Comparison of phytal- and förna-bound macroinvertebrate communities at Lake Fertő, Hungary

By

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Abstract. During 1995-96 the macroinvertebrate fauna of dead reed remains at Lake Fertő was investigated. Our water chemistry and faunistic data were compared to the results of Andrikovics (1973, 1979 a, b), who carried out similar investigations on submersed macrophyton vegetation and the reed stands. From among the water chemistry parameters, the dissolved oxygen conditions showed a significant difference among the study sites. More favourable parameters were measured in submersed macrophyton stands. The oxygen concentration of dead reed remains that are normally pushed to the reed belt, are similar to the level measured in living reed stands. The least diverse macrofauna was found in reed stands. The fauna of submersed macrophyton stands and dead reed remains were found to be richer. Differences were found in the presence and absence of species, animal groups and the dominance relationships of the communities.

Lake Fertő is a typical representative of large European shallow lakes. Due to its shallowness, this is a characteristically unstable, astatic lake as far as physico-chemical and biocoenological data are concerned (Varga, 1962). As a result of shallowness, environmental factors such as wind, temperature and light have relatively great effect on the lake. The temperature of the water and the sediment follows relatively rapidly the air temperature. The water mass of the lake shows a high seasonal variation. As a result of intensive wind disturbance, the water of the lake is mixed with the fine sediment from the lake bottom. This has a significant effect on the planctonic biota and a direct effect on the nutrient material cycles and energy flow of the open water. The predominant northern, north-western wind blows the water towards the southern, reed-covered part of the lake increasing the water level and mixing the water of the reed belt and open water area (Szabó, 1962).

Macrophytes has a special importance in the nutrient cycles of Lake Fertő, similarly to other large, shallow lakes. 80% of Hungarian part of the lake is covered by reed. The extensive, several kilometres wide reed stands cut the open water into several parts, forming bays and limnologically special, so called „inner lakes" (Dinka & Berczik, 1992). A characteristic feature of the reed stands (Scirpeto-Phragmitetum Koch, 1926) is the presence of a canal network throughout the lake having been created for reed management reasons. Water cover of the reed stands greatly fluctuates, and from a botanical point of view, the stands are species-poor areas (Tóth & Szabó, 1962). Nowadays, the reed is thinning out in more and more, mainly due to human disturbance. Reed covered area increases with the filling up of the

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lake. With the increase of harvested often degraded reed stands, *Typha angustifolia* becomes more common (Ráth, 1990). Only 20 % of the reed is not harvested, as a consequence, reed degradation processes are going on their natural way. A considerable amount of reed remains and turn rhizome can also be found there even in harvested areas. This grain detritus forms a suitable habitat for several macroinvertebrate species.

The distribution of submersed macrophyton stands is also characteristic. With a certain periodicity, their expansion, and in some years their decline or disappearance can be observed (Schiemer, 1978; Ráth, 1990). A good example to show this process is that at the beginning of the 70's, there were large submersed macrophyton stands. After their disappearance, they have only been expanded again in recent years. The ecological and zoological conditions and seasonal changes of macrophyton stands (submersed macrophytes and reed belts) are hardly known, despite of their importance. The reason for completing this study was that only a little information was available on the macrofauna of these stands, despite of their high indicator value. Another advantage is, that taxa abundant in these habitats are relatively easy to identify.

