

Expansion range of the golden jackal in Hungary between 1997 and 2006

László Szabó¹, Miklós Heltai¹, Eleonóra Szűcs^{2,*}, József Lanszki³ and Róbert Lehoczki¹

¹ Institute for Wildlife Conservation, Szent István University, Páter K. u. 1, 2103 Gödöllő, Hungary

² Department of Zoology, Mammal Collection, Hungarian Natural History Museum, Ludovika tér 2, 1083 Budapest, Hungary, e-mail: szucs@nhmus.hu

³ Department of Nature Conservation, University of Kaposvár, P.O. Box 16, Kaposvár 7401, Hungary

*Corresponding author

Abstract

The golden jackal (*Canis aureus*), an indigenous predator of Hungary, is listed in the Hungarian Red Data Book as an extinct species because it had disappeared from the country by the beginning of the 20th century. In the 1990s a repatriation process was started in the southern part of Hungary. To monitor the presence of jackals and/or population changes countrywide, a questionnaire survey was mailed to Hungarian game management units (GMUs) between 1997 and 2006. Proof specimens, field observations and hunting bag data were also analysed. During the study period approximately 100 proof specimens were identified. According to official hunting bag data, the number of bags reported has continuously increased for 10 years, with 11 jackals shot in 1997 and a total of 163 specimens shot up to 2006 (linear regression, $R^2=0.949$, $p<0.0001$), which is in parallel with the four animals reported by GMUs in 1997 and the total of 67 up to 2006 (linear regression, $R^2=0.983$, $p<0.0001$). Detection of animals and their signs proves the continuous presence and the existence of stable populations of the species. Independent data collection and analysis confirmed that golden jackals have settled in Hungary. The rate of expansion and population growth are typical of invasive species.

Keywords: Canidae; distribution; occurrence; proof specimen; spreading.

Introduction

In Europe, the golden jackal (*Canis aureus* Linnaeus, 1758) is considered a resident species in the Caucasus, Turkish Thrace, Bulgaria, Albania and on the eastern coast of the Adriatic Sea (Mitchell-Jones et al. 1999, Macdonald and Sillero-Zubiri 2004, IUCN 2007). Recent observations are increasing in Serbia (Milenkovic and Paunovic 2003), Slovakia (Hell and Rajsky 2000), Romania (Kiss 2000) and Ukraine (Rozhenko and Volokh 2000). Jackals are occasionally observed in Slovenia, north-

eastern Italy, Austria (Mitchell-Jones et al. 1999) and Germany (Reinhard 2000). In Greece the jackal population was considerable in the past (Demeter and Spassov 1993), but now – mainly because of habitat destruction – it is by far the rarest canid there (Giannatos and Ioannidis 1991, Karandinos 1991, Giannatos et al. 2005).

Population growth, losses and returns characterise the status of the golden jackal in the Balkans (Genov and Vassilev 1991, Demeter and Spassov 1993, Krystufek et al. 1997). The species was sporadically observed in Macedonia (Milenkovic 1983, 1987, Krystufek and Petkovski 1990) and a stable population was living in Dalmatia (Krystufek and Tvrkovic 1990). Jackals emerged on the coast of Albania (Atanassov 1953) and were present in Croatia. They have wandered into Istria and are spreading in a north-western direction (Krystufek and Tvrkovic 1990).

Until the end of 19th century the jackal was a common native predator living in bushy and wetland areas of Hungary. Presumably it was changes in their natural habitat and persecution of mammal predators that caused the decrease in populations (Demeter and Spassov 1993). In the 1980s occurrences of only young males were proved (Demeter 1984). The Hungarian Red Data Book (Rakonczay 1989) declared the species extinct. Immigrants have been arriving in the south-west since the beginning of the 1990s (Heltai et al. 2000). The population seems to be mainly stable in this region (Heltai et al. 2007). Environmental factors in the Pannonian biogeographic region of Hungary are similar to those in other European regions to the north and west, but particular reasons for population changes are not clear. For a well-founded population plan, more knowledge is needed on the spreading and ecology of the species.

