Vespertilio 11: 57–64, 2007
ISSN 1213-6123

Bat assemblage of an old pastured oak woodland (Gavurky Protected Area, central Slovakia)

Peter Kaňuch[1] & Martin Ceľuch[2]

[1] *Institute of Forest Ecology SAS*, *Štúrova 2*, *960 53 Zvolen*, *Slovakia*; *kanuch@netopiere.sk*
[2] *Slovak Bat Conservation Society*, *P. O. Box 10A*, *940 01 Nitra 1*, *Slovakia*; *mato@netopiere.sk*

Abstract. Here we summarize composition and analyze structure of bat assemblage in pastured woodland (200–300 years old oaks) of Gavurky Protected Area. Non-systematic data collection (from April to September 2001–2007) used mainly mist-netting, supplemented by harp-trapping and sporadically by bat-detectors. Altogether, 12 bat species and 432 individuals were recorded in the area. The most frequently mist-netted species (n=288) were *N. noctula* (67.9%), *M. nattereri* (57.1%), *N. leisleri* (53.6%), *M. bechsteinii* (50%) and *B. barbastellus* (39.3%). Tree-dwelling species were faithful to their area after two or even four years (n=333 banded bats). In total 19 tree roosts of *M. bechsteinii* (n=7), *N. noctula* (6), *N. leisleri* (4), *M. nattereri* (1), *B. barbastellus* (1) and *P. auritus* (1) were found there, including maternity roosts of *M. bechsteinii*, *M. nattereri*, *N. leisleri* and *B. barbastellus*.

Bats, trees, tree-hollows, mist-netting

Introduction

Human-modified artificial tree stands have various characteristics and functions. One of them is semi-shaded pasture for cattle which offers open deciduous forest (e. g. Manning et al. 2006). Old pastured woodland habitat disappeared during the last decades due to changes in farming and land use and became endangered in Slovakia. Oak pastured woodlands, so called Pannonian woodlands, occur mostly in the southern part of the country. Scattered trees of a similar age (more than one hundred years), are the main habitat feature in stark contrast to conventional (natural or managed) forest conditions. Generally, old trees in farmland are important for bats as foraging and roosting sites (e. g. Holmes 1996, Entwistle et al. 2001).

Very poor knowledge about animal diversity of presented habitats (e. g. Krištín et al. 1995) was a challenge for the study of bats as tree dwellers there. The first information about bats in an old pastured woodland – Gavurky (central Slovakia) comprised only the one species *Myotis myotis* (moreover with question mark, Krištín et al. 1995). Later on, during a one year study, 10 bat species (*Myotis myotis*, *Myotis bechsteinii*, *Myotis nattereri*, *Myotis mystacinus*, *Myotis daubentonii*, *Nyctalus noctula*, *Nyctalus leisleri*, *Plecotus auritus*, *Plecotus austriacus* and *Barbastella barbastellus*) were mist-netted at this site (Kaňuch & Krištín 2005). Other ecological and behavioural research on *Nyctalus leisleri* (Kaňuch et al. 2005) and *N. noctula* (Kaňuch 2007) have now been conducted there. The aim of this paper is to summarize the composition and to analyze the structure of bat assemblage living in the Gavurky Protected Area.

Study Area

Gavurky Protected Area is pastured woodland ca. 2 km westward from the Dobrá Niva village (Pliešovská kotlina Basin; 48° 28’ N, 19° 08’ E; 470 m a. s. l.). Target habitat covers around 70 ha of plain area. Our study area represents only the

Fig. 1. Old oaks (mainly *Quercus robur*) in the Gavurky Protected Area (Pliešovská kotlina Basin, central Slovakia) provide plenty of natural roosts for bats (photo by P. Kaňuch).
Obr. 1. Staré duby (hlavne *Quercus robur*) v Chránenom areály Gavurky (Pliešovská kotlina, stredné Slovensko) poskytujú množstvo prirodzených úkrytov pre netopiere (foto P. Kaňuch).

