

Notes on somatic proportions of *Canis lupus* from eastern Slovakia (Carnivora: Canidae)

Poznámky k biometrickým údajom populácie vlka eurázijského (*Canis lupus*) z východného Slovenska (Carnivora: Canidae)

Luboš ČOMOR¹ & Alexander ČANÁDY²

¹ Rúbanisko 3/33, SK–984 03 Lučenec, Slovakia; comor.lubos@gmail.com

² Department of Zoology, Institute of Biology and Ecology, P. J. Šafárik University, Moyzesova 11, SK–040 01 Košice, Slovakia

received on 6 July 2011

Abstract. The paper presents the results of biometric research of the Eurasian wolf (*Canis lupus*) from eastern Slovakia. The data were excerpted from catalogue cards and protocols of the Šariš Museum in Bardejov and the Regional Museum in Prešov. Basic somatic traits were evaluated for 42 individuals. For males, the following values were obtained: weight 23.0–60.0 kg (mean [M] 39.9 kg), body length 105.0–136.0 mm (M 118.1 cm), tail length 28.5–51.0 cm (M 39.2 cm), length of the hind foot 23.5–28.5 cm (M 25.7 cm), length of the auricle 9.2–15.0 cm (M 12.7 cm). Females showed the following measurements: weight 21.3–50.0 kg (M 34.9 kg), body length 103.0–130.0 cm (M 110.9 cm), tail length 31.0–42.0 cm (M 38.0 cm), length of the hind foot 23.0–26.5 cm (M 24.2 cm), height of the auricle 10.3–15.0 cm (M 12.1 cm). The index of tail length ($LCd \times 100/LC$) was a relatively constant parameter for both sexes (33.3% in males, 34.3% in females). Conversely, concerning the relative weight and body length ($P \times 100/LC$), higher values were found in males, which was statistically highly significant ($t=3.37$; $P<0.01$). The ratio of condylobasal skull length to body length ($LCb \times 100/LC$) did not show a significant difference between sexes.

Key words. *Canis lupus lupus*, Eurasian wolf, eastern Slovakia, somatic proportions.

INTRODUCTION

The gray wolf, *Canis lupus* Linnaeus, 1758, has one of the widest distribution ranges among mammals, covering nearly all of Eurasia and North America from tundra to arid areas north of 12° N (Asia) or 15° N (North America). Nevertheless, its range went through very significant changes in the past, as the species was completely exterminated in many regions. Nowadays, *C. lupus* continuously ranges in the eastern half of Europe from northern Scandinavia through Finland, Poland, Russia, Belarus, Ukraine, Slovakia, Hungary and Romania towards the Balkans. Recent populations in western Europe are found on the Apennine and Iberian Peninsulas, in the French Alps and on a part of the Swedish-Norwegian border, where only small, isolated wolf populations are present. In many parts of Europe, a dramatic population growth has been recorded recently, accompanied by some natural reinhabiting of the original areas of occurrence, especially in the main migration direction from east to west and to a lesser extent, from south to north (MITCHELL-JONES et al. 1999, BOITANI 2000, HELL et al. 2001, MECH & BOITANI 2003,

OZOLIŇŠ et al. 2008, ANDĚRA & ČERVENÝ 2009). The huge area of distribution of the species results in high variability of morphological characteristics, coloration and overall habitus of individuals. This variability is reflected in different systematic affiliations of the wolf populations to several subspecies (OKARMA & BUCHALCZYK 1993, BOITANI 2000, HELL et al. 2001, MECH & BOITANI 2003, MILENKOVIĆ et al. 2010).

In Slovakia, occurrence of a single subspecies, the nominotypical Eurasian wolf (*Canis lupus lupus* Linnaeus, 1758), has been described by several authors (FERIANCOVÁ-MASAROVÁ & HANÁK 1965, HELL & PAULE 1982, etc.). In Europe as well as in Slovakia, the Eurasian wolf is the second biggest carnivore species, after the bear, living mostly in mountain areas (ADAMEC 2003, PČOLA 2003, CHOVANCOVÁ et al. 2010). HELL et al. (2001) summarized the historical and present distribution of the species in the Slovakian Carpathians in great detail. Based on the analysis of hunting statistics, they confirmed its current presence (as of the year 1998) mainly in north-eastern Slovakia, as well as establishing of a permanent population in central and north-western Slovakia, which significantly shifted the borders of the current range to the west and partly to the south. More recent data on the enlargement of the Slovakian range in the years 1999–2001 can be found in the work by ADAMEC (2003).

