Acta Zoologica Academiae Scientiarum Hungaricae 54 (Suppl. 1), pp. 75–83, 2008

PHYTOPHILOUS MACROFAUNA ASSESSMENTS IN AN IMPORTANT AQUATIC BIRD AREA: THE KIS-BALATON PROTECTION SYSTEM

DEÁK, CS., GÓR, D. and LAKATOS, GY.

Department of Applied Ecology, University of Debrecen
H-4010 Debrecen, Egyetem tér 1, Hungary, E-mail: deacsa@freemail.hu

Seventeen macrophyte species were sampled in the area of the Kis-Balaton Protection System in order to explore the composition and the quantitative characteristics of the macrofauna that colonize them. Neither the mean densities, nor taxa richness or diversities have shown significant differences. In all the samples of invertebrate macrofauna Chironomidae and Oligochaeta were found to be dominant. Accordingly the proportion of higher taxa, composite feeders and detritus feeders dominated in most of the samples. Ordination method was used to compare qualitatively the macrofauna composition and only the submerged *Ceratophyllum demersum* L. seemed to have a different taxon constitution, while the other macrophytes were more or less similar in this context.

Key words: phytophilous macrofauna, submerged and emergent macrophytes, functional feeding guilds, Kis-Balaton Protection System

INTRODUCTION

The term phytophilous macrofauna refers to macroinvertebrates associated with macrophytes (ROOKE 1984, CYR & DOWNING, 1988, LINHART *et al*. 1998, LINHART 1999). This is a heterogeneous group of aquatic macroinvertebrates which use macrophytes (submerged and emergent) both as a food source and as a place for living (SOSZKA 1975*a, b*). These terms have been used as synonyms in Hungarian literature, like metaphytic macroinvertebrates (MÜLLER *et al*. 2001), zootecton (LAKATOS 1976, KISS & JUHÁSZ 1996) or periphyton (KISS *et al*. 2003). Macroinvertebrates form an important component of shallow lake ecosystems, they are important as detritus and decaying macrophytes decomposers (MCQEEN *et al*. 1986, DANELL & SJÖBERG 1979, VARGA 2001), and also constitute a food source for fish (KEAST 1985) and birds (VAN DEN BERG 1997, MARKLUND & SANDSTEN 2002*a, b*). Waterfowls affect the macro- and microfauna indirectly by their grazer activities, which could result in a notable loss in the biomass of macrophytes and the abundance of the fauna as well (MARKLUND & SANDSTEN 2002*a*), and in addition they have influence on water quality (GERE & ANDRIKOVICS 1992), too. The impacts of the aquatic birds on the phytofauna depends on the trophic guilds they belong to (OLÁH 2003). The aims of this study were to establish the densities (number of individuals) of the phytophilous macrofauna, taxa richness, Shannon diversity, and the percent ratio of the constituent macroinvertebrate taxa associated with emergent and submerged macrophytes. The ratio of the functional feeding groups occurring in the samples was also examined.

MATERIALS AND METHODS

The Kis-Balaton Protection System was created to preserve or even improve the water quality of Lake Balaton (KISS *et al*. 2003), and in additon it is a part of the Kis-Balaton Landscape Protection Area. It serves as a natural filter by the growing up of epiphytic periphyton (biotecton) and the macroinvertebrates living among the vegetation by the emergence of many aquatic insects which removes a great amount of organic matter (e.g. phosphorus) from the system. Morphometric and physico-chemical characteristics of the studied area are compiled in Table 1. Samples were taken from the second phase of the System (Phase II) in July of 2005, sampling and laboratory procedures have been already discussed in a previous study of KISS *et al*. (2003). Seventeen macrophyte species were sampled. The macroinvertebrates were identified down to the lowest possible (usually family and genus) level, except the aquatic worms which were identified as Oligochaeta. For all macrophyte species (emergent and submerged) the taxon richness, Shannon diversity, evenness and the number of individuals of the fauna were defined. Densities were expressed as individuals per square metre (ind. × m^{-2}). The ratios of higher taxon groups and the feeding guilds were also determined. The names of the feeding guilds (FFG) were used by the study of MOOG (2002). To compare the biotic parameters, the non-parametric Mann-Whitney U test was used. The presence-absence data of the fauna was also analysed with multi-dimensional scaling (MDS) ordination method.