southern part of ca. 40 ha. The history of its origin is not clear but in the past the locality was used as managed forest-park with pasture, and later as a training military area by the Soviet army (up to 1989). Since 1997 it has been protected under the national law with conservation management (cattle pasture and anti-succession management of pioneer tree species). Nowadays, the area is a proposed Site of Community Importance (according to Habitat Directive of EU). Habitat is characterised by several species of 200–300 years old oaks (*Quercus robur* group) and turkey oak (*Quercus cerris*). Massive trees (12–18 m high, 100–220 cm diameter at breast height) have a lot of natural (rot), woodpecker and artificial (man-made burn-out) tree-hollows (Fig. 1). Partially dry and broken boughs or loose bark occur in nearly all the trees. Some of them are in the fatal stages of decay. Canopy closure is very low and trees often grow solitarily (mean 4.3±2.1 tree per 0.1 ha). In some parts the overgrowing of pioneer species, namely rose (*Rosa canina*), haw (*Crataegus laevigata*) and birch (*Betula pendula*), is noticeable. Other fauna worth mentioning are a small colony of sousliks (*Spermophilus cittelus*), large endangered beetles (*Cerambyx cerdo*, *Oryctes nasicornis*, *Osmoderma eremita*) as well as bird species of Mediterranean origin (*Otus scops*, *Upupa epops*, *Merops apiaster*) breeding there (see also Krištín et al. 1995).

Methods

Non-systematic data collection was implemented from April to September (2001–2007). The most frequently used method was the mist-netting, supplemented by trapping bats in harp-traps (made by Gaisler et al. 1979) during their evening emergence from tree-hollows. The location for netting was a water pit (10×25 m) located in the central part of the area

(Fig. 2). The bats were usually mist-netted (nets 7–14 m in length) up to midnight. Altogether 61 day visits (including 28 mist-netting sessions) were conducted in the area. Since 2003 all caught individuals (with some exceptions) were banded using incoloy chiropterological rings. Most occupied tree roosts were found before sunrise, as bats swarmed round the tree before they entered the hollows or during the day by listening to vocal calls that roosting bats made (for details of methods see Kaňuch 2005, 2007). The location of roosts of *Myotis bechsteinii* (in 2007) was done using radio-telemetry equipment (Kaňuch et al. in prep.). During the survey we also sporadically used ultrasound bat-detectors (Pettersson D200, D240x). Frequency of occurrence (F) and species dominance (d) were used for analysis of the assemblage structure.

