# Monitoring of plant species along the Drava river and in Baranja (Croatia)

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**Abstract:** After a basic biodiversity assessment, twenty vascular plants are selected for monitoring along the Drava river and the Hungarian-Croatian border: *Butomus umbellatus, Carex bohemica, Carex vesicaria*, *Catabrosa aquatica*, *Cyperus glomeratus*, *Equisetum hyemale, Glyceria fluitans, Hottonia palustris*, *Iris pumila, Leucojum aestivum, Limosella aquatica, Listera ovata, Myricaria germanica*, *Ophrys sphegodes, Orchis militaris, Plantago arenaria*, *Primula vulgaris*, *Reseda inodora, Scirpus triqueter*, *Trapa natans*. During field work in 2007, we made records about thirty populations (sites) of selected vascular plant species on the Croatian side of the Drava floodplain and in Baranja. Several sites of rare, less known and Croatian Red list species (e.g. *Calamagrostis pseudophragmites*, *Cyperus fuscus*, *Leersia oryzoides*, *Potentilla supina*) were pointed out. In the surveyed area numerous NATURA 2000 habitat types were found, some of them calling for priority in protection. The most important plant species, vegetation types and habitats whose occurrences indicate important natural values of the study areas are also listed. Among them there are riparian ecosystems which include a great variety of habitats along Drava river as well as Pannonic dunes, sub-continental xeric grasslands, shrubs and woods.

## 1. Introduction

Drava is the only river in Europe remaining unregulated on its upper-middle section, therefore its floodplain is area of great natural values and unique beauty. Having been a border between countries for hundred years, the region along Drava river has not been properly surveyed yet neither in Hungary nor in Croatia. The investigation of flora and vegetation of the Drava floodplain in Hungary has a more than hundred years long tradition. Mostly natural alluvial forests, sandy areas, oxbows, mires and muddy banks were surveyed (e.g. BOROS 1923, 1925, 1928; HÉJJAS & BORHIDI 1960; KLUJBER et al. 1963; TIHANYI 1964, 1965; VÖRÖSS 1965, 1968; KOVÁCS & KÁRPÁTI 1974; FENYŐSI & HORVÁTH 1995; DÉNES 1998; KEVEY 2002; LÁJER 2002; ORTMANN-AJKAI 2004; ORTMANN-AJKAI & DÉNES 1997; CSIKY & OLÁH 2006). In the framework of a national program (KIRÁLY 2005), according to CE system, flora mapping was carried out in this

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region (CSIKY & OLÁH 2006).

The Drava river from Őrtilos to Matty is protected in Hungary as a part of the Duna-Drava National Park, which was inaugurated in 1996. This area of wetlands, banks, marshes, reed beds and forests holds more than hundred protected plant species. Biomonitoring has been performed since 2000 under the co-ordination of Duna-Drava NP Directorate, in order to obtain information about changing conditions in the habitats of endangered plant species (TÖRÖK 1997) and vegetation types (KOVÁCS-LÁNG & TÖRÖK 1997). Possessing of such information is *conditio sine qua non* for the management and conservation of natural values. The biomonitoring of two endangered plant species, *Fritillaria meleagris*, *Iris sibirica* (JUHÁSZ 2004) and stands of alluvial willow forests is performed in permanent plots along Drava river (JUHÁSZ & DÉNES 2005). The flora mapping on the Croatian side of Drava has not been performed yet, nevertheless there are works containing data about the flora and vegetation of this region (e.g. ILIJANIĆ 1963, 1968; RAUŠ & ŠEGULJA 1983; RAUŠ et al. 1978, 1985; PANJKOVIĆ 1990; TOPIĆ 1998; TRINAJSTIĆ & FRANJIĆ 1999). The inventorisation of macrophytes in the middle section of Drava was performed during 2004-2006 (RAZLOG-GRLICA & GRLICA 2007). Some of the populations of *Fritillaria meleagris* were mapped along Drava river during a survey which was carried out in the whole Croatia (ILIJANIĆ et al. 1998; NIKOLIĆ 2008).

However, the conservation of the areas divided by an artificial border cannot be effective if they are managed in different ways. Therefore, it would be an urgent task to summarize the results of biodiversity assessments, harmonize survey methods, as well as exchange experience in the management of valuable habitats along Drava river in both countries.

The establishing of a common monitoring protocol (PURGER et al. 2007) was the first step in co-ordinating botanical surveys in this area. The harmonization of methods was done relying on the self experience of authors, botanical literature, especially national protocols (TÖRÖK 1997; KOVÁCS-LÁNG & TÖRÖK 1997; NIKOLIĆ 2006; TOPIĆ et al. 2006). After studying the botanical literature of both countries and following a field survey on the Croatian side, 20 vascular plants species were selected for monitoring (PURGER et al. 2007): *Butomus umbellatus* L., *Carex bohemica* Schreb., *Carex vesicaria* L., *Catabrosa aquatica* (L.) P.B., *Cyperus glomeratus* L. (syn: *Chlorocyperus glomeratus* (L.) Palla), *Equisetum hyemale* L., *Glyceria fluitans* (L.) R.Br., *Hottonia palustris* L., *Iris pumila* L., *Leucojum aestivum* L., *Limosella aquatica* L., *Listera ovata* (L.) R. Br., *Myricaria germanica* (L.) Desv., *Ophrys sphegodes* Mill. (syn: *Ophrys sphecodes* Mill.), *Orchis militaris* L., *Plantago indica* L. (syn: *Plantago arenaria* W. et K.), *Primula vulgaris* Huds., *Reseda inodora* Rchb., *Scirpus triqueter* L. (syn: *Schoenoplectus triqueter* (L.) Palla) and *Trapa natans* L.

The main criteria for the selection of these species for monitoring were:

- distribution of the species (preference was given to plants which are rare or extremely rare in both countries),
- status in red lists (NÉMETH 1989; NIKOLIĆ & TOPIĆ 2005; KIRÁLY et al 2007),
- status of protection in both countries (ANONYMOUS 2004, 2005),
- international status in NATURA 2000 and international conventions.

The main aims of our investigations were:

(i) to launch the monitoring of vascular plants on the Croatian side, based on the common protocol (PURGER et al. 2007);

(ii.) to evaluate natural values of the regions in Croatia along Drava river and the Hungarian-Croatian border, upon occurrence of vascular plants, vegetation types and habitats (choosing areas which are worth to be protecting in the framework of the European ecological network, NATURA 2000).

# 2. Material and methods

Methods described in the protocol (PURGER et al. 2007) were used to survey the population of plant species. For the determination of plant species the actual Hungarian (SIMON 2001) and Croatian (DOMAC 2002) handbooks were used. In the habitat of the selected species phytocoenological relevés were taken according to LÁJER et al. (2007). Names of plant communities are given according to BORHIDI (2003) and ANTONIĆ et al. (2005). Geo-coordinates were determined upon maps (NIKOLIĆ 2006, 2008).

# 3. Study area

Botanical surveys were carried out along the Croatian side of the river Drava from Legrad to Donji Miholjac, as well as in Baranja on Bansko Hill, in the forests near Haljevo and Kozarac.

# 4. Results and discussion

During 2007 we spent more than three weeks with field work in the study area. Populations of 20 plant species were surveyed at 28 sites. Only one population of each of the species *Trapa natans*, *Plantago indica, Myricaria germanica, Limosella aquatica, Iris pumila* were examined, because no more populations were found of these species in the study area. Only one stand of *Hottonia palustris*, *Equisetum hyemale* was surveyed because of shortage of time, although few locations had been selected earlier. Data of two populations of other thirteen plant species are presented here. A few thousand records of approximately 500 vascular plant species were collected in the study area, however it is possible that we did not find the best possible sites for the monitoring of each species.

According to our experience we suggest a new/alternative method for monitoring plants species on river gravel and sand banks (*Carex bohemica*, *Cyperus fuscus*, *C. glomeratus*, *Limosella aquatica*, *Scirpus triqueter*), belonging to the amphibious communities (*Isoëto-Nanojuncetea*, incl. *Nanocyperion*) along Drava river. The dynamics of the river and succession of vegetation is very fast, habitats suitable for these species drastically change or move year by year. In such conditions the monitoring of these species cannot be successful in one fixed site. For avoiding this problem we suggest the selection of 10 km long sections along the river. In these sections botanists should determine the population size and number (recording the exact locations as well) of each *Isoëto-Nanojuncetea* species. Monitoring of one section takes at least one day for two persons. This method was not mentioned in the protocol by PURGER et al. (2007), and it has not been tested in the field yet, but we believe that (for long-term monitoring) it will be more useful than the methods suggested earlier for these species.

Data of the surveyed sites and the plant species selected for monitoring are the following:

## 1. *Butomus umbellatus* L.

**Croatian Red List status**: NT.
**International status**: -.
**1st site**
**Date:** 2007.05.24.
**Location**: Suza - Mirkovac (X 5796090.00, Y 5075789.43).
**Habitat**: water-fringe helophyte bed: *Alisma lanceolatum*, *Alisma plantago-aquatica*, *Batrachium trichophyllum*, *Butomus umbellatus* (Fig. 1.), *Calystegia sepium*, *Glyceria maxima*, *Oenanthe aquatica*, *Ranunculus sceleratus*, *Symphytum officinale*, *Typha latifolia*, *Urtica dioica.*
**Phytocoenological relevés: -**.
**Causes of endangerment**: drainage, siltation or drastic dredging of channels.
**Invasive plant species at the site: -**.
**Sampling methods and data**: The population is estimated at 1000 stem/ stand; max. length of stand: 100 m, max. width of stand: 3 m; max. length of habitat: 5000 m, max. width of habitat: 3 m.
**Photographs**: +.
**Comments**: *Butomus umbellatus* is not rare in this region. It tolerates disturbances and drought very well, but it appears and disappears abruptly (e.g. on waste lands, in vernal pools, channels, drainage ditches). The occurrence of this plant depends on special habitat conditions like bare, wet surfaces.
**2nd site**
**Date:** 08.07.2007.
**Location**: Repaš (X 5659824, X 5113473).
**Habitat**: oxbow, water-fringe helophyte bed: *Alisma plantago-aquatica, Berula erecta, Butomus umbellatus, Hypericum tetrapterum, Leersia oryzoides, Lythrum salicaria.*
**Phytocoenological relevés**: -.
**Causes of endangerment**: drainage.
**Invasive plant species at the site:** *Solidago gigantea.*
**Sampling methods and data**: The population in the stand is estimated at 100 individuals; max length of stand: 100 m, max. width of stand 15-20 m; length of habitat: 200 m, max. width of habitat: 15-20 m.
**Photographs**: -.
**Comments**: In the same habitat *Leersia oryzoides* (NT) occurs. About 200 m away, on the edge of a pit there are small populations of *Carex riparia* (VU) and *Equisetum hyemale* (VU).

Fig. 1. *Butomus umbellatus* (Photo by Dragica Purger)

## 2. *Carex bohemica* Schreb.

**Croatian Red List status**: CR.

**International status**: IUCN I: CR, IUCN II: V.

**1st site**

**Date:** 15.08.2007.

**Location**: Between Legrad and Ferdinandovac (X 5671357.18, Y 5107868.35, 107.6 m a.s.l.).

**Habitat**: Bare surfaces of river gravel and sand banks (Fig. 2.), amphibious communities (*Isoëto-Nanojuncetea*, incl. *Nanocyperion*); *Polygono-Eleocharitetum ovatae* Eggler 1933:

*Agrostis stolonifera, Alisma plantago-aquatica, Amaranthus* spp., *Amorpha fruticosa*, *Aster* spp., *Berula erecta, Bidens frondosus, Callitriche palustris, Calystegia sepium, Carex bohemica, Chenopodium ambrosoides, Chenopodium polyspermum, Conyza canadensis, Cyperus fuscus, Cyperus glomeratus, Echinochloa crus-galli, Eleocharis acicularis, Epilobium tetragonum, Erigeron annuus, Festuca arundinacea, Galium palustre, Humulus lupulus, Hypericum perforatum, Juncus articulatus, Leontodon autumnalis, Lindernia dubia, Lycopus europaeus, Lythrum salicaria, Mentha aquatica, Myosoton aquaticum, Myosotis palustris, Oenothera* spp., *Panicum capillare, Phalaroides arundinacea, Plantago lanceolata, Polygonum aviculare, Polygonum hydropiper, Polygonum lapathifolium, Polygonum minus, Polygonum persicaria, Populus alba, Populus nigra, Ranunculus repens, Robinia pseudo-acacia, Rorippa islandica, Rorippa palustris, Rorippa sylvestris, Rumex* cf. *conglomeratus, Salix alba, Salix fragilis, Salix purpurea, Salix viminalis, Scrophularia umbrosa, Scutellaria galericulata, Solanum* *dulcamara, Solidago gigantea, Sonchus oleraceus, Stachys palustris, Taraxacum palustre, Typha latifolia, Urtica dioica, Veronica beccabunga.*

**Phytocoenological relevés**: Date: 15.08.2007., Plot size: 4 m$^2$, ΣE1: 25%, Height E1: 70 cm, Σ organic debris: 0.1%, Σ sand: 60%, Σ gravel: 15%, Cover abundance scale: "Braun-Blanquet old". E1: *Carex bohemica*: 1, *Phalaroides arundinacea*: 2, *Polygonum hydropiper*: 2, *Rorippa palustris*: 2, *Agrostis stolonifera*: 1, *Epilobium tetrapterum*: 1, *Urtica dioica*: 1, *Conyza canadensis*: +, *Leontodon autumnalis*: +, *Polygonum lapathifolium*: +, *Salix purpurea*: +, *Solidago gigantea*: +, *Sonchus oleraceus*: r, *Cyperus glomeratus*: r, *Scrophularia umbrosa*: r, *Salix alba*: r, *Salix viminalis*: r, *Taraxacum palustre*: r. Made by János Csiky and Dragica Purger.

**Causes of endangerment**: river regulation, gravel pits.

**Invasive plant species at the site:** *Aster* spp., *Amorpha fruticosa, Bidens frondosus*, *Chenopodium ambrosoides*, *Conyza canadensis*, *Erigeron annuus*, *Lindernia dubia*, *Oenothera* spp., *Panicum capillare*, *Robinia pseudo-acacia*, *Solidago gigantea*. The river dynamics is so fast in these habitats (annual dwarf sedge vegetation along river bed) that neither of the invasive species mentioned above can completely occupy bare wet surfaces. Mud or silt is the most essential abiotic condition for the existence of *Nanocyperion* plants.

**Sampling methods and data**: Only one flowering individual (polycormon) was found in the stand; max. length of stand: 0.15 m, max. width of stand: 0.15 m; max. length of habitat: 200 m, max., width of habitat: 15 m.

**Photographs**: +.

**Comments**: Other Croatian red list species at the site: *Cyperus fuscus* (VU), *Cyperus glomeratus* (VU), *Scrophularia umbrosa* (DD). *Carex bohemica* is also rare in Hungary. Up to the present, we have known only two actual Hungarian occurrences of this species from the Drava valley.

**2nd site**

**Date:** 16.08.2007.

**Location**: Between Legrad and Ferdinandovac (X 5660070.68, Y 5112684.13, 119.5 m a.s.l.).

**Habitat**: Bare surfaces of river gravel and sand banks, amphibious communities (*Isoëto-Nanojuncetea*, incl. *Nanocyperion*); *Polygono-Eleocharitetum ovatae* Eggler 1933: *Agrostis stolonifera, Alisma plantago-aquatica, Ambrosia artemisiifolia, Artemisia vulgaris, Berula erecta, Bidens frondosus, Calamagrostis pseudophragmites, Calystegia sepium, Carex bohemica, Carex hirta, Chenopodium album, Chenopodium ambrosoides, Chenopodium ficifolium, Chrysanthemum leucanthemum, Conyza canadensis, Cyperus fuscus, Cyperus glomeratus, Digitaria sanguinalis, Echinocystis lobata, Epilobium tetragonum, Eragrostis pilosa, Festuca arundinacea, Galium palustre, Hypericum tetrapterum, Juncus articulatus, Lindernia dubia, Lycopus europaeus, Lythrum salicaria, Mentha aquatica, Myosotis palustris, Oenothera* spp., *Panicum capillare, Phalaroides arundinacea, Plantago lanceolata, Poa compressa, Polygonum hydropiper, Polygonum lapathifolium, Polygonum persicaria, Populus nigra, Portulacca oleracea, Ranunculus repens, Rorippa palustris, Rorippa sylvestris, Rumex* spp., *Salix alba, Salix cinerea, Salix purpurea, Salix viminalis, Setaria viridis, Solanum dulcamara, Solanum nigrum, Solidago gigantea, Sonchus oleraceus, Symphytum officinale, Taraxacum palustre, Tunica saxifraga, Typha latifolia, Urtica dioica, Veronica beccabunga, Veronica catenata, Xanthium* spp.

**Phytocoenological relevés**: Date: 16.08.2007., Plot size: 4 $m^2$, ΣE1: 40%, Height E1: 70 cm, Σ sand: 10%, Σ gravel: 40%, Cover abundance scale: "Braun-Blanquet old". E1: *Carex bohemica*: +, *Ambrosia artemisiifolia*: 2, *Phalaroides arundinacea*: 2, *Polygonum hydropiper*: 2, *Agrostis stolonifera*: 1, *Cyperus glomeratus*: 1, *Juncus articulatus*: 1, *Rorippa palustris*: 1, *Salix purpurea*: 1, *Solidago gigantea*: 1, *Conyza canadensis*: r, *Cyperus fuscus*: r, *Poa compressa*: r. Made by János Csiky and Dragica Purger.
**Causes of endangerment**: river regulation, gravel pits.
**Invasive plant species at the site:** *Ambrosia artemisiifolia, Bidens frondosus, Chenopodium ambrosoides, Conyza canadensis, Echinocystis lobata, Oenothera* spp., *Panicum capillare, Solanum nigrum, Solidago gigantea, Xanthium* spp.
**Sampling methods and data**: Only one flowering individual (polycormon) was found in the stand; max. length of stand: 0.15 m, max. width of stand: 0.15 m; max. length of habitat: 300 m, max., width of habitat: 25 m.
**Photographs**: -.
**Comments**: Other Croatian red list species at the site: *Chenopodium ficifolium* (DD), *Cyperus fuscus* (VU), *Cyperus glomeratus* (VU).

Fig. 2. *Carex bohemica* (Photo by János Csiky)

3. *Carex vesicaria* L.

**Croatian Red List status**: VU.

**International status**: -.

**1st site**

**Date**: 09.06.2007.

**Location:** Repaš (X 5660705.30, Y 5111734.65, 136 m).

**Habitat**: Tussock sedge communities (*Caricetum elatae* Koch 1926) (Fig. 3.): *Alnus glutinosa, Cardamine pratensis, Carex acutiformis, Carex elata, Carex flacca, Carex vesicaria, Ceratophyllum demersum, Equisetum palustre, Frangula alnus, Galium uliginosum, Gratiola officinalis, Iris pseudacorus, Juncus effusus, Leucojum aestivum, Lysimachia vulgaris, Lythrum salicaria, Oenanthe aquatica, Populus nigra, Potamogeton natans, Quercus robur, Salix alba, Salix fragilis, Salix purpurea, Scirpus sylvaticus, Spirodela polyrhiza, Stachys palustris, Succisella inflexa, Symphytum officinale, Utricularia vulgaris, Valeriana officinalis, Viburnum opulus.*

**Phytocoenological relevés**: Date: 09.06.2007., Plot size: 25 $m^2$, ΣE: 80%, ΣE1: 80%, ΣE0: 10%, Height E1: 90 cm, Height E0: 5 cm, Σ organic debris: 20%, Cover abundance scale: "Braun-Blanquet old". E1: *Carex vesicaria*: +, *Carex elata*: 3, *Succisella inflexa*: 2, *Carex acutiformis*: 1, *Leucojum aestivum*: 1, *Cardamine pratensis*: +, *Galium uliginosum*: +, *Lysimchia vulgaris*: +, *Lythrum salicaria*: +, *Symphytum officinale*: +, *Equisetum palustre*: r, *Gratiola officinalis*: r, *Stachys palustris*: r. Made by János Csiky and Dragica Purger.

**Causes of endangerment at the site**: -.

**Invasive plant species at the site: -**.

**Sampling methods and data**: The size of the population was estimated on the basis of sampling; 10 polycormons were counted in the stand; max. length of stand: 15 m, max. width of stand: 10 m; max. length of habitat: 20 m, max., width of habitat: 10 m.

**Photographs**: +.

**Comments**: Other Croatian red list species at the site: *Galium uliginosum* (CR). *Galium uliginosum* is not rare on the Hungarian part of the Drava Plain.

**2nd site**

**Date**: 09.06.2007.

**Location**: Repaš (X 5660849.58, Y 5111854.89).

**Habitat**: Tussock sedge communities (*Caricetum elatae* Koch 1926), riverine willow-poplar forests (*Leucojo-Salicetum albae* Kevey in Borhidi & Kevey 1996); *Agrostis stolonifera, Caltha palustris, Cardamine pratensis, Carex elata, Carex vesicaria, Galium palustre, Iris pseudacorus, Lemna minor, Lemna trisulca, Lythrum salicaria, Poa cf. palustris, Rorippa amphibia, Rorippa austriaca, Salix alba*, *Salix cinerea, Salix fragilis, Spirodela polyrhiza, Succisella inflexa, Utricularia vulgaris.*

**Phytocoenological relevés**: -.

**Causes of endangerment at the site**: -.

**Invasive plant species at the site:** -.

**Sampling methods and data**: 15 polycormons of this species were counted in the stand; max. length of stand: 50 m, max. width of stand: 40 m; max. length of habitat: 100 m, max. width of habitat: 40 m.

**Photographs**: -.

**Comments**: Other Croatian red list species at the site: *Poa cf. palustris* (NT).

Fig. 3. Stand of *Carex vesicaria* (Photo by Dragica Purger)

## 4. *Catabrosa aquatica* (L.) P.B.

**Croatian Red List status**: CR.
International status: IUCN II: E.
**1st site**
**Date:** 12.05.2007.
**Location**: Baranja (Fig. 4.): Kotlina (X 5791470.07, Y 5077921.13).
**Habitat**: shallow marshes (Fig. 5.): *Alisma plantago-aquatica*, *Berula erecta*, *Bidens tripartita*, *Calystegia sepium*, *Catabrosa aquatica*, *Epilobium hirsutum*, *Glyceria plicata* (syn.: *Glyceria notata*), *Lemna minor*, *Lycopus europaeus*, *Lythrum salicaria*, *Mentha aquatica*, *Phalaroides arundinacea*, *Phragmites australis*, *Poa trivialis*, *Ranunculus repens*, *Ranunculus sceleratus*, *Sparganium erectum*, *Symphytum officinale*, *Typha latifolia*, *Veronica anagallis-aquatica*.
**Phytocoenological relevés**: *Glycerio notatae-Catabrosetum aquaticae* Borhidi 2001, Date: 12.05.2007., Cover abundance scale: ”Braun-Blanquet old”, Relevés taken by János Csiky (Table 1.).

Table 1. Phytocoenological relevés of *Glycerio notatae-Catabrosetum aquaticae* Borhidi 2001 made in Baranja, Croatia

| **Data** | **1.** | **2.** | **3.** | **4.** | **5.** | **6.** |
|---|---|---|---|---|---|---|
| Quadrate size ($m^2$) | 10 | 10 | 10 | 10 | 10 | 10 |
| Cover **E1** layer (%) | 99 | 99 | 100 | 100 | 99 | 100 |
| Height **E1** layer (cm) | 120 | 140 | 200 | 160 | 200 | 300 |
| Cover open water (%) | 1 | 0.5 | 0.1 | 0.1 | 1 | 1 |
| Depht of water (cm) | 10 | 20 | 20 | 10 | 10 | 20 |
| **Species** | | | | | | |
| *Catabrosa aquatica* | 5 | 4 | 5 | 5 | 4 | 4 |
| *Glyceria plicata* | 1 | 2 | - | - | 2 | - |
| *Poa trivialis* | 2 | 2 | 1 | 2 | + | r |
| *Ranunculus repens* | - | + | + | + | - | - |
| *Lycopus europaeus* | + | + | - | r | - | + |
| *Symphytum officinale* | - | 2 | + | + | - | - |
| *Berula erecta* | - | 2 | - | 1 | + | 2 |
| *Phalaroides arundinacea* | - | 1 | - | - | - | - |
| *Lythrum salicaria* | 1 | 1 | + | r | + | r |
| *Sparganium erectum* | 2 | 2 | - | - | 2 | - |
| *Alisma plantago-aquatica* | + | + | + | r | r | r |
| *Bidens tripartita* | r | - | - | - | - | - |
| *Lemna minor* | 1 | - | - | - | - | |
| *Veronica anagallis-aquatica* | + | - | - | - | - | - |
| *Calystegia sepium* | - | r | - | - | - | r |
| *Ranunculus sceleratus* | - | - | + | - | r | - |
| *Typha latifolia* | - | 1 | + | 2 | 1 | - |
| *Epilobium hirsutum* | - | 1 | 1 | r | r | - |
| *Mentha aquatica* | - | - | - | r | 2 | - |
| *Phragmites australis* | - | - | - | - | 5 | - |

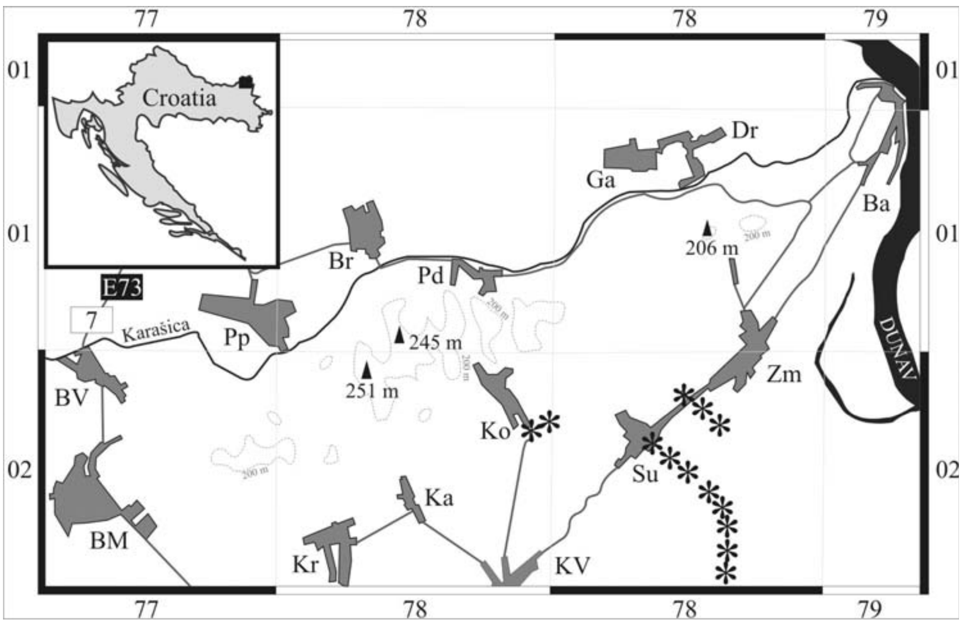


Fig. 4. Distribution of *Catabrosa aquatica* (black asterisks) in Bansko Hill. Abbreviations: **Ko** - Kotlina, **Su** - Suza, **Zm** - Zmajevac

**Causes of endangerment**: drought, siltation or drastic dredging.
**Invasive plant species at the site: -.**
**Sampling methods and data**: Population estimation was done on the basis of samples: 50 stem/ $m^2$ were counted; very dense polycormons continuously spread in the stand; max. length of stand: 200 m, max. width of stand: 2 m; max. length of habitat: 200 m, max. width of habitat: 2 m.
**Photographs**: +.
**Comments**: Other Croatian red list species at the site: *Glyceria plicata* (VU). *Glyceria plicata* and *Catabrosa aquatica* usually grow together in the same habitat, in the shallow streams in the colline region (Croatia, Hungary). In the plains *Catabrosa* becomes rare, while *G. plicata* is replaced by another red list species, *G. fluitans* (VU).

Fig. 5. Stand of *Catabrosa aquatica* (Photo by János Csiky)

**2nd site**
**Date:** 13.05.2007.
**Location**: Baranja: Suza (X 5794043.68, Y 5077651.89).
**Habitat**: shallow marshes (*Oenanthetalia aquaticae*); (*Glycerio notatae-Catabrosetum aquaticae* Borhidi 2001):
*Catabrosa aquatica, Lycopus europaeus, Poa trivialis, Ranunculus repens, Ranunculus sceleratus, Rumex conglomeratus, Veronica anagallis-aquatica.*
**Phytocoenological relevés**: *Glycerio notatae-Catabrosetum aquaticae* Borhidi 2001, Date: 13.05.2007., Plot size: 10 $m^2$, ΣE: 99%, ΣE1: 99%, Height E1: 80 cm, Σ open water: 1%, Depht of water: 20 cm, Cover abundance scale: "Braun-Blanquet old". E1: *Catabrosa aquatica*: 5, *Ranunculus repens*: 2, *Veronica anagallis-aquatica*: 2, *Lycopus europaeus*: 1, *Poa trivialis*: 1, *Ranunculus sceleratus*: 1, *Rumex conglomeratus*: +. Made by János Csiky.
**Causes of endangerment**: drought, siltation or drastic dredging.
**Invasive plant species at the site:** We did not find any in these two sites, but we observed *Reynoutria* x *bohemica* populations not far from here, between Suza and Zmajevac. In that site, *Catabrosa* is really endangered by *Reynoutria*. South from Suza we recorded some other invasive taxa in the *Catabrosa* stands, like *Erigeron annuus*, *Solidago gigantea*.
**Sampling methods and data**: Population estimation was done on the basis of samples: 25 stem/ $m^2$ were counted; max. length of stand: 50 m, max. width of stand: 2m; max. length of habitat: 300 m, max. width of habitat: 2 m.
**Photographs**: +.
**Comments**: -.

## 5. *Cyperus glomeratus* L.

**Croatian Red List status**: VU.
**International status**: -.
**1st site**
**Date:** 15.08.2007.
**Location**: From Legrad to Ferdinandovac (X 5651438.98, Y 5122442.08).
**Habitat**: Bare surfaces of river gravel and sand banks, amphibious communities (*Isoëto-Nanojuncetea*, incl. *Nanocyperion*); (*Polygono-Eleocharitetum ovatae* Eggler 1933):
*Alisma plantago-aquatica, Amaranthus* spp., *Ambrosia artemisiifolia, Anagallis arvensis, Anagallis foemina, Berula erecta, Bidens frondosus, Centaurium pulchellum, Chenopodium ambrosoides, Chenopodium ficifolium, Cyperus fuscus, Cyperus glomeratus* (Fig. 6.), *Eragrostis minor, Galium palustre, Glechoma hederacea, Hypericum tetrapterum, Juncus articulatus, Limosella aquatica, Lindernia dubia, Lycopus europaeus, Lythrum salicaria, Mentha aquatica, Myosotis palustris, Panicum capillare, Phalaroides arundinacea, Plantago major, Polygonum minus, Polygonum persicaria, Populus alba, Populus nigra, Portulacca oleracea, Potentilla supina, Prunella vulgaris, Pulicaria dysenterica, Ranunculus repens, Ranunculus sceleratus, Rorippa palustris, Rorippa sylvestris, Rumex* spp., *Salix purpurea, Salix viminalis, Scirpus triqueter, Scrophularia umbrosa, Senecio vulgaris, Solanum nigrum, Sonchus oleraceus, Symphytum officinale, Trifolium repens, Typha latifolia, Urtica dioica, Verbena officinalis, Veronica anagalloides, Veronica beccabunga, Veronica catenata.*
**Phytocoenological relevés**: -.

**Causes of endangerment**: river regulation, gravel pits.
**Invasive plant species at the site:** *Ambrosia artemisiifolia, Bidens frondosus, Chenopodium ambrosoides, Lindernia dubia, Panicum capillare, Senecio vulgaris, Solanum nigrum.*
**Sampling methods and data**: Estimation of numbers was done on the basis of counting in sampling quadrates (1 $m^2$) and estimating density: population consists of approximately 200 individuals; max. length of stand: 25 m, max. width of stand: 3 m; max. length of habitat: 200 m, max. width of habitat: 50 m.
**Photographs**: +.
**Comments**: Other Croatian red list species at the site: *Chenopodium ficifolium* (DD)*, Cyperus fuscus* (VU)*, Limosella aquatica* (CR)*, Scrophularia umbrosa* (DD).

Fig. 6. *Cyperus glomeratus* (Photo by Jenő J. Purger)

**2nd site**
**Date:** 15.08.2007.
**Location**: Virovski Crnec (X 5671357.18, Y 5107868.35).
**Habitat**: Bare surfaces of river gravel and sand banks, amphibious communities (*Isoëto-Nanojuncetea*, incl. *Nanocyperion*); (*Polygono-Eleocharitetum ovatae* Eggler 1933):
*Acer negundo, Agrostis stolonifera, Alisma plantago-aquatica, Amaranthus retroflexus, Ambrosia artemisiifolia, Amorpha fruticosa, Aster* cf. x *lanceolatus, Berula erecta, Bidens frondosus, Bidens tripartita, Calamagrostis epigeios, Calamagrostis pseudophragmites, Chenopodium album, Chenopodium ambrosoides, Conyza canadensis, Cyperus fuscus, Cyperus glomeratus, Dactylis glomerata, Digitaria sanguinalis, Echinochloa crus-galli, Eleocharis acicularis, Eleocharis palustris, Epilobium tetragonum, Eragrostis pilosa, Festuca arundinacea, Galium mollugo, Galium palustre, Glechoma hederacea, Hypochoeris radicata, Iris pseudacorus, Juncus articulatus, Juncus effusus, Juncus*

*inflexus, Leersia oryzoides, Leontodon autumnalis, Lindernia dubia, Lycopus europaeus, Lythrum salicaria, Mentha aquatica, Myosoton aquaticum, Myosotis palustris, Myriophyllum verticillatum, Oenanthe aquatica, Oenothera* spp.*, Oxalis* spp., *Panicum capillare, Phalaroides arundinacea, Plantago major, Polygonum aviculare, Polygonum hydropiper, Polygonum lapathifolium, Polygonum minus, Polygonum persicaria, Populus alba, Populus nigra, Portulacca oleracea, Potentilla reptans, Ranunculus repens, Ranunculus sardous, Rorippa palustris, Rorippa sylvestris, Rumex hydrolapathum, Rumex* spp., *Salix fragilis, Salix purpurea, Salix viminalis, Scirpus triqueter, Scrophularia umbrosa, Setaria viridis, Solanum dulcamara, Solidago gigantea, Sonchus oleraceus, Tagetes patulus, Typha latifolia, Urtica dioica, Verbascum* spp., *Veronica beccabunga, Veronica catenata.*
**Phytocoenological relevés**: -.
**Causes of endangerment**: river regulation, gravel pits.
**Invasive plant species at the site:** *Acer negundo, Ambrosia artemisiifolia, Amorpha fruticosa, Aster* cf. x *lanceolatus, Bidens frondosus, Chenopodium ambrosoides, Conyza canadensis, Lindernia dubia, Oenothera* spp.*, Oxalis* spp., *Panicum capillare, Solidago gigantea.*
**Sampling methods and data**: Estimation of numbers was done on the basis of counting in sampling quadrates (1 $m^2$) and estimating density: population consists of approximately 150 individuals; max. length of stand: 50 m, max. width of stand: 3 m; max. length of habitat: 200 m, max. width of habitat: 30 m.
**Photographs**: +.
**Comments**: Other Croatian red list species at the site: *Cyperus fuscus* (VU)*, Leersia oryzoides* (NT)*, Scrophularia umbrosa* (DD).

## 6. *Equisetum hyemale* L.

**Croatian Red List status**: VU.
**International status**: -.
**1st site**
**Date:** 09.06.2007.
**Location**: Repaš, not far from the bridge (X 5660453.74, Y 5111340.69).
**Habitat:** Bare surfaces of river gravel and sand banks, riverine willow-poplar forest (*Leucojo-Salicetum albae* Kevey in Borhidi & Kevey 1996) (Fig. 7.).
**Phytocoenological relevés**: -.
**Causes of endangerment**: -.
**Invasive plant species at the site:** *Solidago gigantea*.
**Sampling methods and data**: Estimation of cover (P2): population covers 5% of stand; max. length of stand: 100 m, max. width of stand: 20 m; max. length of habitat: 200 m, max. width of habitat: 30 m.
**Photographs**: +.
**Comments**: populations of *Equisetum hyemale* are recorded in several places. One of the largest populations is near Ferdinandovac.

Fig. 7. *Equisetum hyemale* (Photo by Dragica Purger)

## 7. *Glyceria fluitans* (L.) R. Br.

**Croatian Red List status**: VU.
**International status**: -.
**1st site**
**Date:** 02.06.2007.
**Location**: Martinci Miholjački (X 5726954.69, Y 5074623.22, 95 m a.s.l.).
**Habitat**: Marsh in shallow channel (Fig. 8.), with slow-moving water (*Nasturtio-Glyceretalia*); (*Agrostio-Glycerietum* Magyar ex Soó 1933; *Glycerietum fluitantis* Eggler 1933): *Acorus calamus, Agrostis stolonifera, Alisma plantago-aquatica, Alopecurus aequalis, Batrachium trichophyllum, Carex hirta, Centaurium pulchellum, Cyperus fuscus, Echinochloa crus-galli, Epilobium hirsutum, Equisetum palustre, Glyceria fluitans* (Fig. 9.)*, Juncus articulatus, Juncus compressus, Leersia oryzoides, Lysimachia nummularia, Mentha aquatica, Mentha pulegium, Myosotis palustris, Oenanthe aquatica, Phalaroides arundinacea, Plantago major, Poa trivialis, Polygonum amphibium, Polygonum mite, Potentilla anserina, Ranunculus repens, Ranunculus sceleratus, Rorippa sylvestris, Rumex conglomeratus, Sparganium erectum, Trifolium hybridum, Veronica anagalloides*.
**Phytocoenological relevés**: *Glycerietum fluitantis* Eggler 1933, Date: 02.06.2007., Plot size: 30 m$^2$, ΣE: 95%, ΣE1: 95%, Height E1: 120 cm, Σ open mud: 5%, Σ open water: 0.1%, Depht of water: 1 cm, Cover abundance scale: ”Braun-Blanquet old”. E1: *Glyceria fluitans*: 5, *Agrostis stolonifera*: 2, *Alopecurus aequalis*: 2, *Oenanthe aquatica*: 1, *Batrachium trichophyllum*: +, *Echinochloa crus-galli*: +, *Juncus articulatus*: +, *Lysimachia nummularia*: +, *Mentha aquatica*: +, *Mentha pulegium*: +, *Myosotis palustris*:

+, *Ranunculus sceleratus*: +, *Rorippa sylvestris*: +, *Rumex conglomeratus*: +, *Trifolium hybridum*: +, *Cyperus fuscus*: r, *Plantago major*: r, *Veronica anagalloides*: r. Made by János Csiky and Dragica Purger.

**Causes of endangerment**: siltation or drastic dredging.

**Invasive plant species at the site: -.**

**Sampling methods and data**: Estimation of population was done on the basis of samples: 5-50 stem/ $m^2$ were counted; very dense, almost continuous carpet of the species spread in the stand, max. length of stand: 200 m, max. width of stand: 5 m, max. length of habitat: 500 m, max. width of habitat: 5 m.

**Photographs**: +.

**Comments**: Other Croatian red list species at the site: *Alopecurus aequalis* (VU), *Cyperus fuscus* (VU), *Leersia oryzoides* (NT). This type of habitat is widespread in the plain. In the deepest area of the ponds, channels, ditches *Glyceria fluitans* occurs together with other marshland and *Nanocyperion* species. The survival of such ”pond vegetation” depends on continuous grazing (trampled base and mud), shallow (stagnant or slow-flowing) freshwater on periodically flooded pastures and meadows.

**2nd site**

**Date**: 02.06.2007.

**Location**: Podravska Moslavina: Kneja (X 5729990.50, Y 5073485.51).

**Habitat**: higrophylous meadow: *Ajuga genevensis, Alisma lanceolatum, Athyrium filix-femina, Barbarea vulgaris, Bidens tripartita, Brachypodium sylvaticum, Campanula patula, Cardamine pratensis, Carex remota, Carex strigosa, Cerastium sylvaticum, Circaea lutetiana, Deschampsia caespitosa, Euphorbia palustris, Fraxinus angustifolia, Galium palustre, Geranium robertianum, Glyceria fluitans, Hypericum tetrapterum, Juncus effusus, Lapsana communis, Lychnis flos-cucculi, Lycopus europaeus, Lysimachia nummularia, Myosotis palustris, Poa* cf. *palustris, Polygonum hydropiper, Prunella vulgaris, Pulicaria dysenterica, Rubus caesius*.

**Phytocoenological relevés**: -.

**Causes of endangerment**: inadequate forest road and forest maintenence or drastic dredging.

**Invasive plant species at the site: -.**

**Sampling methods and data**: Counts of polycormons were made: 30 polycormons occurred in the stand, max. length of stand: 50 m, max. width of stand: 3 m, max. length of habitat: 500 m, max. width of habitat: 3 m.

**Photographs**: -.

**Comments**: Other Croatian red list species at the site: *Carex strigosa* (DD), *Poa* cf. *palustris* (NT). This species usually occurs in/near ponds and puddles of roads in forests of the plain. Normally, the maintenance of these roads is essential for *Glyceria fluitans* (for the control of succesion), but drastic (inadequate) interventions or treatments can destroy the habitat.

Fig. 8. *Glyceria fluitans* (Photo by Dragica Purger)

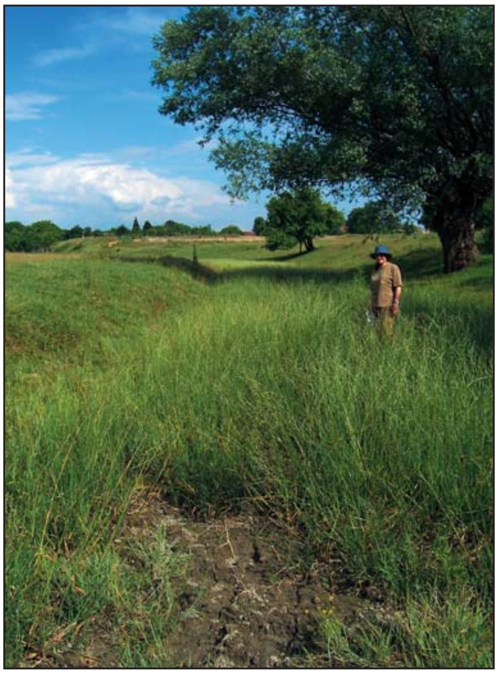

Fig. 9. Stand of *Glyceria fluitans* (Photo by János Csiky)

## 8. *Hottonia palustris* L.

**Croatian Red List status**: EN.
**International status**: -.
**1st site**
**Date:** 13.05.2007.
**Location**: Glibina, between Novi Gradac and Rušani (X 5698862, Y 5088182).
**Habitat**: Rooted submerged and floating vegetation.
**Phytocoenological relevés**: -.
**Causes of endangerment**: drainage, pollution.
**Invasive plant species at the site:** -.
**Sampling methods and data**: The population of *Hottonia palustris* (Fig. 10.), was estimated at 500 individuals in the ditch, max. length of stand: 25 m, max. width of stand: 1.5 m; max. length of habitat: 100 m, max. width of habitat: 3 m.
**Photographs**: +.
**Comments**: The bottom of the oxbow is owergrown by *Phragmites australis*. On the deeper parts there is vegetation of submerged and floating plants. There are also fragments of alluvial willow and poplar forests in the surroundings.

Fig. 10. *Hottonia palustris* (Photo by Jenő J. Purger)

## 9. *Iris pumila* L.

**Croatian Red List status**: ”CR” (see comments).
**International status**: -.
**1st site**
**Date:** 16.04.2007.
**Location**: Zmajevac (X 5797057.03, Y 5081222.59).
**Habitat**: Sub-continental open dry grassland (Fig. 11.): *Agropyron cristatum* subsp. *pectinatum, Artemisia campestris, Convolvulus arvensis, Erodium ciconium, Euphorbia helioscopia, Fumaria schleicheri, Holosteum umbellatum, Iris pumila, Muscari racemosum, Onopordum acanthium, Reseda inodora, Sedum maximum, Setaria verticillata, Sisymbrium orientale, Veronica arvensis, Veronica hederifolia*.
**Phytocoenological relevés**: (see PURGER et al. 2008).
**Causes of endangerment**: invasion of *Robinia pseudo-acacia*, landslip.
**Invasive plant species at the site: -**.
**Sampling methods and data**: The population consists of a single polycormon, estimated at 50 individuals; max. length of stand: 2 m, max. width of stand: 1 m; max. length of habitat: 40 m, max. width of habitat: 20 m.
**Photographs**: +.
**Comments**: Other Croatian red list species at the site: *Agropyron cristatum* subsp. *pectiniforme* (CR)*, Reseda inodora*. *Iris pumila* as well as *Reseda inodora* are new plant species of the Croatian flora suggested to be treated as a ”CR” (critically endangered) species in Croatia (CSIKY et al. 2008; PURGER et al. 2008).

Fig. 11. Stand of *Iris pumila* (Photo by János Csiky)

10. *Leucojum aestivum* L.
**Croatian Red List status**: NT.
**International status**: -.
**1st site**
**Date:** 09.06.2007.
**Location**: Repaš (X 5660849.58, Y 5111854.89, 136 m a.s.l.).
**Habitat**: Tussock sedge community (*Caricetum elatae*): *Alnus glutinosa, Cardamine pratensis, Carex acutiformis, Carex elata, Carex flacca, Carex vesicaria, Equisetum palustre, Frangula alnus, Galium uliginosum, Gratiola officinalis, Iris pseudacorus, Juncus effusus, Leucojum aestivum* (Fig. 12.), *Lysimachia vulgaris, Lythrum salicaria, Oenanthe aquatica, Populus nigra, Quercus robur, Salix alba, Salix fragilis, Salix purpurea, Scirpus sylvaticus, Stachys palustris, Succisella inflexa, Symphytum officinale, Valeriana officinalis, Viburnum opulus*.
**Phytocoenological relevés**: Date: 09.06.2007., Plot size: 25 m$^2$, ΣE: 80%, ΣE1: 80%, ΣE0: 10%, Height E1: 90 cm, Height E0: 5 cm, Σ organic debris: 20%, Cover abundance scale: "Braun-Blanquet old". E1: *Carex vesicaria*: +, *Carex elata*: 3, *Succisella inflexa*: 2, *Carex acutiformis*: 1, *Leucojum aestivum*: 1, *Cardamine pratensis*: +, *Galium uliginosum*: +, *Lysimachia vulgaris*: +, *Lythrum salicaria*: +, *Symphytum officinale*: +, *Equisetum palustre*: r, *Gratiola officinalis*: r, *Stachys palustris*: r. Made by János Csiky, Dragica Purger and Zsuzsanna Mócsi-Csiky.
**Causes of endangerment**: -.
**Invasive plant species at the site: -.**
**Sampling methods and data**: The population is estimated on 500 individuals on the basis of sampling on quadrates: 8 individuals / m$^2$; max. length of stand: 15 m, max. width of stand: 10 m, max. length of habitat: 20 m, max. width of habitat: 10 m.
**Photographs**: +.
**Comments**: Other Croatian red list species at the site: *Carex vesicaria* (VU), *Galium uliginosum* (CR).
**2nd site**
**Date:** 09.06.2007.
**Location**: Molve (X 5660056.05, Y 5108560.53, 124 m a.s.l.).
**Habitat**: higrophilous meadow (*Cirsio cani-Festucetum pratensis* Majovsky & Ružičkova 1975): *Betonica officinalis, Briza media, Campanula patula, Carex cuprina, Carex hirta, Carex melanostachya, Carex pallescens, Carex paniculata, Carex riparia, Cirsium canum, Clinopodium vulgare, Corylus avellana, Lychnis flos-cucculi, Festuca pratensis, Festuca rupicola, Frangula alnus, Galium mollugo, Galium palustre, Galium verum, Gratiola officinalis, Holcus lanatus, Iris pseudacorus, Leontodon autumnalis, Leontodon hispidus, Leucojum aestivum, Lotus tenuis, Lysimachia vulgaris, Lythrum salicaria, Moenchia mantica, Ononis spinosa, Ophioglossum vulgatum, Potentilla reptans, Quercus robur, Ranunculus acris, Ranunculus flammula, Rhamnus cathartica, Salix cinerea, Salix fragilis, Sambucus nigra, Scrophularia scopolii, Succisella inflexa, Thrincia nudicaulis* (syn.: *Leontodon taraxacoides* (Vill.) Mérat).
**Phytocoenological relevés**: -.
**Causes of endangerment**: drainage, ploughing.
**Invasive plant species at the site: -.**
**Sampling methods and data**: The population is estimated at 100 individuals on the basis

of sampling on quadrates; max. length of stand: 50 m, max. width of stand: 50 m, in the stand, max. length of habitat: 300 m, max. width of habitat: 100 m.
**Photographs**: +.
**Comments**: Other Croatian red list species at the site: *Ophioglossum vulgatum* (NT). *Thrincia nudicaulis* and *Scrophularia scopolii* are rare species in Croatia.

Fig. 12. *Leucojum aestivum* (Photo by Jenő J. Purger)

## 11. *Limosella aquatica* L.

**Croatian Red List status**: CR (DD).
**International status**: -.
**1st site**
**Date:** 15.08.2007.
**Location**: From Legrad and Ferdinandovac (X 5651438.98, Y 5122442.08, 128.1 m a.s.l.).
**Habitat**: Amphibious communities on river gravel and sand banks (*Polygono-Eleocharitetum ovatae* Eggler 1933) (Fig. 13.): *Alisma plantago-aquatica, Amaranthus spp., Ambrosia artemisiifolia, Anagallis arvensis, Anagallis foemina, Berula erecta, Bidens frondosus, Centaurium pulchellum, Chenopodium ambrosoides, Chenopodium ficifolium, Cyperus fuscus, Cyperus glomeratus, Eragrostis minor, Galium palustre, Glechoma hederacea, Hypericum tetrapterum, Juncus articulatus, Limosella aquatica, Lindernia dubia, Lycopus europaeus, Lythrum salicaria, Mentha aquatica, Myosotis palustris, Panicum capillare, Phalaroides arundinacea, Plantago major, Polygonum minus, Polygonum persicaria, Populus alba, Populus nigra, Portulacca oleracea, Potentilla supina, Prunella vulgaris, Pulicaria dysenterica, Ranunculus repens,*

*Ranunculus sceleratus, Rorippa palustris, Rorippa sylvestris, Rumex spp., Salix purpurea, Salix viminalis, Scirpus triqueter, Scrophularia umbrosa, Senecio vulgaris, Solanum nigrum, Sonchus oleraceus, Symphytum officinale, Trifolium repens, Typha latifolia, Urtica dioica, Verbena officinalis, Veronica anagalloides, Veronica beccabunga, Veronica catenata*.

**Phytocoenological relevés**: -.

**Causes of endangerment**: river regulation, gravel pits.

**Invasive plant species at the site:** *Ambrosia artemisiifolia, Bidens frondosus, Chenopodium ambrosoides, Lindernia dubia, Panicum capillare, Solanum nigrum.*

**Sampling methods and data**: A population of 10 individuals was counted in the stand; max. length of stand: 5 m, max. width of stand: 5 m; max. length of habitat: 200 m, max. width of habitat: 50 m.

**Photographs**: +.

**Comments**: Other Croatian red list species at the site: *Chenopodium ficifolium* (DD), *Cyperus fuscus* (VU), *Cyperus glomeratus* (VU), *Scrophularia umbrosa* (DD).

Fig. 13. Stand of *Limosella aquatica* (Photo by János Csiky)

## 12. *Listera ovata* (L.) R. Br.

**Croatian Red List status**: -.
**International status**:
**1st site**
**Date**: 09.06.2007.
**Location**: Repaš (X 5660669.23, Y 5111674.54, 87 m a.s.l.).
**Habitat**: *Fraxino-Ulmetum* woodland verges: *Carex brizoides, Listera ovata* (Fig. 14.), *Quercus robur, Ulmus laevis, Viburnum opulus*.
**Phytocoenological relevés**: -.
**Causes of endangerment**: small actual population size.
**Invasive plant species at the site: -.**
**Sampling methods and data**: Only one sterile individual was found; max. length of stand: 0,1 m, max. width of stand: 0,1 m, max. length of habitat: 500 m, max. width of habitat: 5 m;
**Photographs**: +.
**Comments**: Other Croatian red list species at the site: -.

Fig. 14. *Listera ovata* (Photo by Dragica Purger)

**2nd site**
**Date:** 01.04.2007.
**Location**: Haljevo (X 5782562.07, Y 5070996.86, 90 m a.s.l.).
**Habitat**: Oak-Hornbeam forest: *Anemone ranunculoides, Asperula odorata, Carpinus betulus, Cerasus avium, Corydalis cava, Lamium maculatum, Listera ovata, Lonicera caprifolium, Paris quadrifolia, Polygonatum multiflorum, P. latifolium, Quercus robur,*

*Ranunculus auricomus, Scilla bifolia* agg.*, Tilia tomentosa, Viola sylvestris.*
**Phytocoenological relevés**: -.
**Causes of endangerment**: intensive forest management.
**Invasive plant species at the site: -.**
**Sampling methods and data**: Five individuals in bud were counted in the stand; max. length of stand: 100 m, max. width of stand: 20 m; max. length of habitat: 1000 m, max. width of habitat: 200 m.
**Photographs**: +.
**Comments**: -.

## 13. *Myricaria germanica* (L.) Desv.

**Croatian Red List status**: CR.
**International status**: -.
**1st site**
**Date:** 15.08.2007.
**Location**: Legrad (X 5645428.27, Y 5129668.48, 132 m a.s.l.).
**Habitat**: Amphibious communities on river gravel and sand banks (Fig. 15.), riverine willow scrub: *Agrostis stolonifera, Amaranthus retroflexus, Ambrosia artemisiifolia, Amorpha fruticosa, Arrhenatherum elatior, Bidens tripartita, Bidens frondosus, Artemisia vulgaris, Carex hirta, Conyza canadensis, Chenopodium album, Chenopodium ambrosoides, Cyperus fuscus Dactylis glomerata, Digitaria sanguinalis, Erigeron annuus, Festuca arundinacea, Hypericum tetrapterum, Lepidium* spp., *Lotus corniculatus, Lythrum salicaria, Medicago lupulina, Mentha aquatica, Myosotis palustris, Myricaria germanica, Oenothera* spp., *Phalaroides arundinacea, Plantago lanceolata, Plantago major, Poa compressa, Polygonum hydropiper, Polygonum mite, Polygonum persicaria, Populus nigra, Potentilla reptans, Ranunculus repens, Robinia pseudo-acacia, Rorippa palustris, Rorippa sylvestris, Rumex* spp., *Salix alba, Salix fragilis, Salix purpurea, Salix viminalis, Saponaria officinalis, Setaria viridis, Silene vulgaris, Solanum dulcamara, Solidago gigantea, Sonchus oleraceus, Stachys palustris, Stellaria media, Symphytum officinale, Taraxacum palustre, Tunica saxifraga, Urtica dioica, Verbena officinalis, Veronica* cf. *persica, Xanthium* spp.
**Phytocoenological relevés**: -.
**Invasive plant species at the site:** *Ambrosia artemisiifolia, Amorpha fruticosa, Bidens frondosus, Conyza canadensis, Chenopodium ambrosoides, Erigeron annuus, Lepidium* spp., *Oenothera* spp., *Robinia pseudo-acacia, Solidago gigantea, Veronica* cf. *persica, Xanthium* spp.
**Causes of endangerment**: river regulation, gravel pits.
**Sampling methods and data**: 45 flowering individuals were counted in the stand; max. length of stand: 30 m, max. width of stand: 3 m; max. length of habitat: 70 m, max. width of habitat: 20 m.
**Photographs**: +.
**Comments**: Other Croatian red list species at the site: *Cyperus fuscus* (VU).

Fig. 15. Stand of *Myricaria germanica* (Photo by János Csiky)

## 14. *Ophrys sphegodes* Mill.

**Croatian Red List status**: VU.
**International status**: CITES II.
**1st site**
**Date:** 12.05.2007.
**Location**: Gotalovo, near bridge on Drava river (X 5650269.27, Y 5123565.47).
**Habitat**: meadow on embankment along road (Fig. 16.).
**Phytocoenological relevés**: -.
**Causes of endangerment**: change of meadow managements (cessation, alteration of cutting regimes), ploughing.
**Invasive plant species at the site:** *Solidago gigantea*.
**Sampling methods and data**: 120 flowering individuals were counted in the stand; max. length of stand: 150 m, max. width of stand: 5 m; max. length of habitat: 200 m, max. width of habitat: 10 m.
**Photographs**: +.
**Comments**: -.
**2nd site**
**Date:** 12.05.2007.
**Location**: Zmajevac (X 5795965.91, Y 5080189.95, 116 m a.s.l.).
**Habitat**: meadow: *Achillea collina, B. perfoliata* (L.) Huds. *subsp. serotina* (Koch ex Rchb.) Vollm., *Calamagrostis epigeios, Carex distans, Carex hirta, Carlina vulgaris, Chrysanthemum leucanthemum, Cynodon dactylon, Dactylis glomerata, Daucus carota, Euphorbia cyparissias, Festuca pratensis, Festuca rubra, Festuca rupicola, Leontodon*

*hispidus, Lotus corniculatus, Medicago lupulina, Ononis spinosa, Ophrys sphegodes, Pimpinella saxifraga, Poa angustifolia, Polygala comosa, Prunella vulgaris, Scabiosa ochroleuca, Senecio jacobaea, Seseli varium* (syn.: *S. pallasii* Besser), *Thesium ramosum* (*T. arvense* Horv.), *Tragopogon orientalis, Trifolium montanum*.

**Phytocoenological relevés**: Date: 12. 05. 2007., Plot size: 16 m$^2$, ΣE: 90%, ΣE1: 60%, ΣE0: 30%, Height E1: 60 cm, Height E0: 1 cm, Σ organic debris: 1%, Σ loess: 9%, Cover abundance scale: ”Braun-Blanquet old”. E1: *Ophrys sphegodes*: r, *Polygala comosa*: 3, *Cynodon dactylon*: 2, *Leontodon hispidus*: 2, *Ononis spinosa*: 2, *Calamagrostis epigeios*: 1, *Dactylis glomerata*: 1, *Festuca pratensis*: 1, *Festuca rupicola*: 1, *Lotus corniculatus*: 1, *Pimpinella saxifraga*: 1, *Prunella vulgaris*: 1, *Scabiosa ochroleuca*: 1, *Thesium arvense*: 1, *Achillea collina*: +, *Blackstonia perfoliata* subsp. *serotina*: +, *Carex distans*: +, *Carex hirta*: +, *Daucus carota*: +, *Festuca rubra*: +, *Medicago lupulina*: +, *Poa angustifolia*: +, *Senecio jacobaea*: +, *Tragopogon orientalis*: +, *Chrysanthemum leucanthemum*: r, *Carlina vulgaris*: r, *Euphorbia cyparissias*: +, *Seseli varium*: r, *Trifolium montanum*: r. Made by János Csiky.

**Causes of endangerment**: -.

**Invasive plant species at the site: -**.

**Sampling methods and data**: 7 flowering individuals were counted in the stand; max. length of stand: 20 m, max. width of stand: 10 m; max. length of habitat: 40 m, max. width of habitat: 30 m.

**Photographs**: +.

**Comments**: Other Croatian red list species at the site: *Blackstonia perfoliata* subsp. *serotina* (EN). *Thesium ramosum* and *Seseli varium* are not very well known and rare species in Croatia.

Fig. 16. Meadow in the Drava floodplain, an important orchid site
(Photo by Jenő J. Purger)

## 15. *Orchis militaris* L.

**Croatian Red List status**: VU.
**International status**: CITES II.
**1st site**
**Date:** 02.06.2007.
**Location**: Martinci Miholjački (X 5727195.10, Y 5074648.51, 92 m a.s.l.).
**Habitat**: pasture, meadow (*Bromo-Cynosuretum cristati* H-ić 1930): *Achillea collina, Agrostis stolonifera, Agrymonia eupatoria, Anthoxanthum odoratum, Bellis perennis, Bothriochloa ischaemum, Briza media, Bromus commutatus* (syn.: *B. racemosus* L. subsp. *commutatus* (Schrad.) Maire et Weiler)*, Carex caryophyllea, Carex distans, Carlina vulgaris, Cerastium fontanum, Colchicum autumnale, Cruciata pedemontana, Cynodon dactylon, Cynosurus cristatus, Daucus carota, Equisetum ramosissimum, Erigeron annuus, Euphorbia cyparissias, Euphorbia platyphyllos, Festuca pratensis, Festuca rubra, Festuca rupicola, Galium verum, Linum catharticum, Lolium perenne, Lotus tenuis, Luzula campestris, Lysimachia nummularia, Medicago lupulina, Ononis arvensis, Orchis militaris, Plantago lanceolata, Ranunculus acris, Ranunculus repens, Ranunculus sardous, Salix purpurea, Scherardia arvensis, Thrincia nudicaulis, Trifolium campestre, Trifolium dubium, Trifolium pratense, Trifolium repens, Trisetum flavescens, Viola canina.*
**Phytocoenological relevés**: -.
**Causes of endangerment**: -.
**Invasive plant species at the site:** *Erigeron annuus.*
**Sampling methods and data**: 1 flowering individual was found in the stand; max. length of stand: 0.1 m, max. width of stand: 0.1 m; max. length of habitat: 300 m, max. width of habitat: 100 m.
**Photographs**: +.
**Comments**: Other Croatian red list species at the site: *Bromus commutatus* (DD). There are other interesting species (e.g. *Thrincia nudicaulis),* which are rare in Croatia. A small abandoned sand pit, situated in the middle of the pasture, is a potential habitat of *Plantago indica* (similar cases are known on the left side of the Drava, in Hungary). Spring and summer were rather dry in 2007 which conditions were not the best for *Orchis militaris*, thus we hope that this population is actually larger.
**2nd site**
**Date:** 12.05.2007.
**Location**: near bridge on Drava river (X 5650353.43, Y 5123625.59).
**Habitat**: meadow (Fig. 16) (*Bromo-Cynosuretum cristati* H-ić 1930):
*Brachypodium silvaticum, Arrhenatherum elatius.*
**Phytocoenological relevés**: -.
**Causes of endangerment**: change in management of meadow, plaughing.
**Invasive plant species at the site:** *Solidago gigantea.*
**Sampling methods and data**: 15 flowering individuals were counted in the stand; max. length of stand: 50 m, max. width of stand: 30 m; max. length of habitat: 200 m, max. width of habitat: 100 m.
**Photographs**: +.
**Comments**: At the same locality, in a similar habitat, a large population of *Ophrys sphegodes* was surveyed.

## 16. *Plantago indica* L.

**Croatian Red List status**: CR.
**International status**: -.

Fig. 17. *Plantago indica* (Photo by Dragica Purger)

**1st site**
**Date:** 02.06.2007.
**Location**: Viljevo – Podravska Moslavina (X 5734537.51, Y 5073986.71, 105 m a.s.l.).
**Habitat**: Pannonian open sandy grasslands, secondary annual sand grasslands (*Brometum tectorum* Bojko 1934): *Achillea collina, Agropyron repens, Allium* cf. *oleraceum, Apera spica-venti, Arenaria serpyllifolia, Bothriochloa ischaemum, Bromus tectorum, Carduus acanthoides, Carex hirta, Carex praecox, Centaurea micranthos, Centaurea cyanus, Chondrilla juncea, Chrysanthemum leucanthemum, Conyza canadensis, Cynodon dactylon, Erigeron annuus, Erodium cicutarium, Euphorbia cyparissias, Festuca rupicola, Galium mollugo, Galium verum, Koeleria cristata, Lathyrus hirsutus, Linaria genistifolia, Malva alcea, Medicago minima, Melilotus albus, Papaver rhoeas, Picris hieracioides, Plantago indica* (Fig. 17.), *Poa bulbosa, Poa compressa, Potentilla argentea* agg., *Trifolium arvense, Tunica prolifera* (syn.: *Petrorhagia prolifera* (L.) Ball et Heyw.), *Tunica saxifraga* (syn.: *Petrorhagia saxifraga* (L.) Link), *Verbascum phoeniceum, Vicia grandiflora, Vicia hirsuta, Viola arvensis*.
**Phytocoenological relevés**: -.
**Causes of endangerment**: tree plantation, spontaneous expansion of *Robinia pseudo-acacia* from the neighbouring plantation.
**Invasive plant species at the site:** *Conyza canadensis, Erigeron annuus.*
**Sampling methods and data**: 30 individuals of *Plantago indica* in bud were counted; max. length of stand: 1.5 m, max. width of stand: 1 m, max. length of habitat: 30 m, max. width of habitat: 5 m.

**Photographs**: +.
**Comments**: Other Croatian red list species at the site: *Carex praecox* (NT). *Plantago indica* is strictly protected in Croatia, but on the left side of the Drava in Hungary it is neither rare nor protected.

## 17. *Primula vulgaris* Huds.

**Croatian Red List status**: -.
**International status**: -.
**1st site**
**Date**: 02.06.2007.
**Location**: Podravska Moslavina: Kneja (X 5729990.50, Y 5073485.51).
**Habitat**: Oak-hornbeam forest: *Acer campestre, Acer tataricum, Ajuga reptans, Arum maculatum, Carex divulsa, Carex spicata, Carex sylvatica, Carpinus betulus, Cornus sanguinea, Corylus avellana, Crataegus monogyna, Crataegus oxyacantha, Dactylis glomerata* agg.*, Dryopteris filix-mas, Euonymus europaeus, Fragaria vesca, Frangula alnus, Galium aparine, Galium odoratum, Geum urbanum, Hedera helix, Hypericum hirsutum, Knautia drymeia, Ligustrum vulgare, Melampyrum nemorosum, Polygonatum multiflorum, Primula vulgaris, Pulmonaria officinalis, Quercus robur, Rosa arvensis, Rosa canina* agg.*, Rumex sanguineus, Sanicula europaea, Scrophularia nodosa, Symphytum tuberosum, Ulmus minor, Veronica chamaedrys, Veronica montana, Viburnum opulus, Viola alba, Viola sylvestris*.
**Phytocoenological relevés**: -.
**Causes of endangerment**: intensive forest management.
**Invasive plant species at the site:** We did not find any of them at the site, but in some gaps, along forest roads, *Solidago gigantea* is widespread and abundant.
**Sampling methods and data**: The population was estimatied at 100 individuals / stand; max. length of stand: 250 m, max. width of stand: 250 m, max. length of habitat: 500 m, max. width of habitat: 500 m.
**Photographs**: -.
**Comments**: Not at the site, but in the same wood, other interesting or red list species were found like *Carex strigosa* (DD), *Glyceria fluitans* (VU), *Poa* cf. *palustris* (NT), *Dryopteris affinis, D. carthusiana, Veronica montana, Rosa arvensis, Neottia nidus-avis, Tamus communis*. In the edge of the forest, some rare species survived, like *Viola montana*, *Rosa gallica, Pulmonaria mollis, Genista ovata subsp. nervata, Peucedanum carvifolia etc*.
**2nd site**
**Date:** 01.04.2007.
**Location**: Haljevo forest (X 5782562.07, Y 5070996.86).
**Habitat**: Oak-Hornbeam forest (*Carpino betuli-Quercetum robori quercetosum cerris* Rauš 1969)*: Ajuga reptans, Alliaria petiolata, Anemone ranunculoides, Arum maculatum* agg.*, Galium odoratum, Carex divulsa, Carex strigosa, Carex sylvatica, Carpinus betulus, Cerasus avium, Corydalis cava, Cornus sanguinea, Corylus avellana, Crataegus monogyna, Dentaria bulbifera, Euonymus europaeus, Hedera helix, Ligustrum vulgare, Lonicera caprifolium, Polygonatum latifolium, Primula vulgaris* (Fig. 18.), *Rosa arvensis, Sancula europaea, Scilla bifolia* agg.*, Veronica montana, Viola sylvestris* etc.
**Phytocoenological relevés**: -.
**Causes of endangerment**: intensive forest management.

**Invasive plant species at the site: -.**
**Sampling methods and data**: The population was estimated at 80 individuals on the basis of estimation of density; max. length of stand: 300 m, max. width of stand: 100 m, max. length of habitat: 1000 m, max. width of habitat: 500 m.
**Photographs**: +.
**Comments**: -.

Fig. 18. *Primula vulgaris* (Photo by Dragica Purger)

## 18. *Reseda inodora* Rchb.

**Croatian Red List status**: ”CR” (see comments).
**International status**: -.
**1st site**
**Date:** 16.04.2007.
**Location**: Zmajevac (X 5797057.03, Y 5081222.59).
**Habitat**: Sub-continental dry grassland (Fig. 19.): *Agropyron cristatum* subsp. *pectinatum* (CR), *Artemisia campestris, Convolvulus arvensis, Erodium ciconium, Euphorbia helioscopia, Fumaria schleicheri, Holosteum umbellatum, Iris pumila, Lappula squarrosa, Muscari racemosum, Onopordum acanthium, Reseda inodora, Sedum maximum, Setaria verticillata, Sisymbrium orientale, Veronica arvensis, Veronica hederifolia*.
**Phytocoenological relevés**: Date: 16.04.2007., Plot size: 4 $m^2$, Aspect (degrees): 165, Slope (degrees): 65, ΣE: 70%, ΣE1: 70%, ΣE0: 1%, Height E1: 110 cm, Height E0: 7 mm, Σ organic debris: 5%, Σ bare loess: 25%, Cover abundance scale: ”Braun-Blanquet old”. E1: *Reseda inodora*: r, *Iris pumila*: 3, *Agropyron cristatum* subsp. *pectinatum*: 2, *Artemisia campestris*: 2, *Erodium ciconium*: 2, *Sedum maximum*: 2, *Sisymbrium orientale*: 2, *Setaria*

*verticillata*: 1, *Veronica hederifolia*: 1, *Fumaria schleicherii*: +, *Onopordum acanthium*: +, *Convolvulus arvensis*: r, *Euphorbia helioscopia*: r, *Holosteum umbellatum*: r, *Muscari neglectum*: r, *Veronica arvensis*: r. Made by János Csiky.
**Causes of endangerment**: invasion of *Robinia pseudo-acacia* or *Ailanthus altissima*, opening new loess excavations.
**Invasive plant species at the site:** Not at the site, but very close to it, large populations of *Ailanthus altissima* and *Robinia pseudo-acacia* endanger this population.
**Sampling methods and data**: 4 stems were counted / stand; max. length of stand: 10 m, max. width of stand: 10 m, max. length of habitat: 40 m, max. width of habitat: 20 m.
**Photographs**: +.
**Comments**: Other Croatian red list species at the site: *Agropyron cristatum* subsp. *pectinatum* (CR). *Reseda inodora*, as well as *Iris pumila* is a new plant species of the Croatian flora, and suggested to be treated as as ”CR” (critically endangered) species in Croatia (CSIKY et al. 2008; PURGER et al. 2008).

Fig. 19. Habitat of *Reseda inodora* (Photo by János Csiky)

**2nd site**
**Date:** 16.04.2007.
**Location**: Zmajevac (X 5797134.18, Y 5081264.07).
**Habitat**: Sub-continental dry grassland: *Agropyron cristatum* subsp. *pectinatum, Artemisia campestris, Ballota nigra, Chenopodium album, Erodium cicutarium, Euphorbia helioscopia, Lappula squarrosa, Papaver dubium, Reseda inodora, Robinia pseudo-acacia, Sisymbrium orientale*.
**Phytocoenological relevés**: (see CSIKY et al. 2008).
**Causes of endangerment**: The invasion of *Robinia pseudo-acacia* or *Ailanthus altissima*, opening new loess excavations.

**Invasive plant species at the site:** *Robinia pseudo-acacia.*
**Sampling methods and data**: 3 stems were counted / stand; max. length of stand: 5 m, max. width of stand: 2 m, max. length of habitat: 40 m, max. width of habitat: 20 m.
**Photographs**: +.
**Comments**: Other Croatian red list species at the site: *Agropyron cristatum* subsp. *pectinatum* (CR). *Reseda inodora*, as well as *Iris pumila* is a new plant species of the Croatian flora. There were no data about their status earlier: CSIKY et al. (2008) and PURGER et al. (2008) suggested that they should be treated as a "CR" (critically endangered) species in Croatia.

## 19. *Scirpus triqueter* L.

**Croatian Red List status**: -.
**International status**: -.
**1st site**
**Date:** 15.08.2007.
**Location**: From Legrad and Ferdinandovac (X 5651438.98, Y 5122442.08, 128.1 m a.s.l.).
**Habitat**: Bare surfaces on river gravel and sand banks, amphibious communities (*Isoëto-Nanojuncetea*, incl. *Nanocyperion*); (*Polygono-Eleocharitetum ovatae* Eggler 1933):
*Alisma plantago-aquatica, Amaranthus* spp., *Ambrosia artemisiifolia, Anagallis arvensis, Anagallis foemina, Berula erecta, Bidens frondosus, Centaurium pulchellum, Chenopodium ambrosoides, Chenopodium ficifolium, Cyperus fuscus, Cyperus glomeratus, Eragrostis minor, Galium palustre, Glechoma hederacea, Hypericum tetrapterum, Juncus articulatus, Limosella aquatica, Lindernia dubia, Lycopus europaeus, Lythrum salicaria, Mentha aquatica, Myosotis palustris, Panicum capillare, Phalaroides arundinacea, Plantago major, Polygonum minus, Polygonum persicaria, Populus alba, Populus nigra, Portulacca oleracea, Potentilla supina, Prunella vulgaris, Pulicaria dysenterica, Ranunculus repens, Ranunculus sceleratus, Rorippa palustris, Rorippa sylvestris, Rumex spp., Salix purpurea, Salix viminalis, Scirpus triqueter* (Fig. 20.), *Scrophularia umbrosa, Senecio vulgaris, Solanum nigrum, Sonchus oleraceus, Symphytum officinale, Trifolium repens, Typha latifolia, Urtica dioica, Verbena officinalis, Veronica anagalloides, Veronica beccabunga, Veronica catenata*.
**Phytocoenological relevés**: -.
**Causes of endangerment**: river regulation, gravel pits.
**Invasive plant species at the site:** *Ambrosia artemisiifolia, Bidens frondosus, Chenopodium ambrosoides, Lindernia dubia, Panicum capillare, Senecio vulgaris, Solanum nigrum.*
**Sampling methods and data**: 10 individuals were counted; max. length of stand: 0.5 m, max. width of stand: 0.5 m, max. length of habitat: 200 m, max. width of habitat: 50 m.
**Photographs**: -.
**Comments**: Other Croatian red list species at the site: *Chenopodium ficifolium* (DD), *Cyperus fuscus* (VU), *Cyperus glomeratus* (VU), *Limosella aquatica* (CR), *Scrophularia umbrosa* (DD).

Fig. 20. *Scirpus triqueter* (Photo by Jenő J. Purger)

**2nd site**
**Date:** 16.08.2007.
**Location**: Virovski Crnec (X 5666392.21, Y 5109726.78, 110 m a.s.l.).
**Habitat**: Bare surfaces on river gravel and sand banks, amphibious communities (*Isoëto-Nanojuncetea*, incl. *Nanocyperion*); (*Polygono-Eleocharitetum ovatae* Eggler 1933):
*Acer negundo, Agrostis stolonifera, Alisma plantago-aquatica, Amaranthus retroflexus, Ambrosia artemisiifolia, Amorpha fruticosa, Aster* cf. x *lanceolatus, Berula erecta, Bidens frondosus, Bidens tripartita, Calamagrostis epigeios, Calamagrostis pseudophragmites, Chenopodium album, Chenopodium ambrosoides, Conyza canadensis, Cyperus fuscus, Cyperus glomeratus, Dactylis glomerata, Digitaria sanguinalis, Echinochloa crus-galli, Eleocharis acicularis, Eleocharis palustris, Epilobium tetragonum, Eragrostis pilosa, Festuca arundinacea, Galium mollugo, Galium palustre, Glechoma hederacea, Hypochoeris radicata, Iris pseudacorus, Juncus articulatus, Juncus effusus, Juncus inflexus, Leersia oryzoides, Leontodon autumnalis, Lindernia dubia, Lycopus europaeus, Lythrum salicaria, Mentha aquatica, Myosoton aquaticum, Myosotis palustris, Myriophyllum verticillatum, Oenanthe aquatica, Oenothera* spp., *Oxalis* spp., *Panicum capillare, Phalaroides arundinacea, Plantago major, Polygonum aviculare, Polygonum hydropiper, Polygonum lapathifolium, Polygonum minus, Polygonum persicaria, Populus alba, Populus nigra, Portulacca oleracea, Potentilla reptans, Ranunculus repens, Ranunculus sardous, Rorippa palustris, Rorippa sylvestris, Rumex hydrolapathum, Rumex* spp., *Salix fragilis, Salix purpurea, Salix viminalis, Scirpus triqueter, Scrophularia umbrosa, Setaria viridis, Solanum dulcamara, Solidago gigantea, Sonchus oleraceus, Tagetes patulus, Typha latifolia, Urtica dioica, Verbascum* spp., *Veronica beccabunga, Veronica catenata*.

**Phytocoenological relevés**: -.
**Causes of endangerment**: river regulation, gravel pits.
**Invasive plant species at the site:** *Acer negundo, Ambrosia artemisiifolia, Amorpha fruticosa, Aster* cf. x *lanceolatus, Bidens frondosus, Chenopodium ambrosoides, Conyza canadensis, Lindernia dubia, Oenothera* spp*., Oxalis* spp., *Panicum capillare, Solidago gigantea.*
**Sampling methods and data**: 10 individuals were counted; max. length of stand: 0.5 m, max. width of stand: 0.5 m, max. length of habitat: 200 m, max. width of habitat: 30 m.
**Photographs**: +.
**Comments**: Other Croatian red list and rare species at the site: *Cyperus fuscus* (VU), *Cyperus glomeratus* (VU), *Leersia oryzoides* (NT), *Scrophularia umbrosa*.

## 20. *Trapa natans* L.

**Croatian Red List status**: NT.
**International status**: CORINE HD V, BC, IUCN.
**1st site**
**Date**: 02.06.2007.
**Location**: Donji Miholjac (X 5747511.21, Y 5074375.04, 93 m a.s.l.).
**Habitat**: Rooted submerged and floating vegetation (*Trapo–Nymphoidetum* Oberd. 1957) (Fig. 21.): *Alopecurus aequalis, Anagallis arvensis, Batrachium trichophyllum, Bidens frondosus, Butomus umbellatus, Chara spp., Chenopodium ficifolium, Chenopodium murale, Cyperus fuscus, Dichostylis micheliana, Echinochloa crus-galli, Echinocystis lobata, Elodea spp., Equisetum palustre, Juncus articulatus, Juncus bufonius, Lemna minor, Lindernia dubia, Lolium multiflorum, Lythrum salicaria, Mentha aquatica, Myosotis palustris, Myriophyllum spicatum, Myriophyllum verticillatum, Nymphoides peltata, Oenanthe aquatica, Poa trivialis, Polygonum lapathifolium, Ranunculus sceleratus, Riccia spp., Rorippa amphibia, Rorippa palustris, Salix fragilis, Salix purpurea, Trapa natans, Typha latifolia, Veronica anagalloides*.
**Phytocoenological relevés**: -.
**Causes of endangerment**: intensive management of fishpond management.
**Invasive plant species at the site:** *Bidens frondosus, Echinocystis lobata, Elodea spp., Lindernia dubia.*
**Sampling methods and data**: Population estimation was done on the basis of sampling on quadrates (0-20 stem/ 1 $m^2$); max. length of stand: 300 m, max. width of stand: 100 m, max. length of habitat: 2000 m, max. width of habitat: 200 m.
**Photographs**: +.
**Comments**: Other Croatian red list species at the site: *Alopecurus aequalis* (VU), *Butomus umbellatus* (NT), *Chenopodium ficifolium* (DD), *Chenopodium murale* (DD), *Cyperus fuscus* (VU), *Dichostylis micheliana* (VU).

Most of the sites are infected by invasive plants (e.g. *Solidago gigantea*, *Robinia pseudo-acacia*, *Amorpha fruticosa*, *Ailanthus altissima*, *Panicum capillare*, *Lindernia dubia*, *Chenopodium ambrosoides*, *Bidens frondosus*, *Conyza canadensis*, *Ambrosia artemisiifolia*), which are potential danger for valuable stands of natural vegetation in this region. Great attention should be paid to protect native plants and to prevent agressive invasion of aliens.

Fig. 21. Fishponds are habitats of *Trapa natans*, *Nymhoides peltata* and a high number of rare amphibious plants (Photo by Dragica Purger)

One of the important tasks of our survey in 2007 was to evaluate the study area from a botanical point of view, as a first step in the selection of areas worth being incuded in the European NATURA 2000 network. The following five areas have been evaluated:
1. The upper section of Drava river, from Legrad to Terezino Polje,
2. The middle section of Drava river, from Terezino Polje to Donji Miholjac
3. Bansko Hill
4. Haljevo forest
5. Kozarac-Koha (Čeminac) forest

In the five surveyed areas several NATURA 2000 habitat types were found, some of them having priority (*) in protection as important habitats for rare plants, butterflies, birds. etc. (RADOVIĆ et al. 2006, SCHNEIDER-JACOBY 2006):

2340* Pannonic inland dunes
3130 Oligotrophic to mesotrophic standing waters with *Isoëto-Nanojuncetea* vegetation
3240 Alpine rivers and their ligneous vegetation with *Salix elaeagnos*
3270 Rivers with muddy banks with *Chenopodion rubri* pp. and *Bidention* pp. vegetation
40A0* Sub-continental peri-pannonic shrubs
6210 Semi-natural dry grassland (Festuco-Brometalia)
6240* Sub-Pannonic stepic grasslands
6440 Alluvial meadows of river valleys of the *Cnidion dubii*
6510 Lowland hay meadows (*Alopecurus pratensis, Sanguisorba officinalis*)

91H0* Pannonic woods with *Quercus pubescens*
91F0 Riparian mixed forests of *Quercus robur, Ulmus laevis, Ulmus minor, Fraxinus excelsior, F. angustifolia, (Ulmenion minoris*)
92A0 *Salix alba* and *Populus alba* galleries

1. The upper section of Drava river from Legrad to Terezino Polje includes many small tributaries, oxbow lakes, ponds, gravel pits, riverine willow and poplar forests, *Salix alba* and *Populus alba* galleries as well as riparian mixed forests (e.g. pedunculate oak forest of Repaš). Ligneous vegetation with *Salix elaeagnos* is also an important NATURA 2000 habitat type here. The Drava in this section is very dynamic and changable: it forms gravel banks, bars and islands (Fig. 22.). These habitats are suitable for the monitoring of succession from pioneer, amphibious herb vegetation (muddy banks with *Chenopodion rubri* pp. and *Bidention* pp. vegetation and oligotrophic to mesotrophic standing waters with *Isoëto-Nanojuncetea* vegetation including rare species e.g. *Carex bohemica*, *Scirpus triqueter*) through shrubs (*Calamagrostis pseudophragmites*, *Myricaria germanica*, *Salix elaeagnos*) to riverine woods (*Equisetum hyemale*, *Leucojum aestivum*). Other botanical values in this area are rare plants like *Dryopteris carthusiana, Carex strigosa, Epipactis helleborine* agg. and *Peucedanum verticillare.* The latter is abundant at some places. Although *Chrysosplenium alternifolium* is not rare in the country, its occurrence in a riparian mixed forest *(Ulmenion minoris*) of Repaš is unusual in the region.

2. The middle section of Drava river from Terezino Polje to Donji Miholjac comprises sandbanks, sandbars and islands, bare eroded vertical riverbanks, oxbows, ponds. In the floodplains there are riverine forests, scattered meadows and pastures (Fig. 23.). Rivers with muddy banks with *Chenopodion rubri* pp. and *Bidention* pp. vegetation and oligotrophic to mesotrophic stagnant waters with *Isoëto-Nanojuncetea* vegetation (*Dichostylis micheliana*, *Lindernia procumbens*, *Lythrum portula*), rooted submerged and floating vegetation (*Trapa natans*, *Nymphoides peltata*) are endangered habitats in entire Europe, therefore they are important in the ecological network. Marshes (*Acorus calamus*, *Glyceria fluitans*, *Leersia oryzoides*) also add to the natural values of this area. Many rare plants can be found in the forests (*Veronica montana*, *Rosa gallica*, *Dryopteris affinis*, *Listera ovata*), lowland hay meadows (*Ophioglossum vulgatum*, *Ophrys sphegodes*, *Orchis militaris*) and Pannonic inland dunes (*Plantago indica*).

3. Bansko Hill is the last ”border fortress” of Pannonian loess flora in the south-western end of the Carpathian Basin (Purger & Csiky 2008). In this part of Croatia a lot of rare and red list species occur, although a great part of the area is a „culture-desert” now (ploughlands, vineyards, orchards, settlements etc.). Most of the semi-natural grasslands, forest fragments have survived on steep south-facing slopes (Fig. 24.). There are streams, meadows with valuable rare plants on the southern side of Bansko Hill. The protection of these arid, semi-arid and wetland sites is very important, because they are home for several threatened species and add to the biodiversity of Croatia. Sub-Pannonic steppic grasslands and semi-natural dry grasslands (*Festuco-Brometalia*) are habitats for *Agropyron cristatum* subsp. *pectinatum* (CR)*, Iris pumila* („CR”)*, Reseda inodora* („CR”)*, Arabis auriculata* DC. non Lam. („CR”)*, Vicia narbonensis* subsp. *serratiifolia* („CR”)*, Salvia nemorosa* (EN), *Xeranthemum annum* (EN)*, Carex praecox* (NT)*, Nonea pulla*

Fig. 22. Amphibious vegetation at upper section of river Drava
(Photo by Jenő J. Purger)

Fig. 23. Pastures along river Drava are very important habitats not only for plants, but also for birds and many other animal taxa. (Photo by János Csiky)

(DD), *Stipa capillata* (DD). Humid and dry semi-natural grasslands are important sites for orchids and other rare plants: *Ophrys sphegodes* (VU), *Blackstonia perfoliata* subsp. *serotina* (EN), *Thesium arvense, Seseli varium, Dianthus pontederae, Geranium rotundifolium, Ornithogalum sphaerocarpum, Avenula pubescens, Carex stenophylla etc.* Marshes are habitats for e.g. *Catabrosa auquatica* (CR), *Carex riparia* (VU), *Glyceria plicata* (VU), *Carex acutiformis* (NT). In the secondary and fragmented semi-natural forests of Bansko Hill *Polygonatum latifolium* (VU), *Euphorbia salicifolia, Iris variegata, Thalictrum aquilegifolium, Scilla bifolia* agg. grow. Rare weeds occur in the unploughed balk of turves, ridges, borderlands, arable fields, vineyards, like *Agrostemma githago, Erodium ciconium, Lathyrus aphaca* or *Legousia speculum-veneris.*

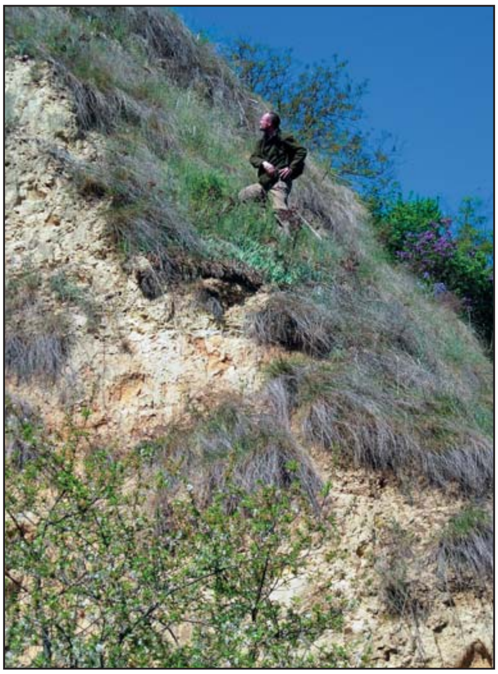

Fig. 24. Bansko Hill is an area with unique habitats of extreme importance for the biodiversity of Croatia (Photo by Dragica Purger).

4. Haljevo is an oak-hornbeam forest (Fig. 25.) with relict stands of beech, therefore a lot of montane and colline plants occur there (*Galanthus nivalis, Galeobdolon luteum, Isopyrum thalictroides, Lathraea squamaria*, *Salvia glutinosa, Scilla bifolia* agg., *Veronica montana*). Several plants with sub-Mediterranean distribution (*Asperula taurina*, *Carex strigosa*, *Lonicera caprifolium*, *Ruscus aculeatus*, *Scutellaria altissima, Tamus communis*, *Tilia tomentosa*) as well as protected and rare (*Dryopteris carthusiana, D. dilatata, Epipactis helleborine, Hesperis sylvestris* (Fig. 26.) plants grow in this forest. Populations of *Primula vulgaris* and *Listera ovata* in this forest are selected for monitoring. In some glades *Cardamine hirsuta* and *Carex strigosa* occur together.

Fig. 25. Haljevo forest (Photo by Dragica Purger)

5. The forest near Kozarac is also an oak-hornbeam forest where rare and valuable plants (*Acer tataricum, Carex strigosa*, *Dianthus armeria, Helleborus odorus, Lathyrus niger, Lonicera caprifolium, Neottia nidus-avis, Primula vulgaris, Ruscus aculeatus* (species listed in the NATURA 2000 list), *Scilla bifolia* agg., *Scutellaria altissima, Staphylea pinnata, Tamus communis* etc.) occur. This forest (Fig. 27.) is a hunting field with over-populated stock of game, therefore, the signes of degradation can be seen in several places. Despite that, the greatest part of this forest has good structure and species composition. It is very valuable from a botanical point of view, and is worth being protected.

The study area partly belongs to the Pannonian sector of the Central-Europaean floral province. In this transitory area the influence of the steppe region is visible in the presence of a number of plants with Pannonian and Pontic distribution, growing only in the north-eastern part of Croatia. These plants have a great importance in increasing the biodiversity of the country.

Fig. 26. *Hesperis sylvestris*, a rare plant of the Haljevo forest (Photo by Béla Tallósi)

Fig. 27. Kozarac forest (Photo by Dragica Purger)

# 5. Conclusion

During field work in 2007 we made records about 30 populations (sites) of 20 vascular plant species. These results can be used as basic references for the monitoring of plants and habitats on the Croatian side of the Drava as well as in the north-eastern part of Croatia. Several sites were pointed out with rare and threatened red list plants.

The riparian ecosystem includes great variety of habitats along the Drava. The most important habitats and plant species whose occurrence indicates great natural values of the study areas are the following:

**1. River banks** (shelf, shallow, riverbed, stagnant waters, fresh water)
a) [3270] River with muddy banks with *Chenopodion rubri* pp. and *Bidention* pp. and [3130] oligotrophic to mesotrophic stagnant waters with *Isoëto-Nanojuncetea* vegetation: *Carex bohemica* (CR), *Limosella aquatica* (CR), *Cyperus fuscus* (VU), *C. glomeratus* (VU), *Leersia oryzoides* (NT), *Poa palustris* (NT), *Scrophularia umbrosa* (DD), *Chenopodium ficifolium* (DD), *Scirpus triqueter*,
b) Marshes (incl. [92A0] *Salix alba* and *Populus alba* galleries), fresh and stagnant waters: *Galium uliginosum* (CR), *Carex riparia* (VU), *C. vesicaria* (VU), *Wolffia arrhiza* (VU), *Carex acutiformis* (NT), *C. buekii* (NT), *Nymphaea alba*, etc.

**2. Scrubs, woods**
a) [3240] Alpine rivers and their ligneous vegetation with *Salix elaeagnos*: *Myricaria germanica* (CR),
b) [92A0] *Salix alba* and *Populus alba* galleries, [91F0] riparian mixed forests (*Ulmion minoris*) and other oak woods in the plain: *Glyceria fluitans* (VU), *Carex acutiformis* (NT), *Poa palustris* (NT), *Carex strigosa* (DD), *Dryopteris carthusiana*, *D. affinis*, *Leucojum aestivum*, *Tamus communis* etc.,
c) Forest-steppe oak woods on loess hills: *Polygonatum latifolium* (VU), *Iris variegata, Thalictrum aquilegifolium* etc.

**3. Meadows, pastures** (incl. escarpments and excavations with semi-natural vegetation)
a) [6210] Semi-natural dry grasslands (*Festuco-Brometalia*): *Blackstonia perfoliata* subsp. *serotina* (EN), *Salvia nemorosa* (EN), *Ophrys sphegodes* (VU), *Orchis militaris* (VU), *C. praecox* (NT),
b) [6510] Lowland hay meadows: *Glyceria fluitans* (VU), *Ophrys sphegodes* (VU), *Orchis militaris* (VU), *Carex acutiformis* (NT), *Leersia oryzoides* (NT), *Ophioglossum vulgatum* (NT), *Bromus commutatus* (DD), *Acorus calamus*, *Leucojum aestivum*, *Scrophularia scopolii* etc.,
c) [2340*] Pannonic inland dunes: *Plantago indica* (CR).

**4. Non-forest vegetation of loess walls**
a) [6240*] Sub-Pannonic steppic grasslands: *Agropyron cristatum* subsp. *pectinatum* (CR), *Iris pumila* ("CR"), *Reseda inodora* ("CR"), *Arabis auriculata* Lam. ("CR"), *Vicia narbonensis* subsp. *serratiifolia* ("CR"), *Salvia nemorosa* (EN), *Xeranthemum annum* (EN), *Carex praecox* (NT), *Nonea pulla* (DD), *Stipa capillata* (DD).

**5. Ploughlands, fishponds**
a) [3270] River with muddy banks with *Chenopodion rubri* pp. and *Bidention* pp. and [3130] oligotrophic to mesotrophic stagnant waters with *Isoëto-Nanojuncetea* vegetation: *Cyperus fuscus* (VU), *Dichostylis micheliana* (VU), *Glyceria fluitans* (VU), *Lindernia procumbens* (VU), *Lythrum portula* (VU), *Butomus umbellatus* (NT), *Chenopodium*

*ficifolium* (DD), *Chenopodium murale* (DD),
b) Rooted submerged and floating vegetation: *Trapa natans* (NT), *Nymphoides peltata*, etc.

Our results suggest that the upper (from Legrad to Terezino Polje) and middle (from Terezino Polje to Donji Miholjac) sections of Drava river, together with Bansko Hill as well as Haljevo and Kozarac forests are extremely valuable areas from a botanical point of view, therefore these parts of Croatia are worth of NATURA 2000 protection.

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# Oak-hornbeam forests (*Circaeo-Carpinetum* BORHIDI 2003 em. KEVEY 2006b) of the floodplains of the Croatian Baranja

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**Abstract**: The phytosociological characteristics and syntaxonomy of the oak-hornbeam forests occurring in Baranja, NE-Croatia is presented in this paper. Results of the analyses based on 20 phytosociological relevés show that this association (*Circaeo-Carpinetum*) differs from the oak-hornbeam forests in the Great Plains occurring on gravely, sandy and loess substrates in several aspects. Being more influenced by ground water, its habitat is more mesophilous, and consequently the association is extrazonal. The species composition shows some similarity to hardwood gallery forests (*Alnion incanae*), whereas the presence of some species with sub-Mediterranean distribution makes this association somewhat related to the oak-hornbeam forests (*Asperulo taurinae-Carpinetum*) of Mecsek floral subdistrict (*Sopianicum*) in Hungary.

## 1. Introduction

The comparative coenological studies of oak-hornbeam forests had been planned by Balázs Kevey earlier (HORVÁT & KEVEY 1983, 1984; KEVEY 1984, 1996-1997, 1997a, 2006a, 2006b, 2007). As experience shows, these are the areas where the largest amount and most natural lowland oak-hornbeam forests are found. The present paper reports on the plant associations of oak-hornbeam forests in the Croatian Baranja region, based on 20 coenological relevés.

## 2. Material and methods

Surveys were made in two forests of Baranja: Beli Manastir, Haljevo forest (Fig. 1., 2.) and Kozarac (Kozarac-Koha or Čeminačka) forest. The survey of the oak-hornbeam stands in these forests was carried out using the traditional quadrate method of the Zürich-Montpellier phytosociological school (BECKING 1957; KEVEY et al. 2007), yielding a total of 20 coenological relevés.

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Fig. 1. Part of the Haljevo forest with dense shrub layer (Photo by Sándor Csete)

Fig. 2. Rare plants occur in the herb layer of the Haljevo forest (Photo by Sándor Csete)

The coenological tables were compiled and statistical calculations done (percentage of different syntaxa weithed by K% and percentage of different syntaxa based on A-D%, for character species) using the KEVEY and HIRMANN (2002) ”NS” computer program package. The calculations are specified in the papers by KEVEY (1993, 1997b, 2006a).

For species names we have followed the nomenclature used by HORVÁTH et al. (1995), whereas for associations the nomenclature suggested by BORHIDI and KEVEY (1996), and BORHIDI (2003) is accepted. The organisation of coenological and characteristic species tables are based on the coenological system of SOÓ (1980), modified according to the latest findings (OBERDORFER 1992; MUCINA et al. 1993; BORHIDI 2003; KEVEY 2006a). Also with syntaxonomic categorisation of species, we have used primarily the Synopsis by SOÓ (1964, 1966, 1968, 1970, 1973, 1980), but we have considered more recent research results as well (BORHIDI 1993, 1995; HORVÁTH et al. 1995; KEVEY 2006a).

## 3. Research history

It was only relatively recently that scientists took notice of oak-hornbeam forests of the Croatian Baranja region. First it was FEKETE and BLATTNY (1913) to report on a few lowland hornbeam habitats from the Drava region, including the location of Beli Manastir. However, the occurrence of this association could have been deduced from the flora lists presented by BOROS (1924) and HORVÁT (1939-1940). The first accurate mentions of oak-hornbeam forests appear in a study by HORVÁT (1942). Despite this, oak-hornbeam forests along Drava were still not indicated on the vegetation map by ZÓLYOMI (1968). The first 9 coenological records from the Ormánság region and the Harkány-Nagynyárád plain (Siklós, Borjád) were published by HORVÁT (1972). Taking notice of the tables presented by the former author, the potential vegetation indicated by JAKUCS (1974) for the more elevated parts of the Drava-plains was oak-hornbeam forests. Later it was HORVÁT and KEVEY (1983, 1984) who analysed the oak-hornbeam stands of the Ormánság region, based on a synthetic table compiled from 20 records. Later, ORTMANN-AJKAI (1998) published on 24 relevés from the forest block between Vajszló and Páprád (Ormánság). Most recently, KEVEY (2006b, 2007) produced two detailed studies on the oak-hornbeam stands of the Drava-plains (Somogy and Baranya counties), using 50-50 recordings.

## 4. Geobotanical and habitat characteristics

According to the climatic zonal map produced by BORHIDI (1961), the Baranya section of the left side plain along Drava is situated predominantly in the closed oakwood zone, whereas its eastern section is already part of the forest-steppe zone. The main reason for this is the decreasing precipitation gradient from the west towards the east and the increasing trend of complex continental effects. Although the Ormánság region belongs to the closed oakwood zone, arid oakwoods are absent from here, due to the relatively high water table. Towards the east, however, arid oakwoods do appear in patches in the Harkány-Nagynyárád plain, and this can be explained with the above mentioned climatic gradient. According to Kevey (2002), the flora of the Drava plains shows considerable changes towards the boundary between the closed forest and forest steppe zones introduced by a Borhidi (1961), this phenomenon being the reason for the same author to separate the *Dravense* floral subdistrict from the southern-plain region (*Titelicum* floral subdistrict), the former being made up by areas of the Drava plains in Baranya and Somogy, west of the region of Harkány. The lowland areas belonging to the forest steppe zone continue into the eastern part of Croatia including Baranja and the eastern part of the Sava plain. This is supported by the climatic charts by Rauš (1975), and Rauš et al. (1985) (Đakovo, Vinkovci, Spačva), showing a definite semi-dry period in the summer season. Besides, the double-peaked precipitation curve a definitely sub-Mediterranean feature is also typical of this lowland region (Rauš 1975; Rauš et al. 1985). This is the primary reason why several sub-Mediterranean floral elements are present in the studied forests (Horvát 1942b).

The studied forest stands are located at around 90-95 m above sea level. As this land is a perfect plain, exposure and relief do not play a role in forming this plant association. The bedrock is young alluvial deposition with loess and clay content (Horvát 1942b), on which brown forest soil has developed. In terms of average moisture content, the soil in these oak-hornbeam forests is mezophilous to subhidrophilous.

# 5. Results

Between mid-May and late June 2007 a total of 20 phytocoenological relevés were compiled from the forests of Beli Manastir and Kozarac (Table 1.). Below is the results yielded by the analysis of these surveys.

## 5.1. Physiognomy

The studied oak-hornbeam forests are 25-32 m tall, depending on their age, with medium or high coverage (70-85%) in the upper canopy. It is *Quercus robur* and *Carpinus betulus* that can form consolidations, but in some places *Tilia tomentosa* can also occur at higher rates. The lower canopy layer is quite variable in its density, with its height and coverage ranging between 18-22 m and from 20 to 60% respectively. It is made up primarily by tree specimens forced underneath the main stand in which *Carpinus betulus* can be abundant, but also *Acer campestre* and *Hedera helix* can be present in significant proportions. The shrub layer, too, has variable degree of density, this feature being associated mostly with forestry activities. Its height is 1.5-5 m, coverage 20-70%. It is made up predominantly by shrub-sized individuals of tree species of the upper canopy layer (*Acer campestre, Carpinus betulus, Tilia tomentosa*). Among shrubs, only *Cornus sanguinea* occur in greater amounts. The lower shrub layer (re-growth) has 3-70% coverage, with *Hedera helix* sometimes even being a facies forming species. Besides *Hedera*, saplings of certain tree species of the canopy can also reach relatively high coverage rates: *Acer campestre, Carpinus betulus, Quercus robur, Tilia tomentosa*.