Here, as part of a larger study, our aims were to develop a monitoring system, to follow the spreading, settlement process and distribution area of the species in Hungary, and to identify its population status by collecting field proof data.

Materials and methods

Mail questionnaire and data processing

Data on the distribution and occurrence of the golden jackal in Hungary were collected by mail questionnaires on an annual basis between 1997 and 2006. Data were based on the voluntary responses of Game Management Units (GMUs). Questions were asked about the occurrence of the species (presence or absence) and whether the presence was stable or occasional. The data received were recorded using Paradox 8 and Quattro Pro 11.0 database programs (Corel Corporation, Ottawa, Canada).

The GMU areas cover the whole country. According to the European Mammal Mapping (Mitchell-Jones et al. 1999), 10 km×10 km units of the universal transverse mercator (UTM)-based distribution map are appropriate for revealing the maximum distribution area of the jackal.

Hunting bags and proof specimens

We compared the results of the questionnaire with country bag data from the Hungarian Game Management Database (Csányi 1998–2007). When processing and evaluating input information from the mail questionnaire, data from respondents who recorded the appearance, occurrence or stable population of jackals in their region were marked. These marked respondents were then asked to send or present proof. Carcasses of shot specimens, photographs of hunting bags, prepared furs and skulls were collected starting in 1999. Whole carcasses, furs, skulls and photographs were identified on the basis of typical external signs (e.g., colour pattern, hair characters; Macdonald and Sillero-Zubiri 2004) of the fur, and partial symphysis of the middle fingers (Demeter and Spassov 1993). Skull identification was carried out according to the descriptions of Demeter and Spassov (1993) and Hell and Bleho (1995). Visual observations were also made in several locations in Hungary. These observations were considered as proved because evidence of indirect observations by other people could not be checked properly. The same method was applied when counting indirect signs, such as scats (Lanszki et al. 2006) and howling by jackals (Jaeger et al. 1996). For each proof specimen, the name of the nearest set-

tlement was noted, as well as the 10 km×10 km UTM code of the location.

Results

Between 1050 and 1202 questionnaires were distributed each year. The response varied between 38.6% and 48.7% (mean 45.3%, n=527) and the area covered by responses was 47.5% of the total (Table 1). On the basis of the questionnaire surveys, the number of GMUs recording the occurrence of golden jackals has increased from 1997. The majority of the observations were unmistakable jackal howling, but there were also many sightings and hunting bags. The number of observations increased from 4 to 67; the trend was positive and significant (Figure 1). Most of the positive responses were recorded for Transdanubia first, and later the number of positive reports seemed to equalise between the two parts of the country. Only 18 UTM cells indicated the presence of golden jackals in 1997 (Figure 2), which is 2.2% of the area of the whole country. The area increased constantly; in 2006 185 UTM cells (22.6%) marked the presence of the species.

Official hunting bag data confirmed the results of the mail questionnaires. Since 1997 the number of reported bags has sharply increased. The number of shots increased from 11 to 163 in the study period; the trend is positive and significant and a total of 763 jackals have been shot (Figure 1). The rate of increase in hunting bags was significant for both the western (linear regression, $R^2=0.924$; $p<0.0001$) and eastern side of the country

Table 1 GMU response rate and area covered between 1997 and 2006 in Hungary.

	1997	1998	2000	2001	2002	2003	2004	2005	2006
Questionnaires sent	1050	1157	1161	1161	1181	1181	1184	1185	1202
Number of responses	428	544	566	516	569	556	549	555	464
Response rate (%)	40.8	47.0	48.7	44.4	48.2	47.1	46.4	46.8	38.6
Area covered by responses (ha)	3771819	4358322	4630176	4371085	4700034	4664985	4483341	4674050	3968933
Area covered (%)	40.9	47.3	50.2	47.4	51.0	49.8	48.6	49.7	42.6

