-Hany and Farnos. Environmental data and variables of the water beetle assemblages (abundance, species richness, Shannon-diversity, Pielou-evenness) were compared between treatments and in time. To the post-hoc comparison of the samples collected at the same time, Tukey Unequal N HSD test and Fisher LSD-test were used on the data from the Nyirkai-Hany and Farnos, respectively. General linear models were used to find the relationship between dependent and independent variables at the Nagy-Vókonya study.

Bray-Curtis dissimilarity indices were used to compare the species-composition of water beetle assemblages.

Discriminant-analysis was used to the multivariate analysis of the water beetle assemblages of the Nyirkai-Hany. By way of that I tested whether the *a priori* categories (planted, control, subsurface flow) are different, considering their water beetle assemblages. The association of the species to management-types was evaluated with indicator-species analysis, the relationship between species, sampling sites and environmental variables were tested by canonical correspondence analysis.

3. New scientific results

(1) The planting of aquatic plants at the Hanság Nyirkai-Hany wetland restoration area had no effect on the composition of water beetle assemblages.

(2) The habitats formed in surface flow and subsurface flow wetlands were different for water beetles, because most of the beetles preferred the subsurface flow wetlands. Differences were more pronounced in spring and autumn, due to the breeding habits of beetles. Although the area of the subsurface flow wetlands was much smaller than the surface flow wetlands, they played an important role in the life cycle of the beetles and the subsurface flow wetlands complemented the restoration area to a more diverse wetland complex.

(3) Mowing of dense cattail stands increased the chance of aerial detectability due to the enhanced polarization visibility of the water surface to beetles. Mowed plots received more solar radiation than unmowed control plots, which increased water temperature and provided more suitable conditions for water beetles than the shaded, relatively cool waters in control plots.

(4) Most of the beetles were negatively affected by the ecologically relatively high grazing intensity (0.9-1.3 animal unit/ha). More beetles preferred the ungrazed area, and the composition of the assemblages was also different between grazed and ungrazed areas. The major effects of grazing that influenced water beetles were the trampling of livestock, reduced vegetation and excessively high water temperature due to the increased solar radiation in vegetation-free waters.

4. Consequences

1. To affect the vegetation and water beetle assemblages significantly by plantation of aquatic plants on a newly created wetland, a higher density of planted vegetation is necessary than used at the Nyirkai-Hany restoration area.

2. The different preferences of water beetles to surface flow and subsurface flow areas is caused mostly by the breeding habits of the beetles. The results emphasize the importance of the subsurface flow-type – though often temporary and smaller – wetlands in the life-cycle of the beetles.

3. Mowing of dense *Typha* stands enhances the chance of aerial colonization, thus it may be a useful management method if the aim is to facilitate the colonization process. By the increased solar radiation, mowing reduced the negative effects of the dense *Typha* stands.

4. Although the ecologically high intensity grazing affects negatively most of the beetles species, it is possible that grazing at lower intensity has benefits by opening dense plant stands. If the lower intensity is not enough to form the needed vegetation structure of the target taxa (e.g. birds), it is advisable also to create non-grazed areas.

The results emphasize the importance of the subsurface flow-type – though often temporary – wetlands, the role of water polarization visibility in the aerial detectability and the effect of water temperature in the habitat selection of water beetles. Based on the responses of water beetle assemblages to the different management techniques, the mosaic-like habitat management seems to be very important in the conservation of the biodiversity of wetlands.

5. References

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