

The need for consistent data collection for large-scale comparative studies illustrated by the study of morphology of the red fox *Vulpes vulpes*

Jan K. Å. Englund*, Morten Elmeros & Lars E. W. Österdahl

ABSTRACT. The size of mammals is often given as the head and body length (HBL). The condylobasal length of the skull (CBL) is also used as a measure of the size of mammals. The HBL in small mammals is mostly measured from the tip of the nose to the root of the tail. In species like whales, human beings and elephants, the measurements are not comparable with those from small mammals which in fact does not matter. On the contrary, it is of prime importance for the measurements taken within the same species to be comparable. If we deal with incomparable data from different authors or museums, it may result in false conclusions. In the present paper this problem is illustrated by the red fox *Vulpes vulpes*. The HBL in Scandinavian red fox is 4.43 to 4.54 times the CBL. Data in the literature indicates that European foxes outside Sweden have a HBL 4.54 to 4.96 times their CBL. The difference is probably an artifact of different measuring techniques. Therefore we believe that CBL gives better information about the size of the foxes. However, the length of the skull is far from ideal here, since the proportion HBL/CBL seems to vary geographically. We suggest that what has been measured and how the measurements have been taken must be carefully reported by the authors. The scientists would know then which data can certainly be used for an extended meta-analysis.

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KEY WORDS: condylobasal length, head and body length, measuring technique, morphology, red fox, Scandinavia, *Vulpes vulpes*.

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Необходимость сбора сопоставимых морфологических данных для проведения широкомасштабного сравнительного анализа на примере обыкновенной лисицы *Vulpes vulpes*

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РЕЗЮМЕ. В качестве критерия размеров животных обычно приводится длина тела (ДТ). В этом же качестве используется также кондильобазальная длина черепа (КДЧ). У мелких млекопитающих ДТ в большинстве случаев измеряется от кончика носа до основания хвоста. Параметры таких видов как кит, человек или слон не сопоставимы с таковыми мелких млекопитающих, что не существенно. Сопоставимость же результатов измерений, произведенных на особях одного вида, имеет первостепенное значение. При обработке несравнимых данных, полученных от разных авторов или из разных музеев, неизбежны ошибочные выводы. Сказанное иллюстрируется в данной статье на примере лисицы *Vulpes vulpes*. ДТ скандинавской лисицы превышает ее КДЧ в 4.43–4.54 раза. По литературным данным, ДТ европейской лисицы (исключая Швецию) превышает КДЧ в 4.54–4.96 раза. Причиной такого расхождения, является, вероятно, артефакт, несоответствие методик измерений. Авторы полагают, что КДЧ дает более верное представление о размерах обыкновенной лисицы. Однако и этот параметр далеко не идеален, поскольку отношение ДТ/КДЧ имеет географическую изменчивость. Авторы считают, что в печатных трудах необходимо тщательное описание объекта и методики измерений. Только при этом условии опубликованные данные могут быть использованы для обширного мета-анализа.

КЛЮЧЕВЫЕ СЛОВА: кондильобазальная длина, длина тела, методика измерений, морфология, лисица, Скандинавия, *Vulpes vulpes*.

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Introduction

Data published in scientific papers serve not only to support the findings and theories being put forward, but also to provide information that other scientists can use to combine with their own data for an extended meta-analysis. This is especially important when studying the morphological variations in animal inhabiting vast geographical areas. However, this has many implications and challenges such as differences in the definition of morphological measurements and how the measurements are taken (Ansell, 1965).

In this study we specifically compared the head and body length and the condylobasal length of red foxes *Vulpes vulpes* Linnaeus, 1758 from data provided in the literature and from data collected by ourselves.

Material and methods

Our study is based on data on structural measurements of foxes from the European continent (data taken from the literature) and from foxes we have collected in Denmark (D1, 55–58° N latitude, $n = 47$) and four regions in Sweden namely northern Norrland (S1, 62–68° N, $n = 363$), southern Norrland inclusive Värmland and Dalarna (S2, 59.5–62.0° N, $n = 346$), central Sweden (S3, 58.5–60.0° N, $n = 312$) and the province Scania inclusive Halland and Blekinge (S4, 55.3–56.3° N, $n = 319$) in the most southern part of Sweden (Fig. 1). All foxes in our study were at least seven months old. Furthermore we only used foxes where we have data from both the head and body length (HBL) and the condylobasal length (CBL). This is not always the case for the literature data.

For HBL a special measuring board with a one mm scale was used (Fig. 2). The fox is placed on its back on the board with the first vertebrae of the tail bent over the end of the board. The body is moderately stretched, a glider is moved to touch the nose, and the measurement is taken to the nearest mm. The procedure is repeated until a consistent value is achieved. The length of the fox was set as the mean of the values after rejecting any extreme values. This way of measuring the head and body length is preferable (Ansell, 1965).

Furthermore 123 foxes have been measured from the tip of the nose to the root of the tail using a measuring tape that followed the back of the body. However, we placed the foxes on their stomachs instead of on the side as recommended by Ansell (1965) and the foxes were not stretched. All measurements were taken by Englund. The CBL was measured as described by von den Driesch (1976).

