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Distribution and conservation management of the Root Vole (*Microtus oeconomus*) populations along the Danube in Central Europe (Rodentia: Arvicolinae)

Rozšírenie a ochranársky manažment populácií hraboša severského (*Microtus oeconomus*) v strednej Európe pozdĺž Dunaja (Rodentia: Arvicolinae)

Andras GUBÁNYI[1], Alexander DUDICH[2], Andrej STOLLMANN[3] & Michal AMBROS[4]

[1] Department of Zoology, Hungarian Natural History Museum, H–1088, Budapest, Baross u. 13, Hungary; gubanyi@zoo.zoo.nhmus.hu
[2] Námestie Svätej Trojice 19/15, SK–969 01 Banská Štiavnica, Slovakia
[3] Krivá 10, SK–947 01 Hurbanovo, Slovakia
[4] Správa Chránenej krajinnej oblasti Ponitrie, Sámova 3, SK–949 01 Nitra, Slovakia; ambros@sopsr.sk

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Abstract. The endangered Mehelyi's root vole, *Microtus oeconomus mehelyi* Éhik, 1928, is the rarest vole subspecies in Central Europe. The decrease in its population size and numbers has justified the strict protection of this subspecies in Slovakia since 1965, and in Hungary since 1974. In addition, Mehelyi's root vole is listed in both the Appendix III to the Bern Convention and the Habitat Directive (HD2). Mehelyi's root vole is considered to be a glacial relict at its current locations, marking the southernmost distribution of this Holarctic species in Europe. Basic research activities concerning this subspecies, of relevant to conservation, have only been started in recent years. Based on literature and field data, the authors reviewed the distribution of Mehelyi's root vole in the floodplain of the Danube (Szigetköz, Žitný ostrov) and its vicinity. Potential strategies for the conservation of the existing populations and their habitats are proposed herein.

Keywords. *Microtus oeconomus*, distribution, conservation biology, island biogeography, action plan, Central Europe, River Danube.

INTRODUCTION

The very first occurrence of root vole, *Microtus oeconomus* (Pallas, 1776), in the Carpathian Basin was recorded by taxidermist Károly Kunszt near Somorja. The 12 specimens collected near the village Somorja were sent to Lajos Méhely for further taxonomic identification. Méhely recognized the specimens as a new species for the Carpathian Basin's fauna (Méhely 1908). Éhik (1928) described *Microtus oeconomus mehelyi*, based on specimens from the neighbourhood of Rajka and Somorja (Šamorín) as *Microtus ratticeps mehelyi*, which seems to be the rarest vole species in the Carpathian basin and has been under strict protection in Slovakia and Hungary since 1965 and 1974, respectively. Mehelyi's root vole is listed as an endangered species in Appendix III to the Bern Convention, and included in the Habitat Directive (HD2) as well. Mehelyi's root vole populations are regarded as glacial relicts demarcating the southernmost edge of the distribution of this holarctic species in Europe (Rácz et al. 2005). Apart from ina-

ccurate and unreliable reports, small populations of this local vole subspecies have been found in fragmented habitats in the following regions of the Carpathian basin: Žitný ostrov, Szigetköz, Hanság, Tóköz, Fertő-tó (Neusiedler See), and Kis-Balaton.

M. oeconomus has been studied from various symbiological aspects, mainly on the Scandinavian Peninsula, due to its holartic distribution and relevantly large populations in these northern territories. Detailed studies have been conducted on the species' seasonal distribution patterns, reproduction, territorial behaviour, home range, and its interactions with other coexisting rodents; e.g. with the sympatric *M. agrestis* (Tast 1966, 1968, Kostian 1970).

Henttonen et al. (1984) studied the social behaviour and intraspecific competition of the root vole. Relevant works include studies concerning the effects of fragmentation and patchy distribution of habitats on the spatial distribution and aggregation of *M. oeconomus*, the effects the habitat connectivity and fragmentation on the growth and sex ratio within population, and the pattern of space use by the species (Andreassen & Ims 1998, Andreassen et al. 1998, Bjornstad et al. 1998, Šilov et al. 1977a, b, Ims & Andreassen 1999). Root vole survival rates in fragmented and degraded habitats were analysed by Johannsen & Ims (1996) and Ims & Andreassen (1999), who described the optimal connectivity level among habitat patches for *M. oeconomus*.

