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CONSEQUENCES OF AN EXTIRPATION TRIAL OF THE TREE OF HEAVEN (*AILANTHUS ALTISSIMA* (MILL.) SWINGLE) ON ROCK GRASSLANDS AND SLOPE STEPPES

L. Erdős, A. Márkus and L. Körmöczi

Erdős, L., Márkus, A. and Körmöczi, L. (2005): Consequences of an extirpation trial of the tree of heaven (*Ailanthus altissima* (Mill.) Swingle) on rock grasslands and slope steppes*. — Tiscia 35, 3-7*

Abstract. Szársomlyó Hill is a valuable nature reserve, where the tree of heaven has expanded its area in the last decades. In 2003 and 2004, the Directorate of the Duna-Dráva National Park conducted a study aiming the eradication of *Ailanthus altissima*. In two grassland communities of the southern hillside, all *Ailanthus* individuals were treated with foliar spray in 15 experimental plots. Two herbicides were applied in four solvents.
The method was successful only on less then half of the treated individuals. The plots with higher *Ailanthus* density must receive repeated treatments. Despite the careful spraying, natural vegetation suffered considerable changes in total cover, and moderate alteration of the species composition. A year after the treatment, the regeneration of the grasslands is obvious.

Keywords: Ailanthus altissima, Banvel 480S, Garlon 4E, invasion, Szársomlyó, Villány Hills.

L. Erdős, Department of Ecology, University of Szeged and Directorate of the Duna-Dráva National Park, **A. Márkus**, Directorate of the Duna-Dráva National Park, **L. Körmöczi**, Department of Ecology, University of Szeged

Introduction

Invasive species are among the serious problems in natural habitats and nature conservation areas. The problem is acute on both global and local scales (Botta-Dukát 2004) but the defence projects are carried out in particular habitats (Mihály and Botta-Dukát 2004). Forcing back or control of the invasive plants need different methods depending on the traits of a certain species and habitat. This needs a more cautious job in nature reserves. Only considerate treatments should be used in sensitive natural habitats that the extirpation of an invasive species should not cause greater damage than its presence.

Efficiency and suitability of extirpation practices applied in areas of intensive land use are not fully known. In the case of a certain nature reserve, the applicable treatment must be tested carefully for being efficient enough and not causing disproportionately large damage (Márkus 2004).

The spread of the population of tree of heaven is not very intensive on the Szársomlyó Hill, therefore its negative effect on the community structure is expressed mainly not due to the dominance of the population but to allelochemicals that are found in each part of the plant (Heisey 1990), and that should cause the impoverishment of the local flora.

With the experiments carried out with the tree of heaven population on Hill Szársomlyó, Duna-Dráva National Park, we intended to contribute to the knowledge of control of this invasive plant.

Material and methods

Szársomlyó Hill is located in the Villány Hills, in the South of Hungary. It consists of Triassic, Jurassic and cretaceous limestone, to a lesser degree of Triassic dolomite (Lehmann 1975). On the southern slope, the edges of the limestone strata emerge on the surface. The foot of Szársomlyó is covered by loess.

The Sub-Mediterranean climate of Szársomlyó is characterized by hot summer and mild winter. The annual mean temperature is 10.9 ºC (Dénes 1994). The temperature regimes of the northern and southern hillsides differ considerably. During the day the southern slope is much warmer, but in the evening the situation changes because of the greater heat radiation on the weakly wooded southern hillside (Horváth and Papp 1964). The mean annual sum of precipitation is 676-697 mm (Dénes 1997).

Szársomlyó belongs to the phytogeographical district Sopianicum. Its flora and vegetation has been studied for more than 200 years (Lehmann 1975). 754 vascular plant species have been revealed from the hill, 75 of which are protected or strictly protected (Dénes 2000). The Szársomlyó Nature Reserve was founded in 1944 (Dudás and Wágner s.a.).

The vegetation of the two hillsides is totally different. The most part of the northern hillside is covered by Illyrian neutrocline sessile oak-hornbeam forests, *Asperulo-Taurinae carpinetum*. On the southern slope there are three main associations: a karstic shrub-forest, *Inulo spiraeifoliae-Quercetum pubescentis*, a rock grassland community, *Sedo sopianae-Festucetum dalmaticae*, and a slope steppe, *Cleistogeni-Festucetum rupicolae* (Lehmann 1975, Dénes 1998).

On the ridge and on the southern slope, tree of heaven, *Ailanthus altissima* (Mill.) Swingle, which is one of the most aggressive invasive plants in Hungary, is expanding its area rapidly. According to Mack et al. (2000), the mere presence of an invasive plant in a nature conservation area is undesirable. What is more, *Ailanthus* is a transformer species (Botta-Dukát et al. 2004): it has a strong effect on the invaded associations by impoverishing the vegetation (Udvardy 1998). *Ailanthus* is able to invade even meso- and oligohemerobic communities in Central and Southern-Europe (Gutte et al. 1987).

The first known data of *Ailanthus* in Hungary were published by J. Barthosságh in 1841 (cit. in Udvardy 2004). He planted *Ailanthus* to the foot of Szársomlyó Hill. There are some circumstances that probably promote the establishment and spread of the tree of heaven on this hill: 1.) Proximity of the settlement. The winged seeds produced by old individuals of *Ailanthus* in Nagyharsány village can easily reach the nature reserve of Szársomlyó. 2.) Disturbance of the grass by trampling of tourists may support the establishment of the tree of heaven, as it can be observed in many cases of invasion (e. g. Bagi 1997, 1999, Szigetvári 2004). 3.) Proximity of the quarry also contributes to the disturbance. 4.) Mine dumps from the former bauxite mines provide a bare ground for invasive species. It is experimentally demonstrated that bare ground encourages the establishment of non-indigenous species (Burke and Grime 1996).

The experimental site was located on the southern slope of Szársomlyó Hill, in two associations: *Sedo sopianae-Festucetum dalmaticae* and *Cleistogeni-Festucetum rupicolae*. We set up twenty-one plots of 5×5 m, fifteen of which were treated with herbicides. Six quadrats served as control. Eight of the fifteen plots treated were established in *Cleistogeni-Festucetum rupicolae* and the other seven in *Sedo sopianae-Festucetum dalmaticae*. Among the controls both associations were represented with three plots, in one of which all individuals of *Ailanthus* were cut with pruning scissors, and in two quadrats no treatment was applied.

The chemical treatment was performed in July 2003 by I. Szidonya with a hand-sprayer. Only the the tree of heaven individuals were sprayed, but a little quantity of chemicals was blown away by the wind which was expected to disturb the grassland species. We wanted to test the effectiveness of two kinds of herbicides, so nine plots were treated with Garlon 4E, and six one with Banvel 480S. The applied concentrations were extremely high (in case of Garlon: 30%, in case of Banvel: 20%) because of the careful method and the small area treated. Solvents were rape oil, diesel oil or Agrol+water in case of 'Garlon' and water or Agrol+water in case of 'Banvel'.

In the plots treated with chemicals four coenological records were made: in the spring of 2003 — before the treatment, and in the spring, summer and autumn of 2004 — after the treatment. Data from the control plots were recorded in the three seasons of 2004. Unfortunately, four of the six control plots were treated in 2004 during a work that was independent of our study. Therefore we established two additional quadrats in order to have control records for autumn.

We examined two main questions: 1.) How successful is the chemical treatment and 2.) What is the effect of herbicides on the surrounding vegetation?

We estimated the percentage cover of the species. Multivariate analyses were computed with SYN-TAX 5.0 program package (Podani 1993). We used Renkonen index and group average clustering algorithm in the classification, and principal components analysis (PCA) as an ordination method.

Results

Although there were only minimal distances among the quadrats, the associations can be distinguished clearly. Steppe meadow is a little bit richer in species. Total cover of the vegetation is much higher in the steppe meadow than in the rock grassland community. Some species were found only in one of the two associations: *Anacamptis pyramidalis*, *Dianthus giganteiformis, Eryngium campestre, Festuca rupicola, Geranium columbinum, Melilotus officinalis* and *Viola arvensis* were typical only of *Cleistogeni-Festucetum rupicolae*, whereas *Asplenium ruta-muraria, Ceterach javorkeanum, Colchicum hungaricum, Helianthemum canum* and *Potentilla arenaria* were typical of *Sedo sopianae-Festucetum dalmaticae*.

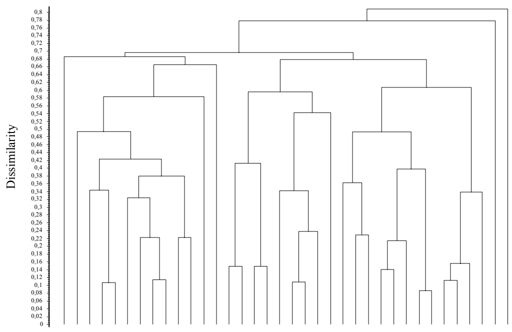

Fig. 1 Result of classification in case of *Sedo sopianae-Festucetum dalmaticae* (: records before treatment, ☐: first records after treatment, : second and third records after treatment, : controls, ⊙: extraordinary plots before treatment, : extraordinary plots after treatment)

On the dendrogram it's obvious, that the records of treated and untreated plots do not form clearly separated groups, they can, however, be grouped with a few exceptions (Fig 1). In order to eliminate the seasonal variability, we compared the coenological records of the spring seasons before and after the treatment. Generally there could be observed considerable differences among treated and control plots with only three exceptions (one in case of *Sedo sopianae-Festucetum dalmaticae* – see Fig. 1, and two in case of *Cleistogeni-Festucetum rupicolae*; they will be marked as extraordinary plots on Fig. 1.), which can be explained variously: 1.) Sweeping away of the herbicide by the wind seems not to have remarkable effects on the vegetation. 2.) Among the solvents probably the rape oil is the least harmful to the plants. The coenological structure of the plots where rape oil was the solvent of the herbicide, changed less than that of the others. But further experiments are needed to verify this observation. 3.) The most important observation is the following: in the quadrats where not great differences can be seen between treated and untreated states, the initial cover of *Ailanthus* was the smallest. We can clearly state from the cenostate transformation of the experimental plots, that it is advisable to begin the eradication of the tree of heaven as early as possible, not only because the fight against this invasive species is more successful in this way, but also because this is a chance to minimize the damage in the surrounding vegetation. This is especially important in nature reserves and other valuable areas.

On the PCA scattergram (Fig. 2) the plots form two slightly overlapping groups. The records made in the spring after the treatment belong to one group, and the others together with the controls to the other one. This suggests that: 1.) the treatment has a considerable influence on the vegetation, but 2.) the regeneration of the vegetation is relatively fast. As a consequence of the treatment both associations suffer changes, but after a year they can be found near the original state.

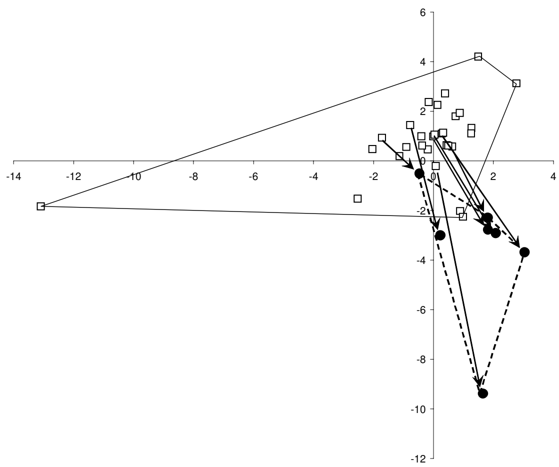

Fig. 2 Result of ordination in case of *Sedo sopianae-Festucetum dalmaticae* (Arrows indicate the transformation of the cenostate due to the treatment. ☐ spring records before the treatment and control plots; ● next year spring records after the treatment)

In case of *Sedo sopianae-Festucetum dalmaticae* chemicals increase the seasonal differences. This phenomenon is easy to understand: both chemicals damage mainly perennial plants (*Festuca dalmatica*, *Artemisia alba* and others), and with the decline of these species annual herbs win greater importance. In contrast, in case of *Cleistogeni-Festucetum rupicolae* the seasonal differences are not increased, which is an unexpected and surprising result.

According to the classification and ordination (Figs 1 and 2), neither of the chemicals seems to be less harmful to the natural vegetation.

In accordance with the results of the coenological records, the effectiveness of the spraying on the tree of heaven after nine months is over 99%. After the treatment all leaves of *Ailanthus* fell down. To the next spring tree of heaven appeared only in 27% of the plots, attaining a total cover of more than

0.1% in a single quadrat. The success didn't last long: to the summer of the same year *Ailanthus* appeared in 53% of the plots (its average cover was 3.35%). In autumn the cover of *Ailanthus* reached or exceeded the initial cover in more than 25% of the quadrats. There is a considerable difference between the two associations: the effect of the treatment on the Ailanthus seems to be more long-lasting in case of *Cleistogeni-Festucetum rupicolae*.

Total or nearly total extirpation of the tree of heaven was successful in 40% of the plots. On the rock grassland Banvel seemed to be more effective of the two chemicals, but on the slope steppe there was not a great difference between Banvel and Garlon. Cutting with scissors was not very effective.

Having examined the total cover of the vegetation, damaging effect of the treatments is obvious (Fig. 3). Average total cover of *Sedo-sopianae-Festucetum dalmaticae* decreased from 75% to 46.4%. (Only the spring records were compared, to exclude the effects of seasonal changes!) Average total cover of *Cleistogeni-Festucetum dalmaticae* changed from 99.4% to 68%. After some months a regeneration process resulted in the increase of average total cover to 56.7% *(Sedo sopianae-Festucetum dalmaticae)* and 81.9% *(Cleistogeni-Festucetum rupicolae),* resp. In autumn total cover decreased again, but this occurred probably due to the seasonal variability.

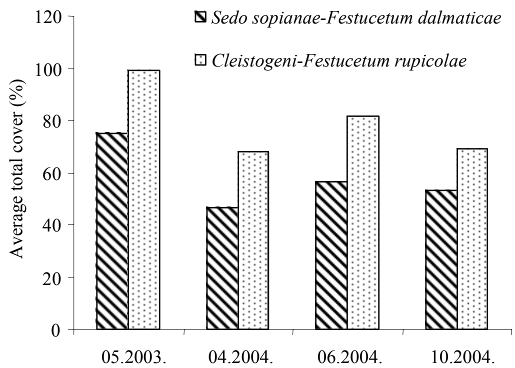

Fig. 3 Average total cover of *Sedo sopianae-Festucetum dalmaticae* and *Cleistogeni-Festucetum rupicolae*. Treatment took place in the summer of 2003

Of course, in the regeneration not only the total cover of the vegetation is important, but also the species composition. The treatment had the most drastic effect on the *Festuca* species. For example on the slope steppe, the average cover of *Festuca dalmatica+Festuca rupicola* dropped from 73.1% to 26.9%! Unfortunately in case of these species regeneration seems to be slow. To the autumn of 2004 they reached only 55% (rock grassland community) and 31% (slope steppe) of their original cover. Beside the *Festuca* species, *Artemisia alba, Thymus praecox, Sanguisorba minor, Potentilla arenaria, Ligustrum vulgare, Rosa canina* and *Crataegus monogyna* were remarkably susceptible to the chemical treatment.

The species number of each treated quadrat increased by the next spring after the treatment compared to the before-treatment spring. This phenomenon can be explained as follows: 1.) The after-treatment records were made in April, one month earlier than the before-treatment ones. In April probably more species can be observed than in May, though there were species which disappeared due to the chemicals. 2.) Most species are insensible to this kind of treatment.

Discussion

Both associations suffered a considerable change due to the treatment. If the initial cover of *Ailanthus* to be treated is low, then less damage is expected in the vegetation. It is expedient to start the fight against this invasive species as early as possible. Neither chemical seems to be less harmful to the plants. Regeneration of the vegetation is relatively fast. In case of *Sedo sopianae-Festucetum dalmaticae* the treatment increases seasonal differences (chemicals damage mainly perennial plants).

Eradication of *Ailanthus* was successful only in 40% of the quadrats for longer time. Total cover of the grass decreased rapidly, which can be assigned mainly to the negative effect of the herbicides on the perennial plants. Some species are very susceptible to the treatment. It is evident that every attempt of extirpation of the tree of heaven must be carried out with much care in a nature reserve in order to avoid unnecessary damages of the other plants.

Acknowledgment

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References

Bagi, I. (1997): Átalakuló homoki vegetáció a Duna-Tisza közén. (Sandy vegetation in progress in the Kiskunság region). – Kitaibelia 2, 253-264.

Bagi, I. (1999): A selyemkóró (*Asclepias syriaca* L.) – Egy invazív faj biológiája, a védekezés lehetőségei. (*Asclepias syriaca* L.; biology and control of an invasive species). – Kitaibelia 4, 289-295.

Botta-Dukát, Z. (2004): A növényi invázióval kapcsolatos hazai

és nemzetközi aktivitás (Hungarian and international activity connected with the plant invasion). In: Mihály B. and Botta-Dukát Z. (eds): Özönnövények. (Invasive plants). – Természetbúvár Alapítvány Kiadó, Budapest, 17-33 pp.
Botta-Dukát, Z., Balogh, L., Szigetvári, Cs., Bagi, I., Dancza, I. and Udvardy, L. (2004): A növényi invázióhoz kapcsolódó fogalmak áttekintése, egyben javaslat a jövőben használandó fogalmakra és definíciókra. (Summary of expressions connected with plant invasion and suggestion for expressions and definitions used in the future). In: Mihály B. and Botta-Dukát Z. (eds): Özönnövények. (Invasive plants). – Természetbúvár Alapítvány Kiadó, Budapest, 35-59 pp.
Burke, M. J. W. and Grime, J.P. (1996): An experimental study of plant cummunity invasibility. – Ecology 77, 776-790.
Dénes, A. (1994): A Mecsek és a Villányi-hegység karsztbokorerdői. (The karst shrubforest of Mecsek and Villány Mountains, South Hungary). – A Janus Pannonius Múzeum Évkönyve 39, 5-31.
Dénes, A. (1997): Lejtősztyeprét tanulmányok a Villányi-hegységben. (Studies of slope steppes in Villány hills). – Kitaibelia 2, 267-273.
Dénes, A. (1998): *Chrysopogono-Festucion dalmaticae* communities in Villány Hills, Hungary. — In: Csontos, P. (ed.): Sziklagyepek szünbotanikai kutatása. Scientia Kiadó, 57-76 pp.
Dénes, A. (2000): A Villányi-hegység flóra- és vegetációkutatásának története, eredményeinek összefoglalása, különös tekintettel a védett és ritka fajok előfordulására. (History of research on flora and vegetation in the Villány Hills; a summary of results, with special regard to the occurence of rare and protected species). In: Uherkovich, Á. (ed): A Villányi-hegység botanikai és zoológiai alapfelmérése. (The flora, vegetation and fauna of the Villány Hills, South Hungary). – Baranya megyei Múzeumok Igazgatósága, Pécs, 47-77 pp.
Dudás, Gy. and Wágner L. (sine anno): Szársomlyói tanösvény. (Nature trail Szársomlyó). – Duna-Dráva Nemzeti Park Igazgatósága, Pécs.
Gutte, P., Klotz, S., Lahr, Ch. and Trefflich, A. (1987): *Ailanthus altissima* (Mill.) Swingle – eine vergleichend pflanzengeografische Studie. – Folia Geobotanica and Phytotaxonomica 22, 241-262.
Heisey, R. M. (1990): Allelopathic and herbicidal effect of extracts from tree of heaven (*Ailanthus altissima*). – American Journal of Botany 77, 662-667.
Horváth, A. O. and Papp, L. (1964): A nagyharsányi Szársomlyón végzett mikroklímamérések eredményei. (Results of the microclimate measurements on Szársomlyó Hill at Nagyharsány). – A Janus Pannonius Múzeum Évkönyve 8, 43-51.
Lehmann, A. (1975): A nagyharsányi Szársomlyó-hegy és növényzete. (Szársomlyó Hill at Nagyharsány and its vegetation). – MTA Dunántúli Tudományos Intézete, Pécs.
Mack, R. N., Simberloff, D., Lonsdale, W. M., Evans, H., Clout, M., and Bazzaz, F. A. (2000.): Biotic invasions: causes, epidemiology, global consequences, and control. – Ecological Applications 10, 689-710.
Márkus, A. (2004): Inváziós növények elleni tevékenységek a nemzetipark-igazgatóságokban. Duna-Dráva Nemzeti Park. (Activities against the invasive plants in the directorates of Hungarian National Parks. Duna-Dráva National Park). In: Mihály B. and Botta-Dukát Z. (eds): Özönnövények. (Invasive plants). – Természetbúvár Alapítvány Kiadó, Budapest, 393 p.
Podani, J. (1993): SYN-TAXpc, computer programs for multivariate data analysis in ecology and systematics, Ver. 5.0. User's guide. — Scientia Publishing, Budapest
Szigetvári, Cs. (2004): Inváziós növények szerepének összehasonlító vizsgálata nyílt homokgyepekben. (Comparative study of the role of invasive species on open sand grasslands). – Thesis, Szegedi Tudományegyetem Ökológiai Tanszék, Szeged
Udvardy, L. (1998): Spreading and coenological circumstances of the tree of heaven (*Ailanthus altissima*) in Hungary. – Acta Botanica Hungarica 41,299-314.
Udvardy, L. (2004): Bálványfa. (Tree of heaven). In: Mihály, B. és Botta-Dukát, Z. (eds): Özönnövények. (Invasive plants). – Természetbúvár Alapítvány Kiadó, Budapest, 143-160 pp.

TISCIA 35, 9-16

CHECKLIST OF THE ASSOCIATIONS OF THE HUNGARIAN SECTION OF TISZA BASIN

O. Makra

Makra, O. (2005): Checklist of the associations of the Hungarian section of Tisza basin. — TISCIA 35, 9-16

Abstract. The paper presents a checklist of the terrestrial and aquatic plant associations along the river Tisza and its tributaries. The natural and semi-natural associations are in focus. Within the terrestrial vegetation units, the associations under natural disturbation of floods and those outlying the dams with remains of the natural or semi-natural species-composition from the former floodplain woods and marches are listed, too. In most cases the reconsideration of the associations mentioned in the literature was carried out according to Borhidi (2004). Checking 43 papers from 1930-ies till the present, I listed 111 plant communities.

Keywords: plant associations, Tisza river

O. Makra, Tisza Reserarch Group by the Hungarian Academy of Sciences and the University of Szeged, Department of Ecology, University of Szeged, H-6701 Szeged, PO Box 51, Hungary

Introduction

The vegetation-research on the flood plain of the Tisza River is lasting for nearly a century. The researchers achieved vegetation exploration of several river sections during this time.

This section briefly summarizes the most important works in respect of the basic researches. Bodrogközy was the first who studied and described the large sedge communities and flood swards vegetation of the Hungarian section on Tisza flood plain (Bodrogközy 1961-1985). Timár investigated the riverbed vegetation of river Tisza — from Szolnok to Szeged — and river Maros, and identified several plant associations (Timár 1950/a, 1950/b). The description of vegetation and flora of the Northern Hungarian Plain forests was a very important study by Simon (1950, 1957). Máthé and Tallós examined several remains of pannonic alkali steppe oak woods on the eastern territory of Tisza Basin (Máthé 1933, 1936, 1939, Tallós 1968).

Even so a summarised checklist of the associations of the Hungarian section of Tisza basin has not been published yet. With this work relying on the bibliography and my field observations, I intend to fill this long–felt gap.

In consequence of the river regulation, the extension of the inundation area flooded more or less regularly was decreased drastically. The main aim of this work is to collect the edafic vegetation-types closed between dikes, under natural disturbation of floods. In addition, the associations got to the flood-protected area and preserving some herb layer species of the former floodplain woods are included in the enumeration, too. The semi-natural associations developed as a consequence of the extensive land-use (mowing, pasturing) are also on the list, but the agricultural fields and forest plantations are excluded. Neither the associations developed on the flood-plain by certain secondary effects (e.g. treading) which hide the specific influences of floods are included.

In most cases the reconsideration of the associations mentioned in the literature was carried out according to Borhidi (2004).

In the case of the following associations I used the former nomenclature (Soó 1964):

(1) *Nymphaeetum albo-luteae, (2) Scirpo-Phragmitetum*: I keep the name when these are used in bibliography without giving coenological relevés.

(3) Salicetum albae-fragilis: According to the current classification, this association is divided into

three parts (*Senecioni sarracenici-Populetum albae, Carduo crispi-Populetum nigrae, Leucoju aestivi-Salicetum albae*). The above denomination was based on the examinations carried out in the Danube basin. There were only few data (coenological relevés) in the bibliography relating to the vegetation of Tisza basin, therefore I keep this older form. Coenotaxonomic state of the stands in this region is unclarified, further examinations are required.

Aquatic communities

The systematic principles of the current nomenclature of the aquatic plant communities deviate from those of the terrestrial-system. The terrestrial vegetation is classified on the basis of dominant species and functional groups (characteristic and differential species). On the other hand, the aquatic communities are classified according to growth and morphological types of plants. Szalma (2004) called attention to the inconsistency of the system and to the need of revision of the aquatic communities, too.

Checking 43 papers from 1930-ies till now, I listed 111 plant communities.

Checklist and references of the associations

Class: Lemnetea (de Bolós et Masclans 1955)
Order: Lemnetalia minoris (de Bolós et Masclans 1955)
Alliance: Riccio-Lemnion trisulcae (R. Tx & Schwabe-Braun 1974)
Ass: *Lemnetum trisulcae* (Knapp et Stoffers 1962): Molnár et al. (1997), Szalma (2003), Penksza et al. (1999), Penksza and Gubcsó (1998)
Ass: *Riccietum fluitantis* (Slavnic 1956): Szalma (2003)
Alliance: Lemnion minoris (de Bolós et Masclans 1955 em. Borhidi 2001)
Ass: *Lemnetum minoris* (Soó 1927): Molnár et al. (1997), Dragulescu (1995), Dragulescu and Macalik (1997), Szalma (2003), Penksza et al. (1999)
Ass: *Lemno minoris-Spirodeletum* (W.Koch 1954): Molnár et al. (1997), Szalma (2003), Tóth et al. (1996), Penksza and Gubcsó (1998)
Ass: *Wolffietum arrhizae* (Miyav & J.Tx. 1960): Tuba (1995), Molnár et al. (1997), Bodrogközy (1982), Szalma (2003)
Alliance: Lemno minoris-Salvinion (Slavnic 1956)
Ass: *Salvinio-Spirodeletum* (Slavnic 1956): Molnár (1996/a), Tuba (1995), Molnár et al. (1997), Bodrogközy (1982), Dragulescu and Macalik (1997), Dragulescu, C. (1995), Szalma (2003), Penksza et al. (1999), Penksza and Gubcsó (1998)
Order: Lemno-Utricularietalia (Passarge 1978)
Alliance: Utricularion vulgaris (Passarge 1964)
Ass: *Lemno-Utricularietum vulgaris* (Soó 1928): Molnár (1996/a), Tuba (1995), Molnár et al. (1997), Bodrogközy (1962), Timár (1954), Dragulescu and Macalik (1997), Szalma (2003), Penksza et al. (1999)
Ass: *Hydrochari-Utricularietum vulgaris* (Borhidi & al. 1998): Deák (2001)
Order:Hydrocharetalia (Rübel 1933)
Alliance: Hydrocharition (Rübel 1933)
Ass: *Hydrocharitetum morsus-ranae* (van Langendonck 1935): Molnár et al. (1997), Deák (2001), Szalma (2003)
Ass: *Stratiotetum aloidis* (Nowinski 1930): Szalma (2003)
Alliance: Ceratophyllion (Den Hartog et Segal 1964)
Ass: Ceratophylletum demersi (Hild 1956): Molnár et al. (1997), Szalma (2003), Penksza et al. (1999), Penksza and Gubcsó (1998)
Ass: *Ceratophylletum submersi* (Den Hartog et Segal 1964): Penksza and Gubcsó (1998), Penksza et al. (1999)
Class: Potametea (Klika in Klika & Novák 1941)
Order: Potametalia (Koch 1926)
Alliance: Potamion lucentis (Rivas Martinez 1973)
Ass: *Elodeetum canadensis* (Eggler 1933): Molnár et al. (1997)
Ass: *Potametum lucentis* (Hueck 1931): Molnár (1996/a), Molnár et al. (1997), Bodrogközy (1982), Bodrogközy (1965), Szalma (2003), Penksza et al. (1999)
Ass: *Myriophylletum verticillati* (Gaudet 1924): Molnár et al. (1997), Szalma (2003)
Ass: *Potametum perfoliati* (Koch 1926. em. Passarge 1964): Molnár et al. (1997), Szalma (2003)
Ass: *Myriophyllo-Potemetum* (Soó 1934): Tuba (1995), Molnár et al. (1997), Bodrogközy (1962), Timár (1954), Dragulescu, (1995), Dragulescu and Macalik (1997), Szalma (2003)
Alliance: Potamion pusilli (Vollmar 1947 em. Hejny 1978)
Ass: *Potametum pectinati* (Carstensen 1955): Molnár et al. (1997), Szalma (2003)
Ass: *Potametum crispi* (Soó 1928): Molnár et al. (1997), Dragulescu (1995), Dragulescu and

Macalik (1997), Penksza et al. (1999), Penksza and Gubcsó (1998)

Ass: *Najadetum marinae* (Fukarek 1961): Molnár et al. (1997), Szalma (2003)

Alliance: Nymphaeion albae (Oberd. 1957)

Ass: *Nymphaeetum albo-luteae* (Nowinski 1928): Molnár (1996/a), Tuba (1995), Molnár et al. (1997), Bodrogközy (1965), Bodrogközy (1962), Dragulescu, (1995), Dragulescu and Macalik (1997), Szalma (2003), Penksza et al. (1999)

Ass: *Ceratophyllo-Nymphaeetum albae* (V. Kárpáti 1963, Borhidi 2001): Timár (1954)

Ass: *Nymphoidetum peltatae* (Allorge 1922, Bellot 1951): Molnár (1996/a), Tuba (1995), Molnár et al. (1997), Timár (1954), Dragulescu (1995)

Ass: *Polygonetum natantis* (Soó 1927): Molnár et al. (1997), Dragulescu (1995), Dragulescu and Macalik (1997)

Ass: *Trapetum natantis* (V. Kárpáti 1963): Molnár (1996/a), Tuba (1995), Molnár et al. (1997), Bodrogközy (1982), Timár (1954), Dragulescu (1995), Dragulescu and Macalik (1997), Deák (2001), Szalma (2003), Penksza et al. (1999)

Alliance: Zannichellion pedicellatae (Schaminée et al. 1990 em.)

Ass: *Najadetum minoris* (Ubrizsy 1948): Molnár et al. (1997)

Ass: *Ranunculetum aquatilis-polyphylli* (Soó 1947): Máthé (1933)

Class: Isoëto-Nanojuncetea (Br.-Bl. et TX. ex Westhoff & al. 1946)

Order: Nanocyperetalia(Klika 1935)

Alliance: Nanocyperion(Koch ex Libbert 1932)

Ass: *Cypero-Juncetum bufonii* (Felföldy 1942, Soó & Csűrös 1949): Molnár et al. (1997), Bodrogközy (1982), Timár (1950/a), Tóth (1967)

Ass: *Dichostylido michelianae-Gnaphalietum uliginosi* (Timár 1947): Molnár et al. (1997), Bodrogközy (1982), Dragulescu and Macalik (1997), Timár (1950/b), Tóth (1967), Kozma and Tölgyesi (1997)

Ass:*Dichostylido-Heleochloetum alopecuroidis* (Timár 1950, Pietsch 1973): Molnár et al. (1997)

Ass: *Eleochareto-Schoenoplectetum supini* (Soó & Ubrizsy 1948): Tuba (1995), Simon (1950)

Alliance: Verbenion supinae (Slavnić 1951)

Ass: *Pulicario-Menthetum pulegii* (Slavnic 1951): Dragulescu and Macalik (1997)

Class: Phragmiti-Magnocaricetea (Klika in Klika & Novak 1941)

Order: Phragmitetalia (Koch 1926)

Alliance: Phragmition australis (Koch 1926)

Ass: *Scirpo-Phragmitetum* (Koch 1926): Tuba (1995), Bodrogközy (1982), Bodrogközy (1965), Bodrogközy (1962), Dragulescu and Macalik (1997), Újvárosi (1941), Tallós and Tóth (1968)

Ass: *Phragmitetum communis* (Soó 1927 em. Schmale 1939): Molnár et al. (1997), Bodrogközy (1982), Deák (2001), Szalma (2003), Tóth (1967), Máthé (1939), Penksza et al. (1999), Penksza and Gubcsó (1998)

Ass: *Schoenoplectetum lacustris* (Chouard 1924) Molnár et al. (1997), Dragulescu (1995), Dragulescu and Macalik (1997), Deák (2001), Szalma (2003)

Ass: *Typhetum angustifoliae* (Soó 1927, Pignatti 1953): Dragulescu (1995), Dragulescu and Macalik (1997), Deák (2001), Szalma (2003), Penksza et al. (1999)

Ass: *Typhetum latifoliae* (G. Lang 1973): Dragulescu, C. (1995), Szalma (2003), Penksza et al. (1999)

Ass: *Glycerietum maximae* (Hueck 1931): Molnár (1996/a), Tuba (1995), Molnár et al. (1997), Bodrogközy (1982), Bodrogközy (1965), Bodrogközy (1965), Bodrogközy (1962), Bodrogközy and Horváth (1977), Dragulescu (1995), Dragulescu and Macalik (1997), Máthé (1936), Deák (2001), Szalma (2003), Kovács (1998), Penksza et al. (1999), Kozma and Tölgyesi (1997)

Ass: *Sparganietum erecti* (Roll 1938): Molnár et al. (1997), Szalma (2003)

Ass: *Equisetetum fluviatilis* (Steffen 1931): Molnár et al. (1997)

Order: Bolboschoenetalia maritimi (Hejny 1967)

Alliance: Cirsio brachycephali-Bolboschoenion (Passarge 1978, Mucina 1993)

Ass: *Polygono-Bolboschoenetum* (Bodrogközy 1962): Bodrogközy (1965), Bodrogközy (1962), Timár (1950/b), Tóth (1967)

Ass: *Schoenoplectetum tabernaemontani* (Soó 1947): Dragulescu (1995)

Ass: *Bolboschoenetum maritimi* (Eggler 1933): Dragulescu (1995), Dragulescu and Macalik (1997), Tóth (1967)

Ass: *Glycyrrhizo echinatae-Phragmitetum* (Timár 1947): Timár (1950/b)

Ass: *Glycyrrhizo echinatae-Phalaroidetum* (Timár 1947): Timár (1950/b)

Order: Nasturtio-Glycerietalia (Pignatti 1953)

Alliance: Glycerio-Sparganion (Br.-Bl. & Sissingh in Boer 1942)

Ass: *Glycerietum fluitantis* (Eggler 1933): Tuba (1995)

Ass: *Leerzietum oryzoidis* (Eggler 1933): Molnár et al. (1997)

Order: Oenanthetalia aquaticae (Hejnỳ in Kopeckỳ & Hejnỳ 1965)

Alliance: Oenanthion aquaticae (Hejnỳ ex Neuhäusl 1959)

Ass: *Oenantho aquaticae-Rorippetum amphibiae* (Lohmeyer 1950): Tuba (1995)

Ass: *Butomo-Alismatetum plantaginis-aquaticae* (Slavnić 1948, Hejnỳ 1978): Molnár et al. (1997), Penksza et al. (1999)

Ass: *Butomo-Alismatetum lanceolati* (Timár 1947, Hejny 1969): Deák (2001)

Ass: *Alismato-Eleocharitetum* (Máthé & Kovács M. 1967): Molnár et al. (1997), Dragulescu (1995), Dragulescu and Macalik (1997)

Ass: *Eleocharitetum palustris* (Ubrizsy 1948): Molnár et al. (1997), Penksza et al. (1999)

Order: Magnocaricetalia (Pignatti 1953)

Alliance: Magnocaricion elatae (Koch 1926)

Suballiance: Caricenion rostratae (Bal.-Tul. 1963, Oberd. et al. 1967)

Ass: *Caricetum elatae* (Koch 1926): Tuba (1995), Máthé (1933), Dragulescu and Macalik (1997), Szalma (2003)

Suballiance: Caricenion pseudocyperi (Borhidi 2001 suball. nov.)

Ass: *Carici pseudocyperi-Menyanthetum* (Soó 1955): Bodrogközy (1967), Dragulescu and Macalik (1997)

Suballiance: Caricenion gracilis (Neuhäusl 1959, Oberd. et al. 1967)

Ass: *Caricetum acutiformis* (Eggler 1933) Molnár (1996/a), Tuba (1995), Máthé, I.(1933), Dragulescu and Macalik (1997), Máthé (1936), Szalma (2003), Tallós and Tóth (1968)

Ass: *Galio palustris-Caricetum ripariae* (Bal.-Tul. Et al. 1993): Simon (1950)

Ass: *Caricetum gracilis* (Almquist 1929): Molnár (1996/a), Tuba (1995), Molnár et al. (1997), Bodrogközy (1967), Bodrogközy (1982), Bodrogközy (1962), Bodrogközy and Horváth (1977), Dragulescu and Macalik (1997), Deák (2001), Tóth et al. (1996), Kozma and Tölgyesi (1997)

Ass: *Caricetum vesicariae* (Br.-Bl. & Denis 1926): Dragulescu and Macalik (1997), Tallós and Tóth (1968)

Ass: *Caricetum distichae* (Steffen 1931): Molnár (1996/a)

Ass: *Caricetum vulpinae* (Soó 1927): Máthé (1933), Dragulescu and Macalik (1997)

Ass: *Caricetum melanostachyae* (Balázs 1943): Molnár et al. (1997), Deák (2001), Gallé (2002/b), Penksza et al. (1999)

Ass: *Carici gracilis-Phalaridetum* (Kovács & Máthé 1967, Soó 1971 corr. Borhidi 1996): Tuba (1995), Molnár et al. (1997), Bodrogközy (1982), Bodrogközy (1965), Bodrogközy and Horváth (1977), Tóth (1967), Kovács (1998)

Class: Scheuchzerio-Caricetea fuscae (R. Tx. 1937)

Order: Scheuchzerietalia palustris (Nordhagen 1937)

Alliance: Rhynchosporion albae (Koch 1926)

Ass: *Caricetum rostratea* (Osvald 1923 em. Dierssen 1982): Tuba (1995), Dragulescu (1997)

Class: Molinio-Arrhenatheretea (R. Tx. 1937)

Order: Molinietalia (Koch 1926)

Alliance: Deschampsion caespitosae (Horvatić 1931 em Soó 1941)

Ass: *Agrostio-Deschampsietum caespitosae* (Újvárosi 1947): Dragulescu and Macalik (1997)

Ass: *Carici vulpinae-Alopecuretum pratensis* (Máthé & Kovács M. 1967): Molnár (1996/a), Tuba (1995), Molnár et al. (1997), Bodrogközy (1982), Bodrogközy and Horváth (1974), Bodrogközy (1961), Bodrogközy (1962), Dragulescu and Macalik (1997), Máthé (1936), Deák (2001), Tóth (1967), Tóth et al. (1996), Kovács (1998), Kozma and Tölgyesi (1997)

Ass: *Agrostetum albae* (Újvárosi 1941): Dragulescu (1995), Dragulescu and Macalik (1997), Timár (1950/b), Máthé (1936), , Tóth (1967)

Ass: *Cirsio cani-Festucetum pratensis* (Májovsky & Ruzicková 1975): Margóczi (2000)

Order: Arrhenatheretalia (R. Tx. 1931)

Alliance: Arrhenatherion (Koch 1926)

Ass: *Pastinaco-Arrhenatheretum* (Knapp 1954, Passarge 1964): Molnár (1996/a), Bodrogközy (1984), Deák (2001), Tóth (1967)

Order: Potentillo-Polygonetalia (R. Tx. 1947)

Alliance: Potentillion anserinae (R. Tx. 1937)

Ass: *Lolietum perennis* (Gams 1927): Bodrogközy (1984), Dragulescu (1995), Tóth (1967)

Ass: *Lolio-Alopecuretum pratensis* (Bodrogközy 1962): Tuba (1995), Molnár et al. (1997), Bodrogközy (1982), Bodrogközy 1985), Bodrogközy (1962)

Ass: *Potentilletum anserinae* (Felföldy 1942): Tuba (1995), Molnár et al. (1997), Bodrogközy

(1985), Dragulescu and Macalik (1997), Szalma (2003)
Ass: *Ranunculetum repentis* (Knapp ex. Oberd. 1957): Molnár et al. (1997), Dragulescu and Macalik (1997), Penksza et al. (1999)
Ass: *Agropyro repentis-Rorippetum austriacae* (Timár 1947, R. Tx. 1950): Molnár et al. (1997), Bodrogközy (1985), Timár (1950/b)
Ass: *Ranunculo repentis-Alopecuretum geniculati* (R. Tx. 1937): Bodrogközy (1985), Bodrogközy (1962)
Ass: *Rumici crispi-Agrostietum stoloniferae* (Moor 1958) : Molnár et al. (1997)
Class: Thero-Suaedetea (Vicherek 1973 em. Borhidi 2003)
Order: Camphorosmo-Salicornietalia (Borhidi 1996)
Alliance: Salicornion prostratae (Soó 1933 corr. Borhidi 1996)
Ass: *Camphorosmetum annuae* (Rapaics ex. Soó 1933): Tallós and Tóth (1968), Máthé (1939)
Order: Crypsidetalia aculeatae (Vicherek 1973)
Alliance: Cypero-Spergularion salinae (Slavnic 1948)
Ass: *Heleochloëtum alopecuroidis* (Rapaics ex Ubrizsy 1948): Bodrogközy (1982)
Class: Festuco-Puccinellietea (Soó 1968 em. Borhidi 2003 hoc loco)
Order: Festuco-Puccinellietalia (Soó 1968)
Alliance: Puccinellion limosae (Soó 1933 em. Varga & V. Sipos ex Borhidi 2003 hoc locco)
Ass: *Puccinellietum limosae* (Magyar ex Soó 1933): Molnár et al. (1997), Máthé (1933), Dragulescu, C. (1995), Máthé (1939)
Ass: *Hordeetum hystricis* (Wendelbg. 1943): Dragulescu (1995)
Ass: *Bassietum sedoidis* (Ubrizsy 1948 corr. Soó 1964): Molnár et al. (1997)
Order: Artemisio-Festucetalia pseudovinae (Soó 1968)
Alliance: Festucion pseudovinae (Soó 1933)
Ass: *Achilleo setaceae-Festucetum pseudovinae* (Soó (1933) 1947 corr. Borhidi 1996): Molnár (1996/a), Molnár et al. (1997), Bodrogközy (1962), Máthé (1933), Máthé (1936), Dragulescu (1995), Gallé (2002/b), Tóth (1967), Tallós and Tóth (1968), Máthé (1939), Penksza and Gubcsó (1998)
Ass: *Artemisio santonici-Festucetum pseudovinae* (Soó in Máthé 1933 corr. Borhidi 1996): Molnár et al. (1997), Bodrogközy (1961), Máthé (1936), Dragulescu, C. (1995), Tallós and Tóth (1968), Máthé (1939), Penksza and Gubcsó (1998)
Alliance: Peucedano officinalis-Asterion sedifolii (Borhidi 1996)
Ass: *Peucedano-Asteretum sedifolii* (Soó 1947 corr. Borhidi 1996): Molnár (1996/a), Bodrogközy and Horváth (1974), Máthé (1933), Máthé (1936), Tallós and Tóth (1968), Margóczi et al. (2002), Penksza and Gubcsó (1998)
Class: Scorzonero-Juncetea gerardii (Vicherek 1973, Golub et al. 2001)
Order: Scorzonero-Juncetalia gerardii (Vicherek 1973)
Alliance: Beckmannion eruciformis (Soó 1933)
Ass: *Agrostio stoloniferae-Glycerietum pedicellatae* (Magyar ex Soó 1933 corr. Borhidi 2003): Penksza et al. (1999)
Ass: *Agrostio stoloniferae-Alopecuretum pratensis* (Soó 1933 corr. Borhidi 2003): Molnár (1996/a), Molnár et al. (1997), Bodrogközy and Horváth (1977), Máthé (1933), Bodrogközy (1966), Gallé (2002/b), Tallós and Tóth (1968), Penksza and Gubcsó (1998)
Ass: *Agrostio stoloniferae-Beckmannietum eruciformis* (Rapaics ex Soó 1930): Máthé (1933), Dragulescu and Macalik (1997), Dragulescu (1995), Máthé (1939)
Ass: *Rorippo kerneri-Ranunculetum lateriflori* (Soó 1947, Borhidi 1996): Penksza et al. (1999)
Class: Festuco-Brometea (Br.-Bl. et R. Tx. ex Klika et Hadaĉ 1944)
Order: Festucetalia valesiacae (Br.-Bl. & R. Tx. ex Br.-Bl. 1949)
Alliance: Festucion rupicolae (Soó corr. 1964)
Ass: *Salvio nemorosae-Festucetum rupicolae* (Zólyomi ex Soó 1964): Molnár (1996/a), Molnár et al. (1997), Bodrogközy (1984), Tóth (1967)
Class: Bidentetea tripartiti (R. Tx. & al. in R. Tx. 1950)
Order: Bidentetalia tripartiti (Br.-Bl. & R. Tx. ex Klika & Hadač 1944)
Alliance: Bidention tripartiti (Nordhagen 1940 em. R. Tx. in Poli & J. Tx. 1960)
Ass: *Bidenti-Polygonetum hydropiperis* (Lohm. In R. Tx. 1950): Molnár et al. (1997), Dragulescu and Macalik (1997)
Ass: *Polygono lapathifolii-Bidentetum* (Klika 1935): Molnár et al. (1997), Deák (2001), Tóth (1967)
Ass: *Xanthio strumarii-Chenopodietum* (I. Pop 1968): Molnár et al. (1997), Dragulescu (1995)
Ass: *Rorippo sylvestris-Xanthietum strumarii* (Timár 1950): Timár (1950/b)

Ass: *Atriplici prostratae-Xanthietum italici* (Timár 1950, Borhidi 2003 ass. nova hoc loco): Timár (1950/a)
Ass: *Chenopodio polyspermi-Atriplicetum sagittatae* (Timár 1950): Timár (1950/a)
Alliance: Chenopodion rubri (Soó 1969)
Ass: *Echinochloo-Polygonetum lapathifolii* (Soó & Csűrös 1947): Molnár et al. (1997), Bodrogközy (1982), Dragulescu and Macalik (1997), Timár (1950/a), Timár (1950/b), Dragulescu (1995), Deák (2001)
Ass: *Chenopodio rubri-Heleochloetum alopecuroidis* (Timár 1950): Timár (1950/b)
Ass: *Chenopodietum rubri* (Timár 1947): Molnár et al. (1997), Timár, L. (1950/b)
Class: Galio-Urticetea (Passarge ex Kopeckỳ 1969)
Order: Convolvuletalia sepium (R. Tx. 1950)
Alliance: Senecion fluviatilis (R. Tx. 1950)
Ass: *Bidenti-Calystegietum* (Felföldy 1943): Bodrogközy (1982)
Ass: *Glycyrrhizetum echinatae* (Slavnic 1951): Dragulescu (1995), Dragulescu and Macalik (1997), Tóth (1967)
Class: Salicetea purpureae (Moor 1958)
Order: Salicetalia purpureae (Moor 1958)
Alliance: Salicion triandrae (T. Müller & Görs 1958)
Ass: *Polygono hydropiperi-Salicetum triandrae* (Kevey in Borhidi & Kevey 1996): Tuba (1995), Timár (1950/a), Timár (1950/b), Dragulescu (1995), Deák (2001), Tóth (1967), Simon (1957)
Alliance: Salicion albae (Soó 1930 em. T. Müller & Görs)
Ass*: Carduo crispi-Populetum nigrae* (Kevey in Borhidi & Kevey 1996): Timár (1950/b)
Ass: *Salicetum albae-fragilis (Soó 1957)*: Molnár (1996/a), Tuba (1995), Molnár et al. (1997), Máthé (1933), Dragulescu (1995), Dragulescu and Macalik (1997), Deák (2001), Szalma (2003), Gallé (2002/a), Gallé (2002/b), Tóth (1967), Margóczi et al. (2002), Horváth and Margóczi (1979), Kozma and Tölgyesi (1997), Penksza et al. (2001), Simon (1957)
Class: Alnetea glutinosae (Br.-Bl. & Tx. ex Westhoff et al. 1946)
Order: Alnetalia glutinosae (Tx. 1937)
Alliance: Alnion glutinosae (Malcuit 1929)
Ass: *Carici elongatae-Alnetum* (Koch 1926): Simon (1957)
Ass: *Fraxino pannonicae-Alnetum* (Soó & Járai-Komlódi in Járai-Komlódi 1958): Simon (1950), Bancsó (1987)
Alliance: Salicion cinereae (T. Müller & Görs ex Passarge 1961)
Ass: *Calamagrosti-Salicetum cinereae* (Soó et Zólyomi in Soó 1955): Tuba (1995), Dragulescu and Macalik (1997), Simon (1957)
Class: Querco-Fagatea (Br.-Bl. & Vlieger in Vlieger 1937 em. Borhidi 1996)
Order: Fagetalia sylvaticae (Pawlowski in Pawl. Et al. 1928)
Alliance: Alnion incanae (Pawlowski in Pawlowski & Wallisch 1928)
Ass: *Aegopodio-Alnetum* (V. Kárpáti , I. Kárpáti & Jurko 1961): Dragulescu and Macalik (1997)
Ass: *Fraxino pannonicae-Ulmetum* (Soó in Aszód 1935 corr. 1963): Tuba (1995), Molnár (1996/a), Molnár (1996/b), Máthé (1933), Dragulescu (1995), Dragulescu and Macalik (1997), Máthé (1936), Simon (1950), Simon (1957), Deák (2001), Gallé (2002/b), Bancsó (1987), Tóth (1967), Kevey (1998), Ujvárosi (1941), Margóczi et al. (2002), Horváth and Margóczi (1979), Penksza and Gubcsó (1998), Penksza et al. (2001)
Alliance: Carpinion betuli (Issler 1931)
Ass: *Circaeo-Carpinetum* (Borhidi nomen novum 2003 hoc loco): Simon (1950), Simon (1957)
Ass: *Carici pilosae-Carpinetum* (Neuhäusl & Neuhäuslová-Novotná 1964 em. Borhidi 1996): Tuba (1995)
Class: Quercetea pubescentis (Doing 1955, Scamoni & Passarge 1959)
Order: Quercetalia cerris (Borhidi 1996)
Alliance: Acer tatarici-Quercion (Zólyomi & Jakucs 1957)
Ass: *Galatello-Quercetum roboris* (Zólyomi & Tallós 1967): Máthé (1933), Máthé (1936), Gallé (2002/b), Tallós and Tóth (1968), Máthé (1939)
Class: Epilobietea angustifolii (R. Tx. & Prsg. In R. Tx. 1950)
Order: Atropetalia (Vlieger 1937)
Alliance: Sambuco-Salicion capreae (R. Tx. & Neumann in R. Tx. 1950)
Ass: *Astero-Rubietum caesii* (I. Kárpáti 1962): Tóth (1967)

References

Bancsó, S. (1987): Cönológiai vizsgálatok Tőserdő három erdőtársulásában, különös tekintettel az aljnövényzetre. (Coenological investigations in three forest associations at Tőserdő with especial regard to the underwood) - Thesis, JATE Növénytani Tanszék, Szeged.

