NATURA SOMOGYIENSIS 7.

Biomonitoring along the river Drava in Hungary, 2000-2004

Biomonitoring a Dráva folyó magyarországi szakasza mentén, 2000-2004

Editor - Sorozatszerkesztő

ÁBRAHÁM LEVENTE

Kaposvár, 2005

Natura Somogyiensis 7.

(A sorozat rövidített neve: Nat. Somogy. 7:)

Megjelent kötetek:
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6. TÓTH SÁNDOR: Magyarország csípősszúnyog-faunája (2004)

Jelen kötetünk kiadását a Nemzeti Kulturális Alap és a Nemzeti Kulturális Örökség Minisztérium támogatása tette lehetővé.

Technikai szerkesztő:
ÁBRAHÁM LEVENTE

ISSN 2062-9990 (Online)
ISSN-1587-1908 (Print)
ISBN 963 7212 47 7

Kiadja a Somogy Megyei Múzeumok Igazgatósága
Felelős kiadó: DR. WINKLER FERENC megyei múzeumigazgató
Nyomdai munkák: PETHŐ NYOMDA BT., Kaposvár

Contents - *Tartalom*

DOI:10.24394/NatSom.2005.7.5

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Hydroelectricity or national park?

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The importance of Drava in nature conservation

River Drava, down to on its section shared by Hungary and Croatia (i.e. above the Mura mouth), is loaded with a range of power plants. Despite this fact, its section reaching from the Mura mouth to its confluence with Danube - especially between Őrtilos and Barcs - appears quite natural, although river regulation has been done in this section as well. The importance of Drava from the aspect of Hungarian and Europan nature conservation is ensured by rare and threatened habitat types associated with upper and middle section characteristics that are constanly in the state of dynamic change. Such habitats are related with a multitude of morphological structures characteristic of this particular Drava reach. As opposed to the straightened, canal-like, strongly transformed flowing waters typical of other Hungarian rivers, here there are several geomorphological phenomena that cannot be observed today in the majority of transformed and regulated rivers. This Drava reach is characterized with dynamic bank-destructing (high embankments), bank-building (low shorelines) and shoal-creating (gravel and sand shoals) aciv-ity, resulting in a particularly diverse range of habitats. Natural values occurring along river Drava are associated with these dynamically changing habitats.

River bed deepening

Of course the fact that a series (23) of hydroelectric power stations do exist above the lowermost one at Dubrava cannot be questioned, yet the river section that follows has remained home for a range of protected, strictly protected and internationally significant plant and animal species. The continuation of riverbed deepening is another undoubtable fact, yet the decision to build another power plant or a series of power stations down to the Danube confluence would be nothing but a technocratic solution to that problem, lacking any ecological basis. One of the proved reasons for increasing riverbed deepening besides river regulations is the altered flow dynamics below hydroelectric power plants. In addition to that, the series of dams built along Drava has cut off the natural migration of gravel and boulders, and it is also an obvious fact that each and every cubic metre of gravel excavated from the river further increases the speed of riverbed erosion. In certain parts of Europe (e.g. Austria, Donau-Auen National Park) instead of permitting gravel excavation from the Danube riverbed, what is done instead is that several hundred thousand m^3 of gravel, specified in its grain size fractions, are released into the river annually, in order to stop further deepening.

ISSN 1587-1908 (Print); ISSN 2062-9990 (Online)

The planned hydroelectric plant and the Duna-Drava National Park

The Drava section where Croatia plans to establish the Novo Virje hydroelectric power plant is between Zákány and Vízvár, where the river turns away from the state border, and flows entirely within the territory of the Republic of Croatia. The common river sections both directly above and below the planned power plant are the ones that make up Duna-Drava National Park.

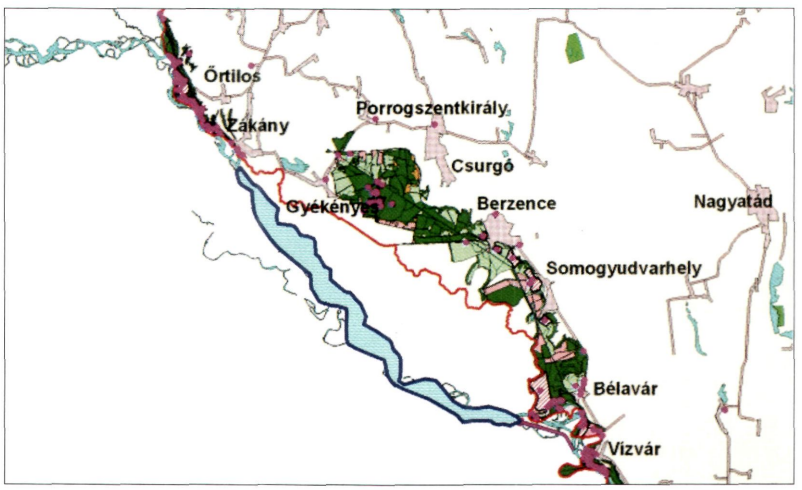

Fig. 1.: Location of the planned hydroelectric power station at Novo Virje, and Duna-Drava National Park

Ecological corridor

River Drava, as an ecological corridor and a continuous system of habitats would be fundamentally threatened by the creation of a hydroelectric plant. The damming of water for nearly 30 kilometres would entirely eliminate the diverse habitats found in this section, leaving what is an artificial reservoir resembling a uniform lake rather than a river, physically cutting in half and thus eliminating the ecological corridor character. Plant and animal populations and communities not respecting state borders will be torn apart and would then disappear due to the lack of suitable habitats. Connections between individuals of the populations would be disrupted, and whether the numbers of individuals in communities above and below the dammed area are suitable for maintaining viable populations is at least questionable. The example of the threatened bird, the little tern (*Sterna albifrons*) is illustrative enough: its breeding populations are found only in this Drava section including both Hungarian and Croatian territories. This bird breeds on gravel shoals with no vegetation at all, thus about 80% of its habitats would surely disappear as a result of damming, moreover those attempting to nest on the section below the power plant would be threatened by the enormous daily fluctuations of water level (1.5-2 m) caused by the operation order of the power station. But this is only one example out of many.

A nature monitoring system has been operated in Hungary since 1999 in the presumed effect zone. By looking at various groups of living organisms (16 groups), the monitoring has provided a wide view on natural values of Duna-Drava National Park, and information about changes of wildlife here. Natural values in the area are well reflected by data shown in Table 1.

Table 1.: Protected and strictly protected animal species listed in international nature conservation agreements ratified by Hungary and in the Habitat and Bird Directives of the EU Natura 2000, living in the Hungarian effect zone of the planned Novo Virje hydroelectric plant

Number of protected species	Number of strictly protected species	Number of species listed in annexes to Natura 2000 directives	Number of species listed by the Bern Convention	Number of species listed by the Bonn Convention	Number of species listed in CITES
262	36	134	232	97	29

Effects expected above the planned interventions

The westernmost areas of Duna-Drava National Park are in its Western-Drava Region, at villages Zákány and Őrtilos. Here the Drava is characterized with gravel shoals, partly without vegetation, and partly covered by purple willow bush associations (*Salicetum purpurae*). These are the shoals where considerable populations of the german tamarisk (*Myricaria germanica*), found only here in Hungary, were discovered. Regarding its habitat requirements and population size, the german tamarisk is very sensitive to damming, because as a member of pioneer plant associations on gravel shoals, its habitats can be significantly influenced by changes affecting water levels and sediment carriage.

The silty banks of the narrow flood area are covered by almond-leaved willow bush associations (*Salicaetum triandre*). Gallery forest habitats that are under considerable inundation and ground water influence, can radically change in case the river is dammed up. The river being quite fast-flowing and carrying gravel, is the only habitat for several reophilous fish species.

Effects expected below the planned interventions

Part of the Eastern Drava Region of Duna-Drava National Park is located below the planned power plant. Here, too, the Drava builds gravel shoals. At some places today's main riverbed runs along the very foot of the Inner-Somogy high bank, at other places it turns away from it, creating a cca. 1000 m wide floodland with dead arms of considerable extent. Oxbows and dead branches are typical in the section below Vízvár. Between the villages Vízvár and Bélavár there are several abandoned gravel pit lakes that have already regenerated and become significant wetland habitats. Natural vegetation in the low floodland areas near Vízvár is made up by willow gallery forests (*Leucojo aestivi - Salicetum albae*). In the willow woods along the river protected plant species are found

such as the summer snowflake (*Leucojum aestivum*), *Peucedanum verticillare*, and the giant scouring rush (*Equisetum hyemale*). Alder gallery forests (*Alnetum*) are more limited here than willow woods, containing the dominant common alder (*Alnus glutinosa*) and some specimens of grey alder (*Alnus incana*).

A particular problem is that the planned tailwater canal would not flow back into the river right at the dam, but would arrive back to the Drava bed at Hungarian border from a 2 km long, concrete bed. Thus, water regime in the present Drava main bed woud change drastically - decrease critically -, with the returned water volume planned to be only 40 m^3/s. This would actually mean that the present main bed (being only Hungarian for more than 1000 m) and the connecting dead branch system near Bélavár and Vízvár (belonging to the national park) would completely dry out, because these areas are situated on the gravel table of the Drava river and are thus continuously connected to the main bed which determines their water volumes and levels. Wetland areas found here are part of habitats for several protected and strictly protected species, and are included in the NATURA 2000 network.

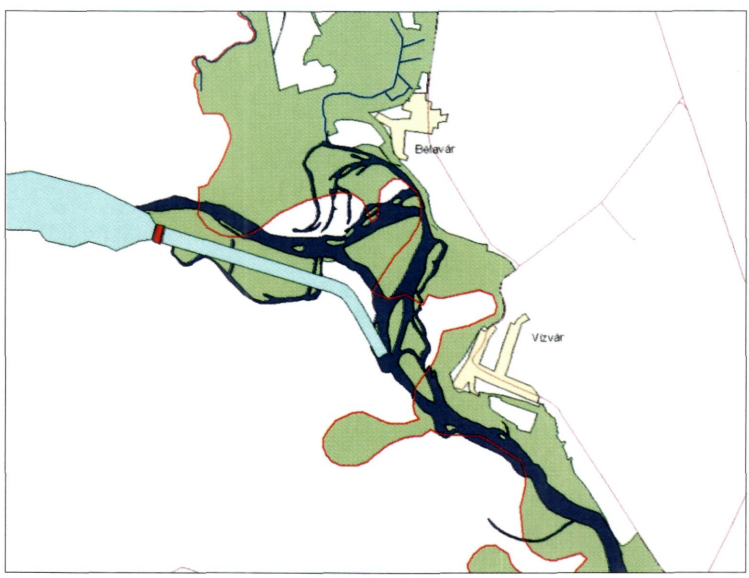

Fig. 3.: The location of the tailwater canal (tail-race) near the Hungarian border

Operating regime

Another problem arises from the operation regime of the power plant. The fluctuation of released water volumes during damming would make it impossible for breeding bird communities to nest on the gravel shoals in the tailwater section near Vízvár. Abrupt water level changes (even as much as 2 m a day) would significantly influence breeding success, and would lead to the elimination of wildlife forms on such gravel shoals.

Ecotourism

There has been an increasing demand for wild-water canoe touring on Drava in recent years. Today around 2000 persons paddle along the section from Őrtilos to Drávaszabolcs, among nomadic circumstances. The planned hydroelectric power plant would fundamentally influence developing ecotourism potential in the region.

Hungary, by founding Duna-Drava National Park and by signing international agreements, as well as by accepting the EU Natura 2000 directives, has committed itself to the long-term conservation and maintenance of natural habitats and wildlife of river Drava. Our duty is similar in the process of introducing the EU Water Framework Directive. Our common objective is to find solutions to problems that arise, in a way that ecological conditions are thoroughly considered and still existing natural values are not destroyed. For we have only borrowed the Drava from our ancestors.

Vízerőmű vagy nemzeti park

ZÁVOCZKY SZABOLCS

A Dráva folyó a magyar-horvát közös érdekű szakasz kezdetéig (Mura torkolat) vízi erőművek sorozatával terhelt. Ennek ellenére a Mura torkolattól a Dunába való torkolásig terjedő szakasza - különösen Őrtilos és Barcs között - természetközeli képet mutat - annak ellenére, hogy a folyószabályozások ezt a szakaszt sem kerülték el.

Horvátország a novo-virjei erőmű telepítését a Drávának arra, a Zákány és Vízvár közötti szakaszára tervezi, ahol a folyó eltávolodik a határtól és teljes egészében Horvát Köztársaság területen folyik. A tervezett erőmű feletti és alatti közös érdekű Dráva szakasz a Duna-Dráva Nemzeti Park területeit jelenti.

A Dráva folyó mint ökológiai folyosó és egybefüggő élőhely rendszer alapvetően van veszélyeztetve a vízlépcső létesítésével. A közel 30 km hosszúságú duzzasztás teljesen felszámolja az ezen a szakaszon található változatos élőhelyeket és helyette egy egyveretű inkább tóra, mint folyóra hasonlító mesterséges víztározó tér alakul ki, ami fizikailag vágja ketté és szünteti meg az ökológiai folyosó jellegét. A két ország határait nem ismerő növény-és állatfajok közösségei (populációi) szakadnak ketté és tűnnek el megfelelő élőhelyek hiányában.

Magyarország 1999 óta természeti monitoring rendszert működtet a feltételezett hatásterületen. A monitoring a vizsgált élőlényeken, élőlénycsoportokon keresztül (16 vizsgált csoport) átfogó képet nyújt a Duna-Dráva Nemzeti Park természeti értékeiről és az itt előforduló élővilág változásáról.

Magyarország a Duna-Dráva Nemzeti Park létesítésével és a nemzetközi természetvédelmi egyezmények aláírásával, valamint az Európai Unió Natura 2000 direktíváinak elfogadásával kötelezettséget vállalt arra, hogy a Dráva folyó természetközeli élőhelyeit és élővilágát hosszú távon megőrzi és fenntartja. Hasonló a feladatunk az EU Víz Keretirányelv bevezetésének folyamata során is. Közös célunk az, hogy a felmerülő problémákra megoldásokat találjunk, de úgy, hogy figyelembe veszzük az ökológiai adottságokat, és nem pusztítjuk el a még meglévő természeti értékeinket.

DOI:10.24394/NatSom.2005.7.11 | Natura Somogyiensis | 7 | 11-18 | Kaposvár, 2005

Biomonitoring of alluvial willow forests

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JUHÁSZ, M., DÉNES, A.: *Biomonitoring of alluvial willow forests.*
Abstract: Alluvial forests with *Salix alba* on floodplain of river Drava were studied in five consequent years. Year-to-year changes in coenological characteristics of the community were pointed out. These changes are unambigiously connected with changes of water supply of the growing place. Preservation of natural state of the community needs temporal surface flooding connected to the river floods.

Key words: biomonitoring, alluvial willow forests, coenological changes

Introduction

Biomonitoring of alluvial willow forests along river Drava is part of an environmental monitoring system, which follows up changes of some abiotical environmental factors and wildlife. Studies aiming to survey environmental changes caused by a Croatian hydro-power plant planned on river Drava have begun in 2000. Coordinated botanical monitoring studies of alluvial forest communities and of populations of chosen herbaceous plants have been performed (JUHÁSZ & DÉNES 2001, 2004). Here we summarize results of five-year study of willow forests.

Existence and characteristics of alluvial plant communities are strongly determined by water supply of their growing place and - in connection of this - by changes of water level of the river. Changes of height and duration of surface water coverage affects species composition of the community and coverage and physiological state of species. Goal of biomonitoring of willow forests is documentation of coenological and compositional state of the community and follow-up of degradational and regenerational processes and changes of growing place characteristics. Coenological indication is based first of all on evaluation of changes of species composition.

Willow forests studied are situated on the left bank of river Drava, in county Somogy, Hungary. River Drava meanders here strongly, its valley runs approximately from northwest to southeast. Larger part of the floodplain belongs to Croatia, the smaller Hungarian part is cc. 300 km^2. Drava enters Hungary at the mouth of river Mura; for twenty kilometers from here the floodplain is bordered by loess hills, further downwards for another fifty kilometers by aeolian sand areas.

ISSN 1587-1908 (Print); ISSN 2062-9990 (Online)

Climate of this area is moderately warm, humid. Annual mean temperature is between 9,7°C and 9,9°C. Hottest summer days' average of many years is about 32,5°C, of coldest winter days is -17,0°C. Annual precipitation 800-840 mm, of which 450-490 mm falls in growing season. Most frequent wind direction is northern, second-frequent is southwestern. Floods of Drava comes in spring, early summer and autumn, low waters in late summer and winter.

There are quaternary deposits in the Drava valley with fluvial and floodplain sand, gravel and mud (MARKÓ-JUHÁSZ 1997). In this area Drava is not constrainted in between dams, so it can change her bed even in our days. Surface of floodplain can be divided into low and high floodplain levels, oxbows and oxbow lakes. Elevation differences make only some meters. Groundwater can be reached anywhere between 0-4 meters, its quantity is reasonable, its level changes are in accordance with level changes of the river.

Materials and methods

Study areas were appointed inside the area effected by the planned power plant. Willow forest near Őrtilos is upstreams of the planned plant, the other one near Vízvár is downstreams of it.

Permanent quadrats were assigned in typical parts of the given stand. (JUHÁSZ 1997, 2004, ORTMANN-NÉ AJKAI 2004). Near Őrtilos, according to terrain characteristics, one 20x10 m and one 20x5 m study plot were assigned, whose data were drawn together in Figures. Study plot near Vízvár is 100x25 m, continuously. Inside permanent quadrats microquadrats of 1x1 m size, chosen by semi-random way, were surveyed; in the smaller Őrtilos plot 30, in larger Vízvár plot 50 ones. Our aim was to represent all parts of the plots by the same chance. Surveys were made in the same part of the year in all study years, in June.

Willow forests were surveyed by estimation of coverage percentages, as usual in phytocoenology. Studied variables: coverage of herb species in all microquadrats and coverage of canopy and shrub layer in permanent quadrats.

Results

Studied willow forests of both plots belong to *Leucojo aestivi-Salicetum albae* community (BORHIDI & KEVEY 1996). Data of surveys were ordered into coenological tabellas and analysed in various ways. In the following changes of coenological spectra of communities and changes of distribution of species by relative water demand and social behaviour types (BORHIDI 1995) are presented. In Figs 1-6 left-hand bars show results based on coverage data (cst), right-hand bars show results based on presence-absence data (csr).

More important growing place and coenologial characteristics of the study plot near Őrtilos are as follows. Here the left-side floodplain of Drava is very narrow, from the river (state border) to the loess hillfoots only 100-1100 m. Whole area is low floodplain, whose caharacteristic natural vegetation are willow forests. On appointed study plots canopy cover is between 25-70%. Most important dominant tree is *Salix alba*, beside it *Alnus glutinosa* and *Alnus incana* can be found. *Humulus lupulus* is a lian climbing up to canopy. Shrub layer is thin, its coverage is max.10%, consists of *Cornus sanguinea*

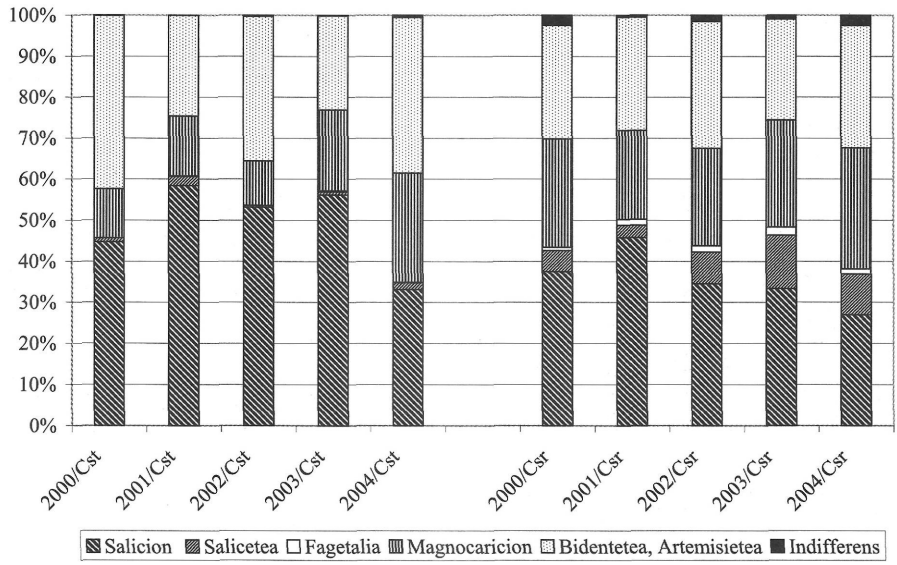

Fig. 1.: Percentage distribution of species by coenological character in willow forest study area at Őrtilos

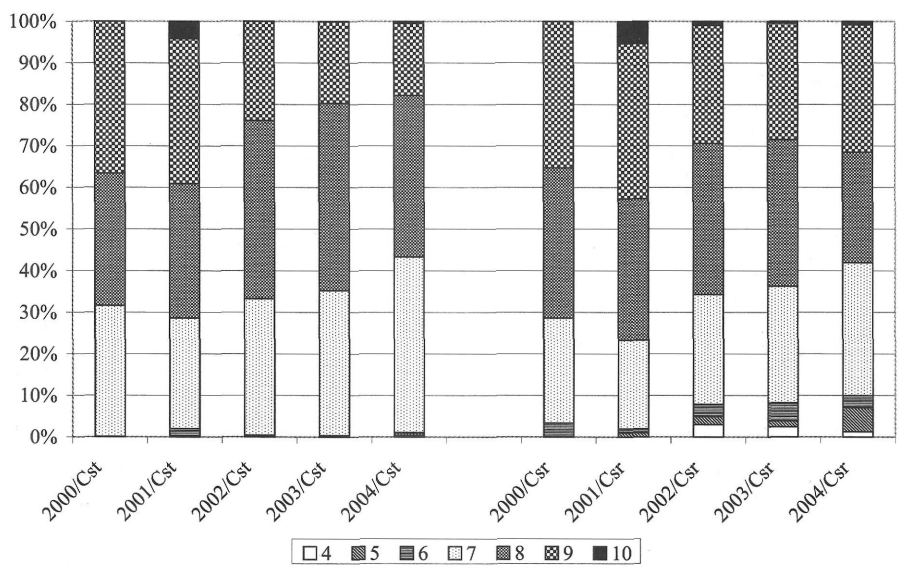

Fig. 2.: Change in percentage distribution of species by relative water demand in willow forest study area at Őrtilos

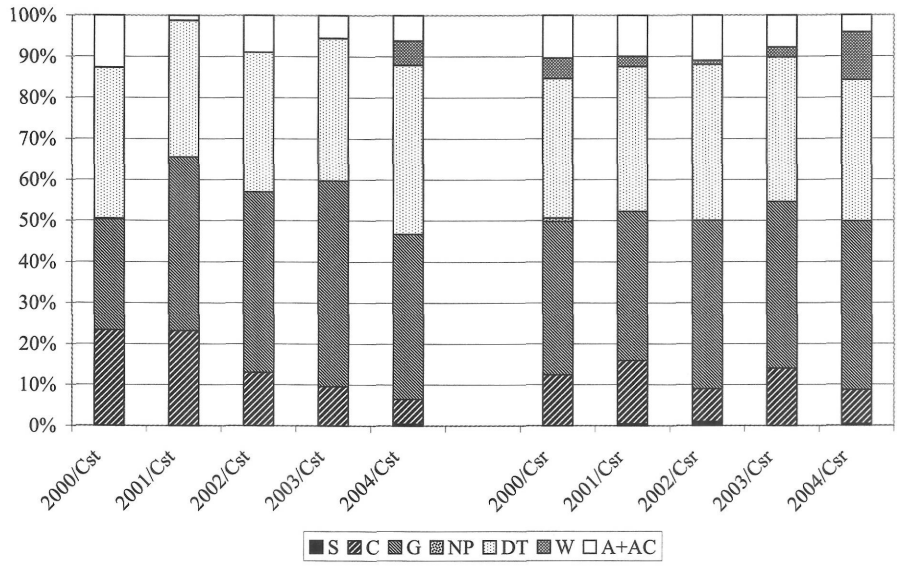

Fig. 3.: Change in percentage distribution of species by social behaviour types in willow forest study area at Őrtilos

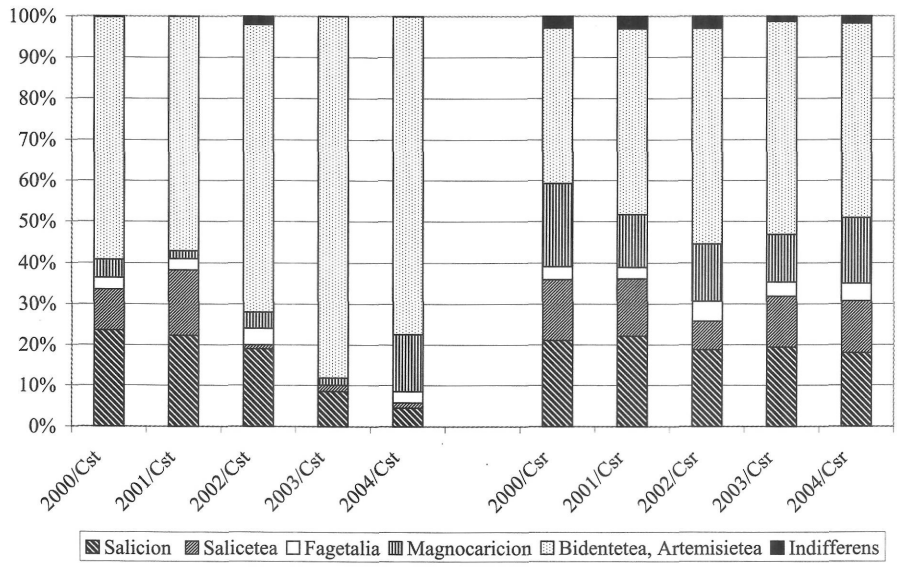

Fig. 4.: Percentage distribution of species by coenological character in willow forest study area at Vízvár

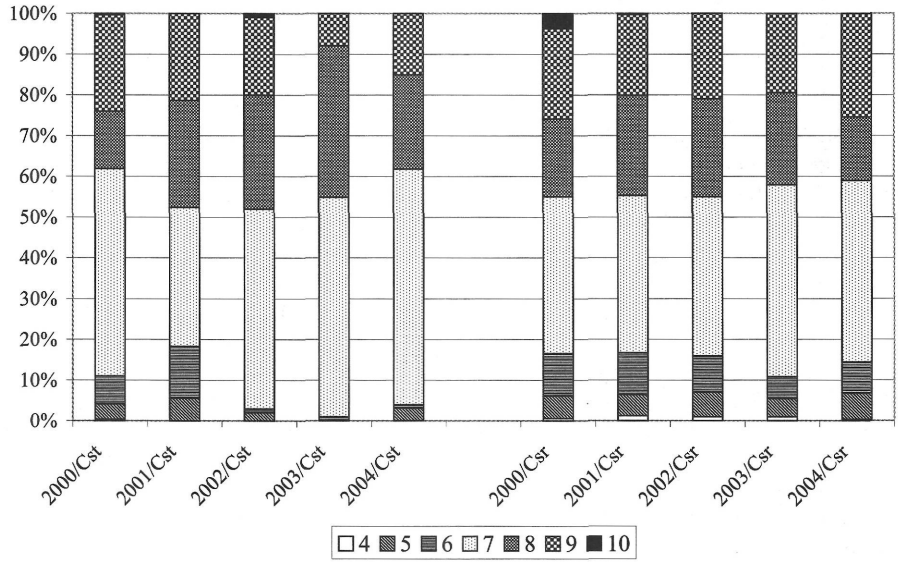

Fig. 5.: Change in percentage distribution of species by relative water demand in willow forest study area at Vízvár

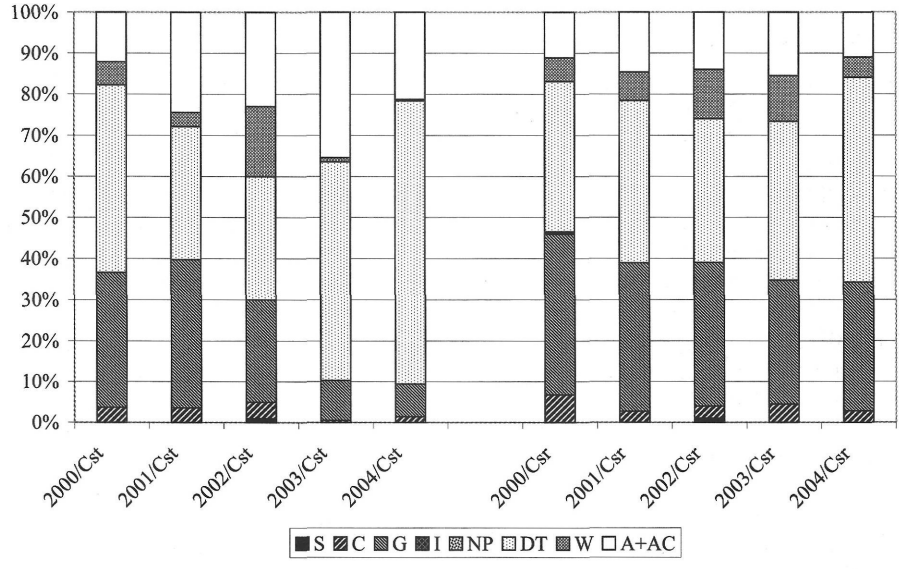

Fig. 6.: Change in percentage distribution of species by social behaviour types in willow forest study area at Vízvár

and *Viburnum opulus*. Coverage of herb layer changes with quantity and duration of surface water cover. *Phalaroides arundinacea* and *Succisella inflexa* are determinant local characteristic species of willow forests. Further characteristic species: *Carex gracilis, Equisetum hyemale, Galium palustre, Iris pseudacorus. Carex pseudocyperus, Carex vesicaria, Angelica sylvestris, Stachys palustris, Polygonum mite* also occur. In some places in the herb layer sometimes swamp and wet meadow species - most often *Lysimachia vulgaris* and *Symphytum officinale* - can reach significant coverage. Disturbance tolerant and weed species have significant coverage mostly in drier parts. Most important natural disturbance tolerant is *Rubus caesius; Urtica dioica* and *Galium aparine* are also common. Alien invasive species occurring here are *Impatiens glandulifera* and *Solidago gigantea*. Distribution of species by coenological characterictics in Őrtilos plot are shown in Fig.1. It shows that this study plot is determined by changing proportions of local characteric species of willow forests, swamp and wet meadow species and disturbance tolerant species. In case of long, high water cover swamp and wet meadow species gain space. In years with average water level changes the stand is determined by total coverage of local characteristic species of willow forests. In drier years proportion of natural disturbance tolerants grow. Results based on presence-absence data on the right-hand side of the figure show finer coenological composition of the community. Here even those coenological groups can be seen which take part in composition of the community with insiognificant cover values. Coenological colouring species like this are species of mesophilous woodlands and indifferent species living in many different communities. Sometimes some species of mesophilous woodland are settle in the study plot; they come supposably from hornbeam-oak forests of the nearby loess hills. Fig.2. shows changes of distribution of species by relative water demand. On 12-degree scale of relative water demand species occur between values 4-10. Community is determined mostly by plants of moist soils and plants of wet, not well aerated soils; their proportions change according to water level changes. Extremities appearing in the study plots are plants of semidry habitats indicating extreme dryness, and water plants of frequently flooded soils indicating extrem wetness. Fig.3. shows distribution of species by social behaviour types in the Őrtilos study area. In this respect community is determined by competitors, generalists and disturbance tolerants in changing proportions. In certain years weeds and invasive alien species appear with significant coverage.

More important growing place and coenologial characteristics of the study plot near Vízvár are as follows. Left-side flood area of Drava here is also relatively narrow. The river - trying to change her bed - steeply undermines the higher level of the neighbouring land. Floodplain is low, only 0-1000 m wide, its characteristic natural community is alluvial willow forests. In appointed study area canopy is formed exclusively by *Salix alba* with 65% coverage. Up the trees climb masses of *Humulus lupulus* and in some places *Hedera helix* too. Coverage of shrub layer is about 25%, its characteristic species is *Cornus sanguinea; Sambucus nigra* is also common. Coverage of herb layer shows small changes year by year, according to height and duration of surface water coverage. Amongst local characteristic species of willow forests *Phalaroides arundinacea* is most common, in some places *Carex gracilis* and *Caltha palustris* can also be found in masses. *Iris pseudacorus, Angelica sylvestris, Equisetum hyemale, Galium palustre, Carex vesicaria, Myosotis palustris, Polygonum mite, Succisella inflexa* also occur. Amongst local characteristic species of alluvial softwoods *Galeopsis speciosa* is relatively common, *Circaea lutetiana* and *Cucubalus baccifer* are more rare. Occurence of swamp and wet meadow species is significant by their species number, more insignificant by their coverage. These species are: *Carex acutiformis, Carex elata, Lythrum salicaria,*

Lysimachia vulgaris, Symphytum officinale. In case of untouched natural conditions this growing place is more wet; rarer and lower floods - relative drying of habitat - is indicated by masses of disturbance tolerant and weed species. Most common disturbace tolerant species is *Rubus caesius*; in some places *Galium aparine, Urtica dioica, Glechoma hederacea* can be found in masses too. Amongst alien invasive species *Impatiens glandulifera* is very frequent, *Solidago gigantea* is rare. Distribution of species by coenological characterictics in Vízvár plot are shown in Fig.4. It shows that this study stand is determined mostly by two large species groups: local characterstic species of willow forests and disturbance tolerant species. In case of good water conditions proportion of local characterstic species of willow forests increases, in dryer years proportion of natural disturbance tolerant and invasive species rises. Results based on presence-absence data on the lefthand side of the figure show finer coenological composition of the community. According to their species number general species of gallery softwoods and swamp and wet meadow species are well represented too. Fig.5. shows changes of distribution of species in Vízvár plot by relative water demand. On 12-degree scale of relativ water demand species occur also between values 4-10; but this stand is determined first of all by plants of moist soils. By surveys and analysing of diagrams we cocluded that Vízvár plot is a little dryer than Ortilos plot. It is shown also by the diagram of distribution of species by social behaviour types (Fig.6). Natural communities of floodplains need floods, need temporary water cover; if it is left out, weeds and degradation follow. Relative dryness of Vízvár plot is indicated by significant proportions of natural disturbance tolerants, native weeds and alien invasive species. Generalists and competitors, indicating natural conditions are also present, so species pool is given for complete regeneration of the community in case of appropiate water conditions.

Conclusions

Coenological studies of alluvial willow forests along river Drava were accomplished in five consequent years. Year-to-year changes in coenological characteristics of the community were pointed out. Analysis of data and field observations unambigiously prove that experienced changes are connected closely with changes of water supply of the growing place. Preservation of natural state of the community needs floods of the river temporal surface flooding of alluvial habitats connected to them.

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Ártéri fűzligetek monitoring vizsgálata

JUHÁSZ MAGDOLNA és DÉNES ANDREA

A Dráva folyó mellett található ártéri ligeterdők monitoring felmérése egy környezeti monitoring rendszer része. A vizsgálatok a Dráva folyón tervezett horvátországi vízerőmű Magyarországot érintő környezeti hatásainak vizsgálata céljából indultak 2000-ben. Az ártéri fűzligetek cönológiai vizsgálatára a tervezett vízerőmű hatáskörzetében két mintaterületet jelöltünk ki. Az Őrtilos község határában lévő állomány a tervezett vízerőmű fölött, a Vízvár község közelében lévő állomány a tervezett vízerőmű alatt található.

Jelen tanulmányban a fűzligetek öt éven át végzett cönológiai felmérésének eredményeit foglaltuk össze. Elemeztük a társulás cönológiai karakter spektrumának változásait, valamint a fajok relatív vízigény és szociális magatartástípusok szerinti megoszlásának változásait. Megállapítottuk, hogy a növénytársulás cönológiai jellemzői tekintetében évről-évre elmozdulások vannak. A felmérések adatainak elemzése a terepi megfigyelésekkel összhangban egyértelműen azt mutatja, hogy a tapasztalt eltérések a termőhely vízellátottságának változásával vannak szoros összefüggésben.

DOI:10.24394/NatSom.2005.7.19 | Natura Somogyiensis | 7 | 19-23 | Kaposvár, 2005

Changes of surface area of assimilating leaves

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JUHÁSZ, M., LÓKI, J.: *Changes of surface area of assimilating leaves.*
Abstract: Physiological state of dominant tree species of temporarily flooded alluvial forests was studied by measuring changes of assimilating surface area. A significant correlation between leaf size and water supply of the growing place was pointed out. Strongest connection with water level changes of the river was shown by changes of assimilation surface of *Salix alba*, living in the low floodplain.

Key words: biomonitoring, alluvial forests, leaf assimilation area

Introduction

Changes of assimilation area of leaves were studied within the scope of biomonitoring of alluvial forests along the river Drava (JUHÁSZ 1997, 2004, JUHÁSZ & DÉNES 2001, 2004, MARKÓ & JUHÁSZ 1997). These studies are part of a complex environmental monitoring system, started in 2000, aiming to monitor environmental effects of a hydroelectric power plant - planned on the river Drava in Croatia - in Hungary.

Existence, species compositon and other characteristics of plant communities living in floodplains are strongly dependent - through water supply of their growing place - on water level changes of the river. The assimilation surface area of leaves is a sensitive indicator of water supply of the growing place. Plants with high water demand are especially sensitive from this point of view, this is why we measured changes of assimilation surface area of leaves of dominant trees of alluvial forest communities temporarily flooded.

Materials and methods

For measuring changes of assimilation surface area of tree leaves study material is collected exactly on the same plots every year in autumn after falling of the leaves. On every plot 200 leaves were collected randomly.

Leaf area is determined by an informatical method (LÓKI 1996) because we have no financial means to obtain a laboratory equipment for this purpose. Essence of the method: collected leaves (200 pcs per plot) are prepared as usual for herbariums (dried

ISSN 1587-1908 (Print); ISSN 2062-9990 (Online)

between blotting papers, under light pressure) for about three weeks, then fastened on white paper and scanned. Assimilation area is determined through measuring leaf surface area. Files are prepared by software Paint Shop Pro for GIS processing. Every leaf area is measured by software IDRISI, average leaf area per plots will be determined by Microsoft Excel.

Results

For measuring of assimilation surface area of leaves material is collected at four plots. Characteristic dominant tree species of low floodplain forests along the Drava is *Salix alba*; its leaves are collected at three plots. First plot is upstreams of the planned power plant (near village Őrtilos), second one is upstreams of the mouth of the lower canal of the planned power plant (near village Bélavár), and third one is downstreams of it (near village Vízvár). Fourth study plot is situated on the wide lowland plain beside the planned power plant, near village Gyékényes; here tree species *Alnus glutinosa* is studied. Research has begun in 2000; here we publish results of five study years (Table 1).

Table 1.: Measured data of leaf assimilation area between 2000-2004, by study plots

years	leaf assimilation area (cm^2)			
	Salix alba B13 **Őrtilos**	*Salix alba* B16 **Vízvár**	*Salix alba* B15 **Bélavár**	*Alnus glutinosa* B14 **Gyékényes**
2000	5.47	5.69	-	24.82
2001	5.93	5.44	5.09	21.9
2002	4.22	4.93	3.99	26.02
2003	5.22	5.35	5.23	26.49
2004	6.35	5.87	5.07	28.55

At study plot near Őrtilos (B13) average surface area of *Salix alba* changed between 4.22 and 6.35 cm^2 during study interval (Fig.1). Assimilating leaf surface area was the smallest in 2002, the largest in 2004. At study plot near Vízvár (B16) changes of average leaf area of *Salix alba* were a little smaller (Fig.2), but the smallest it was also in 2002 (4.93cm^2), the largest also in 2004 (5.87 cm^2). At study plot near Bélavár (B15) research has began a year later. The smallest value was measured here too in 2002 (3.99 cm^2), but the largest value was measured in 2003 (5.23 cm^2). Leaves of *Alnus glutinosa* are significantly larger then those of *Salix alba*. Average leaf surface area during study interval has changed between 21.90 and 28.55 cm^2 (Fig.4); the smallest was in 2001, the largest in 2004.

Result of the study show definite correlation between leaf size and water supply of the growing place. Changes of assimilation area of *Salix alba*, living in low floodplain, show the closest correlation with changes of water level of the river. Smallest values were measured at every plot in 2002, which inevitably shows a strong correlation with lower water levels of this period, resulted by less precipitation. Water supply of growing place of *Alnus glutinosa* depends partly also on water level changes of river Drava, but it is

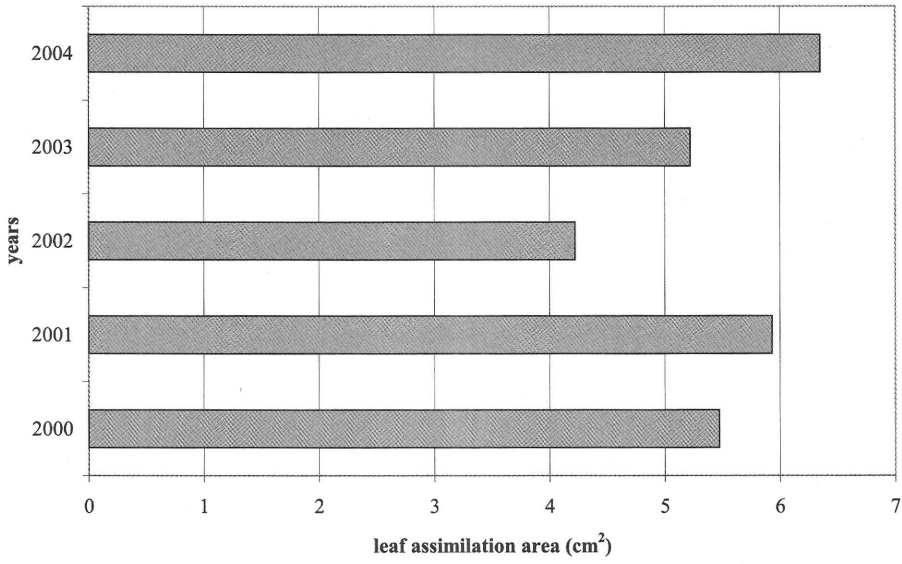

Fig.1. Changes of assimilation area of *Salix alba* at study plot B13 (Őrtilos)

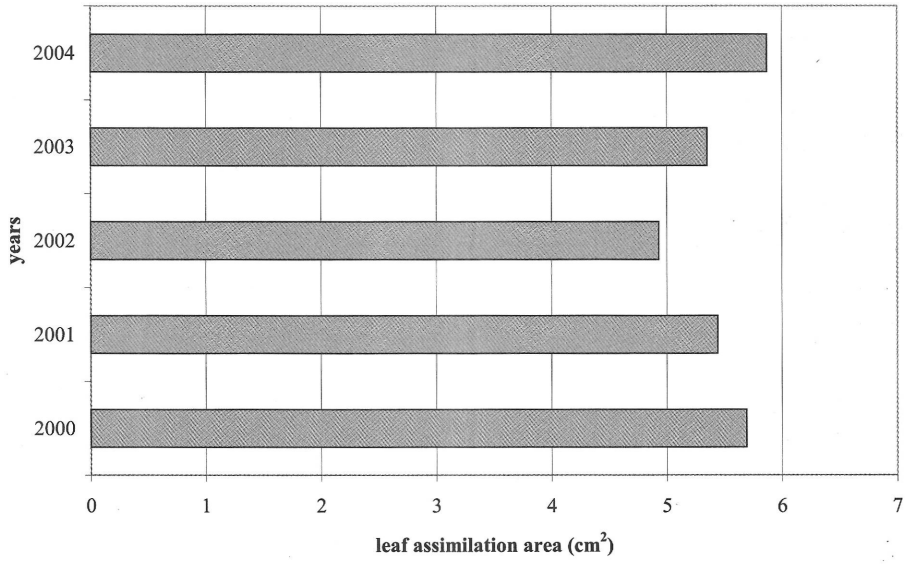

Fig.2. Changes of assimilation area of *Salix alba* at study plot B16 (Vízvár)

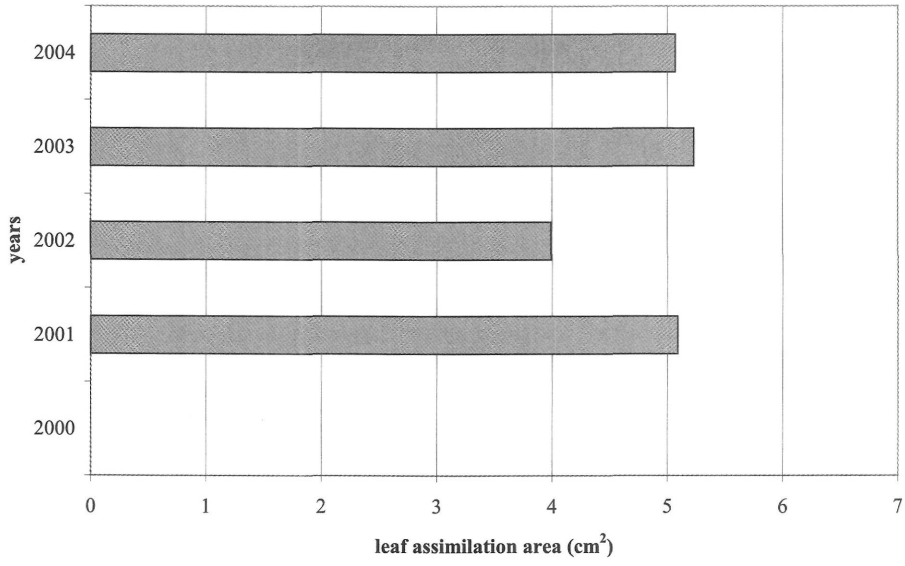

Fig.3. Changes of assimilation area of *Salix alba* at study plot B15 (Bélavár)

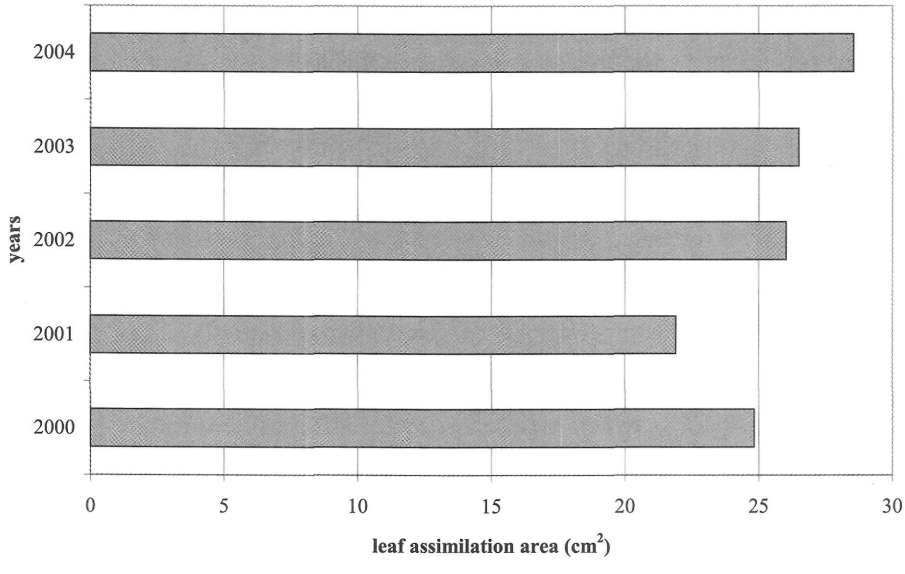

Fig.4. Changes of assimilation area of *Alnus glutinosa* at study plot B14 (Gyékényes)

influenced by the state of drainage canals of the higher floodplain and by waters coming from neighbouring hills. So effect of changes of river water levels is less inevitable; it can be shown out perhaps by evaluation of data of a longer-run measurement series.

Conclusions

Physiological state of dominant tree species of temporarily flooded alluvial communities along river Drava was studied by measuring changes of assimilating surface area. Research was carried out in five consequent years (2000-2004), at four study plots. Evaluation of results shows a significant correlation between leaf size and water supply of the growing place. Strongest connection with water level changes of the river was shown by changes of assimilation surface of *Salix alba*, living in the low floodplain. Average leaf area of this species was smallest at all study plots in 2002, in strong correlation with low water levels of that period.

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Asszimiláló levélfelületek változásainak vizsgálata

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A Dráva folyó árterületén élő, időszakosan vízzel borított ártéri erdőtársulások állományalkotó fafajainak fiziológiás állapotát vizsgáltuk az asszimilációs felület változásának a mérésével. A felmérés öt egymást követő évben (2000-2004) történt, négy mintavételi helyen. Az eredmények értékelése során határozott összefüggés mutatkozott a levelek mérete és a termőhelyek vízellátottsága között. A folyó vízjárásával a legszorosabb kapcsolatot a mélyártérben élő fehér fűz (*Salix alba*) asszimilációs felületének a változása mutatja. Ennek a fafajnak az átlagos levélterülete minden mintavételi helyen 2002-ben volt a legkisebb, ami szoros összefüggésben van az abban az időszakban kialakult alacsony vízszintekkel.

DOI:10.24394/NatSom.2005.7.25

Natura Somogyiensis	7	25-34	Kaposvár, 2005

On experiences in monitoring molluscs (Mollusca) in the area of Duna-Dráva National Park

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HÉRA Z.: *On experiences in monitoring molluscs (Mollusca) in the area of Duna-Dráva National Park.*
Abstract: Researching Mollusc fauna forms part of biomonitoring investigation in the Duna-Dráva National Park aiming study of protected and invasive species, water and terrestrial fauna.
As a result of this investigation, the occurance of new protected species *Vertigo angustior* Jeffreys, 1830, *Vertigo moulinsiana* Dupuy, 1840 or their accurate habitat in this area have become known. Recording frequency circumstances of basic fauna and expansion of newly introduced species *Potamopyrgus antipodarum* (Gray, 1843), *Arion lusitanicus* Mabille, 1868, *Anodonta woodiana* (Lea, 1834) - is repeated every year.

Keywords: protected molluscs, invasive molluscs, biomonitoring

Introduction

Due to the coordination of DDNP started in 2000, biomonitoring investigation began in the river Dráva. 22 sampling sites were marked between Órtilos and Felsőszentmárton. The sampling sites are 5-50 m^2 in size. Investigations were implemented in the following projects: 1. protected species, 2. invasive species, 3. monitoring water fauna, 4. monitoring terrestrial fauna.

According to literature data (VARGA and UHERKOVICH 1998) the number of terrestrial and water Gastropods found in the areas along the Dráva is estimated to be about 100, out of which 90 species were identified during monitoring investigation. An average of 9000 individuals are entered in the database of the national park.

Material and method

1. Sampling applied in the project of protected species

Theodoxus danubialis, Amphimelania holandri - underwater counts of individuals in 10 sites (50x50 cm quadrates) twice a year.

Pomatias elegans, Ena montana - placing artificial hiding - place quadrate (5x1 m^2 surface covered with corrugated cardboard), twice a year and checkings after a month.

Cepaea hortensis - study of its absence by single individual sampling.

Helix pomatia - single individual sampling at an even pace for 20 minutes.

Unio crassus - sweep-netting the riverbed with a 0.5 wide scraping net of 1mm meshes and along a 2 m stretch, five times.

ISSN 1587-1908 (Print); ISSN 2062-9990 (Online)

2. Sampling applied in monitoring invasive species

Potamopyrgus antipodarum - collecting 3 m^3 deposit and underwater individual sampling in 4 (50x50 cm) quadrates.

Arion lusitanicus - single individual sampling counts on 10 m^2 site.

Dreissena polymorpha - collecting 5 dm^3 alluvial deposit (possibly float debris) once a year.

Anodonta woodiana - individual sampling from the riverbed to determine absence, once a year.

Helicella obvia - indivividual sampling to determine absence, once a year.

3. Monitoring water fauna

Collecting alluvial float debris three times a year, float debris from lakes once a year with skimming net, collecting 5 dm^3 material on each occasion.

Quadrate method: underwater counts of individuals on 10 sites of 50x50 cm quadrate, four times a year.

Sweep - netting on riverbed with a 0.5 mm wide scraping net of 1 mm meshes on a 2 m stretch five times a year.

Single individual sampling with a dipping - net or from plants picked out of water with a handle holder, once a year.

4. Monitoring terrestrial fauna

Collecting 25 dm^3 surface debris twice a year.

Single individual sampling of slugs for 20 minutes once a year.

Collecting fluvial float debris three times a year, collecting float debris from lakes once a year with a skimming - net, 5 dm^3 material is collected on each occasion.

Sampling of mollusc communities living in wood assemblages by hiding place - quadrate.

Results and conclusions

During monitoring protected species we managed to prove the presence of 10 mollusca and 2 bivalves species. Strictly protected species were not present among them (Fig. 1).

Amphimelania holandri (Pfeiffer, 1828) a tertiary fossil species with an East and West Balkan distribution, lives in the Dráva and the Sava water system. In the Hungarian waters this species lives in the Dráva, the Zala, the Kerka and the Mura. Its habitat in the section between Bolhó and Őrtilos is on pebbly sandbanks, but it also settled on spurs and protective paving of the bank. On the sampling site near Vízvár, according to the investigation data, it lives in a density exceeding 300 individuals/m^2. Among concomitant fauna members *Ancylus fluviatilis* (Müller, 1774) can be found. In case the planned Croatian power station near Novo Virje is constructed, this habitat and the undelying pebbly sandbank would be destroyed or severly damaged due to the drastic changes in the course of the river. After half a century *Theodoxus danubialis* (C. Pfeiffer, 1828) is present on the national stretch of the Dráva. The first report about its presence comes from SOÓS (1933), formerly it was collected in Légrád (now on Croatian territory). In 1997 one shell was found in the float debris (VARGA and UHERKOVICH 1997). In the autumn of 2001 it was present in mass with an individual density exceeding 200 specimens/m^2 at the mouth of the Mura in Őrtilos at various times (HÉRA 2002). Colonization may have come from the Mura as it occurs in the upper section.

Pomatias elegans (C. Pfeiffer, 1828) lives on the slopes overlooking the Dráva in the environs of Őrtilos hills. Once it may have been more widespread in the country. At present it can be found on the Tihany Peninsula, in the Zala hills and in some parts of the

Fig. 1.: Juvenile induvidual of *Ena montana* (Draparnaud, 1801)

Fig. 2.: *Pseudanodonta complanata* (Rossmassler, 1835) occuring in some parts of smooth granular riverbed sections

Fig. 3.: *Potamopyrgus antipodarum* (Gray, 1843) already settled in the gravelpit lake of Gyékényes

Fig. 4.: *Anodonta woodiana* (Lea, 1834) intensively spreading in the Dráva as well

Mecsek Mountains. This Mediterranean species with West-European distribution has a density of 20 individuals/m^2 on the humid and cool soil of Őrtilos mixed beech woods. In some places this species can be found in the same habitat with a species, *Ena montana* (Drapernaud, 1801) of Alpine - Carpathian distribution and a preference for mountainous climate (HÉRA and VARGA 2001).The latter is a rare species even in our mountainous regions.

In the Zákány-Őrtilos hilly range 2 isolated species were recorded during monitoring investigation. The expansion of grapeyards and orchards on the account of beech woodlands endangers the survival of this species. On the basis of the investigation the estimated number of individuals is 200.

The population of *Cepaea hortensis* (O. F. Müller, 1774) living in the upper cemetery of the village of Zákány is also isolated. The size of the population is about 500 individuals, so far only with yellow shells, either plain or streaked genetical variants have been found. Its habitat is bordered by intensively treated areas, so its dispersion is unlikely. Mollusc species generally spread in groves along the Dráva are *Perforatella bidentata* (Gmelin, 1788) and *Cepaea nemoralis* (O. F. Müller, 1774). Their empty shells are usually present in the float debris of the river. *Helix pomatia* (Linnaeus, 1758) can be frequently found in the woods and in the weeds.

Vertigo angustior (Jeffreys, 1830) and *Vertigo moulinsiana* (Dupuy, 1849) are snail species with unknown habitat and population size. These small molluscs settle on vegetation close to the soil in humid habitats, their empty shells were found in floating debris.

We managed to reveal the presence of individuals belonging to 2 protected bivalve species, *Pseudanodonta complanata* (Rossmässler, 1835) (Fig. 2.) and *Unio crassus* (Philipsson, 1788) in the Dráva and its tributaries. The methods applied do not make possible to estimate population size. It is certain that, compared to other large-bodied Gastropods, both species proved to be rather scarse on slow - flowing sections of the riverbed along the bank and also in the temporary dry and muddy branches.

Table 1.: The protection state of species recorded during monitoring investigation

Species	Protected status	Year of protected status	Corine Biotopes Program	Natura 2000	IUCN Red List 2004
Pomatias elegans	protected	1982			
Ena montana	protected	1993			
Helix pomatia	protected	1993	X	V.	
Theodoxus danubialis	protected	1993			
Amphimelania holandri	protected	2001			
Cepaea hortensis	protected	2001			
Cepaea nemoralis	protected	2001			
Perforatella bidentata	protected	2001			
Pseudanodonta complanata	protected	2001			LR/nt
Unio crassus	protected	2001		II., IV.	LR/nt
Vertigo angustior	protected	2001		II.	LR/cd
Vertigo moulinsiana	protected	2001		II.	LR/cd

In the region of DDNP respectively in its narrower area, several molluscs with ability to quickly spread their area are known to be potentially and factually invasive. In order to protect the natural habitats it is extremely important to monitor the presence and spreading of invasive molluscs even if at present we do not have effective means for slowing it down.

In 2001 *Potamopyrgus antipodarum* (Gray, 1843) (Fig. 3.) was found in a gravel pit lake. A wide range of similar habitats stretch along the Dráva, besides this animal is able to settle even in very small surface water bodies. It is a very resistant species which can endure temporary dry habitats lasting for shorter periods. It produces very high individual density level in detritus.

Its dispersion would determinally affect the mollusc fauna of natural waters.

A new offender of terrestrial ecosystems is *Arion lusitanicus* (Mabille, 1868), a slug, which has been proved to be present in the country since 1986 (VARGA, BÁNKÚTI and KOVÁCS 1995). In 1996 it appeared in great mass in the inner area of Zákány and the Csurgó area.

Since the beginning of monitoring investigation the number of the infested sites has doubled. It spreads in weed assemblages and groves. It requires high humidity and leads a hiding way of life feeding mainly on plants. In the years of higher rainfall its population increases in a noticeable way. At present it does not reach the maximum individual density on any of the sampling sites as it would be expected according to literature data.

The most common member of bivalves *Dreissena polymorpha* (Pallas, 1771). First we came to know about its presence in the holocene from Lake Balaton (1932), since then it has been spreading continuously in lakes and rivers. In the Dráva it has been present since 1997 (VARGA and UHERKOVICH 1998) and has found its way into gravel pits as well. As it leads an immovable way of life it characteristically settles on shells of larger bivalves, but it can also be found on protective paving and vegetal material. According to the surveys it is commonly spread in rivers and lives in masses; its population size has not changed in a traceable manner during investigation.

Anodonta woodiana (Lea, 1834) (Fig. 4.) a bivalve species, originates in East-Asia and it was imported into Europe with different fish species (*Ctenopharyngodon idella, Hypophthalmichthys molitrix*). In 1990 it was already present in the Danubian water system and it is spreading towards the south. It also settled in Lake Balaton and some parts of our larger fishponds. In the Dráva it was identified during water fauna monitoring in 2002. It has been recorded in three of the sampling sites in the river, but also in oxbows and pit lakes. The increase in species area is a fact, the present sampling data do not provide accurate dispersion data.

When monitoring water fauna in float debris 20 water snail shells were found, one of them is a protected species. Table 2. contains the average density data of species in the float debris from three sampling sites over a 5 - year period. Due to the characteristic features of sampling methods, species whose shell does not retain gas bubbles sink to the bottom of the bed, so they are not present in the float debris. This causes the striking contradiction which explains why *Amphimelania holandri* (Pfeiffer, 1828) for example, is of occasional occurance, while in the solid parts of the sampling site its density exceeds 95%.

Table 3. contains species found in float debris of gravel pit lakes in the vicinity of Bélavár. Malacologically this area is valueless, investigation in this area was mainly aimed at monitoring the potential dispersion of invasive and protected species. No such occurance was recorded during the years in question. Species frequency in the sampling sites has considerably changed. The main reason is the fast succession in the lake, which strongly modifies snail population size.