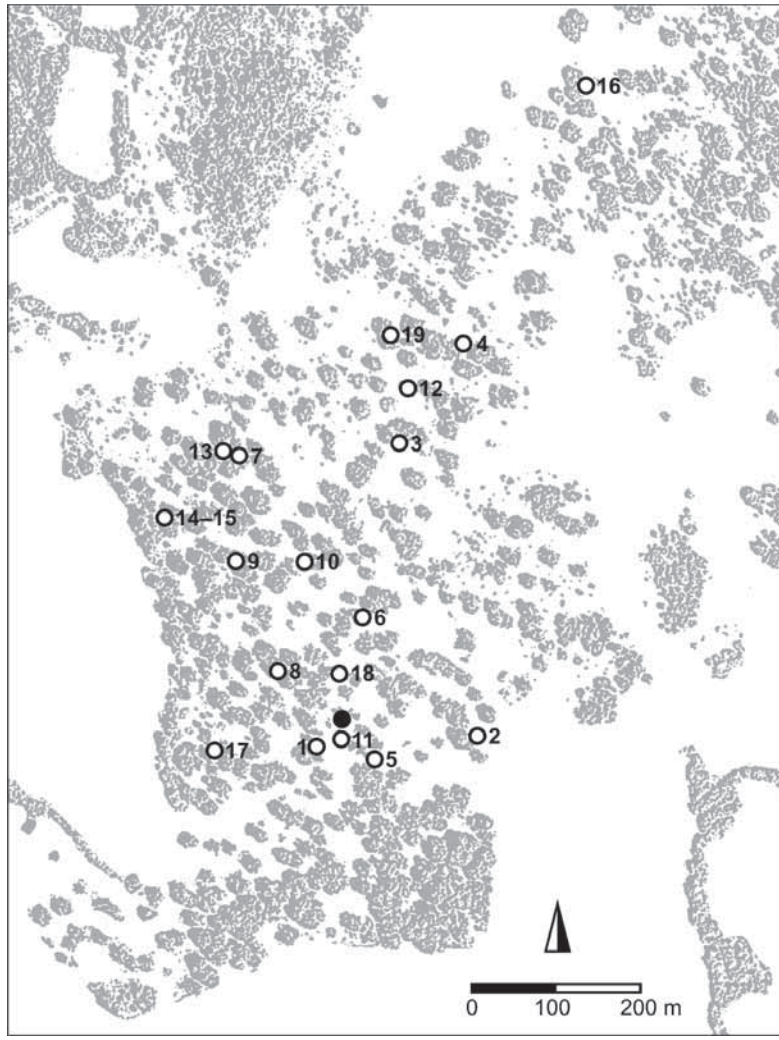

Fig. 2. Study area of pastured oak woodland in the Gavurky Protected Area (grey – trees canopy, circles – tree-hollows of bats, black dot – mist-netting water pit).
Obr. 2. Sledované územie pasienkového dubového lesa v Chránenom areály Gavurky (sivá – koruny stromov, krúžky – stromové dutiny netopierov, plný krúžok – vodná jama, miesto odchytov do siete).

Table 1. Material of recorded bat species in the Gavurky Protected Area, presented in sex and age categories as well in methods of collection
Tab. 1. Zistené druhy netopierov v Chránenom areály Gavurky, zobrazené v pohlavných, resp. vekových kategóriách a podľa metódy zberu dát

species / druh	category / kategória (n)			total / celkom	method / metóda (%)		
	females samice	males samce	juveniles mláďatá	(n)	mist-net sieť	harp-trap harf. pasca	bat-detector detektor
N. leisleri	122	7	24	153	39.9	60.1	–
N. noctula	24	70	3	97	99.0	1.0	–
M. bechsteinii	38	3	10	51	41.2	58.8	–
M. nattereri	43	2	6	51	64.7	35.3	–
M. myotis	14	9	2	25	100.0	–	–
B. barbastellus	11	6	4	21	100.0	–	–
P. auritus	8	6	1	15	100.0	–	–
E. serotinus	2	6	–	8	100.0	–	–
M. mystacinus	3	3	–	6	100.0	–	–
M. daubentonii	1	–	–	1	100.0	–	–
P. austriacus	1	–	–	1	100.0	–	–
P. pipistrellus	–	–	–	3	–	–	100.0
Σ spp. / druhy	267	112	50	432	66.8	32.7	0.5

Results and Discussion

Using combined methods, 12 bat species (39% of Slovak fauna) were recorded in the Gavurky Protected Area; *M. myotis*, *M. bechsteinii*, *M. nattereri*, *M. mystacinus*, *M. daubentonii*, *Eptesicus serotinus*, *Pipistrellus pipistrellus*, *N. noctula*, *N. leisleri*, *P. auritus*, *P. austriacus* and *B. barbastellus* (Table 1). Altogether 432 individuals were recorded. Mist-netting produced the most of data (66.2%). Harp-trapping efficiency was subjective affected by our topic species (*N. leisleri*, *M. bechsteinii*, *M. nattereri*). The most frequently mist-netted species were *N. noctula* (F=67.9%), *M. nattereri* (57.1%), *N. leisleri* (53.6%), *M. bechsteinii* (50%) and *B. barbastellus* (39.3%). Ranking in the species dominance of netted material slightly varied in comparison to the frequency (Fig. 3). The most abundant species again was *N. noctula* (d=33.3%), followed by *N. leisleri* (21.2%), *M. nattereri* (11.5%), *M. myotis* (8.7%), *M. bechsteinii* and *B. barbastellus* (both 7.3%). In comparison to one-year results there (Kaňuch & Krištín 2005), it can be hypothesised that 7–10 mist-netting sessions can produce a representative description of foraging bat assemblage. The rarest species in the area are *M. daubentonii* and *P. austriacus* for which the habitat is not typical (Table 1). In addition to 11 hand-held bat species we also recorded several ultrasound signals (in time-expansion) to identify other species. *Pipistrellus pipistrellus* were identified by this method (30 May, 19, 30 June 2007). Confirmation of this species by mist-netting or location of roosts is required. We suppose that the last three species probably only transmigrate through the area.