RESULTS

The greatest invertebrate abundances (mean densities) were found on *Polygonum amphibium* L., (*Persicaria amphibia* (L.)) *Potamogeton natans* L., and *Hydrocharis morsus-ranae* L. (Fig. 1). When comparing the densities of the fauna on the two main types of macrophytes (Fig. 2), more animals seemed to occur at first

Table 1. Morphometric and physico-chemical characteristics of the sampling sites (physico-chemical values are averages) at the Kis-Balaton Protection System

Surface (km^2)	81
Mean depth (m)	0.9
Secchi depth (m)	0.6
pH	7.64
Conductivity (µS cm^{-1})	667.5
Oxygen (mg l^{-1})	5.47
Oxygen saturation (%)	59.43
Temperature (°C)	17

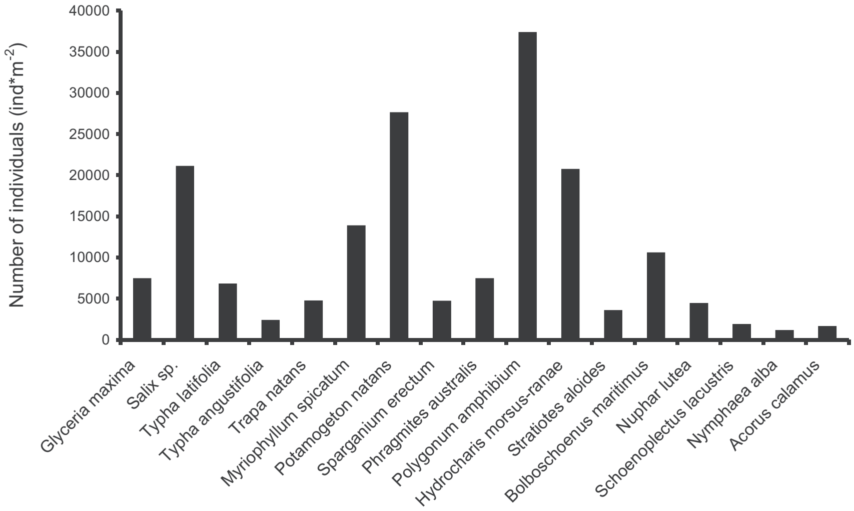

Fig. 1. Abundances of the invertebrates per macrophyte species

sight on submerged vegetation, but the difference statistically proved not to be significant (U = 30.00; Z = –1.014; p = 0.31). Phytophilous taxa richness per macrophytes hardly differed from each other (Fig. 3), and in the case of the two main groups (Fig. 4) the mean taxon numbers had no significant differences (U = 23.5; Z = –1.127; p = 0.27). Diversity and evenness values varied on a large scale (Fig. 5), but the difference was not significant (U= 0,00; Z= –1,00; p= 0,317). The proportion of the taxa based on the density values was done, and the result showed Chironomidae and Oligochaeta dominance (Fig. 6). Among the different feeding guilds, composite or miscellaneous feeders were the dominant group (Fig. 7); this

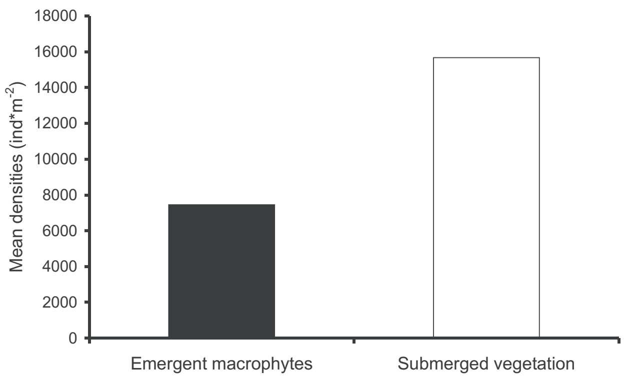

Fig. 2. Mean densities of the macrofauna (ind. × m^{-2})