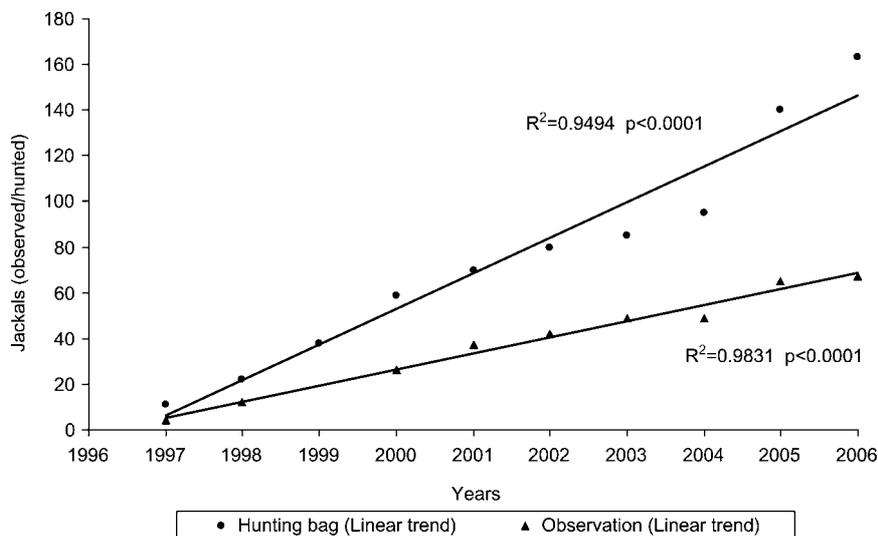


Figure 1 Number of observations and hunting bag data in Hungary between 1997 and 2006 (linear regression).

