MORPHOMETRIC CHARACTERISTICS OF THE WEASEL (*Mustela nivalis* L.) IN THE LIGHT OF LITERATURE DATA

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ABSTRACT

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There is relatively little data available on the morphometrics of the weasel, so in the present study, we attempt to summarise the main characteristics that have been reported from European studies concerning the foretype of *Mustela nivalis*. Accordingly, we have summarised the body size and cranial morphology data reported in 22 studies from 18 countries. We included the mean and extreme values of these parameters, as known from the literature. The fact that in many cases, even the easy-to-record body parameters are not given (EL is missing in most cases, followed by HFL, BW, and BL) makes it very difficult to compare and evaluate them together. The same can be said for some parameters of the skull (BcB, EctB, BcH, among others). When comparing the literature data, we found that there was a significant deviation for some morphological parameters, despite the fact that the measurement followed the conventional methodology both in terms of recording sites and the instruments used for the measurement. This great deviation may be partly explained by the lack of knowledge of age and sex and the small number of elements. Morphometric variation between subspecies can be very significant, so subspecies affiliation is not an irrelevant factor in the comparative analysis of results from different countries. Based on the findings of the relevant literature summarised as the basis for the morphometric study we have compiled and presented here, the analysis of morphometric data is missing at the European scale as well, as there are only a few studies in the international literature that evaluate the sample by age and sex, based on representative element numbers, and in Hungary, no such work has been done.

KEYWORDS: weasel, *Mustela nivalis,* scull morphometric parameters, body morphometric parameters

1. INTRODUCTION

The Eurasian weasel is one of the most understudied species of the Mistelidae family. This is also the case in studies mapping its morphology. The morphometric data of the species can be found mainly in the international literature. In many cases, the data reports of these studies do not provide a representative number of elements, and the morphometric parameters of unknown sex or age of the sample are reported, which makes it very difficult, and in many cases impossible, to analyse the data by sex and age and to prepare comparative summary studies. In Hungary, for a sample with a small number of elements, VÁSÁRHELYI (1942) c.i. ABRAMOV & BARYSHNIKOV (2000), SZÉKY (1972) c.i. FARAGÓ (2012), and LANSZKI & VALKÁR (2009) provide data.

The domestic data are of limited use in international comparisons of skull morphology, while the body parameters offer a wider range of comparisons. The small number of elements and the often unconventionally measured parameters clearly highlight the under-researched nature of the topic and the need for further studies to gain a more comprehensive understanding of the biology of the species.

In accordance with the above, our study aims to provide, using an extensive review of the literature, a comprehensive overview of the results of currently available and relevant studies and to point out new opportunities for domestic research on the species.

2. METHOD AND MATERIAL

We collected the body parameters of this small carnivorous mammal species from 20 studies in 16 countries – Sweden, Denmark, Russia, Lithuania, Belarus, England, Germany, Ukraine, France, Hungary, Switzerland, Romania, Bulgaria, Greece, Spain, Turkey – by MILLER (1912) c.i. ABRAMOV & BARYSHNIKOV (2000), CABRERA (1914) c.i. ABRAMOV & BARYSHNIKOV (2000), CAVAZZA (1914) c.i. ABRAMOV & BARYSHNIKOV (2000), OGNEV (1935) c.i. PAROVSHCHIKOV (1963), VÁSÁRHELYI (1942) c.i. ABRAMOV & BARYSHNIKOV (2000), ZIMMERMANN (1953) c.i. ABRAMOV & BARYSHNIKOV (2000), PAROVSHCHIKOV (1963), BARBU (1968) c.i. ABRAMOV & BARYSHNIKOV (2000), JOENSEN (1969), SZÉKY (1972) c.i. FARAGÓ (2012), KING (1977) c.i. ABRAMOV & BARYSHNIKOV (2000), STOLT (1979) c.i. ABRAMOV & BARYSHNIKOV (2000), DOUMA-PETRIDOU & ONDRIAS (1986) c.i. ABRAMOV & BARYSHNIKOV (2000), MITSKUS & BARANAUSKAS (1990) c.i. ABRAMOV & BARYSHNIKOV (2000), REICHSTEIN (1993) c.i. FARAGÓ (2012), ÇOLAK *et al*. (1999), ABRAMOV & BARYSHNIKOV (2000), LANSZKI & VALKÁR (2009), DEMIRBAŞ & BAYDEMIR (2013), ČANÁDY (2016) (**Table 1**). In accordance with the conventional measurement methodology, the following measurements are reported: ***body weight (BW)*** – weight expressed with the accuracy of the whole, tenth, hundredth of a gram; ***body length (BL)*** – distance in millimetres from the tip of the nose to the anus; ***tail length (TL)*** – distance in millimetres from the anus to the tip of the tail, excluding the tail-end hair patch; ***hindfoot length (HFL)*** – distance in millimetres from the hind end of the heel bone to the end of the longest toe, excluding the claw; ***ear length (EL)*** – distance in millimetres from the lower part of the ear to the tip of the auricle, excluding the hair patch. (LANSZKI & VALKÁR 2009, HOFFMANN *et al.* 2010) (**Figure 1**; **Table 1**).

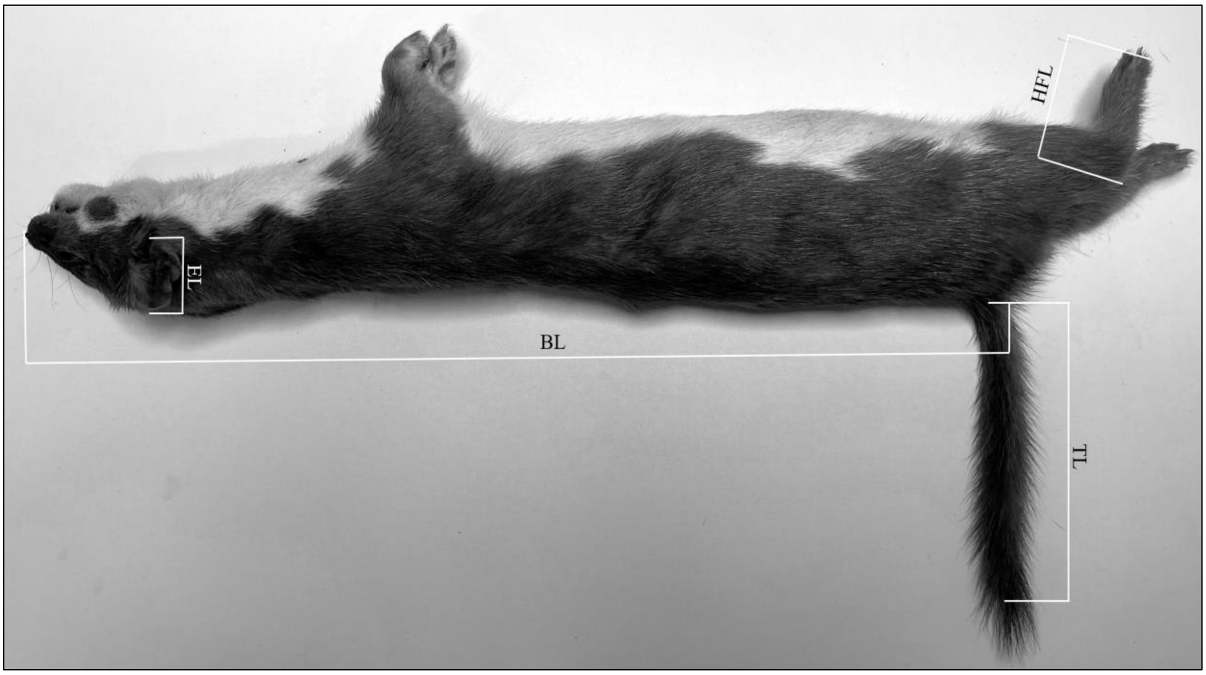

Figure 1. Morphometric measurements of the body (Photo: BENDE A. & VASS G.)