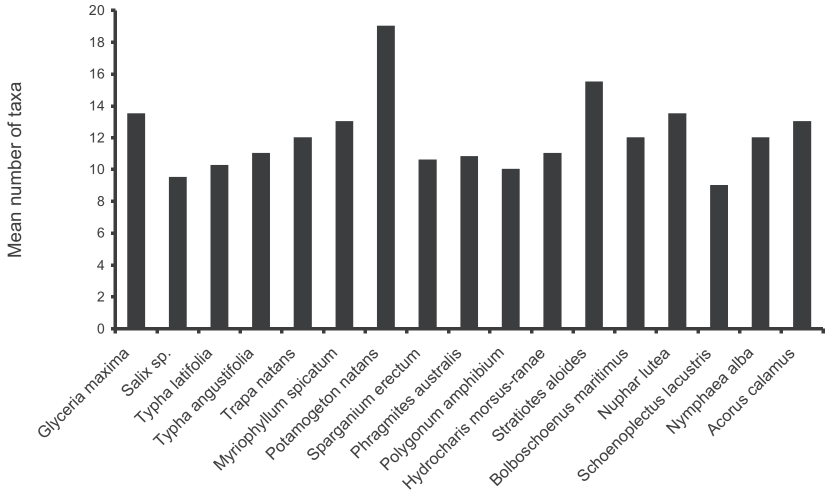

Fig. 3. Taxa richness of the phytophilous macrofaquna on the examined macrophytes

was strongly related with the great amounts of the chironomid larvae. Predators and detritus feeders were sub-dominant. The presence and absence of the invertebrate taxa was analysed by using an ordination method (MDS). It seemed that the submerged plant *Ceratophyllum demersum* L. had a special macrofauna composition while the others were more or less similar in this context (Fig. 8).

