Temporal-spatial patterns of aquatic and semi-aquatic Heteroptera (Gerromorpha, Nepomorpha) at Lake Fertő, Hungary

By

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Abstract. In the framework of zoological studies of decomposing reed litter on Lake Fertő/Neusiedler See from 1995 till 1999, we sampled the macroinvertebrate and Heteroptera fauna as well. Studies show the presence of 12 Gerromorpha and 18 Nepomorpha, altogether 30 species. We evaluated the spatial-temporal pattern of Heteroptera communities using multiple variable statistical methods and some simple diversity variables.

Lake Fertő (Neusiedler See) is situated on the Austro-Hungarian border, and has a special position among lakes in Hungary. It is a real lowland saline lake (sodium-magnesium-hydrogencarbonate-sulphate type), which, given its extreme shallowness (average deep is 1 meter only), is characterized by the strong influence of outer environmental factors. Therefore it is largely unstable considering its physical, chemical and biological features (Szabó, 1962; Varga, 1962). More than 80% of the Hungarian part (75 km^2) of the lake is covered by reeds. The reeds reach deep into the lake area and divide the open water into several parts of different size, forming bays and limnologically special, so called „inner lakes", which are very different from one another from a hydrological point of view, depending on where they are in the lake and how isolated they are (Dinka & Berczik, 1992). The large reeds are laced with canals formed for the purpose of reed cultivation.

Lake Fertő is part of the Fertő-Hanság National Park, declared as a Biosphere Reserve by UNESCO, which makes it especially important to discover the natural values and fauna of the lake as close as possible. Studying macroinvertebrate communities, and especially Heteroptera, is becoming more and more important in limnological research given that these groups are good indicators of environmental changes, thus they can be utilized in surveying the quality of habitats and the water itself (Hufnagel *et al.*, 2000 b; Savage, 1982).

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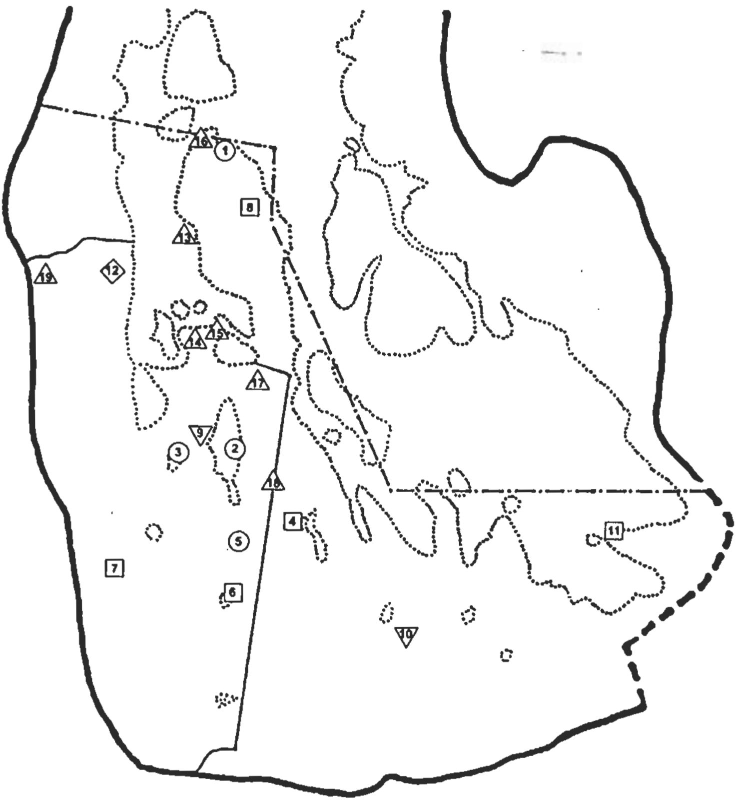

Fig. 1. Sampling sites: 1: B0, 2: Herlakni, 3: Kisherlakni, 4: Hidegségi, 5: Átjáró Ponds, 6: Nagyhatártisztás, 7: Pitner beach, 8: Fertőrákosi Bay-Keresztárok Canal, 9: Herlakni Canal, 10: Homoki ferde Canal, 11: Madárvárta Bay, 12: Nádas 3, 13: Fertőrákosi Bay, 14: Kladler, 15: Gémes Ponds, 16: B0, 17: Püspök, 18: Bozi Canals, 19: next to the Fertőrákos Hydrometeorological Station. (O - macroinvertebrates in 1995-96, 1998-99 and Heteroptera samples, □ - macroinvertebrates in 1995-96, Δ - Heteroptera samples, ∇ - macroinvertebrates in 1995-96 and Heteroptera samples, ◊ - macroinvertebrates in 1998-99 and Heteroptera samples)

The first detailed, comprehensive study was delivered by Géza Horváth (1923), who collected samples in the area in the 1920's and summarized earlier studies and museological data.