Bodrogközy, Gy. (1961): Ökologische Untersuchungen der Mahwiesen und Weiden der Mittel-Theiss (Das Leben der Tisza, XIII). - Phyton 9 (3-4),196-216.
Bodrogközy, Gy. (1962): Die Vegetation des Theiss-Wellenraumes.I. Zönologische und Ökologische untersuchungen in der Gegend von Tokaj (Das Leben der Tisza. XVIII.) Acta Biol. Szeged. 8, 3-44.
Bodrogközy, Gy. (1965): Die Vegetation des Theiss-Wellenraumes II. Vegetationsanalyse und Standortökologie der Wasser- und Sumpfpflanzenzönosen im Raum von Tiszafüred. - Tiscia (Szeged) 1, 5-31.
Bodrogközy, Gy: (1966): Die vegetation des Theiss-wellemraumes III. Auf der Schutzdammstrecke zu Szeged durchgeführten fitozönologischen analysen und Ihre Praktische bewerung. - Tiscia (Szeged) 2, 47-66.
Bodrogközy, Gy. (1967): Vegetation of the Tisza inundation area IV. Examination results of the Magnocaricion associations from the area of Alpár, Tiscia (Szeged) 3, 27-39.
Bodrogközy, Gy. (1982): Ten-year changes in community structure, soil and hydroecological conditions of the vegetation in the protection area at Mártély (S. Hungary). – Tiscia (Szeged) 17, 89-130.
Bodrogközy, Gy. (1984): Hydroecology of the grass-associations found at the dams along the Upper-Tisza. - Tiscia (Szeged) 19, 89-111.
Bodrogközy, Gy. (1985): Hydroecology of the plant communities at the middle Tisza-valley I. Agropyro-Rumicion. - Tiscia (Szeged) 20, 55-97.
Bodrogközy, Gy., Horváth, I. (1974): Study of the indicator role of plant populations of marsh- meadows along the Tisza in the water-household of the environment in the district of Kisköre. – Tiscia (Szeged) 9, 43-51.
Bodrogközy, Gy., Horváth, I.(1977): Connection between stand pattern and the organic-matter production in the marshlands of the inundation area at Körtvélyes. - Tiscia (Szeged) 12, 65-70.
Borhidi, A., Sánta, A. (1999): Vörös könyv Magyarország növénytársulásairól (Reed book of the Hungarian plant communities). - Természet Búvár Alapítvány Kiadó, Budapest.
Borhidi, A. (2003): Magyarország növénytársulásai. (Plant associations in Hungary) - Akadémiai Kiadó, Budapest.
Deák, J, Á. (2001): Élőhelytérképezés és vegetációértékelés a Köröszugban. (Habitat mapping and vegetation assessment at the Köröszug) - szakdologzat, SZTE - Ökológiai Tanszék, Szeged.
Dragulescu, C. (1995): The flora and vegetation of the Mures (Maros) valley - In: Tiscia monograph series, A study of the geography, hydrobiology and ecology of the river and its environment. Szolnok-Szeged, p:47-111
Dragulescu, C., Macalik, K. (1997): The aquatic and paludal flora and vegetation from the Cris/Körös valleys. -In: Tiscia monograph series:The Cris"/Körös River" Valleys, 47-80.
Gallé, L. et al. (2004): Vásárhelyi Terv Továbbfejlesztése 2004. évi ökológiai térképezési munkák - részletes vizsgálatok a Szolnok-országhatár szakaszon. (Ecological mapping works for the Improvement of the Vásárhelyi-Plan in 2004 – detailed examination from Szolnok to the national boundary) - SZTE Ökológiai Tanszék, Szeged.
Horváth, I., Margóczi, K. (1979): Region reconstruction of the Tisza dead-arm at Lakitelek on the basis of the ecological investigations performed is Tőserdő. - Tiscia (Szeged) 14, 89-104.
Kevey, B. (1998): A Fekete- és Fehér-Körös menti keményfás ligeterdők cönológiai értékelése. (Coenological description of the hardwood gallery forests along the Fekete- and Fehér-Körös) - In: Molnár, Zs. (szerk): A Fekete- és Fehér-Körös menti keményfás ligeterdők történeti, erdészeti és botanikai értékelése, jövőbeni kezelésének új koncepciója, Kutatási jelentés, Vácrátót.
Kovács, É., Gallé, L., Dombos, M., Györffy, Gy., Hornung, E., Körmöczi, L., Margóczi, K and Rudner, J. (1998): Ecological state assessment in Mártély Landscape-protection Area. Tiscia 31:107-109.
Kozma, A., Tölgyesi, Gy. (1997): Plant associacions of flood plains along the Middle-Tisza and their agricultural utilization. - Tiscia (Szeged) 14, 105-122.
Margóczi, K. (2000): A Maros alsó szakaszán vizsgált élőhelyek botanikai adatai. (Botanical data of some habitats examine on the lower section of the Maros) – In: Gallé, L. (szerk): A Tisza-völgy természetes és antropogén zavarásának ökológiai hatásai. – (Ecological influence of the natural and antropological disturbations in the Tisza basin) - előrehaladási jelentés, SZTE Ökológiai tanszék, Szeged.
Margóczi, K. (2002/a): Emberi használat és kezelés hatása a Tisza-menti életközösségekre. (Antropological land-use and treatment influence the community structure in Tisza basin.)– In: Gallé, L. (szerk): A Tisza-völgy természetes és antropogén zavarásának ökológiai hatásai. (Ecological influences of the natural and antropological disturbations in the Tisza basin) - zárójelentés, SZTE Ökológiai tanszék, Szeged.
Margóczi, K. (2002/b): Élőhely- és növénytársulási komplexek feltárása és potenciális folyosó szerepe a Tisza és mellékfolyói mentén. (Revelation and corridor function of some biotop- and coenological complexes along the Tisza and its tributaries.) - In: Gallé, L. (szerk): Élőhely-folyosók kutatása a Tisza és mellékfolyói mentén. (Research of the ecological corridors along the Tisza and its tributaries) - zárójelentés, SZTE Ökológiai tanszék, Szeged.
Margóczi, K., Dragulescu, C.,Macalik, K.,Makra, O. (2002): Vegetation description of representative habitat complexes along the Maros (Mures) river. - In: Tiscia monograph series 6 - Ecological aspects of the Tisa River Basin, pp: 45-50
Máthé, I. (1933): A hortobágyi Ohat erdő vegetációja. (Vegetation of the Ohat forest of Hortobágy) - Bot. Közlem. 30, 163-184.
Máthé, I. (1936): Növényszociológiai tanulmányok a körösvidéki liget- és szikes erdőkben. (Fitosociological study in the gallery- and sodic- forest on Körös region) - Acta Geobot. Hung. 1, 150-166.
Máthé, I. (1939): A hencidai "Cserje-erdő" vegetációja. (The vegatation of “Cserje-erdő” in Hencida) - Botanikai közlemények 36, 120-129.
Molnár, Zs. (1996/a): Ártéri vegetáció Tiszadob és Kesznyéten környékén I. Tájtörténeti,florisztikai és cönológiai értékelés. (Flood plain vegetation at Tiszadob and Kesznyéten (Middle-Tisza valley): floristical and plant sociological survey) - Bot. Közlem. 83, 39-50.
Molnár, Zs. (1996/b): Ártéri vegetáció Tiszadob és Kesznyéten környékén II. A keményfaliget-erdők (Fraxino pannonicae-Ulmetum) története és mai állapota.. (Flood plain vegetation at Tiszadob and Kesznyéten (Middle-Tisza valley) II. History and present state of the hardwood floodplain woodlands (Fraxino pannonicae-Ulmetum)). Bot. Közlem. 83, 51-69.
Molnár, Zs., Bagi, I., Kertész., É. (1997): Vegetation and flora of the Hármas-Körös river (Hungary) with some historical remarks - In: Tiscia monograph series:The Cris"/Körös River" Valleys, 81-102.
Penksza, K., Gubcsó, G. (1998): Adatok a Vésztő-Mágor természetvédelmi terület és környékének flórájához és vegetációjához. (Data to the flora and vegetation of the

Vésztő-Mágor nature conservation area and its environment) - Kutatási jelentés, KMNP, Szarvas.
Penksza, K.., Engloner, A., Asztalos, J., Gubcsó, G. and Szegedi, E.. (1999): Adatok a Körös menti "szentély" jellegű holtmedrek flórájához és vegetációjához. - Crisicum 2. pp. 51-65.
Penksza, K., Herczeg, E., Gubcsó, G., Joó, K., Barczi, A., Nemes, B and Pintér, B. (2001): A KMNP Mágor-pusztai és Maros-ártéri területi egységeinek állapotfelvétele. (State assessment of Mágor puszta and Maros floodplain in the Körös-Maros National Park) - Kutatási jelentés, KMNP, Szarvas.
Simon, T. (1950): Montán elemek az Észak-Alföld flórájában és növénytakarójában. (Montan elements at the flora and vegetation of the North-Alföld) - Separatum ex: " Annales Biologicae Universitatis Debreceniensis" I.
Simon, T. (1957): Az Északi Alföld erdői (Die Wälder des nördlichen Alföld). – Akadémiai Kiadó, Budapest.
Soó, R. (1964): A magyar flóra és vegetáció rendszertani-növényföldrajzi kézikönyve I. (Synopsis systematico-geobotanica florae vegetationisque Hungariae I.) - Akadémiai Kiadó, Budapest
Szalma, E. (2003): Vízinövények életformája és élőhelyek szerinti csoportosítása. – Doktori értekezés, Debrecen.
Tallós, P., Tóth, B. (1968): Az Újszentmargitai sziki reliktum erdő termőhelyi adottságai, növénytársulásai és kapcsolatuk a fatermesztési lehetőségekkel. (Site condition and plant associations of the relict forest at Újszentmargita on alkali soil and their connections with sylviculture) - Kísérletügyi Közl. 59D, 75-110.
Timár, L. (1950/a): A Marosmeder növényzete. (Vegetation of the Maros riverbed)- Ann. Biol. Univ. Szeged 1, 117-136.
Timár, L. (1950/b): A Tiszameder növényzete Szolnok és Szeged között. (Vegetation of the Tisza riverbed between Szolnok and Szeged) - Separatum ex: "Annales Biologicae Universitatis Debreceniensis" I. (1950), Debrecen.
Timár, L. (1954): A Tisza hullámterének növényzete Szolnok és Szeged között. I. Vízi növényzet (Potametea Br.-Bl. et Tx.). (Vegetation of the Tisza floodplain between Szolnok and Szeged I. Aquatic vegetation (Potametea Br.-Bl. et Tx.) - Bot. Közlem. 44, 85-98.
Tóth, M. (1967): A Maros hullámterének fitocönológiai jellemzése. (Phytocoenological description of the Maros floodplain) - Doktori értekezés, SZTE Növénytani tanszék, Szeged.
Tóth, T., Molnár, Zs., Bíró, M.,Forgách, B. (1996): A Körös-völgyi természetvédelmi terület tájtörténeti, zoológiai és botanikai felmérése és értékelése. (Historical, zoological and botanical survey on the nature conservation area of Körös valley) - Kutatási jelentés, KMNP, Szarvas.
Tuba, Z. (1995): Overview of the flora and vegetation of the hungarian Bodrogköz. - Tiscia 29, 11-17.
Ujvárosi, M. (1941): A Sajóládi-erdő vegetációja. (The vegetation of Sajólád-forest) - Acta Geobot. Hung. 4, 109-118

TISCIA 35, 17-26

MALACOFAUNISTICAL AND ECOLOGICAL DATA FROM THE TROAŞ VALLEY

T. Domokos and K. Váncsa

Domokos, T. and Váncsa, K. (2005): Malacofaunistical and ecological data from the Troaş valley. – *Tiscia 35, 17-26*

Abstract. Detailed studies on the malacofauna of the Mureş River valley were initiated in the summer of 2000. Till 2002 14 sites were sampled on the flood-plain of the Mureş and in the adjacent territories. However, complex ecological statements require the knowledge of the whole malacofauna of the Mureş drainage area. As a first step data were gathered from the valleys of the Troaş and Dumbroviţa streams. These sites, when compared to the other sites sampled so far, yielded numerous precious taxa which are under protection in the neighboring countries.
Thus the publication of these data is especially important, because no surveys on the malacofauna of this region have been carried out so far. Even professor Grossu in his grand comprehensive work Gastropoda Romaniae does not mention the malacofauna of the Zărand Mountains.
The topographical and hydrological conditions of the sampling sites, in total 10, are depicted on 4 figures. The list of species found is published in 4 tables.
In the 9th site of the Troaş valley, sampling was carried out along a transect, so the different habitats and species identified are depicted on separate figures. The differences between the ecological groups present in the biotopes are visualized via bar-charts.
Finally, data of these transect were compared with the data of another transect with the same character, took of in the verge of the Sălciva village on the Zam-Pass in 2001.

Keywords: Mollusk fauna, Troaş valley, malacofaunistical transect, Carpathian species.

T. Domokos, Munkácsy Mihály Museum, H-5600 Békéscsaba, Széchenyi u. 9.; domokos@bmmi.hu; **K. Váncsa**, H-5600 Békéscsaba, Wlassich u. 11., 4/10. ; kaeszka@freemail.hu

Introduction

From the summer of 2000 we took part in a research organized by the Universities of Szeged and Cluj-Napoca, which surveyed the Mureş River valley as an ecological corridor. In the course of the research 14 sites were sampled between 2000 and 2002, going through the Mureş River valley, to get a general picture of the malacofauna of the valley, which had not been studied previously on this scale.

Due to the shortage of time and funding, the survey was restricted only to an initial step implemented at a larger scale (Váncsa 2002; Domokos *et al*. 2002, Váncsa and Domokos 2003).

Data was collected in the Dumroviţa stream valley (near Groşii Noii village) in the summer of 2001, followed by sampling in the Troaş stream valley during the summer of 2002 (Fig.1). The fieldwork was made possible by a natural science class of the Museum of Arad (Complexul Muzeal Arad).

At the reach of Mureş between Deva and Radna, the Zărand Mountain's short reach but high rushing rivers formed the drainage basin of the Almaş and the Bîrzava. These relatively narrow, high-gradient streams are usually seasonal with relatively low water outputs from precipitation and springs (Andó 1995, Sárkány-Kiss *et al*. 1997).

The streams of the Troaş valley (17 km long valley) and Dumbroviţa valley (approximately 15 km long valley), subjected to surveying, belong to this basin, and they largely contribute to the growing ecological value of the Mureş valley. At a larger scale, together with the Mures river, they belong to the drainage area of the Tisa.

The Dumbrovița valley is situated west of the Troaş valley, its stream charging into the Mureş near Căpruța 25 km below Săvîrşin. Here the sampling took place in a forest reservation (Rezervația Naturală de tip forestier silvic Bîrzava) situated north of the village Groşii Noii.

The Troaş valley, surveyed at length in 2002, is on the SE side of the Zărand Mountains. The valley's waterflows start from a height of 800 m ASL and the Troaş stream gathering them goes to a height of 150 m ASL on the Lipova Plain, where it charges into the Mureş river under Săvîrşin. It gathers several minor permanent and seasonal streams like: Tisa, Galşa, Pietros and Cătălinii. In conformity with the valley character, we tried to collect samples from different stream valleys (Fig. 1).

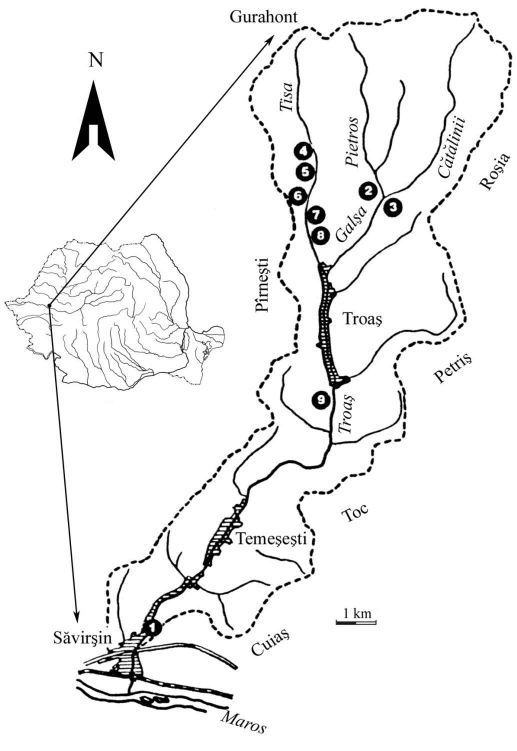

Fig. 1. The sampling sites in the Troaş ecohydrological system (Romania).

According goal was to compare data of these valleys with data coming from the previous surveys implemented at the reach of the Mureş river above Săvîrşin in 2000, in order to see what kind of species derive from the Troaş and Dumbrovița valleys contributing to the enrichment of the malacofauna of the Mureş valley. Furthermore, the actual function rate of the ecological corridor along the 17 km length of the Troaş valley was also evaluated comparing data from nine sites. At sites where the quadrate sampling method was applied the deriving data was investigated cenologically as well.

In the summer of 2000, Gyurkovics and Szekeres were sampling in the forest near Slatina stream close to the nearest Julița village. This territory belongs to the drainage basin of the Almaş and the Bîrzava too. They collected only species belonging to the family Clausilidae, but to complete the malacofaunistical data of the Zărand Mountains they give us the following list of the collected species: *Balea stabilis* (Pfeiffer 1847) 7 pc.; *Balea biplicata* (Montagu 1803) 5 pc.; *Bulgarica vetusta* (Rossmäsler 1836) 1 pc.; *Cochlodina laminata* (Montagu 1803) 3 pc.; *Laciniaria plicata* (Draparnaud, 1805) 3 pc.; *Ruthenica filograna* (Rossmäsler, 1836) 12 pc. We owe thanks for their favour.

Description of the sampling sites

The *Alnus-Carpinus-Fraxinus* zone on the right banks of the Troaş stream. This biotope can be found under a steep granite slope before a big curve, close to the Mihai King's castle fence in Săvîrşin. Between the castle fence and the stream is a forest road boarded with iron barrier. On the shrub level there were: *Crataegus*, *Cornus* and *Corylus*; and herb-likes: *Salvia*, *Telekia*, *Galium*, *Rubus*, *Urtica*, *Cirsium*.

The right banks of the Pietroasa stream with *Alnus*, before it fuses with the Cătălinii stream. The float debris (2 dm^3) collected near the bridge is composed of basalt splinters, *Fagus*, *Carpinus* and *Corylus* yields. Supposedly the float debris comes from the drainage area under Gurahont.

A sunny and nettled place between the left bank of the Cătălinii stream and a forest-path, before the bridge of Galşa stream.

A squelchy place with bract, covered by herb-likes (*Asarum*, *Pteropsida*, *Salvia*, *Telekia*, *Urtica*), between a forest-path in the right banks of the Tisza stream and the foot of the mountain with beeches.

The 3-4 m high mossy cliff formed under the construction of the forest-path which goes in the Tisza valley; near of the sign 35 hm. (The cliff probably has magma origin, possibly basalt.)

Sunny grass-spot near the bridge of the stream which goes into the Tisa. We found two water snails on that little stream too.

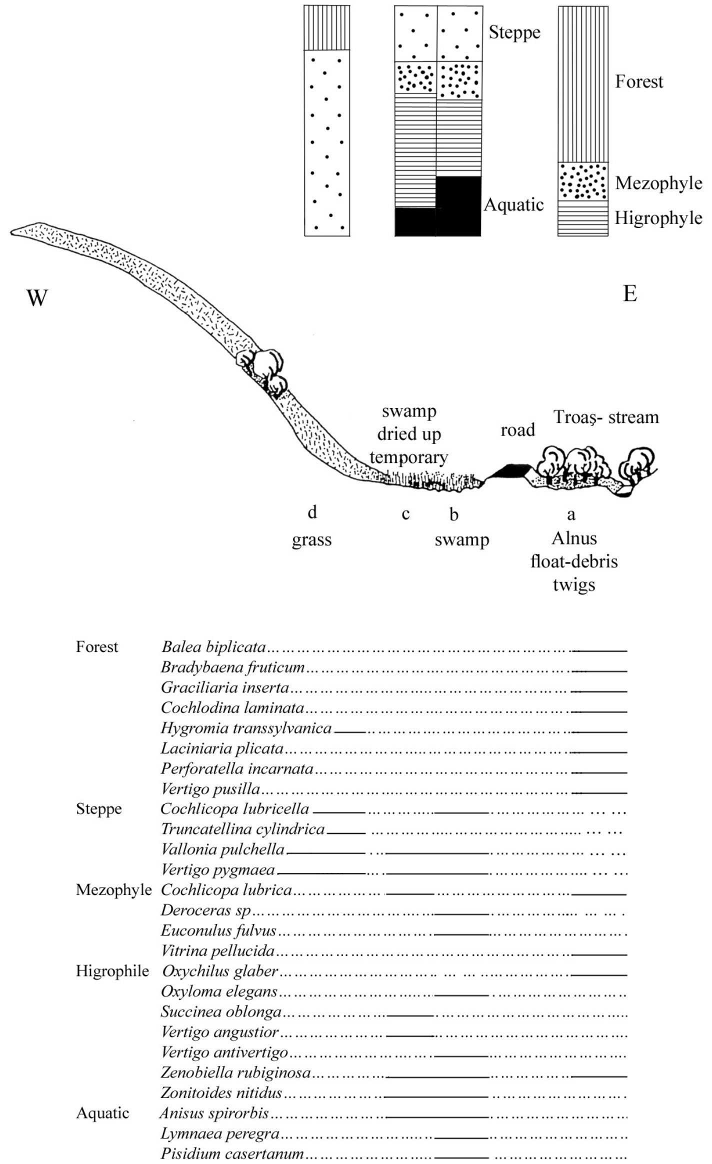

Fig. 2. The W-E oriented malacofaunistical transect and the band-diagrams of the Ložek's ecological species groups on the Troaş Valley (Fig. 1, sampling No. 9). The species groups are fused by authors.

Steep slope with stones near the forest-path on the left bank of the Tisa, and south of the sign of 20 hm.

A forest spot with *Alnus* on the two sides of Tisa stream, near the sign of 20 hm of the forest-path.

A four-biotope collecting transect, a few hundred meters south of the village of Troaş. The biotopes:

-the right bank of the Troaş stream with *Alnus*, east of the high road; in this biotope the soil was covered by alluvia, twigs and stumps

-a sunny and moist swamp with *Orchis*, on the west side of the high road

-a part of the swamp dried up during the summer

-mowed and at times burned grass (with *Crepis*, *Filipendula*, *Fragaria*, *Thymus*) on the steep slope west of the swamp with *Orchis*; on the grass were some bushes and above was bordered with forest.

Methods of collection and data processing

Because of the shortage of time and weather difficulties the sampling was carried out using different methods:

-via singling at the 1st, 3rd, 4th, 5th, 6th, 7th, 8th, 9a and 9b sampling sites (Figs 1. and 2.)

-via mass collection from the float-debris, at the 2nd sampling site

-via quadrate sampling (4 pc. 1/16 m^2) at the 9c and 9d sampling sites (Fig. 2.)

Two singling method have been systematically applied: the spread singling method, and the combined method of singling and quadrate sampling along the transect.

From the samples took with the quadrate method, the entities were sort out with a magnifier.

The following bibliography helped us in the determination of the species: Bába and Kovács (1975); Damjanov AND Likharev (1975); Domokos (1995); Grossu (1955, 1981, 1983, 1987); Kerney *et al*. (1983); Kiss (1981); Kiss and Pintér (1985); Ložek (1964); Pelbárt (2000); Pintér (1984); Pintér and Varga (1981); Richnovszky and Pintér (1979); Soós (1943).

The collected and processed malacological material is published in the Tables 1., 2., 3. and 4. From those tables it is possible to read the number of species and the number of entities by sampling sites, and in the case of quadrate samples the abundance (pc/m^2).

Because in the case of the 9th site, sampling was made all over a transect the results are represented in a complex figure (Fig. 2.). In the figure the found species are indicated by a continuous line under each biotope. The found species have been ranked into ecological groups (Ložek 1964). The percentage of the species groups in a biotope is illustrated by the band-diagrams over the transect's sketch.

Results and discussion

Before all, we have to clear up that in our work we confine only to the publication of data. As long as we have little data available, we can't undertake to make serious analysis and comparisons. On the other hand, we think that the publication of collected and processed data and deducting preconclusions is real, because as we know in the Zărand Mountains nobody had done this kind of work before. So we take the first steps in malacological exploration of this area with the slogan: Somewhere it has to start.

First we set off the endemic and quasi-endemic species of this area because they increase the ecological value of the territory. The species with thin spread area are: *Argna* (*Agardhia*) *parreyssi*, *Graciliaria inserta, Helicigona banatica*. Between them the *Argna parreyssi* and *Helicigona banatica* occur only in Transylvania and in the Praecarpathicum area (Deli 1997), while the habitat of the *Graciliaria inserta* is in the Banat Mountains, in Retezat Mountains, in some places in the Metaliferi Mountains and in the valley of Temeş, Jiu and Sebeş. We have to mention also the Carpathian endemic species with biggest habitats like: *Balea stabilis, Campylea faustina, Hygromia transsylvanica, Perforatella dibothryon* and *Spelaeodiscus triaria* (Bába 1982, Grossu 1955, 1981, 1983, 1987, Ložek 1964).

Professor Lajos Soós told about *Argna* and *Orcula* that they are "notable endemic species" (Soós 1943). Soós wrote about the *Argna*, just like Grossu did on the *Orcula* that they both like limestone. This is surprising because we find them on granite stone. The northernmost boundary of the spread area of *Argna* according to Soós is the south-west corner of Transylvania. Later sources (Pintér *et al.* 1979) mention *Argna parreyssi* from Tiszatelek and Szeged too (both from float-debris), where it comes probably with the hydrochor expansion of the ecological corridor of the Tisza and Mureş Rivers (Deli 1997). We can't exclude the possibility that the specimens found in the alluvia in Szeged comes from the Troaş valley. We know from our experience that *Orcula jetschini* exist in the Bihar Mountains too.

One of the most interesting species found in the Troaş valley is the *Graciliaria inserta*. Its occurrence in the Zărand Mountains is a new literature data, because nobody had described it before from this place (2003, Szekeres pers. comm.).

After the literature data and the scientists opinion, it is a surprising fact that the two *Bulgarica* species *Bulgarica cana* and *Bulgarica vetusta* occur together in a relatively little area. After the ecological claim of this two species they can't be found usually in the same territory (2003, Szekeres pers. comm.).

At the 1st sampling site *Hygromia transsylvanica* making copulation was observed, possibly because of the rainy weather. On this place the *Helix lutescens* were darker than specimens from the Great Plains. Here we found as we know the biggest *Helicigona banatica* which was 35.6 mm wide and 17.7 mm high, besides it was a living specimen! This specimen is the biggest piece of the *Helicigona* collection of the Munkácsy Mihály Museum. On the basis of this short survey it seems that larger and more conical specimens dwell in the Troaş valley lives than in the Bihar Mountains.

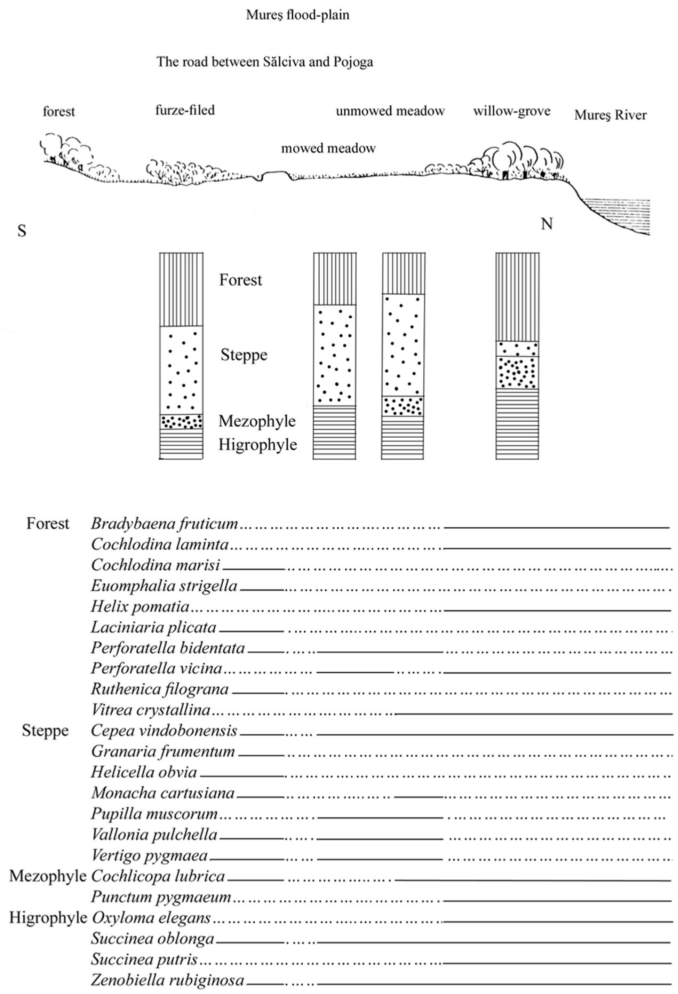

Fig. 3. The N-S oriented malacofaunistical transect on the Mureş River flood-plain, and species found here (07-12. 08. 2001).

At the 2nd sampling site we found the most interesting species from the Troaş valley in float-debris. Because they were in alluvia it would be worthy to find out where each species have their habitats.

At the 5th sampling site we also had to work in rainy conditions and thanks to that we managed to observe the feeding of *Clausilia pumila* on the mossy cliff.

The water species we found at the 6th sampling site were *Ancylus fluviatilis* and *Lymnea peregra* in the little stream which flows into Tisa stream. Sárkány-Kiss, A. published in 1995 his *Ancylus fluviatilis* data concerning the Mureş River (Sárkány-Kiss 1995). The lower points where he found this species were near Răstoliţa, 105 rkm from the spring of the Mureş. Lower in the 600 km polluted reaches of Mureş River this species can not adapt to the conditions. On those territories the *Ancylus* lives on the highest reaches of streams which flow into Mureş.

During the research on the Mureş valley (in 2000) the nearest sampling site to the Troaş valley's 9th site was in the Zam-Pass on the verge of Sălciva village. In both places we took samples from 4 different biotopes along a transect. Since we draw the similar sketches about the sampling places and similar figure about the results, we think that via comparing the figures the registration of differences and causalities is feasible (Fig. 4).

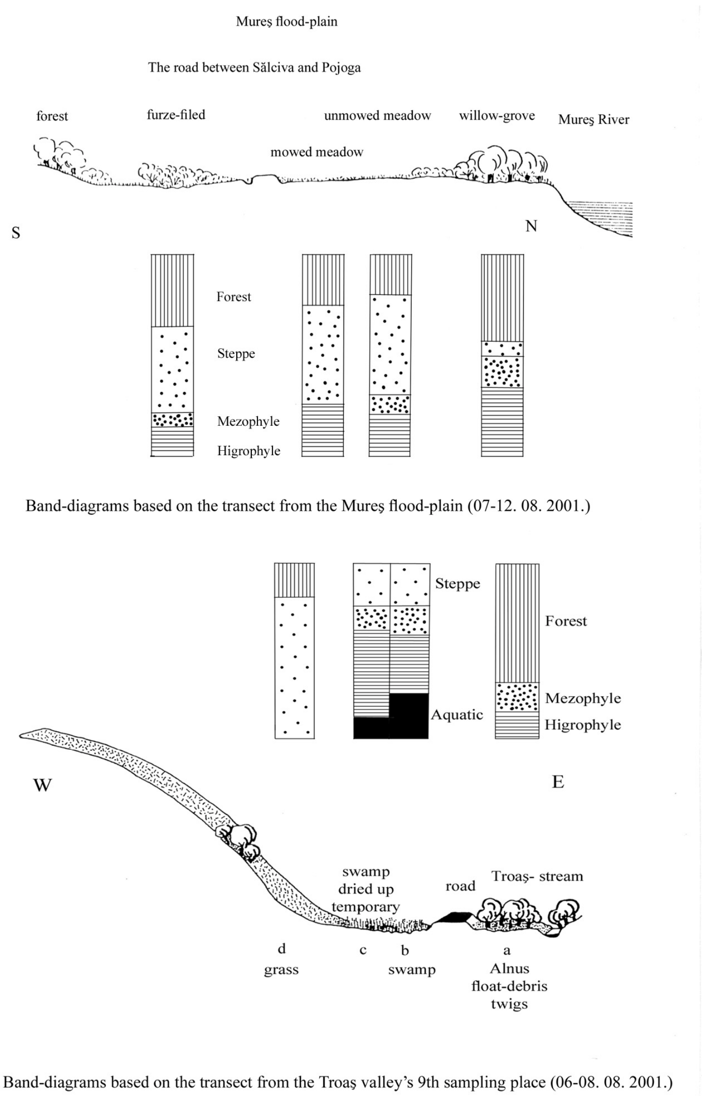

Fig. 4. Comparison of the two sampling place's band diagrams to register the malacofaunistical differences and causalities of the two transects.

The transect from the flood-plain of the Mureş was more extensive (approximately 300 m long) and was situated at a lower elevation than the 9th sampling site from the Troaş valley (Fig. 3). The transect took in the Mureş flood-plain is made up of the following botanical areas:

-50 m wide grove wood, situated on the bank which is rich in plant species (a jungle like *Salicetum albae-fragilis*);

-beyond the grove extends cultivated lands like mowed meadow on the right side of the transect;

- the left side of the transect is the same but with unmowed meadows;

-and finally beyond the road, which connects the villages Sălciva and Pojoga, is a furze-field with mixed botanical domain.

The furze-field closes the transect but it is important to mention that beyond it there are grasslands again and finally the flood-plain is closed by the mountain slope covered by forests made up of alder and beech trees (Váncsa 2002; Domokos *et al.* 2002). So we can see that the two transects are made up of the same habitats and the order of habitats is not radically different too.

Table 1. Malacological material collected via singling in the Troaş valley (06-08. 06. 2002.)

Mollusc species found in the Toraş valley	Sampling sites								
	1.	2.	3.	4.	5.	6.	7.	8.	9.
Achantinula aculeata (O.F. MÜLLER, 1774)	-	11	-	-	-	-	-	-	-
Aegopinella minor (STABILE, 1864)	2	22	-	2	-	-	-	4	-
Acicula banatica (ROSSMÄSLER, 1842)	-	6	-	-	-	-	-	-	-
Ancylus fluviatilis (O.F. MÜLLER, 1774)	-	-	-	-	-	1	-	-	-
Anisus spirorbis (LINNÉ, 1758)	-	-	-	-	-	-	-	-	13
Argna parreyssi (PFEIFFER, 1848)	-	22	-	-	-	-	-	-	-
Balea biplicata (MONTAGU, 1803)	2	-	2	-	-	-	-	-	1
Balea stabilis (PFEIFFER, 1847)	-	4	-	3	-	-	-	3	-
Bradybaena fruticum (O.F. MÜLLER, 1774)	1,+	1	2	-	-	-	-	-	4
Bulgarica cana (HELD, 1836)	-	-	-	1	-	-	-	-	-
Bulgarica vetusta (ROSSMÄSLER, 1836)	-	-	-	-	4	-	1	-	-
Campylea faustina (ROSSMÄSLER, 1835)	-	1	-	-	2	-	-	-	-
Carychium minimum O.F. MÜLLER, 1774	-	24	-	-	-	-	-	-	-
Carychium tridentatum (RISSO, 1826)	-	61	-	-	-	-	-	-	-
Cepea vindobonensis (FERRUSAC, 1821)	+	-	-	+	-	-	1	-	-
Cochlicopa lubrica (O.F. MÜLLER, 1774)	-	30	-	-	-	2	-	-	12
Cochlicopa lubricella (PORRO, 1838)	-	1	-	-	-	-	-	5	67
Cochlodina laminata (MONTAGU, 1803)	-	13	-	1	-	-	1	-	3
Columella edentula (DRAPARNAUD, 1805)	-	6	-	-	-	-	-	-	-
Deroceras sp.	-	-	-	-	-	-	-	-	2
Ena obscura (O.F. MÜLLER, 1774)	-	4	-	1	-	-	-	-	-
Euconulus fulvus (O.F. MÜLLER, 1774)	-	-	-	-	-	-	-	-	1
Euomphalia srigella (DRAPARNAUD, 1801)	12	-	1	8	2	-	2	-	-
Glaciniaria inserta A. & G. B. VILLA	3	-	-	-	-	-	-	-	5
Helicigona banatica (ROSSMÄSLER, 1838)	2	5	1	2	2	-	3	3	-
Helix lutescens ROSSMÄSSLER, 1837	+	-	-	1	-	-	-	-	-
Helix pomatia LINNEUS, 1758	+	-	-	1	1	-	-	-	-
Hygromia transsylvanica (WESTERLUND, 1876)	-	-	-	-	1	-	1	-	5
Laciniaria plicata (DRAPARNAUD, 1805)	-	3	-	3	-	-	1	1	4
Lymnea peregra (O.F. MÜLLER, 1774)	-	-	-	-	-	1	-	-	12
Nesovitrea hammonis (SRTÖM, 1765)	-	-	-	-	-	-	1	-	-
Orcula doliolum (BRUGUÈRE, 1792)	4	80	-	3	-	-	-	5	-
Orcula jetschini KIMAKOWICZ, 1883	-	15	-	-	-	-	-	-	-
Oxychilus glaber (ROSSMÄSSLER, 1835)	-	-	-	-	-	-	-	-	1
Oxyloma elegans (RISSO, 1826)	-	1	-	-	-	-	-	-	7
Perforatella incarnata (O.F. MÜLLER, 1774)	3	1	-	-	-	1	-	1	4
Pisidium casertanum (POLI, 1791)	-	-	-	-	-	-	-	-	3
Ruthenica filograna (ROSSMÄSSLER, 1836)	22	4	3	5	-	-	-	1	2
Speliodiscus triaria (ROSSMÄSSLER, 1839)	-	3	-	-	-	-	-	-	-
Succinea oblonga DRAPARNAUD, 1801	-	2	4	1	-	-	-	-	8
Truncatellina cylindrica (FERUSSAC, 1807)	-	-	-	-	-	-	-	-	1
Vallonia costata (O.F. MÜLLER, 1774)	-	7	-	-	-	13	-	-	-
Vallonia pulchella (O.F. MÜLLER, 1774)	-	4	-	-	-	7	-	-	90
Vertigo angustior JEFFREYS, 1830	-	-	-	-	-	-	-	-	5
Vertigo antivertigo (DRAPARNAUD, 1801)	-	-	-	-	-	-	-	-	14
Vertigo pygmaea (DRAPARNAUD, 1801)	-	2	-	-	-	-	-	-	85
Vertigo pusilla O.F. MÜLLER, 1774	-	-	-	-	-	-	-	-	2
Vitrea crystallina (O.F. MÜLLER, 1774)	-	3	-	-	-	-	-	-	-
Vitrea diaphana (STUDER, 1820)	-	31	-	2	-	-	-	1	-
Vitrea subrimata (REINHARDT, 1871)	-	4	-	-	-	-	-	-	-
Vitrina pellucida (O.F. MÜLLER, 1774)	2	-	-	4	-	-	-	4	7
Zenobiella rubiginosa (SCHMIDT, 1858)	-	-	-	-	-	-	-	1	26
Zonitoides nitidus (O.F. MÜLLER, 1774)	-	9	-	-	-	-	-	2	8
Number of entities	57	380	13	39	12	25	11	31	392
Number of species	13	31	6	16	6	6	8	12	27

„+" – indicate entities being in E1 existence form (active existence), which were not collected.

Table 2. Malacological material collected with quadrate method in Troaş valley from the 9/c sampling place. (08. 06. 2002.)

Species	The 9/c sampling place quadrates					
	1.	2.	3.	4.	Σ	A
Cochlicopa lubrica (O.F. MÜLLER, 1774)	5	-	-	1	6	24
Succinea oblonga (DRAPARNAUD, 1801)	8	-	-	-	8	32
Vallonia pulchella (O.F. MÜLLER, 1774)	28	10	9	1	48	192
Vertigo angustior (JEFFREYS, 1830)	3	2	-	-	5	20
Vertigo pygmaea (DRAPARNAUD, 1801)	26	23	19	4	72	288
Zenobiella rubiginosa (SCHMIDT, 1858)	2	-	-	-	2	8
Zonitoides nitidus (O.F. MÜLLER, 1774)	2	-	-	-	2	8
Number of entities	74	35	28	6	143	

Table 3. Malacological material collected with quadrate method in Troaş valley from 9/d sampling site. (08. 06. 2002.)