For the skull, data of 24 morphometric parameters are summarised in millimetres based on the measurement proposals of ABRAMOV & BARYSHNIKOV (2000) and SCHMIDT (1992) (**Figure 2**; **Tables 2** and **3**).

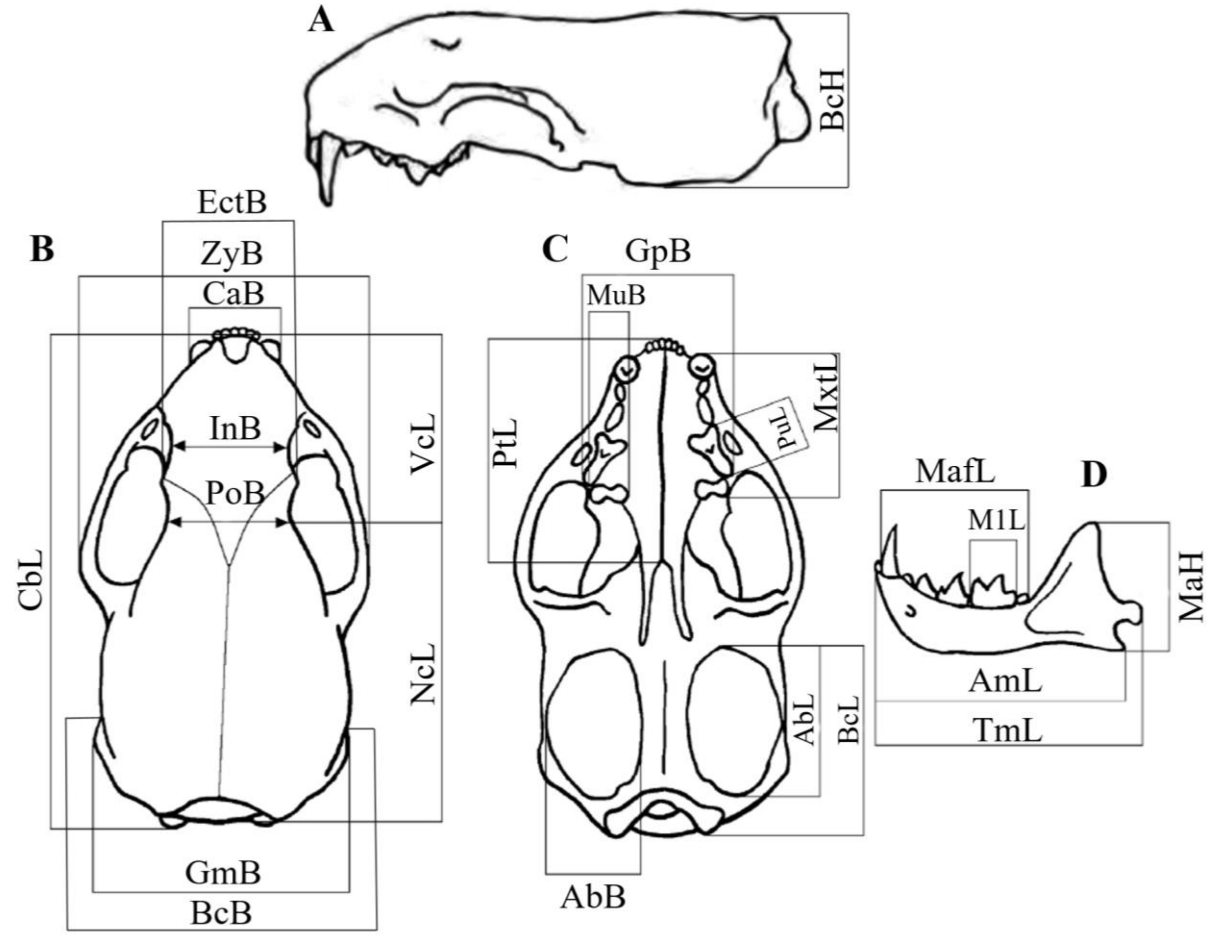

Figure 2. Fixation scheme of skull parameters (own editing following ABRAMOV & BARYSHNIKOV [2000] and SCHMIDT [1992]), lateral [A], dorsal [B], ventral [C] and lateral view of the jaw [D]
CbL - condylobasal length; **NcL** - upper neurocranium length; **VcL** - viscerocranium length; **PtL** - median palatal length; **MxtL** - maxillary tooth-row length; **PuL** - upper carnassial teeth P4 length; **BcL** – greatest length between oral border of the auditory bulla and aboral border of the occipital condyles; **AbL** - greatest diameter of the auditory bulla; **ZyB** - zygomatic breadth; **GmB** - greatest mastoid breadth; **PoB** - postorbital breadth; **InB** - interorbital constriction; **AbB** - least diameter of the auditory bulla; **MuB** - upper molar M^1 breadth; **GpB** - greatest palatal breadth; **CaB** - rostrum breadth; **TmL** - mandible length; **BcB** - braincase breadth; **EctB** - ectoorbital breadth; **BcH** - braincase height; **AmL** - length between the angular process and infradentale; **MatL** - mandibular toothrow length; **M1L** - length of lower carnassial teeth M_1; **MaH** - height of ramus mandibulae.

During data processing, we summarized the results of nine studies of 15 regions – Sweden, Russia, North-Eastern Europe, England, Central Russia, Poland, Germany, France, Hungary, Central Europe, South Europe, Italy, Greece, Spain, Turkey – by OGNEV, 1935 c.i. PAROVSHCHIKOV 1963, PAROVSHCHIKOV 1963, SCHMIDT 1992, REICHSTEIN 1993 c.i. FARAGÓ 2012, ÇOLAK *et al.* 1999, ABRAMOV & BARYSHNIKOV 2000, FARAGÓ 2012, DEMIRBAŞ & BAYDEMIR 2013, ČANÁDY 2016 (**Tables 2** and **3**).