Macroinvertebrate studies done much later provided new data about the Heteroptera fauna of the lake. Andrikovics collected macroinvertebrates in submersed macrophyton stands and reeds in the 1970's (Andrikovics, 1973, 1978, 1979a,b, 1980). As of 1995, having joined the European reed research project "EUREED", studies are aiming at a still unknown habitat: macroinvertebrate communities of decomposing reed litter (Varga, 1997; Varga *et al.*, 1998).

One aim of the studies is to survey the basic state of the fauna, which is of primary interest from the nature conservation, water quality control and reed decomposition studies point of view and serves as a basis for any further ecological research. Based on data sampled in 1998-1999, our further goal was to compare the Heteroptera fauna with data from earlier studies and to find out more about seasonal differences and abundance status of communities.

Material and methods

From 1995 till 1999, we sampled the macroinvertebrate and Heteroptera fauna of Lake Fertő. Sampling occasions can be classified into 3 types:

(1) In 1995-1996 we did pilot study of macroinvertebrates living on decomposing reed litter.

(2) In 1998-1999 we took samples from 5 sites (B0, Átjáró, Kisherlakni, Herlakni Ponds, Nádas 3) of the lake, washed and collected by net from decomposing reed litter 6 times per year (in April, May, June, July, September and October 1998 and in April, June, July, August, September and October 1999). Samples were taken from sheaves of reed placed in spring 1998, except from site B0 where we sampled the fauna from reed piled up in a natural way.

(3) Parallel to the sampling from decomposing reed litter, we collected Heteroptera using nets at the 5 permanent sampling sites (see above) and 9 other sites (Fertőrákos Bay, Kladler, Gémes Ponds, near Fertőrákos Hydrometeorological Station, B0, Herlakni, Bozi, Püspök, Homoki ferde Canals).

In the comprehensive description of the fauna we included all data, but coenotic evaluation is based exclusively on data from years 1998-1999.

At permanent sampling sites some hydrochemical parameters were measured using the WTW portable field equipment (water temperature, pH, dissolved O_2, conductivity).

Description and characteristics of sampling sites

I. Permanent sampling sites (Fig. 1)

B0 (B0): 100,m from the Austro-Hungarian border, the site is situated on the northernmost part of a long reed isle, which is in direct contact with open water. Thus, the site is heavily affected by the prevailing northern - north-western winds. Samples taken from single reeds pushed against the reed wall (outer B0) were handled separately from the ones taken from coated (periphyton) reed stems (inner B0) growing in a small (a couple of square metres), more open area.

Herlakni Pond (HER): the largest inner lake of the Hungarian part of the lake with an area of 53.77 ha. Samples were taken in the middle part of the eastern shoreline of the Pond.

Kisherlakni Pond (KHR): a particularly closed inner lake, situated south-west from Herlakni Pond, with an area of only 2.07 ha.

Table 1. Hydrochemical parameters of regularly sampled sites with minimum and maximum values

Sites	pH	Dissolved O_2 mg/l	Dissolved O_2 %	Conductivity µS/cm
B0	8.53-9.0	5.45-10.1	65.9-102	1537-2250
Átjáró Pond	8.1-8.5	2.13-7.33	26.5-69.2	1583-2560
Kisherlakni Pond	7.88-8.4	0.73-10.2	9.4-95.6	1669-2850
Nádas 3	8.38-8.8	1.19-11.89	12.1-145	1839-3190

Átjáró Pond (ÁtjN): inner lake of 2.53 ha, samples were taken at the angler-stage at the eastern shoreline. On five occasions, we have taken samples also from rhizomes (ÁtjR) floating on the water surface.

Nádas 3 (N3): it is a dieback reed stand at the western shore of the lake, 300 metres from the Fertőrákos Hydrometeorological Station.