Species	The 9/d sampling places quadrates					
	1.	2.	3.	4.	Σ	A
Cochlicopa lubricella (PORRO, 1838)	10	4	13	38	65	260
Hygromia transsylvanica (WESTERLUND, 1876)	-	-	2	-	2	8
Truncatellina cylindrica (FERUSSAC, 1807)	-	-	1	-	1	4
Vallonia pulchella (O.F. MÜLLER, 1774)	8	3	11	19	41	164
Vertigo pygmaea (DRAPARNAUD, 1801)	2	-	6	1	9	36
Number of entities	20	7	33	58	118	

Table 4. Malacological material collected with singling method in Dumbroviţa valley (near Groşii Noi). (06. 05. 2001.)

Species sampled in the Dumbroviţa valley	Number of entities
Balea stabilis (L. PFEIFFER, 1847)	6
Cochlodina laminata (MONTAGU, 1803)	2
Euomphalia srigella (DRAPARNAUD, 1801)	2
Helicigona banatica (ROSSMÄSLER, 1838)	2
Helix lutescens (ROSSMÄSSLER, 1837)	2
Laciniaria plicata (DRAPARNAUD, 1805)	2
Perforatella dibothryion (KIMAKOWICZ, 1890)	1
Number of entities	17

At first sight the most striking difference is the richness in steep species of the transect from Sălciva. This comes from the morphological differences of the territories.

In Troaş valley we found forest species (*Balea biplicata, Hygromia transsylvanica, Perforatella incarnata, Vertigo pusilla*) which weren't traceable in the flood-plain of the Mureş, against that in Zam-Pass the forests are relatively close.

The grown appearance of *Vertigo* species in the Troaş valley shows a variety of habitat and a bigger diversity. Almost each ecological group is represented by *Vertigo* (*Vertigo pusilla* – forest species; *Vertigo pygmaea* – steppe species; *Vertigo angustior* and *Vertigo antivertigo* – higrophyle species) except the mezophyle species group. Against that near Sălciva we found only the commune *Vertigo pygmaea*.

At the sampling of Sălciva transect we didn't bother with water species, so the comparison of this group is not competent.

Comparing the hygrophile species turn out again the diversity of the population from Troaş valley, since against the four species found in the flood-plain of the Mureş (*Oxyloma elegans, Succinea oblonga, Succinea putris* and *Zenobiella rubiginosa*) here we came across much more valuable species in larger numbers like *Oxychilus glaber*, *Oxyloma* *elegans, Succinea oblonga*, *Vertigo angustior*, *Vertigo antivertigo, Zenobiella rubiginosa* and *Zonitoides nitidus*.

Until the transect from the Troaş valley has a ditch form, till the Zam-Pass transect has a platter profile. In the Zam-Pass the transect was 300 m long while in Troaş valley the terrain circumstances let to be surveyed only a 100 m long transect. This morphological and dimensional difference becomes visible in the band-diagrams when compared. In the Zam transect's band-diagrams it can be well sensed that there is a gradual transition between biotopes. Conversely, the Troaş valley transect's diagrams register drastical changes, except for the fine transition between the two part of the swamp, which is understandable regarding the genetic connections of the 9b and 9c biotopes. On the grass of the 9d sampling site we found only steppe species, except *Hygromia transsylvanica*, which is a forest species and it was found near the bushes.

In abstraction we conclude that along the transect of the 9th sampling site we can find a considerably diverse malacofauna. In the Troaş valley the 9th sampling site is the second (with 27 species), regarding the species number, behind the 2nd site (with 30 species), whose samples originate from alluvia collected from a wider territory. The malacofauna which comes from the alluvia is incomparably colored taking account of having 10 species which was not found in the other samples.

In the Dumbroviţa valley we had short time to collect and because of that the collected material is poor. But in spite of what we think is important to mention it for serving data. The going of anyone to collect mollusc again on this place in reasonable time is very improbable. The *Perforatella dibothrion* was the most interesting species we met here, because this species was found only in Deda-Pass on the bank with *Telekia* of a by-stream of Mureş (Váncsa 2002, Váncsa and Domokos 2003). This species is also a Carpathian endemism.

Conclusion

In the Dumbroviţa valley, near Groşii Noii village we recorded 7 species and 17 entities.

In the Troaş valley a total 53 species and 959 entities were found. A part of the collected entities was sent to the Museum of Arad, the other part enrich the malacological collection of the Munkácsy Mihály Museum.

At the sapling sites a lot of rare Transylvanian or Carpathian endemism were found like: *Argna parreyssi, Graciliaria inserta, Hygromia transsylvanica, Orcula jetschini, Perforatella dibothryon, Spelaeodiscus triaria*. These species deserve the protection. We have to mention here that none of these gastropod species appear on the list of the protected species in Romania, so referring to them can not render protection to the habitats either.

This publication proves that is worth to extend the malacological researches over metamorphic and magma rock's soils, which at first sight seem to be poor in species.

The transect researches proves that the morphology of the valleys influence the diversity of the malacofauna found in them, and the character of the transitions between the band-diagrams of habitats.

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References

Andó, M. (1995): The Geography of the River Maros (Mureş) and Its River System -Tiscia monograph series, Sárkány-Kiss et. al.: The Maros/Mureş River Valley, Szolnok - Szeged - Târgu-Mureş, pp. 7-23.

Bába, K. (1982): Eine neue Zoogeographische Gruppierung der Ungarischen Landmollusken und die Wertung des Faunenbildes - Malacologia, 22 (1-2), pp. 441-454.

Bába, K. and Kovács, GY. (1975): Adatok a Királyhágó környéke, a révi szurdokvölgy és a Tordai hasadék Mollusca-faunájához (Románia szocialista Köztársaság). Angaben zur Molluskenfauna der Umgebund von Királyhágó, des Klammtales von Rév und der Tordaier Schlucht (Rumänische Sozialistische Republik) – Soosiana, 3:27-34.

Damjanov, S.G. and Likharev, I.M. (1975): Fauna Bulgarica 4. Gastropoda terrestria, Sofia.

Deli, T. (1997): A Praecarpathicum fejlődése az Alföldön a terrestris Molluscafauna biogeográfiai és paleogeográfiai elemzése alapján. Thesis, Debrecen.

Domokos, T. (1995): A Gastropodák létállapotáról, a létállapotok osztályozása a fenomenológia szintjén – Malakológiai Tájékoztató, 14: 79-82.

Domokos, T., Váncsa, K. and Sárkány-Kiss, A. (2002): Malacofaunistical Study of the Floodplain of the Mureş River in the Zam Region – In. A. Sárkány-Kiss and J. Hamar (eds): Ecological Aspects of the Tisa River Basin, Tiscia monograph series 6., Târgu-Mureş–Szeged–Szolnok, 63-70.

Grossu, A.V. (1955): Fauna Republicii Populare Romîne, Mollusca, Vol. III., Bucureşti.

Grossu, A.V. (1981, 1983, 1987): Gastropoda Romaniae, Vol. II. III. IV., Bucureşti.

Kerney, M.P., Cameron, R.A.D. and Jungbuth, J.H. (1983): Die Landschnecken Nord- und Mitteleuropas - Hamburg und Berlin.

Kiss, É. (1981): A magyarországi recens Clausilidák garatredői. Die Gaumenfalten der rezenten Clausiliiden Ungarns – Soosiana, 9: 37-46.

Kiss, É and Pintér, L. (1985): A magyarországi recens Clausilidák revíziója (Gastropoda). Revizion der rezenten Clausilidae Ungarns – Soosiana, 13: 93-144.

Ložek, V. (1964): Qartärmollusken der Tschechoslowakei. Rozpravy Ú.Ú.Geol. 31.

Pelbárt, J. (2000): Magyarország recens Mollusca faunájának tudományos névszótára – Nagykovácsi.

Pintér, L. (1984): Magyarország recens puhatestűinek revideált katalógusa (Mollusca) – Fol. Hist.-nat. Mus. Matr., 9: 79-90

Pintér, L., Richnovszky, A. and S.Szigethy, A. (1979): A magyarországi recens puhatestűek elterjedése – Soosiana (Suppl. I.)

Pintér, L. and Varga, A. (1981): Bulgarica (Bulgarica) rugicollis (Rossmässler 1836) neu für Ungarn. Új faj a magyar faunában: Bulgarica (Bulgarica) rugicollis (Rossmässler 1836) – Soosiana, 9: 65-66.

Richnovszky, A. and Pintér, L. (1979): Vízicsigák és kagylók (Mollusca) kishatározója – Vízügyi Hidrológia 6., VIZDOK.

Sárkány-Kiss, A. (1995): Malakological Survey on the Mureş (Maros) River – Tiscia monograph series, The Maros/Mureş River Valley, Ed. Hamar, J. & Sárkány-Kiss, A., Szolnok – Szeged – Târgu-Mureş, 193-201.

Sárkány-Kiss, A., Hamar, J. and Sîrbu, I. (1997): Fluvii Carpatorum, Starea ecologică a râului Mureş / A Maros folyó ökológiai állapota. Szolnok - Târgu Mureş, 79-87.

Soós, L. (1943): A Kárpát-medence Mollusca-faunája, Budapest.

Váncsa, K. (2002): A Maros völgye, mint lehetséges ökológiai folyosó; faunaelem-közvetítő hatásának vizsgálata puhatestű populációk esetében. Thesis, Kolozsvár.

Váncsa, K. and Domokos, T. (2003): A Dédai-, és a Zámi-szorosban, valamint az Erdélyi-medencei Maroslekencén (Románia) felvett malakotranszekt tanulságai. A Békés Megyei Múzeumok Közleményei, 24-25. pp. 75-88.

Újvári, I. (1972): Geografia apelor României, Bucureşti, 299-337.

TISCIA 35, 27-35

THE TERRESTRIAL MALACOFAUNA OF THE VALLEY OF RIVER TISZA AND ITS TRIBUTARIES

K. Bába

Bába, K. (2006): The terrestrial malacofauna of the valley of river Tisza and its tributaries. – *Tiscia 35, 27-35*

Abstract: This work presents the results of the area-analytical zoogeographic analyses carried out by the author on the Mollusc fauna of river Tisza and its tributaries, on the basis of his own works and also utilizing data from other researchers, sampled at 18 sites along the rivers, with samples taken from the Romanian parts as well in case of three streams. 88 species have come to light from the Hungarian parts of the rivers along with 65 species collected at the Romanian side respectively. Factors like species distribution, the percentages of the Continental and Sub-Atlantic fauna circles are largely dependent on such components as the average annual precipitation, the stream velocity and the degree of vegetation cover (forestation) reflected in the proportion of shady and open areas. This is clearly reflected in the distributions of the 115 species examined.

Keywords: zoogeographic classification, Continental and Sub-Atlantic fauna circles, Tisza valley

K. Bába, H-6720 Szeged, Vár u.6., Hungary

Introduction

Investigations have been continuously carried out on the river system of river Tisza and its tributaries ever since the foundation of the Tisza Research Working Group that was earlier supported by the Hungarian Academy of Sciences. I started my research work in 1955. Sampling was usually carried out by using 25×25 cm quadrates in 10 cm soil depth. The number of sampling sites was over 800. Besides the gallery forests and willow-poplar woodlands of the Lower, Middle and Upper Tisza, those of the rivers Maros and Fekete-Körös have been considered for investigation. In this compilation besides my own research I have also summarized and evaluated data of other Hungarian malacologists working on the rivers Maros and the Köröses (Czógler and Rotarides 1938, Domokos 1993, 1997, Domokos et al.2000, 2003, Juhász et al. 1998, 1999, Horváth 1962, Kovács 1974, 1980, 1997, Lennert and Répási 2000, Váncsa and Domokos 2003,)

Microclimatic measurements have also been made as part of our investigations (Andó and Bába 1960, 1962). The possible effects and influences of the 1970 floods and water-regulation works have also been evaluated utilizing the work of Andó and Vágás (1972) (Bába 1980e). The possible climatic influences were evaluated in relation to the proportions of gastropods collected (Bába 1979b, 1983b, 1996). The possible transportation effects of the rivers have also been identified in several or my works as well (e.g. Bába 1970).

The possible effects of the vegetation have been discussed at length in my paper in relation to the proportion of the gastropods in case of the river Tisza and its tributaries (Bába 1992b). Details on the sub-associations of the mineralogic succession lines were given in the paper Bába (1995). I have dealt with the gallery forests of the same succession line in the following papers: Bába (1977, 1980c, 2000). The species of the succession line for the whole Tisza drainage area were described in the work of Bába (1992b).

The gastropod successions for the plant communities of the river Tisza and the Great Hungarian Plain have been discussed in several papers (Bába 1979a, 1980, 1985). The complete species list for the areas along the river Tisza has been given in the last publication mentioned.

Materials and methods

In my previous works I was dealing with the analysis of possible interdependence between the proportions of gastropods and several environmental factors like microclimate, climate, vegetation, and the transporting effect of the rivers. This paper deals with the analysis of the zoogeographic composition of gastropod species for three major parts of the valley of river Tisza and its tributaries, partly based on data derived from personal collections (Table 1) and on data of other researchers, investigating the possible relations between the patterns of zoogeographic distribution and such factors as the climate, geographical location and the faunal transport effect of the rivers. 18 units have been set up for the three major parts of the river Tisza and the remaining tributaries sampled (Table 1).

The fauna lists for the given units (numbered) have been compiled on the basis of the following papers and works:

1. Lower Tisza: floodplain and dams: Czógler and Rotarides 1938, Horváth 1962, Bába 1965, 1966, 1972, 1973. 2. River Maros, Hungarian side: Bába 1958, Bába and Kondorossy 1995, Bába 2003, 3. River Maros, Romanian side: Váncsa and Domokos 2003. 4. Middle Tisza: floodplain, dams and cutoff channels: Bába 1972, 1985. 5. River Hármas Körös: flood-plain, cutoff channels, dams: Domokos 1993, Kovács 1974, 1997, 1980. 6. The Hortobágy channel and its surroundings: Pintér and Varga 1983 and perso-nal research; 7. River Berettyó: Domokos 1997, Domokos and Lennert 2000. 8. River Sebes-Körös: floodplain and cutoff channels: Kovács 1974, 1997, 1980, Bába 1980b, 1986b. 10. River Fekete-Körös: Bába and Domokos 2002, Domokos et al. 2003, Lennert and Répási 2000. 11. River Fehér-Körös: floodplain and cutoff channels: Kovács 1974, 1997, 1980, Bába 1992d. 12. River Zagyva: Bába 1979. 13. Érmellék, Romania: Domokos 1997. Cutoff channels along the rivers Körös: Juhász et al. 1999, Juhász et al. 1999. 14. Upper Tisza: Bába 1965, 1975, 1983d, 1992. 15. River Szamos: Bába 1996 and Bába and Sárkány-Kiss 1999a. 16. River Szamos, Romania: Bába and Sárkány-Kiss 1999a,b (till Szamosbazár and the warm Szamos). 17. River Kraszna: Bába 1959. 18. River Bodrog: Bába 1959, Bába et al. 1962.

The following units due to the low number of species found require further research: 7. Berettyó, 13. Érmellék, 15. River Szamos, Hungarian side, 17. River Kraszna, 18.River Bodrog (Table 1.)

The following papers discuss the area-analytical zoogeographic classification of the Hungarian terrestrial malacofauna: Bába 1981, 1982. The papers Bába 1982-1983 I:, 1986a II, 1994 discuss their possible influences and the interpretation of species area maps. Its possible utilizations for the Great Hungarian Plains are detailed in Bába 1983c, 1996.

Results

The zoogeographic classification embedded 9 Continental and 12 Sub-Atlantic fauna circles. Their origination is strictly climate-influenced (Table 2).

The total species number present in the table is 115. 68 of these occur along the river Tisza with 49 species appearing along the Lower Tisza, 42 along the Middle Tisza and 61 along the Upper Tisza respectively. The species numbers were the following for the river reaches: river Maros, Hungarian side 35, Romanian side 58, river Zagyva 48, river Berettyó 19, river Hármas-Körös 38, river Sebes-Körös 35, river Kettős-Körös 44, river Fekete-Körös 45, river Fehér-Körös 40, river Érmellék in Romania 15, channel Hortobágy 28, river Szamos, Hungarian side 15, Romanian side 63, river Kraszna 13, river Bodrog 9 (Table 2).

The distributions of species numbers are depicted on Fig.1. Numbers above 40 species are characteristic for the areas of the Lower Tisza, the Romanian side of the river Maros, the Middle Tisza, the rivers Kettős-Körös, Fekete-Körös, Zagyva, the Upper Tisza and the Romanian side of the Szamos. The possible reasons for this will be detailed later.

In total 27 species have come to light in Romania alone. 63 species were found along the three Romanian rivers with 88 species collected along the Hungarian rivers examined. 104 species are registered in the Great Hungarian Plain (Bába 1994). The number of Hungarian terrestrial species is 138 (Bába 1994).

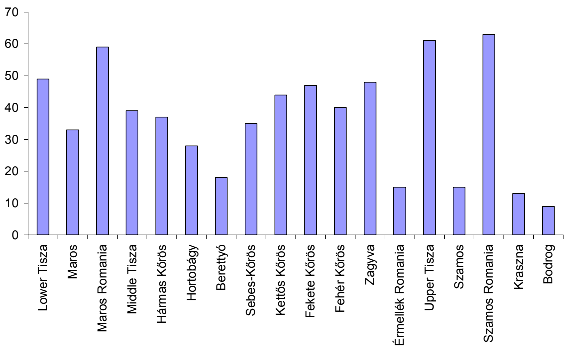

Fig. 1. The distributions of species numbers along the river Tisza and its tributaries under examination

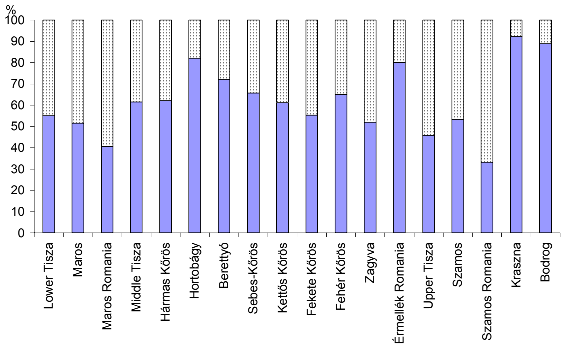

Fig. 2. The proportions of Continental and Sub-Atlantic fauna circles in the studied sites

The distribution of fauna circles according to the species numbers and their percentage distributions are depicted in Table 2. The percentage distributions of the fauna circles from the 18 sampling sites are present on Fig. 2.

The Continental fauna circles tend to be prevailing along the river Tisza and its tributaries, enjoying dominantly continental climatic influences. The most frequent types are the following: 1.1 East_Siberian, 1.4. Holarctic, 3. Caspian-Sarmatian, 5.3. Ponto-pannonian. The continental character of the Hortobágy is clearly observable, which might be related to its open-wide areas lacking any woody vegetation. The high rates of continentality gained for the areas of the rivers Kraszna and Bodrog must be accounted for the lack of sufficient research and data from these regions. The highest percentages of the Sub-Atlantic fauna circles were found at the following sites: 3. river Maros, Romanian side, 14. Upper Tisza, 16. river Szamos, Romanian side. These regions enjoy higher precipitation than any other lowland areas of the Tisza river valley. The proximity of the montane areas play a crucial role in case of the Romanian parts of the river regarding the composition of the fauna (Fig. 2). There the following fauna circles occur quite frequently: 5.22. Illyrian-moesian, 6. Adriato-Mediterranean, 8. Holomediterranean.

The percentage values depicted on Fig 2. seem to be closely related to the average total annual precipitation rates depicted on Fig.3. The white spots cover the areas of the Hortobágy-Hármas-Körös and the mouth of the Zagyva. According to this figure the percentages of the Continental fauna circles are above 55% in the areas enjoying lower precipitation (500-550 mm);i.e. the Lower Tisza, the Middle Tisza, the river Berettyó, and the rivers Sebes-Kettős-Fehér-Fekete Körös. Due to the lack of adequate research the areas of the river Kraszna and Bodrog could not have been considered for evaluation. According to the figure the Romanian sides of the rivers Maros and the Szamos enjoy an annual precipitation of 700-1000 mm (Tufescu 1965). The Érmellék, which is less investigated, receives a rainfall of 600 mm.

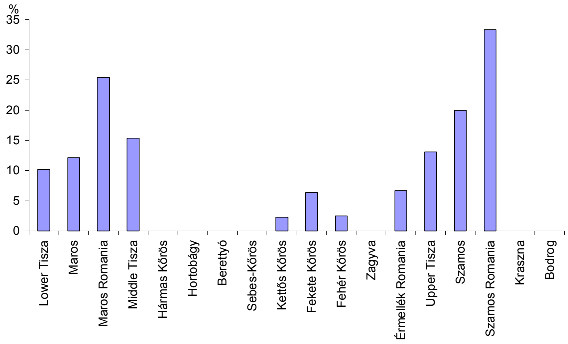

Fig. 3. The percentages of European montane endemics

The possible influences of the precipitation on the composition of the malacofauna is even better observable on the percentages of the European montane species transported by the rivers along the different rivers under examination (Fig. 3). These species belong to the 9.1-9.4 fauna circles (Table 2). There are no such species present in the areas characterized by low rates of annual precipitation; i.e. the sampling sites no 5-8 and 12 respectively. Along the near border regions of the rivers Kettős-Fekete-Fehér Körös, geting an annual precipitation of 550-600 mm, the percentage values of these montane species range between 2 to 6 %. On the contrary along the river Maros, characterized by more lush forest vegetation, higher flow velocity than the Körös and an annual precipitation of 550-600 mm, as well as in the gallery forests of the Lower and Middle Tisza the proportion of European montane elements is high. Furthermore, along the rivers of the Upper Tisza, the Hungarian side of the Szamos and the Romanian side flowing through hilly areas the percentages of the European montane species are outstanding. The climatic conditions and the degree of forest cover is clearly indicated by the higher species and individual number of the terrestrial molluscs (most of the gallery forests and hornbeam-oak woodlands occupy the floodplains of the Upper Tisza and the river Szamos) as seen on the percentage values of the European montane fauna circles (Fig. 3). The gastropod fauna seems to be classified according to the microclimatic conditions and the hydrology and flow rate of the rivers examined (Bába and Andó 1964, Bába 1983, Andó and Vágás 1972).

Table 1.The zoogeographical species distribution for the malacofauna of the river Tisza and its tributaries

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*
	Lower Tisza	Maros	Maros, Romainia	Közép-Tisza	Hármas-Körös	Hortobágy channel	Berettyó	Sebes-Körös	Kettős Körös	Fekete Körös	Fehér Körös	Zagyva	Érmellék, Romania	Upper Tisza	Szarvas	Szamos, Romania	Kraszna	Bodrog
1.1. East-Siberian																		
Carychium minimum O.F. Müller 1774.	+		+	+	+		+	+	+	+	+	+		+		+		
Columella edentula (Draparnaud 1805)	+													+				
Vertigo alpestris Alder 1838																+		
Pupilla muscorum (Linné 1758)	+	+	+	+	+	+	+	+	+	+	+	+		+				
Succinea putris (Linné 1758)	+		+	+		+		+				+		+	+	+	+	+
Punctum pygmaeum (Draparnaud 1801)	+	+	+	+	+	+	+	+	+	+	+	+		+		+		
Discus ruderatus (Ferussac 1821)			+															
Arion subfuscus (Draparnaud 1805)	+		+	+	+			+	+	+	+	+	+	+		+		
Nesovitrea hammonis (Ström 1765)			+	+		+			+	+	+	+	+	+	+			
Bradybaena fruticum (O.F.Müller 1774)	+	+	+	+	+			+	+	+	+	+		+	+	+	+	
Perforatella rubiginosa (A.Schmidt 1853)	+	+	+	+	+			+	+	+	+	+		+	+	+	+	+
Number of species	**8**	**4**	**9**	**8**	**6**	**4**	**3**	**7**	**7**	**7**	**8**	**7**	**2**	**9**	**4**	**7**	**3**	**2**
1.2. West-Siberian																		
Vertigo pygmaea (Draparnaud 1801)	+	+	+	+	+	+	+	+	+	+	+	+		+		+		
Succinea oblonga (Draparnaud 1801)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
Aegopinella pura (Alder 1830)														+		+		
Number of species	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**3**	**1**	**3**	**1**	
1.3. Euro-Siberian																		
Deroceras laeve (O.F.Müller 1774)	+	+		+	+	+		+	+	+				+	+			+
Deroceras reticulatum (O.F.Müller 1774)				+	+	+			+	+	+				+	+		
Deroceras agreste (Linné 1758)	+	+		+	+	+		+	+	+	+			+			+	+
Number of species	**2**	**2**		**3**	**3**	**3**		**2**	**3**	**3**	**2**			**2**	**2**	**1**	**1**	**2**
1.4. Holarctic																		
Cochlicopa lubrica (O.F. Müller 1774)	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+
Vertigo antivertigo (Draparneud 1801)	+			+	+	+		+	+	+	+	+		+				
Vallonia pulchella (O.F. Müller 1774)	+	+	+	+	+	+	+	+	+	+	+	+	+	+			+	+
Vallonia costata (O.F.Müller 1774)	+		+	+	+	+	+	+	+	+	+	+	+	+				
Acanthinula aculeata (O.F.Müller 1774)	+					+			+	+	+	+	+	+				
Heliodiscus syngleyanus (Pilsbry 1890)												+						
Vitrina pellucida (O.F.Müller 1774)	+	+	+	+	+	+		+	+	+	+	+	+	+		+		
Zonitoides nitidus (O.F.Müller 1774)	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+
Euconulus fulvus (O.F.Müller 1774)	+		+	+	+	+	+	+	+	+		+		+		+		
Number of species	**8**	**4**	**6**	**7**	**7**	**8**	**5**	**7**	**8**	**8**	**7**	**9**	**5**	**8**	**1**	**4**	**3**	**3**
2. West-Central-Asian																		
2.1. Turkestian Xeromantan																		
Pyramidula rupestris (Draparneund 1801)																+		
Phenicolimax annularis (Studer 1820)																+		
Number of species																**2**		
2.2. Turkestian																		
Cochlicopa lubricella (Prro 1838)	+	+		+	+	+	+	+	+	+	+	+		+				
Vallonia enniensis (Gredler 1856)		+		+	+	+				+							+	
Number of species	**1**	**2**		**2**	**2**	**2**	**1**	**1**	**1**	**2**	**1**	**1**		**1**			**1**	
3. Caspian-Sarmatian																		
Vertigo angustior Jeffreys 1830								+						+				
Euomphalia strigella (Draparnaud 1801)	+	+	+						+	+	+	+	+	+		+		
Cepaea vindobonensis (Ferussac 1821)	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	
Number of species	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**3**		**2**	**1**	
5.3. Ponto-pannonian																		
Helicella obvia (Menke 1828)	+	+	+	+	+	+			+		+	+						
Helicopsis striata (O.F.Müller 1774)	+		+	+		+			+		+							
Helix pomatia Linné 1758	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+		
Helix lutescens Rossmässler 1837		+	+	+				+	+	+	+		+	+		+	+	
Number of species	**3**	**3**	**4**	**4**	**2**	**3**	**1**	**2**	**4**	**2**	**4**	**2**	**2**	**2**		**2**	**1**	

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*
10.1. Boreo-alpine																		
Arianta arbustorum (Linné 1758)	+			+												+		
Discus ruderatus (Terussac 1821)																+		
Number of species	**1**			**1**												**2**		
5.1. Illyrian (Ponto mediterranean)																		
Acicula banatica (Rossmässler 1842)																+		
Phenacolimax annularis (Studer 1820)																+		
Macrogastra ventricosa (Draparneud 1801)												+						
Clausilia dubia (Draparnaud 1805)			+															
NUMBER OF SPECIES			**1**									**1**				**2**		
5.2.1. Trazian																		
Granaria frumentum (Draparnaud 1801)	+	+	+		+		+	+	+		+							
Bulgarica vetusta (Rossm ssler 1836)																+		
Aegopinella minor (Stabile 1864)	+	+	+		+			+	+	+	+	+	+	+				
Oxychilus glaber (Rossmässler 1838)	+		+									+			+			
Oxychilus inopinatus (Ulicny 1887)								+	+		+	+		+				
Number of species	**3**	**2**	**3**		**2**		**1**	**3**	**3**	**1**	**3**	**3**	**1**	**2**	**1**	**1**		
5.2.2. Illirian-moesian																		
Orcula doliolum (Draparnaud 1801)												+				+		
Chondrina clienta (Westerlund 1883)																+		
Clausilia pumila C.Pfeiffer 12828		+	+							+		+		+				
Laciniaria plicata (Draparnaud 1801)			+	+		+				+		+				+		
Balea biplicata (Montagu 1803)	+	+										+		+		+		
Discus perspectivus (Megerle von Mühlfeld 1816)			+									+						
Vitrea diaphana (Studer 1820)												+		+		+		
Dandebardia rufa (Draparnaud 1805)												+						
Tandonia budapestiensis (Hazay 1881)									+	+	+							
Malacolimax tenellus (O.F.Müller 1774)					+				+					+				
Deroceras sturarnyi (Sünroth 1894)	+																	
Perforatella incarnata (O.F.Müller 1774)	+		+									+		+				
Trichia hispida (Linné 1758)				+								+			+	+		
Number of species	**3**	**2**	**4**	**2**	**1**	**1**			**2**	**3**	**1**	**9**		**5**	**1**	**6**		
6. Adriato-mediterranean																		
Cochlodina laminata (Montagu 1803)		+	+		+					+		+		+		+		
Arion hortensis Ferussac 1819		+		+	+				+					+				
Vitrea crystallina (O.F.Müller 1774)	+	+	+	+	+					+				+	+	+		
Limax cinereoniger Wolf 1803		+	+	+				+		+				+		+		
Lehmania marginata (O.F.Müller 1774)														+				
Number of species	**1**	**4**	**3**	**2**	**3**			**1**	**1**	**3**		**1**		**5**	**1**	**3**		
7. Atlanto-mediterranean																		
Arion cirkumscriptus Johnston 1828	+								+	+	+			+				
Arion fasciatus (Nilsson 1822)					+													
Arion ater (Linné 1758)						+												
Arion sylvaticus Lohmander 1937			+											+		+		
Semilimax semilimax (Ferussac 1802)																+		
Cepaea hortensis (O.F.Müller 1774) Rossmäsler					+													
Number of species	**1**		**1**		**2**	**1**			**1**	**1**	**1**			**2**		**3**		
8. Holo-mediterranean																		
Corychium tridentatum (Risso 1826)			+					+	+	+	+	+		+				
Trancatellina cylindrica (Fesussac 1807)	+	+	+	+	+	+		+	+	+	+	+		+				
Vertigo pusilla (O.F.Müller 1774)												+		+				
Vertigo moulinsiana (Dupuy 1849)								+						+				
Chondrula tridens (O.F.Müller 1774)	+	+	+	+	+	+	+	+	+	+	+	+	+	+				
Ena obscura (O.F.Müller 1774)												+				+		
Oxyloma elegans (Risso 1826)	+		+	+	+	+	+	+	+	+	+	+		+	+			+
Cecilioides acicula (O.F.Müller 1774)	+				+			+	+	+	+	+						
Vitrea subrimata (Reinhardt 1871)			+													+		
Vitrea contracta (Westerlund 1871)								+	+	+		+		+				
Oxychilus draparnaudi (Beck 1837)	+		+		+						+					+		
Oxychilus hydatinus (Rossmässler 1838)										+								
Lehmania nyctelia (Bourguignat 1861)														+				
Limax maximus Linné 1758	+	+		+	+				+	+	+			+		+		

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*
Limax flavus Linné 1758	+						+		+	+				+				
Monacha carthusiana (O.F.Müller 1774)	+	+	+		+		+	+	+	+	+	+		+		+	+	
Number of species	**8**	**4**	**7**	**4**	**7**	**3**	**4**	**8**	**9**	**10**	**8**	**9**	**1**	**11**	**1**	**5**	**1**	**1**
9.1. Transilvanian																		
Argna bielzi Rossmässler 1859															+	+		
Pupilla sterri carpathica Kimakovicz 1890	+													+				
Vitea transsylva Clessin 1877																+		
Oxychilus orientalis Clessin 1887																+		
Carpathica calophana Westerlund 1881																+		
Cochlodina marisii A.Schmidt 1857			+													+		
Macrogastra tumida (Rossmässler 1836)			+															
Balea fallax Rossmässler 1836			+													+		
Balea stabilis (Pfeiffer 1847)			+	+										+		+		
Vestia elata Rossmässler 1836																+		
Hygromia transsylvanica (Westerlund 1876)	+	+												+		+		
Hygromia kovácsi Varga et Pintér 1972		+							+	+	+		+					
Perforatella dybothryon (M.v.,Kimakowicz 1884)			+	+										+				
Chilostoma banaticum (Rossmässler 1838	+	+	+	+						+				+		+		
Number of species	**3**	**3**	**6**	**3**					**1**	**2**	**1**		**1**	**5**	**1**	**10**		
9.2. Carpathian-Sudethan																		
Vestia turgida (Rossmässler 1836)			+															
Vestia gulo (E.A. Bielz 1859)																+		
Bielzia coerulans (M.Bielz 1851)			+	+						+				+		+		
Perforatella vicina (Rossmässler 1842)		+	+	+										+	+	+		
Trichia bielzi (A.Schmidt 1860)			+													+		
Number of species		**1**	**4**	**2**						**1**				**2**	**1**	**4**		
9.3. Carpathian-Baltic																		
Ruthenica filograna (Rossmässler 1836)			+													+		
Macrogastra latestriata (A.Schmidt 1857)																+		
Bulgarica cana (Held 1836)			+													+		
Perforatella bidentata (Gmelin 1788)	+		+	+										+		+		
Chilostoma faustinum (Rossmässler 1835)			+													+		
Number of species	**1**		**4**	**1**										**1**		**5**		
9.4. Alpine-Carpathian																		
Deroceras rodnae Grossu et Lupu 1965															+	+		
Isognomostoma isognomostoma (Schröter 1784)	+		+													+		
Number of species	**1**		**1**												**1**	**2**		
10.2. Boreo-Montane																		
Ena montana (Draparnaud 1801)																+		
Number of species																**1**		
Total Number of species	**49**	**35**	**58**	**42**	**38**	**28**	**19**	**35**	**44**	**45**	**40**	**48**	**15**	**61**	**15**	**63**	**13**	**9**

Table 2. The percentage distributions of fauna circles according to the species numbers

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Fauna circles	Lower Tisza	Maros	Maros Romania	Middle Tisza	Hármas Kőrös	Hortobágy	Berettyó	Sebes-Kőrös	Kettős Kőrös	Fekete Kőrös	Fehér Kőrös	Zagyva	Érmellék Romania	Upper Tisza	Szamos	Szamos Romania	Kraszna	Bodrog
1.1. East-Siberian	8	4	9	4	6	4	3	7	7	7	8	7	2	9	4	7	3	2
1.2. West-Siberian	2	2	3	2	2	2	2	2	2	2	2	2	1	3	1	3	1	-
1.3. Euro-Siberian	2	-	-	3	3	3	-	2	3	3	2	2	-	2	2	1	1	2
1.4. Holarctic	8	4	6	7	7	8	5	7	8	8	7	9	5	8	1	4	3	3
2.1. W;Central-Asian	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
2.2. Turkestanian	1	2	-	2	2	2	1	1	1	2	1	1	-	1	-	-	1	-
3. Caspian_Sarmata	2	2	2	1	1	1	1	2	2	2	2	2	2	3	-	-	2	1
5.3. Ponto-pannonian	3	3	4	4	2	3	1	2	4	2	4	2	2	2	-	2	1	-
10.1. Boreo-alpine	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	2	-	-
Continental	**27**	**17**	**24**	**24**	**23**	**23**	**13**	**23**	**27**	**26**	**26**	**25**	**12**	**28**	**8**	**21**	**12**	**8**
5.1. Illyric	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	2	-	-
5.21 Traziaian	3	2	3	-	2	-	1	3	3	1	3	3	1	2	1	1	-	-
5.22. Illyric-moesian	3	2	4	2	1	1	-	-	2	3	1	9	-	5	1	6	-	-
6. Adriato-mediterranean	1	4	4	3	2	-	-	1	1	3	-	1	-	5	1	3	-	-
7. Atlanto-mediterranean	1	-	1	-	2	1	-	-	1	1	1	-	-	2	-	3	-	-
8. Holomediterranean	9	4	7	4	7	3	4	8	9	10	8	9	1	11	1	5	1	1
9.1. Transylvanian	3	3	6	3	-	-	-	-	1	2	1	-	1	5	1	10	-	-
9.2. Carpathian-Sudetan	-	1	4	2	-	-	-	-	-	1	-	-	-	2	1	4	-	-
9.3. Carpathian-Baltic	1	-	4	1	-	-	-	-	-	-	-	-	-	1	-	5	-	-
9.4. Alpian-Carpathian	1	-	1	-	-	-	-	-	-	-	-	-	-	-	1	2	-	-
10.2. Boreo-montane	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Sub-Atlantic	**22**	**16**	**35**	**15**	**14**	**5**	**5**	**12**	**17**	**21**	**14**	**23**	**3**	**33**	**7**	**42**	**1**	**1**
TOTAL species number	**49**	**33**	**59**	**39**	**37**	**28**	**18**	**35**	**44**	**47**	**40**	**48**	**15**	**61**	**15**	**63**	**13**	**9**
Continental %	*55.1*	*51.5*	*40.7*	*61.5*	*62.2*	*82.1*	*72.2*	*65.7*	*61.4*	*55.3*	*65.0*	*52.1*	*80.0*	*45.9*	*53.3*	*33.3*	*92.3*	*88.9*
Sub-Atlantic %	*44.9*	*48.5*	*59.3*	*38.5*	*37.8*	*17.9*	*27.8*	*34.3*	*38.6*	*44.7*	*35.0*	*47.9*	*20.0*	*54.1*	*46.7*	*66.7*	*7.7*	*11.1*
Sum proportion of 9.1, 9.2, 9.3, 9.4. species (%)	*10.2*	*12.1*	*25.4*	*15.4*	*0.0*	*0.0*	*0.0*	*0.0*	*2.3*	*6.4*	*2.5*	*0.0*	*6.7*	*13.1*	*20.0*	*33.3*	*0.0*	*0.0*

References:

Andó M., Bába K. (1960): Mikroklimatikus megfigyelésekkel egybekapcsolt malakoconologiai vizsgálatok a tokaji Tisza, Bodrog, és Kransza medervonalában IV. Biológiai Vándorgyűlés előadásainak ismertetése, Debrecen, 40.

Andó, M., Bába, K. (1962): Malaco-coenological investigations Connected with Microclimatological observations on the shores of the rivers Tisza, Bodrog and Kraszna. Acta Biol.Acad Sci. Hung. Suppl. 4,27.

Andó M., Vágás J. (1972): A Tisza-völgy 1970 évi nagy árvize. Földrajzi Közlemények I. 18-37.

Bába, K. (1958): Die Mollusken des Inundationsraumes der Maros. Acta Biol. (Szeged) 4, 67-71.

Bába, K., Kolosváry, G., Sterbetz, I., Vásárhelyi, I., Zilahi-Sebes, G. (1962): Das Leben der Tisza XVII. Zoologische Ergebnisse der vierten Tiszaexpadition. Fortsetzung. Acta Biol. (Szeged), VIII, 207-211.

Bába K., Andó M. (1964): Mikroklíma vizsgálatokkal egybekötött Malakocönologiai vizsgálatok ártéri kubikokban. Szegedi Tanárképző Főisk. Tud.Közl. II, 97-110.

Bába K. (1965): Malakocönologiai vizsgálatok a Tisza árterén. Szegedi Tanárképző Főisk. Tud.Közl. II, 93-98.

Bába K. (1966): A Tisza hullámterének puhatestűi Algyő és Szeged között, Szegedi Tanárképző Főisk. Tud.Közl. II, 91-98.

Bába K. (1968): Néhány szárazföldi csigtársulás a Tisza völgyében. (Einige kontinentale Schnekenzönosen in Tisza Tal). Móra Ferenc Múzeum Évkönyve, 169-202.

Bába, K. (1969): Zönologische untersuchungen der an der Flussbettkante der Tisza und ihrer Nebenflüsse Lebenden Schnecken. Tiscia 5, 107-119.

Bába, K. (1970): Ökologische Beobachtungen bezüglich der Schneckenarten in Tisza-Tal. Die Besiedlung der Inundationsraums. Móra Ferenc Múzeum Évkönyve I, 93-100.

