

Skeletons in her Cupboard

Festschrift for Juliet Clutton-Brock

Edited by Anneke Clason, Sebastian Payne and Hans-Peter Uerpmann

Oxbow Monograph 34
1993

Late Medieval lynx skeleton from Hungary

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1. Introduction

Among the wild animal remains found at archaeological sites in Hungary carnivore bones are relatively uncommon. This is especially the case in later historical times when the significance of hunting in food procurement decreased, so that the probability of killing other game declined as well. Consequently, sporadic remains of lynx are more characteristic of prehistoric faunal assemblages both in Hungary (Bökönyi, 1959: 54; 1974: 82; Vörös 1987: 125) and other countries in Europe as summarized by Van Bree and Clason (1971: 134).

Remains of a lynx (*Lynx lynx* L. 1758) from a 15th century pit at the urban settlement of Vác – Széchenyi utca may thus be considered a rarity. Their correct interpretation creates both a need and an opportunity to synthesize ecological, osteometrical and historical information on this animal.

2. Material and methods

2.1 THE ARCHAEOLOGICAL SPECIMEN AND ITS HABITAT

The city of Vác is located in the northern part of present-day Hungary, in the Danube Bend region where the river turns southward to Budapest after a long west-east stretch connecting Vienna with Bratislava.

Elements of the disarticulated skeleton were found in the 15th century Pit 26/a. They included the skull (Figures 1 to 3) with the right mandible, left pelvis, both humeri and radii, left femur, right tibia and three metatarsals from a young, medium size individual. Ribs and vertebrae were not identified.

The city's environment is characterized by a hilly topography with elevations of 500 to 700 meters (relative to the Adriatic sea level) on both banks. The city itself is located on the relatively narrow alluvial deposit on the river's left bank. Its natural environment is characterized by forests even today and was certainly covered by woods throughout the Middle Ages. For centuries the Royal Hunting grounds extended around the royal castle of Visegrád just across the Danube

river (Bartosiewicz, 1989: 2). The most preferred lynx habitat is composed of tall forests with dense undergrowth and windfalls (Guggisberg, 1975: 52; Nowak, 1991: 1195).

In order to reconfirm the common Medieval occurrence of this carnivore in the area, the modern distribution of lynx is also worth considering. While Guggisberg (1975: 51) mentioned no resident lynx populations in Hungary, he refers to the high degree of biological dynamism of this species. The range size of lynx is adaptive. A maximum population density of 5 individuals per 100 square kilometers has been reported from Eastern Europe (Schauenberg 1969: 272). In the case of the site under discussion here the proximity of mountainous regions in present day Slovakia is especially important since increasing population pressure in lynx habitats has been known to result in a west- and southward movements (Hell, 1961: 57). Concomitant relatively frequent occurrences in the hilly regions of Northern Hungary are shown in Figure 4 (Szemethy et al., 1991).

Average distances covered by a lynx in a night's activity period may vary between 5 (Nellis and Keith, 1968) and 19 km (Haglund, 1966). 18 km has been reported from neighboring Slovakia (Schauenberg, 1969: 272). These distances more or less correspond to range sizes between 16 to 75 square kilometers (Saunders, 1963: 387; Haglund, 1966). Based on the 27 square kilometers home range reported by Hell (1968), a quarter of a century ago the population density of European lynx was high in the Carpathian region (Guggisberg, 1975: 55). This statement may still hold true in light of the isolated character of this area in comparison with Scandinavia or Canada. Considering range size an adaptive response, one may hypothesize that different parameters held true in Medieval Hungary before massive deforestation.

2.2 REFERENCE MATERIALS

Osteological literature on lynx is scarce. The age and sex of the Vác – Széchenyi utca individual were estimated using the craniometric analysis of modern reference

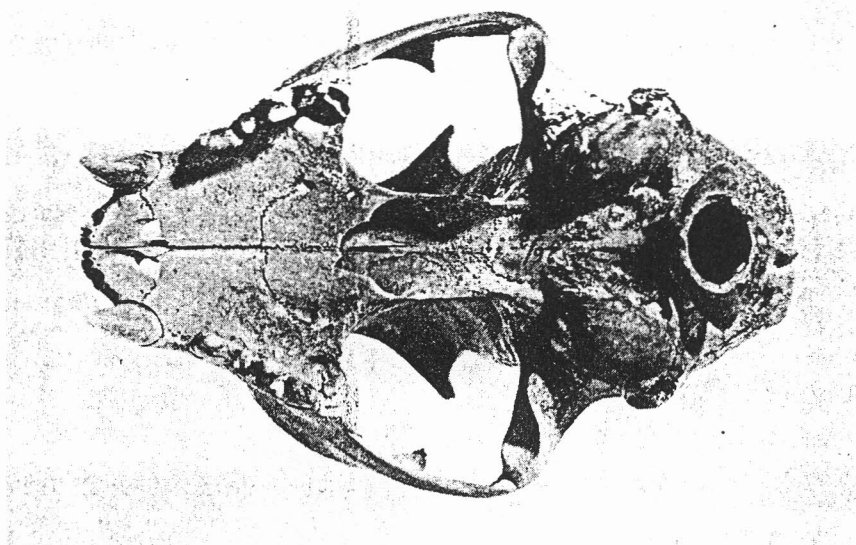


Figure 1: Lynx skull from Vác - Széchenyi utca. Norma basilaris.



Figure 2: Lynx skull from Vác - Széchenyi utca. Norma lateralis.

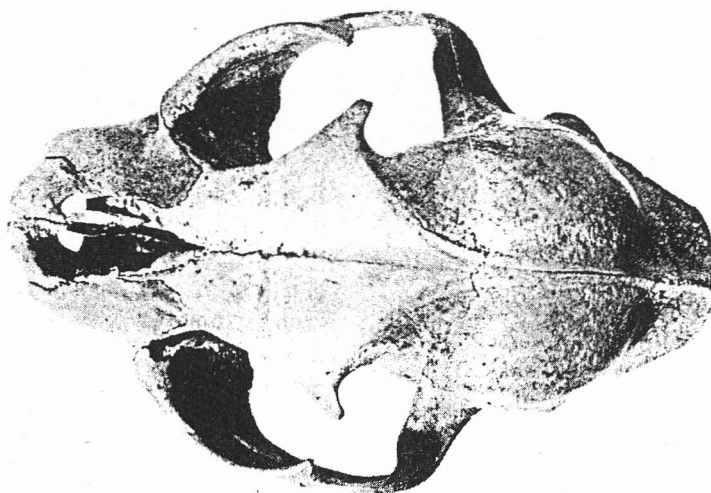


Figure 3: Lynx skull from Vác - Széchenyi utca. Norma frontalis.