Among these, the sometimes massive re-growth of *Quercus robur* is particularly suggesting that acorn production is excellent and the seeds have good germination ability. The coverage of the herb layer varies broadly with a range of 5-90%. In the summer aspect, *Carex pilosa, Galium odoratum* and *Vinca minor* can be facies forming species.

Table 1. Circaeo-Carpinetum

| Table 1/1. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | A-D | K | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Molinio-Juncetea** | | | | | | | | | | | | | | | | | | | | | | | | |
| *Deschampsia caespitosa* (Des,Sal,Ate,Ai) | C | - | - | + | - | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 10 |
| **Galio-Alliarion** | | | | | | | | | | | | | | | | | | | | | | | | |
| *Alliaria petiolata* (Epa) | C | + | + | - | - | + | - | + | + | + | - | + | - | - | + | - | + | + | + | + | + | + | IV | 65 |
| *Chaerophyllum temulum* | C | + | + | - | - | + | + | - | + | + | - | + | - | + | - | + | - | + | - | + | + | + | III | 60 |
| *Parietaria officinalis* (Cal,TA) | C | - | - | - | - | - | - | - | - | - | - | + | - | - | - | - | - | - | - | - | - | + | I | 5 |
| **Calystegion sepium** | | | | | | | | | | | | | | | | | | | | | | | | |
| *Lamium maculatum* (Agi,F,TA,Qpp) | C | + | + | 1 | 1 | 2 | + | 1 | + | + | + | 1 | - | + | + | 1 | - | + | - | - | + | +-2 | IV | 80 |
| *Carpesium abrotanoides* (Sal,Ulm) | C | - | - | - | - | - | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | + | I | 5 |
| **Salicion albae** | | | | | | | | | | | | | | | | | | | | | | | | |
| *Cucubalus baccifer* (Cal,Ulm) | C | - | - | - | - | + | - | - | - | + | - | - | - | - | - | + | - | - | - | - | - | + | I | 15 |
| **Querco-Fagetea** | | | | | | | | | | | | | | | | | | | | | | | | |
| *Acer campestre* (Qpp) | A1 | - | - | - | - | - | - | - | - | - | - | 1 | - | - | 1 | - | - | - | - | - | - | 1 | I | 10 |
| | A2 | - | 2 | - | - | + | + | - | + | - | + | 2 | 1 | + | 2 | 1 | + | + | 2 | 1 | 1 | +-2 | IV | 75 |
| | B1 | 1 | - | 1 | 1 | 2 | 2 | + | 2 | + | + | 2 | 2 | 1 | 2 | 1 | 2 | + | 2 | 2 | 2 | +-2 | V | 95 |
| | B2 | 1 | + | + | + | + | + | + | + | + | + | + | 1 | 1 | 1 | 1 | + | + | + | + | 1 | +-1 | V | 100 |
| | S | 2 | 2 | 1 | 1 | 2 | 2 | + | 2 | + | 1 | 3 | 2 | 2 | 3 | 2 | 2 | 1 | 3 | 2 | 2 | +-3 | V | 100 |
| *Ajuga reptans* (Qpp,MoA) | C | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | V | 100 |
| *Crataegus monogyna* (Qpp) | A2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | + | I | 5 |
| | B1 | + | 1 | + | + | + | - | + | + | + | - | + | + | + | + | 1 | + | 1 | + | + | + | +-1 | V | 90 |
| | B2 | + | + | - | + | + | + | - | - | + | + | + | + | + | + | + | + | + | + | + | + | + | V | 85 |
| | S | + | 1 | + | + | + | + | + | + | + | + | + | + | + | + | 1 | + | 1 | + | + | 1 | +-1 | V | 100 |
| *Geum urbanum* (Epa,Cp,Qpp) | C | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | V | 100 |
| *Quercus robur* (Ai,Cp,Qpp) | A1 | 4 | 5 | 1 | 2 | 4 | 4 | 3 | 3 | 5 | 2 | 3 | 4 | 4 | 4 | 4 | 4 | 5 | 4 | 4 | 4 | 1-5 | V | 100 |
| | B2 | + | 2 | + | - | + | + | + | + | 1 | + | 1 | + | + | + | + | - | 1 | 1 | + | 1 | +-2 | V | 90 |
| | S | 4 | 5 | 1 | 2 | 4 | 4 | 3 | 3 | 5 | 2 | 3 | 4 | 4 | 4 | 4 | 4 | 5 | 4 | 4 | 4 | 1-5 | V | 100 |
| *Ligustrum vulgare* (Cp,Qpp) | B1 | - | + | - | 2 | 1 | + | + | 1 | + | + | + | - | - | - | + | + | - | - | - | + | +-2 | III | 60 |
| | B2 | + | + | + | 2 | + | + | + | 1 | + | + | - | + | - | + | + | + | + | + | + | + | +-2 | V | 90 |
| | S | + | + | + | 3 | 1 | + | + | 2 | + | + | + | + | - | + | + | + | + | + | + | + | +-3 | V | 95 |
| *Brachypodium sylvaticum* (Qpp) | C | - | + | - | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | V | 90 |
| *Cornus sanguinea* (Qpp) | B1 | 2 | 1 | - | - | 1 | + | + | + | 1 | - | + | - | - | + | + | - | - | + | + | + | +-2 | IV | 65 |
| | B2 | + | + | + | + | + | + | + | - | + | - | - | + | + | + | - | - | - | - | + | - | + | III | 60 |
| | S | 2 | 1 | + | + | 1 | + | + | + | 1 | - | + | + | + | + | + | - | - | + | + | + | +-2 | V | 85 |
| *Euonymus europaea* (Qpp) | B1 | - | - | - | - | + | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 10 |
| | B2 | + | + | + | + | + | + | - | + | + | - | + | + | + | + | + | + | + | + | + | - | + | V | 85 |
| | S | + | + | + | + | + | + | - | + | + | - | + | + | + | + | + | + | + | + | + | - | + | V | 85 |
| *Ulmus minor* (Ai,Ulm,Qpp) | A2 | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | - | + | - | + | I | 15 |
| | B1 | + | + | + | + | + | + | - | - | + | - | + | - | - | + | - | - | + | + | + | + | + | IV | 65 |
| | B2 | + | + | + | - | + | + | + | - | + | + | 1 | - | + | + | - | + | + | + | + | + | +-1 | IV | 80 |
| | S | + | 1 | + | + | + | + | + | - | + | + | 1 | - | + | + | - | + | 1 | + | 1 | + | +-1 | V | 85 |
| *Viola alba* (Qpp) | C | - | + | + | + | - | + | + | + | - | + | - | + | + | + | + | + | + | + | + | + | + | IV | 80 |
| *Dactylis polygama* (Qpp,Cp) | C | + | + | - | + | + | - | + | + | - | + | + | + | + | + | + | + | + | - | + | - | + | IV | 75 |
| *Geranium robertianum* (Epa,F) | C | + | + | - | + | + | + | + | + | + | - | + | + | - | + | + | - | + | + | + | - | + | IV | 75 |
| *Polygonatum multiflorum* (F) | C | - | - | + | - | + | + | - | + | + | + | + | + | + | + | - | + | - | - | - | + | + | III | 60 |
| *Clematis vitalba* (Qpp) | B1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | - | - | + | + | I | 10 |
| | B2 | - | - | - | - | + | - | - | + | - | - | + | + | + | + | + | + | + | - | + | + | + | III | 55 |
| | S | - | - | - | - | + | - | - | + | - | - | + | + | + | + | + | + | + | - | + | + | + | III | 55 |
| *Bromus ramosus* agg. (Qpp) | C | - | - | - | - | - | + | + | + | + | + | - | + | + | + | - | - | + | - | - | - | + | III | 45 |
| *Fragaria vesca* (Qpp,Epa) | C | + | + | + | + | - | - | + | - | + | + | + | - | - | - | - | - | - | - | + | - | + | III | 45 |
| *Carex divulsa* | C | + | + | - | - | - | - | - | - | - | - | - | + | - | + | - | + | - | + | + | + | + | II | 40 |
| *Corylus avellana* (Qpp) | B1 | - | + | - | + | + | - | - | - | - | - | + | + | - | - | 1 | - | - | - | - | - | +-1 | II | 30 |
| | B2 | - | + | - | - | + | - | + | - | - | - | - | + | - | + | + | - | - | - | - | - | + | II | 30 |
| | S | - | + | - | + | + | - | + | - | - | - | + | + | - | + | 1 | - | - | - | - | - | +-1 | II | 40 |
| *Veronica chamaedrys* (Qpp,Ara) | C | - | - | + | - | - | - | - | - | - | + | - | - | + | + | + | - | + | - | - | + | + | II | 35 |

| Table 1/2. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | A-D | K | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Crataegus oxyacantha* | B1 | - | - | - | + | - | - | + | - | + | - | - | - | - | - | - | - | + | - | - | - | + | I | 20 |
| | B2 | - | - | + | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 10 |
| | S | - | - | + | + | - | - | + | - | + | - | - | - | - | - | - | - | + | - | - | - | + | II | 25 |
| *Epipactis helleborine* agg. (F) | C | + | - | - | - | + | - | - | - | + | - | - | - | + | - | - | - | - | - | - | - | + | I | 20 |
| *Melittis carpatica* (Cp,Qpp,Qc) | C | - | - | + | - | - | - | - | - | - | - | - | + | + | - | - | - | - | - | - | + | + | I | 20 |
| *Scrophularia nodosa* (GA,Epa) | C | - | - | + | - | - | - | - | - | - | - | - | - | - | + | + | - | - | - | - | + | + | I | 20 |
| *Symphytum tuberosum* (F,Cp,Qpp) | C | - | - | + | + | - | - | + | 1 | - | - | - | - | - | - | - | - | - | - | - | - | +-1 | I | 20 |
| *Lapsana communis* (GA,Epa) | C | - | + | - | - | - | - | - | + | - | - | - | - | - | - | + | - | - | - | - | - | + | I | 15 |
| *Mycelis muralis* | C | - | - | - | - | - | - | - | - | - | + | - | - | - | - | - | - | + | + | - | - | + | I | 15 |
| *Campanula trachelium* (Epa,Cp) | C | - | - | - | - | - | - | - | - | - | - | + | - | - | + | - | - | - | - | - | - | + | I | 10 |
| *Heracleum sphondylium* (Qpp,MoA) | C | - | - | + | - | - | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | + | I | 10 |
| *Neottia nidus-avis* (F,Qpp) | C | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | + | - | - | + | I | 10 |
| *Staphylea pinnata* (Cp,TA) | B2 | - | - | - | + | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 10 |
| *Stellaria holostea* (F,Cp) | C | - | - | - | - | - | - | - | - | - | - | - | + | + | - | - | - | - | - | - | - | + | I | 10 |
| *Tilia cordata* (Cp,Qpp) | A2 | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 5 |
| | B1 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | I | 5 |
| | B2 | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 5 |
| | S | 1 | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | +-1 | I | 10 |
| *Vicia sepium* (Ara,Qpp) | C | + | - | - | - | - | - | - | - | - | - | - | + | - | - | - | - | - | - | - | - | + | I | 10 |
| *Viola mirabilis* (F,Qpp) | C | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | - | + | + | I | 10 |
| *Cephalanthera damasonium* (Qpp) | C | - | - | - | - | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 5 |
| *Clinopodium vulgare* (Qpp) | C | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | - | - | - | - | + | I | 5 |
| *Convallaria majalis* (Qpp) | C | - | - | - | - | - | - | - | - | - | - | - | + | - | - | - | - | - | - | - | - | + | I | 5 |
| *Fallopia dumetorum* (Qpp,GA) | C | - | - | - | - | - | - | - | - | - | - | - | - | - | + | - | - | - | - | - | - | + | I | 5 |
| *Loranthus europaeus* (Cp,Qpp) | A1 | - | - | - | - | - | - | - | - | - | + | - | - | - | - | - | - | - | - | - | - | + | I | 5 |
| *Ranunculus auricomus* agg. (MoA) | C | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 5 |
| **Fagetalia sylvaticae** | | | | | | | | | | | | | | | | | | | | | | | | |
| *Carpinus betulus* (Cp) | A1 | 2 | - | 4 | 3 | 1 | 2 | 3 | 3 | 1 | 4 | 3 | 1 | - | 1 | - | 2 | 1 | 1 | 2 | 1 | 1-4 | V | 85 |
| | A2 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 2-4 | V | 100 |
| | B1 | 2 | 2 | - | - | + | - | - | - | - | 1 | 1 | 2 | 2 | 2 | - | - | 2 | 2 | 1 | 2 | +-2 | III | 60 |
| | B2 | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | - | + | + | + | V | 95 |
| | S | 4 | 3 | 5 | 4 | 3 | 3 | 4 | 5 | 3 | 5 | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 4 | 4 | 5 | 3-5 | V | 100 |
| *Cerasus avium* (Cp) | A1 | - | - | + | 1 | - | - | + | 1 | 1 | - | - | - | - | - | - | - | + | - | - | - | +-1 | II | 30 |
| | A2 | - | - | - | + | - | - | + | - | + | - | - | - | - | - | - | - | + | - | + | - | + | II | 25 |
| | B1 | - | - | - | - | + | - | - | - | - | + | - | - | - | - | - | - | + | - | - | - | + | I | 15 |
| | B2 | + | + | + | + | + | + | - | + | + | + | + | + | + | + | + | + | + | + | + | + | + | V | 95 |
| | S | + | + | + | 1 | + | + | + | 1 | 1 | + | + | + | + | + | + | + | 1 | + | + | + | +-1 | V | 100 |
| *Galium odoratum* | C | 1 | 2 | 2 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | + | 1 | 2 | 3 | 2 | 1 | 2 | 1 | 1 | 2 | +-3 | V | 100 |
| *Hedera helix* | A1 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | + | + | - | - | - | - | - | +-1 | I | 15 |
| | A2 | 1 | 2 | 1 | 2 | 1 | 1 | + | + | 2 | + | + | + | + | 1 | + | 1 | 1 | 2 | 1 | 1 | +-2 | V | 100 |
| | B1 | + | - | - | + | + | + | - | - | - | - | + | + | + | + | + | + | + | + | 1 | - | +-1 | IV | 65 |
| | B2 | 4 | 3 | 1 | + | 1 | 1 | 2 | 2 | + | 1 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 4 | +-4 | V | 100 |
| | S | 4 | 4 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 4 | 1-4 | V | 100 |
| *Pulmonaria officinalis* | C | + | + | + | 1 | + | + | 1 | + | 1 | + | + | + | + | + | + | + | + | + | + | + | +-1 | V | 100 |
| *Stachys sylvatica* (Epa) | C | + | + | + | + | + | + | + | + | + | + | 1 | + | + | 1 | 1 | + | + | + | + | + | +-1 | V | 100 |
| *Viola sylvestris* | C | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | V | 100 |
| *Carex sylvatica* | C | + | + | + | + | + | + | + | 1 | + | 1 | + | 1 | 1 | - | + | + | + | + | + | + | +-1 | V | 95 |
| *Circaea lutetiana* (Ai) | C | + | + | 1 | + | 2 | 1 | 1 | 1 | 1 | 2 | + | + | + | - | + | + | + | + | + | + | +-2 | V | 95 |
| *Sanicula europaea* | C | - | - | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | V | 90 |
| *Milium effusum* | C | - | - | + | + | + | + | + | + | - | + | - | - | + | + | + | - | + | - | - | - | + | III | 55 |
| *Salvia glutinosa* | C | - | - | - | - | 1 | + | - | - | 1 | - | + | + | + | + | 1 | + | - | - | + | + | +-1 | III | 55 |
| *Veronica montana* (Ai) | C | + | - | 1 | 1 | + | 1 | 1 | 1 | 1 | + | - | - | - | - | + | - | - | - | - | - | +-1 | III | 50 |
| *Dentaria bulbifera* (EuF) | C | + | - | 1 | 1 | + | 1 | + | 1 | + | 1 | - | - | - | - | - | - | - | - | - | - | +-1 | III | 45 |
| *Arum orientale* ssp. *besseranum* | C | - | - | + | - | - | - | - | + | + | - | - | - | + | - | - | + | - | - | + | - | + | II | 30 |
| *Euphorbia amygdaloides* | C | - | - | - | + | - | - | + | - | - | - | - | - | - | + | - | + | - | + | - | + | + | II | 30 |
| *Cardamine impatiens* | C | + | + | - | - | - | + | - | + | + | - | - | - | - | - | - | - | - | - | - | - | + | II | 25 |
| *Fagus sylvatica* (EuF) | A1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | 1 | I | 5 |
| | A2 | - | - | - | - | - | - | - | - | + | - | - | - | - | - | - | + | - | - | - | - | + | I | 10 |
| | B1 | - | - | - | - | - | + | - | + | 1 | + | - | - | - | - | - | - | - | - | - | - | +-1 | I | 20 |
| | B2 | - | - | - | - | - | + | - | + | - | + | - | - | - | - | - | + | - | - | - | - | + | I | 20 |
| | S | - | - | - | - | - | + | - | + | 1 | + | - | - | - | - | - | 1 | - | - | - | - | +-1 | II | 25 |
| *Vinca minor* (Cp) | C | - | - | - | - | - | 4 | - | - | - | - | 1 | - | - | - | 1 | - | + | 3 | - | - | +-4 | II | 25 |
| *Athyrium filix-femina* (Qr,VP) | C | + | - | + | - | - | - | - | - | - | + | + | - | - | - | - | - | - | - | - | - | + | I | 20 |

| Table 1/3. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | A-D | K | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Galeopsis speciosa* (Epn,Ai) | C | + | - | - | - | - | + | - | + | - | + | - | - | - | - | - | - | - | - | - | - | + | I | 20 |
| *Moehringia trinervia* | C | - | + | - | - | - | + | + | - | + | - | - | - | - | - | - | - | - | - | - | - | + | I | 20 |
| *Ulmus glabra* (TA) | A2 | - | - | - | - | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 5 |
| | B1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | - | - | - | + | I | 5 |
| | B2 | + | - | - | - | - | + | - | - | - | - | - | - | - | - | - | - | + | - | - | - | + | I | 15 |
| | S | + | - | - | - | - | + | - | + | - | - | - | - | - | - | - | - | + | - | - | - | + | I | 20 |
| *Dryopteris filix-mas* | C | - | + | - | - | - | - | - | - | - | + | - | - | - | - | + | - | - | - | - | - | + | I | 15 |
| *Paris quadrifolia* (Ate,Ai) | C | - | - | - | - | + | - | - | + | + | - | - | - | - | - | - | - | - | - | - | - | + | I | 15 |
| *Rubus hirtus* (Epa,US) | B2 | - | - | + | - | - | - | - | - | - | + | - | - | - | - | - | - | - | - | - | - | + | I | 10 |
| *Acer platanoides* (TA) | B2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | - | - | - | - | + | I | 5 |
| *Carex pilosa* (Cp) | C | - | - | - | - | - | - | 4 | - | - | - | - | - | - | - | - | - | - | - | - | - | 4 | I | 5 |
| *Listera ovata* (Ate,Ai) | C | - | - | - | - | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 5 |
| *Primula vulgaris* (AF) | C | - | - | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 5 |
| *Tilia platyphyllos* (TA,Qpp) | B1 | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 5 |
| **Alnion incanae** | | | | | | | | | | | | | | | | | | | | | | | | |
| *Rumex sanguineus* (Epa,Sal) | C | + | + | - | + | + | + | + | - | + | + | + | + | - | + | + | + | + | + | + | - | + | IV | 80 |
| *Carex remota* | C | + | + | + | - | + | + | - | + | - | + | - | + | - | - | + | - | - | + | - | - | + | III | 50 |
| *Carex strigosa* | C | + | - | - | - | - | + | - | - | - | + | - | - | - | - | - | - | - | - | - | - | + | I | 15 |
| *Festuca gigantea* (Cal,Epa) | C | - | - | - | - | + | - | - | - | - | - | - | - | + | - | - | - | - | - | - | - | + | I | 10 |
| *Viburnum opulus* (Ate) | B2 | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 5 |
| **Aremonio-Fagion** | | | | | | | | | | | | | | | | | | | | | | | | |
| *Lonicera caprifolium* (OCa) | B1 | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 5 |
| | B2 | + | + | + | 1 | + | + | + | + | + | - | - | + | + | - | + | + | + | - | + | + | +-1 | IV | 80 |
| | S | + | + | + | 1 | + | + | + | + | + | - | - | + | + | - | + | + | + | - | + | + | +-1 | IV | 80 |
| *Tamus communis* (Qfa) | B1 | - | - | - | - | - | - | - | - | - | - | - | - | + | - | - | - | - | - | - | - | + | I | 5 |
| | C | - | + | - | - | + | + | - | + | + | - | - | + | + | + | + | + | - | + | - | + | + | III | 60 |
| | S | - | + | - | - | + | + | - | + | + | - | - | + | + | + | + | + | - | + | - | + | + | III | 60 |
| *Scutellaria altissima* (AQ) | C | - | - | - | + | + | - | + | - | - | - | - | - | - | - | - | - | + | + | + | + | + | II | 35 |
| *Helleborus odorus* (QFt,Qfa) | C | - | - | - | 1 | - | - | 1 | - | - | - | - | - | - | - | - | - | - | + | - | 1 | +-1 | I | 20 |
| *Asperula taurina* (Cp) | C | - | - | - | + | - | - | + | - | - | - | - | - | - | + | - | - | - | - | - | - | + | I | 15 |
| *Rosa arvensis* (Cp,Qfa) | B2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | + | I | 5 |
| *Ruscus aculeatus* (Qfa) | C | - | - | - | - | - | - | - | - | - | + | - | - | - | - | - | - | - | - | - | - | + | I | 5 |
| **Quercetea pubescentis-petraeae** | | | | | | | | | | | | | | | | | | | | | | | | |
| *Rosa canina* agg. (Pru,Pru) | B2 | - | - | + | + | + | - | + | + | + | + | - | - | + | - | + | - | - | - | - | - | + | III | 45 |
| *Pyrus pyraster* (Cp) | A2 | - | - | - | - | + | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | + | I | 10 |
| | B2 | - | - | - | - | - | - | - | - | - | - | - | - | - | + | + | - | - | + | + | + | + | II | 25 |
| | S | - | - | - | - | + | - | - | - | + | - | - | - | - | + | + | - | - | + | + | + | + | II | 35 |
| *Malus sylvestris* (Ai,Cp) | B1 | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 5 |
| | B2 | - | - | - | - | - | - | + | - | - | - | - | - | - | - | - | + | - | - | + | - | + | I | 15 |
| | S | - | + | - | - | - | - | + | - | - | - | - | - | - | - | - | + | - | - | + | - | + | I | 20 |
| *Acer tataricum* (OCn,AQ) | B1 | - | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | + | I | 10 |
| | B2 | - | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | + | + | + | I | 15 |
| | S | - | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | + | + | + | I | 15 |
| *Prunus spinosa* (Pru,Pru) | B1 | - | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 5 |
| | B2 | - | - | - | - | - | - | - | - | - | - | - | - | - | + | - | - | - | - | - | + | + | I | 10 |
| | S | - | - | - | - | + | - | - | - | - | - | - | - | - | + | - | - | - | - | - | + | + | I | 15 |
| *Cornus mas* (TA,OCn,Qc) | B1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | + | + | I | 10 |
| *Lithospermum purpureo-coeruleum* (OCn,AQ) | C | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | - | - | + | - | + | I | 10 |
| *Lathyrus niger* (Qc) | C | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | + | I | 5 |
| *Sorbus torminalis* (QFt) | A2 | - | - | - | - | - | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | + | I | 5 |
| **Quercion farnetto** | | | | | | | | | | | | | | | | | | | | | | | | |
| *Tilia tomentosa* (AF) | A1 | - | - | - | 2 | - | - | 2 | 1 | 1 | 1 | - | 1 | + | + | 1 | - | - | + | 1 | - | +-2 | III | 55 |
| | A2 | - | + | 1 | 1 | - | - | 1 | - | 1 | 1 | + | 1 | + | 1 | 1 | + | + | + | - | + | +-1 | IV | 75 |
| | B1 | 2 | 2 | 3 | 2 | + | 2 | 3 | 1 | 3 | 3 | + | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | +-3 | V | 100 |
| | B2 | 1 | + | 2 | 1 | + | 1 | 1 | + | 1 | 1 | + | + | 1 | 1 | 1 | + | + | + | + | + | +-2 | V | 100 |
| | S | 2 | 2 | 4 | 3 | + | 2 | 4 | 2 | 3 | 3 | 1 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | +-4 | V | 100 |
| **Indifferens** | | | | | | | | | | | | | | | | | | | | | | | | |
| *Glechoma hederacea* (MoA,QFt,Sal,Ai) | C | - | - | 1 | 1 | 1 | + | 1 | - | + | - | - | - | + | + | + | - | + | + | + | + | +-1 | IV | 65 |
| *Rubus caesius* (Spu) | B2 | - | + | + | + | + | - | + | - | + | + | - | - | - | - | - | - | - | - | - | - | + | II | 35 |
| *Sambucus nigra* (Epa,US,QFt) | B1 | - | - | - | - | - | - | - | - | - | - | + | - | - | - | - | - | + | - | - | - | + | I | 10 |
| | B2 | - | - | - | - | + | - | - | - | + | - | + | - | + | - | + | - | + | - | - | - | + | II | 30 |
| | S | - | - | - | - | + | - | - | - | + | - | + | - | + | - | + | - | + | - | - | - | + | II | 30 |
| *Urtica dioica* (Ar,GA,Epa,Spu) | C | - | - | - | - | - | - | - | - | + | - | - | - | - | + | + | + | + | - | - | - | + | II | 25 |

| Table 1/4. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | A-D | K | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Galium aparine* (Sea,Epa,QFt) | C | - | - | + | + | + | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | + | I | 20 |
| *Torilis japonica* (Ar,GA,Epa,QFt) | C | - | - | - | - | - | - | + | - | - | - | - | - | + | + | - | - | - | - | + | - | + | I | 20 |
| *Chelidonium majus* (Che,Ar,GA,Epa) | C | - | - | - | - | + | - | - | - | - | - | - | - | - | + | - | - | - | - | - | - | + | I | 10 |
| **Adventiva** | | | | | | | | | | | | | | | | | | | | | | | | |
| *Juglans nigra* | A1 | - | - | - | - | - | - | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | 1 | I | 10 |
| | B2 | - | - | - | - | - | - | + | + | - | - | - | - | - | - | + | - | - | - | - | - | + | I | 15 |
| | S | - | - | - | - | - | - | 1 | 1 | - | - | - | - | - | - | + | - | - | - | - | - | +-1 | I | 15 |
| *Juglans regia* | B1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | - | - | - | - | - | + | I | 5 |
| *Phytolacca americana* | C | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | - | - | - | - | - | + | I | 5 |
| *Quercus rubra* | B2 | - | - | - | - | - | - | - | - | - | - | - | - | - | + | - | - | - | - | - | - | + | I | 5 |

**Abbreviations:** A1: upper canopy layer; A2: lower canopy layer; AF: *Aremonio-Fagion*; Agi: *Alnenion glutinosae-incanae*; Ai: *Alnion incanae*; AQ: *Aceri tatarico-Quercion*; Ar: *Artemisietea*; Ara: *Arrhenatheretea*; Ate: *Alnetea glutinosae*; B1: shrub layer; B2: regrowth; C: herb layer; Cal: *Calystegion sepium*; Che: *Chenopodietea*; Cp: *Carpinenion betuli*; Des: *Deschampsion caespitosae*; Epa: *Epilobietea angustifolii*; Epn: *Epilobion angustifolii*; EuF: *Eu-Fagenion*; F: *Fagetalia sylvaticae*; GA: *Galio-Alliarion*; MoA: *Molinio-Arrhenatherea*; OCa: *Orno-Cotinetalia*; OCn: *Orno-Cotinion*; Pru: *Prunetalia spinosae*; Qc: *Quercetalia cerris*; Qfa: *Quercion farnetto*; QFt: *Querco-Fagetea*; Qpp: *Quercetea pubescentis-petraeae*; Qr: *Quercetalia roboris*; Sal: *Salicion albae*; Sea: *Secalietea*; s.l.: sensu lato (in a broader sense); Spu: *Salicetea purpureae*; TA: *Tilioplatyphyllae-Acerenion pseudoplatani*; Ulm: *Ulmenion*; US: *Urtico-Sambucetea*; VP: *Vaccinio-Piceetea*.

| **Table 1/5. Data recorded** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
|---|---|---|---|---|---|---|---|---|---|---|
| Sample number | 14233 | 14234 | 14235 | 14236 | 14237 | 14238 | 14239 | 14240 | 14241 | 14242 |
| Sampling year | 2007 | 2007 | 2007 | 2007 | 2007 | 2007 | 2007 | 2007 | 2007 | 2007 |
| Sampling time | 16.07 | 16.07 | 16.05 | 17.05 | 17.05 | 06.06 | 06.06 | 06.06 | 06.06 | 06.06 |
| Sloping (degree) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Upper canopy coverage (%) | 80 | 80 | 75 | 80 | 75 | 85 | 85 | 80 | 85 | 75 |
| Lower canopy coverage (%) | 40 | 40 | 30 | 30 | 40 | 25 | 20 | 40 | 40 | 20 |
| Shrub layer coverage (%) | 60 | 50 | 50 | 35 | 20 | 40 | 40 | 30 | 40 | 50 |
| Re-growth coverage (%) | 70 | 50 | 15 | 25 | 3 | 5 | 15 | 25 | 5 | 10 |
| Herb layer coverage (%) | 5 | 15 | 35 | 60 | 50 | 75 | 90 | 60 | 60 | 40 |
| Upper canopy height (m) | 32 | 30 | 25 | 27 | 30 | 30 | 27 | 27 | 30 | 27 |
| Lower canopy height (m) | 22 | 20 | 20 | 20 | 22 | 22 | 20 | 20 | 22 | 20 |
| Shrub layer height (cm) | 350 | 300 | 250 | 200 | 150 | 200 | 200 | 250 | 250 | 250 |
| Mean trunk diameter (cm) | 60 | 60 | 45 | 45 | 60 | 65 | 45 | 50 | 60 | 55 |
| Size of sampling area ($m^2$) | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 |

| **Table 1/6. Data recorded** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** |
|---|---|---|---|---|---|---|---|---|---|---|
| Sample number | 14268 | 14269 | 14270 | 14271 | 14272 | 14267 | 14273 | 14274 | 14275 | 14276 |
| Sampling year | 2007 | 2007 | 2007 | 2007 | 2007 | 2007 | 2007 | 2007 | 2007 | 2007 |
| Sampling time | 16.07 | 16.07 | 16.07 | 16.07 | 16.07 | 20.07 | 20.07 | 20.07 | 20.07 | 20.07 |
| Sloping (degree) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Upper canopy coverage (%) | 70 | 75 | 75 | 70 | 75 | 85 | 85 | 70 | 85 | 70 |
| Lower canopy coverage (%) | 40 | 50 | 50 | 50 | 50 | 45 | 50 | 60 | 50 | 60 |
| Shrub layer coverage (%) | 30 | 70 | 60 | 40 | 25 | 40 | 30 | 50 | 40 | 50 |
| Re-growth coverage (%) | 50 | 40 | 30 | 50 | 30 | 50 | 35 | 20 | 50 | 70 |
| Herb layer coverage (%) | 15 | 15 | 25 | 40 | 40 | 5 | 25 | 40 | 5 | 25 |
| Upper canopy height (m) | 25 | 28 | 28 | 28 | 30 | 28 | 30 | 28 | 27 | 32 |
| Lower canopy height (m) | 18 | 20 | 18 | 15 | 15 | 20 | 18 | 20 | 20 | 18 |
| Shrub layer height (cm) | 500 | 250 | 300 | 300 | 300 | 300 | 400 | 400 | 200 | 350 |
| Mean trunk diameter (cm) | 50 | 55 | 55 | 60 | 65 | 55 | 65 | 55 | 50 | 60 |
| Size of sampling area ($m^2$) | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 |

Location: 1-10: Beli Manastir, Haljevo forest; 11-20:Kozarac forest.
Altitude a.s.l.: 1-20: cca. 90-5 m.
Rock type: 1-20: young alluvium.
Soil: 1-20: brown forest soil.
Survey made by: 1-15, : Balázs Kevey and Sándor Csete; 16-20: Balázs Kevey, Sándor Csete and Dragica Puger.

## 5.2. Species combinations

As revealed by the 20 coenological relevés (Table 1.), the plant association consists of 21 constant and 8 sub-constant species: K V: *Acer campestre, Ajuga reptans, Brachypodium sylvaticum, Carex sylvatica, Carpinus betulus, Cerasus avium, Circaea lutetiana, Cornus sanguinea, Crataegus monogyna, Euonymus europaea, Galium odoratum, Geum urbanum, Hedera helix, Ligustrum vulgare, Pulmonaria officinalis, Quercus robur, Sanicula europaea, Stachys sylvatica, Tilia tomentosa, Ulmus minor, Viola sylvestris*. - K IV: *Alliaria petiolata, Dactylis polygama, Geranium robertianum, Glechoma hederacea, Lamium maculatum, Lonicera caprifolium, Rumex sanguineus, Viola alba*.

Based on the percentage of characteristic species of different syntaxa weithed by their K values (Table 2.) and percentage of characteristic species of different syntaxa weithed by their A-D values (Table 3.), the following important characteristic species play a determining role in the studied oak-hornbeam stands:

The oak-hornbeam stands of the Croatian Baranja, provide refuge for a number of *Fagetalia* elements (percentage of different syntaxa based on K% for character species: 28.3%, percentage of different syntaxa based on A-D% for character species: 37.1%) The most significant species are: *Acer platanoides, Arum orientale, Athyrium filix-femina, Cardamine impatiens, Carex pilosa, C. sylvatica, Carpinus betulus, Cerasus avium, Dentaria bulbifera, Dryopteris filix-mas, Euphorbia amygdaloides, Fagus sylvatica, Galium odoratum, Hedera helix, Milium effusum, Moehringia trinervia, Primula vulgaris, Pulmonaria officinalis, Rubus hirtus, Salvia glutinosa, Sanicula europaea, Stachys sylvatica, Tilia platyphyllos, Ulmus glabra, Veronica montana, Vinca minor, Viola sylvestris*.

This plant association is also related to oak-ash-elm groves (*Fraxino pannonicae-Ulmetum*) as suggested by the presence of the following *Alnion incanae* species (percentage of different syntaxa based on K% for character species: 6.7%, percentage of different syntaxa based on A-D% for character species: 7.1%): *Carex remota, C. strigosa, Circaea lutetiana, Paris quadrifolia, Listera ovata, Viburnum opulus* etc.

There are also several plant species with sub-Mediterranean distribution in the studied oak-hornbeam stands, such as: *Asperula taurina, Carex strigosa, Carpesium abrotanoides, Helleborus odorus, Lonicera caprifolium, Primula vulgaris, Rosa arvensis, Ruscus aculeatus, Scutellaria altissima, Tamus communis, Tilia tomentosa*. These can be categorised partly with *Aremonio-Fagion* (percentage of different syntaxa based on K% for character species: 3.7%, percentage of different syntaxa based on A-D% for character species: 5.0%), and partly with *Quercion farnetto* (percentage of different syntaxa based on K% for character species: 2.1%, percentage of different syntaxa based on A-D% for character species: 4.8%). These plant species are normally absent from other lowland hardwood gallery forests (Kevey 2006a).

Table 2. Percentage of different syntaxa weighed by K% for character species (%)

| | |
|---|---|
| **Molinio-Arrhenatherea** | 1.2 |
| Arrhenatheretea (incl. Arrhenatheretalia) | 0.3 |
| **Molinio-Arrhenatherea s.l.** | 1.5 |
| **Chenopodio-Scleranthea** | 0.0 |
| Secalietea | 0.1 |
| Artemisietea (incl. Artemisietalia et Arction lappae) | 0.3 |
| Galio-Urticetea (incl. Calystegietalia sepium) | 0.0 |
| Galio-Alliarion | 2.7 |
| Calystegion sepium | 0.6 |
| Galio-Urticetea s.l. | 3.3 |
| Epilobietea angustifolii (incl. Epilobietalia) | 5.1 |
| Epilobion angustifolii | 0.2 |
| Epilobietea angustifolii s.l. | 5.3 |
| Urtico-Sambucetea (incl. Sambucetalia et Sambuco-Salicion capreae) | 0.3 |
| **Chenopodio-Scleranthea s.l.** | 9.3 |
| **Querco-Fagea** | 0.0 |
| Salicetea purpureae (incl. Salicetalia purpureae) | 0.5 |
| Salicion albae | 1.4 |
| Salicetea purpureae s.l. | 1.9 |
| Alnetea glutinosae (incl. Alnetalia glutinosae) | 0.3 |
| Querco-Fagetea | 17.9 |
| Fagetalia sylvaticae | 28.3 |
| Alnion incanae | 5.8 |
| Alnenion glutinosae-incanae | 0.3 |
| Ulmenion | 0.6 |
| Alnion incanae s.l. | 6.7 |
| Fagion sylvaticae | 0.0 |
| Eu-Fagenion | 0.8 |
| Carpinenion betuli | 6.5 |
| Tilio platyphyllae-Acerenion pseudoplatani | 0.8 |
| Fagion sylvaticae s.l. | 8.1 |
| Aremonio-Fagion | 3.7 |
| Fagetalia sylvaticae s.l. | 46.8 |
| Quercetalia roboris | 0.2 |
| Querco-Fagetea s.l. | 64.9 |
| Quercetea pubescentis-petraeae | 14.8 |
| Orno-Cotinetalia | 0.9 |
| Orno-Cotinion | 0.3 |
| Quercion farnetto | 2.1 |
| Orno-Cotinetalia s.l. | 3.3 |
| Quercetalia cerris | 0.2 |
| Aceri tatarico-Quercion | 0.6 |
| Quercetalia cerris s.l. | 0.8 |
| Prunetalia spinosae | 0.9 |
| Quercetea pubescentis-petraeae s.l. | 19.8 |
| **Querco-Fagea s.l.** | 86.9 |
| **Abieti-Piceea** | 0.0 |
| Vaccinio-Piceetea | 0.2 |
| **Abieti-Piceea s.l.** | 0.2 |
| **Indifferens** | 1.3 |
| **Adventiva** | 0.7 |

Table 3. Percentage of different syntaxa weighed A-D% for character species (%)

| | |
|---|---|
| **Molinio-Arrhenatherea** | 0.2 |
| **Chenopodio-Scleranthea** | 0.0 |
| Galio-Urticetea (incl. Calystegietalia sepium) | 0.0 |
| Galio-Alliarion | 0.2 |
| Calystegion sepium | 0.1 |
| Galio-Urticetea s.l. | 0.3 |
| Epilobietea angustifolii (incl. Epilobietalia) | 0.5 |
| **Chenopodio-Scleranthea s.l.** | 0.8 |
| **Querco-Fagea** | 0.0 |
| Salicetea purpureae (incl. Salicetalia purpureae) | 0.0 |
| Salicion albae | 0.2 |
| Salicetea purpureae s.l. | 0.2 |
| Querco-Fagetea | 11.2 |
| Fagetalia sylvaticae | 37.1 |
| Alnion incanae | 6.9 |
| Alnenion glutinosae-incanae | 0.1 |
| Ulmenion | 0.1 |
| Alnion incanae s.l. | 7.1 |
| Fagion sylvaticae | 0.0 |
| Eu-Fagenion | 0.3 |
| Carpinenion betuli | 21.3 |
| Tilio platyphyllae-Acerenion pseudoplatani | 0.2 |
| Fagion sylvaticae s.l. | 21.8 |
| Aremonio-Fagion | 5.0 |
| Fagetalia sylvaticae s.l. | 71.0 |
| Querco-Fagetea s.l. | 82.2 |
| Quercetea pubescentis-petraeae | 10.9 |
| Orno-Cotinetalia | 0.1 |
| Quercion farnetto | 4.8 |
| Orno-Cotinetalia s.l. | 4.9 |
| Quercetalia cerris | 0.0 |
| Aceri tatarico-Quercion | 0.1 |
| Quercetalia cerris s.l. | 0.1 |
| Prunetalia spinosae | 0.1 |
| Quercetea pubescentis-petraeae s.l. | 16.0 |
| **Querco-Fagea s.l.** | 98.4 |
| **Indifferens** | 0.2 |
| **Adventiva** | 0.2 |

# 6. Discussion

It is striking that despite the arid and continental climate prevailing here, there are extensive oak-hornbeam stands in the Baranja region. This is primarily due to the fact that there is relatively high water table, ensured by the large number of watercourses crossing the area. This, in turn, enables the development of a cool and humid microclimate, making it possible for oak-hornbeam forests to evolve – in addition to their own zone – extrazonally, in the forest steppe zone too.

As shown by the above results, a number of sub-montane elements (*Fagetalia*) find refuge in the oak-hornbeam stands of Baranja. This forests are similar to the oak-hornbeam forests of young alluvial areas of the Drava plains in Somogy and Baranya counties (Kevey 2006b, 2007), of the Sava plains (Kalinić & Rauš 1973; Rauš 1975; Rauš et al. 1985), the Rábaköz (Kevey ined.), the Bodrogköz region (Hargitai 1938-1939, Kevey ined.), and the Bereg-Szatmár plain (Simon 1951, 1957; Kevey ined.). The reason for such similarity is probably the cool and humid meso- and microclimatic effects created by the proximity of rivers. Based on their habitat characteristics, these oak-hornbeam stands with gallery forest features can be grouped with the *Circaeo-Carpinetum* association, whose syntaxonomic location is shown as follows:

Divisio: **QUERCO-FAGEA** Jakucs 1967
Classis: **QUERCO-FAGETEA** Br.-Bl. et Vlieger in Vlieger 1937 em. Borhidi in Borhidi et Kevey 1996
Ordo: ***FAGETALIA SYLVATICAE*** Pawłowski in Pawłowski et al. 1928
Alliance: **Fagion sylvaticae** Luquet 1926
Suballiance: ***Carpinenion betuli*** Issler 1931
Associatio: *Circaeo-Carpinetum* Borhidi 2003 em. Kevey 2006b

There might have been special floral evolutional aspects playing a role in creating the species composition of Baranja oak-hornbeam stands, as noted by Horvát (1942). This is suggested by the fact that there are several plant species occurring in the Harkány-Nagynyárád plain constituting the eastern part of the Dráva-plain area, and also in the Baranja that are specific elements of the Mecsek floral subdistrict (*Sopianicum*): e.g. *Asperula taurina, Digitalis ferruginea, Helleborus odorus, Ranunculus psilostachys, Scutellaria altissima*. These plants, however, are absent from the *Dravense* floral subdistrict. *Lonicera caprifolium* can also be grouped with these species, but it does appear in some localities of the eastern fringes of the Ormánság region. Thus, the oak-hornbeam stands of the Baranja show some relatedness with the oak-hornbeam forests (*Asperulo taurinae-Carpinetum*) of the Mecsek floral subdistrict (*Sopianicum*), and with Illyrian beechwoods (Horvát 1957b, 1958; Borhidi 1963, 1965, 1966, 1968). This is partly due to the fact that Baranja is one of the southernmost parts of the Hungarian plains, with sub-Mediterranean climate (Rauš 1975; Rauš et al. 1985), also directly adjacent to some smaller units of the floral subdistrict of South-Transdanubia (*Praeillyricum*), such as the Baranyai hilly region, or Villány Hills.

If the percentage values of different syntaxa based on K% of character species in oak-hornbeam forests along Drava river are analysed from the north-west towards the south-east, some interesting correlations can be observed. Namely, the proportion of Fagetalia and *Alnion incanae* elements decrease from the north-west towards the south-east, whereas that of *Quercetea pubescentis-petraeae* species increases (Fig. 3.). This, on the one hand, suggests that the chance for the migration of sub-montane elements decreases from the western section of Drava towards the south-east. On the other hand, the climate of these floodplain sections also changes gradually: the diminishing sub-Atlantic and increasing continental effects towards the south-east cause *Fagetalia* elements to be rarer, and *Quercetea pubescentis-petraeae* species to occur more frequently (Fig. 3., KEVEY 2006b, 2007; This is understandable, since according to the climatic zonal map produced by BORHIDI (1961) the hungarian Baranya county section of Drava belongs to the closed oakwood zone, whereas the Croatian Baranja is part of the forest steppe zone. In a downstream direction along Drava, *Aremonio-Fagion* and *Quercion farnetto* elements increase (Fig. 4., KEVEY 2006b, 2007), which is related with sub-Mediterranean effects gradually increasing towards the south-east.

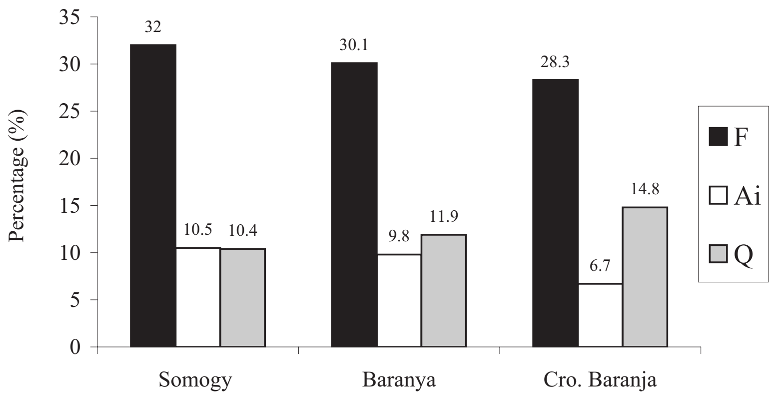


Fig. 3. Percentage of different syntaxa weithed by K% for character species of Fagetalia (F), Alnion incanae (Ai) and Quercetea (Q) elements in oak-hornbeam forests along Drava river

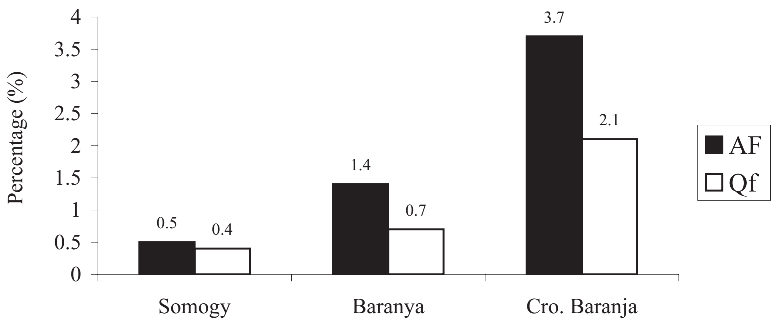


Fig. 4. Percentage of different syntaxa weithed by K% for character species of Aremonio-Fagion (AF) and Quercion farnetto (Qf) species in oak-hornbeam forests along Drava river

# 7. Nature conservation implications

Relatively many montane and sub-Mediterranean plant species find refuge in the oak-hornbeam forest stands of the Croatian Baranja region. Because lowland oak-hornbeam forests have greatly diminished, it is a very positive fact that smaller or greater near-natural stands still exist here. Their sub-montane species (e.g. *Carex pilosa, Euphorbia amygdaloides, Fagus sylvatica, Galium odoratum, Milium effusum, Salvia glutinosa, Sanicula europaea, Veronica montana* stb.) are, in part, de-montane adventive floral elements brought here by rivers, but the majority probably date back to the Beech I period lasting from 3000 B.C. to 800 B.C. However, the sub-Mediterranean species (e.g. *Asperula taurina, Carex strigosa, Carpesium abrotanoides, Lonicera caprifolium, Primula vulgaris, Ruscus aculeatus, Scutellaria altissima, Tamus communis, Tilia tomentosa*) have survived from the Oak period, 5500 B.C. to 3000 B.C. (Zólyomi 1936, 1952; Járai-Komlódi 1966a, 1966b, 1968). This peculiar species combination further increases the significance of the oak-hornbeam forests of the Croatian Baranja region from the view point of historical phytogeography.

A total of 12 species have been found in the oak-hornbeam forests of the Baranja that are under protection in Hungary, further emphasising the significance of these forest associations: *Asperula taurina**, *Carex strigosa**, *Carpesium abrotanoides**, *Cephalanthera damasonium, Epipactis helleborine* agg., *Listera ovata, Lonicera caprifolium**, *Neottia nidus-avis, Primula vulgaris**, *Ruscus aculeatus**, *Scilla vindobonensis, Tamus communis**. Rauš (1971) mentioned two other protected species from the Haljevo forest: *Polystichum aculeatum, Platanthera bifolia*. In the case of plants marked with * among the above listed species, the distribution is concentrated around the floral subdistrict of South-Transdanubia (*Praeillyricum*).

The Duna-Drava National Park was inaugurated in 1996. The forests analysed as part of the present study, probably because of the presence of political borders and the related conflicts of interests, were not brought under protection. In the future it would be necessary to ensure legal protection for these oak-hornbeam forests, before they eventually fall victim to intensifying forestry management.

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# Beech forests (*Circaeo-Carpinetum* BORHIDI 2003 em. KEVEY 2006b *fagetosum* RAUŠ 1975) of the floodplains of the Baranja (NE-Croatia)

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**Abstract**: This paper presents the coenological analysis of a few lowland beech forest stands. The studied area is located in the north-eastern part of Croatia, in the Baranja region (*Titelicum* floral subdistrict). Several montane plant species are found in the investigated stands, probably originating from the "Beech I." period (from 3000 B.C. to 800 B.C.), whereas several sub Mediterranean species probably have survived from the "Oak period" (from 5500 B.C. to 3000 B.C.). Based on former research results, these lowland beech stands can be considered a beech subassociation of oak-hornbeam forests of the plains (*Circaeo-Carpinetum fagetosum*). The presence of some submediterranean plants call the attention to the relatedness of these stands to oak-hornbeam forests (*Asperulo taurinae-Carpinetum*) and beechwoods (*Helleboro odoro-Fagetum*) of the neighbouring Mecsek floral subdistrict (*Sopianicum*). These beech stands are of high significance in terms of floristic and vegetation history, thus deserve strict protection.

## 1. Introduction

Beech *Fagus sylvatica* L. is commonly known as a tree species of montane and hilly regions seldom colonising lowland areas (BLATTNY 1910; FEKETE & BLATTNY 1913; JÁRÓ 1962; SOÓ 1970; KEVEY 1984, 1995, 1996-1997, 1997a). It has been shown by geobotanical studies that beech used to be much more frequent than it is today. It appeared in the Great Plain region as early as in the tertiary period, but in the ice-age it migrated to the south (ZÓLYOMI ex verb.). After this cold period was over, it re-appeared during the warm and wet climate of the "Oak period" (from 5500 B.C. to 3000 B.C.), but only as single specimens in various forests. It reached its highest frequency in the cool and wet "Beech I. period" (from 3000 B.C. to 800 B.C.) when it even formed forests in the margins of the Great Hungarian Plain. During the somewhat warmer and drier, more continental "Beech II. period" (from 800 B.C. to the present day) it withdrew from the lowland region – apart from a few refugia – to the adjoining mountains and hilly regions (ZÓLYOMI 1936, 1937, 1952, 1958, 1980, 1987, 1995; JÁRAI-KOMLÓDI 1966a, 1966b, 1968).

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Even today, beech is found in several locations on young alluvial areas of the Drava lowlands (HORVÁT 1942a, 1942b, 1957a; RAUŠ 1971, 1975; KEVEY 1984, 1995). The current study provides the coenological analyses of beech stands found in the Croatian Baranja.

## 2. Material and methods

Sampling was done using the traditional quadrate method of the Zürich-Montpellier phytocoenological school (BECKING 1957; KEVEY et al. 2007). There are three relatively large beech stands in the Haljevo forest south of Beli Manastir (Fig. 1.), in which a total of 19 relevés were made. There is also an additional one from the forest near Kozarac (Keskend, ”Čeminačka šuma”) where only one small beech stand was found. The coenological tables were compiled and statistical calculations made (percentage of characteristic species of different syntaxa based on K% and on A-D%) using the KEVEY & HIRMANN (2002) ”NS” computer program package. The details of the calculations are specified in the papers by KEVEY (1993, 1997b, 2006a).

For species names we have followed the nomenclature of HORVÁTH et al. (1995), whereas for associations the nomenclature suggested by BORHIDI and KEVEY (1996), and BORHIDI (2003) is accepted. The organisation of coenologial and characteristic species

Fig. 1. Part of the beech stand in Haljevo forest (Photo by Sándor Csete)

tables are based on the coenological system of Soó (1980), modified according to the latest findings (Oberdorfer 1992; Mucina et al. 1993; Borhidi 2003; Kevey 2006a). Also with syntaxonomic categorisation of species, we have used primarily the Synopsis by Soó (1964, 1966, 1968, 1970, 1973, 1980), but we have considered more recent research results as well (Borhidi 1993, 1995; Horváth et al. 1995; Kevey 2006a).

## 3. Research history

The flora of Baranja (Croatia) has been studied by several authors since the beginnings of floristic studies (Marsigli 1726; Kitaibel in Gombocz & Horvát 1938-1939; Nendtvich in Horvát 1942a; Knapp 1966; Simonkai 1973; Tuzson 1914, 1927, 1929; Boros 1922). These botanists, however, all ignored the forests found near Beli Manastir and Kozarac, from where the first data were published by Horvát (1942b). It was again him to call the attention to the occurrence of beech *Fagus sylvatica* in the Baranja, by stating: "*there used to be beech in the forest near Beli Manastir before 1914, but whether it is native there or not still has to be confirmed*". The author used past tense probably because his information was from a clear-cut stand or may had been from a false source. These beech occurrences were confirmed by Rauš (1971). We too, have visited the currently existing stands with the assistance of a local forester László Tóth and gamemarden István Tirk.

## 4. Geobotanical and habitat characteristics

The Baranya section of the left side plain along the Drava is situated predominantly in the closed oak wood zone (*Dravense* floral subdistrict), but the Harkány-Nagynyárád plain in its eastern part is already part of the forest-steppe zone. The boundary between these two zones is also a borderline between floral districts. Accordingly, the Drava plains can be divided into a western *Dravense* and an eastern *Titelicum* floral subdistrict. The latter is continued beyond the Hungarian border, into the north-eastern plains of Croatia (Baranja, eastern part of the Sava-plains). Besides forest steppe climate, the double-peaked precipitation curve, definitely a sub-Mediterranean feature, is also typical of this lowland region (Borhidi 1961; Rauš 1975; Rauš et al. 1985). This is the primary reason why several sub-Mediterranean floral elements are present in this area (Horvát 1942b).

The studied lowland beech forest stands are found at altitudes of 89-94 m above sea level (Rauš 1971). The bedrock is alluvial deposition with loess and clay content (Horvát 1942b), on which brown forest soil has developed. Watercourses crossing the area create moist microclimate. In terms of average moisture content, the soil is mesophilous to subhidrophilous.

# 5. Results

Between mid-May and late June 2007 a total of 20 phytocoenological relevés were compiled from the forests of Beli Manastir and Kozarac (Table 1.). Below is the results yielded by the analysis of these surveys.

## 5.1. Physiognomy

The studied beech wood sections are mature stands with estimated age of about 100 years. The upper canopy layer is 28-35 m high, with 70-85% coverage. The dominant species is *Fagus sylvatica*, with *Quercus robur* and *Carpinus betulus* also being present at relatively high proportions. The lower canopy layer is quite variable in its density with height and coverage ranging between 10-22 m, from 10 to 40% , respectively. It is made up primarily by tree specimens forced underneath the main stand with *Carpinus betulus* and *Fagus sylvatica* being more frequent, and *Tilia tomentosa* also appearing sometimes. The shrub layer also is variable in density, mostly likely due to forestry activities. Its height is 1.5-4 m and its coverage is10-70%. It is made up predominantly by shrub-sized individuals of tree species of the upper canopy layer (*Acer campestre, Carpinus betulus, Fagus sylvatica, Tilia tomentosa*). Shrub species (*Cornus sanguinea, Corylus avellana, Crataegus monogyna, C. oxyacantha, Euonymus europaeus, Ligustrum vulgare, Staphylea pinnata*) are found only as few single specimens. The lower shrub layer has 1-40% coverage with *Hedera helix* sometimes even being a facies forming species. Besides *Hedera*, seedlings of *Tilia tomentosa* can also reach relatively high coverage rates. The coverage of the herb layer varies broadly with a range of 5-70%. Based on the 20 relevés, it is only *Galium odoratum* forming a facies in the summer vegetation aspect.

Table 1. Circaeo-Carpinetum fagetosum

| Table 1/1. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | A-D | K | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Molinio-Juncetea** | | | | | | | | | | | | | | | | | | | | | | | | |
| *Deschampsia caespitosa* (Des,Sal,Ate,Ai) | C | - | - | - | - | - | - | - | - | + | - | - | - | - | - | - | + | - | - | - | - | + | I | 10 |
| **Chenopodietea** | | | | | | | | | | | | | | | | | | | | | | | | |
| *Arctium minus* (Ar,Bia,Pla) | C | - | - | - | - | - | - | - | - | - | - | - | - | + | - | - | - | - | - | - | - | + | I | 5 |
| **Galio-Alliarion** | | | | | | | | | | | | | | | | | | | | | | | | |
| *Alliaria petiolata* (Epa) | C | + | - | - | + | + | + | + | + | + | - | + | + | + | + | + | + | + | + | + | + | + | V | 85 |
| *Chaerophyllum temulum* | C | - | - | - | - | - | - | - | + | - | - | - | - | + | + | + | + | - | - | - | - | + | II | 25 |
| **Calystegion sepium** | | | | | | | | | | | | | | | | | | | | | | | | |
| *Lamium maculatum* (Pa,Agi,F,TA,Qpp) | C | 1 | + | - | 2 | 2 | 1 | + | + | 1 | + | - | + | + | + | + | + | 1 | + | + | - | +-2 | V | 85 |
| *Carpesium abrotanoides* (Sal,Ulm) | C | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | - | - | - | - | - | + | I | 5 |
| **Salicion albae** | | | | | | | | | | | | | | | | | | | | | | | | |
| *Cucubalus baccifer* (Cal,Ulm) | C | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | - | - | - | - | - | + | I | 5 |
| **Alnetea glutinosae (incl. Alnetalia glutinosae)** | | | | | | | | | | | | | | | | | | | | | | | | |
| *Dryopteris carthusiana* (F,Agi,Qr,VP) | C | - | - | - | - | - | - | - | - | - | - | - | + | - | + | - | + | + | - | - | - | + | I | 20 |
| **Querco-Fagetea** | | | | | | | | | | | | | | | | | | | | | | | | |
| *Acer campestre* (Qpp) | A2 | - | - | - | + | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 10 |
| | B1 | 1 | 2 | 2 | + | + | + | 1 | 1 | + | 2 | 3 | 2 | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | +-3 | V | 100 |
| | B2 | + | + | + | + | + | + | + | + | - | + | 1 | 1 | 1 | + | + | 1 | 1 | + | 1 | + | +-1 | V | 95 |
| | S | 1 | 2 | 2 | 1 | 1 | + | 1 | 1 | + | 2 | 3 | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | +-3 | V | 100 |
| *Brachypodium sylvaticum* (Qpp) | C | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | V | 100 |
| *Geum urbanum* (Epa,Cp,Qpp) | C | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | V | 100 |

| Table 1/2. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | A-D | K | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Quercus robur* (Ai,Cp,Qpp) | A1 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 1 | + | + | 1 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | +-2 | V | 100 |
| | B1 | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 5 |
| | B2 | - | + | - | - | + | + | - | + | + | + | + | + | + | + | + | 1 | + | + | + | - | +-1 | IV | 75 |
| | S | 2 | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 1 | + | + | 1 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | +-2 | V | 100 |
| *Euonymus europaea* (Qpp) | B1 | - | - | - | - | + | - | - | - | + | + | - | - | - | - | - | - | + | - | - | - | + | I | 20 |
| | B2 | - | - | + | + | + | - | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | V | 85 |
| | S | - | - | + | + | + | - | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | V | 85 |
| *Geranium robertianum* (Epa,F) | C | + | - | + | + | + | + | + | + | + | + | + | + | - | + | + | + | + | + | + | - | + | V | 85 |
| *Ajuga reptans* (Qpp,MoA) | C | + | + | + | + | + | + | + | + | + | + | + | - | + | + | - | + | - | + | - | + | + | IV | 80 |
| *Crataegus monogyna* (Qpp) | B1 | - | - | + | - | - | - | - | - | + | - | + | - | + | - | - | + | + | + | + | + | + | III | 45 |
| | B2 | - | - | - | + | - | - | - | - | - | + | + | + | + | + | + | + | + | + | + | + | + | III | 60 |
| | S | - | - | + | + | - | - | - | - | + | + | + | + | + | + | + | + | + | + | + | + | + | IV | 70 |
| *Dactylis polygama* (Qpp,Cp) | C | + | - | + | + | + | + | + | + | + | - | + | + | + | - | - | + | - | + | - | + | + | IV | 70 |
| *Ligustrum vulgare* (Cp,Qpp) | B1 | - | - | + | + | + | - | - | - | - | + | + | - | - | + | + | - | - | + | + | - | + | III | 45 |
| | B2 | - | - | + | - | + | - | - | - | + | + | + | + | + | + | + | - | + | + | + | + | + | IV | 65 |
| | S | - | - | + | + | + | - | - | - | + | + | + | + | + | + | + | - | + | + | + | + | + | IV | 70 |
| *Polygonatum multiflorum* (F) | C | + | - | + | - | + | + | + | + | + | + | + | - | + | + | + | - | - | + | - | + | + | IV | 70 |
| *Viola alba* (Qpp) | C | + | + | + | + | + | + | + | - | - | + | + | - | + | - | + | - | - | + | + | + | + | IV | 70 |
| *Ulmus minor* (Ai,Ulm,Qpp) | A2 | - | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 5 |
| | B1 | - | + | + | - | - | - | 1 | + | - | - | - | - | - | + | - | - | + | - | - | - | +-1 | II | 30 |
| | B2 | + | - | + | + | - | - | + | + | - | + | - | - | - | - | - | - | - | + | - | + | + | II | 40 |
| | S | + | + | + | + | + | - | 1 | + | - | + | - | - | - | + | - | - | + | + | - | + | +-1 | III | 60 |
| *Cornus sanguinea* (Qpp) | B1 | - | - | - | - | - | - | - | - | + | - | + | - | + | - | + | - | + | - | - | - | + | II | 25 |
| | B2 | - | - | + | + | - | - | - | - | + | - | + | + | + | + | - | - | + | + | + | - | + | III | 50 |
| | S | - | - | + | + | - | - | - | - | + | - | + | + | + | + | + | - | + | + | + | - | + | III | 55 |
| *Carex divulsa* | C | + | + | + | - | - | + | - | - | + | + | + | + | - | - | - | - | - | + | - | + | + | III | 50 |
| *Fragaria vesca* (Qpp,Epa) | C | + | - | + | - | - | + | - | - | - | + | + | - | + | + | - | + | - | + | - | - | + | III | 45 |
| *Bromus ramosus* agg. (Qpp) | C | - | - | + | + | + | - | - | - | + | + | + | + | + | - | - | - | - | - | - | - | + | II | 40 |
| *Clematis vitalba* (Qpp) | B1 | - | - | - | - | - | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | + | I | 5 |
| | B2 | - | - | - | - | + | - | - | - | + | - | + | + | - | - | + | + | - | - | - | + | + | II | 35 |
| | S | - | - | - | - | + | - | - | - | + | - | + | + | - | - | + | + | - | - | - | + | + | II | 35 |
| *Crataegus oxyacantha* | B1 | + | - | + | + | 1 | - | - | - | 1 | + | - | - | - | - | - | - | + | - | - | - | +-1 | II | 35 |
| | B2 | - | - | + | - | - | - | - | - | - | + | - | - | - | - | - | - | + | - | - | - | + | I | 15 |
| | S | + | - | + | + | 1 | - | - | - | 1 | + | - | - | - | - | - | - | + | - | - | - | +-1 | II | 35 |
| *Veronica chamaedrys* (Qpp,Ara) | C | + | + | + | + | - | - | - | - | + | + | - | - | - | - | - | - | - | - | - | - | + | II | 30 |
| *Veronica hederifolia* (Sea) | C | - | + | - | - | + | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 15 |
| *Corylus avellana* (Qpp) | A2 | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 5 |
| | B1 | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | I | 5 |
| | B2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | - | - | - | - | - | + | I | 5 |
| | S | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | + | - | - | - | - | - | +-1 | I | 10 |
| *Galeopsis pubescens* (Qpp,Epa) | C | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | - | + | - | + | I | 10 |
| *Hypericum hirsutum* (Qpp) | C | - | - | + | - | - | - | - | - | - | + | - | - | - | - | - | - | - | - | - | - | + | I | 10 |
| *Loranthus europaeus* (Cp,Qpp) | A1 | + | - | - | - | - | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | + | I | 10 |
| *Neottia nidus-avis* (F,Qpp) | C | + | - | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 10 |
| *Scrophularia nodosa* (GA,Epa) | C | - | - | - | - | - | + | - | - | - | - | - | + | - | - | - | - | - | - | - | - | + | I | 10 |
| *Symphytum tuberosum* ssp. *angustifolium* (F,Cp, | C | - | - | + | - | - | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | + | I | 10 |
| *Cephalanthera damasonium* (Qpp) | C | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 5 |
| *Epipactis helleborine* agg. (F) | C | - | - | - | - | - | - | - | - | - | - | + | - | - | - | - | - | - | - | - | - | + | I | 5 |
| *Ficaria verna* (Ai) | C | - | - | - | - | - | - | - | - | - | + | - | - | - | - | - | - | - | - | - | - | + | I | 5 |
| *Melittis carpatica* (Cp,Qpp,Qc) | C | - | - | - | - | - | - | - | - | - | - | + | - | - | - | - | - | - | - | - | - | + | I | 5 |
| *Ranunculus auricomus* agg. (MoA) | C | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | - | + | I | 5 |
| *Staphylea pinnata* (Cp,TA) | B1 | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 5 |
| | B2 | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 5 |
| | S | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 5 |
| *Vicia sepium* (Ara,Qpp) | C | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 5 |
| **Fagetalia sylvaticae** | | | | | | | | | | | | | | | | | | | | | | | | |
| *Carex sylvatica* | C | + | + | 1 | + | + | + | + | + | 1 | 1 | + | + | + | + | + | + | + | + | + | + | +-1 | V | 100 |
| *Carpinus betulus* (Cp) | A1 | - | - | - | - | - | 1 | - | 1 | 2 | - | 1 | + | 2 | - | 2 | 2 | 2 | 1 | 2 | 3 | +-3 | III | 60 |
| | A2 | 2 | 2 | - | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 1-2 | V | 95 |
| | B1 | + | + | 2 | 2 | 1 | 2 | 1 | 1 | 2 | 1 | + | + | + | 1 | + | 1 | + | 1 | + | - | +-2 | V | 95 |
| | B2 | + | + | - | + | - | + | + | - | + | + | - | + | + | + | + | + | + | + | + | - | + | IV | 75 |
| | S | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 1 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | 4 | 1-4 | V | 100 |

| Table 1/3. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | A-D | K | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Lonicera caprifolium* (OCa) | B1 | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | + | - | - | + | I | 10 |
| | B2 | - | - | + | + | + | - | - | - | + | + | + | + | 1 | - | - | - | - | + | + | + | +-1 | III | 55 |
| | S | - | - | + | + | + | - | - | - | + | + | + | + | 1 | - | - | - | - | + | + | + | +-1 | III | 55 |
| *Ruscus aculeatus* (Qfa) | C | + | + | - | + | 1 | + | 1 | + | - | - | - | - | - | - | - | - | - | - | - | - | +-1 | II | 35 |
| *Asperula taurina* (Cp) | C | - | - | - | - | - | - | - | - | - | - | + | - | + | - | + | + | - | - | - | - | + | I | 20 |
| *Rosa arvensis* (Cp,Qfa) | B2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | + | + | - | + | I | 15 |
| *Helleborus odorus* (QFt,Qfa) | C | - | - | - | + | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 10 |
| **Quercetea pubescentis-petraeae** | | | | | | | | | | | | | | | | | | | | | | | | |
| *Rosa canina* agg. (Pru,Pru) | B2 | - | - | + | - | - | + | - | - | - | + | - | - | + | - | - | - | - | - | - | - | + | I | 20 |
| *Quercus cerris* (Qr,PQ) | A1 | - | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 5 |
| | B2 | - | - | - | - | + | - | - | - | - | - | - | + | - | - | - | - | - | - | + | - | + | I | 15 |
| | S | - | - | - | - | + | - | - | - | - | - | - | + | - | - | - | - | - | - | + | - | + | I | 15 |
| *Malus sylvestris* (Ai,Cp) | B2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | + | I | 5 |
| **Quercion farnetto** | | | | | | | | | | | | | | | | | | | | | | | | |
| *Tilia tomentosa* (AF) | A1 | - | 1 | + | - | 1 | - | - | - | - | - | - | - | - | - | - | - | + | - | - | - | +-1 | I | 20 |
| | A2 | 1 | - | 2 | - | - | + | + | + | 1 | 1 | - | - | - | - | - | - | - | - | - | 1 | +-2 | II | 40 |
| | B1 | 4 | 3 | 3 | 3 | 3 | 4 | 3 | 4 | 3 | 3 | 1 | 2 | 2 | 2 | 1 | 1 | 2 | 3 | 2 | 2 | 1-4 | V | 100 |
| | B2 | 1 | 1 | + | 1 | 1 | 1 | + | + | + | 1 | + | 1 | 1 | + | 1 | - | 2 | 1 | 1 | + | +-2 | V | 95 |
| | S | 4 | 3 | 4 | 3 | 3 | 4 | 3 | 4 | 3 | 3 | 1 | 2 | 2 | 2 | 2 | 1 | 3 | 3 | 2 | 2 | 1-4 | V | 100 |
| **Indifferens** | | | | | | | | | | | | | | | | | | | | | | | | |
| *Sambucus nigra* (Epa,US,QFt) | B1 | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 5 |
| | B2 | - | - | - | + | - | + | + | - | + | + | + | + | + | + | + | + | - | - | + | - | + | III | 60 |
| | S | - | - | - | + | - | + | + | - | + | + | + | + | + | + | + | + | - | - | + | - | + | III | 60 |
| *Galium aparine* (Sea,Epa,QFt) | C | + | + | + | + | 1 | + | + | + | + | + | - | - | - | - | - | - | + | - | - | - | +-1 | III | 55 |
| *Rubus caesius* (Spu) | B2 | + | - | + | + | + | + | - | + | - | + | - | + | - | + | + | - | + | - | - | - | + | III | 55 |
| *Glechoma hederacea* (MoA,QFt,Sal,Ai) | C | - | + | + | + | + | - | - | + | + | + | - | - | - | - | - | + | - | + | 1 | - | +-1 | III | 50 |
| *Urtica dioica* (Ar,GA,Epa,Spu) | C | - | - | - | + | - | - | + | - | + | - | - | - | - | - | + | - | - | - | - | - | + | I | 20 |
| *Chelidonium majus* (Che,Ar,GA,Epa) | C | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 5 |
| *Rubus fruticosus* agg. (QFt,Epa,US) | B2 | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 5 |
| **Adventiva** | | | | | | | | | | | | | | | | | | | | | | | | |
| *Juglans nigra* | B2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | - | - | - | - | + | I | 5 |
| *Robinia pseudo-acacia* | B1 | - | - | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | I | 5 |

**Abbreviations:** A1: upper canopy layer; A2: lower canopy layer; AF: *Aremonio-Fagion*; Agi: *Alnenion glutinosae-incanae*; Ai: *Alnion incanae*; Ar: *Artemisietea*; Ara: *Arrhenatheretea*; Ate: *Alnetea glutinosae*; B1: shrub layer; B2: regrowth; C: herb layer; Bia: *Bidentetea*; Cal: *Calystegion sepium*; Che: *Chenopodietea*; Cp: *Carpinenion betuli*; Des: *Deschampsion caespitosa*; Epa: *Epilobietea angustifolii*; Epn: *Epilobion angustifolii*; EuF: *Eu-Fagenion*; F: *Fagetalia sylvaticae*; GA: *Galio-Alliarion*; MoA: *Molinio-Arrhenatherea*; OCa: *Orno-Cotinetalia*; Pla: *Plantaginetea*; PQ: *Pino-Quercetalia*; Pru: *Prunetalia spinosae*; Qc: *Quercetalia cerris*; Qfa: *Quercion farnetto*; QFt: *Querco-Fagetea*; Qpp: *Quercetea pubescentis-petraeae*; Qr: *Quercetalia roboris*; Sal: *Salicion albae*; Sea: *Secalietea*; s.l.: sensu lato (in a broader sense); Spu: *Salicetea purpureae*; TA: *Tilio platyphyllae-Acerenion pseudoplatani*; Ulm: *Ulmenion*; US: *Urtico-Sambucetea*; VP: *Vaccinio-Piceetea*.

| **Table 1/4. Data recorded** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
|---|---|---|---|---|---|---|---|---|---|---|
| Sample number | 14248 | 14249 | 14250 | 14251 | 14252 | 14261 | 14262 | 14263 | 14264 | 14265 |
| Sampling year | 2007 | 2007 | 2007 | 2007 | 2007 | 2007 | 2007 | 2007 | 2007 | 2007 |
| Sampling time | 16.05 | 16.05 | 16.05 | 16.05 | 16.05 | 17.05 | 17.05 | 16.05 | 16.05 | 16.05 |
| Altitude a.s.l. (m) | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Sloping (degree) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Upper canopy coverage (%) | 75 | 80 | 70 | 75 | 85 | 70 | 90 | 70 | 75 | 70 |
| Lower canopy coverage (%) | 20 | 25 | 30 | 10 | 20 | 10 | 10 | 10 | 20 | 10 |
| Shrub layer coverage (%) | 70 | 50 | 70 | 60 | 50 | 70 | 50 | 70 | 60 | 70 |
| Re-growth coverage (%) | 3 | 5 | 20 | 5 | 3 | 15 | 15 | 20 | 1 | 5 |
| Herb layer coverage (%) | 30 | 30 | 30 | 30 | 40 | 15 | 15 | 25 | 30 | 25 |
| Upper canopy height (m) | 33 | 32 | 33 | 32 | 32 | 32 | 33 | 35 | 32 | 33 |
| Lower canopy height (m) | 20 | 22 | 10 | 18 | 20 | 22 | 20 | 22 | 18 | 15 |
| Shrub layer height (cm) | 400 | 200 | 500 | 400 | 250 | 350 | 300 | 400 | 400 | 400 |
| Mean trunk diameter (cm) | 60 | 60 | 60 | 55 | 55 | 60 | 60 | 60 | 55 | 60 |
| Size of sampling area ($m^2$) | 1200 | 1200 | 1200 | 1000 | 1000 | 1200 | 1200 | 1200 | 1000 | 1200 |

| Table 1/5. Data recorded | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|
| Sample number | 14243 | 14244 | 14245 | 14246 | 14247 | 14257 | 14258 | 14259 | 14260 | 14266 |
| Sampling year | 2007 | 2007 | 2007 | 2007 | 2007 | 2007 | 2007 | 2007 | 2007 | 2007 |
| Sampling time | 07.31 | 07.31 | 07.31 | 07.31 | 07.31 | 07.31 | 07.31 | 07.31 | 07.31 | 07.31 |
| Altitude a.s.l. (m) | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Sloping (degree) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Upper canopy coverage (%) | 90 | 90 | 90 | 85 | 85 | 80 | 90 | 90 | 80 | 85 |
| Lower canopy coverage (%) | 25 | 25 | 25 | 40 | 40 | 40 | 30 | 30 | 40 | 30 |
| Shrub layer coverage (%) | 40 | 40 | 50 | 30 | 10 | 30 | 30 | 50 | 30 | 20 |
| Re-growth coverage (%) | 10 | 30 | 25 | 20 | 10 | 30 | 40 | 15 | 30 | 30 |
| Herb layer coverage (%) | 10 | 30 | 70 | 40 | 50 | 50 | 50 | 40 | 60 | 5 |
| Upper canopy height (m) | 34 | 35 | 30 | 30 | 30 | 28 | 32 | 32 | 32 | 28 |
| Lower canopy height (m) | 22 | 22 | 20 | 18 | 18 | 20 | 22 | 20 | 20 | 22 |
| Shrub layer height (cm) | 250 | 200 | 200 | 200 | 150 | 150 | 200 | 250 | 150 | 250 |
| Mean trunk diameter (cm) | 70 | 70 | 60 | 55 | 60 | 55 | 70 | 70 | 65 | 60 |
| Size of sampling area ($m^2$) | 1200 | 1200 | 800 | 600 | 800 | 600 | 1200 | 1200 | 1200 | 800 |

Location: 1-19: Beli Manastir, Haljevo forest; 20: Kozarac forest.
Altitude a.s.l.: 1-20: cca. 100 m.
Rock type: 1-20: young alluvium.
Soil: 1-20: brown forest soil.
Survey made by: 1-10, : Balázs Kevey and Sándor Csete; 11-20: Balázs Kevey.

## 5.2. Species combinations

As shown in the 20 coenological relevés (Table 1.), the plant association consists of 20 constant and 9 sub-constant species: K V: *Acer campestre, Alliaria petiolata, Brachypodium sylvaticum, Carex sylvatica, Carpinus betulus, Cerasus avium, Circaea lutetiana, Euonymus europaea, Fagus sylvatica, Galium odoratum, Geranium robertianum, Geum urbanum, Hedera helix, Lamium maculatum, Pulmonaria officinalis, Quercus robur, Stachys sylvatica, Tilia tomentosa, Veronica montana, Viola sylvestris*. - K IV: *Ajuga reptans, Carex remota, Crataegus monogyna, Dactylis polygama, Ligustrum vulgare, Polygonatum multiflorum, Rumex sanguineus, Sanicula europaea, Viola alba*.

Based on the percentage (proportion) of characteristic species of different syntaxa weighted by their K% (Table 2.) and A-D% (Table 3.) the following characteristic species play a determining role in the studied beech stands:

In the beech stands of the Baranja, it is *Fagetalia* elements (percentage of characteristic species of different syntaxa based on K is 30.9%, percentage of characteristic species of different syntaxa based on A-D is 41.0%) that play the most important role. The most significant species are: *Acer platanoides, Acer pseudo-platanus, Actaea spicata, Arum orientale, Athyrium filix-femina, Cardamine impatiens, Carex sylvatica, Carpinus betulus, Cerasus avium, Corydalis cava, Dentaria bulbifera, Dryopteris filix-mas, Euphorbia amygdaloides, Fagus sylvatica, Galium odoratum, Hedera helix, Milium effusum, Moehringia trinervia, Primula vulgaris, Pulmonaria officinalis, Rubus hirtus, Salvia glutinosa, Sanicula europaea, Stachys sylvatica, Ulmus glabra, Veronica montana, Viola sylvestris*.

A few *Alnion incanae* species (percentage of characteristic species of different syntaxa weighted by their K is 7.9%, percentage of characteristic species of different syntaxa weighted by their A-D is 3.8%) give some gallery forest character to the association: *Carex remota, C. strigosa, Cerastium sylvaticum, Circaea lutetiana, Paris quadrifolia, Viburnum opulus*, etc.

There are also several plant species with sub-Mediterranean distribution in the studied beech stands, such as: *Asperula taurina, Carex strigosa, Carpesium abrotanoides, Helleborus odorus, Lonicera caprifolium, Primula vulgaris, Rosa arvensis, Ruscus aculeatus, Scutellaria altissima, Tamus communis, Tilia tomentosa*. either clasified *Aremonio-Fagion* (percentage of characteristic species of this syntaxon weighted by their K is 3.5%, percentage of characteristic species of syntaxa weighted by their A-D is 8.3%), or into *Quercion farnetto* (percentage of characteristic species of this syntaxon weighted by their K: 2.6%, percentage of characteristic species of this syntaxon weighted by their A-D is 8.1%).

# 6. Discussion

The above results show that quite a number of mesophilous deciduous forest elements (*Fagetalia*) find refuge in the beech stands of Baranja. In this respect these forests are similar to the oak-hornbeam forests of young alluvial areas of the Drava plains in Somogy and Baranya counties (Kevey 2006b, 2007), of the Sava plains (Kalinić & Rauš 1973; Rauš 1975; Rauš et al. 1985), or with beech stands of the Mura river (Kevey ined.), Drava river (Rauš 1971; Kevey 1984, 1996-1997, 1997), Sava river (Kalinić & Rauš 1973; Rauš 1975), the Bodrogköz region (Hargitai 1938-1939, Kevey ined.), and the Bereg-Szatmár plain (Simon 1951, 1957; Kevey ined.). The reason for such similarity is probably the cool and humid meso- and microclimatic effects created by the proximity of rivers. Based on their habitat characteristics, these beech stands with gallery forest features can be grouped with the *fagetosum* sub-association of the *Circaeo-Carpinetum* association, whose syntaxonomic location is shown as follows:

Division: **QUERCO-FAGEA** Jakucs 1967
Class: **QUERCO-FAGETEA** Br.-Bl. et Vlieger in Vlieger 1937 em. Borhidi in Borhidi et Kevey 1996
Order: ***FAGETALIA SYLVATICAE*** Pawłowski in Pawłowski et al. 1928
Group: **Fagion sylvaticae** Luquet 1926
Subgroup: ***Carpinenion betuli*** Issler 1931
Association: *Circaeo-Carpinetum* Borhidi 2003 em. Kevey 2006b
*fagetosum* Rauš 1975

There might have been special floral evolutional aspects playing a role in creating the species composition of Baranja beech stands. This is suggested by the fact that there are several plant species occurring in the Harkány-Nagynyárád plain constituting the eastern part of the Dráva-plane area, and also in the Baranja that are specific elements of the Mecsek floral subdistrict (*Sopianicum*): e.g. *Asperula taurina, Digitalis ferruginea, Helleborus odorus, Ranunculus psilostachys, Scutellaria altissima* (Horvát 1942a, 1942b, 1972-1973, 1974, 1976; Kevey & Horvát 2000; Vöröss 1965). These plants, however, are absent from the *Dravense* floral subdistrict. *Lonicera caprifolium* can also be grouped with these species, but it does appear in some localities of the eastern fringes of the Ormánság region. Thus, the beech stands of the Baranja show some relatedness with the oak-hornbeam forests (*Asperulo taurinae-Carpinetum*) and beech woods (*Helleboro*

Table 2. Percentage of different syntaxa weighed by K% for character species (%)

| | |
|---|---|
| **Molinio-Arrhenatherea** | 1.0 |
| Arrhenatheretea (incl. Arrhenatheretalia) | 0.3 |
| **Molinio-Arrhenatherea s.l.** | 1.3 |
| **Chenopodio-Scleranthea** | 0.0 |
| Secalietea | 0.5 |
| Chenopodietea | 0.1 |
| Artemisietea (incl. Artemisietalia et Arction lappae) | 0.2 |
| Galio-Urticetea (incl. Calystegietalia sepium) | 0.0 |
| Galio-Alliarion | 1.8 |
| Calystegion sepium | 0.6 |
| Galio-Urticetea s.l. | 2.4 |
| Epilobietea angustifolii (incl. Epilobietalia) | 5.9 |
| Epilobion angustifolii | 0.2 |
| Epilobietea angustifolii s.l. | 6.1 |
| Urtico-Sambucetea (incl. Sambucetalia et Sambuco-Salicion capreae) | 0.6 |
| **Chenopodio-Scleranthea s.l.** | 9.9 |
| **Querco-Fagea** | 0.0 |
| Salicetea purpureae (incl. Salicetalia purpureae) | 0.8 |
| Salicion albae | 1.3 |
| Salicetea purpureae s.l. | 2.1 |
| Alnetea glutinosae (incl. Alnetalia glutinosae) | 0.6 |
| Querco-Fagetea | 16.6 |
| Fagetalia sylvaticae | 30.9 |
| Alnion incanae | 7.1 |
| Alnenion glutinosae-incanae | 0.4 |
| Ulmenion | 0.4 |
| Alnion incanae s.l. | 7.9 |
| Fagion sylvaticae | 0.0 |
| Eu-Fagenion | 2.3 |
| Carpinenion betuli | 5.3 |
| Tilio platyphyllae-Acerenion pseudoplatani | 1.3 |
| Fagion sylvaticae s.l. | 8.9 |
| Aremonio-Fagion | 3.5 |
| Fagetalia sylvaticae s.l. | 51.2 |
| Quercetalia roboris | 0.3 |
| Querco-Fagetea s.l. | 68.1 |
| Quercetea pubescentis-petraeae | 12.1 |
| Orno-Cotinetalia | 0.7 |
| Quercion farnetto | 2.6 |
| Orno-Cotinetalia s.l. | 3.3 |
| Prunetalia spinosae | 0.3 |
| Quercetea pubescentis-petraeae s.l. | 15.7 |
| **Querco-Fagea s.l.** | 86.5 |
| **Abieti-Piceea** | 0.0 |
| Vaccinio-Piceetea | 0.1 |
| Pino-Quercetalia (incl. Pino-Quercion) | 0.1 |
| Vaccinio-Piceetea s.l. | 0.2 |
| **Abieti-Piceea s.l.** | 0.2 |
| **Indifferens** | 1.8 |
| **Adventiva** | 0.2 |

Table 2. Percentage of different syntaxa weighed A-D% for character species (%)

| | |
|---|---|
| **Molinio-Arrhenatherea** | 0.2 |
| **Chenopodio-Scleranthea** | 0.0 |
| Galio-Urticetea (incl. Calystegietalia sepium) | 0.0 |
| Galio-Alliarion | 0.2 |
| Calystegion sepium | 0.1 |
| Galio-Urticetea s.l. | 0.3 |
| Epilobietea angustifolii (incl. Epilobietalia) | 0.5 |
| **Chenopodio-Scleranthea s.l.** | 0.8 |
| **Querco-Fagea** | 0.0 |
| Salicetea purpureae (incl. Salicetalia purpureae) | 0.0 |
| Salicion albae | 0.2 |
| Salicetea purpureae s.l. | 0.2 |
| Querco-Fagetea | 11.2 |
| Fagetalia sylvaticae | 37.1 |
| Alnion incanae | 6.9 |
| Alnenion glutinosae-incanae | 0.1 |
| Ulmenion | 0.1 |
| Alnion incanae s.l. | 7.1 |
| Fagion sylvaticae | 0.0 |
| Eu-Fagenion | 0.3 |
| Carpinenion betuli | 21.3 |
| Tilio platyphyllae-Acerenion pseudoplatani | 0.2 |
| Fagion sylvaticae s.l. | 21.8 |
| Aremonio-Fagion | 5.0 |
| Fagetalia sylvaticae s.l. | 71.0 |
| Querco-Fagetea s.l. | 82.2 |
| Quercetea pubescentis-petraeae | 10.9 |
| Orno-Cotinetalia | 0.1 |
| Quercion farnetto | 4.8 |
| Orno-Cotinetalia s.l. | 4.9 |
| Quercetalia cerris | 0.0 |
| Aceri tatarico-Quercion | 0.1 |
| Quercetalia cerris s.l. | 0.1 |
| Prunetalia spinosae | 0.1 |
| Quercetea pubescentis-petraeae s.l. | 16.0 |
| **Querco-Fagea s.l.** | 98.4 |
| **Indifferens** | 0.2 |
| **Adventiva** | 0.2 |

*odoro-Fagetum*) of Mecsek floral subdistrict (*Sopianicum*), and also with Illyrian beechwoods ( HORVÁT 1957b, 1958; BORHIDI 1963, 1965, 1966, 1968). This is partly due to the fact that Baranja is one of the southernmost parts of the Hungarian plains, with sub-Mediterranean climate (RAUŠ 1975; RAUŠ et al. 1985), also directly adjacent to some smaller units of the floral district of South-Transdanubia (*Praeillyricum*), such as the Baranyai hilly region, or Villány Hills.

If the percentage of characteristic species of different syntaxa based on K of the Szentegát forest between the villages of Bürüs and Dencsháza (KEVEY 1996-1997) and in the beech stands of the Baranja (Beli Manastir - Kozarac) is compared, some interesting correlations can be observed. Namely, the proportion of *Fagetalia* and *Alnion incanae* elements decrease from the north-west towards the south-east, whereas that of increases *Quercetea pubescentis-petraeae* species (Fig. 2.). This, on the one hand, suggests that the chances for the migration of sub-montane elements decreases from the western section of Drava towards the south-east. On the other hand, the climate of these floodplain sections also changes gradually: the diminishing sub-Atlantic and increasing continental effects towards the south-east cause *Fagetalia* elements to become rarer, and *Quercetea pubescentis-petraeae* species to occur more frequently (Fig. 2.). This is understandable, since – according to the climatic zonal map produced by BORHIDI (1961) – the Baranya county section of Drava, including the Szentegát forest, belong to the closed oak wood zone, whereas the Baranja is part of the forest steppe zone. In a downstream direction along the Drava, *Aremonio-Fagion* and *Quercion farnetto* elements show an increase in frequency (Fig. 3.), which is related to the gradual increase of sub-Mediterranean effects towards the south-east.

It is striking that despite the forest steppe climate prevailing here, there are scattered beech stands among oak-hornbeam forests (*Circaeo-Carpinetum*) in the Baranja region. This is primarily due to the fact that the relatively high water table, maintained by the large number of watercourses crossing the area, enables the persistance of a cool and humid microclimate. These lowland beech woods (*Circaeo-Carpinetum fagetosum*), thus, have been able to develop, in addition to their own zone, in the forest steppe zone as well. Accordingly, their occurrence in lowland areas is considered to be extrazonal.

It must be noted that some foresters regard beech as artificially planted (e.g. Drava left side plain: Szentegát forest between Bürüs and Dencsháza). HORVÁT (1942b), too, consider the origin of the Beli Manastir beech wood as being uncertain. Contrary to these doubts, there are arguments that confirm the nativeness of beech along Drava. For example, a geographic name on the Drava plain (Páprád, ”Bükk-hát” – ”bükk” meaning beech) suggests the occurrence of beech woods there in earlier times, at a location where this tree species grows even today (KEVEY 1995). Furthermore, a document from Sámod, dating back to the age of the Árpád dynasty mentions beech as ”*arbor que dicitur bykfa*” (REUTER 1963). This is further supported by another piece of evidence (Bolman = Bolmány) from the period of King Joseph II (KEVEY 1984, 1995). The studied forest ”Haljevo šuma” is about 8 km both from Bolmány (Bolman) and from Beli Manastir, and thus it is possible that the data from the period of King Joseph II relate to the beech stand of the Haljevo forest. Our survey data, too, from the Szentegát forest (HORVÁT 1972; KEVEY 1984, 1996-1997, 1997a) and the Haljevo forest (Tables 1-3.) suggest the nativeness of beech here, because several species of *Fagetalia* and some belonging to *Fagion* do find refuge here. In addition, Croatian studies (KALINIĆ & RAUŠ 1973; RAUŠ 1971, 1975; RAUŠ et al. 1985) also confirm the nativeness of beech in these areas along Drava. Our experience supports the above opinions, because beech occurs in the oak-hornbeam stands of Haljevo forest as single specimens, and also produces healthy re-growth. In these forest sections beech individuals are represented at a wide scale of age ranging from seedlings to old specimens. Their stands appears to be healthy with no trace of any disease.

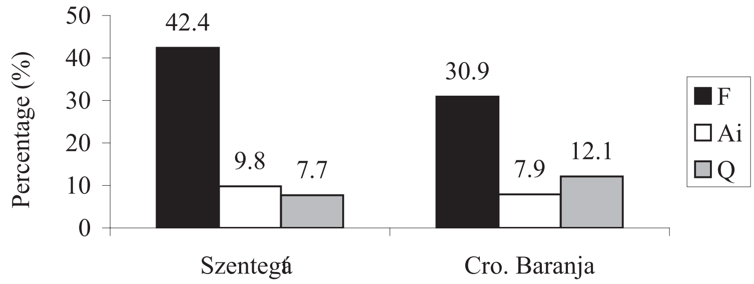


Fig. 2. Percentage of different syntaxa weithed by K% for character species of Fagetalia (F), Alnion incanae (Ai) and Quercetea (Q) elements in the beech stands of Szentegát and Croatian Baranja

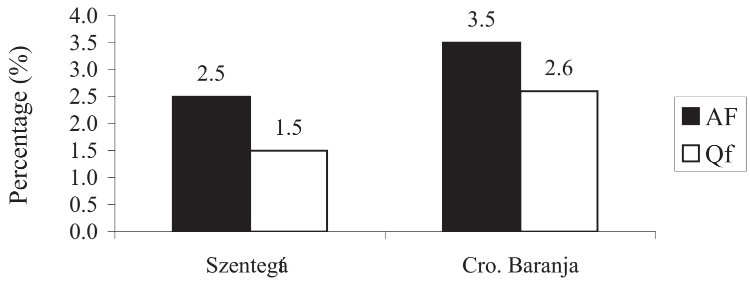


Fig. 3. Percentage of different syntaxa weithed by K% for character species of Aremonio-Fagion (AF) and Quercion farnetto (Qf) elements in the beech stands of Szentegát and Croatian Baranja

# 7. Nature conservation implications

Relatively many montane and sub-Mediterranean plant species find refuge in the beech forest stands of the Croatian Baranja region. Unfortunately, lowland beech stands have diminished considerably because of the climatic changes since 800 B.C., and their stands that have survived until present time have been confined by forestry management to smaller and smaller pockets of land (Ormánság: Páprád ”Bükk-hát”; Bereg-Szatmár plain: Beregdaróc ”Dédai-forest”; Bodrogköz: Sátoraljaújhely ”Long-forest”). For this reason it is a very positive fact that smaller or greater near-natural beechwoods still exist here, whose nature conservation value is outstanding from points of view of vegetation and floral history. Their sub-montane species (e.g. *Actaea spicata, Euphorbia amygdaloides, Fagus sylvatica, Galium odoratum, Milium effusum, Salvia glutinosa, Sanicula europaea,* *Veronica montana* ect.) are, in part, south-montane adventive floral elements brought here by rivers, but the majority probably date back to the Beech I period lasting from 3000 B.C. to 800 B.C. However, the sub-Mediterranean species (e.g. *Asperula taurina, Carex strigosa, Carpesium abrotanoides, Lonicera caprifolium, Primula vulgaris, Ruscus aculeatus, Tamus communis, Tilia tomentosa*) have survived from the Oak period, 5500 B.C. to 3000 B.C. (Zólyomi 1936, 1952; Járai-Komlódi, M. 1966a, 1966b, 1968). This peculiar species combination further increases the significance of the beech forests of the Baranja region from the viewpoint of historical phytogeography.

A total of 12 species have been found in the oak-hornbeam forests of the Baranja that are under protection in Hungary further emphasising the significance of these forest associations: *Asperula taurina**, *Carex strigosa**, *Carpesium abrotanoides**, *Cephalanthera damasonium, Dryopteris carthusiana, Epipactis helleborine* agg., *Lonicera caprifolium**, *Neottia nidus-avis, Primula vulgaris**, *Ruscus aculeatus**, *Tamus communis**. Rauš (1971) mentioned two other protected species from the beech stands of Haljevo forest: *Polystichum aculeatum, Platanthera bifolia*. In the case of plants marked with * among the above listed species, the distribution is concentrated around the floral district of South-Transdanubia (*Praeillyricum*).

The Duna-Drava National Park was inaugurated in 1996. The forests analysed as part of the present study – probably because of the presence of political borders and the related conflicts of interests – were not brought under protection. In the future it would be necessary to ensure legal protection for these oak-hornbeam forests before they eventually fall victim to forestry management that is becoming more and more intensive. In this respect, the recommendations for natural forest renewal by Papp (1975) in oak-hornbeam forests along river Drava and in beech stands of the Szentegát forest (Bürüs, Dencsháza) are notable, which would help preserve the current status of these near-natural forests.

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# Gallery forests of the Drava floodplain NE-Croatia, SW-Hungary

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**Abstract**: The current paper provides a summary of forest associations found in the floodplain areas along river Drava on the Hungarian-Croatian state border. According to our study results, these woody plant associations can be regarded as identical with gallery forests of other lowland areas (*Rumici crispi-Salicetum purpureae, Polygono hydropiperi-Salicetum triandrae, Leucojo aestivi-Salicetum albae, Carduo crispi-Populetum nigrae, Senecioni sarracenici-Populetum albae*). However, the sporadic or more frequent occurrence of some rare plants (*Carex strigosa, Chlorocyperus glomeratus, Equisetum hyemale, Oenanthe banatica, Myricaria germanica, Peucedanum verticillare, Salix elaeagnos*) give these associations some local characteristics.

## 1. Introduction

During quite a long period it was not possible to do any research into the association relations of floodplain forests along Drava, due to the fact that the area used to be strictly guarded as a political border zone. It was not until the 1990s that significant changes did occur in this respect. Information about the association relations of these gallery forests is, thus, still very limited. Because relatively few publications have appeared about the plant associations of the Drava plains, the authors have found it important to publish their knowledge having gained so far on this matter.

## 2. Material and methods

From our earlier research, we have become quite familiar with the Hungarian section of the Drava plains. Thus, in 2007 we aimed at finding out about the Croatian part of the floodland plains, and thus made observations and surveys in several of the forests in the area between Gola and Beli Manastir (Fig. 1., 2.).

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Fig. 1. Succession sequence on gravelly alluvium along Drava: ruderal weed association (right), purple willow bush (centre) and young black poplar stand (left)
(Photo by Sándor Csete)

Fig. 2. White poplar gallery forest on middle-high terrain in the Drava floodplain
(Photo by Sándor Csete)

Coenological surveying in these forests was done using the traditional quadrate method of the Zürich-Montpellier phytosociological school (Becking 1957; Kevey et al. 2007). The coenological tables were compiled and statistical calculations done (percentage of different syntaxa based on K%, for character species) using the Kevey and Hirmann (2002) ”NS” computer program package. The calculations are specified more in detail in the papers by Kevey (1993, 1997b, 2006a). At this stage, data collected are informative only, as we had only one vegetation season for the surveys. During this short period, only the oak-hornbeam forests (Kevey & Csete 2008a) and beech stands (Kevey & Csete 2008b) could be surveyed with enough detail. Only few coenological recordings were made in gallery forests on the right side of the Drava, shown in Tab. 1. This table includes also some data that were gathered in surveys on the left side of the river (purple willow bushes and white poplar stands: 2 recordings of each).

The statistical analysis of character species does not include almond-leaved willow bushes (*Polygono hydropiperi-Salicetum triandrae*), because there was no sufficient data collected regarding this type of association. Similarly, we did not analyse white willow gallery forests (*Leucojo aestivi-Salicetum albae*) and alder groves (*Paridi quadrifoliae-Alnetum*), both of which can be found in the studies by Ortmann-Ajkai (1998a, 1998b), with 5 recordings on each associations. These three associations are somewhat off the linear row of successions that we intend to focus on from purple willow bushes (*Rumici crispi-Salicetum purpureae*) to oak-hornbeam forests (*Circaeo-Carpinetum*), through the example of percentage of different syntaxa based on K%, for character species (Tab. 2). In these analyses we have considered also the results presented by Kevey (2006b, 2006c) and Kevey and Tóth (2006). Based on these survey results and other experience gained in the field, we have found similarities between gallery forests of Drava and those of other plain regions.

In case of species we have followed the nomenclature used by Horváth et al. (1995), whereas with associations the nomenclature suggested by Borhidi and Kevey (1996) and Borhidi (2003) is accepted. The structure of coenologial and character species statistical tables are based on the coenological system of Soó (1980), modified according to the latest findings (Oberdorfer 1992; Mucina et al. 1993; Borhidi 2003; Kevey 2006a). Also with the coeno-systematic categorisation of species, we have used primarily the Synopsis by Soó (1964, 1966, 1968, 1970, 1973, 1980), but we have considered more recent research results as well (Borhidi 1993, 1995; Horváth et al. 1995; Kevey 2006a).

## 3. Research history

Forest associations along Drava have been studied since quite recent times only. The first reports were published by Borhidi (1958). The author presented a coenological survey from an ”alder-ash gallery forest” (today named as *Paridi quadrifoliae-Alnetum*). Later on, some relevés were published in the tables by Klujber et al. (1963), Vöröss (1964, 1965) and Tihanyi (1964), which can be identified partly with what are today almond-leaved willow bushes (*Polygono hydropiperi-Salicetum triandrae*), and partly softwood gallery forests (*Leucojo aestivi-Salicetum albae, Senecioni sarracenici-Populetum albae*). In the

1970s, plant associations along Drava were studied by Kovács and Kárpáti (1973, 1974) who presented cross-sections of the vegetation, demonstrating the zonation of terrain along the river. In this period, coenological research was pursued mostly in lowland oak-hornbeam forests (*Circaeo-Carpinetum*) and oak-ash-elm gallery forests (*Fraxino pannonicae-Ulmetum*) further off the Drava (Horvát 1972; Kárpáti in Horvát 1972; Horvát & Kevey 1983, 1984; Rauš 1971; Rauš et al. 1985).

Surveys have followed each other more rapidly as of the 1990s. Ortmann-Ajkai (1998a, 1998b) published coenological tables on the willow groves (*Leucojo aestivi-Salicetum albae*) (*Leucojo aestivi-Salicetum albae*), alder galleries (*Paridi quadrifoliae-Alnetum*), oak-ash-elm galleries (*Fraxino pannonicae-Ulmetum*) and oak-hornbeam forests (*Circaeo-Carpinetum*) of the lowland along the left side of Drava. Kevey (1996-1997, 1997a) presented the coenological analysis of a lowland beech forest (Bürüs - Dencsháza). Later, the coenological analysis of white poplar stands of the left side of Drava was also performed (Kevey & Tóth 2006). Also, it was around this time that the detailed surveys of oak-ash-elm gallery forests (*Fraxino pannonicae-Ulmetum*) and oak-hornbeam forests (*Circaeo-Carpinetum*) of the Somogy and Baranya Drava lowland sections were completed (Kevey 2006b, 2006c, 2007a, 2007b). In addition to these studies, the current volume of studies presents two reports on the association relations of oak-hornbeam forests and beechwoods (*Fraxino pannonicae-Ulmetum fagetosum*) of the Croatian Baranya lowland region (Kevey & Csete 2008a, 2008b).