We excluded from the set of morphometric studies those data that were not for Europe (North-West Africa, Egypt, Caucasus, Iran, Turkmenistan, Uzbekistan, Kyrgyzstan, Kazakhstan, China, Vietnam, Ural and Altai Mountains, Western Siberia, Siberia, Alaska, North America) and those that were recorded and reported on the basis of samples collected on European islands (Crete, Corsica, Sardinia, Sicily, Majorca, Azores, Crimea, Yamal, Kunashir) (see: ABRAMOV & BARYSHNIKOV 2000). A significant number of studies report data from zoological museum collections (SCHMIDT 1992, ABRAMOV & BARYSHNIKOV 2000, ČANÁDY 2016) (**Tables 2** and **3**).

Tested skulls are cleaned after 15-30 minutes of boiling, then bleached with H_2O_2 for 24 hours, and finally dried (KEMPA *et al*. 2016, MAHAPATRA *et al*. 2018, FARUK & DAS 2023). There are also suggestions for pre-rotting the skulls, which results in easier and faster skinning by boiling. Overcooking of the skull can lead to loosening of the teeth and possibly their falling out, and thus disintegration of the skull bones, especially in the case of such small, thin-walled mammary skulls (HOOPER 1950, 1956). In addition, other methods of maceration are known for the preparation of these small skulls, e.g., dissection with museum beetles (*Dermestes carnivorus*) (BORELL 1938, HOOPER 1956, MAHAPATRA *et al*. 2018, MUÑOZ-SABA *et al*. 2020).

After preparation for the test, each parameter is measured with a calliper, with an accuracy of one-tenth to one-hundredth of a millimetre (ÇOLAK *et al.* 1999, ABRAMOV & BARYSHNIKOV 2000, DEMIRBAŞ & BAYDEMIR 2013, ČANÁDY 2016, LAPOINT *et al*. 2017).

A non-parametric test, the Kruskal-Wallis test, was used for the statistical analysis of skull measurements reported in the literature, as the normal distribution was not met for the data set (n=63: North-Eastern Europe, Central Europe, Southern Europe) based on the Shapiro-Wilk test (W=0.906; p=0.000).

The map of the subspecies described in the distribution area was visualised using ArcGIS 10.3 software, following the work of ABRAMOV & BARYSHNIKOV (2000).

3. RESULTS AND DISCUSSION

The data collected in the studies summarizing the morphometric parameters of the weasel are summarized in **Tables 1**, **2**, and **3**. Although the authors followed the conventional measurement methodology, as specified in the methodology, it is impossible to compare the data from all the sites, as some parameters were not recorded in all cases.

Based on body size studies in 16 countries of the distribution area, the extreme values of body weight of males range from 49.89 g (45.0–63.0 g) (ČANÁDY 2016) to 263. 42 g (260–290 g) (DEMIRBAŞ & BAYDEMIR 2013) varied in a relatively wide range, similar to the other parameters, as there were also significant variations in body length from 130.6-208 mm (OGNEV 1935 c.i. PAROVSHCHIKOV 1963) to 335.5 (263–382 mm) (DOUMA-PETRIDOU & ONDRIAS 1986 c.i. ABRAMOV & BARYSHNIKOV 2000). Compared to the parameters above, there is a smaller but still significant difference in the length of the tail from 23–26 mm (19.0–22.4 mm) (PAROVSHCHIKOV 1963) to 106.44 mm (105–110 mm) (DEMIRBAŞ & BAYDEMIR 2013) and the hind leg from 20.44 (19.0–22.4) mm (ČANÁDY 2016) to 43.28 mm (43–45 mm) (DEMIRBAŞ & BAYDEMIR 2013). The smallest difference was in ear length from 9.69 (8.00–12.00) mm (ČANÁDY 2016) to 14.9 mm (11–18 mm) (REICHSTEIN 1993 c.i. FARAGÓ 2012).

In adult specimens, there is a difference in morphometric parameters between males and females, as is common in *Mustela* species (ERLINGE 1979, MOORS 1980, LANSZKI & VALKÁR 2009, KORABLEV *et al*. 2013 etc.).

One of the most significant parameters showing differences between the two sexes is body weight, with extreme values ranging from 39.6 g (26–56 g) for females (REICHSTEIN 1993 c.i. FARAGÓ 2012) to 263.42 g (260–290 g) for males (DEMIRBAŞ & BAYDEMIR 2013). In addition, there is a significant difference in body length between adults of different sexes. For females, the minimum extreme value of this parameter is 114–162 mm (OGNEV 1935 c.i. PAROVSHCHIKOV 1963), while for males, the body length can be as long as 335.5 mm (263–382) (DOUMA-PETRIDOU & ONDRIAS 1986 c.i. ABRAMOV & BARYSHNIKOV 2000). The smallest variation was in ear length, with maximum values of 12.8 mm (9–15 mm) for females and 14.9 mm (11–18 mm) for males (REICHSTEIN 1993 c.i. FARAGÓ 2012).

In this context, it is important to emphasise that the data set published in the international and Hungarian literature does not allow for comparative statistical analysis in several aspects. Part of the reason for this is the small number of elements: in many cases, the authors provide data based on less than ten samples (MILLER 1912 c.i. ABRAMOV & BARYSHNIKOV 2000, CABRERA 1914 c.i. ABRAMOV & BARYSHNIKOV 2000, CAVAZZA 1914 c.i. ABRAMOV & BARYSHNIKOV, 2000, VÁSÁRHELYI, 1942 c.i. ABRAMOV & BARYSHNIKOV, 2000, ÇOLAK *et al*. 1999, ABRAMOV & BARYSHNIKOV 2000, LANSZKI & VALKÁR 2009, DEMIRBAŞ & BAYDEMIR 2013, ČANÁDY 2016). Also, many authors did not record the age of the specimens examined (OGNEV 1935 c.i. PAROVSHCHIKOV 1963, PAROVSHCHIKOV 1963, SZÉKY 1972 c.i. FARAGÓ 2012, REICHSTEIN 1993 c.i. FARAGÓ 2012, ÇOLAK *et al*. 1999, LANSZKI & VALKÁR 2009, DEMIRBAŞ & BAYDEMIR 2013). They only mention the existence of sexual dimorphism in body sizes but do not support it by statistical methods (JOENSEN 1969). Based on the above, further studies are needed, and the above data should be provided and analysed in a sampling protocol - at fixed measurement sites and with fixed data precision, with the need for representativeness, recording the sex and age group of each individual. Among the morphometric parameters, it is important to mention the results of international studies on skull morphology. For these studies, as for each body size, a conventional measurement methodology provides the basis for comparability, but not all parameters were recorded in each study (BcB, EctB, BcH, among others) (OGNEV 1935 c.i. PAROVSHCHIKOV 1963, PAROVSHCHIKOV 1963, REICHSTEIN 1993 c.i. FARAGÓ 2012, ABRAMOV & BARYSHNIKOV 2000, FARAGÓ 2012, ČANÁDY 2016). As with body size, the data recorded for each parameter by country show a diverse picture within the same age and sex categories. The parameters that offered the widest range of comparison were CbL, ZyB, TmL, PtL, GmB, MaH, MatL, MxtL, InB. The largest size differences in the adult male were as follows: CbL: from 31.91 mm (31.06–32.90 mm) (ČANÁDY 2016) to 45.40 mm (ABRAMOV & BARYSHNIKOV 2000); ZyB: from 16.28 mm (15.43–17.29 mm) (ČANÁDY 2016) to 26.40 mm (ABRAMOV & BARYSHNIKOV 2000); TmL: 16.09 mm (15.40–18.52 mm) (ČANÁDY 2016) to 24.10 mm (ABRAMOV & BARYSHNIKOV 2000); PtL: 12.92 mm (12.13–15.72 mm) (ČANÁDY 2016) to 19.10 mm (ABRAMOV & BARYSHNIKOV, 2000); GmB: 14.78 mm (14.05–15. 10 mm) (ČANÁDY 2016) to 22.40 mm (ABRAMOV & BARYSHNIKOV 2000); MaH: from 7.62 mm (ABRAMOV & BARYSHNIKOV 2000) to 12.50 mm (ABRAMOV & BARYSHNIKOV 2000); MatL: from 9.88 mm (9.08–11.09 mm) (ČANÁDY 2016) 14.00 mm (ABRAMOV & BARYSHNIKOV 2000); MxtL: from 8.44 mm (8.02–9.57) (ČANÁDY 2016) to 12.20 mm (ABRAMOV & BARYSHNIKOV 2000); InB: from 6.91 mm (6.78–7.24) (ČANÁDY 2016) to 10.30 mm (ABRAMOV & BARYSHNIKOV 2000). It is important to emphasise that there is a significant variation in some skull morphological parameters, despite the measurement site being the same. This may be partly explained by the lack of age and sex determination and the small number of elements (e.g., GpB in ČANÁDY [2016] vs. ABRAMOV & BARYSHNIKOV [2000]), but the issue of subspecies affiliation may also cloud the issue of differences in some parameters.