Table 2.: Average density of water snail species in fluvial float debris

Species	Mean frequency
Anisus septemgyratus (Rossmässler, 1832)	2,9
Anisus spirorbis (Linnaeus, 1758)	8,4
Aplexa hypnorum (Linnaeus, 1758)	0,9
Bathyomphalus contortus (Linnaeus, 1758)	3
Bithynia leachi (Sheppard, 1823)	0,4
Bithynia tentaculata (Linnaeus, 1758)	26,6
Gyraulus albus (Müller, 1774)	0,6
Lithoglyphus naticoides (C. Pfeiffer, 1828)	2,7
Lymnaea auricularia (Linnaeus, 1758)	0,7
Lymnaea palustris (Müller, 1774)	2,4
Lymnaea peregra agg. (Müller, 1774)	13,2
Lymnaea truncatula (Müller, 1774)	14,9
Physa acuta (Draparnaud, 1805)	0,1
Physa fontinalis (Linnaeus, 1758)	0,3
Planorbarius corneus (Linnaeus, 1758)	2,3
Planorbis planorbis (Linnaeus, 1758)	6,2
Valvata cristata Müller, 1774	0,9
Valvata piscinalis (Müller, 1774)	7
Viviparus contectus (Millet, 1813)	4,2

Table 3. Average frequency of species in lake float debris

Species	Mean frequency
Anisus septemgyratus (Rossmässler, 1832)	2,9
Anisus spirorbis (Linnaeus, 1758)	8,4
Aplexa hypnorum (Linnaeus, 1758)	0,9
Bathyomphalus contortus (Linnaeus, 1758)	3
Bithynia leachi (Sheppard, 1823)	0,4
Bithynia tentaculata (Linnaeus, 1758)	26,6
Gyraulus albus (Müller, 1774)	0,6
Lithoglyphus naticoides (C. Pfeiffer, 1828)	2,7
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Physa fontinalis (Linnaeus, 1758)	0,3
Planorbarius corneus (Linnaeus, 1758)	2,3
Planorbis planorbis (Linnaeus, 1758)	6,2
Valvata cristata Müller, 1774	0,9
Valvata piscinalis (Müller, 1774)	7
Viviparus contectus (Millet, 1813)	4,2

Table 4.: Average frequency of terrestrial snail shells in fluvial float debris

Species	Mean frequency
Aegopinella ressmanni (Westerlund, 1883)	7.5
Aegopis verticillus (Férussac, 1822)	1
Bradybaena fruticum (Müller, 1774)	4.1
Carychium minimum Müller, 1774	5.4
Carychium tridentatum (Risso, 1826)	0.01
Cecilioides acicula (Müller, 1774)	0.3
Cepaea nemoralis (Linnaeus, 1758)	1.8
Cepaea vindobonensis (Férussac, 1821)	1.2
Clausilia pumila Pfeiffer, 1828	9.5
Cochlicopa lubrica (Müller, 1774)	11.8
Cochlicopa lubricella (Porro, 1838)	0.1
Cochlodina laminata (Montagu, 1803)	0.6
Columella edentula (Draparnaud, 1805)	0.1
Euconulus fulvus (Müller, 1774)	1.3
Helicigona arbustorum (Linnaeus, 1758)	3.2
Helicigona planospira (Lamarck, 1822)	0.4
Helix pomatia Linnaeus, 1758	0.8
Macrogastra ventricosa (Draparnaud, 1801)	0.01
Oxyloma elegans (Risso, 1826)	0.1
Perforatella bidentata (Gmelin, 1788)	7.1
Perforatella incarnata (Müller, 1774)	4.3
Perforatella rubiginosa (A. Schmidt, 1853)	2.9
Perforatella umbrosa (Pfeiffer, 1828)	1.9
Punctum pygmaeum (Draparnaud, 1801)	0.7
Pupilla muscorum (Linnaeus, 1758)	0.5
Semilimax semilimax (Férussac, 1802)	0.4
Sphyradium doliolum (Bruguiére, 1792)	0.01
Succinea oblonga Draparnaud, 1801	0.8
Succinea putris (Linnaeus, 1758)	2
Trichia hispida (Linnaeus, 1758)	0.2
Truncatellina cylindrica (Férussac, 1807)	0.01
Vallonia pulchella (Müller, 1774)	7.7
Vertigo angustior Jeffreys, 1830	0.01
Vertigo antivertigo (Draparnaud, 1801)	0.1
Vertigo moulinsiana (Dupuy, 1849)	0.01
Vertigo pygmaea (Draparnaud, 1801)	0.5
Vitrea crystallina (Müller, 1774)	14.6
Zonitoides nitidus (Müller, 1774)	6.8

The aim of sampling water snails by sweep netting is to study fauna living on the side of the river bed. Each sampling was taken on the gravel-free parts of the river bed. Comparing sample results to ones by quadrate sampling, frequency differences are quite striking due to different ground-base preferences. On Vízvár sampling site, when monitoring *Amphimelania holandri* (Pfeiffer, 1828) on species level, this species revealed an outstanding dominance (an average of 94%) on solid ground-base (the protective paving of the spurs), while this value, studied by sweep netting on a site rich in sediment only 2 m away, is only around 30%. The occurance frequency of *Lithoglyphus naticoides* reached 50% from former 4%.

On the Bolhó sampling site the current is strong and has steep sideway bed. The occurance of *Amphimelania holandri* (Pfeiffer, 1828) is accidental, it has not occurred in the last few years due to the weaker tolerance of ground-base quality. One of the possible causes may have been the perturbation brought about by enforcement of gravel depositing bankside. The low species number of this sampling site is also characteristic.

To get a clearer picture of the fauna, underwater individual sampling of water snails found on vegetation is carried out. Its purpose is to record species with a stable way of life whose presence is characteristically linked to vegetation and rarely found in float debris. In the course of samplings none of the species typically living on water plants were detected.

Investigation of terrestrial snail fauna is also made up of several components. It is part of investigation carried out in alder woods of Lankóci woodland belonging to Gyékényes and data yielded by investigation of terrestrial fauna (12 species) are complemented by those of individual sampling (9 species). No changes in the frequency of dominant species *Aegopinella ressmanni* (Westerlund, 1833), *Zonitoides nitidus* (Müller, 1774), *Perforatella incarnata* (Müller, 1774) were found. Due to the nearness of Dombó Canal phytofag species requiring high humidity appear in this area on the borderline of assemblages. Rich slug fauna inhabits the biomass of tree trunks. Characteristic species are *Arion circumscriptus* (Joston, 1828), *Arion subfuscus* (Draparnaud, 1805), *Deroceras agreste* (Linnaeus, 1758), *Limax cinereoniger* (Wolf, 1803).

An important component in the study of terrestrial snail species along the Dráva refers to water float debris. Table 4. contains average species frequency data collected during the five-year investigation. So far individuals of 38 species have been recorded, among them the occurance along the river of 2 protected species *Vertigo angustior* (Jeffreys, 1803) and *Vertigo moulinsiana* (Dupuy, 1849) have become known. In the float debris of Lake Bélavár we could determine 18 species. The vegetation and the ground surface are severely disturbed by dredging. The swept - in snail shells come from the surrounding weeds and soft-wood groves. Some of them are supposed to be subfossil.

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A Duna-Dráva Nemzeti Park térségében végzett puhatestű (Mollusca) monitoring tapasztalatai

HÉRA ZOLTÁN

A Duna-Dráva Nemzeti Park területén illetve térségében 2000 óta 4 projektben folynak puhatestű biomonitoring vizsgálatok. A kutatások során a korábbi adatokhoz képest 5 védett faj jelenléte, pontszerű előfordulása vagy populációjának areája vált ismertté. A vízi és a szárazföldi fauna monitorozása feltárta a Drávában és a hatásterületén élő puhatestű fauna alapvonásait, jellemző gyakorisági viszonyait, ami egy esetleges vízügyi beavatkozás esetén jó összehasonlítási alapot nyújt a bekövetkező változások kimutatására. A terület életközösségeit számos invázív faj terjedése veszélyezteti. Populációik areájának figyelemmel kísérése, az egyedsűrűség alakulásának regisztrálása rendszeres.

DOI:10.24394/NatSom.2005.7.35 | Natura Somogyiensis | 7 | 35-48 | Kaposvár, 2005

Monitoring dragonflies on the section of the Dráva between Őrtilos and Vízvár (Insecta: Odonata)

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TÓTH S.: *Monitoring dragonflies on the section of the Dráva between Őrtilos and Vízvár (Insecta: Odonata)*
Abstract: The power plant planned on the Croatian section of the Dráva can result in unfavourable changes in the fauna of wetlands by the river and may - among others - affect the dragonflies developing there, too. This necessitates the long-term monitoring of the local dragonfly fauna. Already the experiences of the first few years of monitoring referred to the fact that the shallower wetlands of the area are particularly vulnerable. In the course of the examinations it turned out that the dragonfly fauna of the area is rich - 14 of the 48 species detected so far are protected by law. Outstanding among these are the 5 taxons listed in the Bern Convention (*Aeshna viridis, Gomphus flavipes, Ophiogomphus cecilia, Leucorrhinia caudalis, Leucorrhinia pectoralis*). The composition of the local fauna - similarly to the national situation - is dominated by Pontic-Mediterranean, Siberian and West-Siberian faunal elements. However, the proportions alter to some extent from group to group. The author gives a detailed analysis of the composition of the fauna of the individual sampling sites and offers a separate depiction of the quantitative composition of the fauna according to the subordo.

Key words: Odonata, Drava river, biomonitoring

Introduction

The operation of the power plant planned for the Croatian area of the Dráva (Novo Virje) is expected to affect the wetlands by the river, particularly the fauna living there and bound to the water due to the development of its larvae: such as dragonflies among others.

Dragonflies (Odonata), as insects developing in the water and sensitively reacting to the characteristics of the habitat (indicator organisms), are suitable for tracking the changes occurring in the condition of the habitat. The examinations carried out with them are facilitated by the fact that the Hungarian fauna is well-researched and the number of permanent species is relatively low: altogether 65.

As a result of the odonatological examinations in process for a longer period in the area of the Duna-Dráva National Park, the dragonfly fauna of the area is relatively well known. Based on the publications prepared in the course of the work (DÉVAI 1978, 1981, DÉVAI et al. 1978, 1993, TÓTH 1995, 1998), the occurrence of altogether 54 species (83 per cent of the Hungarian fauna) can be regarded as proven.

The monitoring of dragonflies can be built on larvae, exuviums and imagoes as well. Undoubtedly, primarily the survey of imagoes is justified in the establishment of a quantitative fauna picture. In spite of this, especially in certain periods, e.g. in early spring (when imagoes do not yet fly) and late autumn (when most of the species do not fly any longer) it is worth collecting larvae, too. Collecting exuviums is much easier and far

ISSN 1587-1908 (Print); ISSN 2062-9990 (Online)

more effective than locating larvae. From the point of view of monitoring, however, only the survey of all three stages of the life cycle can result in a roughly realistic picture of the fauna of the sampling sites.

A well-appraisable result in the monitoring by the Dráva can be expected from the examination of the whole dragonfly assemblage of the sampling sites. The protected and - within that group - the very rare taxons mainly listed in the Bern Convention are given priority treatment in the course of the monitoring.

Already the first few years' experiences in monitoring referred to the fact that especially the shallower wetlands of the area are extremely vulnerable, primarily due to the partial or occasionally full drying out owing to the draughty weather. In 2001 two new sampling points had to be marked out partly as a result of this problem.

Material and method

In the monitoring of dragonflies, personal collecting and observation - aided by useful information through bringing up larvae - is fundamental. Both population- and community-level monitoring play a role in sampling. Both methods are based on the principles laid down in volume V. of NBmR (Hungarian Biodiversity monitoring System) (FEKETE et al. 1997, FORRÓ 1997).

The population-level sampling of dragonflies by the Dráva also happens on the basis of the principles of NBmR concerning dragonflies (AMBRUS et al. 1997). This work is aimed at the research of the following five local species listed in the Bern Convention:

Besides population-level monitoring, successful work requires - also based on the principles laid down in NBmR (DÉVAI 1997a) - the community-level monitoring of dragonflies as well. The two methods organically complement each other. In community-level monitoring it is worth following the proposal concerning the quantitative survey of dragonfly imagoes (DÉVAI 1997b).

In monitoring, besides the species listed in the Bern Convention, it is practical to treat the other protected taxons separately as well. Owing to its interesting flatland occurrence - out of the non-protected taxons - it is worth dealing with *Pyrrhosoma nymphula interposita* VARGA, 1968, frequent in our hilly and mountainous areas but rare in plains.

The work took place on the three sampling sites (environs of Zákány-Őrtilos, Lankóci-forest, region of Bélavár-Vízvár) proposed for monitoring by Directorate of the Duna-Dráva National Park.

The sampling frequency occurs in harmony with the phenological features of the whole dragonfly assemblage, taking the differing swarming characteristics of the individual populations into account (DÉVAI 1976a).

Maximum 3–4 sampling sites per day	**Date of the samples (monthly)**											**Total samples**
	IV.	**V.**		**VI.**		**VII.**		**VIII.**		**IX.**	**X.**	
	10–15.	5–10.	18–23.	5–10.	17–25.	1–10.	17–22.	4–9.	22–27.	15–21.	10–15.	
Number of samples	9	9	9	9	9	9	9	9	9	9	9	99

Fig. 1.: Sampling site in the Holt-Dráva (Bélavár)

Fig. 2.: Exuvium of *Cordulia aeneaturfosa*

Fig. 3.: *Libellula quadrimaculata* (female, freshly crawled out of the exuvium)

Fig. 4.: Sampling site in Vízvár (living Dráva)

Fig. 5.: *Ophiogomphus cecilia* (male, meanwhile crawling out of the exuvium)

Fig. 6.: Male imago of *Ophiogomphus cecilia*

Examined variables

In order to be able to determine the possible later changes owing to the power plant, the examination of particularly the following indices is justified:

- The exact species composition, i.e. the number of occurring species.
- The density per species.
- The stages of the life cycle (imago, larva, exuvium).

Results and conclusions

The list of species detected in the sampling sites of monitoring between 2000 and 2004 on the section between Őrtilos and Vízvár in systematical order (the taxons protected in Hungary are marked with one, the species listed in the Bern Convention with two asterisks).

ZYGOPTERA

Calopterygidae

1. *Calopteryx splendens* (Harris, 1782)
2. *Calopteryx virgo* (Linnaeus, 1758)*

Lestidae

3. *Lestes barbarus* (Fabricius, 1798)
4. *Lestes dryas* Kirby, 1890*
5. *Lestes sponsa* (Hansemann, 1823)
6. *Lestes virens vestalis* Rambur, 1842
7. *Lestes viridis* (Van der Linden, 1825)
8. *Sympecma fusca* (Van der Linden, 1820)

Platycnemididae

9. *Platycnemis pennipes* (Pallas, 1771)

Coenagrionidae

10. *Coenagrion ornatum* (Sélys-Longchamps, 1850)*
11. *Coenagrion puella* (Linnaeus, 1758)
12. *Coenagrion pulchellum interruptum* (Charpentier, 1825)
13. *Erythromma najas* (Hansemann, 1823)
14. *Erythromma viridulum* Charpentier, 1840
15. *Pyrrhosoma nymphula interposita* Varga, 1968
16. *Ischnura elegans pontica* Schmidt, 1938
17. *Ischnura pumilio* (Charpentier, 1825)
18. *Enallagma cyathigerum* (Charpentier, 1840)

ANISOPTERA

Aeshnidae

19. *Aeshna affinis* Van der Linden, 1820
20. *Aeshna cyanea* (Müller, 1764)
21. *Aeshna mixta* Latreille, 1805
22. *Aeshna viridis* Eversmann, 1836 **
23. *Brachytron pratense* (Müller, 1764)
24. *Anaciaeschna isosceles* (Müller, 1767) *
25. *Anax imperator* Leach, 1815
26. *Anax parthenope* (Sélys-Longchamps, 1839)

Gomphidae

27. *Gomphus flavipes* (Charpentier, 1825) **
28. *Gomphus vulgatissimus* (Linnaeus, 1758) *
29. *Ophiogomphus cecilia* (Fourcroy, 1785) **
30. *Onychogomphus forcipatus* (Linnaeus, 1758)

Corduliidae

31. *Cordulia aeneaturfosa* Förster, 1902
32. *Somatochlora aenea* (Linnaeus, 1758) *
33. *Epitheca bimaculata* (Charpentier, 1825) *

Libellulidae

34. *Libellula depressa* Linnaeus, 1758
35. *Libellula fulva* Müller, 1764 *
36. *Libellula quadrimaculata* Linnaeus, 1758
37. *Orthetrum albistylum* (Sélys-Longchamps, 1848)
38. *Orthetrum brunneum* (Fonscolombe, 1837) *
39. *Orthetrum cancellatum* (Linnaeus, 1758)
40. *Orthetrum coerulescens anceps* (Schneider, 1845)
41. *Crocothemis servilia* (Drury, 1770)
42. *Sympetrum flaveolum* (Linnaeus, 1758)
43. *Sympetrum meridionale* (Sélys-Longchamps, 1841)
44. *Sympetrum sanguineum* (Müller, 1764)
45. *Sympetrum striolatum* (Charpentier, 1840)
46. *Sympetrum vulgatum* (Linnaeus, 1758)
47. *Leucorrhinia caudalis* (Charpentier, 1840) **
48. *Leucorrhinia pectoralis* (Charpentier, 1825) **

Depiction of the sampling sites based on the dragonfly fauna

Sampling site 1. Dráva (Őrtilos)
The riverbank on the two sides of the port by Őrtilos railway station
Examined area: 50 × 3 m riverside.
Type of the water body: middle size river (code number 2220)
Depiction of the sampling site based on the fauna:
The number of species observed in the water between 2000 and 2004: 7 (+ 10 presumably roaming taxons)
Protected species: *Agrion virgo, Coenagrion ornatum, Gomphus vulgatissimus*
Strictly protected species: *Gomphus flavipes, Ophiogomphus cecilia*
Number of individuals: 577
Number of larvae: 95
Number of exuviums: 62
Number of imagoes: 420
Zygoptera material: *Agrion splendens* (42,59%), *Platycnemis pennipes* (34,82%), *Coenagrion ornatum* (3,76%). Other species together (18,83%).
In the composition of the Zygoptera fauna Ischnura elegans, whose larva probably develops only in small numbers in the Dráva, has a relatively high proportion (14.12%). The majority of the samples collected/observed in the sampling site could have been roaming imagoes.
Anisoptera material: *Gomphus vulgatissimus* (52,32%), *Gomphus flavipes* (13,24%), *Ophiogomphus cecilia* (11,26%). Other species together (23.18%).
Out of the protected species *Anaciaeschna isosceles* and *Orthetrum brunneum* were detected in the sampling site, but only in imago stage. The development of the latter in the Dráva cannot be completely ruled out but so far its larva has not been collected from the water.

Sampling site 2. Dráva (Vízvár)
The river near Vízvár by the stone dam.
Examined area: 50 × 3 m riverside.
Type of the water body: middle size river (code number 2220)
Depiction of the sampling site based on the fauna:
The number of species observed in the water between 2000 and 2004: 12 (+ 12 presumably roaming taxons)
Protected species: *Agrion virgo, Coenagrion ornatum, Gomphus vulgatissimus*
Strictly protected species: *Gomphus flavipes, Ophiogomphus cecilia*
Number of individuals: 1192
Number of larvae: 267
Number of exuviums: 496
Number of imagoes: 829
Zygoptera material: *Agrion splendens* (39,50%), *Platycnemis pennipes* (41,57%), Other species together (18,93%).
Similarly to the previous sampling site, *Ischnura elegans* - less characteristic of the Dráva - also represents a significant part of the collected/observed species (13.68%).
Anisoptera material: *Gomphus vulgatissimus* (37,77%), *Gomphus flavipes* (14,39%), *Ophiogomphus cecilia* (14,03%). Other species together (33,81%).
Out of the protected species *Anaciaeschna isosceles* and *Orthetrum brunneum* were detected in the sampling site, but only in imago stage. The development of the latter in the Dráva cannot be completely ruled out but so far its larva has not been collected from

the water. *Sympetrum sanguineum* - whose individuals found in the sampling site must have been roaming specimens - comes second (19.06%) in the quantitative composition of the species.

Sampling site 3. Patacsini-gravel-pit lake (Murakeresztúr)

Abandoned gravel-pit south-east from Őrtilos railway station, in the flood plain of the Dráva.

Examined area: 150 m^2.

Type of the water body: marshy artificial still water (code number: 1620)

Depiction of the sampling site based on the fauna:

The number of species with proved detection in the water between 2000 and 2004: 33. In the course of the samplings, only the imagoes of a further 8 species were detected, however, presumably the larvae of these also mostly developed there. The protected *Orthetrum brunneum* and *Somatochlora aenea* also belong to these.

Protected species: *Anaciaeschna isosceles, Epitheca bimaculata, Lestes dryas, Leucorrhinia pectoralis, Libellula fulva*

Strictly protected species: *Leucorrhinia caudalis*

Number of individuals: 3025

Number of larvae: 635

Number of exuviums: 149

Number of imagoes: 1241

Zygoptera material: *Ischnura elegans* (32,83%), *Coenagrion puella* (21,41%), *Erythromma viridulum* (16,53%), *Lestes virens* (8,41%), *Erythromma najas* (6,23%). Other species together (14,59%).

Anisoptera material: *Crocothemis servilia* (18,59%), *Orthetrum cancellatum* (12,34%), *Cordulia aeneaturfosa* (9,27%), *Leucorrhinia caudalis* (8,62%), *Sympetrum sanguineum* (8,50%), *Sympetrum vulgatum* (8,38%), *Anax imperator* (6,14%), *Anaciaeschna isosceles* (4,95%). Other species together (23,21%).

Sampling site 4. Dombó-canal (Gyékényes)

A 50 metre section of the canal on the north-western edge of Lankóci forest

Type of the water body: artificial small watercourse (code number: 2340)

Depiction of the sampling site based on the fauna:

The number of species with proved detection in the water between 2000 and 2004: 12. In the course of the surveys, only the imagoes of a further 16 species were detected, but the occurrence of some of these (*Agrion virgo, Coenagrion puella, Brachytron pratense, Sympetrum flaveolum, Sympetrum vulgatum*) in larva stage cannot be ruled out either. In droughty periods Dombó-csatorna (Dombó Canal) is almost like still water in some places, which has a favourable effect on the development of several species.

Protected species: *Coenagrion ornatum, Anaciaeschna isosceles, Gomphus vulgatissimus, Libellula fulva, Orthetrum brunneum*

Strictly protected species: *Ophiogomphus cecilia*

Number of individuals: 2343

Number of larvae: 271

Number of exuviums: 136

Number of imagoes: 1936

Zygoptera material: *Platycnemis pennipes* (30,39%), *Coenagrion ornatum* (28,72%), *Agrion splendens* (26,73%), *Ischnura elegans* (10,81%). Other species together (3,35%)

Anisoptera material: *Orthetrum brunneum* (44,42%), *Sympetrum sanguineum* (13,84%), *Libellula depressa* (13,23%), *Gomphus vulgatissimus* (5,37%). Other species together (23,14%).

Sampling site 5. Büdös-ér (Gyékényes)
Sampling site 6. Méhes-tó (Gyékényes)
Between 2002 and 2004 there were no collecting in two sampling sites due to they were unsuitable for monitoring.

Sampling site 7. Holt-Dráva (Bélavár)
The former bed of the Dráva to the south of Bélavár, in Lókai-mező in the flood-plain of the Dráva.
Examined area: 50 × 3 m.
Type of the water body: marshy natural still water (code number: 1610)
Depiction of the sampling site based on the fauna:
The number of species with proved detection in the water between 2000 and 2004: 35. In the course of the samplings, only the imagoes of a further 8 species were detected, however, presumably, their larvae also mostly developed in the water. *Aeshna viridis* is an exception: it can only be listed as belonging to the fauna of the Holt-Dráva when its larvae are also found there.
Protected species: *Agrion virgo, Anaciaeschna isosceles, Epitheca bimaculata, Gomphus vulgatissimus, Lestes dryas, Libellula fulva, Somatochlora aenea*
Strictly protected species: *Leucorrhinia caudalis, Leucorrhinia pectoralis*
Number of individuals: 2971
Number of larvae: 513
Number of exuviums: 161
Number of imagoes: 2297
Zygoptera material: *Ischnura elegans* (22,03%), *Coenagrion puella* (14,19%), *Erythromma viridulum* (14,00%), *Coenagrion pulchellum* (12,97%), *Platycnemis pennipes* (11,62%), *Lestes virens* (8,03%). Other species together (17,16%).
Anisoptera material: *Crocothemis servilia* (29,26%), *Orthetrum cancellatum* (13,19%), *Cordulia aeneaturfosa* (12,12%), *Anaciaeschna isosceles* (9,42%), *Sympetrum sanguineum* (8,53%), *Leucorrhinia caudalis* (7,63%), *Brachytron pratense* (7,27%), *Sympetrum vulgatum* (6,82%). Other species together (6,75%).

Sampling site 8. Csíkos-árok (Bélavár)
Little north-south watercourse to the north of Bélavár, in a pasture called Csíkos outside the flood plain of the Dráva. As far as the type of the body of water is concerned, originally it could have been a brook but some parts of it have been canalised and its sampling section is an artificial small watercourse. It is a shallow, slow watercourse widening at some points and has a rich vegetation. Especially in summer it stagnates in several places or fully dries out.
Examined area: 50 × 3 m.
Type of the water body: artificial small watercourse (code number: 2340)
Depiction of the sampling site based on the fauna:
The number of species with proved detection in the water between 2000 and 2004: 20. In the course of the surveys, the imagoes of a further 14 species were detected. Presumably their larvae also develop in the small watercourse without exception.
Protected species: *Anaciaeschna isosceles, Coenagrion ornatum, Gomphus vulgatissimus, Libellula fulva, Orthetrum brunneum*
Strictly protected species: -
Number of individuals: 1354
Number of larvae: 302
Number of exuviums: 66
Number of imagoes: 986

Zygoptera material: *Ischnura elegans* (22,47%). *Pyrrhosoma nymphula* (17,24%), *Coenagrion ornatum* (14,64%), *Agrion splendens* (12,01%), *Lestes barbarus* (11,29%), *Platycnemis pennipes* (10,11%). Other species together (12,24%).

Anisoptera material: *Libellula depressa* (23,78%), *Sympetrum sanguineum* (17,35%), *Orthetrum brunneum* (10,14%), *Sympetrum vulgatum* (9,55%), *Sympetrum flaveolum* (5,65%), *Libellula fulva* (5,26%), *Anaciaeschna isosceles* (4,87%). Other species together (23,40%).

Sampling site 9. Lankóci lake (Gyékényes)

Permanent pond in a small gravel pit on Grófi út (Grófi Road) leading from the forester's lodge to Dombó-csatorna (Dombó Canal) in Lankóci-forest.

Examined area: the complete riverside in the water body (about 50×2-3 m).

Type of the water body: pond type other artificial still water (code number: 1350)

Depiction of the sampling site based on the fauna:

The number of species with proved detection in the water between 2000 and 2004: 22. In the course of the samplings, the imagoes of a further 17 species were detected. Presumably the larvae of most of these also developed there. Out of these four species are protected (*Coenagrion ornatum, Lestes dryas, Libellula fulva, Orthetrum brunneum*).

Protected species: *Anaciaeschna isosceles, Epitheca bimaculata, Gomphus vulgatissimus*

Strictly protected species: *Leucorrhinia caudalis, Leucorrhinia pectoralis*

Number of individuals: 902

Number of larvae: 102

Number of exuviums: 82

Number of imagoes: 718

Zygoptera material: *Ichnura elegans* (24,04%), *Platycnemis pennipes* (19,71%), *Erythromma viridulum* (16,59%), *Lestes virens* (8,17%), *Coenagrion puella* (7,45%), *Lestes barbarus* (5,05%). Other species together (18,99%).

Anisoptera material: *Sympetrum meridionale* (23,88%), *Sympetrum vulgatum* (10,87%), *Crocothemis servilia* (10,23%), *Orthetrum cancellatum* (9,59%), *Sympetrum sanguineum* (8,17%), *Libellula depressa* (8,31%), *Sympetrum striolatum* (5,12%). Other species together (22,81%)

Quantitative composition of the fauna (based on frequency)

György Dévai and his colleagues dealt with the relative abundance of Hungarian dragonfly species determined on the basis of UTM maps in several works (DÉVAI & MISKOLCZI 1978, DÉVAI et al. 1994). With the help of the 5-grade experimental scale created by them, the dragonfly species detected in the course of monitoring the Dráva are distributed in the following way:

I. Sporadic species: 6 (19 species in Hungary)

II. Rare species: 7 (8 species in Hungary)

III. Less frequent species: 15 (16 species in Hungary)

IV. Frequent species: 19 (19 species in Hungary)

V. Very frequent species: 1 (1 species in Hungary)

The distribution of species according to abundance is similar to the national one. There is a significant deviation only in the proportion of species with a scattered (i.e. the rarest) presence (nation-wide 19, on the monitored section of the Dráva only 6 species can be put into this category). The abundance of the species is shown in the table summarising the data of monitoring (Table 1.).

Table 1: Summarising data of the dragonfly monitoring

No	Taxon	Sampling sites									Sum of individuals	Percentage (%)			Faunalelements	Frequency
		1.	2.	3.	4.	5.	6.	7.	8.	9.		From total	From Zygoptera	From Anisoptera		
	Suborder ZYGOPTERA															
1.	*Calopteryx splendens*	181	361	4	497	2		14	101	12	1172	9,33	15,17		Pm.	IV
2.	*Calopteryx virgo*	8	12		2			1	1		24	0,19	0,31		Ws.	III
3.	*Coenagrion ornatum*	16	13	1	534			11	123	8	706	5,62	9,14		Pm.	III
4.	*Coenagrion puella*	9	16	258	20	106	21	221	22	31	704	5,41	9,11		Pc.	IV
5.	*Coenagrion pulchellum*		2	39		17	1	202	3	4	268	2,12	3,47		Pc.	IV
6.	*Enallagma cyathigerum*			3							3	0,02	0,04		S.	IV
7.	*Erythromma najas*			83		3	4	69		2	161	1,25	2,08		S.	III
8.	*Erythromma viridulum*			220	14	9	11	218	11	69	552	4,28	7,15		Pm.	III
9.	*Ischnura elegans*	60	125	437	201	67	49	343	189	100	1571	12,17	20,33		Pc.	IV
10.	*Ischnura pumilio*			13		4	4	6	11	5	43	0,33	0,56		Pm.?	IV
11.	*Lestes barbarus*			53	14	14	1	72	95	21	270	2,09	3,5		Hm	IV
12.	*Lestes dryas*			3	4		1	6		3	17	0,13	0,22		S.	IV
13.	*Lestes sponsa*		1	25	2	7	2	51	13	11	112	0,87	1,45		S.	IV
14.	*Lestes virens*		4	112	4	10	6	125	35	34	330	2,63	4,27		Pm.	IV
15.	*Lestes viridis*			12		1	1	5	5	1	25	0,2	0,32		Am.	II
16.	*Platycnemis pennipes*	148	380	40	565	4	1	181	85	82	1486	11,51	19,24		Pc.	IV
17.	*Pyrrhosoma nymphula*						6	5	145	14	170	1,32	2,2		Pm.	II
18.	*Sympecma fusca*	4		28	2	16	12	27	2	19	110	0,85	1,42		Hm.	V
	Suborder ANISOPTERA												99,97			
19.	*Aeshna affinis*			4		1	1	18	5	1	30	0,23		0,58	Hm.	IV
20.	*Aeshna cyanea*			5				5	5	4	19	0,15		0,37	Hm.	III
21.	*Aeshna mixta*	2	5	42	3	6		39	9	12	118	0,91		2,27	Hm.	IV
22.	*Aeshna viridis*							1			1	0,01		0,02	Ws.	I
23.	*Anaciaeschna isosceles*	1	2	84	10	5	7	105	25	11	250	1,94		4,82	Am.	III
24.	*Anax imperator*			104	2	3	8	59	18	20	214	1,66		4,13	Hm.	III
25.	*Anax parthenope*			26		1		18			45	0,35		0,87	Pm.	I
26.	*Brachytron pratense*	2	1	65	4	24	7	81	14	8	206	1,59		3,98	Pc.	III
27.	*Cordulia aeneaturfosa*		10	157	4	7	3	135	5	12	333	2,58		6,42	Ws.	II
28.	*Crocothemis servilia*		1	315		6	4	326	10	48	708	5,5		13,69	Hm.	III
29.	*Epitheca bimaculata*			63				18		4	85	0,66		1,64	Ws.	I
30.	*Gomphus flavipes*	20	40		3						63	0,49		1,21	Ws.	II
31.	*Gomphus vulgatissimus*	79	105		26			1	12	1	224	1,73		4,32	Pm.	III
32.	*Leucorrhinia caudalis*			146				85		6	237	1,83		4,57	Ws.	I
33.	*Leucorrhinia pectoralis*			15			1	14		15	45	0,35		0,87	Ws.	I
34.	*Libellula depressa*		1	34	117	12	14	21	122	39	360	2,79		6,94	Pm.	IV
35.	*Libellula fulva*			21	12	3	2	17	27	2	84	0,65		1,62	Pm.	II
36.	*Libellula quadrimaculata*		2	53		4	2	58	6	4	129	1,1		2,49	S.	III
37.	*Ophiogomphus cecilia*	17	39		4						60	0,46		1,16	Ws.	II
38.	*Onychogomphus forcipatus*		2								2	0,01		0,02	Pc.	I
39.	*Orthetrum albistylum*			18				20		6	44	0,34		0,85	Pm.	III
40.	*Orthetrum brunneum*	2	2	1	215				52	8	280	2,17		5,4	Hm.	III
41.	*Orthetrum cancellatum*			209	3	3	9	147	11	45	427	3,31		8,23	Hm.	III
42.	*Orthetrum coerulescens*			11				6	2		19	0,15		0,37	Pm.	III
43.	*Somatochlora aenea*			4		4		7			15	0,12		0,29	Ws.	II
44.	*Sympetrum falveolum*		1	15	3	3	1	30	29	10	92	0,71		1,77	S.	IV
45.	*Sympetrum meridionale*	2	6	6	2		1	11	10	112	150	1,16		2,89	Hm.	IV
46.	*Sympetrum sanguineum*	19	53	144	67	8	1	95	89	43	519	4,02		10,01	Hm.	IV
47.	*Sympetrum striolatum*			10		2	2	21	13	24	72	0,56		1,39	Hm.	IV
48.	*Sympetrum vulgatum*	7	10	142	9	4	6	76	49	51	354	2,74		6,83	S.	IV
Total		**577**	**1192**	**3025**	**2343**	**356**	**189**	**2971**	**1354**	**902**	**12515**	**99,58**		**100,0**		

Abbrevations: Hm.=Holomediterranean, Am.=Atlantomediterranean, Pm.=Pontomediterranean, Pc.=Ponto-caspian, S.=Siberian, Ws.=West-siberian

Qualitative composition of the fauna

The quantitative processing of the data gained in the course of the monitoring happened according to subordo.

Qualitative composition of the Zygoptera-fauna

In the Zygoptera-fauna of the sampling sites six species reached more significant results (Fig. 7.). These are responsible for 84.43% of the whole collected Zygoptera material.

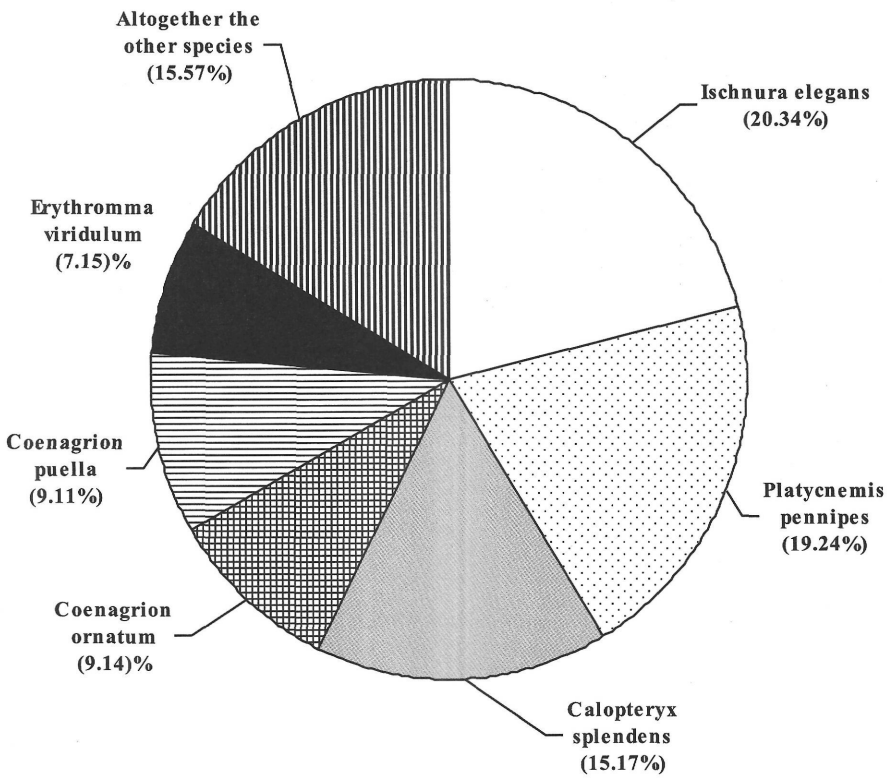

Fig. 7.: Qualitative composition of the Zygoptera-fauna

Qualitative composition of the Anisoptera-fauna

In the Anisoptera-fauna also six species reached more significant results (Fig. 8.). An essential deviation, however, is the fact that these species only make up 47.87% of the full Anisoptera material. The reason for this might be the fact that the number of the taxons belonging to the Anisoptera ordo is significantly larger.

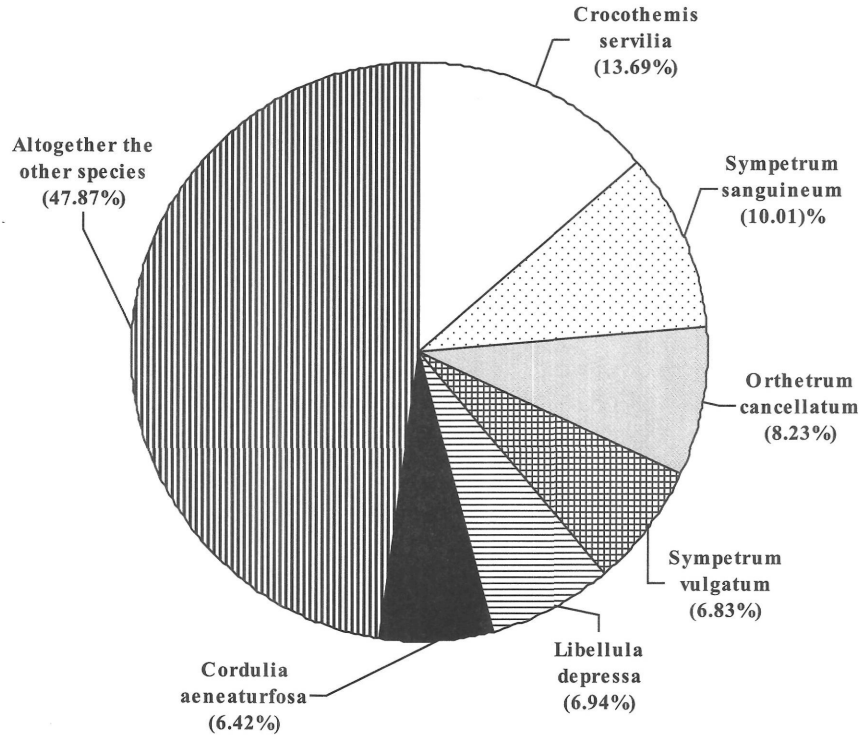

Fig. 8.: Qualitative composition of the Anisoptera-fauna

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Szitakötők monitorozása a Dráva mente Őrtilos és Vízvár közötti szakaszán (Insecta: Odonata)

TÓTH SÁNDOR

A Dráva horvátországi szakaszán (Novo Virje) tervezett vízi erőmű működése előreláthatólag kedvezőtlen változásokat eredményez a folyót kísérő vizes élőhelyek faunájára, többek között az ott fejlődő szitakötőkre. A várható hatások figyelemmel kísérését célozza a szitakötők hosszú távú monitorozása. A munkát indokolja az, hogy a terület szitakötő-faunája gazdag, már az eddigi vizsgálatok során 14 törvényesen védett taxon előfordulását sikerült igazolni. Ezek között több kiemelten értékes elem található, amilyen elsősorban mind az 5, a Berni Egyezményben szereplő taxon (*Aeshna viridis, Gomphus flavipes, Ophiogomphus cecilia, Leucorrhinia caudalis, Leucorrhinia pectoralis*). Már a monitorozás első éveinek tapasztalatai is arra utaltak, hogy a terület vizes élőhelyei közül főleg a sekélyebbek nagyon sérülékenyek, mindenekelőtt az aszályos időjárás hatására bekövetkező részleges vagy esetenkénti teljes kiszáradás miatt.

A kvantitatív faunakép kialakításában elsősorban a szitakötő imágók felmérése indokolt. A monitorozása során azonban kellő hangsúlyt kapott a lárvák és a lárvabőrök felmérése is. A Dráva mentén folyó monitorozásban cél a mintaterületek teljes szitakötő népességének vizsgálata. Ezen belül azonban kiemelten kezeljük a már említett, berni egyezményben szereplő, többnyire ritka taxonokat.

A mintavételezésben mind a populációszintű, mind a közösségszintű monitorozásnak szerepe van. Mindkét módszer alapját a Nemzeti Biodiverzitás-monitorozó Rendszer V. kötetében (FORRÓ 1997) lefektetett alapelvek képezik.

A Duna-Dráva Nemzeti Park igazgatósága három területegységet (Zákány-Őrtilos környéke, Lankóci-erdő, Bélavár-Vízvár térsége) javasolt monitorozásra. Ezek mindegyike megfelel a szitakötő fauna hosszú távú vizsgálatára, mivel illeszkednek a tervezett vízi erőmű valószínűsíthető hatásai által befolyásolt vizes élőhelyekhez. A szitakötők monitorozása jelenleg 7 mintavételi helyen folyik. (A monitorozás indulásakor mintavételi helyül szolgált Büdös-ér, valamint Méhes-tó 2001-ben alkalmatlanná vált a vizsgálatra.).

Az elmúlt 5 évben megfigyelt (kisebb részben begyűjtött) egyedek száma meghaladja a 10 ezret. A vizsgált anyag 48 taxonhoz tartozik, vagyis a hazai fauna 73,8 %-át képviseli.

Az anyag faunaelem csoportok szerinti megoszlásának vizsgálata szerint a helyi faunában - hasonlóan az országos tendenciához - a pontomediterrán, a szibiriai és a nyugat-szibiria faunaelemek dominálnak. Azonban a három kategória tekintetében mind a sorrendben, mind a százalékos arányban jelentős különbségek tapasztalhatók.

A fauna gyakoriság szerinti összetételében 6 faj képviseli a szórványos, 7 faj a ritka, 15 faj a mérsékelten gyakori, 19 faj a gyakori és 1 faj az igen gyakori előfordulású taxonokat. A fajok relatív gyakoriság szerinti megoszlása nagyon közel áll az országoséhoz, csupán a szórványosan előforduló (vagyis a legritkább) fajok aránya tér el jelentősen (országosan 19, a Dráva vizsgált szakaszán mindössze 6 faj sorolható ebbe a kategóriába).

DOI:10.24394/NatSom.2005.7.49 | Natura Somogyiensis | 7 | 49-62 | Kaposvár, 2005

Middle-term changes in caddisfly (Trichoptera) communities of the Hungarian part of Dráva river during the years 1992–2004

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UHERKOVICH Á. & NÓGRÁDI S.: *Middle-term changes in caddisfly (Trichoptera) communities of the Hungarian part of Dráva river during the years 1992–2004.*

Abstract: 113 species are known from the Dráva region. All the collections were quantitative. Some sites were examined during a longer period (i.e. middle term), thus the change of caddisfly communities or collectives are to be studied. The longest and most complete series of data is from Vízvár, the most abundant caddisflies of this site are presented and analysed.

Key words: Trichoptera, Dráva river, communities, quantitive samples

Introduction

The study of caddisfly (*Trichoptera*) fauna of Dráva region dates back to the beginning of the eighties, when ÚJHELYI (1981) and NÓGRÁDI (1985a) went on to collect materials at the waters of the Barcs Juniper Woodland. Their papers introduced 65 caddisfly species from that area. Later – mostly after 1991 – we could extend our activity over the whole area of the Dráva region, mainly around the river and its tributaries. Between 1992 and 2004 we examined the caddisfly fauna and communities of the river systematically. Four papers were published about the results (NÓGRÁDI, UHERKOVICH 1995, 1998, UHERKOVICH 2005, UHERKOVICH, NÓGRÁDI 1992).

Altogether 113 species were recorded out during these years from the whole region, some of them occured here first: *Orthotrichia tragetti* Mosely, *Oxyethira flavicornis* (Pictet), *Micrasema setiferum* (Pictet) (NÓGRÁDI 1985b); *Orthotrichia angustella* (McLachlan), *Hydroptila forcipata* (Eaton), *Adicella syriaca* Ulmer (NÓGRÁDI 1986); *Helicopsyche bacescui* Orghidan & Botosaneanu, *Limnephilus stigma* Curtis (NÓGRÁDI 1988); *Limnephilus subcentralis* Brauer (NÓGRÁDI 1992) and *Hydroptila pulchricornis* (Pictet) (NÓGRÁDI 2001).

It is unquestionable that the fauna of Dráva river and its region is rather rich in species. We can remark that only 85 species have been detected so far from the well-known 'Szigetköz', upper Danube region (UHERKOVICH, NÓGRÁDI 2004), or 74 species from the Szatmár–Bereg Plain (UHERKOVICH, NÓGRÁDI 1998).

Not only the species but the quantitative relations were also recorded in all samples as well. Thus we could study the change of composition of caddisfly communities or collectives of each sites.

ISSN 1587-1908 (Print); ISSN 2062-9990 (Online)

Method and materials

During the last thirteen years we visited many sites along Dráva river several times. Besides the occuring species we always ascertained and made notes about the quantity of each species, thus all the samples were quantitative or near quantitative.

The site Vízvár (XM70; 17°13'30" E, 46°05'15" N) is known very well, as between 1992 and 2004 we collected there yearly. Here the river runs in its natural bed, some branches formed during times, and many shoals formed and changed year by year. Maybe this is the most valuable section of the river owing to its ancient state (Figs. 2-3).

The quantitative results of some years (1992, 1994-1999) were not satisfactory, as we visited the site only a few times. In 1993 and during the years 2000-2004 we sampled there with good results, as those samples contains thousands of caddisflies (Fig. 1). During these thirteen years altogether 20 675 specimens of 60 species were determined from the samples (see Table 1). In some years we did not take larger samples but only occasional ones with few adults (1992, 1994-1998), while in the other years fruitful night capturings were carried out, in 1993 and mostly since 1999 (Fig. 4).

There were some other sites, where we collected larger materials, but we did not visited those regularly. In Drávapalkonya (BR87; 18°11'35" E, 45°47'15" N) and Vejti (YL37; 17°59'00" E, 45°47'35" N) we collected several times in the first half of the nineties. At Drávasztára (YL17; 17°49'45" E, 45°48'40" N) we collected in many years during the period 1992-2004, but not in all years (Fig. 6). The river was regulated at these sites more than a century ago: many bends were cut, thus the bed became shorter. The samples collected in three sites contain about 24 000 caddisfly adults in this period. We also visited some sites a little bit farther from the river, e.g. Barcs and Darány environs, the "Barcs Juniper Woodland" (XL99; 17°33'25" E, 45°59'35" N) , where we collected many times near a forest fen (Fig. 5). In this site a very different fauna formed.

These series of collections were uneven in every sites. It is fact that the circumstances of collections always influence the species composition and mostly the number of adults considerably. The main factor is the actual meteorological situation. The activity depends on the temperature, humidity, clouds and over all the meteorological fronts. Prior to cold fronts, when the air pressure is falling, the activity of insects shoots up considerably. After the passing through of the front, the activity reduces immediately. The intensity of moonlight (i.e. the moon phase) can also influence the activity. The effect of most factors are unforeseenable in collections.

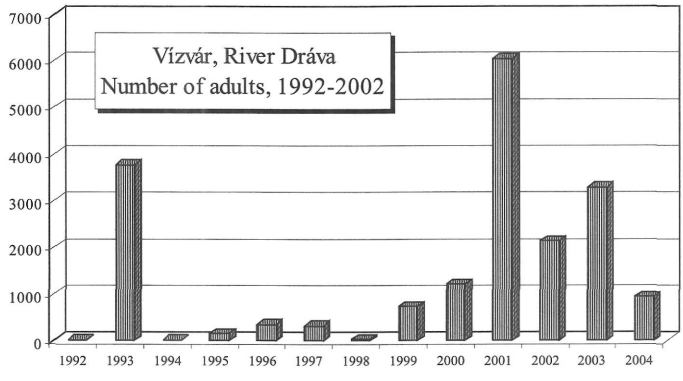

Fig. 1.: The number of caddisfly adults taken at site Vízvár, 1992-2004.
1. ábra: A fogott tegzes imágók példányszáma Vízvárnál, 1992-2004.

Fig. 2.: Branch of Dráva at Vízvár, permanent site of collections (1992)
2. ábra: A Dráva mellékága Vízvárnál, a gyűjtések állandó helye (1992)

Fig. 3.: Quickly forming pebble shoals at Vízvár (1993)
3. ábra: Gyorsan formálódó kavicsátonyok Vízvárnál (1993)

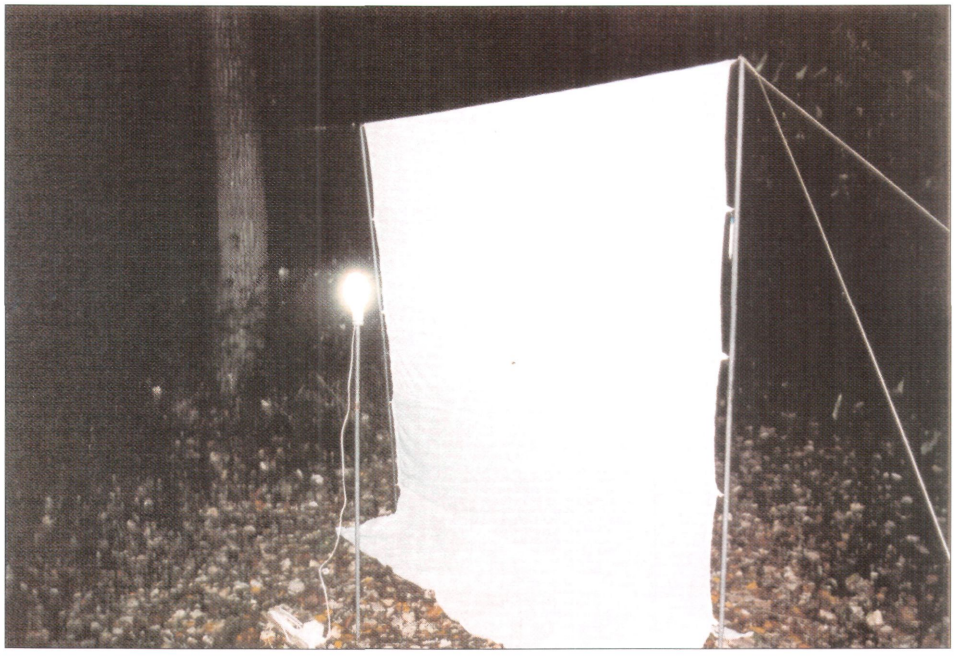

Fig. 4.: Equipment of the night collections at Vízvár (2004)
4. ábra: Az éjjeli gyűjtések felszerelése Vízvárnál (2004)

Fig. 5.: Darány, Nagyberek – forest fen (1992)
5. ábra: Darány, Nagyberek – erdei láp (1992)

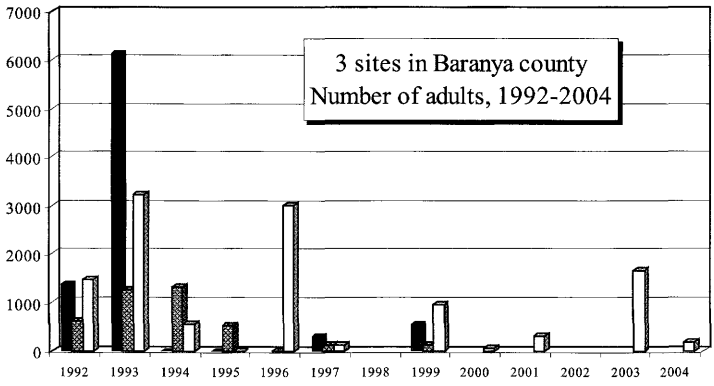

Fig. 6.: The number of caddisflies of some important collecting sites in the Dráva region, 1992-2004 (Drávapalkonya: black, Vejti: grey and Drávasztára: white columns)
6. ábra: A tegzesek egyedszáma a Dráva mente néhány jelentékenyebb gyűjtőhelyén, 1992-2004 (Drávapalkonya: fekete, Vejti: szürke és Drávasztára: fehér oszlopok)

Results

Above all the series of data of Vízvár are evaluated. However, we also have to remark that this series of data is not uniform (see the previous chapter). Mostly the results of the years 1992, 1994 and 1998 were not satisfactory. Taking these facts into consideration we may ascertain as it follows:

One of the most frequent species of these samples is *Hydropsyche contubernalis* McL. It is a widely distributed species all over the country, mostly along larger rivers. It is on wing from May throughout the summer and early autumn months, without characteristic maximum in its activity. At this site, Vízvár, the ratio of *H. contubernalis* is relatively even, only one peak can be observed in the yearly activity (Fig. 7). All the *Hydropsyche* adults – containing all species of genus and also the indetermined females – show a similar run (Fig. 8).

Hydroptila sparsa Curt. and *Psychomyia pusilla* F. are also permanent and frequent member of caddisfly community of the river, and they are also frequent in all larger rivers, mostly in quicker, upper sections (Fig. 9). The activity of *H. sparsa* was on a low level in 1999–2000, but later it became more frequent again. *P. pusilla*, as the most dominant species of the community, has permanent high ratio among the caddisflies (Fig. 10). We cannot show their dominance in the years, when the collected material was unsatisfactory.

The run of two leptocerids, *Ceraclea dissmilis* Steph. and *Setodes punctatus* F. are a little bit uneven. Although both species are frequent along larger and smaller rivers, and also along other types of waters, their hatching is not permanent but jerky. In very advantageous meteorological situation enormous mass of adults can hatch, thus these "peaks of activity" can disfigure the yearly activity (Figs. 11, 12).

The third discussed leptocerid, *Oecetis notata* Ramb. (Fig. 13) shows a higher activity in the years 2001-2004. Indeed, this species was not frequent here earlier, but it was not only frequent but sometimes dominant along the lower section of Dráva in the early nineties, at Drávapalkonya and Drávasztára.

Table 1.: Yearly quantitative data of each species at site Vízvár, 1992-2004.
1. táblázat: Az egyes fajok éves mennyiségi adatai Vízvárnál, 1992-2004.

Species		1992	%	1993	%	1994	%	1995	%	1996	%	1997	%
Adicella syriaca	1		0,00		0,00		0,00		0,00		0,00		0,00
Agraylea sexmaculata	2		0,00		0,00		0,00		0,00		0,00		0,00
Agrypnia varia	3		0,00	3	0,08		0,00		0,00		0,00		0,00
Anabolia furcata	4		0,00		0,00	5	38,46		0,00	21	6,10	216	69,23
Athripsodes aterrimus	5		0,00		0,00		0,00		0,00		0,00	1	0,32
Athripsodes cinereus	6		0,00		0,00		0,00		0,00		0,00		0,00
Brachycentrus subnubilus	7		0,00	1	0,03		0,00		0,00	23	6,69	21	6,73
Ceraclea alboguttata	8		0,00	6	0,15		0,00		0,00		0,00		0,00
Ceraclea annulicornis	9		0,00	1	0,03		0,00		0,00		0,00	1	0,32
Ceraclea dissimilis	10		0,00	30	0,75		0,00	6	4,00	47	13,66		0,00
Chaetopteryx fusca	11		0,00		0,00		0,00		0,00		0,00		0,00
Cyrnus crenaticornis	12		0,00	1	0,03		0,00		0,00		0,00		0,00
Cyrnus trimaculatus	13		0,00	7	0,18		0,00		0,00		0,00	1	0,32
Ecnomus tenellus	14		0,00	6	0,15		0,00	6	4,00	4	1,16		0,00
Glyphotaelius pellucidus	15		0,00		0,00		0,00	1	0,67		0,00		0,00
Goera pilosa	16	2	8,70	35	0,88		0,00		0,00	2	0,58	2	0,64
Grammotaulius nigropunctatus	17		0,00		0,00	1	7,69		0,00		0,00		0,00
Halesus tesselatus	18		0,00		0,00	3	23,08		0,00	7	2,03	19	6,09
Holocentropus dubius	19		0,00		0,00		0,00		0,00		0,00		0,00
Hydropsyche angustipennis	20		0,00	1	0,03		0,00		0,00		0,00		0,00
Hydropsyche bulbifera	21		0,00	2	0,05		0,00		0,00		0,00		0,00
Hydropsyche bulgaromanorum	22	2	8,70	118	2,96		0,00	5	3,33	15	4,36	1	0,32
Hydropsyche contubernalis	23		0,00	153	3,84		0,00		0,00	17	4,94	11	3,53
Hydropsyche modesta	24		0,00		0,00		0,00		0,00		0,00	1	0,32
Hydropsyche ornatula	25		0,00	7	0,18		0,00		0,00	3	0,87		0,00
Hydropsyche pellucidula	26		0,00	1	0,03		0,00	1	0,67		0,00		0,00
Hydropsyche siltalai	27		0,00		0,00		0,00		0,00		0,00		0,00
Hydropsyche sp. indet.	28	4	17,39	172	4,32		0,00	34	22,67	160	46,51	4	1,28
Hydroptila angustata	29		0,00		0,00		0,00		0,00		0,00		0,00
Hydroptila lotensis	30		0,00		0,00		0,00		0,00		0,00		0,00
Hydroptila sparsa	31		0,00	667	16,76		0,00	14	9,33	7	2,03	7	2,24
Leptocerus tineiformis	32		0,00		0,00		0,00		0,00		0,00		0,00
Limnephilus affinis	33		0,00	1	0,03		0,00		0,00		0,00		0,00
Limnephilus auricula	34		0,00		0,00	2	15,38		0,00		0,00	2	0,64
Limnephilus bipunctatus	35		0,00		0,00	1	7,69		0,00		0,00		0,00
Limnephilus flavicornis	36		0,00		0,00		0,00		0,00		0,00		0,00
Limnephilus griseus	37		0,00		0,00	1	7,69		0,00	1	0,29		0,00
Limnephilus lunatus	38		0,00		0,00		0,00		0,00	1	0,29		0,00
Limnephilus vittatus	39		0,00		0,00		0,00		0,00		0,00	1	0,32
Lype phaeopa	40	6	26,09	5	0,13		0,00	4	2,67		0,00	4	1,28
Mystacides azurea	41		0,00		0,00		0,00		0,00		0,00		0,00
Neureclipsis bimaculata	42	9	39,13	74	1,86		0,00	2	1,33	1	0,29	1	0,32
Oecetis furva	43		0,00		0,00		0,00		0,00		0,00		0,00
Oecetis lacustris	44		0,00		0,00		0,00		0,00	1	0,29		0,00
Oecetis notata	45		0,00	7	0,18		0,00		0,00		0,00		0,00
Oecetis ochracea	46		0,00	6	0,15		0,00		0,00	3	0,87		0,00
Orthotrichia angustella	47		0,00	1	0,03		0,00		0,00		0,00		0,00
Orthotrichia costalis	48		0,00		0,00		0,00		0,00		0,00		0,00
Orthotrichia tragetti	49		0,00	2	0,05		0,00	2	1,33		0,00		0,00
Oxyethira flavicornis	50		0,00		0,00		0,00		0,00		0,00	1	0,32
Phryganea grandis	51		0,00		0,00		0,00		0,00		0,00		0,00
Platyphylax frauenfeldi	52		0,00		0,00		0,00		0,00	9	2,62	3	0,96
Potamophylax rotundipennis	53		0,00		0,00		0,00		0,00		0,00	3	0,96
Psychomyia pusilla	54		0,00	2598	65,28		0,00	74	49,33	19	5,52	5	1,60
Rhyacophila dorsalis	55		0,00		0,00		0,00		0,00		0,00	6	1,92
Setodes punctatus	56		0,00	75	1,88		0,00		0,00	2	0,58	1	0,32
Silo nigricornis	57		0,00		0,00		0,00		0,00		0,00		0,00
Silo piceus	58		0,00		0,00		0,00		0,00		0,00		0,00
Stenophylax permistus	59		0,00		0,00		0,00	1	0,67	1	0,29		0,00
Triaenodes bicolor	60		0,00		0,00		0,00		0,00		0,00		0,00

Table 1.: Yearly quantitative data of each species at site Vízvár, 1992-2004.
1. táblázat: Az egyes fajok éves mennyiségi adatai Vízvárnál, 1992-2004.

