COMMUNITY OF SMALL TERRESTRIAL MAMMALS IN DANUBIAN INUNDATION AREA IN AUTUMN 2013

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Abstract: Small mammal communities were studied on 6 localities in the Slovak part of the Danube river branch system. The main aim of the study was to find out the composition of small mammal community in wetland habitats with the predominant vegetation of reeds and sedges. Among the most numerous species belonged *Apodemus agrarius*, recorded at all investigated sites in autumn 2013. This species was first recorded in the region in July 2013, As suggested by the time features of appearance and positions of potential migration barriers, especially the channel- and dike-system of Gabčíkovo hydroelectric power plant, the species colonized the Danube river branch system probably from Hungary by crossing the "old Danube" stream. *Microtus oeconomus*, a rare species in Pannonian Basin, was captured at four sites. Its population in the inland delta of the Danube is threatened by disturbed water regime of area. The species reached the highest relative abundance at site Bodíky – Kráľovská lúka. The family Soricidae was represented by one individual of *Sorex araneus* only. The possible reason of extremely low number of caught shrews is the massive flood in June 2013.

Key words: *Microtus oeconomus*, *Apodemus agrarius*, *Sorex araneus*, Danube, floodplain zone.

INTRODUCTION

Inundated regions are characterized by high variety of ecosystems. Also the inundated area of the river Danube in the area of large river branch system creating so called inland delta is especially abundant in habitats with different level of moistening. However, today the water regime of inland delta is markedly affected by nearby Gabčíkovo river barrage system (GRBS) (Balon & Holčík 1999). The deficit of water causes fast changes of habitats. While the wetlands gradually dry out, hygrophilous species of plants retrograde from them and the new weed plant species appear there (Hahn et al. 2011). Finally, the composition and dynamics of small mammal communities reflect all these changing conditions. One of the effects is decrease of abundance in species bounded to wet habitats. In the case of small terrestrial mammals in the area of Danubian branch system this trend could affect in particular the genus *Neomys* Kaup, 1829 and rare pannonian root vole – *Microtus oeconomus mehelyi* Éhik, 1928. This extensive impact of GRBS construction has an influence not only on the composition of local communities but also on the structure of landscape itself. The robust dams and wide intake and outlet channel can represent significant spatial barrier for dispersal of small terrestrial mammals. Consequently this barrier could impact the metapopulation structure or occasionally the dynamics of the species distribution range.

In the autumn the communities of small mammals are usually the richest because most of the species

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have their population maximum in that period. Assuming that the catch will not cause oversaturation of exposed traps, the autumn is well-timed season for detection of relatively rare species. The main aim of this study was to investigate the small mammal community composition in Danubian inundation area (in its part between rkm 1811 and rkm 1841) with special attention to the occurrence of the rare species *Microtus oeconomus* (Pallas, 1776). Taking into account its habitat requirements, only the wetland localities with reed and sedge were investigated.

MATERIAL AND METHODS

The small mammals were trapped into 25 wooden live traps of Chmela type that have been arranged in line and were spaced each other 5 m. The traps were exposed during two nights and checked in the morning and evening. From 25. 10. 2013 to 30. 11. 2013 we have investigated 6 localities (Figure 1):

1. Vojka nad Dunajom – Stará trstina (N 47° 57' 49'', E 17° 23' 12''; trapping of small mammals carried out between 25–26. 10. 2013). This habitat consists of small reed beds and sedge beds on the bank of the Danubian branch. The hygrophilous herbal vegetation continues into the forest stand and in some parts it borders with clear cutting colonized by ruderal and invasive herbal vegetation. The area of reed and sedge beds is relatively small, approximately 0.5 ha.

2. Vojka nad Dunajom – Žofín (N 47° 57' 26'', E 17° 23' 37''; 25–26. 10. 2013). This wetland covers an area of about 2 ha with different moisture level. On the drier places there is ruderal vegetation consisting mostly of invasive herbs. In the middle of wetland there are reed beds with sedge overgrowth. Distance between this wetland and locality Stará trstina (see above) is approximately 1 km.