Bába K. (1971): Elterjedési és ökologiai adatok a Bradybaena fruticum O.F.Müll. hazai előfordulásához. Szegedi Tanárképző Főisk. Tud.Közl. 89-98.
Bába, K. (1972): The snail coenoses of the willowes in the Middle Tiszaregion. Tiscia 7, 101-103.
Bába, K. (1973): Peopling of the inundation area of the Tisza by Mollusca regeneration of the snail populations in the area of river barrage „Tisza II”. Tiscia 8, 98-99.
Bába K. (1975): Erdők állapotának minősítési lehetőségei. Juhász Gyula Tanárképző Főisk. Tud.Közl. II. 37-51.
Bába, K. (1977): Die kontinentalen Schneckenbestände der Ulmen-Eschen-Auwäldern (Fraxino pannonicae-Ulmetum pannonicum Soó) in der ungarischen Tiefebene. Malacologia 16(1). 51-57.
Bába, K. (1979): Die Sukzession der Schneckenzönosen in den Wäldern des Alföld und die methoden zum Studium der Sukzession. Malacologia 18, 203-210.
Bába K. (1979 b): A csigák mennyiségi viszonyainak és a klimának a kapcsolata. IV. Magyar Malakologiai Találkozó, Göngyös, 5-6.
Bába, K. (1980a): Investigation into the succestion of email assotiations in the flood plain of the River. Atti IV. Congresso S.M.L Siena, 1977-192.
Bába K. (1980b): A csigák mennyiségi viszonyai a Crisicum liget-erdeiben. Békés Megyei Múzeumok Közleményei 6, 85-99.
Bába, K. (1980c): Die quantitativen Verhältnisse der Schnecken in den Auwäldern des Crisicum. Békés Megyei Múzeumok Közleményei 6, 100-101.
Bába, K. (1980d): A history and present-day situation of the investigation of the recent land snails in the Great Hungarian Plain. Tiscia 15, 93-102.
Bába K. (1980e): A vízrendezések hatása a Duna-Tisza köze természeti viszonyaira. Kerekasztal beszélgetés, Kecskemét, 66-80.
Bába K. (1981): Magyarország szárazföldi csigáira vonatkozó új állatföldrajzi felosztás tanulásai. The lessons of a new zoogeographical division concerning the terrestrial snails of Hungary. Soósiana 9, 13-22.
Bába, K. (1982a): Eine neue zoogeographische Gruppierung der ungarischen Landmollusken and die Wertung des Faunabildes. Malacologia 22, 441-454.
Bába K. (1982b): A folyók hatása az Alföld tájegységeinek száraz-földi malakofaunájára. Malakologiai Tájékoztató 2, 22-24.
Bába, K. (1982c): Comparative funistic and oecological investigations into the Land-Mollusken of the Körtvélyes Reservation Area. Tiscia 17, 174-189.
Bába K. (1982-83): Magyarország szárazföldi csigáinak állatföldrajzi besorolásához felhasznált faj area térképek I. Fol.Hist.nat.Mus.Matr. 8, 129-132.
Bába, K. (1983a): History of the investigation of the terrestrial snails of the Great Hungarian Plain and its present situation II. Tiscia 18, 83-95.
Bába, K. (1983b): Effect of the regions of the Tisza Valley on the Malaco-fauna. Tiscia 18, 97-102.
Bába, K. (1983c): Eine möglichkeit für die Ausbildung der einheitlichen Biogeographischen anwendungsweise aus der Phyto-und Zoogeographie. Abstracts Eight Internat. Malacological Congress, Budapest 8.
Bába K. (1983d): A Szatmár-Beregi sík szárazföldi csigái és környezetükre levonható következtetések. Juhász Gyula Tanárképző Főisk. Tud.Közl. ser Biol-Geogr., 17-42.
Bába K. (1985): Csigaegyüttesek szukcessziójáról. Biológiai Tanulmányok 12. Akad. Kiadó Budapest, 163-187.
Bába K. (1986a): Magyarország szárazföldi csigáinak besorolásához felhasznált fajarea térképek és értelmezésük II. Fol.Hist-nat. Mus.Matr. 11, 49-69.
Bába K (1986b): A szabadkígyósi Nagyerdő Mollusca faunájának ökológiai vizsgálata. Környezet és Természetvédelmi Évkönyv 6., Békéscsaba, 135-273.
Bába, K. (1991): Die Verbreitung der Landchnecken in ungarischen Teil des Alföld - A szárazföldi csigák elterjedése az Alföld magyarországi részén. Soósiana 19, 25-59.
Bába, K. (1992): The influence of sylviculture on the structure of snail assemblages. Proc. Of the vinth Internat. Malacological Congress. Edinbourgh 1986, Leiden, 27-34.
Bába, K. (1992a): Seasonal examinations in a fenwood and marsh meadows habitat in the area of Tiszaalpár (Hungary). Lovasi S.IM. Atti Congresso di Parma 24, 1-15.
Bába, K. (1992 b): Die Verbreitung der Landschecken in ungarischen Teil de Alföld II. Verteilung der Pflanzengesellschaf-ten. Soósiana 20, 37-49.
Bába K. (1992c): Erdészeti kezelés és hatásai ligeterdők malakofaunájára két esettanulmány kapcsán. I Kelet-magyarországi vad és halgazdálkodási természetvédelmi konferencia, Debrecen, 242-244.
Bába, K. (1992d): The influence of sylviculture on the structure of snail assemblages. Proc. Of the Ninth Internat. Malacological Congress, 27-34.
Bába, K., Domokos, T. (1992e): The occurence and ecology of Chilostoma banaticum (Rossmässler 1838) in Hungary. Abstr. 11th Intern. Malacological Congress Siena, 383-385.
Bába K. (1994): Csigaegyütesek regionális szünökologiai, állatföldrajzi vizsgálata az Alföldön és a Bükkben. Kandidátusi Tézisek. Szeged, Juhász Gyula Tanárképző Főiskola 1-68.
Bába, K, Kondorossy, P. (1995): Snail assemblages of Gallery forests between Lippa (Lipova) and Makó. Tiscia monograph series, Szolnok-Szeged-Tärgu-Mures, 203-224.
Bába, K. (1996): Die Beziehung der Landschafseinheiten (Regionen) der Theiss-Tiefebene aufgrund der Verteilung der Landschnecken Malakologiai Tájékoztató 15, 69-75.
Bába, K. (1998): The malacofauna of the Tisza-Valley: In habitation and subsequent improverishment. Tiscia 31, 47-54.
Bába, K., Sárkány-Kis, A. (1999a): Temestrial snail funa in the Somes/Szamos River Valley from the spring region to the inflow into the river Tisza. Tiscia monograph series, Szolnok-Szeged-Targu-Mures, 279-296.
Bába, K., Sárkány-Kiss, A. (1999 b): Contribution to the mollusc community of Somesul Cald (Meleg-Szamos gorges. Tiscia Monograph series, Szolnok-Szeged-Tärgu-Mures, 275-278.
Bába, K. (2000): Structural and ecological study of the Molluse fauna of the Hardwood Gallery forests (Fraxino pannonicae Ulmetum Soó 1960) in the Great Hungarian Plain. Tiscia Monograph Series Szeged, 77-82.
Bába, K., Domokos, T. (2002): Seasonal malacological investigation on the willow forest fauna (csigáserdő) on the active flood plain of the Fekete-Kőrös river near Dénesmajor. Ersten Voralberger Malakologischen Gesellschaft 10, 31-42.
Bába K. (2002): Természetvédelem és az erdészeti hatások kapcsolata. I. Magyar Természetvédelmi Biologiai Konferencia Sopron, 72.
Bába K. (2003): Csanytelek és Maroslelle hullámterének malakologiai vizsgálata barbercspdával. Malakologiai Tájékoztató 21, 1-6.
Czógler, K., Rotarides, M. (1938): Analyse einer von Wasser geschwemmten Molluskenfauna. Die Auswürfe des Maros und der Tisza bei Szeged. Magyar Biologiai Kutató Intézet

munkái 1, 8-44.
Domokos T. (1993): A Hármas-Kőrös 45 és 50 töltés kilométere közötti szakaszának (Szarvas) malakoökologiai és cönologiai viszonyai annak hullámtéri és mentett oldalán. Munkácsy Mihály Múzeum Közleményei 12, 59-68.
Domokos T. (1997): Biharugra és környékének malakofaunája, különös tekintettel az ugrai rét és Ször-rétje puhatestű közösségeire. Fol Hist.nat.Mus. Matricum 22, 265-284.
Domokos T., Lennert J. (2000): A Kőrösök és a Berettyó puhatestűi (1902-1948) Crisicum 3, 79-109.
Domokos t., Lennert J., Répási J-né. (2003): A Fekete-Kőrös völgy magyar szakaszának szárazföldi malakofaunája II. A Békés Megyei Múzeumok Közleményei 24. (in press)
Horváth, A. (1962): Kurzbericht üher die Molluskenfauna der zwei Tisza-Expeditionen in Jahre 1958. Opuscula Zoologica, Budapest 5, 77-83.
Juhász P., Kiss B., Olajos P. (1998): Faunisztikai kutatások a Kőrös-Maros NP. Területén Crisicum 1, 105-125.
Juhász P., Kiss B., Olajos Pl, Grigorszky I. (1999): Faunisztikai kutatások a Kőrös-Maros Nemzeti Park működési területén lévő „szentély jellegű holtágakban. Crisicum 2, 99-110.
Kokas J. (1960): Magyarország éghajlati atlasza I. Akad. Kiadó Budapest, 1-78.
Kovács Gy. (1974): Békéscsaba és környéke puhatestű faunája. Állattani Közl. 41 (1-4), 35-41.
Kovács Gy. (1980): Békés megye Mollusca faunájának alapvetése. A Békés Megyei Múzeumok Közleményei 6, 51-83.
Kovács Gy. (1997): A Munkácsi Mihály Múzeum Természettudományi adattára. Napló 2119.
Lennert J., Répási J-né (2000): A Fekete-Kőrös völgy magyar szakaszának szárazföldi malakofaunája I. A Békécs Megyei Múzeumok Közleményei 21, 49-62.
Pintér L, Richnovszky A., Szigethy A. (1979): A magyarországi recens puhatestűek elterjedése Soósiana Suppl. 1, 1-351.
Pintér, L., Szigethy, A. (1980): Die Verbreitung der rezenten Mollusken Ungarns: Neunachweise und berichtungen II Soósiana 8, 65-80.
Pintér, L., Varga, A. (1983): The Mollusca funa of the Hortobágy National Park. Akad.Kiadó, Budapest, 51-54.
Péczely Gy. (1981): Éghajlattan Tankönyvkiadó, Budapest 1-336.
Radó S. (1967): Magyarország nemzeti atlasza Budapest, 1-112.
Tufescu, V. (1965): Atlas Geografic Republic Socialistá Románia Editura Didactica si Pedagogica Bucuresti 1-III.
Váncsa K., Domokos T. (2003): A Dédai és Zámi szorosban, valamint az Erdélyi-medencei Maroskemencén (Románia) felvett malakologiai transzekt tanulságai. Munkácsy Mihály Múzeum 24.

TISCIA 35, 37-40

EDGE EFFECT ON SPIDER ASSEMBLAGES

R. Gallé and B. Fehér

Gallé, R and Fehér, B. (2006): Edge effect on spider assemblages. – *Tiscia 35, 37-40*

Abstract. In the Great Hungarian Plain we collected 3234 adult spiders belonging to 66 species in a poplar forest, its clearing and the nearby grassland. *Titanoeca psammophila* Wunderlich, 1993 occurred in the samples which is new for the Hungarian fauna.
Correspondence analysis showed similarity between the spider assemblages of the wind grooves and those of the clearing.
We applied also correspondence analysis on the data of pitfall traps arranged in transects to locate the edge zone. Higher plant and spider diversity were found in edge zone. Mantel test showed significant correlation between changes of the vegetation and the spider assemblages.

Keywords: diversity, vegetation pattern, Araneae, community, sandy habitat

R. Gallé, B. Fehér, Department of Ecology, University of Szeged, H-6701 Szeged, PO Box 51, Hungary

Introduction

The landscape transformation brought about by the human activity has resulted in the fragmentation and loss of natural habitats. This trend is especially strong in the Great Hungarian Plain, leading to a patter of small quasi natural patches embedded into a matrix of agricultural fields.

As the edges have great influence on such small and fragmented patches, the transition zones are in the focus of both conservational and ecological researches (Horváth *et al*. 2002). The ecotone is a zone where spatial change of the community variables is more pronounced than on the sides of the zone (Lloyd 2000). Ecotones and edge zones are used as synonyms in present paper. Edges may affect the organisms by causing changes in abiotic conditions (Murcia 1995). Thus the abundance, distribution and life cycles (Maeflait 1990) of populations change together with the interactions between them (Murcia 1995). The biota itself plays a role of creating and maintaining the spatial heterogeneity of abiotic factors. For example plants affect air and soil humidity, temperature, intercept light and rainfall (Stewart *et al*. 1999). Vegetation diversity is claimed to be higher in edge zones because of the propagule rain from both adjacent communities (Zólyomi 1987), and the vegetation with high structural and floral diversity tends to have higher invertebrate diversity (Meek *et al*. 2002, Bedford and Usher 1994, Baines *et al.* 1998). Besides higher diversity (Odum 1983), the number of species may also reach higher value by the contribution of species of the adjacent communities and in some cases edge associated species (Magura and Tóthmérész 1997, 2000). Ecotones may serve as unique habitats for these species (Fuisz and Moskát 1992), therefore the protection of edge zones may play an important role in preserving biodiversity (Magura and Tóthmérész 1998).

Arthropods account for the highest proportion of animal biodiversity, and spiders as abundant polyfagous predators are likely to have a great influence on other invertebrate communities (Martin and Major 2001).

In this paper we analysed the properties of spider assemblages of a poplar forest clearing, the forest and the neighbouring sandy grassland in order to answer the following questions:

(1) Do the spider assemblages of the forest and the clearing differ?
(2) Is there any similarity between the assemblages of the clearing and the nearby grassland?
(3) How wide is the transition zone between the clearing and the forest in case of vegetation and spider assemblage?
(4) How does the vegetation influence the spider assemblages?

(5) How does the diversity change along the transects from the forest interior to the clearing?
(6) Are there any ecotonal specialist species?

Materials and methods

Study area and sampling

Our study was carried out in the Kiskunság National Park, near Bugac village in South Hungary. Both vegetation and spider fauna of the study area are relatively well known (Körmöczi 1989, 1991, Loksa 1987, Kerekes 1988).

In order to compare the spider assemblages of the clearing and the grassland, we placed 12-12 pitfall traps in the following habitat types: Sand dune top (ST; *Festucetum vaginatae*), wind groove 1. (WG1; *Molinio-Salicetum rosmarinifoliae*), wind groove 2. (WG2; *Molinio-Salicetum rosmarinifoliae* without considerable abundance of *Salix rosmarinifolia*), forest interior (FI;), clearing (C;). The pitfall traps were plastic jars (6 cm in diameter) filled with ethylene-glycol as preservative.

Ten parallel transects of pitfall traps running from the forest clearing through the edge zone towards the forest interior was applied to examine the effect of forest edges on spider assemblages the distance between the traps was at least 4 meters. The relative cover values of plant species were recorded from 1×1 meter quadrates which were placed in three transects. Each transect consisted of 30 quadrates. The exact arrangement of the pitfall traps is shown in Fig. 1.

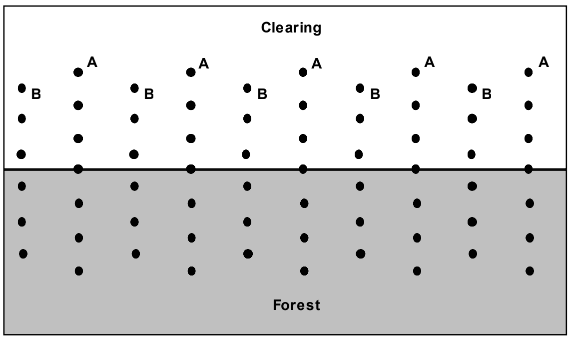

Fig 1. The arrangement of pitfall traps. The data of traps marked with the same letter were pooled.

Data analysis

Principal Component Analysis (PCA; Pilou 1984) was applied in order to determine whether there is difference between the spider assemblages of the forest and the clearing, and to reveal the resemblance of the clearing and the nearby grassland.

We pooled the data of pitfall traps working at the same distance from the trunks of the last trees to 13 groups. Scores from axis 1 of CA ordination were used to define the position and width of the ecotone. Upper and lower quartiles between the ordination score of the pooled data of pitfall traps placed in the forest interior and in the clearing were calculated. Starting from the forest interior consecutive group of traps were added to this zone until traps with ordination score beyond the corresponding quartile occurred. The same was done starting from the clearing. This method gave three zones: forest, clearing and edge zone (Lloyd *et al.* 2000). We used also the same analysis in the case of the vegetation data.

Mantel test on the basis of Bray-Curtis similarity was used to show how the vegetation influences the spider assemblages.

In order to reveal how the diversity changes along the transects Shannon and Simpson-Yule diversity were calculated for each group of traps. Kruskall-Wallis test was applied to show the difference between the forest, the clearing and the edge.

Results

A total of 3234 adult individuals belonging to 66 species were collected including *Titanoeca psammophila* Wunderlich, 1993 which is new for the Hungarian fauna.

Correspondence analysis showed similarity between the spider assemblages of the wind grooves and the clearing. The spider fauna of the clearing differs considerably from the forest (Fig. 2.).

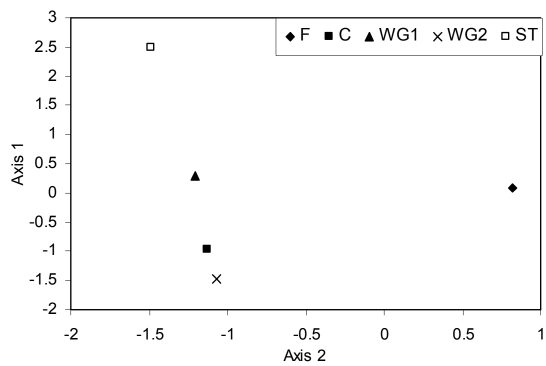

Fig 2. Correspondence analysis of the spider assemblages of the study area. F – forest, C – clearing, WG1 – wind groove (*Molinio-Salicetum rosmarinifoliae*), WG2 – wind groove (*Molinio-Salicetum rosmarinifoliae* without considerable abundance of *Salix rosmarinifolia*), ST – sand dune top (*Festucetum vaginatae*).

The position of the edge zone in the case of the vegetation and the spider assemblages overlapped (Fig. 3.). This transition zone is about 8 meters wide. The Mantel test showed close correlation between the vegetation and the spider assemblages (Mantel test r=0.633, N=13, p<0.001).

In case if spider assemblages we found no significant differences in species richness of the clearing, the edge and the forest interior (H_2=5.763, NS). Both Shannon and Simpson diversity show a significant maximum at the edge zone (Fig. 4A., Kruskal-Wallis test for Shannon diversity H_2=11.49, p<0.005; for Simpson diversity H_2=64.52, p<0.005). We found that the diversity of the vegetation is fluctuating at the edge, no significant differences were detected (Fig. 4B., Kruskal-Wallis test for Shannon diversity Ks=6.39, NS; for Simpson diversity K_s=3.37, NS).

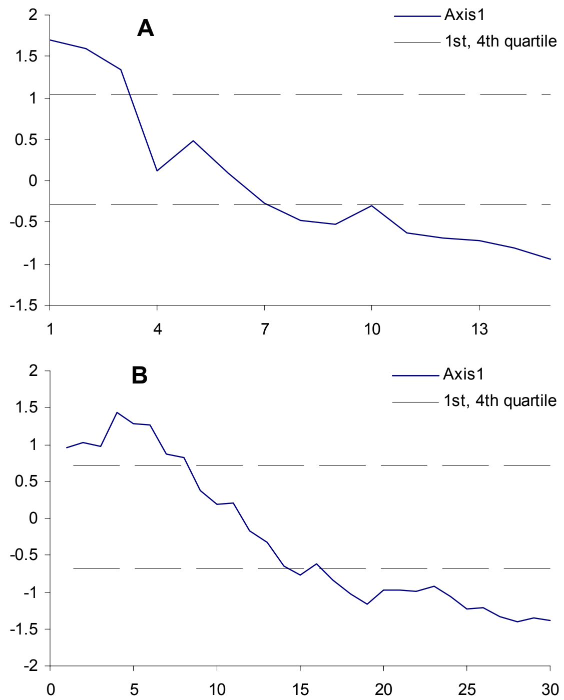

Fig 3. **A** The first axis of Correspondence analysis of the traps of transects starting from the clearing and running towards the forest interior are plotted against the distance from the first trap (clearing). **B** The results of the Correspondence analysis of the relative cover values of botanical quadrates plotted against the distance from the quadrat (clearing).

Discussion

According to Odum (1983) there might be some populations which occur only in the edge zone or reaches the highest density there (Lloyd et al. 2000), because they can utilise sources of both neighbouring habitats (Jose et al. 1996). These categories were made for plant populations, which detect the habitat heteromorphy much sharper then the spiders (Kerekes 1984). In the case of present study the edge zone was so narrow (6-8 meters), that the ground dwelling lycosid spiders move such distances in one day (Greenstone 1979, Kiss and Samu 2000). The net builder spiders have smaller home range, and are strongly influenced by edges, because these populations are highly correlated with the physiognomy of the vegetation. The plant species composition together with the web building spiders of forest edges are influenced by several microclimatic factors such as wind (Baldissera *et al.* 2004), while the forest interior offers different kinds of structures for web attachment (Robinson 1981). However Horváth *et al.* (2002) found higher web spider richness in the edge zone. In the present study we found no significant differences between the species richness of the forest the edge and the clearing.

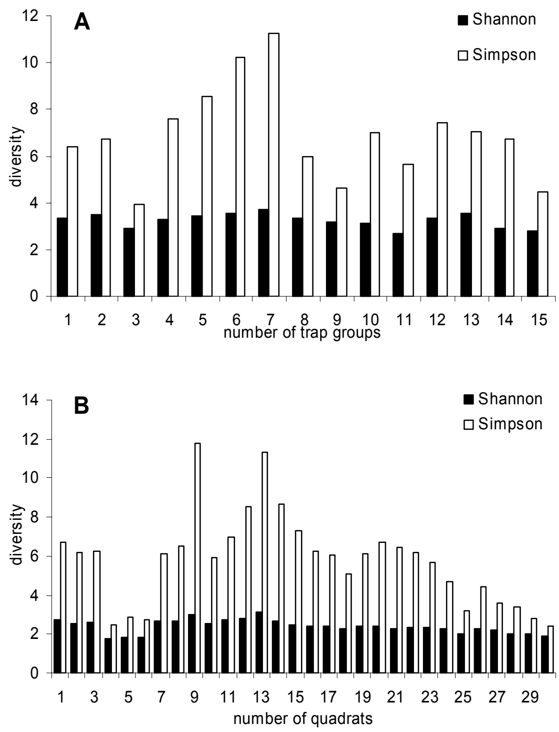

Fig 4. **A** The diversity pattern of the spider assemblages along the transects, starting from the clearing. The plot shows a significant peek at the transition zone. **B** The diversity of vegetation along the transects, also starting from the clearing.

There are several former studies showing the diversity of the ecotone higher than the adjacent habitats (e.g. in case of carabids: Magura and Tóthmérész 1997, 1998, Magura *et al*. 2001, vegetation: Zólyomi 1987, spiders: Tóth and Kiss 1999, Horváth *et al*. 2002). Others found that the value of the diversity is between the diversities of the two neighbouring habitats (Jose 1996, Lloyd *et al*. 2000). Thus the diversity pattern of the present study is not general.

References

Baines, M. Hambler, C., Johnson, P. J., Macdonald, D. W. and Smith, H. (1998): The effect of arable field margin management on the abundance and species richness of Araneae (spiders). — Ecography 21, 74-86.

Baldissera, R., Ganade, G. and Fontoura, S.B. (2004): Web spider community response along an edge between pasture and *Araucaria* forest. — Biological Conservation 118, 403-409

Bedford, S. E. and Usher, M. B. (1994): Distribution of arthropod species across the margins of farm woodlands. — Agriculture, Ecosystem and Environment 48, 295-305.

Fuisz, T. and Moskát, Cs. (1992): The importance of scale in studying beetle communities: Hierarchical sampling or sampling the hierarchy? — Acta Zoologica Academiae Scientiarum Hungaricae 38, 183-197.

Greenstone, M.H. (1979): A line transect density index for wolfspiders (*Pardosa* spp.), and a note on the applicability of catch per unit effort method to entomological studies. — Ecological Entomology 4, 23-29

Horváth, R., Magura T. and Tóthmérész B. (2002): Edge effect on weevils and spiders. — Web Ecology 3, 43-47.

Jose, S., Gillespie, A. R., George, S. J. and Kumar, B. M. (1996): Vegetation responses along edge-to-interior gradient in high altitude tropical forest in peninsular India. — For. Ecol. Manage. 87, 51-62.

Kerekes, J. (1988): Faunistic studies on epigeic spider community on sandy grassland (KNP). — Acta Biologica Szegediensis 34, 113-117.

Kiss, B. and Samu, F. (2000): Evaluation of population densities of common wolf spider *Pardosa agrestis* (Araneae: Lycosidae) in Hungarian alfalfa fields using mark recapture. — Eur. J. Entomol. 97, 191-195.

Körmöczi, L. (1989): Short term structural changes in sandy grassland communities. — Acta Botanica Hungarica 35, 145-160.

Körmöczi, L. (1991): Drought-induced changes in a sandy grassland complex in the Great Hungarian Plain. — Acta Biologica Szegediensis 37, 63-74.

Lloyd, K.M., McQueen, A.A.M., Lee. B.J., Wilson, R.C.B., Walker, S. and Wilson, J.B. (2000): Evidence on ecotone concepts from switch, environmental and anthropogenic ecotones. — Journal of Vegetation Science 11, 903-910.

Loksa, I. (1987): The spider fauna of the Kiskunság National Park. — In: Mahunka, S. (ed.) The Fauna of the Kiskunság National Park 2. 335-342. Akadémiai Kiadó, Budapest.

Maelfait, J. P. and De Keer, R. (1990): The border zone of an intensively grazed pasture as a corridor for spiders araneae. — Biological Conservation, 54, 223-238.

Magura, T. and Tóthmérész, B. (1997): Testing edge effect on carabid assemblages in an oak-hornbeam forest. — Acta Zoologica Academiae Scientiarum Hungaricae 43, 303-312.

Magura, T. and Tóthmérész, B. (1998): Edge Effect on Carabids in an Oak-Hornbean Forest at the Aggtelek National Park (Hungary). — Acta Phytopathologia et Entomologica Hungarica 33, 379-387.

Magura, T. and Tóthmérész, B. (2000): Spatial distribution of carabids along a grass-forest transect. — Acta Zoologica Academiae Scientiarum Hungaricae 46, 1-17.

Magura, T., Tóthmérész, B. and Molnár, T. (2001): Forest edge and diversity: carabids along forest-grassland transects. — Biodiversity and Conservation 10, 287-300.

Martin, T. J. and Major, A. (2001): Changes in wolf spider (Araneae) assemblages across woodland-pasture boundaries in central wheat-belt of New South Wales, Australia. — Austral Ecology 26, 264-274.

Meek, B., Loxton, D., Sparks, T., Pywell, R., Picket, H., Nowakowski, M. (2002): The effect of arable field margin composition on invertebrate biodiversity. — Biological Conservation 106, 259-271.

Murcia, C. (1995): Edge effect in fragmented forests: implications for conservation. — Trends in Ecology and Evolution. 10, 58-62.

Odum, E.P. (1983): Basic Ecology. — Saunders Collage Publishing, Philadelphia.

Pilou, E.C. (1984): The Interpretation of Ecological Data. — John Wiley and Sons Inc., USA.

Robinson J.V. (1981): The effect of architectural variation in habitat a spider community: an experimental field study. — Ecology 61, 73-80

Stewart A.J.A., John, E.A. and Hutchings, M.J (1999): The world is heterogeneous: ecological consequences of living in patchy environment. — In: Stewart A.J.A., John, E.A., Hutchings, M.J (eds)The Ecological Consequences of Environmental Heterogeny, 1-9. Blackwell Sicense LTD.

Tóth, F. and Kiss, J. (1999): Comparative analyses of epigeic spider assemblages in Northen Hungarian winter wheat fields and their adjacent margins. — J. Arachnol. 27, 241-248.

Zólyomi, B. (1987): Coenotone, ecotone and their role of preserving relic species. — Acta Bot. Hung. 33, 3-18.

TISCIA 35, 33-39

SEASONAL CHANGES IN THE MOSQUITO FAUNA (DIPTERA, CULICIDAE) IN THE CITY OF SZEGED IN 1999

Á. Szepesszentgyörgyi and Otgonchimeg Rentsendorj

Á. Szepesszentgyörgyi and Otgonchimeg Rentsendorj (2006): Seasonal changes in the mosquito fauna (Diptera, culicidae) in the city of Szeged in 1999. – *Tiscia 35, 41-47*

Abstract. Authors systematically investigated the Culicidae fauna in Szeged in 1999, with regard to quantitative and qualitative aspects of the mosquito species living in the city following disturbance of their natural habitat by insecticidal treatment. The main species observed in Szeged were *Culex pipiens* (46.9%), *Culex modestus* (10.1%) and *Aëdes vexans* (10.1%). In the course of the mosquito season, the species composition changed at the different sampling sites. Different mosquito assemblages were observed in Szeged than those along the flood area of the River Tisza. After insecticidal treatment, *Aëdes* species may immigrate from other habitats. The investigation revealed a species not reported previously in Szeged: *Anopheles hyrcanus* Pallas, 1771.

Keywords: mosquito assemblages, disturbed habitat, density, multivoltine

Á. Szepesszentgyörgyi, Otgonchimeg Rentsendorj, Bay Zoltán Foundation for Applied Research, Institute for Biotechnology, P.O.Box 2337, H-6726 Szeged, Hungary

Introduction

Mosquitoes have probably always disturbed humans. People began to think about protection against mosquitoes only last century. For this purpose, floral poisons were utilized. These were effective, but expensive. Pesticides with neurotoxic effects (e.g. DDT) and later phosphoric-acid-esters (e.g. Diazinon and Gesarol M) were used more recently. Anti-mosquito treatment must be applied prudently because these chemicals are not only dangerous for aquatic and land animals (Mihályi 1963).

The Culicidae-fauna of Hungary was investigated over a long period by Mihályi and co-workers. The mosquito assemblages in the Tisza basin have been monitored by others, but no study has been reported on urban mosquitoes living in a disturbed habitat. Three main species were revealed in the Tisza basin by the previous measurements: *Aëdes vexans* (41.17%), *Culex modestus* (26.68%) and *Aëdes rossicus* (19.06%) (Branka 1984, Tóth 1977). One of the most important tasks in combating the problem caused by mosquitoes has always been to identify the entomological situation. Weekly chemical anti-mosquito treatment can lead to changes in the composition of the mosquito assemblages. *Aëdes* genus appears after a wet period (Mihályi 1963). The density of natural mosquito assemblages is influenced by the flood of the River Tisza and by the current rainfall. The mosquito assemblages in the Tisza basin are similar to those of the urban mosquitoes in the early and wet springtime. The several-generation mosquitoes remain dominant in the flood area of the Tisza basin. In the course of an arid season, the multivoltine species accompany the several-generation mosquitoes. The individual numbers of the *Culex* genus can be markedly high in a precipitation-poor season. These species easily find the water necessary for their development in the environs of houses and rubbish dumps. The species of the *Culex* genus lay their eggs on the surface of water in the form of rafts (Mihályi 1963).

A detailed investigation of the Culicidae fauna in the Tisza basin is important both inside and outside the built-up areas.

Materials and Methods

Collecting method

Mosquitoes were collected at 11 sampling points in Szeged, selected with regard to the diverse habitats of mosquitoes (Fig. 1). The collection at the different sampling points was performed at the same time. The ”hand sucking” procedure was applied in the capturing of the individuals. Settled blood-sucking mosquitoes were covered up with the funnel-shaped end of the ”hand sucking” device and were sucked up inside the tube. Collection was performed between 19:30 and 21:30, the time depending on the time of sunset. At the time of collection, no other person was present within 20 m. The collected individuals were provided with a slip of paper indicating the date and site of sampling (Erdős 2001). After the mosquito season, the caught mosquitoes were identified via the characteristic features of the species. The main features for the imagos were the colour, size and shape (Mihályi 1963).

Certain phrases were applied in relation to the dominance:

dominant species: the most frequent species or species accounting for >25% of the total number of caught mosquitoes

subdominant species: species accounting for 10-25% of the total number of caught mosquitoes

rare species: species accounting for <10% of the total number of caught mosquitoes

The weekly mosquito control

Chemical anti-mosquito treatment was performed weekly from May until the end of September. This was done by plane with UNITOX 14 ULV at a dose of 0.6 litre/ha (14% dichlorphos) or with K-OTHRIN 1 ULV 0.6 litre/h (0.12% deltametrin) and with the use of a thermal-fog making machine on the ground with UNITOX 100 SC (1000 g dichlorphos/litre) in a concentration of 0.02 litre/ha. The fog-maker was made by the addition of 2 litres of material to 98 litres of diesel oil. The insecticide was sprayed on the vegetation at a dosage of 10-15 litre/ha. The chemical anti-mosquito was applied at dawn or at nightfall in order to protect useful insects (Erdős 2001). The efficacy of this anti-mosquito treatment was 92-100% (Szító 1999, personal communication).

The sampling sites

Szeged is a typical lowland city. The wet areas suitable for the breeding of mosquitoes involve both alkaline waters and non-alkaline waters. The character of these areas depends on the geological factors and on environmental pollution. The data on the composition of the various water samples were kindly provided by L. Zs. Nagy (AtiKöFe) (personal communication).

Alkaline waters: These waters are characterized by a high salt concentration, a high conductance (2000-4000 μS/cm) and a high pH (8.5-9.5). The dominant cations are Na^+ (800-1200 mg/l) and Mg^{2+} (200-400 mg/l). The dominant anions are SO_4^{2-} (300-600 mg/l), Cl^- (400-700 mg/l) and HCO_3^- (500-1000 mg/l).

Non-alkaline waters: These are lakes, back-waters and channels, in general with a layer of silt covering their bed. A moderate conductance (700-1300 μS/cm) and weakly basic pH (8.5-9.5) are characteristic. The dominant cations are Na^+ (30-80 mg/l) and Mg^{2+} (10-30 mg/l). The dominant anions are SO_4^{2-} (20-60 mg/l), Cl^- (20-40 mg/l) and HCO_3^- (100-300 mg/l).

Transitionally alkaline waters: Originally these were not alkaline waters, but by reason of the harmful effects of the local agricultural, communal and industrial pollution (e.g. chemical fertilizer systems, pollution of hot springs, etc.) a considerable quantity of pollution material passed into the water and it began to become alkaline. The waters around Szeged are usually polluted or moderately polluted (Felföldy 1987).

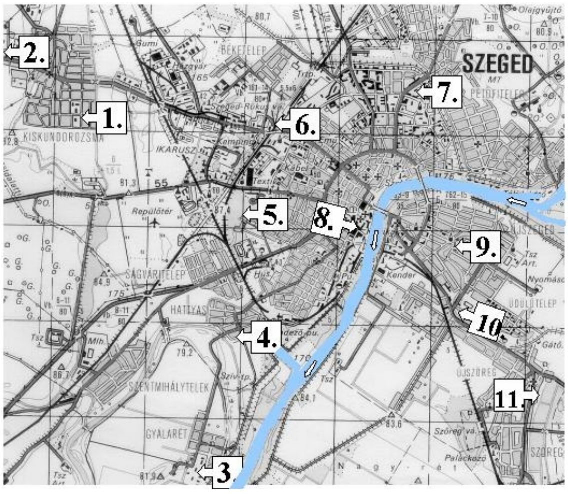

Fig. 1. Sampling sites in Szeged

1. Dorozsma sampling site: This area is situated in a garden suburb with detached houses. The Domaszéki Channel is situated near by. Its surface is 1 ha; average depth is 1-1.5 m. It is not alkaline water. Agricultural pollutants affect this area, as do chemical fertilizers and communal pollution.

2. Dorozsma Sziksós Lake sampling site: This is situated in a holiday home area with detached houses. There is a local clayey-alkaline lake where mosquitoes breed among the reeds along the shore. Its surface is 21 ha, with an average depth of 1.1 m.

3. Gyálarét sampling site: This is situated in a holiday home area with detached houses. The natural waters comprise several channels of the transitionally alkaline Gyálai Holt-Tisza backwater. Total surface of the channels is 1 ha, with an average depth of 1 m and an average width of 4 m. The inshore parts are often reedy.

4. Hattyas sampling site: This area is situated in a garden suburb with detached houses. The Feketepart section of the Gyálai Holt-Tisza backwater is situated nearby. It is tending to become alkaline water because of the inflow of hot water. It is at an advanced stage of silting. Length of the Feketepart section is 1.3 km, with an average width of 20 m, an average depth of 1.6 m and a total surface of 2.6 ha. The inshore parts are often reedy.

5. Móraváros sampling site: This area is situated in a housing estate with blocks of flats. The Sancer Lakes are transitionally alkaline. Average depth of the lakes is 2-4 m and their total surface is 11 ha.

6. Kossuth L. Avenue sampling site: This area is situated among housing estates. There are several lakes: the non-alkaline, highly silted Búvár Lake (3 ha), the alkaline Csemegi Lake (2 ha) and the transitionally alkaline Lencsés Lake (7-8 ha).

7. Olajbányász Square sampling site: This area is situated in a housing estate. There is no natural water.

8. Dom Square sampling site: This is the city centre of Szeged, an area characterized by blocks of flats. There is no natural water.

9. Újszegedi Víztorony Square sampling site: This area is situated in a housing estate and a garden suburb with detached houses. Its natural water is the silted Holt-Maros backwater, which has a length of 4 km, an average width of 25 m, an average depth of 1.5 m and a total surface of 10 ha. It is undergoing rapid silting and is becoming overgrown with vegetation.

10. Kállay Park sampling site: This greenwood area is situated in a garden suburb with detached houses. Its natural water is the silted Holt-Maros backwater (see point 9).

11. Szőreg sampling site: This area is situated in a garden suburb with detached houses. Its natural water is the non-alkaline, silted Szőreg-Deszk main canal. The inshore parts are often reedy.

Characteristics of collected biting mosquito genera

Aëdes genus: In autumn, the females lay their eggs one by one on the ground or on blades of grass. In spring, the eggs develop into larvae in pools which remain on the flood area after flooding. The imagos fly even 18 km per day. The adults are active at daybreak and at nightfall (Mihályi 1963).

Culex genus: This is the most frequent mosquito genus in the studied area. These mosquitoes are active also at night time and enter buildings. The fertilized female mosquitoes live here during the winter and in summer they lay their eggs on the surface of water in the form of a raft. Each raft of eggs contains approximately 300 eggs (5×2-3 mm). The imagos move up to 500 m from their breeding water. During summer 6-7 generations develop (Mihályi 1963). This genus has a high species richness, but not a varied species composition. In Szeged, the species *Culex pipiens molestus* is more frequent than *Culex modestus*, which is dominant alongside the River Tisza.

Theobaldia genus: The large body is a characteristic feature. The fertilized female mosquitoes spend the winter here and in summer they lay their eggs on the surface of water in the form of a raft. The imagos do not enter houses. They are active in biting during winter too (Mihályi 1963). These mosquitoes are relatively rare in their disturbed habitat in Szeged.

Anopheles genus: The fertilized female mosquitoes spend the winter here and in summer they lay their eggs on the surface of water in the form of a net. The female imagos in general suck blood at night. These mosquitoes prefer warm-blooded animals (e.g. cows, horses, pigs, etc.) to humans for their blood. The female imagos display a predilection for dwelling on the walls of stables. Larvae are not found in highly polluted water. Imagos fly 1-4 km per day (Mihályi 1963).

Characteristics of collected biting mosquito species

Culex pipiens molestus Forskal, 1775: This flies from the end of May to October. In winter it is observed in lower numbers, because the fertilized female mosquitoes spend the winter in apartments, cellars, etc.). It prefers human blood to that of warm-blooded animals. It is active throughout the night. It lays its eggs wherever the temperature and oxygen content of the water are suitable (barrels of rainwater, pools, discarded tyres, ditches, reedy lakes, etc.). It is a multivoltine species.

Aëdes vexans Meigen, 1830: This species appear after the flooding of the river. It flies from April until the end of October. It is a cosmopolitan species. Its imagos migrate far away. Some stained individuals have been found as far as 22 km from the breeding site. Its number of generations depends on the number of floodings (Mihályi 1963).

Culex modestus Ficalbi, 1890: This flies from June until early October. It is a thermophilic species; its larvae develop in sunny waters with rich vegetation. It is a multivoltine species (Mihályi 1963).

Aëdes dorsalis Meigen, 1830: This flies from early April until September. It favours alkaline waters and lowland pastures. Its larva is a lover of salt and develops in sunny, shallow lakes or temporary pools. It has 2-3 generations per year (Mihályi 1963).

Aëdes sticticus Meigen, 1838: This flies from early April until September after floods. It lives in forests. Its larvae favour shady waters, and develop in forests on flood areas. The number of generations (2-5) depends on the number of floods and the rainfall. Its eggs are laid on ground and on blades of grass (Mihályi 1963).

Aëdes annulipes Meigen, 1830: This flies from the end of April until the end of July. It has a painful bite. It lives in forests, but its larvae prefer sunny waters. The imagos live in the edges of forests and green woods. It is a univoltine species; it develops only one generation per year (Mihályi 1963).

Theobaldia annulata Schrank, 1776: This flies from spring until late autumn. It plays only a minor part in the damage caused by mosquitoes. It lives outdoors, indoors, in forests and in reedy areas. Its larvae primarily prefer polluted water (Mihályi 1963).

Aëdes cantans Meigen, 1818: This flies from the middle of April until the end of July. This species is not found in forests on flood areas. It has only one generation per year. It is a forest mosquito. It mainly favours marsh-woods. Its larvae prefer shady water (Mihályi 1963).

Aëdes cinereus Meigen, 1818: This flies from April until the end of August. It inhabits reedy areas, greenwoods and brushwoods. It is absent from forests on flood areas and the alkaline waters of the lowland. It has 2 or more generations per year (Mihályi, 1963).

Aëdes rossicus Dolbeskin, Gorickaja and Mitrofanova, 1930: This flies from April until August. It lives in the forests on flood areas of the Rivers Danube and Tisza. It has 1 or more generation per year (Mihályi 1963).

Aëdes caspius Pallas,1771: This flies from the end of April until early October. It is a typical species of the steppes and meadows of the lowland. It does not enter houses. Its larvae tolerate salt and develop in the temporary, sunny lakes of the lowland. The numbers of its generations depend on the floodings of its breeding areas (Mihályi 1963).

Aëdes rusticus Rossi, 1790: This flies from the middle of April until the end of June. It plays a small part in the springtime mosquito problems. It can be found in forests and forest clearings. It has only 1 generation per year (Mihályi 1963).

Aëdes flavescens Müller, 1764: This flies from early April until the middle of August. It is an early spring species. It tolerates salt and develops in alkaline pools on sunny meadows in lowland areas. It has a spring and a summer generation (Mihályi 1963).

Aëdes excrucians Walker, 1856: It flies from the middle of April until the end of July. It plays a small part in the springtime mosquito problems. Its larvae favour colder water. It has 1 or 2 generations per year (Mihályi 1963).

Culex hortensis Ficalbi, 1899: This flies from early April until the end of October. It favours sunny and watery meadows or reedy lakes. In the daytime it hides in hollows or caves. It does not like human blood (Mihályi 1963).

Anopheles messae Falleroni, 1926: This flies from May until the end of September. It is a characteristic species in warm-watered swamps on the lowland. It does not like polluted water. It prefers sunny, shallow water overgrown with vegetation. Its imagos swarm and mate only outdoors (Mihályi 1963).

Anopheles hyrcanus Pallas, 1771: This flies from May until September. It lives outdoors, mainly in reedy lakes. It likes fresh water. This mosquito is sensitive to the salinity of water. It seldom attacks humans (Mihályi 1963).

Undetermined species: The identification of the collected mosquito species was not always easy because the species were collected by human-trap, and were sometimes damaged during collection, so that their determining features were not recognizable. These individuals were included in the quantitative determination, but were not included in the qualitative determination of distribution.

Some of the examined factors relating to the appearance of biting mosquitoes

The most important factors in the development of biting mosquitoes are still shallow water and the appropriate temperature. Some genera require other breeding water conditions too (humidity, salt content, organic substance content, pH, light conditions, light-shade relationship, etc.) (Mihályi 1963). In 1999 we observed the water level of the River Tisza, the average daily temperature and the daily rainfall (Fig. 2). The temperature was suitable for the development of mosquitoes from May until the end of September. Our examinations were performed in this period (Fig. 3). In Szeged, the mosquito season started with the appearance of the

Aëdes species in the middle of May and finished with a predominance of the *Culex* species at the end of September. In low numbers, the individuals of the *Aëdes* genus could be found in October. The individuals of the *Culex* genus spend the winter in the form of imagos.

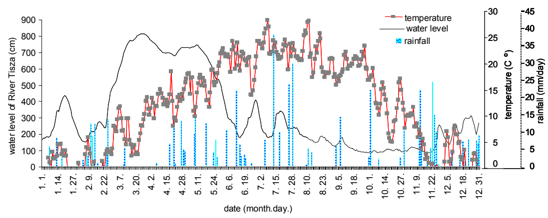

Fig. 2. Water level of River Tisza (cm), daily average temperature (ºC) and daily rainfall (mm) in Szeged in 1999

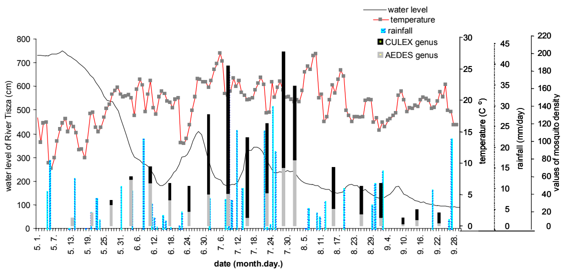

Fig. 3. Water-level of River Tisza (cm), daily average temperature (ºC), daily rainfall (mm) and average mosquito density (ind./hour) in Szeged from May to September in 1999

Water level of the River Tisza: River Tisza rises in the Carpathians. When it descends to Pannonia, it becomes a typical lowland river. River Tisza has two maxima and two minima annually. For the appearance of mosquitoes, the first maximum is more important. It occurs in April as a result of snow melting in the Carpathians. The second maximum occurs at the end of November and is of minor interest for mosquito control. The number of mosquitoes does not depend on the water level of the Tisza, but after the springtime-flood the *Aëdes* mosquito larvae begin to develop in the pools of the flood area (Branka 1984, Mihályi 1963).

Temperature: The temperature reaches the value necessary for the development of mosquito larvae between early May and the end of September. In early May there is a strong fall in temperature during the night, but the eggs of the *Aëdes* species laid on the ground on flood areas in the course of earlier years open in response to the warm daytime. The imagos of the *Culex* genus lay their egg-rafts on the surface of the breeding water after the cessation of the sharp nightly fall in temperature, in the middle of June (Mihályi 1963).

Rainfall: In summer, the mosquitoes breed in temporary water (pools, barrels of rainwater, pools in gardens, etc.), formed in consequence of rainfall (Mihályi 1963). In summer, the multivoltine mosquito species favour the temporary pools.

Results and Discussion

After the springtime flood, there is a humid period along the River Tisza. When the temperature reaches the minimum necessary for the development of mosquitoes (in May), the larvae hatch out from the eggs. The distribution is shown in Fig. 4. In general, the progress of the flood coincides with an increase in daily average temperature. Few mosquito species are present in the flood area. Far from the River Tisza, the local conditions may result in a more diverse mosquito species composition. We found numerous woods-favouring *Aëdes sticticus* and salt-favouring *Aëdes dorsalis* individuals besides *Aëdes vexans* individuals (Table 1).

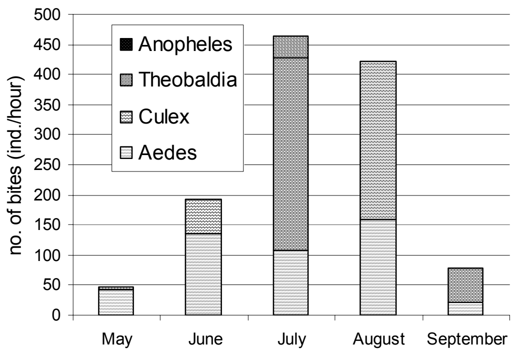

Fig. 4. Numbers (ind./hour) of individuals of biting-mosquito genera collected in Szeged from May to September in 1999.

After the stabilization of the optimal temperature, the individuals of *Culex* genus emerged in force in the middle of June. They became dominant during the dry summer. *Culex pipiens molestus* dominated at nearly all sampling sites, with the exceptions of sites 3 (Gyálarét) and 10 (Kállay Park). The greatest number (3934 ind./hour) was measured at sampling site 6 (Kossuth L. Avenue). This was followed by sampling site 4 (Hattyas), with a mosquito density of 2412 ind./hour, and sampling site 9 (Újszegedi Víztorony Square), with 1722 ind./hour. The salt-tolerant *Aëdes dorsalis* was observed at all sampling sites. The degree of alkaline character of the breeding sites is a feature of this phenomenon. Low numbers of individuals were

Table 1. Numbers of Culicidae species (ind./hour) collected during blood-sucking at collecting sites in Szeged in 1999.