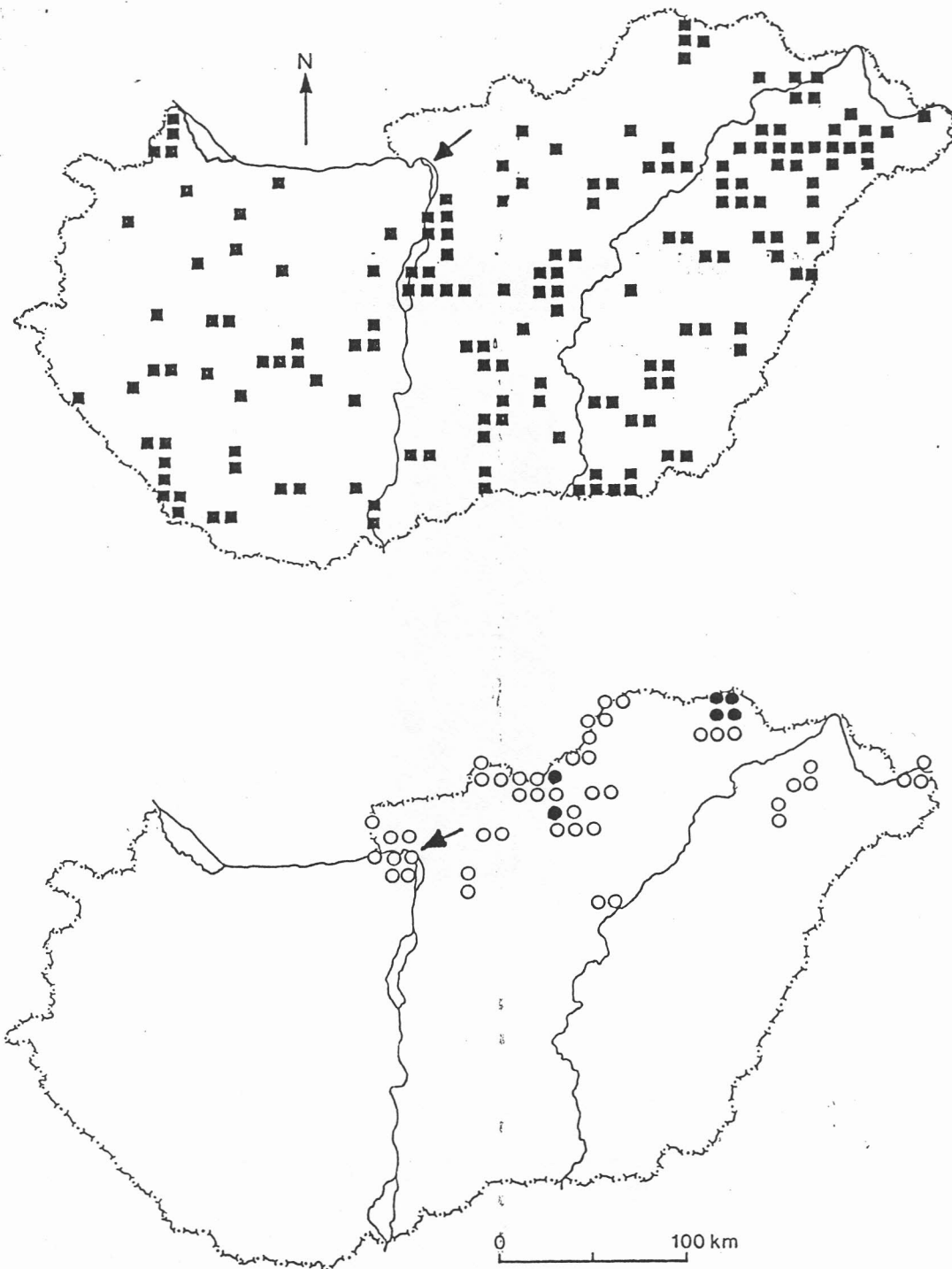


Figure 4: Top: Vác (arrow) and the areas not covered by the 1987 game survey (black squares) in Hungary. Bottom: constant (full dots) and occasional (circles) observations of lynx in 1987. A questionable southeastern occurrence is not shown in this map. (By courtesy of Szemethy et al. 1991).

material. Attempts at sexing by Van Bree and Clason (1971: 131) yielded uncertain results in the case of a Roman Period lynx skull, due to the size overlap between the cranial dimensions of females and males. It has been hypothesized that size-dependent interspecific

allometries pinpointed in the cranial proportions in felids (Starck, 1967: 529) could be translated into sex related-patterns of shape in the case of lynx, a medium size member of this family. The end points of the size interval were represented by series of skulls from both

wild and domestic cats (*Felis silvestris* Schreb. 1777 and *Felis catus* L. 1758) and panthers (*Panthera pardus* L. 1758) from a variety of zoological collections.

The material used in this work is listed in Table 1. Occasionally missing data on sex were estimated using stepwise discriminant analyses.

Table 1: Felid skulls used in the craniometric study

| Species | Female | Male |
|---|--------|------|
| Lynx: | | |
| Naturhistorisches Museum, Wien | 9 | 8 |
| Data by Vasiliu and Decei (1964: 171-174) | 20 | 18 |
| Data by Van Bree and Clason (1971: 131) | 3 | 4 |
| Domestic and wild cat: | | |
| British Museum of Natural History | 42 | 47 |
| Musée d'Histoire Naturelle, Genève | 17 | 14 |
| Naturhistorisches Museum, Basel | 9 | 11 |
| Hungarian Agricultural Museum | 8 | 7 |
| Archaeological specimens | 6 | 9 |
| Panther: | | |
| British Museum of Natural History | 29 | 36 |
| Musée d'Histoire Naturelle, Genève | 6 | 3 |
| Naturhistorisches Museum, Basel | 3 | 3 |
| Hancock Collection, Newcastle Upon Tyne | 3 | 1 |

2.3 PREVIOUS RESEARCH AND METHODS

The relationship between body size and brain volume is not linear due to the earlier development of nerves

compared to muscle tissue during ontogeny (Hammond, 1932). The decrease of relative brain weight with increasing body weight may also be seen during phylogeny. When raw data on a number of felid species summarized by Röhrs (1985: 235) are presented in terms of percentages, brain weight seems to span a range from 0.5% to almost 1.5% of body weight with declining size (Figure 5). Although allometric analyses using these data showed a greater uniformity of cephalisation in modern felids than assumed by Radinsky (1975: 232), in this presentation lynx falls between "small brained" panther and jaguar in spite of its relatively smaller body size. Earlier data on the brain capacity and basal length of more than 30 lynx skulls also confirm that this species is more similar to large felids in terms of its relative brain growth (Röhrs 1961: 134). The same logic was followed in the analysis of cranial measurements aimed at the sexing of the Vác specimen.

Bone measurements were taken following definitions by von den Driesch (1976: 47-49). Allometric calculations were carried out using decimal logarithms in simple regression analyses based on correlations significant at the $P \leq 0.05$ level of probability.

3. Results and discussion

3.1 ARCHAEOLOGICAL CONTEXT AND ENVIRONMENT

With the exception of three tibiae of brown hare (*Lepus europaeus* Pall. 1778) the lynx remains were accompanied by kitchen refuse in Pit 26/a. More than eighty

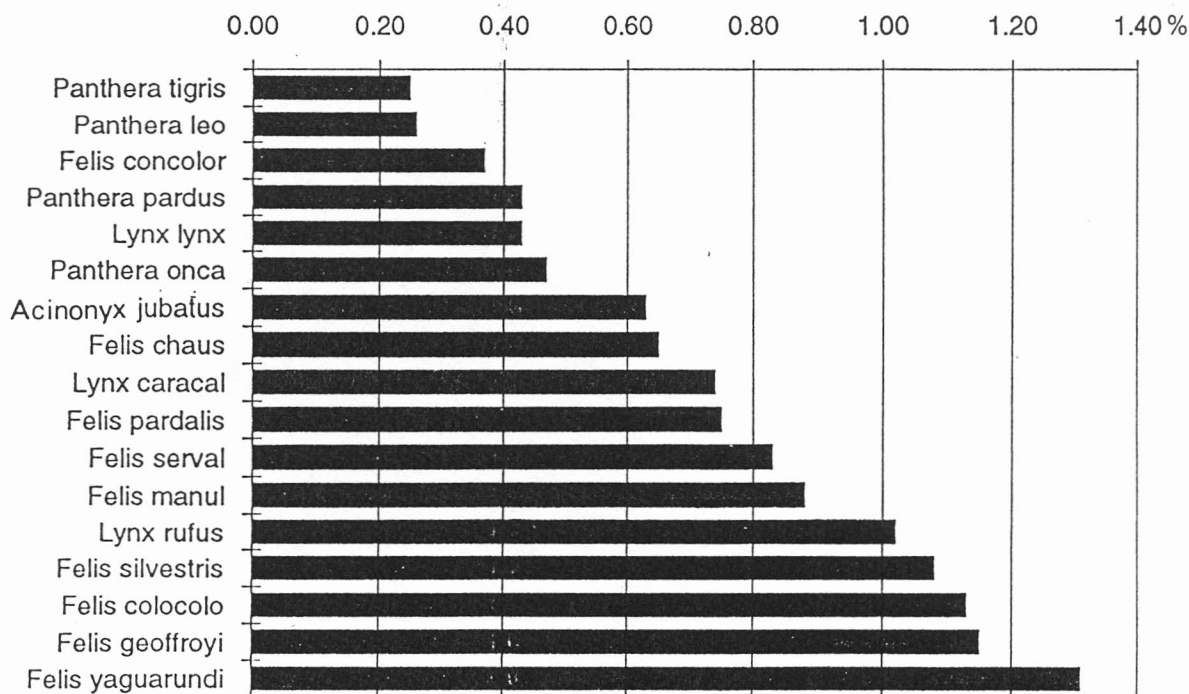


Figure 5: The proportion of brain weight to body weight within the Felidae.