Regarding the total frequency of bat occurrence in natural central European forest conditions (Kaňuch et al. in press), open forest habitat (i.e. pastured woodland) had a different structure of assemblage. The very common occurrence of tree-dwelling (even gleaning) species *M. nattereri*, *M. bechsteinii* and *N. leisleri* contrasts with the most frequently (F=57–31%) mist-netted forest species (*M. mystacinus*, *M. myotis*, *B. barbastellus*, *P. auritus*, *N. noctula* and *Myotis brandtii*). In spite of open stand, we suggest that the amount of potential tree roosts supports the unusual structure of this bat assemblage. On the basis of re-captured individuals it is possible to evaluate site fidelity of some species. We can conclude that tree-dwelling species could be faithful to

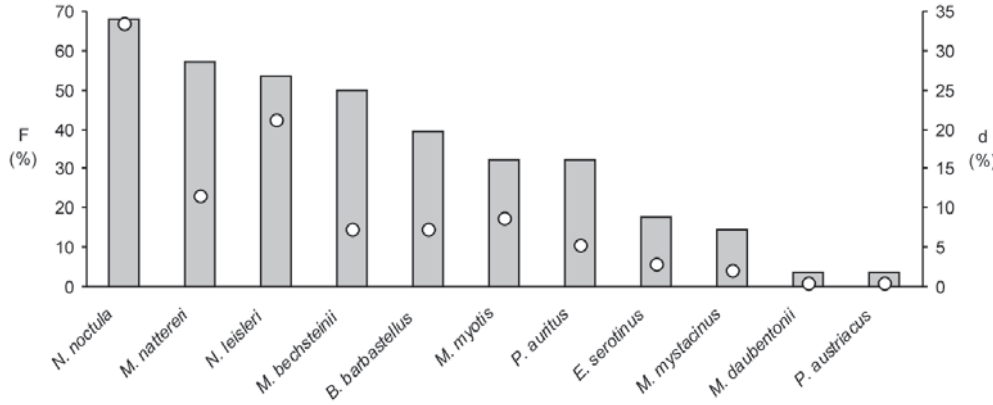

Fig. 3. Frequency of occurrence (F, columns) and species dominance (d, circles) of mist-netted bats (n=28 mist-nettings and 288 bats).
Obr. 3. Frekvencia výskytu (F, stĺpce) a druhová dominancia (d, krúžky) do siete odchytených netopierov (n=28 odchytov a 288 netopierov).

their area also after two or even four years (Table 2). However, higher fidelity is resulted in total number of banded individuals (*N. leisleri*), intensive harp-trapping (*M. bechsteinii*, *N. leisleri*) and species ecology (sedentary males of *N. noctula*). Paradoxically, only one male of *N. noctula* was re-captured outside the area, in Zvolen (16 km away from Gavurky, for details see Ceľuch & Kaňuch 2005).

In total 19 tree roosts (Fig. 2) of six species were found in the area; *M. bechsteinii* (n=7), *N. noctula* (6), *N. leisleri* (4), *M. nattereri* (1), *B. barbastellus* (1) and *P. auritus* (1). Two of them were occupied by two species (*N. noctula*, *N. leisleri*) as solely time-independent colonies (hollow 4). Some male *N. noctula* bats shared a roost with a maternity colony of *N. leisleri* (hollow 5). Five tree-hollows were occupied for at least two years (Table 3). Roosts were originated mostly by woodpecker (often rotted internally) and located in trunks (Fig. 4). Only roosts of *B. barbastellus* (females with young) and *P.* cf. *auritus* (composition unknown) were located under the bark. One temporary *M. bechsteinii* roost was found in a crevice. Aspect and height varied markedly. The most numerous colonies comprised *N. leisleri* (more than 90 individuals sometimes; for more

Table 2. Site fidelity of recaptured bat species during five years of banding
Tab. 2. Vernosť netopierov lokalite počas piatich rokov krúžkovania

species druh	total celkom (%)	recaptures after 0–4 years (%) spätné odchyty počas 0–4 rokov (%) 0	1	2	3	4	banded krúžkované (n)
M. bechsteinii	42.2	40.0	2.2	–	–	–	45
N. noctula	29.8	17.5	12.3	–	–	–	57
N. leisleri	28.7	10.5	12.6	5.6	–	–	143
B. barbastellus	15.4	7.7	–	–	–	7.7	13
P. auritus	10.0	–	–	–	10.0	–	10
M. nattereri	4.8	–	–	4.8	–	–	42
Σ spp. / druhy	24.6	–	–	–	–	–	333