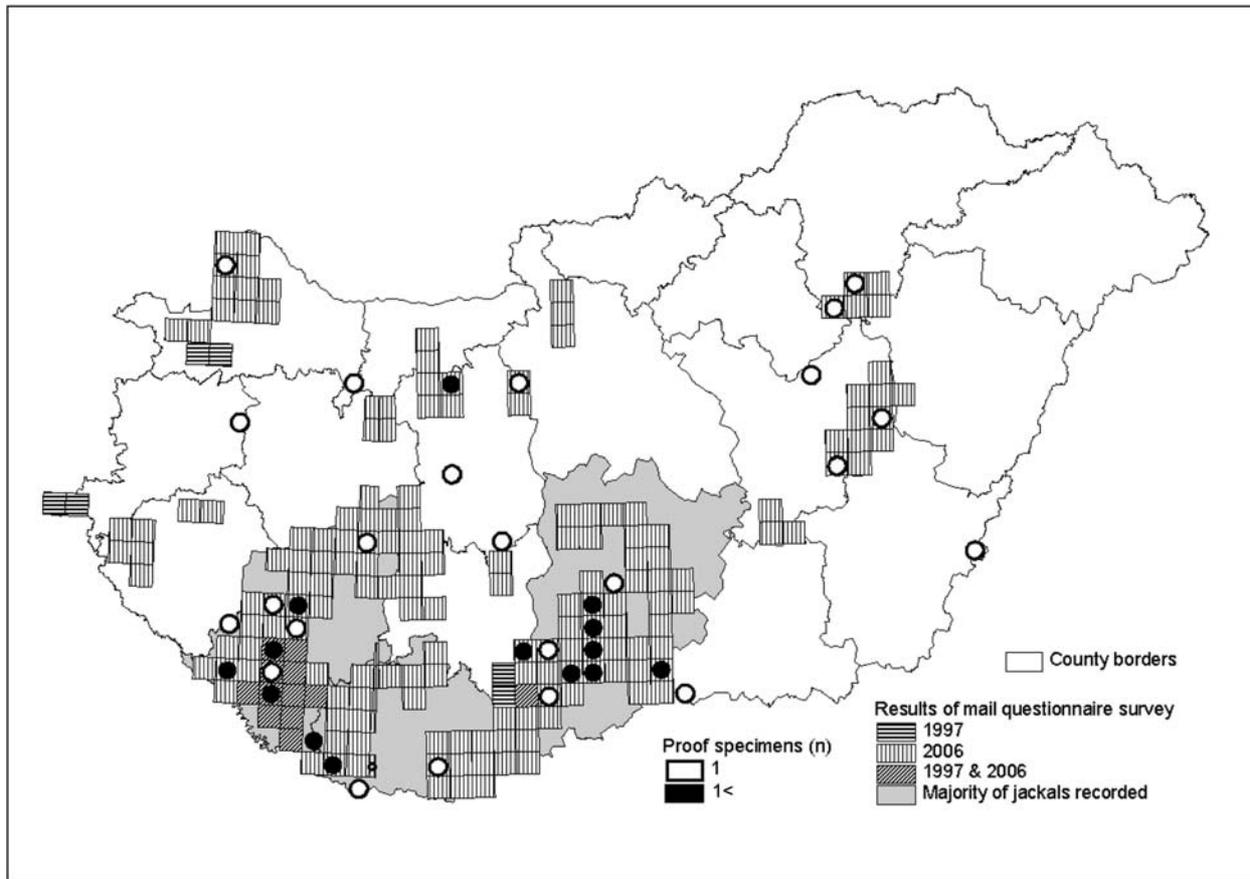


Figure 2 Presence of the golden jackal in Hungary in 1997 and 2006.

(linear regression, $R^2=0.892$; $p<0.0001$). Formal notification of shot jackal was received from 15 counties, but most of these (77%) are to the west of the River Danube (Figure 3).

During the study period 94 specimens were unambiguously identified from carcasses, skulls, furs, photographs and a video (Figure 4). Most of the jackals were found in the southern part of Hungary (Figure 2), including male, female, juvenile and adult specimens. Visual tracking, faeces identification and listening to typical

howling proved its stable presence in two places: near the Croatian border and in Bács-Kiskun county.

Discussion and conclusions

Our results prove the resettlement and spreading of the species in Hungary. In contrast to data collected in the 1980s, when only eight juvenile males were found

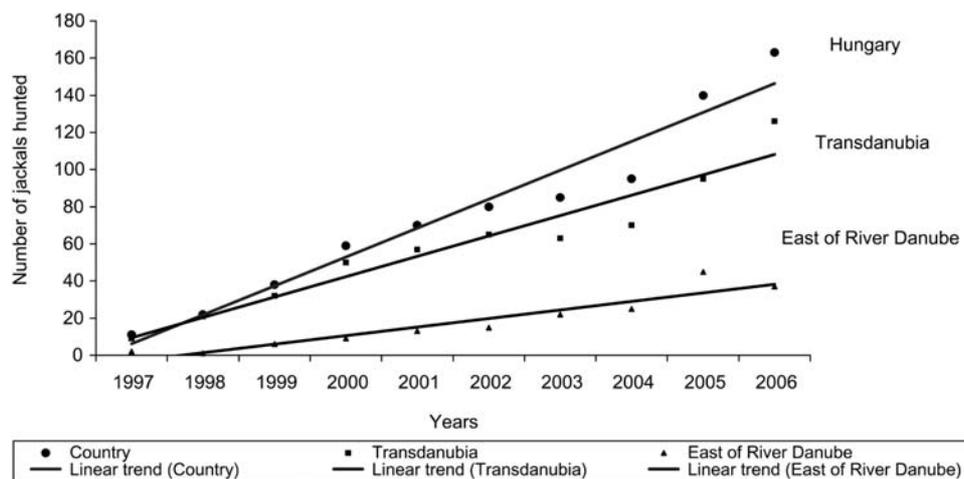


Figure 3 Change in the number of jackals hunted to the west and east of the Danube and in the whole country between 1997 and 2006 (linear regression).