II. Occassional sampling sites (Fig. 1)

Occassional sampling sites can be put into two basic groups: open water areas and canals. The Fertőrákos Bay (Fö) is the largest contiguous open water area, at the southernmost part of which there are the Kladler (Kla) and the Gémes (Gém) Ponds to be found. Out of canals, the Herlakni (Hcs) and the B0 (B0cs) Canals run from east to west, while the Püspök (Pcs), the Homoki ferde (Homoki) and the Bozi (Bozi) Canals are running from north to south. The area close to the Fertőrákos Hydrometeorological Station (Frá) is a special one given that it is not covered permanently by water.

During 1995-96, we sampled the Hidegségi Pond (HID), the Nagyhatártisztás (NHA), the Pitner Beach (Pitner), the Fertőrákos Bay-Keresztárok Canal (Fká), the Madárvárta Bay (Madár) (Fig. 1), which were omitted from the later survey.

Table 1 shows a few hydrochemical characteristics of permanent sampling sites, indicating the range of measured values.

For identification of aquatic and semi-aquatic Heteroptera the following keys were used: Benedek (1969), Hufnagel & Vásárhelyi (2000), Jansson (1969, 1986), Savage (1989), Soós (1963), Stusák (1980), Vásárhelyi (1990) and Vepsalainen & Krajewski (1986). Names of species are consistently provided according to Aukema & Rieger (1995).

Data were processed using multiple variable methods (classifications and ordinations), out of which we publish only a few in this paper, but all of them were used to draw the conclusions. For multiple variable analyses we used SYN-TAX 5.1 software (Podani, 1993a,b). Detailed description of methods used can be found in Podani (1997). To describe diversity we have chosen four simple measures with the intention of projecting them to ordinations. Apart from number of species and individuals we used the Berger-Parker index to describe uniformity (index 1 means dominance of the dominant species), while we also calculated relative abundance of species (number of species per a set number of individuals, see Hufnagel et al., 2000a). The complete list of species was put on a stable zoocoenotic state space (Gaál & Hufnagel, 1999; Hufnagel et al., 1999a,b, 2000b), which makes it possible to compare the surveyed area with other areas in the country that have undergone detailed survey (Bakonyi & Vásárhelyi, 1993b; Csörgits & Hufnagel, 2000a,b; Hufnagel, 1998; Moldoványi, 1977, 1984).

Results and discussion

Faunistic data

To keep it short, the list of species contains the name of the species, the abbreviated name of the sampling site (which can be found at the description of the sites) and the date (year and month) of sample taken. As classification of Heteroptera larvae has been difficult until recently, please note that the publishment of data about larvae fills a knowledge gap.

Microvelia sp. larva: KHR VI. 1998; N3 VI. 1998; ÁtjR VII. 1998; B0 VII. 1999

Microvelia reticulata : KHR V. 1995, IV., V., VII. 1998, IV., VII. 1999; ÁtjN V. 1995, IV., VII. 1998; B0 V., VI. 1998, VII. 1999; Pcs VI. 1999; N3 V., X. 1998, IV., VII. 1999; Hcs X. 1998; Frá IV. 1999; HER VII. 1999; Bozi VII. 1999; HID V. 1995, X. 1996; Madár VIII. 1995; Fká VIII. 1995

Microvelia reticulata larva: KHR VII. 1999; N3 X. 1998, VII. 1999; Hcs X. 1998; Madár VIII. 1995

Microvelia brunoi : N3 X. 1998, IV. 1999; Bozi VII. 1999

Mesovelia furcata : Pcs VI. 1999

Mesovelia furcata larva: HER VII. 1999; Pcs VI. 1999; KHR X. 1998

Hydrometra sp. larva: Hcs X. 1998

Hydrometra stagnorum : HER IV. 1999; Kla VI. 1999

Plea minutissima : B0 V. 1995, V., VI., VII., X. 1998, IV., VI., VII. 1999; KHR V., VI. 1998, IV., VI., VII. 1999; ÁtjN V., VIII. 1995, V. 1996, V., VI., VII. 1998, VI. 1999; N3 V., VI., IX., X. 1998, IV., VII. 1999; ÁtjR VI., VII. 1998; HER V. 1996, VI., VII. 1998, VI., VII. 1999; Fö VII. 1998; Hcs VIII. 1995, V. 1996, X. 1998; Pcs X. 1998, VI. 1999; Frá IV. 1999; Bozi VII. 1999; HID V., VIII. 1995, VII. 1996; Homoki VIII. 1995