Morphological studies of *Canis lupus* from Slovakia were carried out by HELL (1971), PAULE & HELL (1982). On the basis of morphometric studies they found slight differences in body size compared with the data indicated by HEPTNER & NAUMOV (1974) for *C. lupus* in the territory of the former USSR. Despite these differences, they attributed the Slovakian population to the nominotypical subspecies, which conformed the earlier arguments (e.g. FERIANCOVÁ-MASAROVÁ & HANÁK 1965) on the occurrence of one subspecies living in the territory of Slovakia. At the same time, they also point out that this population was rejuvenated and there were only a few older, physically fully mature individuals. Morphological data on the individuals from eastern Slovakia (High Tatras) were presented by CHOVANCOVÁ et al. (2010).

The aim of this study was to further evaluate the somatic dimensions derived from registration data attached to the cranial evidence of museum collections from the territory of eastern Slovakia. Also the data obtained from hunting sites within the study area were evaluated.

MATERIAL AND METHODS

For the study of somatic characteristics of adult *C. lupus*, biometric data on 43 individuals were available, which were obtained by excerption from catalogue cards attached to the cranial evidence from the collections of the Regional Museum in Prešov (KMP) and the Šariš Museum in Bardejov (SARM). The registration cards included basic somatic measurements: P – weight, LC – body length; LCd – tail length; LTp – length of the hind foot, LA – ear height. Absolute dimensions are not sufficient to understand the causes of differences in the shape of two different individuals. Therefore, the use of special indices is frequent, which reflect the relationship between two or more dimensions at once. At the same time, establishing the index is very important because it gives a real opportunity to compare the material studied by different authors. In its simplest form it expresses the division of the selected smallest dimension and selected larger size, usually the result is multiplied by hundred and expressed as a percentage (%).

To reflect the ratio of tail length to total body length, we used the “tail length index” ($LCd \times 100 / LC$). Similarly, the ratio of body weight (P) to total body length (LC) was calculated: $P \times 100 / LC$. The last index was calculated as $LCb \times 100 / LC$, which is the ratio of condylobasal skull length (LCb) to total body length. The condylobasal skull length was measured using a metal digital caliper to the nearest 0.01 mm, but the primary data are not included in this paper. From the above literature it seems that the relevant somatic measurements were obtained from various sources from the period 1960–1992, which were evaluated and processed by J. PALÁŠTHY (KMP) and T. WEISZ (SARM). Finally, it should be also pointed out that

in eastern Slovakia, besides the above mentioned museums, we also visited the East-Slovakian Museum in Košice (VSM), but no somatic dimensions were obtained there. Likewise, DANKO (2005) indicates the occurrence of two skulls of *C. lupus* in the Reports of the Zemplín Museum in Michalovce, however, not giving more detailed somatic data (Š. DANKO in litt.). A greater number of individuals caught by several hunters in the Slovakian Eastern Carpathians (north-eastern Slovakia, the orographic units of Bukovské vrchy Mts., Beskydské predhorie Mts., Laborecká vrchovina Mts.) were provided to us by Š. PČOLA (Poloniny National Park Administration), therefore in the following text he is described as a source of the data (PŠ). Thanks to these data, the total weight was evaluated from 121 individuals (Table 1).

The obtained data set was evaluated using the following statistical characteristics: mean (M), standard deviation (SD) and coefficient of variation (CV). The studied individuals came from a total of 32 sites from 8 orographic units. The following list of the records is ordered by orographic units, giving the site data, sex, date and/or catalogue registration number in the collection of the museum. Where more data from one site were available, they are ordered chronologically. To test the statistical differences between mean values of each parameter for sex groups using the Student's t-test, the conditions necessary for its implementation had to be verified, i.e. whether the data are of normal distribution and homogeneous variances. Data distribution was tested by the chi-square (χ^2) test and F-test was used for testing of equality of variances. In the case of significant differences between variances, the modified t-test was used. The calculated test characteristics were compared with spreadsheet significance at levels 0.05, 0.01, 0.001.

MATERIAL EXAMINED

Košická kotlina basin: ♀ (KMP Z-1796), Stará, Fintice, 26. 11. 1963.