No.	Sampling sites Mosquito species	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	Total	%
(1)	Aëdes annulipes Meigen	102	84	-	18	14	264	-	-	36	276	-	794	5.9
(2)	Aëdes cantans Meigen	-	30	96	6	12	80	6	-	-	66	36	332	2.4
(3)	Aëdes caspius Pallas	30	18	-	-	12	18	-	-	-	-	-	78	0.6
(4)	Aëdes cinereus Meigen	66	24	-	-	-	6	-	-	-	-	-	96	0.7
(5)	Aëdes dorsalis Meigen	42	18	90	144	90	646	18	-	12	48	54	1162	8.6
(6)	Aëdes excrucians Walker	-	-	-	-	6	6	-	6	-	-	-	18	0.13
(7)	Aëdes flavescens Müller	-	-	-	18	-	6	-	-	6	-	-	30	0.22
(8)	Aëdes rossicus D. G. M.	-	42	42	12	-	-	-	-	-	-	-	96	0.7
(9)	Aëdes rusticus Rossi	-	-	-	-	-	6	-	-	-	60	-	66	0.41
(10)	Aëdes sticticus Meigen	78	42	162	72	166	226	6	-	66	78	168	1064	7.85
(11)	Aëdes vexans Meigen	96	120	552	204	42	84	6	-	72	174	18	1368	10.1
(12)	Culex hortensis Ficalbi	-	-	-	-	-	-	-	-	12	-	-	12	0.09
(13)	Culex modestus Ficalbi	204	24	18	528	132	260	-	12	90	6	90	1364	10.1
(14)	Culex pipiens molestus Forskal	336	294	66	1386	500	1998	24	48	1260	222	222	6356	46.9
(15)	Theobaldia annulata Schrank	6	18	-	-	12	252	-	-	108	-	-	396	2.9
(16)	Anopheles messae Falleroni	-	12	-	-	-	-	-	-	-	-	-	12	0.09
(17)	Anopheles hyrcanus Pallas	-	-	-	12	-	-	-	-	-	-	-	12	0.09
(18)	Not determined	-	30	36	12	24	82	-	-	60	30	24	298	2.2
	Total	960	756	1062	2412	1010	3934	60	66	1722	960	612	13554	100

1= Dorozsma; 2 = Dorozsma (Sziksós-Lake); 3 = Gyálarét; 4 = Hattyas; 5 = Móraváros; 6 = Kossuth L. Av; 7 = Olajbányász Square; 8 = Dóm Square; 9 = Víztorony Square; 10 = Kállay Park; 11 = Szőreg

collected at sampling sites 8 (Dom Square) (66 ind./hour) and 7 (Olajbányász Square) (60 ind./hour). The distribution of the individual numbers can be seen in Fig. 5.

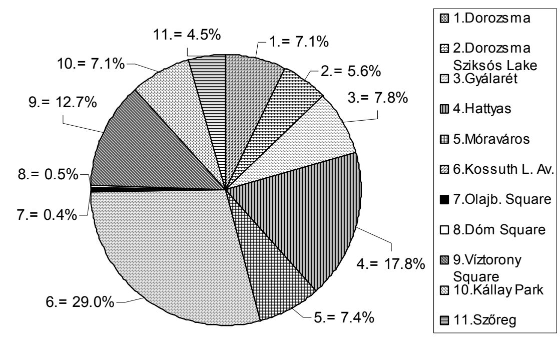

Fig. 5. Frequency distribution (%) of mosquito species collected in Szeged in 1999.

In the middle of summer, the individuals of the *Theobaldia* genus appeared in lower numbers, but at sampling site 6 (Kossuth L. Avenue) they were more significant (252 ind./hour).

Few individuals from the *Anopheles* genus could be collected with the human-trap method. We suggest that the individuals of this genus prefer the blood of animals to human blood. Two individuals of *Anopheles hyrcanus* were collected in Szeged. In earlier examinations, this species was not observed in the Tisza basin, but most recently it has been found in the mosquito assemblage of the Tisza Lake (Szabó 2003, personal communication).

In 1999, *Culex pipiens* (46.9%) was the dominant species in Szeged, with *Culex modestus* (10.1%) and *Aëdes vexans* (10.1%) as subdominant species. Other species appeared in lower numbers: *Aëdes dorsalis* (8.6%), *Aëdes sticticus* (7.85%), *Aëdes annulipes* (5.9%), *Theobaldia annulata* (2.9%) and *Aëdes cantans* (2.4%).

This result can be explained by he impact of urbanization (the presence of communal waste, the application of chemical fertilizers, the presence of polluted water, weekly chemical mosquito treatment etc.). In the modified environment, the dominant species appeared at all collecting sites.

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References

Branka, B. (1984): Investigation of mosquito fauna (Diptera, Culicidae) in Potsije. – Tiscia an Ecological Journal. 20, 111-116.

Erdős, Gy., Szlobodnyik, J. and Gálffy, Gy. (2001): A technological letter on protection against mosquitoes (in Hungarian). – EPINFO. 8, 9: 22-24.

Felföldy, L. (1987): Biological water qualification (in Hungarian). – Vízügyi hidrobiológia. 16, 19-29.

Kertész, K. (1904): A taxonomical review of mosquito fauna in Hungary (in Hungarian). - Állattani Közlemények. 3, 1-75.

Mihályi, F. (1939): Entomological protection against mosquitoes in Hévíz (in Hungarian).– Állattani Közlemények. 36, 107-117.

Mihályi, F. (1954): Preliminary investigations on a solution of the mosquito problem along the Danube (in Hungarian). – Állattani Közlemények. 44, 1-2: 81-86.

Mihályi, F. and Gulyás, M. (1963): The biting mosquitoes of Hungary (in Hungarian). – Akadémiai Kiadó, Budapest.

Mihályi, F., Soós, Á., Sztankay, Sz. and Zoltai, N. (1953): The mosquito status of villages along Lake Balaton and the methods of practical protection (in Hungarian). – A Magyar Tudományos Akadémia Biológiai Osztályának Közleménye. 2, 35-94.

Straub, F. B. (1982): Biological Encyclopedia (in Hungarian). – Academic Publisher, Budapest.

Tóth, S. (1977): Quantitative and qualitative investigations into the Culicidae fauna of the Tisza-basin. – Tiscia 12, 93-99.

Zoltai, N. and Szabó, B. J. (1968): Ten-year culicoidological experience in the Szob-Dunaföldvár reach of the Danube (in Hungarian). – Egészségtudomány. 12, 68-74.

TISCIA 35, 49-54

THE DYNAMICS OF CHIRONOMIDAE LARVAE (DIPTERA) AND THE WATER QUALITY IN MERIC RIVER (EDIRNE/TURKEY)

N. Ozkan and B. Camur-Elipek

Ozkan, N. and Camur-Elipek, B. (2006): The dynamics of Chironomidae larvae (Diptera) and the water quality in Meric River (Edirne/Turkey). – *Tiscia 35, 49-54*

Abstract. The dynamics of Chironomidae (Diptera) larvae and some physicochemical features of water were investigated in Meric River (Edirne/Turkey) from September 1995 to August 1996. Also, the relation between the number of larvae and physicochemical parameters as studied.
The larval Chironomidae fauna was found to be 498 individuals in per m^2 for 65 different species. Polypedilum scalaenum was determined to be dominant.
According to Shannon-Wiener diversity index Meric River had diversity 1.23. Furthermore, according to Pearson correlation index, water temperature ($r = +0.71$, $P<0.05$), pH ($r = +0.61$, $P<0.05$) and Chloride ($r = +0.61$, $P<0.05$) had direct proportional while NO_2-N ($r = -0.73$, $P<0.05$) had inverse proportional with the number of larvae.

Key words: Chironomidae larvae, Meric, Maritza, Evros, River.

N. Ozkan, Trakya University, Faculty of Education, 22030 Edirne / Turkey, **B. Camur-Elipek***, Trakya University, Faculty of Arts and Science, Department of Biology, 22030 Edirne/Turkey, E-mail : belgincamur@yahoo.com
*Corresponding author

Introduction

Larval period of Chironomidae is the longest period of life cycle of these insects. Chironomidae larvae are quite important in production of benthic biomass and they can be found in a many different environments because of their ability to adapt to extremes of some physicochemical composition of water. However, the dynamics and biomass production of these larvae vary in different types of water bodies.

In Turkish streams, Sahin (1980, 1984, 1987, 1991), Tanatmis (1989), Kirgiz and Guher (1992), Ozkan and Kirgiz (1995) discussed the Chironomidae larvae until the present.

In this study, the composition of species and the number of occurrence of Chironomidae larvae in Meric River (Turkey) were examined by considering some ecological factors.

This paper is an introduction to investigations that are planned for the following years in Meric River.

Methods

Study Area

Meric River (Maritza, Evros) is located in European part of Turkey. The river rises in Bulgaria and draws a border among Bulgaria-Greece-Turkey (Fig. 1). Also, it makes an important wetland between Greece and Turkey, and then is poured out to Aegean Sea. The length of the river is 185 km in Turkey. It has 60-520 cm depth and 130-300 m width. Meric River has a lot of tributaries and never dries during summer. The structure of bottom and habitat type varies along the river because it is surrounded by agricultural areas, settlements and a few textile factories. Sewage water of them is poured out to Meric River.

Eight different stations that characterized the river were chosen for this investigation. The material was sampled from these locations between September 1995 and August 1996 at monthly intervals. Nevertheless, the sampling could not been done in February 1996 because of excessive rain.

Station 1: Meric River enters to Turkey from Bulgaria. The structure of bottom consists of sand and mud.

Station 2: There are some Textile Factories around this location. Its bottom has only mud, brownish-black colour of water and fast water flow as compared with the other stations.

Station 3: Arda Stream joints to Meric. The structure of bottom consists of sand and stone.

Station 4: Tunca Stream joints to Meric. Bottom of this location has sand and mud.

Station 5: Edirne city. There are a lot of settlements around this location. Bottom structure consists of sand, mud and detritus.

Station 6: There are a lot of agricultural areas around this location. Water of the river is used for irrigation. The structure of bottom consists of mud and detritus.

Station 7: Also, there are a lot of agricultural areas around this location. Bottom has mud and detritus.

Station 8: Sazlidere Stream which is known as polluted joins to Meric. A lot of industrial factories around Sazlidere are poured out their sewage water to the stream.

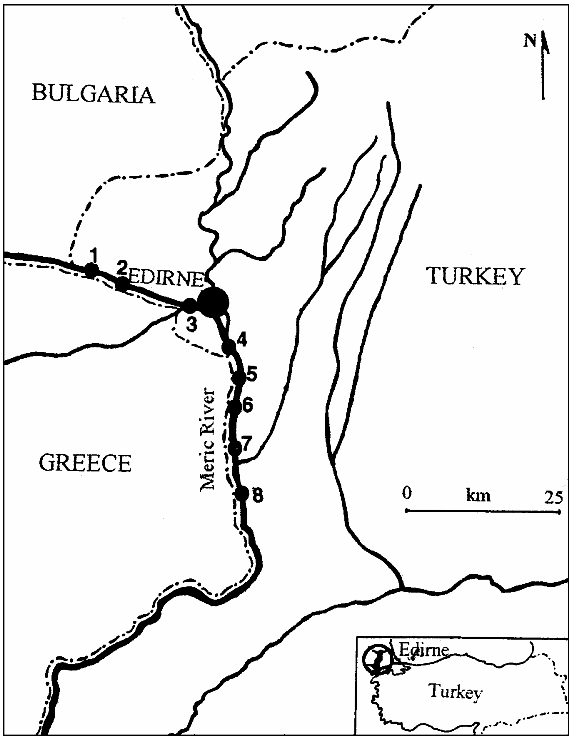

Fig. 1. Geographical situation of Meric River and sampling stations.

Sampling

Samples were collected by using an Ekman Drage (15 cm × 15 cm) twice at each station, sieved on a 0.5 mm sieve and the remaining Chironomidae larvae were preserved in 70 % Ethanol. Larvae were sorted in the laboratory into different species and were evaluated for per m^2. Publications of Chernovskij (1961), Fittkau (1962), Beck and Beck (1969), Bryce and Hobart (1972), Seather (1977), Fittkau and Reiss (1978), Moller and Pillot (1978-1979, 1984), Sahin (1980, 1984, 1987, 1991), Fittkau and Roback (1983), Sahin *et al.* (1988) were utilized for taxonomical diagnosis of the samples. For determining the larval Chironomidae fauna in Meric, sampling was also conducted out of the stations but it was not calculated.

Shannon-Wiener diversity index was applied to obtain statistical data about the distribution of Chironomidae larvae.

Furthermore, preference for substratum type of larvae was recorded.

Distributions of larval Chironomidae in the bottom of river, like other benthic organisms, are related with water qualities. For this aim, at each station water temperature, electrical conductivity and pH of surface water in Meric were measured at the time when benthic sample was taken at monthly. Also, water samples which were taken by a Ruttner water sampler were carried to laboratory in special bottles and dissolved oxygen, biochemical and chemical oxygen demands, Calcium, Magnesium, Chloride, NO_3-N, NO_2-N, Phosphate and Chromium were analyzed.

Pearson correlation index was used to determine if there was any relation between the numbers of Chironomidae larvae and the physicochemical composition of water.

Result and discussion

Between September 1995 and August 1996, 498 individuals in per m^2 for 65 different larval Chironomidae species were found in Meric River (Table 1). The dominant species are *Polypedilum scalaenum* with 24.3% abundancy. It is followed by *P. aberrans* (13.0%), *Chironomus anthracinus* (8.1%) and *Cryptochironomus defectus* (8.1%) (Table 2).

In addition, *Potthastia gaedii, Cryptochironomus conjugens, Zalutschia* sp. and *Micropsectra* sp. were found at outside of the stations.

At all the sampling stations considerable differences were observed for the dynamics of

Table 1. Distribution of Chironomidae larvae in Meric River in the period of investigations as numerically (monthly and stations).

Mths/ Stat	1st	2nd	3rd	4th	5th	6th	7th	8th	Ave	NS	SWI
Aug.	177	-	817	186	112	84	7752	1996	1391	33	1.45
Sep.	243	-	355	71	242	293	216	238	207	16	1.14
Oct.	24	31	1082	34	123	208	498	387	299	13	1.07
Nov.	-	-	82	73	65	38	373	373	124	11	0.99
Dec.	348	38	339	63	-	-	1119	-	239	18	1.22
Jan.	86	-	546	315	284	36	-	-	159	18	1.23
Mar.	322	37	160	84	54	94	-	-	94	15	1.16
Apr.	937	52	175	212	223	399	111	-	264	23	1.32
May	2254	370	410	200	2304	655	1101	2210	1188	35	1.50
Jun.	254	70	359	306	53	183	1228	628	385	19	1.20
Jul.	5616	20	920	244	170	1323	412	380	1136	22	1.28
Ave.	932	56	476	162	330	301	1165	564	498		1.23
NS	36	15	35	27	36	31	35	20			
SWI	1.47	1.13	1.49	1.40	1.50	1.43	1.482	1.21			

(Ave.= Average number of larvae, NS= Number of species, SWI= Shannnon-Wiener Index)

Chironomidae larvae (both species and numbers) because of the fact that the character of different substratum structures and water quality. Species number was the highest at stations 1 and 5 while it was the lowest at station 2. On the other hand, especially at 7th station, the average number of larvae was found very high because it was clear as compared with the other stations. Also, at station 2 average number of Chironomidae larvae was found very poor because of sewage water of the textile factories pours, having a substratum with only mud, brownish-black colour of water and fast water flow as compared with the other stations. Species number was the highest in May while it was the lowest in November. The greatest average number of larvae was observed in summer whereas decreased during winter. It was observed that an average number of larvae increased especially in August, and it decreased in March because of this group have multivoltin species.

These results were also supported by statistically. Shannon-Wiener diversity index was determined the highest at station 5 and in May while was found the lowest at station 2 and in November (Table 1). Although the number of species is equal at stations 1 and 5, the diversity index result is lower at station 1 because of high number of individuals. It is not surprise that the diversity was determined the highest at station 5 because of the hydromorphological structures, type of bottom and habitat conditions are little better which is compared with the others. The reason of the poorest diversity at station 2 is that sewage water of textile factories. As known, Chironomidae larvae are bioindicator in aquatic environments. Only some species live in extreme conditions (like pollution) of water. In this study, only 15 species (*T. punctipennis, Procladius* sp., *Krenopelopia* sp., *C. bicinctus*, *L. pusillus, C. anthracinus, C. viridicollis, C. plumosus, C. tentans*, *P. scalaenum, P. nubeculosum, P. convictum, E. pagana, Beckiella* sp. and *P. lauterborni*) were found at station 2 in low number. Diversity index was determined the poorest in November because of the activities of some predator macroinvertebrates increase in this period. Seasonal variations affect the features of the water and the dynamics of benthic macroinvertebrates. Only 11 species (*T. punctipennis, Procladius* sp., *C. bicinctus, C. anthracinus, P. convictum, P. intermedius, P. connectens, M. chloris, R. demeijerei, S. longipugionis*, and *C. defectus*) were found in November while 35 species were found in May.

Furthermore, 49 species were found in substratum with sand (S), 17 species were found in substratum with mud (M), 13 species were found in substratum with sand-mud (SM), 3 species were found in substratum with sand-stone (SSt), 25 species were found in substratum with sand-detritus (SD), 12 species were found in substratum with mud-detritus (MD), 22 species were found in substratum with sand-mud-detritus (SMD), and 5 species were found in every type (E) of substratum (Table 2).

To determine any relation between the number of larvae and the features of the water, some physicochemical parameters were measured in Meric River. Water temperature, pH, Calcium, Magnesium, Chloride and Chromium were found at normal levels in the course of this study. Electrical conductivity was low quality level in November, December and March. Dissolved oxygen was found inverse proportional with water temperature (when the water temperature increased in the summer months,

Table 2. Taxonomical list of larval Chironomidae in Meric River and their dominancy and preference for substratum.

1-*Tanypus punctipennis* (M,SD,MD,SMD) (0.2%)	34-*Chironomus tentans* (S, M, SD, MD, SMD) (1.6%)
2-*Tanypus kraatzi* (SMD) (0.01%)	35-*Polypedilum aberrans* (S, M, SSt, SD) (13.0%)
3-*Procladius* sp. (S, M, SM, SD, MD, SMD) (2.0%)	36-*Polypedilum scalaenum* (E) (24.3%)
4-*Psectrotanypus varius* (S) (0.01%)	37-*Polypedilum nubeculosum* (S, M, SD) (0.6%)
5-*Krenopelopia* sp. (M) (0.01%)	38-*Polypedilum convictum* (S, M, SD, SMD) (0.8%)
6-*Natarsia punctata* (SD) (0.01%)	39-*Polypedilum bicrenatum* (S, SD, SMD) (0.4 %)
7- *Pentaneurella katterjokki* (S) (0.2%)	40-*Polypedilum exsectum* (SM, SSt) (0.4%)
8- *Smittia aquatilis* (S, SD) (0.2%)	41-*Rheocricotopus fuscipes* (S) (0.01%)
9-*Bryophaenocladius virgo* (S) (0.01%)	42-*Einfeldia pagana* (S, SM, SSt, SD, MD) (3.1%)
10- *Cricotopus bicinctus* (E) (2.5%)	43- *Dicrotendipes nervosus* (S, SM, SD) (0.2%)
11-*Cricotopus fuscus* (S, SM) (0.4%)	44-*Dicrotendipes tritomus* (S, M, SD) (0.2%)
12-*Cricotopus flavocinctus* (S) (0.01%)	45- *Parachironomus arcuatus* (S, SMD) (0.4%)
13-*Cricotopus vierriensis* (S, SM) (0.2%)	46-*Parachironomus longiforceps* (S) (0.01%)
14-*Cricotopus annulator* (SMD) (0.01%)	47-*Beckiella* sp. (S, SM, SD) (0.6%)
15-*Cricotopus reversus* (S) (0.01%)	48-*Paratendipes albimanus* (S) (0.01%)
16-*Cricotopus sylvestris* (S, SD, MD, SMD) (1.0%)	49-*Paratendipes intermedius* (S,M,SD, SMD) (4.9%)
17-*Paratrichocladius rufiventris* (S) (0.2%)	50-*Paratendipes* sp.(S, MD, SMD) (0.2%)
18-*Hydrobaenus pilipes* (S, M, SM, MD) (0.4%)	51-*Paratendipes connectens* (S, SD) (0.4%)
19-*Psectrocladius calcaratus* (SD) (0.2%)	52- *Microtendipes chloris* (SD) (0.01%)
20-*Psectrocladius barbimanus* (S) (0.01%)	53- *Robachia demeijerei* (S, SM) (0.2%)
21-*Psectrocladius limbatellus* (S) (0.01%)	54-*Harnischia fuscimana* (S, SM, SMD) (0.8 %)
22-*Psectrocladius stratiotis* (S) (0.01%)	55-*Cryptotendipes holsatus* (MD) (0.01%)
23-*Limnophyes pusillus* (S, SD, MD) (0.4%)	56-*Stictochironomus longipugionis* (S,M,SD) (0.6%)
24-*Microcricotopus bicolor* (S,SM,SMD) (0.8%)	57-*Cryptochironomus defectus* (S,M,SM,SD,SMD) (8.1%)
25-*Thienemaniella vittata* (S) (0.01%)	58-*Cladotanytarsus mancus* (S, M, SMD) (2.4%)
26-*Paracladius conversus* (SMD) (0.01%)	59-*Cryptochironomus* sp. (S, SD, MD, SMD) (0.6%)
27-*Orthocladius thienemanni* (S, SD) (0.8%)	60- *Cryptocladopelma laccophila* (S) (0.2%)
28-*Chironomus halophilus* (S, M, SD) (0.2%)	61-*Cladotanytarsus mancus* (S, M, SMD) (1.2%)
29-*Chironomus reductus* (S, SMD) (0.4%)	62-*Paratanytarsus lauterborni* (S,SM,MD,SMD) (0.6%)
30-*Chironomus thummi* (MD) (0.4%)	63-*Tanytarsus gregarius* (S, M, SD, SMD) (3.3%)
31-*Chironomus anthracinus* (E) (8.1%)	64- *Virgotanytarsus arduensis* (S, M, SMD) (4.9%)
32-*Chironomus viridicollis* (E) (4.9%)	65- *Rheotanytarsus* sp. (S) (0.2%)
33-*Chironomus plumosus* (E) (1.0%)	

(S=Sand, M= Mud, SM=Sand-Mud, SSt=Sand-Stone, SD=Sand-Detritus, MD=Mud-Detritus, SMD=Sand-Mud-Detritus, E=Every type of substratum)

dissolved oxygen was found as low). BOD was generally found at first quality level whereas COD was generally found at second quality level (only at station 2, it had third quality level). NO_3-N was generally found second and third quality levels (only in May and July, it had fist quality level). NO_2-N was generally found at third and fourth quality levels. Phosphate was found at second quality level (Table 3).

According to Pearson correlation index, the value of p was determined as <0.05 for water temperature (r=+0.71), pH (r=+0.61), Chloride (r=+0.61) and NO_2-N (r=-0.73). Otherwise, the relations between the number of Chironomidae larvae and water temperature, pH and Chloride have direct proportional whereas the relation between number of larvae and NO_2-N has inverse proportional. On the other hand, the relation between number of larvae and the other physicochemical values were not found to be statistically significant.

Until the present, there is not a similar to this study which is performed in Meric River in Turkey. If this study is compared to the study which is performed about Chironomidae larvae in the other rivers in Turkish Thrace: Kirgiz and Guher (1992) evaluated total Chironomidae larvae as a group and determined 515 Chironomidae larvae per m^2 in Sazlidere Stream. The other studies are interested in larval Chironomidae only taxonomically.

Industrious factories, settlements, agricultural areas around the Meric River, which can effect qualitative and quantitative distributions of Chironomidae larvae, are potential danger for the river. The pollution of the river is very important for the Meric Wetland and organisms which are living in.

Consequently, limnological studies should be performed periodically in Meric River. We hope, this will be the previous study for the others which are performed in Meric River in the future.

Table 3. Some physicochemical compositions of the water of Meric River in the period of investigation.

Months/Stations Parameters	WT (°C)	E.C. (µS)	pH	D.O. ($mg.l^{-1}$)	BOD ($mg.l^{-1}$)	COD ($mg.l^{-1}$)	Ca^{+2} ($mg.l^{-1}$)	Mg^{+2} (mg.l-1)	Cl^{-1} ($mg.l^{-1}$)	$NO_3^{-1}N$ ($mg.l^{-1}$)	$NO_2^{-1}N$ ($mg.l^{-1}$)	PO_4^{-3} ($mg.l^{-1}$)	Cr^{+6} ($mg.l^{-1}$)
Aug.	26	242	8	7	4	60	57	26	56	17	0.06	0.17	0.04
Sep.	22	257	7	5	3	53	75	21	47	20	0.02	0.14	0.02
Oct.	17	143	7	5	3	46	80	56	47	19	0.01	0.21	0.04
Nov.	8	116	7	6	3	27	61	14	37	9	0.02	0.10	0.01
Dec.	5	110	8	9	4	46	59	18	41	10	0.03	0.09	0.02
Jan.	4	201	7	9	3	12	64	16	45	8	0.03	0.09	0.04
Mar.	5	135	8	10	6	25	60	16	47	10	0.05	0.05	0.07
Apr.	13	155	7	8	3	46	48	16	45	8	0.06	0.12	0.04
May	20	205	8	5	2	38	50	14	44	6	0.19	0.07	0.02
Jun.	26	284	7	5	3	51	75	19	50	9	0.05	0.12	0.03
Jul.	29	385	8	12	11	57	42	20	81	3	0.24	0.04	0.08
1st station	15	175	8	7	3	45	58	25	38	15	0.03	0.13	0.03
2nd station	15	200	7	7	4	68	61	24	51	15	0.09	0.12	0.04
3rd station	15	171	7	8	3	38	49	17	36	7	0.02	0.05	0.03
4th station	16	222	7	8	4	44	69	26	56	14	0.05	0.12	0.03
5th station	16	203	7	8	5	36	64	23	51	12	0.04	0.12	0.03
6th station	17	213	8	8	5	32	63	22	47	11	0.09	0.13	0.03
7th station	17	217	7	8	4	31	60	16	54	8	0.05	0.05	0.04
8th station	17	226	7	7	4	38	61	16	57	6	0.17	0.14	0.06

(WT=Water temperature, E.C.: Electrical conductivity, D.O.: Dissolved oxygen, BOD: Biochemical oxygen demand, COD: Chemical oxygen demand)

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References

Beck, W.M.Jr. and Beck, E.C. (1969): Chironomidae (Diptera) of Florida III. The Hornishia complex (Chironominae).- Bull. Fla. St. Mus. 13.

Bryce, D. and Hobart, A. (1972): The Biology and identification of the larvae of the Chironomidae (Diptera). - Entomolo. Gazete. 23, 175-215.

Chernovskij, A. (1961): Identification of Larvae of the Midge Family Tendipedidae. - Fauna USSR, 31 (Trans from Russian by Natl. Lending Library for Sci. Tech. Boston). 1-279 pp.

Fitkau, E.J. (1962): Die Tanypodinae (Diptera:Chironomidae), (Die Tribus Anatopyniini, Macropelopiini und Pentaneurini). - Abhandlungen zur larvalsystematik der Insekten 6, Berlin.

Fitkau, E.J. and Reiss, F. (1978): Chironomidae, Limnofauna Europaea. - Illies, J. Gustav Fischer Verlag, Stuttgart, 404-440 pp.

Fitkau, E.J. and Roback, S.S. (1983): The larvae of Tanypodinae (Diptera: Chironomidae) of the Holarctic Region (Keys and Diagnoses) - Ent. Scand. Suppl. Lund, Sweden. 19, 33-110.

Kirgiz, T. and Guher, H. (1992): Trakya Bolgesinde Sazlidere ve Corlu derelerinin Bentik Faunasi uzerinde kirliligin etkileri (Pollution effects on benthic fauna of Sazlidere and Corlu Streams). - Symposium of II. International Ecology and Environmental Problems, 83-92 pp.

Moller, M. and Pillot, H.K. (1978-1979): De Larven der Nederlanse Chironomidae (Diptera). - Tilburg, Leyparkweg, 37.

Moller, M. and Pillot, H.K. (1984): De larven der Nederlandse Chironomidae (Diptera) (Orthocladiinae sensu lato). - Leiden, 1-164 pp.

Ozkan, N. and Kirgiz, T. (1995): Edirne Bolgesi Chironomidae (Diptera) Larvalari ve Yayilislari (Chironomidae Larvae and their distribution in Edirne). - Turkish J.of Zool. 19, 51-58.

Sahin, Y. (1980): Elazig ve kismen cevre illerinin Chironomidae (Diptera) limnofaunasinin tesbiti ve taksonomik incelemesi (Determination of Chironmidae limnofauna of Elazig and their taxonomical analyses). - Firat Univ. Vet. Fak. Derg. Vol. 5.

Sahin, Y. (1984): Dogu ve Guneydogu Anadolu Bolgeleri Akarsu ve Gollerindeki Chironomidae (Diptera) Larvalarinin teshisi ve dagilislari (Identification of Chironomidae larvae in Streams and Lakes of east and south-west Anatolia and their distribution). - Eskisehir, Anadolu Univ.Yay. N.57, Fen-Ed. Fak Yay. N.2.

Sahin, Y. (1987): Marmara, Ege, Sakarya Sistemi Akarsulari Chironomidae Larvalari ve yayilislari (Chironomidae larvae and their distribution in Stream Systems of Marmara, Ege, Sakarya). - Turkish J. of Zool., Vol.11, 179-188.

Sahin, Y., Tanatmis, M., Kucuk, A. (1988): Gokceada Faunasi, Kisim 1- Chironomidae Larvalari (Fauna of Gokceada Island, Part 1- Chironomidae Larvae). - Anadolu Univ. Fen-

Ed. Fak. Derg. Eskisehir. 1, 1-15.
Sahin, Y. (1991): Turkiye Chironomidae Potamofaunasi (Chironomidae Potamofauna of Turkey). - Tubitak, project no: TBAG-869, VHAG-347, TBAG-669, TBAG-792. 1-88 pp.
Seather, O.A. (1977): Taxonomic studies on Chironomidae: Nanocladius, Pseudochironomus and the Harnischia complex. - Ottowa, Fish. and Envi. Can. Bull. 196.
Tanatmis, M. (1989): Enne (Porsuk) cayi omurgasiz limnofaunasi ile ilgili on calismalar (Preliminary studies on Invertebrate limnofauna of Enne Stream). - Anadolu Univ. Yay., No.19, Vol. 1, 15-35.

TISCIA 35, 55-64

INVESTIGATION OF THE EUROPEAN POND TURTLE (*EMYS ORBICULARIS* LINNAEUS, 1758) POPULATION LIVING IN A BACKWATER NEAR THE RIVER TISZA, SOUTHERN HUNGARY

E. Balázs and Gy. Györffy

Balázs, E. and Györffy, Gy. (2006): Investigation of the European pond turtle (*Emys orbicularis* Linnaeus, 1758) population living in a backwater near the river Tisza, Southern Hungary. — *Tiscia 35, 55-64*

Abstract. A European pond turtle population living in a polluted backwater has been investigated since 2002. Turtles were collected with steel cage-traps and then this marked and measured. The average population size estimated by the Frequency of Capture method was 1,187 and by the Petersen-Schnabel method 740, and the density of the population was 142-228 turtles/hectare or 569-913 turtles/km respectively. The sex ratio was near 1:1. The differences between sexes and the distributions of size classes of the following morphological traits were investigated: tail length, shell height, plastron length and width, carapace length and width, and body mass. The turtle population was in good condition based on the correspondence of its body mass to its carapace length. Out of the 458 specimens captured in 2002, 29 males and 54 females were injured, and 65 (33 males and 32 females) had shell abnormalities.

Key words:, capture-recapture, Frequency of Capture method, Petersen-Schnabel method, population size, morphology, sex ratio, body size, condition, Gyálai Holt-Tisza, Hungary.

E. Balázs, Gy. Györffy*, Department of Ecology, University of Szeged, H-6722 Szeged, Egyetem u. 2. Hungary, E-mail: gyorffy@bio.u-szeged.hu
* Corresponding author

Introduction

The European pond turtle (*Emys orbicularis* L. 1758) is the only European species from the subfamily Emydinae and the only native turtle in Hungary. Its distribution area is large, but the sizes of local populations are rather variable and mostly decreasing. We can also see this tendency in European Russia (Bozhansky and Orlova 1998), in the Middle Volga river region, (Bakiev 2004), in the South Urals (Khabibullin 2004), in the Ukraine (Szczerbak 1998), in the Crimea, the Ukraine (Kotenko 2004), in Italy (Ferri *et al.* 1998, Fattizzo 2004), in Catalonia (Mascort 1998), in central Poland (Mitrus and Zemanek 1998), in the Czech Republic (Široký *et al.* 2004), in Slovakia (Novotny *et al.* 2004), and in Northwest Spain (Cordero Rivera and Ayres Fernández 2004).

According to an intensive herpetofaunal mapping project, European pond turtle populations were recorded from 156, 10x10 km UTM squares in Hungary, where this species has the fourth largest known distribution area (Puky *et al.* 2004). It lives in many different water types, even in forest ponds at high elevations, albeit the populations in Pilis, Bakony and Mátra mountains, and in part near lake Balaton may be introduced (Farkas 2000). We can find mostly faunistical data in the Hungarian herpetological literature. Detailed investigations of populations have begun only recently (Kovács *et al.* 2004).

Our main goals were to: i) determine population size and structure, ii) get data about the frequency distribution of different body size values, sex ratio and condition of a turtle population living in a very polluted backwater pool in an urban area.

Study site

The backwater "Gyálai Holt-Tisza" was created between 1855-1887 as part of the regulation work of the river Tisza. It runs along the right side of the river, beyond the dam in an area protected from floods and extends from the Serbian-Hungarian border to the town of Szeged. Its length is 18,7 km, its average width is 86 m, its area is 160 hectares, and its average depth is 3 m. It is divided into three sections by dams and sluices. The utilization of the pools is different. The lower pool is a fishing area while the middle pool is an angler water. The upper one existed as storage of sewage and excess surface waters earlier. Nowadays the water pollution is decreasing, but the water quality is very bad, due to the run-off of thermal waters (Pálfai 2003). As a result of these nearly all-year running waters, the water-level periodically changes, however, a pumping station restores it shortly afterwards (Figs 1. and 2.).

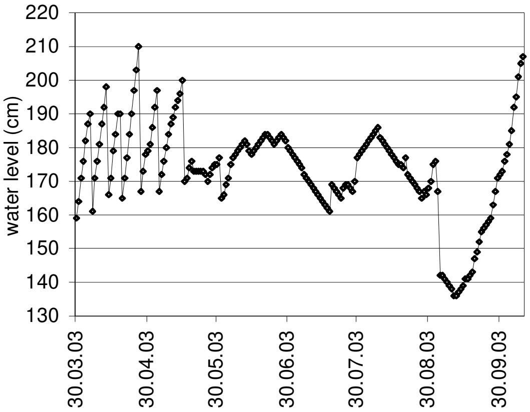

Fig. 1. Changes of the water level in 2003 (daily data).

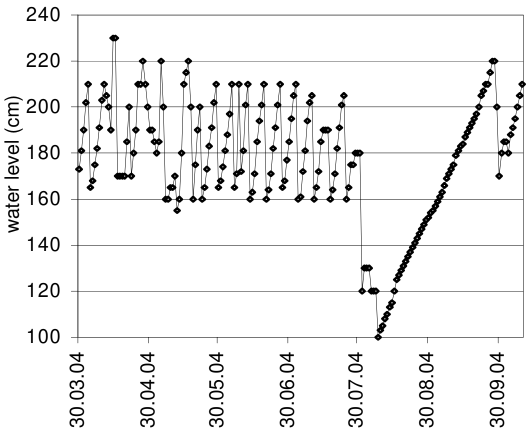

Fig. 2. Changes of the water level in 2004 (daily data)

Our investigations were carried out at the upper pool. This section is between the 15+630 riverkm and 18+660 riverkm, named "Feketevíz" (Blackwater). Samples were taken from the 15+630 riverkm to the 16+952 riverkm.

The southern bank slope is steep while the northern one is flat. The bed of the pool is rather sedimented. The thickness of sediment is 173,50±56,05 cm near the flat slope, 126,73±27,29 cm near the steep slope, and 179,08±67,01 cm in the middle of bed, according to 35 samples from October, 2002. Residential areas, consisting of village-like areas and suburbs of family houses, have been built along the sampled pool. On the shores narrow reed edge is the only plant in the water. As a result of organic and inorganic pollution, thick sediment, and intensive changes of water level, the food web is poor. The seasonality of animal groups depend on the thermal water and rare runoffs from the middle pool (angler water). Long term settlement and reproduction of species is impossible here because of the continuous oxygen depletion. We cannot find benthic invertebrates living in the sediment, neither molluscs, nor fishes. Due to the ecological circumstances, the animal community consists of taxa breathing from the air (Györffy 2005). Primary production is rendered by the toxicity of the water.

Sampling method

Turtles were collected with steel cage-traps (60 × 60 × 100 cm) with two entrances (10 × 20 cm). To prevent the traps from getting under the water, we used empty plastic bottles that were attached to the upper part of the traps. It was important because of the quick changes of water level. Ten traps were used (Table 1.), setting in both banks of the pool. The trapping periods were from 14 June to 4 December 2002, from 28 March to 15 October 2003 and from 31 March to 4 November 2004. The traps were not used in May and June 2004. Samples were taken every 2-4 days.

Each captured turtle was marked with unique combinations of marginal scute notches (Cagle 1939). The following parameters were recorded: straight length and width of carapace and plastron (mm), shell height (mm), length of the base of tail from the end of plastron to the cloacal vent (mm), body mass (to the nearest 0.5 gram), sex, colour of iris, damage and abnormalities. The width of the plastron was measured between the abdominal and femoral scutes. The with of the carapace was measured between the 2nd and 3rd pleural scutes.

We used the EXCEL, STATISTICA and SPSS

computer programs for data analysis. Data normalities were tested with the Shapiro-Wilks method. Pearson correlations were calculated between different body measurements. The significances of differences were tested with the Mann-Whitney U-test. SIMPLY TAGGING was used to estimate the population size with the mark-recapture method.

Table 1: Geographical latitudes and longitudes of the traps.

Trap number	Trap localities	
	North latitude	East longitude
1	46°13′36,7″	20°06′37,7″
2	46°13′38,6″	20°06′34,5″
3	46°13′39,7″	20°06′23,6″
4	46°13′40,6″	20°06′24,1″
5	46°13′40,6″	20°06′16,4″
6	46°13′41,4″	20°06′16,5″
7	46°13′40,6″	20°06′10,4″
8	46°13′41,4″	20°06′03,1″
9	46°13′40,3″	20°06′01,5″
10	46°13′39,8″	20°05′53,6″

Results and discussion

Estimation of population size

We tried to estimate the population size from mark-recapture data. Before choosing the appropriate method, we had to decide if the population is open, or closed. The trapping method is not suitable to collect small turtle individuals, among which the mortality may be rather high. The long lifetime and the relative short sampling periods permit only a little openness regarding the mortality of the older age classes. We consider the population rather closed because of the age-selectivity of traps, the life history of turtles and the extreme sedentary character of individuals (Cheylan and Poitevin 1998, Devaux and Bley 1998, Cadi and Miquet 2004, Kovács *et al.* 2004).

Frequency of Capture Method

Regarding the large amount of data (nearly one thousand marked individuals at the end of 2004), we tried to use the Frequency of Capture Method. This method is reliable, because problems do not arise from unequal catchability, it takes into account the repeated recaptures, and it is useful for not strictly closed populations too (Southwood and Henderson 2000). On the other hand, the different frequency distributions may fit similarly in a given section, but can be very different outside, causing differences in estimations (Demeter and Kovács 1991). Nevertheless, we can reveal the „trapfan" individuals by this method.

If we take into consideration the frequency of capture data, including maximum recapture values, the estimation can be false because of the last values. We can see this from the relationship between the maximum number of captures considered and the estimated number of never trapped turtles (Fig. 3); this means that the maximum number of captures decreases (removing the trapfan individuals), the number of never trapped individuals gets increase until its stagnation. In our opinion these last values are close to reality. We found the exponential function best fitting to our data (e.g. Fig. 4) and this function was used further on.

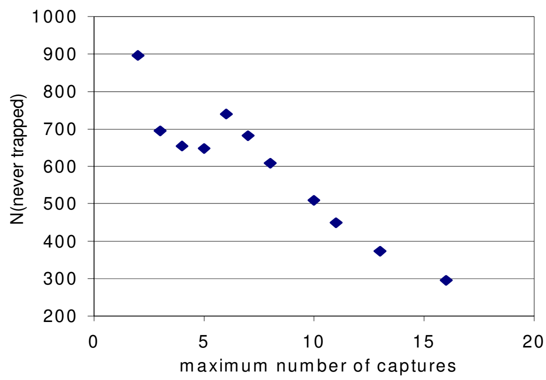

Fig. 3. Relationship between the maximum number of captures considered and the estimated number of never trapped turtles (2002-2004)

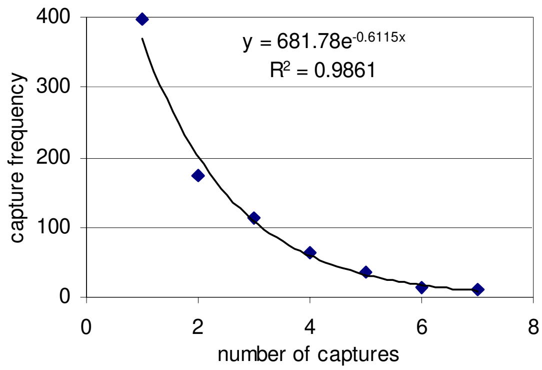

Fig. 4. Capture frequency distribution to 7 captures (2002-2004). N (estimated)= 682+826=1508.

As the number of samples decreases, the maximum number of captures decreases as well, and the section of real estimations gets narrower. On the basis of data from years 2002-2004, the estimations can be good from 3 to 7 maximum number of captures and the population size resulted was

1510±37 individuals (Fig. 3). If data from only one year are investigated, the section of real estimation is between 4-5 maximum number of captures (Figs 5. and 6.).

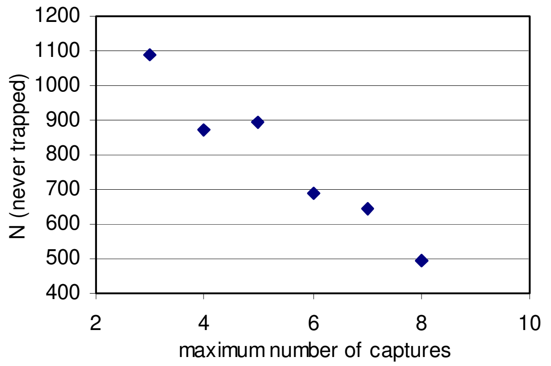

Fig. 5. Relationship between the maximum number of captures considered and the estimated number of never trapped turtles (2003)

According to the above mentioned facts, the population consists of 1369±101 individuals (in 2002, from 4-6 maximum number of captures), 1365±10 individuals (in 2003, from 4-5 maximum number of captures), and 827±12 (in 2004, from 4-5 maximum number of captures) respectively.

Petersen-Schnabel estimation

The Petersen-Schnabel estimation is the most commonly used model as experience has shown that the probability of capture varies between samples, most commonly because of changes in the weather. When only two samples are collected the maximum likelihood estimator is close to Petersen-Lincoln estimator and this method will give the Chapman modification of the Petersen-Lincoln index. This model assumes that all animals in the population have an equal probability of capture at any one time. For our closed population the zero-truncated Poisson test was undertaken for equal catchability in the case of different sample sizes (Table 2). According to the accepted equal catchabilities, we made the Petersen-Schnabel estimations for the different sample groups (Table 3.).

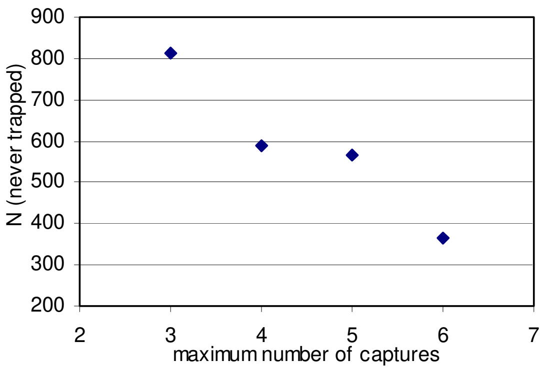

Fig. 6. Relationship between the maximum number of captures considered and the estimated number of never trapped turtles (2004)

By the end of the year 2005 already 978 turtles were marked. We consider this the minimum size of the population. Estimations by the Frequency of Capture Method are above this minimum size, except in 2004. Even though estimations by the

Table 2. Zero-truncated Poisson tests for equal catchability. Abbreviations: Sum(f(i)): total individuals; Sum(i*f(i)): total captures; Mci: mean captures per individual; m: Poisson parameter; Chi-sq.: Chi-squared; Df: degrees of freedom; P: probability; E.c.: equal catchability.

Sample	Sum(f(i))	Sum(i*f(i))	Mci	m	Chi-sq.	Df	P	E.c.
2002 all	466	634	1.36051	0.650255	3.53853	2	0.170458	Accept
2003 all	488	678	1.38934	0.697557	1.68723	3	0.639778	Accept
2004 all	253	299	1,18182	0.343556	1.20568	1	0.272189	Accept
2003 April, July	269	302	1.12268	0.235983	0.232557	1	0.629634	Accept
2004 April, July	179	195	1.08939	0.173423	0.229567	1	0.631845	Accept

Table 3. Estimation of population size by Petersen-Schnabel method.

Sample	Year	N (estimated)	Std. error	Upper conf. limit	Lower conf. limit
All	2002	772	40,26	862	704
	2003	812	40,49	901	743
	2004	637	75,4	815	516
April, July	2003	687	92,6	910	541
	2004	519	103,9	790	369

Petersen-Schnabel method are lower, the tendency is similar.

The surface of the backwater section investigated is about 5,2 hectares. As the average population size estimated by Frequency of Capture Method was 1187, and by Petersen-Schnabel Method was 740, the density of the turtles was 142-228 ind./ha or 569-913 ind./km. These values are rather high compared to data collected from the literature by Fritz (2003). This is the largest turtle population investigated in Hungary until now; nevertheless, based on our other projects there may be other similar populations in backwaters in the Great Hungarian Plain, as believed by Péchy and Haraszthy (1997) earlier. Fortunately, we have found and removed from the backwater only five specimens of *Trachemys scripta elegans* up to the present (three of these in spring of 2006). The ratio of this alien species was lower than in other habitat in Hungary (Kovács *et al.* 2004), and we hope that this North American native species will not endanger the European pond turtle population which has been living here for a long time.