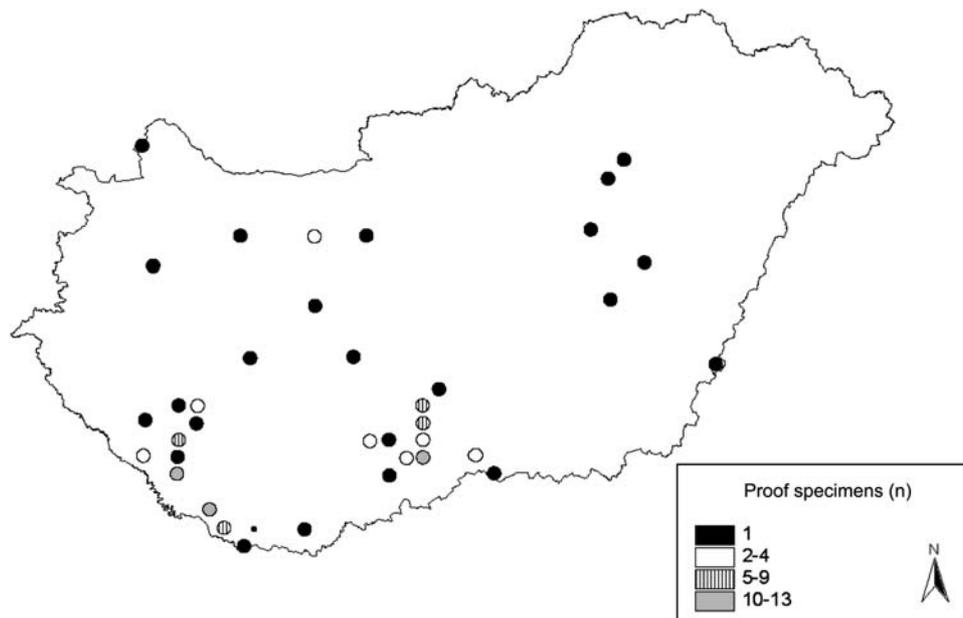


Figure 4 Proof specimens of the golden jackal in Hungary between 1997 and 2006.

(Demeter 1984), in the present study we found more specimens from both sexes and age groups.

Hungarian observations confirm further information regarding the distribution area of the species (Heltai et al. 2000, Heltai 2002, Lanszki and Heltai 2002). Jackals were supposed to be spreading first along the river valleys (in forests of the catchment areas) of the Danube, the Drava and the Sava. First occurrences in Hungary at the beginning of the 1980s (Paks, Danube; Demeter 1984) and the 1990s (Tiszacsege, Tisza; Mitchell-Jones et al. 1999 and Kétújfalú-Lakócsa, Drava; Heltai et al. 2004) confirm this. Jackals are most frequent in the southern part of the country; starting from the suitable zone around the Danube and Drava rivers they are spreading most intensively on the Great Plane along the river Tisza (Szabó et al. 2006).

Jackal immigration is supposed to occur from the direction of the Balkans (Demeter and Spassov 1993, Krystufek et al. 1997). Although the species can be hunted throughout the year except during the breeding season, it seems that the population is still expanding, mostly in the southern part of the country. Jackal observations have now been recorded for every county. Core populations were mainly found in southern counties, but it is likely that settlement will occur further afield. The expansion of observations and hunting bags represents an unlimited growth model (Begon et al. 1990). The possible end of the expansion and the limiting factors are unknown, and neither habitat nor food supply has restricted the spreading of jackals in Hungary so far (Heltai et al. 2000, Heltai 2002, Lanszki and Heltai 2002). The rapid spread of the species to date and the lack of limiting factors mean that it is quite possible that jackals will spread over the whole country in the future. The observation of a breeding family in Austria near the Hungarian border in summer 2007 confirms this. The causes of the spread in the Balkans (sudden population growth) are unknown. Possible contributions are a decrease in wolf populations (Krystufek and Tvrtkovic 1990), the Balkan

wars and mild winters. It is also possible that the introduction of EU directives on carnivore reduction methods (poisons, iron traps, non-selective killing methods, etc.; EC Bird Directive, EC Habitat Directive) have also had an effect.