Čergov Mts.: ♂ (SARM 30/61), Križe, 21. 2. 1961.

Levočské vrchy Mts.: ♀ (KMP Z-2135), Vyšný Slavkov, 16. 8. 1964; ♂ (KMP Z-2717), Tichý potok, 5. 6. 1969; ♂ (KMP Z-2715), Tichý potok, 14. 6. 1969; ♀ (KMP Z-2895), Tichý potok, 31. 5. 1970.

Busov Mts.: ♂ (SARM 75/68), Hutisko, 20. 10. 1968; ♀ (SARM 50/75), Stebník, 12. 10. 1975.

Bukovské vrchy Mts.: ♂ (PŠ), Nová Sedlica, 30. 3. 1975; ♂ (PŠ), Nová Sedlica, 28. 10. 1985; ♂ (PŠ), Nová Sedlica, 18. 3. 1986; ♂ (PŠ), Nová Sedlica, 21. 1. 1987; ♂ (PŠ), Runina, 2. 2. 1982; ♀ (PŠ), Ulič, 14. 12. 1982; ♂ (PŠ), Kolbasov, 27. 10. 1982; ♂ (PŠ), Príslop, 11. 7. 1984.

Ondavská vrchovina Mts.: ♀ (SARM 16/60), Zborov, 13. 1. 1960; ♀ (SARM 161/63), Kečkovce, 28. 10. 1963; ♀ (SARM 100/64), Ladomirová, 14. 9. 1964; ♀ (SARM 110/64), Osikov, 20. 9. 1964; ♂ (SARM 116/64), Korunková, 4. 10. 1964; ♂ (SARM 132/64), Solník (Korunková), 9. 12. 1964; ♂ (KMP Z-2387), Demjata, 27. 6. 1965; ♂ (SARM 7/65), Svidník, 22. 1. 1965; ♀ (SARM 5/66), Svidník, 18. 1. 1966; ♂ (SARM 177/66), Svidník, 31. 12. 1966; ♂ (SARM 10/68), Svidník, 15. 1. 1968; ♂ (SARM 29/68), Svidník, 1. 3. 1968; ♀ (SARM 7/69), 20. 1. 1969; ♀ (SARM 9/71), Svidník, 12. 2. 1971; ♂ (SARM 93/67), Stropkov, 3. 9. 1967; ♂ (SARM 142/67), 27. 11. 1967; ♂ (SARM 80/67), Dukovce, 3. 7. 1967; ♂ (SARM 10/67), Bardejov, 8. 1. 1967; ♀ (SARM 171/67), Kelča, 30. 12. 1967; ♂ (SARM 99/68), Mlynárovce, 26. 12. 1968; ♂ (SARM 100/68), Marhaň, 28. 12. 1968; ♀ (SARM 67/69), Šiba, 15. 11. 1969; ♀ (SARM 6/70), Šiba, 12. 2. 1970; ♂ (SARM 8/70), Šiba, 24. 2. 1970; ♂ (SARM 152/71), Chotča, 21. 11. 1971; ♂ (SARM 39/72), Hertník, 5. 11. 1972; ♂ (SARM 27/73), Mokroluh, 1. 12. 1973; ♂ (SARM 171/73), Kružľov, 16. 9. 1973; ♂ (SARM 51/75), Gaboltov, 17. 10. 1975; ♀ (SARM 55/76), Šarišské Čierne, 21. 9. 1976.