Sex ratio

We identified the sex on the basis of characters mentioned in the literature (Table 4). The sex ratio is near 1:1, a little in favor of females except in 2004 and 2002, when the sampling periods were shorter.

Table 4. Number of identified males and females and the sex ratios in the different years.

Year	2002	2003	2004	2005	2002-2005
Male	232	229	127	124	436
Female	220	242	96	139	465
F/M	0.948	1.057	0.756	1.040	1.066

It is not easy to estimate the sex ratio from samples taken from the traps. Misleading values may be derived from small sample size or from the partial collecting period (Mosiman and Cadi 2004). If the sample size is large enough, we can calculate the number of males and females and from that we can estimate the real sex ratio. In spite of the difficulties there are a lot of sex ratio values in the literature. These female/male (F/M) values are between 0,5 and 4,71 (Fritz 2003). Taking only the examples above 100 individuals; however**,** the ratios drop to between 0,5 and 2,4.The large sample size is not always appropriate (Devaux and Bley 1998). Although Devaux and Bley counted the 1,7 F/M ratio from a sample consisting of 312 turtles, this number might vary depending on the observation period; for example, June and July is the nesting period for females which may lead to artificially high number of females in a study which takes place during these months. That is why we have to be careful comparing different data.

Morphology

The differences of the characteristics between sexes were investigated using data from the years 2002-2003 (Tables 5-6).

In the literature the length of tail commonly means the length from the anus to the end of tail. We measured the length of tail according to this in 2002 (Table 5, Fig. 7). Males have shorter tails than females.

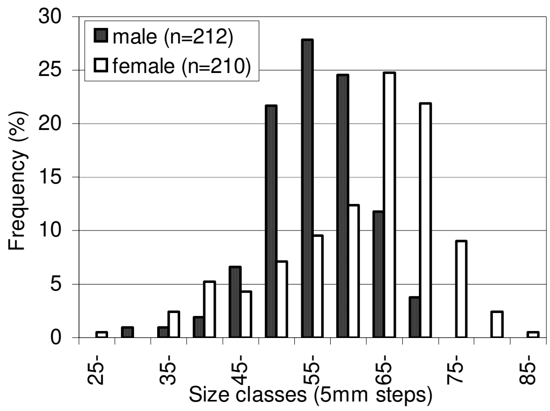

Fig 7. Distribution of size classes of tail length from the anus (2002)

In 2003 we measured both the length of tail base from the end of the plastron to the cloacal vent (Snieshkus 1998) and the width of the tail base (Table 6).

The base of the tail is shorter than the width of it, or these two values are similar in the case of females. The male’s tail base is always longer than its width.

The colour of the iris was recorded in 2003. We distinguished two colour categories: lemon-coloured and dark-coloured (including orange, red, red-brown and brown). 226 of 230 females (98%) had lemon-coloured iris, while 186 of 223 males (83%) had dark-coloured iris.

Distributions of size classes of the different morphological data can be seen separately according to sexes in histograms (Figs. 8-12). The left sides of histograms from female data are longer. This may refer to the uncertainty of sex determination among

Table 5. Morphological data of turtles (PL: length of plastron, PW: width of plastron, CL: length of carapace, CW: width of carapace, SH: shell height, TL: length of tail from the cloacal vent, SD: standard deviation)

	PL		**PW**		**CL**		**CW**		**SH**		**TL**	
sex	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
Mean (mm)	115	150	70	91	130	155	102	117	46	62	57	65,5
SD	9,8	25	5,91	15,2	12,2	25,6	9,01	16,5	4,22	10,6	7,08	10,9

Table 6. Morphological data of the tail base of the different sexes. (LTB: lengh of tail base, WTB: width of the tail base, SD: standard deviation)

Sex	Males (n=224)			Females (n=236)		
Character	LTB	WTB	LTB/WTB	LTB	WTB	LTB/WTB
Mean (mm)	25,50	20,38	1,25	12,86	16,59	0,78
SD	4,66	2,77	0,16	3,25	2,54	0,16

younger individuals, more exactly to the determination of more individuals as female than male.

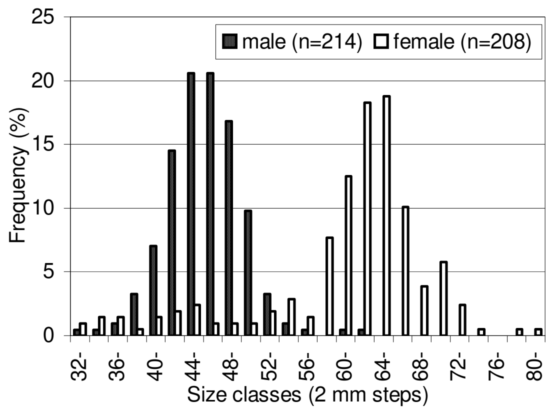

Fig. 8. Distribution of size classes of shell height (2002)

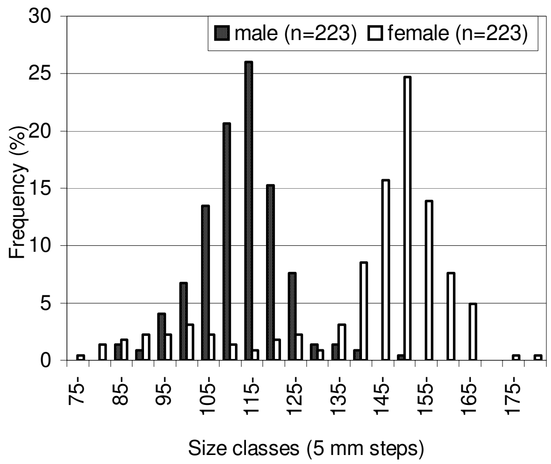

Fig. 9. Distribution of size classes of plastron length (2000).

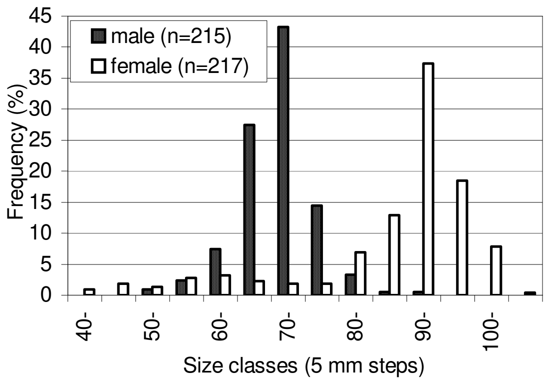

Fig. 10. Distribution of size classes of plastron width (2000).

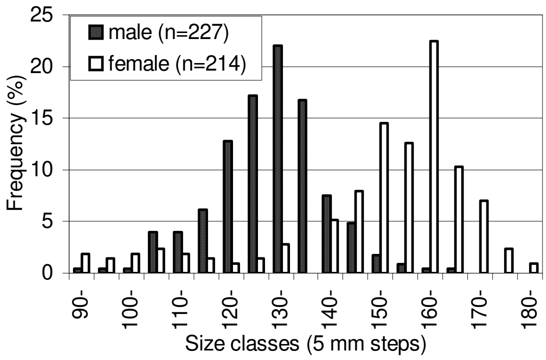

Fig. 11. Distribution of size classes of carapace length (2002).

Significances of differences of morphological parameters between sexes were calculated with Mann-Whitney U-test (Table 7).

We can conclude from the U-values that the tail length and carapace width indicate the smallest differences between males and females. This was one of the reasons not to measure the tail length (from the cloacal vent to the apex) from 2003 on. The carapace width may not be a good parameter to separate the sexes because of the larger variety of male carapaces shapes than that of the females.

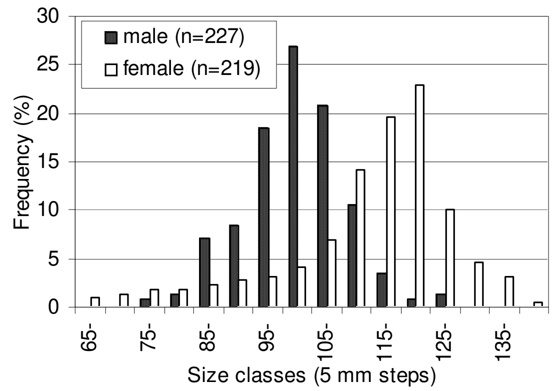

Fig. 12. Distribution of size classes of carapace width (2002).

Table 7. Results of the Mann-Whitney-U-test (2002).

	U	Z	p<	n ♂	n ♀
Plastron length	9010,000	-12,025	0,001	224	231
Plastron width	9213,000	-11,923	0,001	225	231
Carapace length	11129,000	-10,561	0,001	225	231
Carapace width	12157,000	-9,830	0,001	225	231
Shell height	7602,500	-12,722	0,001	223	224
Tail length	12740,500	-7,599	0,001	212	210
Body mass	9314,000	-10,473	0,001	216	209

Stronger correlations were found between the plastral length and width, the carapace length and carapace width, as well as between the shell height and other parameters in the case of females than males (Table 8.).

Table 8. Results of the Pearson-correlations (PL: length of plastron, PW: width of plastron, CL: length of carapace, CW: width of carapace, SH: shell height)

	males			females		
	r	p<	n	r	p<	n
PL & PW	0,903	0,001	230	0,968	0,001	241
CL & CW	0,928	0,001	230	0,974	0,001	241
PL & SH	0,829	0,001	229	0,856	0,001	240
PW & SH	0,791	0,001	229	0,868	0,001	240
CL & SH	0,819	0,001	230	0,863	0,001	240
CW & SH	0,827	0,001	229	0,848	0,001	240

The straight carapace length (CL) is the most comparable morphological trait, because we can find this in most papers (Fritz 2003). The largest male from Hungary measured 190 mm (Kovács *et al.* 2004) CL, while the CL of the largest available female was 183,0 mm (Farkas 2000). Our largest male had a 167,4 mm long carapace, while the CL of the largest female was 190,0 mm. Compared the average CL values (male: 131,05±11,19mm; female: 153,61±19,92mm) to data from previous studies (Fritz 2003, Auer and Taskavak 2004, Mitrus and Zemanek 2004), males from this study were medium-sized, while the females belonged to larger size classes.

Body mass and condition

The mean body mass was 395g for males and 764g for females in 2002. The high ratio of female/male body mass (1,93) might originate from the fact, that the trapping period began at the end of June. If we take into consideration all data till now, the mean values get lower and the F/M body mass ratio is 1,77. Average body mass is 381,13±84,5g for males (n=500, min. value: 82g, max. value: 809,17g) and 676,3±215,1g for females (n=508, min. value: 95g, max. value: 1121g). The distributions of value classes according sex separated from each other well (Fig. 13).

Fig. 13. Distribution of size classes of body mass (2002)

The simplest measure of condition is the body mass condition that compares mass with size (Willemsen *et al.* 2002). The most useful size-parameter was chosen by Pearson correlation between body mass and certain morphological data (Table 9). It is hard to predict the mass from length, that is why we looked at a turtle population from another backwater of better quality as a control group. There was a rich food web in the latter backwater (Tiszakécskei Holt-Tisza) and the water quality was satisfactory (angling water). We have

Table 9. Pearson correlation values between body mass and different morphological data (Gy: backwater ”Gyálai Holt-Tisza”, Tk: backwater ”Tiszakécskei Holt-Tisza”, M: male, F: female, BM: body mass, PL: length of plastron, PW: width of plastron, CL: length of carapace, CW: width of carapace).

area	sex	BM-PL			BM-PW			BM-CL			BM-CW		
		r	p	n	r	p	n	r	p	n	r	p	n
Gy	M	.930	***	231	.900	***	230	.938	***	231	.916	***	230
	F	.954	***	241	.951	***	241	.965	***	241	.947	***	241
Tk	M	.934	***	235	.764	***	235	.953	***	235	.908	***	235
	F	.904	***	187	.909	***	188	.904	***	188	.852	***	188

data about the turtle population living there (Balázs *et al.* 2004).

The best correlation was between body mass and carapace length, or plastron length for both populations and both sexes.

Comparison of the two populations was made with paired t-test of body mass values belonging to given carapace length (Tables 10-11). We see from the descriptive statistics that the ”Gy” mean scores are higher.

Table 10. Paired Samples Statistics. (Gy: backwater ”Gyálai Holt-Tisza”, Tk: backwater ”Tiszakécskei Holt-Tisza”)

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1 (Males)	Gy	357,7667	60	66,7509	8,6175
	Tk	333,2639	60	65,9424	8,5131
Pair 2 (Females)	Gy	640,2222	27	189,4409	36,4579
	Tk	571,8519	27	176,7667	34,0188

There are significant differences in condition between the two populations. Despite the poorer food web in the backwater ”Gyálai Holt-Tisza”, the condition of turtle population living there is better. The cause of this might be the less anthropogenic disturbation (lack of angling).

Injuries and abnormalities

We found only sporadic data about the types and ratio of injuries in turtle populations (Szczerbak 1998, Kovács *et al.* 2004).

The ratio of injured individuals is rather high in the investigated population. From the 458 specimens captured in 2002, 83 were injured, which is more than 18%. There was significant difference between the sexes, out of the 83 injured individuals 29 were male and 54 were female. The difference may be the consequence of the different behaviour, because the females spend more time outside the water in the nesting periods, when they are at the mercy of predators.

We sorted the injuries into four categories (Table 12): serious shell damages, which are fractures of the carapace or plastron and lack of a large piece of shell; slight shell damages, which are the injuries of more than five marginal scutes and bites on the carapace or plastron; serious soft body wounds, which are the maimed limbs; and, finally, slight soft body wounds, which means maimed toes, claws or tailtips. We did not take into consideration the injuries of fewer than five marginal scutes (28 individuals). Of course, one individual could have more than one type of injury.

Table 11. Results of paired samples t-test. (Gy: backwater ”Gyálai Holt-Tisza”, Tk: backwater ”Tiszakécskei Holt-Tisza”)

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 Gy-Tk (Males)	24,5028	39,2368	5,0654	14,3668	34,6387	4,837	59	,000
Pair 2 Gy-Tk (Females)	68,3704	54,6641	10,5201	46,7460	89,9948	6,499	26	,000

Table 12. Number of serious and slight shell and soft body wounds according to sex.

Serious shell damage		Slight shell damage		Serious soft body wound		Slight soft body wound	
♂	♀	♂	♀	♂	♀	♂	♀
11	19	18	40	3	8	13	21

There were shell abnormalities in the case of 14,2 % of the population (65 of 458 individuals). The ratio of the injured specimen was 33 males to 32 females. Because the sex ratio in the population is nearly 1:1, there is no significant difference between abnormally developed sexes. These anomalies could be due rather to the high pollution levels than to the inbreeding depression, outbreeding depression or suboptimal temperature or humidity during incubation (Ayres Fernández and Cordero Rivera 2004).

We found only one plastral anomaly when an accessory scute was in the middle of the plastron. The most frequent type of carapace anomalies (nearly 50 p.c.) was accessory scutes between vertebral and pleural scutes in the posterior part of the carapace. Only two specimens had accessory scutes in the anterior part. The number of marginal scutes are normally 12 in both sides, but there were 13 and occasionally 11 scutes in one side. The ratio of this type of anomaly was 23 p.c. There were accessory scutes not causing asymmetries (6 vertebral, 5-5 pleural or 13-13 marginal scutes).

Acknowledgements

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References

Auer, M. and Taşkavak, E. (2004): Population structures of syntopic *Emys orbicularis* and *Mauremys rivulata* in western Turkey. - Biologia, Bratislava. 59/Suppl. 14, 81-84.

Ayres Fernandez,C.; Cordero Rivera,A. (2004): Asymmetries and accessory scutes in *Emys orbicularis* from Northwest Spain. - Biologia, Bratislava. 59/Suppl. 14, 85-88.

Bakiev, A. (2004): The distribution of *Emys orbicularis* int he Middle Volga region, Russia. – Biologia, Bratislava. 59/Suppl. 14, 9-11.

Balázs, E., Györffy, Gy., and Varga, L. (2004): Testtömegviszonyok és kondíció diszturbált élőhelyen élő mocsári teknős populációban (Body mass relations and condition of an European pond turtle population living in a disturbed habitat). – Előadások és poszterek összefoglalói. 2. Szünzoológiai Szimpózium, Budapest, p.11. (In Hungarian)

Bozhansky, A.T. and Orlova, V.F. (1998): Conservation status of the European pond turtle, *Emys orbicularis* (Linnaeus, 1758), in European Russia. – In: Fritz, U. *et al.* (eds.): Proceedings of the EMYS Symposium Dresden 96. – Mertensiella, 10, 41-46.

Cadi, A. and Miquet, A. (2004): A reintroduction programme for the European pond turtle (*Emys orbicularis*) in Lake Bourget (Savoie, France): first results after two years. - Biologia, Bratislava. 59/Suppl. 14, 155-159.

Cagle, F.R. (1939): A system of marking turtles for future identification. – Copeia 1939, 170-173.

Cheylan, M. and Poitevin F. (1998): Impact of fire on a population of European pond turtles (*Emys orbicularis*) in southeastern France. - In: Fritz, U. *et al.* (eds.): Proceedings of the EMYS Symposium Dresden 96. – Mertensiella, 10, 67-82.

Cordero Rivera, A. and Ayres Fernández, C. (2004): A management plan for the European pond turtle (*Emys orbicularis*) populations of the Louro river basin (Northwest Spain). - Biologia, Bratislava. 59/Suppl. 14, 161-171.

Demeter, A. és Kovács, Gy. (1991): Állatpopulációk nagyságának és sűrűségének becslése (Estimation of size and density of animal populations) – Akadémiai Kiadó, Budapest. (In Hungarian)

Devaux, B. and Bley, S. (1998): *Emys orbicularis galloitalica* in Provence: an example of a small threatened population. - In: Fritz, U. *et al.* (eds.): Proceedings of the EMYS Symposium Dresden 96. – Mertensiella, 10, 83-88.

Farkas, B. (2000): The European pond turtle *Emys orbicularis* (L.) in Hungary – Stapfia 69, 127-132.

Fattizzo, T. (2004): Distribution and conservational problems of *Emys orbicularis* in Salento (South Apulia, Italy). - Biologia, Bratislava. 59/Suppl. 14, 13-18.

Ferri, V., Di Cerbo, A.R. and Pellegrini, M. (1998): „Serranella Emys Project” – preservation initiatives of *Emys orbicularis* populations in Abruzzo. - In: Fritz, U. *et al.* (eds.): Proceedings of the EMYS Symposium Dresden 96. – Mertensiella, 10, 95-101.

Fritz, U. (2003): Die Europäische Sumpfschildkröte (*Emys orbicularis*). - Supplement für Feldherpetologie, Laurenti-Verlag, Bielefeld, pp. 225.

Györffy, Gy. (2005): A Gyálai Holt-Tisza ökológiai vizsgálatának eredményei. (Results of the ecological investigations of the backwater "Gyálai Holt-Tisza") In: Pálfai, I. (ed.): A II. Szegedi Holtág-konferencia előadásai. 2004. szeptember 21. – Környezetvédelmi és Vízügyi Minisztérium, Budapest, 87-108 pp.

Khabibullin, V. (2004): Distribution of *Emys orbicularis* in South Urals, Russia. - Biologia, Bratislava. 59/Suppl. 14, 27-32.

Kotenko, T. (2004): Distribution, habitats, abundance and problems of conservation of the European pond turtle (*Emys orbicularis*) int he Crimea (Ukraine): first results. - Biologia, Bratislava. 59/Suppl. 14, 33-46.

Kovács, T., Anthony, B., Farkas, B., Bera, M. (2004): Preliminary results of a long-term conservation project on *Emys orbicularis* in an urban lake in Budapest, Hungary – Turtle and Tortoise Newsletter 7, 14-17.

Mascort, R. (1998): Distribution and status of the European pond turtle, *Emys orbicularis*, in Catalonia. - In: Fritz, U. *et al.* (eds.): Proceedings of the EMYS Symposium Dresden 96. – Mertensiella, 10, 177-186.

Mitrus, S. and Zemanek, M. (1998): Reproduction of *Emys orbicularis* (L.) in Central Poland. - In: Fritz, U. *et al.* (eds.): Proceedings of the EMYS Symposium Dresden 96. – Mertensiella, 10, 187-192.

Mitrus, S. and Zemanek, M. (2004): Body size and survivorship of the European pond turtle *Emys orbicularis* in Central Poland. - Biologia, Bratislava. 59/Suppl. 14, 103-107.

Mosimann, D. and Cadi, A, (2004): On the occurrence and viability of the European pond turtle (*Emys orbicularis*) in Moulin-de-Vert (Geneva, Switzerland): 50 years after first introduction. - Biologia, Bratislava. 59/Suppl. 14, 109-112.

Novotny, M., Danko, S. and Havas, P. (2004): Activity cycle and reproductive characteristics of the European pond turtle (*Emys orbicularis*) int he Tajba National Nature Reserve, Slovakia. - Biologia, Bratislava. 59/Suppl. 14, 113-121.

Pálfai, I. (2003): Oxbow-lakes in Hungary. – Ministry of Environmental Control and Water Management, Budapest. 125 pp.

Péchy, T. and Haraszthy, L. (1997): Magyarország kétéltűi és hüllői (Amphibians and reptiles of Hungary). – Hungarian Ornithological and Conservation Society, Budapest, 113 pp. (In Hungarian)

Puky, M., Gémesi, D. and Schád, P. (2004): Distribution of *Emys orbicularis* in Hungary with notes on related conservational and education activities. - Biologia, Bratislava. 59/Suppl. 14, 55-60.

Široký, P., Stuchlík, S., and Moravec, J. (2004): Current situation and Pleistocene, Holocene, and historic records of *Emys orbicularis* in the Czech Republic. - Biologia, Bratislava. 59/Suppl. 14, 73-78.

Snieshkus, E. (1998): Some observations on secondary sexual characteristics, sex ratio, and reproductive aspects of European pond turtles, *Emys orbicularis* (Linnaeus, 1758), in the former USSR. - In: Fritz, U. *et al.* (eds.): Proceedings of the EMYS Symposium Dresden 96. – Mertensiella, 10, 253-258.

Southwood, T. R. E. and Henderson, P. A. (2000): Ecological Methods – Blackwell Science.

Szczerbak, N. (1998): The European pond turtle (Emys orbicularis) in Ukraine. - In: Fritz, U. *et al.* (eds.): Proceedings of the EMYS Symposium Dresden 96. – Mertensiella, 10, 259-266.

Willemsen, R. E., Hailey, A., Longepierre, S. and Grenot, C. (2002): Body mass condition and management of captive European tortoises. – Herpetological Journal 12, 115-121.

TISCIA 35, 65-72

CHANGES IN THE FISH FAUNA OF THE RIVER TISZA

Á. Harka

Harka, Á. (2006): Changes in the fish fauna of the River Tisza. – *Tiscia 35, 65-72*

Abstract. The slow transformation of a fauna is a natural phenomenon, but changes over the past 150 years in the River Tisza basin have primarily been the result of human intervention. Factors significantly affecting the structure of fish communities and species are as follows: (1) regulation of rivers to control floods, (2) canalization of rivers, construction of dams and reservoirs, (3) introduction of exotic species, (4) pollution of rivers, (5) increase in water temperature.
Actually number of fish species living in the River Tisza is most probably 68 (in the watershed 70), of which 80% is native, 20% has been introduced. All the species contribute to the unique value of the fish fauna, endemic species in the Tisza watershed, however, deserve special attention: *Scardinius racovitzai* was found and identified exclusively in the thermal pond of Băile Episcopeşti (Püspökfürdő), Romania, on the left bank of the River Crişul Repede (Sebes-Körös). Another unique species is the quasi-endemic Carpathian lamprey (*Eudontomyzon danfordi*), present outside the watershed only in the upper stretch of the neighbouring River Timiş (Temes). This species lived in a number of streams earlier, but has by now disappeared from many places.

Key words: watershed of Danube, regulation of rivers, canalization of rivers, introduction of fishes, pollution of rivers, global warming

Á. Harka, Kossuth Lajos Secondary School, Tiszafüred, Táncsics u. 1. H-5350, Hungary, e-mail: harka@kossuth-tfured.sulinet.hu

Introduction

Based on the size of its drainage area, the River Tisza – Tisza in Hungarian – is the tenth largest river in Europe. With a source in the Ukraine at a height of 1860 meters above sea level, the river drains the eastern region of the Carpathian Basin. After touching Romania and Slovakia, it meanders slowly over the flat lands of the Great Hungarian Plain and meets the Danube in Serbia. Its major tributaries are the rivers Szamos (Someş), Bodrog, Sajó (Slaná), Körös (Criş) and Maros (Mureş) (Fig. 1).

The full length of the River Tisza in the middle of the 19th century was almost 1400 km. Numerous bends of the river were later cut off in an ambitious regulation project shortening it to a mere 946 km. On reaching Romania the river drops as much as 5 m/km, whereas in the Hungarian Plain it slows down to just a few cm/km. Mean discharge of the river below the mouths of the rivers Szamos and Körös is 330 and 650 cu. m/sec, respectively, and 830 cu. m/sec when it reaches the Danube. Water level and discharge however varies dramatically: at the mouth of the River Szamos it may drop to 45 cu. m/sec and rise to as high as 3770 cu. m/sec in flood season (Lászlóffy 1982).

The average breadth of the riverbed is 200 m, ranging from 100 to 450 m in the plains. Extremes in depth are also common: at fords as shallow as 1 m in drought years, but in sharp bends in flood season the water may run as deep as 25 m. The River Tisza basin is dominated by low lying regions offering fauna varied habitats rich in species and nutrients.

In retrospect

The rich fish fauna of the River Tisza is first mentioned in Gesta Hungarorum, a codex written in Latin in the 12th century. When Hungarian tribes settled in the Carpathian Basin in the late 800s „they saw the land was fertile, abundant in game of all sorts, the Tisza and Bodrog rivers teeming with fish and they conceived unspeakable affection for the land" (Anonymus 1977). Another adage, attributed to the Italian historian Marzio Galeotto, who settled in Hungary, says „two thirds of the River Tisza is water, one third is fish". An obvious exaggeration that may be, but it would certainly not have survived for so many centuries without proper grounds.

The fabulous richness of the river is also apparent from later records. Englishman Edward Brown, for instance, squarely proclaimed in 1673, „the Tisza is the richest river in fish all over Europe". Ferenc Rákóczi (1676-1735), Prince of Hungary, notes in his memoirs that, „the river is so abundant in fish that one can scarcely scoop water from it without catching fish" (cit. Szilágyi, 1992).

Venerable scientist Mátyás Bél, convinced that the anecdotal words of M. Galeotto best describe the rich fish fauna of the River Tisza, quotes him centuries later, as late as 1730 (Deák 1984). Martin Schwartner in his Statistik des Königreichs Ungarn (1798) (Statistics of the Kingdom of Hungary) confirms that the „sluggish River Tisza is renowned for harbouring one of the richest fish faunas not only in Hungary but Europe as well" (cit. Répássy 1902-1903).

There is no reason to doubt the truthfulness of these records, it is however questionable whether they show the full picture of the river. There must have been numerous lean years throughout the centuries that have remained unrecorded: it is „big catches, big fish" that make headlines – true even centuries ago.

Répássy's convincing data of the period between 1834-1899 clearly proves that flood and catch are closely related. In flood years, when water is high, catches are abundant, but when water is scarce, capture also diminishes. Thus lean years constitute an integral part of the full picture about the River Tisza. However, the once legendary richness of the fish fauna mainly attributable to vast flood plains remains unquestionable.

Literature review

Early documents record primarily the quantity of fish, whereas species are rarely listed. One exception is Mátyás Bél's manuscript (1730) describing over thirty widespread and easily identifiable fish species native to the Carpathian Basin, nine of which are listed as natives of the River Tisza (Deák, 1984). Prominent botanist Pál Kitaibel when crossing the river at Tiszafüred in 1797 described seven species, of which two are first recorded (Szerencsés and Pozder 1985).

Heckel's study (1847), translated and supplemented with notes by Kornél Chyzer (Heckel 1863), lists 16 fish species in the River Tisza. At the end of the 19th century Pap (1882) and Czirbusz (1884) name as many as 27 and 30 species, respectively, found in the lower stretch of the river. In his comprehensive handbook of fish fauna in Hungary, Herman (1887) lists 34 species native to the river, Vutskits (1902) describes 41 species.

After extensive research in the Upper Tisza region in the 1920s, Vladykov (1931) found a total of 49 species, of which 44 were native to the upper reaches of the Tisza. Vásárhelyi (1960), based on observations of more than fifty years, lists 56 species.

There have been several papers published over the past twenty years on the fish fauna of the River Tisza and its tributaries. Based on publications by Harka (1985, 1997, 1998), Nalbant (1995), Guelmino (1996), Bănărescu *et al.* (1997, 1999), Györe and Sallai (1998), Harka *et al.* (1998, 1999, 2000, 2001, 2002, 2003), Györe *et al.* (1999, 2001), Sallai (1999), Bănărescu (2002) and Harka and Sallai (2004) the number of fish species living in the River Tisza is most probably 71 and 73 in the whole watershed (Table 1).

Changes in the fish fauna

The slow transformation of a fauna is a natural phenomenon, but changes over the past 150 years in the River Tisza basin have primarily been the result of human intervention. Factors significantly affecting the structure of fish communities and species are as follows:

Regulation of rivers to control floods
Canalization of rivers, construction of dams and reservoirs
Introduction of exotic species
Pollution of rivers
Increase in water temperature

1. Regulation of rivers

Hydrographic conditions of the River Tisza were significantly modified by six decades of river regulation initiated in the middle of the 19th century, which had an adverse effect on the majority of fish living in the lower stretches of the river. Cutting off "overgrown" bends and thus creating oxbows reduced the length of the river by 450 km, whereas gradient increased making flood flow much faster. Dikes built along rivers now total more than 4200 km. High waters throughout the centuries had flooded approximately 2 million hectares of flat land on a regular basis and produced ideal conditions for the proliferation of phytophilic species (Fig. 1).

In addition to offering ideal conditions for spawning and the development of fertilized eggs, fry in warm, shallow water grew significantly faster feeding on an abundance of zooplankton. Although

Table 1. Fish species in the watershed of the River Tisza

No.	Species	Presence	No.	Species	Presence
1	*Eudontomyzon danfordi*	+	38	*Rhodeus sericeus*	+
2	*Huso huso*	ex	39	*Carassius carassius*	+
3	*Acipenser gueldenstaedtii*	+	40	*Carassius gibelio*	+
4	*Acipenser nudiventris*	+	41	*Cyprinus carpio*	+
5	*Acipenser stellatus*	ex	42	*Hypophthalmichthys molitrix*	+
6	*Acipenser ruthenus*	+	43	*Hypophthalmichthys nobilis*	+
7	*Anguilla anguilla*	+	44	*Barbatula barbatula*	+
8	*Rutilus rutilus*	+	45	*Misgurnus fossilis*	+
9	*Rutilus pigus virgo*	+	46	*Cobitis elongatoides*	+
10	*Ctenopharyngodon idella*	+	47	*Sabanejewia aurata*	+
11	*Scardinius racovitzai*	(+)	48	*Sabanejewia romanica*	(+)
12	*Scardinius erythrophthalmus*	+	49	*Silurus glanis*	+
13	*Leuciscus leuciscus*	+	50	*Ameiurus nebulosus*	+
14	*Leuciscus souffia agassizi*	+	51	*Ameiurus melas*	+
15	*Leuciscus cephalus*	+	52	*Thymallus thymallus*	+
16	*Leuciscus idus*	+	53	*Hucho hucho*	+
17	*Phoxinus phoxinus*	+	54	*Salmo trutta m. fario*	+
18	*Aspius aspius*	+	55	*Oncorhynchus mykiss*	+
19	*Leucaspius delineatus*	+	56	*Umbra krameri*	+
20	*Alburnus alburnus*	+	57	*Esox lucius*	+
21	*Alburnoides bipunctatus*	+	58	*Lota lota*	+
22	*Chalcalburnus chalcoides mento*	ex	59	*Cottus gobio*	+
23	*Abramis bjoerkna*	+	60	*Cottus poecilopus*	+
24	*Abramis brama*	+	61	*Lepomis gibbosus*	+
25	*Abramis ballerus*	+	62	*Micropterus salmoides*	+
26	*Abramis sapa*	+	63	*Perca fluviatilis*	+
27	*Vimba vimba*	+	64	*Gymnocephalus cernuus*	+
28	*Pelecus cultratus*	+	65	*Gymnocephalus baloni*	+
29	*Chondrostoma nasus*	+	66	*Gymnocephalus schraetser*	+
30	*Tinca tinca*	+	67	*Sander lucioperca*	+
31	*Barbus barbus*	+	68	*Sander volgensis*	+
32	*Barbus peloponnesius petenyi*	+	69	*Zingel zingel*	+
33	*Gobio gobio*	+	70	*Zingel streber*	+
34	*Gobio albipinnatus*	+	71	*Perccottus glenii*	+
35	*Gobio uranoscopus*	+	72	*Proterorhinus marmoratus*	+
36	*Gobio kessleri*	+	73	*Neogobius fluviatilis*	+
37	*Pseudorasbora parva*	+			

+: present in the Tisza River, (+) present only in the watershed of tributaries, ex: extinct

the regulation of the riverbed affected fish population, primarily stagnophilic and reophilic species, it was the loss of spawning grounds in flood plains that had the most detrimental impact on fish proliferation. Not only did levees contain high water, but also blocked free passage for fish seeking spawning grounds – thus the golden age of legendary abundance in fish population came to an end.

2. Canalization of rivers

Dams constructed throughout the River Tisza watershed have also contributed to changes in the environment and fish fauna. Some retain water only in the riverbed, others fill up large reservoirs. There are three dams on the River Tisza: two in Hungary - at Tiszalök (519 river km) and Kisköre (403 river km) – one in Serbia, Novi Bečej (67 river km). In addition, there are quite a few dams of varying sizes on the tributaries.

The natural zonation of rivers is disturbed by the reservoirs built on the upper sections. Near to the reservoirs the fish fauna includes mountain and plain species. In the River Ondava of East Slovakia for example *Salmo trutta fario* L. and *Cyprinus carpio* L., in the upper section of the Rriver Crasna of Romania *Barbatula barbatula* L. and *Lepomis gibbosus* L., in the River Tur *Barbus peloponnesius petenyi* Heckel and *Perca fluviatilis* L. have been collected from the same site. (Harka *et al.* 2000, 2001, 2003).

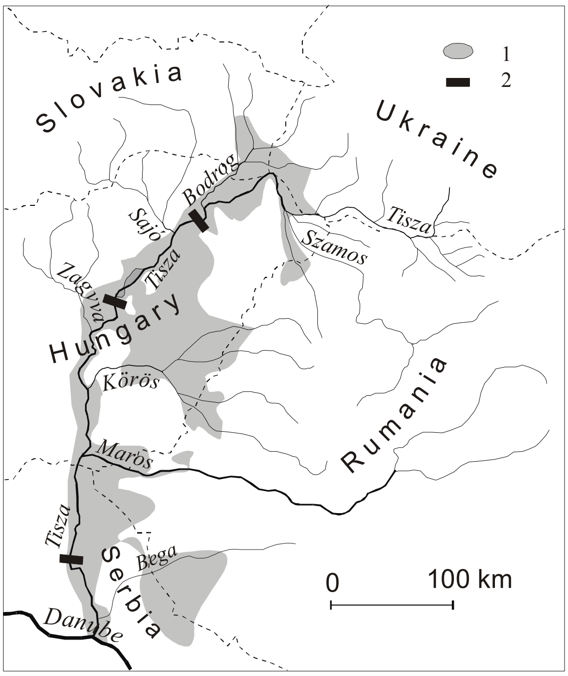

Fig. 1. Map of the River Tisza watershed (1–areas flooded regularly prior to regulation, 2–Hydroelectric dams built after 1950)

Dams in the plains have primarily affected the population, size and ratio of reophilic and stagnophilic species. There were dramatic changes following the construction of the dam at Kisköre, which filled up a reservoir of 127 sq. km between 403-440 river km. As a result there was an unprecedented drop in the population of the reophilic *Acipenser ruthenus* L., *Barbus barbus* L., *Abramis sapa* Pallas whereas *Zingel zingel* L., and *Zingel streber* Siebold, not infrequent earlier, totally disappeared from the region (Harka 1985). Simultaneously, species with a preference to slow moving water proliferated (*Abramis brama* L., *Gobio albipinnatus* Lukasch, *Sander volgensis* Gmelin.), while populations of tolerant, sturdy species (*Rutilus rutilus* L., *Carassius gibelio* Bloch, *Ameiurus nebulosus* Lesueur) boomed at a high rate.

Dams, although not the chief culprits, have also contributed to the disappearance of sturgeons, once a common migratory species in the Tisza.

3. *Introduction of exotic species*

There were numerous attempts to introduce exotic fish species in Europe in the 20th century and quite a few found their way to the Tisza watershed. The first to come were the brown bullhead (*Ameiurus nebulosus*) and the sunfish (*Lepomis gibbosus*) from America, which quickly proliferated in the lower stretches and oxbows in the early years. The largemouth bass does not seem to have found proper habitat in the river, although some specimens are caught sporadically.

In the second half of the last century seven exotic fish species inhabited the watershed of the River Tisza. The first in the line was the German carp (*Carassius gibelio*), initially speading along the Körös River, then appearing in the Tisza and its tributaries in the 1970s with a powerful gradation in some stretches. It was also in the 70s that grass carp (*Ctenopharyngodon idella* Valencienes), silver carp (*Hypophthalmichthys molitrix* Valenciennes) and bighead carp (*Hypophthalmichthys nobilis* Richardson) introduced from the Far East and originally intended for breeding exclusively in commercial fisheries, escaped from fishery ponds and have by now heavily populated the Tisza watershed. With them came the sturdy and rapidly spreading small stone moroko (*Pseudorasbora parva* Schlegel), an unwanted „byproduct" of fish introduction.

Originally a fish species from America and later introduced in the Carpathian Basin via Italy in the 1990s, was the black bullhead (*Ameiurus melas* Rafinesque) that soon invaded the Tisza watershed (Pintér 1991; Harka 1997) as a powerful rival of *Ameiurus nebulosus* Lesueur populations. Early 2001 an epidemic decimated black bullhead populations, but in 2004 the signs of gradation are obvious again. The latest adventive fish species to arrive in the watershed is the amur sleeper (*Perccottus glenii* Dybowski) from the River Amur basin. It first found its way from Aisa to St. Petersburg, Russia in the early years of the last century as an aquarium fish. It is supposed to have spread semi-spontaneously in the River Tisza watershed, where it was first identified in 1997 (Harka 1998).

4. *Pollution of rivers*

Humans have been polluting water ever since they appeared along rivers. Prior to the 20th century the relatively low quantity of mostly organic pollutants was eliminated by the natural biological purification of water which, at that time, remained drinkable in most rivers of the region. Troubles began in the second half of the century with the widespread use of obsolete technologies in industry and agriculture resulting in unprecedented pollution throughout the region. In the 1950s and 60s sensitive species were all but obliterated from the rich fish fauna of the River Bodrog by heavy industrial pollution from Czechoslovakia. Fish species in the rivers Szamos and Sajó also fell victim to pollution resulting in severe degradation of the fauna (Harka 1992, 1995).

Social and economic transformation in the countries along the River Tisza in the late 1980s and early 90s brought about favourable changes. Following the collapse of the so-called Communist heavy industry, sewage emissions dropped so significantly that the water quality of the river received first class ratings all the way down to the mouth of the River Maros.

This favourable tendency came to an abrupt end with the catastrophic cyanide poisoning from the gold mines of the Romanian town of Baia-Mare in February 2000. It was the River Szamos that brought the deadly poison into the Tisza killing approximately 1240 tons of fish in Hungary. Native species worst affected are the economically important carp (*Cyprinus carpio* L.), sheat-fish (*Silurus glanis* L.) and pikeperch (*Sander lucioperca* L.) as well as *Gymnocephalus schraetser*, *Zingel zingel* and *Zigel streber*, rare natural treasures of the region. Damage, however, was more extensive and affected the entire ecosystem.

Cyanide may have disappeared in a matter of weeks from the river basin, but the wounds of nature have not healed completely as species with long life cycles take several years to recover. Fortunately no fish species disappeared from the region and long lasting flood seasons coupled with warm weather in consecutive years after the poisoning brought about favourable conditions in the spawning seasons, which is an encouraging sign for the future.

Toxic waste is dangerous for fish even if it causes no immediate destruction. An infamous case is that of the Romanian River Vişeu, a tributary of the Upper Tisza, continually poisoned with heavy metals by a mine in Baia Borşa. Compared with the unpolluted River Iza, home to 23 fish species, and flowing parallel with the larger Vişeu at a distance of 10-20 km, it harbours only 17 species. The effect of long lasting poisoning is even more striking if the quantities of fish caught in the two rivers are compared: five times as many were netted in the River Iza (Harka *et al.* 2002).

5. Increase in water temperature

Increase in water temperature as opposed to factors discussed above is not entirely of anthropogenic origin, although natural climatic changes are strongly influenced by air pollution. Three other effects – dams slowing down water flow, thermal power stations along rivers and untreated sewage – directly increase the temperature of rivers.

In relation to the complex problem of global warming the impact of rising water temperature on fauna has been investigated only in recent years (Harka *et al.* 2002, Harka and Bíró, manuscript). Warming water appears to encourage the migration of some species from the plains to higher altitudes penetrating the mountain zone of rivers (vertical migration). Others migrate from south to north, significantly extending the borders of their geographical distribution (horizontal migration).

Both tendencies have been observed in the Tisza watershed. Mean annual temperature in the midsection of the main river (Tiszakeszi, 466 river km) has increased from 11.1 to 12.2 C over the past 50 years. (Fig. 2.)

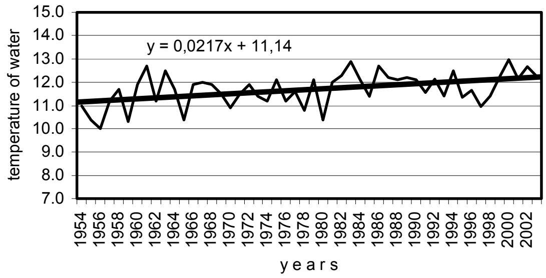

Fig. 2. Changes in the water temperature of the River Tisza at Tiszakeszi, 1954-2003

Prime examples of vertical migration include *Rutilus rutilus, Abramis brama* L., *Chondrostoma nasus* L. and *Perca fluviatilis* that penetrated the higher mountainous reaches of the tributaries (Ardelean *et al.* 2000; Harka *et al.* 2002).

Horizontal migration is characteristic of Ponto-Caspian gobies (*Neogobius fluviatilis* Pallas, *N. kessleri* Günther, *N. melanostomus* Pallas, *Proterorhinus marmoratus* Pallas etc), of which several species have been spreading upriver in the Danube basin over the past decades.

Two goby species, *Proterorhinus marmoratus* and *Neogobius fluviatilis* appear to be spreading in the Tisza watershed (Harka 1990, 1993; Harka and Sallai 2004; Harka and Szepesi 2004a, 2004b; in verb. S. Wilhelm). First to arrive was *Proterorhinus marmoratus* and localities where it has been found so far are recorded in chronological order in Fig. 3.

Treasures in the fish fauna

Scientific research of the fish fauna has identified a total of 71 species in the River Tisza since 1847. *Huso huso* L., *Acipenser stellatus* Pallas and *Chalcalburnus chalcoides mento* Agassiz have not been discovered for half a century, so the number of species is estimated at 68, of which 80% is native, 20% has been introduced. Although two other species are not present in the river, they can be found in the watershed: *Scardinius racovitzai* Müller and *Sabanejewia romanica* Bačescu (Table 1.).

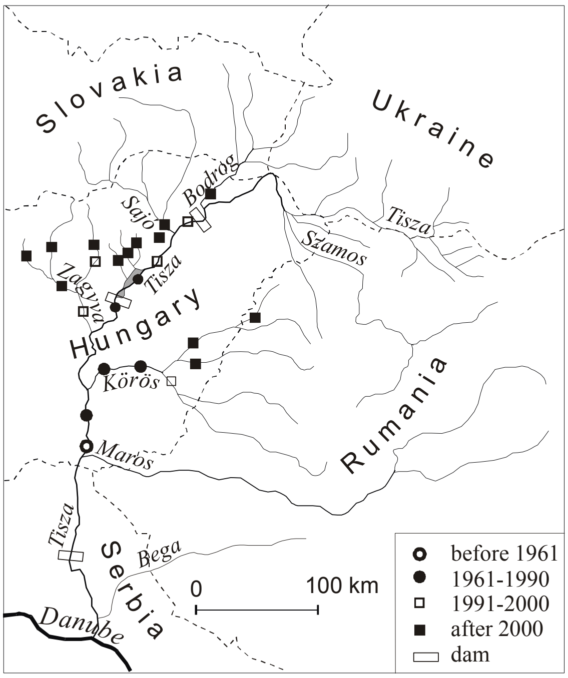

Fig. 3. The distribution of Proterorhinus marmoratus in the watershed of the River Tisza

All the species contribute to the unique value of the fish fauna, endemic species in the Tisza watershed, however, deserve special attention: *Scardinius racovitzai* was found and identified exclusively in the thermal pond of Băile Episcopeşti (Püspökfürdő), Romania, on the left bank of the Crişul Repede (Sebes-Körös) River. Another unique species is the quasi-endemic Carpathian lamprey (*Eudontomyzon danfordi* Regan), present outside the watershed only in the upper stretch of the neighbouring River Timiş (Temes). This species lived in a number of streams earlier, but has by now disappeared from many places. Fig. 4. shows the most important localities where the species has been found over the past 15 years (Terek *et al.* 1987; Nalbant 1995; Koščo and Košuth 1996a, 1996b, 1998, 2000; Bănărescu *et al.* 1997, 1999; Koščo *et al.* 2000; Harka *et al.* 1998, 1999, 2000, 2002 ; Györe *et al.* 1999, 2001; Koščo 2003).