Due to the wide distribution of the weasel, there is considerable variation in morphometric parameters between geographical regions **(Map 1**, **Figure 1**, **Tables 2–3)**.

Map 1. Map of the distribution of subspecies of weasel (*Mustela nivalis* L.) based on ABRAMOV & BARYSHNIKOV (2000) and collection sites of samples providing morphometric parameters

The skull parameter data were compared based on data from three regions, namely the respective parameters of the North Eastern, Central and South European samples (**Figure 3**).

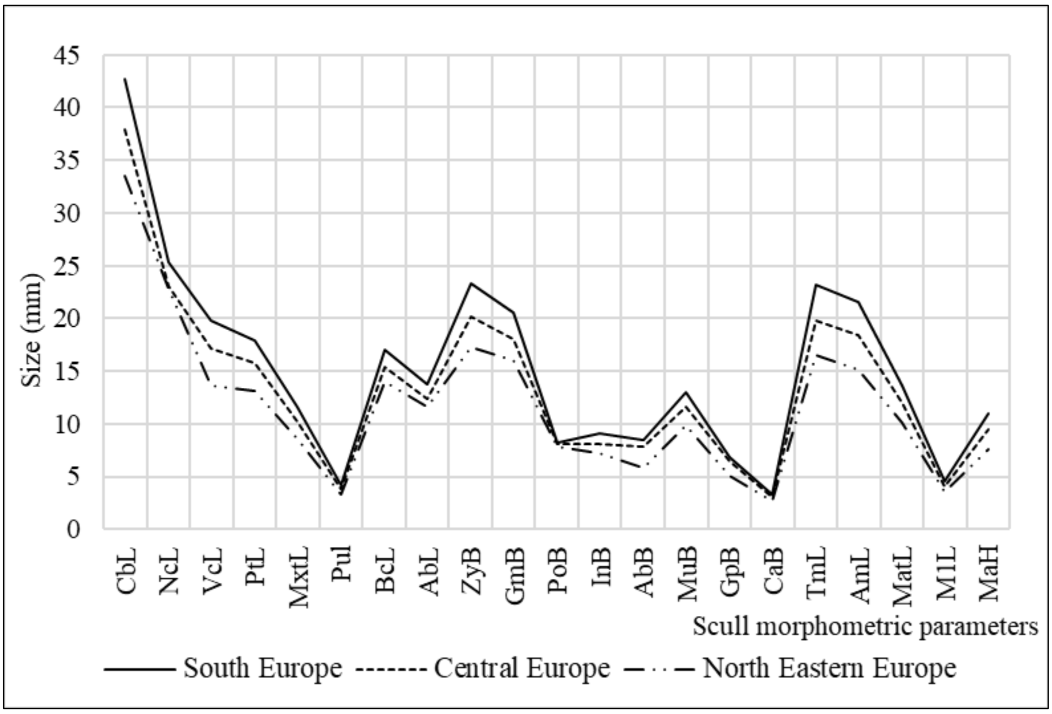

Figure 3. Changes in skull parameters of weasel (*Mustela nivalis* L.) in South, Central and North Eastern Europe based on data from ABRAMOV & BARYSHNIKOV (2000)

In the case of the measured values, the parameters of the South European samples always exceed those of the Central and North Eastern European samples. Those of the Central European samples exceed those of the North Eastern European samples, whereas the results of our statistical analysis showed that these differences were not significant for the skull morphological data of the three regions (n=63) (χ^2= 2.28; p=0.320, df=2) **(Figure 3)**.

In adult specimens, significant (p<0.001) differences between the skull parameters of the two sexes (such as TmL, CbL, VcL, NcL) are reported by several authors (SCHMIDT 1992, LAPOINT *et al*. 2017), while other authors only mention the larger skull sizes of males compared to females and the different skull shape (PAROVSHCHIKOV 1963). Further studies are needed for the analysis of skull morphological parameters because the data recorded in Hungary during weasel studies with a small number of elements (SZÉKY 1972 [n=87♂; 4♀]; FARAGÓ 2012 [n=52♂; 13♀]) are not representative and do not allow comparison with foreign samples, since only the parameters "skull length", "skull width" and "mandibular length" were given. Of these, only the last parameter (TmL) offers the possibility of comparison with data published in the international literature; the two other parameters mentioned above do not correspond to the conventional measurement methodology given in the international literature and cannot be used in comparative analyses.

4. CONCLUSIONS

Summarizing the morphometric literature on the weasel, it can be concluded that there is a need for studies that evaluate the study material by age and sex, based on representative element numbers, but the number of such studies is extremely low, despite the fact that the species is a widespread and large areal one in the Holarctic faunal realm. In order to gain a better understanding of the basic biology of the weasel, it would be important to record morphometric data for samples collected during studies, including those for other purposes such as nutrition, reproduction, etc., and to evaluate these data by age and sex. The morphometric differences between subspecies can be very significant, so the question of subspecies affiliation is not negligible in the comparative analysis of samples collected from each area. The evaluation of these data is greatly complicated by the fact that some authors only use *Mustela nivalis* in their studies (JOENSEN 1969 – Denmark, SCHMIDT 1992 – Poland, REICHSTEIN 1993 c.i. FARAGÓ 2012 – Germany, ÇOLAK *et al.* 1999 – Turkey, LANSZKI & VALKÁR 2009 – Hungary, DEMIRBAŞ & BAYDEMIR 2013 – Turkey, LAPOINT *et al.* 2017 – samples from museums in several countries), but the subspecies is not reported. In comparative studies, it is of particular importance that only the same subspecies, the same sex and age, and the same parameters can be compared. When specifying morphometric characteristics, it is also important to follow conventional measurement methodology, thus allowing for a wide range of comparability between studies carried out in different regions of the distribution area.