Laborecká vrchovina Mts.: ♀ (KMP 522/60), Radvaň nad Laborcom, 3. 8. 1960; ♂ (PŠ), Radvaň nad Laborcom, 2. 1. 1987; ♂ (SARM 6/65), Havaj, 12. 1. 1965; ♂ (SARM 34/65), Osadné (Udavské), 30. 5. 1965; ♂ (SARM 34/66), Krajná Bystrá, 29. 4. 1966; ♂ (PŠ), Rokytovce, 27. 9. 1972; ♀ (PŠ), Krásny Brod, 11. 11. 1972; ♂ (PŠ), Krásny Brod, 13. 1. 1985; ♀ (PŠ), Repejov, 28. 6. 1973; ♀ (PŠ), Repejov, 27. 8. 1974; ♀ (PŠ), Hostovice, 30. 11. 1975; ♀ (PŠ), Hostovice, 8. 1. 1979; ♂ (PŠ), Hostovice, 8. 11. 1992; ♀ (PŠ), Čertižné, 20. 8. 1972; ♂ (PŠ), Čertižné, 25. 8. 1974; ♀ (PŠ), Čertižné, 26. 5. 1975; ♂ (PŠ), Čertižné, 16. 9. 1976; ♀ (PŠ), Čertižné, 7. 11. 1986; ♀ (PŠ), Čertižné, 29. 11. 1987; ♂ (PŠ), Papín, 20. 11. 1977; ♂ (PŠ), Papín, 13. 1. 1980; ♂ (PŠ), Papín, 27. 12. 1981; ♂ (PŠ), Papín, 19. 10. 1983; ♀ (PŠ), Udavské, 14. 1. 1978; ♀ (PŠ), Zvala, 31. 10. 1980; ♀ (PŠ), Prikra, 3. 1. 1981; ♂ (PŠ), Medzilaborce, 26. 12. 1982;

♂ (PŠ), Turcovce, 10. 1. 1982; ♀ (PŠ), Turcovce, 19. 2. 1988; ♀ (PŠ), Ofka, 25. 11. 1984; ♀ (PŠ), Palota, 2. 12. 1982; ♀ (PŠ), Palota, 22. 10. 1985; ♂ (PŠ), Osadné, 12. 1. 1985; ♂ (PŠ), Čabalovce, 9. 2. 1986; ♀ (PŠ), Čabalovce, 9. 2. 1986; ♀ (PŠ), Habura, 1. 12. 1984; ♀ (PŠ), Habura, 8. 11. 1986; ♂ (PŠ), Stakčín, 6. 12. 1987; ♂ (PŠ), Svetlice, 13. 11. 1983; ♂ (PŠ), Svetlice, 15. 1. 1987; ♂ (PŠ), Svetlice, 22. 2. 1987; ♂ (PŠ), Svetlice, 26. 2. 1988; ♂ (PŠ), Zubné, 13. 12. 1987; ♂ (PŠ), Dedačov, 8. 12. 1988; ♂ (PŠ), Snina, 11. 12. 1988; ♂ (PŠ), Snina, 21. 1. 1989; ♂ (PŠ), Pčoliné, 23. 12. 1979; ♀ (PŠ), Pčoliné, 2. 10. 1982; ♀ (PŠ), Pčoliné, 20. 12. 1987; ♀ (PŠ), Dlhé nad Cirochou, 28. 2. 1976; ♂ (PŠ), Nechválava Polianka, 9. 11. 1986; ♀ (PŠ), Nechválava Polianka, 9. 11. 1986; ♀ (PŠ), Pichne, 20. 11. 1988; ♀ (PŠ), Pichne, 30. 11. 1992;

Beskydské predhorie Mts.: ♀ (PŠ), Chlmec, 7. 12. 1980; ♂ (PŠ), Kolonica, 3. 1. 1982; ♂ (PŠ), Kolonica, 14. 11. 1982; ♂ (PŠ), Ruská Volová, 2. 2. 1982; ♂ (PŠ), Kalná Roztoka, 13. 8. 1982; ♂ (PŠ), Kalná Roztoka, 18. 10. 1987; ♀ (PŠ), Kalná Roztoka, 18. 10. 1987; ♂ (PŠ), Klenová, 21. 11. 1982; ♂ (PŠ), Klenová, 27. 10. 1985; ♀ (PŠ), Klenová, 22. 11. 1987; ♂ (PŠ), Uľfa, 9. 10. 1983; ♀ (PŠ), Uľfa, 11. 12. 1984; ♂ (PŠ), Uľfa, 14. 9. 1986; ♀ (PŠ), Dúbrava, 20. 10. 1984; ♀ (PŠ), Stakčín, 26. 12. 1987; ♀ (PŠ), Stakčín, Veľký Brusný vrch, 31. 12. 1981; ♀ (PŠ), Jasenov, 31. 12. 1981.

Eastern Slovakia (no details): ♀ (SARM 38/67), 28. 2. 1967; ♀ (SARM 33/68), Dolkaňa, 17. 3. 1968.