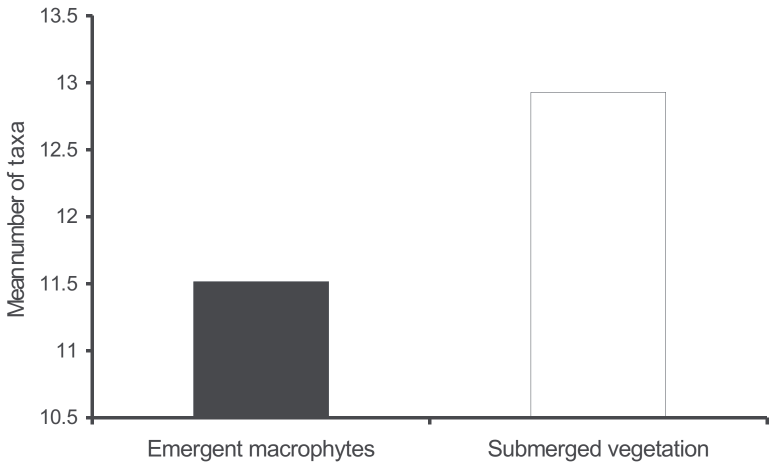

Fig. 4. Comparison of taxa richness of the two macrophyte types

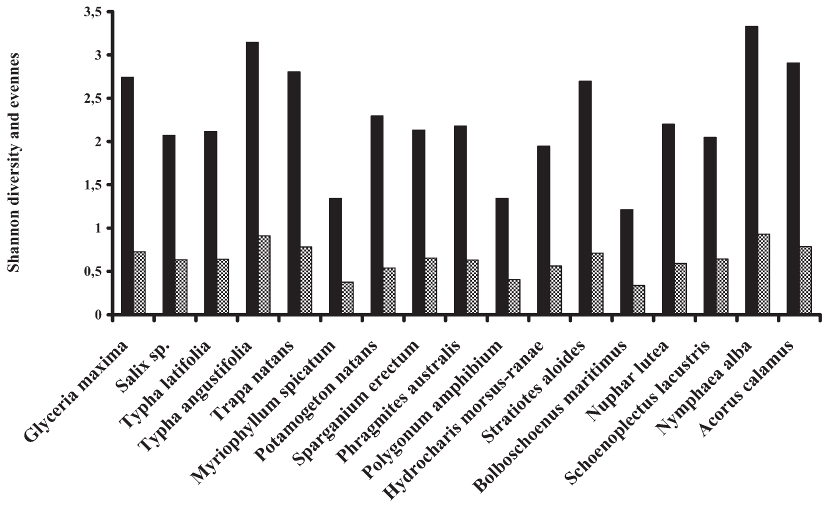

Fig. 5. Diversity and evennes values based on the macrofauna densities

DISCUSSION

The Kis-Balaton Protection System can be regarded as the reconstruction of the former natural wetland which is favourable for many breeding and foraging