percent of the 15th century material (2254 identifiable bones) originated from domestic animals, predominantly cattle (1620 pieces; Bartosiewicz, 1991b: 133) which was the most important source of animal protein at the settlement between the 13th and 16th centuries. The Vác ferry was a major Medieval road station on the way to Vienna. Among livestock, cattle was one of the most important commodities that crossed the Danube river at this point.

A more systematic exploitation of the neighboring forests is shown by the high proportion of remains from wild fruits and berries (e.g. wild apple, raspberry, strawberry, blackberry, blackthorn etc.) in the macrobotanical material. These were gathered in the ecotone between the town and its natural environment. The urban character of the flora is shown by weeds associated with intensive human occupation (*Chenopodium* and *Polygonum* species and plants from the forest's edge). Only sporadic elements of unprocessed grain and plowland weeds were identified. One third of the material originated from cultivated plants (Bartosiewicz and Gyulai, 1992).

3.2 AGEING AND SEXING

The gestation period of lynx falls between 65 to 75 days (Habermehl, 1985: 141). Newborn kittens of the somewhat smaller Canadian lynx weigh 197–211g (Banfield, 1974: 438). Their eyes open at an age of 10–12 days and the cubs start consuming solid food at an age of 50 days (Kunc, 1970).

Males are normally sexually mature by the age of 2.75 years, but may reach this state even a year

earlier. The usual age of sexual maturity in females is 1.75 years, but earlier maturity may occur as well (Kvam, 1991: 151). While the mating period is delayed with increasing geographical latitude (Crowe, 1975: 181), a late February date in the Tatra and Carpathian mountains was reported by Werner (1953: 107).

From the viewpoint of the archaeological specimen under discussion here, it is important that general excitement and concurrent fights at this time may facilitate hunting and also result in the straying of animals. Reproductive and behavioral characteristics thus may serve as a sign of indirect seasonal dating for the pit. Should the animal have been hunted for its pelt specifically, one may also reckon with a winter kill when the fur is in top condition (Nelson, 1986: 28) providing a hypothetical 1.5 years of age for the Vác specimen to be tested by osteological criteria.

3.2.1 Postcranial skeleton

Because only indirect and limited information on dental ageing for lynx is available in the literature (e.g. Habermehl, 1985: 141; Garcia-Perea et al., 1985: 251), the relationship between age and the epiphyseal fusion of the long bones may be appraised only in general terms. The lack of ossification in the epiphyseal plates of late maturing proximal humeri, distal radii and both ends of a left femur (Figure 6) confirm the "young adult" age estimated on the basis of cranial features. Together with the fully developed dentition (Figures 1, 2 and 7), these would point to a 1.5 years *terminus ante quem* age in dogs (Schmid, 1972: 75) which may be considered a realistic estimate for lynx as well in light



Figure 6: Long bones of the Vác lynx. From left to right: humeri, radii, tibia, femur and metatarsals.

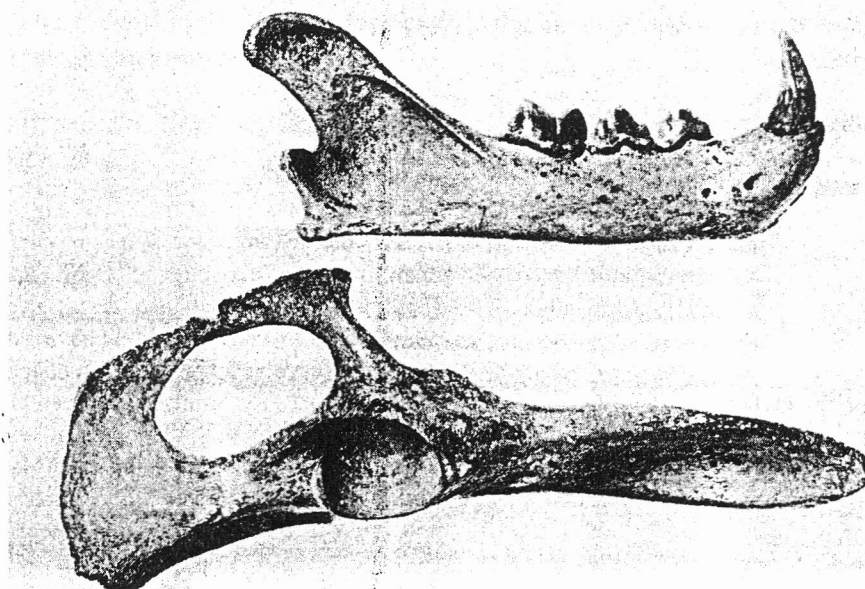


Figure 7: The right mandibula and left pelvis of the Vác lynx.

of the reproductive similarities and comparable 16–18 years maximum life expectancies of these two species. Data on wild cats published by Habermehl (1985: 140) seem to be of little help in this regard.

Bone dimensions also confirm that in spite of the partial fusion of long bone epiphyses, the Vác lynx reached adult size (Tables 2 and 3).

Table 2: Mandibula and pelvis measurements (mm)

| | | |
|--------------|------------------------------|-------|
| Mandibula d. | Total length | 100.0 |
| | Length of the cheektooth row | 38.4 |
| | Height of the vertical ramus | 42.1 |
| | Height behind M1 | 19.2 |
| | Height in front of P3 | 19.1 |
| | Symphysis height | 23.4 |
| Pelvis s. | Greatest length | 148.2 |
| | Symphysis length | 55.2 |
| | Length of acetabulum | 21.9 |
| | Length of foramen obturatum | 37.1 |
| | Smallest breadth of ilium | 21.2 |

Table 3: Long bone measurements (mm)

| Bone | Greatest length | Proximal breadth | Proximal depth | Smallest breadth | Smallest depth | Distal breadth | Distal depth |
|-----------------|-----------------|------------------|----------------|------------------|----------------|----------------|--------------|
| humerus d. | - | - | - | 11.8 | 13.0 | 38.0 | 23.9 |
| humerus s. | - | - | - | 12.1 | 13.6 | 38.2 | 23.8 |
| radius d. | - | 17.2 | 12.8 | 11.6 | 6.2 | - | - |
| radius s. | - | 17.1 | 12.8 | 11.4 | 5.6 | - | - |
| femur s. | - | - | - | 15.5 | 13.2 | - | - |
| tibia d. | - | 32.0 | - | 12.5 | 11.8 | 30.8 | 19.5 |
| metatarsus 3 d. | 94.5 | - | - | - | - | - | - |
| metatarsus 4 d. | 94.2 | - | - | - | - | - | - |
| metatarsus 3 s. | 93.8 | - | - | - | - | - | - |

3.2.2 Cranial characteristics

The inverse relationship between increasing skull size and the concomitant decline in brain dimensions is shown by a pictorial comparison between the skull of a small and a large felid published by Starck (1967: 529). It was assumed that this interdependence may be a fundamental obstacle in sexing felid skulls.