## 4. Phytogeographic and habitat conditions

The western part of the Drava plains (Gyékényes - Barcs, and Gola - Terezin Polje) belongs to the oak-hornbeam zone, the middle section (Barcs - Drávaszabolcs, and Terezino Polje - Črnakovci) to the closed oakwood zone, whereas its eastern part (Drávaszabolcs - Osijek, and Črnakovci - Osijek) stretch into the forest-steppe zone (Borhidi 1961; Rauš 1975; Rauš et al. 1985). The main reason for this is the decreasing precipitation gradient from the west towards the east and the increasing trend of complex continental effects. This phenomenon was the reason for Kevey (2002) to separate the *Dravense* floral subdistrict from the southern-plain region (*Titelicum* floral subdistrict), the former being made up by areas of the Drava plains in Baranya and Somogy, west of the Harkány - Drávaszabolcs - Črnakovci line. The same climatic features are the main reason why drier oakwoods (*Pulmonario mollis-Quercetum roboris*) are also present (Kevey 2006a) in the eastern, more continental parts of the Drava plains – on terrains that are less prone to being influenced by groundwater levels. Besides, the double-peaked precipitation curve is also typical of this lowland region (Rauš 1975; Rauš et al. 1985), which is definitely a sub-Mediterranean feature. This is the primary reason why several sub-Mediterranean floral elements are present in gallery forests along Drava (e.g. *Carex strigosa, Carpesium abrotanoides, Helleborus dumetorum, Helleborus odorus, Knautia drymeia, Lonicera caprifolium, Oenanthe banatica, Peucedanum verticillare, Polystichum setiferum, Primula vulgaris, Ruscus aculeatus, Tamus communis, Tilia tomentosa*), suggesting that these associations are in relationship with the neighbouring west-Balkan floral subregion (*Illyricum*). However, the development of gallery forests are not influenced considerably by such climatic factors, because the primary ecological factors in this land are represented, instead of macroclimate, by water, predominantly in the form of hydrological regimes, and the levels and fluctuation of groundwater.

# 5. Results

Based on our observations and surveys made along the Drava river section between Őrtilos and Barcs (Kevey, Csete & Lendvai ined.; Kevey 2006b, 2006c; Kevey & Tóth 2006), the findings are as follows.

## 5.1. Ligneous plants of shoals and riverside areas

It is the mineralogenous type of succession that has primary role in the Drava floodplain area, associated with water velocity and, consequently, the quality of deposited alluvium. Shoals and watersides are colonised initially by herbaceous ruderal (*Chenopodietea, Plantaginetea, Bidentetea* stb.), semi-ruderal (*Agropyro-Rumicion crispi*) and silt vegetation (*Nanocyperion*). As these pioneer herbaceous associations become colonised by shrubs, alluvial galleries and subsequently willow bush associations will form.

### 5.1.2. Alluvial gallery forests (*Salici-Myricarietum* Moor 1958 and *Salici incanae-Hippophaëtum* Br.-Bl. in Volk 1939)

The initial ligneous plant associations to establish on shoals are German tamarisk and hippophaë alluvial groves (*Salici-Myricarietum, Salici incanae-Hippophaëtum*). In this type of habitat the soil is usually made up of raw gravely and pebbly alluvial substrate, sometimes covered with a veil of silt or fine sand. Typical plants are the protected *Myricaria germanica*, *Salix elaeagnos* and *Hippophaë rhamnoides*. As revealed by observations, *Salix elaeagnos* occurs in several locations in the section between Őrtilos and Vízvár. *Hippophaë rhamnoides*, however, was found in the middle of the previous century in the Zákány floodplain, but its current occurrence has not been confirmed so far. According to more recent observations, *Myricaria germanica* does show up sporadically on gravel shoals, but is unable to survive for extended periods. This is because the rapid succession of shoals leads to the habitat turning into a purple willow association (*Rumici crispi-Salicetum purpureae*) during a few years' time, and *Salix purpurea* shades out *Myricaria germanica* from the habitat.

### 5.1.3. Purple willow bush (*Rumici crispi-Salicetum purpureae* KEVEY in BORHIDI & KEVEY 1996)

The substrate of shoals and waterside in the main riverbed of Drava where water velocity is high, is gravel or coarse sand. In the lower, Baranya section only sandy shoals are found. The water turnover in such habitats is characterised with extremities, because at low water levels the coarse substrate cannot retain water, and thus the habitat dries out considerably. Under such circumstances, purple willow bush associations (*Rumici crispi-Salicetum purpureae*) become established by taking over the habitat from different ruderal and semi-ruderal herbaceous associations (KEVEY 1998).

The shrub layer of such vegetation is a few metres high, with *Salix purpurea*, *Salix alba* and *Populus nigra* occurring in greater amounts. Their herb layer typically consists of *Agrostis stolonifera*, *Poa palustris*, *Phalaroides arundinaceum*, but ruderal and semi-ruderal species can occur as well: *Amaranthus albus, A. chlorostachys, A. retroflexus, Atriplex hastata, Rumex crispus*, *Chenopodium polyspermum*, *Ch. rubrum*, *Bromus sterilis*, etc. In the young stands of such willow bush associations sometimes the protected *Myricaria germanica*, having survived from alluvial groves, can still be found, whereas *Salix elaeagnos* can be present even in more mature stands. There are some very nice, near-natural occurrences of these bush associations in the Drava section between Őrtilos and Barcs, where there is gravel deposition in the unregulated river-bends. Of these, the authors have managed to make two coenological surveys so far (Table 1.).

Table 1. Gallery forests of the Drava floodplain

| Table 1/1. | | Sal. p. | | Pop. n. | | | Pop. a. | | | Ulm. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| **Phragmitetea** | | | | | | | | | | |
| *Carex acutiformis* (Mag,Cgr,MoJ,Sal,Ate) | C | - | - | - | - | - | - | - | - | + |
| *Carex riparia* (Mag,Cgr,MoJ,Sal,Ate) | C | - | - | - | - | + | - | - | + | - |
| *Iris pseudacorus* (Sal,Ate,Ai) | C | - | - | + | + | + | + | - | - | + |
| *Phalaroides arundinacea* (Des) | C | 1 | + | + | + | - | - | - | + | - |
| *Phragmites australis* (MoJ,FPe,Spu,Ate) | C | - | + | - | - | - | - | - | + | - |
| *Poa palustris* (MoJ,Des,Spu,Ate,Ai) | C | - | - | - | - | + | - | - | - | - |
| *Rorippa amphibia* (Pla,Spu,Ate) | C | + | + | - | - | - | - | - | - | - |
| *Rumex palustris* (Bia,Pla) | C | + | + | - | - | - | - | - | - | - |
| *Solanum dulcamara* (Cal,Bia,Spu,Ate,Ai) | C | - | + | - | - | + | - | + | + | - |
| **Caricenion gracilis** | | | | | | | | | | |
| *Carex gracilis* (Pte,Mag,MoJ,Ate,Ai) | C | - | - | + | 1 | 1 | 2 | 1 | + | - |
| **Nanocyperion flavescentis** | | | | | | | | | | |
| *Chlorocyperus glomeratus* (Bia) | C | + | 1 | - | - | - | - | - | - | - |
| **Molinio-Arrhenatherea** | | | | | | | | | | |
| *Achillea millefolium* (Ara) | C | - | - | + | - | - | - | - | - | - |
| *Briza media* (FBt,Qpp) | C | - | - | + | - | - | - | - | - | - |
| *Campanula patula* (Arn) | C | - | - | - | - | - | - | - | + | - |
| *Cardamine pratensis* (Mag,Des,Sal,Ate,Ai) | C | + | - | - | - | - | - | - | - | + |
| *Centaurea jacea* | C | - | + | - | - | - | - | - | - | - |
| *Holcus lanatus* (Qpp,Qrp,PQ) | C | - | - | + | - | - | - | - | - | - |
| *Poa pratensis* (Qpp) | C | - | - | - | - | + | - | + | + | - |
| *Poa trivialis* (Pte,Spu,Ate,Ai) | C | + | - | - | + | + | + | + | + | + |

| Table 1/2. | | Sal. p. | | Pop. n. | | | Pop. a. | | | Ulm. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** |
| *Rumex acetosa* (Mag,Qrp,Qpp) | C | + | - | - | - | - | - | - | - | - |
| *Rumex crispus* (Mag,Cal,Bia,Pla,AR) | C | + | + | - | - | - | - | - | - | - |
| *Vicia cracca* (Mag,Sea,Sci,Qpp) | C | - | - | - | - | - | + | - | - | - |
| **Molinio-Juncetea** | | | | | | | | | | |
| *Deschampsia caespitosa* (Des,Sal,Ate,Ai) | C | + | - | - | - | - | - | - | - | + |
| *Symphytum officinale* (Pte,Cal,Spu,Ate,Ai) | C | - | - | + | + | + | + | + | + | - |
| **Molinietalia coeruleae** | | | | | | | | | | |
| *Angelica sylvestris* (Mag,Ate,Ai) | C | - | - | + | + | + | + | 1 | + | - |
| *Festuca arundinacea* (FPi,AR) | C | + | + | - | - | - | - | - | - | - |
| *Valeriana officinalis* (Mag,FiC) | C | - | - | + | + | + | - | - | + | - |
| **Arrhenatheretea (incl. Arrhenatheretalia)** | | | | | | | | | | |
| *Arrhenatherum elatius* (Alo,Arn,Fvl,Qpp) | C | - | - | + | - | + | - | - | - | - |
| **Festuco-Brometea** | | | | | | | | | | |
| *Cerastium brachypetalum* (Sea,Qpp) | C | - | - | - | - | + | - | - | - | - |
| *Petrorhagia saxifraga* (Fvl) | C | - | + | - | - | - | - | - | - | - |
| **Chenopodio-Scleranthea** | | | | | | | | | | |
| *Artemisia vulgaris* (Ar,Cal,Bia,Pla) | C | + | + | - | - | - | - | - | - | - |
| *Chenopodium album* (CyF) | C | - | + | - | - | - | - | - | - | - |
| *Digitaria sanguinalis* (Ape,TrE) | C | - | + | - | - | - | - | - | - | - |
| *Eragrostis pilosa* (Sea,Pol,Nc) | C | - | + | - | - | - | - | - | - | - |
| *Portulaca oleracea* (Che) | C | + | - | - | - | - | - | - | - | - |
| *Setaria pumila* (Ape,Bia) | C | + | + | - | - | - | - | - | - | - |
| *Tanacetum vulgare* (Ar,Cal,Bia) | C | - | + | - | - | - | - | - | - | - |
| **Secalietea** | | | | | | | | | | |
| *Chenopodium strictum* | C | + | - | - | - | - | - | - | - | - |
| *Eragrostis minor* (TrE,Pol) | C | - | + | - | - | - | - | - | - | - |
| *Melandrium album* (Cau,GA) | C | - | + | - | - | - | - | - | - | - |
| *Panicum capillare* (Che,TrE) | C | + | - | - | - | - | - | - | - | - |
| **Aperetalia (incl. Aphanion)** | | | | | | | | | | |
| *Myosotis arvensis* (Arn,CyF) | C | - | - | + | + | - | - | - | - | - |
| **Chenopodietea** | | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | |
| *Verbena officinalis* (Bia,Pla) | C | - | + | - | - | - | - | - | - | - |
| **Galio-Alliarion** | | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | |
| *Alliaria petiolata* (Epa) | C | - | - | - | - | - | - | - | - | + |
| *Aethusa cynapium* (Che) | C | - | - | - | - | - | + | + | - | - |
| *Chaerophyllum temulum* | C | - | - | - | - | - | - | - | - | + |
| *Melissa officinalis* (Qpp) | C | - | + | - | - | + | - | - | - | - |
| **Calystegion sepium** | | | | | | | | | | |
| *Aristolochia clematitis* (Sea,Sal) | C | - | - | + | + | 1 | 1 | 1 | + | - |
| *Lamium maculatum* (Pa,Agi,F,TA,Qpp) | C | - | - | - | - | - | - | - | - | + |
| *Myosoton aquaticum* (Pte,Spu,Ate,Ai) | C | + | - | - | - | + | - | - | - | - |
| *Rumex obtusifolius* (Sal,Ai) | C | + | - | - | + | - | - | - | - | - |
| *Saponaria officinalis* (Che,Ar) | C | - | + | - | - | - | - | - | - | - |
| **Bidentetea (incl. Bidentetalia)** | | | | | | | | | | |
| *Bidens tripartita* (Pte,Nc,Sea,Sal) | C | + | - | - | - | - | - | - | - | - |
| *Polygonum hydropiper* (Nc,Bin,Spu,Ate,Ai) | C | 1 | - | - | - | - | - | - | - | - |
| *Polygonum mite* (Alo,Bin,Spu,Ai) | C | 1 | + | - | - | - | - | - | - | - |

| Table 1/3. | | Sal. p. | | Pop. n. | | | Pop. a. | | | Ulm. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| **Salicetea purpureae (incl. Salicetalia purpureae)** | | | | | | | | | | |
| *Populus nigra* | A1 | - | - | 4 | 3 | 4 | - | 1 | 1 | - |
| | A2 | - | - | 2 | 2 | 2 | - | - | + | - |
| | B1 | 2 | 2 | - | - | - | - | - | - | - |
| | B2 | 2 | 2 | - | - | - | - | - | - | - |
| | S | 3 | 3 | 5 | 4 | 5 | - | - | 1 | - |
| **Salicion elaeagni** | | | | | | | | | | |
| *Salix elaeagnos* | B1 | 1 | 2 | - | - | - | - | - | - | - |
| | B2 | 1 | 2 | - | - | - | - | - | - | - |
| | S | 2 | 3 | - | - | - | - | - | - | - |
| **Salicion triandrae** | | | | | | | | | | |
| *Salix purpurea* (Cal) | B1 | 3 | 1 | + | + | - | - | - | - | - |
| | B2 | 1 | 1 | - | + | - | - | - | - | - |
| | S | 3 | 2 | + | + | - | - | - | - | - |
| **Salicion albae** | | | | | | | | | | |
| *Agropyron caninum* (Ulm,Qpp) | C | + | - | - | - | - | - | - | - | - |
| *Alnus incana* (Ai,Agi) | B1 | - | - | - | - | - | - | - | + | - |
| *Cucubalus baccifer* (Cal,Ulm) | C | - | - | + | 1 | - | + | + | + | - |
| *Humulus lupulus* (Cal,Ate,Ai) | B1 | - | - | - | + | - | + | - | 1 | - |
| | C | - | - | + | + | + | + | + | - | + |
| | S | - | - | + | + | + | + | + | 1 | + |
| *Salix alba* (Ai,Cal) | A1 | - | - | - | 1 | - | - | - | - | - |
| | A2 | - | - | + | 2 | - | - | - | - | - |
| | B1 | 1 | + | - | - | - | - | - | - | - |
| | B2 | + | + | - | - | - | - | - | - | - |
| | S | 1 | + | + | 2 | - | - | - | - | - |
| **Alnetea glutinosae (incl. Alnetalia glutinosae)** | | | | | | | | | | |
| *Alnus glutinosa* (CAg,Ai,Agi) | A2 | - | - | - | - | - | - | - | + | + |
| *Dryopteris carthusiana* (F,Agi,Qr,VP) | C | - | - | - | - | - | - | - | + | + |
| *Frangula alnus* (Ai,Qr,PQ) | B2 | - | - | + | - | - | - | - | - | - |
| **Querco-Fagetea** | | | | | | | | | | |
| *Acer campestre* (Qpp) | A2 | - | - | - | - | - | - | - | - | 2 |
| | B2 | - | - | - | - | - | - | - | - | + |
| | S | - | - | - | - | - | - | - | - | 2 |
| *Ajuga reptans* (Qpp,MoA) | C | - | - | - | - | - | - | - | - | + |
| *Brachypodium sylvaticum* (Qpp) | C | - | - | - | + | - | + | + | + | + |
| *Carex divulsa* | C | - | - | - | - | - | - | - | - | + |
| *Carex spicata* (Qpp,Epa) | C | - | - | - | - | - | + | - | - | - |
| *Cephalanthera longifolia* | C | - | - | - | - | - | + | - | - | - |
| *Clematis vitalba* (Qpp) | A2 | - | - | - | - | + | - | - | - | - |
| | B1 | - | - | - | - | + | - | - | - | - |
| | B2 | - | - | - | + | + | + | 1 | - | - |
| | S | - | - | - | + | 1 | + | 1 | - | - |
| *Cornus sanguinea* (Qpp) | A2 | - | - | - | - | + | - | - | + | - |
| | B1 | - | - | 3 | 4 | 3 | 4 | 4 | 4 | 3 |
| | B2 | - | - | 1 | 1 | + | 1 | + | + | + |
| | S | - | - | 3 | 4 | 3 | 4 | 4 | 4 | 3 |

| Table 1/4. | | Sal. p. | | Pop. n. | | | Pop. a. | | | Ulm. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| *Corylus avellana* (Qpp) | B1 | - | - | - | - | - | - | - | - | 1 |
| | B2 | - | - | - | - | - | - | - | - | + |
| | S | - | - | - | - | - | - | - | - | 1 |
| *Crataegus monogyna* (Qpp) | A2 | - | - | - | - | - | + | - | - | - |
| | B1 | - | - | 1 | + | + | 1 | 1 | + | + |
| | B2 | - | - | + | + | + | + | + | + | + |
| | S | - | - | 1 | + | + | 1 | 1 | + | + |
| *Crataegus oxyacantha* | B1 | - | - | - | - | - | - | - | - | + |
| | B2 | - | - | - | - | - | - | - | - | + |
| | S | - | - | - | - | - | - | - | - | + |
| *Dactylis polygama* (Qpp,Cp) | C | - | - | + | + | - | - | - | - | - |
| *Euonymus europaea* (Qpp) | A2 | - | - | + | - | - | - | - | - | - |
| | B1 | - | - | + | + | + | - | - | + | - |
| | B2 | - | - | + | + | + | + | + | + | + |
| | S | - | - | 1 | + | + | + | + | + | + |
| *Epipactis helleborine* agg. (F) | C | - | - | - | - | - | - | + | - | - |
| *Fallopia dumetorum* (Qpp,GA) | C | - | - | - | - | + | + | - | + | - |
| *Geranium robertianum* (Epa,F) | C | - | - | - | - | - | - | - | - | + |
| *Geum urbanum* (Epa,Cp,Qpp) | C | - | - | - | - | - | - | - | + | + |
| *Heracleum sphondylium* (Qpp,MoA) | C | - | - | - | - | - | + | + | - | - |
| *Hypericum montanum* | C | - | - | - | - | - | - | - | + | - |
| *Ligustrum vulgare* (Cp,Qpp) | B1 | - | - | + | + | - | + | + | - | + |
| | B2 | - | - | + | + | - | + | + | + | + |
| | S | - | - | + | + | - | + | + | + | + |
| *Poa nemoralis* (Qpp) | C | - | - | + | + | - | - | - | - | - |
| *Polygonatum multiflorum* (F) | C | - | - | - | - | - | - | - | - | + |
| *Quercus robur* (Ai,Cp,Qpp) | A1 | - | - | - | - | - | - | + | - | 1 |
| | A2 | - | - | - | - | - | 1 | + | + | - |
| | B1 | - | - | + | - | - | - | - | - | - |
| | B2 | - | - | + | + | + | + | + | + | + |
| | S | - | - | + | + | + | 1 | 1 | + | 1 |
| *Ranunculus auricomus* agg. (MoA) | C | - | - | - | - | - | - | - | - | + |
| *Scrophularia nodosa* (GA,Epa) | C | - | - | - | + | + | - | - | + | - |
| *Ulmus minor* (Ai,Ulm,Qpp) | A2 | - | - | - | - | - | - | - | - | 2 |
| | B1 | - | - | - | - | - | + | + | - | 2 |
| | B2 | - | - | - | - | + | + | + | - | + |
| | S | - | - | - | - | + | + | + | - | 3 |
| *Viola cyanea* (Qpp) | C | - | - | - | - | - | - | - | - | + |
| **Fagetalia sylvaticae** | | | | | | | | | | |
| *Aegopodium podagraria* (Ai,Cp) | C | - | - | - | - | + | 1 | 2 | - | - |
| *Athyrium filix-femina* (Qr,VP) | C | - | - | - | - | - | - | - | - | + |
| *Cardamine impatiens* | C | - | - | - | - | - | + | + | - | + |
| *Carex sylvatica* | C | - | - | - | - | - | - | - | - | 1 |
| *Carpinus betulus* (Cp) | B2 | - | - | - | - | - | - | - | - | + |
| *Cerastium sylvaticum* (Ai) | C | - | - | - | - | - | - | - | - | + |
| *Cerasus avium* (Cp) | B2 | - | - | - | - | + | - | + | + | + |
| *Circaea lutetiana* (Ai) | C | - | - | + | - | + | + | + | - | + |
| *Galeopsis speciosa* (Epn,Ai) | C | - | - | + | + | + | + | + | + | + |
| *Galium odoratum* | C | - | - | - | - | + | - | - | - | + |

| Table 1/5. | | Sal. p. | | Pop. n. | | | Pop. a. | | | Ulm. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| *Hedera helix* | A2 | - | - | - | 1 | - | - | - | - | 1 |
| | B1 | - | - | - | + | - | - | - | - | + |
| | B2 | - | - | + | 3 | + | - | - | - | 2 |
| | S | - | - | + | 3 | + | - | - | - | 2 |
| *Listera ovata* (Ate,Ai) | C | - | - | - | - | - | - | + | - | - |
| *Moehringia trinervia* | C | - | - | - | - | - | - | - | + | + |
| *Myosotis sparsiflora* (GA,Cp) | C | - | - | - | - | - | + | - | - | - |
| *Omphalodes scorpioides* (TA) | C | - | - | - | - | - | - | - | - | + |
| *Paris quadrifolia* (Ate,Ai) | C | - | - | - | - | - | + | - | - | + |
| *Pulmonaria officinalis* | C | - | - | - | - | - | - | - | - | + |
| *Sanicula europaea* | C | - | - | - | - | - | - | - | - | + |
| *Stachys sylvatica* (Epa) | C | - | - | - | - | - | - | - | - | + |
| *Ulmus glabra* (TA) | B1 | - | - | - | - | - | - | - | - | + |
| *Veronica montana* (Ai) | C | - | - | - | - | - | - | - | - | + |
| *Viola sylvestris* | C | - | - | - | - | - | - | - | - | + |
| **Alnion incanae** | | | | | | | | | | |
| *Carex brizoides* (Ate) | C | - | - | - | + | + | - | - | - | - |
| *Carex remota* | C | - | - | - | - | + | - | - | - | 1 |
| *Carex strigosa* | C | - | - | - | - | - | - | - | - | + |
| *Cephalaria pilosa* (GA) | C | - | - | - | - | - | - | - | - | + |
| *Equisetum hyemale* (F) | C | - | - | 2 | - | 3 | + | + | 4 | - |
| *Fraxinus angustifolia* ssp. *pannonica* (Ate) | A1 | - | - | - | - | - | - | - | - | 4 |
| | A2 | - | - | - | - | - | - | - | - | 1 |
| | B1 | - | - | - | - | - | - | - | - | + |
| | B2 | - | - | - | - | - | - | - | - | + |
| | S | - | - | - | - | - | - | - | - | 4 |
| *Populus alba* (Sal,AQ) | A1 | - | - | - | - | - | 4 | 4 | 4 | - |
| | A2 | - | - | - | - | - | 2 | 2 | 2 | - |
| | B1 | - | - | - | - | - | - | - | + | - |
| | B2 | - | - | - | - | - | - | + | - | - |
| | S | - | - | - | - | - | 5 | 5 | 5 | - |
| *Rumex sanguineus* (Epa,Sal) | C | - | - | - | - | - | - | - | - | + |
| *Ulmus laevis* (Sal,Ulm) | A1 | - | - | - | - | - | + | + | - | - |
| | A2 | - | - | - | - | + | + | + | - | - |
| | B1 | - | - | - | - | - | - | - | - | + |
| | B2 | - | - | - | - | - | + | + | - | - |
| | S | - | - | - | - | + | 1 | 1 | - | + |
| *Viburnum opulus* (Ate) | B1 | - | - | - | - | - | - | - | + | - |
| | B2 | - | - | + | + | + | + | + | + | + |
| | S | - | - | + | + | + | + | + | + | + |
| **Aremonio-Fagion** | | | | | | | | | | |
| *Peucedanum verticillare* | C | - | - | 1 | + | - | + | + | + | - |
| *Tamus communis* (Qfa) | C | - | - | - | - | - | - | + | - | - |
| **Quercetea pubescentis-petraeae** | | | | | | | | | | |
| *Prunus spinosa* (Pru,Pru) | B2 | - | - | + | + | - | - | + | - | - |
| *Pyrus pyraster* (Cp) | B1 | - | - | - | - | - | + | - | - | - |
| *Quercus cerris* (Qr,PQ) | B2 | - | - | - | + | - | - | - | - | - |
| *Rosa canina* agg. (Pru,Pru) | B2 | - | - | - | + | - | - | - | - | - |

| Table 1/6. | | Sal. p. | | Pop. n. | | | Pop. a. | | | Ulm. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| **Indifferens** | | | | | | | | | | |
| *Agropyron repens* (MoA,FPi,FB,ChS,Pla) | C | - | + | - | - | + | - | - | - | - |
| *Agrostis stolonifera* (Pte,MoJ,FPe,Bia,Pla) | C | 1 | + | - | + | - | - | - | - | - |
| *Arenaria serpyllifolia* (KC,FB,ChS) | C | - | + | - | - | - | - | - | - | - |
| *Calamagrostis epigeios* (MoJ,Fvg,Epa) | C | + | + | + | + | - | - | - | - | - |
| *Chrysanthemum leucanthemum agg.* (MoA,Ara) | C | - | - | + | - | - | - | - | - | - |
| *Convolvulus arvensis* (ChS) | C | + | + | - | - | - | - | - | - | - |
| *Cruciata laevipes* (Arn,Fru,Ar,GU,Qpp) | C | - | - | - | + | - | - | - | - | - |
| *Dactylis glomerata* (MoA,FB,Che,Pla,Qpp) | C | - | + | - | - | + | - | - | - | - |
| *Echinochloa crus-galli* (Nc,ChS,Ory,Che) | C | + | - | - | - | - | - | - | - | - |
| *Equisetum arvense* (MoA,Sea,Sal,Ate,Ai) | C | - | - | - | - | + | - | - | + | + |
| *Euphorbia esula* (Mon,FBt,Ar) | C | - | - | - | - | - | + | + | - | - |
| *Galium aparine* (Sea,Epa,QFt) | C | - | - | + | 1 | + | 2 | 1 | + | 2 |
| *Galium mollugo* (MoA,FBt,Qrp,Qpp) | C | - | - | + | + | + | + | - | + | - |
| *Glechoma hederacea* (MoA,QFt,Sal,Ai) | C | - | - | - | + | + | - | - | + | 3 |
| *Lysimachia nummularia* (Pte,MoJ,FPe,Bia,QFt) | C | - | - | + | - | + | - | - | + | + |
| *Lysimachia vulgaris* (Ai,Pte,SCn,MoJ,Sal) | C | - | - | + | + | + | + | + | + | + |
| *Lythrum salicaria* (Pte,MoJ,Bia,Spu,Ate) | C | + | - | - | - | - | - | - | - | - |
| *Medicago lupulina* (MoA,FPe,SS,FBt,ChS) | C | - | - | - | - | + | - | - | - | - |
| *Oenothera biennis* (ChS,Sio,Onn,Spu) | C | - | 1 | - | - | - | - | - | - | - |
| *Plantago lanceolata* (MoA,ChS) | C | + | + | - | - | - | - | - | - | - |
| *Plantago major* (Pla) | C | + | + | - | - | - | - | - | - | - |
| *Polygonum lapathifolium* (Pte,Nc,ChS,Bia,Str) | C | + | + | - | - | - | - | - | - | - |
| *Polygonum persicaria* (Pte,Nc,ChS) | C | + | - | - | - | - | - | - | - | - |
| *Ranunculus repens* (Pte,MoA,ChS,Spu,Ate) | C | - | - | + | - | - | - | - | + | - |
| *Rorippa sylvestris* (Nc,Des,ChS,AR,Spu) | C | + | + | - | - | + | - | - | - | - |
| *Rubus caesius* (Spu) | B2 | - | - | 1 | 1 | 1 | 2 | 2 | + | 2 |
| *Sambucus nigra* (Epa,US,QFt) | B1 | - | - | - | - | - | + | - | + | - |
| | B2 | - | - | - | - | - | + | - | + | + |
| | S | - | - | - | - | - | + | - | + | + |
| *Stellaria media* (ChS,QFt,Spu) | C | - | - | - | - | - | 1 | + | - | - |
| *Taraxacum officinale* (MoA,FPe,CyF,ChS) | C | + | + | + | + | + | + | + | - | - |
| *Torilis japonica* (Ar,GA,Epa,QFt) | C | - | - | + | + | + | + | - | + | - |
| *Trifolium pratense* (Mag,MoA,CyF,Sea,Pla) | C | - | - | + | - | - | - | - | - | - |
| *Urtica dioica* (Ar,GA,Epa,Spu) | C | - | - | - | + | - | + | - | + | + |
| *Vicia hirsuta* (MoA,FB,Sea,Qpp) | C | - | - | + | + | - | - | - | - | - |
| **Adventiva** | | | | | | | | | | |
| *Acer negundo* | A2 | - | - | - | + | - | - | - | - | - |
| | B2 | - | - | - | + | - | - | - | - | - |
| | S | - | - | - | + | - | - | - | - | - |
| *Ambrosia artemisiifolia* | C | + | + | - | - | - | - | - | - | - |
| *Amorpha fruticosa* | B1 | - | - | - | + | - | - | - | - | - |
| | B2 | - | + | - | - | - | - | - | - | - |
| | S | - | + | - | + | - | - | - | - | - |
| *Echinocystis lobata* | C | - | - | - | - | - | + | + | - | - |
| *Erigeron canadensis* | C | + | + | - | - | - | - | - | - | - |
| *Juglans regia* | B2 | - | - | - | - | - | - | - | - | + |
| *Populus x canadensis* | A1 | - | - | - | - | - | 1 | - | - | - |

| Table 1/7. | | Sal. p. | | Pop. n. | | | Pop. a. | | | Ulm. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| *Populus x canadensis* | A1 | - | - | - | - | - | 1 | - | - | - |
| *Robinia pseudo-acacia* | A2 | - | - | + | - | - | - | + | - | - |
| | B1 | - | - | + | - | - | - | - | - | - |
| | B2 | - | - | + | - | - | + | + | + | - |
| | S | - | - | 1 | - | - | + | + | + | - |
| *Solidago canadensis* | C | - | + | - | - | - | - | - | - | - |
| *Solidago gigantea* | C | + | - | 2 | 1 | 3 | 1 | 1 | + | - |
| *Stenactis annua* | C | - | + | + | + | + | + | + | + | - |
| *Xanthium italicum* | C | + | + | - | - | - | - | - | - | - |

**Abbreviations:** A1: upper canopy layer, A2: lower canopy layer, Agi: *Alnenion glutinosae-incanae*, Ai: *Alnion incanae*, Alo: *Alopecurion pratensis*, Ape: *Aperetalia*, AQ: *Aceri tatarico-Quercion*, AR: *Agropyro-Rumicion crispi*, Ar: *Artemisietea*, Ara: *Arrhenatheretea*, Arn: *Arrhenatherion elatioris*, Ate: *Alnetea glutinosae*, B1: shrub layer, B2: re-growth, Bia: *Bidentetea*, Bin: *Bidention tripartiti*, C: herb layer, CAg: *Carici elongatae-Alnenion glutinosae*, Cal: *Calystegion sepium*, Cau: *Caucalidion platycarpos*, Cgr: *Caricenion gracilis*, Che: *Chenopodietea*, ChS: *Chenopodio-Scleranthea*, Cp: *Carpinenion betuli*, CyF: *Cynodonto-Festucenion*, Des: *Deschampsion caespitosae*, Epa: *Epilobietea angustifolii*, Epn: *Epilobion angustifolii*, F : *Fagetalia sylvaticae*, FB: *Festuco-Bromea*, FBt: *Festuco-Brometea*, FiC: *Filipendulo-Cirsion oleracei*, FPe: *Festuco-Puccinellietea*, FPi: *Festuco-Puccinellietalia*, Fru: *Festucion rupicolae*, Fvg: *Festucetea vaginatae*, Fvl: *Festucetalia valesiacae*, GA: *Galio-Alliarion*, GU: *Galio-Urticetea*, ined.: ineditum (unpublished communication), KC: *Koelerio-Corynephoretea*, Mag: *Magnocaricetalia*, MoA: *Molinio-Arrhenatherea*, MoJ: *Molinio-Juncetea*, Nc: *Nanocyperion flavescentis*, Onn: *Onopordion acanthii*, Ory: *Oryzetea sativae*, Pa: *Populion albae*, Pla: *Plantaginetea*, Pol: *Polygonion avicularis*, PQ: *Pino-Quercetalia*, Pru: *Prunetalia spinosae*, Pte: *Phragmitetea*, QFt: *Querco-Fagetea*, Qpp: *Quercetea pubescentis-petraeae*, Qr: *Quercetalia roboris*, Qrp: *Quercion robori-petraeae*, Sal: *Salicion albae*, SCn: *Scheuchzerio-Caricetea nigrae*, Sea: *Secalietea*, Sio: *Sisymbrion officinalis*, s.l.: sensu lato (in a broader sense), s.str.: sensu stricto (in a narrow sense), Spu: *Salicetea purpureae*, SS: *Sedo-Scleranthetea*, Str: *Salicion triandrae*, TA: *Tilio platyphyllae-Acerenion pseudoplatani*, TrE: *Tribulo-Eragrostion minoris*, Ulm: *Ulmenion*, US: *Urtico-Sambucetea*, VP: *Vaccinio-Piceetea*.

| **Table 1/8.** | **Sal. p.** | | **Pop. n.** | | | **Pop. a.** | | | **Ulm.** |
|---|---|---|---|---|---|---|---|---|---|
| **(Data recorded)** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** |
| Sample number | 5204 | 4893 | 14253 | 14255 | 14256 | 8456 | 8457 | 14321 | 14254 |
| Sampling year 1. | 2002 | 2002 | 2007 | 2007 | 2007 | 2004 | 2004 | 2007 | 2007 |
| Sampling time 1. | 12.09 | 06.09 | 24.05 | 24.05 | 08.06 | 20.05 | 20.05 | 08.06 | 31.05 |
| Sampling year 2. | - | - | - | - | - | 2004 | 2004 | - | - |
| Sampling time 2. | - | - | - | - | - | 11.09 | 11.09 | - | - |
| Altitude a.s.l. (m) | 127 | 107 | 77 | 76 | 77 | 98 | 98 | 78 | 125 |
| Sloping (degree) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Upper canopy coverage (%) | - | - | 60 | 50 | 60 | 70 | 65 | 70 | 70 |
| Lower canopy coverage (%) | - | - | 15 | 25 | 10 | 25 | 20 | 20 | 40 |
| Shrub layer coverage (%) | 50 | 50 | 50 | 75 | 50 | 75 | 65 | 75 | 60 |
| Re-growth coverage (%) | 20 | 30 | 10 | 40 | 5 | 20 | 25 | 1 | 25 |
| Herb layer coverage (%) | 20 | 15 | 50 | 10 | 80 | 50 | 40 | 75 | 70 |
| Upper canopy height (m) | - | - | 22 | 20 | 25 | 25 | 22 | 25 | 27 |
| Lower canopy height (m) | - | - | 15 | 13 | 17 | 20 | 17 | 16 | 15 |
| Shrub layer height (cm) | 200 | 250 | 50 | 300 | 400 | 500 | 400 | 300 | 250 |
| Mean trunk diameter (cm) | - | - | 40 | 35 | 50 | 55 | 50 | 45 | 45 |
| Size of sampling area ($m^2$) | 400 | 400 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 |

**Sal.p.:** *Rumici crispi-Salicetum purpureae*
**Pop.n.:** *Carduo crispi-Populetum nigrae*
**Pop.a.:** *Senecioni sarracenici-Populetum albae*
**Ulm.:** *Fraxino pannonicae-Ulmetum*

**Location:** 1: Őrtilos „Sziget”; 2: Vízvár „Alsó-Lóka”; 3–6: Babócsa „Jelkus”, 7–8: Szentborbás „Csicsóka”; 9: Gola „Repaš”.
**Rock type:** 1-2: alluvial gravel; 3–8: alluvial gravel and sand; 9: young alluvial soil.
**Soil:** 1–2: absent; 3–8: raw alluvial soil; 9: alluvial forest soil.
**Survey made by:** 1–3, 9: Kevey & Csete; 4: Kevey, Csete & Lendvai; 5, 8: Kevey & Lendvai, 6, 7: Kevey.

### 5.1.4. Almond-leaved willow bush (*Polygono hydropiperi-Salicetum triandrae* Kevey in Borhidi & Kevey 1996)

In side-branches of the river, sheltered by shoals and smaller islands, water velocity is significantly lower. Here it is fine-particle silt that is deposited from the flowing water, on which silt vegetation (*Nanocyperion*) soon develops. It was this very habitat type where *Selaginella helvetica* – probably having descended from montane areas – was found near Őrtilos in the 1960s. When silt vegetation becomes overgrown by shrubs, almond-leaved willow bush vegetation (*Polygono hydropiperi-Salicetum triandrae*) develops. The water supply of such habitats is much more balanced than in the case of substrates with gravel and coarse sand, therefore they will not dry out even at extended periods of dry weather (Kevey 1998).

Here, too, the shrub layer is a few metres high, with mostly *Salix triandra* and *Salix viminalis*, but also *Salix alba* can be frequent. The shrub layer consists of many marsh species such as *Myosotis palustris*, *Stachys palustris*, *Rorippa amphibia*, *Iris pseudacorus*, *Carex gracilis*, *Carex riparia*, etc. Besides, plants surviving from silt vegetation also do occur, including *Limosella aquatica*, *Gnaphalium uliginosum*, *Cyperus fuscus*, *Eleocharis acicularis*, etc. In the more mature parts of such associations, the protected *Leucojum aestivum* can also be present. Botanical rarities are represented by *Lindernia procumbens* surviving from silt associations, but even *Myricaria germanica*, another protected character species of alluvial groves was found at Zákány.

From the willow bushes from areas along Drava, so far there have been two ”*Salicetum purpureae*” associations recorded by Tihanyi (1964), and a single, quite species-poor one by Vöröss (1965). The species compositions of these recordings suggest that they are a variation of almond-leaved willow bush associations (*Polygono hydropiperi-Salicetum triandrae*), namely a consociation with *Salix purpurea* (Kevey 1993, 2000). No survey was made of this association along Drava in 2007.

## 5.2. Softwood gallery forests

The softwood gallery forests traditionally referred to as ”willow-poplar galleries (*Salicetum albae-fragilis*)” are nowadays treated as three different associations. They were differentiated mostly on the basis of habitat conditions, resulting in different species composition (Kevey in Kevey & Borhidi 1996).

### 5.2.1. White willow gallery forest (*Leucojo aestivi-Salicetum albae* Kevey in Borhidi & Kevey 1996)

Willow galleries (*Leucojo aestivi-Salicetum albae*) develop from almond-leaved willow bush (*Polygono hydropiperi-Salicetum triandrae*) vegetation of watersides covered in sand

and silt. Their raw alluvial substrate is silty, thus the soil is quite heavy. Their development is similar to that of black poplar gallery forests, because the common *Salix alba* or the rare *Salix fragilis* occurring in the shrub layer of almond-leaved willow bushes overgrow and shade out shrub-sized willows (*Salix triandra, Salix viminalis*), making them disappear from the habitat sooner or later (Kevey 1998).

The canopy layer reaches up to more than 20 m, normally with medium coverage, but there are quite sparse stands as well. *Salix alba* occurs in masses, whereas *Salix fragilis* grows as specimens or in smaller groups. Due to frequent flooding, shrubs only seldom develop beneath the canopy layer. The herb layer is dominated mostly by marsh plants: *Caltha palustris, Carex gracilis, C. riparia, Galium palustre*, *Myosotis palustris*, *Rorippa amphibia*, *Iris pseudacorus*, *Polygonum hydropiper, P. minus, P. mite*, *Rorippa amphibia*, *Senecio paludosa, Sium latifolium, Stachys palustris*, etc. A protected, impressive species typical at places is *Leucojum aestivum*.

### 5.2.2. Black poplar gallery forests (*Carduo crispi-Populetum nigrae* Kevey in Borhidi & Kevey 1996)

As gravel shoals and waterside areas covered in coarse sand partially fill up, purple willow bushes (*Rumici crispi-Salicetum purpureae*) develop into black poplar gallery forests (*Carduo crispi-Populetum nigrae*). This process happens by *Populus nigra* normally occurring in purple willow bushes gradually overgrowing and shading out *Salix purpurea*, until the latter is entirely competed out from the habitat. Because this association develops from purple willow bushes growing in habitats with gravel and coarse sand, its raw alluvial soil is normally light (Kevey 1998).

The canopy layer reaching up to about 20 m, with medium coverage, is made up mostly of *Populus nigra* and some *Salix alba*. The shrub layer is poor, mostly made up of *Cornus sanguinea*, but sometimes *Salix purpurea* – surviving from the preceding stage of succession – can also be found in younger stands. In the herb layer *Rubus caesius* sometimes occurs in masses. Typical plants are *Calystegia sepium*, *Cucubalus baccifer*, *Myosoton aquaticum*, *Humulus lupulus, Phalaroides arundinaceum*, etc.

### 5.2.3. White poplar gallery forests (*Senecioni sarracenici-Populetum albae* Kevey in Borhidi & Kevey 1996)

Relatively more elevated terrains of the lower floodplain are populated by white poplar gallery forests (*Senecioni sarracenici-Populetum albae*). This forest association can develop either from black poplar galleries (*Carduo crispi-Populetum nigrae*) or from willow galleries (*Leucojo aestivi-Salicetum albae*). The process of succession lasts for a relatively long period of time. As the habitat is gradually filled up, the habitat of *Populus nigra* and *Salix alba* becomes more and more reduced, until white poplar (*Populus alba*) starts to expand. Because these habitats are located in terrains about 1.5 m higher than either black poplar or willow gallery forests, they are much less frequently flooded.

Their raw alluvial soil is normally light or medium heavy, showing some degree of transition towards more complex forest soils (Kevey 1998).

The canopy of white poplar gallery forests can reach up to a height of 25 m, with white poplar (*Populus alba*) being most abundant. *Salix alba* and *Populus nigra* are rare in these associations, but sometimes solitary specimens of oak-ash-elm gallery forest (*Fraxino pannonicae-Ulmetum*) species including *Fraxinus angustifolia* ssp. *pannonica*, *Quercus robur* and *Ulmus laevis* can show up. A rare species in the lower canopy layer is *Alnus incana*. The shrub layer, consisting mostly of *Cornus sanguinea*, is normally a very dense thicket. The herb layer has much less species and specimens of marsh plants than in willow and black poplar gallery forests. Typical plants are *Rubus caesius*, *Galium palustre*, *Solanum dulcamara*, *Cucubalus baccifer*, *Myosoton aquaticum*, *Humulus lupulus*, *Poa palustris*, *Phalaroides arundinaceum*, etc. Certain herbaceous plants typical of oak-ash-elm forests can also appear: *Anemone ranunculoides*, *Carex strigosa, Carpesium abrotanoides, Dryopteris carthusiana, Ficaria verna*, *Aegopodium podagraria*, *Corydalis cava*, *Impatiens noli-tangere*, *Galanthus nivalis*. A few montane species can sometimes migrate here along the rivers. Such demontane-adventive species is *Petasites albus* found in the white poplar gallery forest at Drávasztára (Kevey 2001; Kevey in Kevey & Tóth 2006). The sporadic occurrence of *Carex strigosa*, *Carpesium abrotanoides*, *Lonicera caprifolium, Peucedanum verticillare*, and *Tamus communis* add some sub-Mediterranean character to the white poplar galleries of the Drava plains.

## 5.3. Forests of elevated floodplain areas

The higher Drava floodplain is inundated only at times of exceptionally high floods. This is where hardwood gallery forests develop, of which two associations are known.

### 5.3.1. Alder gallery forests (*Paridi quadrifoliae-Alnetum* Kevey in Borhidi & Kevey 1996)

Alder galleries (*Paridi quadrifoliae-Alnetum*) are found in relatively low areas or depressions of the higher floodplain. Some are found along streams of flood-prevented areas, but mostly they develop by the filling up of alder bogs or in surface depressions influenced considerably by groundwater. They grow on alluvial forest soils that have longer developmental history (Kevey 1998). Based on five recordings, Ortmann-Ajkai (1998b) has published a coenological table on these alder galleries along Drava. The short description of the association is hereby given based on 37 recordings made by Kevey (ined.).

The medium-high canopy is made up predominantly by *Alnus glutinosa* and *Fraxinus angustifolia* ssp. *pannonica*, often with interspersed specimens of *Ulmus laevis*. In the lower canopy layer, the rare *Alnus incana* also appears sometimes. Typical plants of the shrub layer are *Frangula alnus*, *Padus avium*, *Ribes rubrum* and *Viburnum opulus*. Besides, *Cornus sanguinea* and nitrogen-indicating *Sambucus nigra* are sometimes quite abundant. Several hardwood gallery forest (*Alnion incanae*) elements are found in their herb layer: *Cardamine amara*, *Carex brizoides*, *C. remota, C. pendula, C. strigosa, Cerastium sylvaticum*, *Chrysosplenium alternifolium*, *Crepis paludosa*, *Equisetum telmateja*, *Valeriana dioica*. Plants normally occurring in oak-hornbeam forests of mountain and hilly regions appear here in masses: *Anemone nemororsa, Anemone ranunculoides*, *Asarum europaeum*, *Aegopodium podagraria*, *Corydalis cava*, *Adoxa moschatellina*, *Milium effusum*, *Oxalis acetosella*, *Galeobdolon lutetum*, *Galanthus nivalis*, etc. Interestingly, a few bog forest species also occur here in these lowland alder galleries, such as *Carex elongata* and *Thelypteris palustris*. Alder gallery forests of the Drava-plains also exhibit some sub-Mediterranean character, as indicated by the following plant species: *Carex strigosa, Carpesium abrotanoides, Knautia drymeia, Polystichum setiferum, Primula vulgaris, Ruscus aculeatus, Tamus communis, Tilia tomentosa*. We saw the most beautiful alder gallery forests along Drava in Lankóci forest near Gyékényes.

### 5.3.2. Oak-ash-elm gallery forests (*Fraxino pannonicae-Ulmetum* Soó in Aszód 1935 corr. Soó 1963)

In relatively higher terrains of the Drava floodplain, alder galleries are replaced by oak-ash-elm galleries (*Fraxino pannonicae-Ulmetum*). Most often they are found in depressions surrounded by oak-hornbeam stands (*Circaeo-Carpinetum*), with medium strong influence of groundwater. They can be bordering minor streams either directly or with the inclusion of alder galleries (*Paridi quadrifoliae-Alnetum*) along the water, but they can occur also on the fringes of filling up alder bogs (*Carici elongatae-Alnetum*) and ash-alder bogs (*Fraxino pannonicae-Alnetum*). Due to their elevated situation, these are the gallery forest associations that are least frequently inundated. They grow on alluvial forest soils (Kevey 1998).

On oak-ash-elm gallery forests of the left side of the plains along Drava, first it was Kárpáti I. (in Horvát 1972) to publish a synthetic table based on five recordings. The research of oak-ash-elm gallery forests accelerated in the 1990s. First, Ortmann-Ajkai (1998a, 1998b) published 11 and 40 recordings, respectively, from two forests (Kisszentmárton, Vajszló) in the Ormánság region, then Kevey (2006c, 2007b) published a table including 50 recordings from the Baranya county section and 50 from the Somogy county section of the Drava plains.

The canopy layer can reach 25-30 m height. Characteristic species are *Quercus robur*, *Fraxinus angustifolia* ssp. *pannonica* and *Ulmus laevis*. In the lower canopy layer *Carpinus betulus* can also be present as specimens, and also *Ulmus minor*, strongly decimated by elm disease. The shrub layer is more or less identical with that of alder gallery forests, with the difference that *Frangula alnus* is rarer here. The species composition of herb layer represents a transitional stage between alder galleries (*Paridi quadrifoliae-Alnetum*) and lowland oak-hornbeam forests (*Circaeo-Carpinetum*). Its significant species indicating hardwood gallery forest (*Alnion incanae*) character are *Carex brizoides, C. remota, C. strigosa, Cephalaria pilosa, Cerastium sylvaticum, Chrysosplenium alternifolium, Dryopteris carthusiana, Dryopteris dilatata*, *Impatiens noli-tangere, Leucojum vernum, Listera ovata, Paris quadrifolia, Scilla drunensis*. The most important role is taken, however, by *Fagetalia* elements, showing their greatest frequency in oak-hornbeam forests of hilly and mountain regions: *Anemone nemorosa*, *Isopyrum thalictroides*, *Asarum europaeum*, *Aegopodium podagraria*, *Corydalis ava*, *Dentaria bulbifera*, *Oxalis acetosella*, *Euphorbia amygdaloides*, *Mercurialis perennis, Milium effusum, Pulmonaria officinalis*, *Galeobdolon lutetum*, *Lathraea suqamaria*, *Galanthus nivalis* etc. In oak-hornbeam forests of the Drava lowlands, too, sub-Mediterranean elements can be present: *Carex strigosa*, *Carpesium abrotanoides, Helleborus dumetorum, Knautia drymeia, Lonicera caprifolium, Peucedanum verticillare, Polystichum setiferum, Primula vulgaris, Ruscus aculeatus, Tamus communis, Tilia tomentosa*.

# 6. Discussion

The presence of German tamarisk and hippophaë alluvial groves (*Salici-Myricarietum, Salici incanae-Hippophaëtum*) in the Drava section between Őrtilos (Legrad) and Keskend (Kozarac) is questionable. These two associations are characteristic of mountain river sections where they co-occur with higher number of montane and sub-montane species. Their existing representatives in the studied area are either impoverished versions of these associations or fragments of them. *Myricaria germanica* can survive here only by migrating to newer and newer shoals. However, this has very limited chances, because the gravel shoal building effect of Drava has decreased significantly since hydroelectric power stations were established in Croatia. According to some sources of information, there are a few larger *Myricaria* populations along Drava, but we have not been able to locate these. Thus, in order to be able to confirm or deny the existence of such alluvial galleries along Drava, further research is needed.

The analysis of typical purple willow bush associations (*Rumici crispi-Salicetum purpureae*) has been performed in the Szigetköz region only (KEVEY 1993, 2000, 2006a). However, based on experience gained during field surveys, the authors have managed to make some comparisons between purple willow associations of Szigetköz and Drava (Tab. 1). *Chlorocyperus glomeratus*, *Myricari germanica* and *Salix elaeagnos* occur in many places along Drava. These three species were not recorded from willow bushes in Szigetköz during detailed surveys lasting from 1989 to 2003 (KEVEY 1993, 2000, 2006a), although earlier literature on floral studies (POLGÁR 1941) did report on their occurrences. On the other hand, the two rarities of the Szigetköz region (*Epilobium dodonaei*, *Ribes nigrum*) were not found in areas along Drava. Despite these few differences, the associations in the Szigetköz and the Drava regions can be considered to be the same *Rumici crispi-Salicetum purpureae* vegetation (KEVEY 2006a).

From the willow bushes from areas along Drava, so far there have been two "*Salicetum purpureae*" associations recorded by TIHANYI (1964), and a single, quite species-poor one by VÖRÖSS (1965). The species compositions of these recordings suggest that they are a variation of almond-leaved willow bush associations (*Polygono hydropiperi-Salicetum triandrae*), namely a consociation with *Salix purpurea* (KEVEY 1993, 2000). The currently accepted description of this association originates from the Szigetköz (KEVEY 1993, 2000, 2006a; KEVEY in BORHIDI & KEVEY 1996) where *Salix viminalis* is abundant, *Leucojum aestivum* is sporadic, and one of the recordings even contain *Stellaria nemorum* unique in the entire Great Plain region. These plants have not been found in almond-leaved willow bushes along Drava, but *Lindernia procumbens*, surviving from silt associations, does occur, moreover *Myricaria germanica*, the character species of alluvial galleries was also found in a young stand at Zákány. The latter two species are absent from almond-leaved willow bushes of the Szigetköz area. Based on former observations, species lists and data of other recordings in lowland areas suggest that – despite minor variations among associations in different regions – the almond-leaved willow bushes of silty alluvium along rivers of the Hungarian plain region belong to a single association, namely to *Polygono hydropiperi-Salicetum triandrae* (Kevey 2006a).

From white willow gallery forests along Drava (*Leucojo aestivi-Salicetum albae*) Vöröss (1965) published two less typical recordings, whereas Ortmann-Ajkai (1998a) reported on five surveys. It must be noted, however, that the amount of near-natural willow galleries along Drava is quite low. The most exquisite stands are found along the left side of Drava, near the village Révfalu (outskirts of Drávasztára), whose species composition greatly resembles that of willow galleries of the Szigetköz region (Kevey 1993, 2006a). Based on observations and available research data it appears that the willow gallery forests of different regions of the Hungarian plains belong to the *Leucojo aestivi-Salicetum albae* association (Kevey 2006a).

The detailed surveying of black poplar gallery forests have been completed in the Szigetköz region only (Kevey 1993, 2006a). Such associations in the Drava region could be described on the basis of three recordings (Tab. 1), observations in several locations, and species lists. *Equisetum hiemale* and the huge *Peucedanum verticillare* often constitute vast masses in these associations. In the lower canopy layer of black poplar gallery forests in the outskirts of Zákány and Őrtilos *Salix elaeagnos* is characteristic, moreover, *Myricaria germanica* is also found at one locality. The latter four species have not been found in black poplar gallery forests of the Szigetköz region. On the contrary, there are some species in the Szigetköz area that were not found in poplar forests along Drava: *Ribes nigrum, Carduus crispus, Senecio sarracenicus, Stellaria nemorum*. However, the difference indicated by these few species is not significant. One of the nominal species of the association, *Carduus crispus*, is missing from the three recordings of the Drava region. Nevertheless, the black poplar gallery forests of the Drava floodplain can be identified as *Carduo crispi-Populetum nigrae*, described from the Szigetköz area (Kevey 2006a), with the name regarded as symbolic in the Drava region.

Hungarian white poplar gallery forests (*Senecioni sarracenici-Populetum albae*), too, were described from the Szigetköz region (Kevey 1993, 2006a; Kevey in Borhidi & Kevey 1996). The first five coenological recordings of white poplar gallery forests (*Senecioni sarracenici-Populetum albae*) along Drava were published by Klujber et al. (1963), although part of these recordings reflect atypical, degraded, derived forest types. Vöröss (1964) reported on another five recordings with the name "*Querco-Ulmetum hungaricum populetosum*", which, too, are identified with white poplar gallery forests. In recent years, altogether 23 coenological recordings were taken of this association. Of these 20 were published by Kevey and Tóth (2006), whereas another 3 are presented in the current study (Tab. 1). There are some slight differences between lowland white poplar galleries, depending on the region. In associations of the Szigetköz area *Senecio sarracenicus* and *Carduus crispus* are frequent, but also *Hesperis matronalis, Ribes nigrum* and *Salix elaeagnos* appear in them. So far these plants have not been found in the white poplar gallery forests along Drava, but the sporadic appearance of *Carex strigosa*, *Carpesium abrotanoides*, *Lonicera caprifolium, Peucedanum verticillare* and *Tamus communis* add some sub-Mediterranean character to these stands. This is partly due to the southern exposure of the Drava plains, partly to the proximity of the west-Balkan floral subregion. Even the endemic *Crataegus nigra* grows in the white poplar gallery forests of Mohács island and the Sárköz region (KEVEY ined.). The white poplar galleries of the Tisza region are hardly known at all, but the recordings that have been made so far suggest that *Chrysanthemum serotinum* is a characteristic local species (KEVEY ined.). According to our current knowledge, the presence of a few differential species does not imply that several white poplar gallery forest types should be recognised in the Hungarian Plains, therefore all of their stands are categorised with the *Senecioni sarracenici-Populetum albae* association. However, the surveys having made so far suggest that even this name is symbolic only, because the nominal species *Senecio sarracenicus* is absent from several floodplain habitats.

Lowland alder galleries (*Paridi quadrifoliae-Alnetum*), too, were described based on their stands in the Szigetköz (KEVEY 1993, 2006a; KEVEY in BORHIDI & KEVEY 1996). The presence of some bog forest species (*Carex acutiformis, C. elongata, Thelypteris palustris*) in the alder galleries along Drava support the assumption that lowland alder galleries form through the filling up of alder bogs (*Carici elongatae-Alnetum*). The sub-Mediterranean effect mentioned in the case of white poplar gallery forests (*Senecioni sarracenici-Populetum albae*) appears here in an even more intensified form, probably owing to the geographic location of the Drava plains and the proximity of the west-Balkan floral subregion (*Illyricum*). The frequent occurrence of *Fagetalia* species is related with the fact that alder galleries are flooded much less frequently and for much shorter duration than softwood gallery forests.

The species composition of lowland oak-ash-elm gallery forests (*Fraxino pannonicae-Ulmetum*) varies greatly among different regions, which may have a reason of floral historic nature. Various regions of the Hungarian Great Plain received their floral elements from different geographic areas, this transfer being greatly influenced by rivers flowing form various directions as well as by the climate characteristic for particular areas. In addition, the species composition of these oak-ash-elm gallery forests has been considerably influenced by human activities related mostly with river regulation, drainage of lands, and other land use types (predominantly forestry management). Because of the difference of oak-ash-elm galleries in various parts of the plain region, the division of Fraxino pannonicae-Ulmetum into local associations has been started: *Fraxino pannonicae-Ulmetum* s.str., *Pimpinello majoris-Ulmetum, Scillo vindobonensis-Ulmetum* (KEVEY in BORHIDI & KEVEY 1996), *Carici brizoidis-Ulmetum* (KEVEY 2002). However, because the basis for such division was not coherent with the classification of oak-hornbeam forests of the plain region, KEVEY (2006a) returned to using the name *Fraxino pannonicae-Ulmetum* SOÓ instead of the aforementioned local associations. One of the peculiar features of oak-ash-elm galleries in the Drava plains is that they contain quite a number of *Fagetalia* elements, therefore they are relatively closely related with oak-hornbeam forests (*Circaeo-Carpinetum*) (KEVEY 2006b, 2006c, 2007a, 2007b). The reason for this is partly climatic, because the river section between Gyékényes and Barcs is part of the oak-hornbeam climatic zone (BORHIDI 1961). In addition, the Drava plain region is an area squeezed between hilly and mountain regions, from where submontane elements can relatively easily migrate to floodplain forests. The situation is similar in the case of sub-Mediterranean species which, again, probably have arrived from the direction of the neighbouring west-Balkan floral subregion (*Illyricum*). Finally, it must be noted that the survey recordings appearing in the table published by Vöröss (1964) under the name "*Querco-Ulmetum hungaricum populetosum*" cannot be considered as oak-ash-elm galleries, but instead they are white poplar gallery forests (*Senecioni sarracenici-Populetum albae*), as suggested by their species composition.

As concluded from those mentioned above, according to our current knowledge there are altogether 7 gallery forest association types in the Drava plains, whose syntaxonomic situation can be specified as follows:

Divisio: **QUERCO-FAGEA** Jakucs 1967
- Classis: **SALICETEA PURPUREAE** Moor 1958
  - Ordo: ***SALICETALIA PURPUREAE*** Moor 1958
    - Alliance: **Salicion triandrae** Th. Müller et Görs 1958 em. Kevey hoc loco
      - Associatio 1. *Rumici crispi-Salicetum purpureae* Kevey in Borhidi et Kevey 1996
      - Associatio 2. *Polygono hydropiperi-Salicetum triandrae* Kevey in Borhidi et Kevey 1996
    - Alliance: **Salicion albae** Soó 1930
      - Associatio 1: *Leucojo aestivi-Salicetum albae* Kevey in Borhidi et Kevey 1996
      - Associatio 2: *Carduo crispi-Populetum nigrae* Kevey in Borhidi et Kevey 1996
      - Associatio 3: *Senecioni sarracenici-Populetum albae* Kevey in Borhidi et Kevey 1996
- Classis: **QUERCO-FAGETEA** Br.-Bl. et Vlieger in Vlieger 1937 em. Borhidi in Borhidi et Kevey 1996
  - Ordo: ***FAGETALIA SYLVATICAE*** Pawłowski in Pawłowski et al. 1928
    - Alliance: **Alnion incanae** Pawłowski in Pawłowski et al. 1928
      - Suballiance: ***Alnenion glutinosae-incanae*** Oberd. 1953
        - Associatio: *Paridi quadrifoliae-Alnetum glutinosae* Kevey in Borhidi et Kevey 1996
      - Suballiance: ***Ulmenion*** Oberd. 1953
        - Associatio: *Fraxino pannonicae-Ulmetum* Soó in Aszód 1935 corr. Soó 1963

It appears from percentage values of different syntaxa based on K% for character species (Tab. 2.) that as floodland terrain elevation increases or groundwater level decreases, the proportion of *Fagetalia* elements increases, and that of *Salicetea* species decreases (Fig. 3.). This is the reason why ligneous plant associations strongly influenced by groundwater (*Rumici crispi-Salicetum purpureae, Polygono hydropiperi-Salicetum triandrae, Leucojo aestivi-Salicetum albae*) have very similar species combinations in all areas of the plain region. On the contrary, associations being less influenced by groundwater (*Fraxino pannonicae-Ulmetum, Circaeo-Carpinetum*) show much greater variation among different areas of the region, which is caused by different conditions of floral evolution and climatic factors. It is also notable that the percentage value of *Alnion* *incanae* species based on K% shows an increasing tendency from purple willow bushes towards white poplar galleries, and a decreasing trend towards oak-hornbeam forests (Tab. 2., Fig. 3.).

Table 2. Percentage of different syntaxa based on K%, for character species in gallery forests along Drava

| Table 2/1. | Sal. p. | Pop. n. | Pop. a. | Ulm. | Cp. |
|---|---|---|---|---|---|
| **Cypero-Phragmitea** | 0 | 0 | 0 | 0 | 0 |
| Phragmitetea | 5 | 3.4 | 2.1 | 0.6 | 0.1 |
| Magnocaricetalia (incl. Magnocaricion) | 0.9 | 1.8 | 0.6 | 0.1 | 0 |
| Caricenion gracilis | 0 | 0.5 | 0.2 | 0.1 | 0 |
| Magnocaricetalia s.l. | 0.9 | 2.3 | 0.8 | 0.2 | 0 |
| Phragmitetea s.l. | 5.9 | 5.7 | 2.9 | 0.8 | 0.1 |
| Isoëto-Nanojuncetea (incl. Nanocyperetalia) | 0 | 0 | 0 | 0 | 0 |
| Nanocyperion flavescentis | 3.3 | 0.1 | 0 | 0 | 0 |
| Isoëto-Nanojuncetea s.l. | 3.3 | 0.1 | 0 | 0 | 0 |
| **Cypero-Phragmitea s.l.** | 9.2 | 5.8 | 2.9 | 0.8 | 0.1 |
| **Oxycocco-Caricea nigrae** | 0 | 0 | 0 | 0 | 0 |
| Scheuchzerio-Caricetea nigrae (incl. Scheuchzerio-Caricetalia nigrae) | 0 | 0.3 | 0 | 0 | 0 |
| **Oxycocco-Caricea nigrae s.l.** | 0 | 0.3 | 0 | 0 | 0 |
| **Molinio-Arrhenatherea** | 4 | 3.6 | 1.3 | 1.3 | 1.3 |
| Molinio-Juncetea | 1.7 | 1.9 | 0.8 | 0.4 | 0.2 |
| Molinietalia coeruleae | 0.8 | 1.2 | 0.7 | 0.1 | 0.1 |
| Deschampsion caespitosae | 2 | 0.9 | 0.3 | 0.2 | 0.2 |
| Filipendulo-Cirsion oleracei | 0 | 0.7 | 0 | 0 | 0 |
| Alopecurion pratensis | 0.5 | 0.3 | 0.1 | 0 | 0 |
| Molinietalia coeruleae s.l. | 3.3 | 3.1 | 1.1 | 0.3 | 0.3 |
| Molinio-Juncetea s.l. | 5 | 5 | 1.9 | 0.7 | 0.5 |
| Arrhenatheretea (incl. Arrhenatheretalia) | 0 | 0.8 | 0.2 | 0.3 | 0.3 |
| Arrhenatherion elatioris | 0 | 0.8 | 0 | 0 | 0 |
| Arrhenatheretea s.l. | 0 | 1.6 | 0.2 | 0.3 | 0.3 |
| **Molinio-Arrhenatherea s.l.** | 9 | 10.2 | 3.4 | 2.3 | 2.1 |
| **Puccinellio-Salicornea** | 0 | 0 | 0 | 0 | 0 |
| Festuco-Puccinellietea | 1.1 | 0.9 | 0.4 | 0.1 | 0 |
| Festuco-Puccinellietalia | 1 | 0.1 | 0 | 0 | 0 |
| Festuco-Puccinellietea s.l. | 2.1 | 1 | 0.4 | 0.1 | 0 |
| **Puccinellio-Salicornea s.l.** | 2.1 | 1 | 0.4 | 0.1 | 0 |
| **Sedo-Corynephorea** | 0 | 0 | 0 | 0 | 0 |
| Koelerio-Corynephoretea (incl. Corynephoretalia) | 0.3 | 0 | 0 | 0 | 0 |
| Sedo-Scleranthetea (incl. Sedo-Scleranthetalia et Alysso-Sedion) | 0 | 0.1 | 0 | 0 | 0 |
| **Sedo-Corynephorea s.l.** | 0.3 | 0.1 | 0 | 0 | 0 |
| **Festuco-Bromea** | 0.7 | 0.5 | 0 | 0 | 0 |
| Festucetea vaginatae (incl. Festucetalia vaginatae et Festucion vaginatae) | 0.6 | 0.3 | 0 | 0 | 0 |
| Festuco-Brometea | 0.6 | 1 | 0.1 | 0.1 | 0.1 |
| Festucetalia valesiacae | 0.6 | 0.3 | 0 | 0 | 0.1 |
| Festucion rupicolae | 0 | 0.1 | 0 | 0.1 | 0 |
| Cynodonto-Festucenion | 1.1 | 1 | 0.1 | 0 | 0 |
| Festucion rupicolae s.l. | 1.1 | 1.1 | 0.1 | 0.1 | 0 |
| Festucetalia valesiacae s.l. | 1.7 | 1.4 | 0.1 | 0.1 | 0.1 |
| Festuco-Brometea s.l. | 2.3 | 2.4 | 0.2 | 0.2 | 0.2 |
| **Festuco-Bromea s.l.** | 3.6 | 3.2 | 0.2 | 0.2 | 0.2 |

| Table 2/2. | Sal. p. | Pop. n. | Pop. a. | Ulm. | Cp. |
|---|---|---|---|---|---|
| **Chenopodio-Scleranthea** | 8 | 0.9 | 0.6 | 0.2 | 0.1 |
| Secalietea | 2.9 | 1.9 | 1.5 | 1.3 | 1.3 |
| Aperetalia (incl. Aphanion) | 1.2 | 0.5 | 0 | 0 | 0 |
| Secalietalia | 0 | 0 | 0 | 0 | 0 |
| Caucalidion platycarpos | 0.4 | 0 | 0 | 0 | 0 |
| Secalietalia s.l. | 0.4 | 0 | 0 | 0 | 0 |
| Eragrostetalia | 0 | 0 | 0 | 0 | 0 |
| Tribulo-Eragrostion minoris | 1.2 | 0 | 0 | 0 | 0 |
| Eragrostetalia s.l. | 1.2 | 0 | 0 | 0 | 0 |
| Secalietea s.l. | 5.7 | 2.4 | 1.5 | 1.3 | 1.3 |
| Oryzetea sativae (incl. Oryzetalia et Oryzion sativae) | 0.2 | 0 | 0 | 0 | 0 |
| Chenopodietea | 2.2 | 0.1 | 1.3 | 0.5 | 0.1 |
| Sisymbrietalia | 0 | 0 | 0 | 0 | 0 |
| Sisymbrion officinalis | 0.2 | 0 | 0 | 0 | 0 |
| Sisymbrietalia s.l. | 0.2 | 0 | 0 | 0 | 0 |
| Onopordetalia | 0 | 0 | 0 | 0 | 0 |
| Onopordion acanthii | 0.2 | 0 | 0 | 0 | 0 |
| Onopordetalia s.l. | 0.2 | 0 | 0 | 0 | 0 |
| Chenopodietea s.l. | 2.6 | 0.1 | 1.3 | 0.5 | 0.1 |
| Artemisietea (incl. Artemisietalia et Arction lappae) | 1.2 | 0.7 | 1.3 | 0.6 | 0.3 |
| Galio-Urticetea (incl. Calystegietalia sepium) | 0 | 0.1 | 0 | 0 | 0 |
| Galio-Alliarion | 1 | 1.6 | 4.9 | 3.2 | 2.7 |
| Calystegion sepium | 4.4 | 3.6 | 2.8 | 1.3 | 0.8 |
| Galio-Urticetea s.l. | 5.4 | 5.3 | 7.7 | 4.5 | 3.5 |
| Bidentetea (incl. Bidentetalia) | 6.4 | 0.5 | 0.6 | 0.3 | 0.1 |
| Bidention tripartiti | 0.7 | 0 | 0.1 | 0.1 | 0 |
| Bidentetea s.l. | 7.1 | 0.5 | 0.7 | 0.4 | 0.1 |
| Plantaginetea (incl. Plantaginetalia majoris) | 4.6 | 0.5 | 0.4 | 0.1 | 0 |
| Agropyro-Rumicion crispi | 1.6 | 0.1 | 0 | 0 | 0 |
| Polygonion avicularis | 0.7 | 0 | 0 | 0 | 0 |
| Plantaginetea s.l. | 6.9 | 0.6 | 0.4 | 0.1 | 0 |
| Epilobietea angustifolii (incl. Epilobietalia) | 0.6 | 1.8 | 4.1 | 4.6 | 4.6 |
| Epilobion angustifolii | 0 | 0.7 | 0.6 | 0.3 | 0.2 |
| Epilobietea angustifolii s.l. | 0.6 | 2.5 | 4.7 | 4.9 | 4.8 |
| Urtico-Sambucetea (incl. Sambucetalia et Sambuco-Salicion capreae) | 0 | 0 | 0.4 | 0.5 | 0.5 |
| **Chenopodio-Scleranthea s.l.** | 37.7 | 13 | 18.6 | 13 | 10.7 |

| Table 2/3. | Sal. p. | Pop. n. | Pop. a. | Ulm. | Cp. |
|---|---|---|---|---|---|
| **Querco-Fagea** | 0 | 0 | 0 | 0 | 0 |
| Salicetea purpureae (incl. Salicetalia purpureae) | 5.4 | 4.4 | 3.7 | 1.6 | 0.8 |
| Salicion elaeagni | 2.4 | 0 | 0 | 0 | 0 |
| Salicion triandrae | 1.6 | 0.7 | 0 | 0 | 0 |
| Salicion albae | 2.3 | 3.9 | 4.2 | 2.5 | 1.6 |
| Salicetea purpureae s.l. | 11.7 | 9 | 7.9 | 4.1 | 2.4 |
| Alnetea glutinosae (incl. Alnetalia glutinosae) | 2.3 | 5.1 | 3.9 | 2.7 | 2.2 |
| Alnion glutinosae | 0 | 0 | 0.1 | 0.1 | 0 |
| Alnetea glutinosae s.l. | 2.3 | 5.1 | 4 | 2.8 | 2.2 |
| Querco-Fagetea | 0 | 8.4 | 12.4 | 15 | 16.7 |
| Fagetalia sylvaticae | 0 | 5.3 | 11.5 | 26.5 | 32 |
| Alnion incanae | 3 | 10 | 12.4 | 10.1 | 9 |
| Alnenion glutinosae-incanae | 0 | 0 | 0.3 | 0.6 | 0.5 |
| Ulmenion | 0.4 | 0.9 | 2.4 | 1.5 | 1 |
| Alnion incanae s.l. | 3.4 | 10.9 | 15.1 | 12.2 | 10.5 |
| Fagion sylvaticae | 0 | 0 | 0 | 0 | 0 |
| Eu-Fagenion | 0 | 0 | 0 | 0.2 | 0.2 |
| Carpinenion betuli | 0 | 2 | 1.8 | 4.7 | 5.4 |
| Tilio platyphyllae-Acerenion pseudoplatani | 0 | 0 | 0.2 | 1 | 1 |
| Fagion sylvaticae s.l. | 0 | 2 | 2 | 5.9 | 6.6 |
| Aremonio-Fagion | 0 | 1.4 | 0.1 | 0.5 | 0.5 |
| Fagetalia sylvaticae s.l. | 3.4 | 19.6 | 28.7 | 45.1 | 49.6 |
| Quercetalia roboris | 0 | 0.4 | 0.1 | 0.6 | 1 |
| Quercion robori-petraeae | 0.3 | 0.6 | 0 | 0 | 0 |
| Quercetalia roboris s.l. | 0.3 | 1 | 0.1 | 0.6 | 1 |
| Querco-Fagetea s.l. | 3.7 | 29 | 41.2 | 60.7 | 67.3 |
| Quercetea pubescentis-petraeae | 1.5 | 10 | 8 | 9.8 | 10.4 |
| Orno-Cotinetalia | 0 | 0 | 0.1 | 0 | 0 |
| Orno-Cotinion | 0 | 0 | 0.1 | 0.2 | 0.1 |
| Quercion farnetto | 0 | 0 | 0 | 0.4 | 0.4 |
| Orno-Cotinetalia s.l. | 0 | 0 | 0.2 | 0.6 | 0.5 |
| Quercetalia cerris | 0 | 0 | 0 | 0 | 0.1 |
| Aceri tatarico-Quercion | 0 | 0 | 0.7 | 0.2 | 0.1 |
| Quercetalia cerris s.l. | 0 | 0 | 0.7 | 0.2 | 0.2 |
| Prunetalia spinosae | 0 | 1.4 | 0 | 0.6 | 0.3 |
| Berberidion | 0 | 0 | 0 | 0 | 0.1 |
| Prunetalia spinosae s.l. | 0 | 1.4 | 0 | 0.6 | 0.4 |
| Quercetea pubescentis-petraeae s.l. | 1.5 | 11.4 | 8.9 | 11.2 | 11.5 |
| **Querco-Fagea s.l.** | 19.2 | 54.5 | 62 | 78.8 | 83.4 |
| **Abieti-Piceea** | 0 | 0 | 0 | 0 | 0 |
| Vaccinio-Piceetea | 0 | 0 | 0.1 | 0.4 | 0.6 |
| Pino-Quercetalia (incl. Pino-Quercion) | 0 | 0.6 | 0 | 0.1 | 0.4 |
| Vaccinio-Piceetea s.l. | 0 | 0.6 | 0.1 | 0.5 | 1 |
| **Abieti-Piceea s.l.** | 0 | 0.6 | 0.1 | 0.5 | 1 |
| **Indifferens** | 7.1 | 5.6 | 4 | 2.6 | 1.9 |
| **Adventiva** | 11.9 | 6.1 | 8.5 | 1.6 | 0.4 |

**Sal.p.:** Rumici crispi-Salicetum purpureae (Kevey and Csete ined.: 2 recordings)
**Pop.n.:** Carduo crispi-Populetum nigrae (Kevey. Csete and Lendvai ined.: 3 recordings)
**Pop.a.:** Senecioni sarracenici-Populetum albae (Kevey & Tóth 2006: 20 recordings)
**Ulm.:** Fraxino pannonicae-Ulmetum (Kevey 2006c: 50 recordings)
**Cp.:** Circaeo-Carpinetum (Kevey 2006b: 50 recordings)

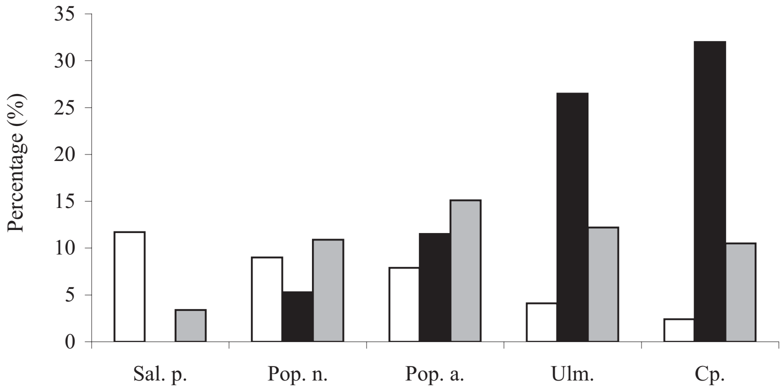


Fig. 3. Percentage of different syntaxa based on K%: Salicetea (white), Fagetalia (black) and Alnion incanae (gray) species. Legends: **Sal.p.:** Rumici crispi-Salicetum purpureae (KEVEY and CSETE ined.: 2 recordings) **Pop.n.:** Carduo crispi-Populetum nigrae (KEVEY, CSETE and LENDVAI ined.: 3 recordings) **Pop.a.:** Senecioni sarracenici-Populetum albae (Kevey and TÓTH 2006: 20 recordings) **Ulm.:** Fraxino pannonicae-Ulmetum (KEVEY 2006c: 50 recordings) **Cp.:** Circaeo-Carpinetum (KEVEY 2006b: 50 recordings)

# 7. Nature conservation implications

The Drava section along the border between Hungary and Croatia is one of our most natural floodplain regions. Its greatest value is that the river can still freely shape its bed, and thus can transform floodplain vegetation. By means of its building and destroying effect, it creates shoals, gravely and sandy rivershore areas, thus providing space for primary succession to proceed.

Especially valuable are purple willow bushes (*Rumici crispi-Salicetum purpureae*), which had been formerly known only from the Szigetköz region. However, since the Danube was diverted in Slovakia in 1992, there have been no possibilities for new purple willow bushes to become established in Szigetköz. Among Hungarian rivers, now it is only along the Drava that the linear succession sequence leading from purple willow bushes of gravely riversides through black poplar gallery forests (*Carduo crispi-Populetum nigrae*) to white poplar galleries (*Senecioni sarracenici-Populetum albae*) can proceed in a natural way. The co-occurrence of these three forest associations can be observed also in several of the river-bends between Őrtilos and Babócsa. Although the number of protected plant species finding refuge in purple willow associations is low, *Myricaria germanica* and *Salix elaeagnos* also do occur here.

Almond-leaved willow bushes (*Polygono hydropiperi-Salicetum triandrae*), too, represent the initial stage of a linear succession sequence, leading through white willow galleries (*Leucojo aestivi-Salicetum albae*) to white poplar gallery forests (*Senecioni sarracenici-Populetum albae*). These three associations can be observed together even today along certain side-branches of Drava. In addition to evidence about succession interrelations, protected species also add to the natural value of almond-leaved willow bushes. Such are *Leucojum aestivum* and *Lindernia procumbens*.

Because of the expansion of willow hybrid plantations, natural willow groves (*Leucojo aestivi-Salicetum albae*) have greatly diminished. Their most exquisite stand was recorded at the village Révfalu, on the left side of Drava (outskirts of Drávasztára). Their protected species *Leucojum aestivum* can be frequent at places, but at some places *Senecio paludosa* or *Fritillaria meleagris* can also appear. Unfortunately, as a result of the fact that Drava is cutting deeper in its bed, the mean water level of willow galleries has dropped, leading to an increased expansion of weeds in the area.

Black poplar galleries (*Carduo crispi-Populetum nigrae*) are among the interesting features of the Drava floodplains, whose typical stands have been so far known from the Szigetköz region only. However, following the diversion of Danube in Slovakia, black poplar galleries started to dry out, their herb layer transforming almost incomparably, and because there are no new purple willow galleries forming, there are no ”supplies” remaining from which black poplar galleries could evolve. According to our current knowledge, it is only along Drava that natural black poplar gallery forests still continue to exist. Among their protected plants, notable are *Equisetum hyemale*, *Peucedanum verticillare*, and also *Salix elaeagnos*, reaching up to the lower canopy layer, but sometimes *Myricaria germanica* and *Orchis purpurea* can also be present. The survival of black poplar gallery forests is threatened primarily by the intensive planting of hybrid poplar stands (*Populus* × *euramericana* agg.). Certain invasive, alien species (*Acer negundo, Amorpha fruticosa, Robinia pseudo-acacia, Solidago gigantea*) also represent serious problem for nature conservation, whose expansion can be further assisted by the lowering trend of groundwater levels in these habitats. The deepening of Drava riverbed is suggested also by the striking phenomenon that *Salix alba* specimens of black poplar galleries are often seen drying out.

The majority of white poplar gallery forests (*Senecioni sarracenici-Populetum albae*) were observed along the Drava section below Barcs. However, there are some remote places with this association where there are no forestry activities practised. This is suggested by the presence of certain shrubs (*Cornus sanguinea, Euonymus europaeus*) which can survive to reaching the lower canopy layer. Their herb layer is home for the protected scouring rush (*Equisetum hyemale*) often forming dense growth. Other protected plants include: *Carex strigosa, Carpesium abrotanoides, Cephalanthera longifolia*, *Dryopteris carthusiana, Epipactis helleborine*, *Equisetum hyemale*, *Fritillaria meleagris*, *Galanthus nivalis, Leucojum aestivum, Lonicera caprifolium, Neottia nidus-avis, Petasites albus, Peucedanum verticillare*, *Platanthera bifolia, Polystichum aculeatum, Tamus communis*. The survival of these associations here are threatened, again, by the expansion of hybrid poplar plantations (*Populus* × *euramericana* agg.). Fortunately, this association type regenerates easily, and thus can be restored by a replacement of tree species.

Alder gallery forests (*Paridi quadrifoliae-Alnetum*) forming through the filling up of alder bogs are only sporadically present along Drava, and their size is normally small. Relatively many protected species find refuge in their herb layer: *Carex strigosa*, *Carpesium abrotanoides, Dryopteris carthusiana*, *D. dilatata*, *Fritillaria meleagris, Galanthus nivalis, Leucojum aestivum*, *L. vernum, Listera ovata, Omphalodes scorpioides, Polystichum aculeatum, P. setiferum, Primula vulgaris*, *Ruscus aculeatus, Scilla* *drunensis*, *Tamus communis, Thelypteris palustris, Veratrum album*. These associations are less threatened than softwood gallery forests, because their habitats are very rarely planted with alien species.

The majority of oak-ash-elm gallery forests (*Fraxino pannonicae-Ulmetum*) are found today in flood-prevented areas. There are relatively many of these associations. Their more frequent protected species are as follows: *Dryopteris carthusiana, Dryopteris dilatata, Carex strigosa, Carpesium abrotanoides*, *Primula vulgaris*, *Carex strigosa*, *Epipactis helleborine* agg., *Galanthus nivalis, Leucojum aestivum, L. vernum, Neottia nidus-avis, Cephalanthera longifolia, Daphne mezereum, Omphalodes scorpioides, Ophioglossum vulgatum, Polystichum aculeatum, P. setiferum, Primula vulgaris, Ruscus aculeatus, Scilla drunensis, Tamus communis, Listera ovata*. Their survival is threatened in many places by forestry management, because clear-cut plots are often re-planted with alien species (*Populus* × *euramericana, Robinia pseudo-acacia, Picea abies* etc.).

Both direct observations and the opinions of hydrological professionals confirm that Drava has cut its riverbed deeper during recent decades which has lead to its mean water level also dropping. The most striking signs of this phenomenon is the appearance of dried-out specimens of *Salix alba* in black poplar gallery forests (*Carduo crispi-Populetum nigrae*), and the expansion of certain adventive species (e.g. *Robinia pseudo-acacia, Solidago gigantea*). White willow reacts much more sensitively to drying out than poplar species. Riverbed deepening has been caused probably by hydroelectric stations in Croatia, because such structures trap the majority of gravely drift carried by the river. As the velocity is high and the drift of the river is quite strong, the load of the river that has been deposited in earlier times is rolled further along. Currently, the amount of deposit brought in by the river is less than the amount taken away, which causes riverbed deepening. Because of the operation of Croatian hydroelectric stations, water level dynamics has been altered significantly. This, in turn, has an impact on shoal formation and on the colonisation of shoals by vegetation, the latter depending mostly on water regimes and seed ripening times. Plants can establish themselves on shoals only at times of low water level. However, the reservoirs upstream can trap, in addition to river deposit, a proportion of plant propagula carried by the river, thus they also influence the species composition of shoals. If a new hydroelectric power plant is established on the Croatian side, more changes are expected to set in. The long-term monitoring programme having been performed since the year 2000 aims at recording and forecasting such processes.

Duna-Drava National Park was inaugurated in 1996. The Croatian forests analysed as part of the present study have not been brought under protection. In the future it would be necessary to declare them protected and create a cross-border Croatian-Slovenian-Hungarian national park along the river Drava.

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# Malacological data (Mollusca) from the Croatian Drava region (N Croatia)

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**Abstract:** Along the Croatian side of Drava river 68 mollusc species (63 snails and 5 bivalves) were collected. Among them *Ena montana* (Draparnaud, 1801) is the rarest species living in an oak-elm grove. *Arion lusitanicus* J. Mabille, 1868 had already appeared also on the Croatian side and it has colonised this area.

## 1. Introduction

The Hungarian section of river Drava and the wider Drava environment have been an intensively researched area in the recent 20 years. After an initial array of faunal investigations (Varga 1995; Varga & Uherkovich 1998, Héra 2002), monitoring studies have been performed in co-ordination by Duna-Drava National Park Directorate (Héra 2005). Nearly one hundred species have been thus revealed, among which 12 species are under legal protection. However, there have been no publications released until now, about the fauna of the Croatian Drava section. The current study is a publication of the first research results collected as part of the DRAVA-INTERECO co-operation project, yielding data from the Croatian parts of Drava water bodies and from habitats along the river.

## 2. Material and methods

All items of the material listed in the current study have been collected by the authors themselves. During a series of smaller field trips, the authors collected together and on their own as well (Table 1.). Sampling techniques normally used in malacological field work have been applied here, too: sample material has been taken both by single specimen collecting, and by soil and humus screening (Héra & Štamol 2007). Collecting specimens from driftwood and screening driftwood debris also proved to be effective (Domokos &

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VARGA 1994). Although in the first half of 2007 the amount of fresh drift material accumulating was insignificant due to prolonged periods of low water levels, it was still possible to investigate drift debris heaps and their remains from earlier periods, all this yielding relatively species-rich material (mostly in the region of Legrad and Starogradački Marof). The collected and processed material is preserved in the collection of the Natural History Department of Somogy County Museum.

Table 1. Data of sampling points

| Settlement | Collecting site | UTM | Latitude N | Longitude E |
|---|---|---|---|---|
| Brodić | Drava river-bank, ferryboat port | XL79 | 46˚01'21" | 17˚15'42" |
| Brodić | oak-ash-elm grove | XL79 | 46˚01'06" | 17˚15'12" |
| Budakovac | polluted oxbow lake along the settlement | YL08 | 45˚51'07" | 17˚37'21" |
| Đelekovec | Šoderica (gravel pits) | XM42 | 46˚14'38" | 16˚55'39" |
| Detkovac | 1 km SE, scrub along plough-land | YL08 | 45˚52'56" | 17˚36'53" |
| Detkovac | oxbow lake of Drava along settlement | YL08 | 45˚53'10" | 17˚36'02" |
| Ferdinandovac | branch of Drava, landmark No B488 | XM70 | 46˚04'31" | 17˚12'29" |
| Ferdinandovac | Drava river-bank, 186th km | XM70 | 46˚03'02" | 17˚15'08" |
| Gola | Jagerov Kut, Querco-Carpinetum | XM61 | 46˚11'44" | 17˚05'24" |
| Gotalovo | at bridge of Drava, 227th km | XM52 | 46˚14'31" | 16˚56'21" |
| Legrad | 1 km E, Drava, river-bank | XM42 | 46˚17'50" | 16˚52'40" |
| Legrad | 1 km N, willow grove along Drava | XM42 | 46˚18'25" | 16˚52'05" |
| Legrad | Drava-Mura mouth | XM42 | 46˚17'48" | 16˚53'10" |
| Lukač | Dugo Selo Lukačko, mesophilous meadow | XL98 | 45˚52'12" | 17˚36'41" |
| Molve | Drava, right river-bank, at bridge | XM61 | 46˚07'45" | 17˚04'01" |
| Noškovci | Drava river-bank | YL17 | 45˚48'03" | 17˚48'30" |
| Novo Virje | branch of Drava | XM70 | 46˚06'49" | 17˚06'44" |
| Novo Virje | Čarda, dead branch of Drava | XM70 | 46˚05'46" | 17˚11'13" |
| Novo Virje | Drava, 202th km, river-bank & pebble shoal | XM70 | 46˚06'47" | 17˚06'55" |
| Novo Virje | willow grove along Drava | XM70 | 46˚05'46" | 17˚11'28" |
| Pitomača | 4 km NW, Querco-Fraxinetum | XM70 | 45˚57'34" | 17˚17'04" |
| Repaš | 1 km NE, Querco-Carpinetum | XM61 | 46˚08'56" | 17˚06'27" |
| Starogradački Marof | Drava river-bank at the ferry to Križnica | XL79 | 45˚57'33" | 17˚18'36" |
| Starogradački Marof | Križnica, Drava left bank, flood area | XL79 | 45˚57'39" | 17˚28'43" |
| Viljevo | Drava river-bank | BR77 | 45˚46'16" | 18˚03'28" |

Below is the list of all the species collected during our field work in 2007. Semicolons separate collection sites, whereas commas are used to separate more accurate place-names for a single collection site. Because all this material has been collected by the authors, collectors' names are not indicated. The species-list follows the taxonomy used in CLECOM-PROJECT (FALKNER et al. 2001), with attention paid to nomenclature used in Hungarian malacological literature (PINTÉR & SUARA 2004).

# 3. Results and Conclusions

List of collected species:

Gastropoda

1. *Viviparus contectus* (Millet, 1813) – Legrad, Drava, river-bank; Novo Virje, Drava, 202th km.
2. *Amphimelania holandrii* (C. Pfeiffer, 1828) – Ferdinandovac, Drava river-bank, 186th km; Legrad, willow grove; Legrad, Drava-Mura mouth; Molve, Drava at bridge.
3. *Bithynia* (*Bithynia*) *tentaculata* (Linnaeus, 1758) – Đelekovec, Šoderica; Legrad, Drava, river-bank; Legrad, willow grove, Legrad, Drava-Mura mouth; Starogradački Marof, ferry to Križnica.
4. *Lithoglyphus naticoides* (C. Pfeiffer, 1828) – Legrad, Drava, river-bank; Novo Virje, branch of Drava; Molve, Drava at bridge.
5. *Valvata* (*Valvata*) *cristata* O.F. Müller, 1774 – Legrad, Drava, river-bank.
6. *Valvata* (*Cincinna*) *piscinalis piscinalis* (O.F. Müller, 1774) – Đelekovec, Šoderica; Legrad, Drava, river-bank.
7. *Galba truncatula* (O.F. Müller, 1774) – Ferdinandovac, Drava river-bank, 186th km; Legrad, Drava, river bank; Legrad, willow grove; Legrad, Drava-Mura mouth; Starogradački Marof, ferry to Križnica.
8. *Stagnicola fuscus* (C. Pfeiffer, 1821) – Budakovac, oxbow lake; Legrad, Drava, river-bank; Legrad, willow grove; Legrad, Drava-Mura mouth; Starogradački Marof, ferry to Križnica.
9. *Radix auricularia auricularia* (Linnaeus, 1758) – Legrad, Drava, river-bank; Legrad, Drava-Mura mouth.
10. *Radix ampla* (W. Hartmann, 1821) – Đelekovec, Šoderica; Legrad, Drava-Mura mouth.
11. *Lymnaea stagnalis* (Linnaeus, 1758) – Đelekovec, Šoderica.
12. *Physella* (*Costatella*) *acuta* (Draparnaud, 1805) – Budakovac, oxbow lake.
13. *Planorbarius corneus corneus* (Linnaeus, 1758) – Ferdinandovac, branch of Drava, landmark No B488; Legrad, Drava, river-bank.
14. *Planorbis* (*Planorbis*) *planorbis* (Linnaeus, 1758) – Legrad, Drava, river-bank; Legrad, Drava-Mura mouth; Novo Virje, Drava, 202th km; Starogradački Marof, ferry to Križnica.
15. *Planorbis* (*Planorbis*) *carinatus* O.F. Müller, 1774 – Legrad, willow grove.
16. *Anisus* (*Anisus*) *spirorbis* (Linnaeus, 1758) – Legrad, Drava, river-bank.
17. *Anisus* (*Anisus*) *septemgyratus* (Rossmässler, 1835) – Legrad, Drava, river-bank.
18. *Bathyomphalus contortus* (Linnaeus, 1758) – Legrad, Drava, river-bank.
19. *Gyraulus* (*Gyraulus*) *albus* (O.F. Müller, 1774) – Legrad, Drava, river-bank.
20. *Gyraulus* (*Lamorbis*) *riparius* (Westerlund, 1865) – Legrad, willow grove.
21. *Carychium* (*Carychium*) *minimum* O.F. Müller, 1774 – Legrad, Drava, river-bank; Legrad, willow grove; Starogradački Marof, ferry to Križnica.
22. *Carychium* (*Saraphia*) *tridentatum* (Risso, 1826) – Legrad, Drava, river-bank.
23. *Succinea putris* (Linnaeus, 1758) – Đelekovec, Šoderica; Legrad, Drava, river-bank; Legrad, willow grove.

24. *Succinella oblonga* (Draparnaud, 1801) – Legrad, willow grove.
25. *Oxyloma* (*Oxyloma*) *elegans elegans* (Risso, 1826) – Budakovac, oxbow lake; Đelekovec, Šoderica; Legrad, Drava, river-bank; Starogradački Marof, ferry to Križnica.
26. *Cochlicopa lubrica* (O.F. Müller, 1774) – Legrad, Drava, river-bank; Legrad, willow grove; Legrad, Drava-Mura mouth; Molve, Drava at bridge; Starogradački Marof, ferry to Križnica.
27. *Cochlicopa lubricella* (Rossmässler, 1834) – Legrad, Drava, river-bank; Starogradački Marof, ferry to Križnica.
28. *Vallonia costata* (O.F. Müller, 1774) – Molve, Drava at bridge; Novo Virje, Čarda.
29. *Vallonia enniensis* (Gredler, 1856) – Molve, Drava at bridge.
30. *Vallonia pulchella* (O.F. Müller, 1774) – Legrad, Drava, river-bank; Lukač, Dugo Selo; Novo Virje, Čarda; Starogradački Marof, ferry to Križnica.
31. *Pupilla muscorum* (Linnaeus, 1758) – Legrad, Drava, river-bank; Starogradački Marof, ferry to Križnica.
32. *Truncatellina cylindrica* (A. Férussac, 1807) – Legrad, Drava, river-bank; Novo Virje, Čarda.
33. *Vertigo* (*Vertigo*) *antivertigo* (Draparnaud, 1801) – Starogradački Marof, ferry to Križnica.
34. *Vertigo* (*Vertigo*) *pygmaea* (Draparnaud, 1801) – Molve, Drava at bridge.
35. *Ena montana* (Draparnaud, 1801) – Brodić, oak-ash-elm grove.
36. *Cochlodina* (*Cochlodina*) *laminata laminata* (Montagu, 1803) – Brodić, oak-ash-elm grove; Legrad, willow grove.
37. *Clausilia* (*Clausilia*) *pumila pumila* C. Pfeiffer, 1828 – Brodić, oak-ash-elm grove; Gotalovo, Drava, bridge; Legrad, Drava, river-bank; Legrad, willow grove; Starogradački Marof, ferry to Križnica.
38. *Cecilioides* (*Cecilioides*) *acicula* (O.F. Müller, 1774) – Legrad, Drava, river-bank;
39. *Punctum* (*Punctum*) *pygmaeum* (Draparnaud, 1801) – Legrad, Drava, river-bank; Novo Virje, Čarda.
40. *Vitrea crystallina* (O.F. Müller, 1774) – Drava, river-bank; Legrad, willow grove; Novo Virje, Čarda; Novo Virje, willow grove; Starogradački Marof, ferry to Križnica.
41. *Euconulus* (*Euconulus*) *fulvus* (O.F. Müller, 1774) – Legrad, Drava, river-bank; Legrad, willow grove.
42. *Zonitoides* (*Zonitoides*) *nitidus* (O.F. Müller, 1774) – Legrad, Drava, river-bank; Legrad, willow grove; Molve, Drava at bridge.
43. *Aegopinella minor* (Stabile, 1864) – Legrad, Drava-Mura mouth.
44. *Aegopinella ressmanni* (Westerlund, 1883) – Brodić, Drava, ferryboat port; Brodić, oak-ash-elm grove; Budakovac, oxbow lake; Detkovac, oxbow lake; Ferdinandovac, Drava river-bank, 186th km; Gotalovo, Drava, bridge; Legrad, Drava, river-bank; Legrad, willow grove; Legrad, Drava-Mura mouth; Novo Virje, Drava, 202th km; Novo Virje, willow grove; Repaš, Querco-Carpinetum; Starogradački Marof, ferry to Križnica.
45. *Aegopis verticillus* (Lamarck, 1822) – Gotalovo, Drava, bridge; Legrad, Drava, river-bank; Legrad, Drava-Mura mouth; Novo Virje, Drava, 202nd km.
46. *Semilimax semilimax* (J. Férussac, 1802) – Brodić, Drava, ferryboat port; Legrad, willow grove; Novo Virje, Čarda; Novo Virje, willow grove.

47. *Deroceras* (*Deroceras*) *laeve* (O.F. Müller, 1774) – Đelekovec, Šoderica.
48. *Deroceras* (*Deroceras*) *agreste* (Linnaeus, 1758) – Đelekovec, Šoderica.
49. *Deroceras* (*Deroceras*) *reticulatum* (O.F. Müller, 1774) – Đelekovec, Šoderica.
50. *Arion lusitanicus* J. Mabille, 1868 – Molve, Drava at bridge.
51. *Arion* (*Mesarion*) *fuscus* (O.F. Müller, 1774) (syn. *Arion subfuscus* (Draparnaud, 1805)) – Legrad, willow grove.
52. *Fruticicola fruticum* (O.F. Müller, 1774) – Brodić, Drava, ferryboat port; Brodić, oak-ash-elm grove; Gotalovo, Drava, bridge; Molve, Drava at bridge; Legrad, willow grove; Legrad, Drava-Mura mouth; Novo Virje, Drava, 202nd km; Novo Virje, wil low grove; Viljevo, Drava.
53. *Monacha* (*Monacha*) *cartusiana* (O.F. Müller, 1774) – Đelekovec, Šoderica; Gotalovo, Drava, bridge; Legrad, Drava, river-bank; Starogradački Marof, ferry to Križnica.
54. *Trichia* (*Trichia*) *hispida* (Linnaeus, 1758) – Legrad, Drava, river-bank.
55. *Pseudotrichia rubiginosa* (Rossmässler, 1838) – Legrad, Drava, river-bank; Legrad, willow grove; Starogradački Marof, ferry to Križnica.
56. *Monachoides incarnatus incarnatus* (O.F. Müller, 1774) – Brodić, Drava, ferryboat port; Brodić, oak-ash-elm grove; Detkovac, oxbow lake; Detkovac, oxbow lake; Ferdinandovac, branch of Drava, landmark No B488; Gola, Jagerov Kut; Gotalovo, Drava, bridge; Legrad, Drava, river-bank; Legrad, willow grove; Legrad, Drava-Mura mouth; Novo Virje, branch of Drava; Novo Virje, Čarda; Starogradački Marof, ferry to Križnica.
57. *Perforatella bidentata* (Gmelin, 1791) – Legrad, Drava, river-bank; Legrad, Drava-Mura mouth; Novo Virje, Drava, 202nd km.
58. *Urticicola umbrosus* (C. Pfeiffer, 1828) – Brodić, Drava, ferryboat port; Brodić, oak-ash-elm grove; Gotalovo, Drava, bridge; Legrad, Drava, river-bank; Legrad, Drava-Mura mouth; Novo Virje, Drava, 202nd km; Pitomača, 4 km NW, Querco-Fraxinetum.
59. *Arianta arbustorum arbustorum* (Linnaeus, 1758) – Brodić, Drava, ferryboat port; Gotalovo, Drava, bridge; Legrad, Drava, river-bank; Novo Virje, Drava, 202nd km.
60. *Faustina illyrica illyrica* (Stabile, 1864) – Gotalovo, Drava, bridge; Legrad, willow grove.
61. *Cepaea* (*Cepaea*) *nemoralis nemoralis* (Linnaeus, 1758) – Brodić, Drava, ferryboat port; Brodić, oak-ash-elm grove; Gotalovo, Drava, bridge; Legrad, willow grove; Novo Virje, branch of Drava; Novo Virje, Čarda; Novo Virje, Drava, 202nd km; Starogradački Marof, ferry to Križnica; Viljevo, Drava.
62. *Cepaea* (*Austrotachea*) *vindobonensis* (C. Pfeiffer, 1828) – Detkovac, 1 km SE, scrub along plough-land; Detkovac, oxbow lake; Ferdinandovac, Drava river-bank, 186th km; Gotalovo, Drava, bridge; Legrad, Drava, river-bank; Legrad, willow grove; Starogradački Marof, Križnica, Drava flood area.
63. *Helix* (*Helix*) *pomatia* Linnaeus, 1758 – Brodić, Drava, ferryboat port; Brodić, oak-ash-elm grove; Detkovac, oxbow lake; Ferdinandovac, branch of Drava, land mark No B488; Gotalovo, Drava, bridge; Noskovci, Drava; Novo Virje, Drava, 202nd km; Starogradački Marof, Križnica, Drava flood area.