Plea minutissima larva: KHR VI., VII. 1998, VII. 1999; B0 VII., X. 1998; ÁtjN VIII. 1995, VII. 1998; Bozi VII. 1999; N3 VI., X. 1998, VII. 1999; HER VII., IX. 1998, VII. 1999; Hcs VIII. 1995, X. 1998; Homoki VIII. 1995

Corixidae larva: Hcs V. 1996, X. 1998; B0 VIII. 1995, VI., VII. 1999; NHA V. 1995; Fká VIII. 1995; HER VIII. 1995, VII. 1996; KHR V. 1996; Pitner VII. 1996; Madár VIII. 1995; HID V. 1995, VII. 1996; ÁtjN V., VIII. 1995, V. 1996

Callicorixa praeusta : KHR VI. 1999

Cymatia coleoptrata : B0 VIII. 1995, IV., VI., VII. 1998, IV., VII., X. 1999; KHR V., VI., VII. 1998, IV., VI., VII., X. 1999; ÁtjN VIII. 1995, VI., VII. 1998, IV., VII., X. 1999; N3 VI., X. 1998, IV., VII. 1999; HER VIII. 1995, IV., VI., VII., IX. 1999; Hcs X. 1998; Pcs IV. 1999; Kla VI. 1999; Bozi VII. 1999; HID V., VIII. 1995, VII., X. 1996; Homoki VIII. 1995; Madár VIII. 1995

Cymatia coleoptrata larva: KHR V., VI., VII. 1998, VI., VII. 1999; N3 V., VI., X. 1998, VII. 1999; ÁtjN VI., VII., IX. 1998, VII. 1999; ÁtjR VII. 1998; B0 VII. 1998; HER IV., VII., IX. 1999; Hcs X. 1998; Kla VI. 1999; Pcs VI. 1999; Gém VI. 1999; Bozi VII. 1999

Cymatia rogenhoferi: Frá IV. 1999

Hesperocorixa linnaei: ÁtjN VIII. 1995, IV. 1998, IV., X. 1999; KHR VIII. 1995, VI., VII. 1998, IV., VII., IX., X. 1999; Gém VI. 1999; N3 VI., X. 1998, IV., VII. 1999; B0 VII., X. 1998, IV., VII., X. 1999; Hcs X. 1998; Pcs IV. 1999; HER IV., VII. 1999; Bozi VII. 1999; HID V. 1995, VII., X: 1996; Madár VIII. 1995

Hesperocorixa linnaei larva: ÁtjN V. 1998, VI. 1999; N3 V., VI. 1998, VII. 1999; KHR VI: 1998, VI. 1999; ÁtjR VII. 1998; HER IV., VI. 1999

Hesperocorixa sahlbergi: KHR VII. 1998

Micronecta sp. larva: B0 IV. 1998

Micronecta scholtzi: B0 IV., V., VI., VII., IX. 1998, VI., VII., IX. 1999; HER IV., VII. 1999; Fö VII. 1998; Fká VIII. 1995

Micronecta scholtzi larva: B0 V., VII. 1998, IV., VII. 1999

Micronecta pusilla: B0 VI., VII. 1999; KHR IX. 1999; Kla VI. 1999; Pcs VI. 1999; Gém VI. 1999

Micronecta pusilla larva: B0 VII. 1999

Sigara falleni: B0 X. 1999

Sigara limitata: HER VII. 1999

Sigara striata: KHR V., VI., VII. 1998, VI., VII., IX., X. 1999; B0 VI., VII., IX., X. 1998, IV., VI., VII., IX., X. 1999; N3 VI. 1998, VII. 1999; ÁtjN VII., X: 1998, VI. 1999; HER IV., VI., VII. 1999; Fö VII. 1998; Frá IV. 1999; Kla VI. 1999; Gém VI. 1999

Sigara striata larva: KHR V., VII: 1998, VI., VII. 1999; N3 V., VI. 1998, VII. 1999; B0 VI., VII., IX. 1998, VII., IX., X. 1999; ÁtjN VI., VII. 1999; HER IV., VII. 1999; Pcs VI. 1999; Gém VI. 1999