3. Bodíky – Bodícke ramená (N 47° 55' 10'', E 17° 27' 9'', 29–30. 11. 2013). This narrow terrain depression (250 m long and 30 m wide) is flooded in the middle part. This small lake follows the shape of close Danubian branch. There are sparse reed beds with fallen tree trunks on the banks of this depression. On the one part of depression there is smaller but relatively connected sedge overgrowth. The depression borders on the forest on the one side and on the other side on the new forest outplanting after clear-cutting.

4. Bodíky – Kráľovská lúka (N 47° 54' 11'', E 17° 29' 22''; 29–30. 11. 2013). This locality is the rest of the Danubian ox-bow bordering on the

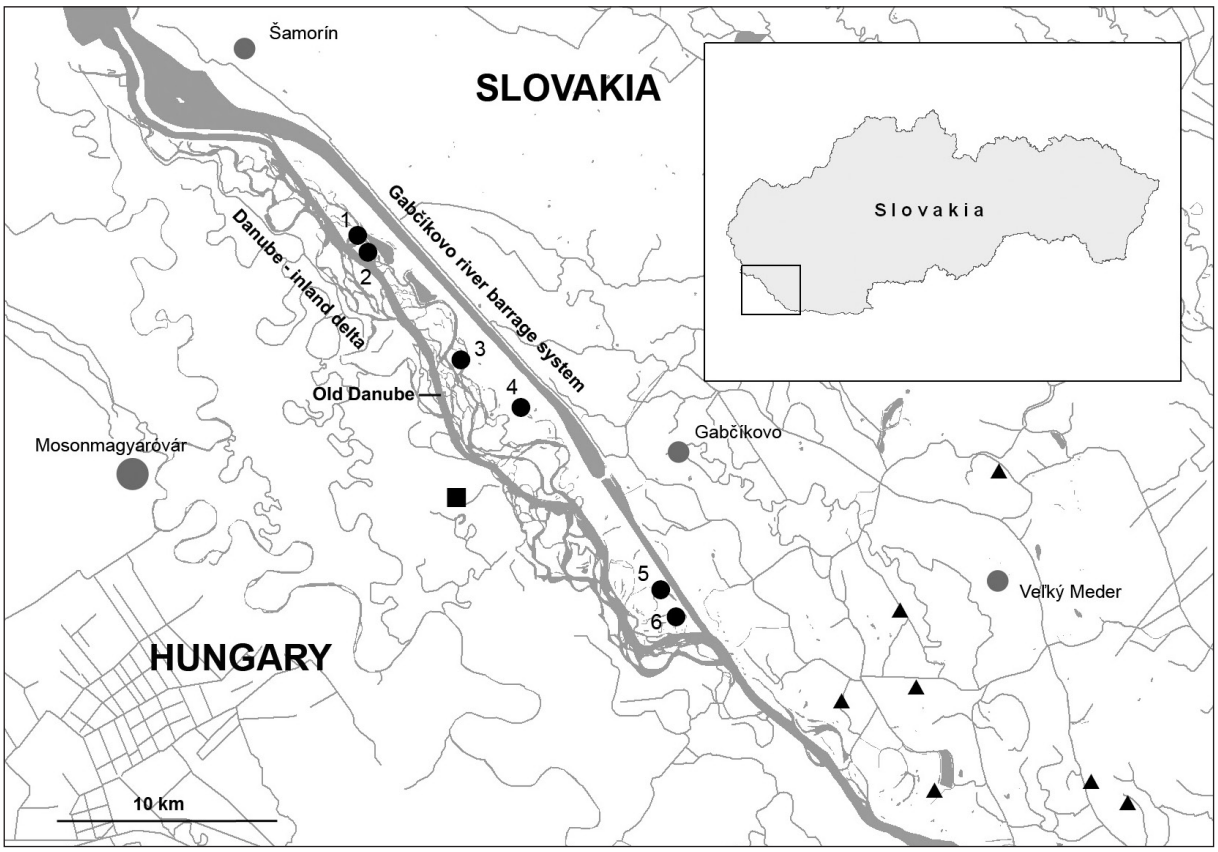

Figure 1. The map of studied localities and localities with presence of *Apodemus agrarius* in 2010 (after Ambros et al. 2010).