Materials and methods

During the 1970's complex investigations were carried out (Andrikovics, 1973, 1979 a) to elucidate the hydroecological and zoological conditions of Lake Fertő, to describe the characteristic animal associations of the different habitats, to indicate ecological differences between submersed macrophyton stands of different size, position and species composition, and their effect on the macrofauna. Therefore, samples were taken from submersed macrophyton stands of over 15 m² surface, from October to April every month, both from isolated inner lake sites (No. 7-11) and from open water sites (No. 1-6) (Fig. 1). A semi-quantitative sampling was applied, a near equal quantity of submersed macrophyton was pulled out over a net with a mesh size of 25. In addition, approximately 10 net samples were also taken. At the beginning of the investigations (in 1971-72) there were still large submersed macrophyton stands in the lake. In the open water *Potamogeton pectinatus* and *Myriophyllum spicatum*, in the inner lakes *Utricularia vulgaris* and *Najas marina* were the dominant species of the submersed macrophyte stands. These stands are disappeared by the middle of the 1970's (Andrikovics, 1988). During the quantitative investigations in 1975-76, sampling was not possible from the same sites. Besides from submersed macrophyton stands, samples were also taken from water-covered reed stands (Andrikovics, 1980) to collect the reed-bound animals, too. A 50x50 cm framed net sampler was used for this purpose (Andrikovics, 1977).

More than 20 years later, in 1995-1996, the macroinvertebrate fauna of floating dead reed remains was studied to investigate the macroinvertebrate species composition, the hydroecological conditions, seasonal dynamics and dominance structure of the species composition of a previously neglected habitat (Varga, 1997). Dead reed remain piles are formed from reed remains that naturally get into the water year by year. As a result of the constant wind effect, they are pushed to the edge of the reed belt. These remains are floating on the water surface and water-covered during the whole year (unlike reed remains in shore deposits). Seasonal samples were taken for 2 years from 5 regular (4 inner lake and 1 open water) and 6 occasional sampling sites (Fig. 1). Samples were taken by surface netting (mesh size: 0.5 mm) and washing out. This sampling method only gives a semi-quantitative estimation.

Water chemistry parameters with the highest effect on the fauna and an ease for regular monitoring such as temperature, pH, conductivity, dissolved oxygen concentration were measured parallel with zoological sampling in both investigation periods (Andrikovics, 1978; Varga, 1997). In both study results were analysed with statistical tests (Andrikovics, 1988; Varga, 1997).

The present paper contains only a part of my results. Even on this basis it is reasonable to compare these results with other similar macrofauna studies. My aim was to make general comparison of the fauna in the above described characteristic habitats of the Lake Fertő. As a pilot study, a metric-multidimensional scale analysis was also completed using the species lists of three sites with several distance functions making similar results. In this article the results of the ordination with Euclidian distance are given.

Results

The macroinvertebrate fauna of dead reed remains are compared separately to those of submersed macrophyton stands and the water-covered reed belts.

Comparison of submersed macrophyton stands and floating dead reed remains

From among the water chemistry parameters dissolved oxygen concentration showed the most striking differences. In submersed macrophyton stands, the concentration of dissolved oxygen is always higher (8.53–13.17 mg/l) than in dead reed remains (1.5–5.9 mg/l). Conductivity values measured in 1971 were considerably higher in submersed macrophyton stands (2040–2568 µS/cm) than in dead reed remains (1415–1882 µS/cm). In 1972, however, these values did not differ from each other (1378–2008 µS/cm). Taxa found in submersed macrophyton stands and dead reed remains are shown in Table 1. The faunistical differences between the two habitats are as follows.

Hirudinoidea: Andrikovics found this group to be a characteristic group for isolated submersed macrophyton stands. In my study, however, its abundance was always low.

Gastropoda: Andrikovics found *Lymnaea peregra* and *Gyraulus crista* in the open water macrophyton stands, and he also recorded *Lymnaea peregra* in the inner lakes with an increased, but not mass occurrence. In dead reed remains *Gyraulus crista* and *Planorbis planorbis* species proved to be most common.

Isopoda: The only representative species of this taxa was *Asellus aquaticus* (a detritus inhabitant), it was found in dead reed remains far more often than in the submersed vegetation.

Ephemeroptera: Andrikovics found *Cloeon dipterum* and *Caenis horaria* to be mass species in reed-encircled submersed macrophyton stands, while in dead reed remains Ephemeroptera species were rare. *Caenis horaria* that lives in the sediment, was not found in dead reed remains at all.