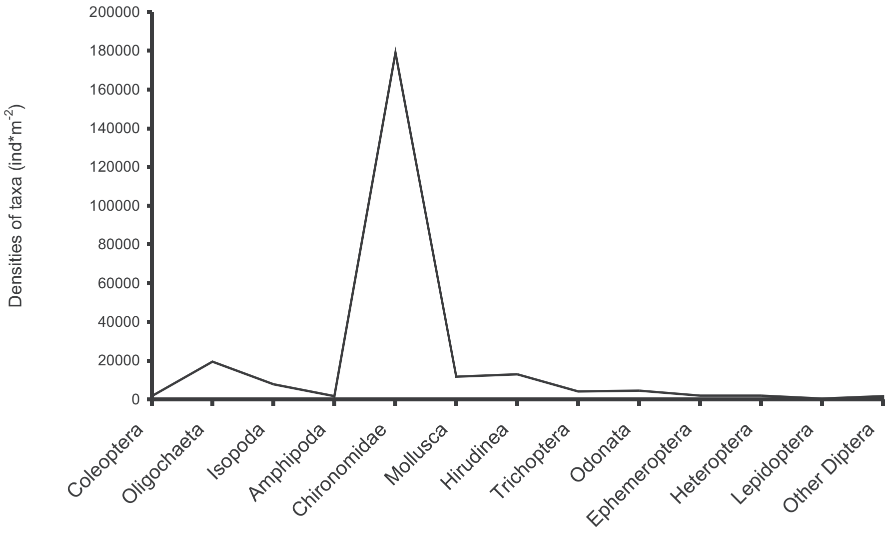

Fig. 6. The ratio of phytomacrofauna taxon groups

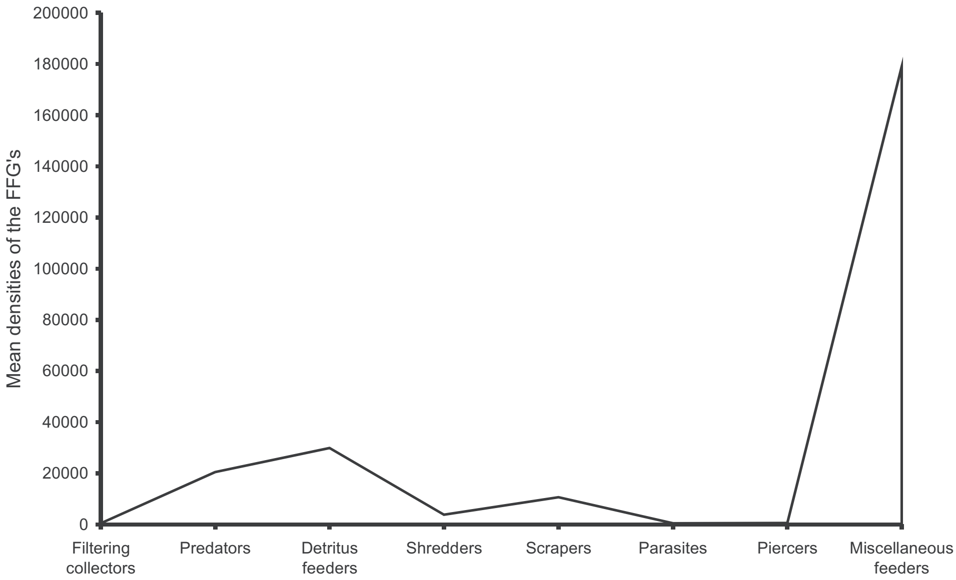

Fig. 7. Proportion of the functional feeding groups

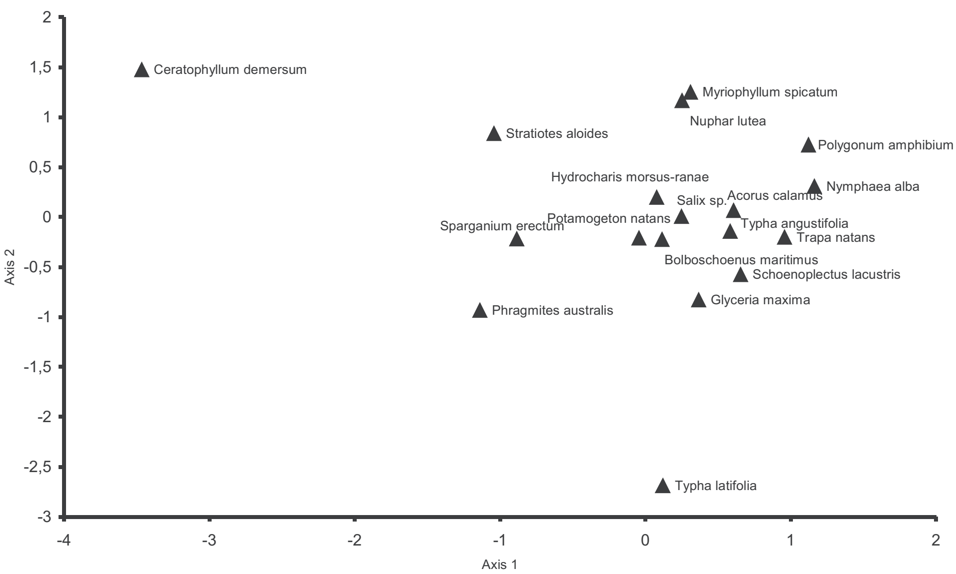

Fig. 8. Plots of the macrofauna taxa presence-absence data using multi-dimensional scaling (MDS) ordination

aquatic birds. Waterfowls can affect the amount of the vegetation and the abundance of the aquatic invertebrates by their strong grazer effect (MARKLUND & SANDSTEN 2002, MARKLUND *et al.* 2002). However, only large waterfowls (swans) had clearly negative effects on macroinvertebrate abundance (MARKLUND & SANDSTEN 2002) and even mixed aquatic bird assemblages have reduced invertebrate macrofauna biomass (MARKLUND *et al.* 2002). Altogether seventeen macrophyte species were sampled in order to examine the composition and quantitative characteristics of the macrofauna colonizing them.These plants differed in their life forms: submerged (floating leaved) and emergent and in structure. Generally, the distribution of the phytophilous macrofauna is strongly affected by the structure of the vegetation (CYR & DOWNING 1988, KORNIJÓW 1989, SOSZKA 1975*a, b*, KRECKER 1939, CHERUVELIL *et al*. 2002, DVOŘAK & BEST 1982, CHERUVELIL *et al*. 2000). The quantitative metrics, like densities, taxon numbers, and diversity of the macrofauna were analyzed and the comparison of the two main vegetation types were also performed in each case. Neither the invertebrate abundances and taxa richness nor the diversity values showed significant differences between the submerged and emergent macrophytes which confirm that plants with dissected morphology did not necessarily offer the largest area (SHER-KAUL *et al*. 1995). When analysing all the taxa that occurred in the samples, a strong chironomid and aquatic worm (Oligochaeta) dominance was found. These results coincide with studies carried out in the same season (DVOŘAK 1996, LINHART 1999, LINHART *et al*. 1998, BOWEN *et al*. 1998, VAN DEN BERG 1997, SOSZKA 1975*a*, KORNIJÓW 1989, HEINO 2000, PIECZYŃSKA 1999, BIGGS & MALTHUS 1982). The ratios of the functional feeding groups had a strong relationship with the taxonomic composition i.e. the great values of miscellaneous (or composite) feeders (Fig. 8) indicated the dominance of chironomid larvae (Fig. 7), the detritus feeders indicated isopods (*Asellus aquaticus*) and Oligochaeta. The ratio of predators showed a normal and healthy trophic state with proportionately many prey organisms. The low number of snails was amazing: they were the second or third most numerous taxon in the above mentioned studies, which could be attributed to the amount of the periphyton growing up mainly on the surface of the emergent vegetation which serves as a substrate for molluscan species as well. The low proportion of other insects in the samples was due to their life cycles (e.g. mayflies, caddisflies) and emergence patterns (SOSZKA 1975*a*). Similarity of the fauna composition was calculated based on the presence and absence of the invertebrate taxons using ordination method (MDS). All the macrophytes were very similar except the submerged and dissected leaved *Ceratophyllum demersum*, which seemed to support special taxa composition (Fig. 9) presumably due to its morphology and large surface.