The comparison of body size data is greatly complicated by the fact that some parameters (in most cases EL, followed by HFL and BW and BL) are not given for both sexes, and some authors do not give the sex (SZÉKY 1972 c.i. FARAGÓ 2012, ÇOLAK *et al.* 1999), while others do not even give the age (PAROVSHCHIKOV 1963, OGNEV 1935 c.i. PAROVSHCHIKOV 1963, SZÉKY 1972 c.i. FARAGÓ 2012, ÇOLAK *et al.* 1999). In the case of body weight (BW), the degree of nutritional status is an important issue, because it can lead to significant variation in such a small species.

The issue is further complicated by the considerable scatter in the data, which raises the question of different morphometric parameters for each subspecies, as for skull parameters and body parameters, even if the authors always use *M. nivalis* in the studies we compared.

Table 1. Morphometric data of weasel (*Mustela nivalis* L.) based on published literature

Region	Literatures	n	sex/age n	BW (g)	BL (mm)	TL (mm)	HFL (mm)	EL (mm)
				$\bar{X}$ (min.-max.) ±SD				
Sweden	Čanády (2016)	9	Ad. ♂	49.89 (45.00–63.00) ±5.37	191.10 (178.00–211.00) ±9.53	29.49 (27.00–34.50) ±2.98	20.44 (19.00–22.40) ±1.03	9.69 (8.00–12.00) ±1.38
Sweden (northern part)	Stolt (1979) c.i. Abramov & Baryshnikov (2000)	87	Ad. ♂	–	202.3 (172–227)	36.1 (23–45)	–	–
Denmark	Joensen (1969)	63	Juv. n♀=13	47.3 (39–58.5)	–	–	–	–
			Ad. n♀=7	51.2 (42.7–73.3)	–	–	–	–
			Juv. n♂=18	70.6 (53.8–86.7)	–	–	–	–
			Ad. n♂=25	96.3 (72.2–131.5)	–	–	–	–
Russia	Parovshchikov (1963)	63	♀	(40–75)	121–188	19–36.8	16–26.3	–
			♂		138–204	23–26	21.2–27	–
	Ognev (1935) c.i. Parovshchikov (1963)	–	♀	–	114–162	18–35.2	17.1–23.5	–
			♂	–	130.6–208	21–40	20–26.7	–
Russia (central part)	Abramov & Baryshnikov (2000)	25	Ad. ♂	–	187.5 (130.6–232)	42.8 (26.2–61)	–	–
Lithuania	Mitskus & Baranauskas (1990) c.i. Abramov & Baryshnikov (2000)	28	Ad. ♂	–	184.0 (182–186)	38 (37–39)	–	–
Belarus	Abramov & Baryshnikov (2000)	4	Ad. ♂	–	189.8 (179–203)	48.0 (46–52)	–	–
England	King (1977) c.i. Abramov & Baryshnikov (2000)	46	Ad. ♂	–	202.0 (175–220)	60.0 (40–75)	–	–
Germany	Reichstein (1993) c.i. Faragó (2012)	241	n♀=103; 102	39.6 (26–56) (n=102)	155.5 (140–167)	34.1 (24–45)	14.9 (11–18)	12.8 (9–15)
			n♂=138	67.7 (37–107)	180.6 (157–204)	41.3 (30–52)	25.5 (21–37)	14.9 (11–18)

Table 1 (cont.): Morphometric data of weasel (*Mustela nivalis* L.) based on published literature

Region	Literatures	n	sex/age n	BW (g)	BL (mm)	TL (mm)	HFL (mm)	EL (mm)
				$\bar{X}$ (min.-max.) ±SD				
Ukraine	ABRAMOV & BARYSHNIKOV (2000)	14	Ad. ♂	–	199.8 (155–238)	57.2 (43–76.4)	–	–
France (central part)	ABRAMOV & BARYSHNIKOV (2000)	46	Ad. ♂	–	217.7 (195–253)	59.8 (39–95)	–	–
Hungary	VÁSÁRHELYI (1942); ABRAMOV & BARYSHNIKOV (2000)	5	Ad. ♂	–	222.0 (205–250)	61.2 (55–66)	–	–
	SZÉKY (1972) c.i. FARAGÓ (2012)	–	♀	–	176 (153–214)	–	–	–
			♂	–	214 (173–237)	–	–	–
	LANSZKI & VALKÁR (2009)	8	$n_{♂}$=8	145.7 (112–220) ±13.16	212.9 (194–239) ±5.87	68.9 (61–83) ±2.34	32.8 (28–39) ±1.29	–
Switzerland (Alps)	CAVAZZA (1914) c.i. ABRAMOV & BARYSHNIKOV (2000)	9	Ad. ♂	–	221.2 (208–243)	39.4 (29.2–52)	–	–
Romania	BARBU (1968) c.i. ABRAMOV & BARYSHNIKOV (2000)	43	Ad. ♂	–	218.0 (181–250)	64.3 (52–76)	–	–
Bulgaria	ZIMMERMANN (1953) c.i. ABRAMOV & BARYSHNIKOV (2000); ABRAMOV & BARYSHNIKOV (2000)	11	Ad. ♂	–	224.5 (189–260)	71.0 (49–85)	–	–
Greece	DOUMA-PETRIDOU & ONDRIAS (1986) c.i. ABRAMOV & BARYSHNIKOV (2000)	28	Ad. ♂	–	335.5 (263–382)	101.7 (65–125)	–	–
Spain	MILLER (1912); CABRERA (1914) c.i. ABRAMOV & BARYSHNIKOV (2000)	6	Ad. ♂	–	243.5 (220–278)	60.8 (50–67)	–	–
Turkey	ÇOLAK *et al.* (1999)	5	–	123.6 (47–225) ±73.65	213.2 (170–255) ±33.45	76.2 (65–100) ±12.51	35.0 (29–42) ±4.42	14.6 (10–20) ±3.66
	DEMIRBAŞ & BAYDEMIR (2013)	5	♂	263.42 (260–290) ±14.16	–	106.44 (105–110) ±2.70	43.28 (43–45) ±1.05	13.22 (9–18) ±4.36

n - number of individuals; Juv - juvenile; Ad. – adult; $\bar{X}$ *- mean; min.-max. - minimum and maximum; ±SD – standard deviation;*
BW – body weight; **BL** – body lenght; **TL** – tail lenght; **HFL** – hind foot lenght; **EL** – ear lenght.