In conclusion, after half a century of absence, the golden jackal is becoming a common predator again in the southern part of Hungary. Invasion-like spreading of the species was proven. We noted the occurrence of golden jackals to the north of our region, where the environmental conditions are similar to the Hungarian moderate climate. The reason for this quick and spontaneous colonisation is controversial, but it is already clear that its occurrence in the north – where the species is declared to be an invasive strange predator and its settlement is to be interfered with – depends on the Hungarian population. This will probably cause problems in nature conservation and wildlife management, although preliminary results of a study of feeding habits did not confirm this (Lanszki and Heltai 2002, Lanszki et al. 2006). Thus, it will be necessary to monitor and manage jackal populations according to an action plan that includes control measures. Planning of jackal management is important in light of the alarming survey in Greece that revealed a continuous population decrease (Giannatos 2004, Giannatos et al. 2005).

Acknowledgements

We thank all the respondents for providing information and the Department of Game Management and Fishery of the Ministry of Agriculture and Rural Development for financial support (reference number VGO-1269, document number 11556/2001).

References

- Atanassov, N. 1953. Untersuchungen über die Schakale (*Canis aureus* L.) in Bulgarien. Isv. Zool. Inst. Bulgarsk. Akad. Nauk. 2: 189–273 (in Bulgarian with German summary).