Odonata: While species found by Andrikovics are characteristic, permanent inhabitants of submersed macrophyton stands, they were infrequent and rare in dead reed remains. *Ischnura pumilio* was the predominant species both in open water- and reed-encircled macrophyton stands.

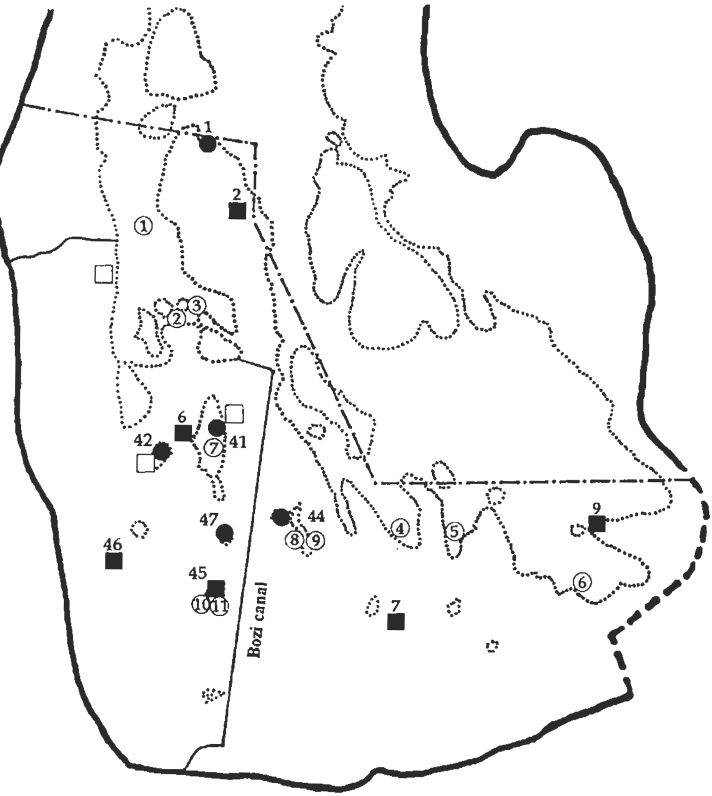

Fig. 1. Sampling sites. ● - Regular- 1:B0, 41: Herlakni-, 42: Kis-Herlakni-, 44: Hidegségi-, 47: Átjáró pond. ■ - Occasional sampling sites of dead reed remains: 45: Nagyhatártisztás, 46: Pitner Beach, 2: Fertőrákosi bay, Keresztárok canal, 6: Herlakni canal, 7: Homoki-ferde canal, 9: Madárvárta bay. 1-11- Submersed macrophyton stands: 1: Fertőrákosi bay, 2-3: Püspök pond, 4: Rucás-, 5: Hegykői-, 6: Madárvárta bay, 7: Herlakni-, 8-9: Hidegségi-pond, 10-11: Nagyhatártisztás; 1,4,6,7,8,10: *Potamogeton pectinatus*-, 2 ,3, 5: *Myriophyllum spicatum*-, 9: *M. verticillatum*-, 11: *Utricularia vulgaris* stand. □ - Living reed stands: Eastern basin of Fertőrákosi bay, 41: Herlakni pond, 42: Kis-Herlakni pond

Trichoptera: In submersed macrophyton stands the members of the genera *Cyrnus, Agrypnia* and *Ecnomus* were the most common. In isolated inner lake submersed macrophyton stands *Cyrnus* was the predominant genus. Trichoptera species were only found in dead reed remains in low number. *Ecnomus tenellus* and *Oecetis furva* were the dominant species. A new species for the Hungarian fauna, *Tricholciochiton fagesi* was found in dead reed remains.

Lepidoptera: Both *Nymphula nymphaeta* and *Parapoynx stratiota* present in submersed macrophyton stands are aquatic species, their caterpillars feed on weed.

Coleoptera: Only a few individuals were found in both investigations. More taxa was collected from dead reed remains than from macrophyton stands.