Table 2. Morphometric data of the skull of weasel (*Mustela nivalis* L.)

Region	Literatures	n	sex/age	CbL (n)	NcL (n)	VcL (n)	PtL (n)	MxtL (n)	PuL (n)	BcL (n)	AbL (n)	ZyB (n)	GmB (n)	PoB (n)	InB (n)
				$\bar{X}$ (min.-max.) ±SD											
Sweden	ČANÁDY (2016)	7; 8; 9	Ad. ♂	31.91 (31.06–32.90) ±0.73 (n=7)	15.99 (15.15–16.45) ±0.44 (n=7)	17.60 (16.70–18.61) ±0.57 (n=7)	12.92 (12.13–15.72) ±1.13 (n=9)	8.44 (8.02–9.57) ±0.48 (n=9)	3.05 (2.65–3.25) ±0.19 (n=9)	–	–	16.28 (15.43–17.29) ±0.53 (n=8)	14.78 (14.05–15.10) ±0.34 (n=7)	–	6.91 (6.78–7.24) ±0.15 (n=8)
Russia	PAROVSHCHIKOV (1963)	63	♀	(31–32.3)	–	–	–	8.8	–	–	–	(15–18)	13.5–17.5	–	–
			♂	(31.2–38)	–	–	–	9.3	–	–	–	(17-19.5)	14.5–17.8	–	–
	OGNEV (1935) c.i. PAROVSHCHIKOV (1963)	–	♀	(30–34.7)	–	–	–	8.2 (7.8–9.7)	–	–	–	14.2–17.8	–	–	–
			♂	(31.7–37.1)	–	–	–	9.1 (8.2–10)	–	–	–	15.1–20	–	–	–
North-Eastern Europe	ABRAMOV & BARYSHNIKOV (2000)	27	Ad. ♂	33.50	22.78	13.57	13.17	8.62	3.34	14.01	11.58	17.24	15.98	7.85	7.23
England	ABRAMOV & BARYSHNIKOV (2000)	30	Ad. ♂	38.25	22.87	17.12	15.83	10.45	3.87	15.52	12.39	20.63	18.07	8.64	8.44
C. Russia	ABRAMOV & BARYSHNIKOV (2000)	13	Ad. ♂	37.34	23.89	16.28	15.21	10.02	3.75	15.34	12.55	19.42	17.72	7.77	7.84
Poland	SCHMIDT (1992)	11; 17	Juv. ♀	31.7 (30.1–33.3) ±0.9 (n=17)	22.9 (21.5–24.0) ±0.8 (n=17)	11.7 (10.9–12.4) ±0.5 (n=17)	–	8.0 (7.3–8.8) ±0.4 (n=17)	–	–	–	16.2 (14.9–17.1) ±0.7 (n=11)	–	8.1 (7.3–8.8) ±0.4 (n=17)	6.5 (5.9–7.2) ±0.3 (n=17)

Table 2 (cont.). Morphometric data of the skull of weasel (*Mustela nivalis* L.)

Region	Literatures	n	sex/age	CbL (n)	NcL (n)	VcL (n)	PtL (n)	MxtL (n)	PuL (n)	BcL (n)	AbL (n)	ZyB (n)	GmB (n)	PoB (n)	InB (n)
				$\bar{X}$ (min.-max.) ±SD											
Poland	SCHMIDT (1992)	26; 29; 32; 33	Sub-ad. ♀	31.6 (29.1–36.8) ±1.6 (n=33)	22.8 (20.3–25.8) ±1.1 (n=32)	11.6 (10.5–14.1) ±0.7 (n=32)	–	8.1 (7.2–10.3) ±0.6 (n=33)	–	–	–	15.8 (14.3–18.8) ±1.1 (n=26)	–	7.6 (6.5–8.7) ±0.5 (n=29)	6.4 (5.5–8.3) ±0.5 (n=32)
		19; 61; 65; 66	Ad. ♀	31.9 (29.5–35.6) ±1.6 (n=65)	22.9 (21.0–26.0) ±1.0 (n=65)	11.5 (10.0–13.0) ±0.7 (n=66)	–	8.1 (7.0–9.4) ±0.5 (n=66)	–	–	–	15.8 (14.2–18.6) ±1.1 (n=61)	–	6.8 (6.0–7.5) ±0.4 (n=19)	6.5 (5.6–7.5) ±0.4 (n=66)
		21; 25; 26	Juv. ♂	36.6 (32.3–39.0) ±1.8 (n=25)	26.1 (23.3–27.9) ±1.1 (n=26)	13.9 (11.7–15.4) ±0.9 (n=25)	–	9.5 (8.0–10.5) ±0.6 (n=25)	–	–	–	19.6 (17.1–21.1) ±1.2 (n=21)	–	8.9 (7.7–9.8) ±0.5 (n=25)	7.6 (6.5–8.4) ±0.5 (n=25)
		41;44;45;46;49	Sub-ad. ♂	36.9 (32.4–40.2) ±2.1 (n=46)	26.2 (23.1–28.8) ±1.6 (n=45)	13.9 (12.0–16.3) ±1.0 (n=49)	–	9.5 (8.3–10.7) ±0.6 (n=49)	–	–	–	19.6 (16.7–22.4) ±1.4 (n=44)	–	8.4 (7.4–9.8) ±0.5 (n=41)	7.7 (6.5–8.8) ±0.5 (n=47)
		48; 72; 78; 79	Ad. ♂	38.7 (33.7–44.5) ±2.2 (n=78)	27.3 (23.9–30.8) ±1.4 (n=78)	14.7 (12.4–16.7) ±1.0 (n=79)	–	10.2 (8.0–11.5) ±0.7 (n=79)	–	–	–	20.6 (17.4–24.6) ±1.6 (n=72)	–	7.9 (6.4–8.9) ±0.6 (n=48)	8.2 (6.5–9.7) ±0.5 (n=79)

Table 2 (cont.). Morphometric data of the skull of weasel (*Mustela nivalis* L.)

Region	Literatures	n	sex/age	CbL (n)	NcL (n)	VcL (n)	PtL (n)	MxtL (n)	PuL (n)	BcL (n)	AbL (n)	ZyB (n)	GmB (n)	PoB (n)	InB (n)
				$\overline{X}$ (min.-max.) ±SD											
Germany	Reichstein (1993) c.i. Faragó (2012)	94	n♀=25	31.09 (29.7–33.0)	–	–	–	–	–	–	–	–	–	–	–
			n♂=69	35.78 (32.0–38.2)	–	–	–	–	–	–	–	–	–	–	–
France	Abramov & Baryshnikov (2000)	22	Ad. ♂	38.10	22.65	17.19	16.08	10.54	3.95	15.36	12.39	20.20	18.00	8.43	8.26
Hungary	Faragó (2012)	65	n♀=13	–	–	–	–	–	–	–	–	–	–	–	–
			n♂=52	–	–	–	–	–	–	–	–	–	–	–	–
C. Europe	Abramov & Baryshnikov (2000)	45	Ad. ♂	37.97	23.02	17.19	15.78	10.25	3.86	15.41	12.42	20.14	17.99	8.13	8.13
S. Europe	Abramov & Baryshnikov (2000)	17	Ad. ♂	42.66	25.29	19.81	17.96	11.62	4.23	17.05	13.73	23.28	20.61	8.24	9.13
Italy	Abramov & Baryshnikov (2000)	4	Ad. ♂	41.43	23.83	19.42	17.78	11.58	4.25	16.40	13.20	22.03	20.03	8.08	8.93
Greece	Abramov & Baryshnikov (2000)	1	Ad. ♂	45.40	25.10	21.90	19.10	12.20	4.50	18.10	14.30	26.40	22.40	9.30	10.30

Table 2 (cont.). Morphometric data of the skull of weasel (*Mustela nivalis* L.)