Sigara lateralis: B0 IX. 1998, VI., X. 1999; Pcs IV. 1999; Homoki IV. 1999; B0cs IV. 1999

Sigara lateralis larva: KHR V. 1998

Notonecta sp. larva: B0 V. 1998; HER IV. 1999; ÁtjN IV. 1999; KHR IV. 1999

Notonecta glauca larva: N3 VII. 1999

Ilyocoris cimicoides: KHR IV., IX. 1998, IX., X. 1999; Hcs X. 1998; N3 IX., X. 1998, VII. 1999; ÁtjN VIII. 1995, X. 1998; HER X. 1999; HID V., VIII. 1995; Homoki VIII. 1995; Madár VIII. 1995

Ilyocoris cimicoides larva: B0 VI. 1998, VII. 1999; N3 VI. 1998, VII. 1999; ÁtjN VIII. 1995, VI., VII. 1998; KHR VII., IX. 1998, VII. 1999; ÁtjR VI., VII. 1998; HER VI., VII., IX. 1999; Kla VI. 1999; Pcs VI. 1999; Gém VI. 1999; HID VIII. 1995, VII. 1996; Fká VIII. 1995; Hcs V. 1996

Ranatra linearis: ÁtjN IX., X. 1998; B0 VII. 1999; KHR X. 1999; HER X. 1999; HID VIII. 1995; Madár VIII. 1995

Table 2. Comparison of species lists obtained during different faunistic investigations in Lake Fertő

Taxa	Horváth 1923	Andrikovics 1979	Decomposing reed litter 1995-1999	Faunistic Heteroptera collecting 1998-99
GERROMORPHA				
Mesoveliidae				
Mesovelia furcata Mulsant & Rey, 1852				+
Hydrometridae				
Hydrometra sp. larva				+
Hydrometra stagnorum (Linnaeus, 1758)	+			+
Veliidae				
Microvelia sp. larva			+	+
Microvelia reticulata (Burmeister, 1835)			+	+
Microvelia bruenoi Drake 1920			+	+
Velia currens (Fabricius, 1794)	+			
Gerridae				
Aquarius paludum paludum (Fabricius, 1794)	+		+	+
Gerris argentatus Schummel, 1832	+		+	+
Gerris asper (Fieber, 1860)	+			+
Gerris lacustris (Linnaeus, 1758)	+		+	+
Gerris odontogaster (Zetterstedt, 1828)	+			+
Gerris thoracicus Schummel, 1832	+			
Limnoporus rufoscutellatus (Latreille, 1807)	+			
NEPOMORPHA				
Nepidae				
Nepa cinerea Linnaeus, 1758	+		+	
Ranatra linearis (Linnaeus, 1758)	+	+	+	+
Corixidae				
Micronecta sp. larva			+	
Micronecta pusilla (Horváth, 1895)		+		+
Micronecta scholtzi (Fieber, 1860)		+	+	+
Cymatia coleoptrata (Fabricius, 1777)	+	+	+	+
Cymatia rogenhoferi (Fieber, 1864)				+
Callicorixa praeusta praeusta (Fieber, 1848)				+
Corixa punctata (Illiger, 1807)	+			
Corixidae larva		+	+	+
Hesperocorixa linnaei (Fieber, 1848)	+	+	+	+
Hesperocorixa sahlbergi (Fieber, 1848)	+			+
Paracorixa concinna concinna (Fieber, 1848)	+	+		
Sigara falleni (Fieber, 1848)				+
Sigara lateralis (Leach, 1817)	+		+	+
Sigara limitata limitata (Fieber, 1848)				+
Sigara striata (Linnaeus, 1758)	+	+	+	+
Naucoridae				
Ilyocoris cimicoides cimicoides (Linnaeus, 1758)	+	+	+	+
Notonectidae				
Notonecta sp. larva		+	+	+
Notonecta glauca glauca Linnaeus, 1758	+	+		+
(*Notonecta glauca* var. *furcata* Fabricius, 1777)	(+)			
Pleidae				
Plea minutissima minutissima Leach, 1817	+	+	+	+
Number of species	21	10	15	24
ΣΣ				30