	1998	%	1999	%	2000	%	2001	%	2002	%	2003	%	2004	%	össz.	%
1		0,00	2	0,28	4	0,34	121	2,00	31	0,85	2	0,06	81	8,68	241	1,17
2		0,00		0,00		0,00	3	0,05	2	0,05	1	0,03		0,00	6	0,03
3		0,00		0,00		0,00		0,00		0,00		0,00		0,00	3	0,01
4	26	86,67	210	28,93	38	3,21	10	0,17	4	0,11	9	0,27	122	13,08	661	3,20
5		0,00		0,00		0,00		0,00		0,00		0,00		0,00	1	0,00
6		0,00	1	0,14		0,00		0,00	2	0,05	1	0,03		0,00	4	0,02
7		0,00		0,00	3	0,25	67	1,11	3	0,08	10	0,30	10	1,07	138	0,67
8		0,00	1	0,14		0,00	9	0,15	4	0,11	6	0,18	2	0,21	28	0,14
9		0,00	1	0,14	6	0,51	1	0,02	2	0,05		0,00		0,00	12	0,06
10		0,00	39	5,37	6	0,51	155	2,57	71	1,95	66	2,00	3	0,32	423	2,05
11		0,00		0,00	1	0,08		0,00		0,00		0,00		0,00	1	0,00
12		0,00		0,00		0,00	1	0,02	6	0,16	2	0,06		0,00	10	0,05
13		0,00		0,00		0,00	2	0,03	2	0,05		0,00	2	0,21	14	0,07
14		0,00	7	0,96	4	0,34	22	0,36	49	1,34	14	0,43	4	0,43	116	0,56
15		0,00	1	0,14	1	0,08	13	0,22		0,00	1	0,03	4	0,43	21	0,10
16		0,00	15	2,07	29	2,45	183	3,03	114	3,13	52	1,58	26	2,79	460	2,22
17		0,00		0,00		0,00	3	0,05		0,00		0,00		0,00	4	0,02
18		0,00	8	1,10	100	8,44	16	0,26	1	0,03		0,00	4	0,43	158	0,76
19		0,00		0,00	1	0,08	2	0,03	1	0,03		0,00		0,00	4	0,02
20		0,00	2	0,28	4	0,34	1	0,02		0,00		0,00		0,00	8	0,04
21		0,00	30	4,13		0,00		0,00		0,00		0,00		0,00	32	0,15
22		0,00	6	0,83	4	0,34	22	0,36	8	0,22	4	0,12	3	0,32	188	0,91
23		0,00	128	17,63	419	35,36	702	11,62	262	7,19	554	16,82	148	15,86	2394	11,58
24		0,00	3	0,41	9	0,76	6	0,10	3	0,08	11	0,33		0,00	33	0,16
25		0,00	20	2,75		0,00	108	1,79	18	0,49	2	0,06		0,00	158	0,76
26	1	3,33	14	1,93	37	3,12	102	1,69	57	1,56	143	4,34	17	1,82	373	1,80
27		0,00		0,00		0,00	1	0,02		0,00		0,00		0,00	1	0,00
28		0,00	158	21,76	205	17,30	604	10,00	533	14,62	232	7,05	195	20,90	2301	11,13
29		0,00		0,00		0,00	1	0,02	6	0,16	2	0,06	1	0,11	10	0,05
30		0,00		0,00	1	0,08		0,00		0,00	9	0,27	3	0,32	13	0,06
31	1	3,33	2	0,28	3	0,25	274	4,54	160	4,39	42	1,28	35	3,75	1212	5,86
32		0,00		0,00		0,00	19	0,31	11	0,30	1	0,03		0,00	31	0,15
33		0,00		0,00	5	0,42	3	0,05		0,00		0,00	1	0,11	10	0,05
34	1	3,33		0,00		0,00	14	0,23		0,00	1	0,03		0,00	20	0,10
35		0,00		0,00		0,00		0,00		0,00		0,00		0,00	1	0,00
36		0,00		0,00	1	0,08	4	0,07	1	0,03		0,00	1	0,11	7	0,03
37		0,00		0,00	1	0,08	2	0,03		0,00		0,00		0,00	5	0,02
38		0,00		0,00		0,00	2	0,03		0,00		0,00	6	0,64	9	0,04
39		0,00		0,00		0,00	2	0,03		0,00		0,00		0,00	3	0,01
40		0,00	6	0,83	3	0,25	19	0,31	21	0,58	2	0,06	6	0,64	76	0,37
41		0,00		0,00		0,00	2	0,03	1	0,03	1	0,03		0,00	4	0,02
42		0,00	2	0,28	1	0,08	5	0,08	16	0,44	6	0,18	3	0,32	120	0,58
43		0,00		0,00		0,00		0,00		0,00	1	0,03		0,00	1	0,00
44		0,00	3	0,41		0,00	11	0,18	4	0,11	6	0,18		0,00	25	0,12
45		0,00		0,00		0,00	104	1,72	43	1,18	169	5,13	7	0,75	330	1,60
46		0,00	2	0,28		0,00	2	0,03	6	0,16	9	0,27	1	0,11	29	0,14
47		0,00		0,00		0,00		0,00		0,00	3	0,09		0,00	4	0,02
48		0,00		0,00		0,00	2	0,03	5	0,14	5	0,15		0,00	12	0,06
49		0,00		0,00	2	0,17	4	0,07	18	0,49	11	0,33		0,00	39	0,19
50		0,00		0,00	1	0,08	7	0,12	9	0,25		0,00	1	0,11	19	0,09
51		0,00	1	0,14		0,00	2	0,03	1	0,03		0,00		0,00	4	0,02
52		0,00	2	0,28	4	0,34	1	0,02		0,00		0,00		0,00	19	0,09
53	1	3,33	2	0,28	10	0,84	6	0,10	1	0,03	4	0,12	9	0,96	36	0,17
54		0,00	39	5,37	241	20,34	3123	51,70	1851	50,78	1794	54,48	202	21,65	9946	48,11
55		0,00		0,00	24	2,03	4	0,07		0,00		0,00		0,00	34	0,16
56		0,00		0,00		0,00	150	2,48	304	8,34	49	1,49	2	0,21	583	2,82
57		0,00		0,00	1	0,08		0,00		0,00		0,00		0,00	1	0,00
58		0,00	11	1,52	16	1,35	110	1,82	12	0,33	67	2,03	30	3,22	246	1,19
59		0,00		0,00		0,00		0,00		0,00		0,00		0,00	2	0,01
60		0,00		0,00		0,00	2	0,03		0,00	1	0,03	1	0,11	4	0,02
61		0,00	10	1,38		0,00	12	0,20	2	0,05		0,00	3	0,32	27	0,13
	30	100,00	726	100,00	1185	100,00	6041	100,00	3645	100,00	3293	100,00	933	100,00	20675	100,00

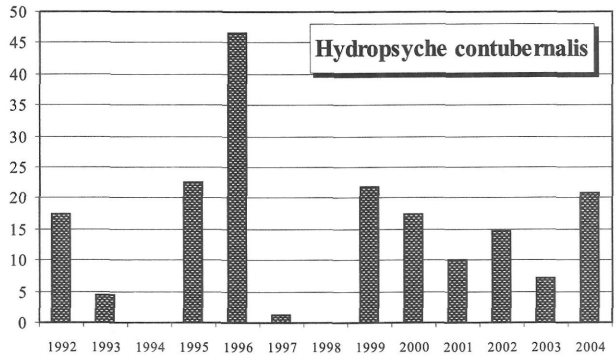

Fig. 7.: Activity of *Hydropsyche contubernalis* McL. at Vízvár, 1992-2004.
7. ábra: A *Hydropsyche contubernalis* McL. aktivitása Vízvárnál, 1992-2004.

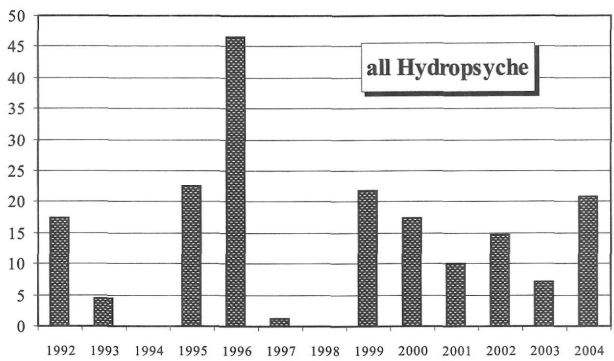

Fig. 8.: Activity of all *Hydropsyche* at Vízvár, 1992-2004.
8. ábra: Az összes *Hydropsyche* együttes aktivitása Vízvárnál, 1992-2004.

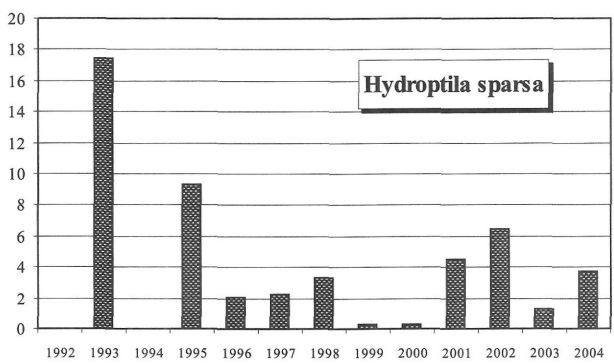

Fig. 9.: Activity of *Hydroptila sparsa* Curt. at Vízvár, 1992-2004.
9. ábra: A *Hydroptila sparsa* Curt. aktivitása Vízvárnál, 1992-2004.

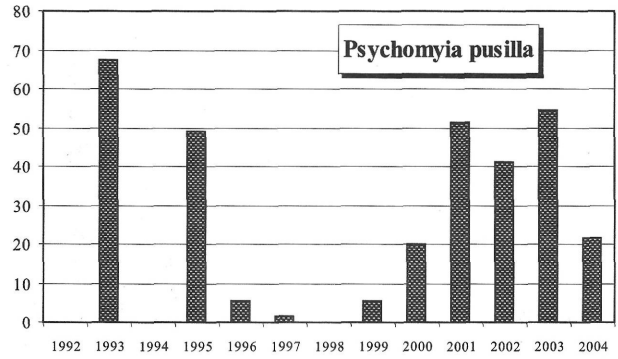

Fig. 10.: Activity of *Psychomyia pusilla* F. at Vízvár, 1992-2004.
10. ábra: A *Psychomyia pusilla* F. aktivitása Vízvárnál, 1992-2004.

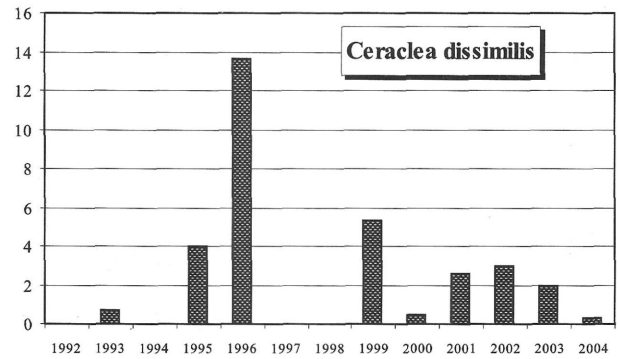

Fig. 11.: Activity of *Ceraclea dissimilis* Steph. at Vízvár, 1992-2004.
11. ábra: A *Ceraclea dissimilis* Steph. aktivitása Vízvárnál, 1992-2004.

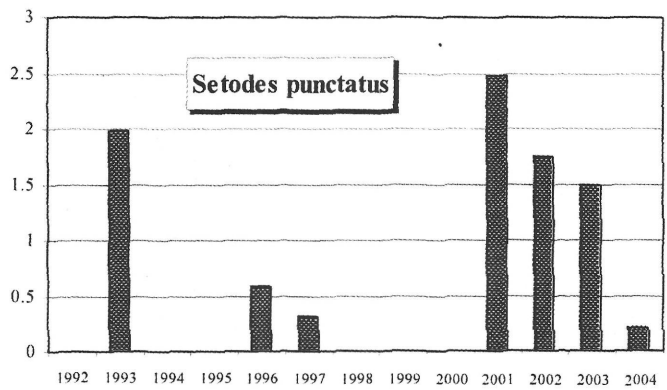

Fig. 12.: Activity of *Setodes punctatus* F. at Vízvár, 1992-2004.
12. ábra: A *Setodes punctatus* F. aktivitása Vízvárnál, 1992-2004.

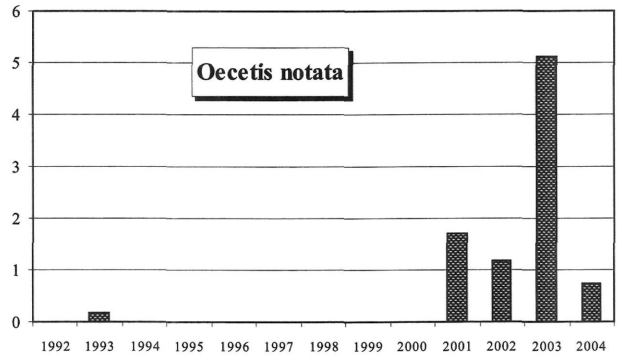

Fig. 13.: Activity of *Oecetis notata* Ramb. at Vízvár, 1992-2004.
13. ábra: Az *Oecetis notata* Ramb. aktivitása Vízvárnál, 1992-2004.

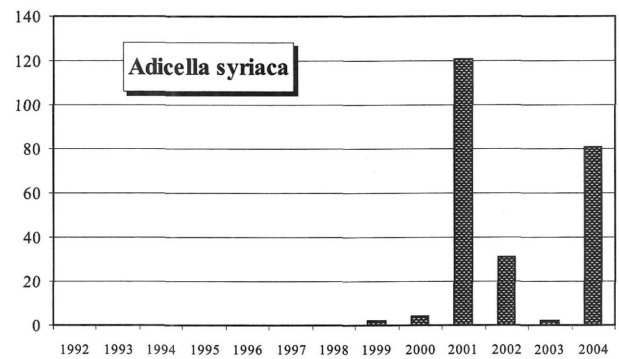

Fig. 14.: Activity of *Adicella syriaca* Ulmer at Vízvár, 1992-2004.
14. ábra: Az *Adicella syriaca* Ulmer aktivitása Vízvárnál, 1992-2004.

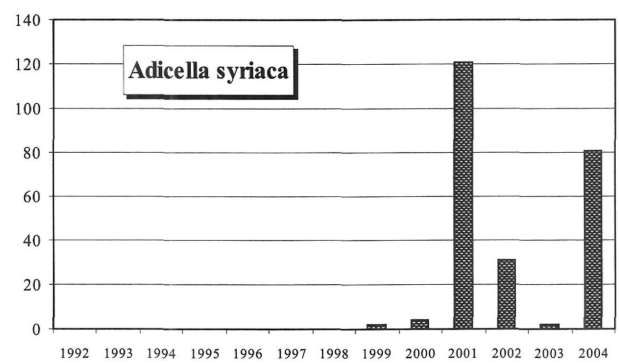

Fig. 15.: Activity of *Silo piceus* Brau. at Vízvár, 1992-2004.
15. ábra: A *Silo piceus* Brau. aktivitása Vízvárnál, 1992-2004.

There are a few species which became more frequent at Vízvár and along other sections of the river only in the last years. Both *Adicella syriaca* Ulmer (Fig. 14) and *Silo piceus* Brau. (Fig. 15) were unknown or very rare in the nineties. In 1999 they appeared and soon they became permanent and not rare members of community.

Although the quantity of collected material was considerable during some years at Drávapalkonya and Vejti, the collecting period was too short there, therefore changes were not shown clearly. At Drávasztára we sampled through years, but the collections of some years were not satisfactory. During the first half of nineties the quantity of *Oecetis notata* Ramb. was outstanding, later it became less frequent.

The other species discussed also in the previous sentences show similar run of activity, with few regularity.

The most valuable species of the Dráva river is the strictly protected *Platyphylax frauenfeldi* Brau., which has a stable population between Szentborbás and Őrtilos. Taking all data from this region into consideration we are presenting its activity, i.e. the graph of its all collected specimens. It seems that there were some outstanding years in the frequency: 1989 (when the light trap functioned at Szentborbás), 1992 and 1992 (light trap at Őrtilos), 1996 (a very advantageous year for night collections) and 2000 (rather lucky meteorological situation in 30th and 31st October at Vízvár and Őrtilos, when 46 specimens were collected on light). We also visited the sites in 1998 and in 1999, but no adults were caught, and the number of adults we only few in the years 2001-2004 (Fig. 16). This graph also shows that the circumstances influence the catch essentially.

We also try to show the activity of two other characteristic species, on the basis of all data of Drava region, from the year 1982. *Trichostegia minor* Curt. is a characteristic species of the region. It lives in forest fens mostly, and it is on wing from May until September, interrupted by a short summer diapause. Although it is not a rarity, we cannot collect its adults every year. *Limnephilus stigma* Curt. has a similar ecological character, but it is a very rare species. The first Hungarian specimens were collected only in 1995 (Jósvafő), first specimens were taken in 1996 along Dráva region (NÓGRÁDI 1998). We visited its site (Gyékényes) several times during last years, but it was collected only in few cases, most specimens in 2004 (Fig. 17).

Besides these four mentioned species we can sketch the graph of other species, as well. They do not show any regularity. We cannot settle whether either the unsatisfactory sampling or the changing circumstances cause the irregularity of graphs.

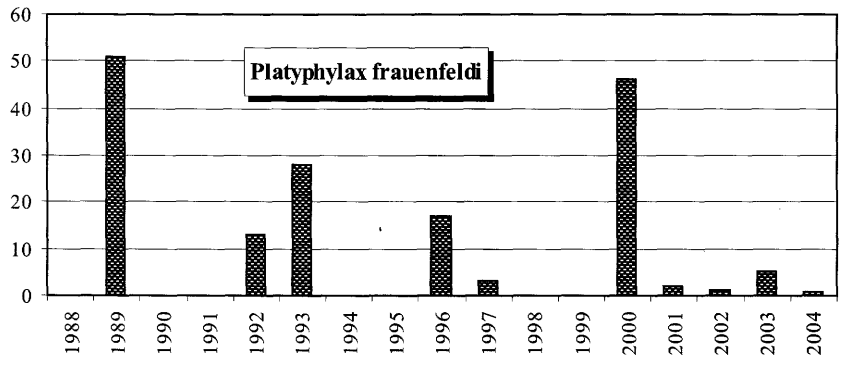

Fig. 16. Activity of *Platyphylax frauenfeldi* Brau. in the Dráva region, 1989-2004.
16. ábra. A drávai tegzes (*Platyphylax frauenfeldi* Brau.) aktivitása a Dráva mentén, 1989-2004.

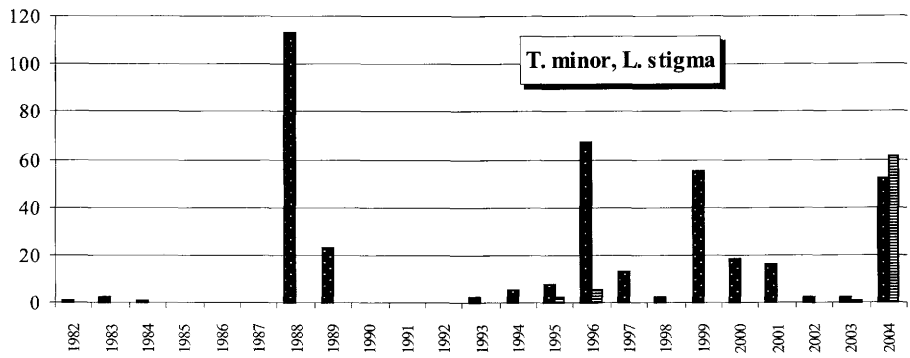

Fig. 17. Activity of *Trichostegia minor* Curt. and *Limnephilus stigma* Curt. in the Dráva region, 1982-2004.
17. ábra. A *Trichostegia minor* Curt. és a *Limnephilus stigma* Curt. aktivitása a Dráva vidékén, 1982-2004.

Conclusions

A middle term (13 years) series of samples is analysed by the activity of some caddisfly species. In the well-known locality of Vízvár some species show permanent and regular activity during the years, while others appeared in the second half of studied period. Activity of some species are also presented by taking into consideration all the data from Dráva region between 1982 and 2004.

As several unforeseenable factors influence the activity, therefore these graphs cannot express the true activity. Permanent light traps functioning through many years can help us to study the changes of activity in its reality.

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Tegzes együttesek középtávú változásai a Dráva magyarországi szakasza mentén, 1992-2004 folyamán

UHERKOVICH ÁKOS és NÓGRÁDI SÁRA

A Dráva magyarországi szakasza mentén 1992 óta rendszeres vizsgálatokat folytattunk. Néhány lelőhelyen évente többször vettünk kvantitatív mintákat tegzesekből. Különösen Vízvárnál voltak eredményesek ezek a gyűjtések, ahol az eltelt 13 évből az utóbbi hatban állandóan mintáztunk, előtte alkalmilag. Ugyancsak sok minta származik a Dráva baranyai szakaszáról is: Drávapalkonya és Vejti mellett a kilencvenes évek elején, Drávasztára mellett pedig 1992 és 2004 között rendszeresen, csaknem minden évben mintáztunk.

Néhány gyakoribb, Vízváron előforduló fajt vizsgálva megállapíthatjuk, hogy egyes fajok állandóan, nagy dominanciával jelen voltak a tegzes együttesekben (pl. *Hydropsyche contubernalis* McL., *Hydroptila sparsa* Curt., *Psychomyia pusilla* F., *Ceraclea dissimilis* Steph., *Setodes punctatus* F.), mások csak az időszak egy részében voltak dominánsak (*Oecetis notata* Ramb.). Két faj csak a vizsgálati időszak második felében, 1999 után jelent meg, de ezután viszonylag gyakorinak mutatkozott (*Adicella syriaca* Ulmer, *Silo piceus* Brau.).

A Dráva egyéb mintavételi helyein hasonló a helyzet, de a rövid adatsorok vagy a csekélyebb számú mintázás miatt az aktivitási diagramok kevésbé értékelhetők.

A Dráva legértékesebb faja, a *Platyphlyax frauenfeldi* Brau. 1989 és 2004 között egyes években nagyobb példányszámban fordult elő (16. ábra). Ennek részben metodikai okai vannak (állandó, telepített fénycsapda működése), illetve 1996-ban és 2000-ben egészen kiváló időjárási körülmények között folytak a gyűjtések, a faj rövid, de erőteljes aktivitását így észlelni tudtuk.

Két másik jellemző faj (*Trichostegia minor* Curt. és *Limnephilus stigma* Curt.) esetén is megfigyelhető, hogy az aktivitás kiszámíthatatlan. Időnként kiugró nagy aktivitást észleltünk (pl. *T. minor*: 1988-89, *L. stigma*: 2004), máskor éveken át nem láthatók ezek a fajok (17. ábra).

A mintavétel körülményei: az időjárási helyzet (hőmérséklet, nedvesség, borultság és mindenekelőtt a fronthelyzet) és a zavaró holdfény (holdfázisok) nagyon változóak, az előbbiek hatásai kiszámíthatatlanok, ezért az egyes mintavételek rendkívül változó eredményt adnak. A belőlük levont következtetések is csak tájékozódásul szolgálnak, az aktivitás valódi mértékét nem fejezik ki hűen. Csak állandó, éveken keresztül működő fénycsapdák anyagának kiértékelésével jutnánk a valóságot megközelítő rajzási adatokhoz.

DOI:10.24394/NatSom.2005.7.63 | Natura Somogyiensis | 7 | 63-73 | Kaposvár, 2005

Biomonitoring of the butterfly fauna in the Drava region (Lepidoptera: Diurna)

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ÁBRAHÁM L.: *Biomonitoring of the butterfly fauna in the Drava region (Lepidoptera: Diurna).*

Abstract: At the beginning of 2000 a biomonitoring research work started along the River Drava in Hungary. The aim of this investigation is to give information on the Hungarian biomonitoring network and up-to-date information on those environmental impacts that will also be spreading to the Drava region of Hungary, if a dam is built at Novo Virje in Croatia. A transect line estimation on the relative populations of *Apatura metis, Lycaena dispar, Maculinea teleius, Maculinea nausithous, Parnassius mnemosyne, Euphydryas maturna* was carried out. In this five-year period the results showed the natural fluctuation and the variability of the surveyed populations.

Key words: Butterfly, Diurna, biomonitoring, River Drava

Introduction

The intensive research of the butterfly fauna in the Drava region started 30 years ago with the complex faunistical and environmental valuation of the Barcs Juniper Woodland Landscape Protection Area. Prior to this research, only random data were available about the Drava region due to its position as a border line area of limited access. The first comprehensive faunistical study of the butterfly fauna of the region was carried out in the course of 'Mecsek and its environs' surveying program (UHERKOVICH 1978).

This extremely valuable fauna revealed by the researches carried out in the Barcs Juniper Woodland Landscape Protection Area played a significant role in the fact that, in 1996, the entire Drava region on the Hungarian side of the river was awarded with a national park status. By this time, the faunisical research of Lepidoptera fauna had been extended to cover the entire length of the River Drava, a 150 km long stretch from Őrtilos to Drávaszabolcs (UHERKOVICH & ÁBRAHÁM 1995). The lepidopterological researches have continued since the establishment of the national park as well, but the new aim of the research was to survey the typical habitats of the region and mainly to provide information for the mamagment plans in preparation (ÁBRAHÁM & UHERKOVICH 1998).

Forming a natural borderline between the two countries, the River Drava runs between Hungary and Croatia. When the Hungarian side of the river came under protection, the idea of establishing a joint national park stretching through both side of the border was raised. But these plans have not yet been implemented as Croatia announced his intentions to build a hydroelectric power station at Novo Virje. The environmental impact caused by the power station will spread across the borders and will certainly bring significant changes to the natural assests of the region.

ISSN 1587-1908 (Print); ISSN 2062-9990 (Online)

Thus in the year of 2000, a new phase of lepidopterolgical investigations commenced on the Hungarian side of the River Drava with a biomonitoring survey that is to decrease the possible environmental impacts of the planned power station. Besides researching the diurnal butterfly fauna, the biomonitoring survey covered the moth fauna as well as other referential groups of insects and vertebrates.

The research work on the butterfly fauna, started in 2000, was designed upon the general ecological concept of population stability. From this point of view, the diurnal butterfly populations, regardless of the natural fluctuation of population, do not show remarkable variability: they can be considered stable. The construction and operation of the planned hydroelectric power station will cause a disturbance in the wetlands alongside the River Drava and consequently induce changes in the size of the examined populations. After a resilient period, the populations will establish a steady fluctuation of an average population size at a certain resilience level.

The main aim of the biomonitoring researches is to keep track of the changes of the Lepidoptera fauna and, at the same time, to provide information that helps to mitigate the negative effects of the oncoming environmental damages.

Material and method

In the course of the butterfly fauna research, the to-be-monitored species were specified in accordance with the recommendation of the Hungarian National Biomonitoring System (NBmR). The monitored species were chosen so as they represent different habitats along the River Drava (along a hydroecological gradient) and also sensitive to environmental changes. (Fig. 1.)

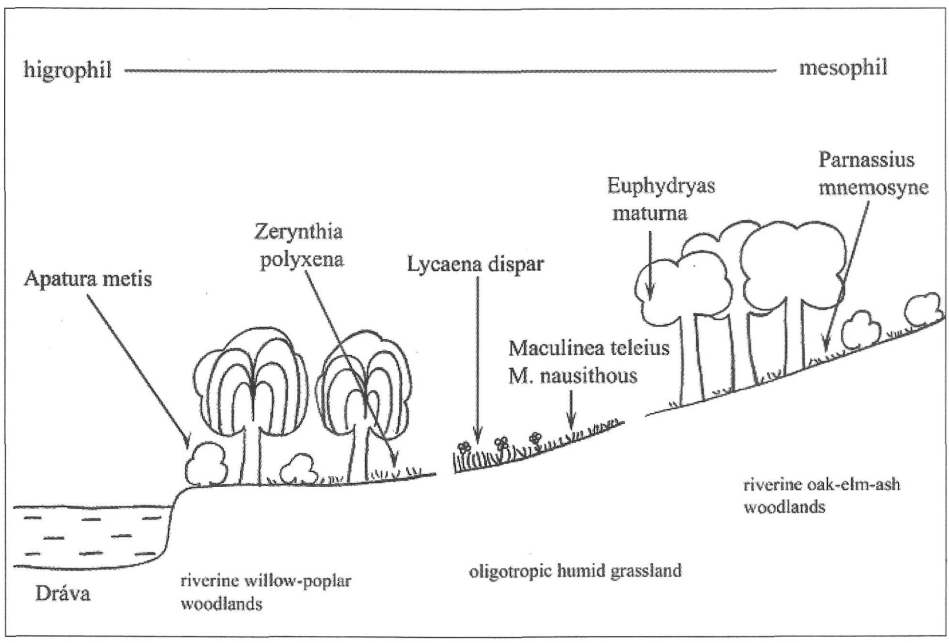

Fig. 1.: The investigated species in the different habitats

Apatura metis is a highly hygrophilous species. The size of the relative population was investigated in the soft-wood open woodlands of the riverbank near Bélavár, Vízvár, Babócsa és Őrtilos.

The species of *Lycaena dispar, Maculinea teleius, Maculinea nausithous* are less hygrophilous. These populations were measured on wetlands and oligotrophic humid grasslands near Babócsa and Gyékényes.

The species of *Euphydryas maturna* is tightly associated with the edges of hardwood forests. In 2001, its populations were found in the Palina forest, near Bélavár, and in the Lankóci forest, near Gyékényes.

Although *Parnassius mnemosyne* is considered to be a mesophilous type, its populations were researched near Péterhida and Bélavár on similar type of habitats.

The investigation of *Zerythia polyxena* would not fit into this hydro ecological gradient line, but it has environmental protection significance to keep track of this potentially endangered monophag population.

A transect line estimation on the relative populations of certain species was carried out mainly in accordance with the methods recommended by NBmR (RONKAY 1997).

Table 1.: Parametres of the transect line method applied in the fieldwork

species	number of transect/site	long x wide of transect	controll time/transect	number of sampling days/year
A. metis	6	100x20 m	20 min	9+7
P. mnemosyne	3	100x20 m	20 min	6
E. maturna	6	100x20 m	20 min	6
M. teleius	9	50x10 m	20 min	9
M. nausithous	9	50x10 m	20 min	9

In the case of *Zerythia polyxena*, we carried out a caterpillar count. Regarding the collecting sites, this method gives an absolute population estimate as each induvidual was counted on certain sampling occasions.

The investigations were carried out at different collecting sites from April to mid September on a yearly basis.

Results

During the course of the biomonitoring survey a transect line estimation on butterflies was carried out. The relative population sizes were analyzed per species with regard to the years of research.

Apatura metis

The figures of five research years show similar time trends (Fig. 2-3) at the four collecting sites alongside the entire length of the river. The figures show the highest relative size of population of the investigated species in the first year of the research, in 2000. This figure dropped to a half/third in 2002, while later showed a minor increase in 2003 (in comparison with the two previous years). In 2004, the size of the first generation population almost reached the relative population size we got in the first year of the research.

The time trend can be seen especially clearly in the first generation where the transect line number of individuals is always higher than in the second generation. Similar trends can be detected in the case of the second generation at all of the three collecting sites

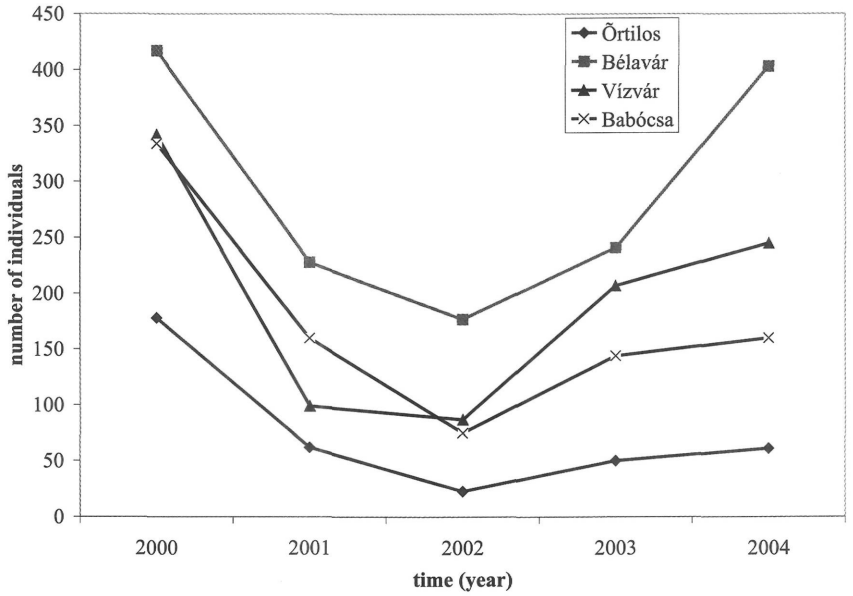

Fig. 2.: The time trends of *Apatura metis* 1st generation population at the permanent sampling sites

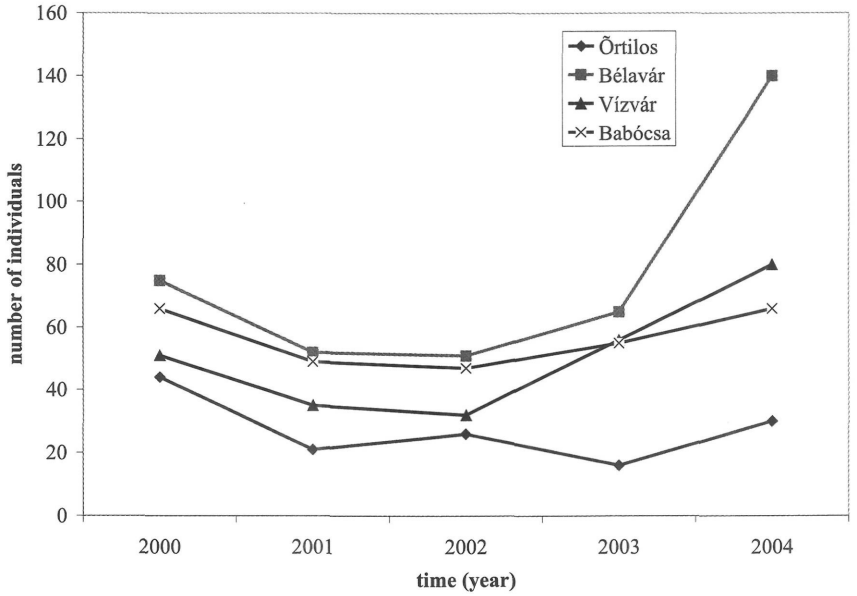

Fig. 3.: The time trends of *Apatura metis* 2nd generation population at the permanent sampling sites.

(Bélavár, Vízvár, Babócsa), while the population trend is less likely to follow this tendency near Őrtilos. This deviance might be explained by the small size of the researched population, as even minor changes in the small number of counted specimen - which can just as well be caused by the current local weather conditions - can appear as bigger scale changes on the timeline trend diagram.

Maculinea teleius and *Maculinea nausithous*

The monitoring of species on the field near Lankóci forests (Gyékényes) has been ongoing for four years continuously. The research work shows different tendencies in the relative population changes of the two investigated species (Fig. 4.). *Maculinea teleius* population reached its biggest size in 2001, and showed roughly the same size in 2002 and in 2003. The year 2004 brought a slight decrease in comparison to the previous years.

Maculinea nausithous population near Gyékényes has shown hardly any considerable change in size during the four years of research (Fig. 4.). This species tends to occur on the shady, half shady edges on the sampling sites. However, during the nectar feeding period, the imagoes can be encountered in any transects.

Lycaena dispar

In the case of this species, during the biomonitoring program, only presence-absence data was collected along the River Drava. In the course of the fieldwork, the sampling sites were located by GPS equipment. Among the recorded data only the data related to the first generation is significant from environmental point of view. The specimens from the second generation live a migrating lifestyle and therefore they tend to occur far from their actual habitat. This kind of data cannot be used to determine the trends but in the

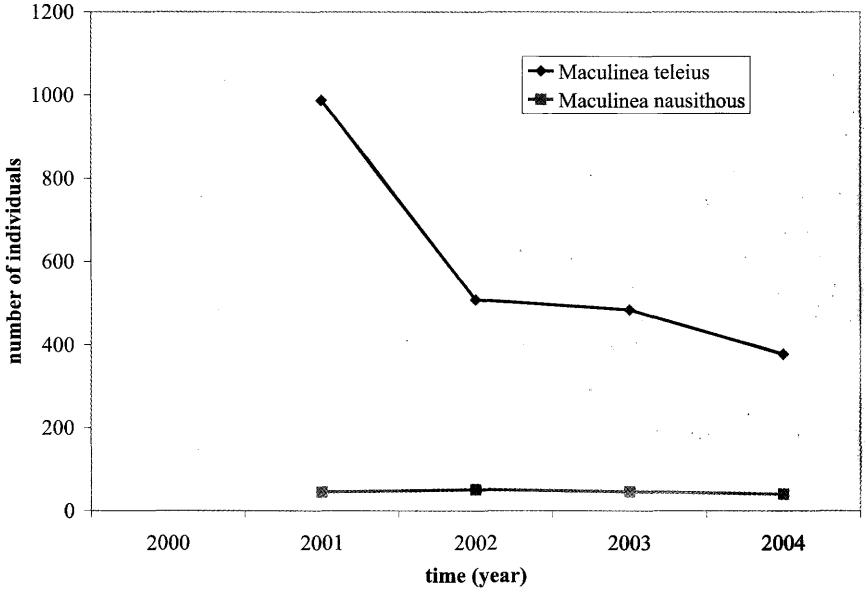

Fig. 4.: The time trends of *Maculinea teleius* and *Maculinea nausithous* population at the permanent sampling sites.

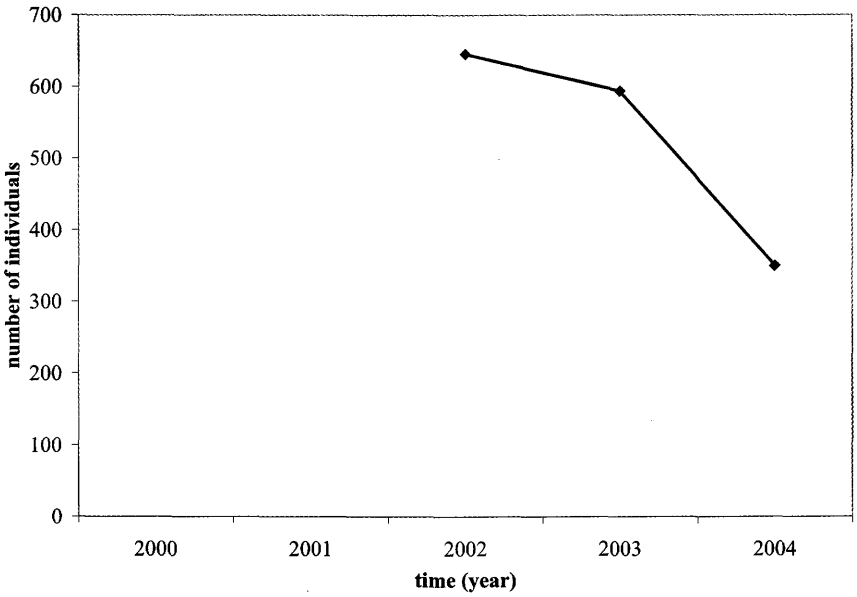

Fig. 5.: The time trends of *Euphidryas maturna* population in Lankoci forest in the permanent sampling sites

long run these figures might make the environmental changes detectable. The main changes in their habitats can be deducted from them.

Euphydryas maturna

In the first year of the investigation, in 2002, the species could be found in large number in the area (Fig. 5). By this time Its caterpillars had gorged on the leaves of *Fraxinus excelsior* creating bare patches in the canopy. Later on, the size of the population seemed to decrease. Since early exact numerical data is not available, it is impossible to state precisely whether we are facing a possible graduation phenomenon or not.

In the following years, similar phenomenon did not occur according to my experience since the population size was reduced to an average level.

In the following years during my fieldwork, the above described mass occurrence was not experienced and the population size reduced back to an average level. The time trends in population changes can be precisely described after investigation in years to come.

Parnassius mnemosyne

According to the results of the investigation, the population sampled in Bélavár is gradually reducing year by year (Fig. 6). This size change was so dramatic on the sampling sites during the biomonitoring, that in 2004 the relative population was only 10% of the relative population in year 2000.

The relative population size of the investigated species near Péterhida was smaller than in Bélavar during the early years of the research work but it showed a gradual increase in the years of 2003 and 2004.

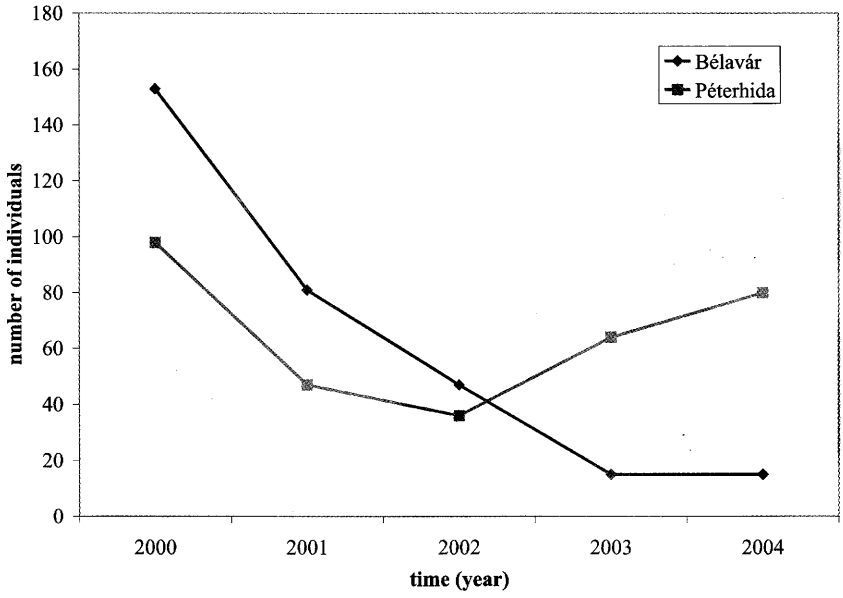

Fig. 6.: The time trends of *Parnassius mnemosyne* population in the permanent sampling sites

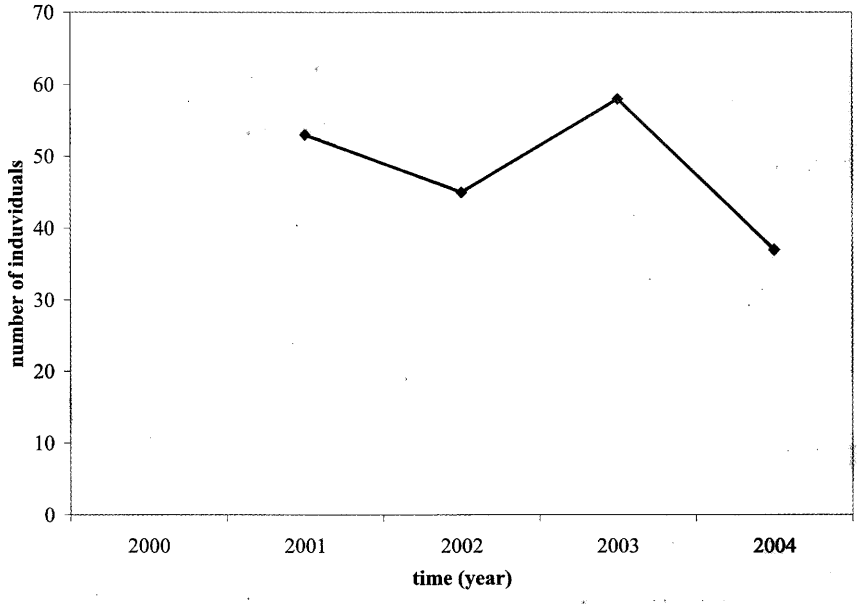

Fig. 7.: The time trends of *Zerynthia polyxena* population in the permanent sampling sites

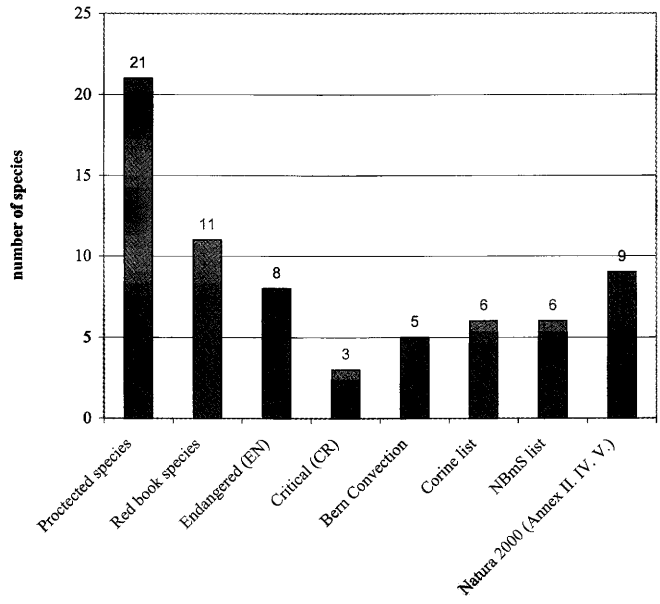

Fig. 8: Number of the protected and endangered species in the Drava region

Zerynthia polyxena

The time trend of this species during the four year of the investigation reflects a relative stability (Fig. 7.). However, the caterpillar population examined was small therefore any changes in the environment implies danger to its stability (ei. get dry).

Because of the construction of the dam, the butterfly fauna of the examined area is highly at risk. Numerous species can be found in the region that are classified as endangered species even in the European Union (Fig. 8). In order to evaluate the results of the teamwork investigation on the butterfly species of the area, at least a decade of collecting work is necessary.

It would require at least a decade of research to give a comprehensive evaluation of the international/community level survey results that has been carried out to investigate the species of butterfly fauna of the region.

Discussion

The biomonitoring research work on the butterflies at the River Drava has surveyed the specific, endangered species of this fauna based on a hydro-ecological gradient.

The distribution of *Apatura metis* population along the River Drava is not even: the highest number of the population lives in the Palinai forests at Bélavár. The first generation is larger in number than the second generation. The variability is significant comparing the results of the sampling from year to year; the stronger the population the less the variability is.

The significance of biomonitoring of this species along the River Drava is indisputable since the construction plans of the dam will presumably put this butterfly species at risk the most. Bélavár, the habitat of the biggest population of this species is the most endangered area where the forming of a new riverbed could cause the end of soft wood. The construction of the dam could also result in low level ground water, in changes of the seasonal water current, and in reducing water supply of the backwater through the pebbles etc, which will all have an effect on the size of the population.

The artificially maintained constantly high water level could disturb the feeding, sucking and mating habits of the butterflies which are used to gathering on the sandy river banks during low water level.

The investigation proved that *Maculinea teleius* has a large population living on the oligitrophic humid grasslands surrounding the Lankóci forests. According to the data from sampling, it is highly presumable that 2001 was a remarkably successful year for *Maculinea teleius* therefore the relative population doubled compared to the following years. I have experienced similar phenomenon before in other habitats, but long sequence data of biomonitoring are not available for this species (CZIGÁNY and ÁBRAHÁM 2000, MacMan project). The biomonitoring process of this species started in 2003 and it was conducted in accordance with the NBmR standards, therefore the local and countrywide tendencies will be comparable only in the future.

The population of *Maculiea nausithous* is considerably smaller therefore this species is endangered to a greater extent. The growth of the population could probably be stimulated by the extension of forests fringes i.e. the appearance of willow bush and alder tree groups.

The survey of *Lycaena dispar* along the River Drava is very likely not suitable to demonstrate the effects caused by the construction of the dam on the environment since this species is absent in patches and lives a migrant lifestyle.

The relative fluctuation of *Euphydryas maturna* population could be estimated after evaluating the results of the investigation in the following years. The population of this species in Hungary can be found in the southwest of the Euro-Siberian distribution area. The population being satellite population has gone through an isolation process and taxonomical separation can be observed (VARGA & SÁNTHA 1972-73). In the region of the Transdanubian Hills and along the River Drava, a subspecies, *Euphydryas maturna idunides* (Fruhstorfer, 1917) which is typical of wet forests (hard wood and riverine woodlands) can be found. This species would become more endangered if the dam is to be constructed. Several observations suggest that the population of the species tends to be fluctuating country wide.

The size of *Parnasius mnemosyne* population is fluctuating in time and space as well. The dynamic changes of the population are due to the natural successions but also influenced by different farming activities for example clear cutting. In the sampling area around Bélavár, where the host plant of this species grows in the underwood of beech forest patches, after partial clear cutting, a succession process started and resulted in decrease of a 10 year-old young population. The other cause of the reducing population lies in degradation which, on the sampling site, manifests itself in the extensive growth of *Robinia pseudo-acacia* and *Ailanthus altissima* trees covered land.

However, in order to evaluate the position of the species from the environmental point of view, the situation shows negative tendencies only in the permanent sampling sites. But 1-1.5 km south of the sampling area I have discovered a population of the species which settled in the region at the turn of the millennium and seems to have been growing continuously since then. I have not encountered a similar phenomenon since my

investigations started in 1992. These observations prove that population of this species is moving in space as well, therefore surveys on permanent sampling sites do not always reflect the metapopulation movement of the species.

Changes caused by succession can also be observed around Péterhida but the process here is much shorter in time. The size of the population investigated is fluctuating and definite tendencies in time cannot be described.

Due to the reproduction strategy of its host plant (a weed), *Zerynthia polyxena* always finds new habitats along the River Drava, however, its ability to compete is not too good so it will disappear from its original habitats in a couple of years. The fluctuation of its host plant in time and in space brings along the dynamism of its butterfly population. The dynamic permanency of the population and metapopulation of *Zerynthia polyxena* along big rivers goes along with the constant disturbance such as the regular flooding in the case of the Drava, which always gives new opportunities to the pioneer plantation species to settle down. This disturbing effect would not occur after the construction of the dam, which would result in the higher endangerment of this species.

The population in the Palinai forests at Bélavár is small but seems to be stable according to the investigation of the last couple of years. However the degradation of the habitat can also be observed here. The biggest danger is the aggressively spreading *Solidago*.

Acknowledgement

The author wishes to express his sincere thank to Duna-Dráva National Park Directorate, Dr. Ildikó Iványi, Mr. Szabolcs Závoczky and Mr. Tibor Parrag so that they supported the monitoring activities and to Mr. Mihály Orsik, Mr. Ottó Paizs, Mrs. Ildikó Csákányi, Mr. György Kovács, Mr. Gergely Szabó for their help in the fieldwork activities.

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Nappali lepkék biomonitoring vizsgálata a Dráva mentén (Lepidoptera: Diurna)

ÁBRAHÁM LEVENTE

A Dráva mentén a nappali lepkék faunisztikai vizsgálata immár 25 éves múltra tekint vissza. A kutatás a Barcsi Borókás Tájvédelmi Körzet alapfauna feltárásával kezdődött (UHERKOVICH 1978), majd a Duna-Dráva Nemzeti Park előkészítésével és megalapításával (1994) a Dráva menti terület egész szakaszára kiterjedt (ÁBRAHÁM & UHERKOVICH 1998; UHERKOVICH & ÁBRAHÁM 1995). 2000-től a horvátországi Novo Virjénél esetlegesen felépülő vízerőmű határokon is átnyúló környezeti károsításának felmérése miatt pedig biomonitoring vizsgálatokat indítottunk el. Jelen tanulmányban a vizsgálatok első eredményeiről adunk hírt.

A nappali lepke populációk felmérése az imágók sávmenti számlálásával (transect line method) történt, amelyben az *Apatura metis*, a *Maculinea teleius*, a *Maculinea nausithous*, az *Euphydryas maturna* és a *Parnassius mnemosyne* relatív populáció nagyságának változásait követtük nyomon állandó mintavételi területeken. E fajok populációi egy hidroökológiai gradiens mentén kitűnően jellemzik a Dráva menti élőhelyeket. Emellett térképeztük a *Lycaena dispar* előfordulási helyeit, valamint a *Zerynthia polyxena* faj esetében hernyószámlálást végeztünk egy mintavételi területen.

A dolgozatban megadott ábrák (Fig. 2-7.) mutatják a relatív populációk évenkénti dinamikus ingadozását. Az *Apatura metis* faj közvetlenül a folyómenti puhafa ligeterdők karakterfaja ezért a vízerőmű felépítése tönkre teheti a faj táplálkozó és szaporodó helyeit. A talajvízszint ingadozások a *Maculinea teleius*, a *Maculinea nausithous*, az *Euphydryas maturna* és a *Zerynthia polyxena* élőhelyek degradációjához vezethetnek. A jelenlegi vizsgálat kimutatta a *Parnassius mnemosyne* populációk dinamikus tér- és időbeli átrendeződését is.

Mivel hazánkban a hosszútávú (long term) vizsgálatokról nappali lepke esetében sincsenek megbízható adataink így a populációk egyedszámára ható külső és belső tényezők pontosítása, a törvényszerűségek feltárása további vizsgálati évek eredményeinek elemzését igényli.

DOI:10.24394/NatSom.2005.7.75 | Natura Somogyiensis | 7 | 75-104 | Kaposvár, 2005

Fishfaunistical monitoring of the Hungarian part of the River Drava (1999-2004)

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SALLAI, Z. & KONTOS, T.: *Fishfaunistical monitoring of the Hungarian part of the River Drava (1999-2004)*
Abstract: Fishfaunistical monitoring in the Hungarian part of the river Drava between 1999 and 2004 wa carried out. A small-capacity, pulsating direct current electric fishing machine with rechargeable battery was used for the surveys. During the monitoring altogether 22.649 fish specimen were caught and identified, representing 44 species. Beyond the monitoring sites, fishfaunistical data were collected in other types of habitats, in side arms, the main channel and backwater arms as well. In addition, our own data was complemented with verified data supported by evidence species or picture documentation regarding the occurrence of species, and also with catching data from the fishery database, so the presence of altogether 57 species has been confirmed. Out of the 57 species of verified occurrence, 23 species have nature conservation status. 5 of these protected species have highest level protection status (*Eudontomyzon mariae, Hucho hucho, Umbra krameri, Zingel zingel, Zingel streber*). Out of the identified species 22 species are listed in the Annexes of the Habitat Directive. Based on the number of species found, the absolute (TA: 114) and relative natural value (TR: 2.036) of the fish fauna was defined. The recent fauna list of the river has been compiled using literature and own data; based on this, the occasional or regular occurrence of altogether 63 species is presumable in the river Drava. Compared to previously published species list, 8 new species could be identified in the Hungarian segment of the Drava, namely: *Eudontomyzon mariae, Alburnoides bipunctatus, Gobio uranoscopus, Gobio kessleri, Sabanejewia bulgarica, Barbatula barbatula, Umbra krameri, Neogobius fluviatilis.*

Keywords: Drava, fishfaunistical monitoring

Introduction

Our research team has undertaken fishfaunistical monitoring activities on the Hungarian part of the river Drava since November 1999. The timeliness of the monitoring surveys was underlined by the plans of the Croatian government regarding the construction of a hydroelectric power plant at Novo Virje. During more than 5 years of surveys, the occurrence of several fish species, which earlier were not known in the Hungarian part of the river, has been confirmed, and information on the size of their population has been collected.

During the monitoring surveys, so far 22.649 fish specimens have been caught, representing 44 species. In order to make the species list as complete as possible, exploratory data were collected in various biotopes in addition to the monitoring sites, and our data were supplemented with information regarding the catch of anglers, so the presence of 57 species was verified until December 2004. Up to now 23 of the species found are under nature conservation protection according to Hungarian legistlation, emphasizing

ISSN 1587-1908 (Print); ISSN 2062-9990 (Online)

the outstanding significance of the findings. We would like to draw attention to the occurrence of the Danubian gudgeon (*Gobio uranoscopus*) in the Drava, which is the third verified location of the species beside its presence in the Upper Tisza and Mura within our faunistic area. Another significant natural value is the constant presence of the bullhead (*Cottus gobio*) in the Drava, as the only known self-sustaining population of the species is in the Szigetköz region, beside the occasional occurrence in the river Ipoly. The presence of the population of ukrainian brook lamprey (*Eudontomyzon mariae*) is especially outstanding; it has been found in the entire Hungarian part of the Drava (Őrtilos, Barcs, Drávakeresztúr, Matty). There are less then 10 habitats of this species in Hungary, and it is well-known for indicating clear water. The occurrence of the protected Kessler's gudgeon (*Gobio kessleri*) should also be underlined. It was first found in April 2002 by the gravel at Őrtilos. Our research team was the first to record the presence of the monkey goby (*Neogobius fluviatilis*) and the protected riffle minnow (*Alburnoides bipunctatus*); this latter has been found in the entire Hungarian river segment. It is also important to note that our working group was the first to find two smaller population of the highly protected European mudminnow (*Umbra krameri*) in the dead bed along the Drava.

Up to the 1990s, fish fauna of the river was described only by data from the 19th century and the early 20th century.

The studies of JURANIC (1880, 1881, 1884) treated the river segment close to Varaždin. The occurrence of 34 and 38 species was registered, without synonyms.

GLOWACKI (1885) stated the occurrence of 63 species in the Drava, containing several synonyms.

VUTSKITS (1904, 1918) listed 46 species in the river, mainly based on the above literature.

The study of ROTARIDES (1944) reports on catching 18 species, identified from the catch of fishermen at the lower segment of the Drava.

The Drava was seriously underresearched - this is well reflected by the fact, the museum revision of MIHÁLYI (1954) could not mention any fish collected in the Drava. Only a few fishes are published, collected by Rotarides in the Drávaszög region from the Béllyei Lake and the Kopácsi Lake.

VÁSÁRHELYI (1961) used earlier, mainly 19th century species list (which will be later detailed) instead of own survey results, therefore the listed species can be ignored in the case of the River Drava.

GICZI (1966) explains the reasons why the starlet and the barbel disappeared from the Drava.

BERINKEY (1972) in his museum revision lists only 10 species from the Drava.

HONSIG-ERLENBURG (1989) names the Drava as habitat in the case of 34 species from the Austrian (Carinthian) segment of the Drava. In addition he calls two species common: the chub (*Leuciscus cephalus*) and the brown trout (*Salmo trutta m. fario*). Later HONSIG-ERLENBURG & FRIEDL (1995a, 1995b) reports, that the Danubian gudgeon (*Gobio uranoscopus*) was found in the tributary of the Drava, in the lavant in December 1994. Then in 2001, again in the lavant, the Danubian semling (*Barbus petényi*), which had been believed to be extinct, was collected.

The book of POVŽ & SKET (1990) indicates the Drava as habitat in the case of 35 species; in the case of common species, the locations are not mentioned.

POVŽ (1992) lists 50 fish species and 2 lamprey species from the Slovenian part of the Drava.

HARKA (1992a) compiled the current fishfaunistical list of the Drava based on his own survey and the catch data of fishermen and anglers, registering the occurrence of altogether 48 species.

The manuscript of MICSKU (1993) is valuable primarily from an ethnographical point of view; however, there is also some information on the occurrence of economically important fish species, such as the eel.

Subsequently MAJER (1998), also based on his own survey and the catch data of fishermen, described the presence of 48 species in the Drava. In this list bleak (*Alburnus alburnus*) is mentioned twice, under a different Hungarian name. The sunbleak (*Leucaspius delineatus*) has no verified occurrence; nevertheless it is among the species listed.

The statement of P. L. Á. (2000) is not faunistic, but Mihály Plecskó, the interviewee, who provided data also to the article of HARKA (1992a), reports on brown and rainbow trouts caught in recent years.

MAJER (2001) publishes the occurrence of the Ukrainian brook lamprey (*Eudontomyzon mariae*) based on the data of other authors. One of the references concerns the book of VÁSÁRHELYI (1961). We could buy the manuscript of this book from the inheritance of Vásárhelyi in a second-hand bookshop. Based on the manuscript, we can state that Vásárhelyi lists the locations mentioned in the fauna catalogue of VUTSKITS (1918), completed with own observations in a few cases, such as the water system of the Tisza. The other reference is made to the article of GYEGINSZKI (1967); he saw the brook lamprey not in the Drava, but in the Raba; Drava is not even mentioned in the article. This latter data is inaccurate in the book of GYÖRE (1995) as well.

MAJER & BÍRÓ (2001) summarized the fishfauna of Somogy county. Their study claims that 64 fish species occur in the waters of the county, out of which 57 lives in the Drava. As this number is primarily a result of literature, it cannot be used as a data for the recent fauna of the Drava; in addition, the species list does not clarify which species are included in the 57. There are several inaccuracies in the study: it is written in the introduction, that Danubian roach (*Rutilus pigus virgo*) was not recorded in the Drava by any other previous authors. In the work of HARKA (1992a) it is listed in the Austrian part of the river, while the earlier publications of MAJER (1995, 1998) do not refer to this species, although all three mentioned literature is cited in the case of Danubian roach. The publication of HARKA (1992a) gives a faunistic overview of the river, therefore the list includes the species appearing the records of the late 19th and early 20th century, but there are no recent observations regarding these species. Thus the study describes the Black Sea shad (*Alosa pontica*) and the souffia chub (*Leuciscus souffia agassizi*), and also the great sturgeon (*Huso huso*) and the stellate sturgeon (*Acipenser stellatus*), but in the summary of the before-mentioned two authors the first two species are not listed at all. All in all, the fauna catalogue compiled by MAJER & BÍRÓ (2001) recent and archive data can not be distinguished.