Numbering of study localities are identical with numbering in text of article; ● – studied localities; ▲ – localities with occurrence of *Apodemus agrarius* in southwestern Slovakia; ■ – locality with occurrence of *Apodemus agrarius* near Lipót in Hungary).

flood-protection dike of inundation area. The bank vegetation is created partly by forest and reed beds with small sedge meadows. Trapping line was situated on the east part of the ox-bow in places with reed and sedge overgrowth.

5. Sap – Išpánoš (Csilli) (N 47° 50' 17'', E 17 °34' 47''; 14–15. 11. 2013). Locality is created by the rest of Danubian ox-bow on the border of cadastral areas of Sap and Gabčíkovo. The banks of this shallow lake are covered by forest and reed-sedge beds. Trapping line was exposed in the west part of the locality where reed and sedge created relatively narrow bank overgrowth. This locality is situated close to GRBS outlet channel. Between this locality and channel there is only 100 meters distance created by grassy stripe and by flood-protection dike of inundation area.

6. Sap – Erčéd (N 47° 49' 42.5'', E 17° 35' 22''; 14–15. 11. 2013). This former river branch is flooded when the water level rise. Locality was completely dry during the trapping action. Vegetation consists of more or less connected sedge overgrowth which absents on the deepest parts of terrain depression. Forest or small reed communities grow on the banks of this old river branch. The area of sedge meadow can be about 0.5 ha large. This locality is 700 m distant from locality Išpánoš.

RESULTS

Between 25. 10. and 30. 11. 2013 we caught all together 160 individuals from 9 species of small mammals. With the highest number we detected *Apodemus agrarius* (Pallas, 1771) (73 individuals), then *Clethrionomys glareolus* (Schreber, 1780) (32 individuals) followed by *Micromys minutus* (Pallas, 1771) (27 individuals). Survey of captures is shown in Tab. 1.

Species *Apodemus agrarius* was present on all six studied localities in Danubian inundation. Its highest abundance was detected on locality Erčéd where 38 individuals were caught, representing 90 % of community. Except locality Bodícke ramená, *A. agrarius* represented a considerable (eudominant) part of communities on all other localities.

Also *Micromys minutus* was found on all investigated localities. It was caught mostly in low numbers and its dominance did not exceed up to 10 %, except localities near Vojka where it was detected in higher ratio. Thus its highest number was detected on locality Žofín, where it reached also the highest dominance (66.67 %), but only two species of small mammals were found there.

Clethrionomys glareolus occurred on 5 localities. Its presence was not detected on locality Žofín near Vojka. On the locality Bodícke ramená the species reached highest number and also the highest ratio of community.

Microtus oeconomus was found on 4 localities. The most of individuals were caught near Bodíky at Kráľovská lúka where 6 of them were detected, and its dominance reached the highest level (40 %) there. In each of other studied communities just one individual was detected and the dominance of the species did not exceed 5 %.

From each of the species *Mus musculus* Linnaeus, 1766, *Microtus arvalis* (Pallas, 1778) and *Sorex araneus* Linnaeus, 1758 only one individual was caught during this research. Especially noteworthy is the single capture of *Sorex araneus*. It was found on locality Bodíky – Kráľovská lúka. On the all other localities no insectivores were detected.

The highest values of species diversity were found at localities Stará trstina and Kráľovská lúka. Six species were detected on both of them. The same number of species was detected on locality Išpánoš and 7 species were determined on Bodícke ramená. But the dominance of species was unequally distributed on these two localities (Tab. 2) because of significant dominance of *Apodemus agrarius* and *Clethrionomys glareolus* at Išpánoš and *Clethrionomys glareolus* at Bodícke ramená. The highest equitability was detected on locality Žofín, but with relatively low value of species diversity index, because the data came from only 2 species of small mammals that have been caught there.

DISCUSSION

Species from family Soricidae usually represent an important part of small mammal communities. Especially *Sorex araneus* occurs in wide range of habitats (Krištofík 2012) and on a lot of them it belongs to dominant or even eudominant species of small mammals (for example Dudich et al. 1985, Dorotovičová–Juhászová 1992, Krištofík 2001). It prefers moderately moist habitats with dense herbal undergrowth (Krištofík 2012) and many authors detected it also in reed beds (for example Dudich et al. 1985, Dudich & Štollmann 1988, Ambros et al. 1999, Krištofík 2001). It is present abundantly also in the lowland floodplain forests (Dudich & Štollmann 1983, Stollmann & Dudich 1984, Pachinger et al. 1996, Pachinger & Haferkorn 1998, Krištofík 1999).