*

Acknowledgements – The authors would like to thank the Department of Applied Ecology for help in macrophyte sampling and in the laboratory processes.

REFERENCES

BIGGS, B. J. F. & MALTHUS, T. J. (1982) Macroinvertebrates associated with various aquatic macrophytes in the backwaters and lakes of the upper Clutha Valley, New Zealand. *New Zealand Journal of Marine and Freshwater Research* **16**: 81–88.

BOWEN, K. L., KAUSHIK, N. K. & GORDON, A. M. (1998) Macroinvertebrate communities and biofilm chlorophyll on woody debris in two Canadian oligotrophic lakes. *Archiv für Hydrobiologie* **141**(3): 257–281.

CHERUVELIL, K. S., SORANNO, P. A., MADSEN, J. D. & ROBERSON, M. J. (2002) Plant architecture and epiphytic macroinvertebrate communities: the role of an exotic dissected macrophyte. *Journal of the North American Benthological Society* **21**(2): 261–277.

CYR, H. & DOWNING, J. A. (1988) The abundance of phytophilous invertebrates on different species of submerged macrophytes. *Freshwater Biology* **20**: 365–374.

DANELL, K. & SJÖBERG, K. (1979) Decomposition of Carex and Equisetum in a northern Swedish lake: dry weight loss and colonization by macro-invertebrates. *Journal of Ecology* **67**: 191–200.

DVOŘÁK, J. (1996) An example of relationships between macrophytes, macroinvertebrates and their food resources in a shallow euthrophic lake. *Hydrobiologia* **339**: 27–36.

GERE, G. & ANDRIKOVICS, S. (1992) Effects of waterfowl on water quality. *Hydrobiologia* **243–244**: 445–448.

HEINO, J. (2000) Lentic macroinvertebrate assemblage structure along a gradients in spatial heterogeneity, habitat size and water chemistry. *Hydrobiologia* **418**: 229–242.

KEAST, A. (1984) The introduced aquatic macrophyte, Myriophyllum spicatum, as habitat for fish and their invertebrate prey. *Canadian Journal of Zoology* **62**: 1289–1303.

KISS, M. K. & JUHÁSZ, P. (1996) Species composition of zootecton associated with water soldier (Stratiotes aloides L.). *Acta Biologica Debrecina Oecologica Hungarica* **7**: 183–189.

KISS, M. K., LAKATOS, GY., BORICS, G., GIDÓ, ZS. & DEÁK, CS. (2003) Littoral macrophyte-periphyton complexes in two shallow waters. *Hydrobiologia* **506–509**: 541–548.

KORNIJÓW, R. (1989) Macrofauna of elodeids of two lakes of different trophy. I. Relationships between plants and structure of fauna colonizing them. *Ekologia Polska* **37**(1–2): 31–48.