In order to elucidate this possibility, the proportion of the two principal measurements and the width of the brain case (greatest skull length: A-P, greatest breadth: Zyg-Zyg and Eu-Eu) as well as the greatest breadth of frontalia (Ect-Ect) and interorbital constriction (Ent-Ent) were compared between sexes in three felid species of different sizes (*Felis silvestris* and *Felis domestica*, *Lynx lynx*, *Panthera pardus*).

As is shown in Figure 8, percentage proportions between these measurements show a clearly decreasing, size dependent tendency in neurocranium dimensions. At the same time, orbital processes defining the greatest width of the frontal bone (measured by Ect-Ect) become less prominent relative to the increase in interorbital breadth (Ent-Ent). While correlations calculated between ratio values may be biased (Atchley et al., 1976), these size dependent changes in proportions typically represent the principle of allometric growth (Huxley, 1932).

A more detailed analysis of the five cranial measurements was carried out by using their decimal logarithms in regression analyses (All measurements of the Vác lynx skull and of the unpublished reference material are presented in the Appendix).

Allometric coefficients of brain case width (Eu-Eu) show the most intensive broadening relative to greatest skull length (A-P) in male lynx (as well as greatest sexual dimorphism). The general tendency, however, is more similar to that of panther. The skull of the Vác lynx is located well within the group of adults (Figure 9), its

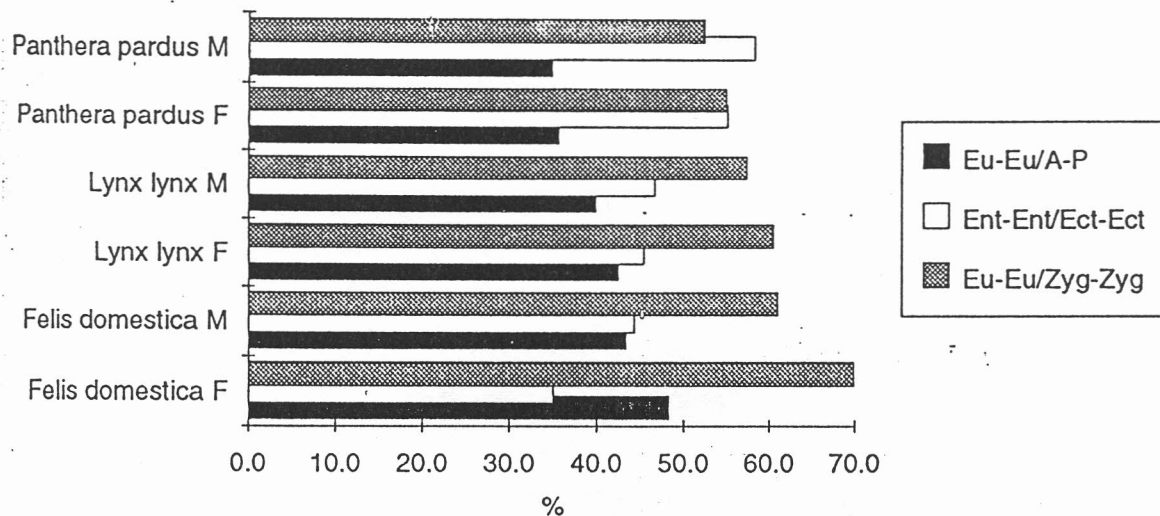


Figure 8: Size and sex related cranial proportions in wild/domestic cat, lynx and panther (F = female, M = male).

sex, however, is difficult to judge. The almost horizontal trend shown by the data points of females intersects with a more intensive brain case widening of males. Neurocranium morphology is also affected by the relationship between brain size and musculature. Of the cranial features relevant to brain case width, the *musculus temporalis* originates from the lateral surface of the skull posterior to the orbit (Gilbert, 1975: 20). The *crista sagittalis* provides more surface for its attachment. Larger absolute size necessitates the development of stronger crests. The *musculus temporalis* is of special functional importance since the *musculus masseterica* is relatively poorly developed in carnivores and felids in particular (Schumacher, 1961: 222).

Table 4: Allometric equations describing the relationship between greatest skull length (lg A-P; x) and the width of the brain case (lg Eu-Eu; y) in three felid species.

| Eu-Eu/A-P | | Female | | Male | |
|-----------|----------------------|--------|---|----------------------|-------|
| | | | r | | r |
| Felis | $y = 0.529x + 0.603$ | 0.842 | | $y = 0.499x + 0.659$ | 0.823 |
| Lynx | $y = 0.368x + 0.979$ | 0.808 | | $y = 0.687x + 0.279$ | 0.726 |
| Panthera | $y = 0.374x + 0.992$ | 0.558 | | $y = 0.455x + 0.808$ | 0.706 |

Table 5: Allometric equations describing the relationship between greatest skull width (lg Zyg-Zyg; x) and the width of the brain case (lg Eu-Eu; y) in three felid species.

| Eu-Eu/Zyg-Zyg | | Female | | Male | |
|---------------|----------------------|--------|---|----------------------|-------|
| | | | r | | r |
| Felis | $y = 0.479x + 0.771$ | 0.875 | | $y = 0.458x + 0.811$ | 0.823 |
| Lynx | $y = 0.315x + 1.142$ | 0.769 | | $y = 0.843x + 0.074$ | 0.734 |
| Panthera | $y = 0.278x + 1.265$ | 0.516 | | $y = 0.486x + 0.828$ | 0.772 |

The greatest width of brain case (Eu-Eu) also increases most intensively relative to greatest skull width (Zyg-Zyg) in male lynx. Allometric coefficients show a clear relative decrease with size in the group of female felids. Due to its rather broad brain case, the Vác lynx skull falls within the group of adults. Even young females have relatively wide brain cases. Overall size increase in male skulls, however, results in a more intensive relative growth (Figure 10). The relationship between these two transverse measurements is remarkably similar to the previous plot between greatest length and brain case width. In both cases, brain case width is plotted against a "frame" measurement defining the largest dimensions of the skull. Sex determination, however, is still difficult on the basis of this graph.

Table 6: Allometric equations describing the relationship between greatest frontal width (lg Ect-Ect; x) and interorbital width (lg Ent-Ent; y) in three Felid species.

| Ent-Ent/Ect-Ect | | Female | | Male | |
|-----------------|----------------------|--------|---|----------------------|-------|
| | | | r | | r |
| Felis | $y = 0.641x + 0.163$ | 0.712 | | $y = 0.852x - 0.176$ | 0.881 |
| Lynx | $y = 1.141x - 0.595$ | 0.969 | | $y = 1.486x - 1.228$ | 0.889 |
| Panthera | $y = 0.678x + 0.612$ | 0.809 | | $y = 1.004x - 0.243$ | 0.722 |

In general, lynx is characterized by an unusually intensive broadening of the interorbital width (Ent-Ent) relative to the greatest frontal width (Ect-Ect), a tendency more strongly manifested in males. The Vác specimen falls within the group of small adults. In this size category its relatively broad interorbital width is more characteristic of young females (Figure 11).

Some of the *musculus temporalis* originates from the

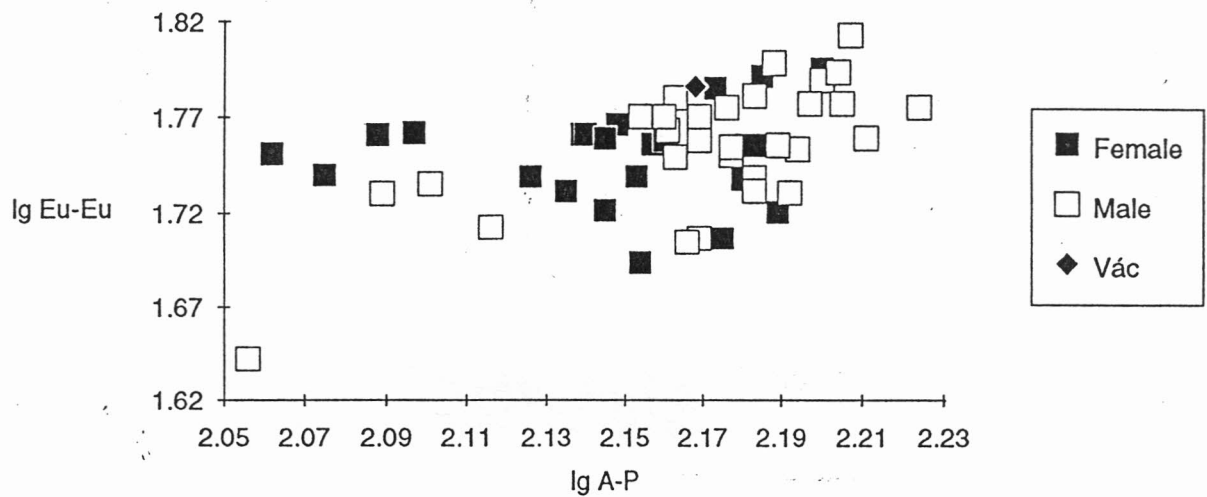


Figure 9: The allometric relationship between greatest skull length (A-P) and the width of the brain case (Eu-Eu) in lynx.