- Begon, M., J.L. Harper and C.R. Townsend. 1990. Ecology: individuals, populations and communities. Blackwell Scientific, Oxford. pp. 197–239.
- Csányi, S., ed. 1998–2007. Hungarian game management database (<http://www.oiva.info.hu/adattar/index.html>).
- Demeter, A. 1984. Recent records of rare or non-resident large carnivores in Hungary. *Vertebr. Hung.* 22: 65–71.
- Demeter, A. and N. Spassov. 1993. *Canis aureus* Linnaeus, 1758. In: (J. Niethammer and F. Krapp, eds.) *Handbuch der Säugetiere Europas*, Vol. 5/I. Aula-Verlag, Wiesbaden. pp. 107–138.
- Genov, P.V. and K.S. Vassilev. 1991. Density and damages caused by jackal (*Canis aureus* L.) to livestock in Southern Bulgaria. *Bulg. Acad. Sci. Ecol.* 24: 58–65.
- Giannatos, G. 2004. Conservation action plan for the golden jackal *Canis aureus* L. in Greece. WWF Greece. 47 pp.
- Giannatos, G. and Y. Ioannidis. 1991. Preliminary survey on the distribution and status of jackal (*Canis aureus* L. 1758) in southern Greece. *Biol. Gallo-Hellenica* 18: 67–74.
- Giannatos, G., Y. Marinos, P. Maragou and G. Catsadorakis. 2005. The status of the golden jackal (*Canis aureus* L.) in Greece. *Belg. J. Zool.* 135: 145–149.
- Hell, P. and S. Bleho. 1995. Contemporary occurrence of jackal (*Canis aureus*) in Slovakia. *Folia Venatoria* 25: 183–187 (in Slovakian with English summary).
- Hell, P. and D. Rajskey. 2000. Immigration des Goldschakals in die Slowakei im 20. Jahrhundert. *Beitr. Jagd- Wildforsch.* 25: 143–147 (in German).
- Heltai, M. 2002. The status and distribution of mammal predators in Hungary. Ph.D. thesis, Szent. István University, Gödöllő, Hungary.
- Heltai, M., L. Szemethy, J. Lanszki and S. Csányi. 2000. Returning and new mammal predators in Hungary: the status and distribution of golden jackal (*Canis aureus*), racoon dog (*Nyctereutes procyonoides*) and racoon (*Procyon lotor*) in 1997–2000. *Beitr. Jagd- Wildforsch.* 26: 95–102.
- Heltai, M., E. Szűcs, J. Lanszki and L. Szabó. 2004. Az arany-sakál (*Canis aureus* Linnaeus, 1758) új előfordulásai Magyarországon [Latest data on the distribution of jackal (*Canis aureus* Linnaeus, 1758) in Hungary]. *Állattani Közlemények*, 89(2): 43–52 (in Hungarian).
- Heltai, M., J. Lanszki, E. Szűcs and L. Szabó. 2007. Arany-sakál. In: (Z. Bihari, G. Csorba and M. Heltai, eds.) 2007. *Magyarország emlőseinek atlasza* [The atlas of Hungarian mammals]. Kossuth Kiadó, Budapest. pp. 215–217.
- IUCN. 2007. *Canis aureus*. In: IUCN 2007. European mammal assessment (<http://ec.europa.eu/environment/nature/conservation/species/ema/>).
- Jaeger, M.M., R.K. Pandit and E. Haque. 1996. Seasonal differences in territorial behaviour by golden jackal in Bangladesh: Howling versus confrontation. *J. Mammal.* 77: 768–775.
- Karandinos, M. 1991. The red data book of threatened vertebrates of Greece. Hellenic Zoological Society. 356 pp.
- Kiss, J.B. 2000. Egy elterjedőben lévő kutyarakon: az arany-sakál [A spreading canid: the golden jackal]. *Erdélyi Nimród* 3: 9 (in Hungarian).
- Krystufek, B. and S. Petkovski. 1990. New record of the jackal *Canis aureus* Linnaeus, 1758 in Macedonia (Mammalia, Carnivora). *Fragm. Balcanica Mus. Macedon. Sci. Nat.* 14(307): 131–138.
- Krystufek, B. and N. Tvrtkovic. 1990. Range expansion by Dalmatian jackal population in the 20th century (*Canis aureus* Linnaeus, 1758). *Folia Zool.* 39: 291–296.
- Krystufek, B., D. Murariu and C. Kurtonur. 1997. Present distribution of the golden jackal *Canis aureus* in the Balkans and adjacent regions. *Mammal Rev.* 27: 109–114.
- Lanszki, J. and M. Heltai. 2002. Feeding habits of golden jackal and red fox in southwestern Hungary during winter and spring. *Z. Säugetierk.* 67: 129–136.
- Lanszki, J., M. Heltai and L. Szabó. 2006. Feeding habits and trophic niche overlap between sympatric golden jackal (*Canis aureus*) and red fox (*Vulpes vulpes*) in the Pannonian ecoregion (Hungary). *Can. J. Zool.* 84: 1647–1656.
- Macdonald, D.W. and C. Sillero-Zubiri. 2004. *Biology and conservation of wild canids*. Oxford University Press, Oxford.
- Milenkovic, M. 1983. Jackal, *Canis aureus* Linnaeus, 1758 (Mammalia, Canidae) in Eastern Serbia. *Serb. Acad. Sci. Arts Proc. Fauna of SR Serb.* 2: 257–262.
- Milenkovic, M. 1987. The distribution of the jackal, *Canis aureus* Linnaeus, 1758. (Mammalia, Canidae) in Yugoslavia. *Serb. Acad. Sci. Arts Proc. Fauna SR Serbia* 4: 233–248 (in Serbian with English summary).
- Milenkovic, M. and M. Paunovic. 2003. Phenomenon of golden jackal (*Canis aureus* L., 1758) expansion in Serbia. In: Meeting report of the Carpathian Workshop on Large Carnivore Conservation. Brasov, Romania. p. 35.
- Mitchell-Jones, A.J., G. Amori, W. Bogdanowicz, B. Krystufek, P.J.H. Reijnders, F. Spitzenberger, M. Stubbe, J.B.M. Thissen, V. Vobralik and J. Zima. 1999. *The atlas of European mammals*. Academic Press, London.
- Rakonczay, Z., ed. 1989. *Vörös Könyv* (Red data book). Akadémiai Kiadó, Budapest (in Hungarian).
- Reinhard, M. 2000. Ein Goldschakal (*Canis aureus*) in Suedbrandenburg – Erstnachweis fuer Deutschland. *Saugetierkundl. Inform.* 4: 477–481.
- Rozhenko, N.V. and A.M. Volokh. 2000. Appearance of the golden jackal (*Canis aureus*) in the south of Ukraine. *Vestnik Zool.* 34: 125–129.
- Szabó, L., M. Heltai and J. Lanszki. 2006. River Tisza as a green corridor in the spread of golden jackal in Hungary. *Vadbiológia* 12: 47–54 (In Hungarian with English summary).