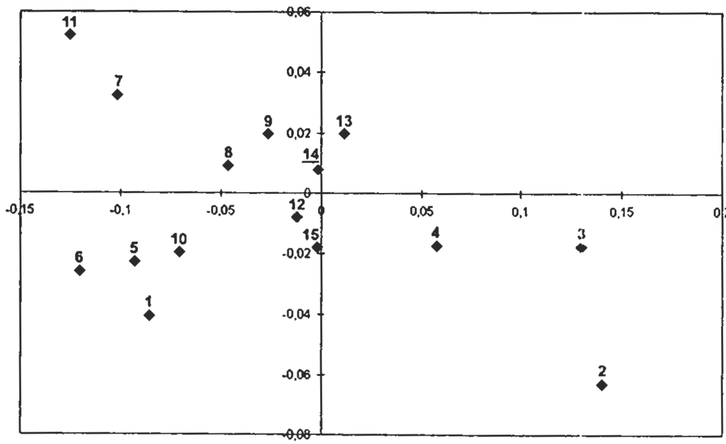

Fig. 2. Abstract spatial representation of coenotic states based on some regularly investigated Hungarian aquatic biotopes. 1: Gubacsi Ridge, 2: Caprera, 3: Szilas, 4: Gyál Streams, 5: Duna-Tisza Canal, 6: Szigetcsép Oxbow, 7: Lake Balaton 1920, 8: Lake Balaton 1980, 9: Rakaca Barrage,n 10: Hortobágy River, 11: Hortobágy Fishpond, 12: Nyéki Oxbow, 13: Naplás Pond, 14: Lake Fertő, 15: Szigetköz

Ranatra linearis larva: ÁtjR VII. 1998; HER VII. 1999

Nepa cinerea larva: BO VII. 1999

Aquarius paludum: Frá IV. 1999

Gerris argentatus: ÁtjN VII. 1999; N3 X. 1998, IV., VII. 1999; Pcs IV., VI. 1999; Homoki IV. 1999; Bozi VII. 1999; HER IV., VI., VII. 1999; Frá IV. 1999; BOcs IV. 1999; Kla VI. 1999

Gerris argentatus larva: BO IX. 1999; N3 X. 1998; Hcs X. 1998; ÁtjN VI. 1999; Pcs VI. 1999

Gerris asper larva: KHR VI., VII., IX. 1999; HER VI., VII. 1999; Gém VI. 1999

Gerris lacustris: BO VII. 1998

Gerris lacustris larva: KHR VII. 1998, VI. 1999; HID VII., X: 1996; ÁtjN V., VIII. 1995; Madár VIII. 1995; Fká VIII. 1995

Gerris odontogaster: HER IV. 1999; Frá IV. 1999

Gerris odontogaster larva: KHR VII. 1999; BO VI. 1999; N3 VII. 1999

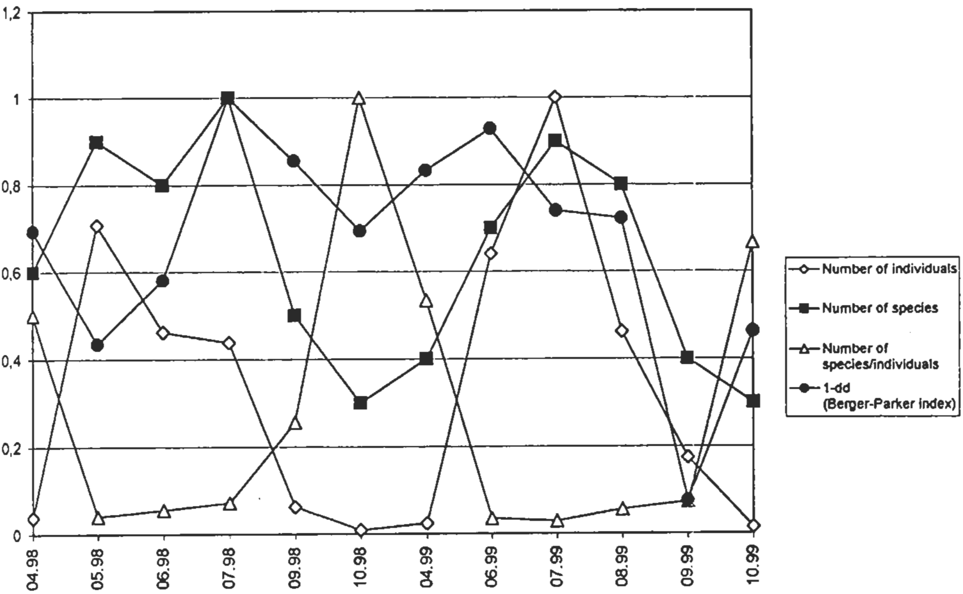

Fig. 3. Seasonal pattern of diversity components. Data have been standardized with their maximum values. (Maximum values for the applied catagories: total number of specimens: 212, species: 10, relative abundance of species: 1.5, Berger-Parker index: 0.72)