Endemic fish of the Danube basin also represent exceptional natural treasures. They include *Gobio uranoscopus* L., *Gymnocephalus schraetser* L. and *Zingel streber*, species commonly found all over the Tisza watershed. The presence of *Sabanejewia romanica*, however, is limited to a narrow habitat in the Tisza watershed. According to Bănărescu (2002b), the species, native to the northern tributaries of the Lower Danube, can be found in the Tisza watershed only in a few small streams on the left side of the Maros river.

Rutilus pigus virgo Heckel, *Leuciscus souffia agassizi* Cuvier et Valenciennes and *Hucho hucho* L., endemic to the watershed of the Upper and Middle Danube, also live in a very limited area of the Tisza watershed (Fig. 4). *Hucho hucho* has been collected exclusively in the Hungarian and Hungarian-Ukranian stretches of the Tisza (Györe *et al.* 1999, 2001) over the past 10-15 years, although it was stocked in the River Hernád in Slovakia. *Rutilus pigus virgo*, besides being present in the Hungarian and Hungarian-Ukrainian stretches of the Tisza, was also collected in the River Túr in Hungary and the estuary of the River Kraszna (Crasna), another tributary of the Upper Tisza (Györe *et al.* 1999, 2001; Harka *et al.* 2001, 2003).

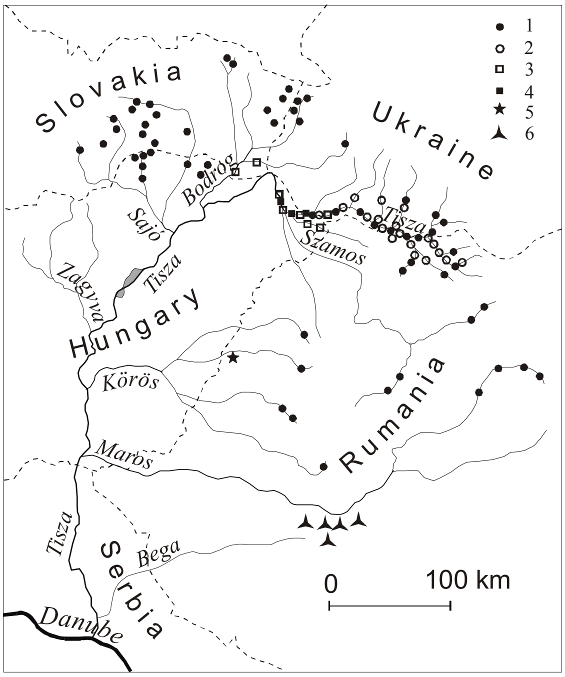

Fig. 4. Important localities where some species of high natural value have been collected over the past 15 years (1–*Eudontomyzon danfordi*, 2–*Leuciscus souffia agassizi*, 3–*Rutilus pigus virgo*, 4–*Hucho hucho*, 5–*Scardinius racovitzai*, 6–*Sabanejewia romanica*)

Leuciscus souffia agassizi is common mainly to the Ukrainian-Romanian stretch of the Tisza and its tributaries in the vicinity (Györe *et al.* 1999, 2001;

Harka *et al.* 2001, 2002, 2003; Koščo 2003; Harka and Sallai 2004)). It is notable that the populations of the three species in the Tisza live at a distance of 250-500 air km from larger, related areas commonly populated by these species. Their isolation further increases their value, but they are also more vulnerable, therefore need more attention and protection.

Among the most treasured imperilled and highly protected fishes of the watershed are the almost extinct ship (*Acipenser nudiventris* Lovetzky), Russian sturgeon (*Acipenser gueldenstaedtii* Brandt and Ratzeburg), Petenyi's barbel (*Barbus pelponnesius petenyi* Heckel), the mudminnow (*Umbra krameri* Walbaum) and the Siberian bullhead (*Cottus poecilopus* Heckel), which reaches the south-western border of its range in this region.

Conservation and proliferation of natural treasures

On large rivers that serve as major waterways like the Danube, Main and Rhine, a chain of dams were constructed in the upper reaches to make them navigable, and smaller rivers are not better off either. Similar in size to the Tisza, the River Dráva (Drau), a tributary of the Danube flowing along the Hungarian-Croatian border is split up by more than twenty dams that severely disturb natural habitat. The free flow of the River Tisza is blocked by dams in the plains only. The natural zonation in the hilly and mountainous regions remains a rare natural treasure in Europe.

Another treasure of the river is the presence of an almost intact natural fish fauna. In spite of the introduction of quite a few exotic species, among them aggressive rivals of native fish, all the originally native species have viable populations with the exception of rare sturgeons and *Chalcalburnus chalcoides mento*.

The survival of valuable species requiring special habitat is attributable to the relatively clean Upper Tisza, where hydrological conditions have not changed significantly, therefore the maintenance of this environment remains top priority.

The survival of the heavily imperilled, disappearing species of *Huso huso*, *Acipenser gueldenstaedtii* and *Acipenser nudiventris* depends on active and dedicated human assistance. Viza 2020 (Sturgeon 2020), an initiative subsidized by WWF Hungary, is aimed at re-establishing sturgeon populations in former habitats by habitat rehabilitation, breeding and stocking and the construction of fish ladders facilitating the migration of the species.

A project started in 2004 aimed primarily at flood control in the Hungarian stretch of the Tisza will also affect fish population. It intends to cut flood peaks by filling up temporary reservoirs built in former flood plains and later emptying them once the flood recedes. Environmentalists are keen on retaining some water in the reservoirs for some 2-3 months, which could to some extent re-establish lost flood plains that were once the cradles of rich fish fauna.

At last, but not least, one must point out the importance of the „green corridor" along the river, home to a rich variety of habitats in the flood plain with oxbows, meadows and forests. Civilized as the Great Hungarian Plain may have become, this unique path for wildlife migration offers safe shelter and plays an important role in maintaining biodiversity.

All the countries involved – Ukraine, Romania, Slovakia, Hungary and Serbia – bear responsibility and have common interest in the preservation of near-natural conditions in and along the River Tisza.

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References

Anonymus (1977): Gesta Hungarorum (Hungarian translation D. Pais) – Budapest, p. 176.

Bănărescu, P. (2002a): Species and Subspecies of Fish and Lampreys Endemic or Almost Endemic to the Drainage Area of the River Tisza. – In: Ecological Aspects of the River Tisza Basin. Tiscia monograph series 6, 167-172.

Bănărescu, P. (2002b): Fish Species with Restricted Ranges in the River Tisza Drainage Area. – In: Ecological Aspects of the River Tisza Basin. Tiscia monograph series 6, 173-178.

Bănărescu, P. M., Telcean, I., Bacalu, P., Harka, Á. and Wilhelm, S. (1997): The Fish Fauna of the Cris/Körös River Basin. – In: Sárkány-Kiss, A., Hamar, J. ed. The Cris/Körös Rivers Valleys, Szolnok–Szeged–Târgu Mures, 301-325.

Bănărescu, P., Telcean, I., Nalbant, T., Harka, Á. and Ciobanu, M. (1999): The Fish Fauna of the River Someș/Szamos Basin. – In Sárkány-Kiss, A., Hamar, J. (ed.): The Someș/Szamos River Valley, Tiscia monograph series, Szolnok–Szeged–Târgu Mures, 249-268.

Czirbusz, G. (1884): Fish Species in the River Tisza near Szeged. – Természettudományi Füzetek 8, 162-165. (in Hungarian)

Deák, A. (1984): De piscatione Hungarica (Hungarian translation). – Budapest, p. 76.
Guelmino, J. (1996): A Contribution to the Research of the Ichthyofauna of the Lower Course of the River Tisza. – Proceedings for Natural Sciences, Matica Srpska, Novi Sad, 90, 49-58.
Györe, K. and Sallai, Z. (1998): The Fish Fauna of the Körös River Basin. – Crisicum I. (Körös-Maros Nemzeti Park Igazgatóság) 211-228. (in Hungarian)
Györe, K., Sallai, Z. and Csikai, Cs. (1999): Data to the Fish Fauna of the River Tisza and its Tributaries in Hungary and Romania. – In: The Upper Tisza Valley (ed. Hamar J., Sárkány-Kiss A.), Szeged, 455-470.
Györe, K., Józsa, V., Specziár, A. and Turcsányi, B. (2001): The Impact of Cianide Poisoning from Romania on the Fish Fauna of the Szamos and River Tiszas. – Halászatfejlesztés (Szarvas) 26, 110-152. (in Hungarian)
Harka, Á. (1985): Ichthyological and Piscatorial Problems at the Kisköre Water Basin. – Tiscia (Szeged) 20, 117-126.
Harka, Á. (1990): Zusätzliche Verbreitungsgebiete der Marmorierten Grundel (*Proterorhinus marmoratus* Pallas) in Mitteleuropa. – Österreichs Fischerei 43, 262-265.
Harka, Á. (1992): Data on the Fish Fauna of the Sajó and Hernád Rivers' Watershed. – Állattani Közlemények 78, 33-39. (in Hungarian)
Harka, Á. (1993): Spreading of the tunebose goby (*Neogobius fluviatilis*) . – Halászat 86, 180-181. (in Hungarian)
Harka, Á. (1995): The Fish Fauna of the Szamos River. – Halászat 88, 14-18. (in Hungarian)
Harka, Á. (1997): Halaink [Fish in Hungary]. – Budapest, p. 175. (in Hungarian)
Harka, Á. (1998): The Amur Sleeper (*Perccottus glehni* Dybowski, 1877), a New Species in the Fish Fauna of Hungary. – Halászat 91, 32-33. (in Hungarian)
Harka, Á., Györe, K., Sallai, Z. and Wilhelm, S. (1998): Fish Fauna of the River Berettyó/Barcău). – Halászat 91, 68-74. (in Hungarian)
Harka, Á., Bănărescu, P. and Telcean, I. (1999): Fish Fauna of the Upper Tisza. – In: The Upper Tisza Valley (ed. Hamar J., Sárkány-Kiss A.), Szeged, 439-454.
Harka, Á., Koščo, J. and Wilhelm, S. (2000): Fish Fauna of the River Bodrog and its Tributaries. – Halászat 93, 130-134. and 93, 182-184. (in Hungarian)
Harka, Á. and Sallai, Z. (2004): Fish Fauna of Hungary. – Nimfea T. E., Szarvas, p. 269. (in Hungarian)
Harka, Á., Sallai, Z. and Wilhelm, S. (2001): Fish Fauna of the River Kraszna/Crasna. – Halászat 94, 34-40. (in Hungarian)
Harka, Á., Sallai, Z. and Wilhelm, S. (2002): Effects of Water Pollution and Global Warming on the Fish Fauna of the Romanian Tributaries of the River Tisza. – Tiscia 33, 51-58.
Harka, Á., Sallai, Z. and Wilhelm, S. (2003): Fishes of the Túr River and its Tributaries). – Halászat 96, 37-44. (in Hungarian)
Harka, Á. and Szepesi, Zs. (2004a): Appearance and Spreading of the Tubenose Goby (*Proterorhinus marmoratus* Pallas, 1811) in the Watershed of the River Zagyva. – Halászat 97, 38-40. (in Hungarian)
Harka, Á. and Szepesi, Zs. (2004b): Distribution of tubenose gogy (*Proterorhinus marmoratus*) and monkey goby (*Neogobius fluviatilis*) in some tributaries of the Middle River Tisza. – Halászat 97, 154-157. (in Hungarian)
Heckel, J. (1863): A Teatise on Freshwater Fish in Hungary with notes and Description of New species. – In: A magyar orvosok és természetvizsgálók VIII. nagygyűlésének évkönyve, Budapest, 193-216. (in Hungarian)
Herman, O. (1887): A magyar halászat könyve I-II. [A Handbook of Fishing in Hungary I-II]. – Budapest, p.860. (in Hungarian)
Koščo, J. (2003): Contribution to the Knowledge of the Ichthyofauna of the Upper River Tisza. – Natura Carpatica 44, 187-196. (in Slovak)
Koščo, J. and Košuth, P. (1995): Ichthyofauna of the Starina River Basin and Reservoir. – Roczniki Bieszczadzkie 4, 143-154. (in Slovak)
Koščo, J. and Košuth, P. (1995): Ichthyofauna of the Ublianka and Stuzycka River Basins. – Roczniki Bieszczadzkie 4, 155-161. (in Slovak)
Koščo, J. and Košuth, P. (1998): Structural and Quantitative Characterization of the Ichthyofauna of the Zbojsky and Ulicka River Basins. – Natura Carpatica 39, 199-210. (in Slovak)
Koščo, J. and Košuth, P. (2000): Ichthyoceoses of Slovak Paradise National Park. – Natura Carpatica 41. 81-94. (in Slovak)
Koščo, J. and Košuth, P. (2000): Ichthyofauna of the Slaná River Basin in the Roznava District. – Folia faunistica Slovaca 5, 157-170. (in Slovak)
Koščo, J., Balázs, P., Ivanec, O., Kovalčuk, A., Manko, P. and Terek, J. (2004): Contribution to the Knowledge of the Ichtyofauna of Streams in the Trans-Carpathian Region in Ukraine. – Acta FSHN Univ. Presoviensis 40, 138-152. (in Slovak)
Nalbant T. (1995): Fish of the Mures/Maros River: Systematics and Ecology. – In: The Maros/Mures River Valley, Szolnok–Szeged–Tirgu Mures, 225- 234.
Pap J. (1882): Notable Fish Species in the River Tisza at Szeged. – Természettudományi Füzetek 6, 49-53. (in Hungarian)
Pintér K. (1991): Appearance of the Black Bullhead in the Tisza Watershed. – Halászat 84, 94-96. (in Hungarian)
Répássy M. (1903): Fishing in the Tisza – Past and Present. – Különlenyomat a „Halászat" IV. évfolyamából. – Pátria, Budapest, p. 35. (in Hungarian)
Sallai Z. (1999): On the Fish Fauna of the Maros River in Hungary. – Crisicum II. 185-198. (in Hungarian)
Szerencsés, I., Pozder, M.(1985): Excerpts from Pál Kitaibel's Diary in 1797. – Tiszafüredi Tanulmányok 58-65. (in Hungarian)
Szilágyi M. (1992): Halászó vizek, halásztársadalom, halászati technika [Fishing in Hungary]. Studia Folkloristica et Ethnographica 29. – Debrecen, p. 248. (in Hungarian)
Terek, J., Brázda, J., Ferianc, P., Halátová, K. and Koščo, J. (1987): Limnology of the Ladomirka Stream. – Prehlad odbornych vysledkov X. Vychodoslovensky TOP, 15-30. (in Slovak)
Vásárhelyi I. (1960): On the Fish fauna of Hungary I. The Fish Fauna of the River Tisza. – Vertebrata Hungarica 2, 19-30. (in Hungarian)
Vladykov V. (1931): Poissons de la Russie sous-carpathique (Tchécoslovaquie). – Mémoires de la Société Zoologique de France 29, 217-374.
Vutskits Gy. (1902): Classis. Pisces – In: Fauna Regni Hungariae (1918), 1-42.

TISCIA 35, 73-84

VEGETATION TYPES OF MOSAIC-COMPLEXES IN THE MIDDLE-TISZA REGION

O. Makra and M. Zalatnai

Makra, O. and Zalatnai, M. (2006): Vegetation types of mosaic-complexes in the Middle-Tisza region. – Tiscia 35, 73-84

Abstract: After the water regulation along the Middle–Tisza region, the area of the semi-natural wetlands decreased and the vegetation strongly fragmentized. Semi-natural habitats which still survived are thus of high conservation importance.
The goal of the study was to survey the recent characteristic vegetation types of the region of the inundated flood area and the protected floodplain outside the dike. The examined site was a habitat-complex close to Rákóczifalva. It is unique in this region because the semi-natural patch-mosaic extended to the flood protected side ensuring between-habitat connections on both parts of the floodplain. We surveyed 6 habitats of a semi-natural zonation-complex, 2 forest stands of native tree species and a hybrid poplar plantation in the region of Csataszög. In forests and grasslands phytocoenological relevès were made. The evaluation of the vegetation was performed on the basis of their naturalness by using Simon's nature conservation ranks of the Hungarian vascular plants (NCR), Borhidi's classification of the Hungarian vascular plants (social behaviour types SBT) and the relative ecological indicator values by Borhidi. The phytocoenological relevés were analyzed by PCA. Temporal changes of the vegetation in landscape level during the last 200 years were examined using historical maps and aerial photographs. We completed the recent vegetation map of the area at Rákóczifalva and compared with that by Timár (1952). Later map is first published in this paper.

Keywords: Middle-Tisza region, vegetation, habitat map, landscape history

O. Makra, Tisza-Research Group, Hungarian Academy of Sciences and Department of Ecology, University of Szeged, **M. Zalatnai**, Department of Ecology, University of Szeged, H-6701 Szeged, PO Box 51, Hungary.

Introduction

The semi-natural wetlands were limited to small area along the River Tisza after the water regulation (Schweitzer 2003). The inundation area was divided into two parts with dikes: the more or less regularly inundated flood plain and the protected flood plain outside the dike. Patches of the original vegetat-ion became smaller and more isolated in consequen-ces of the river control and the intensive land use. There is no any site in the floodplain which remain-ed completely in its natural state. Therefore, the still existing semi-natural areas are of conservation importance (Gallé and Körmöczi 2004).

Majority of the floodplain is too narrow to support natural zonation complex in the Middle-Tisza region, and the few broader sections are dominated by arable lands and forest plantations.

The studied habitat-complexes near Rákóczifal-va and Csataszög are among the few exceptions where there are wide inundated floodplains dominat-ed by quasi-natural vegetation. The Rákóczifalva area is unique in this region because the semi-natural patch-mosaic extends to the flood protected side ensuring between-habitat connections at both parts of the floodplain.

The area has been poorly studied. Timár made a vegetation map at Rákóczifalva in 1952, and beside this, one botanical survey was carried out in 2004 (Gulyás and Lukács 2004).

Our aim was to describe the vegetation of the typical habitat types in the Middle-Tisza region.

As further water management interventions (new bank forming, extending the floodplain region, making a flood-decreasing valley) are planned to improve the safety against floods ("New Vásárhelyi

Plan"), the present study could be considered as a state-assessment before the interventions.

Materials and methods

Region

Middle-Tisza Region is a 254 km section of the river from Tokaj to Cibakháza. Within this region, the examined areas are found at the western edge of the loess ridge of Szolnok. The climate is continental in this geographical region (summer is hot and the average annual precipitation is about 500 mm without precipitation maximum in autumn). The soil of the studied region is mostly silt and clay (Pécsi 1969).

Study sites

The study sites are situated at 47°4'20" north 20°11'20" east and at 47°15'30" north 20°23'40" east, at Rákóczifalva and at Csataszög, respectively and both belong to the Middle-Tisza Landscape Protection Area.

The habitat complex along the river consists of eight main habitat types (sample sites in bracket), willow-poplar gallery forest (Csataszög), planted hybrid poplar forest (Csataszög), inundated floodplain oak forest (Csataszög), marshy meadow (Rákóczifalva), secondary marsh and steppe vegetations on the slopes of the dike (Rákóczifalva) and meadow and oak plantation in the protected flood area (both at Rákóczifalva).

High inundation reaches regularly the floodplain during spring. Inundations can be experienced periodically only in the depression along the dike in case of an intensive and long-lasting flooding in the protected flood area. The studied area lies in the matrix of intensive cultivated areas (Fig. 5).

Methods

Investigations were performed twice in 2003 in May and in August. Flora of the habitat patches was drawn up for both examined regions, Csataszög and Rákóczifalva. The vegetation was sampled with at least five quadrates of 2×2 m area in the grasslands and of 10×10 m in the forests. Relevès of the two periods were drawn together for the further analysis.

Habitat map of the area at Rákóczifalva was made by using the National Habitat-classification System (Bölöni *et al.* 2003) nomenclature and it was digitalized by ArcView 3.2 software.

We used also the maps of the historical First, Second and Third Military Surveys of Hungarian Kingdom, an aerial photograph from the 50s and one made at 2004 to follow the landscape level changes till nowadays. The recent vegetation types are compared with the vegetation map by Timár (1952), which was digitalized for this purpose.

Vegetation of the habitats was evaluated on the basis of their naturalness using Simon's system of nature conservation ranks of the Hungarian vascular plants (Horváth *et al.* 1995) and Borhidi's detailed classification of social behaviour types of the Hungarian vascular plants (Borhidi 1995). We also applied the relative ecological indicator values by Borhidi to characterize the habitats: soil moisture (WB), soil reaction (RB), ammonia-nitrate supply (NB) and salinity (SB) (Horváth *et al.* 1995). During the evaluation we calculated both the number of species belonging to a given category and the species number weighted by the percentage cover.

PCA ordination of the coenological relevès were made by Syntax 5.0. (Podani 1995). The relevès of the grasslands and forests were analysed separately.

Landscape history

Large wetlands without extensive woodlands characterized the studied landscape at the second part of the 18th century on the basis of the map by First Military Survey of Hungary. Different vegetation types can not be distinguished on that map (Fig.1).

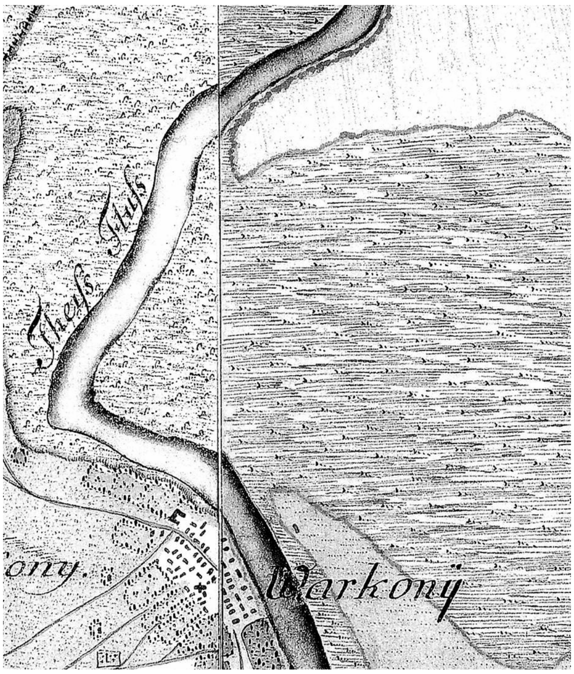

Fig.1. The examined area at the time of the First Military Survey (1782-85)

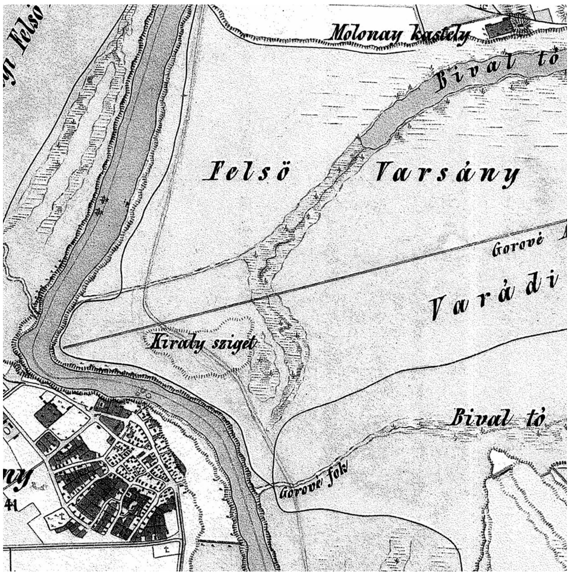

Fig. 2. The area at the time of the Second Military Survey (1819-69)

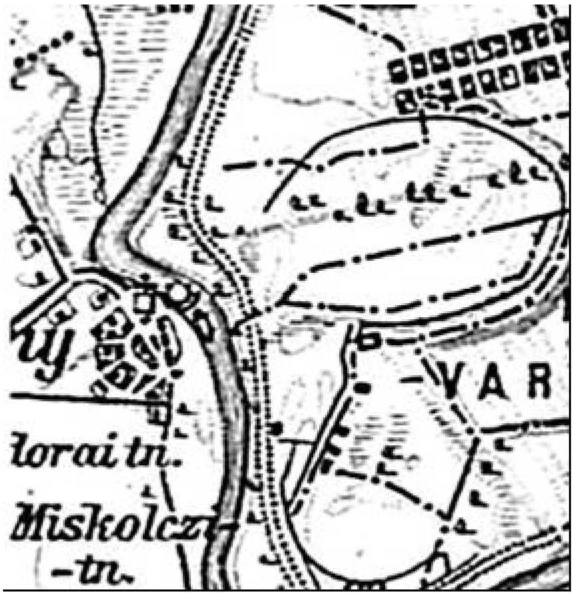

Fig. 3. The area at the time of the Third Military Survey (1872-87)

The Second Military Survey (1819-1869) presumably carried out during or after the river regulation, showed a landscape structure similar to the present situation. It is noticeable on the map that the so-called Bival-lake was an earlier separated backwater connecting to the River Tisza at one point. There were designated reed and tall sedge vegetation patches on the surroundings of the backwater. Probably, these deep-lying habitats were under permanent water cover all the year. The centre of the area was possibly covered by some kind of meadow vegetation (Fig. 2).

The Third Military Survey (1872-1887) was definitely made after the river regulation; the area was similar to the recent conditions. Trees were indicated scattered on the floodplain. No separated vegetation patches are indicated on this map-scale (Fig. 3).

Results and discussion

Evaluation of the previous researches

In the 1950s, Timár investigated the vegetation of the Tisza valley between Szolnok and Szeged. He distinguished four types of the floodplain meadow vegetation and two forest types in this region (Fig. 4). One considerable deficiency is found when comparing the aerial-photograph from 1950 with Timár's vegetation map. Timár marked only one willow-poplar forest stand along the riverbank, but according to the aerial-photograph there was a larger stand of it at the northern end of the area, too.

Actualizing Timár's nomenclature, we could say that the stand of *Carici vulpinae-Alopecuretum pratensis* occured at the largest extension and *Carex melanostachya* became dominant locally in the wetter parts. Due to the lack of coenological relevès, one could not decide whether the *Caricetum melanostachyae* facies was distinguished on association-level. We consider Timár's vegetation type "*Alopecuretum pratensis-Artemisieto-Festucetum pseudovinae"* as *Agrostio-Alopecuretum pratensis*. According to this, there was already some sodic character in one part of the meadow at the 50s.

Another surveying was performed in this area at 2004. A habitat map and a floristic list were made at the floodplain within this scope. Researchers found 145 species and 9 habitat types in the course of their survey (Gulyás and Lukács 2004).

Description and evaluation of the vegetation types

Willow gallery forest (**WGF**)

The forest that was found along the dike on the area of Csataszög consisted of dominant disturbance tolerant and adventive species. These species were dominant at every layer but one. The dominants of the upper foliage were *Salix alba, S. triandra* and *Populus nigra*. *Fraxinus pennsylvanica* dominated the lower foliage in almost one hundred per cent. Three adventive species occurred in the upper shrub layer also dominated by *Fraxinus pennsylvanica*. In the lower shrub layer *Rubus caesius* was in the highest proportion. Herb layer consisted of some

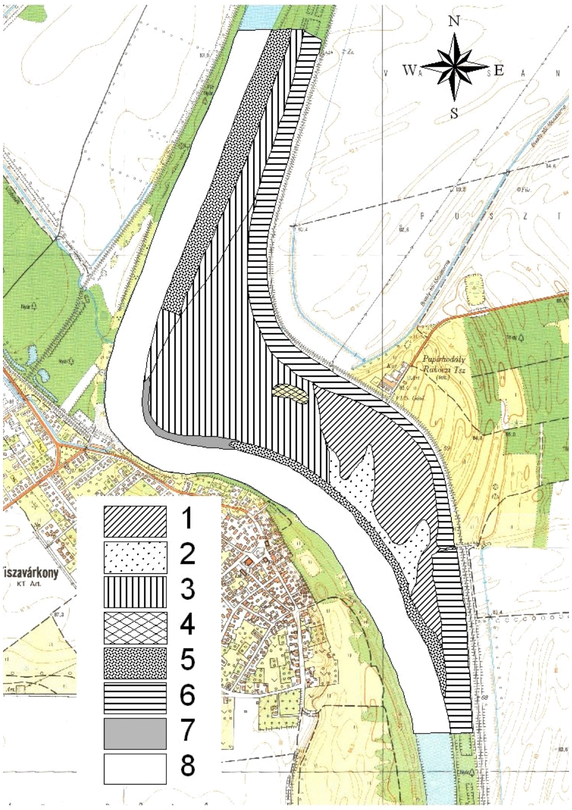

Fig. 4. Vegetation map of the region at Rákóczifalva by Timár at 1952. He used the following association names: 1: *Alopecuretum pratensis-Artemisieto-Festucetum pseudovinae*, 2: *Alopecuretum pratensis, Carex melanostachya fac.*, 3: *Alopecuretum pratensis, Carex praecox fac.*, 4: *Glycyrrhizetum echinatae,* 5: *Salicetum albae-triandrae*, 6: *Populeto-Salicetum albae, Rubus caesius degraded fac.*, 7: sandbank, 8: River Tisza

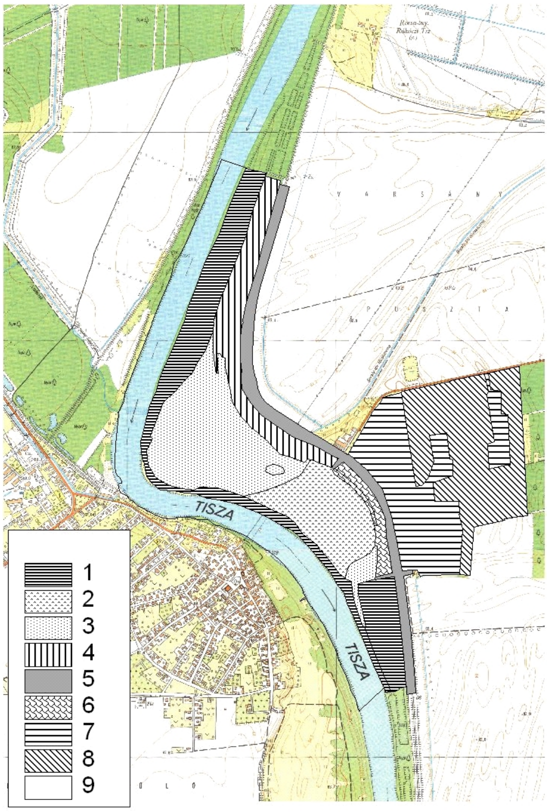

Fig. 5. The habitat map of the examined region at 2003.
1: willow poplar (*Salicetum albae-fragilis*), 2: floodplain marsh meadow (*Caricetum melanostachyae* × *Agrostio-Alopecuretum pratensis*), 3: marsh meadow dominated by *Amorpha fruticosa*, 4: willow plantation along the dike 5: dike, 6: hybrid poplar plantation, 7: grassland in the flood protected area, 8: oak forest in the flood protected area, 9: River Tisza

seedlings of the species, which are mainly adventive, of the upper strata. Species indicating the natural state of the stand were sporadically present: *Clematis vitalba, Lysimachia nummularia, Equisetum palustre, Lycopus europaeus*. The only protected plant was *Leucojum aestivum*, rare and characteristic species of the *Salicetum albae-fragilis* association.

Considering the relative ecological indicator values, basifrequent plants and those of neutral soils were dominant. In respect of the distribution of WB (soil water content) indicator values, the plants of not well aerated soils and semi-humid, fresh and moist soils were dominant. Several categories of the NB (ammonia-nitrate supply) were represented, dominated by the plants of moderately nutrient rich habitats and species indicating mineralogen nitrogen rich soil on the basis of coverage of species (Tables 1-6.).

Poplar plantation (**PP**)

The foliage consisted only of *Populus* × *hybrida*. Four adventive species constituted the shrub stratum, among them the coverage of *Amorpha fruticosa* was almost one hundred per cent, the other three ones – *Acer negundo, Fraxinus pennsylvanica, Echinocystis lobata* – occurred sporadically. Species referring to the naturalness of the stand appeared sparsely: *Lysimachia vulgaris, L. nummularia, Lycopus europaeus, Iris pseudacorus.*

Plants of neutral and weakly alkaline soils were dominant. Considering the distribution of the WB (soil moisture) values, plants of semi-humid, fresh and moist soils were dominant on the basis of the coverage of species, but when taking only the number of species into account the distribution of the values was more balanced. There was the same dichotomy regarding the distribution of the ammonia-nitrate supply values. Various categories were divided in almost the same proportion on the basis of the number of species, but plants of habitats moderately nutrient rich and extremely rich in nitrogen were in higher proportion when considering the percentage cover (Tables 1-6.).

Oak plantation (**OP**)

This stand found in the floodplain in the area of Csataszög was very poor of species, only four species occurred. *Quercus robur* dominated the upper foliage, and the lower stratum was formed by *Fraxinus pennsylvanica*. Herb layer coverage was sparse consisting mainly of seedlings, the *Quercus robur* saplings occurred sporadically. One protected species, *Leucojum aestivum*, was recorded.

Floodplain meadow

The meadow lying in the region of Rákóczifalva is the property of the Directorate of the Environmental Conservation and Water Management of the Middle-Tisza Region. The protected area is managed by Hortobágy National Park. It was mowed by decreasing intensity over the last 15 years. The meadow was not harrowed and drilled up in the last 20 years (Tallósi, personal communication).

Two vegetation types were distinguished, *Caricetum melanostachyae* developed on the depressions and *Agrostio-Alopecuretum pratensis* was found in the backs. On the northern part of the meadow *Amorpha fruticosa* formed large homogeneous patches by the end of August, and *Glycyrrhiza echinata* spred on the southern part because of the non convenient management.

Caricetum melanostachyae **(FM1)**

Generalists (*Carex melanostachya*), disturbance tolerants (*Glycyrrhiza echinata, Lysimachia nummularia*) and ruderal competitors (*Elymus repens*) dominated the stand. Most of the natural association-forming species appeared sporadically: *Scutellaria hastifolia, Lythrum virgatum, Poa pratensis*. High proportion of *Elymus repens* and spreading of the *Glycyrrhiza echinata* and *Amorpha fruticosa* after the mowing at the end of August indicated the disturbation and degradation of the area.

Basifrequent and weakly salt tolerant plants are predominant. Considering the distribution of the soil moisture values, plants indicating the wet, not well aerated soils dominated. Distribution of the NB (ammonia-nitrate supply) values showed that the area is mesothrophic when considering the species number, but on the basis of the coverage values species demanding mineralogen, nitrogen rich soils and those of the submesotrophic habitats were present in the highest proportion (Tables 1-6.).

Agrostio-Alopecuretum pratensis **(FM2)**

The stand was a degraded form of *Agrostio-Alopecuretum pratensis*. At the time of our investigation, few marsh-meadow species were present because of the dry year.

According to the distribution of Borhidi's social behavior types the competitors (*Alopecurus pratensis*) dominated, but considering the number of species the disturbance tolerants (*Galium verum, Glycyrrhiza echinata*), weeds (*Lathyrus tuberosus, Sonchus oleraceus, Vicia sativa*) and ruderal competitors (*Cynodon dactylon, Elymus repens*) gave the highest proportion of the flora. Characteristic of the most species belonging to the above-mentioned behaviour types that they spread out during the vegetation period after some disturbances (e.g. mowing).

Species not occurring on salty soils appeared in high number, but according to the coverage two categories – salt tolerant plans, soils with high chloride content – were present in the highest proportion. The polyhaline *Limonium gmelinii* was in high cover, which caused the second peak in the distribution of SB values (salinity). Neutral, basifrequent and basifilous species were the determinants on the basis of the distribution of the soil reaction values. The soil moisture demand of the species was various, but plants of the fresh soils were present with the highest covering. Plants indicating mineral nitrogen rich soils were dominant (Tables 1-6.).

Dike

A dike was already marked on the map of the Second Military Survey. Both slopes of the dike face to semi-natural patches. One side exposed to the flood area was connected to a willow shelter-forest and a floodplain meadow described previously, an extensive grassland was situated next to the other dike side.

Vegetation of the dike slope facing to the flood area (**D1**)

Vegetation stripes typical of dikes could be found here (Bodrogközy 1968). At the lower part of the slope hygrophilous and marsh-meadow species were dominant: *Alopecurus pratensis, Galium boreale, Poa pratensis, Thalictrum lucidum*. The upper zone was more disturbed, steppe-like vegetation developed here with the following species: *Salvia nemorosa, Cardaria draba, Knautia arvensis, Plantago lanceolata*. At the top of the dike, *Cynodonto-Poetum angustifoliae* association was found along the road.

The main elements of the plant assemblages were neutral and basiphilous plants. The dike provided habitats for species with many kinds of soil moisture demands. Considering the nitrogen supply, the distribution of the species covered a wide range in the indicator spectrum. On the basis of the coverage habitats of mesotrophic and mineralogen nitrogen rich species dominated (Tables 1-6.).

Vegetation of the dike slope facing to the protected flood area (**D2**)

The grassland of the outer dike slope could be regarded as a very disturbed, secondary loess steppe with few species. Determinative elements of the flora belonged to Gramineae: *Festuca pseudovina, Poa angustifolia, Elymus repens*. These and other species indicated the natural state of the habitat such as *Salvia nemorosa, S. austriaca* and *Achillea pannonica*. The upper zone of the dike was covered by *Cynodonti-Poetum angustifoliae* association.

Considering the soil reaction and the coverage the dominant plants were basifrequent and basiphilous. This slope was much drier than the other side, plants of semi-dry habitats and xero-tolerant species prevailed. The distribution of the NB (nitrogen supply) values was wide, but plants indicating moderately oligothrophic and mesotrophic habitats were present in larger proportion (Tables 1-6.).

Grassland on the protected flood area (**GP**)

The grassland outside the dike was not managed regularly. It was grazed by sheep at the 1990s and later it was occasionally pastured, trodden and mown in some patches. There were some weedy patches on the area because of the manure and other organic matter deposited there (Tallósi, personal communication).

Several patch-types of the natural vegetation developed in this area. Near the bottom of the dike a permanent water-covering appeared usually during the spring, and *Carex melanostachya* and *Alopecurus pratensis* dominated vegetation fragments developed. In these patches mainly Cyperaceae and Gramineae prevailed (*Carex melanostachya, C. praecox, Alopecurus pratensis, Poa pratensis, Elymus repens*), other species were present in lower cover. The most important vegetation type of this grassland is a remnant of *Peucedano-Asteretum sedifolii*, with both protected species, *Peucedanum officinale* and *Aster sedifolius*. This vegetation type was one of the most characteristic associations of the Hungarian Great Plain mosaic with *Galatello-Quercetum roboris* (Borhidi 2003).

At the southern part of the grassland farther from the dike, the effects of drying and alkalization became more intense. Mosaics of *Achilleo setaceae-Festucetum pseudovinae*, *Camphorosmetum annuae* and reeds were found on the deeper relief. Appearing characteristic species of the grassy saline "puszta" were as follows: *Festuca pseudovina, Poa angustifolia, Limonium gmelinii, Achillea pannonica, Matricaria chamomilla*. Several smaller patches of the area were dominated by weeds.

This florula is dominated by the disturbance tolerant, generalist and competitor species. It was not of strong saline character considering the distribution of salt-tolerance and soil-reaction indicator values of the flora and the vegetation. Plants indicating neutral, basifrequent and basiphilous soils and weakly sodic habitats were present in the highest proportion with several polyhaline species. We found several patches with high salt concentration without any plant coverage, which did not appear in the diagrams. Plants of extremely dry, semi-dry and fresh-soil habitats were dominant, but in the flora a wide indicator range appeared. With respect to the distribution of the ammonia-nitrate supply the species of the oligothrophic, submesotrophic, mesotrophic and mineral nitrogen rich habitats were present in higher proportion (Tables 1-6.).

Oak forest on the protected area (**OFP**)

The forest is a 50 years old plantation with grass fragments in the deeper relief. *Quercus robur* dominated in the foliage almost one hundred per cent, *Populus alba, P. nigra*, *Robinia pseudo-acacia, Tilia platyphyllos, Fraxinus excelsior* mixed with low coverage in it. Cover of the upper foliage was 60-70 per cent. In the lower foliage *Acer pseudoplatanus* dominated some patches, *Acer platanoides* and *Ulmus laevis* were present in lower abundance. The shrub layer was rare, it consisted of partly young seedlings of *Acer pseudoplatanus, Acer platanoides, Ulmus laevis, Ulmus minor*, *Robinia pseudo-acacia*, partly *Rosa sp, Prunus spinosa, Rubus caesius* and in some patches *Amorpha fruticosa*. No *Quercus robur* seedlings were found in this layer. Monodominant plant patches alternated in the herb layer. The following species were presented in high abundance here: *Calamagrostis epigeios, Poa angustifolia, Carex spicata, Elymus repens, Urtica dioica, Galium aparine*. Most of the species occurred sporadically: *Cucubalus baccifer, Quercus robur, Mycelis muralis, Vincetoxicum hirundinaria, Symphytum officinale, Angelica sylvestris, Cirsium arvense*. Three protected species, *Ornithogalum pyramidale, Cephalanthera damasonium* and

Epipactis sp., were found in the older stands.

Robinia pseudo-acacia plantation ran along the edge of some forest sections with the following degradation indicator species at the herb layer: *Urtica dioica, Conyza canadensis, Ambrosia artemisiifolia, Daucus carota, Cichorium intybus, Elymus repens*. Some *Robinia pseudo-acacia* dominated patches were found inside of the oak forest and seedlings of the robinia spread over the neighbouring stands, too.

Some extended grasslands wedged in the oak forest. On its deeper part *Phragmites australis* dominated vegetation developed with some *Elaeagnus angustifolia*. The other species were: *Cirsium arvense, Lycopus exaltatus, Dipsacus laciniatus*. Marsh-meadow fragments survived on the higher relief dominated by *Alopecurus pratensis*. Other species, as *Aster sedifolius*, *Poa angustifolia, Agrimonia eupatoria, Epilobium pusillum, Galium aparine, Symphytum officinale, Carduus acanthoides* occurred here.

Generalist, disturbance tolerant and competitor species were in higher proportion in the flora, and competitors prevailed considering the coverage frequency of species. On the basis of the soil reaction it could be characterized with neutral, basifrequent and basiphilous plants. Salty soil character is not indicated by the species present. Plants of fresh soils were present in high cover but considering the flora a wide range of the indicator values shared in it. Plants indicating submesotrophic habitats were in high cover but regarding the flora a wider range of the indicator values appeared (Tables 1-6.).

Table 1. Distribution of the species numbers (A) and those weighted by the percentage cover (B) among the categories of the social behavior types of the flora by Borhidi (SBT). Abbreviations of the categories: C: Competitors, S: Specialists, Sr: rare specialists, G: Generalists, Gr: rare generalists, NP: Natural Pioneers, DT: Disturbance Tolerants, W: Weeds, I: Introduced alien species, A: Adventives, RC: Ruderal Competitors, AC: Alien Competitors
Abbreviations of the habitats: WGF: willow gallery forest, PP: poplar plantation, OP: oak plantation, FM1: floodplain meadow, lower part, FM2: floodplain meadow, upper part, D1: dike slope facing to the protected area, D2: dike slope facing to the protected flood area, GP: grassland on the protected flood area, OFP: oak forest on the protected flood area.

A

SBT	WGF	PP	OP	FM1	FM2	D1	D2	GP	OFP
C	3	1	1	1	1	3	3	5	9
S	1	0	0	0	2	2	2	2	2
Sr	1	0	1	0	0	0	0	0	0
G	1	1	0	5	2	11	4	14	9
NP	0	0	0	0	1	0	1	2	0
DT	5	6	0	5	4	27	9	25	16
W	3	1	0	0	4	11	3	8	3
I	2	1	2	0	1	2	0	0	2
A	1	1	0	0	0	0	0	0	0
RC	0	1	0	1	4	5	2	5	5
AC	2	2	1	0	2	2	0	2	3

B

SBT	WGF	PP	OP	FM1	FM2	D1	D2	GP	OFP
C	47	0	76	14	31	7	13	34	70
S	0	0	0	0	18	5	7	1	4
Sr	1	0	0	0	0	0	0	0	0
G	14	0	0	37	8	29	8	24	4
NP	0	0	0	0	4	0	0	0	0
DT	16	57	0	27	12	29	38	26	28
W	0	0	0	0	1	16	24	0	2
I	106	2	132	0	0	0	0	0	24
A	0	0	0	0	0	0	0	0	0
RC	0	0	0	19	17	33	16	13	8
AC	14	92	0	0	0	8	3	0	3

Table 2. Distribution of the species numbers (A) and those weighted by the percentage cover (B) among the categories of Nature Conservation Ranks by Simon (NCR). Abbreviations of the categories: U: unique or rare species, KV: strictly protected species in Hungary, V: protected species in Hungary, E: native edificatory species, K: native accessorial species, TP: natural pioneer species, TZ: disturbance tolerant native species, A: adventive species, G: cultivated species, GY: weeds. (For the legend of the habitats see Table 1.)

A

NCR	WGF	PP	OP	FM1	FM2	D1	D2	GP	OFP
U	0	0	0	0	0	0	0	0	0
KV	0	0	0	0	0	0	0	0	0
V	1	1	1	0	0	2	0	2	1
E	3	1	1	2	1	2	3	4	5
K	5	3	0	5	4	16	7	17	13
TP	0	0	0	0	0	2	1	2	0
TZ	4	4	0	3	7	19	8	19	16
A	1	1	0	0	0	0	0	0	0
G	3	2	3	0	2	4	1	0	3
GY	2	2	0	2	7	18	4	20	11

B

NCR	WGF	PP	OP	FM1	FM2	D1	D2	GP	OFP
U	0	0	0	0	0	0	0	0	0
KV	0	0	0	0	0	0	0	0	0
V	1	0	0	0	0	6	0	2	0
E	47	0	76	49	31	2	11	29	79
K	14	3	0	15	31	44	37	29	13
TP	0	0	0	0	0	2	2	0	0
TZ	16	72	0	14	21	37	22	27	20
A	0	0	0	0	0	0	0	0	0
G	120	75	133	0	0	4	0	0	25
GY	0	0	0	20	9	32	35	13	6

Table 3. Distribution of the species numbers (A) and those weighted by the percentage cover (B) among the categories (1-9) of soil reaction of the habitats (RB). (For the legend of the habitats see Table 1.)