RESULTS AND DISCUSSION

Basic somatic characteristics of *C. lupus* from the territory of eastern Slovakia are given in Table 1. As expected, margins of the measured values as well as the mean values were higher in ♂♂: a highly statistically significant difference was showed in body weight ($t=3.64$; $P<0.001$), total body length ($t=3.22$; $P<0.01$) and length of the hind foot ($t=3.72$; $P<0.001$). In the evaluated material, the value of the tail length index ($LCd \times 100/LC$) within each sex category was balanced and was only slightly higher in ♀♀ (33.3% for ♂♂, 34.3% for ♀♀; Table 1). On the other hand, in the ratio of body weight to total body length ($P \times 100/LC$), higher values were found in ♂♂, which was also highly significant ($t = 3.37$; $P<0.01$). The ratio of condylobasal skull length to body length ($LCb \times 100/LC$) did not show statistically significant differences between sexes (Table 1). Higher average adult male somatic dimensions are also documented by HELL & PAULE (1982), with highly significant differences in body weight and length of the hind foot, as well as in shoulder height of the body. It is notable that we found the same minimum weights of adults (Table 1) as referred by HEPTNER & NAUMOV (1974) (23.3 kg for ♂♂ and 21.0 kg for ♀♀), which in contrary HELL & PAULE (1982) considered impossible, only if they were completely starved and emaciated individuals. Nevertheless, comparing the values of condylobasal skull length (LCb), our data obtained for adults fit in the interval reported by HELL (1971). Similarly, our values of LCb (219.7–255.1 mm; M 241.2) were within the range of values of Carpathian wolves from Poland (223.4–263.4 mm; M 242.1) measured by OKARMA & BUCHALCZYK (1993). In the comparison of cranial measures (LCb), our individuals show smaller values. Nevertheless, the results indicate that our individuals belong to the Carpathian population. OKARMA & BUCHALCZYK (1993) revealed significant differences in several craniometrical characteristics between mountain and lowland wolf populations. They also noticed that ♂♂ were larger than ♀♀, which is consistent with our findings.

It would also be interesting to compare juveniles, where differences in individual growth parameters in relation to age and sex could be detectable. However, such data are not available in most cases, because the species is hunted for trophy, and mainly adults are thus shot.

Based on our results, we believe that despite the confirmed differences in weight and total length of the body, these characteristics are not suitable for sex and age determination. These characteristics can change during growth as well as the overall fitness of the individuals. We

Table 1. Biometric measures of individuals of *Canis lupus* from eastern Slovakia. Legend: N – počet; M – mean; min., max. – range margins; SD – standard deviation; CV – coefficient of variance; t-test – t-test results; ns – non-significant; ** – P<0.01; *** – P<0.001; for other abbreviations see text

Tab. 1. Biometrické parametre jedincov vlka eurázijského (*Canis lupus*) z východného Slovenska. Vysvetlivky: N – počet; M – priemer; min, max – okraje rozpetia; SD – štandardná odchýlka; CV – koeficient variácie; t-test – výsledky t-testu; ns – nepreukazný rozdiel; ** – P<0.01; *** – P<0.001; ostatné skratky vid' text

	sex	N	min–max	M	SD	CV	t-test
P [kg]	♂♂	66	23.0–60.0	39.9	8.2	20.6	***
	♀♀	55	21.3–50.0	34.9	6.6	18.9	
LC [cm]	♂♂	25	105.0–136.0	118.1	7.9	6.7	**
	♀♀	18	103.0–130.0	110.9	6.2	5.6	
LCd [cm]	♂♂	25	28.5–51.0	39.2	4.5	11.4	ns
	♀♀	18	31.0–42.0	38.0	2.9	7.7	
LTp [cm]	♂♂	25	23.5–28.5	25.7	1.3	5.1	***
	♀♀	18	23.0–26.5	24.2	1.3	5.4	
LA [cm]	♂♂	24	9.2–15.0	12.7	1.0	7.9	ns
	♀♀	18	10.3–15.0	12.1	1.1	9.1	
LCd×100/LC [%]	♂♂	25	23.6–41.1	33.3	3.5	10.5	ns
	♀♀	18	28.7–38.3	34.3	2.4	7.0	
P×100/LC [%]	♂♂	24	21.1–40.3	31.0	4.6	14.8	**
	♀♀	17	19.5–37.1	26.1	4.5	17.2	
LCb×100/LC [%]	♂♂	25	19.2–22.3	20.8	0.9	3.9	ns
	♀♀	18	18.5–23.9	20.7	1.3	6.3	