Region	Literatures	n	ivar/kor	CbL (n)	NcL (n)	VcL (n)	PtL (n)	MxtL (n)	PuL (n)	BcL (n)	AbL (n)	ZyB (n)	GmB (n)	PoB (n)	InB (n)
				$\bar{X}$ (min.-max.) ±SD											
Spain	ABRAMOV & BARYSHNIKOV (2000)	15	Ad. ♂	39.93	22.64	18.26	16.47	10.87	3.97	16.06	12.71	22.01	19.29	8.20	8.53
Turkey	ÇOLAK *et al.*, (1999)	5	–	39.56 (35.8–45.7) ±3.95	–	–	15.18 (13.3–17.2) ±1.43	11.64 (10.0–12.8) ±1.07	–	–	13.10 (11.7–14.6) ±1.08	22.54 (18.7-26.8) ±3.50	–	–	8.36 (7.8–9.2) ±8.36
	ABRAMOV & BARYSHNIKOV (2000)	5	Ad. ♂	40.60	22.68	19.36	17.02	11.32	4.18	16.38	13.08	21.00	19.38	8.78	8.82
	DEMIRBAŞ & BAYDEMIR (2013)	4; 5	♂	47.06 (45.95–48.40) ±1.02 (n=4)	–	–	20.15 (19.90¬20.50) ±0.26 (n=5)	12.73 (12.00–13.15) ±0.53 (n=5)	–	–	–	27.05 (26.50–27.70) ±0.5 (n=4)	23.07 (22.60–23.70) ±0.46 (n=4)	7.43 (7.00–7.75) ±0.33 (n=4)	11.15 (11.00–11.50) ±0.24 (n=4)

CbL - condylobasal lenght; **NcL** - upper neurocranium length; **VcL** - viscerocranium length; **PtL** - median palatal length; **MxtL** - maxillary tooth-row length; **PuL** - upper carnassial teeth P^4 length; **BcL** – greatest length between oral border of the auditory bulla and aboral border of the occipital condyles; **AbL** - greatest diameter of the auditory bulla; **ZyB** - zygomatic breadth; **GmB** - greatest mastoid breadth; **PoB** - postorbital breadth; **InB** - interorbital constriction;
Juv. *– juvenile;* ***Ad.*** *– adult;* ***Sub-ad.*** *– subadult;*
n - number of individuals; $\bar{X}$ *- mean; min.-max. - minimum and maximum; ±SD – standard deviation.*

Table 3. **Morphometric data of the skull of weasel (*Mustela nivalis* L.)**

Region	Literatures	n	sex/age	AbB (n)	MuB (n)	GpB (n)	CaB (n)	TmL (n)	*BcB (n)*	*EctB (n)*	*BcH (n)*	AmL (n)	MatL (n)	M_1L (n)	MaH (n)
				$\bar{X}$ (min.-max.) ±SD											
Sweden	ČANÁDY (2016)	7; 8; 9	Ad. ♂	–	–	9.68 (9.18–10.25) ±0.29 (n=9)	–	16.09 (15.40–18.52) ±1.02 (n=8)	–	–	–	14.46 (13.73–15.21) ±0.43 (n=8)	9.88 (9.08–11.09) ±0.58 (n=8)	3.39 (2.99–3.78) ±0.27 (n=8)	7.47 (6.80–8.11) ±0.43 (n=8)
Russia	PAROVSHCHIKOV (1963)	63	♀	–	–	–	–	–	–	–	–	–	–	–	–
			♂	–	–	–	–	–	–	–	–	–	–	–	–
	OGNEV (1935)c.i. PAROVSHCHIKOV (1963)	–	♀	–	–	–	–	–	–	–	–	–	–	–	–
			♂	–	–	–	–	–	–	–	–	–	–	–	–
North-Eastern Europe	ABRAMOV & BARYSHNIKOV (2000)	27	Ad. ♂	5.83	9.83	5.10	2.62	16.50	–	–	–	15.16	10.10	3.58	7.62
England	ABRAMOV & BARYSHNIKOV (2000)	30	Ad. ♂	8.29	11.92	6.80	3.06	19.70	–	–	–	18.51	11.70	4.12	9.24
C. Russia	ABRAMOV & BARYSHNIKOV (2000)	13	Ad. ♂	6.75	11.25	5.53	3.00	19.65	–	–	–	18.03	11.85	4.08	8.83
Poland	SCHMIDT (1992)	14; 15; 17	Juv ♀	–	–	–	–	15.3 (14.0–16.6) ±0.7 (n=14)	16.4 (15.5–17.4) ±0.6 (n=17)	8.7 (8.0–9.4) ±0.4 (n=17)	13.1 (12.4–14.0) ±0.5 (n=17)	–	–	–	7.1 (6.5–8.2) ±0.4 (n=15)

Table 3 (cont.). Morphometric data of the skull of weasel (*Mustela nivalis* L.)

Region	Literatures	n	sex/age	AbB (n)	MnB (n)	GpB (n)	CaB (n)	TmL (n)	*BcB (n)*	*EctB (n)*	*BcH (n)*	AmL (n)	MatL (n)	M_1L (n)	MaH (n)
				$\overline{X}$ (min.-max.) ±SD											
Poland	SCHMIDT (1992)	28; 30; 32; 33	Sub-ad. ♀	–	–	–	–	15.3 (14.1–18.4) ±1.0 (n=30)	15.6 (14.4–17.0) ±0.7 (n=32)	8.5 (7.8–10.7) ±0.7 (n=30)	12.3 (11.1–13.6) ±0.6 (n=32)	–	–	–	7.2 (6.3–8.7) ±0.6 (n=28)
		62; 63; 65; 66	Ad. ♀	–	–	–	–	15.4 (13.5–17.3) ±1.0 (n=66)	14.6 (13.2–16.5) ±0.7 (n=65)	8.5 (7.6–10.5) ±0.6 (n=62)	11.2 (10.0–13.0) ±0.7 (n=63)	–	–	–	7.2 (6.2–8.5) ±0.5 (n=66)
		25; 26	Juv. ♂	–	–	–	–	18.7 (15.5–20.4) ±1.2 (n=25)	18.2 (17.1–19.4) ±0.7 (n=26)	9.8 (8.7–10.7) ±0.6 (n=25)	14.9 (13.4–15.9) ±0.6 (n=25)	–	–	–	8.9 (7.7–10.1) ±0.6 (n=25)
		42; 46; 47; 48	Sub-ad. ♂	–	–	–	–	18.7 (15.6–21.3) ±1.3 (n=46)	17.4 (15.6–19.6) ±1.0 (n=46)	9.8 (8.5–11.3) ±0.7 (n=47)	14.3 (11.8–16.4) ±1.0 (n=42)	–	–	–	9.0 (7.2–11.0) ±0.8 (n=46)
		64; 77; 78; 79	Ad. ♂	–	–	–	–	20.0 (16.5–23.4) ±1.5 (n=78)	17.1 (14.0–19.6) ±0.9 (n=77)	10.5 (8.8–12.2) ±0.7 (n=79)	13.8 (12.5–15.5) ±0.7 (n=64)	–	–	–	9.5 (7.8–11.5) ±0.8 (n=78)