Bivalvia
1. *Unio pictorum latirostris* Küster, 1853 – Novo Virje, Drava, 202nd km.
2. *Sphaerium* (*Sphaerium*) *corneum* (Linnaeus, 1758) – Legrad, Drava-Mura mouth.
3. *Sphaerium* (*Amesoda*) *rivicola* (Lamarck, 1818) – Legrad, Drava, river-bank; Legrad, Drava-Mura mouth.
4. *Pisidium* (*Euglesa*) *casertanum* (Poli, 1791) – Legrad, Drava-Mura mouth.
5. *Dreissena* (*Dreissena*) *polymorpha polymorpha* (Pallas, 1771) – Đelekovec, Šoderica; Gotalovo, Drava, bridge; Legrad, Drava, river-bank; Legrad, Drava-Mura mouth; Novo Virje, Drava, 202nd km; Starogradački Marof, ferry to Križnica.

The 20 species of aquatic snail fauna having been recorded so far makes about half of the number of species known from the Hungarian side of the river. The majority of these snails are characteristic species of slow-moving streams or stagnant waters rich in organic matter, thus these species have arrived in the samples from waters flowing into the river in adjacent areas or by being washed in from lacustrine drifting matter. From a faunal aspect, they are less notable than the snails of the river itself. Among the latter, the most considerable is the Sava aquatic snail *Amphimelania holandrii* (Fig. 1.), a relict species protected in Hungary, found at places on riverbank-protecting stone depositions and spurs, and on gravely riverbed sections. From experience gained so far in Croatia, its densities seem to be lower than on the left side of the river. The Danubian nerite *Theodoxus* (*Theodoxus*) *danubialis danubialis* (C. Pfeiffer, 1828) found in Őrtilos, Hungary and probably brought to the area by the river Mura, has not been found so far on the Croatian side.

Very little research has been done on the bivalve fauna. Among the 5 species recorded so far, the zebra mussel *Dreissena* (*Dreissena*) *polymorpha polymorpha* (Fig. 2.) associated with solid riverbed sections is present everywhere in masses, rapidly colonising newly forming habitats. Typical but rare species of riverbed sections with lower water velocity and sandy or silty cover (both included in the CORINE list) are the compressed river mussel *Pseudanodonta complanata complanata* (Rossmässler, 1835), and thick-shelled river mussel *Unio* (*Crassunio*) *crassus* Philipsson, 1788 whose obvious presence has not been shown in the Croatian side. The genus *Pisidium* is particularly under-represented. The authors have not been able to collect the rapidly spreading adventive swan-mussel *Sinanodonta woodiana* (Lea, 1834).

The common species of land snails have been found in gallery forests. An outstanding malacological value is the mountain bulin *Ena montana*, found in a single sampling point (Brodić), in an oak-ash-elm grove, probably being a relict species of the Drava region from periods with cooler climate, deserving protection. On the Hungarian side this species lives in the relict beechwoods of Őrtilos (Héra & Varga 2001). Two other protected species are found in patches in gallery forests, namely the brown lipped snail *Cepaea* (*Cepaea*) *nemoralis nemoralis* and *Faustina illyrica illyrica* (Fig. 3.), a Dinarian, south-Alpic member of the fauna. The number of slug species, too, was found to be much less that what is likely to be present. Not only two species of the *Limax* genus are expected to occur in addition to *Dreoceras* species that we found everywhere along waters, but also one or two rarer species of mixed deciduous forests e.g. *Malacolimax tenellus* (O.F. Müller, 1774), might be present (Fig. 4.). The fauna of drift debris is also quite incomplete.

Fig. 1. *Amphimelania holandrii* (Photo by Zoltán Héra)

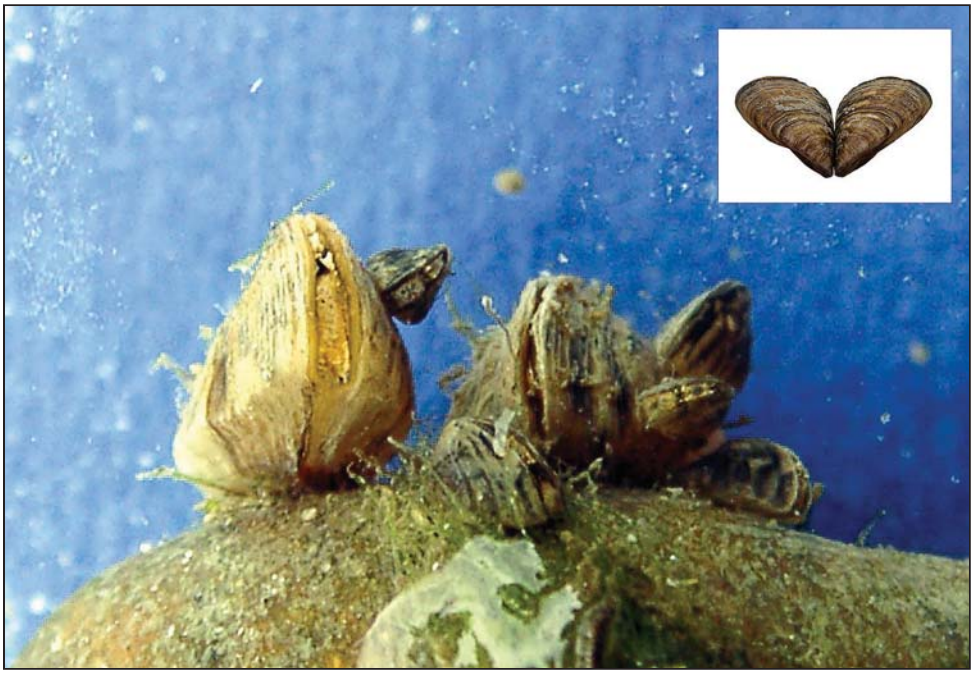

Fig. 2. *Dreissena (Dreissena) polymorpha polymorpha* (Photo by Zoltán Héra)

Fig. 3. *Faustina illyrica illyrica* (Photo by Zoltán Héra)

Fig. 4. *Malacolimax tenellus* (Photo by Zoltán Héra)

Our initial hypotheses listed below are thus justified:

1. The aquatic faunas of Hungarian and Croatian sections do not differ, because water quality has no local variations, and water bodies with identical physical and chemical parameters are found along both sides.
2. The waterside plant associations are the same, although represented in different proportions, therefore their faunas are likely to be identical.
3. Faunas of areas located further off the riverside but still under its climatic influence, and those in periodically water-covered locations subject to anthropogenous effects, can show greater differences.

Factors influencing the results:

1. Data from research covering only one year are available from the Croatian side.
2. Methods applied during the studies in Croatia are only in part identical with periodically repeated or systematically performed methods used in the Hungarian side. (For example, some taxa with specialised lifestyle will only be found accidentally by the currently used methods. *Ancylus fluviatilis* is most probably found on the Croatian side as well, in sections with stronger flow, at depths of around 1.5 m on the bank-protecting stone depositions.
3. The weather of the past one-year period has been very much unlike the average: the significant amount of snow cover typical of the Illyrian climatic influence was absent, therefore there was no production of drifting organic matters associated with high water levels in late winter and early summer. The unusual extreme heat in summer and relatively dry weather had quite significant impact on the activity of molluscs.

Accordingly, it can be stated that the number of species revealed during one year, together with unique faunal specialities, emphasise the valuableness of the malacofauna, similarly to the Hungarian side. In case there will be possibility to carry on with research in the area, the number of species indicated is expected to grow spectacularly, especially if farther, insular habitats of the Drava region also become target areas of biodiversity research.

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# Qualitative and quantitative analysis of zooplankton fauna and water quality assessment in Croatian sampling sites along the river Drava

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**Abstract:** As part of the DRAVA-INTERECO project, and using the methodology specified in the relevant protocol, zooplankton investigations and water quality analyses were performed during 2007 in a total of 23 sampling sites of five water types (living Drava river and side-branches, Drava dead arms, gravel pit ponds, Drava tributaries), within 6 distinguished areas. According to the results of water quality assessment, various sections of river Drava and its side-branches are characterised with beta-alpha-oligohalobic, beta-alpha-mesosaprobic quality, as determined by Felföldy's water quality categorisation system. The water of the studied dead arms was alpha-oligohalobic, beta- and alpha-mesosaprobic, in gravel pit ponds it was beta-alpha-oligohalobic and oligosaprobic, whereas in the selected tributaries it was alpha-mesohalobic and alpha-beta mesosaprobic, due to direct communal wastewater effects. Altogether 38 Rotatoria, 25 Cladocera and 11 Copepoda taxa were shown to exist in the investigated waters. There was hardly any difference found between zooplankton fauna of Drava (from Legrad to Donji Miholjac) and its side-branches. In river Drava itself 12 Rotatoria, 4 Cladocera and 3 Copepoda taxa were found, whereas in the side-branches 14 Rotatoria, 4 Cladocera and 4 Copepoda taxa were shown to occur. Density in Drava and the side-branches was 0-914 ind./100 $dm^3$, and Shannon-Wiener-diversity (H) ranged between 0-3.2. In the zooplankton of the dead arms the low proportion of Rotatoria was striking, in comparison with Hungarian dead arms within Duna-Drava National Park. A total of 28 Rotatoria, 21 Cladocera and 9 Copepoda taxa were identified, mostly occurring in metaphyton. The majority of taxa revealed indicate waters of beta-mesosaprobic and meso-eutrophic qualities. In the river section between Legrad-Terezino Polje, dead arms are not affected by direct communal influence, with density values here ranging between 245-49500 ind./100 $dm^3$, H = 1.98-4.12, whereas in dead arms between Terezino Polje and Donji Miholjac where these water bodies are located directly beside settlements, density was between 317-112566 ind./100 $dm^3$, H = 1.66-3.12. The number of taxa in gravel pit ponds was extremely low (8 Rotatoria, 3 Cladocera, 2 Copepoda) as well as density (0-1460 ind./100 $dm^3$), with diversity (H) ranging between 0-2.51. In a few samples, no zooplankton was found at all. As a result of communal effects, the zooplankton faunas of both the studied creek (14 Rotatoria, 10 Cladocera, 4 Copepoda) and the canal (7 Rotatoria, 6 Cladocera, 3 Copepoda) were characterised by alpha- and beta-mesosaprobic species as early in the season as in the spring period. Density in these water bodies was found to be between 0-2644 ind./100 $dm^3$, with diversity ranging between 0-4.1.

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# 1. Introduction

The first Hungarian limnological data about areas along river Drava were published by WOYNÁROVICH (1944). Following that publication, data are available only from after the 1980s. As part of the complex faunal and nature conservation research of the Barcs Juniper Woodland Landscape Protection Area, zooplankton research has also been started (FORRÓ 1985; RONKAY 1985). More recent research in the area was started in the mid-1990s. Besides Drava river itself and other watercourses arriving here, FORRÓ (1995) and GULYÁS et al. (1995) have done research also in various types of wetland areas along Drava. From the period after the establishment of Duna-Drava National Park, data are available from 1998 (FORRÓ & MEISCH 1998; KÖRMENDI 1998, 1999). Systematic investigations have been performed since the year 2000, as part of the biodiversity monitoring system operated by Duna-Drava National Park Directorate. Results from such research have been made available, in addition to research reports, in several publications (KÖRMENDI 2001, 2005; KÖRMENDI & LANSZKI 2000, 2002a, 2002b; KÖRMENDI & PONYI 2001; KÖRMENDI & P. ZÁNKAI 2001; KÖRMENDI & PAUKER 2006).

However, very limited data are available from Croatian parts of the Drava river and Croatian wetland areas along Drava. Preliminary environmental impact assessment, Zagreb, 1993. in 4 volumes: Y2-NVD.00.09-H01.0, Y2-NVD.00.09-H02.1, Y2-NVD.00.09-H02.2, Y2-NVD.00.09-H02.3, supplement to the preliminary environmental impact assessment Y2-B24.00.23-H01.0, and STANKOVIĆ and TERNJEJ (2007).

Hypothesis: If the water quality of flowing waters, backwaters with abundant aquatic vegetation, bogs, marshes, gravel pit ponds and other typical stagnant waters deteriorate for any reason or these waters take up significant water level fluctuation, or intensive angling or fishery usage is introduced, then there will be measurable qualitative and quantitative changes occurring in the composition of their zooplankton fauna (biological indication). With such information, nature conservation measures can be made in due course (in accordance with the investigation results of other animal and plant taxa).

Objectives: Based on field visits, we intended (i) to select the areas to be studied as well as sampling locations, (ii) to make investigations necessary for water quality assessment and for measuring changes in water quality in the various water types, and (iii) to perform the qualitative and quantitative analysis of zooplankton fauna.

# 2. Material and methods

## 2.1. Stages of baseline surveying

1. Field visits in possible sampling sites (January-March 2007)
2. Designating sampling sites (January-March 2007)
3. Samplings performed as determined in the monitoring protocol (February-December 2007)

At the same time and same place where zooplankton samplings were done, water chemical samplings were also performed. During the processing of the samples, the following parameters were analysed (FELFÖLDY 1987; NÉMETH 1998): pH, specific conductivity, dissolved oxygen, chemical oxygen demand = COD, inorganic nitrogen content (ammonia-ammonium-N, nitrite-N, nitrate-N), phosphate-phosphorus content ($PO_4$-P).

During zooplankton samplings an amount of 5-100 litres of water was filtrated through plankton net, which was followed by the conservation of samples, in accordance with what is specified in the protocol. Each zooplankton sample was derived as the mean of three point samples per one water type (sampling unit). Sampling points in the case of riverine or moving water bodies were lenithic and lothic sections, and in the case of stagnant waters, open water surfaces and metaphytic sections (KÖRMENDI & TERNJEJ 2007).

For the identification of plankton species, mostly the identification manuals of BANCSI (1986, 1988), DÉVAI (1977), EINSLE (1993), GULYÁS and FORRÓ (1999, 2001), KOSTE (1978) were used.

Samplings were performed during a total of 59 occasions between February and December 2007.

## 2.2. Sampling sites

Following initial field visits, zooplankton investigations and water quality assessments were made at the following sampling locations (Table 1.).

Table 1. List of sampling sites designated for baseline surveying

| Water type | Sampling location | Coordinates |
|---|---|---|
| Main Drava course and side-branches | Legrad | N46.29729 E16.87796 |
| | Gotalovo | N46.22613 E17.14594 |
| | Novo Virje | N46.11041 E17.15161 |
| | Sigetec | N46.18644 E16.96063 |
| | Starogradački Marof | N45.95956 E17.30972 |
| | Terezino Polje-Barcs | N45.94630 E17.46387 |
| | Moslavina Podravska | N45.76180 E17.97707 |
| | Noškovci | N45.80068 E17.80812 |
| | Viljevo | N45.76607 E18.10194 |
| | Drávaszabolcs | N45.78472 E18.19954 |
| Drava-dead arms | Legrad | N46.29728 E16.87799 |
| | Čambina | N46.12249 E17.16476 |
| | Ješkovo | N46.17865 E17.04313 |
| | Ferdinandovac-Lijepa Greda | N46.07822 E17.19964 |
| | Novo Virje | N46.09703 E17.18766 |
| | Berek-Terezino Polje | N45.94630 E17.46387 |
| | Detkovac | N45.88951 E17.60182 |
| | Budakovac | N45.85271 E17.62260 |
| | Donji Mihojlac - Stara Drava | N45.77561 E16.15535 |
| Gravel pit ponds | Šoderica | N46.24214 E16.92771 |
| | Gabajeva Greda | N46.14741 E17.01592 |
| Drava tributaries | Ždala-creek | N46.17066 E17.14594 |
| | Županijski canal | N45.86662 E17.55610 |

# 3. Results and discussion

## 3.1. Results of water quality assessments

Based on water quality investigations (Table 2.) it appears that if the samples taken during the study period in various sections of Drava and its side-branches (from Legrad to Drávaszabolcs) are compared, there are no striking differences. If assessed according to the Hungarian Standard No. MSZ 12749, water quality is ”excellent” , and if classified with FELFÖLDY’s (1987) water quality categorisation system, river Drava and its analysed tributaries show beta-alpha-oligohalobic, beta-alpha-mesosaprobic water characteristics in the study period.

The location and utilisation type of the analysed dead arms have considerable influence on water quality. All of the studied water bodies are under fishery or angling utilisation (it may be a task of later periods to find out more about e.g. fish stocking, species composition, etc.). Significant communal effects appear in the case of the dead arm Detkovac-Neteča and the one near Budakovac. The proximity of human dwellings can be a significant source of pollution. The fact that the highest specific conducivity values were measured in these water bodies, can be interpreted as an evidence of this, but more investigations are needed, to be performed later on. The rest of the dead arms are under fishery utilisation, thus they are not affected by direct communal pollution (e.g. Čambina). As our investigations have revealed it, eutrophication is well advanced in all of the water bodies (the proliferation of macrophytic vegetation or algal bloom can be observed in the spring period). To record the process of nutrient accumulation will be a task of a later period. Water quality in the studied period, according to the Hungarian Standard No. MSZ 12749, was found to be ”excellent” or ”good”, and in the FELFÖLDY (1987) water quality categorisation system water bodies ranged between alpha-oligohalobic, alpha-beta-mesosaprobic statuses.

All the studied gravel pit ponds had ”excellent” water quality in the analysed period. Within the area of the Šoderica pit, no mining activities are practised any longer, instead there is significant degree of angling and touristic utilisation. The effects of this can be noticed, and are signified e.g. by the appearance of pondweed vegetation and floating-leaved macrophytes near the waterside, despite the depth of several metres. In the gravel pit ponds near Gabajeva Greda active mining activities are practised, and there was no phytoplanktonic or macrophytic vegetation in the water body during the studied period. Water quality according to the Hungarian Standard No. MSZ 12749 was ”excellent” at the time of the analyses, and in the FELFÖLDY (1987) water quality categorisation system the water was recorded to be beta-alpha-oligohalobic and oligosaprobic.

There are direct communal effects along the creek Ždala and along the Županijski canal at its Brezovica section. The creek Ždala had low water discharge in the spring period, and was strongly overgrown by aquatic vegetation. The communal pollution effect was less pronounced than in the case of the other water body, which was indicated by the fact that even protected *Hottonia palustris* aquatic plants were found in abundance. There is significant organic pollution to the water of Županijski canal, part of which is an effect of the nearby human settlement, but is also caused by the manuring effect of free ranging domestic waterfowl on the waterside. Water quality in the studied period, according to the Hungarian Standard No. MSZ 12749, was found to be ”excellent” or ”good”, and according to the FELFÖLDY (1987) water quality categorisation system beta-alfa-mesohalobic, alfa-beta-mesosaprobic.

Table 2. Results of water chemical analyses

| | **1. Drava** | **2. Drava side branches** | **3. Drava dead arms** | **4. Gravel pit ponds** | **5. Ždala creek** | **6. Županijski canal (Brezovica)** |
|---|---|---|---|---|---|---|
| pH | 7.2-7.7 | 7.1-7.7 | 7.2-8.8 | 7.2-7.5 | 7.2-7.7 | 7.4-7.6 |
| Conducivity µS/cm | 150-90 | 190-250 | 350-580 | 260-280 | 390-10 | 410-440 |
| Ammonia-ammonium-N mg/dm$^3$ | 0.1-0.6 | 0.1-0.4 | 0.1-1.2 | 0-0.2 | 0.3-0.7 | 0.9-2.0 |
| Nitrite-N mg/dm$^3$ | 0-0.02 | 0 | 0.02 | 0.01 | 0-0.02 | 0.02-0.05 |
| Nitrate-N mg/dm$^3$ | 1.1-3.3 | 0.7-3.8 | 0.5-4.2 | 0 | 0.2-4.9 | 0.3-6.1 |
| Phosphate-P mg/dm$^3$ | 0-0.2 | 0.1-0.2 | 0-0.5 | 0 | 0.2-0.4 | 0.2-0.9 |
| KOIsMn mg/dm$^3$ | 3.1-6.2 | 2.7-6.9 | 4.1-18.1 | 1.1-1.7 | 4.7-8.1 | 3.1-21.1 |
| Dissolved oxygen mg/dm$^3$ | 8.9-0.4 | 7.9-10.2 | 6.9-12.3 | 7.8-8.4 | 6.3-9.1 | 5.8-8.8 |

## 3.2. Results of qualitative zooplankton analyses

Based on results having obtained so far, no new taxa were discovered in comparison with former investigations performed in various sections of river Drava (Duna-Drava National Park monitoring 2000-2006). The study period is characterised with low species number, low densities, and mostly euplanktonic taxa. Practically, there was hardly any difference between zooplankton species of Drava side-branches and those of the Drava main course. From the analysis of samples taken from 10 sampling locations in the Drava section between Legrad (Fig. 1.) and Donji Miholjac it can be stated that there is no typical difference between the zooplankton faunas of the sampling locations. The occurrence of euplanktonic and tychoplanktonic taxa appear to be a random distribution. *Bosmina* sp. and juvenile Copepoda occurred in all of the samples taken.

The underrepresentation of Rotatoria fauna, as reflected by species numbers, in the zooplankton of dead arms is striking if compared with dead arms in Hungary formerly studied in areas of Duna-Drava National Park. It is mostly euryoc, metaphytic species that dominated in these waters. The majority of species found indicated beta-mesosaprobic and meso-eutrophic water quality (ARORA 1964; SLADECEK 1983; GULYÁS 1998). The studied nine dead arms are in various stages of succession, under angling utilisation (No data on fish stocking is available yet). The ones located between Legrad-Terezino Polje (Barcs) are further away from human settlements, thus there is no direct communal pollution effect (apart from the dead arm near Ferdinandovac-Lijepa Greda), but those in the river section between Terezino Polje-Donji Miholjac (Drávaszabolcs) stretch directly beside the settlements, only 10-50 m from the communal facilities. From this it follows that the proportion of beta-alpha- and alpha-mesosaprobic taxa with higher tolerance (or preference) for pollution is higher, the species composition has fishpond character.

The number of taxa found in gravel pit ponds was very low, moreover there were a few samples with no zooplankton in them at all. The zooplankton faunas of operating (producing) gravel pit ponds and of those in which production has been discontinued (now being used for tourism and utilised for angling) are considerably similar to gravel pit ponds in Duna-Drava National Park that were studied for 5 years as part of Drava-monitoring program. As succession proceeds in abandoned gravel pit ponds, species numbers are expected to start growing within a period of 3-5 years.

The studied side-waters of Drava (Ždala creek, Županijski kanal) are characterised with considerable water level fluctuation, being overgrown by aquatic macrophytes, and being affected by considerable communal impacts. To find out about the low number of zooplankton taxa, further investigations have to be performed.

The zooplankton faunas of the analysed water bodies are listed in Tables 3., 4. and 5., with the saprobiological indication of particular taxa also being specified (GULYÁS 1998).

Fig. 1. Drava at Legrad (Photo by Jenő J. Purger)

Table 3. Rotatoria fauna of the analysed water bodies (Saprobiological indication: o = oligosaprobic, b = β-mesosaprobic, a = α-mesosaprobic, p = polysaprobic)

| **Species** | **1.** | **2.** | **3.** | **4.** | **5.** | **6.** | **S** |
|---|---|---|---|---|---|---|---|
| *Anuraeopsis fissa* (Gosse) | | | + | | | | |
| *Asplanchna brightwelli* Gosse | | | | | | + | b-a |
| *A. priodonta* Gosse | + | + | | | | | o-b |
| *Bdelloidea sp.* | | | + | | + | | |
| *Beauchampiella eudactylota* (Gosse) | | | + | | | | b |
| *Brachionus angularis* Gosse | | | + | | | | b-a |
| *B. budapestinensis* Daday | | | + | | | | b |
| *B. calyciflorus calyciflorus* Pallas | + | + | + | + | | + | a-b |
| *B. diversicornis* (Daday*)* | + | + | + | | + | | b |
| *B. falcatus* Zacharias | | | + | | | | b |
| *B. forficula* (Wierzejzki) | | | + | | | | b |
| *B. leydigi* Cohn | | | + | | | | b-a |
| *B. quadridentatus quadridentatus* Hermann | | | + | | + | | b-a |
| *B. urceolaris* O. F. Müller | + | + | | | + | + | b-a |
| *Epiphanes senta* (O.F. Müller) | | | | | | + | a |
| *Euchlanis dilatata* Ehrenberg | | | + | | + | | b |
| *Filinia longiseta* (Ehrenberg) | | + | | | | | b-a |
| *Filinia opoliensis* (Zacharias) | | | + | | | | b-o |
| *Hexarthra mira* (Hudson) | | + | + | + | | | b-o |
| *Kellicottia longispina (*Kellicott) | + | + | | | | | o-b |
| *Keratella cochlearis cochlearis* (Gosse) | + | + | + | + | + | | o-b |
| *K. cochlearis tecta* (Gosse) | + | + | + | | + | + | o-b |
| *K. quadrata* (O. F. Müller) | + | + | + | + | + | + | o-b |
| *Lecane bulla* (Gosse) | | | + | | | | b-o |
| *L. closterocerca* (Schmarda) | | | + | | + | | b-a |
| *L. luna* (O. F. Müller) | | | + | | | | o-b |
| *Lepadella patella* (O. F. Müller) | | | | | + | | b-a |
| *Mytilina mucronata* (O.F.Müller) | | | + | | | | |
| *Notholca acuminata* Ehrenberg | | + | | | | | b-o |
| *Platyias patulus* (O.F.Müller) | | | + | | | | b |
| *Polyarthra dolichoptera* (Idelson) | + | + | + | + | + | | b-a |
| *P. vulgaris* Carlin | + | + | + | + | + | | b-a |
| *Synchaeta oblonga* Ehrenberg | + | | | + | | | |
| *S. pectinata* Ehrenberg | + | + | + | | | | o-b |
| *Testudinella patina* (Hermann) | | | + | + | + | | b-o |
| *Trichocerca longiseta* (Schrank) | | | | | + | | |
| *T. pusilla* (Lauterborn) | | | + | | | + | |
| *T. rattus* O.F. Müller | | | | | | | |
| Number of taxa Σ 38 | 12 | 14 | 27 | 8 | 14 | 7 | |

Tabale 4. Cladocera fauna of the analysed water bodies (Saprobiological indication: o = oligosaprobic, b = ß-mesosaprobic, a = α-mesosaprobic, p = polysaprobic)

| Species | 1. | 2. | 3. | 4. | 5. | 6. | S |
|---|---|---|---|---|---|---|---|
| *Acroperus harpae* (Baird) | | | + | | + | | o-b |
| *Alona affinis* (Leydig) | + | | + | | | + | o-b |
| *A. rectangula* Sars | | | | + | + | | o-b |
| *A. quadrangularis* (O.F.Müller) | | | + | | | | o-b |
| *Alonella nana* (Baird) | | | + | | | | o-b |
| *Bosmina coregoni* Baird | + | | | | | | o-b |
| *Bosmina longirostris* (O.F.Müller) | + | + | + | + | + | + | o-b |
| *Ceriodaphnia laticaudata* P.E.Müller | | | + | | | | b-o |
| *C. pulchella* Sars | | | | | + | | o-b |
| *C. quadrangula* (O.F.Müller) | | | + | | | | o-b |
| *C. reticulata* (Jurine) | | | | | | + | b-o |
| *Chydorus. sphaericus* (O.F.Müller) | | + | + | | + | + | o-a |
| *Daphnia cucculata* Sars | + | + | + | | | | |
| *D. longispina* (O.F.Müller) | | + | + | + | + | | |
| *Eurycercus lamellatus* (O.F.Müller) | | | + | | | | o-b |
| *Leydigia leydigii* (Schoedler) | | | + | | | + | o-a |
| *Moina micrura* (Kurz) | | | + | | | | b-a |
| *Oxyurella tenuicaudis* (Sars) | | | + | | | | |
| *Pleuroxus aduncus* (Jurine) | | | + | | + | + | o-b |
| *P. trigonellus*(O.F.Müller) | | | + | | + | | b-o |
| *P. truncatus* (O.F.Müller) | | | + | | | | o-b |
| *Sida crytallina* (O.F.Müller) | | | + | | | | o-b |
| *Scapholeberis mucronata* (O.F.Müller) | | | + | | + | | |
| *Simocephalus. vetulus* (O.F.Müller) | | | + | | + | | b-o |
| *Tretocephala ambigua* (Lilljeborg) | | | + | | | | o-b |
| Number of taxa Σ 25 | 4 | 4 | 21 | 3 | 10 | 6 | |

Table 5. Copepoda fauna of the analysed water bodies (Saprobiological indication: o = oligosaprobic, b = β-mesosaprobic, a = α-mesosaprobic, p = polysaprobic)

| Species | 1. | 2. | 3. | 4. | 5. | 6. | S |
|---|---|---|---|---|---|---|---|
| *Acanthocyclops robustus* (Sars) | | | + | | | | b |
| *Cyclops strenuus* Fischer | | | + | | + | + | b-a |
| *C. vicinus* Ulianine | + | + | + | + | + | + | b-a |
| *Eudiaptomus gracilis* (Sars) | | | + | | + | | o-b |
| *Eucyclops serrulatus* (Fischer) | + | + | + | | | | o-a |
| *Macrocyclops albidus* (Jurine) | | | + | | | | o-a |
| *M. fuscus* (Jurine) | | + | | | | | b-o |
| *Megacyclops viridis* (Jurine) | | | | | + | | b-o |
| *Mesocyclops leuckarti* (Claus) | + | + | + | + | | | o-b |
| *Paracyclops fimbriatus* (Fischer) | | | + | | | + | o-b |
| *Thermocyclops crassus* (Sars) | | | + | | | | b |
| *Juvenilis Copepoda* | + | + | + | + | + | + | |
| Number of taxa Σ 11 | 3 | 4 | 9 | 2 | 4 | 3 | |

## 3.3. Results of quantitative zooplankton analyses

Zooplankton density, diversity and evenness extreme values in the studied water bodies are summarised in Table 6.

There were no tendencies revealed in the density changes of zooplankton fauna in river Drava either when looking at different sampling locations or when considering sampling times. In the dead arms between Legrad-Terezino Polje – excluding the one at Lijepa Greda – the highest densities were recorded in the spring samples (34500-49500 ind./100 $dm^3$), following which the abundance values became strongly variable, with considerably lower densities (4800-14500 ind./100 $dm^3$). In the dead arms between Terezino Polje and Donji Miholjac the highest zooplankton densities took values typical of fishponds (16600-112566 ind./100 $dm^3$), probably as a result of nutrients being washed in from neighbouring areas, and exceeded the value of 5000 ind./100 $dm^3$ throughout the study period, with significant fluctuations.

There were no tendentious changes of zooplankton densities in gravel pit ponds and tributary waters.

Table 6. Zooplankton density, diversity and evenness extreme values in the studied water bodies

| Sampling site | Density (ind./100 $dm^3$) | Shannon-Wiener-diversity (H) | Evenness (J) |
|---|---|---|---|
| **Drava and side-branches** | | | |
| Legrad<br>Gotalovo<br>Novo Virje<br>Sigetec<br>Starogradački Marof<br>Terezino Polje-Barcs<br>Moslavina Podravska<br>Noškovci<br>Viljevo<br>Donji Miholjac-Drávaszabolcs | 0-914 | 0-3.2 | 0-0.98 |
| **Dead arms** | | | |
| Legrad<br>Ždala-Čambina<br>Gola-Ješkovo<br>Novo Virje | 245-49500 | 1.98-4.12 | 0.65-0.98 |
| Ferdinandovac-Lijepa Greda<br>Detkovac<br>Budakovac<br>Donji Mihojlac -Stara Drava | 317-112566 | 1.66-3.12 | 0.75-0.98 |
| **Gravel pit ponds** | 0-1460 | 0-2.51 | 0-0.98 |
| **Drava tributaries** | 0-2644 | 0-4.1 | 0-0.96 |

# 4. Summary

In the initial stage of the project, sampling areas and sampling sites were selected during a series of field visits. When selecting the characteristic wetland habitats within the study area, we have considered the results and experience from the baseline surveying and monitoring that have been going on in the Hungarian Drava section since the year 2000, co-ordinated by Duna-Drava National Park Directorate.

It appeared from our studies that transformed areas and effects strongly influencing natural conditions were found more generally in Baranya county rather than in Somogy. Where there is communal pollution effect in dead arms, the zooplankton fauna will resemble that of fishponds, both in its species composition and as regards quantitative changes. This can be an important aspect in the designation of future protected areas (e.g. national park sites).

As part of the DRAVA-INTERECO project, the analysis of zooplankton was performed according to what had been specified in the monitoring protocol (KÖRMENDI & TERNJEJ 2007). Relying on certain parameters, water quality assessment was also made in the selected water bodies. From the investigation results of zooplankton and water quality during a period of a sole one year, the target water bodies cannot be described in detail. This is because for the basic status of a water body to be assessed, one needs to perform surveys, data collection and evaluation in a number of vegetative seasons due to the seasonal (mono-, di-, polycyclic species) and population dynamical characteristics of zooplankton taxa. Also, it must be considered that weather conditions, changes in water discharge regimes, etc. can significantly alter the taxonomic composition, occurrence frequency and quantitative relations of zooplankton.

Once the basic status has been recorded, monitoring studies can be launched and tendencies can be followed and identified.

There are no protected species among zooplankton taxa; their significance for nature conservation lays primarily in their role in biological and ecological water quality assessment (indications of saprobity, trophity, halobity), and in their key importance in the aquatic food chain as fish food. During the community level monitoring of zooplankton, the analysis of species composition, density, biodiversity, evenness, seasonal changes and production biological status allows, in the long run, to identify various trends (trend-monitoring). With all these information it is possible to follow the processes of eutrophication and succession and provide data for the production of management plans and for the timing of particular interventions in the habitats. For example, if an dead arm is protected or is situated inside a protected area, the results can be used in the reasonable planning of fish stocking of the dead arms, in determining the densities and population structure to be achieved, and in settling fishing and angling technologies and rules. The protection of the water quality of dead arms and their reasonable fish stocking is important not only from an anthropogenic aspect, but these water bodies also act as important feeding grounds for amphibian, reptile, bird and mammal species significant for nature conservation. To treat the process of algal growth, the opportunities provided by biomanipulation could also be utilised. For the nature conservation aimed management of water bodies, two technologies should be used simultaneously, i.e. in addition to stocking with grass carp, it is also essential to populate wit predator species, which, in turn, will slow down the processes of eutrophication, by increasing the densities and biomass of zooplankton organisms. Quite naturally, these technologies and management techniques do not apply to strictly protected (sanctuary type) dead arms.

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# Results of the field surveys on terrestrial isopods (Isopoda, Oniscidea) in the Drava basin, Croatia

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**Abstract:** Field surveys in the main habitat types (floodplain forests, oak forests and river banks) along Drava river resulted 5649 isopod specimens belonging to 19 species, with several new species to the area as well. The most frequent species were common European and cosmopolitan species: *Hyloniscus riparius*, *Armadillidium vulgare* and *Trachelipus rathkii* found in 91%, 80% and 75% of the sites, respectively. It is worthy of note that *Trichoniscus steinboecki*, a new species for the Croatian fauna was also found in the area. The species composition was found to be similar among the main habitat types, ranging from 69 to 74%. Species classification indicated high naturalness for the oak forests followed by the river bank and the floodplain forests. As a conclusion, we found no great differences in the compositions of isopod faunas living on the two sides of the Drava. However, the high proportion of non-native species draws our attention to the perturbing effects of human activity in the area.

## 1. Introduction

Running from the Alps to the Danube, Drava river connects Italy, Austria, Slovenia, Croatia, Hungary and Serbia. It is the historical borderline between Croatia and Hungary on an approximately 200 kilometre long section. This section, however, possesses a great natural heritage like unique indigenous floodplain forests harbouring native plants and animals in great diversity. Conservation biological surveys in the area began on the Hungarian side with the establishment of Duna-Drava National Park in the 1990s. Along with botanical and zoological studies, a four year long faunistical research on isopods has taken place between the years 1996 and 1999. Field surveys resulted 23 species in 19 sites from the Drava area, including new and rare species as well. According to the results published in several articles (FARKAS 1995, 1998a, b, c; FARKAS & VADKERTI 2001; VADKERTI & FARKAS 2002) we have a sound knowledge about the isopod fauna on the Hungarian side. Faunistic data of the terrestrial Isopod fauna of Croatia are given in KARAMAN (1965-66, 1966), PLJAKIĆ (1970) and POTOČNIK (1989). However, no data had

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been published from the Croatian side of Drava until 2004, when 11 species were described from the Croatian Baranja (FARKAS & KRČMAR 2004). Hence, prior to the DRAVA-INTERECO project, the isopod fauna of the Croatian side of Drava river was practically unknown.

The project was carried out between 2006 and 2007 including field surveys on vegetation and fauna. The primary goal was a field data assessment to enable the establishment of new protected areas. Moreover, the preparation of the monitoring protocol for isopods also had been determined. Besides data assessment, the project aimed at deepening responsibility for the environment within local population in Croatia.

To describe the primary status of the observed area, we began with a faunistic survey defining the isopod assemblages of typical habitats and their presence-absence relationships. From the results we were able to attempt the conservation biological evaluation of the Croatian side of the Drava floodplain. Here we present the results and data of the faunistic studies on woodlice, acquired in 2007.

## 2. Methods

Hungarian scientists ranged over the Drava basin led by Croatian nature conservation co-workers during January and February 2007. Sites suitable for sampling had been designated and registered. Altitude and latitude data were acquired by using hand GPS and the GoogleEarth software (http://earth.google.com/). A total of 141 sampling sites representing the characteristic habitats of the area were chosen including wetland willow and oak gallery forests, meadows, riparian and synanthropic habitats (Table 1.). Samplings were carried out from March until December. Every sampling site was visited 3-4 times during the year. The main collecting technique was manual sampling but at some places pitfall trapping was applied, too. Only one or two demonstrative individuals of each species in every sampling site were kept.

For the evaluation of naturalness of isopod assemblages, considering the limitations of this approach, we applied the categories of HORNUNG et al. (2007) that are based on the known distribution and habitat preferences of species in Hungary.

To compare species composition of different habitat types we applied Sørensen index for similarity (PODANI 1997): SOR = 2a/(2a+b+c), where ”a” = species occurring in both habitats; ”b” = number of species that occur exclusively in habitat 1.; ”c” = number of species that occur exclusively in habitat 2.

Hierarchical cluster analysis was performed to reveal similarities between habitat preferences of species. We used binary data and applied Jaccard index with Ward method in the open source R statistical software package (R DEVELOPMENT CORE TEAM 2005).

Table 1. List of sampling sites

| No. | Locality | Habitat | Elevation | Altitude | Longitude |
|---|---|---|---|---|---|
| 1. | Legrad | river bank | 129 | 48º 18’ 04.33” | 16º 52’ 23.24” |
| 2. | Legrad | river bank | 129 | 46º 17’ 58.39” | 16º 52’ 26.27” |
| 3. | Legrad | river bank, builing | 128 | 46º 17’ 55.35” | 16º 52’ 28.22” |
| 4. | Legrad | river bank, debris, rotting log | 130 | 46º 17’ 50.41” | 16º 52’ 40.62” |
| 5. | Legrad | floodplain forest | 131 | 46º 17’ 57.47” | 16º 52’ 20.33” |
| 6. | Legrad | floodplain forest | 130 | 46º 17’ 49.22” | 16º 52’ 30.43” |
| 7. | Legrad | river bank, near restaurant | 127 | 46º 17’ 51.83” | 16º 52’ 53.76” |
| 8. | Legrad | river bank, debris | 126 | 46º 17’ 41.67” | 16º 53’ 11.46” |
| 9. | Legrad | groveforest | 129 | 46º 17’ 43.25” | 16º 53’ 05.41” |
| 10. | Legrad | gravel reef with *Myricaria germanica* | 129 | 46º 17’ 34.99” | 16º 53’ 06.29” |
| 11. | Botovo | floodplain, shrubs | 122 | 46º 14’ 00.33” | 16º 56’ 51.04” |
| 12. | Botovo | willow grove | 126 | 46º 14’ 08.93” | 16º 56’ 47.83” |
| 13. | Botovo | pitfall trap site | 127 | 46º 14’ 08.31” | 16º 56’ 39.91” |
| 14. | Botovo | willow grove | 126 | 46º 14’ 12.78” | 16º 56’ 28.66” |
| 15. | Botovo | carex swamp | 126 | 46º 14’ 20.53” | 16º 56’ 25.07” |
| 16. | Gabajeva Greda | oak forest 3. pitfall trap site | 126 | 46º 08’ 46.08” | 17º 00’ 36.24” |
| 17. | Repaš | oak forest | 129 | 46º 10’ 46.7” | 17º 05’ 19.74” |
| 18. | Repaš | oak forest | 134 | 46º 10’ 48.5” | 17º 05’ 49.97” |
| 19. | Repaš | oak forest | 132 | 46º 10’ 23.5” | 17º 05’ 16.16” |
| 20. | Repaš | oak forest | 122 | 46º 09’ 57.3” | 17º 05’ 23.18” |
| 21. | Repaš | oak forest | 122 | 46º 09’ 58.52” | 17º 05’ 38.18” |
| 22. | Repaš | oak forest | 134 | 46º 09’ 12.38” | 17º 06’ 54.77” |
| 23. | Repaš | oak forest | 132 | 46º 09’ 10.67” | 17º 07’ 22.31” |
| 24. | Repaš | oak forest | 133 | 46º 09’ 07.45” | 17º 07’ 51.16” |
| 25. | Repaš | oak forest | 128 | 46º 08’ 39.53” | 17º 09’ 28.03” |
| 26. | Repaš | 4th pitfall trap site | 131 | 46º 08’ 35.35” | 17º 05’ 49.05” |
| 27. | Repaš | oak forest | 121 | 46º 08’ 31.63” | 17º 07’ 06.44” |
| 28. | Repaš | oak forest | 131 | 46º 08’ 39.71” | 17º 06’ 56.17” |
| 29. | Repaš | oak forest | 128 | 46º 08’ 29.88” | 17º 06’ 56.17” |
| 30. | Repaš | oak forest | 127 | 46º 08’ 34.78” | 17º 05’ 43.74” |
| 31. | Repaški most | willow grove | 113 | 46º 07’ 39.89” | 17º 04’ 18.37” |
| 32. | Repaški most | river bank | 112 | 46º 07’ 38.57” | 17º 04’ 14.29” |
| 33. | Repaški most | river bank | 116 | 46º 07’ 42.84” | 17º 03’ 59.74” |
| 34. | Molve Grede | oak forest | 115 | 46º 06’ 15.86” | 17º 03’ 18.65” |
| 35. | Molve Grede | oak forest | 132 | 46º 06’ 31.22” | 17º 04’ 34.59” |
| 36. | Molve Grede | between Molve and Novo Virje | 124 | 46º 05’ 57.53” | 17º 04’ 19.15” |
| 37. | Novo Virije | oak forest | 133 | 46º 05’ 38.84” | 17º 06’ 38.79” |
| 38. | Drenovica | cemetery, forest | 130 | 46º 05’ 37.94” | 17º 07’ 48.67” |
| 39. | Drenovica | cemetery, forest | 130 | 46º 05’ 44.85” | 17º 07’ 32.46” |
| 40. | Drenovica | shore of small pond | 126 | 46º 05’ 16.75” | 17º 08’ 22.98” |
| 41. | Drenovica | oak forest | 120 | 46º 04’ 41.2” | 17º 10’ 21.2” |
| 42. | Novo Virije | restaurant | 110 | 46º 05’ 52.59” | 17º 11’ 07.68” |
| 43. | Novo Virije | river bank | 111 | 46º 05’ 56.2” | 17º 11’ 02.77” |
| 44. | Novo Virije | wetland forest | 114 | 46º 06’ 08.65” | 17º 10’ 43.95” |
| 45. | Novo Virije | river bank | 113 | 46º 06’ 34” | 17º 10’ 20.69” |
| 46. | Novo Virije | river bank | 113 | 46º 06’ 17.93” | 17º 11’ 19.86” |
| 47. | Novo Virije | wetland forest | 113 | 46º 06’ 09.74” | 17º 11’ 49.67” |
| 48. | Lijepa Greda | oak forest | 124 | 46º 04’ 15.95” | 17º 12’ 31.86” |
| 49. | Lijepa Greda | oak forest | 123 | 46º 04’ 22.3” | 17º 12’ 58.47” |
| 50. | Lijepa Greda | oak forest | 125 | 46º 04’ 01.73” | 17º 13’ 20.66” |
| 51. | Brodić | oak forest | 121 | 46º 01’ 03.84” | 17º 15’ 04.91” |
| 52. | Brodić | oak forest | 122 | 46º 01’ 15.43” | 17º 14’ 47.08” |
| 53. | Brodić | oak forest | 125 | 46º 02’ 29.03” | 17º 14’ 06.85” |

| No. | Locality | Habitat | Elevation | Altitude | Longitude |
|---|---|---|---|---|---|
| 54. | Brodić | oak forest | 126 | 46º 02’ 53.84” | 17º 12’ 56.23” |
| 55. | Brodić | oak forest | 126 | 46º 01’ 28.74” | 17º 13’ 17.86” |
| 56. | Pitomača | oak forest | 121 | 45º 57’ 59.28” | 17º 16’ 22.36” |
| 57. | Starogradački Marof | secondary bush | 105 | 45º 57’ 18.7” | 17º 19’ 03.38” |
| 58. | Starogradački Marof | river bank | 105 | 45º 57’ 26.7” | 17º 19’ 12.99” |
| 59. | Starogradački Marof | river bank | 103 | 45º 57’ 44.8” | 17º 19’ 40.38” |
| 60. | Starogradački Marof | secondary bush | 107 | 45º 57’ 31.92” | 17º 19’ 46.28” |
| 61. | Starogradački Marof | secondary bush | 105 | 45º 57’ 23.14” | 17º 19’ 38.58” |
| 62. | Starogradački Marof | anabranch of Drava | 105 | 45º 57’ 17.3” | 17º 19’ 53.74” |
| 63. | Okrugljača | river bank | 103 | 45º 56’ 33.84” | 17º 22’ 03.01” |
| 64. | Okrugljača | river bank | 103 | 45º 56’ 37.92” | 17º 22’ 10.08” |
| 65. | Okrugljača | river bank | 102 | 45º 56’ 44.96” | 17º 22’ 24.84” |
| 66. | Okrugljača | floodplain forest | 104 | 45º 56’ 50.12” | 17º 22’ 39.7” |
| 67. | Veliko Polje | floodplain forest | 99 | 45º 56’ 24.28” | 17º 29’ 55.9” |
| 68. | Veliko Polje | floodplain forest | 99 | 45º 56’ 23.02” | 17º 30’ 05.11” |
| 69. | Veliko Polje | floodplain forest | 99 | 45º 56’ 19.26” | 17º 30’ 13.26” |
| 70. | Veliko Polje | floodplain forest | 100 | 45º 56’ 14.17” | 17º 30’ 36.52” |
| 71. | Veliko Polje | floodplain forest, river bank | 99 | 45º 56’ 15.84” | 17º 31’ 02.89” |
| 72. | Bekovar-Novi Gradac | floodplain | 100 | 45º 56’ 00.5” | 17º 32’ 50.29” |
| 73. | Bekovar-Novi Gradac | floodplain | 100 | 45º 59’ 02.4” | 17º 33’ 01.44” |
| 74. | Bekovar-Novi Gradac | river bank swamp | 105 | 45º 56’ 02.15” | 17º 33’ 09.88” |
| 75. | Bekovar-Novi Gradac | river bank swamp | 101 | 45º 56’ 01.37” | 17º 33’ 27.45” |
| 76. | Bekovar-Novi Gradac | wetland forest | 101 | 45º 56’ 05.02” | 17º 33’ 36.56” |
| 77. | Bekovar-Novi Gradac | river bank | 99 | 45º 56’ 10.95” | 17º 33’ 56.42” |
| 78. | Bekovar-Novi Gradac | wetland forest | 103 | 45º 55’ 54.48” | 17º 34’ 17.86” |
| 79. | Bekovar-Novi Gradac | river bank, dead wood | 100 | 45º 56’ 07.67” | 17º 34’ 34.04” |
| 80. | Detkovac oxbow | river bank swamp | 98 | 45º 53’ 03.31” | 17º 36’ 33.62” |
| 81. | Detkovac oxbow | reed | 99 | 45º 53’ 07.25” | 17º 36’ 44.55” |
| 82. | Detkovac oxbow | groveforest | 99 | 45º 53’ 08.45” | 17º 36’ 36.82” |
| 83. | Detkovac oxbow | groveforest | 99 | 45º 54’ 04.59” | 17º 36’ 21.84” |
| 84. | Detkovac oxbow | thin shrub edge at river bank | 100 | 45º 53’ 55.51” | 17º 36’ 12.89” |
| 85. | Detkovac oxbow | carex swamp | 101 | 45º 54’ 12.01” | 17º 36’ 21.17” |
| 86. | Detkovac oxbow | floodplain forest | 107 | 45º 54’ 31.65” | 17º 36’ 23.28” |
| 87. | Detkovac oxbow | river bank | 103 | 45º 54’ 42.87” | 17º 36’ 19” |
| 88. | Detkovac oxbow | river bank | 101 | 45º 54’ 36.44” | 17º 36’ 43” |
| 89. | Detkovac oxbow | shrubs near the village | 102 | 45º 53’ 32.77” | 17º 35’ 33.55” |
| 90. | Detkovac oxbow | reed | 98 | 45º 52’ 49.32” | 17º 37’ 06.57” |
| 91. | Detkovac oxbow | reed | 99 | 45º 52’ 40.54” | 17º 37’ 36.61” |
| 92. | Detkovac oxbow | river bank, shrubs | 97 | 45º 53’ 05.55” | 17º 38’ 07.46” |
| 93. | Budakovac | river bank | 101 | 45º 52’ 09.86” | 17º 38’ 35.07” |
| 94. | Budakovac | river bank | 100 | 45º 51’ 52.61” | 17º 38’ 49.59” |
| 95. | Budakovac | shrubs, floodplain | 101 | 45º 52’ 01.35” | 17º 38’ 30.6” |
| 96. | Budakovac | river bank | 99 | 45º 51’ 25.09” | 17º 38’ 51.64” |
| 97. | Budakovac | reed between croplands | 97 | 45º 51’ 27.7” | 17º 38’ 26.27” |
| 98. | Budakovac | backwater, reed | 96 | 45º 51’ 20.03” | 17º 37’ 48.28” |
| 99. | Budakovac | reed | 97 | 45º 51’ 11.63” | 17º 37’ 37.12” |
| 100. | Budakovac | swamp | 97 | 45º 51’ 05.12” | 17º 37’ 30.92” |
| 101. | Budakovac | river bank, urbanised | 99 | 45º 50’ 48.62” | 17º 37’ 41.28” |
| 102. | Budakovac | willow grove | 101 | 45º 50’ 53.25” | 17º 37’ 58.56” |
| 103. | Vaška-Županijski kanal | grove | 99 | 45º 49’ 10.92” | 17º 40’ 01.36” |
| 104. | Vaška-Županijski kanal | river bank, debris | 99 | 45º 49’ 03.27” | 17º 40’ 12.88” |
| 105. | Vaška-Županijski kanal | grove forest | 98 | 45º 50’ 02.24” | 17º 40’ 38.27” |
| 106. | Vaška | floodplain forest | 101 | 45º 50’ 08.24” | 17º 41’ 28.65” |

| No. | Locality | Habitat | Elevation | Altitude | Longitude |
|---|---|---|---|---|---|
| 107. | Vaška | river bank forest | 104 | 45º 50' 10.62" | 17º 41' 43.52" |
| 108. | Vaška | floodplain forest | 105 | 45º 50' 02.7" | 17º 41' 51.2" |
| 109. | Vaška | river bank | 103 | 45º 50' 11.63" | 17º 42' 02" |
| 110. | Vaška | wetland forest | 105 | 45º 49' 54.78" | 17º 42' 10.2" |
| 111. | Sopje | floodplain forest | 98 | 45º 49' 22.24" | 17º 44' 24.83" |
| 112. | Sopje | river bank | 98 | 45º 49' 17.6" | 17º 44' 44.06" |
| 113. | Sopje | river bank | 100 | 45º 49' 09.34" | 17º 45' 04.03" |
| 114. | Sopje | floodplain forest | 101 | 45º 48' 50.81" | 17º 45' 17.13" |
| 115. | Gornje Predrijevo | river bank | 102 | 45º 48' 47.21" | 17º 46' 50.26" |
| 116. | Gornje Predrijevo | river bank | 100 | 45º 48' 32.76" | 17º 47' 37.16" |
| 117. | Gornje Predrijevo | floodplain forest | 100 | 45º 48' 33.33" | 17º 46' 58.19" |
| 118. | Gornje Predrijevo | floodplain forest | 100 | 45º 48' 16.71" | 17º 47' 33.42" |
| 119. | Noškovci-Predrijevačka bara | reed | 92 | 45º 47' 42.99" | 17º 48' 08.08" |
| 120. | Noškovci-Predrijevačka bara | reed | 93 | 45º 47' 29.46" | 17º 48' 55.22" |
| 121. | Noškovci | river bank | 97 | 45º 48' 04.5" | 17º 49' 15.36" |
| 122. | Noškovci | floodplain forest | 100 | 45º 48' 09.98" | 17º 49' 39.09" |
| 123. | Noškovci | river bank | 96 | 45º 48' 24.99" | 17º 49' 28.65" |
| 124. | Noškovci | wetland forest | 98 | 45º 48' 04.68" | 17º 49' 44.19" |
| 125. | Noškovci | river bank | 95 | 45º 47' 32.23" | 17º 49' 39.97" |
| 126. | Noškovci | wetland forest | 102 | 45º 47' 45.83" | 17º 49' 23.25" |
| 127. | Ilmin Dvor | floodplain forest | 94 | 45º 46' 47.71" | 17º 52' 57.38" |
| 128. | Martinci Miholjački | floodplain forest | 92 | 45º 47' 15.3" | 17º 54' 45.39" |
| 129. | Martinci Miholjački | river bank | 91 | 45º 47' 08.14" | 17º 56' 01.88" |
| 130. | Podravska Moslavina | river bank | 90 | 45º 47' 26.8" | 17º 57' 25.12" |
| 131. | Podravska Moslavina | river bank | 88 | 45º 47' 14.84" | 17º 58' 27.04" |
| 132. | Donji Miholjac | river bank | 96 | 45º 46' 49.95" | 18º 07' 03.99" |
| 133. | Donji Miholjac | wetland forest | 91 | 45º 46' 55.52" | 18º 07' 26.88" |
| 134. | Donji Miholjac | river bank | 95 | 45º 47' 06.4" | 18º 08' 26.8" |
| 135. | Donji Miholjac | grove | 90 | 45º 47' 10.7" | 18º 09' 02.24" |
| 136. | Donji Miholjac | grove | 86 | 45º 46' 58.64" | 18º 09' 15.93" |
| 137. | Donji Miholjac | backwater, reed | 88 | 45º 46' 24.88" | 18º 09' 00.42" |
| 138. | Donji Miholjac | river bank | 90 | 45º 46' 56.51" | 18º 11' 02.92" |
| 139. | Donji Miholjac | grove | 90 | 45º 47' 01.98" | 18º 11' 30.56" |
| 140. | Donji Miholjac | river bank | 90 | 45º 47' 10.28" | 18º 11' 34.99" |
| 141. | Donji Miholjac | wetland forest | 87 | 45º 46' 52.3" | 18º 11' 47.67" |

# 3. Results and discussion

## 3.1. Faunistic data

The research resulted in 5649 individuals belonging to 19 terrestrial species. The list below gives the identification number of a sampling site (bold) where a species was found and the dates of samplings. (ID numbers are given in Table 1.).

Ligiidae

1. ***Ligidium germanicum*** Verhoeff, 1901

**1**: 05.V.2007., 09.VII.2007., **18**: 25.III.2007., **19**: 06.VII.2007., **23**: 19.VII.2007., 23.IX.2007., **25**: 11.III.2007., **26**: 10.VI.2007., **27**: 15.IX.2007., **30**: 15.IX.2007., **35**: 21.VII.2007., **36**: 04.III.2007., 20.V.2007., 21.VII.2007., **38**: 04.III.2007., 05.V.2007., 16.VI.2007., 14.XI.2007., **39**: 04.III.2007., 05.V.2007., 16.VI.2007., 14.XI.2007., **41**: 20.V.2007., **47**: 10.VI.2007., 05.X.2007., **50**: 10.VI.2007., **51**: 23.XI.2007., **52**: 13.V.2007., 23.XI.2007., **54**: 04.IX.2007., 12.XII.2007., **56**: 25.III.2007., 12.V.2007., 15.VIII.2007., **67**: 29.VIII.2007., **83**: 20.V.2007., **110**: 23.II.2007., **114**: 20.VII.2007.

Trichoniscidae

2. ***Hyloniscus riparius*** (C.L. Koch, 1838)

**1:** 05.V.2007., 09.VII.2007., 03.X.2007., **2:** 03.III.2007., 05.V.2007., 09.VII.2007., 03.X.2007., **3:** 01.IX.2007., **4:** 02.VI.2007., **5:** 07.IV.2007., 05.VIII.2007., **6:** 02.VI.2007., 01.IX.2007., **7:** 07.IV.2007., 09.VII.2007., 03.X.2007., 05.XII.2007., **11:** 11.III.2007., 19.V.2007., 07.VII.2007., **12:** 11.III.2007., 19.V.2007., 07.VII.2007., 23.XI.2007., **13:** 11.III.2007., 19.V.2007., 07.VII.2007., 23.XI.2007., **14:** 11.III.2007., 07.VII.2007., **15:** 19.V.2007., 07.VII.2007., 23.XI.2007., **16:** 03.VI.2007., 01.IX.2007., **17:** 18.III.2007., 06.VII.2007., **18:** 25.III.2007., **19:** 13.V.2007., 06.VII.2007., **20:** 09.IV.2007., 18.VII.2007., 15.IX.2007., **21:** 13.V.2007., **22:** 02.VI.2007., **23:** 19.VII.2007., **24:** 11.III.2007., 19.VII.2007., **25:** 07.VII.2007., 14.XI.2007., **26:** 10.VI.2007., **27:** 23.XI.2007., **28:** 02.VI.2007., **29:** 19.V.2007., **30:** 11.III.2007., **31:** 07.X.2007., **32:** 15.IV.2007., **33:** 11.III.2007., 07.IV.2007., 07.X.2007., **34:** 21.VII.2007., **35:** 04.III.2007., **36:** 04.III.2007., 20.V.2007., 21.VII.2007., **37:** 04.III.2007., 14.XI.2007., **39:** 16.VI.2007., **40:** 10.III.2007., 20.V.2007., 21.VII.2007., **41:** 10.III.2007., 20.IX.2007., **42:** 15.IV.2007., 07.VII.2007., 05.XII.2007., **43:** 04.III.2007., 15.IV.2007., 07.VII.2007., **44:** 03.III.2007., 19.V.2007., 21.VII.2007., **45:** 19.V.2007., 21.VII.2007., 03.X.2007., **46:** 11.III.2007., 02.VI.2007., 05.VIII.2007., **47:** 17.III.2007., 14.IV.2007., 10.VI.2007., **48:** 14.IV.2007., 10.VI.2007., **49:** 14.IV.2007., 10.VI.2007., **50:** 14.IV.2007., **51:** 13.V.2007., 10.VIII.2007., **52:** 24.III.2007., 13.V.2007., 10.VIII.2007., **53:** 04.IX.2007., **55:** 16.VI.2007., 04.IX.2007., **56:** 12.V.2007., 15.VIII.2007., 23.XI.2007., **57:** 06.V.2007., 05.X.2007., **58:** 18.III.2007., 06.V.2007., **59:** 18.III.2007., 21.VII.2007., **61:** 21.VII.2007., **62:**

21.VII.2007., **63:** 10.III.2007., 09.IV.2007., **64:** 10.III.2007., 09.VI.2007., **65:** 10.III.2007., 09.IV.2007., 09.VI.2007., **66:** 10.III.2007., 09.IV.2007., 09.VI.2007., **67:** 07.IV.2007., 28.VII.2007., 29.VIII.2007., **68:** 07.IV.2007., 28.VII.2007., 29.VIII.2007., **69:** 28.VII.2007., 29.VIII.2007., **70:** 07.IV.2007., 28.VII.2007., **71:** 23.XI.2007., **74:** 29.VIII.2007., **75:** 25.III.2007., **76:** 03.VI.2007., 29.VIII.2007., 14.XI.2007., **78:** 25.III.2007., 03.VI.2007., 29.VIII.2007., **80:** 20.V.2007., **81:** 20.V.2007., **82:** 04.III.2007., 20.V.2007., 30.VII.2007., **83:** 04.III.2007., 20.V.2007., 30.VII.2007., 15.XI.2007., **85:** 20.V.2007., 30.VII.2007., **86:** 03.VI.2007., 25.VIII.2007., **87:** 03.VI.2007., 25.VIII.2007., **88:** 25.VIII.2007., **89:** 11.III.2007., 03.VI.2007., **90:** 18.III.2007., **91:** 18.III.2007., 20.V.2007., 30.VII.2007., **92:** 30.VII.2007., **93:** 05.IX.2007., **94:** 05.V.2007., 20.VII.2007., **95:** 05.V.2007., 05.IX.2007., **96:** 20.VII.2007., 05.IX.2007., **98:** 05.IX.2007., **99:** 25.III.2007., 05.V.2007., 20.VII.2007., **100:** 05.V.2007., 20.VII.2007., 05.IX.2007., **101:** 05.V.2007., 20.VII.2007., **102:** 09.VI.2007., 19.VIII.2007., **103:** 09.VI.2007., 19.VIII.2007., **104:** 15.XI.2007., **105:** 08.IV.2007., 09.VI.2007., 19.VIII.2007., 15.XI.2007., **106:** 05.VIII.2007., **107:** 06.V.2007., 05.VIII.2007., 09.X.2007., **108:** 06.V.2007., 09.VII.2007., 09.X.2007., **109:** 06.V.2007., 09.VII.2007., 09.X.2007., **110:** 23.II.2007., 06.V.2007., 09.VII.2007., 09.X.2007., **111:** 05.V.2007., 20.VII.2007., **112:** 05.III.2007., 05.V.2007., 20.VII.2007., 05.IX.2007., **113:** 05.III.2007., 05.V.2007., 20.VII.2007., **114:** 05.V.2007., 20.VII.2007., 05.IX.2007., **115:** 16.VI.2007., 30.VIII.2007., 07.XII.2007., **116:** 16.VI.2007., 30.VIII.2007., **117:** 16.VI.2007., 30.VIII.2007., 07.XII.2007., **118:** 16.VI.2007., 30.VIII.2007., 07.XII.2007., **119:** 15.VII.2007., 02.IX.2007., **120:** 15.VII.2007., 02.IX.2007., **121:** 15.VII.2007., 02.IX.2007., **122:** 15.VII.2007., 02.IX.2007., **123:** 08.IV.2007., 15.VII.2007., 02.IX.2007., **124:** 04.III.2007., 20.V.2007., 21.VII.2007., **125:** 20.V.2007., 21.VII.2007., **126:** 04.III.2007., 21.VII.2007., **127:** 20.V.2007., 21.VII.2007., 05.X.2007., **128:** 20.V.2007., 21.VII.2007., 05.X.2007., **129:** 20.V.2007., 21.VII.2007., **130:** 20.V.2007., 20.VII.2007., **131:** 20.V.2007., 20.VII.2007., **132:** 14.IV.2007., 09.VI.2007., 10.VIII.2007., **133:** 14.IV.2007., 09.VI.2007., 10.VIII.2007., **134:** 09.VI.2007., 10.VIII.2007., 15.XI.2007., **135:** 09.VI.2007., 10.VIII.2007., **136:** 14.IV.2007., 09.VI.2007., 10.VIII.2007., **137:** 14.IV.2007., 09.VI.2007., 10.VIII.2007., **138:** 14.IV.2007., 09.VI.2007., 10.VIII.2007., 15.XI.2007., **139:** 14.IV.2007., 10.VIII.2007., **140:** 09.VI.2007., 10.VIII.2007., **141:** 09.VI.2007., 10.VIII.2007., 15.XI.2007.

3. ***Trichoniscus steinboecki*** Verhoeff, 1931

**16**: 18.III.2007., 01.IX.2007., **18**: 25.III.2007., 09.IV.2007., **23**: 19.VII.2007., **24**: 19.V.2007., 19.VII.2007., **25**: 07.VII.2007., **26**: 10.VI.2007., **28**: 15.IX.2007., **29**: 19.V.2007., **41**: 20.IX.2007., **48**: 10.VI.2007., **50**: 14.IV.2007., 10.VI.2007., **51**: 10.VIII.2007., **52**: 13.V.2007., 23.XI.2007., **53**: 16.VI.2007., 04.IX.2007., **54**: 16.VI.2007., 04.IX.2007., **56**: 12.V.2007., 15.VIII.2007., **57**: 18.III.2007., 06.V.2007., **133**: 09.VI 2007.

4. ***Haplophthalmus danicus*** Budde-Lund, 1880

**57**: 21.VII.2007., **60**: 21.VII.2007., **67**: 07.IV.2007., 28.VII.2007., **89**: 25.VIII.2007., **105**: 09.VI.2007., **108**: 06.V.2007., 09.VII.2007., **111**: 20.VII.2007., **122**: 02.IX.2007., **124**: 20.V.2007.

5. ***Haplophthalmus montivagus*** Verhoeff, 1941

**16**: 03.VI.2007., 01.IX.2007., **17**: 18.III.2007., 09.IV.2007., **23**: 19.VII.2007., **24**: 19.VII.2007., **25**: 15.IV.2007., 07.VII.2007., **26**: 04.VIII.2007., **27**: 15.IX.2007., **29**: 19.V.2007., **34**: 20.V.2007., **38**: 04.III.2007., 16.VI.2007., **39**: 05.V.2007., 16.VI.2007., 14.XI.2007., **50**: 10.VI.2007., **51**: 23.XI.2007., **52**: 23.XI.2007., **53**: 04.IX.2007., **56**: 12.V.2007.

Platyarthridae

6. ***Platyarthrus hoffmannseggii*** (Budde-Lund, 1893)

**17**: 18.III.2007., **19**: 25.III.2007., 13.V.2007., **25**: 15.IV.2007., **42**: 15.IV.2007., **45**: 21.VII.2007., **89**: 03.VI.2007., **124**: 20.V.2007.

Philoscidae

7. ***Lepidoniscus minutus*** (C.L. Koch, 1838)

**17**: 09.IV.2007., 06.VII.2007., **18**: 13.V.2007., **19**: 25.III.2007., 06.VII.2007., **23**: 09.IV.2007., 19.VII.2007., **24**: 19.V.2007., 19.VII.2007., 12.XII.2007., **25**: 07.VII.2007., **26**: 10.VI.2007., 04.VIII.2007., **27**: 02.VI.2007., **28**: 02.VI.2007., 15.IX.2007., **29**: 15.VIII.2007., **30**: 19.V.2007., **34**: 03.X.2007., **35**: 20.V.2007., 21.VII.2007., **37**: 05.V.2007., **38**: 14.XI.2007., **39**: 05.V.2007., 14.XI.2007., **41**: 21.VII.2007., **47**: 10.VI.2007., 05.X.2007., **48**: 17.III.2007., **50**: 10.VI.2007., **51**: 13.V.2007., 10.VIII.2007., **53**: 16.VI.2007., **54**: 24.III.2007., 12.XII.2007., **56**: 15.VIII.2007.

Oniscidae

8. ***Oniscus asellus*** Linnaeus, 1758

**14**: 19.V.2007., 07.VII.2007., **17**: 06.VII.2007., **42**: 15.IV.2007.

Trachelipodidae

9. ***Porcellium collicola*** Verhoeff, 1907

**1:** 03.III.2007., 05.V.2007., 09.VII.2007., **2:** 05.V.2007., 03.X.2007., **4:** 24.III.2007., 14.XI.2007., **7:** 09.VII.2007., **8:** 02.VI.2007., **12:** 07.VII.2007., **13:** 19.V.2007., 07.VII.2007., 23.XI.2007., **14:** 11.III.2007., 19.V.2007., **15:** 11.III.2007., 19.V.2007., **16:** 03.VI.2007., 01.IX.2007., **17:** 18.III.2007., **19:** 25.III.2007., 23.XI.2007., **20:** 18.VII.2007., 15.IX.2007., **22:** 18.III.2007., **23:** 23.IX.2007., **26:** 04.VIII.2007., 12.XII.2007., **28:** 15.IX.2007., 23.XI.2007., **31:** 07.X.2007., **32:** 15.IV.2007., **33:** 07.X.2007., **34:** 20.V.2007., **35:** 21.VII.2007., 03.X.2007., **36:** 04.III.2007., 20.V.2007., 21.VII.2007., **37:** 05.V.2007., **40:** 10.III.2007., 20.V.2007., 21.VII.2007., 20.IX.2007., **42:** 15.IV.2007., 07.VII.2007., **43:** 04.III.2007., 15.IV.2007., 07.VII.2007., **44:** 03.X.2007., **45:** 03.III.2007., 19.V.2007., 21.VII.2007., 03.X.2007., **46:** 05.VIII.2007., 07.XII.2007., **47:** 17.III.2007., 14.IV.2007., 10.VI.2007., **49:** 17.III.2007., 14.XI.2007., **50:** 17.III.2007., 14.XI.2007., **52:** 10.VIII.2007., **53:** 24.III.2007., 16.VI.2007., **54:** 16.VI.2007., 04.IX.2007., **57:** 06.V.2007., **58:** 21.VII.2007., **59:** 06.V.2007., 05.X.2007., **60:** 21.VII.2007., 05.X.2007., **61:** 18.III.2007., 06.V.2007., 21.VII.2007., **62:** 18.III.2007., 03.VI.2007., 21.VII.2007., 05.X.2007., **63:** 05.X.2007., **64:** 9.VI.2007., **65:** 09.VI.2007., 05.X.2007., **66:** 10.III.2007., 09.IV.2007., 09.VI.2007., 05.X.2007., **67:** 28.VII.2007., 29.VIII.2007., **68:** 28.VII.2007., 29.VIII.2007., **69:** 07.IV.2007., 28.VII.2007., 29.VIII.2007., **70:** 05.XII.2007., **71:** 28.VII.2007., **72:** 25.III.2007., 03.VI.2007., 29.VIII.2007., 14.XI.2007., **73:** 03.VI.2007., **74:** 25.III.2007., 03.VI.2007., 29.VIII.2007., 14.XI.2007., **75:** 03.VI.2007., 29.VIII.2007., 14.XI.2007., **76:** 25.III.2007., **77:** 14.XI.2007., **78:** 29.VIII.2007., **79:** 03.VI.2007., 14.XI.2007., **80:** 30.VII.2007., 15.XI.2007., **81:** 30.VII.2007., 15.XI.2007., **82:** 30.VII.2007., **83:** 30.VII.2007., **84:** 30.VII.2007., **86:** 03.VI.2007., 25.VIII.2007., **87:** 11.III.2007., 05.XII.2007., **88:** 03.VI.2007., 25.VIII.2007., 05.XII.2007., **89:** 25.VIII.2007., **90:** 20.V.2007., **91:** 30.VII.2007., **92:** 20.V.2007., 30.VII.2007., 05.X.2007., **95:** 25.III.2007., **97:** 20.VII.2007., **98:** 05.V.2007., 20.VII.2007., **99:** 05.IX.2007., **100:** 20.VII.2007., **101:** 25.III.2007., 20.VII.2007., **102:** 08.IV.2007., 09.VI.2007., **103:** 09.VI.2007., 19.VIII.2007., **104:** 09.VI.2007., 19.VIII.2007., **106:** 06.V.2007., 05.VIII.2007., 10.X.2007., **108:** 06.V.2007., 09.VII.2007., 09.X.2007., **114:** 20.VII.2007., **117:** 16.VI.2007., 30.VIII.2007., 07.XII.2007., **118:** 14.IV.2007., 16.VI.2007., 30.VIII.2007., 07.XII.2007., **122:** 08.IV.2007., 02.IX.2007., 05.XII.2007., **124:** 20.V.2007., 21.VII.2007., **126:** 20.V.2007., 21.VII.2007., **127:** 20.V.2007., 21.VII.2007., 05.X.2007., **128:** 20.V.2007., 21.VII.2007., 05.X.2007., **132:** 09.VI.2007., 10.VIII.2007., **133:** 09.VI.2007., 10.VIII.2007., 15.XI.2007., **135:** 14.IV.2007., 09.VI.2007., 10.VIII.2007., 15.XI.2007., **137:** 09.VI.2007., 15.XI.2007.

10. ***Trachelipus nodulosus*** (C.L. Koch, 1838)

**3**: 02.VI.2007., 01.IX.2007., 14.XI.2007., **42:** 04.III.2007., 15.IV.2007., **45:** 21.VII.2007., 03.X.2007., **46:** 05.VIII.2007., **57:** 18.III.2007., 06.V.2007., 21.VII.2007., 05.X.2007., **58:** 18.III.2007., 06.V.2007., 05.X.2007., **59:** 06.V.2007., 21.VII.2007., **60:** 18.III.2007., 06.V.2007., 21.VII.2007., **61:** 18.III.2007., 06.V.2007., 21.VII.2007., **62:** 05.X.2007. **72:** 25.III.2007., 03.VI.2007., 29.VIII.2007., 14.XI.2007., **73:** 25.III.2007., 03.VI.2007., 14.XI.2007., **89:** 11.III.2007., 25.VIII.2007., 05.XII.2007., **96:** 05.V.2007., 20.VII.2007., **98:** 25.III.2007., **101:** 20.VII.2007., 05.IX.2007., **130:** 20.V.2007., 20.VII.2007., 23.XI.2007., **131:** 16.II.2007., 20.V.2007., 20.VII.2007., 23.XI.2007., **135**: 09.VI.2007.

11. ***Trachelipus rathkii*** (Brandt, 1833)

**1:** 03.III.2007., 05.V.2007., 09.VII.2007**.,** 03.X.2007**.,** **2:** 03.III.2007., 05.V.2007., 09.VII.2007., 3: 17.III.2007., 01.IX.2007., **4:** 24.III.2007., 14.XI.2007., **5:** 24.III.2007.,

07.IV.2007., 5: 05.VIII.2007., 05.XII.2007., **6:** 17.III.2007., 02.VI.2007., 01.IX.2007., 7: 07.IV.2007., 09.VII.2007., **7:** 03.X.2007., 05.XII.2007., **8:** 17.III.2007., 01.IX.2007., 14.XI.2007., 9: 02.VI.2007., 03.X.2007., **10:** 09.VII.2007., **11:** 11.III.2007., 19.V.2007., 07.VII.2007., 23.XI.2007., **12:** 11.III.2007., 19.V.2007., 07.VII.2007., 23.XI.2007., **13:** 11.III.2007., 19.V.2007., 07.VII.2007., 23.XI.2007., **14:** 11.III.2007., 19.V.2007., 07.VII.2007., 23.XI.2007., 15: 11.III.2007., 19.V.2007., 07.VII.2007., 23.XI.2007., 19: 25.III.2007., 22: 18.III.2007., 02.VI.2007., 05.X.2007., **31:** 15.IV.2007., 07.X.2007., **32:** 15.IV.2007., 07.X.2007., **33:** 11.III.2007., 07.IV.2007., 07.X.2007., **36:** 21.VII.2007., **37:** 16.VI.2007., 40: 10.III.2007., 20.V.2007., 21.VII.2007., **41:** 21.VII.2007., **42:** 04.III.2007., 07.VII.2007., 05.XII.2007., **43:** 15.IV.2007., 07.VII.2007., 05.XII.2007., **44:** 19.V.2007., 21.VII.2007., 03.X.2007., **45:** 03.III.2007., 19.V.2007., 21.VII.2007., 03.X.2007., **46:** 11.III.2007., 02.VI.2007., 05.VIII.2007., 07.XII.2007., **49:** 17.III.2007., 14.IV.2007., 10.VI.2007., **49:** 14.XI.2007., **52:** 24.III.2007., 10.VIII.2007., **57:** 21.VII.2007., 05.X.2007., **58:** 05.X.2007., **59:** 21.VII.2007., 05.X.2007., **61:** 21.VII.2007., **62:** 18.III.2007., 03.VI.2007., 05.X.2007., **63:** 10.III.2007., 09.IV.2007., 09.VI.2007., 05.X.2007., **64:**10.III.2007., 09.VI.2007., 05.X.2007., **65:** 10.III.2007., 09.IV.2007., 09.VI.2007., 05.X.2007., **66:** 10.III.2007., 09.IV.2007., 09.VI.2007., 05.X.2007., **67:** 28.VII.2007., 29.VIII.2007., 05.XII.2007., **70:** 28.VII.2007., 29.VIII.2007., **71:** 29.VIII.2007., **72:** 29.VIII.2007., **73:** 03.VI.2007., 29.VIII.2007., **74:** 03.VI.2007., 29.VIII.2007., 14.XI.2007., **75:** 03.VI.2007., 29.VIII.2007., 14.XI.2007., **77:** 25.III.2007., 03.VI.2007., 29.VIII.2007., 14.XI.2007., **78:** 03.VI.2007., 29.VIII.2007., **79:** 25.III.2007., 03.VI.2007., **80:** 04.III.2007., 20.V.2007., 30.VII.2007., 15.XI.2007., **81:** 04.III.2007., 20.V.2007., 30.VII.2007., **82:** 30.VII.2007., **83:** 30.VII.2007., **84:** 20.V.2007., **85:** 04.III.2007., 20.V.2007., 30.VII.2007., 15.XI.2007., **86:** 11.III.2007., 03.VI.2007., **87:** 11.III.2007., 03.VI.2007., 25.VIII.2007., 05.XII.2007., **88:** 03.VI.2007., 05.XII.2007., **90:** 18.III.2007., 20.V.2007., 30.VII.2007., 05.X.2007., **91:** 18.III.2007., 20.V.2007., 30.VII.2007., 05.X.2007., **92:** 18.III.2007., 20.V.2007., 30.VII.2007., 05.X.2007., **93:** 05.V.2007., 20.VII.2007., 05.IX.2007., **94:** 25.III.2007., 05.V.2007., 20.VII.2007., 05.IX.2007., **95:** 25.III.2007., 05.V.2007., 20.VII.2007., **96:** 25.III.2007., 05.V.2007., 20.VII.2007., 05.IX.2007., **97:** 05.V.2007., 20.VII.2007., **97:** 05.IX.2007., **98:** 05.V.2007., 20.VII.2007., 05.IX.2007., **99:** 05.V.2007., 20.VII.2007., **100:** 25.III.2007., 05.V.2007., 20.VII.2007., 05.IX.2007., **101:** 25.III.2007., 05.V.2007., 20.VII.2007., 05.IX.2007., **102:** 08.IV.2007., 09.VI.2007., **102:** 19.VIII.2007., 10.X.2007., **103:** 08.IV.2007., 09.VI.2007., 19.VIII.2007., 10.X.2007., **104:** 08.IV.2007., 09.VI.2007., 19.VIII.2007., 15.XI.2007., **105:** 08.IV.2007., 09.VI.2007., 19.VIII.2007., 15.XI.2007., **106:** 24.II.2007., 06.V.2007., 05.VIII.2007., 10.X.2007., **107:** 24.II.2007., 06.V.2007., 05.VIII.2007., 09.X.2007., **108:** 06.V.2007., 09.VII.2007., **109:** 23.II.2007., 06.V.2007., 09.VII.2007., 09.X.2007., **110:** 23.II.2007., 06.V.2007., 09.VII.2007., 09.X.2007., **111:** 05.V.2007., 20.VII.2007., 05.IX.2007., **112:** 05.III.2007., 05.V.2007., 20.VII.2007., 05.IX.2007., 05.III.2007., **113:** 05.V.2007., 20.VII.2007., 05.IX.2007., **114:** 05.V.2007., 20.VII.2007., **116:** 30.VIII.2007., 07.XII.2007., **117:** 14.IV.2007., 16.VI.2007., 30.VIII.2007., 07.XII.2007., **118:** 14.IV.2007., 16.VI.2007., 30.VIII.2007., 07.XII.2007., 08.IV.2007., 15.VII.2007., 02.IX.2007., **119:** 05.XII.2007., **120:** 08.IV.2007., 15.VII.2007., 02.IX.2007., 05.XII.2007., **121:** 08.IV.2007., 15.VII.2007., **121:** 02.IX.2007., 05.XII.2007., **122:** 08.IV.2007., 15.VII.2007., 02.IX.2007., 05.XII.2007., **123:** 08.IV.2007., 15.VII.2007., 02.IX.2007., 05.XII.2007., **125:** 04.III.2007., 20.V.2007., 21.VII.2007., 05.X.2007., **126:**

04.III.2007., 21.VII.2007., **127:** 04.III.2007., 20.V.2007., **128:** 04.III.2007., 20.V.2007., 21.VII.2007., 05.X.2007., **129:** 04.III.2007., 20.V.2007., 21.VII.2007., 05.X.2007., **132:** 14.IV.2007., 09.VI.2007., 10.VIII.2007., 15.XI.2007., **134:** 14.IV.2007., 09.VI.2007., 10.VIII.2007., 15.XI.2007., **135:** 14.IV.2007., 09.VI.2007., 10.VIII.2007., 15.XI.2007., **136:** 14.IV.2007., 09.VI.2007., 10.VIII.2007., 15.XI.2007., **137:** 14.IV.2007., 09.VI.2007., 10.VIII.2007., 15.XI.2007., **138:** 14.IV.2007., 09.VI.2007., 10.VIII.2007., 15.XI.2007., **139:** 09.VI.2007., 10.VIII.2007., **140:** 14.IV.2007., 09.VI.2007., 10.VIII.2007., 15.XI.2007., **141:** 09.VI.2007., 10.VIII.2007.

12. ***Trachelipus ratzeburgii*** (Brandt, 1833)

**2:** 09.VII.2007., **5:** 24.III.2007., 07.IV.2007., 05.VIII.2007., **6:** 17.III.2007., 02.VI.2007., 01.IX.2007., 05.XII.2007., **8:** 17.III.2007., 02.VI.2007., **11:** 11.III.2007., 19.V.2007., 07.VII.2007., 23.XI.2007., **12:** 11.III.2007., 19.V.2007., 07.VII.2007., **14:** 07.VII.2007., **16:** 18.III.2007., 03.VI.2007., 01.IX.2007., 12.XII.2007., **17:** 18.III.2007., 09.IV.2007., 06.VII.2007., 12.XII.2007., **18:** 25.III.2007., 09.IV.2007., 13.V.2007., 05.X.2007., **19:** 25.III.2007., 13.V.2007., 06.VII.2007., 23.XI.2007., **20:** 09.IV.2007., 18.VII.2007., 15.IX.2007., **21:** 18.III.2007., 13.V.2007., 23.XI.2007., **22:** 05.X.2007., 12.XII.2007., **23:** 09.IV.2007., 19.VII.2007., 23.IX.2007., 12.XII.2007., **24:** 11.III.2007., 19.V.2007., 19.VII.2007., 12.XII.2007., **25:** 11.III.2007., 15.IV.2007., 07.VII.2007., 14.XI.2007., **26:** 25.III.2007., 10.VI.2007., 04.VIII.2007., 12.XII.2007., **27:** 18.III.2007., 02.VI.2007., 15.IX.2007., 23.XI.2007., **28:** 02.VI.2007., 15.IX.2007., 23.XI.2007., **29:** 04.III.2007., 19.V.2007., 15.VIII.2007., 05.XII.2007., **30:** 11.III.2007., 19.V.2007., 05.XII.2007., **34:** 04.III.2007., 20.V.2007., 21.VII.2007., 03.X.2007., **35:** 04.III.2007., 20.V.2007., 03.X.2007., **36:** 21.VII.2007., **37:** 04.III.2007., 05.V.2007., 16.VI.2007., 14.XI.2007., **38:** 04.III.2007., 05.V.2007., 16.VI.2007., 14.XI.2007., **39:** 04.III.2007., 05.V.2007., 14.XI.2007., **41:** 10.III.2007., 20.V.2007., 21.VII.2007., 20.IX.2007., **43:** 04.III.2007., 07.VII.2007., **44:** 03.III.2007., 19.V.2007., 21.VII.2007., 03.X.2007., **47:** 17.III.2007., 14.IV.2007., 10.VI.2007., 05.X.2007., **48:** 17.III.2007., 14.IV.2007., 10.VI.2007., 14.XI.2007., **49:** 14.IV.2007., 10.VI.2007., 14.XI.2007., **50:** 17.III.2007., 14.IV.2007., 10.VI.2007., 14.XI.2007., **51:** 24.III.2007., 13.V.2007., 10.VIII.2007., 23.XI.2007., **52:** 24.III.2007., 10.VIII.2007., **53:** 24.III.2007., 16.VI.2007., 04.IX.2007., 12.XII.2007., **54:** 24.III.2007., 16.VI.2007., 12.XII.2007., **55:** 24.III.2007., 16.VI.2007., 04.IX.2007., 12.XII.2007., 25.III.2007., **56:** 23.XI.2007., **63:** 10.III.2007., 09.IV.2007., 09.VI.2007., 05.X.2007., **64:** 10.III.2007., 09.VI.2007., **66** 10.III.2007., **67** 07.IV.2007., **68** 07.IV.2007., 28.VII.2007., 29.VIII.2007., 05.XII.2007., **69:** 07.IV.2007., 28.VII.2007., 29.VIII.2007., 05.XII.2007., **70:** 07.IV.2007., 28.VII.2007., 29.VIII.2007., 05.XII.2007., **71:** 07.IV.2007., 28.VII.2007., 29.VIII.2007., **76:** 25.III.2007., 03.VI.2007., 29.VIII.2007., 14.XI.2007., **77:** 03.VI.2007., 29.VIII.2007., **78:** 29.VIII.2007., **79:** 29.VIII.2007., **82:** 20.V.2007., 30.VII.2007., 15.XI.2007., **83:** 20.V.2007., 30.VII.2007., **84:** 04.III.2007., 20.V.2007., 30.VII.2007., 15.XI.2007., **86:** 25.VIII.2007., 05.XII.2007., **93:** 25.III.2007., 05.V.2007., 20.VII.2007., **94:** 20.VII.2007., 05.IX.2007., **102:** 09.VI.2007., 19.VIII.2007., **103:** 08.IV.2007., 09.VI.2007., **105:** 09.VI.2007., 19.VIII.2007., 15.XI.2007., **107:** 24.II.2007., **108:** 09.VII.2007., **110:** 09.VII.2007., **111:** 05.III.2007., 05.V.2007., 20.VII.2007., 05.IX.2007., **112:** 20.VII.2007., **113:** 20.VII.2007., 05.IX.2007., **114:** 05.III.2007., 05.V.2007., 20.VII.2007., 05.IX.2007., **115:** 14.IV.2007., 16.VI.2007., 30.VIII.2007., 07.XII.2007., **116:** 14.IV.2007., 16.VI.2007., 30.VIII.2007., **123:** 02.IX.2007., **124:** 04.III.2007., 20.V.2007., 21.VII.2007., 05.X.2007., **125:** 04.III.2007., 20.V.2007., 21.VII.2007., **126:** 20.V.2007., 21.VII.2007., 05.X.2007., **129:** 04.III.2007., 20.V.2007., 21.VII.2007., 05.X.2007., **132:** 14.IV.2007., **133:** 09.VI.2007., 10.VIII.2007., 15.XI.2007., **136:** 14.IV.2007., 09.VI.2007., **139:** 14.IV.2007., 09.VI.2007., 10.VIII.2007., 15.XI.2007., **141:** 14.IV.2007., 09.VI.2007., 10.VIII.2007., 15.XI.2007.

Cylisticidae

13. ***Cylisticus convexus*** (De Geer, 1778)

**3**: 17.III.2007., 01.IX.2007., **7**: 09.VII.2007., **14**: 19.V.2007., 07.VII.2007., **31**: 15.IV.2007., **44**: 03.X.2007., **52**: 23.XI.2007., **66**: 05.X.2007., **68**: 29.VIII.2007., **81**: 30.VII.2007., **89**: 03.VI.2007., **101**: 05.V.2007., 05.IX.2007., **111**: 05.V.2007., **119**: 08.IV.2007., 15.VII.2007., **127**: 21.VII.2007., **132**: 09.VI.2007., 10.VIII.2007., 15.XI.2007.

Agnaridae

14. ***Protracheoniscus politus*** (C.L. Koch, 1841)

**16**: 03.VI.2007., 01.IX.2007., 12.XII.2007., **17**: 18.III.2007., 09.IV.2007., **18**: 09.IV.2007., 13.V.2007., **19**: 25.III.2007., 13.V.2007., 06.VII.2007., 23.XI.2007., **20**: 09.IV.2007., 15.IX.2007., **21**: 13.V.2007., 23.XI.2007., **22**: 02.VI.2007., **23**: 19.VII.2007., **24**: 19.V.2007., 19.VII.2007., 12.XII.2007., **25**: 15.IV.2007., 07.VII.2007., 14.XI.2007., **26**: 25.III.2007., 10.VI.2007., 04.VIII.2007., 12.XII.2007., **27**: 02.VI.2007., 15.IX.2007., 23.XI.2007., **28**: 18.III.2007., 02.VI.2007., 15.IX.2007., **29**: 04.III.2007., 19.V.2007., 15.VIII.2007., 05.XII.2007., **30**: 19.V.2007., 15.IX.2007., **34**: 20.V.2007., 21.VII.2007., 03.X.2007., **35**: 20.V.2007., 21.VII.2007., **37**: 04.III.2007., 05.V.2007., 14.XI.2007., **38**: 05.V.2007., 16.VI.2007., **39**: 04.III.2007., 14.XI.2007., **41**: 20.V.2007., 21.VII.2007., 20.IX.2007., **47**: 14.IV.2007., 10.VI.2007., **48**: 17.III.2007., 14.IV.2007., 10.VI.2007., 14.XI.2007., **49**: 10.VI.2007., 14.XI.2007., **50**: 17.III.2007., 14.IV.2007., 10.VI.2007., 14.XI.2007., **51**: 13.V.2007., 10.VIII.2007., **52**: 13.V.2007., 10.VIII.2007., 23.XI.2007., **53**: 16.VI.2007., 04.IX.2007., 12.XII.2007., **54**: 24.III.2007., 16.VI.2007., 04.IX.2007., 12.XII.2007., **55**: 24.III.2007., 16.VI.2007., 04.IX.2007., 12.XII.2007., **56**: 25.III.2007., 12.V.2007., 15.VIII.2007., 23.XI.2007., **122**: 15.VII.2007.

Porcellionidae

15. ***Porcellio spinicornis*** Say, 1818

**60**: 06.V.2007., **89**: 25.VIII.2007.

16. ***Porcellionides pruinosus*** (Brandt, 1833)

**3**: 02.VI.2007., 01.IX.2007., 14.XI.2007., **14**: 07.VII.2007., 23.XI.2007., **42**: 15.IV.2007., 07.VII.2007., **60**: 18.III.2007., 06.V.2007., 05.X.2007., **61**: 06.V.2007., **89**: 03.VI.2007.

Armadillidiidae

17. ***Armadillidium versicolor*** Stein,1859

**1:** 05.V.2007., 03.X.2007., **2:** 09.VII.2007., **4:** 24.III.2007., 01.IX.2007., **6:** 02.VI.2007., **7:** 07.IV.2007., 09.VII.2007., **8:** 17.III.2007., 02.VI.2007., 14.XI.2007., **31:** 15.IV.2007., 07.X.2007., **32:** 15.IV.2007., 07.X.2007., **33:** 07.X.2007., **45:** 19.V.2007., **46:** 11.III.2007., 02.VI.2007., **58:** 18.III.2007., 06.V.2007., 21.VII.2007., 05.X.2007., **59:** 18.III.2007., 21.VII.2007., 05.X.2007., **62:** 03.VI.2007., 21.VII.2007., 05.X.2007., **63:** 09.VI.2007., **64:** 05.X.2007., **65:** 10.III.2007., 09.VI.2007., 05.X.2007., **71:** 07.IV.2007., 28.VII.2007., 29.VIII.2007., 23.XI.2007., **77:** 29.VIII.2007., 14.XI.2007., **79:** 25.III.2007., 03.VI.2007., 29.VIII.2007., 14.XI.2007., **84:** 04.III.2007., 20.V.2007., 30.VII.2007., 15.XI.2007., **88:** 11.III.2007., 03.VI.2007., 25.VIII.2007., **93:** 25.III.2007., 05.V.2007., 20.VII.2007., **94:** 05.IX.2007., **95:** 20.VII.2007., 05.IX.2007., **1IV:** 08.IV.2007., 09.VI.2007., 19.VIII.2007., 15.XI.2007., **1V:** 19.VIII.2007., **107:** 06.V.2007., 05.VIII.2007., 09.X.2007., **109:** 23.II.2007., 06.V.2007., 09.VII.2007., **112:** 20.VII.2007., 05.IX.2007., **113:** 05.V.2007., 20.VII.2007., **132:** 10.VIII.2007., **134:** 14.IV.2007., 09.VI.2007., 10.VIII.2007., **138:** 09.VI.2007., 10.VIII.2007., **140:** 14.IV.2007., 09.VI.2007., 10.VIII.2007.

18. ***Armadillidium vulgare*** Latreille, 1804

**1:** 03.X.2007., **3:** 02.VI.2007., 14.XI.2007., **5:** 05.VIII.2007., **7:** 05.XII.2007., **8:** 01.IX.2007., **11:** 19.V.2007., 12**:** 07.VII.2007., 23.XI.2007., **13:** 11.III.2007., 07.VII.2007., **14:** 11.III.2007., 19.V.2007., 23.XI.2007., 15**:** 07.VII.2007., 16**:** 18.III.2007., 03.VI.2007., **17:** 18.III.2007., 09.IV.2007., 12.XII.2007., **19:** 25.III.2007., 13.V.2007., 20**:** 18.VII.2007., 15.IX.2007., **21:** 23.XI.2007., **22:** 18.III.2007., **24:** 12.III.2007., **25:** 13.III.2007., 07.VII.2007., **26:** 12.XII.2007., **28:** 18.III.2007., 23.XI.2007., **29:** 05.XII.2007., **30:** 05.XII.2007., **33:** 07.IV.2007., **34:** 04.III.2007., **34:** 21.VII.2007., **35:** 03.X.2007., **36:** 04.III.2007., 20.V.2007., 21.VII.2007., **37:** 16.VI.2007., **37:** 14.XI.2007., **39:** 16.VI.2007., **39:** 14.XI.2007., **40:** 10.III.2007., 20.V.2007., 21.VII.2007., 20.IX.2007., **41:** 10.III.2007., 20.V.2007., **42:** 04.III.2007., 15.IV.2007., 07.VII.2007., 05.XII.2007., **43:** 15.IV.2007., 07.VII.2007., 05.XII.2007., **44:** 19.V.2007., 21.VII.2007., 03.X.2007., **45:** 19.V.2007., **46:** 02.VI.2007., 05.VIII.2007., 07.XII.2007., **47:** 14.IV.2007., **48:** 17.III.2007., 10.VI.2007., 14.XI.2007., **49:** 17.III.2007., 14.IV.2007., 10.VI.2007., **50:** 14.IV.2007., 10.VI.2007., **51:** 24.III.2007., 13.V.2007., 10.VIII.2007., **52:** 13.V.2007., 23.XI.2007., **53:** 24.III.2007., 12.XII.2007., **54:** 12.XII.2007., **55:** 24.III.2007., 16.VI.2007., 04.IX.2007., **57:** 18.III.2007., 06.V.2007., 21.VII.2007., 05.X.2007., **59:** 18.III.2007., **60:** 18.III.2007., 06.V.2007., 21.VII.2007., 05.X.2007., **61:** 18.III.2007., 06.V.2007., 21.VII.2007., 05.X.2007., **64:** 05.X.2007., **66:** 10.III.2007., 09.IV.2007., 09.VI.2007., 05.X.2007., **67:** 07.IV.2007., 28.VII.2007., 29.VIII.2007., 05.XII.2007., **68:** 07.IV.2007., 28.VII.2007., 29.VIII.2007., 05.XII.2007., **69:** 07.IV.2007., 28.VII.2007., 29.VIII.2007., 05.XII.2007., **70:** 07.IV.2007., 28.VII.2007., 29.VIII.2007., 05.XII.2007., **72:** 03.VI.2007., 29.VIII.2007., **73:** 25.III.2007., 03.VI.2007., 29.VIII.2007., 14.XI.2007., **76:** 03.VI.2007., 29.VIII.2007., **77:** 03.VI.2007., **78:** 25.III.2007., 03.VI.2007., 29.VIII.2007., **79:** 14.XI.2007., **80:** 04.III.2007., 20.V.2007., 30.VII.2007., 15.XI.2007., **81:** 04.III.2007., 20.V.2007., 30.VII.2007., 15.XI.2007., **82:** 04.III.2007., 20.V.2007., 30.VII.2007., 15.XI.2007., **83:** 04.III.2007., 20.V.2007., 15.XI.2007., **84:** 30.VII.2007., **86:** 14.III.2007., 03.VI.2007., 25.VIII.2007., 05.XII.2007., **87:** 25.VIII.2007., **89:** 15.III.2007., **89:** 03.VI.2007., 25.VIII.2007., 05.XII.2007., **90:** 30.VII.2007., 05.X.2007., **91:** 20.V.2007., 30.VII.2007., 05.X.2007., **92:** 18.III.2007., 20.V.2007., 05.X.2007., **94:** 25.III.2007., 05.V.2007., **95:** 05.V.2007., **96:** 25.III.2007., 05.V.2007., 20.VII.2007., 05.IX.2007., **97:** 25.III.2007., 05.V.2007., 20.VII.2007., 05.IX.2007., **98:** 25.III.2007., 05.V.2007., 20.VII.2007., **99:** 25.III.2007., 05.V.2007., 20.VII.2007., 05.IX.2007., **100:** 20.VII.2007., **101:** 25.III.2007., 05.V.2007., 20.VII.2007., **102:** 10.X.2007., **103:** 08.IV.2007., 09.VI.2007., 19.VIII.2007., 10.X.2007., **106:** 24.II.2007., 06.V.2007., 05.VIII.2007., 10.X.2007., **108:** 23.II.2007., 06.V.2007., 09.VII.2007., 09.X.2007., **110:** 06.V.2007., 09.VII.2007., 09.X.2007., **111:** 05.III.2007., 05.V.2007., 20.VII.2007., 05.IX.2007., **112:** 05.V.2007., **113:** 05.III.2007., 05.V.2007., **114:** 05.III.2007., 05.V.2007., **114:** 20.VII.2007., 05.IX.2007., **115:** 14.IV.2007., 16.VI.2007., 30.VIII.2007., 07.XII.2007., **116:** 14.IV.2007., 16.VI.2007., 07.XII.2007., **117:** 14.IV.2007., 16.VI.2007., 30.VIII.2007., 07.XII.2007., **118:** 16.VI.2007., 30.VIII.2007., 07.XII.2007., **119:** 15.VII.2007., 02.IX.2007., 05.XII.2007., **120:** 08.IV.2007., 15.VII.2007., 02.IX.2007., 05.XII.2007., **121:** 08.IV.2007., 15.VII.2007., 02.IX.2007., 05.XII.2007., **122:** 15.VII.2007., 02.IX.2007., 05.XII.2007., **123:** 15.VII.2007., 02.IX.2007., 05.XII.2007., **124:** 04.III.2007., 21.VII.2007., 05.X.2007., **125:** 05.X.2007., **126:** 20.V.2007., 21.VII.2007., 05.X.2007., **127:** 04.III.2007., 20.V.2007., 21.VII.2007., 05.X.2007., **128:** 04.III.2007., 21.VII.2007., 05.X.2007., **130:** 16.II.2007., 20.V.2007., 20.VII.2007., 23.XI.2007., **131:** 16.II.2007., 20.V.2007., 20.VII.2007., 23.XI.2007., **132:** 09.VI.2007., 10.VIII.2007., 15.XI.2007., **133:** 14.IV.2007., 09.VI.2007., 10.VIII.2007., 15.XI.2007., **134:** 15.XI.2007., **135:** 14.IV.2007., 09.VI.2007., 10.VIII.2007., 15.XI.2007., **136:** 09.VI.2007., 10.VIII.2007., 15.XI.2007., **137:** 10.VIII.2007., **138:** 15.XI.2007., **139:** 9.VI.2007., 10.VIII.2007., 15.XI.2007., **141:** 14.IV.2007., **141:** 10.VIII.2007.

19. ***Armadillidium zenckeri*** Brandt, 1833

**13:** 19. V.2007., 07.VII.2007., **15:** 19. V.2007., 07.VII.2007., **40:** 20.V.2007., 21.VII.2007., **74:** 25.III.2007., 03.IV.2007., 29.VIII.2007., 14.XI.2007., **75:** 25.III.2007., 03.IV.2007., 29.VIII.2007., **80:** 20.V.2007., 30.VII.2007., **85:** 04.III.2007., 20.V.2007., 30.VII.2007., 15.XI.2007., **90:** 20.V.2007., **100:** 25.III.2007., 05.V.2007., 20.VII.2007., 05.IX.2007., **137:** 14.IV.2007., 09.IV.2007., 10.VIII.2007.