Table 3. Roost features and characteristics of tree-hollow colonies (for location see Fig. 2) in the Gavurky Protected Area (wp – woodpecker, ub – under bark, cr – crevice, b – bough, t – trunk, r – breeding colony, n – non-breeding colony, m – males, ? – unknown)
Tab. 3. Parametre úkrytov a charakteristiky kolónií v stromových dutinách (polohu pozri v obr. 2) nájdených v Chránenom areáli Gavurky (wp – po ďatľovi, ub – pod kôrou, cr – puklina, b – konár, t – kmeň, N – sever, S – juh, W – západ, E – východ, r – reprodukčná kolónia, n – nereprodukčná kolónia, m – samce; ? – nezistené

hollow dutina	origin, position pôvod a pozícia	aspect orientácia	position výška (m)	species druh	no. of bats počet netopierov	status typ kolónie	years roky
1	wp, b	N	9.0	*N. noctula*	1–9	m	2002, 2005
2	wp, t	NW	9.0	*N. noctula*	5	m	2002
3	wp, t	N	8.5	*N. noctula*	1	m	2002
4	wp, t	S	5.5	*N. noctula*	30–41	n	2002
				N. leisleri	52–96	r	2005, 2006
5	wp, t	E	5.0	*N. noctula*	1–4	m	2003, 2005
				N. leisleri	47–67	r	2003, 2005
6	wp, t	E	5.0	*M. nattereri*	20	r	2005
7	ub, t	SW	9.0	*B. barbastellus*	10–34	r	2005, 2007
8	wp, t	E	8.0	*N. leisleri*	80	r	2005
9	wp, t	S	8.0	*N. leisleri*	15	r	2005
10	wp, t	N	6.0	*N. noctula*	5	m	2005
11	ub, b	S	9.0	*Plec.* cf. *auritus*	?	?	2005
12	wp, t	E	7.0	*Myotis* sp.	?	?	2005
13	wp, b	W	2.5	*M. bechsteinii*	10–27	r	2007
14	wp, t	W	10.0	*M. bechsteinii*	10–15	r	2007
15	wp, t	SE	9.0	*M. bechsteinii*	11	r	2007
16	cr, t	SE	2.5	*M. bechsteinii*	2	n	2007
17	wp, t	E	10.0	*M. bechsteinii*	10–18	r	2007
18	wp, t	E	8.0	*M. bechsteinii*	11–12	r	2007
19	wp, t	N	9.0	*M. bechsteinii*	15	r	2007

see Kaňuch et al. 2005). Larger groups of *N. noctula* consisted of migrating individuals in late summer. Up to present, findings of maternity roosts of some tree-dwelling bats are very rare (*M. bechsteinii* – Sklenář 1981, *M. nattereri* – Kaňuch 2005) or none (*B. barbastellus*), respectively; in spite of their common occurrence in forests in Slovakia (Kaňuch et al. in press).

The interesting bat assemblage occurring in the Gavurky Protected Area is a consequence of the unique habitat character. Predominantly tree-dwelling species which occur in relatively numerous populations are vitally dependent on roost site supply. Regardless of unpredictable disasters (e.g. a thunderstorm in August 2007 damaged numbers of trees), only active conservation management can guarantee the future of this beautiful site (cf. Manning et al. 2006).

Acknowledgements

For the field assistance and friendly accompaniment we thank to (in alphabetical order) P. Baláž, P. Benda, N. Dietrich, T. Hahner, A. Krištín, B. Kršiak, S. Miethaner, A. Mišalová, J. Piško, M. Sárossy, L. Strasser, M. Veľký, I. Záhradníková,

>>

Fig. 4. Tree roosts of *Barbastella barbastellus* (A), *Nyctalus leisleri* (B), *Myotis nattereri* (C) and *Myotis bechsteinii* (D) in the Gavurky Protected Area (photo by P. Kaňuch).
Obr. 4. Stromové úkryty druhov *Barbastella barbastellus* (A), *Nyctalus leisleri* (B), *Myotis nattereri* (C) a *Myotis bechsteinii* (D) v Chránenom areáli Gavurky (foto P. Kaňuch).


A
B
C
D

members of the Working Field Group VZZ (The Netherlands) and Cumberland Bat Group (UK). We are indebted to S. Phillips for providing linguistic proof. This study was partly supported by VEGA agency (grants No. 2/6007/03 and 2/5152/25).