Following protocols of the Hungarian National Biodiversity Monitoring System (NBMS), a biodiversity monitoring program was launched in Hungary in the early 2000s to monitor the population status of *M. oeconomus* in three regions: Szigetköz, Tóköz, and Kis-Balaton. Despite efforts, only a few ecological and genetic studies of practical use for the conservation of root vole populations in Carpathian basin have been performed (Papp et al. 2000, Horváth 2001, Gubányi et al. 2002). Additionally, there is no detailed information on the distribution of this species along the floodplain of the Danube and its surroundings. The primary aim of this study was to perform a critical review of available zoological literature to elucidate the distribution patterns of this strictly protected species and to make proposals for active maintenance and preservation.

MATERIAL AND METHODS

In addition to published data, the authors relied on unpublished field observations (live trapping), on faunistic results of parasitological and small mammalian studies carried out by the Hungarian National Parks, on collection records of the Hungarian Natural History Museum and the Slovak National Museum, and on E. Schmidt's computerised owl pellet catalogue as well. Distribution map of *M. oeconomus mehelyi* along the Danube is shown on Fig. 1. Detailed data are presented in Table 1, indicating the relative frequency of root voles within given samples. 'Coll. VS SAV Staré Hory' designates the Slovak Academy of Sciences at Staré Hory, currently located at the Natural History Section of the National Museum of Slovakia. Protocol of VS SAV Staré Hory stands for the collection log of the Slovak Academy of Sciences' research station at Staré Hory.

RESULTS AND DISCUSSION

Based on a comparison of data taken from literature and those data originating from the collections with more detailed comments, some criticism and clarification has to be made with regard to the details presented in various rows of Table 1:

(1) The small sample size and the high dominance of *M. oeconomus* in the sample are explained by the fact that collection took place during the winter period.

(2) Locality data concerning *M. oeconomus* published by Schmidt (1969) seems to be based on the material collected by L. Csiba in 1962. It was labelled as "Dunasziget", and placed in the owl pellet collection of HNHM. In a subsequent study by Schmidt (1976), Dunasziget is erroneously mentioned as a new locality record of *M. oeconomus*.

(3) Schmidt (1976) tabulated the distribution records of small mammals recovered from owl pellets by species. Unfortunately, the author makes no mention of the collection date of the labelled pellets, the data of which are published on the basis of original materials. Only five of the 8 new localities described in the study proved to be novel. Since there are no bank vole remains in the pellet samples collected at Kisbarát, this locality was probably mentioned by accident. Szigliget and Dunasziget had already been included in an earlier work of Schmidt (1969). The listing of the village Hédervár is also a potential misinterpretation of the data since root voles were probably caught by owls in a reed bed nearer to Lipót.

(4) Dániel et al. (1986) published a new record of *M. oeconomus* from pellets of *Asio otus* that were collected during the winter period in the Botanical Garden at Dunaszentmiklós. Besides the high percentage of *M. arvalis* (57% of 429 specimens), the authors found only a single mandible showing the characteristics of *M. oeconomus*. Unfortunately, the reexamination of this mandible was not possible since the original material had perished. It is a possibility that the long-eared owl caught this root vole specimen either in the vicinity of a fishpond system