Heteroptera: *Notonecta* species were missing from dead reed remains. In reed encircled submersed macrophyton stands the *Ilycoris cimicoides, Sigara striata,*

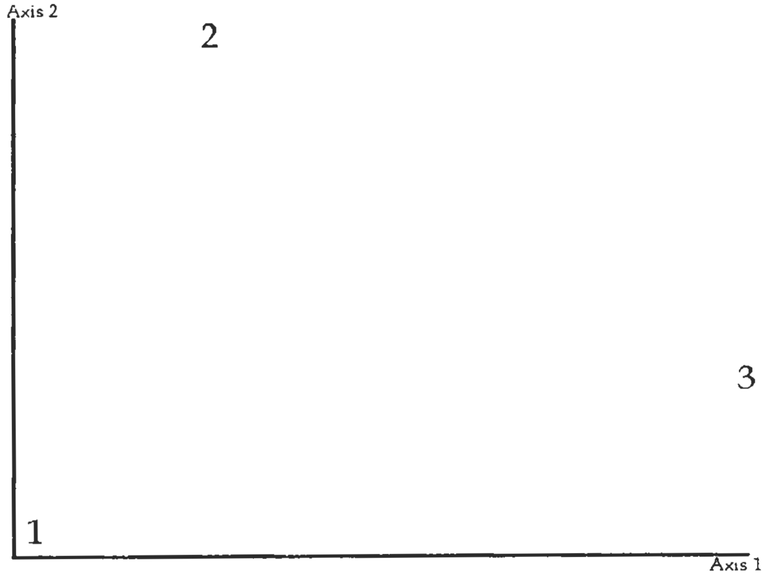

Fig. 2. Ordination (Metric Multidimensional Scale) for the macroinvertebrate communities of three habitats. 1: submersed macrophyton stands, 2: living reed stands, 3: dead reed remains

Cymatia coleoptrata species composition was predominant, while in the open water samples *Micronecta pusilla* predominated. From dead reed remains *Cymatia coleoptrata, Plea minutissima* and the larvae of Corixidae were found in larger number.

Diptera: Due to the well-known taxonomic difficulties and identification problems, no detailed investigation of this group was completed. Andrikovics found Chironomidae to be a frequent and dominant group. In both studies at nearly all sampling sites a high proportion (27-90 %) of the individuals belong to Chironomidae. Within this family the dominant species were from the Orthocladiinae subfamily. From dead reed remains, apart from these groups, Culicidae, Stratiomyidae, Ceratopogonidae, Limoniidae taxa were also frequently found. With the exception of Limoniidae, all these groups were found in the quantitative investigations of Andrikovics as well.

Araneidea: No Araneidea species occurred in the submersed macrophyton samples. Several species were found in dead reed remains, but only *Argyroneta aquatica* was typically aquatic.

The fauna of submersed macrophyton stands and dead reed remains of the open water was found to be much less diverse than that of the inner lakes.

Comparing submersed macrophyton and dead reed remain samples collected from the same part of the lake, obvious differences were found. As an example: dead reed samples from Hidegségi pond (44), besides Chironomidae species, often also contained species of Hirudinoidea, Gastropoda, Isopoda in relatively large number, while in submersed macrophyton samples species of Ephemeroptera and Odonata were dominant. Andrikovics also found a great difference between the two submersed macrophyton sampling sites (*Potamogeton pectinatus, Myriophyllum verticillatum)* of the Hidegségi pond (44). Similarly, Herlakni pond (41) samples were distinctly different originating from *Potamogeton pectinatus* and dead reed remains, just as in Kis-Herlakni pond (42), where samples were collected from *Utricularia vulgaris* and from the dead reed floating among *Utricularia*.

Sokal-Mitchener index and the similarity index of Baroni-Urbani-Buser II was used to analyse the macroinvertebrate fauna of submersed macrophyton stands and dead reed remains respectively. No sampling site or seasonal grouping was possible to show on the dendrograms. What is more, no grouping could be made according to the plant species of the macrophyton stands.