In the summary of the publication of MAJER & BORDÁCS (2001) the occurrence of 40 fish species is reported from the upper, Hungarian segment of the Drava, however, the list of species includes only 39 species.

MAJER (2002) suggest that an Integrated Biotic Index should be introduced, also described in detail in the protocol to the NBmR (National Biodiversity Monitoring System). Without listing the species, he mentions the figure of 59 fish species in the Drava, including also the data of relevant literature.

SALLAI (2002a) published the occurrence of 50 species based on his own surveys. His own observations were completed with the data of fishermen, evidenced by photo documentation; he confirmed the presence of altogether 53 species in the Hungarian part of the Drava.

Table 1. Species detected in the Drava and its tributaries in the last 15 years, based on literature and own data (Protected species in bold)

No.	Species	Literature	Own results
1	***Eudontomyzon mariae***		o
2	***Acipenser nudiventris***	HÁ	(+)
3	*Acipenser ruthenus*	HÁ, MJ	(+)
4	*Anguilla anguilla*	HÁ	(+)
5	*Rutilus rutilus*	HÁ, MJ	+
6	***Rutilus pigus virgo***		+
7	*Ctenopharyngodon idella*	HÁ, MJ	+*
8	*Scardinius erythrophthalmus*	HÁ, MJ	+
9	*Leuciscus leuciscus*	HÁ, MJ	+
10	*Leuciscus cephalus*	HÁ, MJ	+
11	*Leuciscus idus*	HÁ, MJ	+
12	*Aspius aspius*	HÁ, MJ	+
13	***Leucaspius delineatus***	HÁ	+*
14	*Alburnus alburnus*	HÁ, MJ	o
15	***Alburnoides bipunctatus***		+
16	*Abramis bjoerkna*	HÁ, MJ	+
17	*Abramis brama*	HÁ, MJ	+
18	*Abramis ballerus*	HÁ, MJ	
19	*Abramis sapa*	HÁ, MJ	+
20	*Vimba vimba*	HÁ, MJ	+
21	*Pelecus cultratus*	HÁ, MJ	
22	*Chondrostoma nasus*	HÁ, MJ	+
23	*Tinca tinca*	HÁ, MJ	+
24	*Barbus barbus*	HÁ, MJ	+
25	***Gobio gobio***	MJ	+
26	***Gobio albipinnatus***	HÁ	+
27	***Gobio uranoscopus***		o
28	***Gobio kessleri***		o
29	*Pseudorasbora parva*	HÁ, MJ	+
30	***Rhodeus amarus***	HÁ, MJ	+
31	*Carassius carassius*	HÁ, MJ	+
32	*Carassius gibelio*	HÁ, MJ	+
33	*Cyprinus carpio*	HÁ, MJ	+
34	*Hypophthalmichthys molitrix*	HÁ, MJ	+*
35	*Hypophthalmichthys nobilis*	HÁ, MJ	
36	***Misgurnus fossilis***	HÁ, MJ	+
37	***Cobitis elongatoides***	HÁ, MJ	+
38	***Sabanejewia bulgarica***		o
39	***Barbatula barbatula***		o
40	*Ameiurus nebulosus*	HÁ, MJ	+
41	*Ameiurus melas*	MJ	+
42	*Silurus glanis*	HÁ, MJ	+
43	*Esox lucius*	HÁ, MJ	+
44	***Umbra krameri***		o
45	***Thymallus thymallus***	MJ	
46	***Hucho hucho***	MJ	(+)
47	*Salmo trutta m. fario*	HÁ, MJ	(+)
48	*Oncorhynchus mykiss*	HÁ	
49	*Salvelinus fontinalis*	MJ	
50	*Lota lota*	HÁ	+
51	***Cottus gobio***	MJ	+
52	*Lepomis gibbosus*	HÁ, MJ	+
53	*Micropterus salmoides*	HÁ, MJ	+
54	*Perca fluviatilis*	HÁ, MJ	+
55	*Gymnocephalus cernuus*	HÁ, MJ	+
56	***Gymnocephalus baloni***	HÁ, MJ	+
57	***Gymnocephalus schraetser***	HÁ, MJ	(+)
58	*Sander lucioperca*	HÁ, MJ	+
59	*Sander volgensis*	HÁ	(+)
60	***Zingel zingel***	HÁ, MJ	+
61	***Zingel streber***	HÁ, MJ	+
62	*Neogobius fluviatilis*		o
63	***Proterorhinus marmoratus***	HÁ, MJ	+
	Total species	**48/47 (54)**	**50+7 (63)**

Abbrevations: **HÁ**: HARKA, Á., 1992a; **MJ**: MAJER, J., 1998; +: Its presence in the Drava confirmed; (+): Catch of anglers (verified); **o**: New species compared to other lists; *: Found in the water system

SALLAI (2002b, 2002c) published the results of a three-year survey in his summarizing study on the fishfauna of the Hungarian segment of the Drava-Mura water system. Taking into account his earlier results (SALLAI 1999), the occurrence of 55 species in the Drava, 46 species in the Mura was proven. Considering literature, he set forth 64 species living in the Hungarian catchment area of the Drava.

In the book of HARKA & SALLAI (2004) on the fishfauna of Hungary, the Drava is mentioned in the case of 63 species as a site of occurrence.

The study of SALLAI (2004) summarizes the information available on the Drava. Based on his own data, literature and the catch of fishermen, the regular or occasional occurrence of 63 species can be presumed in the recent period.

There are overlaps and differences among the above quoted species lists. When the recent species number is defined, only the occurrence of the minnow (*Phoxinus phoxinus*) is not confirmed in the Hungarian segment, out of the 64 species mentioned in the study of SALLAI (2002b, 2002c). After comparing the species lists, the Hungarian part of the Drava is characterized by the regular or occasional occurrence of 63 fish species in the last 15 years, based on own observations and different literature. (Table 1).

Material and method

Features of the Drava

The entire length of the Drava is 695 km, rising at a height of 1238 m at the Western end of the Carnic Alps. The scope of the catchment area was defined as 40.000 km^2 (MAROSI & SZILÁRD 1967). In Hungary, there is only a section of 170 km, crossing the borderline several times. Considering its length and catchment area, it is one of the most important tributaries of the Danube.

The Hungarian part of the Drava crosses two microregions. The microregion of the valley of the Middle Drava covers the southern part of Somogy county, including the river segment from Őrtilos to Drávatamási, out of which 87 km is on the Hungarian side, extending over 300 km^2. The most typical forest community in this microregion is the rich scrubs and lianas of oak-ash-elm forest, but ash groves, willows, alders and ash-alder bog forests can be also found.

The microregion of the plain of the Drava is located in Somogy and Baranya counties, spanning from Drávatamási to Old, with a territory of 400 km^2. The typical forest communities of the microregion are forests with willow, poplar and alder, and forests with oak, ash and elm.

The water quality of the entire Hungarian part of the River Drava is class I, making it the clearest Hungarian river. The class II, or sometimes class III water of the Mura is counterbalanced by the significantly larger rate of flow of the Drava.

The fluctuation of the water level is above 400 cm in the case of all three measuring sites. The average discharge (KÖQ) is close to 600 m^3/s in the case of the upper two

Table 2. Fluctuation data of the Drava (MAROSI & SOMOGYI 1990)

Measuring sites	LKV	LNV	KQ	KÖQ	NQ
	cm		m^3/s		
Őrtilos	-50	476	276	590	2300
Barcs	-64	618	278	595	2570
Drávaszabolcs	-10	596	151	486	2100

measures, and to 500 m^3/s at Drávaszabolcs. The quantity of water flowing during larger floods (NQ) exceeded eight times the smallest discharge (KQ), while at Drávaszabolcs it can reach a 13 times higher volume (MAROSI & SOMOGYI 1990). The fluctuation data is shown in Table 2.

Short description of the monitoring sites

When the monitoring sites were selected, we were looking for habitats, where the most diverse river habitats can be found together in one place, where most of the species preferring current can find appropriate living conditions. These selection criteria are justified by the fact that these habitats will reflect soonest the changes in the population of more sensible species requiring higher oxygen levels in the case of the possible power plant construction.

The status of the sampling sites was registered by Fujifilm S1Pro digital camera.

11 permanent sampling locations were appointed in the surroundings of five settlements by the Drava (Őrtilos, Vízvár, Barcs, Drávakeresztúr, Matty), where monitoring surveys were undertaken from 1999. Because of the hydroelectric power plants on the upper segment of the Drava, the natural hydrological patterns are impossible to track; the water level might change relatively fast, even with several meters. Therefore we had to appoint extra sites in addition to the permanent sampling sites, where the fish fauna could be sampled under extreme conditions of high water level; these sites can be found within 500 meters of the permanent sites.

In the surroundings of Őrtilos two or three sites have been used, depending on elevation. One of the sampling sites is the bank protecting apron in front of the railway station. The second permanent sampling site is the large gravel reef in front of the watchhouse No. 4. The Danubian gudgeon (*Gobio uranoscopus*) was first found here. The sampling site is shallow, but the current is rapid, with a coarse gravel bed. In the case of higher elevations, the tributary also contains water; in such cases fishing was made by wading in the coastal zone, but as sampling here depends on the water level, this location is not considered a permanent sampling site.

Usually we used four sampling sites in the area of Vízvár. There is a stone dam beyond the 191 river kilometer panel, square with the river bank, next to built boat launching ramp. The second site is a smaller, gravel-bed tributary, directly under the stone dam. We caught Danubian roaches (*Rutilus pigus virgo*) in this tributary several times. The third site is about 1 km above the stone dam, an 80-100 cm deep, rapid current tributary with coarse gravel bed, where we also regularly go fishing. The fourth site is the bank of the tributary close to the main riverbed. The tributary is separated from the main riverbed by a gravel reef; here we also regularly take samples.

In the surroundings of Barcs three sites are used for fishing. One of the sampling sites is under Barcs; next to the C28 border stone there is a longer stone closure, with water on both sides. The outer side is under strong current, the inner side has the characteristics of a stillwater. Another sampling site is right under the bridge of the border crossing at Barcs. The third permanent sampling site is the bathing shore of Barcs, also above the settlement.

Close to Drávakeresztúr, under the mouth of Korcsina there is a longer bank protecting apron, where we also made regular monitoring to collect fishfaunistical data.

We use one permanent sampling site in the area of Matty, in Keselyősfapuszta, the bank protecting apron at the end of the wooden bridge, where a sand-bed can be found between two stone aprons.

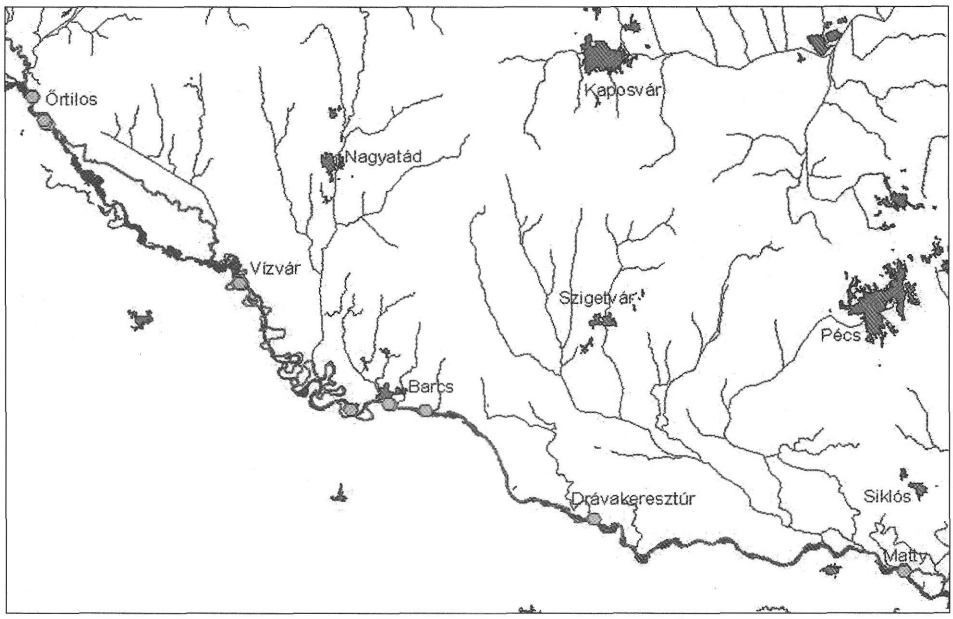

Fig. 1.: Sampling sites along the River Drava

Method of the survey

Fishfaunistical data has been collected with two pulsating direct current electric fishing machines with rechargeable battery: an IUP-12 model (350 V, 4-15 A, 40-120 W) produced in Poland, and a Hans Grassl IG600 model (max. 565 V, 30 A, 1200 W) produced in Germany. Their use does not cause any lasting damage in the caught fishes; they recover and swim away within a short time. Fishes were released after being identified, none of them was collected. Fishing was made from the bank, wading or sometimes from a boat.

Sampling sites were located by a Garmin eTrex Legend GPS, using EOV-coordinates (national projection system). Geocoordinates were measured at the upper and lower points of the segments surveyed, if possible. Consequently the length of the sampling units can be measured relatively precisely. The EOV-coordinates obtained were processed in ArcView 3.0a desktop GIS software (Fig. 1).

The number of specimens per species and the GPS coordinates were recorded by a Toshiba DMR-SX-1 digital dictafon. On-site orientation was supported by 1:25.000 scale military maps. During sampling, the scope of the fishing machine was set to the width of 2 m, square to the cross-section of the riverbed.

In addition to the monitoring sites, we took samples occasionally in other habitats along the Drava, and the catch of anglers was also reviewed several times. Thus we acquired outstanding faunistical data, aiming to obtain the most complete fishfaunistical knowledge of the river.

This is how we could record the occurrence of the European mudminnow (*Umbra krameri*) for the first time in two deadbeds of the Hungarian river segment. In the catch of anglers Danubian roach (*Rutilus pigus virgo*), white-eyed bream (*Abramis sapa*), striped ruffe (*Gymnocephalus schraetser*), zingel (*Zingel zingel*), brown trout (*Salmo trutta m. fario*) and danube salmon (*Hucho hucho*) were found.

Processing of faunistical data was made by Access database management software.

Results

During the monitoring activities between November 1999 and October 2004 altogether 22.649 fish specimens were caught and identified, representing 44 species. Out of the total annual number of specimens the number and percentage of species under nature conservation protection was the following: in 1999: 81 specimens (50.9 %) out of the 159 fish specimens; in 2000: 499 specimens (21.2 %) out of the 2.356 fish specimens; in 2001: 1.580 specimens (31.1 %) out of the 5.081 fish specimens; in 2002: 2.415 specimens (31.2 %) out of the 7.735 fish specimens; in 2003: 1.677 specimens (41.0 %) out of the caught 4.089 specimens; and in 2004: 1.183 specimens (36.6 %) out of the caught 3.229 fish. As a summary it can be stated, that a quarter (24,7%) of the more than 22.000 fish species caught during the monitoring activities is protected.

Proportion of specimens of protected species in the fish fauna of the Drava

Hereby we would like to give an overview of the frequency of protected species caught in the Hungarian part of the Drava from 1999 (Fig. 2). The results clearly reflect that the frequency of the rifle minnow (*Alburnoides bipunctatus*) within protected species was the highest is almost all years, exceeding 14% in 2003. Stone loach (*Barbatula barbatula*) was found in each year, with a frequency of less than 1%, changing between 0.03 and 0.63% during the years. The number of spined loach (*Cobitis elongatoides*) was relatively low in 2002, due to high elevations. If the water level is low, the species can be caught relatively easily; this fact is appropriately proved by the results of the other years, where its proportion was between 0.8 and 10.6%. Up to the present the number of specimens reached its maximum in 2004. Bullhead (*Cottus gobio*) was caught in each year, with a relatively constant frequency, its proportion changing between 0.6 and 2.5%. The minimum of the frequency of the species was recorded in 2004. Ukrainian brook lamprey (*Eudontomyzon mariae*) was first found in 2000, then in 2001 could not be found in any of the sampling sites, while in 2002 it occurred at locations where earlier had not been seen. Its frequency was under 0.1% in each year. The number of white-finned gudgeons (*Gobio albipinnatus*) was outstandingly high in 1999 (13.2 %), due to having only one sampling occasion in the autumn of the first year. From 2000 the frequency of its occurrence was relatively stable, between 0.4 and 2.9%. The common gudgeon (*Gobio gobio*) appeared in the samples only from 2001, in a more or less stable proportion, with a frequency between 0.03 and 0.21%. The frequency of both gudgeons was on the minimum in 2004. Kessler's gudgeon (*Gobio kessleri*) was first caught in 2002, with 3-3 specimens in both years; its frequency remained under 0.1. The most valuable species of the faunistic area is the Danubian gudgeon (*Gobio uranoscopus*); it was first found in the spring of 2000 from the Őrtilos segment of the Drava. Unfortunately the species could not be found at the previous locations in 2003 and in 2004, due to the relatively high daily fluctuation of the water level at Őrtilos. Its frequency was around 0.2%. Balon's ruffe (*Gymnocephalus baloni*) can also be caught primarily at low water levels. Specimens were caught each year; the percentage of the species was between 0.9 and 6.3%. The expansion of the tubenose goby (*Proterorhinus marmoratus*) is still continuous. In the first year it was found only in the river segment of Baranya county, in 2000 also at Barcs, then in 2003 also at Vízvár. Its frequency was between 1.3 and 8.9%. The expansion of the species is well represented by the fact that it reached the maximum of its frequency in 2004. The bitterling (*Rhodeus amarus*) appears among the caught fishes from 1999; despite the increasing frequency in the previous two years, in 2004 its proportion dropped to 3.5%, with figures changing between

Fig. 2: The River Drava near Barcs

Fig. 3: Ukrainian brook lamprey (*Eudontomyzon mariae*)

Fig. 4.: Danubian gudgeon (*Gobio uranoscopus*)

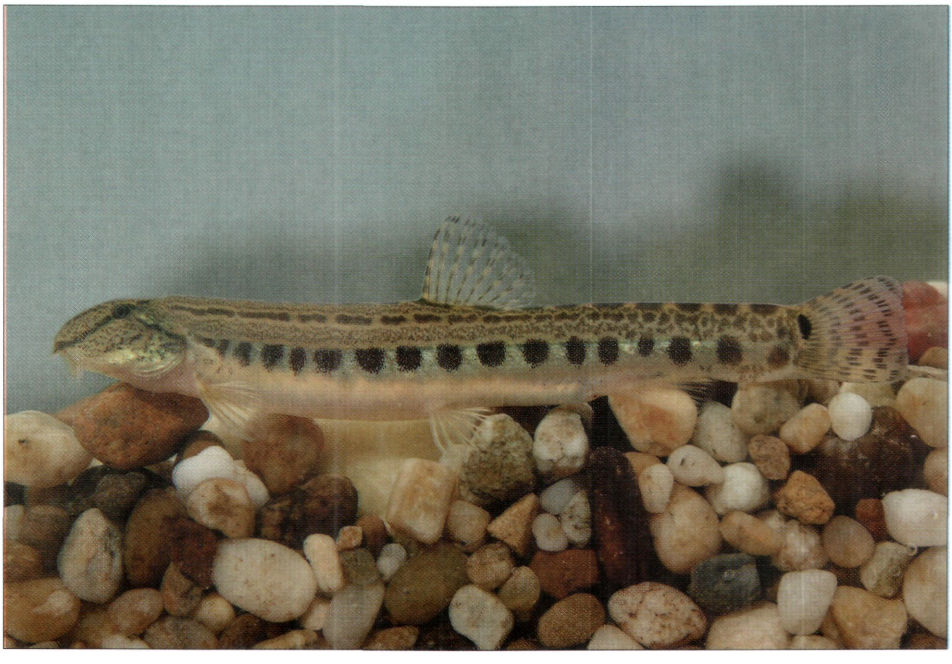

Fig. 5: Spined loach (*Cobitis elongatoides*)

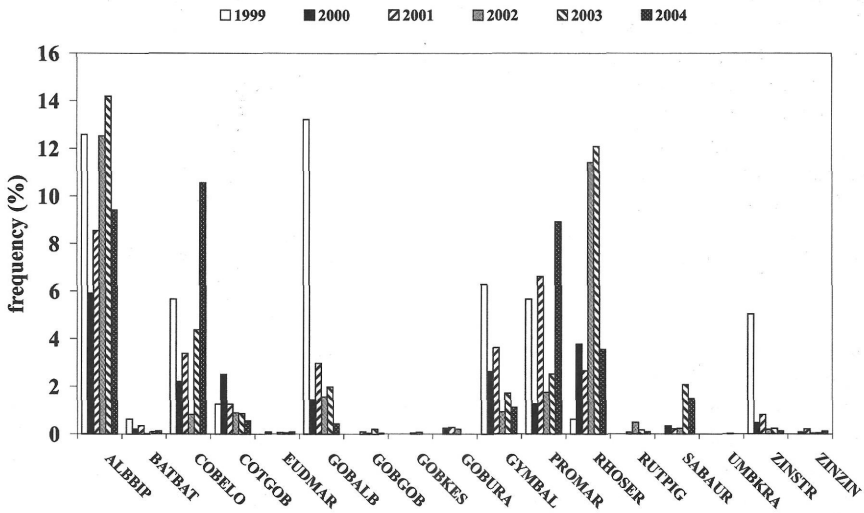

Fig.:6.: Frequency of protected species caught in the Hungarian part of the Drava

0.6 and 12.1 %. The Danubian roach (*Rutilus pigus virgo*) is a particularly endangered, rare endemism. During high waters, more of its specimens were caught, with a percentage between 0.08 and 0.48%; from 2001 it appeared each year. Bulgarian loach (Sabanejewia bulgarica) was first identified in the samples in 2000, its proportion reaching its maximum 2.07% during the low waters of 2003, but its frequency was 1.5% even in 2004. The occurrence of the European mudminnow (*Umbra krameri*) is not typical in the main riverbed; previously it was found in two landside deadbeds, near Cún and Barcs. The adult specimen caught in 2003 had been presumably drifted with high waters through the Mura. The streber (*Zingel streber*) is a highly protected endemic fish, appearing in our samples from 1999. The high number of streber specimens in the first year can be explained by the low number of total specimens caught and the single sampling in autumn. The frequency of the species was under 1% every year, changing between 0.12 és 0.88%. Unfortunately the minimum of its frequency occurred also 2004. The zingel (*Zingel zingel*) was first recorded in the Drava in 2000, with a low number of specimens each year; its percentage was between 0.04 and 0.21%.

Species endangered nationally and on the European level

Below you can find an overview of the species nationally protected and listed in the Annexes of the Habitat Directive, caught in the Drava during the survey period. The figures illustrating frequency always compare the number of specimen belonging to the described species caught in the gives aspect to the total number of specimens caught in the given aspect.

Ukrainian brook lamprey - *Eudontomyzon mariae* (Berg, 1931)

We found this species two times in 2000 near Barcs, at the stone apron near the C27 border stone. During the samplings of 2001, we were systematically looking for the species in the areas covered by soft sediment and detritus, but it was not found in any of

the sampling sites. The statement made in 2001, claiming that the species is a constant element of the fauna of the Drava, could be confirmed with data in April 2002. During the low waters of spring, one adult was caught in the surroundings of Őrtilos, 2 adults and 2 specimens in larva state near Révfalu, and one adult near Matty. The species appeared two times in 2003, an adult was caught in April under Barcs at the earlier location, at the stone apron near the C28 border stone, then in August a specimen in larva state was recorded near Keselyősfapuszta, at the end of the wooden bridge. In 2004 two specimens were caught again at Keselyősfapuszta, in August and in October; then in October another specimen was found at the sampling site near the C28 border stone at Barcs. The above data prove that the species lives in the entire Hungarian segment of the Drava (Fig. 7). It has a high protection status and is listed in Annex II to the Habitat Directive.

Ship sturgeon - *Acipenser nudiventris* Lovetsky, 1828

Almost all of the literature of the 19th century (JURANIC 1880, GLOWACKI 1885, HERMAN 1887) mentions its occurrence in the Drava. The only recent specimen in the Drava was found in 1989 near Heresznye, caught by an angler called Péter Petrik; the fish weighted 20,5 kg (PINTÉR 1991b). The specimen was identified by Károly Pintér. In his bibliography on acipenseridae, published in 1994, there is also a photo (PINTÉR 1991b, 1994). The occurrence data was used by HARKA (1992a) and MAJER (1995), so it does not mean the occurrence of several specimens. As catching acipenseridae with electric fishing machine is almost impossible, we tried to use other fishing equipment, but due to the high transparency of the Drava, our attempts always failed. Protected and listed in Annex V to the Habitat Directive.

Sterlet - *Acipenser ruthenus* Linnaeus, 1758

Unfortunately the presence of the starlet in the Drava is also known only from angling journals. Between 1975 and 1987, 3 sterlets of record size were caught by anglers in the Hungarian segment of the Drava. It is an interesting fact that there is no data available on starlets caught after 1987. We can declare this after reviewing the last 25 volumes of angling journals. During several discussions, anglers said that they had not seen the species for the last years, and they have no information on any starlets caught. Unfortunately the data of the Fishery Database also confirms the same: in 2001 24kg, in 2002 58 kg starlet was recorded within the territory of the entire Hungarian catch area, which is a sadly low amount. The species is rare, endangered, and listed in Annex V to the Habitat Directive.

Danubian roach - *Rutilus pigus virgo* (Heckel, 1852)

Endangered endemism of the Danube. In 2000 two specimens were caught by anglers. In 2001 our surveys also confirmed its presence. In 2001, during the review of catch of anglers 3 specimens was again recorded, near Matty and Révfalu (Drávakeresztúr). Only a smaller population was presumed in the Drava, but the number of specimens (38) found in 2002 proves that the most stable domestic population of the species lives in the Hungarian segment of the Drava. Young and adult specimens were both found, also proving the stability and self-sustaining of the population. Although the number of specimens found in 2003 was less then in the previous year, we caught 1 specimen in August and 4 specimens in October near Vízvár, and 1 specimen both near Barcs and Őrtilos. We had no previous data available regarding the occurrence of the Danubian roach at Őrtilos. In April 2004 an adult specimen was caught by anglers at Révfalu; as the species is protected, we made them throw the fish back. In 2004 only 3 specimens were caught,

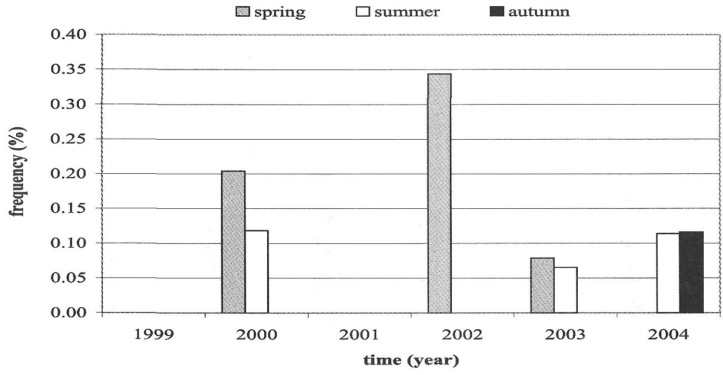

Fig.7.: The frequency of *Eudontomyzon mariae* seasonally between 1999-2004

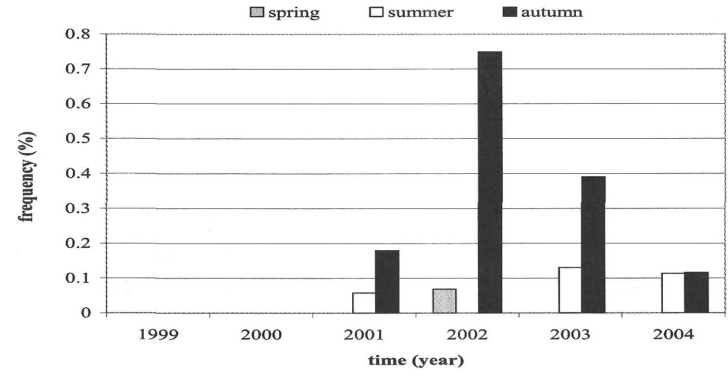

Fig. 8.: The frequency of *Rutilus pigus virgo* seasonally between 1999-2004

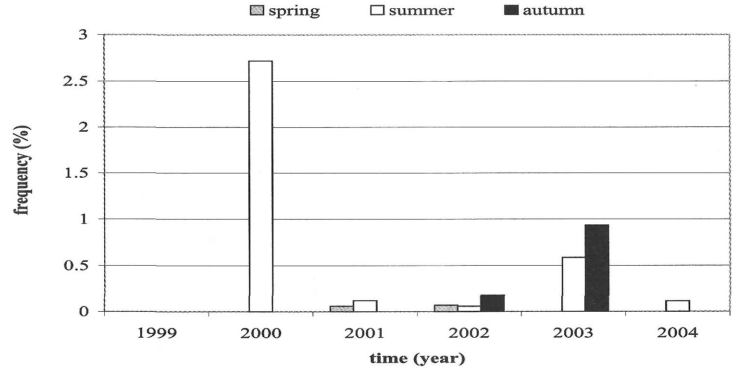

Fig. 9.: The frequency of *Aspius aspius* seasonally between 1999-2004

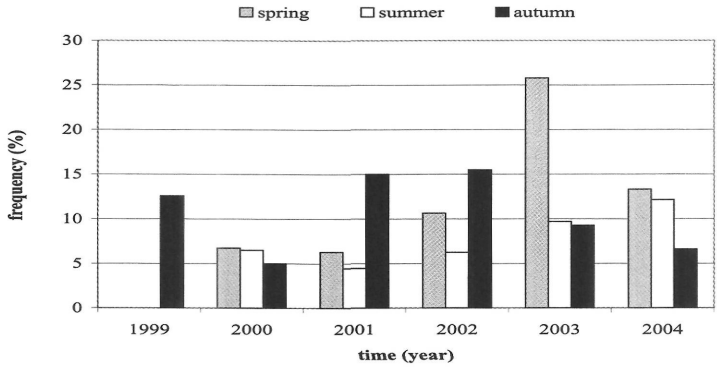

Fig. 10.: The frequency of *Alburnoides bipunctatus* seasonally between 1999-2004

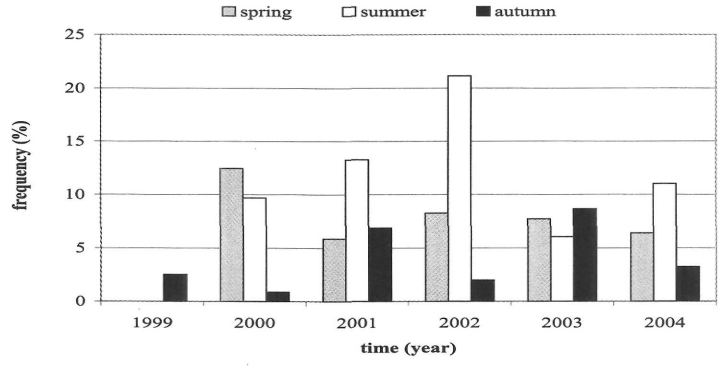

Fig. 11.: The frequency of *Barbus barbus* seasonally between 1999-2004

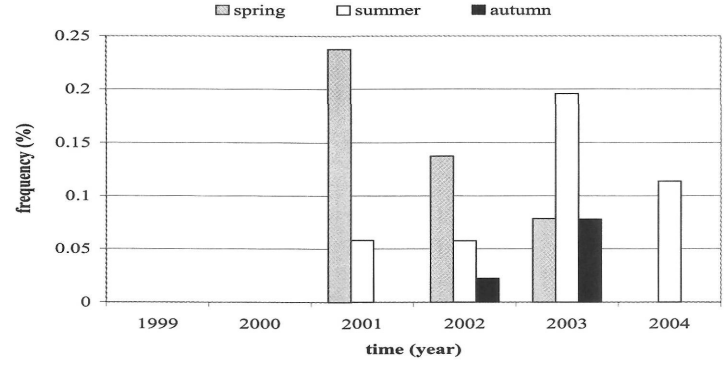

Fig. 12.: The frequency of *Gobio gobio* seasonally between 1999-2004

all of them near Vízvár. (Fig. 8). Occurrence data clearly confirm that the Danubian roach lives in the entire Hungarian segment of the Drava, which is a finding of outstanding importance from nature conservation point of view. This rare species is protected under Hungarian legislation, and listed in Annex II and V to the Habitat Directive as well.

Asp - *Aspius aspius* (Linnaeus, 1758)

A species endangered on the European level, with stable domestic populations. In 1999 1 specimen, in 2000 38 specimens, in 2001 11 specimens, in 2002 10 specimens, in 2003 21 specimens and in 2004 1 specimen were caught in the river. In 2003 we found it at all of the sampling sites, primarily young, 0+ - 2+ old specimens (Fig. 9). The species occurs in the entire Hungarian segment, and listed in Annex II and V to the Habitat Directive.

Sunbleak - *Leucaspius delineatus* (Heckel, 1843)

The species appear in the species list of MAJER (1998), but no verified occurrence data is published. One single specimen was found in Tornyi-Rinya in 2000 (SALLAI 2002b, 2002c). In spite of several samplings, we failed to catch other specimens, although HARKA (1992a) reports the occurrence of several hundreds of specimens in this tributary. We were looking for the species in the marshland habitats along the Drava, but up to now it was not found. It is a rare element of our fauna, under national protection.

Riffle minnow - *Alburnoides bipunctatus* (Bloch, 1782)

Out of the protected species, riffle minnow was represented with the highest number of specimens. The species was not mentioned in any previous fishfaunistical studies (HARKA 1992a, MAJER 1995, 1998), although it was found in the entire Hungarian segment of the river. In 1999 20 specimens, in 2000 397 specimens, in 2001 489 specimens, in 2002 967 specimens, in 2003 596 specimens, in 2004 304 specimens were caught. It is protected (Fig. 10).

Barbel - *Barbus barbus* (Linnaeus, 1758)

Out of the economically important species, barbel was found in the highest numbers. The number of specimens caught confirms the existence of large populations (1999: 5 specimens, 2000: 206 specimens, 2001: 466 specimens, 2002: 572 specimens, 2003: 302 specimens, 2004: 193 specimens), indicating the optimal breeding conditions of the species in the Drava (Fig. 11). High numbers can be found in the catch of anglers; the amount caught was 625-826 kg in the segment of Baranya, and 396-1807 kg in the segment of Somogy. The species is listed in Annex V to the Habitat Directive.

Common gudgeon - *Gobio gobio* (Linnaeus, 1758)

The first specimen was caught in November 2000 near Drávasztára. In the Drava it is considered rare, also stated by HARKA (1992a); in 2000 one, in 2001 8, in 2002 4, in 2003 9, and in 2004 one specimen were found (Fig. 12). It is often confused with the close relative, the white-finned gudgeon (*Gobio albipinnatus*), which is common in our larger rivers (HARKA 1996), and also the most common gudgeon in the Drava. Protected.

White-finned gudgeon - *Gobio albipinnatus* Lukasch, 1933

It can be commonly found all throughout the Hungarian segment of the Drava, having a stable, self-sustaining population. In spite of this fact, the only reference made to the species in the relevant literature is the article of HARKA (1992a). We caught 42 specimens in 1999, 82 specimens in 2000, 202 specimens in 2001, 121 specimens in 2002, 83

specimens in 2003, but only 14 specimens in 2004 (Fig. 13). Protected and listed in Annex II to the Habitat Directive.

Danubian gudgeon - *Gobio uranoscopus* Agassiz, 1828

Our working group was the first to record the species in the Drava. It is a rare fish living in the upper segments with rapid current and gravel bed. Beside the Drava, two other Hungarian habitats are known: Upper Tisza and Mura. In 2000 6 specimens, in 2001 14 specimens, in 2002 16 specimens were found. Earlier the only site to find the species was near Őrtilos, but in October 2001 a young specimen occurred near Vízvár. In April 2002 another specimen was caught near Vízvár, unfortunately we have not met the species since then. The population in the Drava is small and vulnerable! (Fig. 14) An endemic and endangered element of the fauna of the Danube basin, listed in Annex II to the Habitat Directive, besides being nationally protected.

Kessler's gudgeon - *Gobio kessleri* Dybowski, 1862

Earlier literature never mentioned the Kessler's gudgeon in the river. After finding the species in the Mura River (SALLAI 2002b), its presence in the Drava was also presumed. The low waters in spring favoured the appearance of the fish; we managed to catch adult specimens in April 2002 and 2003 as well, on the gravel reef of the monitoring sites at Őrtilos. It is a rare endemism living in the upper segments, with rapid current, sand and gravel beds. It is protected and listed in Annex II to the Habitat Directive.

Bitterling - *Rhodeus amarus* (Bloch, 1782)

The Hungarian population of the species is considered stable; numerous populations can form, where the large mollusc required for its breeding are available in appropriate quantity. We caught 49 specimens in 1999, 181 specimens in 2000, 259 specimens in 2001, 883 specimens in 2002, 508 specimens in 2003, and 115 specimens in 2004 (Fig. 15). Based on the results of recent years, the bitterling became the third most common protected species in the Drava, after riffle minnow and spined loach. It is protected and listed in Annex II to the Habitat Directive.

Weatherfish - *Misgurnus fossilis* (Linnaeus, 1758)

A rare species of marshland habitats. It can be found in silt-charged tributaries and deadbeds with rich, thick vegetation. In the habitats surveyed middle-sized populations live. No specimen was caught at the monitoring sites. Besides being protected under national legislation, its European importance is recognized by being listed in Annex II to the Habitat Directive.

Spined loach - *Cobitis elongatoides* Băcescu & Majer, 1969

The taxon was created during the complex taxonomic revision of *C. taenia* (FREYHOF et al. 2000). All populations of spined loaches living in our faunistic area belong to the species *C. elongatoides* (ERŐS 2000). It is a common species in domestic national waters as well as the Drava River. Often we caught specimens in great quantities in the river segments covered with soft sediment. Stable, self-sustaining populations live in the Drava and its tributaries. In 1999 18 specimens, in 2000 248 specimens, in 2001 279 specimens, in 2002 65 specimens, in 2003 184 specimens were caught. Until now, the maximum of its frequency was reached in 2004, with 341 specimens caught (10.6 %), making the spined loach the most frequent protected species in 2004 (Fig. 16). Protected and listed in Annex II to the Habitat Directive.

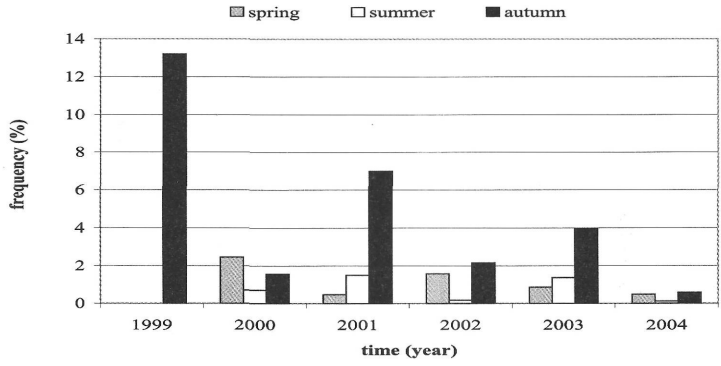

Fig. 13.: The frequency of *Gobio albipinnatus* seasonally between 1999-2004

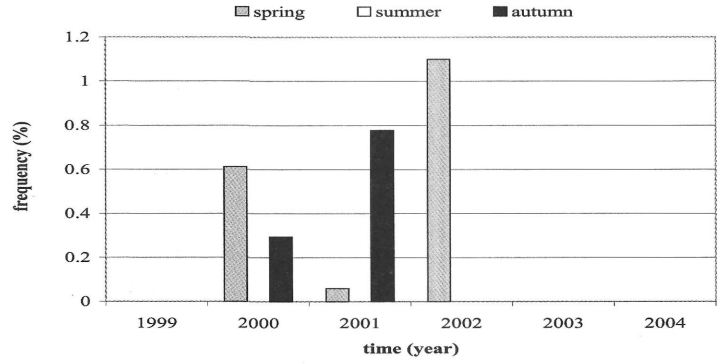

Fig. 14.: The frequency of *Gobio uranoscopus* seasonally between 1999-2004

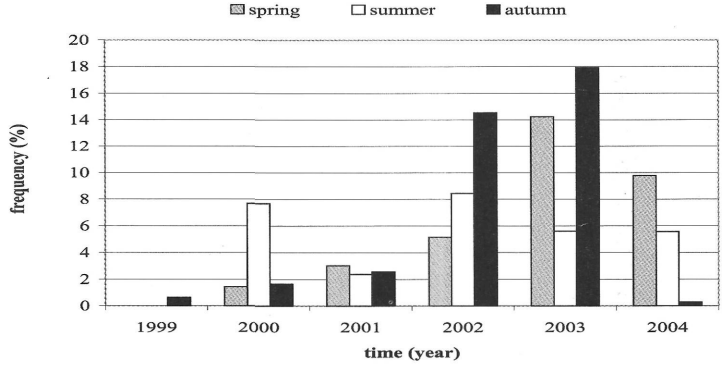

Fig. 15.: The frequency of *Rhodeus amarus* seasonally between 1999-2004

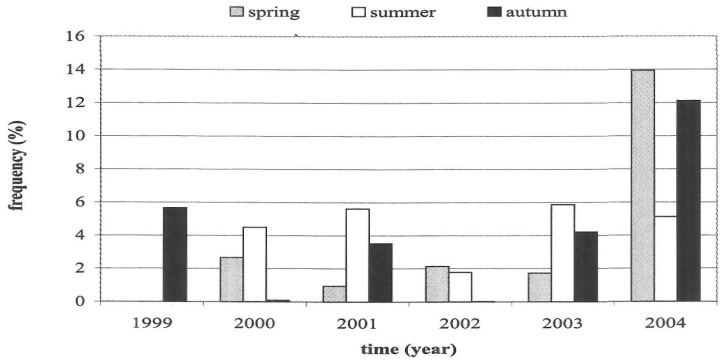

Fig. 16.: The frequency of *Cobitis elongatoides* seasonally between 1999-2004

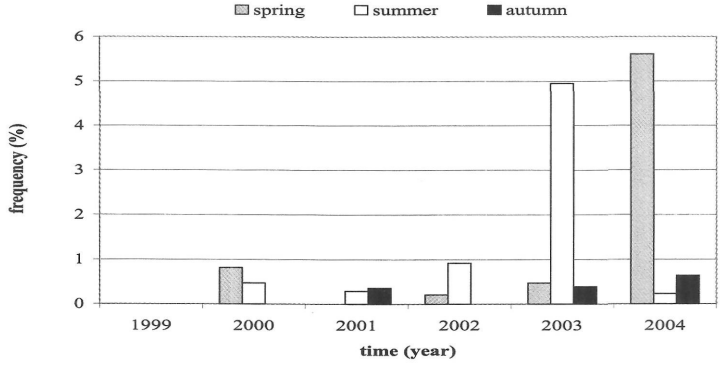

Fig. 17.: The frequency of *Sabanejewia bulgarica* seasonally between 1999-2004

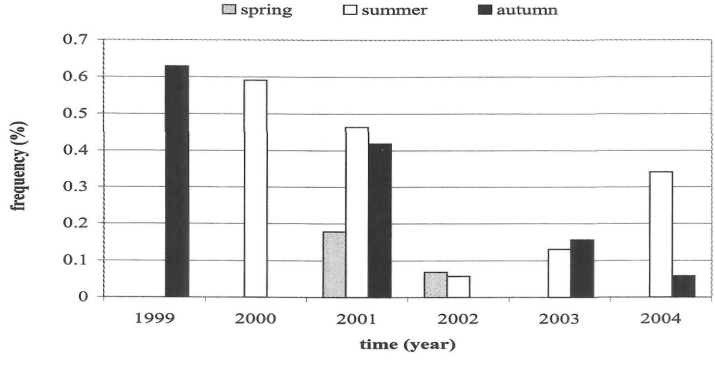

Fig. 18.: The frequency of *Barbatula barbata* seasonally between 1999-2004

Bulgarian loach - *Sabanejewia bulgarica* (Drensky, 1928)

Previously there was no published data available regarding its occurrence in the Drava recently. We first found it in the area of Vízvár in March 2000. Later it was caught at several locations from Őrtilos to Révfalu (Drávakeresztúr). A stable, self-sustaining population lives in the river. In 2000 13 specimens, in 2001 47 specimens, in 2002 18 specimens, in 2003 87 specimens and in 2004 48 specimens were caught. (Fig. 17). This rare and endangered species is nationally protected and also listed in Annex II to the Habitat Directive.

Stone loach - *Barbatula barbata* (Linnaeus, 1758)

Earlier literature (HARKA 1992a, MAJER 1995, 1998) does not make reference to its occurrence in the Hungarian segment of the Drava. Because of its presence in the Mura River (SALLAI, 1999), its appearance in the Drava was also expected. So far it has been found in the river from Őrtilos to Révfalu (Drávakeresztúr); 1 specimen in 1999, 6 specimens in 2000, 24 specimens in 2001, 2 specimens in 2002, 4 specimens in 2003 and 2004 as well (Fig. 18). Its population in the Drava is small, requires high level of oxygen, protected.

European mudminnow - *Umbra krameri* Walbaum, 1792

The presence of the species in the Hungarian segment of the Drava was not known earlier. POVŽ (1992) indicates the species in the Slovenian segment of the Mura River, but the presence of the European mudminnow is confirmed also on the Hungarian side of the river (SALLAI 1999). In 2001 it was found in the deadbeds: in Cún-Szaporcai-Holt-Dráva and in Nagy-Bók (Barcs). Since we had to take samples among difficult situation at both sites - rich aquatic vegetation, soft sediment - we could not provide reliable information on the size of the population, but as both locations have the typical marshland habitat requirements, stable, self-sustaining populations are presumed. On 5 April 2005 in a silent bay close to the railway station of Őrtilos, a 70 mm standard and an 85 mm fully developed, healthy, adult specimens were found in the nest. The specimen was released after making photographs. It is a rare, endangered species, living in moors and marshland habitats, with a high protection status under national legislation and listed in Annex II to the Habitat Directive.

Danube salmon - *Hucho hucho* (Linnaeus, 1758)

MAJER (1998) reports a specimen caught in October 1990 near Őrtilos, based on the data provided by Ferenc Énok. The publication refers to the name of the collector inappropriately, as László Énok. A stable population lives in the Austrian segment of the Drava, proven by the record specimens found (SCHULZ 1985, OFFERMANNS 1986). The only data on its verified occurrence in the country was provided by Péter Tóth, angler in Fityeháza. He made available the photo of the specimen caught in December 1998, which we would like to thank hereby. During our surveys, we have not met the species, the power plant constructed on the Croatian side blocks the migration of the populations living in the upper segments, therefore we can declare that the species has disappeared from this section of the Drava; nevertheless, drifted specimens might be found. An indigenous species of the Danube basin, having a high protection status under national legislation and listed in Annex II and V to the Habitat Directive.

Bullhead - *Cottus gobio* Linnaeus, 1758

The first occurrence of the species in Hungary, in the Drava was published by MAJER (1995, 1998); suggesting only occasional occurrence. Recent findings have completely cleared off this presumption. In the Hungarian segment of the Drava, between Őrtilos

and Révfalu (Drávakeresztúr) it was found at each of the sampling sites. The self-sustaining population of the species can be considered stable, appropriately confirmed by the number of specimens found: in 1999 2 specimens, in 2000 89 specimens, in 2001 98 specimens, in 2002 69 specimens, in 2003 36 specimens and in 2004 18 specimens were caught (Fig. 19). The presence of the species in the Drava is remarkable from a nature conservation point of view, as there is only one population is Szigetköz is known in Hungary! A rare, endangered species, which is protected under national legislation and also listed in Annex II to the Habitat Directive.

Balon's ruffe - *Gymnocephalus baloni* Holčik & Hensel, 1974

A stable, self-sustaining population of the species lives in the entire Hungarian segment of the Drava. It was found all the way from Őrtilos to Matty, in convincing numbers: in 1999 20 specimens, in 2000 119 specimens, in 2001 318 specimens, in both 2002 and in 2003 72 specimens, and in 2004 36 specimens were caught (Fig. 20). It is protected under national legislation and listed in Annex II and IV to the Habitat Directive. Most of them were seen near the bank protection aprons every year.

Striped ruffe - *Gymnocephalus schraetser* (Linnaeus, 1758)

The occurrence of the species in the Drava was first described by JURANIC (1880, 1884) and by GLOWACKI (1885). It is mentioned in all of the recent articles (HARKA 1992a, MAJER 1998, MAJER & BORDÁCS 2001). Nevertheless, we have no own data regarding its occurrence in the Drava. One specimen was found near Őrtilos, caught by an angler, who told us that in this segment he regularly catches striped ruffe. We asked him to keep the fish alive, if he manages to catch one. The angler was trying to help us, but unfortunately the specimen swallowed the hook too deep and did not survive. We took the specimen, which will be placed in the fish collection of the Museum of Natural Sciences. Very rare, endangered endemism, protected and listed in Annex II and V to the Habitat Directive.

Zingel - *Zingel zingel* (Linnaeus, 1758)

Zingel is a very rare, endangered fish of the Danubian water system, the center of its area is the Danube basin. It was found in the entire Hungarian segment of the Drava; based on the number of specimen found, its population is stable. It was found at the majority of the sampling sites between Őrtilos and Matty, including both end-points. We caught 9 specimens in 2000, 16 specimens in 2001, 3 specimens 2002 3, 2 specimens in 2003 and 4 specimens in 2004 (Fig. 21). Although the number of specimens caught is decreasing during the years, but this does not necessarily mean the decline of its population. It has a high protection status under national legislation and listed in Annex II and V to the Habitat Directive.

Streber - *Zingel streber* (Siebold, 1863)

A very rare, endangered endemism of the country. Its oxygen-demand is higher, then that of the previous species, therefore it was only found between Őrtilos and Barcs. In 1999 8 specimens, in 2000 18 specimens, in 2001 48 specimens, in 2002 15 specimens, while in 2003 only 10 specimens, and in 2004 only 4 specimens were caught (Fig. 22). The number of specimens found indicates a stable, self-sustaining population, despite the decreasing numbers. It has a high protection status under national legislation and listed in Annex II to the Habitat Directive.

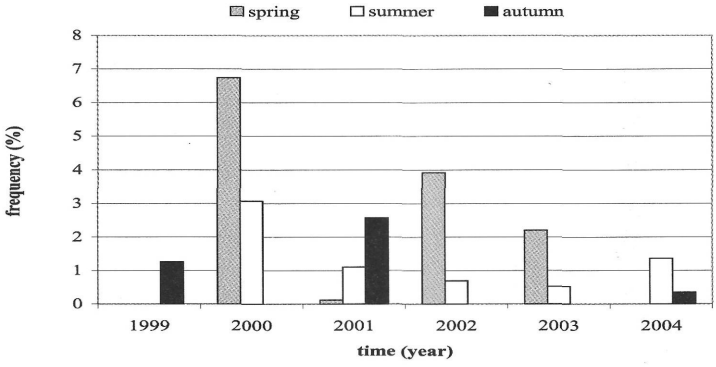

Fig. 19.: The frequency of *Cottus gobio* seasonally between 1999-2004

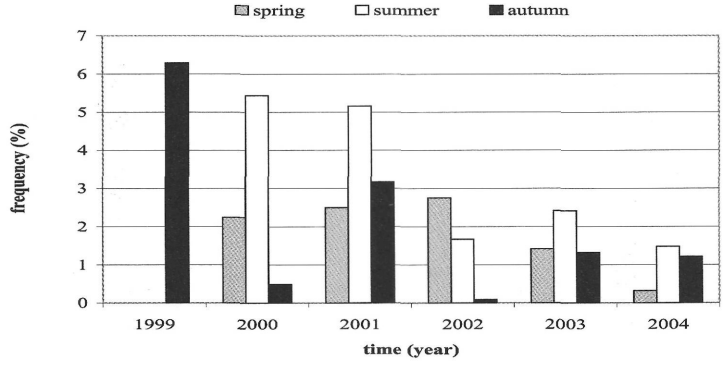

Fig. 20.: The frequency of *Gymnocephalus baloni* seasonally between 1999-2004

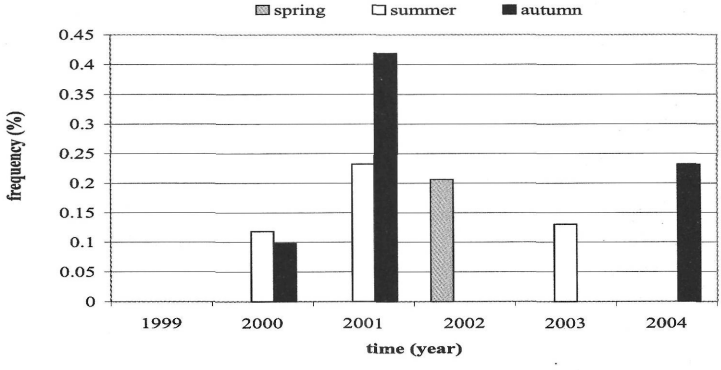

Fig. 21.: The frequency of *Zingel zingel* seasonally between 1999-2004

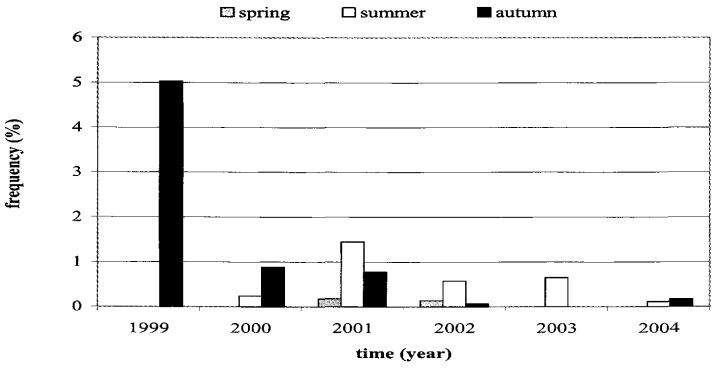

Fig. 22.: The frequency of *Zingel streber* seasonally between 1999-2004

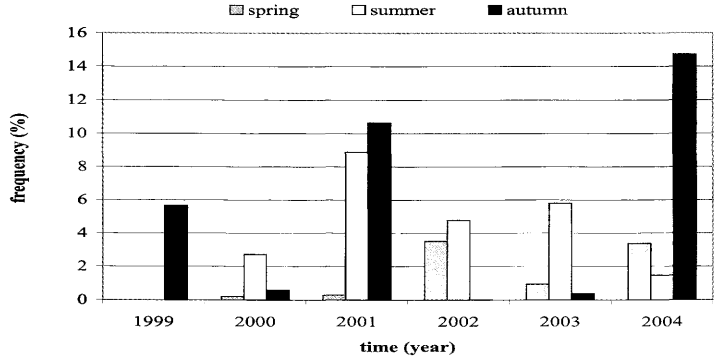

Fig. 23.: The frequency of *Proterorhinus marmoratus* seasonally between 1999-2004

Tubenose goby - *Proterorhinus marmoratus* (Pallas, 1814)

A pontocaspic faunistic element in expansion, with an increasing population also in the Drava. Increase in 2001 was especially good, as specimens of the age 0+ been caught in great quantities at several of the sampling sites. A stable, self-sustaining population lives in the Drava, confirmed by the number of specimens found: in 1999 39 specimens, in 2000 71 specimens, in 2001 351 specimens, in 2002 135 specimens, in 2003 106 specimens were caught; the high number of the year 2001 is explained by catching many young ones. It is also worth mentioning that previously it was found upstream the river only until Barcs, but in 2003 it appeared also near Vízvár. The maximum of its frequency was reached in 2004: 8,9%, with 288 specimens (Fig. 19). Its national protection was justified by the suggestion to include it in the Annexes to the Habitat Directive, which was finally not approved because of its invasive nature.

Characteristics of the fish fauna

The quality composition of the fish fauna is determined by the number of species, the quantity composition is determined by frequency of the species. The objective of fish-

faunistical researches is to regularly collect fishes in large quantities, but also the identification of the specimens. Because of the economic importance of fishes, catching fish is regulated by legislation, which he also had to respect during the survey.

The rapid current and the meandering bed of the Drava is like epipotamon, favouring primarily species living on the level of nase and barbel, therefore its fauna consists of mainly reophil species, preferring rapid currents, such as the dace (*Leuciscus cephalus*), the nase (*Chondrostoma nasus*), the riffle minnow (*Alburnoides bipunctatus*), the barbel (*Barbus barbus*), the white-finned gudgeon (*Gobio albipinnatus*), the Danubian roach (*Rutilus pigus virgo*), the Balon's ruffe (*Gymnocephalus baloni*), the East European bream (*Vimba vimba*), the burbot (*Lota lota*), the bullhead (*Cottus gobio*), the streber (*Zingel streber*). In addition to the above listed species, other endangered endemic species preferring rapid currents are also represented with smaller populations, such as the Danubian gudgeon (*Gobio uranoscopus*), the Kessler's gudgeon (*Gobio kessleri*), the stone loach (*Barbatula barbatula*) and the zingel (*Zingel zingel*).

Besides reophil species, almost the same numbers of eurytop species easily adopting to lotic and lenitic conditions as well were found, such as the bleak (*Alburnus alburnus*), the roach (*Rutilus rutilus*), the Prussian carp (*Carassius gibelio*), the bitterling (*Rhodeus amarus*), the tubenose goby (*Proterorhinus marmoratus*), the pike (*Esox lucius*), the silver bream (*Abramis bjoerkna*) and the perch (*Perca fluviatlis*).

In addition these species, significant populations of adventive species with a broad range of tolerance are also present, such as the false rasbora (*Pseudorasbora parva*) and the pumpkinseed (*Lepomis gibbosus*).

In some of the deadbeds and tributaries earlier separated, stagnophil species preferring marshland habitats can also find appropriate living conditions, and occasionally can be drifted to the main riverbed, such as the rudd (*Scardinius erythophthalmus*), the tench (*Tinca tinca*) and the European mudminnow (*Umbra krameri*).

In the main riverbed of the Drava, reophil species are dominant, which is partly due to the favourable breeding conditions. This statement is also supported by the high number of young specimens of reophil species. In the tributaries, depending on currents, eurytop species prevail over reophil species. Stagnophil species preferring marshy habitats were represented in the smallest proportion.

Expressing the natural value of the fish fauna

GUTI (1993, 1995) developed a system to express the nature conservation status of domestic fish species, using the categories of IUCN. Based on the suggested system, our natural waters can be qualified by the nature conservation status of the species, expressing their relative and absolute natural value. The absolute natural value (T_A) of the fish fauna is made up of the scale of value of the faunistic elements and the number of endemic species; relative natural value (T_R) is the absolute natural value (T_A) divided by the number of faunistic elements with an assigned scale of value (GUTI 1993, 1995).

Absolute natural value: $T_A = 4n_E + 3n_V + 2n_R + n_A + 0n_{In} + n^*$

$$T_A = 4*4_E + 3*13_V + 2*18_R + 14_T + 0*7_X + 9^* = 16 + 39 + 36 + 14 + 0 + 9 = 114$$

Relative natural value: $T_R = \dfrac{T_A}{n_E + n_V + n_R + n_A + n_{In}}$

$$T_R = \frac{114}{4_E + 13_V + 18_R + 14_A + 7_{In}} = \frac{114}{56} = 2{,}036$$

If the natural value of the fauna is quantified, the absolute natural value (T_A) mainly reflects the number of endangered fish species, while relative natural value (T_R) reflects their proportion.

Based on the scale of value, all faunistic elements, of which the presence in the Drava is verified (the table does not contain the species listed in literature), were classified, together with the corresponding scale of value, as summarized in Table 3.

Based on Table 3, the absolute and relative natural value of the fish fauna of the Drava has been defined. The species list in the table has been compiled using the nomenclature of KOTTELAT (1997) and the taxonomic order of NELSON (1984). As a comparison, the absolute (T_A) and relative natural value (T_R) of some other national waters are also shown, based on the book of GYÖRE (1995) (Table 4).

Discussion

Based on relevant literature and own survey, the recent fish faunistic list of the Drava has been compiled, illustrated in Table 1. Data from literature and from own surveys are shown separately. Thus the regular or occasional occurrence of 63 species is presumable. The number of species under nature conservation protection is 23, out of which 5 species has a high protection status (Ukrainian brook lamprey - *Eudontomyzon mariae*, Danube salmon - *Hucho hucho*, European mudminnow - *Umbra krameri*, zingel - *Zingel zingel*, streber - *Zingel streber*).

22 of the species are listed in the Annexes to the Habitat Directive. The value of the fish fauna is further increased by 9 endemic faunistic element of the Danube catchment area (roach - *Rutilus pigus virgo*, Danubian gudgeon - *Gobio uranoscopus*, Kessler's gudgeon - *Gobio kessleri*, Danube salmon - *Hucho hucho*, European mudminnow - *Umbra krameri*, Balon's ruffe - *Gymnocephalus baloni*, striped ruffe - *Gymnocephalus schraetser*, zingel - *Zingel zingel*, streber - *Zingel streber*).