Student t-test was used when comparing two different ways of measuring HBL, and also for the comparisons of HBL/CBL between Danish and Swedish foxes.

Results

The ratio between the HBL and the CBL in both males and females differed considerably between our material and that from the published studies. In our material the

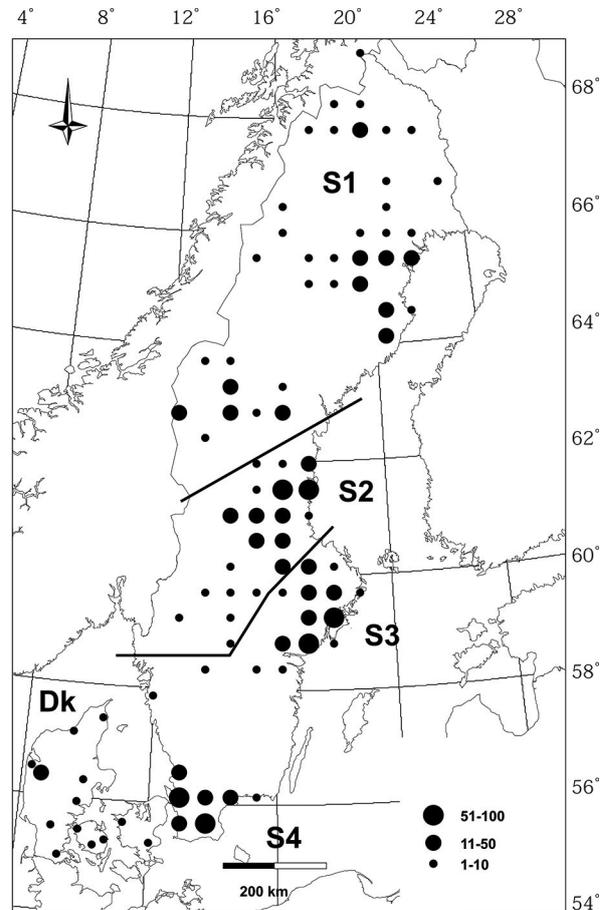


Fig. 1. The distribution of the material per 50 × 50 km squares within five areas in Scandinavia (S1 — northern Norrland, S2 — southern Norrland, S3 — central Sweden, S4 — Scania, Dk — Denmark). Size of black circles show the number of studied fox specimens.

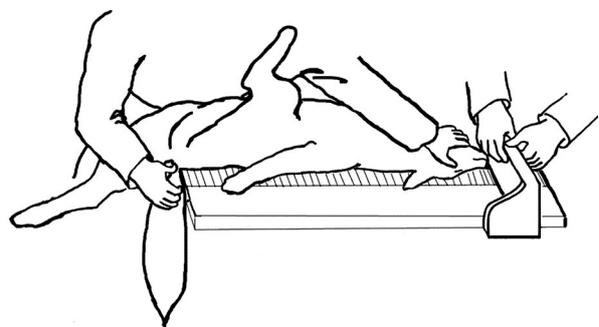


Fig. 2. The method used to position foxes on the measuring board.

HBL was 4.4 to 4.5 times longer than the CBL for both sexes, while the HBL in the previously published European material was as much as 4.6 to 5.0 and 4.5 to 4.8 times longer than the CBL for males and females respectively (Table 1). Therefore, according to the literature, most foxes

in Europe have much longer bodies relative to the length of the skull than the Swedish foxes (Fig. 3).

The difference in the Danish foxes measured by Englund and others is remarkable (Fig. 3, Table 1). According to our data, the HBL for both sexes in Danish foxes was 4.4 times longer than the skulls while according to others it was 4.6 and 4.7 times longer. Therefore, if our limited data on Danish foxes give the true picture, then they have shorter bodies relative to the skulls than the Swedish foxes (Fig. 3, Table 2; $p < 0.01$

in six times out of eight) and also shorter bodies than Danish foxes, measured by other researchers.

According to Stubbe & Stubbe (1977), the HBL in male and female German foxes is 5.0 and 4.8 times longer than their skulls, which is extremely different from our data (Fig. 3, Table 1).

The measurement attained when using a measuring tape that follows the back and the neck was 716.9 mm, which is 61.5 mm longer than with our method (655.4 mm), $sd = 42.8 / 33.6$; $n = 123$.