## 3.2. Frequency of species in the Drava basin

*H. riparius* was found in 91% of the 141 sampling sites. This species has the highest occurrence rate among the collected species. This small secretive isopod does not prefer any of the vegetation types. It could have been found in every habitat type including synanthropic ones. It likes permanently wet, humid places and never leaves its shelter. The species belonged to the group of the most frequent species in the Hungarian side of the Drava basin, too.

The frequency of *A. vulgare* was also high. It turned up in 80% of the sampling sites. It lives on every continent and known as one of the most widely distributed species in the world. Its sclerotic cuticle protects this woodlouse from desiccation and provides ability to leave its shelter and spread. Similarly to the previous species it has no specific habitat and it is able to consume a wide range of different plants. Its reproduction strategy is iteroparous. It proved to be the most common species in South-Transdanubia

*T. rathkii* was sampled in 75% of the sampling sites. This species is often found in wetland willow-poplar forests but it likes disturbed and synanthropic sites, too. *T rathkii* turned up in huge abundances by pitfall trapping in riverine forests of the Drava lowland in Hungary. This is the fourth most frequent species in that region. It appeared regularly also in coastal habitats of the river very close to the waterside. Its abundant colonies were found at the bank of Drava in organic debris and reed vegetation. This isopod species has adapted to the annual floods. Along with *H. riparius*, *T. rathkii* is often one of the first isopods that colonises the floodplains after major floods. In Central Europe this species is a dominant member of assemblages in floodplains (e.g. FARKAS 1998d; TUF & TUFOVÁ 2005), but it is adapted to such harsh environments as sodic plains in Hungary (VILISICS et al. 2005). As a common and widely distributed isopod, *T. rathkii* is known from natural and urban habitats from west, north and east from the Alps. From Europe it has also been introduced to North America. It is also a typical woodlouse in urban environments, parks and gardens.

*P. collicola* came up in the 66% of the sampling sites. At present very little is known about this species. It may be one of the most common isopod species of Central Europe by the results of systematic samplings in Hungary (FARKAS 2006). Similarly to the previous species *P. collicola*, too, lacks definite habitat preference. It could be found in dry oak and wet riverine forests just like in meadows and synanthropic sites. Occasionally turns up multitudinous. Its ecology is lesser-known.

The frequency of *T. ratzeburgii* reached 57%. This impressive and typically sylvicolous isopod has a wide European distribution from England to Eastern Europe (SCHMALFUSS 2003). In Central Europe it is a common woodlouse in natural oak, beech and willow forests, occurring mainly under the bark of dead trees (e.g. TUF & TUFOVÁ 2005). In Western Europe it is ordinary in coniferous woods. This species was one of the most frequent species in the Repaš forest.

*A. versicolor* was sampled in 25% of the sampling sites. This Eastern European species often occurs in sites under natural or anthropogenic disturbance (e.g. NAVRÁTIL 2007; HORNUNG et al. in prep), however HUDÁKOVÁ and MOCK (2006) proved its occurrence from undisturbed habitats in the Western Carpathians in Poland. Recent surveys provided further evidence for its distribution both in willow-poplar groves, and in human settlements (Esztergom, Budapest, Szigetszentmárton) along the Danube (VILISICS unpubl).

Abundant colonies were found on the riverbank often together with *T. rathkii*. Due to the lack of distribution data this isopod was considered as rare and obscure, until recent surveys revealed its occurrence in several places in Transdanubia. Supposedly, more sampling efforts will result in more data of this species, proving a much broader distribution area in Hungary.

*P. politus* was found in 23% of the 141 sampling places. Similarly to *T. ratzeburgii* it highly favours woodlands, especially oak and beach forests. This species is a common and often dominant member of the soil fauna of Central- and Eastern-European deciduous forests (e.g. TUF & TUFOVÁ 2005; VILISICS & FARKAS 2004), but it's also sensitive to human disturbance. It occurs mainly in moist and humid habitats within leaf litter and under logs.

*Lepidoniscus minutus* turned up in 16% of the sampling sites. The distribution of this isopod is restricted between North-Eastern Italy, Southern Germany, Southern Poland, Hungary and Northern Greece, including the rest of the countries laying within this area (SCHMALFUSS 2003). The species is widely distributed in the Pannonian region particularly in natural oak and beech forests (FARKAS 2005; FARKAS & VILISICS 2006; VILISICS 2007). One can find it under fallen bark and logs, even in dry habitats. Since this isopod has no published data from anthropogenic habitats, assumingly it has a low tolerance for human perturbation, therefore its presence is a good indicator for naturalness. Despite its wide distribution, *L. minutus* occurs in low densities and abundance.

The most remarkable species of the isopod fauna is *Trichoniscus steinboecki* that occurred in 13% of the sampling places. Field surveys in Repaš forest provided evidences for the occurrence of this isopod for the first time in Croatia. The species has been first described from Steiermark, cental Austria as an Alpine endemic isopod (STROUHAL 1947). The Austrian sampling localities lay on high elevations above 1000 metres a.s.l. Extensive field samplings in the past three years in Hungary revealed a much broader distribution of this minute isopod, including natural habitats in every major mountainous area of Transdanubia. So far we have no evidence on its occurrence in floodplains or lowlands (VILISICS 2005; FARKAS & VILISICS 2006; VILISICS 2007; HORNUNG et al. in prep), however, the known Hungarian localities did not exceed 600 metres of elevation above sea level either. The typical habitat for the species can be described as humid ravines in natural deciduous (oak or beech) forests. We suppose that rivers connecting with the Alps may be a key factor in the distribution of this autochtonous species. The species was rather abundant in Repaš forest, creeping within moist leaf litter and under bark of fallen trees.

The frequency of the remainder species is equal or under 11%. Among them *A. zenckeri* is a notable species characteristic in *Carex* meadows where it is often multitudinous.

The distribution of the other species is strongly influenced by human activity. Buildings, ruins, moults of debris, garbage heaps could help their settling. *Oniscus asellus* the common European sow-bug is one of them. This is a dominant species all over Europe from the Atlantic coast to Central Europe and Scandinavia (GRUNER 1966; MEINERTZ 1964; SCHMALFUSS 2003) in natural and disturbed areas as well, but not in the Mediterranean basin. Introduced to the New World, the species is frequent in some parts of the USA, too (unpublished, http://bugguide.net, 01.16.2008). Despite its wide European distribution, the species has sporadic occurrences in the Pannonian biogeographical region (FORRÓ & FARKAS 1998). Faunistic data also suggest that *O. asellus*, although a rare species, shows preference for anthropogenic habitats and we cannot consider it as a native species.

Field surveys at the Drava river proved the occurrence of this isopod, however the sampling sites were restricted to heaps of illegally deposited debris and trash, adjacent to the road at Botovo.

## 3.3. Isopod assemblages of typical habitat types

The majority of the 141 sampling sites, 83%, took place in riverine groves, oak forests and the coast of Drava river and some at stagnant waters. Isopod assemblages in the main habitat types can be described as follows:

In the riverine groves (willow and poplar forests) samples were taken at 41 sites. At this habitat type 17 isopod species were found, five of them turning up in 70% of the sample areas. The typical species of riverine groves are *A. vulgare* and *H. riparius*, both found in 90% of the samples. These are followed by *T. rathkii* with 83% and *P. collicola* with 76%.

The common species were the same in willow forests as in the last analysis taking into account all of the sample areas. These were followed by *T. ratzeburgii* with also a high occurrence of 71%. The wetlands are subject to annual floods during the regular fluctuation of water levels. During such momentous periods the majority of the soil fauna is destroyed. Following the flood, the inundation areas are re-colonised by species possessing fast colonisation abilities (e.g. TUF 2003).

Some species (*H. danicus, C. convexus, L. germanicus, T. nodulosus, A. versicolor*) not native in the area were found only in 7-15% of the willow-poplar forests. Another seven species were found characteristically only from one sample area.

In the oak forests not as many species were found as in the other areas: we have found 13 species. Unambiguously, the most common species in riverine oak forests was *T. ratzeburgii*, found at all (32) of the sample areas in oak forests. The species *P. politus* showed similar frequency, occurring in 97% of the sample areas. Data from recent surveys and from the Croatian Baranja (FARKAS & KRČMAR 2004) prove that both species are common in wetland oak forests.

Two generalist species (*H. riparius, A. vulgare*) – besides oak forests – occured in most habitats in high frequencies.

Among species indicating natural oak forests two less known and rather rare isopods, *L. minutus* and *L. germanicum* with high frequencies (75%, 53%, respectively) were present. *T. steinboecki*, new to the Croatian fauna, was found in the oak forest as well. We found individuals of this species in the oak forest and on the riverside too. In addition to the numerously mentioned four species (*T. rathkii, A. vulgare, H. riparius, P. collicola*), *A. versicolor* can be noted for its frequent appearance.

## 3.4. Composition of isopod assemblages

According to the Sørensen index of similarities (Table 2.) we can consider the three observed habitat types relatively alike, with similarities between 69 and 74%. The evaluation of naturalness of isopod assemblages revealed that the highest percentage (77%) of native species was found in the oak forest, followed by the river bank (70%) and the willow forests (53%), respectively (Fig. 1.).

Table 2. Sørensen index for similarity indicates values of similarities between isopod assemblages in different habitats

| | Willow | Oak | River bank |
|---|---|---|---|
| Willow | - | 0.73 | 0.69 |
| Oak | - | - | 0.74 |
| River bank | - | - | - |

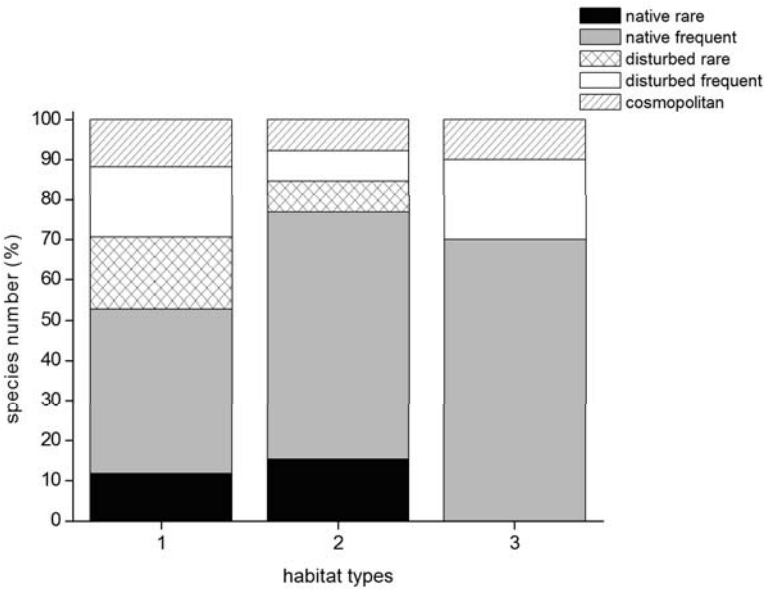


Fig.1. Composition of different categories of naturalness within three habitat types (1: willow forest, 2: oak forest, 3: river bank)

The bulk of the isopods proved to be native frequent, in other words native generalist species (e.g. *T. rathkii, P. collicola*), but we found a few rare native ones as well (*A. zenckeri, T. steinboecki*). Species typical in disturbed habitats occurred in each area, their highest proportion (47%) was found in the willow forest. This might indicate an ongoing degradation process. On the contrary, the low number of non-native species indicate a relatively high natural value for the oak forest.

The dendrogram upon similarities of isopods (Fig. 2.) revealed three distinct species groups. The first group consists of four species occurring exclusively in the willow forest. The second smallest group of 5 species was formed by isopods occurring in the oak forest, but not on the river bank. The third and largest group included 10 species that were found in each of the three habitat types. According to the analyses we can conclude that the isopod fauna of the observed habitat types are rather homogenous with a few specialist species preferring one certain habitat. As a conclusion we assume that there is no great difference between the composition of isopod faunas living on either side of the Drava. The same species were found to be the most frequent ones and the structures of the assemblages were also similar. The prominent absence of rare Alpine and Illyric isopods such as *Hyloniscus vividus, Calconiscellus karawankianus, Protracheoniscus franzi* and *Porcellium recurvatum* known from the Hungarian side might account for either human degradation or insufficient sampling efforts in the area.

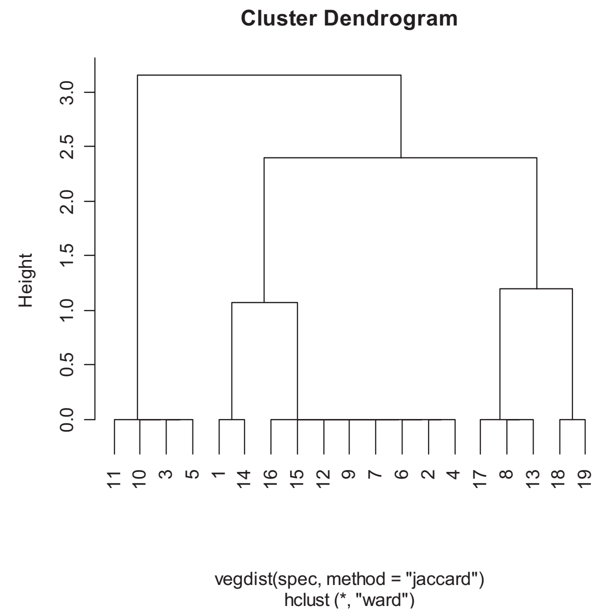


Fig. 2. The hierarchical cluster analysis shows similarities between the species according to their presence in the observed habitats. 1: *Armadillidium versicolor,* 2: *Armadillidium vulgare,* 3: *Armadillidium zenckeri,* 4: *Cylisticus convexus,* 5: *Haplophthalmus danicus,* 6: *Hyloniscus riparius,* 7: *Ligidium germanicum,* 8: *Oniscus asellus,* 9: *Platyarthrus hoffmannseggii,* 10: *Porcellio spinicornis,* 11: *Porcellionides pruinosus,* 12: *Porcellium collicola,* 13: *Protracheoniscus politus,* 14: *Trachelipus nodulosus,* 15: *Trachelipus rathkii,* 16: *Trachelipus ratzeburgii,* 17: *Trichoniscus steinboecki,* 18: *Haplophthalmus montivagus,* 19: *Lepidoniscus minutus*

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# Population-level baseline surveying and preparative investigations for the monitoring of carabid beetles (Coleoptera, Carabidae) in areas along the Drava river and in Baranja (Croatia)

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**Abstract:** From studies performed in 2007, focusing on Croatian areas of the Drava region, and from the analysis of formerly collected material in Croatian Baranja, a total of 173 carabid beetle species are listed. Among those reported hereby, 17 species had been unknown from this area: *Acupalpus intersitialis, Amara eutynota, Amara fulva, Amara lunicollis, Amara pseudostrenua, Anisodactylus nemorivagus, Bembidion prasinum, Bembidion starki, Bembidion testaceum, Dyschirius chalybaeus gibbifrons, Dyschirius politus, Elaphropus quadrisignatus, Harpalus subcylindricus, Licinus cassideus, Paratachys fulvicollis, Philorhizus quadrisignatus, Trechoblemus micros.* The majority of rare species that were found to be new in the area and (or) those bearing particular faunistic significance were collected at the Drava riverside with sparse vegetation or on gravel shoals (*Bembidion azurescens, Bembidion doris, Bembidion fasciolatum, Bembidion prasinum, Bembidion testaceum, Blemus discus, Paratachys fulvicollis, Perileptus areolatus, Trechoblemus micros*), and in hayfield or meadow type of grassy habitats (*Amara mintivaga, Amara pseudostrenua, Anisodactylus nemorivagus, Bradicellus csikii*). Carabid beetle assemblages with high species diversity were revealed in hayfields of the Drava floodplain, these habitats being the ones in which most of the important species were recorded. The carabid assemblages having been recorded in oak forests and oak-hornbeam forests surviving in a natural status in large expanses on the Croatian side, are characterised with low species numbers and few species of faunistic significance. Among the *Carabus* species protected in Hungary and now found in large numbers, only the most common representatives were found (*Carabus cancellatus maximus, Carabus convexus convexus, Carabus coriaceus praeilliricus, Carabus germari exasperatus, Carabus granulatus, Carabus nemoralis nemoralis, Carabus ullrichi baranyensis*).

## 1. Introduction

The baseline surveying aiming at providing the fundamentals for biomonitoring investigations, was focused on the Croatian areas along river Drava and in Baranja, where hardly any studies had been done formerly on the carabid beetle fauna. The transnational results of the faunal investigations of carabid communities – commonly known to have high indicative significance in nature conservation – will be suitable to be used in the extension of NATURA 2000 network onto valuable natural sites along the entire Hungarian-Croatian Drava region. The conservation of characteristic carabid beetle assemblages associated with specific habitat types – and especially of taxa representing

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high faunal or natural values – in Croatian and Hungarian highly natural areas of the valley of the state border river has immense importance.

Areas along Drava on the Croatian and Hungarian sides of the river, respectively, are highly different if compared from the aspect of carabid beetle habitats. The most fundamental characteristics in which the Croatian side is different, are as follows:

- larger expanses of arenicolous areas or sandy grasslands like the Barcs Juniper Grove in Hungary, are absent,
- wooded high bank areas near the water are mostly absent, such as the ones near Vízvár and Bélavár in Hungary,
- the occurrence rate of dry grasslands on flood-protected floodplain is insignificant, the proportion of wet meadows directly along the river is much higher,
- there are much larger areas of wet meadows and hayfields with orchids on the Croatian protected side
- the proportion of flood-protected dead branches of the river is much greater,
- the proportion of low-lying, continuous oak-hornbeam forests is much greater,
- generally, areas inside the flood-prevention dyke are more typically mosaical.

On the basis of former observations and experience gained during preliminary field visits it could be assumed that the conditions for the survival of near-natural species assemblages in Croatian areas are more favourable in the uppermost Drava section between Legrad and Terezino Polje. Due to the presence of dykes, it is mostly the areas inside the actual floodplain that have been able to sustain their naturalness, and because of the infrequency of floodings affecting large areas of the entire inundation area, characteristic faunal elements of what used to be an open floodplain could also survive. As a result of unnatural water level fluctuations, the most endangered are species associated with shoals and the rivershore, whose most sensitive representatives, also being the most valuable from faunal aspects, could be recorded only occasionally even from the much better studied Hungarian river sections. In accordance with those outlined above, our working hypothesis contains the following assumptions:

- despite the high level of research having been done on the Hungarian side of river Drava and county Baranya, the occurrence of species formerly unknown from the area is expected, due to the difference of the Croatian side
- although there is high degree of unnatural water level fluctuation on Drava, it is expected that valuable shoal-dwelling or rivershore carabid communities, possibly of high diversity and natural value and maybe also including new faunal elements, can be found
- it is assumed that *Carabus* species with high faunal and nature conservation value (e.g. *Carabus intricatus, Carabus scheidleri, Carabus glabratus* – being protected in Hungary) can be recorded in the highly natural oak-hornbeam forests of Croatian areas, along with other interesting and valuable forest species
- highly diverse carabid communities, enriched with a number of characteristic faunal elements, are expected from wet hayfields in the Drava floodland and from oxbows
- grassland fragments existing on more elevated, drier, flood-prevented areas surviving in small pockets in the Croatian side are characterised with highly typical carabid assemblages possibly with low number of species.

Partly being associated with the proximity of Pécs as a scientific centre, and partly with the zoogeographic characteristics of the target area, the Drava region and county Baranya are considered to have been researched for long, as regards their insect fauna. As proven by museum specimens from the late 19th century, János Frivaldszky, one of the pioneers in Hungarian fauna research, has collected beetles in this region, also evidenced, apart from conserved material, by written accounts too (Frivaldszky 1874). Knowledge about carabid beetles of the region was further broadened in the early 20th century by the activities of Béla Viertl and Ernő Kaufmann, thus we have information about 232 carabid beetles occurring in the region at that time (Viertl 1894; Kaufmann 1914a, 1914b), including recordings from Baranya and habitats along the Drava. During nearly a century that has passed since then, several entomologists have worked in the region, which fact has resulted in a growing number of records on – sometimes rare – carabid beetles and publications giving an account on them. Hungarian scientists have only accidentally visited the Croatian part of Baranja (Duna-Drava confluence) and the region south of the river. The number of publications released in Croatia on carabids of the region is negligible.

However, there is considerable amount of relatively well-based information available on the carabid fauna of nature conservation areas of national significance and already designated NATURA 2000 sites, along the Hungarian Drava section and in Hungarian areas of Baranya. The surveying of Croatian areas not being protected but being rich in faunistic and natural values, along with finding out about their biodiversities, are fundamental criteria for being integrated in the European ecological network. Gaining better knowledge about the distribution of carabid beetle species and species assemblages that represent faunistic or nature conservation value or that are NATURA 2000 indicator species contributes to the establishment of a cross-border ecological network or other type of transnational nature conservation area (e.g. common national park). From the aspect the extension or linkage of NATURA 2000 network towards Croatia, the launching of biomonitoring beyond the borders has great importance, for it is a precondition of planning habitat reconstruction activities. Former experience (literature) and the results of the baseline surveying that has been carried out provide data for the designation of Croatian as well as further Hungarian areas along river Drava. In studies evaluating the ecological status of areas suggested for being included in the NATURA 2000 network, as well as in planning possible conservation measures for the entire area, carabid beetle taxa representing higher faunistic and natural value have high importance, along with the habitats hosting them.

## 1.1. Information on research history in Hungarian areas along Drava

The earliest data on carabid beetles along Drava date back to approximately the same period when studies into coleopterans were started in Hungary. This early period of observations and research into beetle species in Baranya and along Drava is associated primarily with the activities of Lajos Mitterpacher, János Frivaldszky, Béla Viertl and Ernő Kaufmann. Frivaldszky (1874) published data about 65 carabid species from this region, although his records lack exact locations in many cases. Viertel (1894) focused his work on the surroundings of the city of Pécs, but the origins of this 172 carabid beetle species listed in his paper without localities must be interpreted in a broad sense in several of the cases, thus possibly including areas along Drava, too. Kaufmann published his findings about carabids in the early part of the last century (KAUFMANN 1914a, 1914b). In his synthetic, public educational publications he lists and describes altogether 232 species, but exact locations of collecting are mentioned only for few of them. It is not possible to determine the exact origins even of specimens preserved as part of his heritage (stored in the Hungarian National History Museum), because the location is specified solely as ”Pécs” in most of the cases. Most possibly, part of the specimens used for the publications were not collected at the location specified on the labels, thus again it is quite likely that certain specimens were collected in the Drava region or other places of Baranya.

Although there are some data from Baranya in the grand work by CSIKI (1946) introducing the ground beetles of the Carpathian Basin, there are none originating from the Drava region.

During the most recent two and a half decades of the past century, older and contemporary data on carabids of the region were made available through the research activities and publications of Sándor Horvatovich. The author reports on carabid species collected along Drava in several papers (HORVATOVICH, 1976, 1978, 1979, 1980, 1981a, 1981b, 1982, 1989, 1995, 1998, 2002). Most of the data appearing in a number of different publications regard the area of Barcs and the Barcs Juniper Woodland. In recent decades the Barcs Juniper Woodland has become a highly preferred area for fauna research, mostly due to its nature conservation significance. Altogether 228 species are listed in the first synthetic work dealing with the carabid fauna of the Drava region (HORVATOVICH 1995). New occurrence data are given on a number of species that are considered to be rare in the entire Carpathian Basin: *Cylindera arenaria viennensis* (Schrank, 1781), *Carabus marginalis decorus* Seidlitz, 1891, *Elaphus cupreus* Duftschmid, 1812, *Epaphius secalis* (Paykull, 1790), *Bembidion elongatum* Dejean, 1831, *Bembidion clarkii* (Dawson, 1829), *Bembidion doris* (Panzer, 1797), *Bembidion gilvipes* Sturm, 1825, *Harpalus marginellus* Dejean, 1829, *Harpalus progrediens* Schauberger, 1922, *Harpalus tenebrosus centralis* (Schauberger, 1929), *Ophonus melletii* (Heer, 1837), *Pterostichus aterrimus* (Herbst, 1784), *Pterostichus transversalis* (Duftschmid, 1812), *Platynus scitulus,* Dejean 1828), *Amara montivaga* Sturm, 1825. The paper includes several *Carabus* species, being under protection in Hungary. As a continuation of the former publication, newer data are given in HORVATOVICH (1998), listing further 35 species, again including quite a few faunistic rarities: *Tachys sexstriatus* Duftschmid, 1812, *Perileptus areolatus* (Creutzer, 1799), *Harpalus honestus* (Duftschmid, 1812), *Stenolophus proximus* Dejean, 1829, *Platynus longiventris* Mannerheim, 1825, *Lionichus quadrillum* (Duftschmid, 1812). Accordingly, the two publications report about the occurrence of a total of 265 ground beetle species in the region. The checklist of the carabids of Baranya county, having been released recently by the same author (HORVATOVICH 2002) includes 351 species, the bulk of which were collected in areas along Drava. A considerable proportion of data originating from this period are a result of the collecting activity of József Sár who worked for Janus Pannonius Museum and has himself published beetle data from the Drava region (SÁR 1993).

The knowledge having been gained about the ground beetle fauna of the Drava region was further enriched by a degree thesis produced at the University of Pécs (BÉRCES 1997). The author performed his surveys in six localities (Felsőszentmárton, Vejti, Kisszentmárton, Majláthpuszta, Szaporca, Drávaszabolcs) in the Drava floodland, and the pitfall trapping yielded, among 93 species altogether, 12 species that had not been recorded formerly in the Drava region: *Carabus clathratus auraniensis* G. Müller, 1902, *Nebria brevicollis* (Fabricius, 1792), *Bembidion lunulatum* (Geofroy in Fourcroy, 1785), *Harpalus luteicornis* (Duftschmid, 1812), *Bracycellus csiki* Laczó, 1912, *Stenolophus proximus* Dejean, 1829, *Synuchus vivalis* (Illiger, 1798), *Chlaenius nigricornis* (Fabricius, 1787), *Callistus lunatus* (Fabricius, 1775), *Licinus depressus* (Paykull, 1790), *Brachinus crepitans* (Linnaeus, 1758), *Brachinus elegans* (Chaudoir, 1842).

During the monitoring activities that proceeded along the Hungarian side of the Drava floodplain, surveys were made in 2000-2001 in Babócsa, Gyékényes, Őrtilos and Vízvár: which yielded 87 species. The resulting publication reports on the occurrence of a total of 55 species (BÉRCES 2003). The collected material contained altogether 11 species that had not been formerly known from the area: *Cychrus attenuatus* Fabricius, 1792, *Elaphrus uliginosus* Fabricius, 1792, *Elaphrus ullrichi* Redtenbacher, 1842, *Dyschirius digitatus* (Dejean, 1825), *Bembidion stephensi* (Croth, 1866), *Harpalus cupreus fastuosus* Faldermann, 1835, *Harpalus xanthopus* Gemminger & Harold, 1868, *Poecilus punctulatus* (Schaller, 1783), *Pterostichus foveolatus* (Duftschmid, 1812), *Paranchus albipes* (Fabricius, 1796), *Chlaenius tibialis* Dejean, 1826.

The majority of the beetle material collected along Drava is preserved in Janus Pannonius Museum in Pécs, but some specimens originating from here are stored also in the Hungarian Natural History Museum and in the Mátra Museum (HEGYESSY & SZÉL 2002).

## 1.2. Research history in Croatian areas along Drava

Available information on research in Croatian Drava sections is much scarcer. We have not come across any studies dealing with carabid beetle faunistic investigations focusing strictly on the Drava region. According to what is published in literature, data regarding the Drava region can be found in papers dealing with the area of East-Slavonia and Baranja, on research having been performed in farmlands, with agricultural and pest control objectives (ŠTRABAC 1981, 1985; ŠTRBAC et al. 1979; SEKULIĆ & HORVATOVICH 1973). Such observations in the Drava region and Baranja were made in the areas of Beli Manastir, Osijek, Valpovo and Podravska Slatina. The published data report on the occurrence of a total of 57 carabid species, among which 8 species – *Calosoma auropunctatum* (Herbst, 1784), *Acupalpus meridianus* (Linnaeus, 1761), *Dicheirotrichus placidus* (Gyllenhal, 1827), *Poecilus sericeus* Fischer von Waldheim, 1823, *Laemostenus terricola terricola* (Herbst, 1784), *Calathus rotundicollis* Dejean, 1828, *Zabrus tenebrioides* (Goeze, 1777), *Amara apricaria* (Paykull, 1790) – have no records from Hungarian areas of Drava.

## 2. Study area and methods

During our research we used mainly pitfall trapping, an efficient method widely used in the study of soil surface fauna. A number of species, however, cannot be collected successfully with pitfall traps, so in these cases we used various other methods so as to increase the probability of revealing these. In order to reduce the deficiencies of pitfall trapping, other methods were applied, too, specifically in the case of waterside and for species living on plants (lamp, sweep netting, umbrella, screening, various specimen collecting methods) (Tallósi & Vujčić-Karlo 2007).

In addition to our own collecting activities between 25 February 2007 and 31 August 2007, focusing mostly on Croatian Drava sections, we have also been able to process and identify the material collected by Sándor Farkas and Stjepan Krčmar using pitfall-traps between 29-30 July 2003 and 14-15 August in 25 sampling locations selected in the area of Baranja (Table 1.) (Farkas & Krčmar 2004). We had only one sampling location in the Hungarian – relatively well-researched – areas (Vízvár), where trapping was done predominantly with light.

We have aimed at trying to sample all the typical biocoenoses in the research area, and provide the fullest possible picture, by systematic surveys, about their carabid assemblages. The transforming effect of human presence can be pointed out, to smaller or greater degree, in all of the near-natural habitat types in the region. In the case of watercourses, such effects are caused by water management and regulation interventions in the past, and also by cross-dams and reservoirs having been built on Drava river, while in the case of forests, this means the artificial transformation of forest structures – although this is less intense in Croatian areas. Due to the unnatural water level fluctuations that have been provoked by hydroelectric power stations on the upper reaches of Drava, the highly valuable and characteristic carabid beetle habitats on gravel shoals and rivershores have been subject to serious impacts. The effect of frequent floodings on the ground beetle fauna of the river shoreline is still unknown, although it is assumed that several valuable species must have disappeared. Accordingly, we have paid particular attention to the study of such beetle communities. In Croatia, there are still extensive wet hayfields in the flood zone of rivers, which are managed and have grass associations interchanging with mosaics of more or less silted, marshy oxbows and softwood gallery forests. Samplings in such areas covered all of the existing habitat types, with the greatest emphasis laid on grassland-types of habitats.

Weather factors have strong influence on the insect populations of soil surface, including carabids. Our surveys were performed from February to September 2007, when extremely dry weather prevailed from the onset of the vegetative season throughout the whole year. The drought was accompanied in the summer by very high temperatures. As a result, soils dried out considerably and permanently even in wet meadows and forests within the floodland. The material collected back in 2003 in Baranja that we used for comparison with the samples collected by ourselves in 2007, also originated form a year which was characterised with extremely arid weather.

Part of the collected beetle material has been prepared, and the rest are stored in a dry state, in paper cylinders.

Table 1. Sampling sites and collecting methods in characteristic habitats along river Drava and Croatian Baranja

| Collecting site | Habitat type | Method | Data source |
| --- | --- | --- | --- |
| Bansko brdo: Karanac | mixed forest | pitfall trap | collected by the author |
| Bansko brdo: Podolje | along creek | specimen collecting, sweep netting, umbrella | collected by the author |
| Baranjsko Petro Selo | oak forest | pitfall trap | Farkas, S.& Krčmar, S. |
| Batina | locust-tree stand | pitfall trap | Farkas, S.& Krčmar, S. |
| Beli Manastir: Haljevska šuma | oak-hornbeam forest | pitfall trap | Farkas, S.& Krčmar, S. |
| Beli Manastir: Haljevska šuma | oak-hornbeam forest, wet forest line clearance (grass) | pitfall trap, specimen collecting, umbrella, screening | collected by the author |
| Bilje: Drava floodland | poplar forest | pitfall trap | Farkas, S.& Krčmar, S. |
| Bolman | willow stand-poplar forest | pitfall trap | Farkas, S.& Krčmar, S. |
| Darda | willow stand along canal | pitfall trap | Farkas, S.& Krčmar, S. |
| Detkovac | Rivershore | specimen collecting | collected by the author |
| Zmajevac: Danube floodplain area, „Gyűrűsháti kapu” | poplar forest | pitfall trap | Farkas, S.& Krčmar, S. |
| Zmajevac: Danube floodplain area, „Monyorós 1” | Sedge | pitfall trap | Farkas, S.& Krčmar, S. |
| Zmajevac: Danube floodplain area, „Monyorós 2” | poplar forest | pitfall trap | Farkas, S.& Krčmar, S. |
| Ferdeinandovac: Štorgina greda | oak-hornbeam forest | pitfall trap | collected by the author |
| Gotalovo: flood-protected Drava floodplain | hayfield | pitfall trap, specimen collecting, sweep netting, umbrella, screening | collected by the author |
| Grabovac | clearing in oakwood with sedge | pitfall trap | Farkas, S.& Krčmar, S. |
| Hlebine: Stolac | oak forest | pitfall trap, umbrella, screening | collected by the author |
| Jagodnjak | willow stand along canal | pitfall trap | Farkas, S.& Krčmar, S. |
| Kneževi Vinogradi | locust-tree stand | pitfall trap | Farkas, S.& Krčmar, S. |
| Kneževo 1 | locust-tree stand | pitfall trap | Farkas, S.& Krčmar, S. |
| Kneževo 2 | oak forest | pitfall trap | Farkas, S.& Krčmar, S. |
| Kopačevo | hybrid poplar plantation | pitfall trap | Farkas, S.& Krčmar, S. |
| Kopački rit: „Szakadás 2” | waterside | pitfall trap | Farkas, S.& Krčmar, S. |
| Kopački rit: „Szakadás 1” | willow stand | pitfall trap | Farkas, S.& Krčmar, S. |
| Kozarac | oak-hornbeam forest | pitfall trap | Farkas, S.& Krčmar, S. |
| Križnica | rivershore | specimen collecting | Farkas, S.& Krčmar, S. |
| Legrad: lido | rivershore, willow bush, old gravel pit | pitfall trap, specimen collecting, umbrella, screening | collected by the author |
| Mekiš | dry hayfield | pitfall trap, sweep netting | collected by the author |
| Novačka: Jagerov kut | oak-hornbeam forest, forest line clearance (grass) | pitfall trap, specimen collecting, umbrella, screening | collected by the author |
| Novi Gradac | alder bog | specimen collecting | collected by the author |
| Novo Virje: Širine, Drava floodland | hayfield, gravelly riverbank, oxbow | pitfall trap, specimen collecting, sweep netting, umbrella, screening | collected by the author |
| Repaš: Drava floodland | hayfield, bank of oxbow | pitfall trap, specimen collecting, sweep netting, umbrella, screening | collected by the author |
| Repaš: flood-protected Drava floodplain | gravel pit | specimen collecting | collected by the author |
| Suza | poplar forest | pitfall trap | Farkas, S.& Krčmar, S. |
| Tikveš 1 | oak forest | pitfall trap | Farkas, S.& Krčmar, S. |
| Tikveš 2 | oak forest | pitfall trap | Farkas, S.& Krčmar, S. |
| Tikveš 3 | scrub | pitfall trap | Farkas, S.& Krčmar, S. |
| Topolje | willow stand, reedbed | pitfall trap | Farkas, S.& Krčmar, S. |
| Uglješ | bank of canal | pitfall trap | Farkas, S.& Krčmar, S. |
| Viljevo | softwood gallery forest | specimen collecting | collected by the author |
| Vízvár | softwood gallery forest, high bank (turf) | lamp, light trapping, specimen collecting | collected by the author |

# 3. Results

## 3.1. Faunistic results

### CICINDELINAE

*Cylindera germanica* (Linnaeus, 1758) - **Gotalovo**: flood-protected Drava floodplain, hayfield, 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Mekiš**: dry hayfield, 09.07.-31.08.2007., pitfall trap, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 12.05.2007., specimen, (TB); 12.05.-09.07.2007., pitfall trap, (TB).

BRACHININAE

*Brachinus explodens* Duftschmid, 1812 - **Ferdeinandovac**: Štorgina greda, oak-hornbeam forest, 25.02.2007., specimen, (TB); **Gotalovo**: flood-protected Drava floodplain, hayfield, 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Mekiš**: dry hayfield, 12.05.-09.07.2007., pitfall trap, (TB); **Repaš**: Drava floodland, hayfield, 11.05.2007., specimen, (TB).

OMOPHRONINAE

*Omophron limbatum* (Fabricius, 1776) - **Novo Virje**: Širine, Drava floodland, hayfield, 09.07.2007., specimen, (TB).

CARABINAE

*Calosoma inquisitor* (Linnaeus, 1758) - **Hlebine**: Stolac, oak-hornbeam forest, 14.04.-11.05.2007., pitfall trap, (TB).

*Carabus cancellatus maximus* Haury, 1880 (Fig. 1.) - **Bansko brdo**: Karanac, mixed forest, 16.04.-13.05.2007., pitfall trap, (TB); **Bansko brdo**: Podolje, along creek, 16.04.2007., specimen, (TB); **Baranjsko Petro Selo**: oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Beli Manastir**: Haljevo, oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Beli Manastir**: Haljevska šuma, oak-hornbeam forest, 16.04.-13.05.2007., pitfall trap, (TB); 13.05.-10.07.2007., pitfall trap, (TB); **Bilje**: Drava floodplain area, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Bolman**: poplar forest - willow stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Darda**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Gyűrűsháti Kapu, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Monyorós 1, sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Monyorós 2, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Ferdeinandovac**: Štorgina greda, oak-hornbeam forest, 25.02.2007., specimen, (TB); 15.04.-12.05.2007., pitfall trap, (TB); 12.05.-09.07.2007., pitfall trap, (TB); **Gotalovo**: flood-protected Drava floodplain, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Grabovac**: clearing in oakwood with sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Hlebine**: Stolac, oak-hornbeam forest, 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Kneževi Vinogradi**: locust-tree stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kneževo 2**: oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kopački rit**: Szakadás 1, willow stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kozarac**: oak-hornbeam forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Mekiš**: dry hayfield, 15.04.-12.05.2007., pitfall trap, (TB); 12.05.-09.07.2007., pitfall trap, (TB); **Novačka**: Jagerov kut, oak-hornbeam forest, 11.05.-08.07.2007., pitfall trap, (TB); forest line clearance, 08.07.2007., specimen, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 15.04.-12.05.2007., pitfall trap, (TB); 12.05.-09.07.2007., pitfall trap, (TB); 09.07.-31.08.2007., pitfall trap, (TB);

**Repaš**: Drava floodland, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Suza**: poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Tikveš 1:** oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Tikveš 2**: oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Tikveš 3**: scrub, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Topolje**: willow stand, reedbed, 29.07.-15.08.2003., pitfall trap, (FS&KS).

Fig. 1. *Carabus cancellatus maximus* - Its several subspecies inhabit a variety of habitat types of the Carpathian Basin. A protected species in Hungary, it is a Carabus typically occuring in moderately moist forests (Photo by Béla Tallósi)

*Carabus clathratus auraniensis* G. Müller, 1902 - **Zmajevac**: Danube floodplain area, Monyorós 1, sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS).

*Carabus convexus convexus* Fabricius, 1775 - **Zmajevac**: Danube floodplain area, Gyűrűsháti Kapu, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Hlebine**: Stolac, oak-hornbeam forest, 11.05.-08.07.2007., pitfall trap, (TB); **Novačka**: Jagerov kut, oak-hornbeam forest, 14.04.-11.05.2007., pitfall trap, (TB).

*Carabus coriaceus praeillyricus* Szél, 1993 - **Bansko brdo**: Karanac, mixed forest, 16.04.-13.05.2007., pitfall trap, (TB); **Baranjsko Petro Selo**: oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Beli Manastir**: Haljevska šuma, oak-hornbeam forest, 13.05.-10.07.2007., pitfall trap, (TB); **Darda**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Ferdeinandovac**: Štorgina greda, oak-hornbeam forest, 12.05.-09.07.2007., pitfall trap, (TB); **Gotalovo**: flood-protected Drava floodplain, hayfield, 11.05.-08.07.2007., pitfall trap, (TB); **Grabovac**: clearing in oakwood with sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Hlebine**: Stolac, oak-hornbeam forest, 11.05.-08.07.2007., pitfall trap, (TB); **Kneževo 1**: locust-tree stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kneževo** 2: oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kozarac**: oak-hornbeam forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Novačka**: Jagerov kut, oak-hornbeam forest, 11.05.-08.07.2007., pitfall trap, (TB); **Repaš**: Drava floodland, hayfield, 31.08.2007., specimen, (TB); **Tikveš 3**: scrub, 29.07.-15.08.2003., pitfall trap, (FS&KS).

*Carabus germari exasperatus* Duftschmid, 1812 (Fig. 2.) - **Zmajevac**: Danube floodplain area, Gyűrűsháti Kapu, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Ferdeinandovac**: Štorgina greda, oak-hornbeam forest, 25.02.2007., specimen, (TB); 12.05.-09.07.2007., pitfall trap, (TB); 09.07.-31.08.2007., pitfall trap, (TB); **Gotalovo**: flood-protected Drava floodplain, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Hlebine**: Stolac, oak-hornbeam forest, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Kneževo** 1: locust-tree stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Novačka**: Jagerov kut, oak-hornbeam forest, 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Repaš**: Drava floodland, hayfield, 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Tikveš 1**: oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Tikveš 2**: oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Tikveš 3**: scrub, 29.07.-15.08.2003., pitfall trap, (FS&KS).

*Carabus granulatus granulatus* Linnaeus, 1758 (Fig. 3.) - **Baranjsko Petro Selo**, oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Bolman**: poplar forest-willow stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Darda**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Gyűrűsháti Kapu, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Monyorós 1, sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Monyorós 2, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Ferdeinandovac**: Štorgina greda, oak-hornbeam forest, 09.07.-31.08.2007., pitfall trap, (TB); **Gotalovo**: flood-protected Drava floodplain, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); **Grabovac**: clearing in oakwood with sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Jagodnjak**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kopački rit**: Szakadás 1, willow stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Novačka**: Jagerov kut, oak-hornbeam forest, 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Novo Virje:** Širine, Drava floodland, hayfield, 15.04.2007., specimen, (TB); 15.04.-12.05.2007., pitfall trap, (TB); 12.05.-09.07.2007., pitfall trap, (TB); 09.07.-31.08.2007., pitfall trap, (TB); **Repaš**: Drava floodland, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Topolje**: willow stand, reedbed, 29.07.-15.08.2003., pitfall trap, (FS&KS).

Fig. 2. *Carabus germari exasperatus* - It is a protected, commonly distributed and usually quite frequent species of South-Transdanubia's forest habitats (Photo by Béla Tallósi)

Fig. 3. *Carabus granulatus granulatus* - A frequent Carabus species of meadows, marshy meadows and softwood gallery forests, sometimes found quite abundantly. It is protected in Hungary (Photo by Béla Tallósi)

*Carabus nemoralis nemoralis* O. F. Müller, 1764 (Fig. 4.) - **Bansko brdo**: Karanac, mixed forest, 16.04.-13.05.2007., pitfall trap, (TB); **Bansko brdo**: Podolje, along creek, 16.04.2007., specimen, (TB); **Beli Manastir**: Haljevska šuma, oak-hornbeam forest, 16.04.-13.05.2007., pitfall trap, (TB); **Beli Manastir**: Haljevska šuma, oak-hornbeam forest, 13.05.-10.07.2007., pitfall trap, (TB); **Kneževo 2**: oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Novačka**: Jagerov kut, oak-hornbeam forest, 14.04.-11.05.2007., pitfall trap, (TB).

Fig. 4. *Carabus nemoralis nemoralis* - Belonging to the rarest members of the Carabus genus, this species is a typical, protected species of lower mountains and sometimes hilly regions. It is protected in Hungary (Photo by Béla Tallósi)

*Carabus ullrichi baranyensis* Sokolár, 1908 - **Topolje**: willow stand, reedbed, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Uglješ**: bank of canal, 29.07.-15.08.2003., pitfall trap, (FS&KS).

*Cychrus caraboides* (Linnaeus, 1758) - **Legrad**: lido, gravelly riverbank, 11.05.-08.07.2007., pitfall trap, (TB); **Repaš**: Drava floodland, hayfield, 11.05.2007., specimen, (TB).

*Leistus piceus piceus* Frölich, 1799 (Fig. 5.) - **Beli Manastir**: Haljevo, oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Beli Manastir**: Haljevska šuma, oak-hornbeam forest, 16.04.-13.05.2007., pitfall trap, (TB); 13.05.-10.07.2007., pitfall trap, (TB); **Novačka**: Jagerov kut, oak-hornbeam forest, 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 12.05.-09.07.2007., pitfall trap, (TB); **Repaš**: Drava floodland, hayfield, 11.05.-08.07.2007., pitfall trap, (TB).

Fig. 5. *Leistus piceus piceus* - This is a relatively rare carabid of montane forests, mostly beechwoods, deeper valleys of creeks and streams. Its occurrences in Hungary are rather restricted to mountain areas (Photo by Béla Tallósi)

Fig. 6. *Nebria brevicollis* - A usual and commonly appearing member of the zoocoenoses of mesophilous forests. Its occurrence in a lowland region indicates the good natural status of the habitat (Photo by Béla Tallósi)

*Nebria brevicollis* (Fabricius, 1792) (Fig. 6.) - **Beli Manastir**: Haljevska šuma, oak-hornbeam forest, 13.05.2007., specimen, (TB); 13.05.-10.07.2007., pitfall trap, (TB); **Ferdeinandovac**: Štorgina greda, oak-hornbeam forest, 12.05.-09.07.2007., pitfall trap, (TB); **Gotalovo**: flood-protected Drava floodplain, hayfield, 11.05.-08.07.2007., pitfall trap, (TB); **Novačka**: Jagerov kut, forest line clearance, 14.04.2007., specimen, (TB); 11.05.2007., specimen, (TB); **Novačka**: Jagerov kut, oak-hornbeam forest, 11.05.-08.07.2007., pitfall trap, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 15.04.-12.05.2007., pitfall trap, (TB); **Repaš**: Drava floodland, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB).

*Notiophilus palustris* (Duftschmid, 1812) - **Tikveš 2**: oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS).

*Notiophilus rufipes* Curtis, 1829 - **Bansko brdo**: Podolje, along creek, 16.04.2007., specimen, (TB); **Gotalovo**: flood-protected Drava floodplain, hayfield, 14.04.-11.05.2007., pitfall trap, (TB).

*Elaphus aureus* P. Müller, 1821 – **Legrad**: lido, gravelly riverbank, 14.04.-11.05.2007., pitfall trap, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 12.05.2007., specimen, (TB); **Repaš**: Drava floodland, waterside, 11.05.2007., specimen, (TB).

*Elaphrus cupreus* Duftschmid, 1812 - **Novi Gradac**: alder bog, 15.04.2007., specimen, (TB).

*Elaphrus riparius* (Linnaeus, 1758) - **Novo Virje**: Širine, Drava floodland, waterside, 15.04.2007., specimen, (TB).

*Loricera pilicornis* (Fabricius, 1775) - **Novo Virje**: Širine; Drava floodland; waterside; 15.04.2007., specimen; (TB); 12.05.2007., specimen; (TB); **Repaš**: Drava floodland; hayfield; 11.05.-08.07.2007., pitfall trap; (TB).

*Clivina fossor* (Linnaeus, 1758) - **Zmajevac**: Danube floodplain area, Monyorós 1, sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Monyorós 2, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kopački rit**: Szakadás 1, willow stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Mekiš**: dry hayfield, 12.05.-09.07.2007., pitfall trap, (TB); **Repaš**: Drava floodland, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.2007., specimen, screening, (TB); 08.07.2007., specimen, (TB); **Vízvár**: willow-poplar gallery forest, 13.05.2007., lamp, (TB); 08.-09.07.2007., lamp, (TB).

*Dyschirius aeneus* (Dejean, 1825) - **Kopački rit**: Szakadás 2, waterside, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Repaš**: Drava floodland, hayfield, 08.07.2007., specimen, (TB); **Vízvár**: willow-poplar gallery forest, 08.-09.07.2007., lamp, (TB).

*Dyschirius chalybaeus gibbifrons* Apfelbeck, 1899 - **Novo Virje**: Širine, Drava floodland, hayfield, 12.05.2007., specimen, (TB).

*Dyschirius globosus* (Herbst, 1784) - **Baranjsko Petro Selo**: oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Bolman**: poplar forest-willow stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Darda**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Gyűrűsháti Kapu, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Monyorós 1, sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Grabovac**: clearing in oakwood with sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kopački rit**: Szakadás 2, waterside, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Legrad**: lido, gravelly riverbank, 11.05.2007., specimen, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 12.05.2007., specimen, sweep-netting (TB).

*Dyschirius politus* (Dejean, 1825) - **Novo Virje**: Širine, Drava floodland, waterside, 12.05.2007., screening, (TB); **Vízvár**: willow-poplar gallery forest, 08.-09.07.2007., lamp, (TB).

*Perileptus areolatus* (Creutzer, 1799) - **Legrad**: lido, gravelly riverbank, 11.05.2007., specimen, (TB); 2007.VIII.31, specimen, (TB); **Repaš**: flood-protected Drava floodplain, gravel pit, 14.04.2007., specimen, (TB).

*Trechus pilisensis* Csiki, 1918 - **Hlebine**: Stolac, oak-hornbeam forest, 14.04.-11.05.2007., pitfall trap, (TB).

*Trechus quadristriatus* (Schrank, 1781) - **Baranjsko Petro Selo**: oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Beli Manastir**: Haljevo, oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Beli Manastir**: Haljevska šuma, oak-hornbeam forest, 13.05.-10.07.2007., pitfall trap, (TB); **Bolman**: poplar forest-willow stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Darda**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Gyűrűsháti Kapu, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Ferdeinandovac**: Štorgina greda, oak-hornbeam forest, 09.07.-31.08.2007., pitfall trap, (TB); **Hlebine**: Stolac, oak-hornbeam forest, 11.05.-08.07.2007., pitfall trap, (TB); **Jagodnjak**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kneževo** 2: oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kozarac**: oak-hornbeam forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Novačka**: Jagerov kut, forest line clearance, 11.05.2007., screening, (TB); 08.07.2007., specimen, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 15.04.-12.05.2007., pitfall trap, (TB); **Repaš**: Drava floodland, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); 31.08.2007., specimen, (TB); **Suza**: poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Tikveš 2**: oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Uglješ**: bank of canal, 29.07.-15.08.2003., pitfall trap, (FS&KS).

*Epaphius secalis* (Paykull, 1790) - **Legrad**: lido, gravelly riverbank, 11.05.2007., specimen, (TB); 11.05.-08.07.2007., pitfall trap, (TB); 2007.VIII.31, specimen, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 12.05.-09.07.2007., pitfall trap, (TB); 09.07.-31.08.2007., pitfall trap, (TB); **Repaš**: Drava floodland, hayfield, 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB).

*Blemus discus* (Fabricius, 1792) (Fig. 7.) - **Repaš**: Drava floodland, gravelly riverbank, 11.05.2007., specimen, (TB); **Vízvár**: willow-poplar gallery forest, 08.-09.07.2007., lamp, (TB).

Fig. 7. *Blemus discus* - This species is found in several places in various moist habitats – mostly on waterside, under plant debris –, but is frequent only at particular localities (Photo by Béla Tallósi)

*Trechoblemus micros* (Herbst, 1784) - **Novo Virje**: Širine, Drava floodland, waterside, 15.04.2007., specimen, (TB); 15.04.-12.05.2007., pitfall trap, (TB); 12.05.2007., specimen, (TB).

*Paratachys bistriatus* (Duftschmid, 1812) - **Legrad**: lido, gravelly riverbank, 2007.VIII.31, specimen, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 12.05.2007., specimen, screening, (TB); **Repaš**: Drava floodland, waterside, 08.07.2007., specimen, (TB); **Vízvár**: willow-poplar gallery forest, 08.-09.07.2007., lamp, (TB).

*Paratachys micros* (Fischer von Waldheim, 1828) - **Kopački rit**: Szakadás 2, waterside, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Legrad**: lido, gravelly riverbank, 11.05.2007., specimen, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 12.05.2007., specimen, (TB); **Vízvár**: willow-poplar gallery forest, 13.05.2007., lamp, (TB).

*Paratachys fulvicollis* (Dejan, 1831) - **Novo Virje**: Širine, Drava floodland, gravelly riverbank, 12.05.2007., specimen, (TB); **Vízvár**: willow-poplar gallery forest, 08.-09.07.2007., lamp, (TB).

*Elaphropus quadrisignatus* (Duftschmid, 1812) - **Legrad**: lido, gravelly riverbank, 14.04.2007., specimen, (TB).

*Tachyta nana* (Gyllenhal, 1810) - **Novačka**: Jagerov kut, forest line clearance, 08.07.2007., specimen, (TB).

*Bembidion articulatum* (Panzer, 1796) - **Beli Manastir**: Haljevska šuma, oak-hornbeam forest, 13.05.2007., specimen, (TB); **Darda**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Detkovac:** gravelly-sandy rivershore, 25.02.2007., specimen, (TB); **Križnica:** riverbank, 25.02.2007., specimen, (TB); **Legrad**: lido, gravelly riverbank, 11.05.2007., specimen, (TB); **Novo Virje**: Širine, Drava floodland, waterside, 15.04.2007., specimen, (TB); **Repaš**: Drava floodland, waterside, 14.04.2007., specimen, (TB); 11.05.2007., specimen, (TB); 31.08.2007., specimen, (TB); **Repaš**: flood-protected Drava floodplain, gravel pit, 14.04.2007., specimen, (TB); **Uglješ**: bank of canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Vízvár**: willow-poplar gallery forest, 13.05.2007., lamp, (TB); 08.-09.07.2007., lamp, (TB).

*Bembidion azurescens* Dalla Torre, 1877 - **Legrad**: lido, gravelly riverbank, 11.05.2007., specimen, (TB)

*Bembidion biguttatum* (Fabricius, 1779)- **Novo Virje**: Širine, Drava floodland, hayfield, 12.05.2007., specimen, (TB); **Vízvár**: willow-poplar gallery forest, 08.-09.07.2007., lamp, (TB).

*Bembidion dalmatinum* Dejean, 1831 - **Bansko brdo**: Podolje, along creek, 16.04.2007., specimen, (TB); **Beli Manastir**: Haljevska šuma, oak-hornbeam forest, 13.05.2007., specimen, (TB).

*Bembidion decorum* (Panzer, 1799) – **Detkovac**: gravelly-sandy rivershore; 25.02.2007.; specimen; (TB); **Legrad**: lido; gravelly riverbank; 14.04.2007.; specimen; (TB); 11.05.2007.; specimen; (TB); 2007.VIII.31; specimen; (TB); **Novo Virje**: Širine; Drava floodland; gravelly riverdhore; 12.05.2007.; specimen; (TB); **Repaš**: Drava floodland; gravelly riverbank of oxbow; 14.04.2007.; specimen; (TB); 11.05.2007.; specimen; (TB).

*Bembidion dentellum* (Thunberg, 1787) - **Zmajevac**: Danube floodplain area, Monyorós 2, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Grabovac**: clearing in oakwood with sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kopački rit**: Szakadás 1, willow stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Legrad**: lido, gravelly riverbank, 14.04.2007., specimen, (TB); **Novo Virje**: Širine, Drava floodland, waterside, 15.04.2007., specimen, (TB); 12.05.2007., specimen, (TB); **Repaš**: Drava floodland, waterside, 14.04.2007., specimen, (TB); 31.08.2007., specimen, (TB); **Viljevo**: willow-poplar gallery forest, 25.02.2007., specimen, (TB).

*Bembidion doris* (Panzer, 1797) – **Novo Virje**: Širine, Drava floodland, gravelly riverbank, 12.05.2007., specimen, (TB); **Repaš**: Drava floodland, waterside, 31.08.2007., specimen, (TB).

*Bembidion fasciolatum* (Duftschmid, 1812) – **Legrad**: lido, gravelly riverbank, 14.04.2007., specimen, (TB).

*Bembidion fumigatum* (Duftschmid, 1812) - **Bolman**: poplar forest - willow stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Darda**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kopački rit**: Szakadás 2, waterside, 29.07.-15.08.2003., pitfall trap, (FS&KS).

*Bembidion gilvipes* Sturm, 1825 - **Zmajevac**: Danube floodplain area, Monyorós 1, sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Monyorós 2, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS).

*Bembidion inoptatum* Schaum, 1857 - **Zmajevac**: Danube floodplain area, Monyorós 2, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Jagodnjak**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Križnica**: rivershore, 25.02.2007., specimen, (TB); **Novi Gradac**: alder bog, 15.04.2007., specimen, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 15.04.-12.05.2007., pitfall trap, (TB); 12.05.2007., specimen, (TB).

*Bembidion lampros* (Herbst, 1784) - **Ferdeinandovac**: Štorgina greda, oak-hornbeam forest, 25.02.2007., specimen, (TB); **Kopački rit**: Szakadás 2, waterside, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Novačka**: Jagerov kut, forest line clearance, 14.04.2007., specimen, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 15.04.2007., specimen, (TB); **Repaš**: Drava floodland, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.2007., specimen, (TB); 11.05.-08.07.2007., pitfall trap, (TB); **Repaš**: flood-protected Drava floodplain, gravel pit, 14.04.2007., specimen, (TB).

*Bembidion modestum* (Fabricius, 1801) - **Legrad**: lido, gravelly riverbank, 14.04.2007., specimen, (TB); 11.05.2007., specimen, (TB); 2007.VIII.31, specimen, (TB).

*Bembidion octomaculatum* (Goeze, 1777) - **Beli Manastir**: Haljevska šuma, oak-hornbeam forest, 13.05.2007., specimen, (TB); **Detkovac**: gravelly-sandy rivershore, 25.02.2007., specimen, (TB); **Legrad**: lido, gravelly riverbank, 11.05.2007., specimen, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 12.05.2007., specimen, (TB); **Vízvár**: willow-poplar gallery forest, 13.05.2007., lamp, (TB); 08.-09.07.2007., lamp, (TB).

*Bembidion prasinum* (Duftschmid, 1812) - **Legrad**: lido, gravelly riverbank, 14.04.2007., specimen, (TB).

*Bembidion properans* (Stephens, 1828) - **Bansko brdo**: Podolje, along creek, 16.04.2007., specimen, (TB); **Beli Manastir**: Haljevska šuma, oak-hornbeam forest, 13.05.2007., specimen, (TB); **Repaš**: Drava floodland, hayfield, 11.05.2007., specimen, (TB).

*Bembidion punctulatum* Drapiez, 1820 - **Legrad**: lido, gravelly riverbank, 14.04.2007., specimen, (TB); 11.05.2007., specimen, (TB); 2007.VIII.31, specimen, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 15.04.2007., specimen, (TB); **Repaš**: Drava floodland, hayfield, 11.05.2007., specimen, (TB); **Viljevo**: willow-poplar gallery forest, 25.02.2007., specimen, (TB).

*Bembidion quadrimaculatum* (Linnaeus, 1761) - **Darda**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Detkovac**: gravelly-sandy rivershore, 25.02.2007., specimen, (TB); **Jagodnjak**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kopački rit**: Szakadás 2, waterside, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Križnica**: rivershore, 25.02.2007., specimen, (TB); **Legrad**: lido, gravelly riverbank, 14.04.2007., specimen, (TB); 11.05.2007., specimen, (TB); **Repaš**: Drava floodland, hayfield, 11.05.2007., specimen, (TB); **Uglješ:** bank of canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Vízvár**: willow-poplar gallery forest, 13.05.2007., lamp, (TB); 08.-09.07.2007., lamp, (TB).

*Bembidion quadripustulatum* Audinet-Serville, 1821 - **Zmajevac**: Danube floodplain area, Monyorós 1, sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kopački rit**: Szakadás 2, waterside, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Vízvár**: willow-poplar gallery forest, 08.-09.07.2007., lamp, (TB).

*Bembidion semipunctatum* (Donovan, 1806) - **Detkovac**: gravelly-sandy rivershore, 25.02.2007., specimen, (TB); Križnica: rivershore, 25.02.2007., specimen, (TB); **Novo Virje**: Širine, Drava floodland, waterside, 15.04.2007., specimen, (TB); 12.05.2007., specimen, (TB); **Viljevo**: willow-poplar gallery forest, 25.02.2007., specimen, (TB).

*Bembidion starki* Schaum, 1860 - **Vízvár**: willow-poplar gallery forest, 08.-09.07.2007., lamp, (TB).

*Bembidion subcostatum javurkovae* Fassati, 1944 - **Novo Virje**: Širine, Drava floodland, waterside, 09.07.2007., specimen, (TB); **Bansko brdo**: Podolje, along creek, 16.04.2007., specimen, (TB).

*Bembidion tenellum* Erichson, 1837 - **Kopački rit**: Szakadás 2, waterside, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Vízvár**: willow-poplar gallery forest, 13.05.2007., lamp, (TB).

*Bembidion testaceum* (Duftschmid, 1812) - **Legrad**: lido, gravelly riverbank, 2007.VIII.31, specimen, (TB).

*Bembidion tetracolum* Say, 1823 - **Legrad**: lido, gravelly riverbank, 14.04.2007., specimen, (TB); 14.04.-11.05.2007., pitfall trap, (TB); 11.05.2007., specimen, (TB); 11.05.-08.07.2007., pitfall trap, (TB); 2007.VIII.31, specimen, (TB); **Novo Virje**: Širine, Drava floodland, waterside, 12.05.2007., specimen, (TB); **Repaš**: Drava floodland, waterside, 11.05.2007., specimen, (TB).

*Bembidion varium* (Olivier, 1795) - **Legrad**: lido, gravelly riverbank, 2007.VIII.31, specimen, (TB); **Repaš**: Drava floodland, waterside, 08.07.2007., specimen, (TB); **Vízvár**: willow-poplar gallery forest, 13.05.2007., lamp, (TB); 08.-09.07.2007., lamp, (TB).

*Asaphidion flavipes* (Linnaeus, 1761) - **Bolman**: poplar forest-willow stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Detkovac**: gravelly-sandy rivershore, 25.02.2007., specimen, (TB); **Zmajevac**: Danube floodplain area, Monyorós 2, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Jagodnjak**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kozarac**: oak-hornbeam forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Legrad**: lido, gravelly riverbank, 14.04.2007., specimen, (TB); 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Novačka**: Jagerov kut, forest line clearance, 14.04.2007., specimen, (TB); 11.05.2007., specimen, (TB); **Novo Virje**: Širine, Drava floodland, hay-field, 15.04.-12.05.2007., pitfall trap, (TB); 12.05.-09.07.2007., pitfall trap, (TB); **Repaš**: Drava floodland, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.2007., specimen, screening, (TB); 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Suza**: poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Topolje**: willow stand, reedbed, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Uglješ**: bank of canal, 29.07.-15.08.2003., pitfall trap, (FS&KS).

*Patrobus atrorufus* (Stroem, 1768) - **Legrad**: lido, gravelly riverbank, 14.04.-11.05.2007., pitfall trap, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 15.04.-12.05.2007., pitfall trap, (TB); 12.05.2007., specimen, (TB); 12.05.-09.07.2007., pitfall trap, (TB); **Repaš**: Drava floodland, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.2007., specimen, (TB); 11.05.-08.07.2007., pitfall trap, (TB); 08.07.2007., specimen, (TB); 31.08.2007., specimen, (TB).

*Stomis pumicatus* (Panzer, 1796) - **Baranjsko Petro Selo**: oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Bilje**: Drava floodland, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Darda**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Ferdeinandovac**: Štorgina greda, oak-hornbeam forest, 15.04.-12.05.2007., pitfall trap, (TB); **Hlebine**: Stolac, oak-hornbeam forest, 14.04.-11.05.2007., pitfall trap, (TB); **Jagodnjak**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Mekiš:** dry hayfield, 12.05.-09.07.2007., pitfall trap, (TB); **Novačka**: Jagerov kut, oak-hornbeam forest, 11.05.-08.07.2007., pitfall trap, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 15.04.-12.05.2007., pitfall trap, (TB); 09.07.-31.08.2007., pitfall trap, (TB); **Repaš**: Drava floodland, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Tikveš 2**: oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS).

*Poecilus cupreus* (Linnaeus, 1758) - **Zmajevac**: Danube floodplain area, Gyűrűsháti Kapu, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); Zmajevac: Danube floodp-lain area, Monyorós 1, sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Monyorós 2, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Grabovac**: clearing in oakwood with sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Hlebine**: Stolac, oak-hornbeam forest, 08.07.-31.08.2007., pitfall trap, (TB);

**Kneževo** 2: oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kopački rit**: Szakadás 1, willow stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Novo Virje**: Širine, Drava floodland, hayfield, 09.07.-31.08.2007., pitfall trap, (TB); **Topolje**: willow stand, reedbed, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Uglješ**: bank of canal, 29.07.-15.08.2003., pitfall trap, (FS&KS).

*Poecilus versicolor* (Sturm, 1824) - **Zmajevac**: Danube floodplain area, Gyűrűsháti Kapu, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Gotalovo**: flood-protected Drava floodplain, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); **Gotalovo**: flood-protected Drava floodplain, hayfield, 11.05.-08.07.2007., pitfall trap, (TB); **Gotalovo**: flood-protected Drava floodplain, hayfield, 08.07.-31.08.2007., pitfall trap, (TB); **Kopačevo**: hybrid poplar plantation, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kopački rit**: Szakadás 1, willow stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Novačka**: Jagerov kut, forest line clearance, 14.04.2007., specimen, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 15.04.-12.05.2007., pitfall trap, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 12.05.-09.07.2007., pitfall trap, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 09.07.-31.08.2007., pitfall trap, (TB); **Uglješ:** bank of canal, 29.07.-15.08.2003., pitfall trap, (FS&KS).

*Pterostichus anthracinus* (Illiger, 1798) - **Bolman**: poplar forest-willow stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Gyűrűsháti Kapu, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Monyorós 2, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Grabovac**: clearing in oakwood with sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Hlebine**: Stolac, oak-hornbeam forest, 14.04.-11.05.2007., pitfall trap, (TB); **Kneževo 2**: oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kopački rit**: Szakadás 1, willow stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Novo Virje**: Širine, Drava floodland, hayfield, 15.04.2007., specimen, (TB); 15.04.-12.05.2007., pitfall trap, (TB); **Repaš**: Drava floodland, hayfield, 14.04.2007., specimen, (TB); **Topolje**: willow stand, reedbed, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Viljevo**: willow-poplar gallery forest, 25.02.2007., specimen, (TB); **Vízvár:** willow-poplar gallery forest, 13.05.2007., lamp, (TB).

*Pterostichus melanarius* (Illiger, 1798) (Fig. 8.) - **Baranjsko Petro Selo**: oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Bilje**: Drava floodland, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Bolman**: poplar forest-willow stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Darda**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Gyűrűsháti Kapu, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Monyorós 1, sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Monyorós 2, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Gotalovo**: flood-protected Drava floodplain, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); **Gotalovo**: flood-protected Drava floodplain, hayfield, 11.05.-08.07.2007., pitfall trap, (TB); **Grabovac**: clearing in oakwood with sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Jagodnjak**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kopački rit**: Szakadás 1, willow stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Mekiš**: dry hayfield, 09.07.-31.08.2007., pitfall trap, (TB); **Novačka**: Jagerov kut, oak-hornbeam forest, 11.05.-08.07.2007., pitfall trap, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 15.04.-12.05.2007., pitfall trap, (TB); 12.05.-09.07.2007., pitfall trap, (TB); 09.07.-31.08.2007., pitfall trap, (TB); **Repaš**: Drava floodland, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Suza**: poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Topolje**: willow stand, reedbed, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Uglješ**: bank of canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Viljevo**: willow-poplar gallery forest, 25.02.2007., specimen, (TB); **Vízvár**: willow-poplar gallery forest, 08.-09.07.2007., lamp, (TB).

Fig. 8. *Pterostichus melanarius* - One of the most widespread carabids, this species normally occurs in low numbers. It is more frequent in lowlands, and is a dominant species of wet hayfields (Photo by Béla Tallósi)

*Pterostichus melas* (Creutzer, 1799) - **Bansko brdo**: Karanac, mixed forest, 16.04.-13.05.2007., pitfall trap, (TB); **Baranjsko Petro Selo**: oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Batina**: locust-tree stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Beli Manastir**: Haljevo, oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Beli Manastir**: Haljevska šuma, oak-hornbeam forest, 16.04.-13.05.2007., pitfall trap, (TB); 13.05.-10.07.2007., pitfall trap, (TB); **Bilje**: Drava floodland, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Darda**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Gyűrűsháti Kapu, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Ferdeinandovac**: Štorgina greda, oak-hornbeam forest, 12.05.-09.07.2007., pitfall trap, (TB); 09.07.-31.08.2007., pitfall trap, (TB); **Gotalovo**: flood-protected Drava floodplain, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); **Gotalovo**: flood-protected Drava floodplain, hayfield, 11.05.-08.07.2007., pitfall trap, (TB); **Gotalovo**: flood-protected Drava floodplain, hayfield, 08.07.-

31.08.2007., pitfall trap, (TB); **Hlebine**: Stolac**,** oak-hornbeam forest, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Kneževi Vinogradi**: locust-tree stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kneževo 2**: oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Mekiš**: dry hayfield, 15.04.-12.05.2007., pitfall trap, (TB); 12.05.-09.07.2007., pitfall trap, (TB); **Novačka**: Jagerov kut**,** forest line clearance, 11.05.2007., specimen, (TB); **Novačka**: Jagerov kut**,** oak-hornbeam forest, 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Novo Virje**: Širine, Drava floodland**,** hayfield, 15.04.-12.05.2007., pitfall trap, (TB); 12.05.-09.07.2007., pitfall trap, (TB); **Repaš**: Drava floodland**,** hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Suza**: poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Tikveš 1:** oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Tikveš 2:** oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Tikveš 3**: scrub, 29.07.-15.08.2003., pitfall trap, (FS&KS).

*Pterostichus minor* (Gyllenhal, 1827) - **Bolman**: poplar forest-willow stand, 29.07.-15.08.2003., pitfall trap, (FS&KS).

*Pterostichus niger* (Schaller, 1783) (Fig. 9.) - **Bilje**: Drava floodland**,** poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Bolman**: poplar forest-willow stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Gyűrűsháti Kapu**,** poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Monyorós 1**,** sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Monyorós 2**,** poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Jagodnjak**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kneževi Vinogradi**: locust-tree stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kopački rit**: Szakadás 1**,** willow stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Legrad**: lido**,** gravelly riverbank, 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Novo Virje**: Širine, Drava floodland**,** hayfield, 12.05.-09.07.2007., pitfall trap, (TB); 09.07.-31.08.2007., pitfall trap, (TB); **Repaš**: Drava floodland**,** hayfield, 11.05.-08.07.2007., pitfall trap, (TB); **Suza**: poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Topolje**: willow stand, reedbed, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Viljevo**: willow-poplar gallery forest, 25.02.2007., specimen, (TB); **Vízvár**: willow-poplar gallery forest, 08.-09.07.2007., lamp, (TB).

*Pterostichus oblongopunctatus* (Fabricius, 1787) - **Ferdeinandovac**: Štorgina greda**,** oak-hornbeam forest, 15.04.-12.05.2007., pitfall trap, (TB); 09.07.-31.08.2007., pitfall trap, (TB); **Gotalovo**: flood-protected Drava floodplain**,** hayfield, 14.04.-11.05.2007., pitfall trap, (TB); **Hlebine**: Stolac**,** oak-hornbeam forest, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Novačka**: Jagerov kut**,** forest line clearance, 11.05.2007., specimen, (TB).

Fig. 9. *Pterostichus nige*r - A widely distributed, characteristic carabid beetle of moist, grassland types of habitats (Photo by Béla Tallósi)

*Pterostichus ovoideus* (Sturm, 1824) - **Kneževo 2**: oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Ferdeinandovac**: Štorgina greda**,** oak-hornbeam forest, 15.04.-12.05.2007., pitfall trap, (TB); 12.05.-09.07.2007., pitfall trap, (TB); **Gotalovo**: flood-protected Drava floodplain**,** hayfield, 11.05.-08.07.2007., pitfall trap, (TB); **Hlebine**: Stolac**,** oak-hornbeam forest, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Legrad**: lido**,** gravelly riverbank, 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Novačka**: Jagerov kut**,** forest line clearance, 14.04.2007., specimen, (TB); 08.07.2007., specimen, (TB); **Novačka**: Jagerov kut**,** oak-hornbeam forest, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Novo Virje**: Širine, Drava floodland**,** hayfield, 15.04.-12.05.2007., pitfall trap, (TB); 12.05.-09.07.2007., pitfall trap, (TB); 09.07.-31.08.2007., pitfall trap, (TB); **Repaš**: Drava floodland**,** hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Viljevo**: willow-poplar gallery forest, 25.02.2007., specimen, (TB).

*Pterostichus strenuus* (Panzer, 1796) - **Zmajevac**: Danube floodplain area, Gyűrűsháti Kapu**,** poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Gotalovo**: flood-protected Drava floodplain**,** hayfield, 11.05.-08.07.2007., pitfall trap, (TB); **Jagodnjak**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kopački rit**: Szakadás 1**,** willow stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Legrad**: lido**,** gravelly riverbank, 14.04.-11.05.2007., pitfall trap, (TB); **Mekiš**: dry hayfield, 09.07.-31.08.2007., pitfall trap, (TB); **Novačka**: Jagerov kut, forest line clearance, 11.05.2007., specimen, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 15.04.-12.05.2007., pitfall trap, (TB); 12.05.-09.07.2007., pitfall trap, (TB); 09.07.-31.08.2007., pitfall trap, (TB); **Repaš**: Drava floodland, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB).

*Pterostichus vernalis* (Panzer, 1796) - **Bolman**: poplar forest-willow stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Gyűrűsháti Kapu, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Monyorós 1, sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Gotalovo**: flood-protected Drava floodplain, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); **Grabovac**: clearing in oakwood with sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Jagodnjak**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kopački rit**: Szakadás 2, waterside, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kopački rit**: Szakadás 1, willow stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Legrad**: lido, gravelly riverbank, 11.05.-08.07.2007., pitfall trap, (TB); **Novi Gradac:** alder bog, 15.04.2007., specimen, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 15.04.-12.05.2007., pitfall trap, (TB); 12.05.-09.07.2007., pitfall trap, (TB); 09.07.-31.08.2007., pitfall trap, (TB); **Repaš**: Drava floodland, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Viljevo**: willow-poplar gallery forest, 25.02.2007., specimen, (TB).

*Abax carinatus* (Duftschmid, 1812) (Fig. 10.) - **Bansko brdo**: Karanac, mixed forest, 16.04.-13.05.2007., pitfall trap, (TB); **Bansko brdo**: Podolje, along creek, 16.04.2007., specimen, (TB); **Baranjsko Petro Selo**: oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Batina**, locust-tree stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Beli Manastir**: Haljevo, oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Beli Manastir**: Haljevska šuma, oak-hornbeam forest, 16.04.-13.05.2007., pitfall trap, (TB); 13.05.-10.07.2007., pitfall trap, (TB); **Darda**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Gyűrűsháti Kapu, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Monyorós 2, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Ferdeinandovac**: Štorgina greda, oak-hornbeam forest, 15.04.-12.05.2007., pitfall trap, (TB); 12.05.-09.07.2007., pitfall trap, (TB); 09.07.-31.08.2007., pitfall trap, (TB); **Gotalovo**: flood-protected Drava floodplain, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Grabovac**: clearing in oakwood with sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Hlebine**: Stolac, oak-hornbeam forest, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Kneževi Vinogradi**: locust-tree stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kneževo** 2: oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kozarac**: oak-hornbeam forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Mekiš**: dry hayfield, 15.04.-12.05.2007., pitfall trap, (TB); 09.07.-31.08.2007., pitfall trap, (TB); **Novačka**: Jagerov kut, forest line clearance, 11.05.2007., specimen, (TB); **Novačka**: Jagerov kut, oak-hornbeam forest, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 15.04.-12.05.2007., pitfall trap, (TB); 12.05.-09.07.2007., pitfall trap, (TB);

09.07.-31.08.2007., pitfall trap, (TB); **Repaš**: Drava floodland, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Suza**: poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Tikveš 1:** oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Tikveš 2**: oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Tikveš 3**: scrub, 29.07.-15.08.2003., pitfall trap, (FS&KS).

Fig. 10. *Abax carinatus* - This is a typical species of moderately moist forests. It is found mostly in hilly regions and lower mountains (Photo by Béla Tallósi)

*Abax parallelepipedus* (Piller & Mitterpacher, 1783) (Fig. 11.) - **Beli Manastir**: Haljevska šuma, oak-hornbeam forest, 16.04.-13.05.2007., pitfall trap, (TB); 13.05.-10.07.2007., pitfall trap, (TB).

*Abax parallelus* (Duftschmid, 1812) - **Bansko brdo**: Podolje, along creek, 16.04.2007., specimen, (TB); **Beli Manastir**: Haljevo, oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Beli Manastir**: Haljevska šuma, oak-hornbeam forest, 16.04.-13.05.2007., pitfall trap, (TB); 13.05.-10.07.2007., pitfall trap, (TB); **Zmajevac**: Danube floodplain area, Gyűrűsháti Kapu, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Ferdeinandovac**: Štorgina greda, oak-hornbeam forest, 15.04.-12.05.2007., pitfall trap, (TB); 12.05.-09.07.2007., pitfall trap, (TB); 09.07.-31.08.2007., pitfall trap, (TB); **Gotalovo**: flood-protected Drava floodplain, hayfield, 11.05.-08.07.2007., pitfall trap, (TB); **Hlebine**: Stolac, oak-hornbeam forest, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); **Kneževi Vinogradi**: locust-tree stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kneževo 2**: oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS);

**Novačka**: Jagerov kut**,** forest line clearance, 08.07.2007., specimen, (TB); **Novačka**: Jagerov kut**,** oak-hornbeam forest, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Repaš**: Drava floodland**,** hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB).

Fig. 11. *Abax parallelepipedus* - It is a commonly distributed species known to occur in wet forests of hills and mountains. It very rarely occurs in lowlands (Photo by Béla Tallósi)

*Agonum duftschmidi* Schmidt, 1994 - **Repaš**: Drava floodland**, waterside,** 14.04.-11.05.2007., pitfall trap, (TB).

*Agonum emarginatum* (Gyllenhal, 1827) *syn.: Agonum afrum* Duftschmid, 1812; *Agonum moestum auct., nec* Duftschmid, 1812 - **Detkovac**: gravelly-sandy rivershore, 25.02.2007., specimen, (TB); **Legrad**: lido**,** gravelly riverbank, 14.04.2007., specimen, (TB); 11.05.2007., specimen, (TB); 2007.VIII.31, specimen, (TB); **Novo Virje**: Širine, Drava floodland, waterside, 15.04.2007., specimen, (TB); 15.04.-12.05.2007., pitfall trap, (TB); 12.05.2007., specimen, (TB); 12.05.-09.07.2007., pitfall trap, (TB); 09.07.2007., specimen, (TB); **Repaš**: Drava floodland, waterside, 14.04.2007., specimen, (TB).

*Agonum fuliginosum* (Panzer, 1809) syn.: *Europhilus fuliginosus* (Panzer, 1809) - **Legrad**: lido**,** gravelly riverbank, 14.04.-11.05.2007., pitfall trap, (TB); **Repaš**: Drava floodland**,** waterside**,** 31.08.2007., specimen, (TB).

*Agonum longicorne* Chaudoir, 1846 - **Novačka**: Jagerov kut**,** forest line clearance, 11.05.2007., specimen, (TB).

*Agonum micans* (Nicolai, 1822) syn.: *Europhilus micans* (Nicolai, 1822) – **Gotalovo**: flood-protected Drava floodplain**,** waterside**,** 14.04.-11.05.2007., pitfall trap, (TB); **Legrad**: lido**,** gravelly riverbank, 14.04.2007., specimen, (TB); **Novo Virje**: Širine, Drava floodland, waterside, 12.05.2007., specimen, (TB); **Repaš**: Drava floodland**,** waterside**,** 14.04.-11.05.2007., pitfall trap, (TB); 11.05.2007., specimen, (TB); 08.07.2007., specimen, (TB); **Viljevo:** willow-poplar gallery forest, 25.02.2007., specimen, (TB).

*Agonum permoestum* Puel, 1938 syn.: *Agonum moestum* auct., nec Duftschmid, 1812 - **Bansko brdo**: Podolje**,** along creek, 16.04.2007., specimen, (TB); **Zmajevac**: Danube floodplain area, Gyűrűsháti Kapu**,** poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Gotalovo**: flood-protected Drava floodplain, waterside, 14.04.-11.05.2007., pitfall trap, (TB); **Grabovac**: clearing in oakwood with sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Hlebine**: Stolac**,** oak-hornbeam forest, 14.04.-11.05.2007., pitfall trap, (TB); **Jagodnjak**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kopačevo**: hybrid poplar plantation, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kopački rit**: Szakadás 2**,** waterside, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Legrad**: lido**,** gravelly riverbank, 14.04.2007., specimen, (TB); **Novačka**: Jagerov kut**,** forest line clearance, 14.04.2007., specimen, (TB); **Novi Gradac:** alder bog, 15.04.2007., specimen, (TB); **Topolje**: willow stand, reedbed, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Viljevo**: willow-poplar gallery forest, 25.02.2007., specimen, (TB).

*Agonum viduum* (Panzer, 1796) - **Bansko brdo**: Podolje**,** along creek, 16.04.2007., specimen, (TB).

*Anchomenus dorsalis* (Pontoppidan, 1763) - **Gotalovo**: flood-protected Drava floodplain**,** hayfield, 11.05.-08.07.2007., pitfall trap, (TB); **Novačka**: Jagerov kut**,** forest line clearance, 14.04.2007., specimen, (TB); **Novo Virje**: Širine, Drava floodland**,** hayfield, 12.05.-09.07.2007., pitfall trap, (TB); **Repaš**: Drava floodland**,** hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); **Vízvár**: willow-poplar gallery forest, 08.-09.07.2007., lamp, (TB).

*Oxypselaphus obscurus* (Herbst, 1784) syn.: *Platynus obscurus* Herbst, 1784 - **Bilje**: Drava floodplain**,** poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Bolman**: poplar forest - willow stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Darda**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Detkovac**: gravelly-sandy rivershore, 25.02.2007., specimen, (TB); **Zmajevac**: Danube floodplain area, Gyűrűsháti Kapu**,** poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Monyorós 1**,** sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Monyorós 2**,** poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Gotalovo**: flood-protected Drava floodplain**,** hayfield, 11.05.-08.07.2007., pitfall trap, (TB); **Grabovac**: clearing in oakwood with sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Jagodnjak**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kopačevo**: hybrid poplar plantation, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kopački rit**: Szakadás 1**,** willow stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Novo Virje**: Širine, Drava floodland**,** hayfield, 15.04.-12.05.2007., pitfall trap, (TB); **Repaš**: Drava floodland**,** hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); **Tikveš 2**: oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Topolje**: willow stand, reedbed, 29.07.-15.08.2003., pitfall trap, (FS&KS).

*Paranchus albipes* (Fabricius, 1796) syn.: *Platynus ruficornis* (Goeze, 1777) - **Legrad**: lido, gravelly riverbank, 14.04.2007., specimen, (TB)

*Platynus assimilis* Paykull, 1790 - **Detkovac**: gravelly-sandy rivershore, 25.02.2007., specimen, (TB); **Zmajevac**: Danube floodplain area, Gyűrűsháti Kapu, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Monyorós 2, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Križnica:** rivershore, 25.02.2007., specimen, (TB); **Legrad**: lido, gravelly riverbank, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); **Novačka**: Jagerov kut, forest line clearance, 14.04.2007., specimen, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 12.05.2007., specimen, (TB); 12.05.-09.07.2007., pitfall trap, (TB); **Repaš**: Drava floodland, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); **Viljevo**: willow-poplar gallery forest, 25.02.2007., specimen, (TB).

*Platynus krynickii* (Sperk, 1835) - **Detkovac**: gravelly-sandy rivershore, 25.02.2007., specimen, (TB); **Hlebine**: Stolac, oak-hornbeam forest, 14.04.-11.05.2007., pitfall trap, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 15.04.-12.05.2007., pitfall trap, (TB).

*Platynus livens* (Gyllenhal, 1810) - **Novo Virje**: Širine, Drava floodland, waterside, 15.04.2007., specimen, (TB); **Zmajevac**: Danube floodplain area, Gyűrűsháti Kapu, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS).

*Synuchus vivalis* (Illiger, 1798) - **Zmajevac**: Danube floodplain area, Gyűrűsháti Kapu, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Monyorós 2, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Gotalovo**: flood-protected Drava floodplain, hayfield, 11.05.-08.07.2007., pitfall trap, (TB).

*Platyderus rufus* (Duftschmid, 1812) - **Ferdeinandovac**: Štorgina greda, oak-hornbeam forest, 12.05.-09.07.2007., pitfall trap, (TB); **Gotalovo**: flood-protected Drava floodplain, hayfield, 08.07.-31.08.2007., pitfall trap, (TB); **Hlebine**: Stolac, oak-hornbeam forest, 14.04.-11.05.2007., pitfall trap, (TB); **Novačka**: Jagerov kut, oak-hornbeam forest, 11.05.-08.07.2007., pitfall trap, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 12.05.-09.07.2007., pitfall trap, (TB); **Repaš**: Drava floodland, hayfield, 14.04.-11.05.2007., pitfall trap, (TB).

*Calathus fuscipes* (Goeze, 1777) - **Beli Manastir**: Haljevo, oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Bolman**: poplar forest-willow stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Darda**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Gyűrűsháti Kapu, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Monyorós 2, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Gotalovo**: flood-protected Drava floodplain, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Jagodnjak**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kneževo 2**: oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kopačevo**: hybrid poplar plantation, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Mekiš**: dry hayfield, 15.04.-12.05.2007., pitfall trap, (TB); 12.05.-09.07.2007., pitfall trap, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 15.04.-12.05.2007., pitfall trap, (TB); 12.05.-09.07.2007., pitfall trap, (TB); 09.07.-31.08.2007., pitfall trap, (TB); **Repaš**: Drava floodland, hayfield, 11.05.-08.07.2007., pitfall trap, (TB); 31.08.2007., specimen, (TB).

*Calathus melanocephalus* (Linnaeus, 1758) - **Bilje**: Drava floodland, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Gyűrűsháti Kapu, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Gotalovo**: flood-protected Drava floodplain, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); **Novačka**: Jagerov kut, forest line clearance, 08.07.2007., specimen, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 12.05.-09.07.2007., pitfall trap, (TB); **Repaš**: Drava floodland, hayfield, 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); 31.08.2007., specimen, (TB); **Repaš**: Drava floodland, hayfield, 11.05.2007., screening, (TB).

*Dolichus halensis* (Schaller, 1783) (Fig. 12.) - **Mekiš**: dry hayfield, 11.05.-08.07.2007., pitfall trap, (TB); **Vízvár**: willow-poplar gallery forest, 08.-09.07.2007., lamp, (TB).

*Laemostenus terricola* (Herbst, 1784) (Fig. 13.) - **Bansko brdo**: Karanac, mixed forest, 16.04.-13.05.2007., pitfall trap, (TB); **Beli Manastir**: Haljevo, oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Beli Manastir**: Haljevska šuma, oak-hornbeam forest, 13.05.2007., specimen, (TB); **Kneževi Vinogradi**: locust-tree stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kneževo 1**: locust-tree stand, 29.07.-15.08.2003., pitfall trap, (FS&KS).

*Amara aenea* (de Geer, 1774) - **Bansko brdo**: Podolje, along creek, 16.04.2007., specimen, (TB); **Ferdeinandovac**: Štorgina greda, oak-hornbeam forest, 25.02.2007., specimen, (TB); **Križnica:** rivershore, 25.02.2007., specimen, (TB); **Novačka**: Jagerov kut, forest line clearance, 14.04.2007., specimen, (TB); 11.05.2007., specimen, (TB); **Vízvár**: high bank, turf, 15.04.2007., specimen, (TB).

*Amara anthobia* A. Villa & G. B.Villa, 1833 - **Novo Virje**: Širine, Drava floodland, hayfield, 12.05.2007., specimen, (TB); **Vízvár**: high bank, turf, 15.04.2007., specimen, (TB).

*Amara aulica* (Panzer, 1796) - **Legrad**: lido, gravelly riverbank, 11.05.-08.07.2007., pitfall trap, (TB).

*Amara bifrons* (Gyllenhal, 1810) - **Repaš**: Drava floodland, hayfield, 08.07.2007., specimen, (TB).

Fig. 12. *Dolichus halensis* - It is a species typical of moderatly moist steppe meadows, appearing sometimes in high numbers at places (Photo by Béla Tallósi)

Fig. 13. *Laemostenus terricola* - Stays in cavities and tunnels in the soil of forested areas, but it has been found in various types of buildings as well (well-holes, cellars, etc.). Most of its occurrences have been reported from hilly or montane regions (Photo by Béla Tallósi)

*Amara communis* (Panzer, 1796) (Fig. 14.) - **Legrad**: lido**,** gravelly riverbank, 11.05.-08.07.2007., pitfall trap, (TB); **Novačka**: Jagerov kut**,** forest line clearance, 11.05.2007., specimen, (TB); **Novo Virje**: Širine, Drava floodland**,** hayfield, 15.04.-12.05.2007., pitfall trap, (TB); 12.05.-09.07.2007., pitfall trap, (TB); 09.07.-31.08.2007., pitfall trap, (TB); **Repaš**: Drava floodland**,** hayfield, 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB).

Fig. 14. *Amara communis* - This carabid is a characteristic species of wet hayfields and meadows, but it is frequent only locally (Photo by Béla Tallósi).

*Amara convexior* Stephens, 1828 - **Beli Manastir**: Haljevo**,** oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Ferdeinandovac**: Štorgina greda**,** oak-hornbeam forest, 25.02.2007., specimen, (TB); 15.04.-12.05.2007., pitfall trap, (TB); 09.07.-31.08.2007., pitfall trap, (TB); **Gotalovo**: flood-protected Drava floodplain**,** hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); **Hlebine**: Stolac**,** oak-hornbeam forest, 11.05.-08.07.2007., pitfall trap, (TB); **Novačka**: Jagerov kut**,** forest line clearance, 14.04.2007., specimen, (TB); **Novačka**: Jagerov kut**,** oak-hornbeam forest, 08.07.-31.08.2007., pitfall trap, (TB); **Novo Virje**: Širine, Drava floodland**,** hayfield, 15.04.-12.05.2007., pitfall trap, (TB); 09.07.-31.08.2007., pitfall trap, (TB); **Repaš**: Drava floodland**,** hayfield, 14.04.-11.05.2007., pitfall trap, (TB).

*Amara equestris* (Duftschmid, 1812) - **Gotalovo**: flood-protected Drava floodplain**,** hayfield, 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB).

*Amara eurynota* (Panzer, 1796) - **Gotalovo**: flood-protected Drava floodplain**,** hayfield, 11.05.-08.07.2007., pitfall trap, (TB).

*Amara familiaris* (Duftschmid, 1812) - **Baranjsko Petro Selo**: oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Novačka**: Jagerov kut, forest line clearance, 14.04.2007., specimen, (TB); 11.05.2007., specimen, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 09.07.-31.08.2007., pitfall trap, (TB); **Vízvár**: high bank, turf, 15.04.2007., specimen, (TB).

*Amara fulva* (O. F. Müller, 1776) – **Legrad**: lido, gravelly riverbank, 14.04.-11.05.2007., pitfall trap, (TB); **Vízvár**: willow-poplar gallery forest, 08.-09.07.2007., lamp, (TB).

*Amara lucida* (Duftschmid, 1812) - **Ferdeinandovac**: Štorgina greda, oak-hornbeam forest, 25.02.2007., specimen, (TB); **Novačka**: Jagerov kut, forest line clearance, 14.04.2007., specimen, (TB).

*Amara lunicollis* Schiödte, 1837 – **Gotalovo**: flood-protected Drava floodplain, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB).

*Amara montivaga* Sturm, 1825 - **Gotalovo**: flood-protected Drava floodplain, hayfield, 11.05.-08.07.2007., pitfall trap, (TB).

*Amara ovata* (Fabricius, 1792) - **Beli Manastir**: Haljevska šuma, oak-hornbeam forest, 13.05.2007., specimen, (TB); **Legrad**: lido, gravelly riverbank, 14.04.-11.05.2007., pitfall trap, (TB).

*Amara plebeja* (Gyllenhal, 1810) - **Mekiš**: dry hayfield, 15.04.-12.05.2007., pitfall trap, (TB).

*Amara pseudostrenua* Kult, 1946 - **Mekiš**: dry hayfield, 12.05.-09.07.2007., pitfall trap, (TB).

*Amara saphyrea* Dejean, 1828 - **Beli Manastir**: Haljevska šuma, oak-hornbeam forest, 13.05.-10.07.2007., pitfall trap, (TB); **Ferdeinandovac**: Štorgina greda, oak-hornbeam forest, 25.02.2007., specimen, (TB); 15.04.-12.05.2007., pitfall trap, (TB); **Gotalovo**: flood-protected Drava floodplain, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); **Hlebine**: Stolac, oak-hornbeam forest, 14.04.-11.05.2007., pitfall trap, (TB); **Novačka**: Jagerov kut, forest line clearance, 11.05.2007., specimen, (TB); 08.07.2007., specimen, (TB); **Repaš**: Drava floodland, hayfield, 14.04.-11.05.2007., pitfall trap, (TB).

*Amara similata* (Gyllenhal, 1810) - **Grabovac**: clearing in oakwood with sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Novo Virje**: Širine, Drava floodland, hayfield, 12.05.2007., specimen, (TB).

*Anisodactylus binotatus* (Fabricius, 1787) - **Gotalovo**: flood-protected Drava floodplain, hayfield, 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Grabovac**: clearing in oakwood with sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Jagodnjak**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kopački rit**: Szakadás 1, willow stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Novačka**: Jagerov kut, forest line clearance, 11.05.2007., specimen, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 15.04.2007., specimen, screening, (TB); **Repaš**: Drava floodland, hayfield, 11.05.2007., specimen, (TB); 11.05.-08.07.2007., pitfall trap, (TB).

*Anisodactylus nemorivagus* (Duftschmid, 1812) - **Gotalovo**: flood-protected Drava floodplain, hayfield, 14.04.-11.05.2007., pitfall trap, (TB).

*Parophonus dejeani* Csiki, 1932 syn.: *Parophonus complanatus* (Dejean, 1829) - **Gotalovo**: flood-protected Drava floodplain, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB).

*Parophonus maculicornis* (Duftschmid, 1812) - **Ferdeinandovac**: Štorgina greda, oak-hornbeam forest, 25.02.2007., specimen, (TB); **Gotalovo**: flood-protected Drava floodplain, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); **Legrad**: lido, gravelly riverbank, 11.05.-08.07.2007., pitfall trap, (TB); **Mekiš**: dry hayfield, 09.07.-31.08.2007., pitfall trap, (TB); **Novačka**: Jagerov kut, forest line clearance, 14.04.2007., specimen, (TB); 11.05.2007., specimen, (TB); **Repaš**: Drava floodland, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); 31.08.2007., specimen, (TB); **Vízvár**: high bank, turf, 15.04.2007., specimen, (TB).

*Harpalus affinis* (Schrank, 1781) syn.: *Harpalus aeneus* FABRICIUS, 1775 - **Vízvár**: high bank, turf, 15.04.2007., specimen, (TB).

*Harpalus atratus* Latreille, 1804 - **Bansko brdo**: Karanac, mixed forest, 16.04.-13.05.2007., pitfall trap, (TB); **Bansko brdo**: Podolje, along creek, 16.04.2007., specimen, (TB); **Baranjsko Petro Selo**: oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Beli Manastir**: Haljevo, oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Darda**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Ferdeinandovac**: Štorgina greda, oak-hornbeam forest, 12.05.-09.07.2007., pitfall trap, (TB); **Kneževi Vinogradi**: locust-tree stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Tikveš 1**: oak forest, 29.07.-15.08.2003., pitfall trap, (FS&KS).

*Harpalus dimidiatus* (P. Rossi, 1790) - **Gotalovo**: flood-protected Drava floodplain, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Mekiš**: dry hayfield, 15.04.-12.05.2007., pitfall trap, (TB); 12.05.-09.07.2007., pitfall trap, (TB); 09.07.-31.08.2007., pitfall trap, (TB).

*Harpalus distinguendus* (Duftschmid, 1812) - **Vízvár**: high bank, turf, 15.04.2007., specimen, (TB).

*Harpalus flavicornis* Dejean, 1829 - **Mekiš**: dry hayfield, 15.04.-12.05.2007., pitfall trap, (TB); 12.05.-09.07.2007., pitfall trap, (TB); 09.07.-31.08.2007., pitfall trap, (TB).

*Harpalus griseus* (Panzer, 1796) (Fig. 15.) - **Bilje**: Drava floodland, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Monyorós 2, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Gotalovo**: flood-protected Drava floodplain, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); **Kopačevo**: hybrid poplar plantation, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Novačka**: Jagerov kut, forest line clearance, 11.05.2007., specimen, (TB); **Vízvár**: willow-poplar gallery forest, 08.-09.07.2007., lamp, (TB).

Fig. 15. *Harpalus griseus* - A common carabid beetle of grassland habitats particularly in Transdanubia. A dominant species in light-trap material (Photo by Béla Tallósi).

*Harpalus latus* (Linnaeus, 1758) - **Ferdeinandovac**: Štorgina greda, oak-hornbeam forest, 15.04.-12.05.2007., pitfall trap, (TB); 09.07.-31.08.2007., pitfall trap, (TB); **Gotalovo**: flood-protected Drava floodplain, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); **Grabovac**: clearing in oakwood with sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Hlebine**: Stolac, oak-hornbeam forest, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Novačka**: Jagerov kut, forest line clearance, 14.04.2007., specimen, (TB); 11.05.2007., specimen, (TB); **Novačka**: Jagerov kut, oak-hornbeam forest, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 15.04.-12.05.2007., pitfall trap, (TB); 12.05.-09.07.2007., pitfall trap, (TB); **Repaš**: Drava floodland, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.2007., specimen, (TB); 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB).

*Harpalus rubripes* (Duftschmid, 1812) - **Bilje**: Drava floodland, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Gotalovo**: flood-protected Drava floodplain, hayfield, 11.05.-08.07.2007., pitfall trap, (TB); **Mekiš**: dry hayfield, 15.04.-12.05.2007., pitfall trap, (TB); 12.05.-09.07.2007., pitfall trap, (TB).

*Harpalus rufipes* (De Geer, 1774) - **Bansko brdo**: Karanac, mixed forest, 16.04.-13.05.2007., pitfall trap, (TB); **Bansko brdo**: Podolje**,** along creek, 16.04.2007., specimen, (TB); **Batina**: locust-tree stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Bilje**: Drava floodland**,** poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Darda**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Gyűrűsháti Kapu**,** poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Monyorós 1**,** sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Monyorós 2**,** poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Gotalovo**: flood-protected Drava floodplain**,** hayfield, 08.07.-31.08.2007., pitfall trap, (TB); **Hlebine**: Stolac**,** oak-hornbeam forest, 08.07.-31.08.2007., pitfall trap, (TB); **Jagodnjak**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kneževo 1**: locust-tree stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kopačevo**: hybrid poplar plantation, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kopački rit**: Szakadás 2**,** waterside**,** 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kopački rit**: Szakadás 1**,** willow stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Mekiš**: dry hayfield, 15.04.-12.05.2007., pitfall trap, (TB); 12.05.-09.07.2007., pitfall trap, (TB); **Novačka**: Jagerov kut**,** forest line clearance, 11.05.2007., specimen, (TB); **Novačka**: Jagerov kut**,** oak-hornbeam forest, 11.05.-08.07.2007., pitfall trap, (TB); **Novo Virje**: Širine, Drava floodland**,** hayfield, 09.07.-31.08.2007., pitfall trap, (TB); **Repaš**: Drava floodland**,** hayfield, 08.07.-31.08.2007., pitfall trap, (TB); 31.08.2007., specimen, (TB); **Suza**: poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Topolje**: willow stand, reedbed, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Uglješ**: bank of canal, 29.07.-15.08.2003., pitfall trap, (FS&KS).

*Harpalus subcylindricus* Dejean, 1829 - **Gotalovo**: flood-protected Drava floodplain**,** hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); 08.07.-31.08.2007., pitfall trap, (TB); **Mekiš**: dry hayfield, 15.04.-12.05.2007., pitfall trap, (TB); 12.05.-09.07.2007., pitfall trap, (TB); 09.07.-31.08.2007., pitfall trap, (TB).

*Harpalus tardus* (Panzer, 1796) - **Bansko brdo**: Podolje**,** along creek, 16.04.2007., specimen, (TB); **Zmajevac**: Danube floodplain area, Gyűrűsháti Kapu**,** poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Gotalovo**: flood-protected Drava floodplain**,** hayfield, 14.04.-11.05.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB); **Mekiš**: dry hayfield, 09.07.-31.08.2007., pitfall trap, (TB); **Novo Virje**: Širine, Drava floodland**,** hayfield, 15.04.-12.05.2007., pitfall trap, (TB); **Repaš**: Drava floodland**,** hayfield, 14.04.-11.05.2007., pitfall trap, (TB); **Vízvár**: high bank, turf, 15.04.2007., specimen, (TB).