Legend to Table 3:

E: *Endangered*: The population decreased during the 20th century, the species could be occasionally seen in the last decade. The size of the population and the extension of its habitat are supposedly under the critical level. The species faces extinction - scale of value: 4

V: *Vulnerable*: The species has some habitats, but the number of specimens is decreasing and the habitats decline. If the factors causing the decline of the population become constant, it is classified under category "disappearing" - scale of value: 3

R: *Rare*: Generally the species can be found in small numbers and in specific habitats. Unlike the previous categories, it is potentially endangered. In case its habitats decline, it is classified under category "endangered" - scale of value: 2

A: *Abundant*: Specimens can be found in the majority of natural waters in large numbers, living in different habitats. Relatively resistant to anthropogenic impacts, but if natural supplies are not sufficient, it falls under category "rare" - scale of value: 1

In: *Introduced*: Species introduced in the Carpathian basin deliberately or accidentally during the last 100 years, with steady self-sustaining populations - scale of value: 0

Im: *Immigrant*: Occasionally occurring species, living Europe-wide, which presumably had no self-sustaining population in domestic waters.

*: Endemic: Endemic faunistic element of the catchment area of the Danube

Table 3. The endangered status and nature conservation scale of value of fish species of the Drava

No.	Scientific name	Endangered status	Nature conservation value
1	*Eudontomyzon mariae*	E	4
2	*Acipenser nudiventris*	E	4
3	*Acipenser ruthenus*	R	2
4	*Anguilla anguilla*	Im	-
5	*Rutilus rutilus*	A	1
6	*Rutilus pigus virgo*	V*	4
7	*Ctenopharyngodon idella*	In	0
8	*Scardinius erythrophthalmus*	A	1
9	*Leuciscus leuciscus*	R	2
10	*Leuciscus cephalus*	A	1
11	*Leuciscus idus*	R	2
12	*Aspius aspius*	R	2
13	*Leucaspius delineatus*	V	3
14	*Alburnus alburnus*	A	1
15	*Alburnoides bipunctatus*	V	3
16	*Abramis bjoerkna*	A	1
17	*Abramis brama*	A	1
18	*Abramis sapa*	R	2
19	*Vimba vimba*	V	3
20	*Chondrostoma nasus*	R	2
21	*Tinca tinca*	R	2
22	*Barbus barbus*	A	1
23	*Gobio gobio*	A	1
24	*Gobio albipinnatus*	R	2
25	*Gobio uranoscopus*	E*	5
26	*Gobio kessleri*	V*	4
27	*Pseudorasbora parva*	In	0
28	*Rhodeus amarus*	A	1
29	*Carassius carassius*	R	2
30	*Carassius gibelio*	A	1
31	*Cyprinus carpio*	A	1
32	*Hypophthalmichthys molitrix*	In	0
33	*Misgurnus fossilis*	R	2
34	*Cobitis elongatoides*	R	2
35	*Sabanejewia bulgarica*	V	3
36	*Barbatula barbata*	R	2
37	*Ameiurus nebulosus*	In	0
38	*Ameiurus melas*	In	0
39	*Silurus glanis*	R	2
40	*Esox lucius*	A	1
41	*Umbra krameri*	V*	4
42	*Hucho hucho*	E*	5
43	*Salmo trutta m. fario*	R	2
44	*Lota lota*	V	3
45	*Cottus gobio*	V	3
46	*Lepomis gibbosus*	In	0
47	*Micropterus salmoides*	In	0
48	*Perca fluviatilis*	A	1
49	*Gymnocephalus cernuus*	A	1
50	*Gymnocephalus baloni*	R*	1
51	*Gymnocephalus schraetser*	V*	4
52	*Sander lucioperca*	R	2
53	*Sander volgensis*	V	3
54	*Zingel zingel*	V*	4
55	*Zingel streber*	V*	4
56	*Neogobius fluviatilis*	R	2
57	*Proterorhinus marmoratus*	R	2

Table 4.: Absolute and relative natural value of the fish fauna of some natural waters on the basis of the book of GYÖRE (1995), including own data (in decreasing order based on the absolute natural value (T_A)).

Water	Author	Natural value	
		Absolute (TA)	Relative (TR)
Tisza	Györe 1995	120	2,034
Drava	Sallai+Anglers' data	114	2,036
Drava	Sallai 2002	111	2,018
Duna	Guti 1995	112	1,931
Upper-Tisza	Györe et al. 1995	98	2,279
Rába	Harka 1992	90	1,800
Tisza Lake	Györe 1995	88	1,660
Mura	Sallai 1999	84	1,953
Bodrog	Harka 1992	64	1,778
Hármas-Körös	Györe 1988	58	1,634
Maros	Nalbant 1995	56	1,647
Sajó	Harka 1992	54	1,800
Hortobágy-Berettyó	Sallai 1996	51	1,378
Túr	Harka 1994	50	1,428
Zagyva	Harka 1989	47	1,566
Hernád	Harka 1992	43	2,047
Balaton	Bíró 1993	43	1,303
Fertõ Lake	Guti 1990	34	1,308

We carried out fishfaunistical monitoring activities in the Hungarian segment of the Drava River between 1999 and 2004. A small-capacity, pulsating direct current electric fishing machine with rechargeable battery has been used for the surveys.

During the monitoring surveys, in 1999 159 specimens, in 2000 2.356 specimens, in 2001 5.081 specimens, in 2002 7.735 specimens, in 2003 4.089 specimens, and in 2004 3.229 specimens were caught and identified. The altogether 22.649 fish specimen represented 44 species.

As our knowledge on the river was insufficient, fishfaunistical data was collected in other types of habitats, in side arms, the main channel and backwater arms as well, beyond the monitoring sites. In addition, our own data was complemented with verified data supported by evidence species or picture documentation regarding the occurrence of species, and also with catching data from the Fishery Database, so the presence of altogether 57 species has been confirmed. Out of the 57 species of verified occurrence, 23 species have nature conservation status. 5 of these protected species have highest level protection status (Ukrainian brook lamprey - *Eudontomyzon mariae*, Danube salmon (*Hucho hucho*), European mudminnow - *Umbra krameri*, zingel - *Zingel zingel*, streber - *Zingel streber*). Out of the identified species 22 species are listed in the Annexes of the Habitat Directive. Based on the number of species found, the absolute natural value (TA: 114) and relative natural value (TR: 2,036) of the fish fauna was defined. The high absolute natural value of the Drava (114) clearly reflects the proportion of endangered species.

Based on relevant literature and own survey, the recent fish faunistic list of the Drava has been compiled; based on this list, the regular or occasional occurrence of 63 species is presumable. Compared to previously published species list, we have recorded 8 species in the Hungarian segment of the Drava: Ukrainian brook lamprey (*Eudontomyzon mariae*), riffle minnow (*Alburnoides bipunctatus*), Danubian gudgeon (*Gobio uranoscopus*), Kessler's gudgeon (*Gobio kessleri*), Bulgarian loach (*Sabanejewia bulgarica*), stone loach (*Barbatula barbatula*), European mudminnow (*Umbra krameri*), monkey goby (*Neogobius fluviatilis*). Out of the recorded species, 22 are listed in the annexes to the Habitat Directive.

Acknowledgements

We would like to express our thanks to the colleagues of the Danube-Drava National Park Directorate for their assistance in sampling and for helping us with their knowledge throughout our work, namely Hajnalka Tarlósi Daczóné, László Fenyősi, Zoltán Horváth, Ervin Mezei.

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A Dráva magyarországi szakaszának halfaunisztikai célú monitorozása (1999-2004)

SALLAI ZOLTÁN & KONTOS TIVADAR

1999-2004 között halfaunisztikai célú monitorozást végeztünk a Dráva folyó magyar szakaszán. A vizsgálathoz kisteljesítményű, pulzáló egyenáramot előállító, akkumulátoros rendszerű elektromos halászgépet használtunk.

A monitoring jellegű vizsgálatok során az 1999-es évben összesen 159, 2000-ben 2356, 2001. évben 5081, 2002-ben 7735, 2003-ban 4089, míg 2004-ben 3229 halegyedet fogtunk és határoztunk meg. Az eddig fogott 22649 halpéldány összesen 44 fajt képviselt.

Mivel a folyóról rendelkezésre álló eddigi ismereteink meglehetősen hiányosak voltak, a monitoring helyeken kívül, más jellegű élőhelyeken és végeztünk halfaunisztikai célú adatgyűjtéseket, mellékágakban, holtmedrekben és a főágban egyaránt. Továbbá saját adatainkat kiegészítettük horgászoktól származó, bizonyító példánnyal vagy képdokumentációval hitelesített fajok előfordulási adataival, valamint a Halászati Adattárban lévő fogási adatokkal, így összesen 57 faj jelenlétét tudtuk eddig bizonyítani. Az 57 bizonyított előfordulású fajból 23 faj természetvédelmi oltalom alatt áll. A természetvédelmi oltalom alatt álló fajok közül 5 faj fokozottan védett (dunai ingola - *Eudontomyzon mariae,* galóca - *Hucho hucho*, lápi póc - *Umbra krameri*, magyar bucó - *Zingel zingel*, német bucó - *Zingel streber*). A megállapított fajszám alapján kifejeztük a halfauna abszolút (TA: 114) és relatív természeti értéket (TR: 2,036). A Dráva halfaunájának magas (114) abszolút természeti értéke hűen tükrözi az előforduló veszélyeztetett fajok magas arányát.

Szakirodalmi és saját adatok alapján összeállítottuk a folyó recens faunalistáját, mely alapján összesen 63 faj alkalmi vagy rendszeres előfordulása valószínűsíthető a Drávában. A korábbi publikált fajlistákhoz képest új fajként sikerült a Dráva magyar szakaszáról kimutatnunk eddig 8 fajt, melyek a következők: dunai ingola (*Eudontomyzon mariae*), sujtásos küsz (*Alburnoides bipunctatus*), felpillantó küllő (*Gobio uranoscopus*), homoki küllő (*Gobio kessleri*), kőfúró csík (*Sabanejewia bulgarica*), kövicsík (*Barbatula barbatula*), lápi póc (*Umbra krameri*), folyami géb (*Neogobius fluviatilis*). A megállapított fajszámból 22 faj a Habitat Directive függelékeiben is megtalálható.

DOI:10.24394/NatSom.2005.7.105 | Natura Somogyiensis | 7 | 105-117 | Kaposvár, 2005

Herpetofauna of the Dráva-valley (2002-2004)

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KOVÁCS T. & BRANDON A.: *Herpetofauna of the Dráva-valley (2002-2004).*
Abstract: As part of the Duna-Dráva National Park (DDNP) initiated Dráva Monitoring Program involving over 25 indicator taxa groups, monitoring of amphibians and observing water dependent reptiles since 2000 have been conducted by one of the authors (Kovács). The monitoring protocol has been adjusted to reflect principles expressed by the Ministry of Environmental Protection and Water, Directorate for Nature Protection. In this work we aim to complement our work in quantifying number of species by also identifying water-bodies as possible egg-laying habitats. The basis of the entire program is to estimate possible effects of the planned Croatian hydroelectric power station. Although the location of the station would be on a section of the Dráva that belongs to Croatia, it undoubtedly would influence the water regime and the condition of various wetlands along many sections of the Dráva.
Data was collected altogether from 21 sites and from 2002 to 2004 the presence of 2 newt, 8 anuran, 1 terrapin, 1 lizard, and 3 snake species were established in the study area. Using three separate indices we estimated herpetofauna habitat quality of the sampled areas. Besides of the distributional data we present the variance in the water level of the breeding sites between 2002-2004.

Key words: Amphibians, reptiles, Drava valley, long-term monitoring

Introduction

Monitoring programs are increasingly being employed to assess trends in species abundance, distribution, and biodiversity (GIBBS et al. 1998, HINTERMANN et al. 2000, YOCCOZ et al. 2001). Widespread amphibian population declines (BLAUSTEIN and WAKE 1990, PHILLIPS 1990, GRIFFITHS and BEEBEE 1992) have initiated a more critical global review of the status of amphibian species (VIAL and SAYLOR 1993). Complicating the understanding of amphibian declines and population dynamics is naturally high fluctuations of many populations (PECHMANN and WILBUR 1994, MARSH 2001) and metapopulation dynamics, with decreases in some local populations coinciding with increases in others (SJÖGREN 1991). Amphibians have also been recognized as potential indicators of environmental change (VITT et al. 1990, STEBBINS and COHEN 1995, BOWERS et al. 1998), an additional factor driving inventory and monitoring efforts. Moreover, monitoring data are essential to identify key issues for policy and management goals, such as assessing priorities for conservation and land use, for environmental impact assessment, and for informing managers, policy-makers, and the general public about the state of nature (STORK and SAMWAYS 1995). To assess the status of amphibian populations, distribution patterns and population characteristics need to be examined. However, assessments are difficult because few comparable data sets and long-term studies exist (BLAUSTEIN 1994,

ISSN 1587-1908 (Print); ISSN 2062-9990 (Online)

REED and BLAUSTEIN 1995). The need to establish inventories and monitoring has been emphasized, both in Hungary and elsewhere (PECHMANN and WILBUR 1994, KORSÓS 1997).

The assessment of Hungary's amphibians and reptiles has a long history. Well known zoologists of the XIX. and early XX. century, including Géza Encz, Lajos Méhelyi, Ottó Hermann and Gyula Fehérváry have contributed to the detailed anatomical knowledge about the country's herpetofauna and its taxonomic classification. Following the Second World War emphasis was placed on the faunal description of various regions. Prominent works include DELY (1967, 1987, 1990), MARIÁN (1960, 1963, 1968, 1981, 1982 1987), MARIÁN and MARIÁN (1980), MARIÁN and SZABÓ (1968), MARIÁN and TRASER (1978) and SZABÓ (1956). As a result of these works we had a comprehensive knowledge about the Hungarian herpetofauna including species distributions by the end of the 1970s. However, in some areas, such as the Velencei and the Cserhát mountains we lack not only detailed assessments, but elementary species lists as well. In the past two decades strict faunal surveys were not in the focus of Hungarian herpetologists - other than the complex issue of the edible frog (GUBÁNYI and CREEMER 1994, LŐW et al. 1989, TUNNER and KÁRPÁTI 1997, KOVÁCS 2003). Today civil organizations are trying to fill these resulting gaps in knowledge. The first surveys of amphibians and reptiles with their protection in mind were conducted 20 years ago. A prominent species of this activity was the Hungarian Meadow Viper (KORSÓS 1991, KORSÓS and FÜLÖP 1994) which has suffered serious population losses since the 1980s. As a result of the strengthening of Hungarian nature protection, increasingly more long-term monitoring projects were launched, specifically with protection in mind. Monitoring reptile and amphibian populations became an integral part of these projects in the most important locations, such as the Szigetköz, Kis-Balaton and Dráva-valley.

As part of the Duna-Dráva National Park (DDNP) initiated Dráva Monitoring Program involving over 25 indicator taxa groups, monitoring of amphibians and observing water dependent reptiles since 2000 have been conducted by one of the authors (Kovács). The monitoring protocol has been adjusted to reflect principles expressed by the Ministry of Environmental Protection and Water, Directorate for Nature Protection. However, this protocol was only finalized in 2003, thus methods used at the Dráva are unique in many ways. The relevant sections of the National Biodiversity Monitoring Program that concern amphibians deal primarily with wet habitats (KISS et al. 2002). In this work we aim to complement our work in quantifying number of species and individuals by also identifying water-bodies as possible egg-laying habitats. The basis of the entire program is to estimate possible effects of the planned Croatian hydroelectric power station. Although the location of the station would be on a section of the Dráva that belongs to Croatia, it undoubtedly would influence the water regime and the condition of various wetlands along many sections of the Dráva.

Prior to the data collected in the Dráva monitoring program - started in 2000 - there were no publications or other informative literature on the herpetofauna of the Dráva valley. Other surveys, if they were conducted, were not reported. To date only one publication has been made from the data of the reports (KOVÁCS 2002). Geographically, the closest survey was done by PUKY (2000).

Methods

Samples were taken at habitat areas identified by the DDNP. In choosing exact locations the effects of the modifications on the Dráva were considered. Thus, where possi-

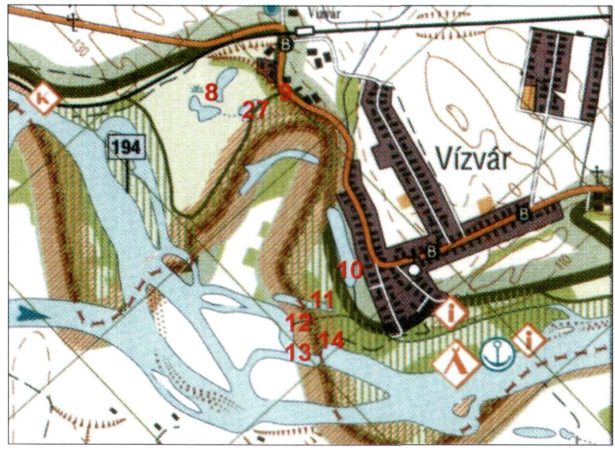

Fig. 1.: Sample sites by Vízvár

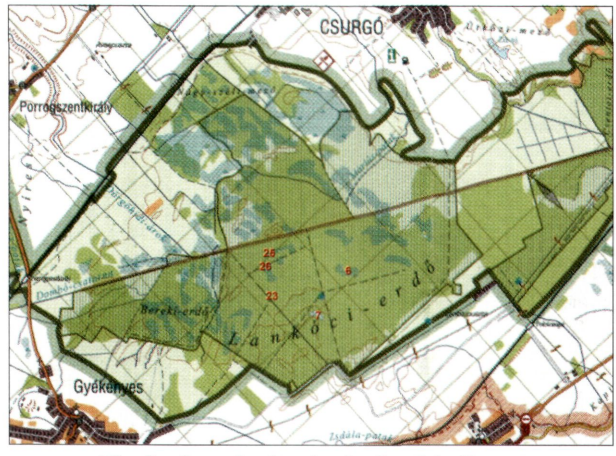

Fig. 2.: Sample sites in the Lankóc Forest

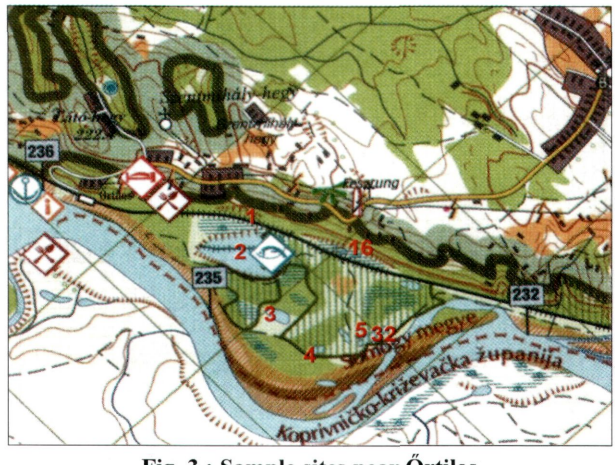

Fig. 3.: Sample sites near Őrtilos

Fig. 4.: Agile frog (*Rana dalmaitina*) in Lankoci forest

Fig. 5.: Pond turtle (*Emys orbicularis*) at Duics-gödrök

ble, egg-laying areas less than 1 km from the river were marked. Three regions were involved in the monitoring: Őrtilos (46°17.0′; 16°53.5′), Lankóc Forest (46°13.5′; 17°03.5′) and Vízvár (46°06.0′; 17°13.5′). Data was collected from 21 sites in the following areas (geographical coordinates available in DDNP report): Őrtilos (7), Lankóc Forest (6), Vízvár (8). The following types of water-bodies were identified: used or unused gravel pits (13), oxbows (1), alder swamps (5) and unknown origin (2). Detailed descriptions of these water-bodies are not within the scope of this paper.

The following methods were used for collection and observation: riparian visual encounter surveys, counting egg-masses, utilizing the call-based Wisconsin-index, catching salamanders by bottle-traps, netting tadpoles and larvae. Members of the edible frog complex were identified based on four morphological parameters after capturing them with a net. Terrapins were captured with a 60x60x100cm fish-basket, using pig-liver as bait. Snakes and lizards were registered only by visual observation. The methods of the field survey are described in the protocol of the Amphibian-Reptile project of National Biodiversity Monitoring System (KISS et al. 2002). The selected methods are harmonized with those presented by Heyer et al (1994).

Sample sites are indicated on figures 1., 2., and 3. Sampling was conducted on seven occasions between 15th March and 30th September, focusing on the breeding season in March, April and May. Considering the low activity of amphibians in the dry season field visits were cancelled in July and August. The date of the field works were designated flexibly depending on the weather conditions.

In 2002, 2003 and 2004 regular water-level measurements were also taken at seven water bodies which represent different types of water regimes:

1. direct contact with the Dráva through surface stream (Kenderáztató),
2. indirect contact with the Dráva through ground waters (Horgászgödör, Horgásztó /Vízvár/)
3. water regime fairly independent from the Dráva (Égés, Duics, Kis-Duics, Mélymocsár)

Results and discussions

From 2002 to 2004 the presence of 2 newt, 8 anuran, 1 terrapin, 1 lizard, and 3 snake species were established in the study area (Table 1). Generally, species common in the low-lying areas of the Carpathian Basin are represented in the Dráva valley. The following are missing from the current list:

1. species of hilly and mountainous areas of Hungary: Alpine Newt (*Triturus alpestris*), Fire Salamander (*Salamandra salamandra*), Yellow-bellied Toad (*Bombina variegata*), Common Frog (*Rana temporaria*);
2. species of dry grasslands, dry forest or rocky areas: Green Toad (*Bufo viridis*), Snake-eyed Skink (*Ablepharus kitaibelii*), Wall Lizard (*Podarcis muralis*), Balkan Wall Lizard (*Podarcis taurica*), Green Lizard (*L. viridis*);
3. species of relict ice-age habitats: Viviparous Lizard (*Zootoca vivipara*);
4. species distributed in small, well defined areas of Hungary: Italian Crested Newt (*T. carnifex*), Common Adder (*Vipera berus*), Meadow Viper (*Vipera ursinii rakosiensis*), Large Whip Snake (*Coluber caspius*);
5. species difficult to detect: Aesculapian Snake (*Elaphe longissima*), Slow Worm (*Anguis fragilis*).

Table 1. Current species list of the surveyed locations. Tv: Smooth Newt (*Triturus vulgaris*), Td: Danubian Crested Newt (*T. dobrogicus*), Bo: Fire-bellied Toad (*Bombina bombina*), Bb: Common Toad (*Bufo bufo*), Pf: Common Spadefoot Toad (*Pelobates fuscus*), Ha: European Treefrog (*Hyla arborea*), Ra: Moor Frog (*Rana arvalis*), Rd: Agile Frog (*R. dalmatina*), Re: Edible Frog (*R. kl. esculenta*), Rl: Pool Frog (*R. lessonae*), Eo: Pond Turtle (*Emys orbicularis*), La: Sand Lizard (*Lacerta agilis*), Nn: Grass Snake (*Natrix natrix*), Nt: Dice Snake (*N. tessalata*), Ca: Smooth Snake (*Coronella austriaca*)

Locations	*Site No.*	Tv	Td	Bo	Bb	Pf	Ha	Ra	Rd	Re	Rl	Eo	La	Nn	Nt	Ca
Örtilos region																x*
Andrasik	*1*	x		x	x	x	x	x	x	x	x	x		x		
Horgásztó	*2*	x		x	x		x		x	x	x	x	x	x	x	
Horgászgödör	*3*	x	x	x	x		x		x	x	x			x		
Keskeny-gödör	*4*	x	x	x	x	x	x	x	x	x	x	x	x	x		
Apró gödör	*5*	x		x	x	x			x	x	x			x		
93-as	*16*	x	x	x	x	x	x		x	x	x			x		
Holtág-gödör	*32*	x		x	x				x	x	x	x		x		
Lankóc Forest																
Égés	*6*	x	x	x	x	x	x	x	x	x	x	x		x		
Lapos	*7*	x	x	x	x	x	x	x	x	x	x	x		x		
Híd	*23*								x	x	x	x		x		
Nagyláp	*25*								x	x	x	x				
Mélymocsár	*26*								x			x				
Kubik	*31*								x	x	x	x		x		
Vízvár region																
Duics	*8*	x	x	x	x	x	x	x	x	x	x	x		x		
Kis Duics	*9*	x	x	x	x	x	x	x	x	x	x	x		x		
Horgásztó	*10*	x	x	x	x		x	x	x	x	x			x		
Kenderáztató	*11*	x	x	x	x	x	x	x	x	x	x	x		x		
Zoli-gödör	*12*								x	x		x				
Apró gödör	*13*								x	x	x	x				
Nyakas gödör	*14*									x		x				
Feneketlen-tó	*27*				x	x			x	x	x			x		

* Smooth Snake was observed 600m away from the Horgásztó (No. 2).

Habitat Assessment

Using three separate indices, BCK (BÁLDI et al. 1995), P (KISS 2005) and BK (BAKÓ and KORSÓS 1999), we estimated herpetofauna habitat quality of the sampled areas (Table 2). Each index type consists of a scoring list of all native amphibian and reptile species. The scores are based on the distribution, abundance and level of vulnerability of each species. Results demonstrated that there is significantly strong agreement amongst the indices with a 100% match in rank between BCK and P indices. The BK index agreed in 20 of 21 sites with the other two indices.

Table 2. Combined evaluation of wet areas as amphibian-reptile habitats by three different indices

Locations	*Site No.*	BCK	P	BK
Örtilos region				
Andrasik	*1*	292	15	23
Horgásztó	*2*	290	15	20
Horgászgödör	*3*	223	12	17
Keskeny-gödör	*4*	347	19	28
Apró gödör	*5*	193	10	15
93-as	*16*	251	14	22
Holtág-gödör	*32*	211	11	15
Lankóc Forest				
Égés	*6*	320	18	27
Lapos	*7*	320	18	27
Híd	*23*	139	7	10
Nagyláp	*25*	111	6	8
Mélymocsár	*26*	73	4	6
Kubik	*31*	139	7	10
Vízvár region				
Duics	*8*	320	18	27
Kis Duics	*9*	320	18	27
Horgásztó	*10*	246	13	19
Kenderáztató	*11*	320	18	27
Zoli-gödör	*12*	92	5	6
Apró gödör	*13*	111	6	8
Nyakas gödör	*14*	65	4	5
Feneketlen-tó	*27*	144	8	12

The distribution of water dependant amphibians and reptiles is determined, beyond larger climatic factors, by the number and spatial distribution of water bodies suitable for egg-laying and feeding. Another important factor is the water retention ability and water level of the water bodies. Habitats along the Dráva river can be grouped into two main categories. The first contains water bodies the water circulation of which is determined by the river's flow. The circulation of the other type is not measurably influenced by the Dráva due to larger distances and barriers between them (eg. Lankóc Forest). Fig. 6. represents the water levels of seven water bodies in 2002, 2003 and 2004. The consecutive years differed in the all over water supply. While 2002 can be accounted as an average year, 2003 was extremely dry and 2004 was extremely wet. The last year, beside of the high volume of precipitation was characterized by an unusually high flood of the Dráva river. It clearly shows that while the level of most water bodies was drastically reduced by the end of summer in 2002, even to the point of drying out, the water level of the Horgászgödör of Őrtilos (No. 3) and the Kenderáztató of Vízvár (No. 11), both strongly influenced by the Dráva, visibly increased due to the rise in the level of the river.

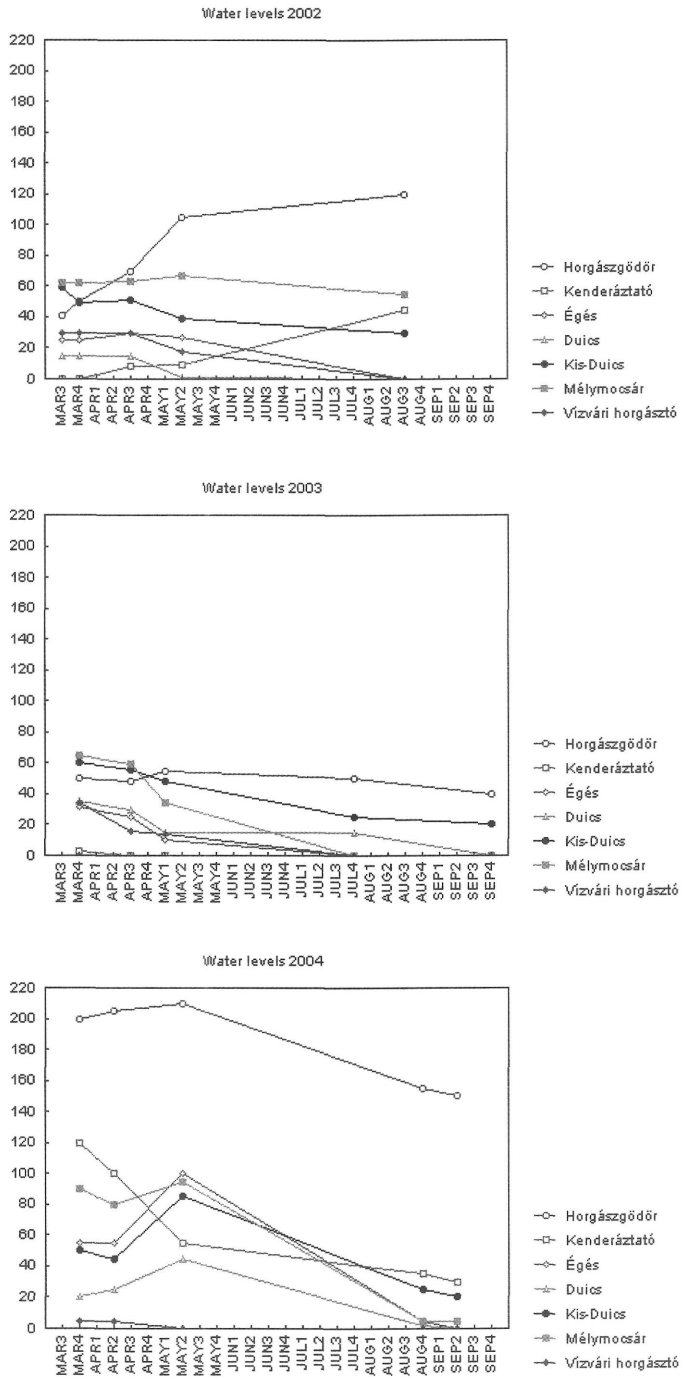

Fig. 6.: Water levels (cm) in selected water-bodies. 1, 2, 3, 4= week of the given month

Species Distribution

Moor Frogs and Agile Frogs appeared in the same ponds roughly at the same time and probably competed for the better breeding sites. Moor Frogs formed compact choruses and built egg-mats unlike the Agile Frogs, which dispersed their egg clutches. When the water level was low the Moor Frog sites became insufficient for choruses and laying eggs. In 2003 due to the dry climatic conditions Moor Frog has delayed the egg-laying in Lankóc Forest's Égés site (No. 6) and only a few individuals were observed even in 2004 (before the presented observation period, 2000 was definitely a rich year, while the drier 2001 season resulted in poor recruitment of Moor Frogs).

Large newts were identified as Danube Crested Newts by using the Wolterstorff index (forelimb length/distance between legs). This species occupies the Carpathian Basin (GRIFFITHS 1996) and not the related northern crested newt (*T. cristatus*) from which it was separated. Danube Crested Newts were always found together with Smooth Newts, whereas the latter species occupied some ponds where the first was not present. The relative density of Smooth Newts was always higher than that of Danube Crested Newts.

Common Toad and Tree Frog are common species of the region and can be observed in the majority of the monitored sites. However, their proportion in the local amphibian community showed wide variety. Common Toads formed large choruses (>100 specimens) in those water bodies which possessed relative large open surfaces (No. 2, 10, 16, 27 and 32). Similarly, large mating assemblages (>50 specimens) were observed in Tree Frog in some of the ponds (No. 1, 6, 7, 8 and 16). The correlation between the vegetation structure and the abundance of this latter species has not yet been revealed.

Even in the larger fishponds or lakes Pool Frog/Edible Frog breeding communities were found. In some locations (No. 12, 14) the pure Edible Frog populations indicated disturbed habitats. Surprisingly Marsh Frogs (from the green frog complex) are a rare species in the Dráva valley and were found only in some locations situated out of the surveyed areas.

European Pond Turtle was observed in much higher number of the water bodies than it had been assumed earlier. However, the frequency of the observations during the years were not uniform. In 2003 the species disappeared completely from 7 of the 21 sites already by April and later they left 2 more sites due to the long drought. These sites were quickly recolonized in 2004.

Green toads were not found in the breeding ponds. This was unexpected since considerable numbers were killed on the roads of the surrounding villages. It seems that they are unable to compete with other species for the best breeding sites, and instead sought ephemeral puddles.

One of the most crucial factors affecting the breeding sites and amphibian breeding success is the water level of the Dráva river, which changes dramatically depending on the schedule of the Dubrava power station in Croatia built more than 10 years ago. Fast daily changes of water level make several inlets of the river unsuitable for breeding amphibians. Another important point is the annual variation in water regime. In 2000 the water level in the river Dráva did not show striking variation so the most optimal aquatic plant community developed in those ponds located close to the river. Due to favourable breeding conditions, the number of mating amphibians reached an optimum. The following year (2001) started with very high water levels in the sample sites in Ortilos and Vízvár regions, so the native shallow water vegetation could not properly develop. However, in Lankóc Forest, 5 km away from the river, the level of the river did not influence pond wildlife. Year 2002 was again similar to the starting year of the project (2000) followed by the great fluctuations in 2003 and 2004.

Low water level naturally provides less breeding habitat, and in many species exposure of eggs to dry conditions can result in significant losses of the yearly progeny. According to observations by the Dráva, overly high water levels for extended periods of time are also disadvantageous for egg-laying in some habitats. Most of the gravel pits are lined by steep walls with minimal plant protection. In case of high water levels even this narrow strip of vegetation cannot develop, and even bottom anchored reed-grass populations do not reach the surface of the water. Under these conditions amphibians cannot find suitable habitat either for egg-laying or for cover. An illustrative example is the Horgászgödör at Őrtilos (No. 3), where in 2002 no newts were observed at all, and only a limited numbers of eggs of other species.

Conclusions

The Dráva monitoring revealed that the Moor Frog, which previously was not considered important in amphibian conservation biology in Hungary, is sensitive to the quality and drying of egg-laying areas. This may be due to its propensity to lay eggs close to riparian edges. While the much more water-dependant Edible Frog, Moor Frog, Pool Frog, and Fire-bellied Toad utilize shallow, muddy waters as well, the Moor Frog only tolerates minor destruction of the egg-laying areas. Our field observations indirectly prove immigration of Pond Terrapins from their habitats. In 2002 and 2003 when the Kenderáztató at Vízvár (No. 11) temporarily dried out the terrapins disappeared from its bed. At the same time 4 individuals were found in the Apró gödör (No. 13) where previously none were found. The hole has an approximately 30m^2 surface area, and is subject to human disturbance. It is not suitable as long-term terrapin habitat, but in drought periods it may be a good refuge.

Long term monitoring of species in the *Rana esculenta* complex is important. Surveys of the Kis-Balaton show significant change in four populations during a ten-year period (KOVÁCS 2004). The change in species composition can indicate change in water quality, especially dissolved oxygen, and the existence of suitable over-wintering sites.

Studies to date have not indicated significant changes in the herpetofauna by the Dráva River. However, there is cause for concern: the recurring droughts have, in 2002-2003, significantly reduced the number of Moor Frogs, Edible Frogs, Pool Frogs and Fire-bellied Toads.

The Croatian investing company (Hrvatska Elektropriveda) have compiled a series of impact assessments regarding the expected changes of the water regime of the Dráva River (www.kvvm.hu). According to these studies there will be a drastic change in the level of the ground water below the main dam of the planned reservoir: 1. a side-canal would derive the majority of the water from the recent main branch of the river and 2. the outflowing water would have a dramatically accelerated speed which could carve the river bed 2 m lower in the first 10 years. Also the daily changes of the water level could reach 2 m in the Dráva which may be unfavourable for the current natural plant and animal communities. At this stage it is uncertain how this will affect water levels at amphibian egg-laying sites, thus the direction of change cannot be predicted as the connection between the breeding ponds and the river has not yet been revealed.

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KOVÁCS TIBOR ÉS BRANDON ANTHONY

A Dráva völgy kétéltű és hüllőfaunája (2000-2004)

A Duna-Dráva Nemzeti Park 2000-ben indította el természetvédelmi célú biodiverzitás-monitorozási programját a Dráva Őrtilos és Vízvár közti szakaszán a Horvátország által megépíteni szándékozott vízerőmű tervei kapcsán. A monitorozásra kijelölt élőlény-csoportok közé bevonták a kétéltűeket és a vizek mentén előforduló hüllőket. Jelen tanulmány a program 2002-2004 közti időszakának eredményeit mutatja be.

A mintavételi helyek kijelölése három régióban, 21 ponton történt meg. Az első Őrtilos-Szentmihályhegy közelében, a Dráva kissé kiszélesedő árterén található, és kizárólag egykori kubikgödröket vagy kavicsbánya-tavakat foglal magába. A második körzet a Lankóci-erdő, ahol a mintavételi pontok közt szerepel újonnan nyitott kubikgödör és stabil, természetvédelmi szempontból kifejezetten értékes égerláp is. A harmadik körzet Vízvár mellett található, ahol egykori holtágak, kubikok, mesterséges eredetű horgásztavak és égerlápok is szerepelnek a mintavételi helyek listáján.

A vizsgálati periódusban 2 gőte- (*Triturus vulgaris, T. dobrogicus*), 8 béka- (*Bombina bombina, Bufo bufo, Pelobates fuscus, Hyla arborea, Rana arvalis, R. dalmatina, R. lessonae, R. kl. esculenta*), 1 teknős- (*Emys orbicularis*), 1 gyík (*Lacerta agilis*) és három kígyófaj (*Natrix natrix, N. tessalata, Coronella austriaca*) jelenlétét sikerült kimutatni.

A mintavételbe bevont víztesteket a bennük előforduló fajok száma alapján értékeltük, melyhez három különféle indexet használtunk. A víztestek értéksorrendje mindhárom index alapján közel azonosnak mutatkozott. A legmagasabb értékpontokat a változatos növényzeti struktúrával rendelkező erdei lápok és idősebb kubikgödrök érték el, míg a legalacsonyabbakat a meredek falú, gyakorlatilag növénymentes, a Dráva napi vízszintingadozása által is erősen befolyásolt víztestek esetében kaptuk.

Folyamatosan mértük néhány kiválasztott víztest vízszintjét is. A 2002. évi, átlagosnak mondható vízállást 2003-ban szélsőséges szárazság követte, majd 2004-ben a Dráva árvizek miatt igen magas vízszinteket regisztráltunk. Világossá vált, hogy még közvetlenül a Dráva egykori árterén elhelyezkedő víztestek között is eltérő mértékű a Dráva vízállásától való függőség, ez pedig erősen befolyásolja a bennük előforduló fajok számát az adott évben.

DOI:10.24394/NatSom.2005.7.119

Natura Somogyiensis	7	119-141	Kaposvár, 2005

Studies of avian communities along river Drava, between 2000-2004 (Aves)

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FENYŐSI L.: *Studies of avian communities along river Drava, between 2000-2004 (Aves)*
Abstract: The monitoring of avian fauna (Aves) along river Drava was launched in 2000. According to our results total density in the floodland sample areas in 2000-2004 was found to range between 54.0-76.56 pairs/10 ha. In the study years a total of 5-14 pairs of *Sterna albifrons* and 50-90 pairs of *Sterna hirundo* bred annually in the Drava section between river kilometres 236-180, being distributed in 2-3 nest colonies. Between river kilometres 199-180 a minimum of 32-48 pairs of *Charadrius dubius* and minimum 5-15 pairs of *Actitis hypoleucos* occupied their territorries in the studied years. The nesting of 1116-2370 pairs of *Riparia riparia* and 2-23 pairs of *Merops apiaster* was recorded in the Drava section between river kilometres 199-133 in the study years. During our investigations in the Berzence grassland habitat 10-15 bird species were found to breed annually, with total density varying between 9.28-13.34 pairs/10 ha. Data from the waterfowl surveys in 2001-2004 between river kilometres 199-184, 30 species occurred among the studied taxa, with the maximum number of specimens recorded in this section being 4650. The *Ciconia ciconia* population along river Drava decreased from 58 to 45 pairs in the studied years. During the monitoring studies we have gathered data on the occurrence of a total of 162 bird species.

Key words: Aves, Drava, biomonitoring, nature conservation

Introduction

The Government of the Hungarian Republic decreed in 1999 that a monitoring system of the Drava region be established, which is essential for analysing changes in the status of nature conservation areas. As part of "Drava Monitoring", the study of birds (Aves) was also launched, since the presence/absence of the target species and the densities and reproduction of the particular populations bear information in respect of tracing down changes in the condition of habitats. The "Protocol" completed in spring 2000 (Proposal for the Monitoring of Birds) included the proposed target taxa and project objectives. When choosing the species, the publication by BÁLDI et. al. (1997) was taken as a basis, with the authors specifying 82 taxa, of which 63 are part of the minimal, 74 as part of the optimal, and 82 as part of the maximal program. There are about 35 of these species occurring regularly along the Somogy county section of the Drava, of which 25 also nest there. Nester species are scattered in small numbers over large areas, with often only one or two pairs being present, therefore instead of species monitoring it seemed more reasonable to monitor avian communities, focusing on both rare and more frequent species that have suitable indicative capacity.

Being state border areas, river Drava and its environment used to be strictly guarded until the 1990s, therefore research work was practically not done there. Although there

ISSN 1587-1908 (Print); ISSN 2062-9990 (Online)

were several intensive studies done in Belső-Somogy, there are almost no references to the Drava region in publications about the southern Somogy region (e.g. VASVÁRI 1937, SZÉCHENYI 1942, MARIÁN 1958, KÁRPÁTI 1979, MARIÁN & PUSKÁS 1985, BANK 1989). As of the 1990s, an increasing number of shorter articles have dealt with the avian fauna of the Drava, e.g. FENYŐSI 1993a, 1993b, BÉCSY, FENYŐSI & HORVÁTH 1995, FENYŐSI 1995a, 1995b, FENYŐSI et al. 1995, FENYŐSI & STIX 1996, 1998, JUHÁSZ 1995. The avian fauna of the Hungarian area affected by the planned hydroelectric power plant at Durdevac was investigated by BANK (1990) who provided evidence of the occurence of 163 bird species from the region of Őrtilos and Gyékényes. FENYŐSI 1996 provided a summary of observations along river Drava between 1983-1996, with faunal as well as population estimation data being presented. Since the mid-1990s, the more interesting observation data have been published in corresponding issues of the journal Túzok (HADARICS 1996-1999). Reports on Drava region populations were presented by FENYŐSI (1998a) and FENYŐSI & HORVÁTH (2000) on white storks, by FENYŐSI et al. (1998) on barn owls, and by HORVÁTH et al. 2002 on black storks. Short communications were released by FENYŐSI (1998b) on the little tern population nesting along river Drava, by FENYŐSI 1999 on Canada goose occurrence, and by HORVÁTH (2002) on lesser spotted eagle ocurrence. Organized by the Hungarian Water Wildlife Research Group, the waterfowl monitoring of the Drava reach between Barcs and Szentborbás was launched in 1996. The results are found in the study volmes by FARAGÓ (1997, 1999, 2001) and in the papers by FENYŐSI (2000a, 2002), where it is reported that 27 water bird species occurred on the Barcs-Szentborbás Drava-reach in the studied period. The avian fauna of areas along the Hungarian section of river Drava was reported by PURGER (1998) to include 154 species based on observations between 1995-97, and 217 species based on available literature data. The results of bank swallow population surveys done between river kilometres 199-132 of Drava in 2000-2003 were presented by FENYŐSI (2003). Water birds occurring on the gravel-pit pond excavated in Gyékényes in the Drava gravel plateau were studied by MEZEI (2001, 2003). Further information is provided about the avian fauna of the Drava in the synthetic bibliographic study on the birds of the Barcs Juniper Woodland (FENYŐSI 2000b), and by the work analysing the checklist and ornithological literature of birds having occurred in Somogy county before 2000, in PURGER & FENYŐSI 2001. Publications on the avian fauna of Croatian and Slovenian territories of the Drava are released in the leaflets Acrocephalus and Troglodytes, especially from the regions of Maribor-Ptuj, Ormoz-Légrád and Donji Miholjac. Results of ornithological research in areas affected by the planned hydroelectric power plant are published by RADOVIC (1996), reporting on the occurrence of 95 bird species. The avian fauna of Croatian territories of the Drava between Gyékényes and Bélavár is dealt with by RADOVIC (2004).

The area investigated in this paper is primarily the 1-4 km wide stripe extending along Drava between Őrtilos-Gyékényes and Bélavár-Szentborbás, with data originating predominantly from these areas. Although the Drava section between Gyékényes and Bélavár is exclusively Croatian, some investigations were nevertheless done here too. The selected monitoring areas where regular sampling was done within Duna-Drava National Park are as follows:

- the water body of river Drava, both Huungarian and Croatian, with gravel shoals and high banks
- floodland forests near Őrtilos-Zákány and Vízvár
- Jalszina-meadow in Berzence

The Zákány hills in the westernmost pocket of the study area belong to the Zalaapáti-plateau small region. The other small region, of 1-4 km width, extending on the left side

of the Drava from Őrtilos to Drávatamási, is the Middle Drava Valley. The Drava reach below Drávatamási belongs to the Drava Lowland small region, whereas areas of the Barcs Juniper Woodland are groupped with the small region of Eastern Inner Somogy. These small regions are characterised with moderately warm climate (with the annual mean temperature being around 10.0-10.5 °C), and with precipitation amounts decreasing from the northwest towards the southeast (mean: 750 mm).

Material and methods

The investigation of birds (Aves) within "Drava Monitoring" has, from the beginning, focussed on several significant taxa and has meant various methods. We believe that the selected communities and taxa well represent the avian fauna of the area, and, in the case of long term investigations, can reflect changes in the status of habitats. The monitoring of passerine communities in the Őrtilos-Zákány and the Vízvár sampling areas was done using the method of "double-visit fixed radius point count technique" (MOSKÁT 1986, 1987). Members of *Passeriformes* species, as well as representatives of *Columbiformes* and *Piciformes* were recorded. Among shoal-nesters, the characteristic, nesting communities of *Charadrius, Actitis* and *Sterna* species, not observable anywhere else in Hungary, were monitored. The method followed was specimen counts and recording pairs and families moving together, as well as, in case of colony nesters, the counting of nests and incubating individuals. *Riparia riparia* and *Merops apiaster* populations were monitored between river kilometres 198-133 of the Drava. In the case of *Riparia riparia* the number of breeding pairs was calculated from counts of nest hollows, whereas *Merops apiaster* populations were recorded by individual counting. In recent years we have extended our surveys onto colonies found in Croatian Drava sections between river kilometres 236-198. On the Hungarian-Croatian river section between Bélavár (199 river km) and Heresznye (184 river km) migrating and overwintering populations of waterfowl are surveyed in January-March and October-December. Surveys are done primarily from boat, with species and nuber of individuals being recorded. In the Berzence Jalszina-meadow we use territory-mapping for investigating the nesting bird community. The open area is walked over 4-6 times in the nesting period, and the positions of individuals displaying nesting behaviour are fixed in a grid. The number of territories and nesting pairs can thus be determined. White storks are studied in 17 villages in the arwas between Őrtilos and Szentborbás. Data recording inside the villages and in the outskirts is done in spring and in July, with parameters used in population surveys being recorded (HX, Hpa, HE, HPm, HPo, JZg, JZG, JZM, STD). Other faunal data are also continuously recorded in in monitoring areas, thus creating a faunal database.

Results

Monitoring passerine communities

- Zákány sample area

The sample area was designated in the outskirts of the vilages Zákány and Őrtilos, in the floodland forest bordered by the railway line and river Drava (Fig. 1.). The survey was done in a 100 m radius circle in the case of 7 sampling points, and in a 100 m radius

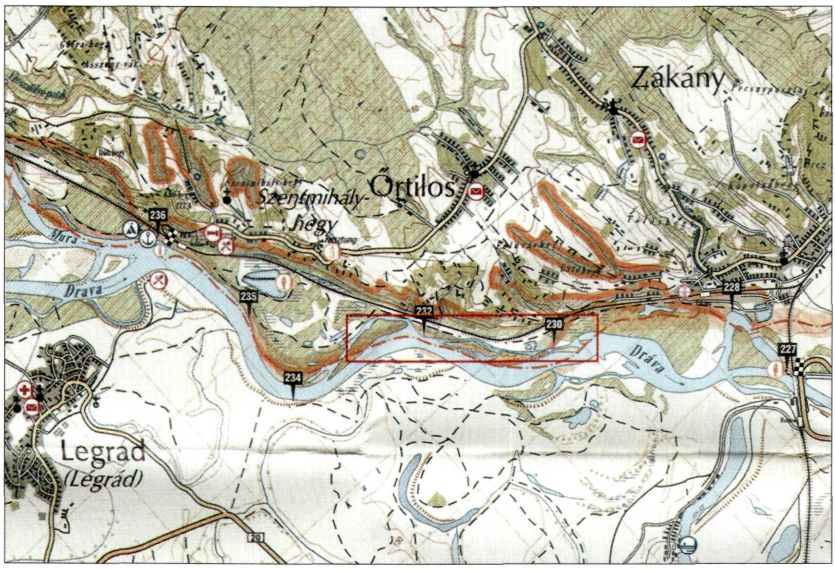

Fig. 1.: Location of the Zákány sample area

semi-circle in 8 other sampling points (due to habitat characteristics). Thus, the studied area covers 34.54 ha. Results of the surveys between 2000-2004 in the sample area are shown in Tables 1-2.

There were 42 species nesting at least once in the monitoring area between 2000-2004; these are listed in Table 1. Among nesting species in the sample area the dominant ones were *Sylvia atricapilla* (D:11.31), *Turdus merula* (D:7.54), *Fringilla coelebs* (D:7.25), *Phylloscopus collybita* (D:6.09) and *Sturnus vulgaris* (D:6.67). The presence of the nest-

Table 1.: Checklist of species nesting in the Zákány sample area between 2000-2004

Acrocephalus palustris
Aegithalos caudatus
Coccothraustes coccothraustes
Carduelis chloris
Certhia brachydactyla
Certhia familiaris
Columba palumbus
Corvus corone cornix
Cuculus canorus
Dendrocopos major
Dendrocopos medius
Dendrocopos minor
Dryocopus martius
Emberiza citrinella
Erithacus rubecula
Ficedula albicollis
Fringilla coelebs
Garrulus glandarius
Jynx torquilla
Lanius collurio
Locustella fluviatilis
Locustella naevia
Motacilla alba
Muscicapa striata
Oriolus oriolus
Parus caeruleus
Parus major
Parus palustris
Phylloscopus collybita
Phylloscopus trochilus
Picus canus
Picus viridis
Remiz pendulinus
Serinus serinus
Sitta europaea
Streptopelia turtur
Sturnus vulgaris
Sylvia atricapilla
Sylvia communis
Troglodytes troglodytes
Turdus merula
Turdus philomelos

Table 2.: Results of the surveys done in the Zákány sample area between 2000-2004

Year	Number of species	Number of nesting pairs	Density (pairs/10 ha)
2000	30	209	60.61
2001	36	230	66.7
2002	33	261	75.69
2003	36	263	76.27
2004	36	264	76.56

ing populations of *Acrocephalus palustris* (8-17 pairs annually), *Dendrocopos medius* (1-2 pairs annually), *Ficedula albicollis* (3-5 pairs annually) and *Locustella fluviatilis* (6-17 pairs annually) in the sample area is considered to be an important nature conservation value.

- Vízvár sample area

The sample area is located south of the village Vízvár, in the floodland forest on the left side of the Drava (Fig. 2.). The survey was done in a 100 m radius circle in the case of 10 sampling points, and in a 100 m radius semi-circle in 5 other sampling points (due to habitat characteristics). Thus, the studied area covers 39.25 ha. Results of the surveys between 2000-2004 in the sample area are shown in Tables 3-4. There were 42 species nesting at least once in the monitoring area between 2000-2004; these are listed in Table 3. Among nesting species in the sample area the dominant ones were *Sylvia atri-capilla* (D:10.0-10.5), *Fringilla coelebs* (D:5.5-7.25), *Sturnus vulgaris* (D:4.25-6.25), *Turdus merula* (D:3.75-5.25) and *Phylloscopus collybita* (D:4.25-5.0). The presence of the populations of *Dendrocopos major* (6-9 pairs annually), *Ficedula albicollis* (1-8 pairs annually) and *Locustella fluviatilis* (3-6 pairs annually) in the sample area is considered to be an important nature conservation value.

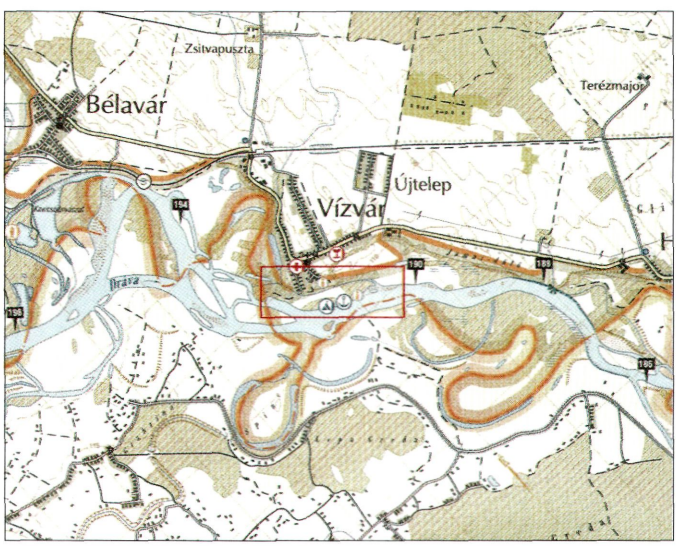

Fig. 2.: Location of the Vízvár sample area

Table 3.: Checklist of species nesting in the Vízvár sample area between 2000-2004

Acrocephalus palustris
Aegithalos caudatus
Coccothraustes coccothraustes
Carduelis carduelis
Carduelis chloris
Certhia brachydactyla
Certhia familiaris
Columba palumbus
Cuculus canorus
Dendrocopos major
Dendrocopos minor
Dryocopus martius
Emberiza citrinella
Erithacus rubecula
Ficedula albicollis
Fringilla coelebs
Garrulus glandarius
Locustella fluviatilis
Locustella naevia
Motacilla alba
Muscicapa striata
Oriolus oriolus
Parus caeruleus
Parus major
Parus palustris
Passer montanus
Phylloscopus collybita
Phylloscopus sibilatrix
Phylloscopus trochilus
Picus canus
Prunella modularis
Remiz pendulinus
Serinus serinus
Sitta europaea
Streptopelia turtur
Sturnus vulgaris
Sylvia atricapilla
Sylvia borin
Sylvia communis
Troglodytes troglodytes
Turdus merula
Turdus philomelos

Table 4.: Results of the surveys done in the Vízvár sample area between 2000-2004

Year	Number of species	Number of nesting pairs	Density (pairs/10 ha)
2000	25	136	34
2001	35	233	58.25
2002	34	216	54
2003	33	241	60.25
2004	32	254	63.5

The monitoring of shoal-nesters

Gravel shoals of the Drava are potential habitats for nesting communities unique in the Carpathian Basin, the species of which - *Actitis hypoleucos, Charadrius dubius, Sterna albifrons* and *Sterna hirundo* - can reliably indicate changes in the status of these habitats with their presence or absence. Surveying the gravel shoals is extremely difficult, due to special state border regulations, accessibility, and the erratic and unpredictable water regimes. The monitoring of shoal nesters is done as follows:

- Drava section between river kms 199-180 is a distinguished monitoring area (Fig. 3.), where a complete survey of shoal nesters (*Actitis hypoleucos, Charadrius dubius, Sterna albifrons* and *Sterna hirundo*) is done, with regular samplings
- populations of the the colony-nesting *Sterna* species are walk-surveyed in the entire Croatioan-Hungarian section of river Drava between Őrtilos (236 river km) and Bolhó (180 river km)
- for the more exact knowledge of *Actitis hypoleucos* and *Charadrius dubius* nesting populations, we also survey the Croatian river section between Őrtilos (236 river km) and Bélavár (199 river km), and also make population estimations.

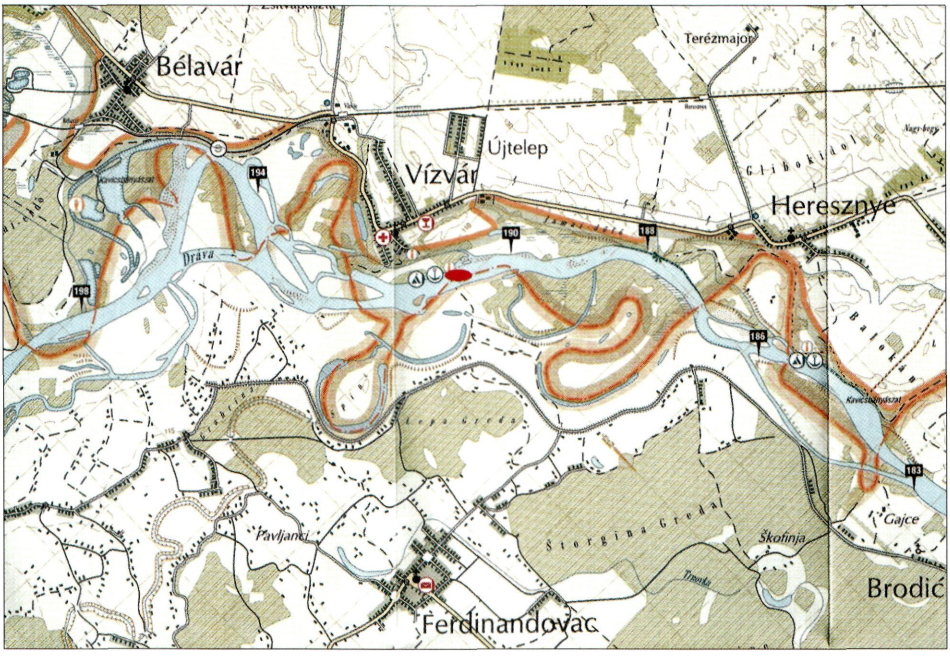

Fig. 3.: The Drava section between river kilometres 199-180

Population survey of *Sterna* species

Populations of *Sterna* species settling on gravel shoals were surveyed in the Drava section between Őrtilos (236 river km) and Bolhó (180 river km) in 2000-2004 (there are no gravel shoals in the Drava section below Bolhó that are suitable for stern nesting, therefore new colonies are not expected to form). Between 2000-2004 there were 2-3 nest colonies annually in the Drava section between Őrtilos (236 river km) and Bolhó (180 river km), with 5-14 pairs of Sterna albifrons, and 50-90 pairs of *Sterna hirundo* nesting there (Table 5.).

Unfortunately, nestings proceeded at a very low success rate in the studied period, due to late flood waves. According to earlier experience, water levels above 200 cm measured on the Barcs fluviometer are always with critical effect on nest colonies, these flood waves necessarily destroying the clutches. Daily water levels of the Drava, measured in Barcs in May-July 2004 are shown in Fig. 4.

Table 5.: Stern colonies in 2000-2004, between 236-180 Drava river kilometres

Year	Drava, 230-229 river km		Drava, 218 river km		Drava, 190-191 river km	
	S. albifrons	*S. hirundo*	*S. albifrons*	*S. hirundo*	*S. albifrons*	*S. hirundo*
2000	min. 8 pairs	min. 36 pairs	0	0	min. 6 pairs	min. 20 pairs
2001	min. 2 pairs	min. 45 pairs	0	0	min. 8 pairs	min. 45 pairs
2002	0	0	0	0	min. 5 pairs	min. 50 pairs
2003	0	0	min. 2 pairs	min. 15 pairs	min. 6 pairs	min. 40 pairs
2004	min. 1 pairs	min. 25 pairs	min. 2 pairs	min. 11 pairs	min. 4 pairs	min. 40 pairs

Fig. 4.: Daily water levels of the Drava, measured at Barcs in May-July 2004

Actitis hypoleucos and *Charadrius dubius* population survey between 199-180 Drava river kilometres

We attempted to do a complete population survey of *Charadrius dubius* and *Actitis hypoleucos* in the Hungarian-Croatian area of the Drava section between river kilometres 199-180 (cca. 650 ha). Population survey was done from both ashore and boat, completed with the walk-surveying of certain gravel shoals. Based on numbers of observed individuals, recorded pairs and incubating birds, nesting data of the studied species in 2000-2004 were found to be as presented in Table 6.