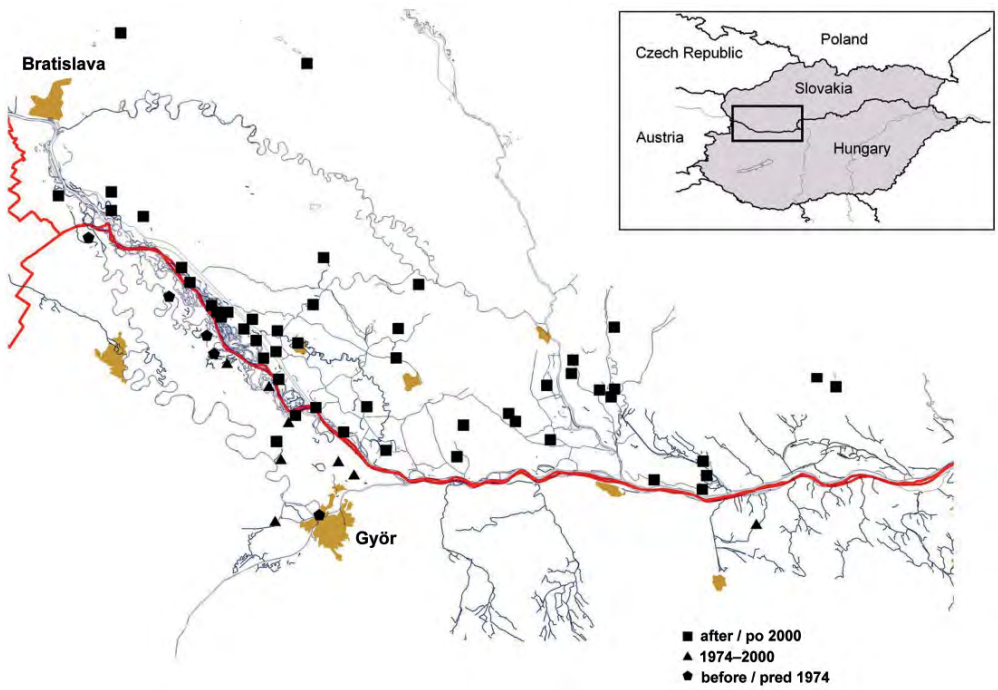

Fig. 1. Distribution map of *Microtus oeconomus* along the middle reaches of the Danube.
Obr. 1. Mapa rozšírenia *Microtus oeconomus* pozdĺž stredného toku Dunaja.

Table 1. Occurrence of *Microtus oeconomus* along middle reaches of the Danube: combined results from pellets and stomach contents of raptors, and live trapping. Legend: year – year of collection; ST – stomach content; P – pellets; T – trapping; n – sample size; F – frequency [%]
Tab. 1. Rozšírenie *Microtus oeconomus* pozdĺž stredného toku Dunaja: výsledky kombinované na základe analýzy vývržkov a žalúdkov predátorov a odchytov. Vysvetlivky: rok – rok zberu, ST – obsah žalúdkov; P – vývržky; T – ochyt; n – veľkosť vzorky; F – frekvencia [%]

year rok	locality lokalita	ST	P	T	n	F	reference zdroj
1902	Šamorín (Csallóközsomorja)	−	−	+	12	−	Méhely (1908)
1921	Győr	−	+	−	1	−	Greschik (1924)
1925	Rajka	−	−	+	3	−	Éhik (1928)
1953	Gabčíkovo (Bös)	−	−	+	−	−	Hanzák (1955)
1954	Čilizská Radvaň (Csilizradvány)	−	−	+	170	−	Kratochvíl & Rosický (1955)
1954	Gabčíkovo (Bös, Varjas)	−	−	+	22	−	Hodková (1979)
1954	Gabčíkovo (Bös)	−	+	−	6	3.0	Balát (1956)
1954	Vrakúň (Várkony)	−	+	−	3	1.0	Folk (1956)
1956	Svätý Jur, Šúr	−	−	+	1	−	Brteková (1957)
1959	Čičov, Hamské tŕstie (Csicsó, Hami nádas)	−	−	+	7	−	Štollmann (1962)
1961	Bodíky (Bodak)	−	−	+	26	−	B. Matoušek
1962	Dunasziget, Tejfalusziget	−	−	+	1	50.0	Csiba L.
1962	Dunasziget, Doborgazsziget	−	+	−	6	31.6	Csiba L. (Schmidt 1969)
1964	Baka	−	−	+	8	62.0	Brtek (1986)
1965	Veľký Meder (Nagymegyer)	−	−	+	−	−	Feriancová-Masárová & Hanák (1965)
1967	Sap (Palkovičovo)	−	−	+	−	−	Binder & Štollmann (1975)
1967	Hroboňovo (Alistál)	−	−	+	3	5.0	Brtek (1986)
1967	Gabčíkovo, Vrani dvor	−	−	+	3	4.0	Brtek (1986)
1968	Rusovce (Oroszvár)	−	−	+	1		Pachinger (1993)
1969	Hamuliakovo (Gutor)	−	−	+	1		Pachinger (1993)
1970	Kalinkovo	−	−	+	1		Pachinger (1993)
1971	Dunaremete	−	+	−	11	15.0	Schmidt (1976)
1971	Hédervár	−	+	−	3	1.6	Schmidt (1976)
1972	Kisbodak	−	+	−	16	21.0	Schmidt (1976)
1974	Čičov (Csicsó)	−	−	+	18	11.0	Darola & Štollmann (1984)
1974	Vrbová nad Váhom (Vágfüzes) − Listové jazero (Leveles)	−	−	+	12	0.2	Binder & Štollman (1975)
1974	Pusté Úľany	−	+	−	17	2.0	Šilhár (1975)
1981	Vrbová nad Váhom (Vágfüzes) − Kingyes	−	−	+	1	1.0	Štollmann & Ambros (1998)
1981	Čičov, Hamské tŕstie	−	−	+	3	18.0	Coll. SAV Staré Hory
1982	Gabčíkovo, V. Tejka	−	−	+	10	7.7	Pachinger (1987)
1982	Dolný Štál (Alistál)	−	+	−	1	−	Noga & Obuch (2003)
1983	Baka, Dekan	−	−	+	5	4.5	Pachinger (1987)
1983	Vojka, Ostrov	−	−	+	3	2.7	Pachinger (1987)
1984	Dunaszentmiklós	−	+	−	1	0.3	Dániel et al. (1986)
1984	Bodíky, Bodická brána	−	−	+	4	1.7	Pachinger (1987)
1984	Bodíky, Šulianska brána	−	−	+	4	1.3	Pachinger (1987)
1984	Bodíky, Veľký Ostrov	−	−	+	6	1.4	Pachinger (1987)