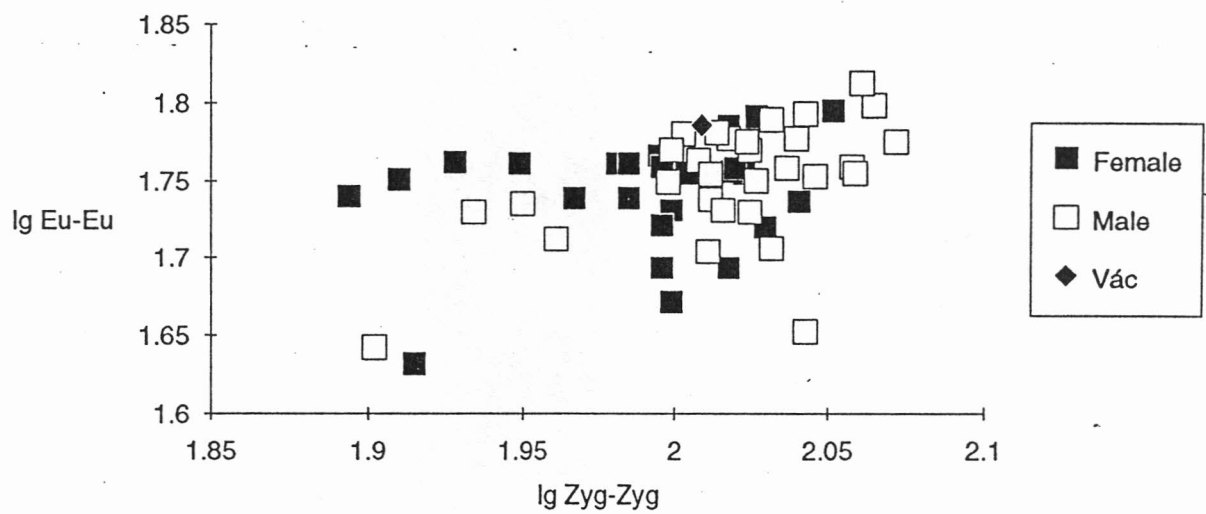


Figure 10: The allometric relationship between greatest skull width (Zyg-Zyg) and width of the brain case (Eu-Eu) in lynx.

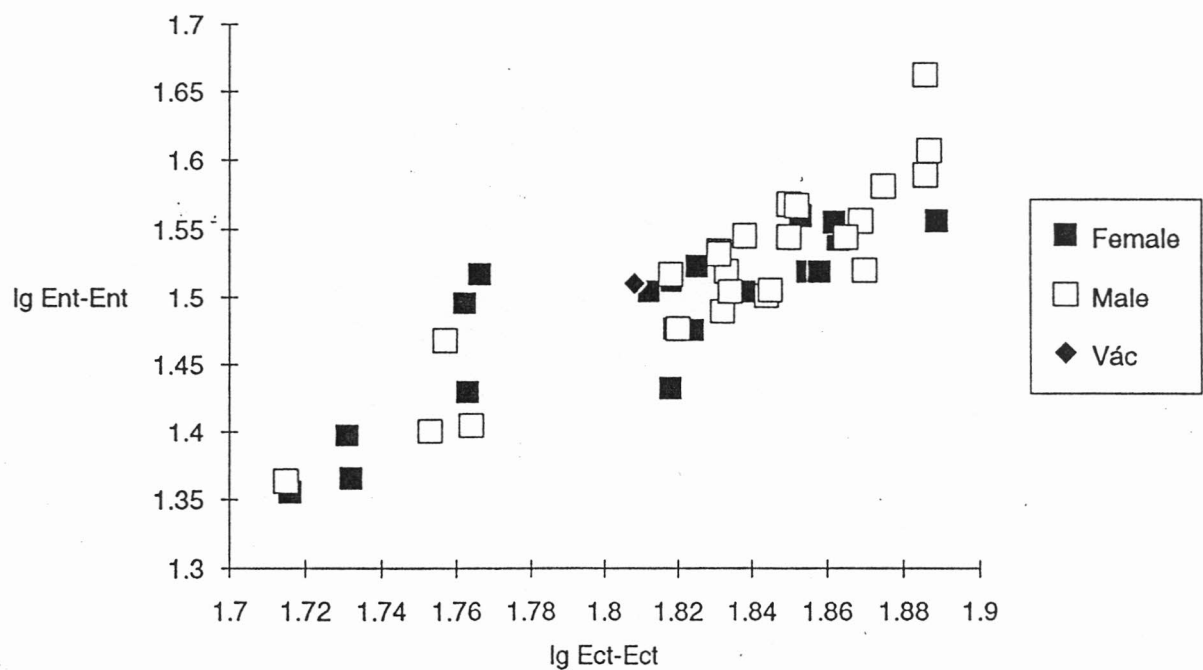


Figure 11: The allometric relationship between greatest frontal width (Ect-Ect) and interorbital width (Ent-Ent) in lynx.

orbital ligament and the connective tissue closing off the orbit's aboral part. It may not thus require the presence of particularly long postorbital processes (represented by the Ect-Ect width) to support increasing musculature even in large males. Thus, interorbital width seems to grow relatively more intensively.

There is a complex relationship between eye size, the *musculus temporalis* and the postorbital processes of the frontal bone and zygomatic arch which support the orbital ligament (Ewer, 1973: 34). At the same time, the *musculus masseterica* originates on the zygomatic arch as well (Gilbert, 1975: 20).

While no ontogenetic data were found on eye size in felids, classic data published by Pálsson (1955: 437) on 14 lambs outlined a progressive allometric relationship when eye weight (g) was looked at as the function of brain weight (g):

$$\lg W_{\text{eye}} = 1.814 \lg W_{\text{brain}} - 2.256 \quad (r = 0.977, P \leq 0.001)$$

In spite of fundamental differences between the visual fields of sheep and cat (Bartosiewicz, 1980: 29), this marked ontogenetic tendency clearly indicates the existence of three major factors (differential growths of brain, eye and muscle) influencing the development of the orbital region.

All of the studied allometric equations suggest that sexual dimorphism in the relative growth intensity of neurocranium width measurements represented by the width of the brain case (Eu-Eu) and interorbital width (Ent-Ent) is greater in larger species, and lynx again is especially close to panther in this regard. Since the anatomical function of neurocranium dimensions is not limited to neural development, the same tendencies also mean that smaller female skulls retain a more infantile form, while particularly large males exhibit a relatively intensive growth of the muscular surfaces. Bivariate plots of the measurements show that this "dynamism" becomes apparent in the presence of extremely large male skulls which could be sexed by visual appraisal anyway. It is remarkable, however, that sexual dimorphism in the allometry of these measurements is as clearly expressed as is the case for the phylogenetically distant European elk (*Alces alces* L. 1758) whose antlers make the sexing based on skull formation significantly easier (Bartosiewicz, 1987: 749). However, while growth tendencies are sexually different in felids, the dimensions of individual skulls are of little actual distinctive value.