Table 2 features a comparison of the above data with earlier studies of Lake Fertő. Based on the survey, presence of 12 Gerromorpha and 18 Nepomorpha (altogether 30) species is confirmed. This number of species is quite significant compared to the fauna of our National Parks or important aquatic biotopes (e.g. Hortobágy National Park: 7 Gerromorpha and 22 Nepomorpha, altogether 29 species; Kiskunsági National Park: 8G/19N, altogether 27 species; Bükk National Park: 11G/21N, altogether 32 species; Duna-Dráva National Park, Barcs: 2G/5N, altogether 7 species; Bátorliget: 7G/12N, altogether 19 species; Balaton: 8G/19N, altogether 27 species; Budapest with 10G/13N, altogether 23 species) (Bakonyi & Vásárhelyi, 1981, 1987, 1993a; Halászfy, 1953; Vásárhelyi & Bakonyi, 1987; Vásárhelyi et al., 1990). From the complete list of species we have calculated the coordinates to represent the similarity pattern of the samples on the basis of their coenotic relations (Fig. 2). The plot shows that Lake Fertő is situated on the edge of the quarter of big lakes, near the axes, which is quite understandable if we consider the shallow nature of the lake and the strong segregation of open water by reeds.

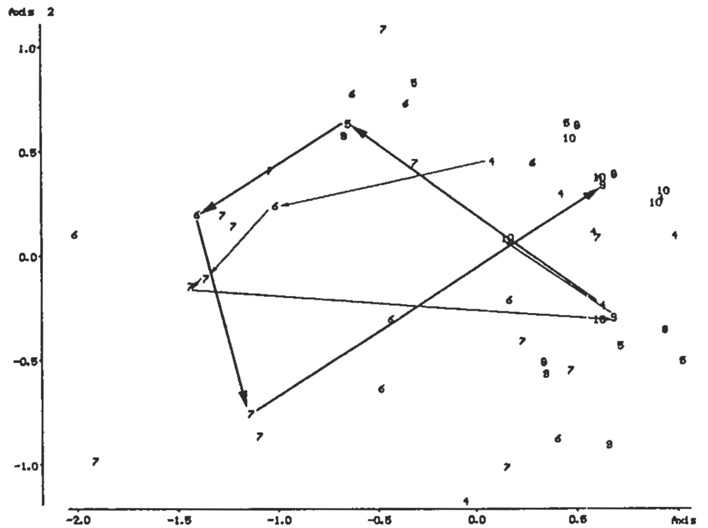

Fig. 4. Ordination plot for sampling occassions of Heteroptera assemblages (Metric Multidimensional Scaling). Numbers stand for months. Locations from Kisherlakni Pond are connected with arrows. → 1998, ➔ 1999

Seasonal dynamics

To make all the months comparable, we used the monthly totals of samples collected from decomposing reed litter *via* the same method. To describe seasonal patterns, we have shown the temporal changes of number of species, total number of individuals, relative abundance of species and the Berger-Parker index (Fig. 3). On the vertical axis, we have shown the values of each data standardized with its maximum in order to be able to show them together. Curves of number of species and number of individuals undoubtedly show the two vegetation periods. As number of individuals grow, number of species gets saturated, thus high values of abundance of species coincide with low values of number of individuals. Seasonality is not shown by the Berger-Parker index. In the course of the two years, diversity components show a similar dynamic pattern. In the spring, when both the number of species and number of individuals are low, the Berger-Parker index and relative abundance of species show a higher value. In the middle of summer (in July), both the number of species and number of individuals are at their peaks, but this state is also characterized by higher uniformity and lower relative species abundance, *i.e.* with growing number of species and individuals dominance of dominant species gets stronger, too. In autumn,