year rok	locality lokalita	ST	P	T	n	F	reference zdroj
1984	Gabčíkovo	−	−	+	1	14.0	Coll. SAV Staré Hory
1985	Vojka, Žofín	−	−	+	5	1.9	Pachinger (1987)
1985	Topoľovec (Nyárad)	−	−	+	1	2.0	Dudich et al. (1987)
1987	Györladamér, falu határ	−	−	+	4	16.5	Matskási et. al. (1992)
1987	Kisbajcs	−	−	+	4	30.0	Matskási et. al. (1992)
1987	Lipót, Macska sziget	−	−	+	1	10.0	Matskási et. al. (1992)
1990	Marcelová (Marcelháza)	−	−	+	3	7.0	A. Stollmann
1990	Ásványráró, Gémes	−	−	+	1	50.0	Matskási et. al. (1992)
1990	Ásványráró, Kucsérok	−	−	+	4	21.0	Matskási et. al. (1992)
1990	Vámosszabad, Lajna mocsár	−	−	+	2	22.0	Matskási et. al. (1992)
1990	Börcs	−	+	−	3	4.7	Mátics (1990)
1990	Marcelová (Marcelháza)	−	−	+	3	−	Protocol of SAV Staré Hory
1991	Gabčíkovo, Csóka	−	−	+	60	19.0	Krištofík (1999)
1992	Dolný Štál (Alistál)	−	−	+	1	1.0	Štollmann & Ambros (1998)
1992	Gabčíkovo (Bös)	−	−	+	1	17.0	Štollmann & Ambros (1998)
1992	Veľký Meder (Nagymegyer)	−	−	+	1	8.0	Štollmann & Ambros (1998)
1992	Ásványráró, Kucsérok	−	−	+	6	31.0	Mészáros F., Murai É., Gubányi A. & Kriska T.
1992	Kisbajcs, nádas	−	−	+	3	37.5	Mészáros F., Murai É., Gubányi A. & Kriska T.
1992	Dolný Štál (Alistál)	−	−	+	1	−	Protocol of SAV Staré Hory
1992	Veľké Kosihy (Nagykeszi)	−	−	+	1	1.0	A. Stollmann
1992	Sap (Szap)	−	−	+	1	25.1	Coll. VS Staré Hory
1992	Číčov (Csicsó)	−	−	+	7	5.0	Bukovský et al. (1993), Pecina (1994)
1992	Horný Bar, Bodíky	−	−	+	13	1.0	Krištofík (1999)
1992	Dunaj. Streda (Dunaszerdahely)	−	+	−	1	−	Noga & Obuch (2003)
1992	Martovce (Martos)	−	+	−	1	−	Noga & Obuch (2003)
1993	Sap (Szap)	−	+	−	1	−	Noga & Obuch (2003)
1993	Patince (Patpuszta)	−	+	−	1	−	Noga & Obuch (2003)
1993	Medveďov (Medve)	−	−	+	10	4.0	Krištofík (1999)
1993	Ásványráró, Kucsérok	−	−	+	1	33.0	Gubányi A.
1993	Ásványráró, Öntés-tó	−	−	+	4	57.0	Gubányi A.
1993	Lipót, falu határ, nádas	−	−	+	4	57.0	Mészáros F.
1994	Trstená na Ostrove (Nyárasd)	−	−	+	5	31.0	P. Pilinský & L. Brtek
1994	Zemianska Olča	−	+	−	1	−	Noga & Obuch (2003)
1994	Gabčíkovo	−	+	−	1	−	Noga & Obuch (2003)
1995	Ňárad (Nyárasd)	−	+	−	1	−	Noga & Obuch (2003)
1995	Ásványráró, Kucsérok	−	−	+	3	25.0	Gubányi A. & Mészáros F.
1995	Ásványráró, Kucsérok	−	−	+	1	11.0	Gubányi A., Mészáros F., Murai É., Matskási I. & Hajdu É.
1995	Horný Bar, Kráľovská lúka	−	−	−	1	1.4	P. Pilinský
1995	Kisbajcs, nádas	−	−	+	5	27.0	Mészáros F. & Gubányi A.
1995	Kisbajcs, nádas	−	−	+	2	25.0	Gubányi A.
1995	Lipót, Holt-Duna	−	−	+	3	19.0	Gubányi A., Mészáros F., Murai É., Matskási I. & Hajdu É.
1995	Nagybajcs, nádas	−	−	+	13	39.0	Gubányi A., Mészáros F., Murai É., Matskási I. & Hajdu É.