Based on extensive research of small mammal's occurrence in the south part of Danubian Lowland Dudich et al. (1985) wrote that *Sorex araneus* reaches the highest abundance and also dominance in the moist habitats. During 3-year research in reed overgrowths outside the inundation zone of Danube Krištofík (2001) recorded 16 small mammal species and 6 of them belonged to Soricidae. *Sorex araneus* was the most abundant among them

Table 1. The abundance, dominance and frequency of small mammals in Danubian inundantion area in autumn 2013.

A – abundance; D – dominance; F – frequency; V–ST – Vojka, Stará trstina; V–Z – Vojka, Žofín; B–KL – Bodíky, Kráľovská lúka; B–BR – Bodíky, Bodické ramená; S–I – Sap, Išpánoš; S–E – Sap, Erčéd

Species/Localities	V–ST		V–Z		B–KL		B–BR		S–I		S–E		Total		
	A	D (%)	A	D (%)	A	D (%)	A	D (%)	A	D (%)	A	D (%)	A	D (%)	F (%)
Apodemus agrarius	5	25,00	7	33,33	3	20,00	1	4,35	19	48,72	38	90,48	73	45,63	100,00
Apodemus flavicollis	3	15,00			1	6,67	3	13,04	4	10,26			11	6,88	66,67
Apodemus sylvaticus	1	5,00					2	8,70	1	2,56	1	2,38	5	3,13	66,67
Clethrionomys glareolus	3	15,00			3	20,00	14	60,87	11	28,21	1	2,38	32	20,00	83,33
Micromys minutus	7	35,00	14	66,67	1	6,67	1	4,35	3	7,69	1	2,38	1	16,88	100,00
Microtus arvalis							1	4,35					27	0,63	16,67
Microtus oeconomus	1	5,00			6	40,00			1	2,56	1	2,38	9	5,63	66,67
Mus musculus							1	4,35					1	0,63	16,67
Sorex araneus					1	6,67							1	0,63	16,67

and it belonged to those species of small mammals with the highest dominance. Moreover it was euconstant with 100 % of occurrence frequency. Formerly, during the years 1991 – 1993 Krištofík (1999) detected *S. araneus* with 80.6 – 97.2 % frequency of occurrence in the same area of floodplain forests as the forests which we investigate presently in this study.

The absence of other species from family Soricidae is also striking. Although another species of this family are usually present in wetland communities of small mammals in lower extent (Krištofík 2001), at least the species of genus *Neomys* and also *S. minutus* could be expected there. On wetland locality near Medveďov Krištofík (2001) caught them in low densities. Also Dudich et al. (1985) recorded them in semi-aquatic habitats and wetlands in the south part of Danubian Lowland. On the other side, they emphasize that between 1981 – 1984 species *Neomys fodiens* (Pennant, 1771) and *S. minutus* were detected only rarely.