*Harpalus tenebrosus* Dejean, 1829 syn.: *Cryptophonus tenebrosus centralis* (SCHAUBERGER, 1929) - **Vízvár**: willow-poplar gallery forest, 08.-09.07.2007., lamp, (TB).

*Ophonus azureus* (Fabricius, 1775) (Fig. 16.) - **Mekiš**: dry hayfield, 12.05.-09.07.2007., pitfall trap, (TB); **Novačka**: Jagerov kut**,** forest line clearance, 11.05.2007., specimen, (TB); 08.07.2007., specimen, (TB); **Vízvár**: willow-poplar gallery forest, 13.05.2007., lamp, (TB); 08.-09.07.2007., lamp, (TB).

Fig. 16. *Ophonus azureus* - A typical species of dry or moderatley moist grassy habitats, mostly in lowland regions (Photo by Béla Tallósi)

*Ophonus diffinis* (Dejean, 1829) - **Mekiš**: dry hayfield, 12.05.-09.07.2007., pitfall trap, (TB).

*Ophonus puncticeps* Stephens, 1828 - **Darda**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Repaš**: Drava floodland**,** hayfield, 08.07.-31.08.2007., pitfall trap, (TB); **Vízvár**: willow-poplar gallery forest, 08.-09.07.2007., lamp, (TB).

*Ophonus puncticollis* (Paykull, 1798) - **Mekiš**: dry hayfield, 15.04.-12.05.2007., pitfall trap, (TB).

*Ophonus punctatulus* (Duftschmid, 1812) syn.. *Ophonus nitidulus* (STEPHENS, 1828) - **Bolman**: poplar forest-willow stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kozarac**: oak-hornbeam forest, 29.07.-15.08.2003., pitfall trap, (FS&KS).

*Ophonus rufibarbis* (Fabricius, 1792) - **Repaš**: Drava floodland**,** hayfield, 08.07.2007., specimen, sweep-netting, (TB); **Vízvár**: willow-poplar gallery forest, 08.-09.07.2007., lamp, (TB).

*Stenolophus discophorus* Fischer von Waldheim, 1823 - **Kopački rit**: Szakadás 2**,** waterside**,** 29.07.-15.08.2003., pitfall trap, (FS&KS).

*Stenolophus mixtus* (Herbst, 1784) - **Darda**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Jagodnjak**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kopački rit**: Szakadás 2, waterside, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Repaš**: Drava floodland, hayfield, 11.05.2007. screening (TB); 31.08.2007., specimen, (TB); **Viljevo**: willow-poplar gallery forest, 25.02.2007., specimen, (TB); **Vízvár**: willow-poplar gallery forest, 13.05.2007., lamp, (TB); 08.-09.07.2007., lamp, (TB).

*Stenolophus skrimshiranus* Stephens, 1828 - **Repaš**: Drava floodland, hayfield, 08.07.2007., specimen, (TB); **Vízvár**: willow-poplar gallery forest, 08.-09.07.2007., lamp, (TB).

*Stenolophus teutonus* (Schrank, 1781) - **Uglješ:** bank of canal, 29.07.-15.08.2003., pitfall trap, (FS&KS).

*Acupalpus dorsalis* (Fabricius, 1787) - **Kopački rit**: Szakadás 2, waterside, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Repaš**: Drava floodland, hayfield, 08.07.2007., specimen, (TB); **Vízvár**: willow-poplar gallery forest, 08.-09.07.2007., lamp, (TB).

*Acupalpus flavicollis* (Sturm, 1825) - **Bansko brdo**: Podolje, along creek, 16.04.2007., specimen, (TB).

*Acupalpus interstitialis* Reitter, 1884 - **Repaš**: Drava floodland, hayfield, 08.07.2007., specimen, sweep-netting, (TB); **Repaš**: Drava floodland, hayfield, 31.08.2007., specimen, (TB); **Vízvár**: willow-poplar gallery forest, 08.-09.07.2007., lamp, (TB).

*Acupalpus maculatus* (Schaum, 1860) - **Repaš**: Drava floodland, hayfield, 08.07.2007., specimen, (TB); **Vízvár**: willow-poplar gallery forest, 08.-09.07.2007., lamp, (TB).

*Acupalpus meridianus* (Linnaeus, 1761) - **Repaš**: Drava floodland, hayfield, 11.05.2007., sweep-netting, (TB).

*Anthracus consputus* (Duftschmid, 1812) - **Grabovac**: clearing in oakwood with sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Legrad**: lido, gravelly riverbank, 14.04.2007., specimen, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 15.04.2007., specimen, screening, (TB); 12.05.2007., specimen, (TB).

*Bradycellus csikii* Laczó, 1912 - **Gotalovo**: flood-protected Drava floodplain, hayfield, 2007.V.11, sweep-netting, (TB); 11.05.-08.07.2007., pitfall trap, (TB).

*Chlaenius nigricornis* (Fabricius, 1787) - **Novi Gradac**: alder bog, 15.04.2007., specimen, (TB).

*Chlaenius nitidulus* (Schrank, 1781) - **Jagodnjak**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Legrad**: lido, gravelly riverbank, 14.04.-11.05.2007., pitfall trap, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 15.04.2007., specimen, screening, (TB); 09.07.2007., specimen, (TB); **Repaš**: Drava floodland, hayfield, 11.05.2007., specimen, (TB).

*Chlaenius spoliatus* (P. Rossi, 1790) - **Kopački rit**: Szakadás 2**,** waterside**,** 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kopački rit**: Szakadás 1**,** willow stand, 29.07.-15.08.2003., pitfall trap, (FS&KS).

*Chlaenius vestitus* (Paykull, 1790) - **Bansko brdo**: Podolje**,** along creek, 16.04.2007., specimen, (TB); **Jagodnjak**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS).

*Oodes helopioides* (Fabricius, 1792) - **Darda**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Gyűrűsháti Kapu**,** poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Monyorós 1**,** sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Monyorós 2**,** poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Grabovac**: clearing in oakwood with sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kopački rit**: Szakadás 2, waterside**,** 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kopački rit**: Szakadás 1**,** willow stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Novi Gradac**: alder bog, 15.04.2007., specimen, (TB); **Novo Virje**: Širine, Drava floodland**,** hayfield, 15.04.2007., specimen, screening, (TB); 15.04.-12.05.2007., pitfall trap, (TB); 12.05.-09.07.2007., pitfall trap, (TB); **Topolje**: willow stand, reedbed, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Viljevo**: willow-poplar gallery forest, 25.02.2007., specimen, (TB).

*Oodes gracilis* A. & J. B. Villa, 1833 – **Darda**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kopački rit**: Szakadás 2**,** waterside**,** 29.07.-15.08.2003., pitfall trap, (FS&KS).

*Licinus cassideus* (Fabricius, 1792) - **Bolman**: poplar forest - willow stand, 29.07.-15.08.2003., pitfall trap, (FS&KS).

*Licinus depressus* (Paykull, 1790) - **Bilje**: Drava floodland**,** poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Gyűrűsháti Kapu**,** poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Monyorós 2**,** poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Grabovac**: clearing in oakwood with sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Kopačevo**: hybrid poplar plantation, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Suza**: poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Tikveš 3**: scrub**,** 29.07.-15.08.2003., pitfall trap, (FS&KS).

*Badister collaris* Motschulsky, 1844 syn.: *Badister anomalus* Perris, 1866 - **Zmajevac**: Danube floodplain area, Gyűrűsháti Kapu**,** poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS).

*Badister lacertosus* Sturm, 1815 - **Zmajevac**: Danube floodplain area, Gyűrűsháti Kapu**,** poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Mekiš**: dry hayfield, 15.04.-12.05.2007., pitfall trap, (TB); **Novo Virje**: Širine, Drava floodland**,** hayfield, 12.05.2007., screening, (TB); 15.04.-12.05.2007., pitfall trap, (TB); 12.05.-09.07.2007., pitfall trap, (TB); 11.05.-08.07.2007., pitfall trap, (TB).

*Badister meridionalis* Puel, 1925 - **Grabovac**: clearing in oakwood with sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Vízvár**: willow-poplar gallery forest, 08.-09.07.2007., lamp, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 15.04.-12.05.2007., pitfall trap, (TB).

*Badister peltatus* (Panzer, 1796) - **Zmajevac**: Danube floodplain area, Monyorós 1, sedge, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Vízvár**: willow-poplar gallery forest, 08.-09.07.2007., lamp, (TB).

*Badister sodalis* (Duftschmid, 1812) - **Novo Virje**: Širine, Drava floodland, hayfield, 15.04.-12.05.2007., pitfall trap, (TB); 09.07.2007., specimen, (TB); **Repaš**: Drava floodland, hayfield, 14.04.-11.05.2007., pitfall trap, (TB).

*Badister unipustulatus* Bonelli, 1813 - **Jagodnjak**: willow stand along canal, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Novi Gradac**: alder bog, 15.04.2007., specimen, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 15.04.2007., specimen, (TB); **Repaš**: Drava floodland, hayfield, 08.07.2007., specimen, (TB); **Vízvár**: willow-poplar gallery forest, 08.-09.07.2007., lamp, (TB).

*Panagaeus cruxmajor* (Linnaeus, 1758) - **Gotalovo**: flood-protected Drava floodplain, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 12.05.-09.07.2007., pitfall trap, (TB).

*Lebia chlorocephala* (J. J. Hoffmann et al., 1803) - **Gotalovo**: flood-protected Drava floodplain, hayfield, 14.04.-11.05.2007., pitfall trap, (TB).

*Demetrias imperialis* (Germar, 1824) - **Repaš**: Drava floodland, hayfield, 08.07.2007., umbrella, (TB).

*Paradromius longiceps* (Dejean, 1826) - **Repaš**: Drava floodland, hayfield, 08.07.2007., umbrella, (TB); **Vízvár**: willow-poplar gallery forest, 08.-09.07.2007., lamp, (TB).

*Philorhizus quadrisignatus* (Dejean, 1825) – **Repaš**: Drava floodland, hayfield, 08.07.2007., umbrella, (TB); **Vízvár**: willow-poplar gallery forest, 08.-09.07.2007., lamp, (TB).

*Syntomus obscuroguttatus* (Duftschmid, 1812) - **Bolman**: poplar forest - willow stand, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Zmajevac**: Danube floodplain area, Gyűrűsháti Kapu, poplar forest, 29.07.-15.08.2003., pitfall trap, (FS&KS); **Gotalovo**: flood-protected Drava floodplain, hayfield, 11.05.-08.07.2007., pitfall trap, (TB); **Novo Virje**: Širine, Drava floodland, hayfield, 15.04.-12.05.2007., pitfall trap, (TB); 12.05.-09.07.2007., pitfall trap, (TB); **Repaš**: Drava floodland, hayfield, 14.04.-11.05.2007., pitfall trap, (TB); **Uglješ**: bank of canal, 29.07.-15.08.2003., pitfall trap, (FS&KS).

*Syntomus truncatellus* (Linnaeus, 1761) - **Gotalovo**: flood-protected Drava floodplain**,** hayfield, 14.04.-11.05.2007., pitfall trap, (TB); **Repaš**: Drava floodland**,** hayfield, 11.05.2007., sweep-netting, (TB); 11.05.-08.07.2007., pitfall trap, (TB).

*Odacantha melanura* (Linnaeus, 1767) - **Novo Virje**: Širine, Drava floodland**,** hayfield, 15.04.2007., umbrella, (TB).

*Drypta dentata* (P. Rossi, 1790) - **Novo Virje**: Širine, Drava floodland**,** hayfield, 09.07.2007., umbrella, (TB).

Based on research data from former studies that were performed in Hungarian areas along Drava (Horvatovich 1976, 1978, 1979, 1980, 1981a, 1981b, 1982, 1989, 1995, 1998, 2002; Bérces 1997, 2003), a total of 279 carabid beetles are known. From the much less researched Croatian areas, including the Baranja region, too, 57 species have been recorded which include – despite the fact that data were collected in agrocoenoses – 11 species that have not been found on the Hungarian side of the river (*Acupalpus meridianus, Amara apricaria,* [*Calathus rotundicollis*]*, Calosoma auropunctatum, Dicheirotrichus placidus, Laemostenus terricola, Poecilus sericeus, Pterostichus longicollis, Pterostichus macer,* [*Pterostichus madidus*]*, Zabrus tenebrioides*). The majority of these are widely distributed species and at least 2 are misidentified (these ones are written between square brackets). They occur in areas belonging to Hungary, too, as suggested by earlier observations (Horvatovich 2002; Tallósi et al. 2006). The total number of species having been reported to occur in Hungarian and Croatian areas along Drava is 290 [288].

From the results of the samplings performed by the author in 2007 in Croatian areas and from the identification of the material collected earlier in Baranja by Farkas and Krčmar (2004), 173 species were recorded, including 17 (*Acupalpus intersitialis, Amara eutynota, Amara fulva, Amara lunicollis, Amara pseudostrenua, Anisodactylus nemorivagus, Bembidion prasinum, Bembidion starki, Bembidion testaceum, Dyschirius chalybaeus gibbifrons, Dyschirius politus, Elaphropus quadrisignatus, Harpalus subcylindricus, Licinus cassideus, Paratachys fulvicollis, Philorhizus quadrisignatus, Trechoblemus micros*), that were formerly unknown in the studied region (Table 2.).

Table 2. Carabid beetle species found along Drava river and in the Croatian Baranja (TB - collected by the author, species new for the region are given in **bold**; BS - Bérces, S.; HS - Horvatovich, S.; H - data from Hungarian areas; S&H - Sekulić, R. and Horvatovich, S.; ŠP - Štrbac, P, HR - data from Croatian areas)

| No. | Species | TB | BS | HS | H | S&H | ŠP | HR |
|---|---|---|---|---|---|---|---|---|
| 1. | *Abax carinatus* (DUFTSCHMID, 1812) | * | * | * | * | | | |
| 2. | *Abax parallelepipedus* (PILLER & MITTERPACHER, 1783) | * | * | * | * | | * | * |
| 3. | *Abax parallelus* (DUFTSCHMID, 1812) | * | * | * | * | | | |
| 4. | *Acupalpus brunnipes* (STURM, 1825) | | | * | * | | | |
| 5. | *Acupalpus dorsalis* (FABRICIUS, 1787) | * | | * | * | | | |
| 6. | *Acupalpus dubius* SCHILSKY, 1888 | | | * | * | | | |
| 7. | *Acupalpus elegans elegans* (DEJEAN, 1829) | | | * | * | | | |
| 8. | *Acupalpus exiguus* DEJEAN, 1829 | | | * | * | | | |
| 9. | *Acupalpus flavicollis* (STURM, 1825) | * | | * | * | | | |
| **10.** | ***Acupalpus interstitialis* REITTER, 1884** | * | | | | | | |
| 11. | *Acupalpus luteatus* (DUFTSCHMID, 1812) | | | * | * | | | |
| 12. | *Acupalpus maculatus* (SCHAUM, 1860) | * | | * | * | | | |
| 13. | *Acupalpus meridianus* (LINNAEUS, 1761) | * | | | | | * | * |
| 14. | *Acupalpus parvulus* (STURM, 1825) | | | * | * | | | |
| 15. | *Agonum angustatum* DEJEAN, 1828 | | | * | * | | | |
| 16. | *Agonum atratum* (DUFTSCHMID, 1812 | | | * | * | | | |
| 17. | *Agonum duftschmidi* SCHMIDT, 1994 | * | | * | * | | | |
| 18. | *Agonum emarginatum* (GYLLENHAL, 1827) | * | | * | * | | | |
| 19. | *Agonum fuliginosum* (PANZER, 1809) | * | * | * | * | | | |
| 20. | *Agonum gracilie* STURM, 1824 | | | * | * | | | |
| 21. | *Agonum gracilipes* (DUFTSCHMID, 1812) | | | * | * | | | |
| 22. | *Agonum longicorne* CHAUDOIR, 1846 | * | | * | * | | | |
| 23. | *Agonum lugens* (DUFTSCHMID, 1812) | | | * | * | | | |
| 24. | *Agonum marginatum* (LINNAEUS, 1758) | | | * | * | | | |
| 25. | *Agonum micans* (NICOLAI, 1822) | * | * | * | * | | | |
| 26. | *Agonum moestum* (DUFTSCHMID, 1812) | | * | * | * | | | |
| 27. | *Agonum permoestum* PUEL, 1930 | * | | * | * | | | |
| 28. | *Agonum piceum* (LINNAEUS, 1758) | | | * | * | | | |
| 29. | *Agonum scitulum* DEJEAN, 1828 | | | * | * | | | |
| 30. | *Agonum sexpunctatum* (LINNAEUS, 1758) | | * | * | * | | | |
| 31. | *Agonum thoreyi* DEJEAN, 1828 | | | * | * | | | |
| 32. | *Agonum versutum* STURM, 1824 | | | * | * | | | |
| 33. | *Agonum viduum* (PANZER, 1797) | * | | * | * | | | |
| 34. | *Agonum viridicupreum* (GOEZE, 1777) | | | * | * | | | |
| 35. | *Amara aenea* (DE GEER, 1774) | * | * | * | * | * | * | * |
| 36. | *Amara anthobia* A. & J.B. VILLA, 1833 | * | * | * | * | | | |
| 37. | *Amara apricaria* (PAYKULL, 1790) | | | | | * | | * |
| 38. | *Amara aulica* (PANZER, 1797) | * | * | * | * | | * | * |
| 39. | *Amara bifrons* (GYLLENHAL, 1810) | * | | * | * | | | |
| 40. | *Amara chaudoiri incognita* FASSATI, 1946 | | * | * | * | | | |
| 41. | *Amara communis* (PANZER, 1797) | * | * | * | * | | | |
| 42. | *Amara consularis* (DUFTSCHMID, 1812) | | | * | * | * | | * |
| 43. | *Amara convexior* STEPHENS, 1828 | * | * | * | * | | | |
| 44. | *Amara equestris* (DUFTSCHMID, 1812) | * | | * | * | | | |
| **45.** | ***Amara eurynota* (PANZER, 1797)** | * | | | | | | |
| 46. | *Amara familiaris* (DUFTSCHMID, 1812) | * | * | * | * | | * | * |
| **47.** | ***Amara fulva* (O.F. MÜLLER, 1776)** | * | | | | | | |
| 48. | *Amara gebleri* DEJEAN, 1831 | | * | * | * | | | |
| 49. | *Amara lucida* (DUFTSCHMID, 1812) | * | | * | * | | | |
| 50. | *Amara lunicollis* SCHIÖDTE, 1837 | * | | | | | | |
| 51. | *Amara majuscula* CHAUDOIR, 1850 | | | * | * | | | |
| 52. | *Amara montivaga* STURM, 1825 | * | | * | * | | | |
| 53. | *Amara ovata* (FABRICIUS, 1792) | * | * | * | * | | | |
| 54. | *Amara plebeja* (GYLLENHAL, 1810) | * | | * | * | | * | * |
| **55.** | ***Amara pseudostrenua* KULT, 1946** | * | | | | | | |
| 56. | *Amara saphyrea* DEJEAN, 1828 | * | * | * | * | | | |
| 57. | *Amara similata* (GYLLENHAL, 1810) | * | * | * | * | | | |
| 58. | *Amara tricuspidata tricuspidata* DEJEAN, 1831 | | | * | * | | | |
| 59. | *Anchomernus dorsalis* (PONTOPPIDAN, 1763) | * | * | * | * | * | * | * |
| 60. | *Anisodactylus binotatus* (FABRICIUS, 1787) | * | * | * | * | | | |
| **61.** | ***Anisodactylus nemorivagus* (DUFTSCHMID, 1812)** | * | | | | | | |
| 62. | *Anisodactylus signatus* (PANZER, 1797) | | * | * | * | * | * | * |
| 63. | *Anthracus consputus* (DUFTSCHMID, 1812) | * | | * | * | | | |
| 64. | *Anthracus longicornis* (SCHAUM, 1857) | | | * | * | | | |
| 65. | *Asaphidion flavipes* (LINNAEUS, 1761) | * | * | * | * | | * | * |
| 66. | *Badister bipustulatus* (FABRICIUS, 1792) | | | * | * | | | |
| 67. | *Badister collaris* MOTSCHULSKY, 1844 | * | * | * | * | | | |
| 68. | *Badister dilatatus* CHAUDOIR, 1837 | | | * | * | | | |
| 69. | *Badister lacertosus* STURM, 1815 | * | * | * | * | | | |
| 70. | *Badister meridionalis* PUEL, 1925 | * | * | * | * | | | |
| 71. | *Badister peltatus* (PANZER, 1797) | * | | * | * | | | |
| 72. | *Badister sodalis* (DUFTSCHMID, 1812) | * | | * | * | | | |
| 73. | *Badister unipustulatus* BONELLI, 1813 | * | | * | * | | | |

| No. | Species | TB | BS | HS | H | S&H | ŠP | HR |
|---|---|---|---|---|---|---|---|---|
| 74. | *Bembidion articulatum* (PANZER, 1796) | * | | * | * | | | |
| 75. | *Bembidion assimile* GYLLENHAL, 1810 | | | * | * | | | |
| 76. | *Bembidion azurescens* DALLA TORRE, 1877 | * | | * | * | | | |
| 77. | *Bembidion biguttatum* (FABRICIUS, 1779) | * | * | * | * | | | |
| 78. | *Bembidion clarkii* (DAWSON, 1829) | | * | * | * | | | |
| 79. | *Bembidion dalmatinum* DEJEAN, 1831 | * | * | * | * | | | |
| 80. | *Bembidion decorum* (PANZER, 1800) | * | | * | * | | | |
| 81. | *Bembidion dentellum* (THUNBERG, 1787) | * | * | * | * | | | |
| 82. | *Bembidion doris* (PANZER, 1797) | * | | * | * | | | |
| 83. | *Bembidion elongatum* DEJEAN, 1831 | | * | * | * | | | |
| 84. | *Bembidion fasciolatum* (DUFTSCHMID, 1812) | * | | * | * | | | |
| 85. | *Bembidion femoratum* STURM, 1825 | | | * | * | | | |
| 86. | *Bembidion foraminosum* STURM, 1825 | | | * | * | | | |
| 87. | *Bembidion fulvipes* STURM, 1827 | | | * | * | | | |
| 88. | *Bembidion fumigatum* (DUFTSCHMID, 1812) | * | | * | * | | | |
| 89. | *Bembidion gilvipes* STURM, 1825 | * | * | * | * | | | |
| 90. | *Bembidion guttula (FABRICIUS, 1792)* | | * | * | * | | | |
| 91. | *Bembidion illigeri* NETOLITZKY, 1914 | | | * | * | | | |
| 92. | *Bembidion inoptatum* SCHAUM, 1857 | * | | * | * | | | |
| 93. | *Bembidion lampros* (HERBST, 1784) | * | * | * | * | | * | * |
| 94. | *Bembidion laticolle* (DUFTSCHMID, 1812) | | | * | * | | | |
| 95. | *Bembidion lunatum* (DUFTSCHMID, 1812) | | | * | * | | | |
| 96. | *Bembidion lunulatum* (GEOFROY in FOURCROY, 1785) | | * | * | * | | | |
| 97. | *Bembidion mannerheimi* C.R. SAHLBERG, 1827 | | | * | * | | | |
| 98. | *Bembidion minimum* (FABRICIUS, 1792) | | | * | * | | | |
| 99. | *Bembidion modestum* (FABRICIUS, 1801) | * | | * | * | | | |
| 100. | *Bembidion octomaculatum* (GOEZE, 1777) | * | | * | * | | | |
| **101.** | ***Bembidion prasinum* (DUFTSCHMID, 1812)** | * | | | | | | |
| 102. | *Bembidion properans* (STEPHENS, 1828) | * | * | * | * | | * | * |
| 103. | *Bembidion punctulatum* DRAPIEZ, 1820 | * | | * | * | | | |
| 104. | *Bembidion pygmaeum* (FABRICIUS, 1792) | | | * | * | | | |
| 105. | *Bembidion quadrimaculatum* (LINNAEUS, 1761) | * | | * | * | | * | * |
| 106. | *Bembidion quadripustulatum* AUDINET-SERVILLE, 1821 | * | | * | * | | | |
| 107. | *Bembidion semipunctatum* (DONOVAN, 1806) | * | | * | * | | | |
| **108.** | ***Bembidion starki* SCHAUM, 186** | * | | | | | | |
| 109. | *Bembidion stephensii* CROTCH, 1866 | | * | | * | | | |
| 110. | *Bembidion striatum* (FABRICIUS, 1792) | | | * | * | | | |
| 111. | *Bembidion subcostatum javurkovae* FASSATI, 1944 | * | * | * | * | | | |
| 112. | *Bembidion tenellum* ERICHSON, 1837 | * | | * | * | | | |
| **113.** | ***Bembidion testaceum* (DUFTSCHMID, 1812)** | * | | | | | | |
| 114. | *Bembidion tetracolum* SAY, 1823 | * | | * | * | | | |
| 115. | *Bembidion varium* (OLIVIER, 1795) | * | | * | * | | | |
| 116. | *Blemus discus discus* (FABRICIUS, 1792) | * | | * | * | | | |
| 117. | *Brachinus crepitans* (LINNAEUS, 1758) | | * | | * | * | * | * |
| 118. | *Brachinus ejaculans* FISCHER VON WALDHEIM, 1825 | | | * | * | | | |
| 119. | *Brachinus elegans* (CHAUDOIR, 1842) | | * | | * | | | |
| 120. | *Brachinus explodens* DUFTSCHMID, 1812 | * | * | * | * | | * | * |
| 121. | *Bradycellus csikii* LACZÓ, 1912 | * | * | | * | | | |
| 122. | *Bradycellus harpalinus* (AUDINET-SERVILLE, 1821) | | * | * | * | | | |
| 123. | *Bradycellus verbasci* (DUFTSCHMID, 1812) | | | * | * | | | |
| 124. | *Broscus cephalotes* (LINNAEUS, 1758) | | | * | * | | * | * |
| 125. | *Calathus erratus* (C.R. SAHLBERG, 1827) | | * | * | * | | | |
| 126. | *Calathus fuscipes* (GOEZE, 1777) | * | * | * | * | | | |
| 127. | *Calathus melanocephalus* (LINNAEUS, 1758) | * | | * | * | | * | * |
| 128. | *Calathus mollis* (MARSHAM, 1802) | | | * | * | | | |
| 129. | [*Calathus rotundicollis* Dejean, 1828] | | | | | | * | * |
| 130. | *Callistus lunatus* (Fabricius, 1775) | | * | * | * | | | |
| 131. | *Calosoma auropunctatum* (HERBST, 1784) | | | | | * | | * |
| 132. | *Calosoma inquisitor* (LINNAEUS, 1758) | * | | * | * | | | |
| 133. | *Calosoma sycophanta* (LINNAEUS, 1758) | | | * | * | | | |
| 134. | *Carabus cancellatus maximus* HAURY, 1880 | * | * | * | * | * | | * |
| 135. | *Carabus clathratus auraniensis* G. MÜLLER, 1902 | * | * | * | * | | | |
| 136. | *Carabus convexus convexus* FABRICIUS, 1775 | * | * | * | * | | | |
| 137. | *Carabus coriaceus praeillyricus* SZÉL, 1993 | * | * | * | * | | * | * |
| 138. | *Carabus germari exasperatus* DUFTSCHMID, 1812 | * | * | * | * | | | |
| 139. | *Carabus granulatus* LINNAEUS, 1758 | * | * | * | * | | * | * |
| 140. | *Carabus hortensis* LINNAEUS, 1758 | | * | * | * | | | |
| 141. | *Carabus intricatus* LINNAEUS, 1761 | | * | * | * | | | |
| 142. | *Carabus marginalis decorus* SEIDLITZ, 1891 | | | * | * | | | |
| 143. | *Carabus nemoralis nemoralis* O.F. MÜLLER, 1764 | * | * | * | * | | * | * |
| 144. | *Carabus ullrichi baranyensis* SOKOLÁR, 1908 | * | * | * | * | | | |
| 145. | *Chlaenius festivus* (PANZER, 1796) | | | * | * | | | |
| 146. | *Chlaenius nigricornis* (FABRICIUS, 1787) | * | * | * | * | | | |
| 147. | *Chlaenius nitidulus* (SCHRANK, 1781) | * | | * | * | | | |
| 148. | *Chlaenius spoliatus* (ROSSI, 1790) | * | | * | * | | | |
| 149. | *Chlaenius tibialis* DEJEAN, 1826 | | * | | * | | | |
| 150. | *Chlaenius tristis* (SCHALLER, 1783) | | * | * | * | | | |
| 151. | *Chlaenius vestitus* (PAYKULL, 1790) | * | * | * | * | | | |
| 152. | *Cicindela campestris* LINNAEUS, 1758 | | | * | * | | * | * |
| 153. | *Cicindela hybrida hybrida* LINNAEUS, 1758 | | | * | * | | | |

| No. | Species | TB | BS | HS | H | S&H | ŠP | HR |
|---|---|---|---|---|---|---|---|---|
| 154. | *Cicindela soluta pannonica* MANDL, 1935 | | | * | * | | | |
| 155. | *Clivina collaris* (HERBST, 1784) | | * | * | * | | | |
| 156. | *Clivina fossor* (LINNAEUS, 1758) | * | * | * | * | * | * | * |
| 157. | *Cychrus attenuatus* (FABRICIUS, 1792) | | * | | * | | | |
| 158. | *Cychrus caraboides* (LINNAEUS, 1758) | * | * | * | * | | | |
| 159. | *Cylindera arenaria viennensis* (SCHRANK, 1781) | | | * | * | | | |
| 160. | *Cylindera germanica* (LINNAEUS, 1758) | * | | * | * | | * | * |
| 161. | *Demetrias atricapillus* (LINNAEUS, 1758) | | | * | * | | | |
| 162. | *Demetrias imperialis* (GERMAR, 1824) | * | | * | * | | | |
| 163. | *Demetrias monostigma* SAMOUELLE, 1819 | | | * | * | | | |
| 164. | *Diachromus germanus* (LINNAEUS, 1758) | | | * | * | * | | * |
| 165. | *Dicheirotrichus placidus* (GYLLENHAL, 1827) | | | | | | * | * |
| 166. | *Dolichus halensis* (SCHALLER, 1783) | * | | * | * | * | * | * |
| 167. | *Dromius agilis* (FABRICIUS, 1787) | | | * | * | | | |
| 168. | *Dromius linearis linearis* (OLIVIER, 1795) | | | * | * | | | |
| 169. | *Dromius quadrimaculatus* (LINNAEUS, 1758) | | | * | * | | | |
| 170. | *Drypta dentata* (P.ROSSI, 1790) | * | * | * | * | | | |
| 171. | *Dyschirius aeneus* (DEJEAN, 1825) | * | | * | * | | | |
| **172.** | ***Dyschirius chalybaeus gibbifrons* APFELBECK, 1899** | * | | | | | | |
| 173. | *Dyschirius digitatus* (DEJEAN, 1825) | | * | | * | | | |
| 174. | *Dyschirius globosus* (HERBST, 1784) | * | * | * | * | | | |
| 175. | *Dyschirius nitidus* (DEJEAN, 1825) | | | * | * | | | |
| **176.** | ***Dyschirius politus* (DEJEAN, 1825)** | * | | | | | | |
| 177. | *Dyschirius tristis* STEPHENS, 1827 | | | * | * | | | |
| **178.** | ***Elaphropus quadrisignatus* (DUFTSCHMID, 1812)** | * | | | | | | |
| 179. | *Elaphropus sexstriatus* (DUFTSCHMID, 1812) | | | * | * | | | |
| 180. | *Elaphrus aureus* P. MÜLLER, 1821 | * | * | * | * | | | |
| 181. | *Elaphrus cupreus* DUFTSCHMID, 1812 | * | * | * | * | | | |
| 182. | *Elaphrus riparius* (LINNAEUS, 1758) | * | | * | * | | | |
| 183. | *Elaphrus uliginosus* FABRICIUS, 1792 | | * | | * | | | |
| 184. | *Elaphrus ulrichi* W. REDTENBACHER, 1842 | | * | | * | | | |
| 185. | *Epaphius secalis* (PAYKULL, 1790) | * | * | * | * | | | |
| 186. | *Harpalus affinis* (SCHRANK, 1781) | * | | * | * | | * | * |
| 187. | *Harpalus anxius* (DUFTSCHMID, 1812) | | | * | * | | | |
| 188. | *Harpalus atratus* LATREILLE, 1804 | * | * | * | * | | | |
| 189. | *Harpalus autumnalis* (DUFTSCHMID, 1812) | | * | * | * | | | |
| 190. | *Harpalus calceatus* (DUFTSCHMID, 1812) | | | * | * | | * | * |
| 191. | *Harpalus cupreus fastuosus* FALDERMANN, 1835 | | * | | * | * | | * |
| 192. | *Harpalus dimidiatus* (ROSSI, 1790) | * | | * | * | * | | * |
| 193. | *Harpalus distinguendus* (DUFTSCHMID, 1812) | * | | * | * | * | * | * |
| 194. | *Harpalus flavicornis* DEJEAN, 1829 | * | | * | * | | | |
| 195. | *Harpalus froelichi* STURM, 1818 | | | * | * | | | |
| 196. | *Harpalus griseus* (PANZER, 1797) | * | | * | * | | | |
| 197. | *Harpalus honestus* (DUFTSCHMID, 1812) | | | * | * | | | |
| 198. | *Harpalus latus* (LINNAEUS, 1758) | * | * | * | * | * | | * |
| 199. | *Harpalus luteicornis* (DUFTSCHMID, 1812) | | * | * | * | | | |
| 200. | *Harpalus marginellus* DEJEAN, 1829 | | | * | * | | | |
| 201. | *Harpalus picipennis* (DUFTSCHMID, 1812) | | | * | * | | | |
| 202. | *Harpalus progrediens* SCHAUBERGER, 1922 | | * | * | * | | | |
| 203. | *Harpalus rubripes* (DUFTSCHMID, 1812) | * | * | * | * | | | |
| 204. | *Harpalus rufipes* (DE GEER, 1774) | * | * | * | * | * | * | * |
| 205. | *Harpalus serripes* (QUENSEL, 1806) | | | * | * | | | |
| 206. | *Harpalus servus* (DUFTSCHMID, 1812) | | | * | * | | | |
| 207. | *Harpalus smaragdinus* (DUFTSCHMID, 1812) | | | * | * | | | |
| **208.** | ***Harpalus subcylindricus* DEJEAN, 1829** | * | | | | | | |
| 209. | *Harpalus tardus* (PANZER, 1797) | * | * | * | * | | | |
| 210. | *Harpalus tenebrosus centralis* SCHAUBERGER, 1929 | * | | * | * | | | |
| 211. | *Harpalus xanthopus* GEMMINGER & HAROLD, 1868 | | * | | * | | | |
| 212. | *Laemostenus terricola terricola* (HERBST, 1784) | * | | | | * | | * |
| 213. | *Lebia chlorocephala* (HOFFMANN, 1803) | * | * | * | * | | | |
| 214. | *Lebia cruxminor* (LINNAEUS, 1758) | | | * | * | | | |
| 215. | *Leistus ferrugineus* (LINNAEUS, 1758) | | * | * | * | | | |
| 216. | *Leistus piceus piceus* FRÖLICH, 1799 | * | * | * | * | | | |
| **217.** | ***Licinus cassideus* (FABRICIUS, 1792)** | * | | | | | | |
| 218. | *Licinus depressus* (PAYKULL, 1790) | * | * | * | * | | | |
| 219. | *Lionichus quadrillum* (DUFTSCHMID, 1812) | | | * | * | | | |
| 220. | *Loricera pilicornis* (FABRICIUS, 1775) | * | * | * | * | | | |
| 221. | *Masoreus wetterhalli* (GYLLENHAL, 1813) | | | * | * | | | |
| 222. | *Microlestes maurus* (STURM, 1827) | | | * | * | | | |
| 223. | *Microlestes minutulus* (GOEZE, 1777) | | | * | * | | | |
| 224. | *Nebria brevicollis* (FABRICIUS, 1792) | * | * | * | * | | | |
| 225. | *Notiophilus biguttatus* (FABRICIUS, 1799) | | | * | * | | | |
| 226. | *Notiophilus palustris* (DUFTSCHMID, 1812) | * | * | * | * | | | |
| 227. | *Notiophilus rufipes* CURTIS, 1829 | * | * | * | * | | | |
| 228. | *Odacantha melanura* (LINNAEUS, 1767) | * | | * | * | | | |
| 229. | *Olisthopus sturmi* (DUFTSCHMID, 1812) | | | * | * | | | |
| 230. | *Omophron limbatum* (FABRICIUS, 1776) | * | | * | * | | | |
| 231. | *Oodes gracilis* A. & J.B. VILLA, 1833 | * | | * | * | | | |
| 232. | *Oodes helopioides* (FABRICIUS, 1792) | * | * | * | * | | | |
| 233. | *Ophonus azureus* (FABRICIUS, 1775) | * | | * | * | * | | * |

| No. | Species | TB | BS | HS | H | S&H | ŠP | HR |
|---|---|---|---|---|---|---|---|---|
| 234. | *Ophonus diffinis* (DEJEAN, 1829) | * | | * | * | | | |
| 235. | *Ophonus melletii* (HEER, 1837) | | | * | * | | | |
| 236. | *Ophonus puncticeps* STEPHENS, 1828 | * | | * | * | | | |
| 237. | *Ophonus puncticollis* (PAYKULL, 1798) | * | | * | * | * | | * |
| 238. | *Ophonus punctulatus* (DUFTSCHMID, 1812) | * | * | * | * | | | |
| 239. | *Ophonus rufibarbis* (FABRICIUS, 1792) | * | | * | * | | | |
| 240. | *Ophonus rupicola* (STURM, 1818) | | | * | * | | | |
| 242. | *Oxypselaphus obscurus* (HERBST, 1784) | * | * | * | * | | | |
| 243. | *Panagaeus bipustulatus* (FABRICIUS, 1775) | | | * | * | | | |
| 244. | *Panagaeus cruxmajor* (LINNAEUS, 1758) | * | * | * | * | | | |
| 245. | *Paradromius longiceps* (DEJEAN, 1826) | * | | * | * | | | |
| 246. | *Paranchus albipes* (FABRICIUS, 1796) | * | * | | * | | | |
| 247. | *Paratachys bistriatus* (DUFTSCHMID, 1812) | * | | * | * | | | |
| **248.** | ***Paratachys fulvicollis* (DEJEAN, 1831)** | * | | | | | | |
| 249. | *Paratachys micros* (FISCHER VON WALDHEIM, 1828) | * | | * | * | | | |
| 250. | *Parophonus dejeani* CSIKI, 1932 | * | * | * | * | | | |
| 251. | *Parophonus maculicornis* (DUFTSCHMID, 1812) | * | | * | * | | | |
| 252. | *Patrobus atrorufus* (STROEM, 1768) | * | * | * | * | | | |
| 253. | *Perigona nigriceps* (DEJEAN, 1831) | | | * | * | | | |
| 254. | *Perileptus areolatus (CREUTZER, 1799)* | * | | * | * | | | |
| **255.** | ***Philorhizus quadrisignatus* (DEJEAN, 1825)** | * | | | | | | |
| 256. | *Philorhizus sigma* (P.ROSSI, 1790) | | | * | * | | | |
| 257. | *Platyderus rufus* (DUFTSCHMID, 1812) | * | * | * | * | | | |
| 258. | *Platynus assimilis* (PAYKULL, 1790) | * | * | * | * | | * | * |
| 259. | *Platynus krynickii* (SPERK, 1835) | * | * | * | * | | | |
| 260. | *Platynus livens* (GYLLENHAL, 1810) | * | * | * | * | | | |
| 261. | *Platynus longiventris* MANNERHEIM, 1825 | | | * | * | | | |
| 262. | *Poecilus cupreus cupreus* (LINNAEUS, 1758) | * | * | * | * | * | * | * |
| 263. | *Poecilus lepidus lepidus* (LESKE, 1758) | | | * | * | | * | * |
| 264. | *Poecilus punctulatus* (SCHALLER, 1783) | | * | | * | | | |
| 265. | *Poecilus sericeus* FISCHER VON WALDHEIM, 1823 | | | | | * | * | * |
| 266. | *Poecilus versicolor* (STURM, 1824) | * | * | * | * | | * | * |
| 267. | *Polistichus connexus* (GEOFFROY in FOURCROY, 1785) | | | * | * | | | |
| 268. | *Pterostichus anthracinus* (ILLIGER, 1798) | * | * | * | * | | | |
| 269. | *Pterostichus aterrimus* (HERBST, 1784) | | | * | * | | | |
| 270. | *Pterostichus cursor* (DEJEAN, 1828) | | | * | * | | | |
| 271. | *Pterostichus cylindricus* (HERBST, 1784) | | | * | * | * | | * |
| 272. | *Pterostichus diligens* (STURM, 1824) | | * | * | * | | | |
| 273. | *Pterostichus foveolatus* (DUFTSCHMID, 1812) | | * | | * | | | |
| 274. | *Pterostichus gracilis* (DEJEAN, 1828) | | | * | * | | | |
| 275. | *Pterostichus longicollis* (DUFTSCHMID, 1812) | | | | | | * | * |
| 276. | *Pterostichus macer* (MARSHAM, 1802) | | | | | | * | * |
| 277. | [*Pterostichus madidus* (Fabricius, 1775)] | | | | | | * | * |
| 278. | *Pterostichus melanarius* (ILLIGER, 1798) | * | * | * | * | * | * | * |
| 279. | *Pterostichus melas* (CREUTZER, 1799) | * | | * | * | * | | * |
| 280. | *Pterostichus minor* (GYLLENHAL, 1827) | * | | * | * | | | |
| 281. | *Pterostichus niger* (SCHALLER, 1783) | * | * | * | * | | * | * |
| 282. | *Pterostichus nigrita* (PAYKUL, 1790) | | * | * | * | | | |
| 283. | *Pterostichus oblongopunctatus* (FABRICIUS, 1787) | * | * | * | * | | | |
| 284. | *Pterostichus ovoideus* (STURM, 1824) | * | * | * | * | | | |
| 285. | *Pterostichus strenuus* (PANZER, 1797) | * | * | * | * | | | |
| 286. | *Pterostichus transversalis* (DUFTSCHMID, 1812) | | * | * | * | | | |
| 287. | *Pterostichus vernalis* (PANZER, 1796) | * | * | * | * | | * | * |
| 288. | *Stenolophus discophorus* FISCHER VON WALDHEIM, 1824 | * | | * | * | | | |
| 289. | *Stenolophus mixtus* (HERBST, 1784) | * | * | * | * | | | |
| 290. | *Stenolophus proximus* DEJEAN, 1829 | | * | * | * | | | |
| 291. | *Stenolophus skrimshiranus* STEPHENS, 1828 | * | | * | * | | | |
| 292. | *Stenolophus teutonus* (SCHRANK, 1781) | * | * | * | * | * | | * |
| 293. | *Stomis pumicatus* (PANZER, 1796) | * | * | * | * | | * | * |
| 294. | *Syntomus foveatus* (GEOFFROY in FOURCROY, 1785) | | | * | * | | | |
| 295. | *Syntomus obscuroguttatus* (DUFTSCHMID, 1812) | * | | * | * | | | |
| 296. | *Syntomus pallipes* (DEJEAN, 1825) | | | * | * | | | |
| 297. | *Syntomus truncatellus* (LINNAEUS, 1761) | * | * | * | * | | | |
| 298. | *Synuchus vivalis* (ILLIGER, 1798) | * | * | * | * | | | |
| 299. | *Tachita nana* (GYLLENHAL, 1810) | * | | * | * | | | |
| 300. | *Tachys diabrachys* (KOLENATI, 1845) | | | * | * | | | |
| 301. | *Tachys haemorrhoidalis* (PONZA, 1805) | | | * | * | | | |
| 302. | *Tachys parvulus* (DEJEAN, 1831) | | | * | * | | | |
| **303.** | ***Trechoblemus micros* (HERBST, 1784)** | * | | | | | | |
| 304. | *Trechus obtusus* ERICHSON, 1837 | | * | * | * | | | |
| 305. | *Trechus pilisensis* CSIKI, 1918 | * | * | * | * | | | |
| 306. | *Trechus quadristriatus* (SCHRANK, 1781) | * | * | * | * | * | * | * |
| 307. | *Zabrus tenebrioides* (GOEZE, 1777) | | | | | * | * | * |
| | Total | **173** | **123** | **265** | **279** | **27** | **43** | **57** |

## 3.2. Habitat preference of carabid beetles

Hereby we first summarise the habitat preference of carabid beetle species revealed in 2007 by trapping and by the identification of formerly collected material, in characteristic habitat types along Drava and Baranja.

### 3.2.1. Forest type habitats

Wet softwood gallery forests (willow-poplar forests): *Agonum micans, Badister collaris, Bembidion lampros, Blemus discus, Carabus cancellatus, Carabus granulatus, Cychrus caraboides, Elaphrus cupreus, Platynus assimilis, Pterostichus anthracinus, Pterostichus melanarius, Pterostichus niger, Pterostichus ovoidesus, Pterostichus strenuus*

Arid oak forests, oak-hornbeam mixed forests: *Abax carinatus, Abax palalellepipedus, Abax paralellus, Amara convexior, Amara saphyrea, Asaphidion flavipes, Badister miredionalis, Badister lacertosus, Bembidion lampros, Bembidion varium, Bembidion dentellum, Calosoma inquisitor, Carabus cancellatus, Carabus convexus, Carabus coriaceus, Carabus germari exasperatus, Harpalus atratus, Harpalus latus, Laemostenus terricola, Leistus piceus, Nebria brevicollis, Notiophilus rufipes, Platyderus rufus, Pterostichus melas, Pterostichus oblongopunctatus, Pterostichus ovoidesus, Pterostichus strenuus, Stomis pumicatus, Trechus pilisensis, Trechus quadristriatus, Synuchus vivalis, Tachyta nana*

Arid, mixed forests with higher elevation (Baranja): *Abax carinatus, Abax paralellus, Amara convexior, Amara saphyrea, Trechus quadristriatus, Synuchus vivalis, Pterostichus ovoidesus, Pterostichus strenuus, Pterostichus melas, Carabus cancellatus, Carabus convexus, Carabus coriaceus, Carabus germari exasperatus, Carabus nemoralis, Carabus ullrichi, Harpalus atratus, Platyderus rufus, Bembidion lampros.*

Forest edge (ecotone) associations, shrubs: *Licinus depressus, Philorhiizus quadrisignatus, Paradromius longiceps, Lebia chlorocephala,*

### 3.2.2. Wetland habitats

Sparse vegetation on gravelly riverbanks, gravel shoals, along streams: *Agonum viduum, Bembidion azurescens, Bembidion dalmatinum, Bembidion doris, Bembidion fasciolatum, Bembidion modestum, Bembidion prasinum, Bembidion punctulatum, Bembidion subcostatum, Bembidion tetracolum, Bembidion testaceum, Chlaenius vestitus, Elaphrus aureus, Paranchus albipes, Paratachys fulvicollis, Perileptus areolatus, Omophron limbatum*

Marshy meadows, sedges, waterside of oxbows, lakesides: *Agonum duftschmidi, Agonum emarginatum, Agonum fuliginosum, Agonum longicorne, Agonum micans, Agonum permoestum, Antracus consputus, Badister peltatus, Badister unipustulatus, Bembidion articulatum, Bembidion biguttaum, Bembidion fumigatum, Bembidion gilvipes, Bembidion inoptatum, Bembidion octomaculatum, Bembidion quadrimaculatum, Bembidion quadripustulatum, Bembidion semipunctatum, Bembidion starki, Bembidion varium, Blemus discus, Carabus clathratus, Chlaenius nigricornis, Chlaenius nitidulus, Chlaenius spoliatus, Clivina fossor, Demetrias imperialis, Drypta dentata, Dyschirius* *aeneus, Dyschirius gibbifrons, Dyschirius golbosus, Dyschirius politus, Elaphrus riparius, Notiophilus palustris, Odacantha melanura, Oodes gracilis, Oodes helopioides, Oxypselaphus obscurus, Paratachys micros, Paratachys bistriatus, Platynus livens, Pterostichus anthracinus, Stanolophus discophorus, Stenolophus mixtus, Stenolophus skirmshirianus, Stenolophus teutonus, Trechoblemus micros*

### 3.2.3. Grassland associations

Arid grassland, steppe-meadow type grassland: *Amara aulica, Amara bifrons, Amara equestris, Amara eurynota, Amara familiaris, Amara fulva, Amara lunicollis, Amara montivaga, Amara ovata, Anisodactylus nemorivagus, Bradicellus csikii, Dolichus halensis, Harpalus dimidiatus, Harpalus flavicornis, Harpalus rubripes, Harpalus subcylindricus, Harpalus tenebrosus, Licinus cassideus, Ophonus azureus, Ophonus diffinis, Ophonus puncticeps, Ophonus puncticollis, Ophonus punctulatus, Ophonus rufibarbis*

Wet hayfields: *Acupalpus dorsalis, Acupalpus flavicollis, Acupalpus interstitialis, Acupalpus maculatus, Acupalpus meridianus, Amara communis, Amara plebeja, Amara pseudostrenua, Amara similata, Anchomenus dorsalis, Badister sodalis, Bembidion properans, Brachinus explodens, Bradicellus csikii, Carabus granulatus, Dyschirius golbosus, Epaphius secalis, Notiophilus palustris, Parophonus dejeani, Parophonus maculicornis, Pterostichus vernalis*

Grassland vegetation of disturbed habitats: *Amara aenea, Calathus fuscipes, Calathus melanocephalus, Harpalus affinis, Harpalus griseus, Harpalus rufipes.*

The highest number of rare species and those with particular faunistic importance were found on gravelly riverbank, on gravel shoals, and in dry steppe meadow type grassland. The latter is quite infrequent in areas along Drava: such habitats are found in Baranja in small and fragmented grassland patches of loess elevations, and in higher terrain of flood-protected parts of the Drava floodland. The ground beetle assemblages recorded in the highly natural oak forests and oak-hornbeam forests having survived on the Croatian side in large expanses contained relatively low species and very few species with high faunistic significance. *Carabus* species, comprising a protected genus in Hungary, were found in high numbers, but they represented the most common, widely distributed species. Among the most significant forest species known from the Hungarian side (BÉRCES 2003; HORVATOVICH 1995, 1998), only *Leistus piceus* was found. The Baranja occurrence of a few species typical of low mountain regions (*Abax parallelepipedus, Carabus nemoralis*) is interesting from the aspect that they are now found in a lowland region, but the species themselves are not considered to be of particular faunistic value.

## 3.3. Short description of the most significant species

*Abax parallelepipedus* - Known mostly from moist forests of montane and hilly regions, it is a commonly distributed species. It occurs much rarer in lowlands, with more recent data having been published from the Szigetköz and Bereg areas only (KÖDÖBÖCZ &

Magura 1999). Also, from the Drava region, only few occurrences are known, from the areas of Őrtilos, Gyékényes and Putony (Horvatovich 1995; Bérces 2003). Although several forests were sampled along Drava in Croatia, all seeming to be suitable habitats for this species, it was revealed only from the quite highly natural oak-hornbeam forest at Haljevo (Haljevska šuma), near Beli Manastir.

*Acupalpus interstitialis* - Data for this species in the Carpathian basin originate from lowland areas, mostly from the Great Plain region. It had not been recorded formerly in the Drava region. During our studies, a few specimens were found in the floodland area near Repaš, in hayfield, and from material collected by light in Vízvár.

*Agonum viduum* - It is found mostly along creeks in montane areas, in which habitats it is not rare. From areas along Drava, data have been published only from the Barcs Juniper Woodland (Horvatovich 1981b, 1995). Now we recorded a single specimen from a creek valley in the north of Bansko brdo (Podolje).

*Amara equestris* - In Hungary, this species has been collected in grassland associations of lowlands and hilly regions. Its Hungarian occurrences are published by Szél (1996). In recent years, it was found in the Great Plain, too (Újszász: Szőrös-puszta, collected by B. Tallósi). As suggested by Viktor Ködöböcz, it occurs at several locations in the Nyírség region (personal communication). Quite recently, it has been reported to occur at several locations of Mecsek Mountains, too (Tallósi et al. 2006). From the Drava region, it was known from the Barcs Juniper Woodland only (Horvatovich 1981b, 1995). It was now collected from the flood-protected Drava floodplain near Gotalovo, in a moderately wet hayfield.

*Amara eurynota* - One of the largest-bodied species of its genus, it has wide distribution but usually appears in small numbers. Its known occurrences are restricted mostly to mountain and hilly regions, but it has been found also in moderately wet grassland habitats in several locations of the Great Plain region. No records have been published so far on its occurrence in the Drava region. We found a single specimen in the moderately moist hayfield of the flood-protected Drava floodplain near Gotalovo.

*Amara fulva* - It is a commonly distributed species of lowland sandy grasslands of the Carpathian basin, although it is not frequent. It has not been recorded in the Drava region. We revealed its occurrence beside the old gravel pit at Legrad and from material collected by light at Vízvár.

*Amara lunicollis* - It has been found to be a sporadically occurring, quite rare species in the Carpathian Basin. Its occurrence data have been summarised by Szél (1996). It is found mostly in moderately moist grassland associations, but it has not been known from the Drava region so far. During our investigations, we recorded several specimens in the flood-protected Drava floodplain near Gotalovo, in a moderately moist hayfield.

*Amara montivaga* - Being a montane species, it is found only sporadically in the area of present-time Hungary, in open, moist habitats. Most of its occurrence data originate from the western border areas of the country (Nagy et al. 2004), but it has been reported also from the Buda Hills, near Nagykovácsi (Hegyessy & Szél 2002). The closest occurrence to the Drava region is signified by data from Mecsek Mountains (Kaufmann 1914a; Horvatovich 1978), and from the vicinity of Cún-Szaporca along Drava (Horvatovich 1995). We found a single specimen in the moderately moist hayfield of the flood-protected Drava floodplain near Gotalovo.

*Amara pseudostrenua* - Its occurrence data in Hungary are mostly from the Great Plain region (ÁDÁM & MERKL 1986; HEGYESSY & SZÉL 2002). It has not been recorded before in areas along Drava. One specimen was collected in a moderately moist hayfield of cca. 0.5 ha area.

*Anisodactylus nemorivagus* - It is a species preferring moist habitats, occurring sporadically in Hungary. It is found in lowlands, hills and mountainous landscapes as well (HIEKE 1983; HEGYESSY & SZÉL 2002; KÖDÖBÖCZ 2001; KUTASI 2004). We recorded a few specimens in the flood-protected Drava floodplain near Gotalovo, in a moderately moist hayfield.

*Bembidion azurescens* - This species is found mostly along larger watercourses. Its occurrence is sporadic, but in suitable habitats it can be quite frequent (SZÉL 1996). It has been recorded formerly at several locations along Drava (HORVATOVICH 1995, 1998), yet it belongs to the rarer species. We collected this species on the gravelly surface of the riverside lido near Legrad.

*Bembidion doris* - Its few Hungarian occurrence data are from South- and West-Transdanubia (NAGY et al. 2004), the Balaton region (SÁGHY et al. 2003), and from Bakony Mountains (KUTASI 2004). From areas along Drava, it has been found only in the Barcs Juniper Woodland (HORVATOVICH 1981, 1995). Now it was revealed at the riverside, from a gravel shoal type of habitat near Novo Virje, and from the gravelly waterside of an oxbow at Repaš.

*Bembidion fasciolatum* - In Hungary it has been revealed along the shore of larger rivers (HEGYESSY & SZÉL 2002). HORVATOVICH (1995) mentions it as occurring at the Drava rivershore at Őrtilos. Although it is described as a montane species by the same author, it is not categorised as an important or rare species. We collected it on the gravelly rivershore of the lido, on the Croatian side near Legrad, opposite Őrtilos.

*Bembidion gilvipes* - It is a rare species found mostly in wet, marshy habitats. It has been reported to be restricted to areas along Drava (BÉRCES 1987; HORVATOVICH 1995). Two specimens were found in the material collected in 2003 by S. Farkas and S. Krčmar in Baranja, in the Danube floodland near the village Zmajevac.

*Bembidion prasinum* - It is a species of sporadic occurrence, living at rivershores. During recent decades it has been found near Tiszabecs in the Upper-Tisza region (HEGYESSY & SZÉL 2002). A more recent record originates from the Szigetköz area, but no occurrences have been reported from the Drava region. We collected its specimens from the gravelly surface of the lido near Legrad.

*Bembidion starki* - It is a species that is found very rarely. There is an old occurrence reported from Bőszénfa in the Zselic mountain region (HORVATOVICH 1990). It had no earlier data from the Drava region, now a single specimen was caught by light at Vízvár.

*Bembidion testaceum* - It has been collected near rivers at several locations of the Carpathian basin, but it had no data from the Drava region. We identified it from the material collected on the gravelly surface of the lido near Legrad.

*Blemus discus* - It is reported to have been found in plant debris of moist habitats, mostly watersides (HEGYESSY & SZÉL 2002), but it is common only at some places. It is known from several Transdanubian locations (HORVATOVICH 1979, 1992), and it has been revealed in the Middle-Tisza region as well (TALLÓSI 2003). Some localities are known from the Mecsek Mountains and its surrounding areas (TALLÓSI et al. 2006), and it was collected earlier from the Drava region as well (HORVATOVICH 1995, 1998). During our research in the target area, huge numbers were caught by light at Vízvár: and it was revealed also from the side of an oxbow near Repaš on the Croatian side of the river.

*Bradycellus csikii* - NAGY et al. (2004) reports this species to be more common and more widely distributed than what was thought earlier. It has been collected from lowland areas as well as from mountains (SZÉL 1996). A few occurrences are known from Mecsek Mountains, too (TALLÓSI et al. 2006). Two specimens were revealed from the flood-protected Drava floodplain near Gotalovo, in moderately moist hayfield.

*Carabus cancellatus maximus* - Its several subspecies inhabit a variety of habitat types of the Carpathian Basin. It is a *Carabus* species typically occurring in moderately moist forests of lowlands, hilly regions as well as mountains, but it has been revealed also in the Hortobágy puszta grassland (TALLÓSI 2007) and the floodland of Tisza river (TALLÓSI 2003). It is found in all forest-type habitats throughout the Drava region and in Baranja. It is important because of its nature conservation status: it is a protected species in Hungary.

*Carabus clathratus auraniensis* - It is a *Carabus* species of marshes and marshy meadows. In suitable habitats it can appear anywhere, but usually it is not frequent. It occurs regularly and is found in large numbers at certain places, in the margins of marshes and marshy meadows in the Great Plain and especially in the Tiszántúl region (TALLÓSI 2001, 2003, 2007). It has been collected in several localities along Drava (BÉRCES 1997, 2003; HORVATOVICH 1998). A single specimen was found in the material collected in 2003 by S. Farkas and S. Krčmar in Baranja in the Danube floodland near Zmajevac.

*Carabus convexus convexus* - It is a protected *Carabus* species occurring in Hungary mostly in moderately moist oak forests and oak-hornbeam forests of hilly and mountain areas, usually in low numbers. It has some earlier data from the Drava region too (HORVATOVICH 1995, 1998). During our survey performed on the Croatian side of the river we have managed to indicate its occurrence only from the oak-hornbeam forests near Hlebine and Novačka.

*Carabus coriaceus praeilliricus* - Despite its protected status in Hungary, it is one of the commonest *Carabus* species of hilly and mountain forests. In the lowland region, however, it is absent or is very rare in even the most natural forests. During our surveys in Croatian forests and forest-type habitats along Drava and in Baranja, it was found to be present everywhere.

*Carabus germari exasperatus* - In Hungary it is a commonly distributed, normally frequent, protected species of forest-type habitats of South-Transdanubia. In Croatia, too, it was found to occur in most of the studied forests.

*Carabus granulatus* - Another protected *Carabus* in Hungary, it is a common species of meadows, marshy meadows and softwood gallery forests, sometimes being present in masses. It was found regularly in its typical habitats in Croatia as well.

*Carabus nemoralis nemoralis* - Belonging to the rarer *Carabus* species, it is another protected species in Hungary, found mostly in drier habitats of lower mountain or sometimes hilly regions. There are a number of occurrences having been reported from the Drava region (BÉRCES 1997; HORVATOVICH 1995, 1998). Now it was found in mixed forests of Bansko brdo, and from highly natural oak forests and oak-hornbeam forests near Kneževo, Novačka and Haljevska šuma.

*Carabus ullrichi baranyensis* - Protected in Hungary, it is a species occurring frequently in hills and low mountain areas. Its lowland subspecies *Carabus ullrichi planitiae* Csiki 1906 can abound in masses in many forest habitats of the Jászság area (TALLÓSI

2003). It has been shown to exist in several localities of the Hungarian side of Drava (Bérces 2003; Horvatovich 1995, 1998). On the Croatian side, however, we have been able to identify it from the material collected in Baranja (Topolje: Ugleš), but we have not been able to find it in oak forests along Drava.

*Dyschirius chalybaeus gibbifrons* - Although data are known from several locations of Hungary, it is more frequent in the eastern parts. It is encountered mostly in waterside habitats (Hegyessy & Szél 2002; Ködöböcz 2006; Tallósi 2003). It had no earlier data from the Drava area and Branja. We collected it on the silty waterside of an oxbow near Novo Virje.

*Dyschirius politus* - In the Carpathian Basin it normally occurs in low-lying wet areas, mostly on watersides. There are several occurrences having been reported (Hegyessy & Szél 2002; Ködöböcz 2006; Nagy et al. 2004), yet it is not a frequent species. Prior to our studies it had not been recorded in areas along Drava. We found a few specimens near Novo Virje, on the silty waterside of an oxbow, and by light in Vízvár.

*Elaphropus quadrisignatus* - Only few habitats are known to exist in Hungary, e.g. Mosonmagyaróvár, Dömös, Pécs (Nagy et al. 2004). Prior to our studies it had not been recorded in areas along Drava. We found a single specimen on the gravelly surface of the lido near Legrad.

*Elaphrus cupreus* - It is distributed in marshy areas, mostly in the eastern parts of the Great Plain, but can be found sporadically in other areas of the country as well (Ádám & Merkl 1986; Hegyessy & Szél 2002; Kutasi 2000a, 2000b; Nagy et al. 2004; Rozner 2003; Szentkirályi 2001). It has been found in Mecsek Mountains, too (Tallósi et al. 2006), although it is a rare species. It is known from several areas in the Drava region (Bérces 1997; Horvatovich 1995, 1998). On the Croatian side, we collected a single specimen near Novi Gradac.

*Epaphius secalis* - Occurring in many places in Hungary, it is even frequent at places (Nagy et al. 2004). From earlier times, there are sporadic data from the Hungarian side of Drava (Bérces 1997, 2003; Horvatovich 1995, 1998). On the Croatian side, it is mostly wet meadows where we collected this species, near Legrad, Repaš and Novo Virje. From the latter, it was collected in abundance.

*Harpalus subcylindricus* - Being common mostly in the eastern part of Hungary, it can belong to the dominant species in dry or saline grasslands (Tallósi 2003, 2005, 2007). It was not collected formerly in areas along Drava. Now several specimens were found in the vicinity of the village Mekiš.

*Harpalus tenebrosus* - It is a relatively infrequent carabid beetle of warm and arid grassland habitats. It has been found throughout Hungary, but it is most typically collected in lowlands and hilly regions (Hegyessy & Szél 2002; Horvatovich 1982, 1992; Kádár & Lövei 1997; Kádár & Szél 1999a; Kutasi 1998, 2000a; Szentkirályi 2001). Earlier information on its occurrence in the Drava region is available on one record only (Horvatovich 1995). A new specimen in this region was found during our studies, using light at Vízvár.

*Laemostenus terricola* - It stays in underground holes and tunnels of forested areas, but it has been revealed also in various types of artificial structures (shafts, cellars, etc.). It was reported most often from hilly regions and mountains (Hegyessy & Szél 2002; Horvatovich 1978, 1989; Kádár & Szél 1999b; Kutasi 2000a, 2000b; Nagy et al. 2004; Szél 1996), but its presence in lowland areas is supported by few data only (Ádám 1981).

No former data are available on its presence in the Drava region. During our surveys in forest type habitats of Croatian Baranja, it was found in several of the localities: Haljevska šuma, Kneževi Vinogradi, Kneževo, Bansko brdo.

*Leistus piceus piceus* - It is a relatively rare species of moist montane forests, mostly beechwoods, and of deeper valleys of creeks and streams. Its occurrences in Hungary, too, are restricted to mountains (HEGYESSY & SZÉL 2002; HORVATOVICH 1975, 1978, 1979; SZÉL 1996; NAGY et al. 2004). In Transdanubia, however, this species does descend to areas with lower elevation (HORVATOVICH 1990; ROZNER 2003). It was earlier collected in several locations along the Hungarian side of Drava (BÉRCES 1997; HORVATOVICH 1995, 1998), and now we revealed it in a number of places during our surveys in Croatia: Haljevska šuma, Novačka, Novo Virje, Repaš.

*Licinus cassideus* - A rare and warmth-loving beetle of arid, grassy areas, it is found in the Great Plain mostly in sandy or loess grasslands (ÁDÁM 1981; ÁDÁM & MERKL 1986; TALLÓSI 2003; KUTASI et al. 2004). Sometimes it is also found on south-facing, treeless slopes of hilly regons and mountains (HEGYESSY & SZÉL 2002; HORVATOVICH 1989; SZÉL 1996). It was found earlier in Mecsek Mountains too (HORVATOVICH 1978; TALLÓSI et al. 2006), and now it was revealed from the vicinity of Bolman.

*Odacantha melanura* - It is a typical carabid species of reedbeds and high sedge associations, It has several occurrences in various parts of the country (ÁDÁM & MERKL 1986; ÁDÁM & RUDNER, 1996; HEGYESSY & SZÉL 2002; KÖDÖBÖCZ 2001; KUTASI 2000a, 2004; SÁGHY et al. 2003; TALLÓSI 2003; NAGY et al. 2004). By present time, it has become rarer as a result of reed-burning and fires of the undergrowth. There is only one former occurrence in the Drava region, from the Barcs Juniper Woodland (HORVATOVICH 1981). On the Croatian side, it was revealed at Novo Virje.

*Paradromius longiceps* - Its Hungarian occurrences include, among others: Szentendre, Pócsmegyer, Pécel, Fertő-tó (CSIKI 1946), Ócsa: Nagy-erdő (ÁDÁM & MERKL 1986), Debrecen, Derecske (KÖDÖBÖCZ personal communication), Kétegyháza (ÁDÁM & RUDNER 1996) and Hosszúhetény (HORVATOVICH 1991). There is only one former occurrence from the Drava region, i.e. from the area of Cún-Szaporca (HORVATOVICH 1985). As part of our surveys, we could reveal its presence in the material collected using light at Vízvár: and from the areas of Repaš on the Croatian side.

*Paratachys fulvicollis* - Old Hungarian occurrence data are known from Bakony and the Balaton Uplands (TÓTH 1973), as well as from Zselic (HORVATOVICH 1979). One specimen was now collected at Vízvár with light, and we also caught it on the gravelly Drava rivershore at Novo Virje on the Croatian side.

*Parophonus dejeani* - It is a species living in arid, warm grassland habitats of plain regions. There are only few reliable data on its Hungarian occurrence (HEGYESSY & SZÉL, 2002; NAGY et al. 2002), due to the fact that it was often confused with *Parophonus maculicornis*, a quite similar species. Several pieces of earlier data are available on its occurrence in the Drava region (BÉRCES 1997, 2003; HORVATOVICH 1995, 1998). During our studies, a number of specimens were found on the Croatian side, in a moderately moist hayfield in the flood-protected Drava floodplain near Gotalovo.

*Perileptus areolatus* - It is found sporadically, mostly on gravelly and sandy riverside sections flushed by fresh water. There are several locations of occurrence on the Hungarian side of Drava (HORVATOVICH 1998). In Croatia we collected this species on the gravelly and sandy rivershore near Legrad and Repaš.

*Philorhizus quadrisignatus* - Its Hungarian occurrences are from the area of Haláp (Ködöböcz 2006). During our studies we found a single specimen in the material collected using light in Vízvár: and another one from Repaš on the Croatian side.

*Pterostichus minor* - A commonly distributed species throughout Hungary, it was mostly found in wet habitat types (Hegyessy & Szél 2002; Nagy et al. 2004). There are no earlier data on its occurrence from the areas along Drava. We found it near Bolman in Baranja.

*Trechoblemus micros* - This species is usually found in caves and underground cavities (Szél 1999). Sporadically it also occurs at waterside areas and other wetland habitats. It is relatively rare (Ádám & Merkl 1986; Hegyessy & Szél 2002; Nagy et al. 2004; Tallósi 2003), with no earlier data from the Drava region. Now we found it on the Croatian side of the river, near Novo Virje.

## 4. Summary

From studies performed in 2007, focusing on Croatian areas of the Drava region, and from the analysis of formerly collected material in Croatian Baranja, a total of 173 carabid beetle species are listed. Among those found, 17 species had been unknown from this area.

The majority of rare species that were found to be new in the area and (or) those bearing particular faunistic significance were collected on the gravelly riverside and gravel shoals of Drava, and from dry steppe meadow type of grassland habitats. Carabid beetle assemblages with high species diversity were revealed in hayfields and other wet grassland patches of the Drava floodplain, these habitats being the ones in which most of the important species were recorded. The carabid assemblages having been recorded in oak forests and oak-hornbeam forests surviving in a natural status in large expanses on the Croatian side, are characterised with low species numbers, and very few species of faunistic significance. Among the *Carabus* species protected in Hungary and now found in large numbers, only the most common representatives were found.

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# *Myrmeleon bore* (Tjeder, 1941), an ant-lion species new to the fauna of Croatia (Neuroptera: Myrmeleontidae)

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**Abstract:** As part of the results of zoological studies performed along river Drava in Croatia in 2007, a new species of the country's neuropteran fauna, *Myrmeleon bore* (Tjeder, 1941) was found. This locally frequent species is typical of the northern plain regions of Croatia, i.e. to its subpannonian region.

Pursued as part of the Slovenia-Croatia-Hungary interregional co-operation scheme, conservation biological baseline surveying was launched in 2007, performed mostly by Hungarian researchers, along the right side of the river Drava in Croatia. Fauna surveying and biological monitoring has been performed on the left side of the river, in Hungary, for years now, but the surveying of natural values on the right side of the river has been quite incomplete. The neuropteran fauna of the area is totally unexplored (DEVETAK 1992a, 1992b). Research activities along the state border river have become more intensive during the last two decades, and due to the high richness in nature conservation values, the areas in Hungary were declared protected under the name Duna-Drava National Park in 1996, then were designated as NATURA 2000 sites.

The aim of the present investigations in Croatia has been to get closer to extending protected areas across the border, and to come out with recommendations for new NATURA 2000 site designations in Croatia.

The series of investigations carried out in 2007 aimed at the baseline surveying of several invertebrate as well as vertebrate taxa, with neuropterans not being included in the target taxa. However, during field surveys in floodplain waterside habitats along Drava it was striking that many ant-lion pits occurred in the sandy surface (Fig. 1.). After the larvae had been excavated from the pits it was determined that a new ant-lion species, formerly unknown from Croatia's fauna, *Myrmeleon bore* (Tjeder, 1941) was found there, which could even be frequent locally.

The finding of this species was expected almost for sure, because it had been recorded earlier in Hungarian territories neighbouring this Croatian area (ÁBRAHÁM 1995, 1998; ÁBRAHÁM & PAPP 1991).

The taxonomically separate status of *Myrmeleon bore* has been known since the middle of the 20th century. Data about its distribution, however, became widely known only around the end of the 20th century (DOBOSZ 1993; KACIREK 1997; LETARDI 1997; RÖHRICHT 1998). It occurs throughout the Palaeartic (ASPÖCK et al. 2001). According to

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Fig. 1. Pits of ant-lion in the loose sandy soil  (Photo by Levente Ábrahám)

Fig. 2. Habitat of *Myrmeleon bore* in Drava region (Photo by Levente Ábrahám)

Fauna Europaea (www.faunaeur.org), so far it has been found in 12 European countries.

Most probably, its larvae are locally frequent in Croatia's northern areas with loose (sandy) soils, making their pits in open habitats (Fig. 2.). The larvae of this ant-lion species are easy to care for, making the species widely used in ecological investigations (Matsura 1986, 1987; Ábrahám 2006).

Because the high altitude mountain range with alpine character stretching along the middle of the country is unsuitable for ant-lions preferring dry and warm conditions, the ant-lion fauna of Croatia is typically divided into two parts. For several species, the northern boundaries of their distribution area extend along the Adriatic region under Mediterranean influence, e.g.: *Palpares libelluloides* (Linnaeus, 1764), *Delfimeus irroratus* (Olivier, 1811), *Neuroleon microstenus* (MacLachlan, 1898)*, Nicarinus poecilopterus* (Stein, 1863), *Gymnocnemia variegata* Schneider, 1845.

The northern parts of the country with continental climate are lowlands with alluvial soil deposition, where the proportion of natural habitats is low, due to intensive agricultural land use. This species has good indicative characteristics, and as such has outstanding nature conservation significance in the region. As a character species of the areas along the Drava river (subpannonian region), it deserves protected status due to its narrow distribution range in Croatia. In several European countries it is protected or is included in Red Lists eg. Germany, Austria, Poland (Gepp & Hölzel 1989).

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# On the caddisflies (Trichoptera) of the common Croatian-Hungarian reach of Drava river

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**Abstract:** The examination of caddisflies (Trichoptera) started fifteen years ago along the Drava river, just on the Croatian-Hungarian border. The study of the Croatian side went on only in the year 2007. Up to the present 85 species were pointed out from this reach, these species being present in both countries. The most valuable species from the aspect of nature conservation is *Platyphylax frauenfeldi* Brauer, 1857 (Limnephilidae) its global ultimate existing population living in the river system of Drava and Mura, along the common border. In the undisturbed reaches of Drava one of the most diverse caddisfly communities of Central Europe is found.

## 1. Introduction

The first paper of the caddisflies of the Hungarian reach of Drava river was published only 15 years ago: at that time, UHERKOVICH and NÓGRÁDI (1992) reported about the occurrence of 44 species from a site at Szentborbás (Hungary). Then they discovered a relatively strong population of *Platyphylax frauenfeldi* Brauer, 1857 (Limnephilidae) among others. Since that time an intensive study was carried out by the authors of the paper cited above on the caddisflies of the whole Hungarian section of Drava river. They published several locality data in two larger papers (NÓGRÁDI & UHERKOVICH 1995, 1998), later they wrote about some results of biomonitoring carried out since 1999 (UHERKOVICH & NÓGRÁDI 2005). In some short papers they gave data of new and rare Hungarian species – among others those from Drava water system (NÓGRÁDI 1994, 1998, 2001; UHERKOVICH 2005), and two special papers were dedicated to the most valuable caddisfly species of Hungarian fauna, *Platyphylax frauenfeldi* Brau. (UHERKOVICH & NÓGRÁDI 1997; MALICKY et al. 2002).

The authors' papers dealing with caddisflies of major Hungarian rivers and endangered species of Hungary (NÓGRÁDI & UHERKOVICH 1998, 2002; UHERKOVICH 2006; UHERKOVICH & NÓGRÁDI 2002) show many connections and data for caddisflies of Dráva river. Currently 113 caddisfly species are known from the Drava area, these run up to 54% of the total Hungarian fauna (cf. NÓGRÁDI & UHERKOVICH 2002).

On the other hand, neither important papers nor species lists (check lists) have been published yet about the caddisflies of the Croatian side of Drava river. In the most recent volume of Natura Croatica PREVIŠIĆ et al. (2007) list 24 species from the Croatian section of Drava, where some hydroelectric power plants were built in the past. The authors report on five species as being new for Croatian fauna. Some of those species are frequent along

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the common Croatian-Hungarian sections (*Hydroptila sparsa* Curt., *Oecetis ochracea* Curt., *Mystacides longicornis* L.), while others also occur in the Hungarian Drava region but are rarer (*Tinodes pallidulus* McL., *Hydroptila vectis* Curt.).

## 2. Collecting sites along the common Croatian-Hungarian border

Our earlier collecting sites lay close to the state border, 50…200 m away from that, but in some cases only a few meters away. All of these sites – except for only one (Bélavár, Almás-berek, Zsdála brook) – lay in such situations where the state border follows the course of the river or it crosses the river. We presumed that caddisflies which were collected in these sites developed and/or lived in the common reach of the river, and we could have as well collected them on the opposite, Croatian, side too (UHERKOVICH et al. 2007). Actually, collections would result in very similar (practically identical) species lists and quantitative data on the opposite site.

Table. 1. Localities along the common Croatian-Hungarian section of Drava river

| Locality in Hungary | Locality on the opposite side (Croatia) | In the species list | UTM grid | longitude East | latitude North |
|---|---|---|---|---|---|
| **Barcs, Drava-riverside*** | Terezino Polje | Barcs | – | – | – |
| **Barcs, Rinya-Ó-Dráva** | Starogradački Marof / Križnica | Barcs, Rinya | XL89 | 17°23’40” | 45°57’40” |
| **Bélavár, Zsdála-stram, Almás-berek** | Ždala | Bélavár, Zsdála | XM61 | 17°11’15” | 46°08’00” |
| **Bélavár, Zsdála mouth (Drava-riverside)** | Novo Virje | Bélavár | XM60 | 17°10’45” | 46°06’40” |
| **Drávapalkonya, Drava-riverside** | Donji Miholjac | Drávapalkonya | BR87 | 18°11’35” | 45°47’15” |
| **Drávasztára, Drava-riverside** | Noškovci | Drávasztára | YL17 | 17°49’45” | 45°48’40” |
| **Drávasztára, Nagy-Füzes-forest** | Noškovci | Drávasztára, Nagy-Füzes | YL27 | 17°51’05” | 45°47’05” |
| **Drávatamási, high bank** | Novi Gradac | Drávatamási | XL99 | 17°33’35” | 45°56’25” |
| **Heresznye, high bank** | Ferdinandovac | Heresznye, magaspart | XM70 | 17°15’40” | 46°03’55” |
| **Heresznye, Rasztina, Drava-riverside** | Brodić | Heresznye | XM70 | 17°15’50” | 46°02’50” |
| **Hirics, Suggó, Drava-riverside** | Podravska Moslavina | Hirics | BR67 | 18°00’50” | 45°47’25” |
| **Matty, Keselyősfa-puszta, Drava-riverside** | Sveti Đurađ | Matty | BR87 | 18°16’50” | 45°46’05” |
| **Őrtilos, railway station** | Legrad | Őrtilos | XM42 | 16°53’15” | 46°17’55” |
| **Szentborbás, Water measuring station** | Budakovac | Szentborbás | YL08 | 17°39’05” | 45°51’45” |
| **Vejti, Drava-riverside** | Podravska Moslavina | Vejti | YL37 | 17°59’00” | 45°47’35” |
| **Vízvár, Drava-riverside** | Ferdinandovac | Vízvár | XM70 | 17°13’30” | 46°05’10” |
| **Zaláta, Adravica-mouth** | Noškovci | Zaláta | YL27 | 17°51’25” | 45°47’10” |

* it covers several sites located side by side (Drávaerdő; port; former plastic works; Szilonics-puszta; railway station), so its UTM grid is uncertain (=XL89 or 99), and coordinates also differ.

Table 2. Collections of caddisflies in the Drava section in Croatia: localities and their data

| Full locality name | In the species list | UTM | longitude East | latitude North | Date of sampling (* sampling on light) |
|---|---|---|---|---|---|
| **Brodić, ferry boat port** | **Brodić** | XL79 | 17˚15’42” | 46˚01’21” | 02.07.2007* |
| **Đelekovec: Šoderica** (Fig. 1.) | **Đelekovec** | XM42 | 16˚55’39” | 46˚14’38” | 11.05.2007, 02.08.2007 |
| **Ferdinandovac** | **Ferdinandovac** | XM70 | 17˚15’08” | 46˚03’02” | 03.06.2007* |
| **Gotalovo** (Fig. 2.) | **Gotalovo** | XM52 | 16º57’36” | 46º13’37” | 09.06.2007* |
| **Legrad, mouth of Mura** | **Legrad** | XM42 | 16˚53’10” | 46˚17’48” | 15.06.2007* |
| **Molve, Drva riverside at bridge** | **Molve** | XM42 | 16˚55’39” | 46˚14’38” | 11.05.2007 |
| **Noškovci, Bobrovac** (Fig. 3.) | **Noškovci** | YL17 | 17º48’27” | 45º48’03” | 13.06.2007* |
| **Pitomača, Šašnato Polje** (Fig. 4.) | **Pitomača** | XL79 | 17º18’27” | 45º58’21” | 14.07.2007* |
| **Starogradački Marof / Križnica** | **Starogradački Marof** | XL89 | 17º23’40” | 45º57’40” | 11.05.2007 |

Fig. 1. Gravel pit pond in early spring (Đelekovec: Šoderica).
Here only daytime caddisfly sampling was carried out (Photo by Ákos Uherkovich)

Fig. 2. Important nighttime sampling site at Gotalovo railway bridge
(Photo by Ákos Uherkovich)

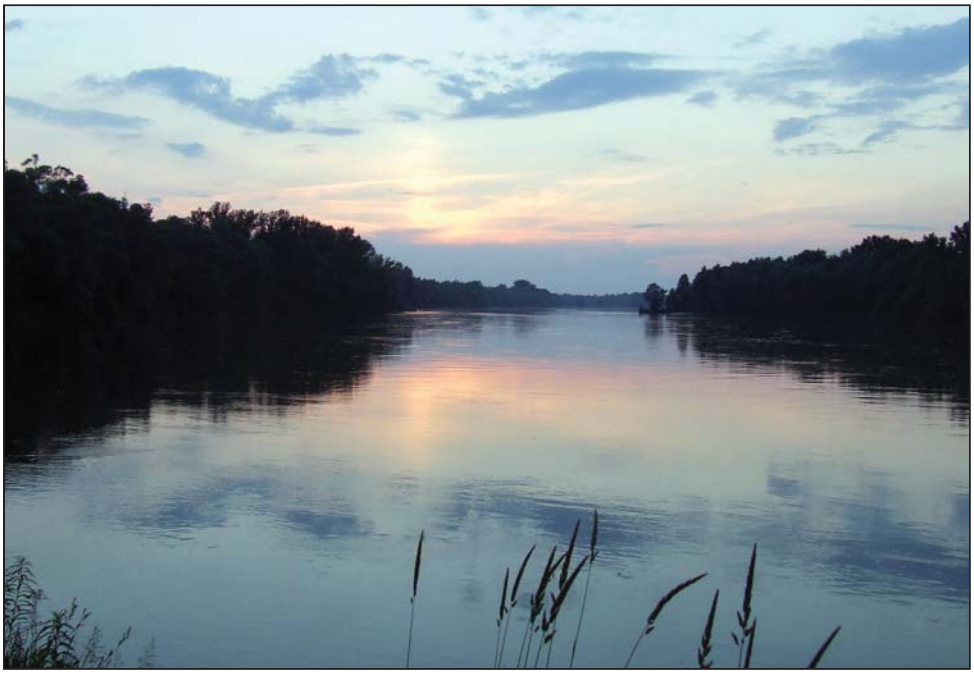

Fig. 3. Drava river 2.5 km NW of Noškovci (117.3 river km) at sunset, before sampling on light (Photo by Ákos Uherkovich)

Fig. 4. Collecting sheet and lamp prior to night sampling on the right side of Drava, near Pitomača, Šašnato Polje (174.7 river km) (Photo by Ákos Uherkovich)

# 3. List of caddisflies of the common section and the results of monitoring in 2007

In this chapter the nomenclature and system of NÓGRÁDI and UHERKOVICH (2002) is applied. After the species name – interrupted by a hyphen – the short name (see Table 1.) of the published localities of the common section follows. Then, separated by two asterisks, the data of recent examinations in Croatia (2007) are given in **bold**.

**Rhyacophilidae**

*Rhyacophila dorsalis* (Curtis, 1834) – Bélavár; Drávasztára; Őrtilos; Vejti; Vízvár.

**Glossosomatidae**

*Glossosoma boltoni* Curtis, 1834 – Őrtilos ** **Legrad**

*Agapetus laniger* (Pictet, 1834) – Őrtilos; Vízvár ** **Ferdinandovac, Gotalovo, Legrad, Pitomača**

**Hydroptilidae**

*Orthotrichia angustella* (McLachlan, 1865) – Drávasztára; Vejti; Vízvár ** **Noškovci**

*Orthotrichia costalis* (Curtis, 1834) – Barcs, Rinya; Drávapalkonya; Heresznye; Őrtilos; Szentborbás; Vejti.

*Orthotrichia tragetti* Mosely, 1930 – Bélavár. Drávapalkonya; Drávasztára; Heresznye; Őrtilos; Szentborbás; Vejti; Vízvár ** **Gotalovo, Noškovci**

*Oxyethira falcata* Morton, 1893 – Őrtilos; Vejti.

*Oxyethira flavicornis* (Pictet, 1834) – Barcs, Rinya; Bélavár; Őrtilos; Vízvár ** **Ferdinandovac, Pitomača**

*Ithytrichia lamellaris* Eaton, 1873 – Őrtilos; Szentborbás.

*Hydroptila angustata* Mosely, 1939 – Őrtilos; Szentborbás.

*Hydroptila forcipata* (Eaton, 1873) –Bélavár Őrtilos; Vejti..

*Hydroptila lotensis* Mosely, 1930 – Őrtilos; Vejti ** **Brodić, Legrad, Noškovci, Pitomača**

*Hydroptila sparsa* Curtis, 1834 – Barcs, Rinya; Bélavár; Drávapalkonya; Drávasztára; Drávasztára, Nagy-Füzes; Drávatamási; Heresznye; Őrtilos; Tótújfalu; Vejti; Vízvár ** **Brodić, Legrad, Noškovci, Pitomača**

*Hydroptila vectis* Curtis, 1834 – Őrtilos.

*Agraylea sexmaculata* Curtis, 1834 – Bélavár; Drávapalkonya; Drávasztára; Őrtilos; Szentborbás; Tótújfalu Vejti ** **Brodić, Pitomača**

**Hydropsychidae**

*Hydropsyche angustipennis* Curtis, 1834 – Bélavár, Zsdála; Drávasztára, Nagy-Füzes; Heresznye, magaspart; Őrtilos; Vejti; Vízvár ** **Legrad**

*Hydropsyche bulbifera* McLachlan, 1878 – Őrtilos; Vízvár.

*Hydropsyche bulgaromanorum* Malicky, 1977 – Barcs; Bélavár; Drávapalkonya; Drávasztára; Drávasztára, Nagy-Füzes; Drávatamási; Heresznye; Matty; Őrtilos; Szentborbás; Tótújfalu; Vejti; Vízvár ** **Brodić, Ferdinandovac, Gotalovo, Legrad, Noškovci, Pitomača, Starogradački Marof**

*Hydropsyche contubernalis* McLachlan, 1865 – Barcs; Barcs, Rinya; Bélavár; Drávapalkonya; Drávasztára; Drávasztára, Nagy-Füzes; Drávatamási; Heresznye; Matty; Őrtilos; Szentborbás; Tótújfalu; Vejti; Vízvár ** **Brodić, Ferdinandovac, Gotalovo, Legrad, Molve, Noškovci, Pitomača, Starogradački Marof**

*Hydropsyche modesta* Navás, 1925 – Barcs; Barcs, Rinya; Drávapalkonya; Drávasztára, Nagy-Füzes; Őrtilos; Szentborbás; Vejti; Vízvár ** **Ferdinandovac**

*Hydropsyche ornatula* McLachlan, 1878 – Barcs; Bélavár; Drávapalkonya; Drávasztára; Heresznye; Őrtilos; Szentborbás; Vejti; Vízvár.

*Hydropsyche pellucidula* (Curtis, 1834) – Barcs; Bélavár; Drávasztára; Heresznye; Őrtilos; Szentborbás; Vejti; Vízvár ** **Ferdinandovac, Gotalovo, Legrad**

*Hydropsyche siltalai* Döhler, 1963 – Őrtilos; Vízvár.

**Polycentropodidae**

*Neureclipsis bimaculata* (Linnaeus, 1758) – Barcs; Barcs, Rinya; Bélavár; Drávapalkonya; Drávasztára; Drávasztára, Nagy-Füzes; Őrtilos; Szentborbás; Vejti; Vízvár ** **Brodić, Ferdinandovac, Gotalovo, Legrad**

*Plectrocnemia conspersa* (Curtis, 1834) – Őrtilos.

*Polycentropus irroratus* (Curtis, 1834) – Vejti.

*Holocentropus dubius* (Rambur, 1842) – Bélavár Szentborbás.

*Holocentropus picicornis* (Stephens, 1836) – Bélavár; Drávapalkonya; Drávasztára; Matty; Őrtilos; Szentborbás.

*Cyrnus crenaticornis* (Kolenati, 1859) – Barcs, Rinya; Bélavár; Drávasztára, Nagy-Füzes; Szentborbás; Vejti; Vízvár ** **Đelekovec**

*Cyrnus trimaculatus* (Curtis, 1834) – Drávasztára; Szentborbás; Vejti; Vízvár ** **Noškovci**

**Psychomyidae**

*Psychomyia pusilla* (Fabricius, 1781) – Barcs; Barcs, Rinya; Bélavár; Drávapalkonya; Drávasztára; Drávasztára, Nagy-Füzes; Drávatamási; Heresznye; Őrtilos; Szentborbás; Tótújfalu; Vejti; Vízvár ** **Brodić, Ferdinandovac, Gotalovo, Legrad, Molve, Pitomača**

*Lype phaeopa* (Stephens, 1836) – Barcs; Bélavár; Drávasztára; Drávasztára, Nagy-Füzes; Drávatamási; Szentborbás; Vejti; Vízvár.

*Lype reducta* (Hagen, 1868) – Őrtilos; Szentborbás.

**Ecnomidae**

*Ecnomus tenellus* (Rambur, 1842) – Barcs, Rinya; Bélavár; Drávapalkonya; Drávasztára; Drávasztára, Nagy-Füzes; Drávatamási; Heresznye; Szentborbás; Tótújfalu; Vejti; Vízvár ** **Brodić, Đelekovec, Ferdinandovac, Gotalovo, Legrad, Pitomača**

**Phryganeidae**

*Trichostegia minor* (Curtis, 1834) – Barcs, Rinya; Bélavár; Drávasztára; Drávasztára, Nagy-Füzes; Matty; Őrtilos; Szentborbás; Vejti ** **Noškovci**

*Agrypnia varia* (Fabricius, 1793) – Bélavár; Drávasztára; Őrtilos; Vízvár ** **Legrad**

*Phryganea grandis* Linnaeus, 1758 – Barcs; Barcs, Rinya; Drávapalkonya; Őrtilos; Szentborbás; Tótújfalu; Vízvár.

**Brachycentridae**

*Brachycentrus subnubilus* Curtis, 1834 – Barcs; Bélavár; Drávapalkonya; Dráva-sztára; Hirics; Őrtilos; Tótújfalu; Vejti; Vízvár; Zaláta ** **Molve, Starogradački Marof**

**Limnephilidae**

*Limnephilus affinis* Curtis, 1834 – Barcs, Rinya; Drávasztára; Matty; Őrtilos; Szentborbás; Vízvár.

*Limnephilus auricula* Curtis, 1834 – Barcs, Rinya; Drávasztára, Nagy-Füzes; Matty; Őrtilos; Vejti; Vízvár.

*Limnephilus bipunctatus* Curtis, 1834 – Matty; Szentborbás; Vízvár.

*Limnephilus decipiens* (Kolenati, 1848) – Őrtilos.

*Limnephilus extricatus* McLachlan, 1865 – Őrtilos.

*Limnephilus flavicornis* (Fabricius, 1787) – Barcs; Barcs, Rinya; Bélavár; Drávapalkonya; Drávasztára; Matty; Őrtilos; Szentborbás; Vejti; Vízvár.

*Limnephilus griseus* (Linnaeus, 1758) – Bélavár; Őrtilos; Szentborbás; Vízvár.

*Limnephilus incisus* Curtis, 1834 (syn.: *Colpotaulius incisus)* – Bélavár; Drávasztára; Vejti.

*Limnephilus lunatus* Curtis, 1834 – Barcs, Rinya; Bélavár; Drávapalkonya; Őrtilos; Szentborbás; Tótújfalu; Vejti; Vízvár.

*Limnephilus rhombicus* (Linnaeus, 1758) – Őrtilos; Vízvár.

*Limnephilus vittatus* (Fabricius, 1798) – Matty; Szentborbás; Vízvár.

*Grammotaulius nigropunctatus* (Retzius, 1783) – Barcs; Barcs, Rinya; Bélavár; Matty; Szentborbás; Vejti; Vízvár.

*Glyphotaelius pellucidus* (Retzius, 1783) – Barcs; Barcs, Rinya; Bélavár; Drávapalkonya; Drávasztára, Nagy-Füzes; Matty; Őrtilos; Szentborbás; Vejti; Vízvár.

*Anabolia furcata* Brauer, 1857 – Bélavár; Drávasztára; Őrtilos; Szentborbás; Vejti; Vízvár.

*Potamophylax luctuosus* (Piller & Mitterpacher, 1783) – Drávasztára, Nagy-Füzes.

*Potamphylax rotundipennis* (Brauer, 1857) – Bélavár; Őrtilos; Vízvár.
*Halesus tesselatus* (Rambur, 1842) – Bélavár; Őrtilos; Szentborbás; Vízvár.
*Platyphylax frauenfeldi* (Brauer, 1857) – Barcs; Bélavár; Őrtilos; Vízvár.
*Stenophylax permistus* McLachlan, 1895 – Barcs; Barcs, Rinya; Drávapalkonya; Matty; Őrtilos; Szentborbás; Vízvár.
*Micropterna lateralis* (Stephens, 1837) – Őrtilos.
*Chaetopteryx fusca* Brauer, 1857 – Őrtilos; Vízvár.
*Chaetopteryx major* McLachlan, 1876 – Őrtilos.

**Lepidostomatidae**
*Crunaecia irrorata* (Curtis, 1834) – Őrtilos.

**Goeridae**
*Goera pilosa* (Fabricius, 1775) – Barcs; Barcs, Rinya; Bélavár; Bélavár, Zsdála; Drávasztára; Őrtilos; Szentborbás; Vízvár ** **Brodić, Ferdinandovac, Legrad, Noškovci, Pitomača**
*Silo piceus* (Brauer, 1857) – BV Őrtilos; Vízvár.
*Silo nigricornis* (Pictet, 1834) –Vízvár.

**Leptoceridae**
*Athripsides albifrons* (Linnaeus, 1758) – Őrtilos.
*Athripsodes aterrimus* (Stephens, 1836) – Barcs; Barcs, Rinya; Drávapalkonya; Heresznye; Őrtilos; Szentborbás; Tótújfalu; Vejti; Vízvár ** **Noškovci**
***Athripsodes cinereus*** (Curtis, 1834) – ** **Brodić, Gotalovo, Legrad**
*Ceraclea alboguttata* (Hagen, 1860) – Drávapalkonya; Drávasztára; Őrtilos; Szentborbás; Tótújfalu; Vízvár ** **Brodić, Legrad, Noškovci**
*Ceraclea annulicornis* (Stephenes, 1836) – Drávapalkonya; Drávasztára, Nagy-Füzes; Őrtilos; Szentborbás; Vejti; Vízvár ** **Gotalovo, Legrad**
*Ceraclea aurea* (Pictet, 1834) – Drávapalkonya; Drávasztára; Szentborbás, Vejti ** **Gotalovo, Legrad**
*Ceraclea dissimilis* (Stephens, 1836) – Bélavár; Drávapalkonya; Drávasztára; Drávasztára, Nagy-Füzes; Heresznye; Őrtilos; Szentborbás; Tótújfalu; Vejti; Vízvár ** **Brodić, Ferdinandovac, Gotalovo, Legrad, Pitomača**
*Ceraclea riparia* (Albarda, 1874) – Őrtilos; Vejti.
*Ceraclea senilis* (Burmeister, 1838) –Barcs, Rinya; Drávapalkonya.
*Mystacidea azurea* (Linnaeus, 1761) – Őrtilos ** **Brodić**
*Mystacides longicornis* (Linnaeus, 1758) – Őrtilos ** **Legrad**
*Mystacides nigra* (Linnaeus, 1758) – Drávasztára; Őrtilos; Vejti ** **Brodić, Molve**
*Triaenodes bicolor* (Curtis, 1834) –Bélavár ** **Ferdinandovac**
*Triaenodes simulans* Tjeder, 1929 – Vejti.
*Oecetis furva* (Rambur, 1842) – Barcs, Rinya; Bélavár; Drávapalkonya; Őrtilos; Szentborbás; Vejti.
*Oecetis lacustris* (Pictet, 1834) – Bélavár; Drávapalkonya; Drávasztára; Heresznye; Őrtilos; Szentborbás; Vejti; Vízvár ** **Ferdinandovac, Legrad**
*Oecetis notata* (Rambur 1842) – Bélavár; Drávapalkonya; Drávasztára; Drávatamási; Őrtilos; Szentborbás; Tótújfalu; Vejti; Vízvár ** **Brodić, Ferdinandovac, Gotalovo, Legrad, Noškovci, Pitomača**
*Oecetis ochracea* (Curtis, 1825) – Barcs; Barcs, Rinya; Bélavár; Drávapalkonya; Heresznye; Matty; Őrtilos; Szentborbás; Tótújfalu; Vejti; Vízvár ** **Brodić, Đelekovec, Legrad, Pitomača**
*Oecetis tripuctata* (Fabricius, 1793) – Szentborbás ** **Brodić, Legrad, Noškovci, Pitomača**
*Setodes punctatus* (Fabricius, 1793) – Bélavár; Drávapalkonya; Drávasztára; Őrtilos; Szentborbás; Vejti; Vízvár ** **Brodić, Ferdinandovac, Gotalovo, Legrad, Noškovci, Pitomača**
*Leptocerus tineiformis* Curtis, 1834 – Bélavár; Drávapalkonya; Drávasztára; Őrtilos; Szentborbás; Tótújfalu; Vejti ** **Gotalovo, Legrad, Noškovci**
*Adicella syriaca* Ulmer, 1907 – Bélavár Őrtilos; Vízvár ** **Ferdinandovac, Noškovci, Pitomača**

## 3.1. Some further species living (being detected) a little farther off but still within the ervironment of Drava river.

*Phryganea bipuncta* Retzius, 1783 – The very single specimen found in South Transdanubia was collected several hundred meters away from the state border, near Bélavár. Its occurrence is possibile in Croatian land too.

*Limnephilus stigma* Curtis, 1834 – It is not rare in Gyékényes, Lankóci forest during these years, otherwise this is the only recent occurrence in Hungary. It may come to light in alderwoods of the opposite side.

*Rhadicoleptus alpestris* (Kolenati, 1848) – A single specimen was collected earlier in Gyékényes, Lankóci forest. In South-Transdanubia it is very rare and occurs sparsely, it is more distributed in West-Hungary.

*Limnephilus subcentralis* Brauer, 1857 – Several specimens were captured in the 1980's in four sites of South-Transdanubia, among others in the Barcs Juniper Woodland. During the last twenty years it was not collected again.

*Setodes viridis* (Fourcroy, 1785) – This species is not rare in some localities of West-Hungary. A single adult was collected several hundred meters away from the Drava river, near Őrtilos. Presumably the larvae or pupae were swept from the Mura or Kerka water system, and probably the species bred in Drava temporarily.

*Helicopsyche bacescui* Orghidan & Botosaneanu, 1953 – The only collecting site in the Carpathian Basin is located at Somogyudvarhely, about two kilometres from the Croatian border. As it has rather special ecological demands, it does not occur in further sites in this region.

These are the most interesting species, and beside them probably 10 to 15 other species would be found to occur along the Croatian side of the river.

## 4. The main results of the examinations on the Croatian side in 2007

We visited several points on the Croatian side of river: the living and dead branches, gravel pits and lakes between February and November 2007. As we have already examined the left (Hungarian) side, the living river-branch could not cause surprise. Here, species known from earlier times were collected during this year too. In April the species *Brachycentrus subnubilus* Curt. was on wing in every site, somewhere it swarmed in masses. This species hatches first, others are on wing only weeks later. In May only some *Hydropsyche contubernalis* McL., *H. modesta* Navás and *Mystacides niger* L. specimens were on wing. Along the oxbow lakes and gravel lakes we did not observe any caddisflies at that time.

First we collected on June 9 (Gotalovo, Drava bank, Fig. 2.) with light, when 364 adults of 15 species were taken. Among the species of this collection *Agapetus laniger* Pict. was the rarest one: it is very rare along Drava river. Other relatively rare species are *Ceraclea aurea* Pict., *C. annulicornis* Steph. and *Athripsodes cinereus* Curt. Three *Hydropsyche* species (*H. bulgaromanorum* Mal., *H. contubernalis* McL., *H. pellucidula* Curt.), *Neureclipsis bimaculata* L., *Psychomyia pusilla* F., *Ceraclea dissimilis* Steph., *Oecetis* *notata* Ramb., *Setodes punctatus* F. also belong to the characteristic species of river. On the contrary, *Ecnomus tenellus* Ramb. and *Leptocerus tineiformis* Curt. came from an oxbow lake or gravel pit, while *Orthotrichia tragetti* Ulmer might develop either in standing or in running water.

In June we visited Noškovci (Fig. 3.) and Legrad as well, where also a low number of species and specimens were collected. At Gotalovo four hydroptilid species were caught, rarer species were *Cyrnus trimaculatus* Curt. and *Oecetis tripunctata* F. *Adicella syriaca* Ulmer is also a characteristic species of the common section of the river, and it was found in this sample. On 15th June, near Legrad we collected a sample containing 25 species. The most interesting species was *Glossosoma boltoni* Curt., which is a rarity in almost entire Hungary, although it can be frequent in NW Hungary (Szigetköz, cf. UHERKOVICH & NÓGRÁDI 2001). Other interesting species are *Ceraclea aurea* Pict. and *Oecetis tripunctata* F.