Table 1. (contiued)
Tab. 1. (pokračovanie)

year rok	locality lokalita	ST	P	T	n	F	reference refrencia
1996	Sap (Szap), ostrov Podkova	−	−	+	2	−	Facuna (1997)
1996	Horný Bar, Bodíky	−	−	+	1	−	Pilinský (1996)
1996	Číčov, Hamské tŕstie	−	−	+	2	1.0	A. Stollmann
1996	Nová Vieska, Arad	−	+	−	3	−	Noga & Obuch (2003)
1997	Kisbajcs, nádas	−	−	+	1	−	Gubányi A.
1997	Lipót, Holt-Duna	−	−	+	12	50.0	Gubányi A.
1997	Sap, Ercséd	−	−	+	6	2.3	Jedlička et al. (1987), Facuna (1997)
1997	Čalovec (Megyercs)	−	−	+	1	−	A. Stollman
1997	Čalovec (Megyercs)	−	−	+	5	−	Štollmann & Ambros (1998)
1997	Okoličná na Ostrove, Violin	−	−	+	6	21.0	Ambros et al. (1999)
1998	Lipót, Holt-Duna	−	−	+	29	65.0	Gubányi A. & Rácz G.
1998	Svätý Jur	−	+		1	−	Noga & Obuch (2003)
1999	Gbelce (Köbölkút) – Parížske močiare (Párás mocsár)	−	−	+	1	−	Ambros et al. (1999b, 2005)
1999	Nová Vieska, Arad pusta	−	−	+	1	2.0	Ambros et al. (1999a)
2000	Lipót, Holt-Duna	−	−	+	24	11.0	Gubányi A.
2000	Martovce (Martos)	−	−	+	4	10.0	Ambros et al. (2001)
2000	Martovce (Martos)	−	−	+	10	22.0	Ambros et al. (2001)
2001	Dunaszeg	−	−	+	2	9.0	Gubányi A.
2001	Lipót, Holt-Duna	−	−	+	35	17.0	Gubányi A.
2002	Lipót, Holt-Duna	−	−	+	8	38.0	Gubányi A.
2002	Gbelce (Köbölkút) – Parížske močiare (Párás mocsár)	−	−	+	2	9.0	Baláž et al. (2003)
2002	Marcelová (Marcelháza)	−	−	+	3	−	Lengyel et al. (2002)
2002	Nesvady (Naszvad)	−	−	+	3	14.0	Baláž et al. (2003)
2002	Kameničná (Keszegfalva)	−	−	+	17	10.0	Baláž et al. (2003)
2002	Čalovec (Megyercs)	−	−	+	1	2.0	Baláž et al. (2003)
2002	Komárno-Cserhát (Komárom)	−	−	+	1	1.0	Baláž et al. (2003)
2003	Lipót, Holt-Duna	−	−	+	73	77.0	Gubányi A.
2003	Iža (Izsa, Nagy Harcsás)	−	−	+	2	4.0	Baláž et al. (2003)
2004	Lipót, Holt-Duna	−	−	+	76	80.0	Gubányi A.
2004	Marcelová (Marcelháza)	−	−	+	9	−	Gubányi A & A. Stollmann
2005	Lipót, Holt-Duna	−	−	+	57	47.0	Gubányi A.
2006	Lipót, Holt-Duna	−	−	+	22	56.0	Gubányi A.
2006	Marcelová (Marcelháza)				5		M. Ambros & I. Baláž
2006	Martovce (Martos), Stará Nitra				4		Bridišová et al. (2006)
2006	Malý a Veľký Vék (Kis és Nagy Vék)				10		Bridišová et al. (2006)
2006	Chotín (Hetény), Fialkový potok				7		Bridišová et al. (2006)

situated north of Tata, or in a known locality of *M. oeconomus* in Slovakia, named Izsa. Taking into consideration the above-mentioned facts, this report must be considered as an erroneous or unreliable record.