Súhrn

Spoločenstvo netopierov starého dubového hája (Chránený areál Gavurky, stredné Slovensko). V práci zhŕňame údaje o druhovom zložení a analyzujeme štruktúru spoločenstva netopierov pasienkového lesa (200–300 ročné duby) v Chránenom areály Gavurky. Nesystematický zber dát (od apríla do septembra 2001–2007) sa sústredil najmä na odchyt do sietí, doplnený o odchyt do harfových pascí prípadne použitie bat-detektorov. Celkovo bolo zistených 12 druhov (432 jedincov). K najčastejšie do siete odchytávaným (n= 288) druhom patrili *N. noctula* (67,9 %), *M. nattereri* (57,1 %), *N. leisleri* (53,6 %), *M. bechsteinii* (50 %) a *B. barbastellus* (39,3 %). Vernosť stromových druhov k územiu bola zistená od 2 do 4 rokov (n=333 okrúžkovaných netopierov). Spolu bolo na lokalite nájdených 19 stromových úkrytov *M. bechsteinii* (n=7), *N. noctula* (6), *N. leisleri* (4), *M. nattereri* (1), *B. barbastellus* (1) a *P. auritus* (1). Reprodukčné úkryty boli zistené pri *M. bechsteinii*, *M. nattereri*, *N. leisleri* a *B. barbastellus*.

References

Ceľuch M. & Kaňuch P., 2005: Winter activity and roosts of the noctule (*Nyctalus noctula*) in an urban area (Central Slovakia). *Lynx*, *n. s.*, **36**: 39–45.

Gaisler J., Hanák V. & Dungel J., 1979: A contribution to the population ecology of *Nyctalus noctula*. *Acta Sci. Natur. Brno*, **13** (1): 1–38.

Holmes M., 1996: Ancient trees – their importance to bats. Pp.: 69–70. In: Read H. J. (ed.): *Pollard and Veteran Tree Management II*. Corporation of London, London, 258 pp.

Entwistle A. C., Harris S., Hutson A., Racey P., Walsh A., Gibson S., Hepburn I. & Jonhston J., 2001: *Habitat Management for Bats. A Guide for Land Managers, Land Owners and Their Advisors*. The Joint Nature Conservation Committee, London, 48 pp.

Kaňuch P., 2005: Roosting and population ecology of three syntopic tree-dwelling bat species (*Myotis nattereri*, *M. daubentonii* and *Nyctalus noctula*). *Biologia*, *Bratislava*, **60**: 579–587.

Kaňuch P., 2007: Evening and morning activity schedules of the noctule bat (*Nyctalus noctula*) in Western Carpathians. *Mammalia*, **71**: 126–130.

Kaňuch P. & Krištín A., 2005: Factors influencing bat assemblages in forest parks. *Ekológia* (*Bratislava*), **24**: 45–56.

Kaňuch P., Krištín A. & Krištofík J., 2005: Phenology, diet, and ectoparasites of Leisler's bat (*Nyctalus leisleri*) in the Western Carpathians (Slovakia). *Acta Chiropterol.*, **7**: 249–258.

Kaňuch P., Danko Š., Ceľuch M., Krištín A., Pjenčák P., Matis Š. & Šmídt J., in press: Relating bat species presence to habitat features in natural forests of Slovakia (Central Europe). *Mammal. Biol.*

Krištín A., Urban P., Manica M., Háberová I., Kulfan J., Bozalková I., Stolár M., Šušlík V. & Janičina P., 1995: Hodnotenie lokalít Lešť a Gavúrky – geologická charakteristika, biotické zložky. Pp.: 87–109. In: Liška M., Roložník M., Háberová I., Krištín A., Haršáni L. & Burda P. (eds.): *Biodiverzita a ochrana prírody v oblastiach využívaných bývalou sovietskou armádou v Slovenskej republike*. Svetová únia ochrany prírody, Bratislava, 127 pp.

Manning A. D., Fischer J. & Lindenmayer D. B., 2006: Scattered trees are keystone structures – Implications for conservation. *Biol. Cons.*, **132**: 311–321.

Sklenář J., 1981: Nález kolonie netopýra velkouchého (*Myotis bechsteini*) v Nízkych Tatrách. *Biológia*, *Bratislava*, **36**: 1057–1059.

došlo 31. 10. 2007