Our data show that anually at least 32-48 pairs of *Charadrius dubius* and at least 5-15 pairs of *Actitis hypoleucos* occupied nesting territories in the studied area (Table 6.). It was found that territory occupation and nesting success was considerably affected by water levels of the Drava. For example, due to prolonged high water levels, *Charadrius dubius* nested also in ploughland environments adjoining the river in several locations. Flood waves arriving in June-July tended to wash away a significant proportion of clutches, and, in certain years, replacement clutches as well.

Table 6.: Results of population survey between 199-180 Drava river kilometres in 2001-2004

Species	Bélavár199-193 river km	Vízvár 192-188 river km	Heresznye 187-184 river km	Bolhó 183-180 river km	Total
	2001				
C. dubius	8-10 pairs	15 pairs	8-10 pairs	4-5 pairs	35-40 pairs
A. hypoleucos	1-2 pairs	3-4 pairs	1-2 pairs	-	5-8 pairs
	2002				
C. dubius	9 pairs	20 pairs	4 pairs	3 pairs	min. 36 pairs
A. hypoleucos	3 pairs	4 pairs	3 pairs	-	min. 10 pairs
	2003				
C. dubius	15 pairs	22 pairs	6 pairs	5 pairs	min. 48 pairs
A. hypoleucos	4 pairs	5 pairs	2 pairs	1 pairs	min. 12 pairs
	2004				
C. dubius	4 pairs	19 pairs	4 pairs	5 pairs	min. 32 pairs
A. hypoleucos	2 pairs	8 pairs	3 pairs	2 pairs	min. 15 pairs

Table 7.: Results of population estimations between Drava river kilometres 236-199, in 2002 and 2004

Species	236-229 river km	229-199 river km	Total
	2002		
C. dubius	8-10	40-60	48-70
A. hypoleucos	2-4	10-15	12-19
	2004		
C. dubius	min. 17	30-45	47-62
A. hypoleucos	min. 8	min. 16	24

Actitis hypoleucos and *Charadrius dubius* nesting population survey on the Drava section between Őrtilos (236 river km) to Bélavár (199 river km)

For the more exact knowledge of *Actitis hypoleucos* and *Charadrius dubius* nesting populations, we also surveyed river sections outside the monitoring area - between 236-199 river kms -, and made censuses and population estimations. The results are presented in Table 7.

As a summary of corresponding surveys, the *Charadrius dubius* population on the entire Hungarian-Croatian section of river Drava between Őrtilos (236 river km) and Bolhó (180 river km) can be estimated to at least 100-120 pairs, and the *Actitis hypoleucos* population to at least 30-40 breeding pairs. We believe that the stable populations of these bird species represent serious nature conservation values.

The monitoring of Riparia riparia (and Merops apiaster) populations

The monitoring area is the Drava section between Bélavár and Szentborbás (betwen 199 river km to 133 river km), where all the colonies on both the left and right side of the main river branch were surveyed each year. Nest hollows were counted, and, by assuming that 60% of hollows were occupied by nesting pairs (SZÉP 1991), their number was determined. Results are shown in Table 8.

Population size in the sample area in the studied period was found to be as shown in Fig. 5. In the Drava section at 65 river km, the number of colonies varied between 7-12, and the number of breeding pairs ranged between 1116-2370. In the studied period the

Table 8.: Results of riverbank surveys between Drava river kilometres 199-133, in 2000-2004

Year	Number of colonies	Number of *Riparia riparia* nest hollows	Number of *Riparia riparia* breeding pairs	Number of *Merops apiaster* breeding pairs
2000	12	3950	2370	14
2001	8	2540	1524	12
2002	12	1860	1116	5
2003	8	3265	1959	2
2004	7	2979	1787	23

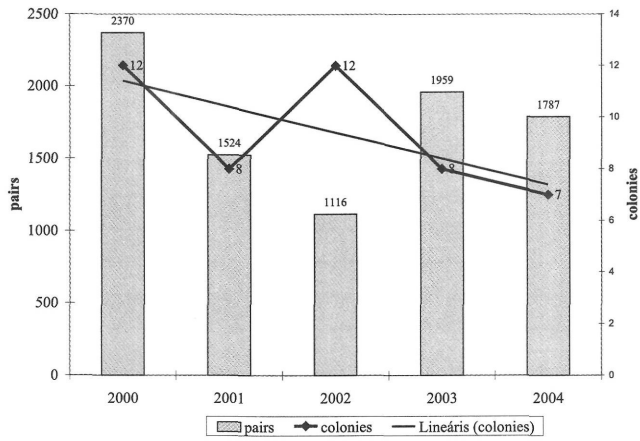

Fig. 5.: Changes in *Riparia riparia* population between Drava river kilometres 199-133

trend of population size changes was found to be decreasing. The distribution of colonies according to nest hollow numbers is shown in Fig. 6. From this figure it appears that the proportion of colonies with less than 200 nest hollows is considerably higher than the combined proportion of larger colonies. However, in 2003-2004 the distribution of colonies with diffeent sizes is much more balanced. In each of the years, the largest colony formed near Heresznye (188 river km and 184-185 river km), with the largest colonies numbering 950-720-348-666-600 pairs, respectively, in successive study years.

For a more exact knowledge of *Riparia riparia* populations in the region, in addition to surveying the sample area, from 2001 we have also made censuses in three extra areas: in the mostly Croatian Drava section between 236-199 river kms, in the Viktorpuszta sand pit in the vicinity of the town Barcs, and at the waste-heap embankment of the Csíkos pit lake at Bélavár. The results are presented in Table 9.

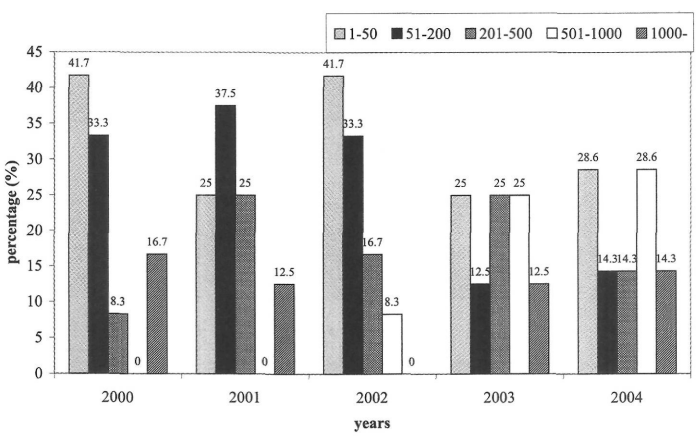

Fig. 6.: The distribution of nesting colonies, based on nest hollow numbers, between Drava river kilometres 199-133

Table 9.: Survey of other riverbank sites, 2001-2004

Year	Area	Number of colonies	Number of *Riparia riparia* nest hollows	Number of *Riparia riparia* breeding pairs	Number of *Merops apiaster* breeding pairs
2001	Drava 236-199 river km	3	2400	1440	0
	Barcs-Viktorpuszta	1	700	420	1
	Total	**4**	**3100**	**1860**	**1**
2002	Drava 236-199 river km	8	980	588	0
	Barcs-Viktorpuszta	1	1160	696	3
	Total	**9**	**2140**	**1284**	**3**
2003	Drava 236-199 river km	9	1190	714	0
	Barcs-Viktorpuszta	1	1820	1092	1
	Bélavár, Csíkos	1	35	21	7
	Total	**11**	**3045**	**1827**	**8**
2004	Drava 236-199 river km	9	2390	1434	1
	Barcs-Viktorpuszta	1	920	552	1
	Bélavár, Csíkos	1	25	15	10
	Total	**11**	**3335**	**2001**	**12**

As a summary of our investigations, we want to note the following:

- there was a decreasing trend of populations in the monitoring area during the studied period
- the entire Drava region - i.e. the Drava section between river kilometres 237-133, including the Viktorpuszta and Csíkos pits - is rather characterised with stability (Fig. 7.); yellow parts of the bars in Fig. 7. indicate population sizes of the monitoring-areas, whereas the green segments show populations of the other areas.
- although for determining the number of nesting pairs we employed the method known from the literature (i.e. 60% of nest hollows are considered to be occupied breeding pairs according to SZÉP 1991), we assume that due to the fact that Drava embank-

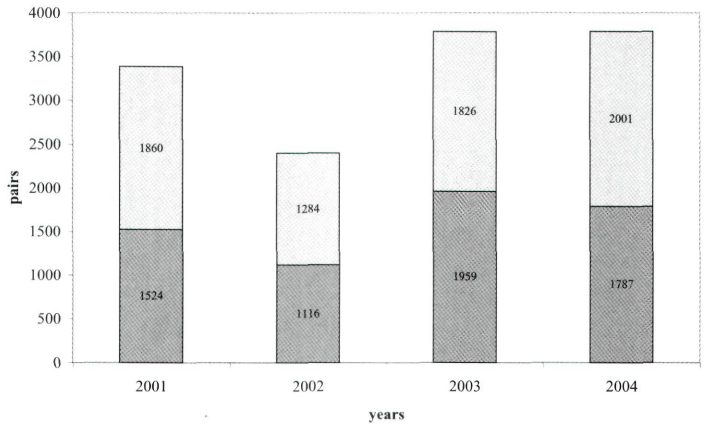

Fig. 7.: *Riparia riparia* populations in the Drava region between 2000-2004

ments are being continuously reproduced, the rate of occupied nests can be higher than 60%, at least 75% according to our estimation.

The monitoring of birds in the Jalszina-meadow at Berzence

The sample area is located near the village Berzence, in the Jalszina-meadow, covering 34 ha (Fig. 8.). During area surveys, the observed bird species and their numbers were recorded, and the position of individuals displaying territorial behaviour were fixed in a grid. The nesting bird community of the area was determined by evaluating the recording sheets and by marking the boundaries of territories. Although the number of samplings was less then what iusual for this method, this fact was balanced by the perfect observability of the meadow, by its relatively small extent, and the smaller (2x50m) stripe width applied. During the recordings in the successive years from 2001 to 2004, the number of bird species observed was 33, 24, 30, and 36, respectively. Of these, the number of species surely nesting in the area was 10 in 2001 (32 pairs), 12 in 2002 (35 pairs), 15 in 2003 (42 pairs), and 13 in 2004 (46 pairs) (Table 10.). The number of breeding pairs and density values are specified in Table 10.

From Table 10 it appears that the nesting bird community of the area was made up of 10-15 species in the various years. Among these, the species with the highest densities were usually *Alauda arvensis, Saxicola torquata, Miliaria calandra,* and *Acrocephalus schoenobaenus, Emberiza schoeniclus, Locustella naevia*. In 2003, and especially in 2004, extensive patches had long lasting water cover. This is what may have caused the appearance of species like *Anas* sp., *Fulica* and *Gallinula* for breeding, and also a significant change of density in certain species (e.g. *Saxicola rubetra, Acrocephalus schoenobaenus*). It is notable that the 3rd-4th highest density value in the studied years was reached by *Locustella naevia*. Table 11 includes the complete list of birds observed in the area (68 species). Among species listed in Table 11, we assume that *Ixobrychus*

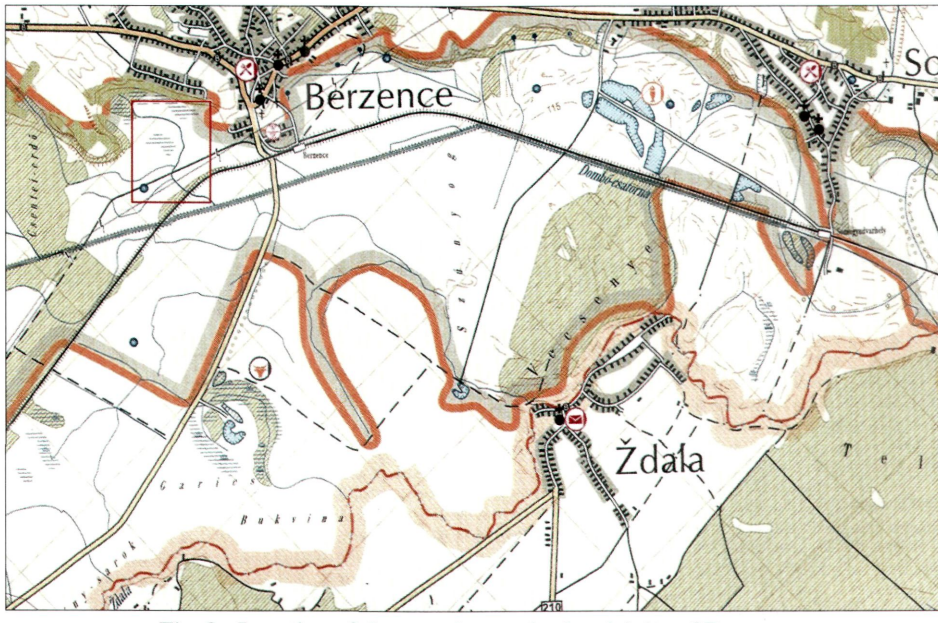

Fig. 8.: Location of the sample area in the vicinity of Berzence

Table 10.: Results of territory mapping in the Berzence meadow in 2001-2004

Species	2001		2002		2003		2004	
	Pairs	Density	Pairs	Density	Pairs	Density	Pairs	Density
Anas platyrhynchos	0	0	0	0	0	0	2	0.58
Anas querquedula	0	0	0	0	1	0.29	3	0.87
Coturnix coturnix	0	0	0	0	1	0.29	0	0
Phasianus colchicus	0	0	1	0.29	2	0.58	0	0
Crex crex	0	0	0	0	1	0.29	0	0
Gallinula chloropus	0	0	0	0	0	0	1	0.29
Fulica atra	0	0	0	0	0	0	4	1.16
Cuculus canorus	0	0	1	0.29	0	0	0	0
Alauda arvensis	0	0	5	1.45	7	2.03	4	1.16
Saxicola rubetra	1	0.29	2	0.58	1	0.29	5	1.45
Saxicola torquata	5	1.45	4	1.16	7	2.03	4	1.16
Locustella naevia	3	0.87	3	0.87	4	1.16	4	1.16
Locustella luscinioides	2	0.58	1	0.29	0	0	0	0
Acrocephalus arundinaceus	1	0.29	0	0	0	0	0	0
Acrocephalus schoenobaenus	5	1.45	4	1.16	1	0.29	8	2.32
Acrocephalus palustris	0	0	0	0	2	0.58	0	0
Sylvia communis	1	0.29	0	0	1	0.29	1	0.29
Lanius collurio	1	0.29	1	0.29	2	0.58	1	0.29
Emberiza citrinella	0	0	1	0.29	1	0.29	0	0
Emberiza schoeniclus	8	2.32	5	1.45	3	0.87	3	0.87
Miliaria calandra	5	1.45	7	2.03	8	2.32	6	1.74
Total	**32**	**9.28**	**35**	**10.15**	**42**	**12.18**	**46**	**13.34**

Table 11.: Checklist of all the observed bird species in the Berzence meadow in 2001-2004

Acrocephalus arundinaceus
Acrocephalus palustris
Acrocephalus schoenobaenus
Aegithalos caudatus
Alauda arvensis
Anas acuta
Anas clypeata
Anas platyrhynchos
Anas querquedula
Anser anser
Anthus pratensis
Apus apus
Ardea cinerea
Ardea purpurea
Aythya nyroca
Buteo buteo
Carduelis cannabina
Carduelis carduelis
Chloris chloris
Ciconia ciconia
Ciconia nigra
Circus aeruginosus
Corvus corax
Coturnix coturnix
Crex crex
Cuculus canorus
Cygnus olor
Delichon urbica
Dendrocopos major
Egretta alba
Emberiza citrinella
Emberiza schoeniclus
Erithacus rubecula
Falco subbuteo
Falco tinnunculus
Falco vespertinus
Ficedula albicollis
Fringilla coelebs
Fulica atra
Gallinago gallinago
Gallinula chloropus
Garrulus glandarius
Haliaeetus albicilla
Hirundo rustica
Ixobrychus minutus
Lanius collurio
Locustella fluviatilis
Locustella luscinioides
Locustella naevia
Luscinia megarhynchos
Miliaria calandra
Motacilla alba
Oriolus oriolus
Parus major
Phasianus colchicus
Philomachus pugnax
Phylloscopus sibilatrix
Picus canus
Rallus aquaticus
Saxicola rubetra
Saxicola torquata
Sylvia atricapilla
Sylvia communis
Sylvia nisoria
Tachybaptus ruficollis
Turdus merula
Turdus viscivorus
Vanellus vanellus

Table 12.: Occurring waterfowl species and their specimen numbers in the Drava section between river kilometres 199-184, in 2001

Species	03/02/2001	07/03/2001	07/04/2001	12/10/2001	09/12/2001
Tachybaptus ruficollis	8	14			9
Podiceps cristatus	1				
Phalacrocorax carbo	44	35	2	7	13
Egretta alba	9	3		3	6
Ardea cinerea	3		2	18	2
Cygnus olor	10	2		8	11
Anas crecca	41				60
Anas platyrhynchos	3810	8	27		1355
Bucephala clangula	1				3
Mergus merganser					1
Haliaeetus albicilla	3	1			2
Pandion haliaetus				1	
Circus aeruginosus			1		
Gallinula chloropus					1
Fulica atra	4				1
Vanellus vanellus		54	1		
Charadrius dubius			1		
Actitis hypoleucos			4		
Tringa ochropus	6	1	11		4
Tringa nebularia			1		
Alcedo atthis			2	4	2
Total	**3940**	**118**	**52**	**41**	**1470**

minutus and *Gallinago gallinago* are occasional nesters. It is remakable from the complete list that the proportion of migrating species and those visiting the area for feeding is much higher (69.9%) than those of breeding there (30.1%).

The monitoring of wintering and migrating water birds on the Drava section between Bélavár (199 river km) and Heresznye (184 river km)

Wintering and migrating water birds on the Drava section between Bélavár (199 river km) and Heresznye (184 river km), as well as in side-branches associated with this river section were monitored in 2001-2004, from autumn to spring (from September to March). Bird censuses were made from ashore (Hungarian areas), and from boat (Hungarian-Croatian areas). The results of the recordings are presented in Tables 12-15, from where it appears that during 24 samplings, a total of 30 species belonging to the studied taxa were observed. As our results suggest, higher abundance values and species numbers in this Drava section can be expected in the period between December-February; the highest values were observed on 20th January 2002, with 15 species and 4650 individuals. Based on the recordings, the most frequent *A. platyrhynchos* (91.7%) is followed by *Phalacrocorax carbo* (79.2%), *Egretta alba* (79.2%), *Ardea cinerea* (75%), *Cygnus olor* (62.5%) and *Haliaeetus albicilla* (54.2%). It was found that 92% of all bird specimens observed (17 884) were *Anas platyrhynchos*, therefore this species turned out to be the absolutely dominant one.

Table 13.: Occurring waterfowl species and their specimen numbers in the Drava section between river kilometres 199-184, in 2002

Species	20/01/2002	25/02/2002	30/10/2002	10/12/2002
Tachybaptus ruficollis	8		9	4
Podiceps cristatus	1	1	1	
Phalacrocorax carbo	9	56	113	27
Egretta alba	3		6	
Ardea cinerea	5	3	2	
Cygnus olor	2	17		
Anas crecca	23			
Anas platyrhynchos	4580	4	10	238
Anas acuta	1			
Aythya ferina	1			
Aythya fuligula	4			
Bucephala clangula	4			5
Mergus albellus	6			
Haliaeetus albicilla	1	3	2	1
Tringa ochropus	2	5	1	
Alcedo atthis			1	
Total	**4650**	**89**	**145**	**275**

Table 14.: Occurring waterfowl species and their specimen numbers in the Drava section between river kilometres 199-184, in 2003

Species	20/02/2003	27/03/2003	04/09/2003	30/09/2003	14/10/2003	22/10/2003	14/11/2003	02/12/2003	11/12/2003
Gavia arctica								1	
Tachybaptus ruficollis	5					2			
Podiceps cristatus	1								
Phalacrocorax carbo	17	7		4				5	25
Egretta alba	3		4	8	9	8			5
Ardea cinerea	6	4	2	8		2	1		
Ciconia nigra			6						
Cygnus olor	16		3				1		23
Anas crecca	5								
Anas platyrhynchos	735	32	400	7	20	10		500	50
Anas acuta	1								
Bucephala clangula	4								
Mergus albellus	3								
Haliaeetus albicilla	2	2				1			
Pandion haliaeetus				1					
Rallus aquaticus						1			
Gallinula chloropus						1			
Tringa nebularia				6					
Tringa ochropus	3								
Alcedo atthis		1	2		1	2	2		
Total	**801**	**46**	**417**	**34**	**30**	**27**	**4**	**506**	**103**

Table 15.: Occurring waterfowl species and their specimen numbers in the Drava section between river kilometres 199-184, in 2004

Species	27/01/2004	15/02/2004	04/09/2004	15/10/2004	17/11/2004	07/12/2004
Tachybaptus ruficollis	4	6		3	5	5
Phalacrocorax carbo	13	56		59	20	65
Egretta alba	10	7	1	2		6
Ardea cinerea	3	5		5	2	6
Cygnus olor	12	6		2	3	6
Anas penelope	22					
Anas crecca	30	8		4		60
Anas platyrhynchos	2130	1085	10	190	280	980
Aythya ferina						6
Aythya fuligula					1	
Bucephala clangula		4				4
Haliaeetus albicilla	2		1	1		
Fulica atra	1					
Tringa nebularia			2			
Tringa ochropus	1			2		
Larus cachinnans						1
Total	**2228**	**1176**	**14**	**268**	**311**	**1139**

The monitoring of white stork (Ciconia ciconia) populations

The sample area along river Drava selected in 2000 is made up of 17 village districts between Őrtilos and Barcs. The extent of the area including both outskirts and inner village areas is 511 km2. During the surveys we also visisted, in addition to nests inside the villages, those few that are located in the outkirs. The following abbreviations and parameters are used for presenting the results:

HX: uninhabited nest
HE: solitary individual
HPa: number of breeding pairs
HPo: unsuccessful nesting
HPm: successful nesting
JZG: number of young birds leaving the nest

The most notable findings of the surveys between 2000-2004 are presented in Figures 9-10. From Fig. 9 it appears that between 2000-2004 the number of nesting pairs (Hpa) decreased from 58 to 45 (by almost 20%). Associated with this trend, the number of uninhabited or abandoned nests (HX) in the same period grew to fivefold the initial value (increased from 3 to 15). The number of young birds leaving the nests varied between 79-108 in 2000-2004 (Fig. 10). It is seen from Fig. 10 that the high number of fledgelings in 2000 is unparalelled in the rest of the study years. The rate of successful (Hpm) vs. unsuccessful (Hpo) nestings in the studied period appeared to be balanced, with minor fluctuations (Fig. 10).

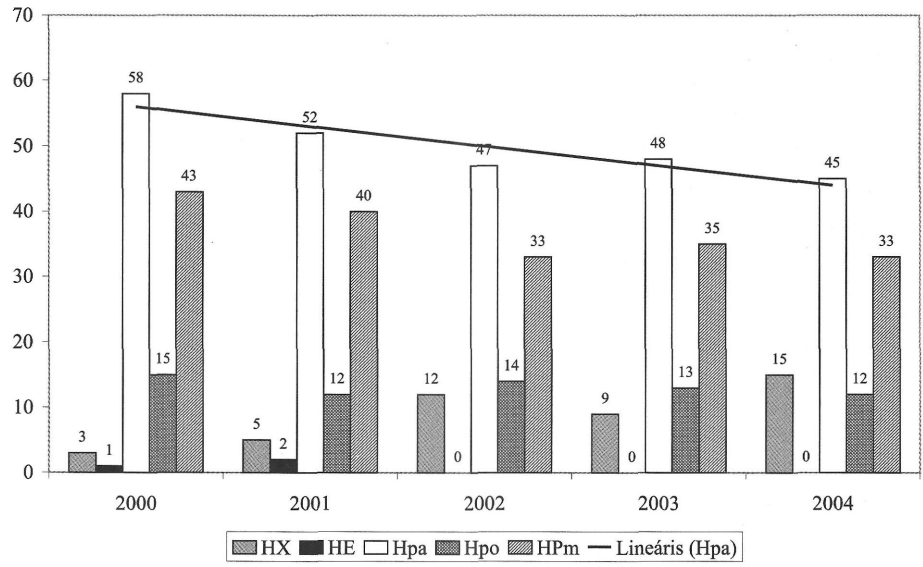

Fig. 9.: White stork population in the studied area in 2000-2004

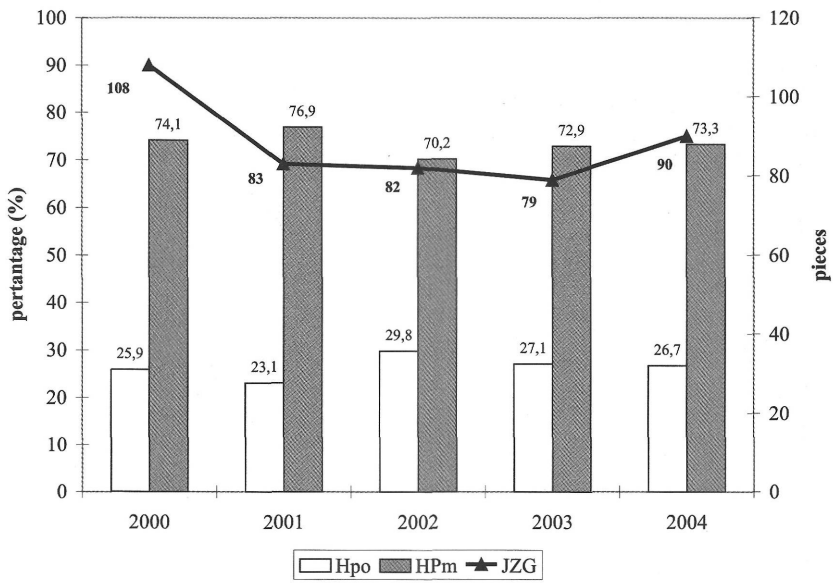

Fig. 10.: Changes in the rate of unsucessful (HPo) and successful (HPm) nestings, and in the number of young birds leaving the nest (JZG), from 2000-2004

Faunal data

Between 2000-2004 között a we could provide evidence on the occurrence of 142 bird species in the monitoring areas, and on another 20 species in other Drava areas and national park habitats. Accordingly, we have data about a total of 162 bird species along river Drava in the period 2000-2004 (Table 16). According to the legal categorization by the 13/2001. (V.9.) decree of the Ministry of Environment, out of these 162 bird species the following 25 are strictly protected:

Ardea purpurea
Athene noctua
Aythya nyroca
Chlidonias niger
Ciconia ciconia
Ciconia nigra
Circus pygargus
Crex crex
Egretta alba
Egretta garzetta
Falco peregrinus
Falco vespertinus
Haliaeetus albicilla
Himantopus himantopus
Íxobrychus minutus
Limosa limosa
Merops apiaster
Milvus migrans
Numenius arquata
Nycticorax nycticorax
Pernis apivorus
Phalacrocorax pygmeus
Recurvirostra avosetta
Sterna albifrons
Tringa totanus

The 25 species listed above make up 31% of the 81 Hungarian strictly protected birds, and 13 of them is now proved to breed in the studied areas.

Acknowledgements

I want to recognize the following professionals for providing valuable support to this study: Mr. Sándor Csór, Mr. Zoltán Horváth, Mr. Dr. Zsolt Kalotás, Mr. Ervin Mezei, Mr. Zoltán Sallai, Mr. József Selyem, and to Mr. Balázs Trócsányi for the English translation.

Table 16.: Species checklist of birds in the studied area, 2000-2004.

Gavia stellata
Gavia arctica
Tachybaptus ruficollis
Podiceps cristatus
Podiceps grisegena
Podiceps nigricollis
Phalacrocorax carbo
Phalacrocorax pygmeus
Ixobrychus minutus
Nycticorax nycticorax
Egretta garzetta
Egretta alba
Ardea cinerea
Ardea purpurea
Ciconia nigra
Ciconia ciconia
Cygnus olor
Anser fabalis
Anser albifrons
Anser anser
Tadorna tadorna
Anas penelope
Anas crecca
Anas platyrhynchos
Anas acuta
Anas querquedula
Anas clypeata
Aythya ferina
Aythya nyroca
Aythya fuligula
Bucephala clangula
Mergus albellus
Mergus merganser
Pernis apivorus
Milvus migrans
Haliaeetus albicilla
Circus aeruginosus
Circus cyaneus
Circus pygargus
Accipiter gentilis
Accipiter nisus
Buteo buteo
Pandion haliaetus
Falco tinnunculus
Falco vespertinus
Falco subbuteo
Falco peregrinus
Coturnix coturnix
Phasianus colchicus
Rallus aquaticus
Porzana porzana
Crex crex
Fulica atra
Grus grus
Gallinula chloropus
Haematopus ostralegus
Himantopus himantopus
Recurvirostra avosetta
Charadrius dubius
Pluvialis squatarola
Vanellus vanellus
Calidris ferruginea
Philomachus pugnax
Gallinago gallinago
Scolopax rusticola
Limosa limosa
Numenius phaeopus
Numenius arquata
Tringa totanus
Tringa nebularia
Tringa ochropus
Tringa glareola
Actitis hypoleucos
Larus ridibundus
Larus canus
Larus cachinnans
Sterna hirundo
Sterna albifrons
Chlidonias niger
Columba palumbus
Streptopelia decaocto
Streptopelia turtur
Cuculus canorus
Athene noctua
Strix aluco
Asio otus
Apus apus
Alcedo atthis
Merops apiaster
Upupa epops
Jynx torquilla
Picus canus
Picus viridis
Dryocopus martius
Dendrocopos major
Dendrocopos medius
Dendrocopos minor
Alauda arvensis
Riparia riparia
Hirundo rustica
Delichon urbica
Anthus pratensis
Anthus spinoletta
Motacilla flava
Motacilla cinerea
Motacilla alba
Troglodytes troglodytes
Prunella modularis
Erithacus rubecula
Luscinia megarchynchos
Phoenicurus phoenicurus
Saxicola rubetra
Saxicola torquata
Oenanthe oenanthe
Turdus merula
Turdus pilaris
Turdus philomelos
Turdus viscivorus
Locustella naevia
Locustella fluviatilis
Locustella luscinioides
Acrocephalus palustris
Acrocephalus schoenobaenus
Sylvia nisoria
Sylvia communis
Sylvia borin
Sylvia atricapilla
Phylloscopus sibilatrix
Phylloscopus collybita
Phylloscopus trochilus
Regulus regulus
Muscicapa striata
Ficedula albicollis
Ficedula hypoleuca
Aegithalos caudatus
Parus palustris
Parus caeruleus
Parus major
Sitta europaea
Certhia familiaris
Certhia brachydactyla
Remiz pendulinus
Oriolus oriolus
Lanius collurio
Lanius excubitor
Garrulus glandarius
Corvus frugilegus
Corvus corone cornix
Corvus corax
Sturnus vulgaris
Passer domesticus
Passer montanus
Fringilla coelebs
Serinus serinus
Carduelis chloris
Carduelis carduelis
Carduelis spinus
Carduelis cannabina
Carpodacus erythrinus
Pyrrhula pyrrhula
Coccothraustes coccothraustes
Emberiza citrinella
Emberiza schoeniclus
Miliaria calandra

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Madárközösségek vizsgálata a Dráva somogyi szakasza mentén, 2001-2004-ben

FENYŐSI LÁSZLÓ

A Dráva-mentén 2000-től a "Dráva Monitoring" keretén belül madártani vizsgálatokat végzünk. A rendszeres mintavételekkel érintett monitoring-terület a folyó magyar-horvát vízteste kavicszátonyokkal és magaspartokkal, az Őrtilos-Zákány és Vízvár határában húzódó ártéri erdők, illetve a berzencei Jalszina-rét. A madarak (Aves) vizsgálata a kezdetektől több fontosabb csoportot érint, illetve több módszert jelent, az alábbiak szerint:

- énekesmadár-közösségek monitorozása az őrtilos-zákányi és vízvári mintaterületeken (a *Passeriformes* fajok mellett a *Columbiformes* és *Piciformes* rend fajait is vizsgáljuk)
- zátonyfészkelők (*Charadrius, Actitis* és *Sterna* fajok) monitorozása
- a *Riparia riparia* és *Merops apiaster* állomány monitorozása
- vonuló és telelő vízimadarak állományának monitorozása a Dráva 199-184 fkm-ei közötti folyószakaszon
- a berzencei Jalszina-réten fészkelő madárközösség monitorozása
- fehér gólya állomány monitorozása az Őrtilos-Szentborbás közötti területen

Énekesmadár-közösségek monitorozása

A zákányi mintaterületen 2000-2004-ben 42 faj fészkelését mutattuk ki, ezek közül dominánsnak a *Sylvia atricapilla* (Denzitás:11,31 pár/10 ha), *Turdus merula* (D:7,54) és *Fringilla coelebs* (D:7,25) bizonyult. Jelentős természeti értéknek tartjuk az *Acrocephalus palustris* (évi 8-17 pár), a *Dendrocopos medius* (évi 1-2 pár), a *Ficedula albicollis* (évi 3-5 pár) és *Locustella fluviatilis* (évi 6-17 pár) fészkelőállományát. A vízvári mintaterületen 2000-2004-ben szintén 42 faj fészkelését mutattuk ki, dominánsnak a *Sylvia atricapilla* (D:10,0-10,5), a *Fringilla coelebs* (D:5,5-7,25) és a *Sturnus vulgaris* (D:4,25-6,25) bizonyult. E mintaterületen jelentős természeti értéknek tartjuk a *Dendrocopos major* (évi 6-9 pár), a *Ficedula albicollis* (évi 1-8 pár) és a *Locustella fluviatilis* (évi 3-6 pár) állományát.

Zátonyfészkelők monitorozása

A Dráva Őrtilos (236 fkm) és Bolhó (180 fkm) közötti szakaszán - a 180. fkm alatt már nincsenek csérek megtelepedésére alkalmas zátonyok - 2000-2004-ben a telepesen fészkelő *Sterna*-fajok állományát vizsgáltuk. Eredményeink szerint a vizsgált időszakban évente 2-3 fészektelep alakult ki és *Sterna albifrons* 5-14 párban, *Sterna hirundo* 50-90 párban fészkelt. 2000-2004-ben a Dráva 199-180 fkm-ek közötti magyar-horvát területén (cca. 650 ha-on) a *Charadrius dubius* és *Actitis hypoleucos* fajok teljes állományfelmérését végeztük. Eredményeink szerint e területen évente min. 32-48 pár *Charadrius dubius* és min. 5-15 pár *Actitis hypoleucos* foglalt revírt. A 236-199 fkm-ek között gyűjtött adatainkat is figyelembe véve a *Charadrius dubius* állomány az Őrtilos (236 fkm) és Bolhó (180 fkm) közötti teljes magyar-horvát szakaszán min. 100-120 párra, az *Actitis hypoleucos* állomány min. 30-40 költőpárra tehető! A Drávánál a *Sterna-Charadrius-Actitis* fajok alkotta fészkelőközösség, továbbá e fajok stabil állományai igen jelentős természeti értéket képviselnek.

Partfal-fészkelők monitorozása

2000-2004-ben a Dráva 66 fkm-es szakaszán (199-133 fkm-ek között) végzett felméréseink során a *Riparia riparia* telepek száma 7-12, a költőpárok száma 1116-2370 pár között változott, s a vizsgált időszakban az állománynagyság csökkent. 2001-től három újabb területen végeztünk számlálásokat. Eredményeink szerint e területeken a telepszám 4-11 között, a költőpárok száma 1284-2001 pár között változott.

A berzencei Jalszina-rét madárvilágának monitorozása

A Berzence község határában található mintaterületen (kiterjedése 34 ha) a felvételezések során 2001-ben 33 madárfajt, 2002-ben 24 madárfajt, 2003-ban 30 madárfajt és 2004-ben 36 madárfajt észleltünk. Ezek közül a területen 2001-ben biztosan fészkelt 10 faj 32 párban, 2002-ben 12 faj 35 párban, 2003-ban 15 faj 42 párban és 2004-ben 13 faj 46 párban. A vizsgált években a terület vízviszonyaitól függően az *Alauda arvensis, Saxicola torquata, Miliaria calandra, illetve az Acrocephalus schoenobaenus, Emberiza schoeniclus* és *Locustella naevia* denzitása volt a legmagasabb. Figyelmet érdemel, hogy a vizsgált években denzitásban a 3-4. legmagasabb értékű a *Locustella naevia* volt.

Telelő és vonuló vízimadarak monitorozása a Dráva 199-184 fkm-ek közötti szakaszán

A Bélavár (199 fkm) és Heresznye (184 fkm) közötti Dráva-szakaszon, továbbá az e szakaszhoz kapcsolódó mellékágakban a vonuló és telelő vízimadarak vizsgálatát végeztük 2001-2004-ben, az ősztől-tavaszig terjedő időszakokban. A 24 mintavétel során a vizsgált csoportokból összesen 30 faj előfordulását sikerült megfigyelnünk. Eredményeink szerint magasabb faj- és egyedszámot december-február hónapokban észleltünk, egy felvétel során a maximum 15 faj és 4650 pd. volt. A gyakorisági sorrendben az Anas platyrhynchos-t (91,7%) a Phalacrocorax carbo (79,2%), Egretta alba (79,2%), Ardea cinerea (75%), Cygnus olor (62,5%) és Haliaeetus albicilla (54,2%) követi. Az összes észlelt egyed (17 884 pd.) 92%-a Anas platyrhynchos volt, így ez alapján is abszolút domináns fajnak számít.

Fehér gólya (Ciconia ciconia) állomány monitorozása

Az Őrtilos és Barcs között található településeken (17 település) a 2000-2004. években elvégeztük a fehér gólya állomány monitorozását. Eredményeink szerint a vizsgált időszakban jelentősen - közel 20%-al - csökkent a költőpárok száma, 58-ról 45-re. Ezzel együtt az eltelt időszakban a lakatlan fészkek száma megötszöröződött (3-ról 15-re nőtt).

Faunisztikai adatok

2000-2004 között a monitoring területeken 142 madárfaj, illetve a Dráva-mentén további 20 madárfaj előfordulását sikerült bizonyítanunk. E szerint a Dráva-mentén 2000-2004-ben mindösszesen 162 madárfaj előfordulásáról van adatunk, melyek közül 25 fokozottan védett madárfaj.

DOI:10.24394/NatSom.2005.7.143

Natura Somogyiensis	7	143-156	Kaposvár, 2005

Bat monitoring along the Drava River (Mammalia: Chiroptera)

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DOMBI I: *Bat monitoring along the Drava River (Mammalia: Chiroptera).*

Abstract: In the Drava monitoring project bat monitoring has been carried out along the Drava between Őrtilos and Babócsa since 2000 with the methods below, three times a year: capture with net and ringing, sampling with bat-detector along a path, point counting in the case of Daubenton's bat and pond bat, survey of building-dwelling colonies. Four sampling areas were chosen: Őrtilos - floodplain of Drava, Gyékényes - Lankóci forest, Vízvár - floodplain of Drava and village, Babócsa - Mérus forest and backwater of Drava to carry out monitoring on. 17 species of bats were indicated in the five years of research, three of them are endangered species Barbastelle bat (*Barbastella barbastellus*), Bechstein's bat (*Myotis bechsteini*) and the pond bat (*Myotis dasycneme*). The region is quite abundant in species of which most are vulnarable not only in Hungary but also across Europe. All this indicates the natural status of the sampling areas and marks the importance of the floodplain along Drava in the conservation of the species concerned.

Key words: bat, monitoring, bat-detector, Drava, habitat

Introduction

Danube-Drava National Park Management started the natural monitoring of the upper part of River Drava in Hungary in 2000 with the purpose of monitoring the effects of the hydroelectric power plant panned at Novo Virje, Croatia and prognosticating its probable impact based on records of original state of the area. As a part of this wide-range project, bat monitoring is performed by our Foundation. Samples are taken following the standard monitoring rules of sampling in the same sample area, at the same time, administering the same methods to be able to do any comparisons among results. Four sample areas were chosen: Őrtilos floodplain, Gyékényes - Lankóci forest, Vízvár - Drava bank and settlement, Babócsa - Mérus forest and the backwater of Drava.

Material and methods

Sample areas

More features had to be taken into account simultaneously while choosing the appropriate sample areas. Here they follow:

- impact of Drava on the bat colony in the sample area present
- representative sampling in the same sample areas even during the long period - ten years - of monitoring with the possible least effect of the inevitably occurring natural changes.

ISSN 1587-1908 (Print); ISSN 2062-9990 (Online)

- true representation of the bigger range and characteristic habitats based on the features, characteristics and size of the chosen area.
- easy accessibility, secure identification on map

Four sample areas were chosen, respectively:

- Őrtilos - Drava bank, floodplain areas South from the railway station, gravel-pit lake
- Gyékényes - Lankóci forest, old oak forests, Berek and surroundings
- Vízvár - Drava bank, part of bank under the village and the settlement
- Babócsa - Mérus forest and the backwater of Drava at Babócsa

According to different sampling methods more types of sampling areas were chosen. Consequently, there are point count and linear sampling areas.

Sampling methods

Basically, four methods were applied. The first one was capturing bats, identifying them in hand, thus data collection. The second one was without actually capturing the animals, only observing them on their hunting area using bat-detectors. The third method was finding the building-dwelling colonies in their roost-sites and other observations. All of these methods are among those suggested by NBmR, but adaptation to local conditions was necessary.

1. Capturing bats with net

The point is to put up nets in the appropriate areas, where bats are most likely to fly through during the night and thus captured. Then identification of the species and data collection, such as age, sex, forearm length (FA), body mass, time of capturing, and net number are recorded. If the animal is ringed, the ring number is also written down. Moreover, additional data can be: condition of breasts concerning sucking, turgidity of testicles, former scars, other individual characteristics, amount of parasites on body, in case of long-eared bats (*Plecotus* sp.) length of thumb and claws, width of ear-cap. Capture circumstances are always recorded as follows: time of capture, weather condition, net position, temperature and humidity per hour. Advantages: precise identification of species, and with the help of age and sex, further data can be gained on reproduction conditions. During the project 6x3 and 12x3 meters, Polish 70/2 thread quality nets were used.

2. Observations with bat-detectors

It is a method demanding high technical and professional knowledge. It is based on the reception and transformation of the ultrasound sent out by bats. Differences of echolocation calls among species allow identification and counting of individuals. Advantage: mobility, so that observation is not restricted to a given area, also bats flying in the surroundings are easily and with a great probability detectable. Therefore this method supplies more data, than capturing. identification to species cannot always be achieved in the field, but by recording the sound it can be analysed later on the computer. By all means it is suitable for measuring the intensity of bat-movement, and their relative frequency. It is also apt to observe the different usage of each habitat-type. The detector is used in two methods:

Point count sampling with bat-detector: at waterside, sampling on one spot, monitoring Daubenton's bat (*Myotis daubentoni*) and pond bat (*Myotis dasycneme*).

Line transect sampling: observation is accomplished along a pre-determined line.

Equipment used during the monitoring from 2001: Pettersson D240X bat-detector and Sony WMD6C tape recorder. Sound-recordings are analysed using Cool 2000 software.

Fig. 1.: Greater mouse-eared bat (*Myotis myotis*) - Rarefying, house-dwelling species

Fig. 2.: Bechstein's bat (*Myotis bechsteini*) - Endangered, rare species

Fig. 3.: Noctule bat (*Nyctalus noctula*) - Most common species along Dráva river

Fig. 4.: Grey long-eared bat (*Plecotus austriacus*) - Common, house-dwelling bat

3. Surveying building-dwelling colonies

It has a very crucial part in monitoring, since many species live exclusively in buildings. Most of them are parent-colonies, thus keeping track of them well indicates the changes occurring around them. During the project we mainly concentrated on clerical buildings, because previous studies showed that most of building-dwelling colonies live in the towers or attics of churches. Throughout the survey churches are observed and characterised once a year following the same aspects of data collection. The characteristics of the buildings as habitats, the detected species and number of individuals, presence of other species (barn owl, pigeon, mart, etc.), and changes compared to previous years (e.g. locked window) are recorded during the assignment. A total number of 19 buildings were involved in the monitoring

The observed settlements are as follows: Őrtilos, Zákány, Surd, Gyékényes, Nemespátró, Porrogszentkirály, Csurgó, Berzence, Somogyudvarhely, Bélavár, Vízvár, Heresznye, Bolhó, Babócsa.

Features of sample areas

1. Őrtilos

Reasons for the choice: Drava enters Hungary at this point, so impacts from abroad are noticed the earliest here. Nevertheless at Zákány it leaves Hungary again and flows down in Croatia, where it may face other effects. Therefore the Őrtilos part can function as a control-area, where the probable negative effects on Drava River can occur in a different way than at the part below Vízvár.

General classification: Well-confined area. We can meet variable surface features, from the mainstream to the distributaries, from gravel-pit lakes, to railway embankments. The ligneous vegetation mainly consists of middle-aged forests. Older forests are situated only along the distributaries continuously filling-in and above the railway. The main species are white willow (*Salix alba*), poplars (*Populus* sp.), Hungarian ash (*Fraxinus angustifolia*), common oak (*Quercus robur*). Above the railway highland species can also be found, such as beech (*Fagus sylvatica*), sycamore maple (*Acer platanaoides*), hornbeam (*Carpinus betulus*). Lack of old stocks is a disadvantage concerning the bats, since the number of roosting sites is restricted. This fact is also proved by the collected data. Because of the lack of tree-holes the bat-stock on the area can only be reported as low based on previous research. The gravel-pit lakes that are filling in are used as a foraging site by those bat species which hunt mostly above water and other open areas, such as the noctule bat (*Nyctalus noctula*), the Daubenton's bat (*Myotis daubentoni*), and the common pipistrelle (*Pipistrellus pipistrellus*). There is a relatively large area with treeless, grove-flora, part of which are covered with reed and other water-indicator vegetation. These are foraging sites, too.

Methods applied: capture, sampling with detectors - point count and line transect and method.

2. Lankóci forest

Reasons for the choice: The area is a bit further away from Drava, however with its old oak and hornbeam forest represents a very precious habitat.

General classification: The old hardwood and softwood stocks offer very good roosting sites for bats. The chosen area is covered with a very versatile vegetation, from the stagnant water sedge and alder-swamp to the oak forests. This high level of diversity can ascertain the different roost demands of each bat species. Diverse vegetation also supplies the animals with a steady and dependable nutrition base. Paths and openings are well utilised by bats during hunting, thus observations having been carried out with

detectors or by capturing the animals well represent the bat-fauna and also the stock-size. Although the forested area is bigger the chosen sampling spots are reliably characterise distinctive habitats.

Methods applied: capture and sampling with detectors - line transect method.

3. Vízvár

Reasons for the choice: Drava River enters Hungary above the village again, thus any impact present still in Croatia can be well indicated in the area. Forestation is very good in the region, meaning exclusively willow-poplar groves. Because of the closeness of the settlement, both building-dwelling and forest stock can be well observed on the sampling sites.

General classification: The area is situated right next to Drava, thus its effect is obvious. We can find softwood gallery forest remained in their natural condition with a rich shrub level and undergrowth. The main species are white willow (*Salix alba*), and poplars (*Populus* sp.). The old forests offer the hole-dwelling bats great roosts. Distributaries and temporarily flooded areas supply the bats with very good foraging sites during the whole active period. The attics of buildings and the church in the settlement are the roost sites of the building-dwelling species, which does not usually make up big colonies, but lead a solitary life or live in colonies of only some individuals. These species feed on the floodplains, too. However, the lights in the streets should also be mentioned since they function as light-traps attracting insects that the bats willingly exploit.

Methods applied: capture, sampling with detectors - line transect along the bank of Drava and in the settlement and point counting at the distributary of Drava.

4. Babócsa

Reasons for the choice: The Mérus forest is a relict-like, old, hardwood forest that represents a very important habitat due to its island-like features. Because of the collecting effect, many sensitive species are found here in greater or smaller number. The current of the Drava, the changing groundwater level has a great impact on the health, the renewability of the forest that indirectly effects the bats, too.

The backwater of Drava once a river-basin, now one backwater of the river, which is filling up steadily. The old willows in the surroundings offer great habitats for the Daubenton's bat (*Myotis daubentoni*) and the pond bat (*Myotis dasycneme*), as they are strongly related to water due to their life-style.

General classification: Nature-like forest, where the main and additional species of trees are also present. It is at least 500 meters away from the water and takes up 80 ha (~200acres). It is surrounded by big meadows and turfs and offers excellent roost sites. Openings and the surrounding open flooded habitats are good foraging sites. The whole district is heterogene concerning both age-distribution and diversity.

The backwater of the Drava is filling up, it is flooded during high-water, but by the end of the summer it almost dries out completely. The old willows (*Salix* sp.) in the bank-lane give great roost sites and the big open watersurface and the groves offer a good foraging site for the bats.

Methods applied: capture in the oak forest, sampling with detectors - line transect in the oak forest and between the backwater of Drava and point count at the backwater of Drava.

Results

During the 5 monitoring years so far the presence of 17 bat species has been proved in the observed area. It is 61% of the 28 officially recorded as occurring national species that is very promising. Moreover, a new long-eared species, *Plecotus macrobullaris* was also successfully identified. The latter is just a presumption, since identification is not always unequivocal in the field, proof can only be given after genetic examinations. It was indicated as *Plecotus* sp. at the data collection. Identified species are shown in Table 1. indicating the method with which their presence was proved.

Table 1.: The species of bat fauna with sampling methods

Species	Mist-net	Detector	In building
Daubenton's bat (*Myotis daubentoni*)	X	X	
Pond bat (*Myotis dasycneme*)		X	
Bechstein's bat (*Myotis bechsteini*)	X	(X)	
Natterer's bat (*Myotis nattereri*)	X	X	
Whiskered bat (*Myotis mystacinus*)	X	(X)	
Brandt's bat (*Myotis brandti*)	X	(X)	
Greater mouse-eared bat (*Myotis myotis*)	X	X	X
Lesser mouse-eared bat (*Myotis blythi*)	X		
Noctule bat (*Nyctalus noctula*)	X	X	
Leisler's bat (*Nyctalus leisleri*)	X	X	
Serotine bat (*Eptesicus serotinus*)	X	X	X
Sopran pipistrelle bat (*Pipistrellus pygmeus*)	X	X	
Common pipistrelle (*Pipistrellus pipistrellus*)	X	X	X
Nathusius' pipistrelle bat (*Pipistrellus nathusii*)		X	X
Long-eared bat (*Plecotus auritus*)	X	(X)	
Grey long-eared bat (*Plecotus austriacus*)	X	(X)	X
Plecotus sp.	X		
Barbastelle bat (*Barbastella barbastellus*)	X	X	

The table well indicates that the nets or the detector are both very important in identifying different species, as two of them, the Pond bat (*Myotis dasycneme*) and the Nathusius' pipistrelle bat (*Pipistrellus nathusii*) were only identifiable using detectors. Those bats that were difficult to identify with detector [marked (X)] netting was ascertaining.

Table 2. shows the species identified in the different sampling areas.

It is visible that the most number of species was observed in Babócsa and in the Lankóci forest, but the other areas are also very abundant in species. More important is the fact that in all four areas the presence and reproduction of at least two endangered, habitat-specific species were justified. The high number of species and the presence of the rare ones indicate that the habitat features in the sampling areas are very good, their condition is near-natural.

Table 2. : The species identified in the different sampling areas

Species	Őrtilos	Lankóci forest	Vízvár	Babócsa
M. daubentoni	X	X	X	X
M. dasycneme	X		X	X
M. bechsteini		X	X	X
M. nattereri		X	X	X
M. mystacinus	X	X	X	X
M. brandti	X	X	X	X
M. myotis		X		X
M. blythi		X		
N. noctula	X	X	X	X
N. leisleri		X		X
E. serotinus	X	X	X	X
P. pygmeus	X	X	X	X
P. pipistrellus	X	X	X	X
P. nathusii	X	X	X	X
P. auritus	X	X	X	X
P. austriacus	X	X	X	X
Plecotus sp.	(X)		(X)	
B. barbastellus	X	X	X	X
Total	**12 species**	**16 species**	**14 species**	**16 species**

Species reported along River Drava

Daubenton's bat (*Myotis daubentoni*)

Common in the whole country has a strong connection to water; its roosting sites are mostly in the old forests near the water. It hunts above water, for mosquitoes, caddy-flies and may-flies. Important indicator species due to its sensitivity to habitat and nutrition-base. It is well traceable in large numbers in all sampling areas, though in the Lankóci forest it is rarer, because of lack of open water surface.

Pond bat (*Myotis dasycneme*)

Endangered, rare species. So far it has only been indicated with detectors. Its life-style is similar to the Daubenton's bat's (*Myotis daubentoni*), but it is more connected to the old willow forests. It is endangered in its whole habitat (SCHOBER & GRIMMBERGER. 1987).

In Őrtilos and in Vízvár some individuals are regularly detected, in Babócsa at the backwater of Drava several hundreds of individuals were detected in 2001, but since then it has only been seen occasionally.

Bechstein's bat (*Myotis bechsteini*)

Endangered, rare species. Nowadays it is vulnarable all around Europe, in our country it was only known from the mid-mountains. Hence its presence in the plains is fairly remarkable! It is closely related to old, mixed, hardwood forests. Its nutrition consists of moths and mosquitoes. Except for Őrtilos it was caught everywhere and its reproduction

was confirmed. It seems to have a steady stock in the Lankóci forest and in the Mérus forest in Babócsa. In Vízvár only one old female was captured that assured the reproduction of the species.

Natterer's bat (*Myotis nattereri*)

Not a common species. It prefers mountainous homeranges, it only has sporadic data in the plains. The reason for this is the disappearance of old, hardwood forests in the floodplain and its roosting sites with them.

Along the Drava it is present and its reproduction is proved in the Lankóci forest, in Vízvár and in the Mérus forest in Babócsa. Its presence indicates good, natural habitats, but its stock is most probably vulnerable.

Whiskered bat (*Myotis mystacinus*)

Not a common species. It prefers mountainous homeranges, it only has sporadic data in the plains. It is due to the disappearance of the old, hardwood forests in the floodplain, hardwood mixed and grove forests.

Along the Drava its presence and reproduction is known in the floodplain of Drava next to Őrtilos and Vízvár, in the Lankóci forest, and the Mérus forest in Babócsa. Its presence indicates good, natural habitats, but they are most probably vulnarable because of the shrinking homerange.

Brandt's bat (*Myotis brandti*)

Not a common species. It prefers mountainous homeranges, it is rather rare in the plains. Its habitat demands are rather lesser-known, but based on its occurrence data so far, the best living space for the species is the old hardwood, the hardwood mixed and mosaic-like forests. Because these areas have become rather scarce recently the species is vulnarable.

Along the Drava its presence and reproduction is known in all sampling areas. Its presence indicates good, natural habitats.

Greater mouse-eared bat (*Myotis myotis*)

Rarefying species. In the summer it lives in buildings in the winter it draws in caves. Females make up big parental colonies, while the males remain lonesome, or live in colonies of a few individuals. Depending on the level of disturbance the colony may use more suitable buildings. Strangely enough, a considerable part of its nutrition are beetles, moreover mostly from the ground beetles, family Carabidae, since it often feeds from the ground.

In the sampling area its 150 individual-colony was found in the Catholic church in Babócsa, and a 40-50 individual-colony in the Protestant church in Somogyudvarhely. Occasionally it occurs in the Catholic church in Berzence and in Bolhó and in the Lutheran church in Nemespátró.

Lesser mouse-eared bat (*Myotis blythi*)

It lives in buildings and caves. Its life-style is similar to the greater mouse-eared bat (*Myotis myotis*), they often create mixed colonies.

Along the Drava the species did not have any data until July 2005. Colonies were not found in any of the buildings, so the turning-up of its three individuals from the Lankóci forest is quite outstanding and interesting.

Noctule bat (*Nyctalus noctula*)

Common, generally wide-spread species. It lives in tree-holes, and can make up a 100-individual-colony. It is not connected to special habitats, but in old forests and diverse areas it is present in a larger number. Building-dwelling colony is not known from the sampling areas neither from the surroundings. It feeds on mosquitoes to maybeetle, its nutrition-spectrum is very wide.

It is indicated in great numbers in all sampling areas along the Drava, it is the most common species. It is indicated mostly with detectors.

Leisler's bat *(Nyctalus leisleri)*

Rare species. Nowadays it is in the mountains, but it was reported from the plains and floodplains, from Gemenc and Béda-Karapancsa (DOMBI 2003). Its roosting sites are exclusively in tree-holes. It is demanding concerning its habitat, it only occurs in old, natural, mixed forests. It has small 20-30 individual-colonies. it feeds on mosquitoes and moths. Its hunting areas are forests, forest edges and flooded areas.

On the Drava only some individuals turned up in the Lankóci forest and the Mérus forest in Babócsa, which proved reproduction. Unfortunately, the species has not been captured in none of the areas since 2001, it has only one datum with detector from the Lankóci forest in 2004.

Common pipistrelle (*Pipistrellus pipistrellus*)

Generally common species in the whole country. It turns up mainly in urban areas. Due to its size it feeds on mosquitoes and plant-lice.

It is present in all sampling areas along the Drava, but not in the same number as the soprano pipistrelle bat (*Pipistrellus pygmeus*)

Soprano pipistrelle bat (*Pipistrellus pygmeus*)

It was only recently separated from the common pipistrelle (*Pipistrellus pipistrellus*) based on genetic and acoustic researches. It is a forest-dwelling species, its roosting sites are tree-holes. Its national occurrence is not clarified yet, but it is most probably not rare. Its nutrition-base is similar to the related species.

It is present in all sampling areas along the Drava. It is not common anywhere, but neither rare.

Nathusius' pipistrelle bat (*Pipistrellus nathusii*)

It prefers the plains. It is characteristic in floodplains and habitats close to water, it lives in holes. Its hunting areas are on flooded or near water habitats, where it feeds mostly on mosquitoes.

In all sampling areas we only managed to indicate it with detector. One building-dwelling colony is known from the perish in Berzence.

Long-eared bat (*Plecotus auritus*)

It is usually common in the midlands, but data from the hills and plains were also reported. By the latter we mean exclusively old, hardwood (oak-ash-elm gallery forests), or hardwood mixed forests It feeds mostly in the forests on moths.

It was indicated in all four sampling areas along the Drava. Its presence indicates good, natural habitat.

Grey long-eared bat (*Plecotus austriacus*)

It is common and wide-spread in the whole country, mostly in human settlements and

in the near surroundings. Restorations of buildings and lack of knowledge can cause its decrease in number. Its hunting areas can be found around the settlements.

It is present in all four sampling areas along the Drava. Its traces and colonies of few individuals were found in all checked buildings. Significant colonies are known from Surd, Somogyudvarhely, Bolhó, the largest of them is of 25-30 individuals.

Serotine bat (*Eptesicus serotinus*)

It is common and wide-spread in the whole country, it occurs in settlements and in their close surroundings. Restorations of buildings and lack of knowledge can cause its decrease in number. Its hunting areas can be found around the settlements.

It is present in all four sampling areas along the Drava. Its traces or colonies of few individuals were found in almost all the checked buildings. But only one significant colony was found in Zákányfalu that consists of 40-80 individuals.

Barbastelle bat (*Barbastella barbastellus*)

Endangered, rare species. It has already disappeared from most part of Europe, so the national stock should be treated with particular care (BIHARI 1996). Its most powerful stock is in the mid-mountains, but is also has data from the plains. There it finds its demands in old hardwood grove forests, sometimes in castle-parks, so that their disappearance or fragmentation leads to the extinction of the species.

Along the Drava in all sampling areas its presence and also reproduction was proved. In Vízvár one lactating female turned up only in 2005, beforehand we did not know about the species!

Results of different sampling methods

The number of captured and tagged bats between 2000 - July 2005 is shown in Table 3. except for the small species (*Pipistrellus* sp., *Myotis mystacinus* and *Myotis brandti*) all the individuals of all the species were ringed. Several years' of recaptures have proved how much the long-eared bat (*Plecotus auritus*), the grey long-eared bat (*Plecotus austriacus*), the Barbastelle bat (*Barbastella barbastellus*) and the Bechstein's bat (*Myotis bechsteini*) depend and insist on their territories and habitats.

The capture data do not reliably reflect the ratio of the stocks of different species. The low number of captures in case of the otherwise very common noctule bat (Nyctalus noctula), common pipistrelle (Pipistrellus pipistrellus) and soprano pipistrelle bat (*Pipistrellus pygmeus*) can be explained with their life-style and the circumstances of the captures. Those bats hunting high in the forests are captured rather rarely during a net capture method in the paths and openings. In case of the other species the ratios are approximately realistic, which are also backed up by the data gained through the bat-detector observations.

A great advantage of bat-detector observations is the greater number of individuals spotted and that we receive data on the relative frequency of those species hard to capture with net. Its disadvantage is the problems with identifying species. Sometimes individuals are only possible to be identified to genus level, but it happens that even that is hard to tell for sure. As an example Table 4. shows the results of the 2004 bat-detector observations.