Table 3 (cont.). Morphometric data of the skull of weasel (*Mustela nivalis* L.)

Region	Literatures	n	sex/age	AbB (n)	MuB (n)	GpB (n)	CaB (n)	TmL (n)	*BcB (n)*	*EctB (n)*	*BcH (n)*	AmL (n)	MatL (n)	M_1L (n)	MaH (n)
				$\overline{X}$ (min.-max.) ±SD											
Germany	REICHSTEIN (1993) c.i. FARAGÓ (2012)	94	n♀=25	–	–	–	–	15.70 (14.8–17.0)	–	–	–	–	–	–	–
			n♂=69	–	–	–	–	18.77 (15.5–20.0)	–	–	–	–	–	–	–
France	ABRAMOV & BARYSHNIKOV (2000)	22	Ad. ♂	8.20	11.76	6.57	3.24	19.72	–	–	–	18.62	11.98	4.21	9.38
Hungary	FARAGÓ (2012)	65	n♀=13	–	–	–	–	17.33 (13.0–21.8)	–	–	–	–	–	–	–
			n♂=52	–	–	–	–	21.94 (15.9–25.2)	–	–	–	–	–	–	–
C. Europe	ABRAMOV & BARYSHNIKOV (2000)	45	Ad. ♂	7.88	11.67	6.48	3.05	19.80	–	–	–	18.44	11.94	4.12	9.46
S. Europe	ABRAMOV & BARYSHNIKOV (2000)	17	Ad. ♂	8.41	13.00	6.77	3.28	23.21	–	–	–	21.58	13.62	4.60	10.96
Italy	ABRAMOV & BARYSHNIKOV (2000)	4	Ad. ♂	9.03	12.88	7.07	3.23	22.30	–	–	–	20.95	13.40	4.55	10.58
Greece	ABRAMOV & BARYSHNIKOV (2000)	1	Ad. ♂	10.70	14.30	7.70	3.40	24.10	–	–	–	23.70	14.00	4.60	12.50

Table 3 (cont.). Morphometric data of the skull of weasel (*Mustela nivalis* L.)

Region	Literatures	n	sex/age	AbB (n)	MuB (n)	GpB (n)	CaB (n)	TmL (n)	*BcB (n)*	*EctB (n)*	*BcH (n)*	AmL (n)	MatL (n)	M_1L (n)	MaH (n)
				$\bar{X}$ (min.-max.) ±SD											
Spain	ABRAMOV & BARYSHNIKOV (2000)	15	Ad. ♂	8.78	12.50	7.10	3.15	20.88	–	–	–	19.69	12.55	4.21	10.17
Turkey	ÇOLAK *et al.*, (1999)	5	–	–	–	–	–	21.28 (17.8–24.3) ±2.46	18.95 (16.8–20.1) ±1.66	–	–	–	12.06 (10.2–13.5) ±1.04	–	–
	ABRAMOV & BARYSHNIKOV (2000)	5	Ad. ♂	8.04	12.66	6.86	3.30	21.84	–	–	–	20.10	13.08	4.36	10.02
	DEMIRBAŞ & BAYDEMIR (2013)	4; 5	♂	–	–	–	–	25.41 (24.30–26.25) ±0.86 (n=5)	–	–	17.41 (17.20–17.90) ±0.32 (n=4)	–	14.53 (14.00–15.20) ±0.49 (n=5)	–	11.83 (11.20–12.20) ±0.43 (n=5)

AbB – least diameter of the auditory bulla; **MuB** – upper molar M^1 breadth; **GpB** – greatest palatal breadth; **CaB** – rostrum breadth; **TmL** – mandible length; **BcB** – braincase breadth; **EctB** – ectoorbital breadth; **BcH** – braincase height; **AmL** – length between the angular process and infradentale; **MatL** – mandibular toothrow length; **M_1L** – length of lower carnassial teeth M_1; **MaH** - height of ramus mandibulae. A ***BcB, EctB, BcH*** paramétereket SCHMIDT (1992) rögzítette.

Juv. *– juvenile;* ***Ad.*** *– adult;* ***Sub-ad.*** *– subadult;*

n – number of individuals; $\bar{X}$ *– mean; min.-max. – minimum and maximum; ±SD – standard deviation.*

According to the map published by ABRAMOV & BARYSHNIKOV (2000) showing the distribution of each subspecies, *M. nivalis* is present in several subspecies in the reference countries of our samples (*M. n. vulgaris, M. n. rossica, M. n. boccaela* see. **Map 1**), but there are no statistically verified differences in the morphometric characteristics of these subspecies, so it is not known to what extent the differences in the data series (small number of elements), which are restricted to adult individuals, are influenced by the question of subspecies affiliation.

An important methodological issue in examining the difference in adult body weight between the sexes would be whether to weigh the animals with full or empty stomachs, but no methodological approach is given by the authors. Unfortunately, data reporting varies with regard to the accuracy of the recording of the data, with some authors reporting the results of their measurements as integer values and others with an accuracy of up to a hundredth (**Tables 2** and **3**). In addition, the question of element numbers should be mentioned, as some studies base their findings on data from samples of less than ten specimens (in MILLER 1912 c.i. ABRAMOV & BARYSHNIKOV 2000, CAVAZZA 1914 c.i. ABRAMOV & BARYSHNIKOV 2000, CABRERA 1914 c.i. ABRAMOV & BARYSHNIKOV 2000, VÁSÁRHELYI 1942, ABRAMOV & BARYSHNIKOV 2000, ZIMMERMANN 1953 c.i. ABRAMOV & BARYSHNIKOV 2000, ÇOLAK *et al.* 1999, LANSZKI & VALKÁR 2009, DEMIRBAŞ & BAYDEMIR 2013, ABRAMOV & BARYSHNIKOV 2000, ČANÁDY 2016), which, although a valuable addition to the scarce knowledge of the species, does not meet the need for representativeness and thus does not provide a reliable basis for comparison, especially by age and sex.

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