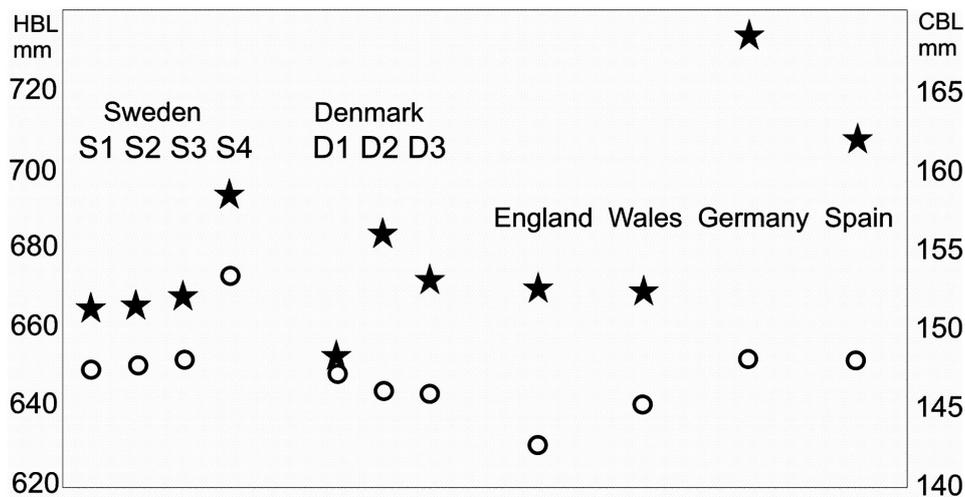


Fig. 3. HBL (stars) and CBL (circles) in males of *Vulpes vulpes*. The number of specimens and references is given in Table 1.

Table 1. The proportions between HBL and CBL.

Region	Males			Females		
	HBL/CBL	n (HBL)	n (CBL)	HBL/CBL	n (HBL)	n (CBL)
S1	4.51	210	210	4.49	153	153
S2	4.50	216	216	4.50	130	130
S3	4.51	170	170	4.54	142	142
S4	4.52	198	198	4.51	121	121
D1	4.43	26	26	4.44	21	21
D2	4.68	?	18	4.70	?	15
D3	4.61	7	7	4.68	7	7
England	4.70	34	94	4.66	31	98
Wales	4.61	?	165	4.54	?	214
Germany	4.96	39	58	4.80	27	31
Spain	4.87	65	22	—	—	—

Notes:

S1 to D1 — all foxes have been measured by J. Englund;

D2, D3 — data from Wandeler & Lüps (1993);

England — HBL data from Kolb & Huson (1974); CBL data from Huson & Page (1979);

Wales — HBL data from Lloyd (1980) as cited by Cavallini (1995); CBL data from Huson & Page (1979);

Germany — data from Stubbe & Stubbe (1977);

Spain — HBL data from Travaini & Delibes (1995); CBL data from Wandeler & Lüps (1993).

Table 2. The proportion between HBL and CBL of *Vulpes vulpes*. The *p*-values show the significance of the differences in the proportions in foxes from different parts in Sweden compared with the foxes in Denmark (D1).

HBL/CBL	Males					Females				
	S1	S2	S3	S4	D1	S1	S2	S3	S4	D1
mean	4.51	4.50	4.51	4.52	4.43	4.49	4.50	4.54	4.51	4.44
sd	0.146	0.120	0.154	0.127	0.096	0.131	0.143	0.148	0.109	0.101
<i>n</i>	210	216	170	198	26	153	130	142	121	21
median	4.49	4.50	4.51	4.51	4.41	4.48	4.49	4.53	4.51	4.43
max	5.04	4.85	4.91	4.90	4.69	4.82	5.08	4.91	4.78	4.63
min	4.20	4.14	4.05	4.03	4.27	4.22	4.15	4.14	4.28	4.26
<i>p</i> <	0.01	0.01	0.01	0.001	–	–	0.05	0.01	0.01	–

Discussion

The differences between the Scandinavian and the continental foxes in HBL and CBL measurements are remarkably large (Fig. 3, Table 1). We suggest that this mainly is a result of how structural measurements were defined and taken. If so the different measurements of HBL are not comparable and may result in false conclusions, if the data are combined.

In some publications HBL has been measured from the tip of the nose to the base of the tail. However, this distance can be measured the shortest or the longest way where the measuring tape follows all the curves in the back and in the neck. The latter measure is about 62 mm longer (9.4%).

Sometimes the foxes have been measured from the tip of the nose to the tip of the tail and then the HBL was determined by subtracting the length of the tail. However, the length of the tail sometimes is measured from the tip of tail to the back of the fox while in other cases from the tip of the tail to the anus. The latter measurement will give an average of 3.3% longer estimate of tail length (14.3 mm, *n* = 61) and subsequently shorter estimates for the body length.

Apart from the challenges that may be caused by differences in what has been measured, it is also important to consider how they have been measured. Before the measurements are taken, the foxes may or may not have been stretched, another factor to consider.

Thus, when analyzing data from different publications, the risk for false conclusions is eminent.

The length of the skull is often used as a substitute for the size of mammals. This measurement is well defined and accurate. However, our data show that the proportion between the length of the skull and the head and body length is not constant (Fig. 3 and Table 1, 2; note the different distances between the stars and the circles in Swedish and Danish foxes measured by Englund, S1–S4 and D1).

We believe that the Swedish foxes have longer bodies relative to the skulls, than what the foxes in the western part of the continental Europe have.

Conclusion

When describing the size of mammals the authors should inform the readers very carefully what has been measured and how the measurements were taken. Another conclusion is that the length of the skull is not a consistent proxy for the size of mammals in individuals from different regions and direct comparisons between studies may result in false conclusions. Therefore the proportion between the skull and the head and body length should always be determined, with at least a moderate large number of specimens from all areas studied, before a large material of skulls are used in an extended meta-analysis.

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