The great proportion of noctule bat (*Nyctalus noctula*) is clearly noticeable showing the real frequency of the species. The great number of detection of the three *Pipistrellus* sp., and the serotine bat (*Eptesicus serotinus*) is also apparent. These species can actually be considered as quite common, and they can be indicated more easily from a greater

Table 3. : The number of captured and tagged bats between 2000 - July 2005

Species	Sampling area				Total (ind.)
	Őrtilos	Lankóci forest	Vízvár	Babócsa	
M. daubentoni	20	12	23	41	**96**
M. bechsteini		20	1	6	**27**
M. nattereri		1	1	4	**6**
M. mystacinus	3	21		18	**42**
M. brandti	9	16		3	**28**
M. myotis		3		17	**20**
M. blythi		3			**3**
N. noctula		3		4	**7**
N. leisleri				2	**2**
E. serotinus		7		2	**9**
P. pygmeus	1		1	1	**3**
P. pipistrellus	1	3	8	11	**23**
P. auritus	11		4	3	**18**
P. austriacus	8		13	2	**23**
Plecotus sp.	22		6		**28**
B. barbastellus	7	5	1	21	**34**
Total (ind.)	**82**	**94**	**58**	**135**	**369**

Table 4.: The results of the 2004 bat-detector observations

Species	Number of detections in the sampling area				Total (ind.)
	Őrtilos	Lankóci forest	Vízvár	Babócsa	
M. daubentoni	21	2			**23**
M. bechsteini		1		1	**2**
M. mystacinus/brandt	2	2		5	**9**
N. noctula	26	21	90	13	**150**
N. leisleri		1			**1**
E. serotinus	1	57	6		**64**
P. pygmeus	6	5	6	5	**22**
P. pipistrellus	4	5	56		**65**
P. nathusii	6	14	6	10	**36**
B. barbastellus	1	2			**3**
Plecotus sp.	5				**5**
Myotis sp.	10	12		1	**23**
Chiroptera	7	26	7	9	**49**
Total (ind.)	**89**	**148**	**171**	**44**	**452**

distance, too. The small ratio of *Myotis* sp., *Plecotus* sp. and *Barbastella* sp. can be due to their rarity and also their hard delectability. Neither species, nor genera were identifiable in 11 % of all cases.

Point counts sampling of the Daubenton's bat (*Myotis daubentoni*) and pond bat (*Myotis dasycneme*) was carried out in Őrtilos, Vízvár and Babócsa. Data showed great fluctuation comparing the years. In some cases it can be explained with the drastic change of environment, for example in Babócsa the dry conditions of backwater of the Drava in August, or the migration of parts of colonies. According to the data collected so far the best sampling area is the backwater of the Drava in Babócsa. Also the pond bat (Myotis dasycneme) was detected the most often here, which fact justifies the good habitat features of the area. The species was detected the most numerously in July 2002 (200 ind. within 1 hour). The situation is the worst in Őrtilos. The number of Daubenton's bat (*Myotis daubentoni*) is the smallest here and the pond bat (*Myotis dasycneme*) only occurs rarely, too. The reason for that seems to be the small number of prey due to the great current of the river.

18 clerical buildings of 14 settlements of the research area are monitored. Bats live or lived in all observed buildings. Five species were indicated. According to their frequency, they are respectively: serotine bat (*Eptesicus serotinus*), grey long-eared bat (*Plecotus austriacus*), greater mouse-eared bat (*Myotis myotis*), Nathusius' pipistrelle bat (*Pipistrellus nathusii*), common pipistrelle (*Pipistrellus pipistrellus*). Four steady colonies are known, in the other places bats are only present in small numbers and just occasionally. The most significant colony that is of greater mouse-eared bat (*Myotis myotis*) is in the Catholic church in Babócsa, but the number of its individuals unfortunately decreased from 150 to 70-80. Hopefully, it is only about migration to another site, since an increase was recorded in the other significant colony at Somogyudvarhely at the same time. Here there are 40-50 individuals. The grey long-eared bat (*Plecotus austriacus)* rarely has a big colony, though it was detected almost everywhere. A 25-30 individual parent colony lives in Surd. The biggest colony of the serotine bat (*Eptesicus serotinus*) with 60-80 individuals can be found in Zákányfalu in the Catholic church.

Discussion

The monitoring project having been carried out since 2000 revealed the fact that the Drava between Őrtilos and Babócsa has a very significant bat-fauna. 17 species of bats were indicated in the four sampling areas that takes out 61 % of the national bat-fauna. The detection of three endangered species Barbastelle bat (*Barbastella barbastellus*), Bechstein's bat (*Myotis bechsteini*) and the pond bat (*Myotis dasycneme*) with strong reproducing stocks are of special importance. All the European stocks of the three species are crucially endangered, because the old forests having served as their natural habitats are extinct. Since reproducing colonies live along the Drava the protection of their habitats is a cardinal duty. Interesting, but so far not proved the appearance of a new species in our country which is likely to be *Plecotus macrobullaris*. During the survey it is registered as *Plecotus* sp., and it was detected in Őrtilos and Vízvár.

During the monitoring it became clear that all our chosen methods should be applied simultaneously to receive accurate and reliable data on the bat colonies and to trace any changes. None of them on its own provide enough data neither in quality, nor in quantity concerning all the species. The other lesson that we learned is that still a lot of intense research years are needed even to gain result on the original state, since after five years new species occurred in the given sample areas.

It is unpredictable for the time being what effects the would-be hydroelectric power plant should have on the bat-fauna in the Drava region. Recently the most threatening factor is the timbering in the natural forests along the river.

Acknowledgements

The author would like to express his sincere thanks to Somogyvári Orsolya, Görföl Tamás and many voluntary helps for letting the program come true.

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Denevér-monitoring a Dráva mentén (Mammalia: Chiroptera)

DOMBI IMRE

A Dráva természeti monitoring keretében 2000 óta végezzük a folyó Őrtilos - Babócsa közti szakaszának denevér-monitoringját az alábbi módszerekkel évi három alkalommal: hálózásos befogás és gyűrűzés, denevérdetektoros útvonalbejárás, vízi és tavi denevér pontszerű számlálás, épületlakó kolóniák felmérése. Négy mintaterületet választottunk ki, ezek a következők: Őrtilos - Dráva ártér, Gyékényes - Lankóci erdő, Vízvár - Dráva ártér és falu, Babócsa - Mérus erdő és Holt-Dráva végzünk monitoringot. A kutatás öt éve alatt 17 denevérfajt mutattunk ki, köztük három fokozottan védettet. Ezek a pisze denevér (*Barbastella barbastellus*), nagyfülű denevér (*Myotis bechsteini*) és a tavi denevér (*Myotis dasycneme*). A terület igen fajgazdag, és közülük soknak veszélyeztetett nemcsak a hazai, de európai helyzete is. Mindez mutatja a mintaterületek természetes állapotát és jelzi a Dráva ártér fontosságát a fenti fajok fenmaradásában.

DOI:10.24394/NatSom.2005.7.157 | Natura Somogyiensis | 7 | 157-167 | Kaposvár, 2005

Small and medium sized predators monitoring along River Dráva

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HELTAI M., SZEMETHY L., SZABÓ L., SZŐCS E.,: *Small and medium sized predators monitoring along River Dráva.*

Abstract: We have been working on the small and medium sized predator species' monitoring since 1999, within the framework of Monitoring River Dráva's nature conservation area. The monitoring is carried out with live trapping. In the first two years of our work the methods were finalized. In our work, given valuable results since 2001 we have caught 86 individuals of seven predator species (red fox, polecat, weasel, stone and pine marten, wild cat, domestic cat) so far, during the 26 848 trap-nights. The average catch effectiveness was 0.317 captures/ 100 trap-nights. We could prove the presence of the ermine and the otter on the research area with additional methods. The wild cat, and the pine marten turned out to be the most frequent predator. Both species have narrow-bearing, and find human disturbance hard to bear. These qualities give the ability to these species to be the indicators of the changes in living places of the territory by follow the changes of their population with attention.

Key words: predator monitoring, live trapping, stone marten, wild cat

Introduction

Hungary is one of the most richest area in natural values in Europe and most of the predator species, that can be found on the Continent appear here too. Only with the exception of those rare, narrow-bearing species, with relatively small spreading area even in Europe, like the brown bear (*Ursus arctos*), the wolverine (*Gulo gulo*), the common genet (*Genetta genetta*), the European mink (*Mustela lutreola*) and the American mink (*Mustela vison*), or the marbled polecat (*Vormela peregusna*). In the second part of the 20th century some native predator species returned and created increasing populations, like the wolf (*Canis lupus*), the lynx (*Felis lynx*) or the golden jackal (*Canis aureus*), which became extinct from the territory of Hungary long before. Besides some invasive species appeared, which are also spreading in Europe, and are considered as non indigenous species, like the raccoon (*Procyon lotor*) and the raccoon dog (*Nyctereutes procionoides*) (HELTAI 2002). Despite of this, the national research of these species is surprisingly trifling compared with other groups, such as song birds, small rodents or amphibians, while internationally is quite scanty. There were quite few publications about the nationwide spreading and the changes in populations of one or other predators in the past decades.

ISSN 1587-1908 (Print); ISSN 2062-9990 (Online)

The lack of information is proved by the facts of BÁLDI et al. (1995), who were considering the given species' status of protection and research as an independent point of view, when working out the appraising system of the national vertebrate species. They estimated -among others- whether there is or not information about the nationwide spreading and the changes in number of individuals, and furthermore the number of publications about the studies on the given specie. In their system the specie about every information is available got 0 points in principle, while about nothing is known got 45. The studied predator species - except the red fox (15 points) - got 28 points or higher rates, but the 40 points of the common polecat and the lynx, or the 38 points in case of the weasel means total lack of information virtually.

This incognizance enforced the working out of monitoring predator species to be completed as part of the National Biodiversity Monitoring System. (TÖRÖK et al. 2001). László Szemethy and Miklós Heltai, the colleagues of St. István University's Department of Wildlife Biology and Management suggested two different types of data collecting methods. On the one part they suggested a continuous data collection based on a nationwide survey with questionnaires, on the other part a survey on fields on appointed monitoring points based upon live trapping. Their suggestions were confirmed with their earlier experiences (SZEMETHY and HELTAI 2002).

The nationwide survey with questionnaires was started in 1987 and they have been continuing it with the support of the Ministry of Agriculture, Wildlife Management Fund ever since. HELTAI (2002) gave a summary of the results found till now in his PhD thesis. The testing of the survey on fields was also started, but because the lack of the nature conservation support first of all it served the following of the populations of the fair games or of those species which are important in game management (SZEMETHY et al. 2000).

The nature protective monitoring of river Dráva, that started in 1999 gave the opportunity to try the monitoring on fields based on trapping that had been worked out for the predator species and make an alteration in it if necessary. So our purpose was dual, on the one hand monitoring of the mammal predators' stock on the indicated research areas on the other hand testing the applied methods.

We carried out our researches on the increased protected soft-wooded grove forests of a floodplain area and on artificially renovated oak forests, bordered by the River Dráva and the Stream Zsdála, situated on the south by the village Bélavár, on the monitoring points that were appointed by the Duna-Dráva National Park.

Methods

Description of the basic status

The predator species which might be found on the area, their present status and their stock alteration were defined upon the bag data of the National Database of Game Management and upon wide extended faunistical works (LANSZKI and PURGER 2002, HELTAI 2002) that can be related to the area.

Trapping according to the original protocol

According to the original sampling method the work was continued three times a year with 100 small sized "stone marten" traps. The trapping periods were: winter (January-February), summer (June-July), autumn (October-November). One or other trapping campaign stood about a one week long accustoming after outplacement and about an

Fig.1.: Ready for works. Packing down the traps.
Photo: M. Heltai

Fig. 2.: Making friends with the stone marten.
Photo: L. Szabó

Fig. 3.: The most beautiful and valuable predator of research area, the wild cat
Photo: F. Jarovics

Fig. 4.: One of the species that can be hardly trapped, the fox. We caught it.
Photo: J. Jarovics

intensive, continuous trapping for three weeks. The traps were set along appointed transects in every 50 meters, the lure was the same within one transect. We kept changing eggs, fish and cattle-liver as baits.

The applied traps were 70 cm long and had a 15 x 15 cm door-size. It is suitable for catching small sized of a mustelids kind first of all. The trap is classed among the tip over-doored traps, and it's locking device follows one of the most conventional solutions, it's rodded. The door, made of sheet-iron, and counterweighted at the back side turns up inside the trap. The rod that sets out from the tread-pedal situated at the end of the trap and troppling in the middle shores it up here. When the animal steps onto the pedal the rod is pulled out under the door, that falls down and slips through the steel-spring which prevents it of being opened again and is situated at the bottom of the trap. The trap can be handled at it's back side. This side can be opened by removing a screw: on the one hand the lure can be put in here onto the prepared hook, on the other hand in case of a capture the caught animal can be get out here.

After identifying the specie, and the sex of the caught animals and the classification into age-groups is done, we signed them with a fur paint used in the animal-husbandry and we released them at the place where they were captured. The fur paint means minimal disturbance for the animal and provides the recapture controlling during a trapping campaign.

The processing of the trapping's data was based partly on the number of captured individuals' species -that is the measurable diversity among predator species- partly on the trapping effectiveness - that is the frequency of the predator species. We defined the effectiveness by the number of captures relating to a 100 trap-night.

Changes in the trapping protocol

The first two years of the program (1999 and 2000) was about the continuous refinement of the trapping method. The final method was worked out till the end of 2000, so that's why we have been publishing data from the results just from then. The changes were necessary because of the inadequate efficiency of the trapping.

Changes in the trapping periods

The summer trappings were totally unsuccess virtually. The primary reason for this was the extreme swelter of summer's forepart in the past few years. Partly, in the extraordinary warmness the lure went wrong almost immediately and lost all it's attractiveness. The unusual inactiveness of the predator species was also because of the weather. There has been a hybrid-maize seed production with watering for years on the agricultural fields (on meadow Suli) within the indicated area, significantly disturbing the territory and contributing to the unsuccessful. Because of these combined effects we stopped the trappings in the summer, while during the autumnal (October-November) and the end of the winter (February-March) periods we made a 6-6 weeks long continuous trapping after one-one week accustoming, so the yearly whole term of the trapping extended from 9 weeks to 12.

Changes in the outplacement and in the lure

It was proved in the course of the first two years that the uniform trap placing, worked out for small rodents can't be used in the case of the predator species. The reason for this is that the mammal predators show territorial behaviour generally in one or the whole part of the year and the size of the habitats used by them can be considered relatively large. That's why it was necessary to make an alteration in the originally planned outplacing method. We had been trying to find inside the indicated area the most suitable

trapping places since the year 2001. We payed attention all the time to the traps to be located equally on the territory if possible. So it was an opportunity for us to form the trap places not by necessity, just because we passed 50 meters, but we could choose those places where the successful trapping has the highest possibility.

We also gave up the uniform, planned in advance outplacements of the bait. We used the next materials as varied as possible fitting in the given traps and areas according to the disappeared lures outplaced as dragging: liver, fish, chicken-neck, raw and boiled egg, dry dog food, dog salami, table-tennis ball, flavoured bread, pieces of chicken meat, *Valeriana officinalis*, apple, grape.

Changes in the applied traps

In the first two years we kept trying new kinds of traps, which were not in the protocol. According to these tests we decided to use a total of 24 traps too, which are bigger than those we applied earlier. This alteration had three reasons. The most important was that already after the initial researches it was found out, that one of the most valuable predators of the territory is the wild cat. This medium sized predator species can be trapped more successfully with bigger sized traps. The second reason was that during our observations it seemed to be that first of all the pine marten went sooner into the trap, that was larger than the one before. The third reason was in turn that probably the effectiveness could be grown with making the trap-park more various. Therefore the trap-park stood about 76 small sized 1stone marten1 traps, 12 medium sized „stone marten" traps and 12 large sized traps from 2001.

The medium sized 1stone marten1 trap is all the same in it' s material, shape and work as the small sized trap, the only difference is in the size. It's door size is 25x25 cm whilst the length is 100 cm.

The 150 cm long, 35 cm wide and 45 cm tall large sized trap belongs to the slipping-doored traps. The doors run in the rails prepared on the two sides of the trap. The lifted doors are held by the rectangular holding element, which is fixed up to the door keeping axle and turns round on it. The longer arm of the holding element shores up the door, the thin wire-bowden sets out from it's shorter part toward the locking mechanism. The locking mechanism is a dual lever, that can hold the doors together or separately too. So the trap can be used both ways as a mechanism with one or two doors. The tread-pedal can be inlayed into the counter-holder situated at the bottom of the locking mechanism, or we can hang the lure up directly here. By pushing the tread pedal or pulling the lure the locking mechanism is releasing, the bowden get loosen, the door keeper turns out round the axle under the door that falls down. The material of the trap's case part is spot-welded wire netting, which has a 2.5x5 cm mesh. The stiff frame round the doors is formed by flat-irons that are fixed with screws end-to-end. There is a door covered with sheet-iron in the middle of the trap above the tread-pedal, which can be opened after unfastening a screw to make the feeding easier. A small penthouse can be put onto the locking mechanism to protect the lock from the falling twigs or from birds ready for sitting on it. Whilst the sensitiveness of the locking mechanism, namely the scale of the strength needed for the letting off can be regulated practically everything can be captured with the trap, that is willing to go in it and can't get through the mesh. Of course because of it's size it is suitable first of all for capturing major sized predator species like the red fox, the badger or the wild cat.

Results

The predator species which probably appear on the area

According to data on the national mammal predator species' nationwide spreading and stock alteration published in the last decade the following summary can be given in the case of one or other species related to the Hungarian reach of river Dráva so to the research area:

- Red fox (*Vulpes vulpes*): native, has an increasing stock, is a common species that appears everywhere along river Dráva;
- Raccoon dog (*Nyctereutes procyonoides*): settler, non indigenous, has a spreading stock, it's presence along river Dráva can't be precluded;
- Raccoon (*Procyon lotor*): settler, non indigenous, has a spreading stock, it's presence along river Dráva can't be precluded;
- Golden jackal (*Canis aureus*): returned, native, it's listed in the Red Book (RAKONCZAY 1989), has an increasing and spreading stock, it's presence along river Dráva is certain;
- Stone marten (*Martes foina*): native, common, has an increasing stock and spreading territory, but is a species that avoids closed forest areas, it also settled in the villages along the river, it's presence along river Dráva is certain;
- Common polecat (*Mustela putorius*): native, common, has a stable stock, but is a specie that avoids closed forest areas, it's presence along river Dráva is certain;
- Wolf (*Canis lupus*): returned, native, it's listed in the Red Book (RAKONCZAY 1989), the population is changeable, it's presence along river Dráva can be precluded in the past 15 years;
- Lynx (*Lynx lynx*): returned, native, it's listed in the Red Book (RAKONCZAY 1989), the population is changeable, it's presence along river Dráva can be precluded;
- Wild cat (*Felis silvestris*): native, it's listed in the Red Book (RAKONCZAY 1989), has a decreasing stock and spreading territory, it's presence along river Dráva is certain;
- Ermine (*Mustela erminea*): native, has a stable stock, it's presence along river Dráva is possible;
- Steppe polecat (*Mustela eversmanni*): native, probably has an increasing stock, likes the dry, open grass-grown areas, it's presence along river Dráva is not possible;
- Pine marten (*Martes martes*): native, has an increasing stock and spreading territory, it's presence along river Dráva is certain;
- Otter (*Lutra lutra*): native, it's listed in in the Red Book (RAKONCZAY 1989), has a stable stock and spreading area, it's presence along river Dráva is certain;
- Badger (*Meles meles*): native, common, has an increasing stock and spreading area, it's presence along river Dráva is certain;
- Weasel (*Mustela nivalis*): native, common, has a stable stock stabil, avoids closed forests, it's presence along river Dráva is certain.

The results of the trapping

There were 26 848 trap nights altogether between 2001 and 2004, during this period we captured 86 individuals of seven predator species (red fox, weasel, marten, beech marten, common polecat, wild cat, cat). The average capture effectiveness counted for the whole period was 0.32 (n=4, SD=0.0819). The obvious presence of other two species the ermine and the otter was proved by footprints and excrements with observations apart from the trapping.

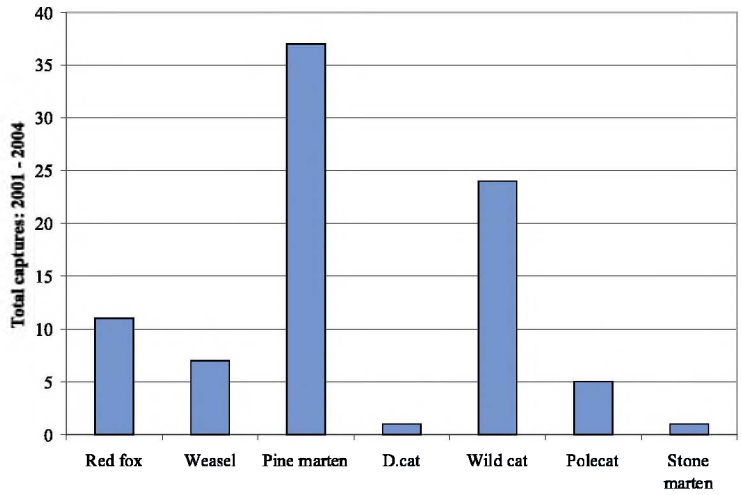

Fig. 5.: The captured species and number of captures

According to the results of the trapping the most frequent predators of the area are the pine marten and the wild cat. From the wild cat's presence point of view the area seems to be especially important, because during the elapsed period we never caught any hybrid cats, and we only captured one domestic cat, in the first year. The presence of the weasel on the territory is waving probably it depends on the availability of the small mammals - as a potential food source- very much. It can be regarded as a surprise that we couldn't capture the badger till now on the research area, which is otherwise spreading nationwide and can be trapped relatively well (Fig. 5).

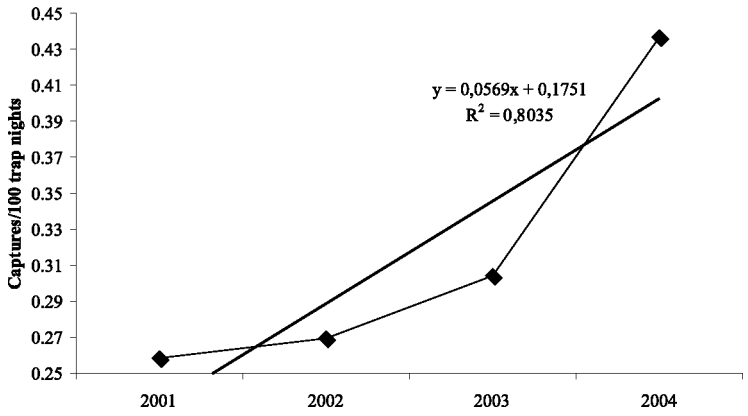

Fig. 6.: Alteration of the capture effectiveness (NS)

The effectiveness of the trapping has been increasing continually since 2001. While in the first whole year we captured a mammal predator about every fourth day (0.2586 captures/ 100 trap nights), till then every second day in 2004 (0.4366 captures/ 100 trap nights). Whereas the increasing of the effectiveness at the present not obviously shows the increasing of the predator species' density, but probably improving the knowledge about trapping and getting to know more about the territory corrected our results (Fig. 6).

Conclusions

The river Dráva region's rich predator fauna significantly contributes to the territory's extraordinary values. In addition to the three species, which are in the Red Book (RAKONCZAY 1989) -wild cat, otter, golden jackal- most of our protected and fair game predators have breeding populations on the river region.

Bearing the nationwide tendency and the adaptation ability of the predator species in mind the decreasing of the narrow-bearing, more sensible species' population while the increasing of the multitudinous species' population can be prognosticated in constant habitat conditions.

This means the following in case of the single species. The density of the small sized Mustelids (weasel, ermine, common polecat) depends on the available amount of food sources first of all. Namely if intensive agricultural works don't affect the territory, then their number will range in the next few years particularly together with the rising of the small rodents. We don't expect a changing in the spreading of the generalist and opportunist predators present in large numbers (stone marten, badger, red fox), their stock density conceivably increases onwards. The same could be probable in the case of the golden jackal, although what is happening with it's population's European spreading centre in the Balkans acts as an important and unknown factor. Within constant habitats the stock of the marten and the otter could stay stable, while the wild cat populations can remain expectedly in the most undisturbed areas also free from cats with their characteristic populations nowadays. The sedentation of our large sized predators (wolf, lynx) on the plain Dráva is not probable nor in the next few years, can the permanent appearing of the fauna-strange raccoon dog however be expected.

The case is different when significant changes happen in the habitats or in the management along our one of the most beautiful river. Neither the otter, nor the pine marten and especially the wild cat tolerate the disturbance deriving from the human activity, or the changes in habitats as a result of that. In case of the ermine's habitat cessation or decreasing its stock would decrease too, because due to its special habitat needs and to its typical territory usage it might not be able to settle down on new areas. Whereas the further decreasing of the multitudinous species' populations won't significantly depend on the incidental changes. This means, that the predators that get into worse habitat circumstances even have to fight with the competition caused by the species with increasing stock, squarely they will be the losers of it.

These last consequences give the value of the predator stock on the strictly protected area situated south from Bélavár and the importance of the monitoring point formed here. The most common predators of the area bordered by the railway from north, by the stream Zsdála from west, by the river Dráva from south, whilst by the abandoned pebble-mine lakes from east are the weasel and the wild cat and the otter has a significant stock too. All these three species belong to those predators, which are narrow-bearing, can hardly tolerate the human proximity or not at all, are hard hit by the changes made

upon the tranquility and structure of habitats. This means that in case of any intervention - river control, building of reservoir and/or power plant - their stock and probably also their spreading territory will decrease on the area. Two of these three species - the pine marten and the wild cat - can be well and efficiently monitored with the method based upon trapping that was formerly worked out and altered during the programme.

In the case of wild cats the particular research area has a specific importance. The wild cat stock in our country is decreasing and the remained major populations are mostly endangered by hybridisation with domestic cats. The Bélavár area has not just a significant and stable wild cat population, but it seems that is not endangered with hybridisation at the moment, which would be outstandingly suitable for the first national wild cat reserve.

On the whole it is ascertainable that the predator fauna along the river is extremely rich at the moment and the stock of each species is significant. This status quo could be maintained only if the relative un-perturbance of the territory is provided furthermore. As nature conservation handling we can speak about massive sparsing of large numbered species and preventing the fauna-strange predators from settling down.

Acknowledgements

The monitoring was supported by the Directorate of the Duna-Dráva National Park. We specially thank for the help of Szabolcs Závocky and Ákos Zöldvári. The work of Ferenc Járovics was indispensable, we specially thank for his enthusiasm.

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Kis- és közepesméretű ragadozó emlősök monitoringja a Dráva mentén

HELTAI MIKLÓS, SZEMETHY LÁSZLÓ, SZABÓ LÁSZLÓ és SZŐCS EMESE

1999-óta végezzük a Dráva folyó természetvédelmi monitorozásának keretében a kis és közepes testű ragadozó fajok állományainak monitorozását élve fogó csapdázással. A munka első két évében a módszertan véglegesítése történt meg. A 2001-óta értékelhető eredményeket adó munkában eddig összesen 26 848 csapda-éjszakát teljesítve hét ragadozó faj (róka, közönséges görény, menyét, nyest, nyuszt, vadmacska, házimacska) 86 egyedét fogtuk meg. Az átlagos fogási hatékonyság 0,317 fogás/100 csapda éjszaka volt. Kiegészítő módszerekkel bizonyítani tudtuk a hermelin és a vidra jelenlétét a vizsgálati területen. A leggyakoribb ragadozónak a vadmacska és a nyuszt bizonyult. Mindkét faj szűktűrésű, az emberi zavarást nehezen tűrő. E tulajdonságaik alkalmassá teszi e fajokat arra, hogy állományváltozásaik nyomon követésével a terület élőhelyi változásainak indikátor fajai legyenek.

DOI:10.24394/NatSom.2005.7.169 | Natura Somogyiensis | 7 | 169-178 | Kaposvár, 2005

Otter monitoring between 2000 and 2004 in the Drava region (Hungary)

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LANSZKI J: *Otter monitoring between 2000 and 2004 in the Drava region (Hungary).*
Abstract: The monitoring of the strictly protected Eurasian otter (*Lutra lutra*) started during the winter of 2000, in the Danube-Drava National Park, along the Drava River (between Őrtilos and Barcs). The relative density of otters was surveyed by spraint counts along a standard route (line transect survey). The highest otter spraint density was measured at Bélavár (on Drava and backwater), and relatively high values were also found on ponds where the human disturbance was low. On the Dráva River, the mean relative density was moderate, which may be associated with the high fluctuations of water levels and the steep riverside. Otter density was lower on gravel-pit lakes and backwaters with intensive angling, as well as on watercourses and streams in connection with the Dráva River. From 2002 the monitoring was completed by genetic analysis (using nine DNA markers) from freshly collected spraints. The results of the diet composition examined by spraint analysis are also summarized. It can be concluded on the basis of the above findings that the otters' population sensitively reflects the changes of the habitats, preservation of the riverside vegetation and that of the landscape.

Key-words: Lutra lutra, Drava River, backwater, relative density, diet

Introduction

The Eurasian otter *Lutra lutra* (Linnaeus, 1758) is a widely occurring predator in Europe, living in a large variety of watery habitats (MASON and MACDONALD 1986, KRUUK 1995, KRANZ 2000, CONROY and CHANIN 2002). The species shows continuous presence in all the habitats along the Drava River (HELTAI et al. 2004), which is one of the least artificially modified rivers in Central Europe, being rich in natural habitats. All sections of the river are included in the Danube-Drava National Park (IVÁNYI and LEHMANN 2002). Monitoring of the strictly protected and threatened otter started in year 2000 on the Drava River and on connecting watery habitats, after planning a high-capacity hydroelectric power station on the river in the region Novo Virje.

Otter numbers are limited by fish populations (reviewed by KRUUK 1995), and feeding behaviour is dependent on the available food supply (ERLINGE 1967, 1969, WISE et al. 1981, KRUUK and MOORHOUSE 1990, KRUUK et al. 1991, CARSS 1995, RUIZ-OLMO et al. 2001). In addition to the abundance of available food, other factors affecting occurrence and feeding habits are type of habitats, quality of bankside, steepness of waterside banks and the degree of human influence to which the area is exposed (ERLINGE 1967, KEMENES and DEMETER 1995, JEDRZEJEWSKA et al. 2001, RUIZ-OLMO et al. 2001, LANSZKI 2002, RUIZ-OLMO et al. 2002, CLAVERO et al. 2003).

ISSN 1587-1908 (Print); ISSN 2062-9990 (Online)

The freshwater otter has a secretive habit and is active at night; therefore spraints and tracks indicating the presence of the species (REUTHER et al. 2000) give the primary base for confirmation of its occurrence and presence and for monitoring of changes in occurrence by means of systematic questionnaire-based surveys. Determination of the size of an otter population often poses practical problems. Genetic analysis (e.g. DALLAS et al. 1999) is the method primarily suitable for application for this purpose, which were also started along the Drava River in 2002. Relative density of otters can also be measured on the basis of the number of spraints and tracks indicating the presence of the species in relation to the unit length of the route used; this allows comparison of areas studied by identical methods. The line transect method (e.g. ROBSON and HUMPHREY 1985, MASON and MACDONALD 1986, REID et al. 1987, PRIGIONI et al. 1995) is suitable for this, but can also entail error. Primary considerations are the frequency of sample collection and the determining and fixing of the route, together with the importance of extending the study for as long as possible. Territory marking by the otter (i.e., frequency of defecation) is influenced by social behaviour related to breeding, and also by season (e.g. CONROY and FRENCH 1985, KRUUK and CONROY 1987).

The objective of this study, initiated in 2000, was to monitor the otter population living beside the Drava, to assess the basic situation in sampling areas and to examine possible factors influencing distribution.

Material and methods

The study was carried out in SW Hungary. The main data recorded for the habitats studied alongside the Drava, which served as sampling areas, are shown in Table 1. This study included not only the above areas but also several aquatic habitats in the Balaton-Drava ecology network.

The main stem of the Drava River has a steep riparian region, characterised by Central European slow river floodplain woods, composed of willows and poplar. Backwaters on lower relief are covered by Central European slow river floodplain woods and ash-alder woods, while those on higher relief are surrounded by ash-oak-alder forests (IVÁNYI and LEHMANN 2002, JUHÁSZ 2004). The Drava is a high regime watercourse river, the early-summer and autumn flood marks and winter-end low-water marks are characteristics (the difference is approximately seven metres). The river remains "near natural", unpolluted, with meandering courses and many old river-beds.

Diet composition was determined by spraint (faecal) analysis. Sampling commencing in January 2000 alongside the Drava was performed every six weeks at first, then every four weeks from May 2002 to June 2004 and after every six weeks along a standard route (Table 1).

The feeding habits of the otter were examined by spraint analysis. The data obtained related to samples for winter and spring and summer and autumn collectively. Diet composition was determined through microscope examination, on the basis of characteristics of feather, bone, scales, pharyngeal teeth, chitin shell, teeth and hair (LANSZKI et al. 1999, 2001) Diet composition and food niche breadth were calculated on the basis of the relative frequency of occurrence of items in the spraints, this in turn being based on minimum number present per sample.

Food niche breadth for each period was calculated by the Levins index (KREBS 1989). The taxa used were: mammals, birds, reptiles and amphibians, fish, invertebrates and plants. To calculate relative otter density the number of spraints (both the total and fresh)

Fig. 1.: Otter (*Lutra lutra*)

Fig. 2.: River Dráva at Novo Virje

Fig. 3.: River Dráva at Vízvár

Fig. 4. Erzsébet Island at Babócsa

Table 1. The main parameters of the sample collection. WS - winter and spring, SA - summer and autumn, *under bridges and surroundings, - no sample collection was performed

Areas	2000	2000	2001	2001	2002	2002	2003	2003	2004	2004	Line
	WS	SA	WS	SA	WS	SA	WS	SA	WS	SA	transect
	Sample size per periods										m
Monitoring areas:											
Õrtilos, Drava	15	23	53	68	40	18	90	15	61	18	1800
Dombó canal, Gyékényes	30	24	41	62	36	114	28	42	48	55	600*
Lankóci wetland forest	23	13	43	27	28	32	39	0	0	3	2000
Bélavár, backwater	-	46	104	67	117	86	68	58	54	28	500
Bélavár, Drava	-	-	-	-	43	99	302	106	153	63	500
Vízvár, Drava	36	20	33	15	80	26	73	26	63	16	1500
Babócsa, backwater	114	26	35	40	46	46	92	52	196	18	1600
Connecting areas											
Dombó canal, Berzence	-	47	62	22	52	77	206	42	142	42	200*
S.udvarhely, gravel pit ponds	5	0	35	14	70	57	42	51	14	-	2000
Babócsai stream	53	126	84	40	77	106	90	21	91	9	400
Barcs-Komlósdi stream	-	9	15	52	112	72	106	58	79	11	200*
Barcs, Kis-bóki backwater	4	0	45	20	83	62	32	21	27	5	600
Barcs, Középrigóci ponds	199	64	151	191	120	117	161	248	102	3	2000
Korcsina canal, Lakócsa	-	31	38	26	0	24	18	3	19	27	200*

Table 2. Diet composition of otters living in different habitats in SW Hungary. MA-mammals, BI-birds, RA-reptiles and amphibians, IV-invertebrates, PL-plants

Area	MA	BI	RA	Fish	IV	PL
	Percentage relative frequency					
Õrtilos, Drava	1.4	5.7	7.2	79.7	6.0	0.1
Dombó canal, Gyékényes	5.2	3.7	29.4	44.6	16.0	1.1
Lankóci forest	7.1	2.4	23.1	48.8	17.3	1.2
Bélavár, Drava	0.2	3.1	9.1	84.8	2.1	0.7
Bélavár, backwater	1.0	1.0	14.4	71.3	11.9	0.5
Vízvár, Drava	2.4	11.1	8.5	67.9	9.3	0.9
Babócsa, backwater	1.0	2.0	13.4	72.8	10.8	0.0
Dombó canal, Berzence	7.0	1.4	10.1	68.4	12.4	1.0
S.udvarhely, g.p.ponds	2.6	0.0	17.9	70.4	8.0	1.2
Babócsai stream	7.8	2.5	14.4	55.3	19.0	0.9
Barcs-Komlósdi stream	4.0	2.3	8.7	62.7	21.6	0.7
Barcs, backwater	0.9	1.5	8.2	73.6	15.7	0.2
Barcs, ponds	0.7	3.9	9.5	67.3	17.9	0.7
Korcsina canal	1.9	0.0	22.0	32.5	41.7	1.9
Boronka, fish ponds	1.7	2.7	7.6	80.9	6.9	0.4
Fonó, fish pond	1.5	5.9	12.6	66.5	9.2	4.4
Petesmalom, fish ponds	1.1	1.1	4.7	86.0	5.8	1.3
Fonói stream	2.6	1.1	22.9	52.8	18.0	2.8

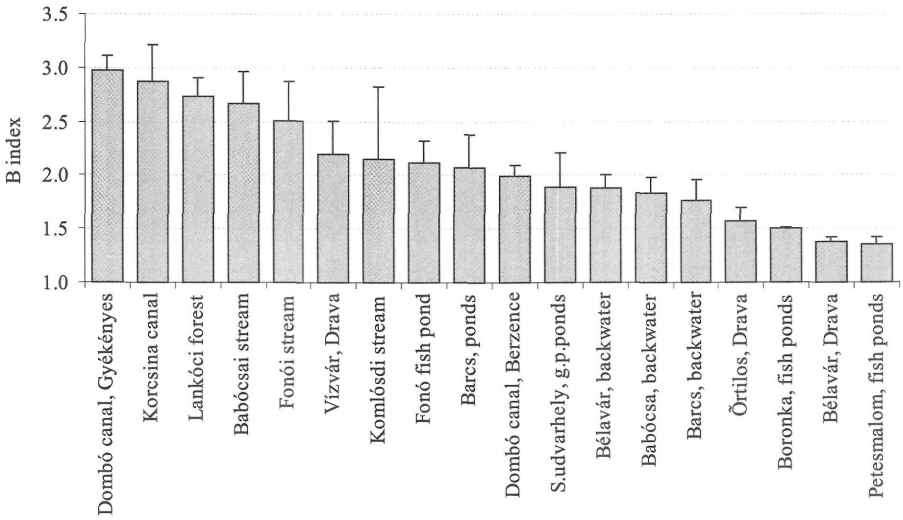

Fig. 5.: Trophic niche breadth (B) of otters in SW Hungary (2000-2004)

collected was taken relative to the unit length of the route section. Calculation of density ranking involved correction on the basis of duration and frequency of sampling. The data were recorded in an Excel spreadsheet, and the SPSS 10.0 program (1999) was used for data processing.

Results

Diet composition and food niche breadth

Various fish species composed the main proportion of the diet of the otter in the Drava, in some of its backwaters, in streams with constant flow rate, and in the fishponds (Table 2). In addition to these fish species which formed the principal food source, a significant role was also played by secondary food sources, i.e. amphibians and birds, along certain stretches of the Drava (at Vízvár), and in the gravel pit pool close to the Drava (Somogyudvarhely). Consumption of mammals and invertebrates not normally characteristic of the otter diet occurred frequent in the habitats alongside the Drava which periodically dried up, e.g. the Lankóci alder forest, the canals and some streams. For more detail see LANSZKI et al. 2001, LANSZKI 2002, LANSZKI and MOLNÁR 2003.

The food niche of the otter (Fig. 5) proved narrow in the areas where fish were its primary food source. The niche was moderately broad in areas where, in addition to fish, secondary food taxa (amphibians and birds) also occurred frequently in its diet. The areas characterised by a broad food niche were exposed to periodically arising disadvantages (i.e., running dry, large fluctuations in water level, and fishing/human disturbance). The scale of these fluctuations in habitat conditions was indicated by deviation values relative to the mean (s.e.).

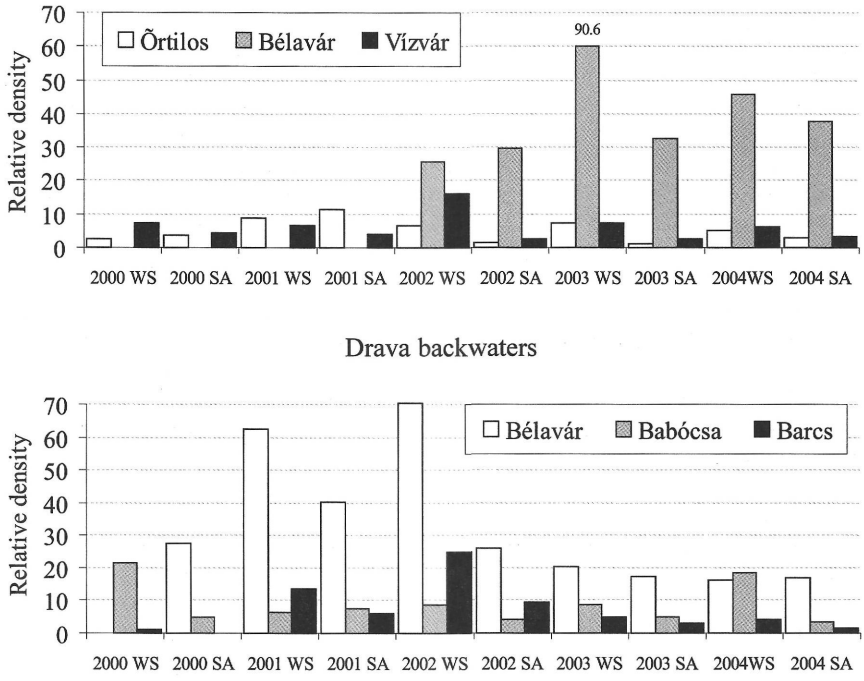

Fig. 6.: Relative abundance of otters along the Drava River and habitats, in Hungary WS - winter and spring, SA - summer and autumn

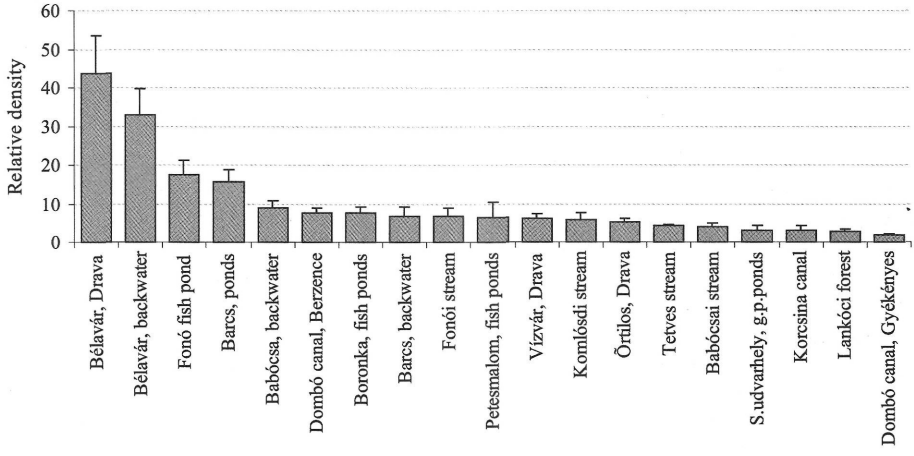

Fig. 7.: Relative density of otters in SW Hungary (2000-2004)

Population density

The indirect line transect method based on the number of spraints collected over the five years of the study (Fig. 6) was used for the purpose of monitoring otter density ranking for each habitat (Fig. 7) and to follow changes in this ranking. It would not be possible to draw distinct boundaries between the areas of high, medium and low otter density shown in Fig. 7. The highest otter density data were recorded in the habitats in which human influence was minimal (in areas protected by enhanced conservation management: in the backwater and on the Drava at Bélavár, in the Barcs, Középrigóci ponds, and in places where the primary aim was fish production, such as Fonó fish pond). Medium otter density was recorded in the rapidly flowing, open stretches of the Drava (i.e., in Őrtilos and Vízvár), the backwaters alongside the Drava (Barcs and Babócsa), the ponds under conservation management (Boronka and Petesmalom) and the streams with constant flow rate. Otter density proved low in the habitats which ran dry periodically (the Lankóci alder forest, the Dombó canal and the Korcsina canal), the streams with low flow rate (Tetves stream) and the ponds where there was intensive fishing (Somogyudvarhely).

The results of the molecular genetic analysis have supported the otter observations, showing continuous otter presence along the River Drava between Őrtilos and Barcs (LANSZKI 2002 and unpublished data). The mean distance of 3.3 km between positive sites was less than a night movement of otters (ERLINGE 1968, JENKINS 1980). The genetic structure showed clear and close relation between populations living in different river sections and backwater habitats.

Discussion

In this study fish of various species constituted the main food source for the otter in the Drava, its backwaters and fishponds, where there was an abundant supply of fish. Low frequency of occurrence (below approx. 50-60%) of the principal fish prey indicated that were periods when these fish species were low, or that the quantities available fluctuated greatly from season to season. At such times secondary food sources became more significant. In the habitats prevalent in Hungary these sources were most frequently amphibians and birds. Frequent consumption of other taxa not characteristic in the diet of otters (e.g. mammals and invertebrates) highlighted a lack of commonly available (i.e., primary and secondary) food sources. Such disadvantages arose in habitats which periodically ran dry and where the food supply was sparse. When fish supply is plentiful the food niche of the otter is generally narrow, as the decisive proportion of its diet consists of various species of fish.

The generally moderate density of otters recorded on the Drava (one individual per 6-7 kilometres) may have been related primarily to strong river current and substantial fluctuation in water level, and, where the water level was low, may also have been due to the riverbank, which was too steep for the otters. Otters are discouraged by steep banks or those with unfavourable degrees of plant cover (i.e., where vegetation is too dense or bare) which prevent them getting into and out of the water (KEMENES and DEMETER 1995, KRUUK 1995). Water entry places play an important role in social behaviour, e.g. in play, grooming and the marking of territory. Deterioration of these areas (e.g. removal of vegetation on the banks) has a negative effect, as does substantial change in water level. Otters only occasionally mark territory on the stones surrounding the banks

of the Drava, which protrude when the water level is low. Substantial fluctuations in water level, which can occur every few days, result in spraints which serve as important chemical and visual markers being washed away in the water prematurely.

It can thus be established that the hydroelectric power stations currently in operation exert an adverse effect on the rhythm of life of the otters studied on the banks of the River Drava. If a new, high-capacity power station is built on this tail-like river section, habitats alongside the Drava would suffer further from the effects of running dry, accompanied by deepening of the riverbed, moderate formation of river shoals and further lowering of the underground water table. This could pose a threat to the stability of populations of species associated with water, including otters living in the surrounding area.

Acknowledgements

Monitoring of the otter alongside the River Drava was supported by the Directorship of the Danube-Drava National Park. The associated research was funded by OTKA (project no. F 037557) and the Bolyai Scholarship.

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A vidra monitorozás 2000 és 2004 között a Dráva mentén

LANSZKI JÓZSEF

A fokozottan védett vidra (*Lutra lutra*) monitorozása a Duna-Dráva Nemzeti Park területén, Őrtilos és Barcs közötti szakaszon 2000 telén kezdődött. A táplálék-összetétel vizsgálat eredménye hullatékanalízisen alapult. A vidra relatív sűrűségének felmérése standard útvonalon (vonal transzekt módszerrel) végzett hullaték gyűjtéssel zajlott. Legnagyobb vidrasűrűség Bélaváron (a Dráván és a holtágon), valamint a kevéssé zavart halastavakon volt. A Dráván közepes volt a vidrasűrűség a nagy vízszintingadozásnak, a sebes folyásnak és a meredek partoldalnak köszönhetően. Az alacsony vízhozamú patakokon és időszakosan kiszáradó csatornákon a táplálékforrások mennyiségének nagymértékű ingadozása miatt szintén alacsony volt a vidrasűrűség. 2002-től a monitorozás kiegészült friss hullatékokból végzett molekuláris genetikai analízissel (kilenc DNS marker alkalmazásával). Megállapítható, hogy a vidra az élőhelyi változásokra az előfordulásán, a táplálkozási szokásain és az egyedsűrűségén keresztül érzékenyen reagál.

DOI:10.24394/NatSom.2005.7.179 | Natura Somogyiensis | 7 | 179-189 | Kaposvár, 2005

Landscape ecological analysis of barn owl pellet data from the Drava lowlands, Hungary

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Abstract: Small mammal fauna monitoring in the Drava Lowlands has been done partly by barn owl pellet collecting and analysis. In the present study the correlations between landscape patterns and barn owl food composition (i.e. the indirect representation of small mammal communities) were analysed using an approach how the cummulated data of particular breeding pairs can be interpreted as characteristic for the patch composition of the mosaic landscape considerably larger than the hunting range of barn owls. For landscape ecological analysis CORINE LANDCOVER 1:50.000 mapping categories were applied, based on which natural or semi-natural areas, differing from each other also in their barn owl hunting qualities, were differentiated. Three larger areas along river Drava were investigated: two in the upper reach monitoring zone (Zákány-Porrogszentkirály, and Berzence-Heresznye), and one in the lower Drava reach (Drávaiványi-Szaporca). In the two upper-reach zones the localities differed from the greater scale landscape in less than 30% of the patches, with only 3-5 patches showing significant difference. In the lower reach there was one sampling locality with 6 patches differing from the greater-scale area, although in the entire lower section 33% or less difference was found between patch compositions of the two scales. Based on patch overlap calculations and homogeneity tests it was concluded that small mammal faunal data of the localities can be cumulated and can be evaluated on much larger landscape ecological scales than barn owl hunting ranges.

Keywords: Landscape pattern, small mammals community, pellet analysis, *Tyto alba*

Introduction

The most widely used and, in Hungarian zoological studies, a quite conventional method for general small mammal distribution data analysis and for more detailed presence/absence analysis within particular regions is indirect monitoring using barn owl pellets. This methodology is acceptable from a nature conservation aspect, and is capable of producing masses of abundance data. It allows for both quantitative and qualitative analysis of the distribution patterns of small mammal species, and, by using relative abundance values of various species in the particular samples, it also makes possible to compare small mammal communities of various areas. The monitoring, at various depths, of changes in distribution is essential in all Hungarian mammal species (CSORBA and PECSENYE 1997), thus, in small mammals, the most effective data collecting method in the faunal exploration of the Drava Lowlands has been monitoring that relies on barn owl pellet analysis. Besides distribution monitoring, the small mammal fauna of partic-

ISSN 1587-1908 (Print); ISSN 2062-9990 (Online)

ular habitat complexes can also be analysed, and, using quantitative variables and indices derived from basic regular data, changes in the proportions of taxa as well as their trends can be examined. By means of landscape pattern analysis of habitats along Drava, and by applying GIS, small mammal distribution in the area can be interpreted at a landscape ecological scale as well.

Owls are important top predators of Cetral-European ecosystems, with the barn owl *Tyto alba* (Scop., 1769), strictly protected in Hungary, having special importance due to its role in small mammal faunal studies. Because of its significant role in the food chain, and because its behaviour and habitat are closely associated with humans, there have been several studies focusing on its habits, nesting characteristics, breeding biology and ecology (TAYLOR 1994, MIKKOLA 1983), and feeding ecological studies dealing with the barn owl as a predator provide important data concerning prey species as well. Indirect monitoring based on barn owl pellet analysis provides information about the composition and structure of small mammal communities using the mosaic-pattern hunting areas surrounding particular nesting sites. (SCHMIDT 1973, WIJNANDTS 1984). Habitat patches differing in their sizes determine the local densities of small mammal populations found there, and the higher percentage of small mammals in various patches are represented in barn owl food as well, however these correlations can become clearer if areas analysed are larger (HORVÁTH et al. 2003). River Drava being a green corridor in the south of Hungary, is an important conservation area, with lowland areas along the river being inhabited by dense barn owl populations. Regular pellet collecting has been done in these areas, and their data are used in anlyses of spatial and temporal distribution of small mammals. In the present study monitoring data from the upper river section (Somogy county) are ivestigated together with barn owl pellet data. Correlations were analysed between landscape patterns of barn owl nesting areas and the compositions of small mammal communities shown in barn owl pellets, as well as we looked at statistical differences in the feeding ecology between owls nesting in Drava Lowland areas that differ in their patch compositions. We have performed regular pellect collecting in barn owl nesting areas of the Drava Lowlands, and based on their spatial distributions three larger regions were differentiated. Landscape ecological and small mammal faunal data of these regions were summed and evaluated on a larger spatial scale and on the local hunting area scale as well.

Answers were sought to the following questions: (i) are the patch compositions of the larger designated areas similar to the hunting areas of the barn owls, thus can we draw conclusions for the small mammal composition of the entire area, (ii) what are the differences between the Drava sections in their food and patch compositions, (iii) are the differences in patch compositions of the different-scale areas expressed also in the food compositions of barn owls in those areas, or how does patch composition determine the type of small mammal fauna shown during monitoring?

Material and Methods

A total of 17 barn owl nesting locations were selected along river Drava, so that small mammal communities indicated from owl pellets can be analysed based on the landscape ecological investigation of the owls' hunting ranges. Nesting locations were compared based on both owl feeding data and vegetation patch composition.

The first sampling period in the selected nesting sites lasted during the first nesting period, from spring to late June. The second sampling period lasted from August to

November, including any possible second nesting. If pellets were collected several times in a particular nesting area, then their data were treated together within that period.

Small mammal identification was done according to SCHMIDT (1967), ÁCS (1985) és UJHELYI (1994), based on skull characteristics and tooth morphology. Some identification guides differentiate Neomys species - *Neomys fodiens* (Pennat, 1771) and *Neomys anomalus* (Cabrera, 1907) - based on the height of the coronal process of the mandible. Withtin the genus *Apodemus*, we treated the wood mouse *Apodemus sylvaticus* (Linnaeus, 1758), yellow-necked wood mouse *Apodemus flavicollis* (Melchior, 1834) and the pygmy field mouse *Apodemus microps* (Kratochvíl és Rosicky, 1952) together as wood mice (*Apodemus* spp.). The differentiation of the two *Mus* species occurring in Hungary, i.e. the house mouse (*Mus musculus* Linnaeus, 1758) and the gleaner mouse (*Mus spicilegus* Petényi, 1882) from owl pellet skeletal remains is still not totally settled. These two species were then separated based on the upper and lower zygomatic arches (DEMETER 1995, DEMETER et al. 1995). If these were either missing or only mandibles were present, then only the genus was determined (*Mus* spp.). Hereby is a list of taxa that are determined in pellet analyses at non-species lebvels (only small mammals are considered):

Soricidae indet. (any unidentifiable shrew)

Neomys spp. (*Neomys fodiens* or *N. anomalus*)

Apodemus [*Sylvaemus*] spp. (any species belonging to the *Sylvaemus* subgenus - *sylvaticus* or *flavicollis* or *microps*)

Mus spp. (*musculus* or *spicilegus*)

Rattus spp. (*rattus* or *norvegicus*).

For landscape ecological analysis CORINE LANDCOVER 1:50.000 mapping categories were applied, based on which we determined 17 patch categories differing in their qualities from the aspect of barn owl hunting. Using the software ArcView 3.2 the following patch types were established: waters, wet areas (marshes), forests (closed or

Table 1: UTM codes, sample numbers, pellet numbers and prey abundance values for the 17 villages selected

	Nesting sites	UTM codes	Number of samples	Number of pellets	Total number of individuals
Upper reach	1. Zákány	XM52	3	299	747
	2. Gyékényes	XM52	3	42	118
	3. Porrogszentkirály	XM52	4	339	1017
Middle reach	4. Berzence	XM62	2	39	116
	5. Somogyudvarhely	XM61	2	130	410
	6. Vízvár	XM70	3	48	157
	7. Heresznye	XM70	1	38	152
Lower reach	8. Drávafok	YL18	6	196	409
	9. Drávaiványi	YL18	2	14	45
	10. Zaláta	YL27	3	136	406
	11. Nagycsány	YL28	5	150	415
	12. Piskó	YL27	5	115	306
	13. Vejti	YL37	6	162	422
	14. Vajszló	YL38	5	130	294
	15. Páprád	BR68	7	184	305
	16. Cún	BR77	2	72	160
	17. Szaporca	BR77	3	112	328
	Total		62	2206	5807

open, dry or wet deciduous forests, as well as coniferous forests and forest plantations), natural and degraded grasslands, shrubby areas, unvegetated open areas, ploughlands, perennial cultivated plants (vineyards and orchards), agricultural areas with various types of cultivation, artificial surfaces (artificial, non-agricultural vegetated areas and urban areas). Two areas were selected in the upper Drava monitoring areas (between Zákány-Porrogszentkirály, and Berzence-Heresznye, respectively), whereas in the lower section only one larger area was chosen (Drávaiványi-Szaporca). The local landscape ecological analysis of the hunting areas was done on the basis of the patch composition in a 2 km radius around the nesting sites, whereas for the greater-scale analysis of the particular Drava section we used the patch composition of the area bordered by the attingents of 10 km radius circles around nesting sites and by the line of the Drava. As part of lanscpe ecological analysis, the patch diversity values of the entire river section areas were calculated, and the comparison of sampling localities and larger-scale areas was done by G-tests and patch overlap calculatioons (Schoener-index).

In the case of all 17 places, the analysis of barn owl food composition was done using the cumulated data from pellet samples collected in 2002 (Table 1). For comparing small mammal proportions at various river sections homogeneity tests (G-test) were applied. Any correlation between habitat patches that were found to be occurring in considerably different rates within the various sampling areas and the abundance of their characteristic small mammals were tested using regression analysis.

Results

Regarding patch composition, the three Drava sections and the cumulation of their sampling localities were found by G-tests to be homogenous, with only one case of significant difference on the lower and middle section, and two patches with significant difference in the upper section. Patch overlap values also showed high degree of similarity in all three comparisons (lower section: 0.82; middle section: 0.74; upper section: 0.73).

The statistical analysis of patch compositions of the three greater areas revealed higher patch overlap between the upper and middle sections (0.85), whereas these two areas were more different from the lower region in respect of their patch distributions, thus smaller overlap values were obtained (0.64 and 0.62). Based on G-tests the upper and

Table 2: Homogeneity G-test of patch compositions in the various Drava reaches

Patch type	p_i (total reach)	p_i (total reach)	G-values
	Upper reach	Middle reach	
Mixed agricultural areas	9.49	2.23	4.84*
	Middle reach	Lower reach	
Marshes	**0.18**	4.36	4.77*
Dry closed deciduous forest	**46.87**	19.63	11.50***
	Upper reach	Lower reach	
Mixed agricultural areas	9.49	2.66	4.06*
Dry closed deciduous forest	**39.08**	19.63	6.57*
Forest plantation	3.58	11.51	4.38*

***: $p < 0.001$; ** : $p < 0.01$, *: $p < 0.05$

Table 3: Homogeneity G-test of cumulated pellet samples in the various Drava reaches

Prey taxa	p_i (total reach)	p_i (total reach)	G-values
	Upper reach	Middle reach	
M. arvalis	46.81	29.58	3.92*
	Middle reach	Lower reach	
S. araneus	19.88	4.27	10.94***
M. arvalis	29.58	55.63	8.09**

***: $p < 0.001$; ** : $p < 0.01$, *: $p < 0.05$

middle sections were significantly different in one, the lower and middle in two, and the lower and upper in three patch types (Table 2). When food composition was analysed, there were less clear differences than expected between the three river sections. However, significant differences i.e. inhomogeneity occurred in the ratios of the common vole, the most preferred prey animal of the barn owl. This may be due to different small mammal availabilities related with patch composition differences in the various Drava sections. Another significant difference was found in the common shrew, a protected insectivorous small mammal of indicator significance, playing an important role in rating areas with different landscape patterns (Table 3). When data from nesting localities of one of the Drava sections were compared with data for the entire length, more significant results were obtained both in patch composition and in small mammal distributions of their corresponding habitat patches. In patch composition analysis only those patch types were emphasized among significant ones that were habitats of significantly different prey taxa in that sample. This revealed correlation between the most frequent

Table 4: Homogeneity G-test of pellet samples and patch compositions in the various nesting localities and in complete Drava reaches

Reaches	Nesting sites	Prey taxa / patch types	pi (total reach)	pi (given nest site)	G-values
Upper reach	Zákány	*M. arvalis*	46.81	21.02	10.06**
		crop field	14.85	1.76	11.79***
	Gyékényes	*C. glareolus*	3.77	0.00	5.23*
		Apodemus spp.	12.65	3.39	5.69*
		dry closed deciduous forest	39.08	0.00	54.18***
		wet closed deciduous forest	13.63	0.00	18.89***
Middle reach	Berzence	*S. araneus*	19.88	0.86	21.58***
		C. glareolus	3.47	0.00	4.81*
		dry closed deciduous forest	46.87	0.00	64.98***
		M. arvalis	29.58	58.62	9.74**
		crop field	13.31	63.73	35.89***
		mixed agricultural areas	2.23	11.55	6.91**
	Heresznye	*Apodemus spp.*	9.10	0.00	12.62***
		dry closed deciduous forest	46.87	0.00	64.98***
Lower reach	Vajszló	*S. araneus*	4.27	13.95	5.41*
		dry closed deciduous forest	19.63	49.29	13.19***
		forest plantation	11.51	24.11	4.56*

***: $p < 0.001$; ** : $p < 0.01$, *: $p < 0.05$

prey taxa (*M. arvalis, Apodemus* spp. and *S. araneus*) and their most characteristic habitat patches (ploughland, broad-leaved forests). As suggested by G-tests, the relative frequency of the typically forest-dwelling small mammal *C. glareolus*, found at lower proportions in the samples, is also determined by the ratios of closed, dry deciduous forests. Thus, in these species the relative frequency calculated for a particular Drava section differed from values obtained for certain localities, whic is because of the fact that the habitat patches typical of these species differed significantly too when locaities and larger-scale areas were compared (Table 4).