(5) Since the original inventory records by B. Edelényi (1974) on the parasitological investigation of *M. oeconomus* is no longer available, we reviewed the published data and matched it with the number of specimens listed in the catalogue of HNHM.

In conclusion, the distribution of *M. oeconomus* along the river Danube is – according to currently available data (Table 1) – restricted to the middle sections of the river. The known localities were found only in protected areas, such as Nature reserves or Landscape Protection Areas in Hungary. In contrast, only some 70% of the root vole habitats are under protection in Slovakia and the remaining 30% seem to have been left without an appropriate level of conservation.

Records acquired before 1999 are most valuable from a faunistic point of view while the applied methodologies were not suitable for appropriate evaluation of temporal or spatial dynamics of *M. oeconomus* populations.

Summing up these findings and experiences accumulated in the course of long-term faunistic studies by various authors, Mehelyi's root vole populations were affected by the following factors: (1) fragmentation and decrease of suitable habitats; (2) effects of water supply on the condition of reed-beds and large sedge communities; (3) harvesting of reed-beds, problems with habitat conservation plans; and (4) random anthropogenic effects.

(1) Fragmentation and decrease of suitable habitats. Aqueous habitats have shrunk considerably on both sides of the River Danube, a process best indicated by the fragmentation of large sedge communities, particularly on the Hungarian side. The findings of NBMS, as well as data reported by others, confirmed that root vole populations could survive only in specific habitats. Large sedge communities and reed-beds developed from freshwater marshland by siltation are characteristic features of these sites. The most prevalent components include the following plant species: *Carex acutiformis*, *Carex elata*, *Phalaris arundinacea*, *Phragmites australis*, *Calamagrostis epigeios*, *Cirsium arvense Lycopus europeus*, *Deschampsia cespitosa*, *Lythrum salicaria*, *Lysimachia vulgaris*, *Typha latifolia*, *Sium latifolium*, *Mentha aquatica*, *Potentilla anserina*, *Caltha palustris*, *Lysimachia nummularia*, *Iris pseudacorus*, *Symphytum nigrum*, *Vicia cracca*, *Salix cinerea*.

(2) Effects of water supply on reed-beds and large sedge communities. In territories where root vole populations have been found, ruderal plant communities with higher soil-nitrogen levels have appeared as a consequence of mineralization induced by aridity. Simultaneously with the decline of stocks of reed-beds and sedges, a significant increase in the number of plant species of lowland mesotrophic meadows has also been observed. Finally, the driest areas are populated mainly by *Solidago gigantea* rendering these areas unsuitable for *M. oeconomus*.

At the same time, the permanent and extreme artificial flooding of reed-beds and non-tussock beds of large sedges may lead to dramatic thinning in the sedge patches. In addition, early spring flooding may also increase predation on *M. oeconomus*. Voles find refuge from high water on top of tussock sedges where they can be easily caught by predatory birds. Figures 2 and 3 show changes in population sizes of *M. oeconomus* in dry and wet reed beds.

Experience shows that a suitable water level is crucial for *M. oeconomus*. Optimum habitats (large sedge communities) are covered by a few centimetres of water in the spring and early summer weeks. Contrary to this, permanently high (20–30 cm) water levels throughout the vegetative season in non-tussock beds of large sedge seems to create unsuitable habitats for root vole populations.

(3) Harvesting of reed-beds, problems with habitat conservation plans. Among habitat conservation management practices carried out at various areas, clear-cut harvesting of reed-beds

is one of the most damaging treatments. In open surface areas without any natural refuge *M. oeconomus* populations may have a dramatically reduced chance of survival. Another practice, frequent mowing in patches between reed beds and meadows may eradicate *Carex* spp., the root vole's preferred food source.

(4) Random anthropogenic effects. Reed beds and sedge communities, crucial requirements for maintaining small mammal populations, sometimes suffer from such dramatic human impact as caused by controlled burning. Mention must be made of the damaging practice of storing harvested reed stalks in strictly protected areas, thereby fostering the growth of weeds. Combined effects of different treatments, for instance full-reaping along with permanently high water level in reed-beds (Hungary, Szigetköz), could also have an enormous influence on small mammalian communities.