consider length of the hind foot as a more appropriate characteristic, which often can reach adult values already in immature individuals. Morphological data on wolf individuals from the High Tatras (3 ♀♀, 1 ♂), published by CHOVANCOVÁ et al. (2010) are consistent with the aforementioned literature data. Their data are also within the limits of our findings, with the exception of adult male body length. Our mean values compared with those given by HELL & PAULE (1982), were lower except the height of the auricle for both sexes. Overall, we can conclude that our results and biometry of individuals from the territory of eastern Slovakia conform the allegations of the population to *C. lupus*. At the same time, the results are consistent with the values given from other countries (HEPTNER & NAUMOV 1974, OKARMA & BUCHALCZYK 1993, BOITANI 2000, OZOLIŇŠ et al. 2008).

SÚHRN

V práci sú prezentované výsledky biometrického výskumu vlka euroázijského (*Canis lupus*) z východného Slovenska. Údaje boli získané excerpovaním z katalógových kariet a protokolov Šarišského múzea v Bardejove (SARM) a Krajského múzea v Prešove (KMP). Boli vyhodnotené základné somatické znaky 42 jedincov. Pre samce *C. lupus* boli získané nasledujúce hodnoty somatických znakov: hmotnosť (P) 23,0–60,0 kg, priemerne (M) 39,9 kg; dĺžka tela (LC) 105,0–136,0 cm, M 118,1 cm; dĺžka chvosta (LCd) 28,5–51,0 cm, M 39,2 cm; dĺžka zadného chodidla (LTp) 23,5–28,5 cm, M 25,7 cm; výška ušnice (LA)

9,2–15,0 cm, M 12,7 cm. Samice *C. lupus* mali nasledujúce miery: hmotnosť 21,3–50,0 kg, M 34,9 kg; dĺžka tela 103,0–130,0 cm, M 110,9 cm; dĺžka chvosta 31,0–42,0 cm, M 38,0 cm; dĺžka zadného chodidla 23,0–26,5 cm, M 24,2 cm; dĺžka ušnice 10,3–15,0 cm, M 12,1 cm. Index dĺžky chvosta (LCd×100/LC) bol relatívne konštantným parametrom pre obe pohlavia (33,3 % samce, 34,3 % samice). Naopak v pomere hmotnosti a dĺžky tela ($P \times 100/LC$), boli zistené vyššie hodnoty pri samcoch, ktoré boli štatisticky vysoko preukazné ($t=3,37$; $P<0,01$). Testovanie hodnôt pomeru kondylobazálnej dĺžky lebky k dĺžke tela ($LCb \times 100/LC$) oboch pohlaví nepotvrdilo štatisticky významný rozdiel.

ACKNOWLEDGEMENTS

We thank M. FULÍN of the East-Slovakian Museum Košice, T. JÁSZAY of the Šariš Museum in Bardejov for their help during the study and B. TOMÁŠOVÁ of the Regional Museum in Prešov for access to the documentary material for the morphometric study of the Eurasian wolf. At the same time we wish to thank Mr. LAZORÍK of the Regional Museum in Prešov for his kind assistance. Our thanks also include Š. PČOLA of the Poloniny NP Administration for providing more data. We also thank L. MOŠANSKÝ and D. MIKLISOVÁ for assistance with the work.