The relative proportions of *C. glareolus* and *S. araneus* in the Drava sections were noted as characteristic for forest patches; and relative proportions of M. spicilegus és a *C. suaveolens* as characteristic for natural grasslands. When patch ratios and the relative frequencies of these species were charted together, it suggested that relative prey species abundance in the food of the owls depends on the extent of the characteristic small mammal habitats.(Figure 1-2). The correlations obtained by homogeneity tests were then tested with regression analysis too, to reveal significant correlation between relative frequencies of habitat patches and that of the particular species, in the case of *M. arvalis, Apodemus* spp., and *C. glareolus* (Figure 3-5). As patch proportions grew, relative frequencies of wood mice (*Apodemus* spp.) and common vole increased with an exponential curve, whereas for the bank vole significant linear correlation was found, showing that as the proportions of forested patches grew, the abundance of this species in the owl pellets also increased. When relationships between landscape ecological parameters and small mammal community parameters derived from pellet data were analysed in the case of localities, significant correlation was found between patch diversity and prey species number, meaning that the number of species indicated by pellets is in linear correlation with patch diversity (Figure 6).

Conclusions

Spatial heterogeneity is one of the most essential factors determining processes in populations and communities. The effect of heterogeneity is seen mostly in landscapes and habitats transformed by humans (KOZAKIEWICZ 1983). In respect of the Drava reaches subject to barn owl pellet collecting and analysis as part of small mammal indirect monitoring, landscape ecological analyses showed that among the three studied areas the one in the lower section was considerably different from the two areas in the upper reach. When interpreting the results, it has to be noted that the proportions of wet forest patches were considerably higher and those of ploughlands were lower in the upper Drava section. An important finding was the significant difference in the frequency of marshy areas in the lower (Baranya county) section. These results clearly indicated landscape ecological differences between the various Drava reaches, and, accordingly, differences occurred also in the compositions of their small mammal communities as shown by owl pellets. The results obtained are remarkable because due to seasonal differences in the hunting strategy of the barn owl, and due to the presence of prey preferences, i.e. to density-dependent hunting, the over-representation or under-representation of certain species can considerably influence small mammal abundance values obtained from pellets. Selective predation is studied in the barn owl (COLVIN and MCLEAN 1986, DICKMAN et al. 1991, TAYLOR 1994), but there are no data showing how much significance prey selection has in comparing data of various temporal and spatial scales, in relation to small mammal availability expected on the basis of mosaic habitat patches.

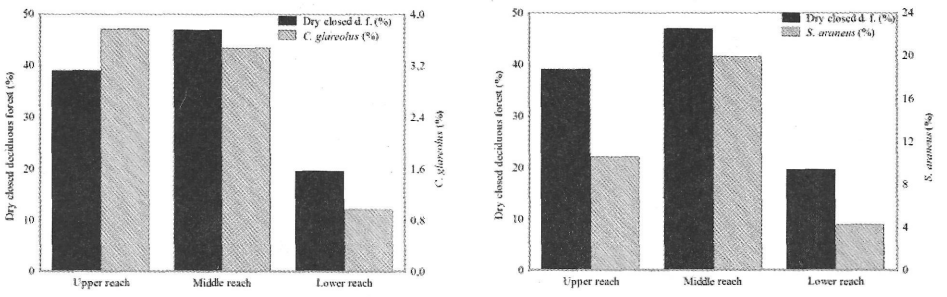

Fig. 1. Relationship between the proportions of dry, closed forests as potential habitats, and *C. glareolus* / *S. araneus* relative frequencies in the three studied Drava reaches

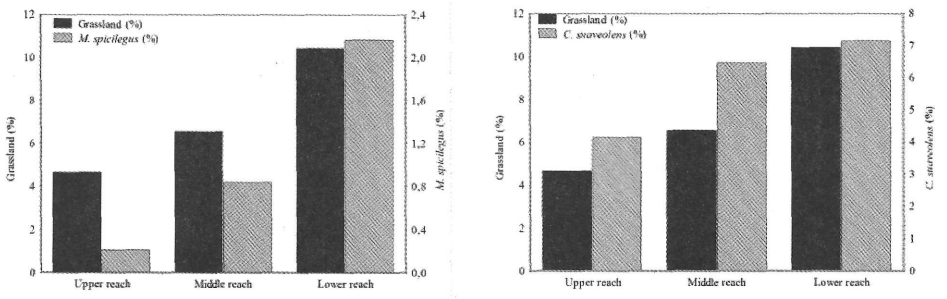

Fig. 2. Relationship between the proportions of natural grasslands as potential habitats, and *C. suaveolens* / *M. sipcilegus* relative frequencies in the three studied Drava reaches

Based on patch patterns the area designated in the lower Drava section was significantly different from the two regions selected in the upper reach, although this difference could not be statistically proved. As seen from the homogeneity tests, among species that differed significantly in their percentages in the the entire reaches, it was the common shrew that had similarly high G-values for its habitat, i.e. for closed, dry forests. As shown by G-tests performed in order to compare patch compositions and prey compositions of barn owl hunting areas and the corresponding Drava reaches, in the case of several nesting locations the proportions of both certain patyh types and their characteristic small mammals differed significantly from values obtained for the larger-scale areas. These relationships are seen primarily in species that are heavily preyed upon by the barn owl. We have shown in our earlier investigations that the sizes of various habitat patches within the hunting range of the barn owl often determines the frequency values of small mammals calculated from pellets, which can be proved by regression analysis (HORVÁTH et al. 2003). In most cases, the correlations between proportions of patch types and prey species having striking homogeneity-test G-values could be clearly shown by regression analysis in the present study, too, consequently, barn owl pellet

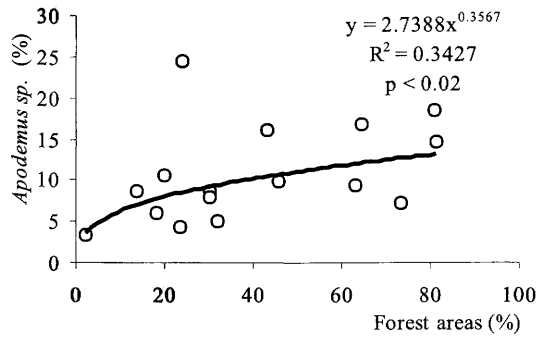

Fig. 3. Correlation between the proportions of wooded areas and *Apodemus* sp. relative frequencies

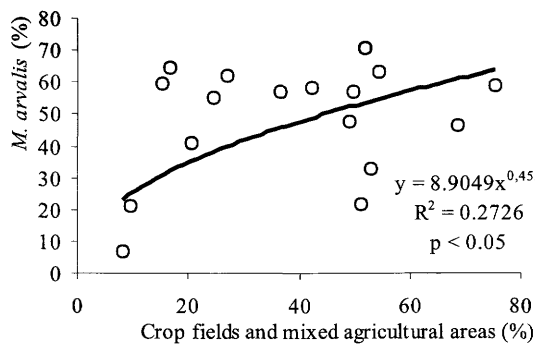

Fig. 4. Correlation between the proportions of ploughlands / mixed use areas and *M. arvalis* relative frequencies

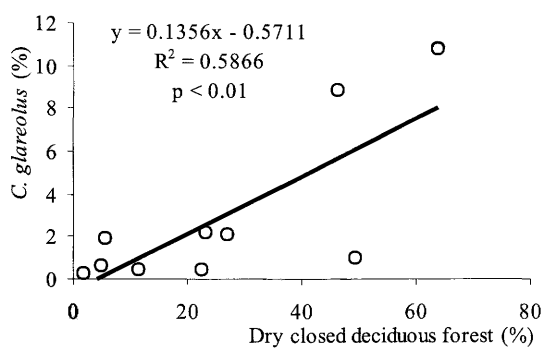

Fig. 5. Correlation between the proportions of dry, closed forest and *C. glareolus* relative frequencies

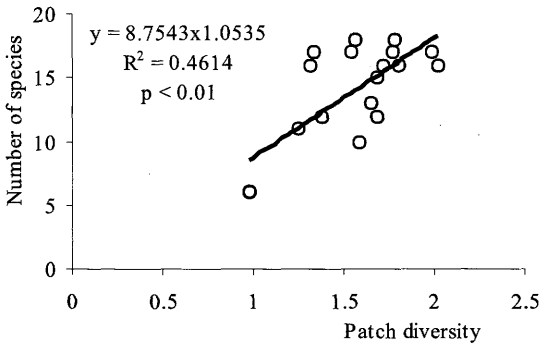

Fig. 6. Correlation between patch diversity and species number

analysis is applicable for the landscape-scale characterization of small mammal communities and their habitat vegetation patches.

In our earlier study we also looked at how prey diversity changed in relation to certain distinguished patches. Patches that are less optimal for the barn owl cause lower species diversity, which was expressed in the case of local hunting areas mostly by the higher rate of inner areas of human settlements. Thus it was concluded that in settlements with higher proportions of inner areas the small mammal community shown from pellets is less diverse. Another important relationship was revealed for forest patches, too: as the percenmtage of this patch type grew, species diversity followed an exponential function (HORVÁTH et al. 2003). As patch size grows, its perimeter grows at a smaller rate, but in this patch it is the perimeter, i.e. the edge zone that acts as potential hunting area for the owl, where, by preying upon forest species, its prey composition becomes wider. As forest size grows, the number of species that can be caught will not grow further, meaning that in patch with a certain ratio of area/perimeter all the potentially hunted species will be represented in the food. Larger forest patches than this size will not cause higher species diversity; it is rather the smaller, separated forest fragments that can be beneficial for the barn owl, as these are the ones that have higher area/perimeter ratios, i.e. larger forest edge proportions. A correlation revealed in the present study for bank vole occurrence in the Drava sections has provided new information for the evaluation of forest patch proportions. Similarly to the issue of diversity, it was presumed that there is exponential or logarithmic correlation between the frequency of the bank voles and increasing numbers of forest patches, meaning that above a certain amount of forest the quantity of bank voles indicated by pellets will not be considerably higher, due to the fact that the barn owl does not hunt in closed forests. However, a linear correlation occurred between wooded areas and relative abundance values of this species, which suggests that a higher fragmentation of forests along river Drava means a high ratio of perimeter/area providing higher chances for the owls to successfully hunt for bank voles inhabiting forest edges.

Based on patch overlap calculations and homogeneity tests of patch composition, small mammal faunal data of smaller localities can be cumulated and, in the case of our sampling areas along river Drava, can be evaluated on landscape ecological scales much larger than the actual hunting ranges of barn owls.

Acknowledgement

Monitoring activites were supported by the Duna-Drava National Park Directorate.

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A Dráva menti gyöngybagoly köpetekből nyert adatok tájökológiai elemzése

HORVÁTH GYŐZŐ, MOLNÁR DÁNIEL, NÉMETH TAMÁS és CSETE SÁNDOR

Dél-Magyarországon a Dráva folyó természetvédelmi szempontból jelentős ökológiai zöldfolyosónak tekinthető és a folyó menti sík területen nagyobb sűrűségű regionális gyöngybagoly-állomány fészkel. A térségben rendszeres köpetgyűjtést folytatunk, amely alapján a kisemlősök elterjedésének tér-időbeli viszonyait monitorozzuk. Jelen tanulmányban a tájmintázat és a gyöngybagoly táplálék-összetétele közötti összefüggéseket vizsgáltuk abban a megközelítésben, hogy az egyes költőpárok adatainak összesítése mennyiben vonatkoztatható a gyöngybagoly zsákmányolási körzeténél lényegesen nagyobb mozaikos táj foltösszetételére. A tájökológiai elemzéshez a CORINE LAND-COVER 1:50.000-es térképezési kategóriákat alkalmaztuk, amely alapján a gyöngybagoly vadászata szempontjából is eltérő minőségű természetes, vagy természetközeli területeket különítettünk el: vizek (álló és folyóvizek), vizenyős területek (mocsarak), erdők (lombos és tűlevelű erdők), természetes gyepek, természetközeli rétek, átmeneti erdős-cserjés területek, növényzet nélküli és kevés növényzettel fedett nyílt területek. A kategorizálás másik csoportjában az antropogén területeket vettük figyelembe: szántóföldek, állandó növényi kultúrák (szőlők, gyümölcsösök), legelők, vegyes mezőgazdasági területek, mesterséges felszínek (mesterséges nem mezőgazdasági zöld területek és urbanizált területek). A Dráva mentén három nagyobb területet elemeztünk, a Dráva felső szakaszának monitorozási terültén kettő (Zákány-Porrogszentkirály, illetve Berzence-Heresznye), míg az alsó Dráva szakaszon egy szakaszt jelöltünk ki (Drávaiványi-Szaporca). A vadászterületek lokális tájökológiai elemzését a költőhelyek körüli 2 km-es sugarú kör területének foltösszetétele alapján végeztük, míg az adott Dráva szakasz nagyobb léptékben történő vizsgálatához a költőhelyek körüli 10 km-es sugarú körök érintői és a Dráva vonala által határolt terület foltösszetételét használtuk fel. A Dráva legfelső két szakaszán a lokális területek a foltok kevesebb, mint 30 %-ában különböztek a nagyobb léptékű tájhoz viszonyítva, mindössze 3-5 folt esetén volt szignifikáns különbség. Az alsó szakaszon volt olyan lokális mintahely, ahol 6 folt aránya különbözött szignifikánsan a nagyobb területtől, de a teljes szakaszt tekintve 33 %-os, vagy ennél kisebb különbséget kaptunk a két térbeli skálán vett foltösszetétel között. A foltátfedés számítás és a homogenitás tesztek alapján a lokális területek esetén kapott kisemlős faunisztikai adatok összegezhetők és a baglyok vadászterületeinél lényegesen nagyobb tájökológiai skálán is értékelhetők.

DOI:10.24394/NatSom.2005.7.191 | Natura Somogyiensis | 7 | 191-207 | Kaposvár, 2005

Population dynamics and spatial pattern of small mammals in protected forest and reforested area

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HORVÁTH, GY. MOLNÁR, D., & CSONKA, G.: *Population dynamics and spatial pattern of small mammals in protected forest and reforested area*

Abstract: Small mammal monitoring using live trapping was done along the upper section of river Drava in 2003-2004, using capture-mark-recapture. Our sample areas were located in a strictly protected alder gallery forest (Lankóci-erdő) and in a neighbouring plot under gradual reforestation which had been clear-cut in 2000. A total of 9 small mammal species were recorded in the two sites, each comprising a 1-hectare sampling grid. The small mammal community revealed here had three characteristic rodent species (*Apodemus flavicollis, A. agrarius, Clethrionomys glareolus*), and two frequent shrew species (*Sorex araneus, Crocidura leucodon*). With the populations assumed to be closed, population sizes of the three dominant rodents were estimated from daily capture data. The highest estimated values were obtained for the two *Apodemus* populations (*A. agrarius and A. flavicollis*). Population sizes of the bank vole could be estimated from the protected area only. A spatial analysis with the nearest neighbour method showed that individuals of the more frequent species aimed at an even distribution, both in 2003 when densities were lower, and in 2004 when densities were higher. The more detailed analysis of the spatial pattern in 2004 suggested that by the end of late autumn, the different species are already organised in a pattern of winter survival strategy. It was shown by spatial distribution data that in this period the area of the closed alder gallery forest was occupied by individuals of yellow-necked wood mouse and bank vole. In the inner, larger part of the 1 ha forest section, it was mostly yellow-necked wood mice that established their home ranges. Striped field mice occupied only the reforested areas. Using extensive areas, the reforested area was inhabited also by bank voles, which fact is a proof for population translocation between the two areas in this species.

Keywords: population dynamics, spatial pattern, nearest neighbour method, small mammal, *Apodemus, Clethrionomys*

Introduction

In animal ecological studies including small mammals, some of the authors have found it important in the recent 10-15 years that the analysis of species movements be done on a landscape ecological scale (MERRIAM 1990, 1991). As habitats are becoming increasingly fragmented, small mammal populations tend to occur in mosaical, heterogeneous habitat complexes that consist of patches of various size and character. Such habitat fragments can form also in an original forest, as a result of forestry activities (clear felling, regrowth, reforestation). In a heterogeneous environment, movement between various habitats has an important role, and it is also crucial how much the var-

ISSN 1587-1908 (Print); ISSN 2062-9990 (Online)

ious fragments are optimal or suboptimal for survival of the given population, and how the migration pattern between them influence the seasonal pattern of density. This relationship, however, works on the other way round too: density increase in a particular patch can force certain individuals of the population to migrate between habitats or microhabitats. Various population dynamic data and information on movements of small mammals in mosaic landscapes with variable vegetation are important for the understanding of casual interrelationships that determine the stability of landscapes in an ecological sense (SZACKI and LIRO 1991).

Focusing primarily on Europe, several publications have dealt with the study of structure and ecology of small mammal populations in various forest types (JENSEN 1975, SMAL and FAIRLEY 1982, JUCHIEWICZ et al. 1986; HESKE and STEEN 1990). Changes in the small mammal fauna were investigated in habitats of intact areas and in those under forestry management (HANSSON 1978). In several species, the number of captures as a function of plant cover was also analysed (JENSEN 1984, MAZURKIEWICZ 1994).

The live trapping study of small mammals in a strictly protected alder gallery forest (Lankóci-erdő) was launched in autumn 2000, in the upper Drava reach. In addition to the closed forest section, we also started trapping in plot that was clear-cut in 2000 and is now gradually regrowing beside the closed forest, thus in 2003-2004 the population- and community-level monitoring of small mammals was performed together in the two plots. One of our objectives has been to find out about the small mammal community and about the changes in its composition, in the alder bog-forest, a type of floodland forests. The 1-ha felled plot besides the strictly protected area is in a state of gradual spontaneous reforestation, thus our other objective has been to investigate the ecological question of how the two areas are used by small mammals, and whether there is migration between the old, closed alder gallery forest and the area which was felled some years ago but is now regrowing. The present study investigates (i) to what extent the composition of the communities in the two sample areas differ from each other, (ii) how dense the populations of characteristic species can grow in the different habitats, and (iii) what kind of spatial pattern these populations will have using the two different areas.

Material and method

Study area

The live-trapping monitoring of small mammals was done in two neighbouring habitats of Lankóci-forest in 2003-2004. One is a strictly protected lowland alder gallery forest (*Paridi quadrifoliae-Alnetum*), bordered by an edge zone abounding in shrubs. The other area is located beside the first one: it is an approximately 1 hectare forest section, in the state of gradual spontaneous reforestation following clear-felling. Since the area was clear-cut, plant cover has increased in the regrowing area, making the plot increasingly suitable for small mammals. In the studied alder forest, a highly variable plant association has formed, as a result of high levels of precipitation, with a number of larger, sedge-covered patches. Due to the wet period in late winter and spring, these patches turn into areas with stagnant water. In addition to the variable vegetation, the moss-covered stumps and fallen trunks provide excellent shelter for small mammals, and also serve as suitable trap stations. There is one forestry road north of the two selected forest sections and another one between the two, both of which, have played an important role in making the once continuous forest become fragmented.

Trapping protocol and monitoring

For population level monitoring the small mammals were captured using live-trapping, and the method of capture-mark-recapture was applied. One trapping session included five nights, this period being long enough, in case of sufficient number of captures and recaptures, for population sizes to be estimated using various models, as the shortness of the period allows the population to be considered to be closed. For capturing the animals, plastic box-type live traps were used in both areas, earlier tested by HORVÁTH et al. (1996) and HORVÁTH (1996). A trapping grid covering 1 hectare and consisting of 11 by 11 trap stations 10 m apart was used in both the protected alder gallery forest (Grid A) and the neighbouring regrowing plot (Grid B). Bacon and mixed grains with aniseed extract and vegetable oil added, were used as bait. Traps were checked twice each day, (at 7^{00} and at 19^{00}), thus each session yielded 9 checkings. In both years, monitoring was done in three trapping periods: in July, August and October in 2003, and in July, September and October in 2004. From the number of traps in the two grids and the number of sampling nights, our sampling covered 3630 trap-nights a year, that is a total of 7260 trap nights for the two years covered in the present study. Captured animals were marked individually according to BEGON (1979), and we also recorded the sex (in females: gravidity or lactation, too), age and body mass. Ages were determined based on body mass and overall appearance.

Statistical methods

Our capture data were recorded based ion a Manly-Parr diary of captures. Three capture parameters were specified: total number of captures, total number of recaptures, number of known individuals). Small mammal species percentages were calculated for the different sampling plots and for the sampling periods. Capture data of the strictly protected area and the regrowing plot were compared using homogeneity G-tests (ZAR 1996). As trapping sessions lasted for 5 nights, the populations can be considered to be closed, without any births, deaths emigration or immigration. For the estimation of population size we applied the MARK (COOCH and WHITE 1998) software used primarily for testing and modelling survival and capture probabilities, and the program also includes the CAPTURE application that was designed earlier for estimating sizes and densities of closed populations, here operating as a submenu. The various estimators for closed populations running within that consider the constancy or temporal dependence of capture probability, the reaction of individuals to being trapped, and also the possible change of capture probability due to individual characteristics of the animal. Based on the 5-day periods, we could perform population size estimations for the 2004 data only.

For the analysis of spatial distribution of individuals and populations we recorded the coordinates of trap stations and captures, based on which it was possible to analyse the spatial distribution of the various species both statistically and graphically, using the new Biotas 2.0 program. For analysing the distribution of individuals within the population, the nearest neighbour method, and the evaluation of spatial relationship between the populations was done by calculating the degree of association (Yates-correction χ^2-value). Changes in the space use of the frequent species were evaluated using the higher amount of capture data from 2004, by charting together the monthly capture values in the two areas, emphasising the spatial arrangement occurring after the autumn peak density.

Results

In the two year period (2003-2004) within the monitoring in Lankóci-forest, analysed in the present paper, a total of 9 small mammal species were found to occur in the trapping grid set up in the protected alder gallery forest and in the neighbouring regrowing area (both the scientific names of species, and their abbreviation used in our database are indicated):

MAMMALIA
Insectivora:
Soricidae:
1. *Sorex araneus* (Linnaeus, 1758) [SAR]
2. *Crocidura suaveolens* (Pallas, 1811) [CSU]
3. *Crocidura leucodon* (Hermann, 1780) [CLE]

Rodentia:
Muridae:
Arvicolinae:
4. *Clethrionomys glareolus* (Schreber, 1780) [CGL]
5. *Microtus arvalis* (Pallas, 1779) [MAR]
6. *Microtus subterraneus* (de Sélys Longchamps, 1836) [MSU]
Murinae:
7. *Apodemus agrarius* (Pallas, 1771) [AAG]
8. *Apodemus flavicollis* (Melchior, 1834) [AFL]
9. *Apodemus sylvaticus* (Linnaeus, 1758) [ASY]

In 2003 a much lower number of animals were captured in Lankóci forest than the average of earlier monitoring years, which was even more pronounced in the number of recaptures. Therefore, it was not possible to make seasonal population size estimations, not even with closed population models. Among earlier years, the number of captured species was 8 in 2000-2001, which dropped to 6 in 2002. In 2003, despite the fact that there were two sampling grids that year (which doubled the number of trap stations), there were 7 species in the closed forest section (Grid A), and 5 species in the regrowing plot (Grid B). Although 2004 was a more favourable year in terms of weather (lush vegetation, sufficient amount of available food), only 5 species were found to occur in the closed forest. Two protected shrew species (*S. araneus, C. leucodon*) reappeared in the area, thus the number of shrew species was the same as in the previous year, and together with earlier years (2000-2002), we found 5 protected native shrew species in the study area. As to rodents, 5 species were captured in 2003: besides the three wood mouse species, a colouring element of the community, i.e. the pine vole, (*M. subterraneus*) was also captured, as well as the bank vole (*C. glareolus*) that had strikingly high density values in former years. In 2004, however, the common wood mouse (*A. sylvaticus*) was not revealed, and only one vole species, i.e. the bank vole was found to be present. Although the latter species started to stabilise again, it was still not abundant enough to be able to become the dominant species. The yellow-necked wood mouse (*A. flavicollis*) continued to be the leader one in the ranking of dominance in 2004, in both of the small mammal communities sampled (Tables 1-2.).

The relative frequencies of the three common rodent species (*A. agrarius, A. flavicollis, C. glareolus*) and of the two common shrews (*S. araneus, C. leucodon*) in the studied months differed in both years between the closed alder gallery forest and the regrowing area. In 2003 the proportion of A. agrarius in the protected forest was highest in August, this species showing up in the closed forest in the autumn as well, although with lower frequency. In the regrowing plot this animal appeared in the two summer months

Table 1. Capture parameters of species trapped in Lankóci forest in 2003

Species	Number of captures			Number of recaptures			Number of individuals		
Months	06.	08.	10.	06.	08.	10.	06.	08.	10.
Grid A									
Sorex araneus	10	10	2	1	1	-	9	10	2
Crocidura leucodon	2	3	2	-	-	-	2	3	2
Clethrionomys glareolus	17	3	-	6	-	-	13	3	-
Microtus subterraneus	1	-	-	-	-	-	1	-	-
Apodemus agrarius	3	13	6	1	7	4	2	9	3
Apodemus flavicollis	41	12	4	8	6	0	35	10	4
Apodemus sylvaticus	-	1	-	-	-	-	-	1	-
Grid B									
Sorex araneus	3	14	9	-	-	2	3	14	8
Crocidura leucodon	-	10	6	-	1	1	-	9	6
Clethrionomys glareolus	-	-	2	-	-	1	-	-	1
Apodemus agrarius	3	3	-	1	3	-	2	2	-
Apodemus flavicollis	9	5	3	1	-	2	8	5	2

with nearly identical frequency values, but instead of the expected density growth, no individuals of this species were captured in the autumn sampling month. The unfavourable environmental conditions encountered in 2003 are best expressed by the monthly distribution of *A. flavicollis* relative frequency. In both areas this species was most frequent in June, then decreased gradually by autumn when the population was rather found in the regrowing forest area. The distribution revealed for *C. glareolus* can be evaluated if the very low numbers are regarded. The strong preference of this species for closed forests is shown mainly by the values obtained in June. This year, with its densities much lower than the average, only few individuals were found in the regrowing plot. The proportion of common shrew in June was higher in the closed alder forest than in the regrowing area, and in August it was present in the two areas with more or less similar frequencies, but its proportion at the October sampling was higher in the regrowing area. The relative frequencies of *C. leucodon* during the months was quite even in the closed forest section, suggesting that in the strictly protected area this species is also continuously represented at lower numbers besides common shrew. *C. leucodon* was a more characteristic species in the regrowing area (Table 1.), appearing mostly in the drier August and October, clearly shown by relative frequency values (Fig. 1.).

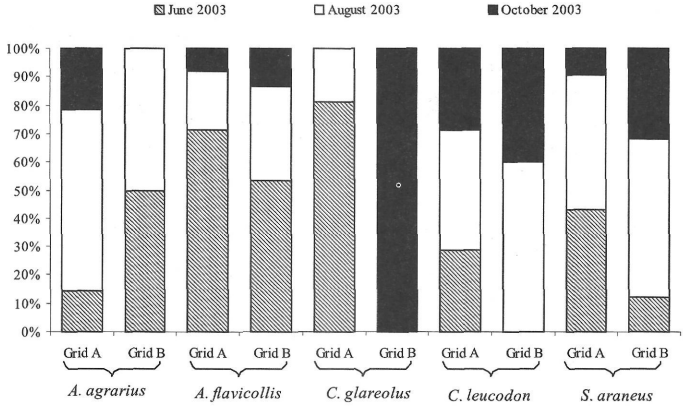

Fig. 1.: Distribution of the relative frequency values of characteristic small mammal species in the sampling months in 2003

Table 2: Capture parameters of species trapped in Lankóci-forest in 2004

Species	Number of captures			Number of recaptures			Number of individuals		
Months	08.	09.	10.	08.	09.	10.	08.	09.	10.
Grid A									
Sorex araneus	-	5	1	-	-	-	-	5	1
Crocidura leucodon	-	1	2	-	-	-	-	1	2
Clethrionomys glareolus	38	34	35	9	14	24	29	27	20
Apodemus agrarius	18	12	-	8	6	-	12	8	-
Apodemus flavicollis	46	37	55	13	27	48	33	23	23
Grid B									
Sorex araneus	-	1	-	-	-	-	-	1	-
Crocidura leucodon	3	1	14	1	-	4	3	1	10
Crocidura suaveolens	-	-	2	-	-	-	-	-	2
Clethrionomys glareolus	9	5	31	1	-	16	8	5	21
Microtus arvalis	2	-	-	-	-	-	2	-	-
Apodemus agrarius	36	25	29	22	16	19	17	15	14
Apodemus flavicollis	29	4	-	13	2	-	19	4	-
Apodemus sylvaticus	4	1	1	2	-	1	2	1	1

Capture numbers of the same small mammals were higher the following year, and because environmental parameters were also different in 2004 (the dry year was followed by one with more precipitation), species distributions in the various sampling months were also different, even if it is considered that sampling was done from August to October. *A. agrarius* was present in the regrowing area with almost identical proportions as in the forest plot, which fact - with capture parameters (Table 2.) also regarded - indicates that this species preferred this type of habitat to the closed alder gallery forest. In the case of A. flavicollis the results were the other way round, with an even distribution of its relative frequencies during the months being characteristic for Grid A. In the regrowing area its proportion was remarkable in August, then in autumn individuals of the population began to use this habitat less. The bank vole was found to be more stabile in 2004 both in capture parameters and in the distribution of relative frequencies during the months. Even the seasonal distribution of its relative frequency suggested that this species used not only the closed forest this year, but by autumn a considerable proportion of its population also occupied the regrowing plot. Among the two shrews, common shrew tended to use the closed forest, whereas *C. leucodon* was found in the regrowing area, but both species were captured only from August on (Table 2.) (Fig. 2.).

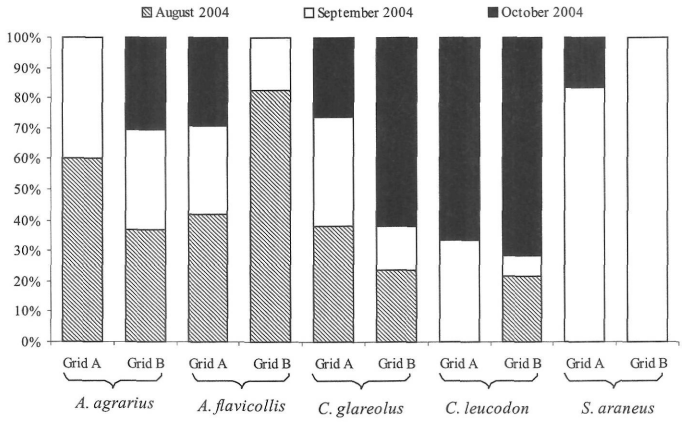

Fig. 2.: Distribution of the relative frequency values of characteristic small mammal species in the sampling months in 2004

Table 3: Results of the homogeneity test (G-test) between the two sample areas

	Grid A		Grid B		
Speies	**N_i**	**p_i**	**N_i**	**p_i**	**G-values**
S. araneus	21	19.26	25	41.66	8.43**
C. leucodon	7	6.42	15	25	1.27
C. glareolus	16	14.67	1	1.67	11.89***
M. subterraneus	1	0.91	0	0	11.73***
A. agrarius	14	12.84	4	6.67	1.98
A. flavicollis	49	44.95	15	25	5.77*
A. sylvaticus	1	0.91	0	0	1.27

*: $p < 0.05$; **: $p < 0.01$; $p < 0.001$

Table 4: Results of the homogeneity test (G-test) between the two sample areas (August)

	Grid A vs. Grid B		G-values
Speies	**A%**	**B%**	
Sorex araneus	0	0	-
Crocidura leucodon	0	3.89	5.40*
Clethrionomys glareolus	37.25	11.68	14.04***
Apodemus agrarius	17.64	46.75	13.64***
Apodemus flavicollis	45.09	37.66	0.66

*: $p < 0.5$,**: $p < 0.01$, ***: $p < 0.001$

For a detailed statistical analysis of differences between the two study plots, capture data from 2003 proved to be insufficient. The assumed differences between the areas were thus evaluated based on the cumulated data of 3 months only. From the results of G-tests performed for each species it appears that in most species inhomogeneity was found to exist between the two areas. The two, typically forest-dwelling species that had been more abundant before 2003 (*A. flavicollis, C. glareolus*) were now found to be characteristic for the closed forest, whereas for the distribution of A. agrarius no significant difference was found between habitat types. Apparently, this generalist species was found with similar proportions in the two areas, with individuals of the population moving about in the boundary area between the two plots, i.e. in the edge zones. The significant difference found for the distribution of *S. araneus* is a consequence of merging its data, as it could be seen above from relative frequencies during the months that this species changed location, moving mostly to the regrowing area in August and October. However, the significant result of the G-test cannot clearly prove whether it is the closed alder gallery forest or the regrowing forest area that is the more suitable habitat for this species (Table 3.).

The higher number of captures in 2004 made it possible to analyse the assumable difference between the two plots month by month (Tables 4-6.). From G-tests for the various species it appears that there was inhomogeneity for most of the species in all three months between the two plots. For August, the significant G-test results obtained for the striped field mouse and for the bank vole must be noted. The striped field mouse which is capable of fast dispersal, was found to be occurring at significantly higher frequencies in the regrowing area than the 1:1 distribution hypothesised by the G-test., whereas the bank vole was more abundant in the closed forest. Another important phenomenon in the comparison of the two areas in the same month is the homogenous distribution of the yellow-necked wood mouse, showing that the reforested area is also a suitable habitat for this species, and that individuals of the population establish their home ranges here, too (Table 4.).

Table 5: Results of the homogeneity test (G-test) between the two sample areas September)

	Grid A vs. Grid B		G-values
Speies	**A%**	**B%**	
Sorex araneus	**5.61**	2.77	0.98
Crocidura leucodon	**1.12**	2.77	0.72
Clethrionomys glareolus	**38.20**	13.88	11.80***
Apodemus agrarius	**13.48**	69.44	41.33***
Apodemus flavicollis	41.57	11.11	18.75***

*: $p < 0.5$,**: $p < 0.01$, ***: $p < 0.001$

Table 6: Results of the homogeneity test (G-test) between the two sample areas (November)

	Grid A vs. Grid B		G-values
Speies	**A%**	**B%**	
Sorex araneus	1.07	0	1.17
Crocidura leucodon	2.15	18.91	15.31***
Clethrionomys glareolus	**37.63**	41.89	0.22
Apodemus agrarius	**0**	39.18	54.32***
Apodemus flavicollis	59.13	0	883.15***

*: $p < 0.5$,**: $p < 0.01$, ***: $p < 0.001$

Results of homogeneity tests for September showed that the distribution of striped field mouse was again inhomogenous, in preference for Grid B. Similar inhomogeneity was received for the bank vole too, but this species remained to be present in higher numbers in the closed alder gallery forest. The former homogenous distribution of the yellow-necked wood mouse now changed: individuals of the population rather occupied the closed forest, thus the G-test for the distribution of relative frequencies revealed significant difference. For shrews, the statistical analysis indicated homogenous distribution in the two areas (Table 5.).

The unexpected results described earlier for November capture data were confirmed by the G-tests too. Striped field mice were present only in the regrowing plot by then, clearly indicated by significant inhomogeneity. The same result was obtained for the yellow-necked wood mouse, its individuals captured in November in the closed forest only. Finally, the most striking piece of result was that the distribution of the bank vole turned the other way round: higher percentages were found in the regrowing plot than in the closed forest (Table 6.). Significant difference was found for the distribution of the white-toothed shrew, found in greater numbers in the regrowing forest, thus it is assumed that it prefers the vegetation structure found there.

In the monitoring years before 2003 when trapping was done only in the strictly protected forest, it was primarily the common shrew whose population size could be estimated a from capture-recapture data. In the sample area of the closed alder gallery forest shrew density decreased considerably in 2003, therefore insufficient capture-recapture data were obtained, so it was not possible to apply estimation methods (MARK/CAPTURE). However, from data collected in 2004, we could perform population size estimations of the three dominant species (*A. agrarius, A. flavicollis, C. glareolus*). From capture or life history matrix on Grid A, estimations were made for all three populations. Although the bank vole was present in higher numbers in Grid B in November 2004, it was still not possible to perform population estimation for this area. The success of estimations is greatly influenced by recapture rates, i.e. the success of capture-mark-recapture, thus there were of course months in the two other species too

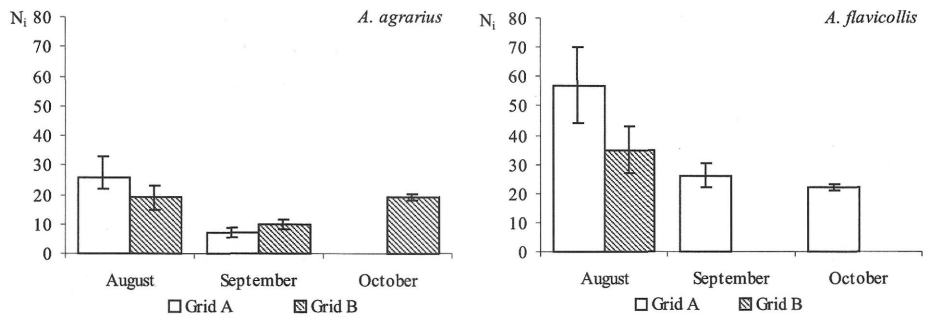

Fig. 3.: Estimated abundance values of striped field mouse (*A. agrarius*) and yellow-necked wood mouse (*A. flavicollis*) populations in Grids A and B of the sample area of Lankóci-forest in 2004

when data in the life history matrix proved to be insufficient for an estimation. The most estimations were obtained for the two *Apodemus* (*A. agrarius* and *A. flavicollis*) populations. Estimated population sizes were charted for each species, with data for Grids A and B shown in the same graph, the standard error of the estimation also indicated (Fig. 3.).

Population size of the bank vole, thus, could be estimated for Grid A only. Quite similar results were obtained for August and September (August: 41 individuals/ha, September: 46 individuals/ha). In August it was the most fitting M_{th}-estimator, (Mth: recapture probability is time-dependent and also depends on individual variability within the population), and in September the M_0-estimator (M_0: recapture probability is constant in time) that proved to be suitable for population estimation. In November the estimated population size (11 individuals/ha) indicated well that individuals emigrate from the area, resulting in a population decline in the closed forest. When estimations were made from August and September data, high standard errors were obtained, thus variation coefficients produced percentages that were higher than acceptable (August: cv = 27.12 %, September: cv = 27.99 %), based on which the estimated values for these two months can not be regarded statictically acceptable. In November higher capture success produced acceptable estimation for this species, too (cv = 10.14 %) (Fig. 4.).

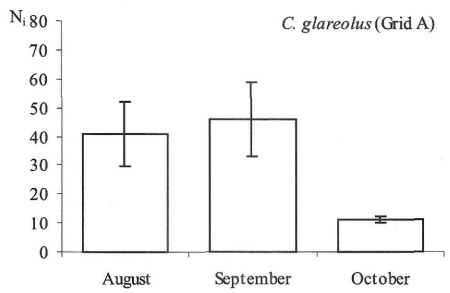

Fig. 4.: Estimated abundance values of the bank vole (*Clethrionomys glareolus*) population in Grid A of the sample area of Lankóci forest

Both the homogeneity tests of capture data in the two study plots and the population dynamics of the frequent rodent species indicated that the spatial arrangement of individuals of the various populations is an important factor in creating and changing the spatial and temporal pattern of small mammals moving between the strictly protected closed forest and the regrowing area. By evaluating capture point coordinates in the Biotas program we first analysed the space use and distribution of individuals in the populations of the three frequent rodents. Because of the low capture rates in 2003, in this analysis we used yearly cumulated data in both years (2003, 2004) for performing the graphical analysis of space use and the distribution investigations applying the nearest neighbour method. The use of the closed forest and the regrowing area in the three studied species was different among the two years. The striped field mouse, a generalist species in habitat use, occupied the edge area between Grids A and B in 2003. In 2004, the greater density of its population resulted in an increased space use, thus the striped field mouse populated the regrowing plot as well as the edge areas. Difference in the space use of the yellow-necked wood mouse between the two years was smaller. This species clearly preferred to use the closed alder gallery forest, although even in 2003 it did occur in a certain patch of the regrowing plot that was covered by larger trees and dense vegetation. In the following year, individuals of the population dispersed more intensely in the regrowing forest area. In the comparison of the two years, the most striking difference in space use was found for the bank vole. When it had low densities in 2003, it used mostly the closed forest, with only few individuals captured in the edge zone of the regrowing plot. In the following year it was found that as density grew, individuals started to use the regrowing plot more intensely (Fig. 5.).

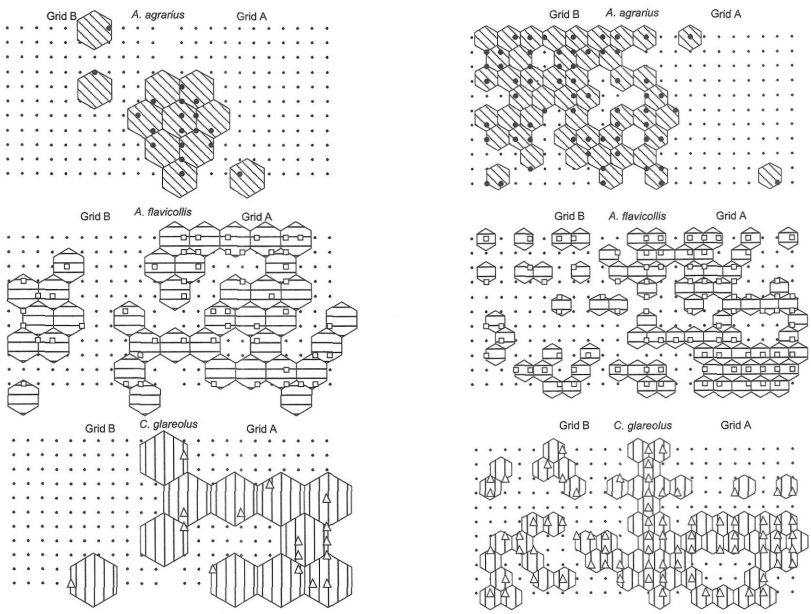

Fig. 5.: Space use by the three characteristic species in the regrowing forest area (B) and the closed alder gallery forest (A) in 2003 (left) and in 2004 (right)

Table 7. Nearest neighbour distances within populations of the three frequent rodent species. with stadard deviation values. in 2003-2004

Statistical values	2003		2004	
Species	Mean distance (m)	± SD	Mean distance (m)	± SD
A. agrarius	14.98	0.75	13.36	0.23
A. flavicollis	15.97	0.37	15.33	0.15
C. glareolus	47.25	0.83	12.46	0.19

However, the analysis of the distribution of individuals within the populations showed that although densities were different in the two years, individuals in all three species aimed at reaching an even spatial distribution. According to the null-hypothesis of the nearest neighbour method individuals are randomly distributed. Yet, results of the two years showed in all three species that this hypothesis should be rejected, the distribution of individuals being even. In terms of the average distance of nearest neighbours, the bank vole had significant difference between the two years, indicating that individual territories were further apart in 2003 when densities were low. The two Apodemus species are known to have larger home ranges and are capable of covering considerable distances, yet the average distance from the nearest neighbour was almost the same in the two years, for both species (Table 7.).

It must be emphasised for Fig. 5 above that it is created from cumulated data, and besides the fact that spatial distribution is density dependent, it is also important to find out how space use and spatial patterns transform as population sizes change throughout the year. For such analyses monthly data should have contained higher capture values, thus the seasonal changes of spatial distribution were analysed from our 2004 data only.

For the closed alder gallery forest and the regrowing forest area it was assumed that due to the difference in resource distribution and interspecific competition, the two habitats are used by the various species taking turns, therefore considerable migration and partial population translocation can be measured among the two areas. For the analysis of the assumed population translocation between the closed forest and the regrowing plot, i.e. between two areas with dissimilar physiognomic structure, the daily capture data of the three populations in the two plots were charted on a graph so that the daily and monthly changes in population dynamics can demonstratively indicate changes in space use (Fig. 6.). In the case of yellow-necked wood mouse, even the August data were remarkable, as capture maxima in the two areas appeared distinctly even within the five-day trapping session. In the closed forest, the capture peak occurred in the first few days, whereas in the regrowing plot it commenced in the second half of the period. From data of the two autumn months it clearly appears that individuals of the population tended to leave the regrowing area and occupied the closed forest where the spatial arrangement of the population then stabilised. For the striped field mouse, capture maximum clearly occurred in August in the regrowing plot, with its abundance decreasing gradually in the closed alder gallery forest, to disappear completely from this area by November. In the more open habitat its spatial structure stabilised, its abundance not reaching the August maximum. The population of bank voles in August-September had higher abundance in the closed forest, then in November it had higher capture rates in the regrowing plot (Fig. 6.). Looking at the trend of population sizes throughout the months, the most striking shift between the use of the two habitats was observed in the case of the yellow-necked wood mouse and the striped field mouse. As to the bank vole, its appearance in the regrowing plot is a result of dispersal, shown by the fact that a part of the population, with similar size to that migrating to the open area, stayed in the closed forest. Emigration from the closed alder gallery forest can be assumed, even if capture coordi-

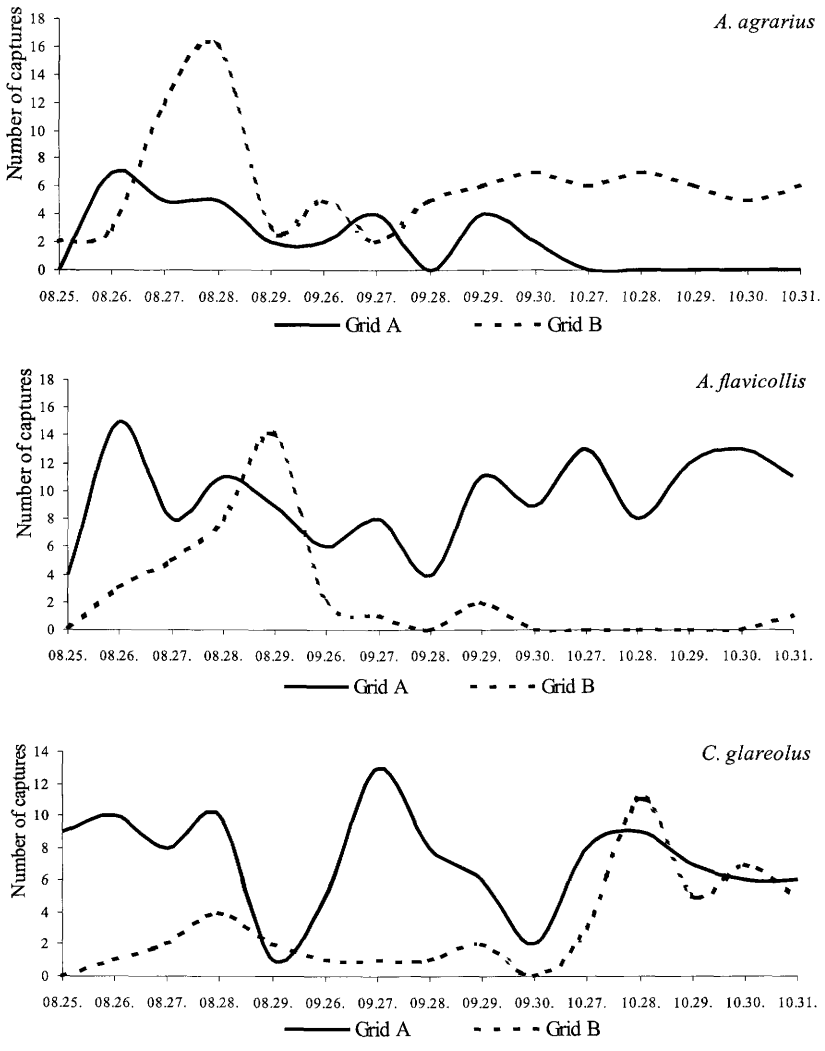

Fig. 6.: Daily capture numbers of the three characteristic species during the three sample months in Grids A and B of the sample area of Lankóci forest in 2004

nates of individuals caught at least twice did non confirm i.e. it was not possible to show individuals that proved this migration direction.

The program Biotas, compatible with GIS softwares, is capable of displaying the spatial arrangement of several populations together, based on which it is possible to calculate spatial association between two particular populations. Similarly to the evaluation of populations one by one, we calculated spatial association between species pairs on a monthly basis, regarding the entire study area (Grids A and B together). Yates correction χ^2-values obtained for the August data were low in all three species pairs (*A. agrarius vs. A. flavicollis, A. agrarius vs. C. glareolus, A. flavicollis* vs. *C. glareolus*), thus significant spatial association - i.e. statistically confirmed common space use - could not be

proved in either of the pairings (χ^2 = 0.008 - 0.506, NS). For September 2004 there was no significant spatial association for the pairs *A. agrarius* vs. *A. flavicollis* and *A. agrarius* vs. *C. glareolus* (χ^2 = 0.4 - 0.68, NS), sugesting that the two typical forest dwelling species (*A. flavicollis, C. glareolus*) are spatially separated from the population of the striped field mouse preferring more open areas yet having wide tolerance in terms of habitat. However, in the pairing of *A. flavicollis* vs. *C. glareolus* significant spatial association was observed (χ^2 = 6.95, $p < 0.05$). In September, the yellow-necked wood mouse completely moved into the closed forest, and also the bank vole population increased in the area near the closed alder gallery forest. Consequently, the two populations had to share habitats in the protected forest section at a greater degree, the significant spatial association thus being the result of higher spatial overlap in September. For the November capture data, low, non-significant levels of association were obtained again in all three pairings (χ^2 = 1.18 - 1.84, NS). This result, too, suggests that this month individuals of the various populations were arranged in a way that spatial overlap is minimal, the three populations trying to occupy suitable habitat patches in segregation from each other. The detailed seasonal analysis of population dynamics and spatial organisation of species suggests that by November, after density peaks, the species are already arranged according to their winter survival strategies. Because unexpected results were produced in that month - especially in terms of the spatial distribution of the bank vole - we therefore charted the November capture and location data of the three frequent species together. In that graph capture locations of individuals of the three species, and hexagonal grids corresponding to space coverage. That way, graphics show the areas that are separated with no overlap between populations, as well as those with spatial overlap between two or three populations (Fig. 7.).

Based on spatial distributions observed by early November, the area of the closed alder gallery forest was occupied by individuals of the yellow-necked wood mouse and the bank vole populations. In the larger, central part of the 1 hectare forest section only yellow-necked wood mice had their home ranges. In the inner, marginal rows of the grid where higher bank vole capture densities occurred in August and September, the habitat use of the two populations overlapped in November. There were yet another two patches in the closed forest with the space use of the two typically forest-dwelling species overlapping in November, both areas touching the border zone towards Grid B. Based on our November data, the most striking result in Grid B was that bank voles, a species with higher capture frequency, gained space. Thus, it was mostly the striped field mouse and the bank vole that shared among themselves the more open, regrowing forest area. Bank voles were present in higher numbers in the section of Grid B closer to the forestry road, whereas the striped field mouse tended to use the more centrally located areas where in small patches it had habitat overlap with bank voles that had much lower capture frequencies (Fig. 7.).

Conclusions

Research done both in nearctic and palearctic temperate regions has proved that small mammals are important indicator objects, signifying degradation processes of the areas, as well as the harmful effects of forestry interventions that decrease biological diversity (e.g. MAZURKIEWICZ 1984, STEPHENSON 1993, LINZEY and KESNER 1997, SAITOH and NAKATSU 1997, STEVENS and HUSBAND 1998). Long-term studies have also revealed how drastic changes to ecological background parameters (e.g. droughts that can influence

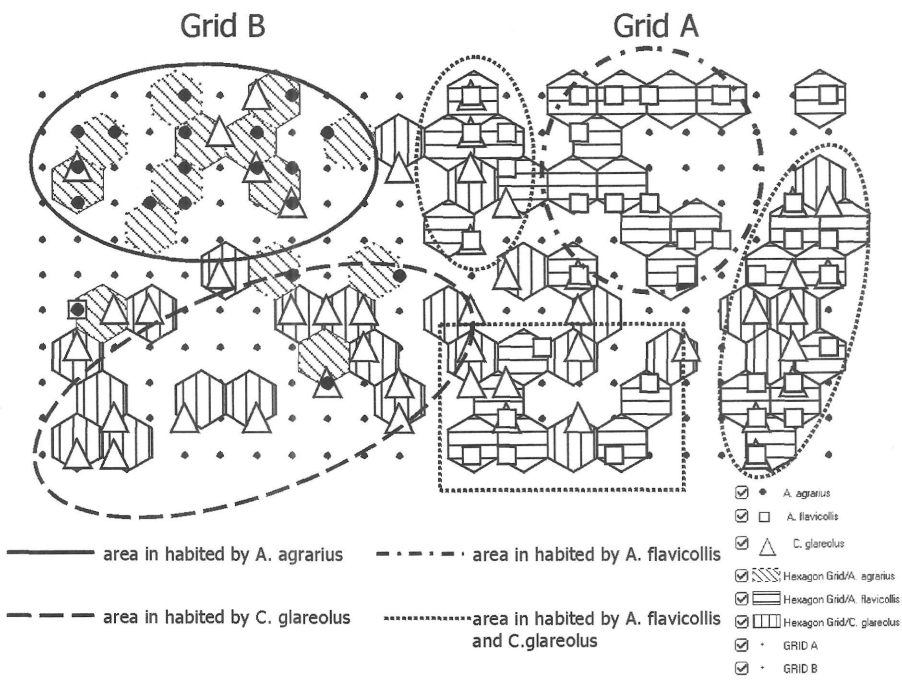

Fig. 7.: Space use and spatial overlap by the three frequent species after the density peak in 2004 in the alder gallery forest and in the regrowing forest

structural factors of floodland forests, or considerable water cover) acting as environmental disturbance can transform quantitative characteristics of small mammal populations and their spatial patterns. In the case of small mammals acting as indicator species, positive or negative changes in the quality of habitats are signified by transformations in the structure of their populations and communities.

In the first three years (2000-2002) of small mammal monitoring in Lankóci-forest in the upper Hungarian reach of river Drava we had samplings only in the strictly protected closed alder gallery forest where 8 small mammal species (5 rodents and 3 shrews) were recorded. The results of that trapping period have already been compared in our other papers with data from a long-term monitoring in a lowland oak-hornbeam forest (Bükkhát-forest, Baranya county) where the 10-year investigation yielded occurrence data of a total of 10 small mammal species (HORVÁTH et al. 2004). These 8 and 10 species, respectively, that were shown in our investigations can be regarded as good results: both the drier lowland oak forest and the alder bog forest studied in the upper Drava reach are quite diverse if compared with surveys of small mammal communities of other European temperate forests. As part of the IBP programme, JENSEN (1975) made surveys in beech forests and recorded 8 species (2 shrews and 6 rodents). HAFERKORN (1994) recorded 6 species in ash-elm gallery forest, but due to the insufficiency of data, for several years he could track the dynamics of three populations only. JUCHIEWICZ et al. (1986) performed small mammal community investigations in beechwoods and pine

forests in the Carpathians, revealing 6 species in both habitat types, but with no considerable difference in diversities (although data were not analysed statistically). In two out of three study years, the small mammal community turned out to be more diverse in the pine forest.

During the studies in 2003-2004 analysed in the present paper, the number of species recorded decreased because of the unfavourable survival conditions in 2003, despite that the regrowing forest area neighbouring the strictly protected forest section was also introduced to the investigations. Changes in environmental conditions had the greatest influence on the bank vole population which had twice or three times higher densities in earlier years than had the *Apodemus* species that were characteristic species in the present study period as well. Due to more favourable survival conditions, capture parameters improved in 2004, based on which it was possible to analyse the space use and spatial overlap of the three most frequent species, as well as we could determine any spatial association between their populations. We clearly showed a shift in area and habitat use by the two *Apodemus* populations in autumn, and the higher bank vole capture frequency in the regrowing area around November was explained by emigration starting from the closed forest as abundance grew. However, due to the low rate of recaptured individuals we could not directly confirm the assumed directions of migration. In the case of striped field mouse, the preference of the edge zone of forest habitats could be demonstrated here in Lankóci forest too, as well as the fact that in this habitat individuals of the population dispersed in the regrowing area instead of the closed forest. Looking at the edge zone - closed forest gradient, it was the A. agrarius population that was present with higher abundance in the edge zones than in the central and inner patches of the studied forest section. This phenomenon has been noted earlier for this species in papers produced at our department (HORVÁTH et al. 1996, HORVÁTH et al. 2001). The considerable degree of dispersion by *A. agrarius* in the regrowing area of Lankóci forest is primarily the result of habitat selection, and is caused also by competition between populations of the the three dominant species (*A. agrarius, A. flavicollis, C. glareolus*) (ZEJDA 1967, GLIWICZ 1984, CHELKOWSKA et al. 1985). In the case of the bank vole, the pure faunal evaluation of capture data, the statistical analysis of relative proportions, and results from the investigation of space use by the population all suggest that it was a pronounced surge of emigration that caused the observed spatial pattern between the closed alder gallery forest and the regrowing area, possibly enhanced by competition with the yellow-necked wood mouse showing similar densities (GLIWICZ 1981, 1984). Of course this cannot be proved during a single trapping period, but the distribution of individuals does follow the arrangement of resources (shelter, food), which is probably entirely different in respect of the two areas in November than in the summer months.

With a view to the results having gained we believe that continuing monitoring is important; the synchronous monitoring of the two habitats with different vegetation structure has yielded many information about small mammal ecology, despite the fact that the year 2003 had low density values. Based on longer term studies it will be possible to seek answer to such actual questions about the upper Drava reach like how drastic changes in the water regimes of floodland forests influence the spatial patterns and demographic fluctuations of settling and dispersing small mammals.

Acknowledgement

Monitoring activities were supported by the Duna-Drava National Park Directorate.

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Kisemlősök populációdinamikája és térbeli mintázata védett erdei és újraerdősödő területen

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A Dráva felső szakasza mentén 2003-2004-ben a kisemlősök elevenfogó csapdázásos monitorozását végeztük fogás-jelölés-visszafogás módszerrel. Mintaterületünk egy fokozottan védett égerligetben (Lankóci-erdő) és az ezzel szomszédos, 2000-ben tarra vágott, majd fokozatosan újraerdősödő területen volt. A két évében összesen 9 kisemlős fajt mutattunk ki a két területen működtetett, egyenként 1 ha-os mintavételi kvadráttal. Az itt található kisemlős közösségnek három karakter rágcsáló faja (*Apodemus flavicollis, A. agrarius, Clethrionomys glareolus*), valamint gyakoribb két cickányfaj (*Sorex araneus, Crocidura leucodon*) volt. A napi fogási adatokból a populációkat zártnak feltételezve becsültük a három karakter rágcsáló populáció méretét. A legtöbb becsült értéket a két *Apodemus* (*A. agrarius* és *A. flavicollis*) populációnál kaptuk. Az erdei pocok populáció méretét csak a zárt védett erdő adataiból tudtuk becsülni. A legközelebbi szomszéd módszerrel végzett térbeli elemzés azt mutatta, hogy a gyakori populációk egyedei az egyenletes eloszlásra törekedtek, ami mind a kisebb sűrűségű 2003-as, valamin a nagyobb denzitású 2004-es évben is jellemző volt. A két *Apodemus* (*A. agrarius, A. flavicollis*) populációnál az őszi időszakban egyértelműen kimutattuk a terület-, illetve élőhely-váltást, míg az erdei pocoknál a népesség növekedésével a zárt erdőből kiinduló emigráció eredményeként értelmeztük az újraerdősödő területen novemberre megjelenő nagyobb fogási gyakoriságot. A kevés többször visszafogott egyed azonban nem tudta konkrétan igazolni a feltételezett migrációs útvonalakat. A térbeli mintázat 2004-es részletesebb elemzése azt sugallta, hogy ősz végén a fajok már a téli túlélési stratégiának megfelelően rendeződtek. Ebben az időszakban a térbeli eloszlások alapján a zárt égerliget területét a sárganyakú erdeiegér és az erdei pocok populáció egyedei foglalták el. A kijelölt 1 ha-os erdőtag belső, nagyobb részében inkább a sárganyakú erdeiegér egyedek jelölték ki mozgáskörzeteiket. A pirók erdeiegér kizárólag az újraerdősödő területet foglalta el. Jelentős területet használva, az újraerdősödő területen az erdei pocok jelent meg mellette, amely eredmény ennél a fajnál a két terület közötti jelentős populáció transzlokáció tényét bizonyította.