As a consequence of cultivation or aridification of their original habitats, *M. oeconomus* has disappeared from several localities in the last two decades. For example, areas where the species does not occur any longer are Gabčíkovo, Velký Meder, Dunasziget, Kisbajcs). This species can

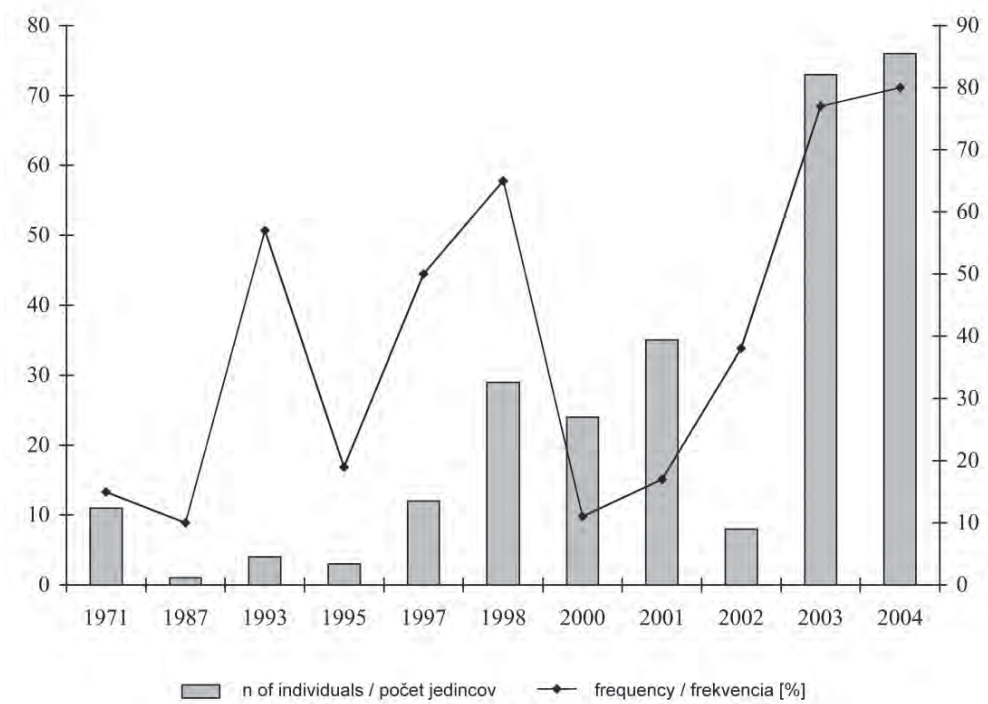

Fig. 2. Sample size (left axis) and value of frequency (right axis) within small mammal community of *Microtus oeconomus* in a wet reed bed (Hungary, Szigetköz, Lipót) between 1971 and 2004.
Obr. 2. Veľkosť vzorky (ľavá os) a frekvencia (pravá os) *Microtus oeconomus* v spoločenstve drobných zemných cicavcov vo vlhkých trstinách (Maďarsko, Szigetköz, Lipót) v období od 1971 do 2004.