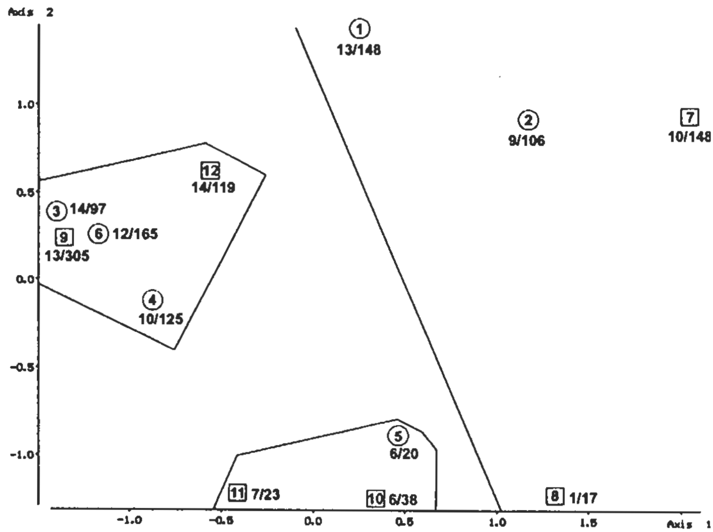

Fig. 5. Ordination plot for sampling locations of Heteroptera assemblages (Metric Multidimensional Scaling). Next to each point stand number of species and individuals, respectively. 1,7: B0 inner; 2,8: B0 outer; 3,9: Kisherlakni Pond; 4,10: Átjáró Pond – reed; 5: Átjáró Pond – rhizome; 6, 11: Nádas 3; 12: Herlakni Pond, O - samples from 1998, □ - samples from 1999

numbers of individuals of the dominant species decrease most heavily, thus lower number of individuals in the autumn coincides with a higher relative abundance of species and lower uniformity. The very same phenomenon can be observed at other macroinvertebrate groups, too. Similarity of the Heteroptera communities of each sampling site over the course of time is shown by an ordination made by principal coordinate analysis (Fig. 4). Samples taken over the summer (in June/July) appear mainly on the left side of the chart, while spring and autumn samples appear mixed on the right side. Therefore it is apparent that differences between sampling sites are primarily due to samples taken in the summer. In the figure we have drawn the temporal trajectory of the Kisherlakni Pond, which shows two loops in parallel with the two years of samples taken.

Similarity pattern of yearly data of sampling sites

Data from samples taken from decomposing reed litter were summarized according to sampling sites and years and the similarity patterns were analyzed by ordination (Fig. 5). Beside individual data points, we also showed the number of individuals and number of species. Interestingly, samples from site B0 separate well from other sites, which can be explained by the difference of the habitats. Site B0, unlike other sites, is a more open area exposed to the prevailing northern, north-eastern winds, where we can find a couple of cubic metres of reed debris piled up naturally. A difference is also evident considering hydrochemical parameters as pH and lower values for dissolved O_2 concentration are higher than those of other sites, while conductivity is lower. The difference of B0 from other sites is reflected by the macro-invertebrate fauna as well. Two more groups can be identified on the figure: samples from both years from the Kisherlakni Pond are similar to those of Herlakni Pond in 1999 and those of Nádas 3 and Átjáró Pond in 1998. This is separated from the other group (Átjáró Pond rhizome in 1998, Nádas 3 and Átjáró Pond in 1999) because of considerably higher values of the number of individuals and number of species. Interestingly, samples taken in 1998 at Átjáró Pond and Nádas 3 belong to the first group, while the ones taken in 1999 belong to the other. This can be explained by the higher degree of shading throughout 1999, caused by strong proliferation of filamentous algae on the surface of the reed sheaf in the case of Nádas 3, while caused by sinking of the reed sheaf near to the sediment surface in the case of Átjáró Pond. Thus it is not surprising that samples taken from the rhizome show up in this group as degradation of the rhizome is much quicker versus the reed stem, and therefore rhizome pieces originally floating on the water surface sink to the bottom after a couple of months.

Basic patterns of composition and changes of Heteroptera communities are well visible on the basis of studies done between 1995 and 1999, but to explore finer interconnections and causal relations further research is required. Apart from extending the range of study to other macroinvertebrate groups, new results could be obtained by studying other types of habitats and by conducting more detailed hydrochemical investigations.

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