In July I collected at Pitomača, Šašnato Polje (Fig. 4.), again in company of J. J. Purger, coordinator of the project team. At normal circumstances we collected sixteen species, without rarities. The most interesting species was again *Agapetus laniger* Pict., which is another characteristic and dominant species of Danube in Szigetköz. *Adicella syriaca* Ulmer also occured in that sample: it is a characteristic caddisfly of South-Transdanubia occurring mostly along the Drava.

Due to the adverse weather, attempts remained unsuccessful to collect in the second half of October and in the beginning of November. Thus the species list does not contain typical autumn species, e.g. several limnephilids (*Anabolia, Halesus, Platyphylax, Chaetopteryx*), which would occur during these weeks. During a longer biomonitoring much of them surely would come to light, and also many *Limnephilus* species are on wing mostly in the autumn months.

## 5. Nature conservation

Among 85 species, only one (*Platyphylax frauenfeldi* Brau.), is protected in Hungary, whereas in Croatia there is no protected caddisfly species. However, the number of endangered species is rather high (see NÓGRÁDI & UHERKOVICH 1999; UHERKOVICH 2006). To preserve the current status of the river is a rather important task of nature conservation authorities in Croatia and Hungary.

## 6. Summary

Along the common Croatian-Hungarian section of Drava river 85 caddisfly species were found during the past fifteen years. These data derive from the Hungarian side mostly, whereas the number of species and specimens of caddisflies collected in the Croatian side is rather low.

We have to state that many such species live in Drava river which have disappeared from the rivers of lowlands in general. Thus *Rhyacophila dorsalis* Curt., *Glossosoma boltoni* Curt., *Agapetus laniger* Pict., *Polycentropus irroratus* Curt. *Ceraclea riparia* Albd. live

along the upper Hungarian branches of the Danube (Szigetköz), in the upper Hungarian branches of Tisza and in some smaller watercourses of W-Hungary, in addition to Drava river. Besides these species several other species preferring fast-running water live here (*Orthotrichia ang*ustella McL., *Ithytrichia lamellaris* Eaton, *Hydroptila forcipata* Eaton, *Hydropsyche siltalai* Döhler, *Potamophylax luctuosus* Pill. et Mitt., *Athripsodes albifrons* L., *Ceraclea aurea* Pict., *Oecetis tripunctata* F.)

*Platyphylax frauenfeldi* Brau. was hardly ever collected after its description, and during the seventies of the last century it seemed that it had become extinct from Europe. Its first adults were collected at Magyarszombatfa (W Hungary) and nearby Barcs-Középrigóc (S Hungary) in Hungary. After these findings there was an important discovery that this species lives in Drava too – between Szentborbás and Őrtilos, practically in the entire river section in county Somogy – and at places it might be less rare. Many specimens were bred from eggs after collecting several adults at Őrtilos, and the morphology of larvae and pupae, and its life history and nutrition was clarified (MALICKY et al. 2002).

Other characteristic species of Drava are *Silo piceus* Brau. and *Adicella syriaca* Ulmer, being rare or absent in other regions of Hungary.

This great richness of caddisfly species and specimens is due to the hardly regulated or native bed of the river. In the main and side branches there are faster and slower running water bodies, many microhabitats, i.e. mosaic-like patterns of biotopes. Another reason is the low level of pollution. The zoogeographical situation and the proximity of upper branches and other, unregulated small watercourses also assist the formation of various caddisfly communities.

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# Baseline survey and biological monitoring of butterflies (Lepidoptera) in Croatian areas along the Drava river

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**Abstract:** In 2007 a project was carried out as part of the Slovenia-Hungary-Croatia Neighbourhood Program, to survey the natural values in the Drava region of Croatian part. Within this framework a baseline survey and biological monitoring of butterflies were started along the river Drava. Altogether 78 species have been revealed so far, about 25% of the fauna are known as protected or endangered species. A NATURA 2000 species, *Lopinga achine* is a new to the fauna of Croatian Drava region. A transect line estimation on the relative population of NATURA 2000 species: *Parnassius mnemosyne, Lycaena dispar, Maculinea teleius, Maculinea nausithous, Euphydryas maturna, Apatura metis* was carried out. In case of data of *Zerynthia polyxena*, a caterpillar count was sampled.

## 1. Introduction

The study of butterfly fauna along the river Drava in Hungary was started around 30 years ago. The initial steps in surveying the fauna was made by UHERKOVICH (1978) by performing a complex faunal and nature conservation investigation of the Barcs Juniper woodland. This work was fundamental in the process of declaring areas along Drava river a national park (Duna-Drava National Park, 1996).

Before the establishment of the national park, research into the butterfly fauna – focusing mainly on species composition – was carried on, with the investigations extended onto the entire Drava lowland area stretching from Őrtilos to Drávaszabolcs (150 km) (UHERKOVICH & ÁBRAHÁM 1995). Following the designation of the national park area, the primary aim of further lepidopterological studies was to survey the most characteristic habitats in the area. These research data were used mainly as information for producing national park management plans (ÁBRAHÁM & UHERKOVICH 1998).

Then, a new period of lepidopterological studies in the Drava region commenced in 2000, with species level population assessments being performed (ÁBRAHÁM 2005).

The exploration of the butterfly fauna in areas along the Drava in Croatia was started, like in Hungary, around the late 1970s (KRANJČEV 1981). Later, these results were published together with findings about natural habitats and natural values in the region (KRANJČEV 1985, 1986). Eventually, the abundance of natural assets and the richness of the butterfly fauna lead to the entire Croatian Drava region becoming appointed as a Prime Butterfly Area (PBA) (MILOŠEVIČ & ŠAŠIČ 2003).

In the lower Croatian Drava section (Baranja) the butterfly fauna has been studied since

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the1990s, with two papers having been published so far (Krčmar 2002; Krčmar et al. 1996). However, apart from the faunal exploration of butterflies in areas along the Drava in Croatia, no information has been available about population sizes and dynamics.

As part of the Slovenia-Hungary-Croatia Neighbourhood Programme, in co-operation with the University of Kaposvár, we have had the opportunity to launch the baseline surveying and biological monitoring of butterflies in the Croatian Drava section. The aim of the current paper is to provide a brief evaluation of results having achieved so far.

## 2. Material and methods

During baseline surveying, the fauna was sampled by individual specimen collecting and visual observations. Samplings were done along the river Drava on its section stretching from Legrad to Donji Miholjac.

Population-level monitoring surveys of butterflies were performed on the section between Legrad and Okruglica. Mainly line transect counts were applied as part of population monitoring studies (Ábrahám et al. 2007).

## 3. Results and discussion

### 3.1. Preliminary results of baseline surveying

A total of 78 species have been revealed so far along river Drava, as part of the survey having been carried out since spring 2007 (Table 1.). Except for one particular species, these had been known from the fauna of the area. *Lopinge achine* is a NATURA 2000 indicator species (Fig. 1.), therefore the fact that its population was found here has particular nature conservation significance. Concluded from the baseline survey results (Table 1.), this species has to be included in any future biological monitoring study in the area.

Fig. 1. *Lopinga achine* feeding (Photo by Levente Ábrahám).

Table 1. Checklist of species from Legrad to Dojni Miholjac found during the baseline surveying

**Hesperiidae**
*Erynnis tages* (Linnaeus, 1758)
*Carcharodus alceae* (Esper, 1780)
*Pyrgus carthami* (Hübner, 1813)
*Pyrgus malvae* (Linnaeus, 1758)
*Heteropterus morpheus* (Pallas, 1771)
*Carterocephalus palaemon* (Pallas, 1771)
*Thymelicus lineola* (Ochsenheimer, 1808)
*Thymelicus sylvestris* (Poda, 1761)
*Ochlodes venata* (Bremer & Grey, 1853)

**Papilionidae**
*Zerynthia polyxena* ([Denis & Schiffermüller], 1775) (Fig. 2.)
*Parnassius mnemosyne* (Linnaeus, 1758)
*Iphiclides podalirius* (Linnaeus, 1758) (Fig. 3.)
*Papilio machaon* Linnaeus, 1758 (Fig. 3.)

**Pieridae**
*Leptidea sinapis* (Linnaeus, 1758)
*Leptidea reali* Reissinger, 1989
*Anthocharis cardamines* (Linnaeus, 1758)
*Pieris brassicae* (Linnaeus, 1758)
*Pieris rapae* (Linnaeus, 1758)
*Pieris napi* (Linnaeus, 1758)
*Pontia daplidice* (Linnaeus, 1758)
*Colias erate* (Esper, 1805)
*Colias croceus* (Fourcroy, 1785)
*Colias hyale* (Linnaeus, 1758)
*Colias alfacariensis* Ribbe, 1905
*Gonepteryx rhamni* (Linnaeus, 1758)

**Lycaenidae**
*Hamearis lucina* (Linnaeus, 1758)
*Lycaena phaeas* (Linnaeus, 1761)
*Lycaena dispar* (Haworth, 1803)
*Lycaena tityrus* (Poda, 1761)
*Lycaena thersamon* (Esper, 1784) (Fig. 4.)
*Thecla betulae* (Linnaeus, 1758)
*Callophrys rubi* (Linnaeus, 1758)
*Satyrium spini* (Denis & Schiffermüller, 1775)
*Cupido argiades* (Pallas, 1771)
*Cupido alcetas* (Hoffmannsegg, 1804)
*Celastrina argiolus* (Linnaeus, 1758)
*Maculinea teleius* (Bergsträsser, 1779) (Fig. 5.)
*Maculinea nausithous* (Bergsträsser, 1779) (Fig. 6.)
*Plebeius argyrognomon* (Bergsträsser, 1779)
*Plebeius argus* (Linnaeus, 1758)
*Polyommatus semiargus* (Rottemburg, 1775)
*Polyommatus icarus* (Rottemburg, 1775)

**Nymphalidae**
*Lybithea celtis* (Laicharting, 1782)
*Argynnis paphia* (Linnaeus, 1758)
*Argynnis aglaja* (Linnaeus, 1758)
*Issoria lathonia* (Denis & Schiffermüller, 1775)
*Brenthis daphne* (Denis & Schiffermüller, 1775)
*Boloria euphrosyne* (Linnaeus, 1758)
*Boloria dia* (Linnaeus, 1767)
*Vanessa atalanta* (Linnaeus, 1758)
*Vanessa cardui* (Linnaeus, 1758)
*Inachis io* (Linnaeus, 1758)
*Aglais urticae* (Linnaeus, 1758)
*Polygonia c-album* (Linnaeus, 1758)
*Arachnia levana* (Linnaeus, 1758)
*Nymphalis antiope* (Linnaeus, 1758)
*Nymphalis polychloros* (Linnaeus, 1758)
*Euphydrias maturna* (Linnaeus, 1758)
*Melitaea cinxia* (Linnnaeus, 1758)
*Melitaea phoebe* (Denis & Schiffermüller, 1775)
*Melitaea trivia* (Denis & Schiffermüller, 1775)
*Melitaea didyma* (Esper, 1778)
*Melitaea athalia* (Rottemburg, 1775)
*Melitaea aurelia* Nickel, 1850
*Neptis sappho* (Pallas, 1771) (Fig. 7.)
*Apatura metis* Freyer, 1829
*Apatura ilia* (Denis & Schiffermüller, 1775) (Fig. 8.)
*Pararge aegeria* (Linnaeus, 1758)
*Lasiommata megera* (Linnaeus, 1767)
*Lopinga achine* (Scopoli, 1763)
*Coenonympha arcania* (Linnaeus, 1761)
*Coenonympha glycerion* (Borkhausen, 1788)
*Coenonympha pamphilus* (Linnaeus, 1758)
*Aphantopus hyperantus* (Linnaeus, 1758)
*Maniola jurtina* (Linnaeus, 1758)
*Melanargia galathea* (Linnaeus, 1758)
*Minois dryas* (Scopoli, 1763)
*Brintesia circe* (Fabricius, 1775)

Fig. 2. *Zerynthia polyxena* settling (Photo by Levente Ábrahám)

Fig. 3. *Papilio machaon*, *Iphiclides podalirius* feeding (Photo by Levente Ábrahám)

Fig. 4. *Lycaena thersamon*, one of the rarest copper along the river Dráva (Photo by Levente Ábrahám)

Fig. 5. *Maculinea teleius* mating (Photo by Levente Ábrahám)

Fig. 6. *Maculinea nausithous* sitting on its host-plant *Sanguisorba officinalis* (Photo by Levente Ábrahám)

Fig. 7. *Neptis sappho* at rest (Photo by Levente Ábrahám)

Fig. 8. *Apatura ilia* assemblage (Photo by Levente Ábrahám)

## 3.2. Evaluation of the monitoring survey in 2007

The numeral data of the survey are given in separate tables and diagrams for each species. All of the surveyed species are listed in NATURA 2000.

***Parnassius mnemosyne***

The population of *Parnassius mnemosyne* along the river Drava is considered to be a lowland occurrence, which makes it extremely important from nature conservation aspects. Almost all of the lowland populations existing in the region have become isolated and thus form so-called metapopulation patterns, most of them being threatened by extinction in the area.

From the figures obtained by the survey it appears that the relative population size of *Parnassius mnemosyne* in Repaš was greater than that of the Brodić population (Fig. 9.).

During 3 samplings in 2007 in Brodić, only 11 specimens were seen. On the same sampling days in Repaš, a total of 90 specimens were observed (Table 2.).

Table 2. *Parnassius mnemosyne* recordings

| Sampling site | Sampling time in 2007: 14. May | 17. May | 22. May | 27. May | 3. June | 7. June | **Σ** | **Aver.** |
|---|---|---|---|---|---|---|---|---|
| Brodić 1 | 0 | 0 | 1 | 1 | 2 | 1 | **5** | **0.83** |
| Brodić 2 | 0 | 0 | 1 | 1 | 1 | 1 | **4** | **0.67** |
| Brodić 3 | 0 | 1 | 1 | 0 | 0 | 0 | **2** | **0.33** |
| **Σ** | **0** | **1** | **3** | **2** | **3** | **2** | **11** | **1.83** |
| **Average** | **0.00** | **0.33** | **1.00** | **0.67** | **1.00** | **0.67** | | |
| Repaš 1 | 2 | 5 | 4 | 12 | 7 | 3 | **33** | **5.50** |
| Repaš 2 | 2 | 3 | 7 | 8 | 4 | 3 | **27** | **4.50** |
| Repaš 3 | 2 | 4 | 8 | 9 | 5 | 2 | **30** | **5.00** |
| **Σ** | **6** | **12** | **19** | **29** | **16** | **8** | **90** | **15.00** |
| **Average** | **2.00** | **4.00** | **6.33** | **9.67** | **5.33** | **2.67** | | |

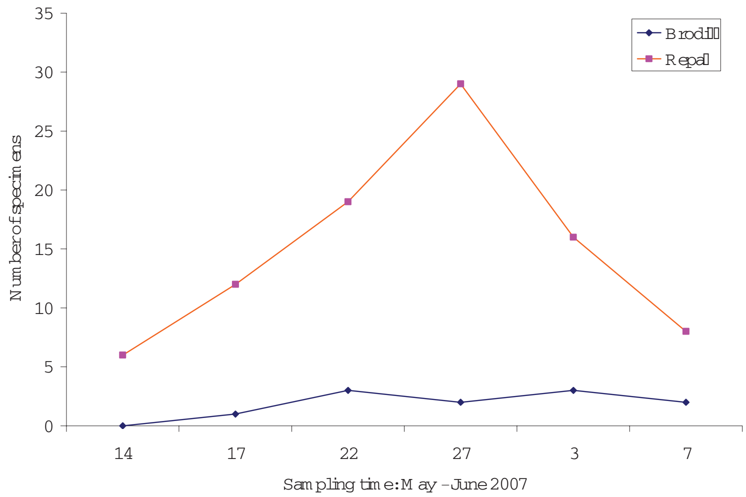


Fig. 9. Flight activity of *Parnassius mnemosyne* in 2007

***Zerynthia polyxena*** (Fig. 2.)

The population revealed on the Drava riverside near Molve and Starogradački Marof is small (Table 3.). The size of the habitat patch does not even reach 1 ha. The type of management practised in the area (haymaking, weed infestation – *Solidago*) can considerably influence the status of the population.

Table 3. Caterpillar count data of *Zerynthia polyxena.*

| | | |
|---|---|---|
| Molve | *Aristolochia clematitis* | 273 ex. |
| Molve | *Zerynthia polyxena* caterpillar | 102 ex. |
| Starogradački Marof | *Aristolochia clematitis* | 107 ex. |
| Starogradački Marof | *Zerynthia polyxena* caterpillar | 45 ex. |

***Maculinea teleius*** **and** ***Maculinea nausithous***

During sampling along a transect, 508 specimens of *Maculinea teleius* (Fig. 5.), and 51 specimens of *Maculinea nausithous* (Fig. 6.), were counted (Table 4.).

Table 4. Sampling data of *Maculinea teleius* and *Maculinea nausithous* near Molve.

| Species | Date | Number of transect | | | | | | | | | Σ | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | |
| *M. teleius* | 10.07.2007 | 3 | 0 | 4 | 2 | 0 | 3 | 1 | 3 | 2 | 18 | 2 |
| *M. nausithous* | 10.07.2007 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *M. teleius* | 17.07.2007 | 4 | 2 | 4 | 1 | 1 | 3 | 2 | 1 | 3 | 21 | 2 |
| *M. nausithous* | 17.07.2007 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *M. teleius* | 21.07.2007 | 7 | 10 | 9 | 11 | 7 | 6 | 8 | 8 | 8 | 74 | 8 |
| *M. nausithous* | 21.07.2007 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 4 | 0 |
| *M. teleius* | 27.07.2007 | 12 | 16 | 15 | 19 | 21 | 13 | 17 | 21 | 12 | 146 | |
| *M. nausithous* | 27.07.2007 | 2 | 1 | 2 | 1 | 0 | 0 | 1 | 2 | 4 | 13 | 1 |
| *M. teleius* | 01.08.2007 | 23 | 18 | 24 | 17 | 16 | 18 | 13 | 18 | 13 | 160 | |
| *M. nausithous* | 01.08.2007 | 1 | 1 | 3 | 4 | 2 | 1 | 0 | 0 | 2 | 14 | 1 |
| *M. teleius* | 07.08.2007 | 4 | 8 | 11 | 10 | 4 | 7 | 6 | 9 | 6 | 65 | 7 |
| *M. nausithous* | 07.08.2007 | 4 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 3 | 11 | 1 |
| *M. teleius* | 15.08.2007 | 2 | 3 | 4 | 0 | 2 | 1 | 3 | 3 | 6 | 24 | 2 |
| *M. nausithous* | 15.08.2007 | 2 | 2 | 1 | 0 | 0 | 1 | 0 | 1 | 2 | 9 | 1 |

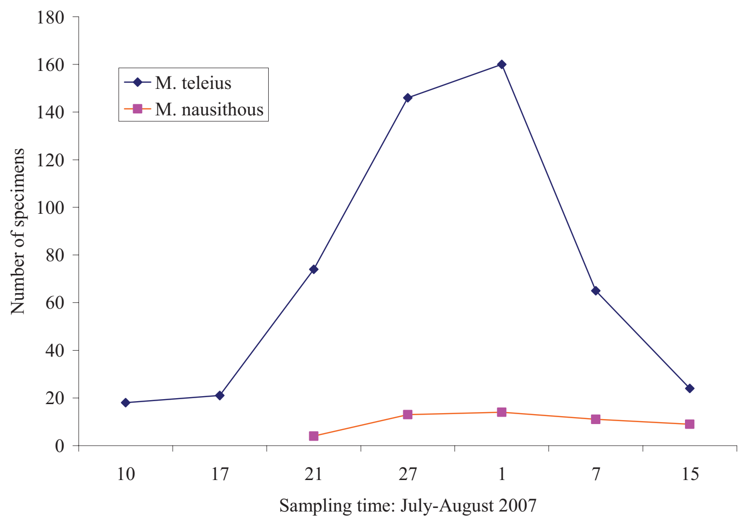


Fig. 10. Flight activity of *Maculinea teleius* and *Maculinea nausithous* in Molve

The size of *Maculinea teleius* population exceeds by far the size of *Maculinea nausithous* population (Fig. 10.). These two species occur in identical habitats, but it seems that in their behavioural ecology they do segregate within a habitat.

In laying eggs, *Maculinea nausithous* shows preference for those *Sanguisorba officinalis* inflorescences that emerge above the general herb layer of the meadow.

Egg-laying females deposit their eggs along vegetation margins (shrub, forest edges).

The humidity demand of this species is higher than that of *Maculinea teleius*; adult specimens tend to move along more humid, shaded margin areas.

***Lycaena dispar***

This species can occur anywhere within the studied area, provided that the habitat is moist, such as in hayfields or along streams (Table 5.). Its population seems to be stabile in the Drava area (Fig. 11.).

Table 5. Sampling data of *Lycaena dispar*

| Number of transect | | 1 | 2 | 3 | 4 | 5 | 6 | Σ | Average |
|---|---|---|---|---|---|---|---|---|---|
| **Legrad** | 1st gereration | 5 | 12 | 9 | 8 | 11 | 5 | 50 | |
| **Okruglica** | 1st generation | 9 | 4 | 8 | 4 | 4 | 3 | 32 | |

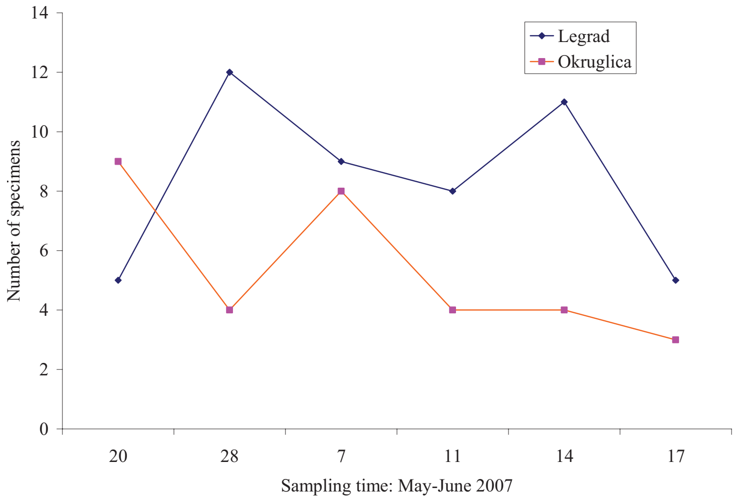


Fig. 11. Flight activity of *Lycaena dispar*

***Euphydryas maturna***

Several large populations were found along Drava in the study year. It is a member of margin communities, therefore especially high numbers were found in transects where its food plant *Fraxinus excelsior* was present in groups and flowering *Aegopodium podagraria* were found abundantly in the edge habitat (Table 6., Fig. 12.).

Table 6. *Euphydryas maturna* recordings, by samplings in 2007.

| Brodić | 8. May | 15. May | 19. May | 24. May | 29. May | 03. May | 11. May | Σ | Aver. |
|---|---|---|---|---|---|---|---|---|---|
| transect 1 | 3 | 4 | 12 | 31 | 21 | 9 | 3 | 83 | 11.9 |
| transect 2 | 3 | 14 | 32 | 22 | 30 | 20 | 6 | 127 | 18.1 |
| transect 3 | 1 | 8 | 43 | 54 | 25 | 15 | 7 | 153 | 21.9 |
| transect 4 | 0 | 7 | 16 | 40 | 12 | 14 | 4 | 93 | 13.3 |
| transect 5 | 2 | 4 | 25 | 35 | 27 | 9 | 3 | 105 | 15.0 |
| transect 6 | 0 | 5 | 11 | 27 | 29 | 11 | 2 | 85 | 12.1 |
| Σ | 9 | 42 | 139 | 209 | 144 | 78 | 25 | | |

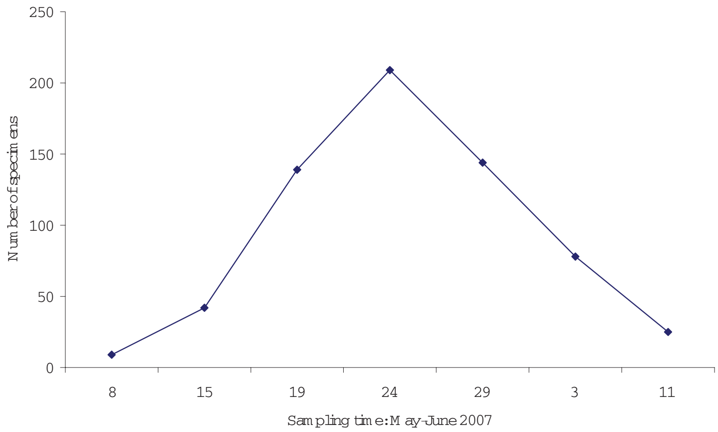


Fig. 12. Flight activity of *Euphydryas maturna* in Brodić

***Apatura metis***

Throughout Europe, it occurs locally only. Its populations in Croatia are found along the rivers Danube and Drava. *Apatura metis* populations along Drava are more abundant in the lower river section than in the upper reach (Table 7., 8., Fig. 13.). Its population size revealed in 2007 in Croatia seems to be outstandingly high in comparison with earlier studies along river Drava in Hungary.

Table 7. Recordings of *Apatura metis* 1st generation, by samplings in 2007.

| Date | 16. May | 23. May | 29. May | 1. June | 4. June | 8. June | 12. June | 18. June | 21. June | 24. June | Σ | Aver. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Legrad | 0 | 0 | 3 | 2 | 4 | 4 | 4 | 3 | 1 | 2 | 23 | 2.3( |
| Okruglica | 0 | 3 | 31 | 36 | 39 | 21 | 20 | 11 | 12 | | 4177 | 17.7 |

Table 8. *Apatura metis* recordings, by transects.

| **Number of transect** | | **1** | **2** | **3** | **4** | **5** | **6** | **Σ** | **Average** |
|---|---|---|---|---|---|---|---|---|---|
| **Legrad** | 1st gereration | 5 | 12 | 9 | 8 | 11 | 5 | 50 | 8.3 |
| **Okruglica** | 1st generation | 9 | 4 | 8 | 4 | 4 | 3 | 32 | 5.3 |

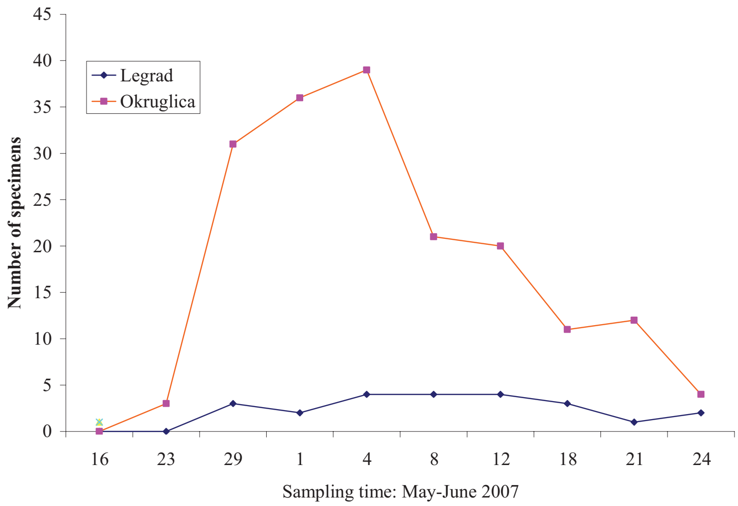


Fig. 13. Flight activity of *Apatura metis* 1st generation.

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# Data to the fish fauna of Croatian Drava sections

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**Abstract:** Fish faunistic monitoring was launched in 2007 on Croatian sections of river Drava. Based on information from literature and our own former data, the current ichthyofauna of the river was compiled, which suggests the occasional or regular occurrence of a total of 64 fish species in Drava. As specified in the monitoring protocol having been produced earlier, a low-power, battery-operated electric fishing machine working with pulsating direct current was used for the investigations. During the investigations that have been performed so far in Croatia we have captured and identified a total of 1477 fish specimens, representing altogether 40 species. Occasionally, the catches of anglers were also examined. Among the 64 species whose occurrence is now proved, 24 are protected legally by nature conservation in Hungary. Of these, 5 are strictly protected (*Eudontomyzon mariae*, *Hucho hucho*, *Umbra krameri*, *Zingel zingel*, *Zingel streber*). Altogether 22 of the 64 species are listed in the Appendices of Habitat Directive. Based on the number of species determined, the absolute ($T_A$: 119) and relative ($T_R$: 1.919) conservation values of the fish fauna were expressed.

## 1. Introduction

The fish fauna of Drava has been monitored in the Hungarian river sections since November 1999. Such monitoring activities of Hungarian territories are performed in 5 sampling areas, at a total of 10 sampling sections, in three seasonal sessions (spring, summer, autumn). All monitoring studies must be preceded by the designation of sampling locations: normally this is done during the first year. This is how we intended to perform the fish faunistic monitoring in Croatia, but due to the fact that the authority permits were obtained quite late, and because water levels were high at the times of sampling, only sporadical data could be collected during 2007. In the current paper we have summarised our ichthyofaunistic data about the Croatian Drava sections, hoping that the monitoring that was launched in 2007 will be continued, otherwise what is done is not monitoring, only occasional data collecting. We have given accounts on the research history of the fish fauna of Drava in several other papers (SALLAI 2002A, 2004; SALLAI & MRAKOVČIĆ 2007). After comparing the species lists, river Drava is characterised with the regular or occasional occurrence of 64 fish species in the last 15 years (SALLAI & MRAKOVČIĆ 2007).

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# 3. Material and methods

## 3.1. Features of river Drava

The entire length of the Drava is 695 km, rising at an altitude of 1238 m at the Western end of the Carnic Alps. The catchment area was defined as covering 40.000 km$^2$ (MAROSI & SZILÁRD 1967). Considering the length and catchment area of the river, it is one of the most important tributaries of the Danube.

The water quality of the entire Hungarian segment of the Drava is class I, making it the clearest Hungarian river. Class II, or sometimes class III waters of the Mura are counterbalanced by the significantly higher velocity 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 measuring sites, and to 500 m$^3$/s at Drávaszabolcs. According MAROSI and SOMOGYI (1990) 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 (Table 1.)

Table 1. Fluctuation of water dynamics of the Drava (MAROSI & SOMOGYI 1990)

| Measuring site | Lowest measured water level (cm) | Highest measured water level (cm) | Normal (80%) low water discharge (m$^3$/s) | Discharge at medium water level (m$^3$/s) | Exceptional (2%) high water discharge (m$^3$/s) |
|---|---|---|---|---|---|
| Őrtilos | -50 | 476 | 276 | 590 | 2300 |
| Barcs | -64 | 618 | 278 | 595 | 2570 |
| Drávaszabolcs | -10 | 596 | 151 | 486 | 2100 |

## 3.2. Survey methods

Fish faunistic data were 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. Fish were released after being identified, none of them was collected. Fishing was done from the bank or by wading (SALLAI & MRAKOVČIĆ 2007).

Sampling sites were located by a GARMIN eTrex Legend GPS, using Hungarian EOV-coordinates (national projection system). Geo-coordinates were measured at the uppermost and lowermost points of the sections surveyed, if possible. Consequently the length of the sampling units could be measured relatively precisely. The EOV-coordinates obtained were processed in ArcView desktop GIS software (Fig. 1.).

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

The catch collected by anglers has been also investigated several times. For the processing of faunistic data, the database software Access was used.

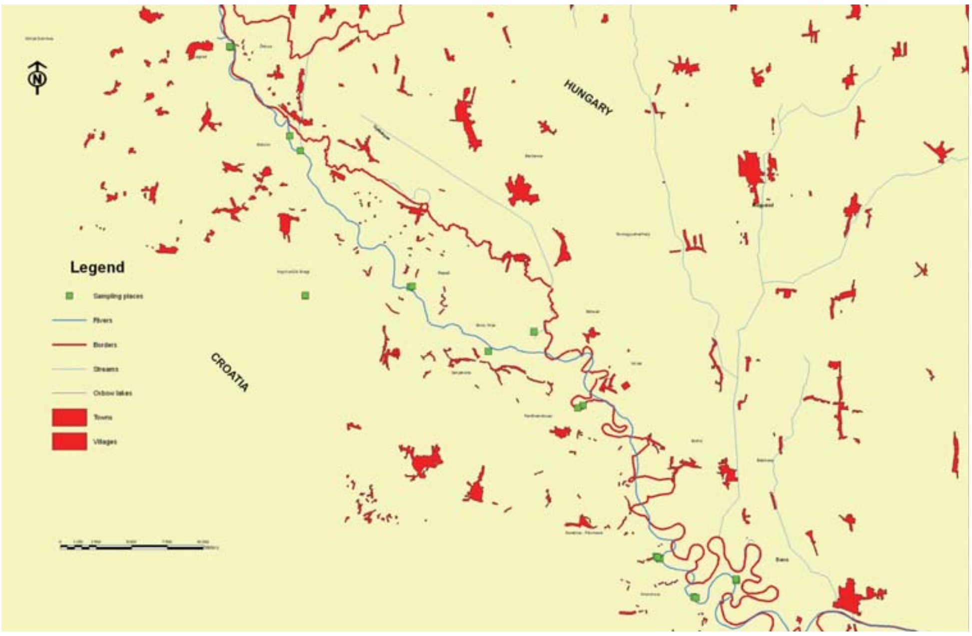


Fig. 1. Sampling locations along Croatian sections of Drava, based on GPS fixes

# 4. Results

Based on the evolutional system of Nelson (1984), we are listing below, in a taxonomic order, the species occurring in the Croatian section of river Drava, together with their occurrence data. Different capture sites for one species are listed in an alphabetical order.

As to the form of specifying occurrence data, we have followed the faunistic data publication method suggested by Dévai et al. (1987), by giving the place and date of collection, followed by the number of specimens. Then, the code of the collector is added, together with the code for the method of collecting. The following abbreviations are used for the various collectors: Zoltán Sallai - SZ, Tivadar Kontos - KT. Unknown collectors were labelled as ”ANONYM”. Data from anglers' catches are signified with ”+H” (hook), whereas data obtained from the authors' fishing activity are marked with the code ”+EFG” (electric fishing gear).

OSTEICHTHYES
Cyprinidae

**1. Roach** *Rutilus rutilus* (Linnaeus, 1758)
Being a frequent, commonly distributed species in Drava and its water system, its description is included in all of the related literature sources (Heckel 1847; Juranic 1880, 1884; Glowacki 1885; Herman 1887; Harka 1992, 1997; Majer 1995, 1998; Majer & Bíró 2001; Majer & Bordács 2001; Sallai 2002a, 2002b, 2004). It is more frequent in

side-branches and oxbows, and less common in the main bed.

Drava (Legrad): 21.08.2004., 13, SZ & KT, +EFG; 25.10.2004., 1, SZ & KT, +EFG; 31.08.2007., 7, SZ, +EFG; Drava, Bistra canal (Koprivnički Bregi): 31.08.2007., 13, SZ, +EFG; Drava, Čambina-oxbow (Novo Virje): 21.08.2004., 2, SZ & KT, +EFG; 25.10.2004., 18, SZ & KT, +EFG; Drava, downstream from the mouth of Rogstrug canal, small lake (Đuretina - Pitomača): 09.10.2004., 4, SZ & KT, +EFG; Drava, Križnica bridge downstream (Križninica): 09.10.2004., 2, SZ & KT, +EFG; Drava, Repaš meadow: 31.08.2007., 22, SZ, +EFG; Drava, Rogstrug canal (Đuretina - Pitomača): 09.10.2004., 1, SZ & KT, +EFG; Drava, Špinc-oxbow (Ferdinandovac): 31.08.2007., 2, SZ, +EFG.

2. **Danubian roach** *Rutilus virgo* (Heckel, 1852)

The first occurrences of Danubian roach were published by JURANIC (1880) and GLOWACKI (1885). From most recent times, it was first MAJER & BÍRÓ (2001) and MAJER & BORDÁCS (2001) to have reported on its occurrence in Drava. From the Croatian river section, too, it was reported to occur, by MRAKOVČIĆ et al. (2006). From our own data we can state that Danubian roach is present all along the Hungarian section of Drava, which fact bears outstanding nature conservation significance. Individuals were captured in the main riverbed and in side-branches as well. It is a rare, threatened Danubian endemism. It is protected in Hungary, and is listed in Annex II. of the Habitat Directive.

Drava (Legrad): 31.08.2007., 1, SZ, +EFG; Drava, Botovo bridge (Botovo): 31.08.2007., 1, ANONYM, +H.

3. **Grass carp** *Ctenopharyngodon idella* (Valenciennes, 1844)

It is first HARKA (1992) to mention this species as occurring in the Hungarian section of Drava. Concluded from the harvested quantities of this fish recorded in the Hungarian Fishery Database – exceeding 2000 kg almost every year since 1998 – it seems likely that despite the strict banning of restocking it in river Drava, it is still being replenished by fishery management entities operating in the area. It is an adventive species, therefore its presence in our natural waters is unwanted.

Drava, Čambina-oxbow (Novo Virje): 25.10.2004., 1, SZ & KT, +EFG.

4. **Rudd** *Scardinius erythrophthalmus* (Linnaeus, 1758)

In the majority of relevant literature, there are references to the occurrence of this species in Drava (HECKEL 1847; JURANIC 1880, 1884; GLOWACKI 1885; HERMAN 1887; HARKA 1992, 1997; MAJER 1995, 1998; MAJER & BÍRÓ 2001; MAJER & BORDÁCS 2001; SALLAI 2002a, 2002b). It is a relatively common, stagnophilic species of side-branches and oxbows.

Drava, Čambina-oxbow (Novo Virje): 21.08.2004., 1, SZ & KT, +EFG; 25.10.2004., 30, SZ & KT, +EFG; Drava, Repaš meadow: 31.08.2007., 4, SZ, +EFG.

5. **Dace** *Leuciscus leuciscus* (Linnaeus, 1758)

First it was described from Drava by HECKEL (1847). Ichthyological studies of the past 10 years also mention this species (HARKA 1992; MAJER 1995, 1998; MAJER & BORDÁCS 2001; SALLAI 2002a, 2002b). The captured individuals occurred mostly in river sections with high water velocity and gravelly riverbed substrate, but occasionally, a few specimens were also encountered in side-branches with slower water current. It is a moderately common, rheophilic species of river Drava.

Drava (Legrad): 31.08.2007., 6, SZ, +EFG.

6. **Ide** *Leuciscus idus* (Linnaeus, 1758)

This species is listed in each of the literature items that were published in the 19th century (HECKEL 1847; JURANIC 1880, 1884; GLOWACKI 1885; HERMAN 1887). Also, it is reported in more recent fish faunistic publications about Drava (HARKA 1992, 1997; MAJER 1995, 1998; MAJER & BÍRÓ 2001; MAJER & BORDÁCS 2001; SALLAI 2002a, 2002b). From the paper by MAJER (1998) and based on our own studies (SALLAI 2002a, 2002b) it can be stated that this species occurs all along the Hungarian Drava section. As concluded from the information published by HARKA (1992) and from our own experience, it is a rare, rheophilic species of Drava.

Drava, Rogstrug canal (Đuretina - Pitomača): 09.10.2004., 1, SZ & KT, +EFG.

7. **Chub** *Squalius cephalus* (Linnaeus, 1758)

It is reported to occur in Drava by all relevant literature (HECKEL 1847; JURANIC 1880, 1884; GLOWACKI 1885; HERMAN 1887; HARKA 1992, 1997; MAJER 1995, 1998; MAJER & BÍRÓ 2001; MAJER & BORDÁCS 2001; SALLAI 2002a, 2002b). It is a commonly distributed, quite frequent species of the river itself and the water bodies belonging to its water system.

Drava (Legrad): 21.08.2004., 5, SZ & KT, +EFG; 25.10.2004., 10, SZ & KT, +EFG; 31.08.2007., 13, SZ, +EFG; Drava, Bistra canal (Koprivnički Bregi): 31.08.2007., 1, SZ, +EFG; Drava, Botovo bridge (Botovo): 31.08.2007., 6, SZ, +EFG; Drava, canal (Donja Dubrava): 25.10.2004., 5, SZ & KT, +EFG; Drava, downstream from the mouth of Rogstrug canal (Đuretina - Pitomača): 09.10.2004., 1, SZ & KT, +EFG; Drava, downstream from the mouth of Rogstrug canal, small lake (Đuretina - Pitomača): 09.10.2004., 44, SZ & KT, +EFG; Drava, Križnica bridge, downstream (Križnica): 09.10.2004., 3, SZ & KT, +EFG; Drava, Repaš meadow (Repaš): 31.08.2007., 3, SZ, +EFG; Drava, Rogstrug canal (Đuretina - Pitomača): 09.10.2004., 3, SZ & KT, +EFG.

**8. Minnow** *Phoxinus phoxinus* (Linnaeus, 1758)

This species is a rare, tiny-bodied species of the carp family, preferring strong current. Characterised with Eurasian distribution, it is a native, protected fish species in Hungary. No proof specimens have been found in the Hungarian sections of Drava.

Drava, canal (Donja Dubrava): 25.10.2004., 3, SZ & KT, +EFG; Drava, oxbow close to the canal (Donja Dubrava): 25.10.2004., 3, SZ & KT, +EFG.

**9. Bleak** *Alburnus alburnus* (Linnaeus, 1758)

Relevant literature mentions this species as occurring in Drava (HECKEL 1847; JURANIC 1880, 1884; GLOWACKI 1885; HARKA 1992, 1997; MAJER 1995, 1998; MAJER & BORDÁCS 2001; SALLAI 2002a, 2002b). It is a commonly distributed, eurytopic species in river Drava, occurring all along the Hungarian section and having stable, self-sustaining populations in the water system of the river.

Drava (Legrad): 21.08.2004., 4, SZ & KT, +EFG; 31.08.2007., 57, SZ, +EFG; Drava, Bistra canal (Koprivnički Bregi): 31.08.2007., 8, SZ, +EFG; Drava, Čambina-oxbow (Novo Virje): 25.10.2004., 1, SZ & KT, +EFG; Drava, downstream from the mouth of Rogstrug canal, small lake (Đuretina - Pitomača): 09.10.2004., 51, SZ & KT, +EFG;

Drava, Križnica bridge, downstream (Križnica): 09.10.2004., 24, SZ & KT, +EFG; Drava, Repaš meadow: 31.08.2007., 4, SZ, +EFG; Drava, Rogstrug canal (Đuretina - Pitomača): 09.10.2004., 2, SZ & KT, +EFG.

10. **Spirlin** *Alburnoides bipunctatus* (Bloch, 1782)
First it was Juranic (1884) and Glowacki (1885) to describe this species from Drava, but the fish faunal studies of Drava from more recent times (Harka 1992; Majer 1995, 1998; Majer & Bordács 2001) do not include this species at all. Among species protected by nature conservation this was the one with the highest number of captured individuals. We have found it to occur all along the Hungarian section of the river (Sallai 2002a, 2002b). It is a moderately frequent, protected species (Fig. 2.).

Drava, Botovo bridge (Botovo): 31.08.2007., 19, SZ, +EFG; Drava, downstream from the mouth of Rogstrug canal (Đuretina - Pitomača): 09.10.2004., 29, SZ & KT, +EFG; Drava, downstream from the mouth of Rogstrug canal, small lake (Đuretina - Pitomača): 09.10.2007., 2, SZ & KT, +EFG; Drava, Križnica bridge, downstream (Križnica): 09.10.2007., 61, SZ & KT, +EFG.

Fig. 2. Spirlin *Alburnoides bipunctatus* is a frequent fish species of river Drava (Photo by Zoltán Sallai)

11. **Silver bream** *Blicca bjoerkna* (Linnaeus, 1758)
First it was Heckel (1847) to publish about its presence in river Drava, and it is also reported as occurring in the river by all relevant literature from the recent period (Harka 1992, 1997; Majer 1995, 1998; Majer & Bordács 2001; Sallai 2002a, 2002b). This species can be encountered in habitats with both stagnant and flowing waters. It is a moderately frequent, eurytropic species occurring all along the Hungarian section of the river.

Drava (Senjanska): 31.08.2007., 1, SZ, +EFG; Drava (Legrad): 31.08.2007., 6, SZ, +EFG; Drava, Rogstrug canal (Đuretina - Pitomača): 09.10.2007., 2, SZ & KT, +EFG.

12. **Bream** *Abramis brama* (Linnaeus, 1758)
Ichthyological studies produced in the 19th century all include this species as occurring in river Drava (Heckel 1847; Juranic 1880, 1884; Glowacki 1885; Herman 1887). Similarly, each of the publications from the past 10 years mentions its presence in the river. It is moderately frequent, appearing in both stagnant and movig waters.

Drava, 153 rkm (Terezino Polje): 21.08.2004., 2, ANONYM, +H, Drava, Botovo bridge (Botovo): 31.08.2007., 1, ANONYM, +H; Drava, Križnica bridge, downstream (Križnica): 09.10.2007., 1, SZ & KT, +EFG; Drava, Rogstrug canal (Đuretina - Pitomača): 09.10.2007., 1, SZ & KT, +EFG.

13. **Vimba** *Vimba vimba* (Linnaeus, 1758)
Papers from both early and recent times contain references to the occurrence of this species in river Drava (Heckel 1847; Juranic 1884; Glowacki 1885; Herman 1887; Harka 1992; Majer 1998; Majer & Bordács 2001; Sallai 2002a, 2002b). Several times it was found in large numbers at gravel shoals. Occurring all along the Hungarian Drava section, it was found to be more frequent than species belonging to the genus *Abramis*. It is a moderately frequent, rheophilic species.

Drava (Legrad): 21.08.2004., 7, SZ & KT, +EFG; 31.08.2007., 61, SZ, +EFG.

14. **Nase** *Chondrostoma nasus* (Linnaeus, 1758)
First it was Heckel (1847) to give an account on the presence of this species in river Drava, but also, it has been reported in all of the publications that have been produced in the most recent 10 years (Harka 1992; Majer 1995, 1998; Majer & Bordács 2001). It is present throughout the Hungarian sections of river Drava (Sallai 2002a, 2002b), and it was found to be quite frequent in the upper reaches.

Drava (Legrad): 21.08.2004., 5, SZ & KT, +EFG; 31.08.2007., 9, SZ, +EFG; Drava, Botovo bridge (Botovo): 31.08.2007., 1, ANONYM, +H.

15. **Tench** *Tinca tinca* (Linnaeus, 1758)
Among earlier studies (Juranic 1880, 1884; Glowacki 1885; Herman 1887), it is only Heckel (1847) not mentioning this species among those being present in Drava. Also, in publications having appeared in the most recent decade, the authors list this species among those being present in river Drava (Harka 1992; Majer 1995, 1998; Sallai 2002a, 2002b). Being present along the entire Hungarian section of Drava, it is a rare, stagnophilic species of side-branches and oxbows.

Drava, Botovo bridge, downstream (Botovo): 31.08.2007., 1, SZ, +EFG; Drava, Čambina-oxbow (Novo Virje): 25.10.2004., 5, SZ & KT, +EFG; Drava, Repaš meadow (Repaš): 31.08.2007., 3, SZ, +EFG.

16. **Barbel** *Barbus barbus* (Linnaeus, 1758)
All of the publications that have appeared on the fish fauna of river Drava include the description of this species (Heckel 1847; Juranic 1880, 1884, Glowacki 1885; Herman 1887; Harka 1993, 1997; Majer 1995, 1998; Majer & Bordács 2001). Among

economically significant species, barbel is the one that has been revealed in the largest amounts (SALLAI 2002a, 2002b). The high numbers representing populations of considerable size indicate that this species finds optimal breeding conditions in the waters of Drava. We could regularly capture its individuals at gravel shoals and rock embankments. It is a common rheophilic species listed in Annex V. of the Habitat Directive.

Drava (Legrad): 21.08.2004., 2, SZ & KT, +EFG; 25.10.2004., 1, SZ & KT, +EFG; 31.08.2007., 3, SZ, +EFG; Drava, Botovo bridge (Botovo): 31.08.2007., 5, SZ, +EFG; Drava, downstream from the mouth of Rogstrug canal (Đuretina - Pitomača): 09.10.2007., 13, SZ & KT, +EFG; Drava, Križnica bridge, downstream (Križnica): 09.10.2007., 12, SZ & KT, +EFG.

17. **Danubian gudgeon** *Gobio obtusirostris* Valenciennes, 1842

Among faunistic publications from the 19$^{th}$ century only JURANIC (1880, 1884) and GLOWACKI (1885) described this species from the Drava. We found the first specimen in the river in November 2000 at Drávasztára. It is a rare species in river Drava, as stated earlier by HARKA (1992) too. Several authors have still continue to confuse this species with the closely related Danube whitefin gudgeon (*Romanogobio vladykovi*) which is a common species in our larger rivers (HARKA 1996).

Drava, canal (Donja Dubrava): 25.10.2004., 3, SZ & KT, +EFG; Drava, Križnica bridge, downstream (Križnica): 09.10.2007., 1, SZ & KT, +EFG.

18. **Danube whitefin gudgeon** *Romanogobio vladykovi* (Fang, 1943)

This species was first described in the 20$^{th}$ century only, and it is an interesting fact that it is mentioned only by HARKA (1992), among most recent publications on Drava fish fauna. It is present all along the Hungarian section of Drava. This species is a commonly distributed, relatively frequent fish with stabile, self-sustaining population. It is protected in Hungary, and is listed in Annex II. of the Habitat Directive.

Drava, 168 rkm (Širine): 09.10.2007., 3, SZ & KT, +EFG; Drava, downstream from the mouth of Rogstrug canal (Đuretina - Pitomača): 09.10.2007., 1, SZ & KT, +EFG; Drava, Križnica bridge, downstream (Križnica): 09.10.2007., 3, SZ & KT, +EFG; Drava, Rogstrug canal (Đuretina - Pitomača): 09.10.2007., 1, SZ & KT, +EFG.

19. **False rasbora** *Pseudorasbora parva* (Temminck & Schlegel, 1846)

It is an adventive species of Asian origin, having been introduced to Europe in the second half of the 20$^{th}$ century. All fish faunistic studies during the recent 10 years have mentioned it as appearing in river Drava (HARKA 1992; MAJER 1995, 1998; MAJER & BORDÁCS 2001). It is a common species, being present in the entire Hungarian section of Drava, and also occurring in all of the water bodies belonging to the Drava catchment.

Drava (Legrad): 25.10.2004., 11, SZ & KT, +EFG; Drava, Bistra canal (Koprivnički Bregi): 31.08.2007., 8, SZ, +EFG.

20. **Bitterling** *Rhodeus amarus* (Bloch, 1782)

Among earlier faunistic works, it was only GLOWACKI (1885) to have reported this species from Drava, but in publications of the more recent period, it is always mentioned (HARKA 1992; MAJER 1995, 1998; MAJER & BORDÁCS 2001; SALLAI 2002a, 2002b). Hungarian populations of the bitterling can be regarded as stable. Where bivalve species required for its spawning are available in abundance, large bitterling populations have been able to develop. They are encountered in side-branches as well as at rocky embankments. In Hungary it is a protected species, and is listed in Annex II. of the Habitat Directive. It is a moderately frequent species, found throughout the Drava water system.

Drava (Senjanska): 31.08.2007., 4, SZ, +EFG; Drava, Bistra canal (Koprivnički Bregi): 31.08.2007., 1, SZ, +EFG; Drava, downstream from the mouth of Rogstrug canal (Đuretina - Pitomača): 09.10.2007., 4, SZ & KT, +EFG; Drava, downstream from the mouth of Rogstrug canal, small lake (Đuretina - Pitomača): 09.10.2007., 7, SZ & KT, +EFG; Drava, Križnica bridge, downstream (Križnica): 09.10.2007., 6, SZ & KT, +EFG; Drava, Repaš meadow (Repaš): 31.08.2007., 42, SZ, +EFG; Drava, Rogstrug canal (Đuretina - Pitomača): 09.10.2007., 17, SZ & KT, +EFG.

21. **Crucian carp** *Carassius carassius* (Linnaeus, 1758)

The presence of this species in river Drava has been indicated by literature since the late 19th century (JURANIC 1880, 1884; GLOWACKI 1885; HERMAN 1887) up to recent times (HARKA 1992; MAJER 1995, 1998; MAJER & BORDÁCS 2001; SALLAI 2002a, 2002b). Small populations are found in stagnant water bodies, oxbows of Drava, overgrown by aquatic vegetation. In spite of the fact that we have suggested its inclusion in the list of protected species in Hungary (SALLAI 2000), it was left out, although its populations have been reported to have been diminishing not only in Hungary but also in neighbouring countries.

Fig. 3. Becoming increasingly rare, Crucian carp *Carassius carassius* is an endangered species of Drava oxbows (Photo by Zoltán Sallai)

Bănărescu (1993, 1994) indicated the Crucian carp (*Carassius carassius*) to be the second most endangered species in Romania after *Romanichthys valsanicola*. It is a vanishing, endangered member of our fauna, considered to be rare in the Drava water system (Fig. 3.).

Drava, Čambina-oxbow (Novo Virje): 21.08.2004., 1, SZ & KT, +EFG; 25.10.2004., 2, SZ & KT, +EFG.

22. **Prussian carp** *Carassius gibelio* (Bloch, 1782)

Several authors specify the date of this species being introduced to Hungary to be 1954. According to our current knowledge, however, we can state that Prussian carp had been present in Hungary even before that date, this assumption adequately proved in the publication by Jaczó (1944). With regard to these, we can establish that the first occurrences of this species in Drava were recorded by Heckel (1847), Juranic (1880, 1884) and Glowacki (1885). Among recent studies focusing on the fish fauna of the Drava water system, Prussian carp is included in each (Harka 1992; Majer 1995, 1998; Sallai 1999; Majer & Bordács 2001; Sallai 2002a, 2002b). It is present all along the main branch, in side-branches, oxbows and tributary waters. It is a very frequent, eurytopic species of Drava and the water bodies belonging to its water system.

Drava (Legrad): 25.10.2004., 3, SZ & KT, +EFG; Drava (Senjanska): 31.08.2007., 2, SZ, +EFG; Drava, Bistra canal (Koprivnički Bregi): 31.08.2007., 270, SZ, +EFG; Drava, Čambina-oxbow (Novo Virje): 25.10.2004., 7, SZ & KT, +EFG; Drava, Križnica bridge, downstream (Križnica): 09.10.2007., 1, SZ & KT, +EFG; Drava, Rogstrug canal (Đuretina - Pitomača): 09.10.2007., 1, SZ & KT, +EFG; Drava, Spinc-oxbow (Ferdinandovac): 31.08.2007., 1, SZ, +EFG.

Cobitidae

23. **Weatherfish** *Misgurnus fossilis* (Linnaeus, 1758)

This species was first mentioned from Drava by Juranic (1880, 1884) and Glowacki (1885). Harka (1992) and Majer (1995, 1998) reported on the present-time occurrence of this species in river Drava. The weatherfish is a typical but rare member of marsh fish communities. It can be encountered in permanent, silted water bodies such as side-branches and oxbows, grown over by lush aquatic vegetation. It has medium-sized populations in the studied habitats. In addition to being protected in Hungary, it is also listed in Annex II. of the EU Directive on habitats of community interest (Fig. 4.).

Drava, Bistra canal (Koprivnički Bregi): 31.08.2007., 1, SZ, +EFG.

Fig. 4. Proof photograph of the adult weatherfish *Misgurnus fossilis* found in Bistra canal (Photo by Zoltán Sallai)

24. **Danubian spined loach** *Cobitis elongatoides* Băcescu & Majer, 1969

Due to the taxonomic revision of the *C. taenia* species complex (FREYHOF et al. 2000), Danubian spined loach populations living in Hungary belong to the new *C. elongatoides* species (ERŐS 2000). It is a species with common distribution in Hungarian natural water bodies. In river sections where the bottom is covered with soft sediment, this species was often caught in huge numbers. It has stable, self-sustaining populations in river Drava and its water system. As a moderately frequent species, it is present throughout the entire Hungarian river section. It is protected in Hungary, and is listed in Annex II of the Habitat Directive.

Drava (Legrad): 21.08.2004., 2, SZ & KT, +EFG; Drava, downstream from the mouth of Rogstrug canal, small lake (Đuretina - Pitomača): 09.10.2007., 1, SZ & KT, +EFG; Drava, Križnica bridge, downstream (Križnica): 09.10.2007., 63, SZ & KT, +EFG; Drava, oxbow close to the canal (Donja Dubrava): 25.10.2004., 1, SZ & KT, +EFG; Drava, Repaš meadow (Repaš): 31.08.2007., 9, SZ, +EFG; Drava, Rogstrug canal (Đuretina - Pitomača): 09.10.2007., 77, SZ & KT, +EFG; Drava, Špinc-oxbow (Ferdinandovac): 31.08.2007., 4, SZ, +EFG.

25. **Bulgarian golden loach** *Sabanejewia bulgarica* (Drensky, 1928)

The first ever proof specimen in Hungary was found by JÁSZFALUSI (1948) in river Tisza, at Kőtelek. There had been no former occurrence data from Drava in the literature, and the absence of this species was even pointed out by HARKA (1992). The only early (photographic) evidence on its occurrence in Drava, an unpublished piece of information, was made available for us by László Fenyősi. First we found the species near Vízvár in March 2000. Based on our data this species can be found in Drava from Őrtilos to Révfalu (Dravakeresztúr) wherever there is optimal habitat for this fish. It has a small but self-sustaining population in the river. We found it mostly in river sections with rapid water current and gravelly riverbed substrate, but in some cases we also caught its representatives in main riverbed sections with soft sediment substrate, moreover, at rocky embankment. It is a rare and endangered faunal element being listed in Annex II. of Habitat Directive, and being under protection in Hungary.

Drava, 168 rkm (Širine): 09.10.2007., 46, SZ & KT, +EFG.

Balitoridae

26. **Stone loach** *Barbatula barbatula* (Linnaeus, 1758)

Among literature items published in the 19th century, this species is listed in the studies by JURANIC (1880, 1884) and GLOWACKI (1885), but the publications of recent years do not mention it from the Hungarian section of Drava (HARKA 1992; MAJER 1995, 1998; MAJER & BORDÁCS 2001). Inferred from its occurrence in the river Mura (SALLAI 1999), we expected to find it in Drava, too, and actually revealed its presence from Őrtilos to Révfalu (Drávakeresztúr). From these data it appears that there is a smaller, self-sustaining population existing in the river, rather than these individuals having been drifted downstream from their original distribution. It was mostly in sections with strong current and gravelly substrate that we could capture its specimens, but several specimens occurred at rocky embankments. It is considered to be a rare species, protected in Hungary.

Drava (Legrad): 21.08.2004., 1, SZ & KT, +EFG; Drava, downstream from the mouth of Rogstrug canal (Đuretina - Pitomača): 09.10.2007., 3, SZ & KT, +EFG; Drava, Križnica bridge, downstream (Križnica): 09.10.2007., 1, SZ & KT, +EFG; Drava, Rogstrug canal (Đuretina - Pitomača): 09.10.2007., 2, SZ & KT, +EFG.

Ictaluridae

27. **Black bullhead** *Ameiurus melas* (Rafinesque, 1820)

It would be difficult to exactly define the date of the introduction of this species to Hungary, because it is most likely that even the first import shipments of brown bullhead (*Ameiurus nebulosus*) contained both species, due to incorrect identification (PINTÉR 1991). The first Hungarian occurrence in nature was recorded by PINTÉR (1991), in the floodland of the river Hármas-Körös. Today it is found in most of the natural water bodies. It was first described from river Drava by MAJER (1998). In comparison with the populations in the eastern, Tiszántúl region, it was found to be quite infrequent, being present in only two Drava-oxbows. It is a rare adventive species of the Drava water system (Fig. 5.).

Drava, Čambina-oxbow (Novo Virje): 25.10.2004., 10, SZ & KT, +EFG; Drava, Rogstrug canal (Đuretina - Pitomača): 09.10.2007., 1, SZ & KT, +EFG.

Fig. 5. Black bullhead *Ameiurus melas* is found in river Drava's Croatian sections, too. (Photo by Zoltán Sallai)

Siluridae

28. **Catfish** *Silurus glanis* Linnaeus, 1758
The majority of relevant publications, both older and recent, have this species on their checklist as being present in Drava (Heckel 1847; Glowacki 1885; Herman 1887; Harka 1993, 1997; Majer 1995, 1998; Majer & Bordács 2001; Sallai 2002a, 2002b). Most of the specimens caught belonged to the age group of 1-2 years, almost all of them found at rocky embankments. It is a moderately frequent predator species of the river.

Drava, downstream from the mouth of Rogstrug canal (Đuretina - Pitomača): 09.10.2007., 4, SZ & KT, +EFG; Drava, downstream from the mouth of Rogstrug canal, small lake (Đuretina - Pitomača): 09.10.2007., 1, SZ & KT, +EFG; Drava, Križnica bridge, downstream (Križnica): 09.10.2007., 1, SZ & KT, +EFG.

Esocidae

29. **Pike** *Esox lucius* Linnaeus, 1758
Almost all of the ichthyological studies on the fauna of Drava include this species (Heckel 1847; Juranic 1880, 1884, Glowacki 1885; Herman 1887; Harka 1993, 1997; Majer, 1995 1998; Majer & Bordács 2001; Sallai 2002a, 2002b). Occurring all along the Hungarian river section, it is a commonly distributed, moderately frequent species of the Drava water system.

Drava (Legrad): 21.08.2004., 1, SZ & KT, +EFG; Drava, Čambina-oxbow (Novo Virje):

25.10.2004., 3, SZ & KT, +EFG; Drava, canal (Donja Dubrava): 25.10.2004., 1, SZ & KT, +EFG; Drava, Križnica bridge, downstream (Križnica): 09.10.2007., 1, SZ & KT, +EFG; Drava, Repaš meadow (Repaš): 31.08.2007., 8, SZ, +EFG; Drava, Rogstrug canal (Đuretina - Pitomača): 09.10.2007., 7, SZ & KT, +EFG.

Salmonidae

30. **Brown trout** *Salmo trutta m. fario* Linnaeus, 1758
This species was first reported to occur in river Drava by Juranic (1880, 1884) and Glowacki (1885). Majer (1998) reported on the brown trout specimen caught by Ferenc Énok at Őrtilos in 1990. P. L. Á. (2000) gives an account on a brown trout and a rainbow trout caught in recent years by Mihály Plecskó fisherman from Vízvár. The trout occurrence data published by Harka (1992) originated also from Plecskó. Ferenc Énok made available the capture data of a brown trout caught by him in March 2002 at Őrtilos, for which we hereby express our high appreciation.

Drava, canal (Donja Dubrava): 25.10.2004., 4, SZ & KT, +EFG; Drava, oxbow close to the canal (Donja Dubrava): 25.10.2004., 1, SZ & KT, +EFG.

Lotidae

31. **Burbot** *Lota lota* (Linnaeus, 1758)
The first occurrence data of burbot in Drava was published by Heckel (1847). Among more recent ichthyofaunistic publications, both Harka (1992) and Majer (1995) mention this species. However, from the latter paper it is not clear which species were found by the author himself and which were listed relying on literature; the author includes all Hungarian sturgeons in his species list, although the recent occurrence of a few of them is questionable. Majer (1998), in his later study, does not at all mention burbot, although this study is cited in his paper dealing with the fauna of Somogy (Bíró & Majer 2001). The burbot is a moderately frequent species of Drava. In most of the cases, its specimens – mostly older individuals – were caught at rocky embankments.

Drava, downstream form the mouth of Rogstrug canal (Đuretina - Pitomača): 09.10.2007., 2, SZ & KT, +EFG.

Cottidae

32. **Sculpin** *Cottus gobio* Linnaeus, 1758
The first authors to describe the occurrence of this species in Drava were Juranic (1880, 1884) and Glowacki (1885). Its presence in Drava in recent times was published by Majer (1998), these data suggesting occasional occurrence rather than permanent presence. However, this assumption was totally rejected by our experience in recent years. We have found this species in almost all of our sampling points in the Hungarian section of Drava between Őrtilos and Révfalu (Drávakeresztúr). The self-sustaining population of this species can be considered to be stable, this fact being well represented by the number of specimens found: 2 in 1999, 89 in 2000, 98 in 2001, 69 in 2002, and 36 in 2003. As regards body size, it must be noted that the smallest specimen found had a standard length measurement of 26 mm, whereas the largest measured was 120 mm. The presence of this

species in Drava has outstanding nature conservation significance, because it has no other populations in Hungary apart from the one in Szigetköz (GUTI 1997) It is a rare, endangered species of our fauna, being listed, in addition to its protected status in Hungary, in Annex II. of the Habitat Directive.

Drava, canal (Donja Dubrava): 25.10.2004., 3, SZ & KT, +EFG; Drava, downstream from the mouth of Rogstrug canal (Đuretina - Pitomača): 09.10.2007., 10, SZ & KT, +EFG; Drava, Križnica bridge, downstream (Križnica): 09.10.2007., 3, SZ & KT, +EFG.

Centrarchidae

33. **Pumpkinseed** *Lepomis gibbosus* (Linnaeus, 1758)
This species, similarly to other adventive species, was introduced to our waters in the first decade of the 20th century, but neither of the introduced fishes lived up to expectations. The pumpkinseed or sunfish was first listed among species occurring in Drava by HARKA (1992). We have been able to observe it in higher numbers in side-branches and oxbows where mostly young specimens were caught. At rocky embankments, however, predominantly older specimens were captured. It is a frequent adventive species of Drava and its water system.

Drava (Legrad): 21.08.2004., 10, SZ & KT, +EFG; 25.10.2004., 2, SZ & KT, +EFG; Drava, Čambina-oxbow (Novo Virje): 21.08.2004., 6, SZ & KT, +EFG; 25.10.2004., 23, SZ & KT, +EFG; Drava, downstream from the mouth of Rogstrug canal (Đuretina - Pitomača): 09.10.2007., 7, SZ & KT, +EFG; Drava, downstream from the mouth of Rogstrug canal, small lake (Đuretina - Pitomača): 09.10.2007., 12, SZ & KT, +EFG; Drava, Repaš meadow (Repaš): 31.08.2007., 3, SZ, +EFG; Drava, Rogstrug canal (Đuretina - Pitomača): 09.10.2007., 9, SZ & KT, +EFG; Drava, Spinc-oxbow (Ferdinandovac): 31.08.2007., 22, SZ, +EFG.

34. **Largemouth bass** *Micropterus salmoides* (Lacépède, 1802)
This species, too, was brought to Hungary from North-America, around the beginning of the 20th century. Its first occurrence data from Drava is reported by VUTSKITS (1913a, 1913b). HARKA (1992) and MAJER (1998), too include this species in their species list. Formerly, it was regularly stocked in some gravel pit ponds near Drava, thus even a smaller self-sustaining population could establish itself at Bélavár. It is a rare, adventive species (Fig. 6.).

Drava (Legrad): 21.08.2004., 1, SZ & KT, +EFG; Drava, Čambina-oxbow (Novo Virje): 25.10.2004., 1, SZ & KT, +EFG.

Fig. 6. A rare, adventive species in river Drava is largemouth bass *Micropterus salmoides* (Photo by Zoltán Sallai)

Percidae

35. **Perch** *Perca fluviatilis* Linnaeus, 1758

This species was first reported from Drava around the end of the 19th century by JURANIC (1880, 1884) and GLOWACKI (1885). All of the recent publications mention it as appearing in the river (HARKA 1993, 1997; MAJER 1995, 1998; MAJER & BORDÁCS 2001; SALLAI 2002a, 2002b). It is a commonly distributed, moderately frequent fish species of Drava and its water system.

Drava (Legrad): 21.08.2004., 3, SZ & KT, +EFG; Drava, downstream from the mouth of Rogstrug canal (Đuretina - Pitomača): 09.10.2007., 3, SZ & KT, +EFG; Drava, downstream from the mouth of Rogstrug canal, small lake (Đuretina - Pitomača): 09.10.2007., 1, SZ & KT, +EFG; Drava, Repaš meadow (Repaš): 31.08.2007., 3, SZ, +EFG.

36. **Ruffe** *Gymnocephalus cernua* (Linnaeus, 1758)

The ruffe is included in the species list of all of the literature items dealing with the fish fauna of Drava (JURANIC 1880, 1884; GLOWACKI 1885; HERMAN 1887; HARKA 1993, 1997; MAJER 1995, 1998; MAJER & BORDÁCS 2001; SALLAI 2002a, 2002b). Its populations in Hungary follow a decreasing trend. It has been found to be very rare in river Drava.

Drava, Rogstrug canal (Đuretina - Pitomača): 09.10.2007., 1, SZ & KT, +EFG.

37. **Danube ruffe** *Gymnocephalus baloni* Holčik & Hensel, 1974

As a result of the sensational discovery by HOLČIK and HENSEL (1974), a new species was added to the *Gymnocephalus* genus. The first proof specimens in Hungary were found in several water bodies (BOTTA et al. 1984). Its first occurrence in Drava was recorded by HARKA (1992). A stable, self-sustaining population lives in the river, inhabiting the entire Hungarian section. We recorded this species all along the river from Őrtilos to Matty, and the number of specimens found suggests that the population is stable. It was found to occur at rocky embankments where it sometimes occurred in masses. Besides being protected in Hungary, it is listed in Annexes II. and IV. of the Habitat Directive (Fig. 7.).

Drava (Legrad): 21.08.2004., 1, SZ & KT, +EFG; Drava, downstream from the mouth of Rogstrug canal (Đuretina - Pitomača): 09.10.2007., 5, SZ & KT, +EFG; Drava, downstream from the mouth of Rogstrug canal, small lake (Đuretina - Pitomača): 09.10.2007., 3, SZ & KT, +EFG; Drava, Križnica bridge, downstream (Križnica): 09.10.2007., 2, SZ & KT, +EFG.

Fig. 7. Danube ruffe *Gymnocephalus baloni* is s NATURA 2000 indicator species living in Drava (Photo by Zoltán Sallai)

38. **Zingel** *Zingel zingel* (Linné, 1766)

Its first occurrence in Drava was published by JURANIC (1880, 1884) and GLOWACKI (1885). HARKA (1992) included this species in his list based on personal communication with Plecskó, whereas MAJER (1998) referred to information from Énok. Based on our own results, it appears that zingel is present with a small population throughout the entire section of Drava, which can be regarded as stable, as inferred from numbers of specimens found. We found this species in river Drava at the majority of sampling points between Őrtilos and Matty, including the uppermost and lowermost sampling stations. Apart from few exceptions, the caught specimens were revealed at rocky embankments almost exclusively. It is an endemic, endangered species of the Danube's catchment area, found to be rare in Drava. It is a strictly protected species in Hungary, listed in Annexes II. and V. of the Habitat Directive.

Drava, downstream from the mouth of Rogstrug canal (Đuretina - Pitomača): 09.10.2007., 2, SZ & KT, +EFG; Drava, Križnica bridge, downstream (Križnica): 09.10.2007., 1, SZ & KT, +EFG.

Gobiidae

39. **Monkey goby** *Neogobius fluviatilis* (Pallas, 1814)
This species was first found in Hungary in lake Balaton, in 1971 (BÍRÓ 1971). Earlier literature did not mention its occurrence in Drava. Similarly to the case in the Danube, it is spreading in Drava, too. In the Danube it was initially known from the reach below the Sió mouth only (HARKA 1997), but in October 2001 several specimens were caught at Neszmély as well. In river Drava, first it occurred only at the lower Baranya section, but in the autumn of 2001 several adult individuals were caught at Drávakeresztúr. In 2002, it appeared also at the Somogy county river section, at Barcs. The standard length of its largest specimen was 142 mm. It is moderately frequent in the Baranya section, and rare in Somogy county.

Drava, 168 rkm (Širine): 09.10.2007., 1, SZ & KT, +EFG; Drava, downstream from the mouth of Rogstrug canal (Đuretina - Pitomača): 09.10.2007., 1, SZ & KT, +EFG; Drava, Križnica bridge, downstream (Križnica): 09.10.2007., 4, SZ & KT, +EFG.

40. **Tubenose goby** *Proterorhinus semilunaris* (Heckel, 1837)
The first proof specimens of this species in Hungary were described by KRIESCH (1872) with the name *Gobius rubromaculatus*, based on individuals caught in the canal of the hot spring that flowed into the Danube beside the gunpowder mill at Óbuda. From recent times, first it was HARKA (1992) to publish its occurrence in Drava. It is a Pontic-Caspian faunal element, with an increasing population in Drava. The reproductive success in 2001 was particularly high, indicated by the fact that masses of its individuals belonging to the 0+ age group were found in several of the sampling points. Its population in Drava is stabile and self-sustaining, this assumption being supported by the numbers found. We have so far revealed its occurrence in the section between Matty and Vízvár, but based on information about its expansion, it is expected to colonise new river sections too. Being moderately frequent, the tubenose goby is protected in Hungary, and this was justified by the fact that it was proposed for being included in Annexes II. and V. of the Habitat Directive which eventually did not happen.

Drava, 168 rkm (Širine): 09.10.2007., 3, SZ & KT, +EFG; Drava, downstream from the mouth of Rogstrug canal (Đuretina - Pitomača): 09.10.2007., 13, SZ & KT, +EFG; Drava, Križnica bridge, downstream (Križnica): 09.10.2007., 15, SZ & KT, +EFG; Drava, Rogstrug canal (Đuretina - Pitomača): 09.10.2007., 13, SZ & KT, +EFG.

# 5. Conclusion

## 5.1. Characterisation of the fish fauna

The qualitative composition of the fish fauna is determined by the number of occurring species, whereas its qualitative composition depends on the frequencies of various species. Fish faunistic investigations yield high numbers of fish and is done regularly, with its main aim being the identification of the species of each captured individual. However, due to the high economic significance of fish, capturing is legally regulated, and the authors had to comply with these rules when carrying out their study.

The rapid flow of Drava and its winding course favours the epipotamon type of species living mostly in the nase and barbel zones of rivers, thus its fish fauna is made up predominantly of these current-loving, rheophilic species such as e.g. chub *Squalius cephalus*, nase *Chondrostoma nasus*, spirlin *Alburnoides bipunctatus*, barbel *Barbus barbus*, Danube whitefin gudgeon *Romanogobio vladykovi*, Danubian roach *Rutilus virgo*, Danube ruffe *Gymnocephalus baloni*, vimba *Vimba vimba*, burbot *Lota lota*, sculpin *Cottus gobio*, and streber *Zingel streber*. Besides the listed species, some other current-loving, rare and endangered endemics are also present in the fauna with their smaller populations such as stone gudgeon *Romanogobio uranoscopus*, sand gudgeon *Romanogobio kesslerii*, stone loach *Barbatula barbatula* and zingel *Zingel zingel*.

In addition to the rheophilic species, quite similar amounts were found of eurytopic species favouring both lotic and lentic water bodies like leak *Alburnus alburnus*, roach *Rutilus rutilus*, Prussian carp *Carassius gibelio*, bitterling *Rhodeus amarus*, tubenose goby *Proterorhinus semilunaris*, pike *Esox lucius*, silver bream *Blicca bjoerkna* and perch *Perca fluviatlis*.

Also, some adventive species with wide environmental tolerance were also present with considerable population, e.g. the false rasbora *Pseudorasbora parva* and pumpkinseed *Lepomis gibbosus*.

In some side-branches and oxbows that became separated longer time ago, stagnophilic species preferring marsh-like conditions also find suitable habitats for themselves, and these can occasionally drift into the main branch as well – such species are e.g. rudd *Scardinius erythophthalmus*, tench *Tinca tinca* and European mudminnow *Umbra krameri*.

In the main riverbed of Drava rheophilic species dominate, which is partly due to the favourable breeding conditions for such fish. This is supported by the fact that high proportions of young specimens of rheophilic species were captured. In the side-branches, however, depending on the current, eurytopic species dominate instead of rheophilic species. The lowest numbers of fish being present in the study area are the ones representing stagnophilic species that prefer marsh-like habitats.

## 5.2. Expressing the conservation value of the fish fauna

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

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

$$T_A = 4*4_E + 3*13_V + 2*21_R + 14_T + 0*10_{In} + 9^* = 16 + 39 + 41 + 14 + 0 + 9 = 119$$

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

$$T_R = \frac{119}{4_E + 13_V + 21_R + 14_A + 10_{In}} = \frac{119}{62} = 1.919$$

When quantifying the conservation value of the fauna, the absolute conservation value ($T_A$) mainly reflects the number of endangered fish species, while relative conservation value ($T_R$) reflects their proportion.

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

Based on Table 2, the absolute and relative conservation values of the fish fauna of river Drava have been defined ($T_A$ = 119, $T_R$ = 1.919). The species list in the table was compiled using the nomenclature of KOTTELAT (1997) and the taxonomic order of NELSON (1984).

## 5.3. Nature conservation evaluation of the fish fauna

Based on data from available literature and our own investigations, we compiled the list of species currently existing in Drava (Table 2.). The table differentiates between data from literature and those collected by the authors. From these findings, the occasional or regular presence of a total of 64 species in the Hungarian and Croatian sections of river Drava is suggested. The number of species protected by nature conservation in Hungary is 24, of which 5 are strictly protected (Ukrainian brook lamprey *Eudontomyzon mariae*, Danube salmon *Hucho hucho*, European mudminnow *Umbra krameri*, zingel *Zingel zingel*, streber *Zingel streber*).

Altogether 22 of the determined total species number are listed in the Appendices of Habitat Directive. The high value of the fish fauna is further increased by the fact that, 9 species are endemic faunal elements of the Danube's water system (Danubian roach *Rutilus virgo*, stone gudgeon *Romanogobio uranoscopus*, sand gudgeon *Romanogobio kesslerii*, Danube salmon *Hucho hucho*, European mudminnow *Umbra krameri*, Danube ruff *Gymnocephalus baloni*, yellow pope *Gymnocephalus schraetser*, Zingel *Zingel zingel*, Streber *Zingel streber*).

Table 2. Status of endangerment (ES) and nature conservation value (NCV) of fish species of river Drava

| No. | Species | Family | ES | NCV |
|---|---|---|---|---|
| 1. | Ukrainian brook lamprey *Eudontomyzon mariae* (Berg, 1931) | Petromyzontidae | E | 4 |
| 2. | Ship sturgeon *Acipenser nudiventris* Lovetsky, 1828 | Acipenseridae | E | 4 |
| 3. | Sterlet *Acipenser ruthenus* Linnaeus, 1758 | Acipenseridae | R | 2 |
| 4. | Eel *Anguilla anguilla* (Linnaeus, 1758) | Anguillidae | Im | - |
| 5. | Roach *Rutilus rutilus* (Linnaeus, 1758) | Cyprinidae | A | 1 |
| 6. | Danubian roach *Rutilus virgo* Heckel, 1852 | Cyprinidae | V* | 4 |
| 7. | Grass carp *Ctenopharyngodon idella* (Valenciennes, 1844) | Cyprinidae | In | 0 |
| 8. | Rudd *Scardinius erythrophthalmus* (Linnaeus, 1758) | Cyprinidae | A | 1 |
| 9. | Dace *Leuciscus leuciscus* (Linnaeus, 1758) | Cyprinidae | R | 2 |
| 10. | Chub *Squalius cephalus* (Linnaeus, 1758) | Cyprinidae | A | 1 |
| 11. | Orfe *Leuciscus idus* (Linnaeus, 1758) | Cyprinidae | R | 2 |
| 12. | Minnow *Phoxinus phoxinus* (Linnaeus, 1758) | Cyprinidae | R | 2 |
| 13. | Asp *Aspius aspius* (Linnaeus, 1758) | Cyprinidae | R | 2 |
| 14. | Sunbleak *Leucaspius delineatus* (Heckel, 1843) | Cyprinidae | V | 3 |
| 15. | Bleak *Alburnus alburnus* (Linnaeus, 1758) | Cyprinidae | A | 1 |
| 16. | Spirlin *Alburnoides bipunctatus* (Bloch, 1782) | Cyprinidae | V | 3 |
| 17. | Silver bream *Blicca bjoerkna* (Linnaeus, 1758) | Cyprinidae | A | 1 |
| 18. | Bream *Abramis brama* (Linnaeus, 1758) | Cyprinidae | A | 1 |
| 19. | Blue bream *Ballerus ballerus* (Linnaeus, 1758) | Cyprinidae | R | 2 |
| 20. | Zobel *Ballerus sapa* (Pallas, 1814) | Cyprinidae | R | 2 |
| 21. | Vimba *Vimba vimba* (Linnaeus, 1758) | Cyprinidae | V | 3 |
| 22. | Razor fish *Pelecus cultratus* (Linnaeus, 1758) | Cyprinidae | R | 2 |
| 23. | Nase *Chondrostoma nasus* (Linnaeus, 1758) | Cyprinidae | R | 2 |
| 24. | Tench *Tinca tinca* (Linnaeus, 1758) | Cyprinidae | R | 2 |
| 25. | Barbel *Barbus barbus* (Linnaeus, 1758) | Cyprinidae | A | 1 |
| 26. | Danubian gudgeon *Gobio obtusirostris* Valenciennes, 1842 | Cyprinidae | A | 1 |
| 27. | Danube whitefin gudgeon *Romanogobio vladykovi* (Fang, 1943) | Cyprinidae | R | 2 |
| 28. | Stone gudgeon *Romanogobio uranoscopus* (Agassiz, 1828) | Cyprinidae | E* | 5 |
| 29. | Sand gudgeon *Romanogobio kesslerii* (Dybowski, 1862) | Cyprinidae | V* | 4 |
| 30. | False rasbora *Pseudorasbora parva* (Temminck & Schlegel, 1842) | Cyprinidae | In | 0 |
| 31. | Bitterling *Rhodeus amarus* (Bloch, 1782) | Cyprinidae | A | 1 |
| 32. | Crucian carp *Carassius carassius* (Linnaeus, 1758) | Cyprinidae | R | 2 |
| 33. | Prussian carp *Carassius gibelio* (Bloch, 1782) | Cyprinidae | A | 1 |
| 34. | Carp *Cyprinus carpio* Linnaeus, 1758 | Cyprinidae | A | 1 |
| 35. | Silver carp *Hypophthalmichthys molitrix* (Valenciennes, 1844) | Cyprinidae | In | 0 |
| 36. | Bighead carp *Hypophthalmichthys nobilis* (Richardson, 1845) | Cyprinidae | In | 0 |
| 37. | Weatherfish *Misgurnus fossilis* (Linnaeus, 1758) | Cobitidae | R | 2 |
| 38. | Danubian spined loach *Cobitis elongatoides* Băcescu & Majer, 1969 | Cobitidae | R | 2 |
| 39. | Bulgarian golden loach *Sabanejewia bulgarica* (Drensky, 1928) | Cobitidae | V | 3 |
| 40. | Stone loach *Barbatula barbatula* (Linnaeus, 1758) | Balitoridae | R | 2 |
| 41. | Brown bullhead *Ameiurus nebulosus* (LeSueur, 1819) | Ictaluridae | In | 0 |
| 42. | Black bullhead *Ameiurus melas* (Rafinesque, 1820) | Ictaluridae | In | 0 |
| 43. | Catfish *Silurus glanis* Linnaeus, 1758 | Siluridae | R | 2 |
| 44. | Pike *Esox lucius* Linnaeus, 1758 | Esocidae | A | 1 |
| 45. | European mudminnow *Umbra krameri* Walbaum, 1792 | Umbridae | V* | 4 |
| 46. | Danube salmon *Hucho hucho* (Linnaeus, 1758) | Salmonidae | E* | 5 |
| 47. | Brown trout *Salmo trutta* m. *fario* Linnaeus, 1758 | Salmonidae | R | 2 |
| 48. | Rainbow trout *Oncorhynchus mykiss* (Walbaum, 1792) | Salmonidae | In | 0 |
| 49. | Brook trout *Salvelinus fontinalis* (Mitchill, 1814) | Salmonidae | In | 0 |
| 50. | Grayling *Thymallus thymallus* (Linnaeus, 1758) | Thymallidae | Im | - |
| 51. | Burbot *Lota lota* (Linnaeus, 1758) | Lotidae | V | 3 |
| 52. | Sculpin *Cottus gobio* Linnaeus, 1758 | Cottidae | V | 3 |
| 53. | Pumpkinseed *Lepomis gibbosus* (Linnaeus, 1758) | Centrarchidae | In | 0 |
| 54. | Largemouth bass *Micropterus salmoides* (Lacepedé, 1802) | Centrarchidae | In | 0 |
| 55. | Perch *Perca fluviatilis* Linnaeus, 1758 | Percidae | A | 1 |
| 56. | Ruffe *Gymnocephalus cernuus* (Linnaeus, 1758) | Percidae | A | 1 |
| 57. | Danube ruffe *Gymnocephalus baloni* Holčik & Hensel, 1974 | Percidae | R* | 1 |
| 58. | Yellow pope *Gymnocephalus schraetser* (Linnaeus, 1758) | Percidae | V* | 4 |
| 59. | Pikeperch *Sander lucioperca* (Linnaeus, 1758) | Percidae | R | 2 |
| 60. | Volga pikeperch *Sander volgensis* (Gmelin, 1788) | Percidae | V | 3 |
| 61. | Zingel *Zingel zingel* (Linné, 1766) | Percidae | V* | 4 |
| 62. | Streber *Zingel streber* (Siebold, 1863) | Percidae | V* | 4 |
| 63. | Monkey goby *Neogobius fluviatilis* (Pallas, 1814) | Gobiidae | R | 2 |
| 64. | Tubenose goby *Proterorhinus semilunaris* (Heckel, 1837) | Gobiidae | R | 2 |

Legend to Table 2:

E: Endangered: The population has decreased during the 20th century, and the species was occasionally seen during 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, such a 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, these species fall under the category ”rare” – scale of value: 1

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

Im: Immigrant: Species being present occasionally, living throughout Europe, probably having no self-sustaining population in domestic waters.

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

## 5.4. Evaluation of the ichthyofauna of river Drava on the basis of functional guilds

Based on literature data (HARKA & SALLAI 2004) and our own investigations, the presence of a total of 64 species is proved in the past 15 years. We have evaluated the current fish fauna of Drava in fuctional groups, too, on the basis of the guild differentiation established in the methodological protocol. Altogether 13 elements (20.3%) of the Drava’s fish fauna are of adventive origin. From the aspect of tolerance of oxygen deficiency and ammonium, 23 species are regarded as intolerant, and 29 as tolerant. In their habitat use, 30 species belong to the benthic, 35 to the rheophilic, and another 12 to the limnophilous guild, which distribution well represents the proportion of current-loving species. Among the faunal elements of Drava 22 are litophilous, and 15 are phytophilous as to their reproduction guilds. In their selection of spawning environment, 52 species (81.3%) have special requirements, whereas 11 species (17.2%) are less choosy for the spawning substrate. Based on their feeding habits, 15.6% of the species living in river Drava (10 species) are predators, 10.9% (7 species) are predator-invertivorous, and another 26.6% (17 species) are omnivorous. In migratory behaviour, 1 species is diadromous and 15 species are potamodromous.

## 6. Summary

The experience that was gained during the monitoring of the ichthyofauna of Hungarian sections of river Drava between 1999-2006 and the methodological protocol developed for the same monitoring, were adapted in 2007 for Croatian conditions. Relying on the adapted protocol, sampling sites were selected and fish faunistic data collecting was launched in 2007 on Croatian sections of river Drava. A low-power, battery-operated

electric fishing machine working with pulsating direct current was used for the investigations. During the investigations that have been performed so far in Croatia we have captured and identified a total of 1477 fish specimens, representing altogether 40 species. Together with occurrence data for each species, exact numbers of specimens are also given.

Based on information from literature and our own former data, the current ichthyofauna of the river was compiled, which suggests the occasional or regular occurrence of a total of 64 fish species in river Drava. Among the 64 species whose occurrence is now proved, 24 are protected legally by nature conservation in Hungary. Of these, 5 are strictly protected (Ukrainian brook lamprey *Eudontomyzon mariae*, Danube salmon *Hucho hucho*, European mudminnow *Umbra krameri*, Zingel *Zingel zingel*, Streber *Zingel streber*). Altogether 22 of the 64 species are listed in the Appendices of Habitat Directive. Based on the number of species determined, the absolute ($T_A$: 119) and relative ($T_R$: 1.919) natural values of the fish fauna were expressed.

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# Preliminary evaluation of the herpetofauna of habitats selected as sample areas for biomonitoring along river Drava, Croatia

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**Abstract:** As part of the DRAVA-INTERECO INTERREG IIIA Croatian-Hungarian co-operation scheme, areas on the Croatian side of river Drava were surveyed during 2007 in a series of field visits, in order to provide a baseline status report of the herpetofauna of the target area. Earlier data on the amphibian and reptile fauna of this region originate predominantly from monitoring activities performed in Hungarian areas along the river. Our surveys were made in aquatic habitats, wetland areas and arid, open areas as well, using netting in ponds and puddles, visual and aquatic observations, transect walks and intentional search of particular habitats, but no trapping was applied. The high number of sampling sites (in excess of 10 localities, along the entire Croatian Drava section) and time limitations allowed qualitative (amphibian and reptile faunistic) data collecting only, but no counts or population assessments could be performed. A total of 7 amphibians (*Triturus vulgaris,Bufo bufo, Hyla arborea, Rana dalmatina, Rana kl. esculenta, Rana lessonae, Rana ridibunda*) and 7 reptile species (*Emys orbicularis, Lacerta viridis, Podarcis muralis, Elaphe longissima, Natrix natrix, Natrix tessellata, Dolicophis caspius*) were found and their occurrence data recorded. In addition to these, *Triturus dobrogicus*, *Pelobates fuscus*, *Rana arvalis*, *Lacerta agilis*, *Coronella austriaca*, *Anguis fragilis* are also assumed to be present and are thus expected to occur. The new occurrence record of *Dolicophis caspius* in Croatian Baranja bears great importance. In designating areas for nature conservation or monitoring, it is recommended that the results from the analyses of other taxa are considered collectively, so that valuable areas or habitats at the risks of human disturbance or facing degradation are selected. At species level, it is important to produce a complete inventory of amphibian and reptile species in areas along Drava, for which our results can be used as a firm basis.

## 1. Introduction

There have been no comprehensive surveys made on the herpetofauna of areas along river Drava focusing on both the Hungarian and the Croatian side of the river. Data available on the herpetofauna of this region are based predominantly on the results of monitoring activities having been performed in Hungarian areas along the river (KOVÁCS 2004; KOVÁCS & BRANDON 2005). Research results on any investigation on the Croatian

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side are less known, with the majority of information derived from the publications listed in the literature section of our study.

In order to produce some of the missing information and additional faunal data, the surveying of amphibian and reptile species in Croatian sample areas having been selected earlier for NATURA 2000 protection and biodiversity monitoring was launched in 2007, as part of the DRAVA-INTERECO co-operation scheme.

River Drava is a border river flowing along the borderline between neighbouring countries and as such separates areas and habitats that are highly similar to each other, or sometimes are even identical from an ecological aspect. Accordingly, the target areas were designated on the basis of information on the degree of research and possible nature conservation status of habitats on the opposite side of the river.

For the monitoring and sampling of herpetofauna one needs relatively high input and efforts even if aiming at establishing solely the status of presence vs. absence in any particular reptile or amphibian taxon, unlike in the case of other efficiently trappable (mostly invertebrate) taxa. Moreover, the chances of encountering amphibians and reptiles on any given field survey are greatly influenced by the weather on the chosen day. Because reptile and amphibian species are protected by the nature protection acts of both Hungary and Croatia, and because the time available for studies did not allow permanent presence in any of the selected habitats, no trapping methodologies were applied. The amphibian and reptilian monitoring protocol produced for the target area did not suggest the use of any of the trapping techniques. (SCHÄFFER & KLETEČKI 2007; TRÓCSÁNYI & KLETEČKI 2007). Due to time limitations, it was not possible to calculate abundance and estimate population sizes. Instead, the data published here can serve as preliminary data from the target area, and surveys should be continued as a joint effort between Croatian and Hungarian professionals, in the proposed sites.

## 2. Material and methods

It was only the vegetation season of the year 2007 that was available for performing the research activities aiming at the evaluation of areas and their herpetofaunas, and at providing suggestions for monitoring. During the study period, the following areas were included in data collecting: Bansko Hill (Karanac, Kamenac, Kotlina, Podolje), Batina, Belišće, Botovo, Gabajeva Greda, Haljevo, Kozarac, Legrad, Mekiš, Noškovci, Novo Virje, Podravske Sesvete, Veliki Pažut Posebni Zooloski Rezervat, Viljevo, Ždala, Zmajevac. The studied areas included a high variety of habitats and microhabitats ranging from forests, vineyards, orchards and loess embankments to oxbows, culverts and canals, temporary water bodies and gravel pit ponds. Where it seemed to be bearing importance, the description of particular study sites are given together with species description.

When surveying amphibians, water bodies and the surrounding habitats were visited, and the presence of any species was tested visually and acoustically (SCHÄFFER & KLETEČKI 2007). In order to be able to provide evidence about the existence of any Caudata species, and to capture green frogs *Rana esculenta complex* for identification, long-handled nets were used. To find amphibians ranging further off their aquatic habitats outside the breeding season, transect walks were performed in seemingly suitable habitats.

Because the spring season in 2007 set in quite early and abruptly, the breeding season came round earlier for amphibians and was reduced in duration quite significantly, this preventing the authors from collecting large data pools. Consequently, population sizes and densities were not estimated during this study period.

For reptiles, the following survey methods were applied (TRÓCSÁNYI & KLETEČKI 2007). In the case of terrapins we visited apparently suitable habitats and attempted to determine the species, numbers and age of any specimens seen by the naked eye or binoculars. In lizards, we made a thorough survey of pre-determined plots of land or carried out line transects in suitable habitats, whereas in snakes the target areas having been selected earlier based on habitat suitability or literature data were scrutinised, snakes were searched for in possible basking spots, under stones and logs. No trapping was done for either amphibians or reptiles.

For the collected sample of dead snake specimen, DNS-sequencing was performed with cytochrome-b. For the comparison with samples from other distribution areas of the large whip snake, DNA sequence similarities were calculated and dendrograms produced. Phenograms were tested using maximum parsimony with bootstrap. The MEGA program was used for computer analysis of data.

# 3. Results

The subject areas of our investigations varied according to habitat types, and thus were far apart, therefore the number of surveys, the extent of areas sampled and the number of species detected proved to be lower than optimal and what had been realistically expected.

Among the EU's NATURA 2000 nature conservation directives, the Habitat Directive reptile list includes 11 species occurring in Hungary (all of them being protected), and the number of listed amphibians occurring in Hungary is also 11. All of the species now found to be occurring in our target area exist in Hungary too, and they are all protected by law. There is no IUCN Red List species among them, and neither of the threatened (1) and vulnerable (1) species of the Hungarian fauna appear here. The results of the surveys are summarised for all of the amphibian and reptile species (Table 1).

## 3.1. Amphibian and reptile species found in the study areas

AMPHIBIA
CAUDATA
Salamandridae

**Smooth newt** *Triturus vulgaris* (Linnaeus, 1758).
This is the most common newt species of Hungary as well as and the entire Carpathian Basin. In terrestrial habitats it occurs in many types of moist places ranging from gardens, cultivated lands to scattered logs and leaf litter. For breeding it favours shallow water bodies that are heavily overgrown by aquatic plants where it attaches its eggs one by one onto the leaves. Among the areas studied Haljevo forest was found to be the most suitable

habitat. Here, large numbers of smooth newts gather at springtime for mating in temporary water bodies. During our summer sampling, we found many larval forms in Haljevo canal, which could be easily identified from their characteristic external gill lobes. In Hungary it is the *Triturus vulgaris vulgaris* form that occurs, but further to the south, including Croatia according to literature (KRIZMANIĆ et al. 1997), *Triturus vulgaris meridionalis* also appears in addition to the nominal form. It is thus expected to appear also in the southwestern parts of Hungary.

ANURA
Bufonidae

**Common toad** *Bufo bufo* (Linnaeus, 1758).
One can encounter this toad species in reedbeds, forests, groves, meadows. During our spring field survey, the mating calls of males could be heard along the Karašica channel, and a few specimens were seen as well, but the mating season had already ended by that time. During the field visits in June, the metamorphosed young toads were already present in the undergrowth of the wetter parts of Haljevo forest (Fig. 1.). The fact that metamorphosis had been completed relatively early was due to the permanently warm weather of the 2007 season.

Fig. 1. Newly metamorphosed common toad *Bufo bufo* in Haljevo forest (Photo by Dávid A. Schäffer)

Hylidae

**Common tree frog** *Hyla arborea* (Linnaeus, 1758).
Outside its breeding season, this frog species spends most of its time on reed, in trees and bushes, from where its loud call can travel quite a distance. In most of the cases, tree frogs were recorded on the basis of their call (e.g. Kozarac, Bansko Hill, Haljevo, Novo Virje), but during field surveys in the spring several specimens were seen too (Fig. 2.).

Fig. 2. Common tree frog *Hyla arborea* in Bansko Hill (Photo by Dávid A. Schäffer)

Ranidae

**Agile frog** *Rana dalmatina* (Fitzinger in Bonaparte, 1838).
Occurring in lowland and hilly regions, this species prefers moist clearings adjacent to forests. Many egg clusters were observed in spring in Haljevo canal and in deeper puddles of the dirt road near the canal. Mature specimens were present in a variety of localities, and were recorded in Bansko Hill and Kozarac too.

**Edible frog** *Rana kl. esculenta* (Linnaeus, 1758)*,* **pool frog** *Rana lessonae* (Camerano, 1882)*,* **marsh frog** *Rana ridibunda* (Pallas, 1771).
Members of this species group spend most of their time sitting in the water or at the water's edge. In the field it is difficult to precisely distinguish between the species, and in many cases the result is uncertain. Morphometric data taken from the hind leg usually allow relatively reliable identification. On the basis of a few measurements taken in the field, it appears that the target area is characterised with the breeding complex of pool frog and edible frog. These species were recorded, in addition to areas beside Drava, from Haljevo and Kozarac, from the canal outside Mekiš, from Botovo (Šoderica) and from the Drava oxbow (Stara Drava) north of Belišće (Fig. 3).

Fig. 3. Green frogs in the canal and culvert next to Kozarac forest
(Photo by Dávid A. Schäffer)

REPTILIA
TESTUDINES
Emydidae

**European pond terrapin** *Emys orbicularis* (Linnaeus, 1785).
Being Europe's only native testudine species, it prefers stagnant or nearly stagnant waters, with the substrate of the bottom being silty or muddy. Pond terrapins select tree-trunks fallen into the water or the lowermost branches of trees overhanging the water surface, on which they climb out from the water to thermoregulate. Where the bank of the water body is steep and there are no branches or tree-trunks, they sit in waterside vegetation (sedge tufts or rush) to bask.
Among the water bodies visited during the surveys, it was the Belišće oxbow and the side-branch at Noškovci that was found to be suitable habitats, as suggested by the presence of an adult basking terrapin in the waterside zone of each of the two locations.

SAURIA
Lacertidae

**Green lizard** *Lacerta viridis* (Laurenti, 1768).
It prefers arid habitats that can heat up intensively, with open vegetation and some scattered shrubs or small trees. Among the sites visited during the studies, the Batina and Zmajevac areas were of such character. A subadult female specimen was recorded in Batina, basking on top of a small *Ligustrum* hedge.

**Common wall lizard** *Podarcis muralis* (Laurenti, 1768).
It occurs sporadically, but in suitable habitats it is present regularly, sometimes in extreme densities. This species is associated with sunlit rocky surfaces either of natural or artificial origin. It prefers patches of low coverage, where vegetation is short, sparse and patchy. However, as a "pioneer" species, it can sporadically show up – although in small numbers – in insular, small patches inside forest habitats where the aforementioned conditions are present as a result of some kind of human activity (e.g. forestry roads, steep loess embankments, edges of clear-cut forest patches, etc.). One might encounter a basking wall lizard even on large tree stumps left in place inside very young – still short – stands of re-growing forests. Wall lizards were expected to occur in Batina, Zmajevac (maybe Haljevo). An adult specimen was seen rushing back into the crevice of a man-made rock wall at Batina, and it is assumed that larger numbers are present in that locality.

SERPENTES
Colubridae

**Aesculapian snake** *Elaphe longissima* (*Zamenis longissimus*) (Laurenti, 1768)
This snake is found both in lowland and hilly or low mountain regions, in shrubby or wooded habitats, but also in anthropogenic environment. A recent road casualty was found in the outskirts of the village Zmajevac, with unusually dark coloration, measuring about 100 cm. (Fig. 4.). Aesculapian snakes are known to have a graphite grey variety in Mecsek Mountains (TRÓCSÁNYI et al. 2007); the encountered dead specimen probably belonged to the colour variety which used to be differentiated as var. *subgrisea* Werner, 1897.

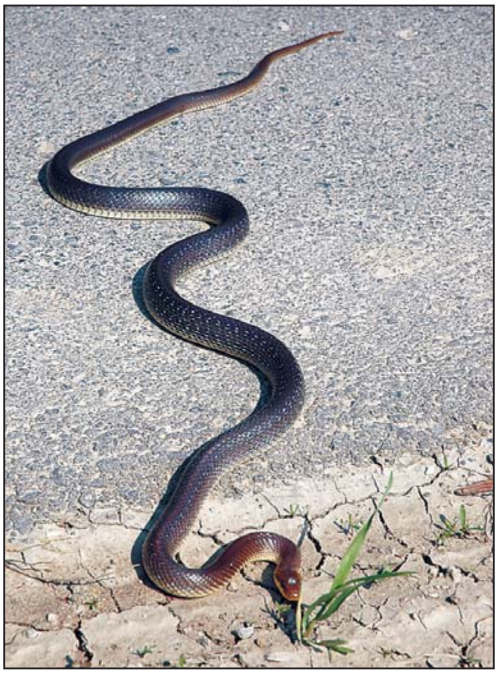

Fig. 4. Adult Aesculapian snake crossing the road at Kozarac (Photo by Jenő J. Purger)

**Grass snake** *Natrix natrix* (Linnaeus, 1758)
This is our most frequent, common snake species found in moist areas, wet meadows and forest edges, and, most commonly, along water bodies of various size. It can travel significant distances from lakes and watercourses from where it takes its primary food. A subadult specimen in a pre-moulting status, measuring approximately 50 cm, was captured at the Belišće sampling point (Fig. 5.), along with the shed skin of an adult specimen.