Morphological studies of the skull revealed not only smoother muscular surfaces but some degree of superior interorbital convexity as well. Although García-Perea et al. (1985: 258) did not consider this trait of diagnostic value in sexing the skulls of Iberian lynx (*Lynx pardina* Temminck 1824), a depression in the area of the *margo nasalis* of the frontal bone occurred more consistently on male skulls of the Vienna collection.

3.3 CULTURAL IMPLICATIONS

In the case of the lynx found at Vác – Széchenyi utca, there is no reason to suppose that the animal was exploited for anything but its pelt. A contemporary sketch by Albrecht Dürer nicely shows the rather long, soft and thick hair of this animal (Figure 12).



Figure 12: Sketch of a dozing lynx by Albrecht Dürer from 1521.

As opposed to various methods of butchering for meat, skinning has been rather highly standardized throughout history. Although the use of metal tools represents a major technical leap, skinning marks in typical locations were identified, for example, on the distal metapodials of wild cat at the Danish Mesolithic site of Tybrind Vig (Trolle-Lassen, 1987: 101). Such marks are concentrated on the third left (Figure 13), and third as well as fourth right metatarsals of the lynx found in Vác. Although no cuts occurred on the skull of this specimen, less fleshy parts of the skull may display similar skinning marks (Van Bree & Clason, 1971: 134).

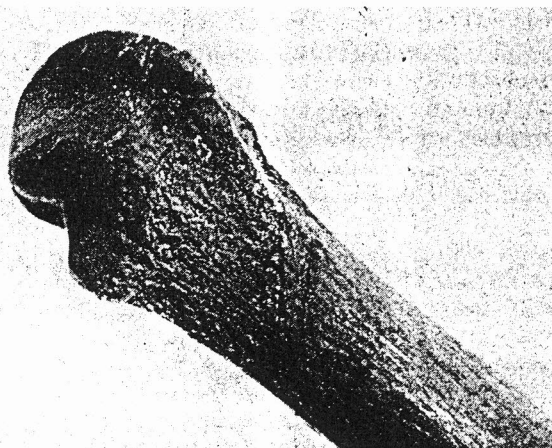


Figure 13: Skinning marks made with a metal knife at the distal end of a metatarsal.

The presence of non-peripheral skeletal elements suggests that the bones belong to an animal which was most probably killed in the proximity of the town. Primary skinning or commercial flaying would at most have the skull and paws left partially intact to facilitate transportation or for decorative purposes.

Body weight data (W; kg) and greatest skull lengths (A-P; mm) of 10 female and 7 male lynx from the eastern Carpathians (Vasiliu and Decei, 1964: 166–167, 170–171) were pooled to estimate the body weight of the Vác specimen. The calculation resulted in the following allometric equation:

$$\lg W = 2.084 \lg (A-P) - 3.286 \quad (r = 0.456, P \leq 0.05)$$

The relationship between these two traits is undoubtedly influenced by seasonal fluctuations in body weight (low correlation) and is by definition allometric because of the different dimensions involved. Still the 17.2 kg weight estimate obtained for the Vác female using this equation seems realistic for a young adult female. It falls far below the 23 kg median of the broad, 8 to 38 kg live weight range published by Novikov (1962: 284).

It is unlikely that the whole carcass would have been hauled to the settlement from any greater distance. The only exception could be if the animal was snared or found frozen during a hard winter. Under those circumstances, off-site skinning on the spot would not have been feasible. This possibility may also be reckoned with in the absence of traumatic modifications of the bones.

During the Middle Ages, the privilege of wearing furs from Mustelids and genet was limited to the high nobility, while only lambskin or rabbit fur were available to common people (Ewer, 1973: 72). Although no direct reference to the actual value of individual fur types is available from Vác, Turkish customs records from 1563 and 1564 (Káldy-Nagy, 1968: 37) mention furs within the general framework of hides trading at this important post. Although cattle hides provided the overwhelming majority of these shipments, 89 Forints worth of unspecified finer furs were registered among

other hides and pelts during a period between July and March (Figure 14). According to the same source, the price of a cattle hide was 0.5 Ft.

Lynx is one of the least frequently depicted animals in the history of European art (Dent, 1976: 12). The representation of a ferocious looking lynx occurs in the 1548 Chronicle by Johannes Stumpf (Eiberle, 1972: 18; Figure 15) which may be a better expression of this animal's popular image during the Middle Ages than Dürer's naturalistic sketch. While in Nordic mythology the mysterious lynx had been regarded as sacred to Freya, the goddess of beauty and love (Guggisberg, 1975: 49), it was increasingly looked upon as a blood-thirsty pest with the advance of time. The way lynx fell out of grace is comparable to the story of cats which were degraded from divine creatures to "Satan's Messengers" with the advance of Christianity (Bartosiewicz, 1991a: 2). The attitude toward lynx, however, looks less superstitious since it could be rationalized the same way as the fearful reputation of wolves. Eiberle (1972: 42), for example, concludes that the disappearance of lynx was a direct result of extinction by man in Switzerland.

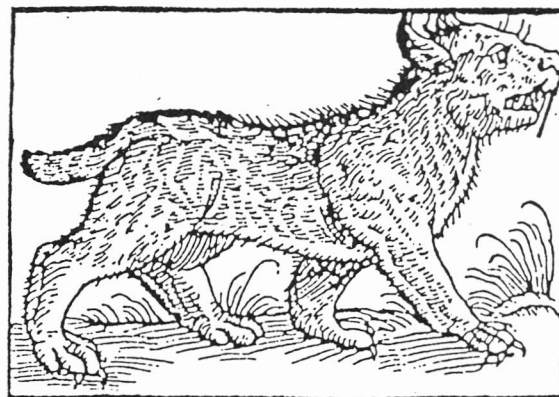


Figure 15: A 1548 picture of lynx from Switzerland.

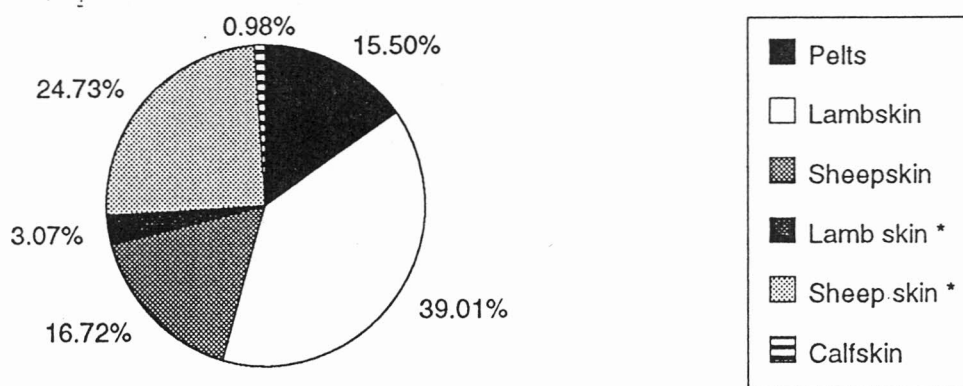


Figure 14: The percentage contribution of furs to the value of fine hides recorded at Vác during 1563–1564. Skins used for leatherware rather than pelts are marked by asterisks.

Evidence of this hostile sentiment sometimes even surfaces in the recent zoological literature. According to Novikov (1962: 284) lynx is "a noxious predatory animal" and Hell (1961: 58) reported the widespread and ruthless persecution of lynx when its populations increased in Slovakia during the 1950's. It may alternatively explain, why the young 15th century female may have been killed in the proximity of Vác, even if the rest of the faunal material contains no evidence that regular hunting of any sort took place.

4. Conclusions

Remains of lynx from a late Medieval, 15th century urban deposit at Vác – Széchenyi utca in Hungary provided a rare opportunity to analyze the biological characteristics and culture-historical role of this animal.