Comparison of water-covered reed stands and dead reed remains

The dissolved oxygen concentration varied between 0.2–2.0 mg/l during a day (1976. 07–08.). 47 taxa were found in the quantitative reed belt samples (Andrikovics, 1979) (Fig. 1). The faunistical differences between the two habitats are as follows.

Hirudinoidea: Typical mass species were found to be similar in the two investigations: *Glossiphonia heteroclita, Helobdella stagnalis, Erpobdella octoculata*. Two species were found only in the reed stand samples, both of them with a small individual number (*Theromyzon tessulatum* and *Piscicola geometra*).

Gastropoda: They were characteristic in both investigations. The species composition was nearly identical, except for *Gyraulus albus* found only in the reed stands and *Lymnaea palustris* found only in dead reed remain samples.

Isopoda: The only recorded species, *Asellus aquaticus* was found to be abundant in all samples in both investigations.

Ephemeroptera: *Cloeon dipterum* and *Caenis robusta* were found in both studies, though the first species was more common on live reed, the latter on the dead reed remains.

Odonata: This group is represented by a small individual number in both studies. No common species was detected.

Heteroptera: A much more diverse heteropteran community was collected from dead reed remains.

Coleoptera: A more diverse community was found in dead reed remains again. With the exception of *Bidessus geminus*, all reed stand beetles were also found in dead reed remains.

Trichoptera: Andrikovics described *Orthotrichia costalis, Oxyethira* and *Limnephilus* species to be characteristic for the emerge vegetation. Dominant species on dead reed remains - *Ecnomus tenellus* and *Oecetis furva* - were also present, unlike the representatives of the genus *Cyrnus*, which existed in dead reed remains.

Lepidoptera: The two species detected in the submersed macrophyton stands were also found in the reed belt samples.

Diptera: Chironomid species were the most common in both studies. Family Tabanidae was found only in the reed stand and not in the dead reed samples.

Using Hummon's index for analysing the macroinvertebrate samples, we can conclude that the similarity between samples taken in different time periods is very low.

Discussion

On the basis of our general evaluation of all sampling sites, the following conclusion can be drawn. The dissolved O_2 conditions are always more favourable (more balanced and higher oxygen concentration) in submersed macrophyton stands than in dead reed remains or in reed stands, since submersed macrophytes produce a large amount of oxygen *via* their photosynthetic activity. With the exception of the open water edge, where in oxygen rich water is mixed with the water of the reed stand, reed belts are always characterised by a low level of dissolved oxygen concentration during the day, while at night they can become anaerobic. Dead reed remains are usually situated at the edge of the reed belt. Therefore, their oxygen concentration is similar to that habitat type, especially as degradation processes already start in those areas. The oxygen conditions of submersed macrophyton stands were between those of the open water and the reed stands. The most important phenomenon of the transitional status was that its climatic conditions were different from those of the open water and the dead reed remains. The microclimate of open water macrophyton stands is basically determined by the open water, while the microclimate of inner pond and reed belt-edge macrophyton stands is also influenced by their species composition. Differences of conductivity data can be explained by a higher water level due to a more rainy year, but apart from this, a high salt concentration of the lake is well shown, too.

The list of determined species can generally be characterized by the lack of halophil species. Due to the astatic nature of Lake Fertő, mostly euriok species were found in the samples. The fauna of open water submersed macrophyton stands and dead reed remains differ. The open water macrophyton stand samples did not contain as many species as the samples from the inner lakes. This can be explained by the unfavourable colonisation conditions caused by the strong and constant wind. From a certain viewpoint, both sites can be considered transitional, colonisation can be expected from the reed stands or by species that put their eggs on plants. Reed stands serve as an appropriate habitat for only few species due to unfavourable water chemistry conditions. Especially the inner, oxygen-poor part of the reed stand is uniform with a low species diversity. The species composition in reed stands is relatively diverse, but the small individual number indicate the unfavourable conditions (Andrikovics, 1979).