It is difficult to explain such a low occurrence or nearly absence of Soricidae in research covering a large area of Danubian inundation in autumn 2013. Although Hulejová Sládkovičová et al. (2013) suggested the gradual loss of Soricidae on Danubian Lowland, we consider as unreal such a radical disappearing of the whole trophic group. As more likely cause of its absence could be the effect of extreme flood in July 2013. However, after a 3-year research, Krištofík (1999) mentions that temporary floods have not significant influence on the composition of small mammal communities. According to him, floods do not cause decrease of catching rate of small mammals. On the contrary the number of caught animals slightly grows. In the case of *S. araneus* he recorded significant increase in number of detected individuals after prolonged flood. Author explained this by decrease of food opportunities and so by higher attractiveness of bait in traps. Wijnhoven et al. (2006) also mentioned the quick re-colonization by *S. araneus* after the flood. But in the case of flood in Jun 2013 the process of community changes could be different. The reason could be the large range of flood. The flood wave was massive with the highest flow rate in the history of measurement. All the inundation area was under the water for about 5 days. During the monitoring of consequences of catastrophic flood in 1965 on small mammals Brtek (1986) found out that rodents are able to re-colonize area after prolonged flood more rapidly than Soricidae. He states that population of *S. araneus* was concentrated mostly in area of refugees during the first year and it grew slower than population of rodents. We assume the similar phenomenon could occur also in 2013. Moreover locality Kráľovská lúka, where occurs one individual of *S. araneus*, is situated close to the flood-protection dike, and Brtek (1971, 1986) considers dikes to be one of the most important refugees of terrestrial fauna during the floods. Connection between extraordinary low detection of Soricidae in autumn 2013 and flood in June in the same year is confirmed by absence of Sorcidae on locality Vojka – Stará trstina shortly after the water dropped. In July 2013, approximately one month after the flood, only rodents were recorded on the locality (5.–6. 7. 2013; 8 individuals of *Apodemus agrarius*, 8 of *A. flavicollis* (Melchior, 1834)) and Soricidae absented (unpublished data). In December 2011 4 individuals of *S. araneus* (6.6 % dominance) and also 4 individuals of *S. minutus* were captured at the same locality (unpublished data).

The continuous distribution range of *Apodemus agrarius* reaches Slovakia on the east and on the north of the middle part of country. However in present its area of distribution is characterised by strong expansion (Dudich & Štollmann 1986, Dudich 1997, Stanko 2012). In the last decades its spread to the west was detected in regions near

Slovak Karst Mountains (Dudich & Štollmann 1986) and similarly in the areas of the Hron (Uhrin & Benda 2000) and Ipeľ rivers (Dudich et al. 2003, Stanko 2012). The rate of expansion was estimated for about 3 km per year (Dudich 1997). In 2010 *A. agrarius* was detected also on 7 localities of Danubian Lowland. (in the area of Čiližský brook and channels Holiare – Kosihy and Veľký Meder – Holiare) (see Fig. 1) on the east from our studied part of inundation area. It is not expected that its expansion into the region of Danubian Lowland would be from Slovak populations. It is more likely that the Danubian Lowland is colonized from Hungary (Ambros et al. 2010). This is in accordance with a tendency to shift the borders of distribution range in western Hungary where it spreads westward and in north-westerly direction (Bihari 2007).

In the inundation area on the Slovak side of the river Danube (on the southwest of GRBS) this species was detected for the first time in July 2013 on locality Vojka – Stará trstina. We caught 8 individuals (16 individuals/100 trapping nights) (see above). The presence of *A. agrarius* had never been detected before this record in the area around rkm 1811 – 1841 despite the intensive research of small mammals (for example Pachinger et al. 1996, 1997, Krištofík 1999) carried in this area. The absence of this species in catches 2 or 3 years before current records in 2013 (Ambros et al. 2010, Hulejová Sládkovičová et al. 2013) could predicate of the way of its penetration into this area. The species formerly was not present neither on locality Bodíky – Kráľovská lúka (April 2011; unpublished data) nor on locality Vojka – Stará trstina (December 2011; unpublished data), and right on these localities this species was recorded just in 2013. Therefore we assume the colonisation of studied part of Danubian branch system from Hungary and not from the new known localities on Danubian Lowland. It is not likely that from 2010 would *Apodemus agrarius* had overcome approximately 30 km long distance between the closest localities on Danubian Lowland (Čobánsky chrbát near village Kľúčovec, or locality near village Čiližská Radvaň) and our westernmost locality (Vojka – Stará trstina). Moreover this species would have to overcome considerable migration barriers on this way like wide channels of GRBS with massive and regularly mown dikes. Much more likely is direct colonisation from Hungary because only the stream of "Old Danube" would have to be overcome. After the start of operation of barrage system, the water level in the "Old Danube" radically decreased (Balon & Holčík 1999, Hahn et al. 2011). Surrounding area along with the river branch system create more favourable conditions for overcoming of potential migration barriers than wide intake and outlet channel of GRBS do. In Hungary the closest occurrence of *A. agrarius* is near village Lipót (Gubányi 2010) in close vicinity of the Danubian inundation. The distance between this locality and our studied localities is approximately 4 – 10 km long (Bodíky – Kráľovská lúka, or Vojka – Stará trstina and Sap – Erčéd). *A. agrarius* was detected near Lipót in May 2010 for the very first time (Ambros et al. 2010). In the case of colonisation from around Lipót this species would overcome about 10 km distance during 3 years (if the colonisation was not done from closer unknown localities in Hungary). It would correspond with estimated expansion rate in the middle Slovakia (Dudich 1997).