A

RB	WGF	PP	OP	FM1	FM2	D1	D2	GP	OFP
1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	1	0	0	1
5	0	0	0	1	1	2	1	3	3
6	9	7	2	3	6	24	5	21	17
7	6	2	2	4	7	12	9	19	16
8	3	4	0	4	6	20	9	21	10
9	0	0	0	0	0	1	0	0	0

B

RB	WGF	PP	OP	FM1	FM2	D1	D2	GP	OFP
1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	1
5	0	0	0	19	8	14	11	11	2
6	29	78	76	16	31	45	2	28	78
7	43	71	43	37	45	34	49	31	21
8	33	0	0	25	8	33	44	30	17
9	0	0	0	0	0	0	0	0	0

Table 4. Distribution of the species numbers (A) and those weighted by the percentage cover (B) among the categories (1-9) of the nitrate supply of the habitats (NB). (For the legend of the habitats see Table 1.)

A

NB	WGF	PP	OP	FM1	FM2	D1	D2	GP	OFP
1	0	0	0	0	2	0	1	3	0
2	0	0	0	0	0	4	3	10	3
3	1	0	0	1	3	10	6	14	6
4	3	3	1	2	4	9	3	12	8
5	0	1	0	6	4	17	6	11	2
6	3	1	2	0	3	6	1	3	11
7	6	4	0	2	3	10	4	8	12
8	3	2	1	1	1	4	0	2	2
9	2	2	0	0	0	1	0	1	3

B

NB	WGF	PP	OP	FM1	FM2	D1	D2	GP	OFP
1	0	0	0	0	4	0	0	2	0
2	0	0	0	0	0	10	4	14	4
3	0	0	0	1	12	11	32	36	16
4	3	2	76	47	0	4	25	13	66
5	0	0	0	15	35	54	30	9	0
6	41	74	44	0	1	10	0	0	8
7	44	18	0	34	39	29	15	27	20
8	1	0	0	0	0	5	14	0	1
9	16	55	0	0	0	3	0	0	5

Table 5. Distribution of the species numbers (A) and those weighted by the percentage cover (B) among the categories (0-9) of the salt concentration of the soil of the habitats (SB). (For the legend of the habitats see Table 1.)

A

SB	WGF	PP	OP	FM1	FM2	D1	D2	GP	OFP
0	18	12	4	6	12	50	17	43	42
1	0	1	1	6	5	8	4	11	4
2	0	0	0	0	0	1	0	2	0
3	0	0	0	0	1	1	1	4	1
4	0	0	0	0	0	0	0	1	0
5	0	0	0	0	1	0	1	2	0
6	0	0	0	0	0	0	0	0	0
7	0	0	0	0	1	1	1	1	0
8	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0

B

SB	WGF	PP	OP	FM1	FM2	D1	D2	GP	OFP
0	105	149	209	27	22	100	47	37	115
1	0	0	0	70	47	25	42	43	4
2	0	0	0	0	0	0	0	2	0
3	0	0	0	0	4	1	12	16	1
4	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0
7	0	0	0	0	18	1	5	1	0
8	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0

Table 6. Distribution of the numbers (A) and those weighted by the percentage cover (B) among the categories (1-12) of the soil moisture of the habitats (WB). (For the legend of the habitats see Table 1.)

A

WB	WGF	PP	OP	FM1	FM2	D1	D2	GP	OFP
1	0	0	0	0	0	0	0	1	0
2	0	0	0	0	3	4	2	4	2
3	1	0	0	1	3	14	10	15	7
4	1	2	0	0	4	13	6	15	9
5	2	1	1	1	5	7	2	10	10
6	2	1	2	3	3	7	3	5	8
7	4	4	1	2	2	5	0	6	8
8	4	2	0	3	0	8	0	3	3
9	4	3	0	2	0	3	1	4	0

B

WB	WGF	PP	OP	FM1	FM2	D1	D2	GP	OFP
1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	4	5	2	3	0
3	0	0	0	1	17	38	79	32	19
4	0	0	0	0	4	18	5	21	3
5	14	74	0	19	9	18	15	11	18
6	13	18	119	15	50	25	6	22	73
7	27	55	0	24	8	8	0	1	6
8	3	2	0	1	0	11	0	0	1
9	36	1	0	36	0	3	0	9	0

Multivariate evaluation

On the basis of the ordination, the floodplain meadow and the protected floodplain meadow stands separate from the dike grasslands. The points of the two meadows are rather diffuse, they form elongated parallel clouds. It indicates the large inner heterogeneity of these areas. The floodplain meadow has a lower (wetter) and an upper (drier) part and these two areas separate from each other sharply in the ordination diagram. The upper part is not only drier but its soil has alkaline characteristics, too. The points of the protected flood area divide into two groups on the diagram, because this meadow is very mosaic-like: drier, wetter, and sodic patches of vegetation combine. Both slopes of the dike are similar to each other and have more homogeneous vegetation.

Three major effects which are correlated with each other could cause this point-pattern: the change of the sodic character of the habitat-patches, a moisture gradient away from the river and the differences in the degree of floods (Fig. 6.)

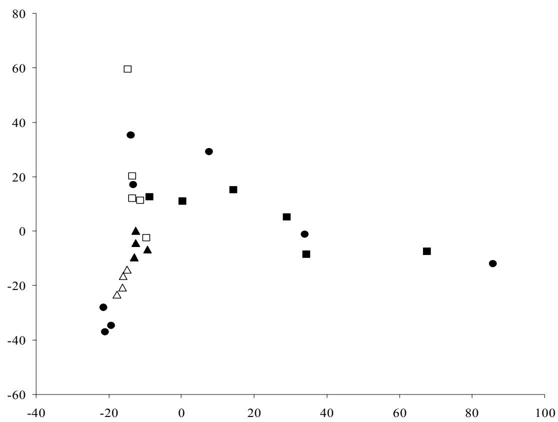

Fig.6. Ordination diagram of the grasslands. ■ lower part of the floodplain meadow □ upper part of the floodplain meadow ▲ dike slope facing to the floodplain △ dike slope facing to the protected floodplain ● protected floodplain meadow

Ordination of the forest relevès showed the expected results, the relevès of the forest types are well separated from each other. Its primary reason was the different foliage species composition (oak, willow, poplar). The same invasive species (*Amorpha fruticosa*, *Acer negundo*, *Fraxinus pennsylvanica*) constituted the shrub layers, and the herb layers were rare in species in both stands. The ordination points of the oak plantations of the protected and non-protected floodplain partly overlapped. Some stands are very far from the overlap because of more tree species in the upper canopy and the richer herb layer (Fig. 7).

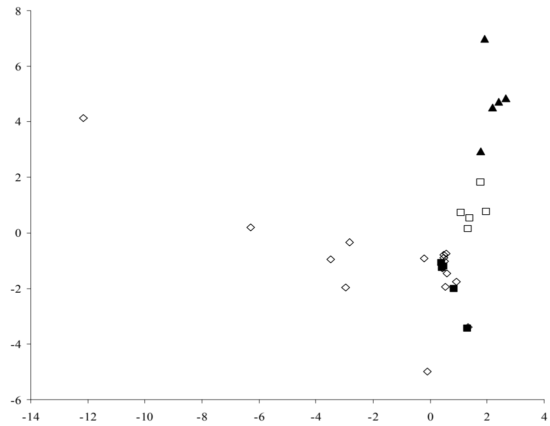

Fig. 7. Ordination diagram of the forests. ■ Oak plantation □ Willow gallery forest ▲ Poplar plantation ◇ Oak forest on the protected area

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References

Bodrogközy, Gy. (1968): Results of investigations of an experiment aiming at the development of biological defence and productivity of grass associations on the Tisza dam, in the environment of Szeged. - Tiscia (Szeged) 4. 37-52.

Borhidi, A. (1995): Social behaviour types, the naturalness and relative ecological indicator values of the higher plants in the Hungarian Flora. – Acta. Bot. Hung. 39 (1-2): 97-181.

Borhidi, A. (2003): Magyarország növénytársulásai (Plant associations of Hungary). – Akadémiai Kiadó, Budapest

Bölöni, J., Kun, A. and Molnár, Zs. (eds.): Élőhelyismereti útmutató 2.0 (Habitat guide 2.0), Vácrátót, 2003.

Gallé, L., Körmöczi, L. (ed.): Vásárhelyi Terv Továbbfejlesztése, 2004. évi ökológiai térképezési munkák - részletes vizsgálatok a Szolnok-országhatár szakaszon, (New Vásárhelyi Plan, ecological mapping in 2004 – detailed examinations from Szolnok to the frontier). – Technical report, 2004. ÖKO Rt.

Gulyás, G. and Lukács, B., A. (2004): Botanikai vizsgálatok a Tisza 323,36-319,27 fkm. közötti szakaszán, illetve ehhez a szakaszhoz tartozó bal parti hullámterén. (Botanical surveys of the Tisza and its left side floodplain between 323,36 and 319,27 rkm). - In: Kiss, B. (ed.): A Tisza 323,36-319,27 fkm. közötti szakaszának, illetve ehhez a szakaszhoz tartozó bal parti hullámterének ökológiai, természetvédelmi szempontú alapállapot felmérése, (Sustainable use and management rehabilitation of flood plain in the Middle Tisza District; LIFE03ENV/H/000280) Technical report.

Horváth, F., Dobolyi Z. K., Morschhauser, T., Lőkös, L., Karas, L. and Szerdahelyi, T. (1995): FLÓRA adatbázis 1.2, (FLORA database 1.2). - MTA-ÖBKI, Vácrátót.
Pécsi, M. (1969): A tiszai Alföld, (The Plain of the River Tisza). - Akadémiai Kiadó, Budapest
Podani, J. (1993): SYN-TAX 5.0: Computer programs for multivarieta data analysis in ecology and systematics. – Abstarcta Botanica 17, 289-302.
Schweitzer, F. (2003): Folyóink hullámtereinek fejlődése, kapcsolatuk az árvizekkel, árvízvédelmi töltésekkel. (Evolution of river flood plains, their relationship with floods and with the system of embankments in Hungary). - In: Teplán, I. (ed.): A Tisza és vízrendszere, MTA Társadalom-kutató Központ, Budapest, 107- 116 pp.
Map of the First Military Survey (1782-85)
Map of the Second Military Survey (1819-1869)
Map of the Third Military Survey (1872-1887)

Appendix

Average coverage values of the species at the nine examined vegetation types

FM1: floodplain meadow 1, deeper part, FM2: floodplain meadow 2, upper part, D1: dike slope facing to the flood area, D2: dike slope facing to the protected flood area, GP: grassland on the flood protected area, OFP: oak forest in the flood protected area, OP: oak plantation, WGF: willow gallery forest, PP: poplar plantation

species / habitats	**FM1**	**FM2**	**D1**	**D2**	**GP**	**OFP**	**WGF**	**PP**	**OP**
upper foliage									
Populus alba	0,0	0,0	0,0	0,0	0,0	1,0	0,0	0,0	0,0
Populus hybrida	0,0	0,0	0,0	0,0	0,0	0,0	0,0	44,0	0,0
Populus nigra	0,0	0,0	0,0	0,0	0,0	0,3	10,0	0,0	0,0
Quercus robur	0,0	0,0	0,0	0,0	0,0	32,5	0,0	0,0	76,0
Quercus rubra	0,0	0,0	0,0	0,0	0,0	0,3	0,0	0,0	0,0
Robinia pseudo-acacia	0,0	0,0	0,0	0,0	0,0	1,5	0,0	0,0	0,0
Salix alba	0,0	0,0	0,0	0,0	0,0	0,0	33,3	0,0	0,0
Salix fragilis	0,0	0,0	0,0	0,0	0,0	0,0	14,0	0,0	0,0
Ulmus laevis	0,0	0,0	0,0	0,0	0,0	1,3	0,0	0,0	0,0
lower foliage									
Acer platanoides	0,0	0,0	0,0	0,0	0,0	4,5	0,0	0,0	0,0
Acer pseudoplatanus	0,0	0,0	0,0	0,0	0,0	3,5	0,0	0,0	0,0
Fraxinus angustifolia	0,0	0,0	0,0	0,0	0,0	0,0	3,3	0,0	0,0
Fraxinus excelsior	0,0	0,0	0,0	0,0	0,0	1,5	0,0	0,0	0,0
Fraxinus pennsylvanica	0,0	0,0	0,0	0,0	0,0	0,0	54,0	0,0	0,0
Morus alba	0,0	0,0	0,0	0,0	0,0	0,0	13,3	0,0	43,3
Tilia platyphyllos	0,0	0,0	0,0	0,0	0,0	1,0	0,0	0,0	0,0
shrub layer									
Acer negundo	0,0	0,0	0,0	0,0	0,0	0,0	0,0	16,0	0,0
Acer platanoides	0,0	0,0	0,0	0,0	0,0	2,1	0,0	0,0	0,0
Acer pseudoplatanus	0,0	0,0	0,0	0,0	0,0	2,1	0,0	0,0	0,0
Amorpha fruticosa	0,0	0,0	0,0	0,0	0,0	0,5	5,0	67,0	0,0
Echinocystis lobata	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Fraxinus pennsylvanica	0,0	0,0	0,0	0,0	0,0	0,0	12,0	0,0	76,0
Populus alba	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0
Prunus spinosa	0,0	0,0	0,0	0,0	0,0	1,5	0,0	0,0	0,0
Rosa sp.	0,0	0,0	0,0	0,0	0,0	1,5	0,0	0,0	0,0
Ulmus laevis	0,0	0,0	0,0	0,0	0,0	0,4	0,0	0,0	0,0
Ulmus minor	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0
grass layer									
Acer negundo	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,8	0,0
Achillea pannonica	0,0	0,0	0,3	1,7	7,5	0,0	0,0	0,0	0,0
Agrimonia eupatoria	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0
Agrostis stolonifera	0,0	0,0	0,0	0,0	1,3	0,6	0,0	0,0	0,0
Allium sp.	0,0	0,0	0,3	0,0	0,0	0,0	0,0	0,0	0,0
Alopecurus pratensis	14,3	31,0	1,5	0,3	16,4	1,0	0,0	0,0	0,0
Amorpha fruticosa	0,0	0,2	3,8	0,0	0,0	0,0	9,0	6,7	0,4
Angelica sylvestris	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Aristolochia clematitis	0,0	0,0	6,3	0,0	0,0	0,0	0,0	0,1	0,0

(Appendix continued)

species / habitats	FM1	FM2	D1	D2	GP	OFP	WGF	PP	OP
Arrhenatherum elatius	0,0	0,0	0,0	3,8	0,0	0,6	0,0	0,0	0,0
Artemisia pontica	0,0	0,0	4,3	2,0	0,0	0,0	0,0	0,0	0,0
Bidens tripartitus	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Bromus inermis	0,0	0,0	3,8	0,0	0,0	0,0	0,0	0,0	0,0
Bromus mollis	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Bromus tectorum	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Calamagrostis epigeios	0,0	0,0	0,0	0,0	0,0	4,5	0,0	0,0	0,0
Capsella bursa-pastoris	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Cardaria draba	0,0	0,0	3,8	23,8	0,0	0,0	0,0	0,0	0,0
Carduus acanthoides	0,0	0,0	0,7	0,0	0,6	0,0	0,0	0,0	0,0
Carduus sp.	0,0	0,0	0,0	0,0	1,3	0,0	0,0	0,0	0,0
Carex hirta	0,0	0,0	0,7	0,0	0,0	0,5	0,0	0,0	0,0
Carex melanostachya	34,2	0,0	0,0	0,0	20,5	0,0	0,0	0,0	0,0
Carex praecox	1,4	8,2	3,3	6,8	0,0	0,0	0,0	0,0	0,0
Centaurea pannonica	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Cephalanthera damasonium	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Cerastium dubium	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Chenopodium vulvaria	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Cirsium arvense	0,0	0,1	1,0	0,0	0,1	0,2	0,0	0,0	0,0
Clematis integrifolia	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0
Clematis vitalba	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Convolvulus arvensis	0,0	0,0	0,0	0,0	3,1	0,0	0,0	0,1	0,0
Cucuballis baccifer	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0
Cynodon dactylon	0,0	9,2	18,6	5,0	1,9	0,0	0,0	0,0	0,0
Dactylis glomerata	0,0	0,0	0,3	0,0	0,0	0,0	0,0	0,0	0,0
Daucus carota	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Dianthus giganteiformis sp. pontederae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Echinocystis lobata	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Elymus repens	19,3	8,0	13,8	11,3	5,6	2,1	0,0	0,0	0,0
Equisetum palustre	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Eryngium campestre	0,0	0,0	0,3	0,0	0,7	0,1	0,0	0,0	0,0
Euphorbia cyparissias	0,0	0,0	0,4	0,0	0,0	0,0	0,0	0,0	0,0
Euphorbia lucida	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Euphorbia virgata	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Falcaria vulgaris	0,0	0,0	0,0	0,3	0,0	0,0	0,0	0,0	0,0
Festuca pratensis	0,0	0,0	0,0	0,3	0,0	0,0	0,0	0,0	0,0
Festuca pseudovina	0,0	0,0	1,4	12,0	28,1	1,5	0,0	0,0	0,0
Fraxinus pennsylvanica	0,0	0,0	0,0	0,0	0,0	0,0	27,0	1,6	12,8
Galium aparine	0,0	0,0	0,0	0,0	0,0	1,3	0,0	0,0	0,0
Galium boreale	0,0	0,0	5,3	0,0	0,0	0,0	0,0	0,0	0,0
Galium verum	0,0	4,0	0,0	1,3	11,9	1,9	0,0	0,0	0,0
Geranium molle	0,0	0,0	0,2	0,0	0,0	0,0	0,0	0,0	0,0
Glechoma hederacea	0,0	0,0	6,3	0,0	0,0	0,0	0,0	0,0	0,0
Glycyrrhiza echinata	11,7	7,5	0,9	0,0	0,0	0,0	0,0	0,0	0,0
Humulus lupulus	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Iris pseudacorus	0,0	0,0	0,5	0,0	0,0	0,0	0,0	0,0	0,0
Juncus compressus	0,0	0,0	0,3	0,0	0,0	0,0	0,0	0,0	0,0
Knautia arvensis	0,0	0,0	0,5	0,0	0,0	0,0	0,0	0,0	0,0
Koeleria cristata	0,0	0,0	0,0	0,0	0,3	0,0	0,0	0,0	0,0
Lactuca serriola	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0
Lamium purpureum	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Lathyrus tuberosus	0,0	0,2	0,3	0,0	0,0	0,0	0,0	0,0	0,0
Lens culinaris	0,0	0,1	0,1	0,0	0,0	0,0	0,0	0,0	0,0
Leucojum verum	0,0	0,0	0,0	0,0	0,0	0,0	1,2	0,0	0,1
Limonium gmelini	0,0	18,3	0,7	5,0	11,0	0,0	0,0	0,0	0,0
Linaria vulgaris	0,0	0,0	2,2	0,0	0,0	0,0	0,0	0,0	0,0
Lotus corniculatus	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0

(Appendix continued)

species / habitats	**FM1**	**FM2**	**D1**	**D2**	**GP**	**OFP**	**WGF**	**PP**	**OP**
Lycopus europaeus	0,0	0,0	0,0	0,0	0,0	0,0	0,2	0,5	0,0
Lycopus exaltatus	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Lysimachia nummularia	12,6	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Lysimachia vulgaris	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,1	0,0
Lythrum virgatum	0,2	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0
Matricaria chamomilla	0,0	0,0	0,0	0,0	0,6	0,0	0,0	0,0	0,0
Medicago falcata	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0
Melandrium album	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0
Mycelis muralis	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Myosotis ramosissima	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Ornithogalum umbellatum	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0
Papaver confine	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Pimpinella saxifraga	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Plantago lanceolata	0,0	0,0	2,0	0,1	0,1	0,0	0,0	0,0	0,0
Plantago media	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Poa angustifolia	0,0	0,0	0,7	10,0	11,3	13,8	0,0	0,0	0,0
Poa nemoralis	0,0	0,0	0,0	0,0	0,0	0,5	0,0	0,0	0,0
Poa pratensis	0,0	0,0	14,8	0,0	5,0	0,0	0,0	0,0	0,0
Populus alba	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Populus nigra	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Potentilla argentea	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0
Potentilla reptans	0,5	0,2	1,9	0,0	0,0	0,0	0,0	0,0	0,0
Prunus spinosa	0,0	0,0	0,0	0,0	0,0	4,2	0,0	0,0	0,0
Quercus robur	0,0	0,0	0,0	0,0	0,0	0,2	0,0	0,0	0,1
Ranunculus pedatus	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Ranunculus polyanthemos	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Ranunculus repens	0,0	0,0	0,5	0,0	0,0	0,0	0,0	0,0	0,0
Ranunculus sardous	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Rorippa austriaca	0,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Rosa canina	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Rubus caesius	0,0	0,0	2,5	0,0	0,0	1,1	15,0	53,3	0,0
Rumex confertus	2,0	0,0	2,2	0,0	0,0	0,0	0,0	0,0	0,0
Salvia austriaca	0,0	0,0	0,0	1,5	0,0	0,0	0,0	0,0	0,0
Salvia nemorosa	0,0	0,0	5,0	20,0	0,0	0,0	0,0	0,0	0,0
Salvia pratensis	0,0	0,0	0,0	0,0	1,9	0,0	0,0	0,0	0,0
Scabiosa ochroleuca	0,0	0,0	0,4	0,0	0,0	0,0	0,0	0,0	0,0
Scorzonera cana	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0
Scutellaria hastifolia	0,8	0,0	1,4	0,0	0,0	0,0	0,0	0,0	0,0
Setaria pumila	0,0	6,0	0,0	0,0	0,0	0,5	0,0	0,0	0,0
Silene multiflora	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Solanum dulcamara	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Sonchus asper	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0
Sonchus oleraceus	0,0	0,2	0,5	0,0	0,0	0,0	0,0	0,0	0,0
Stenactis annua	0,0	0,0	3,8	0,0	0,9	0,2	0,0	0,0	0,0
Symphytum officinale	0,0	0,0	3,9	0,0	0,0	0,2	0,0	0,0	0,0
Taraxacum officinale	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Thalictrum lucidum	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Trifolium striatum	0,0	4,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Trinia ramosissima	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Urtica dioica	0,0	0,0	0,0	0,0	0,0	1,3	0,7	1,3	0,0
Valerianella locusta	0,0	0,0	1,8	1,6	0,0	0,0	0,0	0,0	0,0
Verbena officinalis	0,0	0,0	2,1	0,0	0,0	0,0	0,0	0,0	0,0
Veronica prostrata	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Vicia angustifolia	0,0	0,0	1,6	0,0	0,0	0,0	0,0	0,0	0,0
Vicia sativa	0,0	0,8	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Vincetoxicum hirundinaria	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0

DATA TO THE MACROZOOBENTHOS OF BACKWATER "GYÁLAI HOLT-TISZA"

A. Szító and Gy. Györffy

Szitó, A. and Györffy, Gy. (2006): Data to the macrozoobenthos of backwater "Gyálai Holt-Tisza" – *Tiscia 35, 85-87*

Abstract. The total area of the investigated backwater was 160 hectares. Individual density and species composition were investigated in 24 sampling places. Deep sediment was characteristic for all backwater areas. The species richness was as follows: Oligochaeta 2, Isopoda 1, Trichoptera 1, Chironomids 10, fly larva 1 (Syrphidae), and ceratopogonids. *Limnodrilus hoffmeisteri* was dominant and the most abundant, its individual density changed between 0 and 3475/m^2, which indicated the hard degradation of the backwater. We suspected temporary oxygen depletion in such areas, where Oligochaete were absent during the propagation period. The bivoltine Diptera and Trichoptera species only populated the different areas of backwater temporarily, their individual density depended on the oxygen quantity of the sediment/water line. The area of the backwater is highly degraded. The species number increased from the northern to the southern part because of the different utilisation of the area in the past and present.

Keywords: backwater, macrozoobenthos, evaluation of ecological stage

A. Szító, Institute for Fisheries, Aquaculture and Irrigation, H-5540 Szarvas, Anna-liget 8.,
Gy. **Györffy**, Department of Ecology, University of Szeged, H-6701 Szeged, P.O.B. 51.

Introduction

The backwater Gyálai Holt-Tisza is one of the cut-offs of the River Tisza between 159.6 and 167.6 river kms. This biotope is the biggest in the Tisza River valley with its length of 18.7 km and total water surface of 160 hectares (Pálfai, 2003). The biotope has been divided into three pools by dams and sluices from 1906, and the utilization of the pools is different (Fig. 1).

The lower pool from the pumping station of Lúdvár to the sluice of "Szérűskerti átjáró" is a fishing area while storing excess surface waters and providing water for irrigation; the middle pool from the sluice of the "Szérűskerti átjáró" to the sluice of "Fehérparti átjáró" is an angler water while storing excess surface waters which is also used for irrigation. The upper pool from the sluice of "Fehérparti átjáró" to "Hattyasi szivattyútelep" existed as storage of sewage and excess surface waters earlier; nevertheless, the water pollution decreased nowadays, but did not come to an end (Pálfai, 1991, 2003). The macrozoobenthos was unknown in this backwater; therefore, we started to collect some basic data in the spring of 2000.

Material and methods

Samples were collected in April of 2000 with an Ekman-Birge dredge on each sampling site of the examined areas from a surface of 20×20 cm a time. The total sampled surface was 400 cm2 of each site.

Samples were washed through a net with a mesh size of 250 µm immediately after collecting and the retained material was preserved in 3-4% formol solution. The main investigation part of the backwater took place from the "Röszkei átjáró" to the end of the country border (between Serbia and Hungary). We collected 14 samples here, 3 samples at "Szérűskerti átjáró", 6 samples between "Fehérparti átjáró" and "Szérűskerti átjáró", and one sample in the "Feketevíz" area (Fig. 1, Table 1). The middle pool between "Szérűskerti átjáró" and "Fehérparti átjáró" is an area that is strongly separated by hydraulic structures. Similar to this was the other part of backwater called "Feketevíz" near the city of Szeged. The lower pool between the

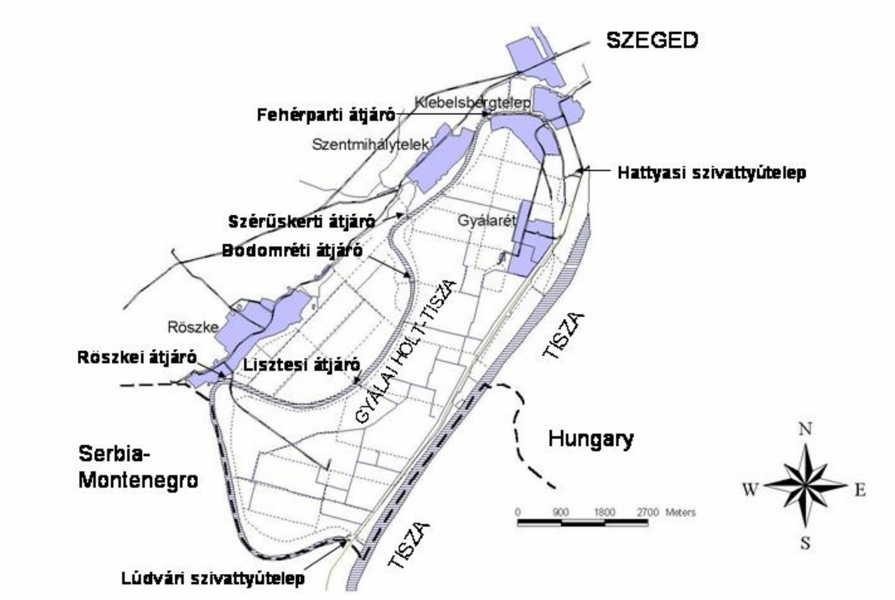

Fig. 1. Backwater "Gyálai Holt-Tisza" with sampling places

country border and "Szérűskerti átjáró" often gets water supply from the River Tisza, while the middle pool gets the supply from the drainage waters (Fig. 1). Hungarian and foreign author's works were used for the species determination (Ashe *et al*. 1990, Bíró 1981, Ferencz 1979, Fittkau 1962, Fittkau *et al*. 1983, Hirvenoja 1973, Pinder *et al*. 1983).

Samples were evaluated according to the different sections of the backwater.

Results

Sixteen species were present in the samples while the individual density fluctuated between 0 and 3475 per square meter. *Limnodrilus hoffmeisteri* was the most abundant; however, that same species was absent in 6 sampling places. The great variation between samples demonstrated by the standard deviations, may signal the significant heterogeneity of the biotope (Table 1).

The species number changed between 1 and 6; one species was present in 7 sampling places: *Limnodrilus hoffmeisteri* was collected 4 times, both *Tubifex tubifex* and Ceratopogonids one time, while *Limnephilus flavicornis* was found 2 times. Tolerant species to the low oxygen concentrations formed the macrozoobenthos. Ten species of the Chironomids were detected, their individual density changed between 0 and 2650 per square meter. The species number was the highest in the least polluted southern section and progressively decreased toward the northern part. *Limnodrilus hoffmeisteri* was the only species found in "Feketevíz", it was present near "Fehérparti átjáró"; the cause of its presence may be the opening of the sluices after heavy precipitation. Long term settlement and reproduction of species was impossible here because of the continuous oxygen depletion. Regarding the species composition the upper pool was the most separated; its ecological circumstances were suitable to develop a deficient food web only (Györffy 2005).

Conclusions

Sixteen species of macrozoobenthos were detected in the backwater "Gyálai Holt-Tisza", but the species richness varied from 1 to 6 in sampling places. Moreover, the common, everywhere abundant species were often present in low individual density only. The macrozoobenthos showed an extremely strong degradation. The species tolerance to the low oxygen concentrations was different, but all species were characteristic to eutrophic-hypertrophic ecosystems. *Limnodrilus hoffmeisteri* was the most tolerant to the low oxygen concentrations and temporary oxygen depletions, but its absence was detected in some sampling sites because of the long term or continuous oxygen depletion.

Table1. The species composition and individual density in different parts of the backwater "Gyálai Holt-Tisza"

Taxa	Röszkei átjáró-Lúdvári pump st.		Szérűskerti átjáró-Röszkei átjáró		Fehérparti átjáró-Szérűskerti átjáró		Feketevíz
	Average (n=14)	st. dev.	Average (n=3)	st. dev.	Average (n=6)	st. dev.	(n=1)
Limnodrilus hoffmeisteri	555,36	1222,3	91,67	62,92	65,5	68,71	25
Tubifex tubifex	51,79	129,15	16,67	28,87	0	0	0
Asellus aquaticus	0	0	8,33	14,43	0	0	0
Procladius choreus	1,79	6,68	0	0	0	0	0
Tanypus punctipennis	16,07	31,94	0	0	0	0	0
Chironomus riparius	0	0	0	0	8,33	12,91	0
Cryptochironomus redekei	5,36	10,65	0	0	8,33	12,91	0
Dicrotendipes nervosus	5,36	14,47	41,67	72,17	0	0	0
Glyptotendipes gripekoveni	3,57	13,36	0	0	0	0	0
Parachironomus arcuatus	17,86	22,85	0	0	12,5	20,92	0
Parachironomus tenuicaudatus	0	0	883,33	1530	0	0	0
Cladotanytarsus mancus	0	0	41,67	72,17	0	0	0
Tanytarsus curticornis	1,79	6,68	0	0	0	0	0
Ceratopogonida larvae	16,29	41,06	0	0	8,33	20,41	0
Diptera larvae	1,79	6,68	8,33	14,43	0	0	0
Limnephilus flavicornis	7,14	20,64	0	0	0	0	0
Density (ind/m^2)	684,14	1382,2	1091,67	1587,9	103	49,44	25
Species number	12		7		5		1

The big changes of the individual density between 0 and 3475 per square meter showed the degraded and heterogenic stage of the investigated biotope. Most of the species that formed the macrozoobenthos were dipteran larvae, which were able to settle the areas temporarily, when the oxygen depletion came to an end, but they left or died due to the continuous oxygen depletion. The species richness was the biggest (12) in the border part where the anthropogenic disturbation was the lowest, and it fluctuated between 7 and 5 when the anthropogenic effects became stronger (e.g. closeness of a settlement or a resort area, usage for angling), while the species richness was only one in the "Feketevíz", whose ecosystem was heavily polluted in the past, presently gets term-, salt- and organic pollution effects.

These results are substantial for previous information collection only. To get a more thorough picture, we will need to investigate further based on samples taken at different times.

References

Ashe, P. and Cranston, P. S. (1990): Chironomidae. In: Soós (ed.) Catalogue of Palaearctic Diptera. – Akadémiai Kiadó, Budapest, 113-449.

Bíró, K. (1981): Az árvaszúnyoglárvák (Chironomidae) kishatározója (A guide for identification of Chironomidae). In: Felföldy (ed.) VHB 11,1-230, VÍZDOK, Bp..

Ferencz, M. (1979): A vízi kevéssertéjű gyűrűsférgek (Oligochaeta) kishatározója (A guide for the identification of aquatic Oligochaeta). - In: Felföldy (ed.) VHB 7, 1-170, VÍZDOK, Bp..

Fittkau, E. J. (1962): Die Tanypodinae (Diptera, Chironomidae). – Abhandlungen zur Larvensystematik der Insekten, 6, 1-453.

Fittkau, E. J. and Roback, S. S. (1983): 5. The larvae of Tanypodinae (Diptera: Chironomidae) of the Holarctic region - Keys and diagnoses. – Ent. Scand. Suppl., 19, 33- 110.

Györffy, Gy. (2005): A Gyálai Holt-Tisza ökológiai vizsgálatának eredményei (Results of ecological investigations of back-water Gyálai Holt-Tisza). — In: Pálfai, I. (ed.): A II. Szegedi Holtág-konferencia előadásai. 2004. szeptember 21. – Környezetvédelmi és Vízügyi Minisztérium, Budapest, 87-108.

Hirvenoja, M. (1973): Revision der Gattung Cricotopus van der Wulp und ihrer verwandten (Diptera: Chironomidae). – Ann. Zool. Fenn., 10, 1-163.

Pálfai, I. (1991): Holtágak és síkvidéki tározók komplex értékelése II. A Gyálai Holt-Tisza esettanulmánya. (Complex evaluation of backwater and plain reservoirs II. The case study of Gyálai Holt-Tisza) - Alsó-Tisza vidéki Vízügyi Igazgatóság, Szeged, pp.1-37.

Pálfai, I. (2003): Oxbow-lakes in Hungary. – Ministry of Environmental Control and Water Management, Budapest, pp. 1-127.

Pinder, L. C. V. and Reiss, F. (1983): 10. The larvae of Chironominae (Diptera: Chironomidae) of the Holarctic Region. - Keys and diagnoses. – Ent. Scand. Suppl. 19, 293-435.

LIVING GASTROPOD SPECIES COLLECTED FROM BIRD FEATHERS

K. Bába

Bába, K. (2006): Living gastropod species collected from bird feathers. – Tiscia 35, 91-93

Abstract: 9 aquatic gastropods and 3 undetermined gastropod eggs were found in the feathers of 9 bird species collected as part of the 25 year-bird capture work of Dr. József Rékási and the preparator works of József Siprikó. So far no definite conclusions could have been made regarding the expansion of the aquatic gastropods via the transportation of birds by a simple comparison of the distributional areas of the birds and the gastropods collected. This requires further investigations via the recapturing of ringed birds.

K. Bába, H-6720 Szeged, Vár u.6., Hungary

Introduction

There are several options for gastropods to expand their distribution areas. Many terrestrial and aquatic gastropods managed to expand their areas of distribution as a result of the gradual warming of the climate following the Pleistocene. (Brohmer *et al.* 1960). However, rivers also play an important role in the expansion and redistribution of terrestrial gastropods as well (Bába 1978, 1982), the final outcome of which is largely influenced by the climatic conditions as well (Bába 1979). The soil, humidity and climatic conditions of the plant communities along with their area of geographical expansion can be regarded as further important factors (Bába 1986).

The expansion of aquatic gastropods is feasible via transportation by the rivers. Their floodplains used to expand over large areas before the river control works. The majority of these gastropods managed to inhabit and survive in the minor ponds, lakes and marshy areas under relatively permanent water coverage after the river regulations. The construction of an artificial network of channels further enhanced the expansion of aquatic gastropods. A good example is the species *Lithoglyphus naticoides* (Pfeiffer 1828) which managed to make its way as far as the Baltics and to Belgium and France towards the west between 1921-1924 (Brohmer *et al.* 1960).

Theoretically speaking the migration of birds may serve as another possible tool for the expansion of aquatic gastropods, in other words on their way from the summer hatching areas down to their winter habitats. Aquatic gastropods found in wild fowl feathers might help us to elucidate something about this previously mentioned factor.

Materials and method

It was the birdman Dr. József Rékási who happened to come across some living aquatic gastropods in the feathers of wild fowl in the county of Békés as part of his bird catching and delousing works between 1964-1981. Species collected before 1970 were determined by the famous Hungarian malacologist Dr. Andor Horváth associate professor and were published in the dissertation of Dr. Rékási (Rékási 1970). Gastropod species from specimens of garganey have come to light during the preparation works of József Siprikó at the Department of Zoology, University of Szeged, Gyula Juhász Teacher's Training College. The author is really grateful for the utilization of their data in this work.

Gastropods found

Specimens and eggs of living aquatic gastropods have been collected from 8 different wild fowl species. While József Rékási managed to collect 29 aquatic and terrestrial gastropods from the stomach of 17 wild fowl species through the course of his 25 year bird-catching work (Rékási and Richnovszky 1974) 8 aquatic gastropod species have come to light from the feathers of 8 birds. In three cases he also managed to collect undetermined gastropod eggs.

The following avian orders and families yielded specimens of living gastropods, with their distributional areas marked:

Ordo: Ciconiiformes, Familia Ardeidae: *Ardea cinerea* Linné 1758, Mosztonga 10/03/1965 *Theodoxus danubialis* (C. Pfeiffer 1828) 2 specimen. The hatching area of the bird is NE Europe with winter habitats in South and Western Europe and Northern Africa. The gastropod *Theodoxus* is Ponto-Mediterranean, Ponto-Pannonian (Bába 2002).

Familia: Ciconiidae: *Ciconia ciconia* (Linné 1758) Bácsalmás 20/08/1964 4 gastropod eggs in the feather and one specimen of *Viviparus acerosus* (Bourguignat 1862).

The bird *Ciconia* is Holarctic (Americas, Eurasia) hatching in Europe, Denmark and Turkey and spending the winter in Africa. The gastropod *Viviparus* is Ponto-Mediterranean (Bába 2003).

Ordo: Anseriformes. Família: Anatidae; *Anas platyrhynchos* Linné 1758. Katymár-Fekete böge 16/08/1977. 1 *Valvata* specimen, 2 *Viviparus contectus* (Millet 1813). The bird *Anas* can be found in Eurasia, Iceland, Greenland and Northern America. Hatching sites are the areas of Scandinavia and Northern Europe. The winter habitat is in Northern Africa. The gastropod *Viviparus* is West-Siberian including Europe. The other species of the family Anatidae investigated is *Athya ferina* (Linné 1758), Madaras-Priszpa Pond 10/09/1971. This species started to expand from the steppe areas of Eastern Europe towards Western and Central Europe as well as Southern Europe a hundred years ago. It resides in France, Spain, and Northern Africa up to the delta of the river Nile as well as Afghanistan and Northern Indian during the winter. 13 specimens of *Lithoglyphus naticoides* (C. Pfeiffer 1828) and 1 specimen of *Valvata piscinalis* (O.F. Müller 1774). have been collected from the feathers. The gastropod *Lithoglyphus* is Ponto-Caspian. The species *Valvata* has a distributional area ranging from Northern Europe to Southern and Western Europe with a refugium in Turkistan thus it is Central Asian (Bába 2003).

Three gastropods have been found from the feathers of the third Anatidae: *Anas querquedula* Linné 1758. 08/05/1984. Mindszent, male bird: *Valvata piscinalis* (O.F. Müller 1774) 173 pcs., *Gyraulus albus* (O.F. Müller 1774) 6 pcs., *Lymnaea peregra* (O.F. Müller 1774) 1 pc. The bird *Anas* inhabits the mountain woodlands of Eurasia up to the zone of the steppes. The species *Valvata piscinalis* has been mentioned earlier the species *Gyraulus* and *Lymnaea* are East Siberian with the latter having an area of distribution in N Africa as well.

Ordo: Galliformes. Familia: Phasianellidae; *Phasianus colchicus* Linné 1758 Kunbaja 01/12/1981 in the reed. From the feathers the following gastropods were collected: *Physa fontinalis* (Linné 1758). The bird *Phasianus* can be found in Eurasia from the river Amur with sporadic occurrences in the Americas and a Holarctic zoogeographical distribution. It was naturalized to Europe by the Romans and evolved as the hybrid of several subspecies. The gastropod *Physa* is widespread in the Palaearctic and the Americas: Holarctic.

Ordo: Gruiformes. Familia: Rallidae. *Fulica atra* Linné 1758. Bácsalmás-Sóstó 11/11/1969 with 9 gastropod eggs and 2 *Lymnaea stagnalis* in its feathers. The bird *Fulica* is widespread in Europe and Asia residing in Northern Africa for the winter. The gastropod *Lymnaea* is Holarctic; with occurrences in Europe, Asia and the Americas.

Ordo: Lariformes. Familia Laridae. *Larus ridibundus* Linné 1758. Bácsborsod, Kígyóspatak 10/12/1970. Distributed in the temperate and cold zone of Eurasia up to Iceland , residing in S Europe, N Africa and Turkey in the winter. Hatching areas are in Iceland and Scandinavia. From the feathers 4 *Bithynia tentaculata* (Linné 1758) were collected. The gastropod is Central Asian.

Ordo Columbifornes. Familia; Columbidae. *Streptopelia decaocto* (Frivaldszky 1838) Bácsalmás inner areas 25/04/1968. 23 *Helicella obvia*, (Menke 1828) were collected from the stomach, 2 juvenile ones were still alive following the autopsy as well. A further specimen of *Vallonia pulchella* (O.F. Müller 1774) have come to light from the stomach alive as well.

The denotation of the distributional area enables us to examine the possible transportation effect of birds on aquatic gastropods. The above mentioned birds and gastropods have different areas of distribution. The distribution area of the species *Pleysa fontinalis* is the same as that of *Phasianus*. However this overlap might be the outcome of human activities as well via naturalization. It must be noted as well that *Phasianus* is not a wild fowl thus it can serve as a transportation medium for aquatic gastropods occasionally only. The situation is completely different for the species *Anas querquendula* Linné 1758 and the gastropod species *Gyraulas albus* and *Lymnaea peregra* collected from its feathers. Here the distribution area of the bird is the same as that of the gastropods.

References

Borhmer, P., Ehrmann, P., Ulmer, G. (1960): Die Tierwelt Mitteleuropas. Mollusken von Dr. Zilch A. et Dr. Jaeckel, S.G.A. Verlag von Quelle et Meyer, Leipzig 1-294.

Bába, K. (1978): The water corried Mollusks of four river and the analysis of the fauna of the deposit. Tiscia 13, 186.

Bába, K. (1979): A csigák mennyiségi viszonyainak és a klímának a kapcsolata. IV. Magyar Malakologus Találkozó Gyöngyös, Heves megyei Tanács Nyomdája. 5-6.

Bába, K. (1982): A folyók hatása az Alföld tájegységeinek szárazföldi Malakofaunájára. Malakologiai Tájékoztató, Eger 2, 22-24.

Bába, K. (1982): Eine neue zoogeographische Gruppierung der ungarischen Landmollusken und die Wertung des Faunabildes Malacologia 22, 441-454.

Bába, K. (1982-83): Magyarország szárazföldi csigáinak állatföldrajzi besorolásához használt faj-areatérképek. I. Fol. Hist.-nat. Mus.Matr. 8, 129-132.

Bába K. (1986): Eine Möglichkeit für die Ausbildung der einheitlichen biogeographischen Anwendungsweise aus der Phyto und zoogeographie. Proc. 8th International Malacological Congress, Budapest 1983, 7-12.

Bába, K. (2002): An area-analytical zoogeorraphical classification of the gastropod family Neritidae. Nachrichtenblatt der Ersten Voralberger Malakologischen Gesellschaft Rankweil 10, 8-14.

Bába, K. (2003): The area-analytical zoogreographic classification of Viviparidae Bulletino Malacologico (in press)

Bába, K (2003): The area-analytical zoogegraphic classification of Valvatidae Bulletino Malacologico (in press)

Magyar G., Hadarics T., Waliczky Z., Schmidt A., Nagy T. and Bankovics A., (1998): Magyarország madarainak névjegyzéke. Annotated list of the Birds of Hungary. Magyar Madártani és Természetvédelmi Egyesület Budapest-Szeged, 1-202.

Heinzel, H., Fitter, R. and Parslo, J. (1997): Pareys Vogelbuch. Alle Vögel Europas, Nordafrikas, und der Mittleren Ostens. Verlag Paul Parey. Hambrug und Berlin. 1-334.

Sauer F. (1996): Vizi madarak Magyar Könyvklub, Budapest 1-287.

Rékási, J. (1970): Bromatologiai és ökológiai vizsgálatok Bácsalmás és környékének vadmadarain, különös tekintettel egyes urbanizált madárfajokra. Doktori disszertáció, Szeged, JATE, 1-429.

Rékási, J. and Ricknovszky, A. (1974): Adatok a madarak csigatáplálékának kérdéséhez. Angaben zur Frage der Schneckennahrung bei Vögeln Soósiana 2, 45-50.