Differences between samples from the same sites, but from different vegetation stands proved that not only the similar ecological macro-environment, but also the relative position (open water and isolated inner pond) and morphology of the substrate vegetation has an effect on the zoocenosis. The quality and morphology of the substrate and the developing periphyton as a food supply, also affect on the macroinvertebrate community. In this particular case it is especially true, since most of the species identified feed on detritus (most Chironomida, Ephemeroptera, Isopoda and Trichoptera species). Few herbivore species were found. Only snails, *Asellus* sp. and several Trichoptera and Chironomidae larvae could be put into that category.

Reed stand samples were the least diverse. Nearly the same species number was recorded in submersed macrophyton and dead reed remain samples, but the dominance pattern differed. In submersed macrophyton stands Hirudinoidea, Odonata and Trichoptera, while on the dead reed remains Coleoptera, Heteroptera and Araneidea species were more common. The relatively low number of Coleoptera species in submersed macrophyton stands could also be caused by a sampling error, since this group is extremely species-rich and mobile. Spiders were found only in dead reed remains. The only aquatic spider was *Argyroneta aquatica.* The other non-aquatic species live near the water bodies, probably they either overwinter in reed stems and on dead reed remains or they were already dead at the time of the collection.

Habitats investigated during this study due to their location, morphology and hydroecological characteristics provide different conditions favourable for species with different ecological needs. *Notonecta* species are missing from dead read remains and reed stands, since they are bound to macrophyton stands. No Lepidoptera larvae were found on dead reed, since they feed on living vegetation. The *Cloeon simile* preferring open water habitats and the mud dweller *Caenis horaria* could only be collected from submersed macrophyton stands. *Ecnomus tenellus,* though it was present in all three habitats, could only be recorded in large number in near-reed submersed macrophyton stands. *Agrypnia* (Phryganeidae) and *Limnephilus* species mostly develop in reed stands. *Oecetis* species live in a wide range of habitats, *Oecetis furva* and *O. ochracea* were detected in all three examined habitats.

Our working hypothesis, that the invertebrate community of dead- and live reed samples are more similar to each other than to those of the submersed macrophyton stands, has not been proved. This hypothesis was based on the fact that the locality and oxygen conditions of dead reed remains are more similar to those of the reed stands than to the submersed macrophyton stands. To a certain extent, dead reed remains can be considered as a phase of reed stands. The quality of the substrate and the developing periphyton are also similar in reed stands and dead reed remains. Despite in the ordination, samples representing each site was situated nearly at the same distance from the samples of the two other habitats. None of the investigated habitats showed higher similarity to any other habitats (Fig. 2).

Summary

The macroinvertebrate fauna of submersed macrophyton stands, reed belts and dead reed remains considerably differed according to studies carried out in the 1970's and 1990's. Besides water chemistry, position of vegetation stands within the lake, the quality and morphology of the plant as a substrate also have a decisive role. Habitat differences were also proved by metric multidimensional scaling carried out for preliminary testing.

The lowest macrofauna diversity was found in the reed belt. Unfavourable water chemistry conditions led to smaller individual numbers. Submersed macrophyton stand and dead reed remain samples were more diverse. The species

composition and dominance relationships were found to be different between these habitat types.

Further investigations are needed to clarify the ecological conditions causing these differences in species composition and abundance, and to elucidate the role of dead reed remains in the ecosystem as a whole. These investigations can also be useful by applying new statistical methods to reveal tendencies and correlation in macro-invertebrate fauna changes.