Age determination of this individual could be successfully carried out using the reproductive traits of lynx and interspecific comparisons of epiphyseal fusion. Reliable sexing, on the other hand, was not significantly more successful than in previous studies in spite of detailed interspecific allometric study of cranial characteristics.

As far as the Vác lynx skull is concerned, it falls within the area of size overlap between adult females and males and it could equally be assigned to the trend covered by either sex in Figures 9 and 10. The relationship between interorbital width and greatest frontal width (Figure 11) is of somewhat greater informative value. Growth tendencies outlined by interspecific allometries provide additional background information on the effect of size on form to identify this specimen as a female with reasonably high probability, even if no evidence is available in terms of formal statistical significance.

Although tendencies of relative growth display gross differences between females and males, individual identification would have been almost impossible without a major reference material and in depth analysis of the head's functional anatomy.

The animal was evidently skinned. Osteological ageing as well as behavioral and ecological traits of lynx suggest that the young animal under discussion here died most probably during the winter. It may thus have been hunted for its pelt which was obviously valuable.

The estimation of body weight leads to an additional interpretation. The presence of several bones of the skeleton within the pit without any signs of trauma, points to the possibility that the animal had been found frozen either in a trap or by accident and skinned in town. This version is also supported by the small number of wild animal bones from the site, indicating the negligible role played by active hunting.

Finally, killing this lynx as a hated pest may have taken place at any time, although the late winter rutting season in this case is more likely.

5. Acknowledgements

Grateful thanks are due to all the fellow osteologists who provided access to the reference materials in the six collections listed in Table 1. L. Szemethy kindly contributed the unpublished maps in Figure 4. The photographs were taken by K. Pálfay and T. Kádas.

Literature

- Atchley, A. H., Gaskins, C. T. and Anderson, D. 1976. Statistical properties of ratios I. Empirical results. *Syst. Zool.* 25: 137-138.
- Banfield, A. W. F. 1974. *The mammals of Canada*. University of Toronto Press, Toronto.
- Bartosiewicz, L. 1980. Changes in the skull proportions of cattle. *Ossa* 7: 19-31.
- Bartosiewicz, L. 1987. Sexual dimorphism in the cranial development of Scandinavian moose (*Alces alces* L. *alces*). *Can. J. Zool.* 65: 747-750.
- Bartosiewicz, L. 1989. The natural environment of Acs – Vaspusztá. In Gabler, D. (Ed.) *The Roman Fort at Acs – Vaspusztá (Hungary) on the Danubian limes*. BAR International Series 531 (i): 1-4.
- Bartosiewicz, L. 1991a. Cat beliefs (in Hungarian). *Macska* 2:1-2.
- Bartosiewicz, L. 1991b. Animal remains from Medieval Vác in Hungary (in Hungarian). *Váci Könyvek* 5: 129-152.
- Bartosiewicz, L. and Gyulai, F. 1992. Provisioning of 13th-16th century Vác, Hungary. *Medieval Europe 1992, York*, Pre-printed Papers.
- Bökönyi, S. 1959. Die frühalluviale Wirbeltierfauna Ungarns. *Acta Arch. Hung.* 11: 39-102.
- Bökönyi, S. 1974. Verzeichnis der auf dem Burghügel gefundenen Tierreste. In J. Banner and I. Bóna (Eds.): *Mittelbronzezeitliche tell-Siedlung bei Békés*. Akadémiai Kiadó, Budapest: 82.
- Bree, P. J. H. Van and Clason, A. T. 1971. On the skull of a lynx *Lynx lynx* (Linnaeus, 1758), found in the Roman castellum at Valkenburg, Province of Zuid-Holland, the Netherlands. *Bijdragen tot de Dierkunde* 41(2), 130-135.
- Crowe, D. M. 1975. Aspects of ageing, growth and reproduction of bobcats from Wyoming. *J. Mammalogy* 56: 177-198.
- Dent, A. 1976. *Dieren in de kunst*. De Haan, Bussum.
- Driesch, A. von den, 1976. *Das Vermessen von Tierknochen aus vor- und frühgeschichtliche Siedlungen*. Institut für Paläoanatomie, Domestikationsforschung und Geschichte der Tiermedizin der Universität München.
- Eiberle, K. 1972. *Lebensweise und Bedeutung des Luchses in der Kulturlandschaft dargestellt anhand der Ausrottungsgeschichte in der Schweiz*. Verlag Paul Parey, Hamburg und Berlin.
- Ewer, R. F. 1973. *The Carnivores*. Weidenfeld and Nicholson, London.
- Garcia-Perea, R., Gisbert, J. and Palacios, F. 1985. Review of the biometrical and morphological features of the skull of the Iberian lynx, *Lynx pardina* (Terminck 1824). *Säugetierkundliche Mitt.* 32/3: 249-259.
- Gilbert, S. G. 1975. *Pictorial anatomy of the cat*. University of Washington Press, Seattle and London.
- Guggisberg, C. A. W. 1975. *Wild cats of the world*. David & Charles, Newton Abbot – London.
- Habermehl, K.-H. 1985. *Altersbestimmung bei Wild- und*

- Pelztieren*. Verlag Paul Parey, Hamburg - Berlin.
- Haglund, B. 1966. Winter habits of lynx (*Lynx lynx* L.) and wolverine (*Gulo gulo* L.) as revealed by tracking in the snow. *Viltrevy* 4: 81-310.
- Hammond, J. 1932. *The development of mutton qualities of sheep*. Oliver and Boyd, Edinburgh.
- Hell, P. 1961. Starkes Anwachsen der Luchsbestände in der Slowakei. *Zeitschr. f. Säugetierkunde* 26/1: 57-59.
- Hell, P. 1968. Population density of the Lynx in the Czechoslovakian Carpathians. *Acta Sc. nat. Brno* 2 (5/6): 57-64.
- Huxley, J. S. 1932. *Problems of relative growth*. Methuen, London.
- Káldy-Nagy, Gy. 1968. Statistical data on the westbound trade of the areas under Turkish rule in 1560-1564 (in Hungarian). *Történeti-Statistikai Évkönyv* 1965-66: 27-83.
- Kunc, L. 1970. Breeding and rearing the northern lynx, *Felis l. lynx*, at Ostrava. *Zoo. Int. Zoo Yb.* 10: 83-84.
- Kvam, T. 1991. Reproduction in the European lynx, *Lynx lynx*. *Zeitschr. f. Säugetierkunde* 56: 146-158.
- Nellis, C. H. and Keith, L. B. 1968. Hunting activity and success of lynxes in Alberta. *J. Wildl. Mgmt.* 32: 718-722.
- Nelson, R. K. 1986. *Hunters of the Northern Forest*. The University of Chicago Press, Chicago - London.
- Novikov, G. A. 1962. *Carnivorous Mammals of the Fauna of the USSR*. Israel Progr. Sci. Transl. Jerusalem.
- Nowak, R. M. 1991. *Walker's Mammals of the World*. 5th Edition, Volume II. The Johns Hopkins University Press, Baltimore- London.
- Pálsson, H. 1955. Conformation and body composition. In Hammond, J. (Ed.) *Progress in the physiology of farm animals*. Butterworths Scientific Publications, London: 430-542.
- Radinsky, L. 1975. Evolution of the felid brain. *Brain, Behav. Evol.* 11: 214-254.
- Röhrs, M. 1961. Allometrie und Systematik. *Zeitschr. f. Säugetierkunde* 26/3: 130-137.
- Röhrs, M. 1985. Cephalisation bei Feliden. *Zeitschr. f. Säugetierkunde* 50/4: 234-240.
- Saunders, J. K. 1963. Movements and activities of the lynx in Newfoundland. *J. Wildl. Mgmt.* 27: 384-390.
- Schauenberg, P. 1969. Le lynx, *Lynx lynx* (L.), en Suisse et dans les pays voisins. *Rev. Suisse Zool.* 257-287.
- Schmid, E. 1972. *Atlas of animal bones*. Elsevier Publishing Company, Amsterdam - London - New York.
- Schumacher, G. H. 1961. *Funktionelle Morphologie der Kaumuskulatur*. Gustav Fischer Verlag, Jena.
- Starck, D. 1967. Le crane des mammifères. In Grassé, P.-P. (Ed.) *Traité de zoologie, anatomie, systématique, biologie*. Tome XVI, Mammifères. Masson et Cie. Éditeurs, Paris: 405-549.
- Szemethy, L., Baranyai, N. and Horváth, A. 1991. Occurrence and relative density of protected carnivores in Hungary. *20th IVGB Congress*, Hungary.
- Trolle-Lassen, T. 1987. Human exploitation of fur animals in Mesolithic Denmark - a case study. *Archaeozoologia* 1/2, 85-102.
- Vasiliu, D. G. and Decei, P. 1964. Über den Luchs (*Lynx lynx*) der rumänischen Karpaten. *Säugetierkundl. Mitt.* 11/4: 155-183.
- Vörös, I. 1987. Animal remains from the Copper Age settlement at Tiszalúc - Sarkad. (in Hungarian). *Folia Archaeologica* XXXVIII: 121-127.
- Werner, K. F. 1953. Beiträge zur Freilandbiologie des südost-europäischen Luchses. *Säugetierkundl. Mitt.* 1: 104-110.