REFERENCES

- ADAMEC M., 2003: Rozšírenie, stav a ochrana vlka (*Canis lupus*) a rysa (*Lynx lynx*) na Slovensku [Extension status and protection of the wolf (*Canis lupus*) and lynx (*Lynx lynx*) in Slovakia.]. Pp.: 30–34. In: GADÓ G. P. & PAČEŇOVSKÝ S. (eds.): *Vlky a rysy v oblasti slovensko-maďarských hraníc [Wolves and Lynxes in the Region of Slovakian-Hungarian Border]*. WWF Maďarsko, Budapešť, 76 pp (in Slovak).
- ANDĚRA M. & ČERVENÝ J., 2009: *Velcí savci v České republice. Rozšíření, historie a ochrana. 2. Šelmy (Carnivora) [Large Mammals in the Czech Republic. Distribution, History and Conservation. 2. Carnivores (Carnivora)]*. Národní muzeum, Praha, 216 pp (in Czech, with a summary in English).
- BOITANI L., 2000: *Action Plan for the Conservation of the Wolves (Canis lupus) in Europe. Nature and Environment, No. 113*. Council of Europe Publishing, Strasbourg, 86 pp.
- DANKO Š., 2005: Katalóg zoologických zbierok stavovcov v Zemplinskom múzeu v Michalovciach [The catalogue of vertebrate fauna collections from Zemplin Museum in Michalovce]. *Natura Carpatica*, **46**: 165–198 (in Slovak, with an abstract in English).
- FERIANCOVÁ-MASÁROVÁ Z. & HANÁK V., 1965: *Stavovce Slovenska 4. Cicavce [Vertebrates of Slovakia 4. Mammals]*. Vydavateľstvo SAV, Bratislava, 331 pp (in Slovak).
- HELL P., 1971: Príspevok ku kraniometrickému štúdiu vlka obyčajného (*Canis lupus* L.) zo západných Karpát [Beitrag zum kraniometrischen Studium des Wolfes (*Canis lupus* L.) aus den Westkarpaten]. *Lynx, n. s.*, **13**: 5–14 (in Slovak, with a summary in German).
- HELL P. & PAULE L., 1982: Ergebnisse den taxonomischer Untersuchungen des Wolfes (*Canis lupus*) in den Slowakischen Karpaten. *Folia Zoologica*, **31**: 255–270.
- HELL P., SLAMEČKA J. & GAŠPARIK J., 2001: *Vlk v slovenských Karpatoch a vo svete [Wolf in Slovakian Carpathians and in the World]*. PaRPRESS, Bratislava, 182 pp (in Slovak).
- HEPTNER V. G. & NAUMOV N. P., 1974: *Die Säugetiere der Sowjetunion. Band II. Seekühe und Raubtiere*. Gustav Fischer Verlag, Jena, 1006 pp.
- CHOVANCOVÁ B., ZIEĽBA F., URBAN P., HLÓŠKA L., JAMROZY G., WAŽNA A. & CICHOCKI J., 2010: Mäsožravce [Carnivora]. Pp.: 579–608. In: KOUTNÁ E. & CHOVANCOVÁ B. (ed): *Tatry. Príroda. [Tatras. Nature]*. Baset, Praha, 639 pp (in Slovak).
- MECH L. D. & BOITANI L. (eds.), 2003: *Wolves. Behavior, Ecology and Conservation*. The University of Chicago Press, London, 448 pp.
- MILENKOVIĆ M., ŠIPETIĆ V. J., BLAGOJEVIĆ J., TATOVIĆ S. & VUJOŠEVIĆ M., 2010: Skull variation in Dinaric–Balkan and Carpathian gray wolf populations revealed by geometric morphometric approaches. *Journal of Mammalogy*, **91**(2): 376–386.

- MITCHELL-JONES A. J., AMORI G., BOGDANOWICZ W., KRYŠTUFEK B., REIJNDERS P. J. H., SPITZENBERGER F., STUBBE M., THISSEN J. B. M., VOHRALÍK V. & ZIMA J., 1999: *The Atlas of European Mammals*. Academic Press, London & San Diego, 484 pp.
- OKARMA H. & BUCHALCZYK T. 1993: Craniometrical characteristics of wolves *Canis lupus* from Poland. *Acta Theriologica*, **38**: 253–262.
- OZOLIŅŠ J., ŽUNNA A., PUPILA A., BAGRADE G. & ANDERSONE-LILLEY Ž., 2008: *Wolf (Canis lupus) Conservation Plan*. Latvian State Forestry Institute “Silava”, Salaspils, 40 pp.
- PČOLA Š., 2003: Vlk dravý (*Canis lupus*) a rys ostrovid (*Lynx lynx*) v slovenských Východných Karpatoch [Wolf (*Canis lupus*) and lynx (*Lynx lynx*) in the Slovakian Eastern Carpathians]. Pp.: 42–47. In: GADÓ G. P. & PAČEŇOVSKÝ S. (eds.): *Vlky a rysy v oblasti slovensko-maďarských hraníc* [Wolves and Lynxes in the Region of Slovakian-Hungarian Border]. WWF Maďarsko, Budapešť, 76 pp (in Slovak).