KRECKER, F. H. (1939) A comparative study of the animal population of certain submerged aquatic plants. *Ecology* **20**: 553–562.

LAKATOS, GY. (1976) A terminological system of the biotecton (periphyton). *Acta Biologica Debrecina Oecologica Hungarica* **13**: 193–198.

LINHART, J. (1999) Phytophilous macrofauna in the Stratiotes aloides vegetation of the Lake Łukie, Poland. *Acta Universitatis Palackianae Olomucensis Facultas Rerum Naturalium Biologica* **37**: 67–76.

LINHART, J., UVÍRA, V., RULÍK, M. & RULÍKOVÁ, K. (1998) A study of the composition of phytomacrofauna in Batrachium aquatile vegetation. *Acta Universitatis Palackianae Olomucensis Facultas Rerum Naturalium Biologica* **36**: 39–60.

MARKLUND, O. & SANDSTEN, H. (2002) Reduction of benthic macroinvertebrates due to waterfowl foraging on submerged vegetation during autumn migration. *Aquatic Ecology* **36**: 541–547.

MARKLUND, O., SANDSTEN, H., HANSSON, L. A. & BLINDOW, I. (2002) Effects of waterfowl and fish on submerged vegetation and macroinvertebrates. *Freshwater Biology* **47**: 2049–2059.

MCQUEEN, D. J., POST, J. R. & MILLS, E. L. (1986) Trophic relationships in freshwater pelagic ecosystems. *Canadian Journal of Fisheries and Aquatic Sciencies* **43**: 1571–1581.

MOOG, O. (ed.) (2002) *Fauna Aquatica Austriaca.* Edition 2002. Wasserwirtschaftskataster, Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft, Vienna.

MÜLLER, Z., KISS, B. HORVÁTH, R. CSABAI, Z., SZÁLLASY, N., MÓRA, A. BÁRDOSI, E. & DÉVAI, GY. (2001) Quantitative studies on macroinvertebrates inhabiting weed and marsh vegetation stand in the Apota region of Lake Tisza. *Hydrological Bulletin* **81**: 423–425. [in Hungarian]

OLÁH, J. JR. (2003) Vízimadár anyagforgalmi guildek. (Waterbird trophic guilds.) *Magyar Vízivad Közlemények* **10**: 395–423.

PIECZYŃSKA, E., KOLODZIEJCZYK, A. & RYBAK, J. I. (1999) The responses of littoral invertebrates to eutrophication-linked changes in plant communities. *Hydrobiologia* **391**: 9–21.

ROOKE, J. B. (1984) The invertebrate fauna of four macrophytes in a lotic system. *Freshwater Biology* **14**: 507–513.

SCHEFFER, M., ACHTERBERG, A. A. & BELTMAN, B. (1984) Distribution of macro-invertebrates in a ditch in relation to the vegetation. *Freshwater Biology* **14**: 367–370.

SHER-KAUL, S., OERTLI, B., CASTELLA, E. & LACHAVANNE, J. B. (1995) Relationship betwen biomass and surface area of six submerged aquatic plant species. *Aquatic Botany* **51**: 147–154.

SOSZKA, G. J. (1975*a*) The invertebrates on submerged macrophytes in three Masurian lakes. *Ekologia Polska* **23**(3): 371–391.

SOSZKA, G. J. (1975*b*) Ecological relations between invertebrates and submerged macrophytes in the lake littoral. *Ekologia Polska* **23**(3): 393–415.

VAN DEN BERG, M. S., COOPS, H., NOORDHUIS, R., VAN SCHIE, J. & SIMONS, J. (1997) Macroinvertebrate communities in relation to submerged vegetation in two Chara-dominated lakes. *Hydrobiologia* **342–343**: 143–150.

VARGA, I. (2001) Macroinvertebrates in reed litter. *International Review of Hydrobiology* **86**: 573–583.

Revised version received November 11, 2007, accepted November 25, 2007, published December 17, 2008