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Table 1. List of species and other taxa

Species	Submersed macrophyton stands (Andrikovics)	Reed stands (Andrikovics)	Dead reed remains (Varga)
Hirudinoidea			
Theromyzon tessulatum O.F.Müll.	+	+	
Piscicola geometra L.	+	+	
Hemiclepsis marginalis O.F.Müll.	+		
Glossiphonia heteroclita L.	+	+	+
G. heteroclita f. *papillosa* Braun	+		
Hirudo medicinalis L.	+		
Helobdella stagnalis L.	+	+	+
Erpobdella octoculata L.	+	+	+
Gastropoda			
Lymnaea stagnalis L.	+		
Lymnaea peregra Müll.	+	+	+
Lymnaea auricularia L.	+		
*Lymnaea truncula*ta Müll.	+		
Lymnaea palustris O.F.Müll.			+
Planorbis planorbis L.	+	+	+
Physa fontinalis L.	+	+	+
Bithynia tentaculata L.	+	+	+
Gyraulus albus O.F.Müll.		+	
Gyraulus crista L.	+	+	+
Gyraulus laevis Ald.	+		
Gyraulus sp.	+		
Isopoda			
Asellus aquaticus L.	+	+	+
Ephemeroptera			
Cloeon dipterum L.	+	+	+
Cloeon simile Etn.	+		
Caenis horaria L.	+		
Caenis robusta Etn.	+	+	+
Odonata			
Sympecta fusca Vanderl.	+		
Ischnura elegans Vanderl.	+	+	
Ischnura pumilio Charp.	+		+
Enallagma cyathigerum Charp.	+	+	
Coenagrion puella L.	+		
Coenagrion pulchellum Vanderl.	+		
Coenagrion sp.		+	
Erythromma najas Hansem.	+		
Crocothemis erythraea Brullé	+		
Heteroptera			
Notonecta glauca L.	+		
Notonecta sp. larva	+		
Plea minutissima McGreg & Kirk	+		+
Micronecta pusilla Horv.	+		
Micronecta Scholtzii Fieb.			+
Cymatia coleoptrata Fabr.	+	+	+
Paracorixa concinna Fieb.	+		
Sigara striata L.	+	+	
Corixidae sp. larva	+		+
Corixidae sp. juv.		+	
Hesperocorixa linnei [Fieb.]			+
Gerridae larva			+
Microvelia reticulata Scholz			+
Ranatra linearis L.	+		+
Ilycoris cimicoides L.	+		+
Coleoptera			
Haliplus ruficollis Deg.	+		
Haliplus variegatus Sturm.			+
Haliplidae sp. larva	+		+
Haliplus sp.			+

Laccophilus variegatus Germ.	+	+	+
Bidessus unistriatus Schrank			+
Bidessus geminus F.		+	
Noterus crassicornis Müll.	+	+	+
Noterus clavicornis De Geer			+
Hygrotus inequalis Fabr.			+
Dytiscidae sp. larva	+	+	+
Ochtebius sp.			+
Limnebius aluta Bedel			+
Cercyon obsoletus Gyll.			+
Enochrus maritimus Thoms.		+	+
Hydroptilidae sp. larva		+	+
Palpicornia larva	+		
Stenus sp.			+
Ptenidium sp.			+
Scirtes sp. larva			+
Trichoptera			
Ecnomus tenellus Ramb.	+	+	+
Cyrnus crenaticornis Kol.			+
Cyrnus sp.	+		
Holocentropus picicornis Steph.	+	+	+
Holocentropus sp.			+
Athripsodes senilis Burs.	+		
Agraylea multipunctata Curt.		+	
Oxyethira sp.		+	
Tricholeiochiton fagesii Guinard			+
Orthotrichia costalis Curt.		+	
Phryganeidae sp. juv.	+	+	
Limnephilidae sp. juv.		+	
Oecetis ochracea Curt.	+	+	+
Oecetis furva Ramb.	+	+	+
Oecetis sp.	+		
Lepidoptera			
Nymphula nymphaeta L.	+	+	
Parapoynx stratiota L.	+	+	
Diptera			
Chironomidae	+	+	+
Culicidae			+
Chaoboridae	+	+	+
Tabanidae		+	
Stratiomyidae	+	+	+
Ceratopogonidae	+	+	+
Limoniidae			+
Araneidea			
Donacochara speciosa Thorell			+
Linyphiidae			+
Tetragnatha sp.			+
Clubiona sp.			+
Argyroneta aquatica Clerk			+
Pirata sp.			+
Hydracarina	+	+	+