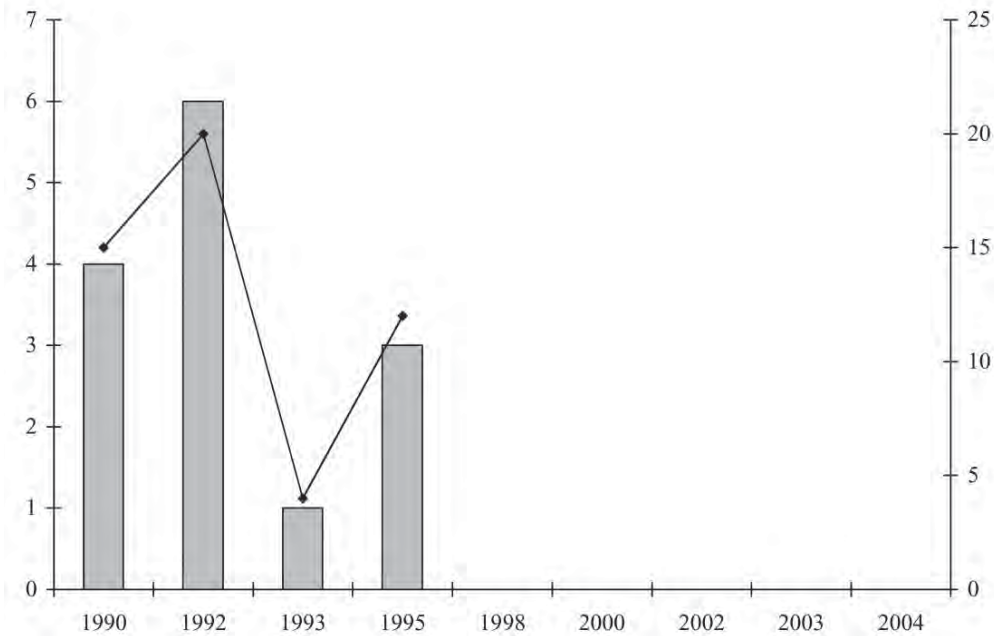

Fig. 3. Sample size (left axis) and value of frequency (right axis) within small mammal community of *Microtus oeconomus* in a drying reed bed (Hungary, Szigetköz, Ásványráró) between 1971 and 2004 (for legend see Fig. 2).
Obr. 3. Veľkosť vzorky (ľavá os) a frekvencia (pravá os) *Microtus oeconomus* v spoločenstve drobných zemných cicavcov vo vysychajúcich porastoch trstiny (Maďarsko, Szigetköz, Ásványráró) v období od 1971 do 2004 (vysvetlivky pozri v obr. 2).

survive in small habitat fragments in Slovakia (e.g. Dobosfenék) while the Danube's floodplain in Hungary provides suboptimal habitats for long term survival of populations.

In order to save *M. oeconomus* populations – a species listed in the Habitat Directive – the following treatments should be included in complex local conservation plan:

(1) A SCHEDULE FOR THE HARVEST OF REED-BEDS. Reeds should be harvested every year between the 1st of January and the 28th of February. Approximately half a hectare of the given area should be left intact every year. In contrast to the current practice, harvested reeds stalks should be stored outside of the protected areas.

(2) TREATMENTS OF TUSSOCK SEDGE AND LARGE SEDGE COMMUNITIES, BORDERS OF REED BEDS, LOWLAND MEADOWS. Treatment of tussock sedge communities is a difficult task because using human labour seems to be the only feasible method. Mowing once a year at the end of the vegetative season and cutting tussocks occasionally using a specialized traditional tool are acceptable in practice. Following harvest, all dry residues should be cleared from the area. Large sedge communities are always wedged between lowland mesotrophic meadows and reed beds. The above mentioned process can be recommended for tussocks as well, once a year, in the second half of July. Rotary scythe may be used for harvesting, but the horizontal position of the scythes must be set 25 to

30 cm above the soil surface. Marginal parts of reed-beds are usually overgrown by *Solidago gigantea*, an undesirable element of this habitat. Giant goldenroot should also be cut before blossoming. At the same time, for prevention and/or retardation of natural successive processes in the habitats of large sedge communities grubbing of bushes is also recommended.

(3) Operation and treatment of channels and ditches with a view to conservation. Regular dredging of channels as part of maintenance should also include removing grabbed sludge from the area. During the vegetative season the mowing of dams overgrown by weeds is recommended at least three times.

(4) Regulation of hunting, fishing and agricultural activities in the territories. The long-term hunting development strategy for reed-beds should include an action plan for the reduction of big game stocks. In addition to the general disturbance of fragmented habitats by wild boar, frequent rooting may reduce the size of *M. oeconomus* populations since boars often prey on voles. For this reason, a significant decrease in wild-boar populations would be desirable for relevant areas. Although the feeding of game stocks is a generally accepted custom among game wardens, to better protect root vole populations this practice should be strictly prohibited in areas of concern, particularly in the vicinity of reed beds. In view of the current condition of lowland meadows, grazing and other animal husbandry activity is not recommended in areas covered by our studies.

SÚHRN

Microtus oeconomus mehelyi Éhik, 1928 je najvzácnejší poddruh hraboša severského v strednej Európe. Jeho populačný pokles opodstatnil ustanovenie striktnej ochrany taxónu na Slovensku od roku 1965, v Maďarsku od roku 1974. Hraboš severský Méhelyiho sa uvádza aj v Prílohe III Bernskej konvencie ako aj v prílohách Smernice o habitatoch (HD2). Považuje sa za glaciálny relikt a jeho aktuálne výskyty ohraničujú najjužnejší areál tohto holoarktického druhu v Európe. Napriek potrebe ochrany, základné výskumné aktivity venované tomuto druhu sa začali len v ostatných rokoch. Autori na základe literárnych ako aj vlastných terénnych údajov revidovali rozšírenie hraboša severského Méhelyiho v povodí rieky Dunaj (Szigetköz, Žitný ostrov). V článku sa navrhuje potenciálna stratégia ochrany súčasných populácií a ich habitatov.

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