Apodemus agrarius was detected in the wide range of habitats (Stanko 2012) but in middle Europe it prefers mostly wet habitats in the open landscape (Zejda 1967). It usually occurs in floodplain forests and in alluviums of lowland rivers (Dudich & Štollmann 1983, Štollmann & Dudich 1984, Stanko et al. 1998). During the low population densities, populations concentrate to wet alluvial habitats and the species also spreads along the riparian vegetation of streams and rivers (Ferianc 1963, Uhrin & Benda 2000, Stanko 2012). Therefore its occurrence in wetland communities of Danubian inundation is in accordance with habitat preference of this species. Moreover, *A. agrarius* is an opportunistic species with good capability for spreading, covering distances of several hundred meters in a few days (Liro & Szacki 1987). It is able to colonize/re-colonize habitats in short time after flood and reach high dominance in small mammal communities affected by flood (Balčiauskas et al. 2012). We assume the intricate river branch system of Danube presents not only suitable living conditions but also ideal conditions for rapid spreading of this species.

There are only a few published data about *Microtus oeconomus* occurrence in Danubian inundation in area of river branch system from recent period. Almost all our knowledge comes from the end of 20th century (mainly 80th and 90th years) when an extensive research was going on in this area (Pachinger 1987, Ambros 2010). Just in that time Pachinger (1995, 2002 – 2003) noticed its decline in this region. He explained it by the change of flooding character in the last centuries and by disruption of dynamics of the water regime due to construction and operation of GRBS. Even it was suggested that gene pool of *M. oeconomus* could completely disappear in Danubian branch system in a certain period (Pachinger 1995, 2002–2003, Ambros 2010). More recent data about *M. oeconomus* occurrence in Danubian branch system on the southwest of GRBS came from 2010 – 2011. This species was detected on locality Sap – Erčéd and Vojka – Stará trstina (Miklós et al. 2011, unpublished data). Another occurrence was recorded in 2011 close to inundation area near Gabčíkovo (locality Veľký les, unpublished data).

All these information suggest that *Microtus oeconomus* still lives in the area of Danubian river branch system. The hypothesis about its local extinction and later re-colonisation can be confirmed only by genetic analysis. Our research has found its occurrence at various sites scattered along Danubian branch system. Despite a relatively low number of caught individuals it is clear that this species survived the massive flood in Jun 2013.

In the past *M. oeconomus* was detected on all our studied localities. On locality Vojka – Stará trstina it was caught for the first time in December 2011 (unpublished data) but on the other parts of inundation it was detected in the 80th years in the last century (Pachinger 1987, 1995) namely locality Vojka nad Dunajom – island and Vojka nad Dunajom – Žofín, which is probably connected with locality Stará trstina through riparian vegetation of Danubian branches and hygrophilous vegetation of ox-bows. Directly on the locality Sap – Erčéd *Microtus oeconomus* was detected in 2010 (Miklós et al. 2011). Although traps were not exposed at the same place like in autumn 2013, from the habitat conditions implies that it is identical locality. Around Erčéd this species was known even sooner, more precisely form 1992 (Stollmann & Ambros 1998). In 2003 it was caught on the close locality Išpánoš (Noga pers.com.) where its occurrence was confirmed in autumn 2013. Its presence on locality Bodíky – Kráľovská lúka was known thanks to more authors (Pilinský 1996, Krištofík & Mašán 1995, Krištofík 1997, Stollmann & Ambros 1998). The last data comes from 1997 (Krištofík 1997). We have detected 6 individuals (40 % dominance) what suggests relatively strong position of this species in the small mammal community. The mentioned facts point out the importance of this locality for *M. oeconomus* (12 individuals / 100 trapping nights).

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