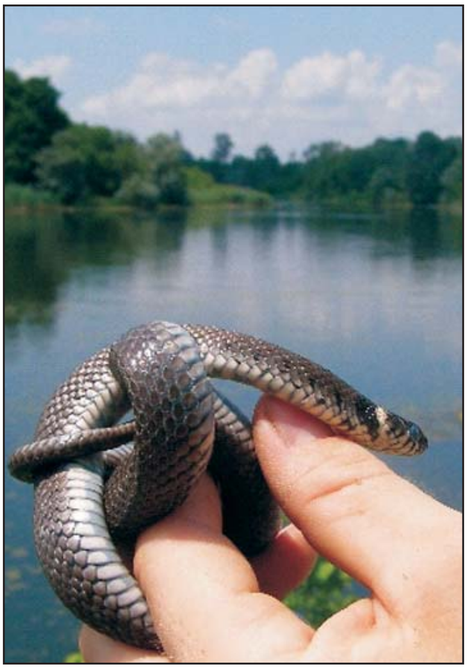

Fig. 5. A young grass snake specimen in pre-moulting stage, captured at the side of Stara Drava at Belišće (Photo by Balázs Trócsányi)

**Dice snake** *Natrix tessellata* (Laurenti, 1768)
More strongly associated with water bodies than grass snake, this species can appear swimming even in large expanses of stagnant or flowing water, including large rivers such as the Danube or Drava. It hunts almost exclusively on fish, catching them in shallow parts of the water, usually near the bank. It can appear wherever there is a sufficiently large water body with stabile fish fauna. We found a specimen at the large, abandoned gravel pit pond (Šoderica) at Botovo.

**Large whip snake** *Dolicophis* (*Hierophis*) *caspius* (Gmelin, 1789)
This is a snake distributed predominantly in the region of the Balkan and the Black Sea, reaching the northwestern fringes of its distribution in Hungary. As a result of strong anthropogenic disturbance to the remaining insular habitat patches and the shrinkage of its habitats anyway, the large whip snake is close to becoming extinct in Hungary. It prefers hot, steep, rocky or loess slopes with open vegetation, that heat up rapidly. According to DELY (1978), in Hungary it has survived in two separate smaller regions. However, recent research and new occurrence data along with fossilic finds suggest that the fragments of a

once coherent distribution area along river Danube might exist (KORSÓS et al. 2002), despite that the two large, important populations have been decreasing recently.
New occurrences are reported by KRČMAR et al. (2007) as well (road casualty), from a Croatian location biogeographically associated with the aforementioned areas along the Danube, in the Bansko loess ridge in Croatian Baranja, near the Danube. During our surveys, we intentionally searched the promising areas and revealed the remains of a dead specimen in Batina, on an elevated loess embankment. From the size, macroscopic scale morphology and subcaudal scale numbers of the remains, we could quite reliably decide about the identity of the species. Total length was estimated to range between 140-170 cm, and the tail section was collected for laboratory DNA analysis. The DNA sequence clearly showed that the sample was from the remains of a large whip snake individual. Moreover, the comparison with samples from other distribution areas of the large whip snake, DNA sequence similarities suggest that the sample from Batina is more associated with those collected further south in the Balkan than with specimens of the Hungarian Szársomlyó Hill which is located spatially much closer than any other site of proved occurrence. The detailed results of the genetic analysis will be published elsewhere.

Table 1. Reptile and amphibian occurrences in the target area, recorded during 2007.

| Species | Locality | Date |
|---|---|---|
| *Triturus vulgaris* | Haljevo | 14.06.2007. |
| *Bufo bufo* | Haljevo | 14.06.2007. |
| *Hyla arborea* | Bansko Hill, Kozarac | 30.03.2007. |
| | Haljevo | 14.06.2007. |
| | Novo Virje | 12.05.2007. (Širine), 06.08.2007. |
| | Gotalovo, Hlebine | 14.04.2007. |
| | Novi Gradac | 15.04.2007. |
| | Novačka | 14.04.2007., 12.05.2007. |
| | Repaš, Legrad | 12.05.2007. |
| *Rana dalmatina* | Gola (Jagerov kut) | 14.04.2007. |
| | Hlebine | 14.04.2007., 14.06.2007. |
| | Bansko Hill, Kozarac | 30.03.2007. |
| | Haljevo | 15.04.2007. |
| | Novi Gradac | 14.04.2007., 12.05.2007. |
| | Novačka, Repaš, Novo Virje (Širine) | 12.05.2007. |
| *Rana kl. esculenta, Rana lessonae, Rana ridibunda* | Kozarac | 30.03.2007. |
| | Novačka | 14.04.2007. |
| | Haljevo, Belišće (Stara Drava), Mekiš, | 14.06.2007. |
| | Botovo (Šoderica) | 08.06.2007. |
| *Emys orbicularis* | Belišće, Noškovci | 14.06.2007. |
| | Novo Virje (Širine) | 12.05.2007. |
| | Hlebine | 14.04.2007. |
| *Lacerta viridis* | Batina | 14.06.2007. |
| *Podarcis muralis* | Batina | 14.06.2007. |
| *Elaphe longissima* | Haljevo | 01.04.2007.. |
| | Zmajevac | 14.06.2007. |
| *Natrix natrix* | Belišće | 14.06.2007. |
| | Haljevo | 01.04.2007. |
| | Novačka, Gotalovo | 14.04.2007. |
| | Ferdinandovac | 15.04.2007. |
| | Novo Virje (Širine) | 12.05.2007. |
| | Legrad | 08.06.2007. |
| *Natrix tessellata* | Botovo (Šoderica) | 08.06.2007. |
| *Dolicophis caspius* | Batina | 14.06.2007. |

# 3. Conclusions

In addition to the 7 amphibian species found in the target area, the appearance of Danube crested newt *Triturus dobrogicus* (Kiritzescu, 1903), spadefoot toad *Pelobates fuscus* (Laurenti, 1768) and moor frog *Rana arvalis* (Nilsson, 1842) is also anticipated. From the 7 reptile species that were recorded during the surveys, the presence of 6 had been expected, whereas the occurrence of one species (large whip snake) had very low chances. Apart from these species, sand lizard *Lacerta agilis*, smooth snake *Coronella austriaca*, and slow worm *Anguis fragilis* are also assumed to be present and are thus expected to occur. The red-eared slider *Trachemys scripta elegans*, an introduced North-American invasive that has been found in many fishponds and lakes in Hungary and Europe, is also likely to appear. This non-native species has been characterised as an aggressive habitat competitor to the European pond terrapin, therefore it is hoped that it is not present in natural and semi-natural water bodies along Drava. The new occurrence record of *Dolicophis* (*Hierophis*) *caspius* in Croatian Baranja bears great importance. This Balkanic snake reaching the edge of its northernmost distribution in Hungary and therefore being highly vulnerable and strictly protected here, has survived in small and confined populations. From data derived from the genetic identification and DNA analysis of the remains that were recovered during surveys of the current project, further important conclusions can be drawn regarding the origins and relatedness of Hungarian insular populations. Accordingly, these results can be among the most highly factual representations of the transboundary nature of our DRAVA-INTERECO project. If herpetofaunistic studies are carried on, area designations for monitoring, nature conservation and NATURA 2000 network can rely on more input, and further useful and analysable data can be gathered about the herpetofauna of the Drava region. The authors suggest that the distributions of all of the amphibian and reptile species existing in the target areas should be precisely documented in the future, but the monitoring to be performed in the long run should concentrate on particular sample habitats rather than on species. In designating areas for nature conservation or monitoring, it is recommended that the results from the analyses of other taxa are considered collectively, so that valuable areas or habitats at the risks of human disturbance or facing degradation are selected. At species level, it is important to produce a complete inventory of amphibian and reptile species in areas along Drava, for which our results can be used as a firm basis. Also, it is advisable to focus attention to the occurrences of the large whip snake in the target areas, and to the numbers and trends of any possible appearance of invasive red-eared sliders. If numbers are to be looked at, easily trappable species should be chosen for monitoring, such as frogs and toads during breeding time, newts in their annual aquatic life stage early in the season, or transect counts can be performed to reveal numbers of frogs (along canals) or lizards (in large expanses of short-grass hayfields or wet meadows). Animal and plant species showing high symmetry in their taxonomic composition at the two sides of river Drava can be most effectively ensured protection if a common biosphere reserve or a transboundary national park is established.

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# Community structure of small mammals in three different forest habitats in the Drava plain region

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**Abstract:** As part of the Croatian-Hungarian interregional programme (DRAVA-INTERECO), small mammal population and community level monitoring was performed during 2007, applying the capture-mark-recapture method. Trapping sessons were run in three forest patches with different vegetation structure, during a period of four months (July-October). Based on capture data the compositon and structure of small mammal communities were anaysed. No marked differences were found between the three habitats based on either diversity and evenness calculations or diversity odering of communities. While species compostions were found to be similar, dominance relations were different in the community structures of various habitat patches. The degree of heterogeneity within a community was found to be smallest in the protected forest habitat. However, in the reforested habitat and in the Croatian habitat under forestry management the different heterogeneities determined by dominance values of the species created a different type of community structure.

## 1. Introduction

Loss of habitat quality, which is the ability of a habitat to contribute to the reproduction and survival of a species (KROHN 1992), is presently considered the main reason for decreases in species richness and diversity (NOSS 1991; MORRISON et al. 1992). Loss of habitats and the reduction of their quality is caused primarily by fragmentaion, a result of various types of land use. The remaining temperate zone deciduous forests are particuarly sensitive to these processes: because these ecosystems are species-rich communities, not only they represent higher taxonomic diversity due to their complex food chain system, but also have greater functional or ecological diversity. These processes appear also along the green corridor of the Drava region where various types of forest (floodland softwood groves, hardwood gallery forests) are preent only in the form of smaller or somewhat larger pockets. Forest fragmentation can decrease the rate of gene flow between metapopulations, which are subpopulations occupying partially isolated remnant forest patches, resulting in less genetic variability and reduced long term viability for interior forest species (BENNETT 1990; VAN APELDOORN et al. 1992; RAJSKA-JURGIEL 1992; KOZAKIEWICZ 1993; DIFFENDORFER et al. 1995).

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Despite the clear need for the long-term preservation of biodiversity and forest ecosystems, the main type of forest use has remained the clear-cutting of areas in many places. Foresty management has either negative, positive or neutral effect on different species (e.g. Laurance 1990; deMaynadier & Hunter 1995; Duguay et al. 2000; Payer & Harrison 2000; de Bellefeuille et al. 2001). This disturbance gradient could lead to a range of responses from ecosystem components, including small mammals. In landscapes subject to repeated disturbance, response of small mammal communities could be particularly complex. Small mammals increase species richness and functional diversity in ecosystems (Carey & Johnson 1995); are a vital prey base for many species, including raptors, reptiles, and other mammals (Fedriani et al. 2000); and play a key role in the distribution of plant species (Mittelbach & Gross 1984; Chambers & MacMahon 1994) and mycorrhizal fungi (Maser et al. 1978). Because of these factors, small mammals have been identified as potential indicators of sustainable forest management (Carey & Harrington 2001; Pearce & Venier 2005). Even apart from the disturbing effects of forestry activities, small mammals are characterised with highly variable population dynamics, therefore longer periods are required to be able to find out about the responses to such habitat disturbances and the trends of these changes (Pearce & Venier 2005). Small mammals are highly suitable for indicating habitat changes in temperate zone deciduous forests (e.g. the complete clear-cutting of trees in certain areas, the resulting habitat fragmentation, the planned reforestation or spontaneous forest re-growth) (e.g. Carey & Harrington 2001). Small mammal populations are well-researched, have short ”turnover”, and their migration patters can be traced well, thus are suitable for the study of ”edge effect” forming between various habitat fragments (e.g. Hansson 1998; Manson et al. 1999; Nickel et al. 2003).

As regards protected areas along Drava river, small mammals are considered to be an adequate taxon and suitable monitoring subject for following the habitat conditions of remaining forested areas with different vegetation structure (softwood and hardwood gallery forests). Among disturbing factors in habitats along Drava, important are the fluctuation of water levels (in floodland forest directly adjacent to the river), and the variation of groundwater table levels (further away from the river), both of which have an effect on colonisation/re-colonisation processes and spatial patterns of small mammals. Another very important disturbing effect is the management activities of remaining forests. The biodiversity monitoring of the upper sections of Drava river was launched in 2000. Within that high priority programme, small mammal population and community monitoring was run as a sub-programme between 2000-2006. As part of the Croatian-Hungarian interregional programme (DRAVA-INTERECO), this monitoring could be continued in 2007, this time with an additional forest fragment located in Croatia also being part of the sampling. Thus, now there were three different habitats in which small mammal population and community monitoring could be pursued, focusing on vegetation structure, forestry management and nature conservation measures.

In the current study we have aimed at finding out (i) about the species composition of small mammal communities of the three different quality habitats, (ii) whether there is any difference between these communities revealed by diversity ordering, and (iii) how much difference is found in the proportions of character species and rare species, and how much heterogeneity within the communities differs in the comparison of the three habitats.

## 2. Material and methods

As part of the DRAVA-INTERECO project, small mammal montoring was continued in the sampling areas formerly designated and studied in Lankóci forest, Hungary (Fig. 1). Assisted by the support of the interregional cooperation programme, the eighth monitoring year was completed in 2007 in the Hungarian study area. One of the sampling areas selected here is a strictly protected alder gallery forest (*Paridi quadrifoliae-Alnetum*) (distinguished thereinafter as *protected forest habitat*). This association type occurs mostly on relatively lower terrain of higher floodplain areas, mostly on alluvial forest soil. Before river regulations, areas of this forest type used to be inundated only at times of higher floods. Such forest stands today are found almost exclusively along watercourses and oxbows in flood-prevented areas, thus they have developed during the course of gallery forest or bog forest succession. The second sample area is located besides a strictly protected forest, where clear-cutting was performed in the year 2000 on a plot of more than 1 hectare (Fig. 1). Since then, this area has been gradually becoming covered in forest re-growth, the development of vegetation having accelerated during the recent years (2004-2005) with higher precipitation (distinguished thereinafter as *reforested habitat*). The third habitat was designated for sampling in the Repaš forest in Croatia, representing a larger fragment of once uninterrupted forest habitats stretching on the opposite side of the Drava (Fig. 2). Here, we applied our traps  in a drier oak-hornbeam forest (*Circaeo-Carpinetum*) stand, well representing Repaš forest (distinguished thereinafter as *habitat under forestry management*).

Fig. 1. Lankóczi forest in Hungary (Photo by Győző Horváth)

Fig. 2. Repaš forest in Croatia (Photo by Győző Horváth)

In all three habitats, a standard trapping grid of 11×11 stations was set up, with plastic box-type traps (75×180×95) positioned 10 m apart, and thus covering an area of 1 hectare (HORVÁTH & KOVAČIĆ 2007). The synchronous monitoring of small mammals in 2007 was performed in the three habitats for four month (July, August, September and October). Based on the established protocol, 5-night trapping sessions were carried out in each month (HORVÁTH & KOVAČIĆ 2007). The sampling intensity of monitoring can be measured with the indicator of trap nights calculated from trap station numbers and sampling nights in the various habitats. Accordingly, the small mammal communities of the studied forest habitats were evaluated on the basis of data from a total of 7260 trap nights. The capture-mark-recapture (CMR) method was applied for population- and community-level monitoring. The captured individuals were tattoo-marked on their toes, this method ensuring individual identification for the entire capture history of every small mammal individual. Upon capture, we recorded the sex (also gravidity or lactation in females), age, body mass, trap number and individual code for each animal. Age was determined from body mass and external body features.

Capture data were stored in a Microsoft Access database, and processed using a Manly-Parr diary of captures. Two capture parameters were used as base data: total number of captures, total number of recaptures. The annual relative proportions of species within small mammal communities of the different habitats were calculated using these parameters. This derived information was then used for analysing dominance relations within the communities, and the patterns of character and rare species proportions in the various habitats. For this, Kruskal–Wallis one-way analysis of variance was performed (ZAR 1996). The diversity of the small mammal communities in the different periods was calculated with the Shannon-Wiener-formula

$$H(S) = -\sum_{i=1}^{S} p_i \ln p_i$$

and with Simpson's or quadratic diversity

$$D = 1 - \sum_{i=1}^{S} p_i^2$$

where $p_i$ is the relative abundance of the i$^{th}$ species in the sample, and $S$ is the number of species present. The Simpson-index is particularly sensitive to the population sizes of different species, and is less sensitive to the number of species present in the community. That is why it is an adequate diversity index for small mammal assemblages, provided that the variation in the number of component species is low but population sizes are considerably dissimilar (ADAMCZEWSKA-ANDRZEJEWSKA et. al. 1979). The reciprocal value of Simpson's diversity was also given (1/D) which provides higher diversity figures and thus a more demonstrative indicator for the characterisation of different communities (MAGURRAN 1988; HEROLDOVÁ et. al. 2006). In addition to Shannon-diversity, evenness (J) was also calculated (PIELOU 1975). Shannon-diversity values calculated for the analysed period were then tested using *t*-test and diversity ordering ((Exp)Rényi- and RTS-diversity) (TÓTHMÉRÉSZ 1997). Heterogeneity within the community, i.e. dominance-diversity relations were evaluated based on dominance-diversity curves. For the above calculations the program packages DivOrd 1.60 and NuCoSa 1.05 (TÓTHMÉRÉSZ 1993, 1994, 1996) were used.

# 3. Results

During the four-month monitoring period in 2007, the total number of captures in the four forest habitats with different vegetation structure was 2331.

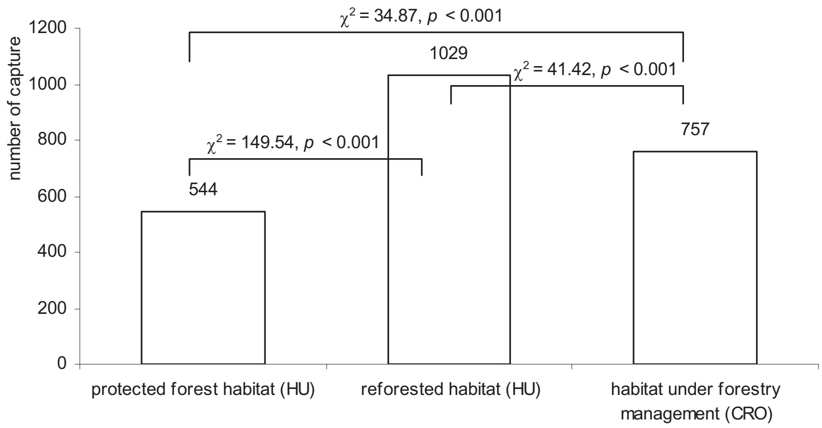


Fig. 3. Capture numbers of small mammals in the three different forest habitats

Table 1. Capture and community parameters of small mammals in the three different forest habitats

| Sampling area | protected forest habitat (Lankóci forest, Hungary) | | reforested habitat (Lankóci forest, Hungary) | | habitat under forestry management (Repaš forest, Croatia) | |
|---|---|---|---|---|---|---|
| | number of | | number of | | number of | |
| Species (code) | captures | recaptures | captures | recaptures | captures | recaptures |
| *S. araneus* (SAR) | 24 | 1 | 34 | 0 | 23 | 0 |
| *S. minutus* (SMI) | - | - | - | - | 2 | 0 |
| *N. fodiens* (NFO) | 3 | 0 | 11 | 2 | - | - |
| *N. anomalus* (NAN) | 1 | 0 | 1 | - | - | - |
| *C. suaveolens* (CSU) | 1 | 0 | - | - | 1 | 0 |
| *C. leucodon* (CLE) | 1 | 0 | 10 | 4 | 3 | 0 |
| *C. glareolus* (CGL) | 437 | 343 | 456 | 235 | 295 | 83 |
| *M. agrestis* (MAG) | - | - | 4 | 2 | - | - |
| *M. subterraneus* (MSU) | - | - | 2 | 2 | - | - |
| *A. flavicollis* (AFL) | 56 | 42 | 86 | 21 | 308 | 99 |
| *A. sylvaticus* (ASY) | 1 | 0 | 6 | 1 | 56 | 20 |
| *A. agrarius* (AAG) | 20 | 15 | 420 | 282 | 69 | 21 |
| Total: | 544 | 401 | 1030 | 549 | 757 | 223 |
| Species richness (S) | 9 | | 10 | | 8 | |
| Shannon-diversity (H[S]) | 0.79 | | 1.23 | | 1.30 | |
| Evenness (J) | 0.36 | | 0.53 | | 0.62 | |
| Simpson-diversity (D) | 0.38 | | 0.63 | | 0.67 | |
| Simpson 1/D | 2.64 | | 1.58 | | 1.49 | |

Trapping was most effective in the reforested habitat in Lankóci forest, where the number of captures exceeded 1000. We had high capture numbers too in the Repaš forest, Croatia (habitat under forestry management), whereas the lowest total number of captures was recorded in the protected Lankóci forest habitat. Capture numbers were found to be significantly different in the four sampling sites (Fig. 3). This result already suggested that differences in habitat quality and vegetation structure have an effect on the small mammal biomass present in the habitats, which is reflected by the variation in trappability and capture efficiency revealed by standard sampling. Altogether 9 species were captured both in the protected forest habitat and in the reforested habitat, but species composition was different: 5 shrews and 4 rodents occurred in the closed alder gallery forest, while rodents (6 species) were in majority and shrews were represented with 3 species in the reforested habitat. Eight species were recorded in the Repaš forest habitat under forestry management, with 4 shrews and 4 rodents making up this small mammal assemblage (Table 1.).

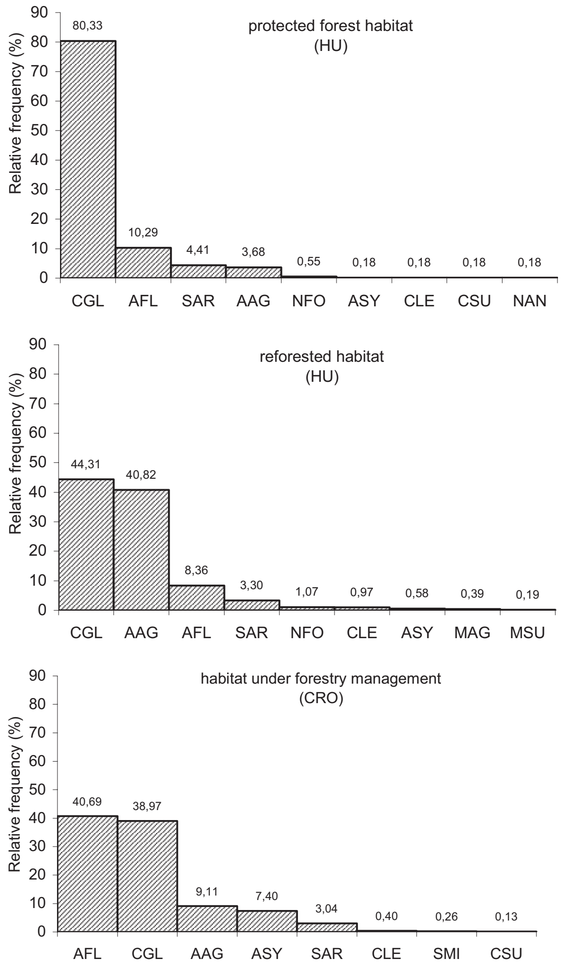


Fig. 4. Histogram of species-abundance in the three habitats

As regards species composition, it was the same rodent species in all three habitats that had higher capture numbers (*A. flavicollis*, *A. agrarius*, *C. glareolus*), and among shrews only *S. araneus* was caught at relatively high rates in the studied habitats. Water shrews, too, preferring wetland areas, appeared in the Lankóci forest, contributing to a varied species composition mostly in the closed, protected forest. No water shrews occurred, however, in the drier Repaš forest. The highest number of rodents were found in the reforested habitat where species like *M. agrestis*, *M. subterraneus* also appeared, not being present either in Hungarian or Croatian closed forests.

The species abundance histograms charted on the basis of capture numbers express the dominance relations of different species within the small mammal community. Both in the protected forest and the reforested habitat part of Lankóci forest, bank vole was found to be the most frequent species. Its dominance value in the closed forest was strikingly high: 80% of capture numbers was made up by bank vole captures, and the next species in the ranking had 10% or lower relative frequency values. In the reforested habitat, striped field mouse was the second most frequent species, its frequency value only slightly differing from that of the first-ranked bank vole population. Accordingly, in the closed forest it was the bank vole and in the reforested habitat it was bank vole and striped field mouse together that were determining the quantitative occurrence values in the entire small mammal community. In these two neighbouring areas the species composition was rendered more colourful by shrews and rarer rodents. In the Repaš habitat under forestry management in Croatia, a different type of species composition was revealed. Here, the first two highest-ranking species of dominance ordering were yellow-necked wood mouse and bank vole. Other small mammals being present in the community were represented at frequency values below 10% (Fig. 4).

The communities of the three habitats were evaluated using Shannon- and Simpson-diversity values and evenness. The strikingly high abundance values of character species were reflected clearly in the values of evenness. The lowest value of evenness was recorded in the protected forest habitat, and the highest value was found in the Croatian forest habitat under forestry management. Here, the number of species was lower, and the relative frequency values of the two dominant species were nearly the same. Similar frequency values were found for the dominant species in the reforested habitat as well, but here more rare species appeared, resulting in lower evenness values. It is known from literature on community ecology that various types of diversity indicators yield different results, and react in different ways to heterogeneity within the community, i.e. to changes in the relative frequencies of species making up the community. Shannon-diversity emphasises the effect of rare species, whereas Simpson's or quadratic diversity is sensitive to the effect of dominant species. Nevertheless, the small mammal communities of the studied three habitats were characterised similarly by the two diversity indicators. As revealed by these indicators, the most diverse habitat was Repaš forest under forestry management, the one with highest evenness, followed by the reforested habitat that had higher species number (9). The lowest diversity was found for the small mammal community of the protected forest habitat with the same (9) number of species but with the lowest evenness. There are only small differences between diversity values, best expressed by the reciprocal value of Simpson's diversity (1/D) (Table 1).

Based on values of diversity we cannot straightforwardly decide which of the three habitats was actually more diverse. To be able to see that, *t*-statistics was performed between Shannon diversity values, and besides, to analyse heterogeneity within the community, we run dominance-diversity analysis and scale-dependent diversity calculations i.e. diversity ordering. Based on *t*-tests, the Shannon-values of the reforested habitat and the one under forestry management were significantly higher than those of the community in the protected forest habitat where a single dominant species (bank vole) was determining frequency relations within the community. There was no significant difference between Shannon-values of the reforested area and the one under forestry management (Table 2.).

Table 2. Statistical *t*-test of Shannon-diversity values

| Sampling area | Protected forest habitat (Lankóci forest, Hungary) | Reforested habitat (Lankóci forest, Hungary) | Habitat under forestry management (Repaš forest, Croatia) |
|---|---|---|---|
| Protected forest habitat (Lankóci forest – Hungary) | - | - | - |
| Reforested habitat (Lankóci forest – Hungary) | t = 8.81<br>$p < 0.001$ | - | - |
| Habitat under forestry management (Repaš forest – Croatia) | t = 10.35<br>$p < 0.001$ | t = 1.85<br>*n.s.* | - |

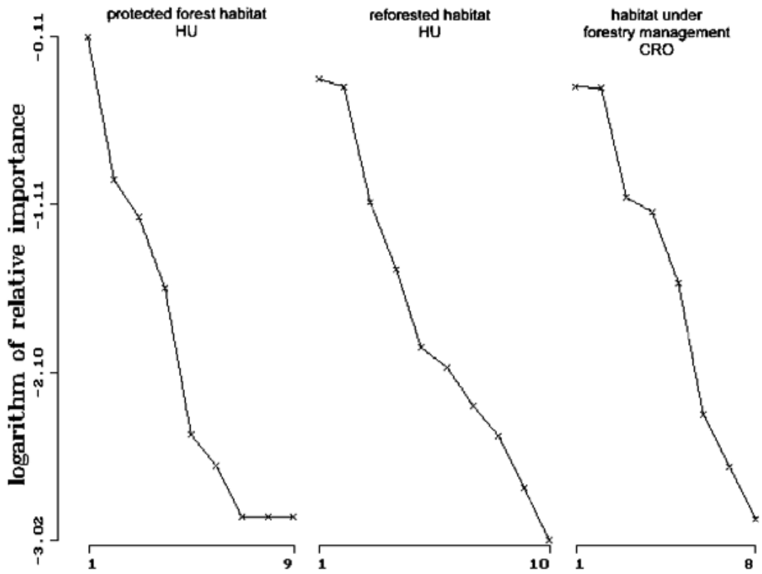


Fig. 5. Dominance-Diversity Curves of the three small mammal communities

In case of dominance-diversity curves, the horizontal axis appears as a line whose length is proportionate with the number of species, representing the community in the sampled habitat, whereas the vertical axis displays the logarithm of relative importance. It was found for all three habitats that the curve is very steep, which is caused by the fact that there were one or two species with very high relative importance in the community. The analysis of dominance curves provided evidence that the typical forest-dwelling species (*A. flavicolis*, *C. glareolus*) were dominant in all three habitats, and *A. agrarius* was the absolutely dominant species in the reforested habitat. Accordingly, the heterogeneity of small mammal communities was found to be low in all three studied habitats (Fig. 5). Among scale-dependent diversity estimation methods first we applied Rényi's diversity ordering. In this method, at low scale parameter values the diversity function is sensitive to the effect of rare species, and at high scale-parameter values to that of dominant species. When ordering with RTS-diversity, the sensitivity of the function is just the opposite. If the diversity profiles representing the communities of the different samples, and species abundance curves intersect, then the communities cannot be ordered based on diversity, and there is no statistically acceptable difference between their diversities.

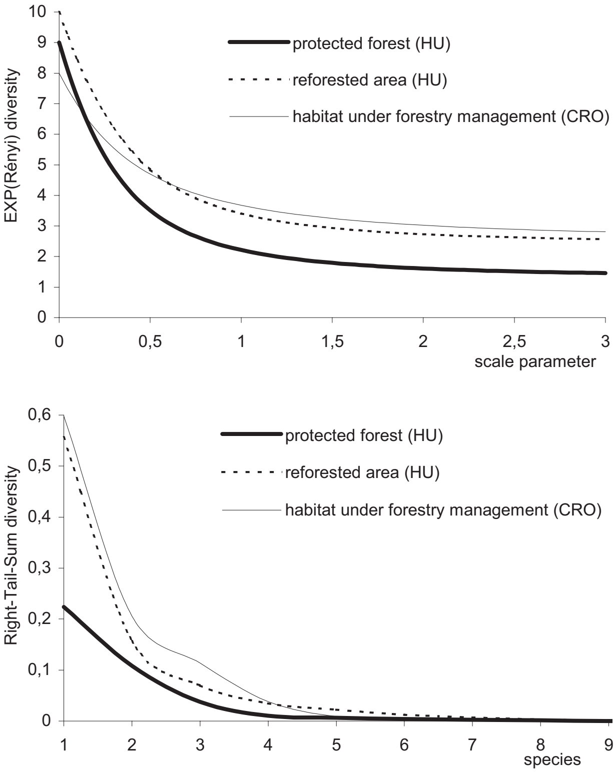


Fig. 6. Diversity ordering of small mammal communities of the three studied areas

As revealed by Rényi's diversity ordering, the diversity profiles of small mammal communities of the reforested habitat and the one under forestry management in Croatia are similar, the profiles intersect, and closely fit each other. At higher scale parameter values both curves are furter off the axis which fact suggests that in these two communities not only one species determines evenness, but instead, at least two species have high relative frequency values. The small mammal community of the protected forest was characterised with the absolute dominance of bank vole, causing that the diversity profile runs closer to the axis of the scale parameter. The diversity profiles of the communities of the two closed forest habitats intersect at low scale parameter values where the function is sensitive to rare species. When tested with the RTS-function, species abundance curves did not separate more prominently, suggesting that the diversity values of the small mammal communities in the three different forest patches do not differ significantly. Neither of the diversity ordering methods supported the assumption that there is statistically acceptable difference between diversities of the three analysed communities (Fig. 6.).

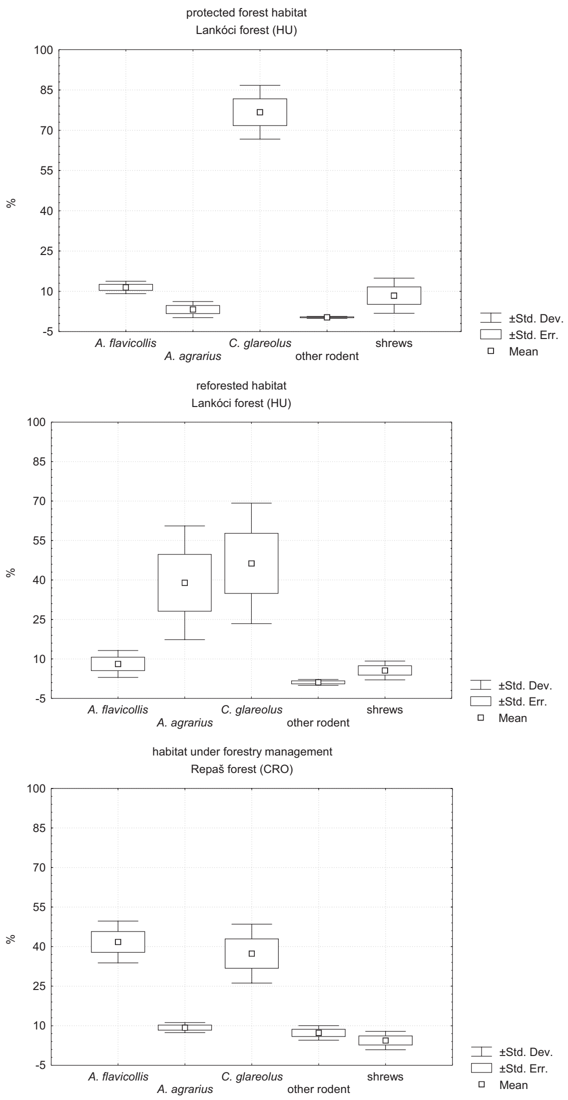


Fig. 7. Relative frequency values of the dominant components of the small mammal communities in the three different forest habitats

The relative proportions of species were evaluated in all three communities also by combining data of rare shrews and other less frequent rodents (Fig. 7). Statistical data of frequency values indicated well that besides the absolute dominance of bank vole in the protected forest, the importance of distinguished character species (*A. flavicolis*, *A. agrarius*), rare shrews and other less frequent rodents is similarly subordinated. The reforested area was somewhat different in that it was its two dominant species (*A. agrarius*, *C. glareolus*) that fundamentally determined the structure of the community. This is the area in which the structure of vegetation is most adequate for the habitat preference of *A. agrarius*. However, in the closed protected forest the dispersion of the *C. glareolus* population which had a boom in 2007 after several years inhibited the strengthening expansive colonisation by striped field mouse, a typical species in this habitat patch. Similarly to the reforested area, the community structure in the habitat under forestry management in Croatia was characterised with the dominance of two species. Here, it was the striped field mouse that had similarly low relative frequency to that of rare rodents and shrews, and thus was subordinated. In this forest patch, community structure was determined by the typically permanent co-existence of the dominant yellow-necked field mouse and bank vole. There was significant difference (Kruskal-Wallis ANOVA: H = 9.5, $p < 0.05$) between the three different forest habitats in the distribution of the relative frequencies of distinguished character species, rare shrews and other rodents. The results, thus have proved that the species composition of the small mammal communities in the three different habitats are quite similar, but because dominance relations are different, there is variation in their community structures.

## 4. Discussion

The first step in surveying biological resources is to estimate biological diversity, i.e. to establish species richness in a given space, at a given time (WILSON et al. 1996). Near-natural areas are becoming more and more degraded; populations and communities are confined to smaller and smaller areas, or can even completely disappear from some locations. Consequently, surveys made at the levels of landscape ecology have also become important (FORMAN & GORDON 1986; MERRIAM 1984; OPDAM 1988), in addition to the levels of regionality. Such problems have arisen in Central-European temperate forests, Europe's ancient natural plant associations, too. Small mammals are important to the forest ecosystem because they disperse seeds and mycorrhizae, contribute to soil mixing and aeration processes, ingest insects, seed, and plants, and are a food source for many other wildlife species. Research that focuses on how small mammal species react to the edge habitat created by forested corridors is of particular importance since corridor use is currently a widespread means of incorporating the needs of wildlife species on recently harvested land (BEIER & LOE 1992). The category of "small mammals" includes a number of species with different ecological needs, thus the proportions of these species, and the changes of their proportions relative to each other are reliable indicators of changes in their habitats. There are several small mammal species living together in forests with dense herb layer, thus they are extremely suitable for the investigation of their ecological requirements and habitat use, and for looking at interspecific relationships (e.g. microhabitatpartitioning) (HANSSON 1998). On the other hand, if viewed from nature conservation aspects, the study of small mammal fauna, population and community ecology, important information can be revealed for nature conservation evaluation and habitat qualification. Small mammals living in European temperate deciduous forest are usually generalists, occupying various sized forest patches following their dispersion. Rodents that have higher densities (mice and voles) can be present in areas of early succession stages. With their good abilities to colonise, they are suitable for monitoring habitat conditions prevailing after various types of natural disturbance e.g. fires, fluctuation of water table, and after artificial interventions (perturbation) by forestry, e.g. clear-cutting.

For small mammal monitoring in the upper section of Drava river, the sampling sites in the Hungarian Lankóci forest were designated in a way that the changes in the composition of the small mammal community together with population and community level patterns can be evaluated as a comparison of a strictly protected closed forest and an adjoining habitat following clear-cutting and now regrowing. The trapping grids that were set out touched two forest patches with different vegetation, and the edge zone between them. Thus, capture data provided an insight into how the habitat-dependent densities of dominant species in the community influenced the composition and structure of small mammal communities in the two habitats. Bank vole (PETRUSEWICZ 1983), wood mouse, yellow-necked wood mouse (MONTGOMERY 1980; GURNELL 1985), and striped field mouse, are typical generalist species of European forest habitats, the latter particularly preferring open areas with dense vegetation but also appearing as an expansive species with high density values in woodlands and forested stripes (GLIWICZ 1981; SZACKI & LIRO 1991). In all three forest habitats studied, the typically forest-dweller yellow-necked wood mouse and bank vole, as well as the edge-preferring striped field mouse were found to be character species. The structure of the recorded small mammal communities was determined by the relative proportions of either the most dominant species (protected forest), or of two, equally dominant species (reforested habitat and habitat under forestry management). HANSSON (1998) emphasises that generalist species, too, prefer habitats with secure resources to less optimal ones. Thus, driven by the aim of successful reproduction and survival, one or more small mammal species differentiate patches with more abundant resources even within a larger forested area. These patches are regarded as hotspots which have an influence on the species richness of neighbouring less preferred areas, and on dynamics between optimal and sub-optimal areas. From the aspect of small mammal composition, the protected alder gallery forest and the neighbouring reforested area in Hungary can be considered as a hotspot as understood by HANSSON (1998). In addition to food availability, small mammals in the studied forest habitats depend on environmental elements such as logs, fallen trees, openings of the canopy, coverage of herb layer, rotting tree-trunks, leaf litter and humus, all of which can be considerably modified by forestry management, spontaneous changes of vegetation and nature conservation management (BOWMAN et al. 2000; CAREY & HARRINGTON 2001). Based on the revealed data, the heterogeneity of small mammal communities was lowest in the protected forest, whereas in the reforested habitat and the Croatian habitat under forestry management, community structure was different due to heterogeneity determined by species dominance values. The abundance of dominant species is determined, in addition to environmental background factors, by the habitat selection behaviour of the species, by competition between the character populations and also by increased dispersion (ZEJDA 1967; GLIWICZ

1984; CHELKOWSKA et. al. 1985). Our results showed that variation in the species composition of small mammal communities in various forest habitats was very little, but the difference in the relative frequencies of character species determining community structure was significant.

## 5. Summary

As part of the Croatian-Hungarian interregional programme (DRAVA-INTERECO), small mammal population and community level monitoring was performed during 2007. Trapping grids of 1 ha area were laid out in three plots differing in vegetation structure, forestry management and nature conservation measures. As regards species composition, rare species were more significant in the reforested area (HU), whereas in the protected forest (HU) it was bank vole, and in the area under forestry management (CRO) it was bank vole and yellow-necked wood mouse that had absolutely dominant populations and thus determined the evenness of species within the community. The degree of small mammal community heterogeneity was found to be smallest in the protected forest habitat, whereas in the reforested habitat and in the Croatian habitat under forestry management the different heterogeneities determined by dominance values of the species created a different type of community structure. The distribution of relative frequency values of character species with different dominance (*A. flavicolis*, *A. agrarius*, *C. glareolus*), as well as the distribution of relative frequencies of rare shrew and other less frequent rodents were found to be significantly different in the comparison of the three studied habitats.

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# Population dynamics of dominant rodent species in three different forest habitats

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**Abstract.** Small mammal population and community level monitoring was performed in 2007 as part of the Croatian-Hungarian interregional program (DRAVA-INTERECO), applying the capture-mark-recapture method. Trapping was done in three forest patches with different types of vegetation structure, with the population dynamical analysis of three characteristic rodent species. In the protected forest habitat it was the bank vole *Clethrionomys glareolus* (Schreb.), in the reforested habitat striped field mouse *Apodemus agrarius* (Pall.) and bank vole, whereas in the habitat under forestry management in Croatia it was the yellow-necked wood mouse *Apodemus flavicollis* (Melch.) and bank vole that had higher population densities. Both the rank correlation analysis of daily number of captures, and the significant difference among the monthly relative frequencies of the three populations in the various habitats suggest that habitats differing in their vegetation structures and degrees of forestry management lead to different population dynamics within the same species.

## 1. Introduction

Animal biologists are interested in the population size of animals, whether they are community ecologists, wildlife managers, conservationists or population ecologists. Consequently, the estimation of abundance has been a critical issue in the study of mammals (Seber 1982). Methods involving marked animals or capture-mark-recapture (CMR) were independently discovered several times. By means of continuous monitoring assisted by the CMR method, we can gain insight into the spatial and temporal patterns created by the natural variability of species, which can be evaluated at the level of their populations. Long term investigations make it possible to separate the short-term fluctuations – a result of natural ecological processes – from more prolonged trends, based on which appropriate nature conservation strategies can be worked out (Spellerberg 1991). Most of the small mammal studies lasting longer than 5 years focus on rodent species (Ostfeld 1988). Species with great temporal variation of abundance are more likely to go extinct as a result of disturbance or negative environmental conditions (e.g. habitat fragmentation leading to small populations and isolation) (Pimm & Redfearn 1988; Pimm 1991). Co-variance among species can also signify important factors

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influencing population dynamics. The population dynamics of different species is expected to be similar if their demographic parameters under identical environmental conditions are strongly influenced by temporal variation. On the contrary, independent or negative temporal association between species can imply that the species react to different environmental changes, or they react differently to their surroundings, thus their abundance relations are determined by intrinsic factors (TAMARIN 1983). Finally, interactions between populations, such as competition, also must be noted, which has a strong effect on co-existing species (HESKE et al. 1994). Although it is very difficult to exclude strong interactions between species, but if their population dynamics positively correlate, this similarity signifies that environmental changes are highly influential in the fluctuations of abundance throughout the succession of years (BROWN & HESKE 1990; HESKE et al. 1994).

Characteristic species of the small mammal communities of Central-European forests are yellow-necked wood mouse *Apodemus flavicollis* and bank vole *Clethrionomys glareolus*, whose biology is quite well known (GOLLEY et al. 1975; PETRUSEWICZ 1983; FLOWERDEW et al. 1985). Their optimal habitats in Central-Europe are purely deciduous, mixed forests with fertile soil (PUCEK 1983; FLOWERDEW et al. 1985). These two species are different in their feeding ecology and adaptation to predators. Mice are seed-eaters and thus the fruits of forest trees are their primary food sources (DROŻDŻ 1966; ZEMANEK 1972; JENSEN 1982). Bank voles, however, feed on both seeds and leaves (HOLIŠOVA 1971; GEBCZYŃSKA 1976, 1983). Both species supplement their diet with invertebrate animals, although the possible food spectrum in this respect is wider in the case of voles than in mice. The list of food items eaten by voles overlaps with that of mice, but there are items that are preferred by voles but are ignored by mice (HANSSON 1985). Thus, the most important niche dimensions on which the co-existence of these two rodent species depends, are food types of variable availability and shelters. The striped field mouse *Apodemus agrarius* appears in the forests as a generalist species capable of reaching high densities and intense dispersion, particularly preferring open areas with dense vegetation, as well as hedgerows and forest stripes (GLIWICZ 1981, SZACKI & LIRO 1991). This species uses a wide range of habitat types, occurring in agricultural fields, meadows, pastures, shrubs and around farm buildings (ANDRZEJEWSKI & WROCLAVEK 1961; CHELKOWSKA 1969; ANDRZEJEWSKI et al. 1978; BABINSKA-WERKA et al. 1979).

Population biologists have studied the size limitations of populations and the intervals of population cycles. What these cycles are created by is studied by estimating rates of reproduction, mortality and migration, all influenced by various effects. According to most recent ecological research results, internal mechanisms account for the stabilisation of populations rather than for the regular fluctuation of density (NORRDAHL 1995). The primary external factors influencing the population fluctuation of small mammal populations as regulatory mechanisms are diseases, food limitations and predation (COWELL et al. 1998). Cycles in rodent species are formed by internal and external factors together, the problem lying in the interrelation between these two factors. Spatial behaviour is a key issue in the life of rodents, best illustrated by edge effect. It is not fully known which are the mechanisms that trigger changes in social behaviour. According to current views, phenotypic changes are caused by maternal and stress effects, but genetic research is less advanced, thus very little is known about social behaviour linked with kinship. Both predation and search for food, as external factors, can influence the cyclic dynamism of small mammal populations. Results from single-factor research suggest that neither predation nor food search are essential factors of cyclicity, but interaction between predation and food can be of crucial importance in understanding the mechanisms of external factors in rodents (KREBS 1994). An important ecological question is which types of experimental interventions can stop such cycles. Fencing around rodent populations could result in the reduction of their population to half to one-fifth of the original size, meaning a reduction of about 50% compared with the control population outside the fence (BOONSTRA & KREBS 1977). However, the emigration of individuals has strong regulative influence on population density, thus dispersion as a result of locomotion behaviour means an advance in access to resources LIDICKER (1962).

In the small mammal monitoring of the studied forest habitats along river Drava the above mentioned three species (*A. flavicollis*, *A. agrarius*, *C. glareolus*) appeared as characteristic populations with higher densities and with determining effect on small mammal populations. In the current study we have aimed at finding out about (i) the differences between population dynamics of the three coexisting species in the forest habitats differing in their vegetation structures, (ii) how much the character populations are influenced by the co-existing populations, as revealed by daily capture values, seasonal patterns of relative frequencies and temporal changes of estimated population sizes.

## 2. Material and methods

As part of the DRAVA-INTERECO project, trapping was performed in two sample areas in Lankóci forest, Hungary in 2007. One of the designated sampling sites here was a strictly protected alder gallery forest (*Paridi quadrifoliae-Alnetum*), and the second sampling plot was a reforested habitat adjoining the former strictly protected closed forest. The third area was selected in the Repaš forest in Croatia, in a more arid oak-hornbeam forest (*Circaeo-Carpinetum*) stand, which differed from the other two, in addition to vegetation structure and microclimatic features, in the fact that it was subject to intensive forestry management.

Based on the established monitoring protocol, a standard trapping grid of 11×11 traps was applied in each of the three habitats, with the live-trapping box traps positioned 10 m apart, thus the estimated population size values were projected onto an area of 1 hectare (HORVÁTH & KOVAČIĆ 2007). Small mammal synchronous monitoring in the forest habitats was pursued for four months in 2007 (July, August, September and October). In every month, a standard 5-night sampling session was carried out. In accordance with the 5-day trapping intervals, it can be assumed that the population is closed, meaning that there are no births, deaths, no emigration or immigration, and marking is not lost from any of the individuals. Thus, the closed population estimation method could be applied for data evaluation (HORVÁTH & KOVAČIĆ 2007). Based on the number of trap stations being operated in particular grids, and on the number of sampling nights, we used the entire 2007 pool of 7260 trap night data for the population dynamical evaluation of character species. For population level monitoring, the capture-mark-recapture (CMR) method is essential. For individual identification of captured animals, the tattoo-marking of toes was applied, which provides clear identification throughout the capture history of the small mammals. Upon capture, the sex (also lactation or gravidity in females), age, body weight, trap number and individual code were recorded. Age was determined on the basis of body weight and other external features.

In all three sample areas the obtained capture data were stored in a basic table within an *Access* database, and processed with the Manly-Parr diary of captures. As baseline data, seasonal total capture numbers for the three species (spring and summer combined), and the monthly values of relative proportions of the different species were given. Seasonal differences among capture data were compared using $\chi^2$-test, and the differences of particular species among various habitats were tested with Kruskal–Wallis one-way analysis of variance. Based on four sampling months and five-day sampling periods, the temporal dynamics of daily capture numbers of different species was also looked at and tested with Spearmann rank-correlation regarding both species and habitats (ZAR 1996).

For the three character species we had sufficient capture-recapture data for population estimation. Methodologies for CMR-based population estimation have improved rapidly since the 1980s, which made it possible – with continuously developing computer softwares – that mathematical models were more and more involved in data processing, providing ever broadening opportunities. While CMR and removal sampling are still considered useful in specific situations, their usefulness may have been overrated in the biological literature (WHITE et al. 1982). Numerous attempts have been made to formulate a unified approach to density and abundance estimation (OTIS et al. 1978; WHITE et al. 1982; POLLOCK et al. 1990). In fact, there has been a move, in recent years, towards the testing of hypotheses of biological interest rather than estimation of numerical quantities such as population size and survival rate (LEBRETON et al. 1992; NICHOLS 1992). The key parameter in the estimation of population size using CMR is capture probability (OTIS et al. 1978; SEBER 1982; NICHOLS & POLLOCK 1983). This is the probability of capture of a given individual during a single sampling session; the proportion of a population captured during a single sampling session will thus depend on the capture probability of each individual. The simplest models assume that the capture probability of all individuals are constant over time and are not altered by capture-marking- handling. However, in nature, capture probabilities are rarely equal and the literature abounds with statistical efforts to overcome this essential confounding variable i.e. unequal capture probability. In fact, the need to deal with these methodological assumptions has resulted in the development of complex procedures and statistics, requiring large software systems for satisfactory analysis (NICHOLS et al. 1981; BROWNIE & POLLOCK 1985).

For the estimation of the size of the analysed populations, the authors have used the MARK (COOCH & WHITE 1998) program, which is to be used mainly for testing and modelling survival and capture probabilities within populations. The CAPTURE program formerly having been worked out for abundance and density estimation of closed populations is included in MARK, now as a sub-menu appearing for being run after testing capture probability and the time dependence of closedness. The closed population models that can be applied within the program have a basic assumption that there are no deaths, births, emigration or immigration between two sampling periods. Therefore, these models are normally used in studies that are performed during a relatively short duration of time. It is the capture histories of individual animals that constitute the data input from which the program will calculate its estimations. First it was POLLOCK (1974, 1975), than, in an improved version OTIS et al. (1978), WHITE et al. (1982) and POLLOCK and

OTTO (1983) to organise them into a coherent system. The models differ in how they treat capture probability. Closed population estimators take into account the constant time dependence of capture probability, as well as the response of animal individuals to being captured, and any specimen-based variation in capture probability. The program CAPTURE provides estimators with five models, and it also includes a model selection function assisting in choosing the most adequate model when performing the analysis. Model $M_0$ has the assumption that all the individuals share the same capture probability (*p*) throughout the entire survey, in each trapping period. Model $M_h$ calculates with individual heterogeneity, assuming that each individual has a unique capture probability which is constant throughout the trappings. Model $M_b$ pays attention to behavioural responses of individuals to being caught, but not to heterogeneity or temporal variation. Model $M_{bh}$ considers both heterogeneity and trap response, whereas model $M_t$ does not allow either heterogeneity or trap response in calculating capture probability, but does consider time dependence.

# 3. Results

The quantitative data of trapping success for the three generalist small mammals, and also their seasonal variations, differed between the three forest habitats. The combined capture values of the three species were highest in the reforested habitat where, surprisingly, the summer value was significantly higher than the autumn. Combined capture values were similar in the two closed forests, among which the protected alder gallery (Lankóci forest) yielded significantly higher capture values in autumn than in summer, this having been caused by the expected autumn small mammal density increment. However, there were no significant differences in the drier forest at Repaš forest under forestry management among the seasonal distribution of capture values combined for the three species (Table 1.). Capture values for individual species, though, showed a different pattern. In the protected forest, bank vole was present with about 10 times higher abundance than *Apodemus* species also living there. Bank voles reached a considerable density peak in this habitat, thus there was significant difference in the seasonable distribution of their capture values. Yellow-necked wood mice and striped field mice had low capture values both in summer and in autumn in the protected forest habitat, with no significant seasonal difference in either of the species. In the reforested habitat the abundance values of mice species was significantly higher in summer than in autumn. In *Apodemus* populations, the absence of autumn density growth was probably caused by the massive dispersion of bank vole which species had higher capture values in the reforested habitat, too, and reached a high density peak in autumn. Similarly to the closed forest patch, the seasonal distribution of bank voles had significant differences in the reforested habitat, too. In the habitat under forestry management, neither of the three populations had significant differences among seasonal abundance values. Here, the three co-existing populations had a stabile density throughout the study period (July-October), thus, instead of rapid demographic growth in the autumn, they were characterised with stagnating density values (Table 1.).

Table 1. Seasonal capture numbers of characteristic rodent species

| Sampling area | protected forest habitat (Lankóci forest – Hungary) | | reforested habitat (Lankóci forest – Hungary) | | habitat under forestry management (Repaš forest – Croatia) | |
|---|---|---|---|---|---|---|
| | number of captures | | number of captures | | number of captures | |
| Species (code) | summer | autumn | summer | autumn | summer | autumn |
| *A. flavicollis* (AFL) | 47 | 39 | 63 | 23 | 138 | 170 |
| $\chi^2$-value | 0.74, *n.s.* | | 18.60, $P < 0.001$ | | 3.32, *n.s.* | |
| *A. agrarius* (AAG) | 10 | 11 | 319 | 101 | 35 | 34 |
| $\chi^2$-value | 0.04, *n.s.* | | 113.15, $P < 0.001$ | | 0.014, *n.s.* | |
| *C. glareolus* (CGL) | 242 | 348 | 152 | 304 | 147 | 148 |
| $\chi^2$-value | 19.04, $P < 0.001$ | | 50.67, $P < 0.001$ | | 0.03, *n.s.* | |
| Total | 299 | 398 | 534 | 428 | 320 | 352 |
| $\chi^2$-value | 14.06, $P < 0.001$ | | 11.06, $P < 0.001$ | | 1.52, *n.s.* | |

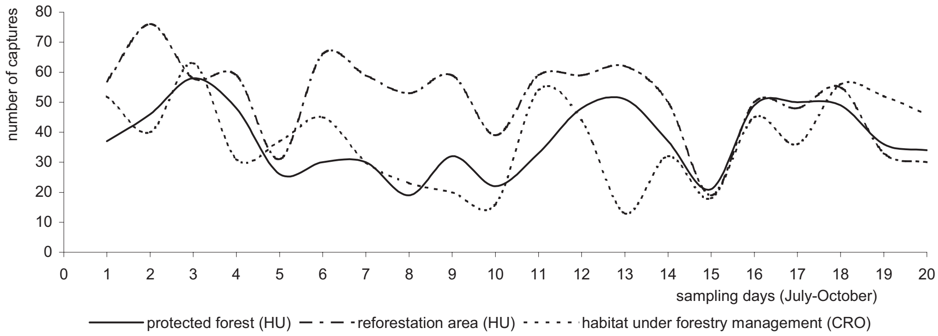


Fig. 1. Combined daily capture numbers of the three studied rodent populations in the three different forest habitats

Population dynamical differences between the habitats were reflected also by the temporal variation of daily number of captures. When the sample areas were compared, there was no significant correlation between the combined daily number of captures of the three rodents in either of the cases (protected forest (HU) vs. reforested habitat (HU): $R_S = 0.28$, *n.s.*; protected forest (HU) vs. habitat under forestry management (CRO): $R_S = 0.37$, *n.s.*; reforested habitat (HU) vs. habitat under forestry management (CRO): $R_S = 0.008$, *n.s*). The lowest rank correlation value was obtained for the comparison of the reforested habitat and the one under forestry management, reflecting the greatest difference in capture numbers trends (Fig. 1.).

The rank-correlation analysis of daily capture numbers of the studied populations was performed for each habitat separately. The demographic trends from daily capture data of the three species were superimposed in the case of all three habitats (Fig. 2.). In the case of the protected forest, rank-correlation was performed between yellow-necked wood mouse and bank vole only, due to the very low abundance values obtained there for the striped field mouse. The density of bank voles in this habitat had a considerable negative effect on yellow-necked wood mouse abundance, with no significant rank-correlation between capture numbers of the two populations ($R_S = 0.16$, *n.s.*).

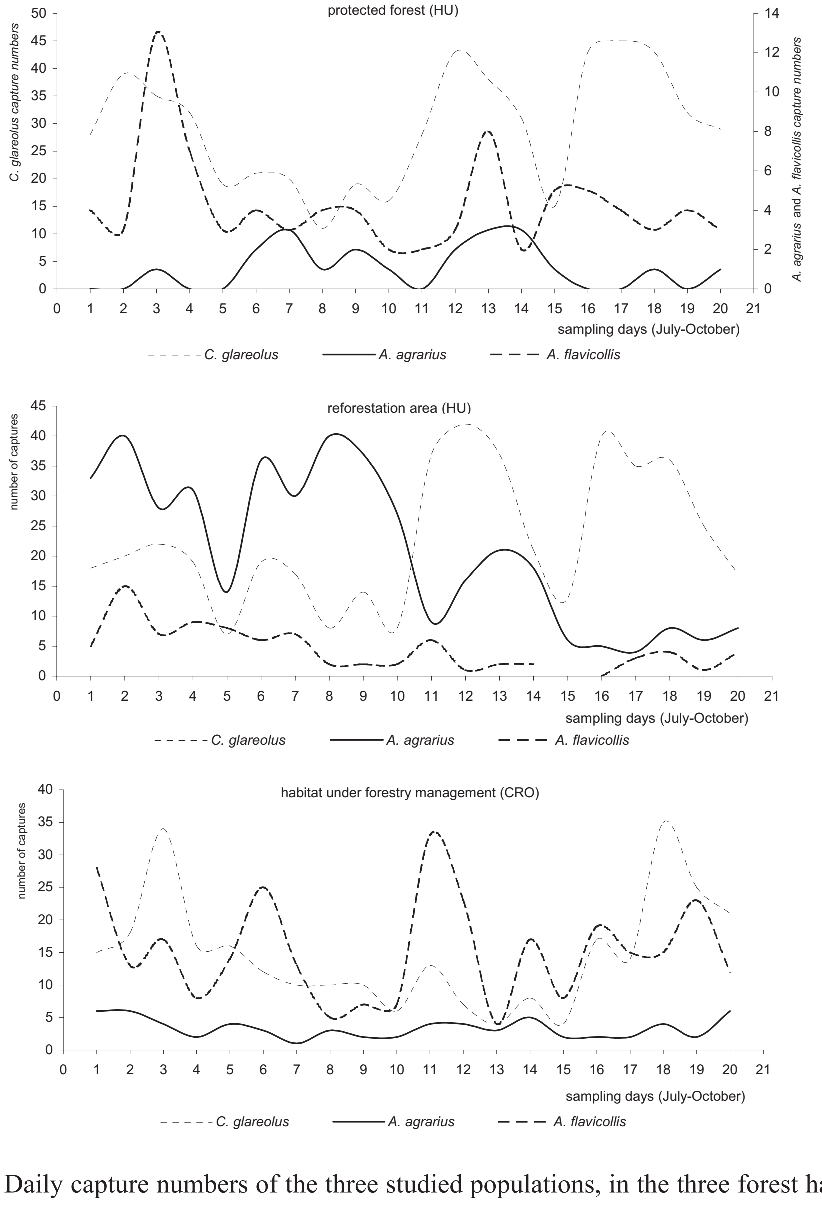


Fig. 2. Daily capture numbers of the three studied populations, in the three forest habitats

The numbers of yellow-necked wood mouse in the reforested habitat were very low, meaning that here this species was dominated by the two other. Accordingly, only the rank-correlation of striped field mouse and bank vole daily capture numbers was performed in this sampling area. As demography fluctuated, in summer striped field mouse was dominant in the reforested area with dense vegetation, then in autumn its density decreased as bank voles started to disperse. Accordingly, rank-correlation analysis between these two species yielded a negative coefficient, although the relationship was statistically not significant, which clearly signified that the temporal changes of the abundance values of these two populations were different ($R_S$ = -0.4, *n.s.*). In the forest of Repaš under forestry management it was again striped field mouse that had a subordinated population size and low density, thus here too, rank-correlation analysis was run between capture values of yellow-necked wood mouse and bank vole. In this habitat, the latter two species with higher dominance had nearly identical capture values, being particularly balanced in the autumn period, thus rank-correlation values between these two populations were found to be positive, though not being significant statistically ($R_S$ = 0.35, *n.s.*). Also, with rank-correlation, we have looked at how the demographic changes of the different populations – reflected by daily capture values – are related in the comparison of various habitats. In case of the yellow-necked wood mouse, rank-correlation value was close to zero, showing that the trends of daily capture numbers fluctuated differently in the three habitats ($R_S$ = -0.2 – 0.07, *n.s.*). In the case of the bank vole, data obtained for Lankóci forest (both the protected forest and the reforested habitat) showed no significant correlation with values calculated for Repaš forest ($R_S$ = 0.19 – 0.43, *n.s.*). However, bank vole capture values were strongly correlated in the comparison of the protected forest section and the reforested area of Lankóci forest ($R_S$ = 0.85, $P$ < 0.05). This finding clearly showed that it was the same bank vole population that was monitored in these two habitat patches, and its individuals dispersed from the protected forest into the reforested area, driven by density dependent dispersion. Similarly to the yellow-necked wood mouse, no correlation between daily capture numbers was revealed in the comparison of habitats in the case of striped field mouse either ($R_S$ = -0.1 – 0.26, *n.s.*).

The seasonal variation of relative frequencies of the studied populations showed different patterns in the three forest habitats. In all three species, monthly calculated relative proportions were found to be significantly different in the comparison of habitats (*A. flavicollis*: H = 8, $P$ < 0.05; *C. glareolus*: H = 6.7, $P$ < 0.05; *A. agrarius*: H = 9.84, $P$ < 0.01).

In each of the three study areas, closed model population estimations could be performed only for the populations with the highest capture numbers. Yellow necked wood mouse and bank vole populations could be estimated in the protected forest habitat, calculated from monthly capture histories. In both species, results were obtained when using mixed model series, meaning that our capture data were suitable for different estimators in each month. In the case of the bank vole population, it was time dependence of capture probability, behavioural response, and individual heterogeneity within the population – or a combination of these – that were influential factors. Large population size was estimated for this species in the protected closed forest. Based on the estimations, population size from the middle of summer until September was found to be high and relatively stabile, then the highest peak occurred in October. This higher rate of population increment was supported also by the values of the standard errors of estimation. Based on the low values (8.05-11.84%) of the coefficient of variation (cv %) that expresses the reliability of estimation, the population sizes estimated were acceptable. Yellow-necked wood mice in the protected forest had smaller population size in all four months.

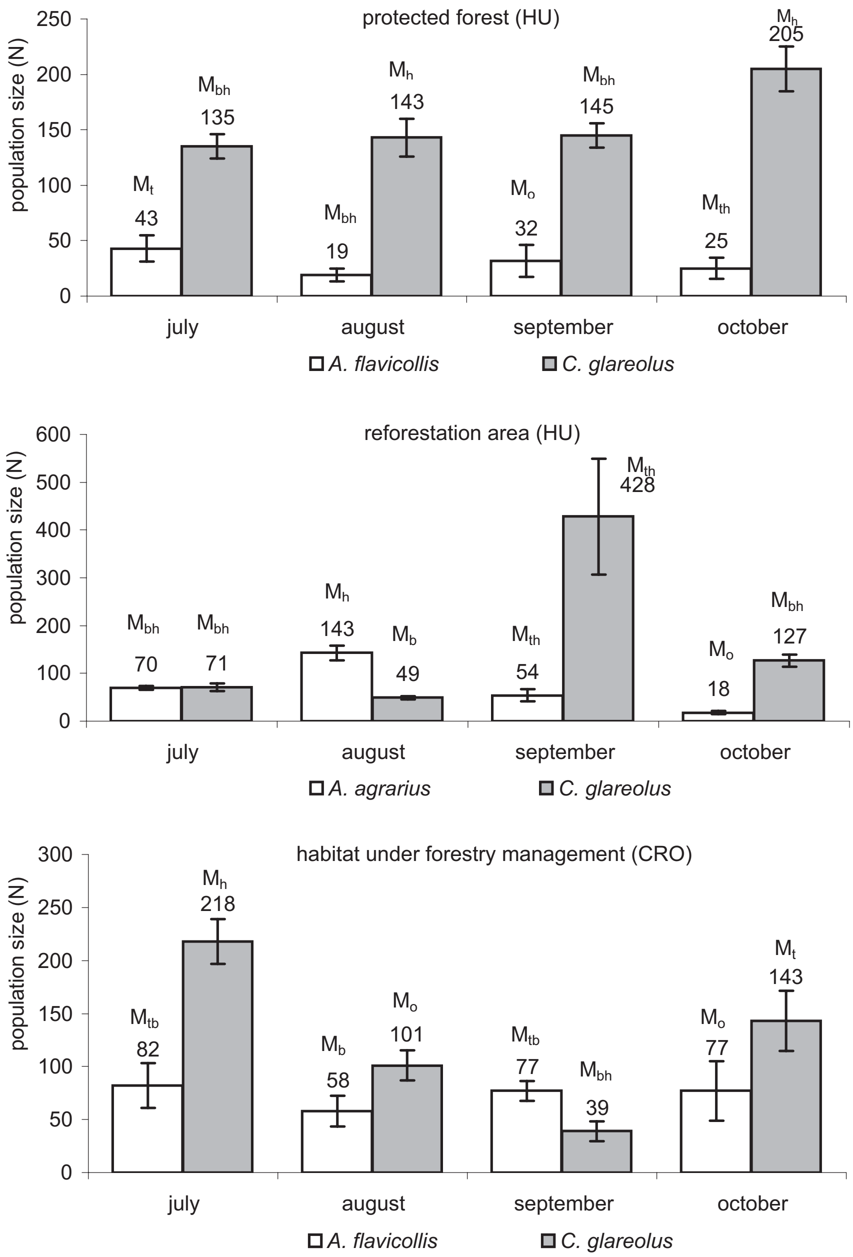


Fig. 3. Estimated population size values in the three habitats (the diagrams include the standard errors of estimation and the best fitting model for each month)

In this species too, it was time dependence of capture probability, behavioural response, and individual heterogeneity within the population that were influential factors, but the fact that the values of the coefficient of variation (cv %) were above 20% indicated that the capture history data of yellow-necked wood mouse were not sufficient for closed population estimation, i.e. the reliability of the estimated values was not acceptable (Fig. 3.).

In the reforested habitat we estimated the size of striped field mouse and bank vole populations. In the case of both species it was the model looking at time dependence of capture probability, behavioural response, and individual heterogeneity within the population that was adequate for population estimation. In July and August striped field mouse was present in the area with higher abundance. In these two months, the estimated size of the population was acceptable, based on the values of the coefficient of variation. The population size of the striped field mouse, characteristic for the reforested habitat, decreased significantly as bank voles appeared in higher numbers. However, the population size estimated for the two autumn months cannot be considered to be a reliable estimation, because of the high value of the coefficient of variation. Bank vole population in the reforested habitat in September was estimated to be strikingly high, which was regarded as an over-estimation, due to the high values of the coefficient of variation. In the rest of the months in this habitat, standard errors of the estimation and the coefficients of variation allowed the acceptance of estimated abundance values (Fig. 3).

In the Croatian habitat under forestry management, population size estimation was performed for yellow-necked wood mouse and bank vole. In both populations, primarily it was time dependence of capture probability, behavioural response, and individual heterogeneity within the population that had greatest effect in the estimation. However, in both species there was one case when the $M_0$-model – assuming constant capture probability –suited best our estimations. The abundance of the two species followed an alternating fluctuation in this habitat, with insignificant differences.

# 4. Discussion

Patterns of co-variation in abundance among species also can indicate important factors affecting population dynamics. Similarity in population dynamics among species is expected if species abundance is strongly influenced by temporal variation in the same general environmental factors (Heske et al. 1997). The demographic trends of small mammals can follow different patterns during a year, driven by a variety of factors, and influenced – in addition to abiotic environmental background variables – by intraspecific interactions within a population and by interspecific effects between different populations. Therefore, it is important that the seasonal patterns of abundance are also studied, which should be evaluated at levels of population and community as well.

Seasonal dynamics and the seasonal changes of density are greatly influenced by the migration pattern of individual populations. Populations can be considered to be open between monthly sampling sessions, therefore the abundance-influencing factors such as births, deaths, and the rate of immigration and emigration must be taken into account, moreover, as put forward by Gliwicz (1989), higher migration activity during mating time should also be considered. The latter is expressed mostly in larger home ranges of young specimens, caused by being driven out from the parents' territories. The emigration of young individuals has an important role in gene exchange, making this issue a significant matter in evolutionary ecology (GLIWICZ 1990; WOLFF 1993).

As revealed by our studies of yellow-necked wood mouse, striped field mouse and bank vole populations in the three forest habitats along river Drava, both the rank correlation analysis of daily capture values and the significant difference among the monthly relative frequencies of the three populations in the various habitats suggest that habitats differing in their vegetation structures and degrees of forestry management lead to different population dynamics within the same species. Although it is obvious that there are several possible internal and external factors playing a role in demographic fluctuations, our results showed that habitat quality was reflected in abundance values of character populations. Also, the mutual density-dependence of coexisting populations was observed, shown by our data most prominently in Lankóci forest. Here, the density of bank voles that went through a rising abundance cycle had a strong effect on the populations of the two co-existing *Apodemus* species, as recorded clearly in the protected forest and also observed – though unexpectedly – in the reforested habitat. This effect was not that straightforward in the Croatian habitat under forestry management, because here bank voles and yellow-necked wood mice had stabile co-existing populations with balanced annual demographic fluctuations. When discussing about competition between these two species in forest habitats, GLIWICZ (1981) emphasised that spatial segregation has an important role: in addition to food, important parts of the territory such as shelters can be regarded as niche-dimensions for which there is strong interspecific competition. Bank vole is a species more bound to particular localities, holding on to its territory and home range (MAZURKIEWICZ & RAJSKA-JURGIEL 1998). This is because of the social structure of bank voles: it is female individuals that divide the available space and keep territories, which has a strong regulating and maintaining effect on the population (BUJALSKA 1994a, 1994b). The stabilisation of bank vole population in the studied protected forest habitat and the adjoining reforested area negatively influenced the densities of the two *Apodemus* populations.

In all three habitats, closed population estimation provided an acceptable picture about the changes of abundance in the majority of study months. Estimated population size values showed that the qualitative difference between the protected forest and the reforested habitat had an influence on population sizes of the character species in the two habitats, with density-dependent dispersion – causing mutual interaction between the populations – significantly contributing to this effect.

# 5. Summary

Small mammal population and community level monitoring was performed in 2007 as part of the Croatian-Hungarian interregional program (DRAVA-INTERECO). Trapping was done in three forest patches with different types of vegetation structure, forestry management and nature conservation activities, with a trapping grid covering an area of 1 hectare. The population dynamical analysis of three characteristic rodent species was performed in the three habitats, for the same length of time between July and October.

In the protected forest habitat it was bank vole *Clethrionomys glareolus* (Schreb.), in the reforested habitat striped field mouse *Apodemus agrarius* (Pall.) and bank vole, whereas in the habitat under forestry management in Croatia it was yellow-necked wood mouse *Apodemus flavicollis* (Melch.) and bank vole that had higher population densities. Both the rank correlation analysis of daily number of captures, and the significant difference among the monthly relative frequencies of the three populations in the various habitats suggest that habitats differing in their vegetation structures and degrees of forestry management lead to different population dynamics within the same species. The mutual density-dependence of co-existing populations was observed, shown by our data most prominently in Lankóci forest. Here, the density of bank voles that went through a rising abundance cycle had a strong effect on the populations of the two co-existing *Apodemus* species, as recorded clearly in the protected forest and also observed unexpectedly in the reforested habitat. This effect was not so straightforward in the Croatian habitat under forestry management, because here bank voles and yellow-necked wood mice had stabile co-existing populations with balanced annual demographic fluctuations.

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# Surveying Eurasian otter *Lutra lutra* distribution and population monitoring in areas along the river Drava

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**Abstract:** The aim of our studies as has been to survey Eurasian otter *Lutra lutra* occurrence simultaneously in Hungarian and Croatian wetland habitats along Drava, using the same methods, and also to assess the permanence of otter occurrence, and look at anthropogenic factors influencing otter existence. During the baseline investigations, areas potentially suitable as otter habitats were surveyed in 81 locations of Hungary and in 61 locations in Croatia. Permanent otter occurrence in Hungarian (H) and Croatian (C) surveying locations turned out to be H: 65.4%, C: 49.2%, occasional occurrence H: 25.9%, C: 44.3%, and negative occurrence H: 8.7%, C: 6.6%. Otters occur along the Drava sections between Legrad and Donji Miholjac, as well as in the majority of adjoining wetland habitats. We intend to use the results of our investigations for establishing a background database for new Croatian NATURA 2000 sites, and for promoting the higher nature conservation status of Drava wetlands.

## 1. Introduction

The Eurasian otter *Lutra lutra* is a significant species of the European Ecological Network (EECONET). In Hungary it was declared as legally protected in 1974, and since 1982 it has been a strictly protected species. In the EU Habitat Directive (92/43/EEC) it is listed among species in need of strict protection (Annex IV.), and also in the list species of community interest whose protection requires the designation of special areas of conservation (Annex II. (a). It is a NATURA 2000 indicator species. According to the Hungarian Red Data Book (RAKONCZAY 1990) it is currently endangered. Its European distribution data and population trends, as well as results from ecological research strongly support the fact that the otter is a vulnerable species, an important indicator of wetland habitats, a keystone species. The survival of its populations depends primarily on human activities. Otter species conservation actions also assist the protection of other species (e.g. Eurasian beaver *Castor fiber*, ferruginous duck *Aythya nyroca*, European pond terrapin *Emys orbicularis*) and habitats important from nature conservation aspects. It is a flagship species of nature conservation.

Otters are threatened by a number of factors among which the most important ones include: transformation of wetland habitats (disappearance of fragmentation), management problems of green corridors (canals, streams) that have a role in migration (e.g. barren waterside, removal of waterside vegetation, weed infestation); problems arising from fish

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use and farming such as fishery or angling (e.g. the drainage of ponds in the autumn-winter period, intensive human presence, insufficiencies of the subsidy system); problems of near-natural habitats (e.g. summer drying out, shortage of fish food, disturbance); poaching; water pollution (killing food organisms and causing the accumulation of toxic materials); mortality caused by the growth of traffic (for more details see Grogan et al. 2001; Lanszki et al. 2007).

The otter is a protected species in Croatia, and is listed in the Croatian Red Data Book (State Department for Nature Conservation 2004) as data deficient. A survey was made in the territory of former Yugoslavia in 1982, by British researchers Liles and Jenkins (1984). However, otter habitats along tha Drava were not investigated as part of this study. In all the areas covered, a total of 129 localities were investigated, of which otter signs were revealed in 67 cases (44%). High rate of otter occurrence was reported from along the rivers Drina and Bosna, but only fragmented populations were found in the rest of the places. In a European comprehensive study (Conroy & Chanin 2002), otter populations in Croatia were reported on as follows: „Otters are rare along the seacoast, but are relatively frequent in the western parts of the country." Croatian researchers have also performed otter surveys (www.zelena-akcija.hr), but habitats along the Drava were not studied as part of that. The population surveys launched in February 2005 proceeded along three rivers: Krka (5 localities), Cetina (7 localities), and Lika (15 localities). Otter signs were found in 19 localities out of the total of 27. Along the rivers Krka and Lika 80% and 100% of the surveyed localities, respectively, were found to be positive. However, no otter signs were found along the river Cetina (www.zelena-akcija.hr).

In Hungary, data collection on otter occurrence along the Hungarian side of Drava, as part of nation-wide surveying, was launched in 1995, and otter monitoring in the Drava section of Somogy county has been done since 2000 (Lanszki 2005). The results of four different Hungarian otter surveys were synthesised in a study by Kemenes (2005). To match data from these different surveys is problematic. Otter occurrence data, as revealed by nation-wide questionnaire surveys, were gathered by the NGO Foundation for Otters (Anonymous 1996). In this survey, observations made by fishermen, anglers, nature-lovers, staff members of state nature conservation organisations were collected. Another country-wide questionnaire survey was made among game management bodies by the Hungarian Game Management Database (Heltai 2002; Heltai et al. 2005). From this survey, one can conclude on country-level tendencies of population change. Because there were no standard surveying locations or statistical evaluation, population tendencies revealed cannot be regarded to be certain (Reuther & Krekemeyer 2003).

The aim of our studies as part of the Croatian-Hungarian Interregional programme has been to survey otter occurrence simultaneously in Hungarian and Croatian wetland habitats along Drava, using the same methods, and also to assess the permanence of otter occurrence, and look at anthropogenic factors influencing otter existence. We intend to use the results of our investigations for establishing a background database for new Croatian NATURA 2000 sites, and for promoting the higher nature conservation status of Drava wetlands.

# 2. Material and methods

## 2.1. Sampling area

As part of the DRAVA-INTERECO programme, the baseline survey along the Drava catchment was performed between December 2006 and April 2007. During the baseline investigations, areas potentially suitable as otter habitats were surveyed in 81 locations of Hungary (abbreviated as: H or Hun), and in 61 locations in Croatia (abbreviated as: C or Cro) (Fig. 1.). The surveyed habitat types (and the number of cases in each of the localities) were as follows: Drava river (H: 16, C: 29 localities), oxbows or backwaters (H:11, C: 8), streams (H: 15, C: 9), canals (H: 26, C: 11), fishponds and angling ponds combined (H: 4, C: 1), bog, marsh (H: 3, C: 0), gravel pit ponds (H: 6, C: 3).

## 2.2. Sampling methodology

The species-level otter population assessment and habitat evaluation is actually an adaptation of the Information System for Otter Surveys - ISOS, as jointly recommended by the *German Association for Otter Protection* and *IUCN/SSC Otter Specialist Group* (REUTHER et al. 2000). This methodology was supplemented with certain evaluation criteria (e.g. steepness and vegetation coverage of waterside) specified in the surveys by KEMENES and DEMETER (1994, 1995) in Hungary, and combined with experience (e.g. permanent and occasional occurrence) from otter monitoring (LANSZKI 2005; LANSZKI & SALLAI 2006). Finally, the combined surveying sheet proposed in the otter action plan (LANSZKI and HELTAI 2005) was used, with our survey at the same time serving as a test of the applicability of the new methodology (LANSZKI & KOVAČIĆ 2007). The surveying sheet is sown in Annex 1.

Otters in Central-Europe are predominantly nocturnal, secretive animals, making them hard to encounter in the wild. Their presence is indicated by their spraints (droppings) which have characteristic fishy smell and normally contain fish remains, their anal jelly (mucous secretion), their footprints, prey remains, tracks, scratch marks and grass balls. Otters normally mark their territories at the foot of bridges or in their immediate surroundings. The location of otter landing points (where they climb out from the water) bears important information (LANSZKI & KOVAČIĆ 2007). Apart from these places, traces and marks are found on fallen tree trunks, roots, embankment paving as well. The tracing of otter occurrence is mostly done on the basis of primary signs, such as spraints, anal jelly, footprints, scratch marks, grass balls and otter holts or nests. About one third of the footprints revealed are complete imprints, and in the rest of the cases they are incomplete, therefore otter densities estimated from footprint numbers are only vague indications. The cause of death cannot always be determined for various prey remains, thus such remains are often unreliable signs.

According to IUCN recommendations, only positive or negative occurrence records are differentiated. In case of a more finely detailed survey, however, the regularity or occasionality of otter occurrence is classified on the basis of the number and condition of otter signs and traces.

1. The presence of otters is *permanent* if at least two primary signs (otter spraints or footprints) of various age (fresh or 1-2 days old or older) are found in a particular survey plot. Spraints are considered fresh if they are still moist, 1-2 days old if they are still entire and are dry (smelling fishy), and they are categorised as old if dry and disintegrated. An inhabited (used) otter holt or the occurrence of anal jelly used for territory marking signify permanent occurrence even if no other sign is revealed. Such findings are very rare in comparison with other primary signs/proofs (e.g. spraints, footprints). During the surveys there were 6 places found in Hungary and 4 locations in Croatia where otter host, den or nest was found, whereas 11 and 4 locations, respectively, yielded anal jelly.
2. Otter presence is *occasional* (non-permanent) if only old or fresh spraints or footprints are found.
3. Otter presence is *negative* if no sign or proof of an otter was found during a systematic survey in at least a 600 m long riverside section. This, however, does not mean that there are no otters living there, just indicates the absence of such signs.

When evaluating waterside vegetation, the condition of the vegetation found within 2-3 m of the water's edge is evaluated.

1. *Barren* waterside is recorded when the shoreline is paved in concrete, or the embankment of streams or irrigation canals is regularly mowed and lacks any woody plants.
2. The waterside is categorised as covered in *sparse* vegetation when it has short weeds, or is sparsely vegetated with taller plants, i.e. it lacks suitable shelter for the otters.
3. The waterside has *dense vegetation with thin patches* when it has a patchy mosaic of densely overgrown and sparsely vegetated areas.
4. The waterside vegetation is categorised as *dense vegetation covering large areas*, when there are extensive, dense gallery forests, willow bushes, reedbeds or sedges on the waterside or adjacent to it.

On the basis of the naturalness of the wetland habitat, locations were categorised in three major classes.

1. *Near-natural habitat*: covered with vegetation typical of wetland habitats, where the edge of the water is not transformed considerably, i.e. is near-natural. For example, the waterside has a mosaic of softwood gallery forest, willow bush, reed/sedge/cattail association, or a combination of these.
2. *Mixed type of habitat*: near-natural and artificial elements are both present (e.g. an oxbow intensively utilised for angling, bordered by reeds, willow bushes, and having platforms built by anglers).
3. *Artificial habitat*: the waterside is intensively transformed (e.g. by a flood-prevention dyke, or by paving with concrete), and there is no original vegetation or only traces of it exist. Such can be a stream or canal running through a resort area, or between high embankments among agricultural lands, or surrounded by intensively used pastures, or bordered by mown grass in the case of an angling pond.

Anthropogenic (disturbance) effects were evaluated both separately (e.g. nearby settlements, traffic, typical human/management activities, degree of naturalness of the area, pollution - one by one), and combined. The reason for going into details with combined disturbance is that particular factors can have significant effects on their own, or, on the contrary, even the combined effect of several factors can be negligible. Disturbance effects are evaluated on a gradient with the following categories: 0 (no), 1 (moderate), 2 (medium) and 3 (significant).

The surveying of bridges is important in revealing otter presence. In Britain, for example, surveys in Natura 2000 sites with otter being an indicator species, are made with bridges being the starting points. Unfortunately, it is also near bridges that otters are increasingly often run over by cars, a regrettable fact related with increasing traffic on rural roads. Major bridge types are as follows:

a) Bridges standing on pillars (piers) that traverse a river without influencing the shape of the river's bed.
b) Bridges with berms (raised banks of concrete, rocks or earth) on both river banks which are not flooded at normal water level.
c) Bridges with a berm on one riverbank which is not flooded at normal water level.
d) Bridges having no berm and offering no possibility to pass under the bridge out of the water at normal water level.
e) Bridges formed from pipes.

Surveys are made, as recommended by the IUCN minimum standard methodology, along a 600 m long waterside section. The location and direction of surveying is recorded (underlined) on the surveying sheet. These data provide guidance for the next surveys to be performed, as well as for statistical evaluation. In some cases it is not possible to perform the survey on the entire 600 m length, due to the inaccessibility of certain sections (for example because the waterside has been built in, closed down or is bordered by a wide and thick reedbed). Such deviation must be accurately indicated on the survey sheet. Where deciding about otter presence seems to be difficult, an artificial otter spraint point can be established (e.g. by placing a larger rock under a bridge).

A detailed guide was produced for field surveys, based on specific literature available (Lanszki 2007a, 2007b).

# 3. Results

Data were recorded in the sample areas from several different aspects (Annex 1.). Among these, some important points and results are presented in detail in the followings.

## 3.1. Otter occurrence, and regularity of occurrences

Areas surveyed and evaluated during the study are shown in Figure 1. Permanent otter occurrence in Hungarian and Croatian surveying locations turned out to be H: 65.4%, C: 49.2%, occasional occurrence H: 25.9%, C: 44.3%, and negative occurrence H: 8.7%, C: 6.6%. During the surveys there were 6 places found in Hungary and 4 locations in Croatia where otter host, den or nest was found, whereas 11 and 4 locations, respectively, yielded anal jelly. The distributions of otter occurrence in the surveying locations of the two countries did not differ significantly ($\chi^2 = 5.22$, df = 2, P = 0.073).

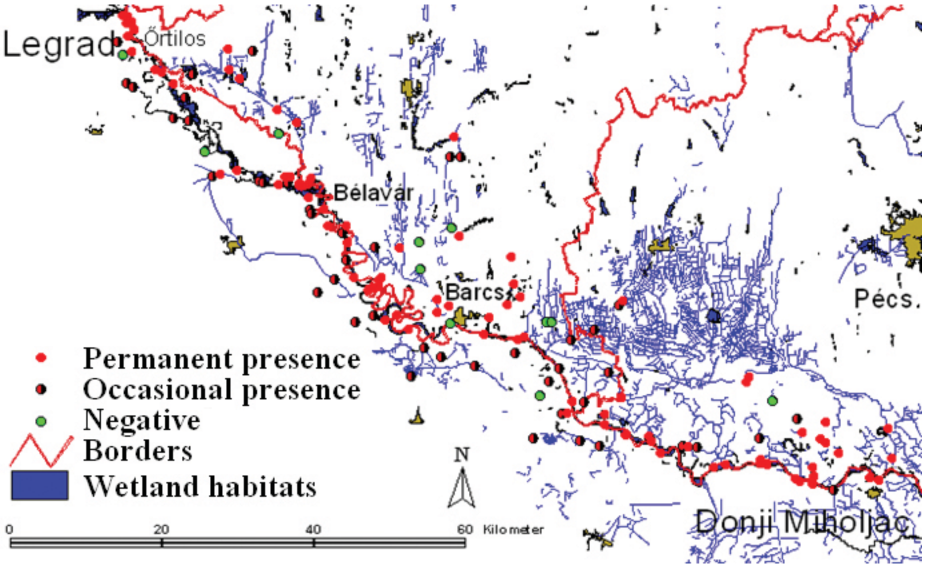


Fig. 1. Locations evaluated during otter surveys on the Drava catchment

Results of the surveys in various habitat types are shown in Fig. 2. Otter was found to be present in almost all of the surveyed locations along Drava and its backwaters. In Croatian canals and streams, occasional otter presence was more typical. Accordingly, significant difference between locations in the two countries were found in the case of streams and canals only (P<0.001).

(From surveys made in Hungarian <Hun> and Croatian <Cro> areas; the number of surveyed localities are shown the numbers)

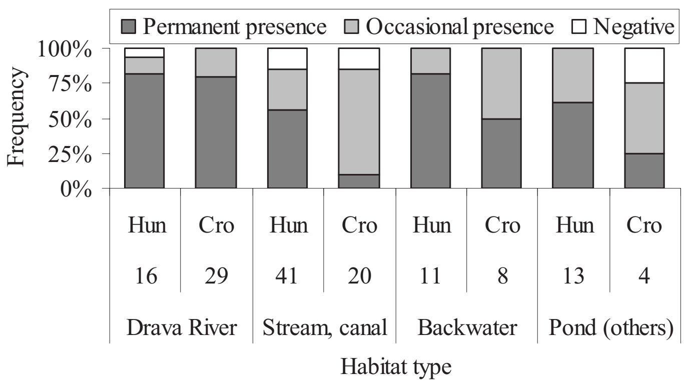


Fig. 2. Otter occurrence in relation to habitat type

The distribution of otter occurrences in relation to waterside vegetation coverage is shown in Fig. 3. The frequency of occurrences (especially that of permanent occurrences) showed a tendency of growth as waterside vegetation became denser. The results of the surveys performed in the two countries show that the distributions were different among them ($\chi^2 = 8.02$, df = 3, $P < 0.05$), which fact is primarily due to differences revealed in the case of barren and sparse vegetation categories (Fig. 3.).

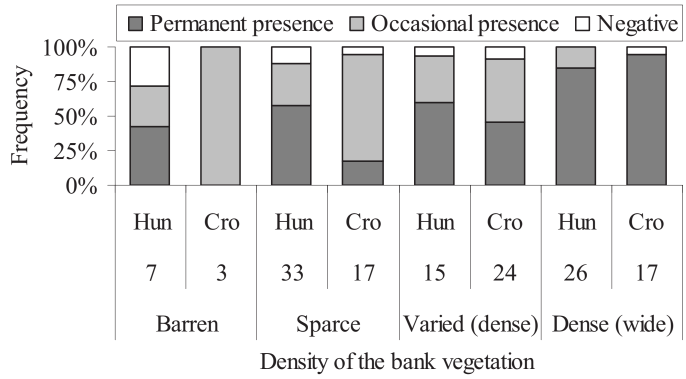


Fig. 3. Otter occurrence in relation to vegetation coverage

Otter occurrences as reflected in the naturalness of the wetland habitat are shown in Fig. 4. Occurrences recorded in the evaluated locations of the two countries did not differ significantly ($\chi^2 = 2.03$, df = 2, $P = 0.363$).

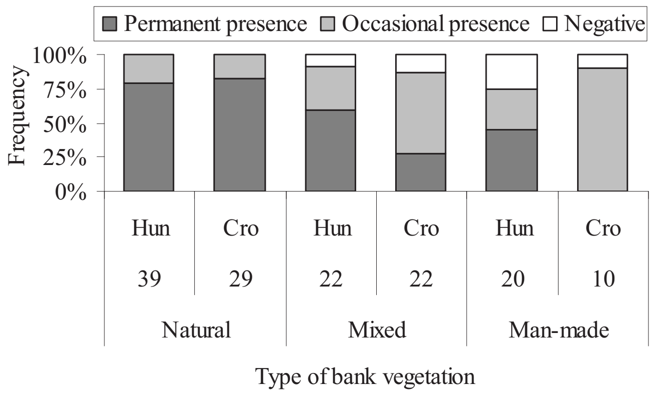


Fig. 4. Otter occurrence in relation to the status of vegetation at the waterside

The summarised effect of anthropogenic disturbance is shown in Fig. 5. As the degree of disturbance grew, the cases of negative occurrence increased. The frequency distributions at surveying locations in Hungary and Croatia did not differ significantly ($\chi^2 = 2.65$, df = 3, $P = 0.449$) in this respect (Fig. 5.).

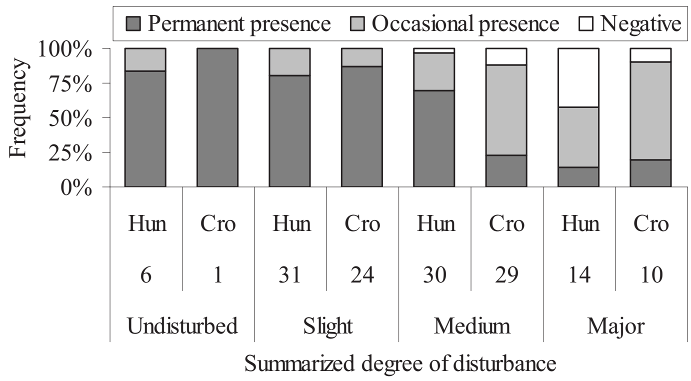


Fig. 5. Otter occurrence in relation to summarised effects of disturbance

In cases of surveys made near wide bridges with pillars, bridges with berms on both sides, and non-bridge locations, otter occurrence rates turned out to be equally high (Fig. 6.). Least advantageous were bridges without landing points (under-bridge berms) (Annex 1: Figs *d* and *e*).

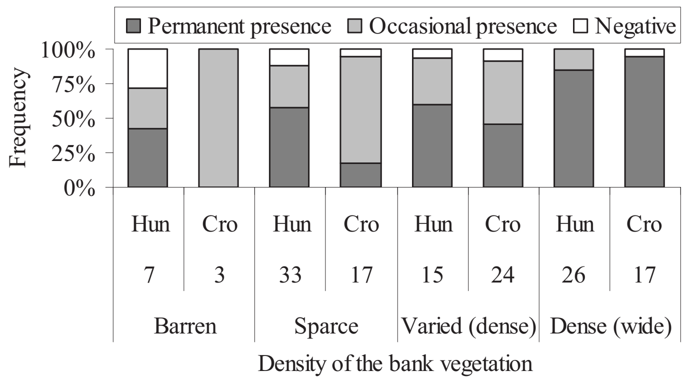


Fig. 6. Otter occurrence in relation to bridge types (surveyed locations)

## 3.2. Evaluation

It can be stated that otters occur along the Drava sections between Legrad and Őrtilos-Szentmihályhegy and between Donji Miholjac-Drávaszabolcs, as well as in the majority of adjoining wetland habitats. The density of the positive occurrence points indicate that the otter population along Drava is strong and uniform. This is supported also by findings of molecular genetic studies having performed in the area (LANSZKI et al. 2008).

Frequent otter occurrence is typical mostly of Drava sections and backwaters with more constant fish supply, and in fishponds and angling ponds of which only few were surveyed. Occurrence on smaller streams and canals is rare, but more typically permanent.

As vegetation coverage on the waterside grows, otter occurrence – including the rate of permanent presence – increases. In this respect, results are in accordance with the statements made by KEMENES and DEMETER (1994, 1995). Otter occurrence tends to be more frequent along natural watersides than where vegetation is less natural and the water-side is transformed. Particularly favourable, extensive otter habitats are recorded between Legrad and Starogradecki Marof, but the near-natural habitats along the Drava in Croatian sections of Baranya county are sometimes small (narrow stripes), and human impact is significant (e.g. cultivated farmlands stretching right to the edge of the water). In some of the backwaters (e.g. Budakovac) the intensive use of waters for angling is recorded, including the transformation of the shoreline. The low number of small watercourses on the right side of Drava are often not satisfactory (steep and barren banks, intensive agricultural management). In some areas nature conservation measures should be taken. Thus, it appears that there is considerable variation in the environmental condition of different areas. The adaptability of otters is signified by the fact that they are also present in areas that seem to be unfavourable, provided that sufficient food and/or shelter are available.

Being highly suitable for monitoring, otters could be a good indicator species of planned new NATURA 2000 sites. The majority of the sites included in the present report can be suggested for annual surveying. From the assessment of otter populations repeated each year, information can be gained about any changes of their distribution in the region. The annual surveys, however, are not suitable for tracing any changes of otter population size. For that purpose, samplings should be done in thoroughly selected, typical habitats. Such areas surveyed as part of the present study were: Legrad area (Drava main branch and side-branch), Gola - Repaš - Molve (Drava main branch), Ždala (wetland areas of the Repaš forest and the Čambina backwater), Novo Virje area (Drava side-branch and main branch), Podravska Slatina - Budakovac (Drava dead branch), Donji Miholjac (Drava main branch and dead branch). The monitoring results that have been gathered during the monitoring activities on the Somogy county Drava section since 2000 (LANSZKI 2005; LANSZKI et al. 2008) can be relied on in this respect.

For the surveying of otter occurrence and habitat evaluation, a new survey sheet was tested (LANSZKI & HELTAI 2005). Based on findings in the field, some modifications and refinements were made. The completion of the sheet – that contains much more information than the ones used formerly – takes about one minute following the survey walk in the particular sites (i.e. it is not sophisticated or time-consuming). Data collected on the sheets can be easily recorded in a computer database, and can be used for statistical evaluation later on. The surveyed sites can be accessed relatively easily both by car and on foot, allowing about 10-15 places to be surveyed during a single day.

A detailed field guide in Hungarian and English language was produced for otter surveying, as part of the Interreg programme (LANSZKI 2007a, 2007b). So as to be able to provide a broader overview, we intend to evaluate data from the surveys performed along the Drava in combination with data obtained from the South-Transdanubian areas (e.g. fishponds, smaller or larger streams and rivers not having been focused on in the present studies). Also, otter feeding studies (e.g. LANSZKI & SALLAI 2006) will be continued, by processing otter droppings collected in the field.

During our field observations in Croatia, large number of unique landscape elements representing cultural historic value were encountered. These include objects and buildings still used today as part of floodplain farmland management.

The unparalleled richness of the Drava landscape in natural assets certainly makes it justified to designate NATURA 2000 sites as soon as possible, and to establish a bilateral, Croatian-Hungarian national park or common biosphere reserve.

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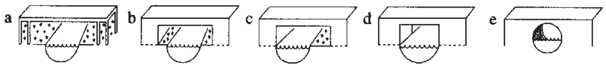
# Annex 1. Model for site examination reports

**1. Basic data** No:…….…
Date of survey (yy/mm/dd):…………………………………………………..…..……………...
Place of survey: nearest settlement(s): ……………….……………………….…………………………..
Name of area: ………………………………………………………………………………………..….…
**2. Description of surveyed area.**
GPS measurement: ………………………………UTM co-ordinate: ………………altitude a.s.l..: ……………….
Type of water /habitat*: stream, canal, irrigation canal, drainage ditch, river,
fishpond, wintering fishpond, angling pond, reservoir, bog, marsh, oxbow, other: ……………………….….……………
Extent of wetland: ……. ha, or………x …….…….m. Weather at time of survey: …………………
Width of watercourse*: <1m, 1-2m, 2-5m, 5-10m, 10m< note.…….……………………………..
Water depth*: <30 cm, 30-100 cm, 100cm< note:..……………………….........................…..
Waterside vegetation*: barren(concrete paved shoreline, mowed embankment of irrigation canals)
sparse (no shelter, low weed coverage, sparsely vegetated)
suitable at patches (variable area with densely vegetated and sparse plots)
thick, entire (extensive, overgrown, e.g. reedbed, thicket, marshy area)
Steepness of bank*: level(<15º) / medium (15-45º) / steep 45º< note:………………….…….
Waterside*: paved, concrete, earth, sandy, grassy, sedge/reed, other: ………………………….….…
Water levels in the last 2 weeks *: flooding, high, normal, low, extremely low,
dry patches, dried out, other: …………………………..……………….…………………..………………
Type of waterside vegetation (multiple choice is OK) *: forest/plantation/reed, cattail/willow bush/high sedge/pasture/
**Shape and type of bridge***:




other:….….
Width of area under bridge: ………….m, height: …………m, at normal water level.
Width of landing (sprainting) point under bridge: ……, ……..m, note: ……………………….…………………..….
Landing (sprainting) point under bridge*: paved, concrete, earth, sandy, grassy, other: ……………...………………..….
Other information: sluice, grid, other:…………………………………………………………………..….
Human impact*: Settlements: no / few houses/ small village / large village / town / large city, ………………………
Traffic: no / dirt road / public road with low traffic / main road / highway and motorway, …………..…
Disturbance: no / game mgmt./ angling/ crop production. / animal farming / industrial plant, …………
Pollution: free /only drift waste /occasional deposition /industrial scale ………
Combined human effects: 0 (no) 1 2 3 (large scale)
Specify disturbance effect: ……………………………………………………………..…………………..…
Habitat: natural/ protected area / semi-natural / mixed /settlement ..…………………………………….
**3. Surveying method**
The direction and method of searching in case of watercourses *: left / right side, upstream / downstream from bridge, watercourse
In stagnant waters: N, E, S, W
Distance of search for signs *: only around bridges, 600 m, other (e.g. 4x150, 2x300 m) in metres: ………………..…
Surveying*: finishing at the first sign, entire length, influential factors (if searched section is shorter): ……………..
**4. Otter presence**
Otter occurrence*: Positive / Negative (If positive: Permanent / Not permanent / Undetermined)
Signs found: ……. pcs **f**resh (<1 day old) spraint / anal jelly collected: yes /no
……. pcs **m**oist spraint (1-2 days old) collected: yes /no
……. pcs **o**ld spraints (dry) collected: yes /no
footprints (no. of individuals: ……adult, ……..young) photo: yes / no
food remains: fish / amphibian / other: ………………………………….……………………
otter holt / nest: note: …………………………… photo: yes / no
other: observed live otter, observed cubs, call, dead otter: specify
Notes: …………………………………………………………………..……….…………………..….
Photos were made of the followings: ……………………………………………………….………….....…..…

**Name of surveyor**, postal address, phone numbers, e-mail, other: ……………………………………………...……….
…………………………………………………….…………...……………………………………………
***underline or circle**