APPENDIX

| Inv. No. | A-P | A-B | B-P | A-N | N-P | B-St | St-P | B-N | Eu-Eu | Post. | Zyg-Zyg | Ect-Ect | Ent-Ent | Ot-Ot | Cond. | C-C | Mol-Mol | Pm-Pd | P4 l. | P4 w. | Sex | Age |
|----------|-------|------|-------|-------|------|------|------|-------|-------|-------|---------|---------|---------|-------|-------|------|---------|-------|-------|-------|-----|-----|
| 1584 | 115.8 | 37.9 | 94.9 | 83.5 | 49.1 | 51.0 | 45.3 | 77.0 | 56.5 | 42.1 | 81.5 | 52.1 | 22.7 | 52.1 | 30.9 | 29.1 | 53.1 | 30.1 | 0.0 | 0.0 | F | j |
| 32834 | 123.0 | 36.1 | 101.1 | 92.1 | 50.8 | 54.1 | 48.0 | 83.1 | 57.9 | 44.8 | 89.1 | 58.1 | 26.9 | 55.5 | 28.2 | 27.8 | 54.1 | 32.0 | 17.3 | 7.9 | F | j |
| 32835 | 119.2 | 37.1 | 99.9 | 83.6 | 48.1 | 53.8 | 47.5 | 78.9 | 55.1 | 42.9 | 78.5 | 54.0 | 25.0 | 52.9 | 30.6 | 30.5 | 57.5 | 29.1 | 0.0 | 0.0 | F | j |
| 2535 | 143.9 | 41.0 | 120.8 | 104.1 | 58.1 | 66.0 | 55.2 | 96.5 | 57.2 | 40.0 | 104.9 | 71.8 | 33.1 | 61.5 | 31.1 | 31.1 | 58.1 | 34.9 | 18.2 | 8.8 | F | a |
| 74 B | 158.9 | 42.1 | 132.1 | 106.0 | 66.1 | 73.8 | 59.9 | 105.7 | 62.5 | 44.1 | 113.2 | 77.6 | 36.1 | 67.1 | 29.9 | 28.3 | 61.8 | 40.0 | 17.2 | 7.5 | F | a |
| 1429 | 149.5 | 42.9 | 125.0 | 107.2 | 61.1 | 68.9 | 57.2 | 101.0 | 61.1 | 42.9 | 104.5 | 72.4 | 33.1 | 63.9 | 31.9 | 31.1 | 60.2 | 37.8 | 19.0 | 8.3 | F | a |
| 4824 | 125.3 | 38.2 | 102.1 | 91.1 | 50.0 | 54.0 | 49.5 | 81.1 | 58.0 | 40.1 | 84.9 | 54.1 | 23.2 | 56.2 | 33.1 | 29.1 | 55.8 | 34.2 | 19.1 | 9.2 | F | a |
| 1349 | 138.2 | 41.8 | 115.1 | 111.9 | 54.1 | 63.9 | 52.0 | 91.1 | 57.9 | 41.3 | 96.1 | 66.9 | 29.9 | 58.5 | 30.0 | 29.2 | 58.3 | 34.8 | 17.2 | 8.2 | F | a |
| 1583 | 141.2 | 43.0 | 117.2 | 100.0 | 57.5 | 64.0 | 53.8 | 92.1 | 58.5 | 41.1 | 99.1 | 66.1 | 30.0 | 61.6 | 32.2 | 31.0 | 60.9 | 37.2 | 20.4 | 8.9 | F | a |
| 1425 | 126.5 | 36.4 | 103.2 | 92.5 | 54.1 | 56.1 | 46.0 | 81.5 | 54.5 | 40.7 | 89.5 | 58.2 | 25.4 | 54.9 | 29.0 | 28.2 | 56.1 | 31.8 | 16.5 | 8.1 | M | j |
| 1431 | 123.2 | 37.2 | 103.1 | 91.5 | 49.1 | 50.9 | 46.1 | 85.0 | 53.8 | 41.1 | 86.2 | 56.8 | 25.2 | 54.1 | 30.2 | 27.9 | 52.5 | 30.2 | 15.5 | 7.6 | M | j |
| 3973 | 159.0 | 41.2 | 133.0 | 114.1 | 63.8 | 70.3 | 63.5 | 103.0 | 61.7 | 41.7 | 107.9 | 74.1 | 36.1 | 65.2 | 32.8 | 32.9 | 62.5 | 38.7 | 19.2 | 9.0 | M | a |
| 1424 | 145.9 | 41.1 | 123.2 | 106.4 | 57.9 | 68.9 | 55.1 | 97.1 | 60.4 | 42.4 | 101.1 | 68.2 | 33.1 | 62.5 | 31.2 | 31.1 | 58.5 | 36.5 | 17.5 | 8.1 | M | a |
| 1430 | 146.0 | 41.5 | 122.0 | 105.0 | 59.0 | 68.2 | 53.1 | 96.0 | 56.2 | 40.0 | 99.9 | 68.1 | 30.9 | 59.9 | 30.0 | 32.0 | 60.8 | 37.2 | 18.9 | 8.8 | M | a |
| 1427 | 150.5 | 43.3 | 126.1 | 111.3 | 58.9 | 69.2 | 56.9 | 102.4 | 59.8 | 39.9 | 106.0 | 70.2 | 32.1 | 61.1 | 28.7 | 29.9 | 60.1 | 39.9 | 17.8 | 8.7 | M | a |
| 1582 | 145.2 | 42.1 | 124.9 | 102.1 | 56.9 | 66.1 | 58.7 | 95.2 | 58.1 | 39.0 | 102.1 | 66.2 | 30.0 | 61.6 | 32.2 | 31.0 | 60.9 | 37.2 | 20.4 | 8.9 | M | a |
| 9999 | 152.9 | 43.0 | 128.9 | 106.1 | 63.4 | 69.4 | 59.0 | 97.4 | 60.5 | 43.2 | 103.5 | 70.0 | 31.8 | 63.6 | 32.9 | 30.2 | 62.2 | 40.0 | 17.2 | 8.7 | M | a |
| Vác | 147.6 | 44.2 | 123.8 | 104.2 | 60.9 | 65.1 | 59.6 | 98.8 | 61.2 | 39.8 | 102.5 | 64.4 | 32.4 | 66.1 | 34.1 | 41.2 | 67.0 | 32.8 | 19.5 | 8.9 | | a |

Measurements of lynx skulls kept in the Naturhistorisches Museum, Wien. Abbreviations: F = female, M = male, j = juvenile, a = adult. 9999 is a default code for a non-inventorized individual.