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## Body weight and body dimensions of Eurasian lynx (*Lynx lynx*) in the Bohemian Forest (reintroduced „Bohemian-Bavarian-Austrian“ population)

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### Abstract

The variability of body weight and body dimensions of the Eurasian lynx was studied in the reintroduced Bohemian-Bavarian-Austrian population. In 1996–2018, 27 males and 21 females were examined. The material was obtained from telemetry, road kills and illegal kills. The weight and basic external body parameters were measured and analysed as well as the individual growth per time. Adult males exhibit significantly bigger values in main measured parameters. The study indicates that there are substantial differences in the development of body length and weight. The growth of length is finished approximately in 2 years in both sexes. The weight development is longer, finishing in approximately 3 years in female and in 4 (5) years in male lynx. The study collected data from the wild and can bring one of the basic but useful information for future monitoring and population viability assessment.

*Key words:* Eurasian lynx, Bohemian-Bavarian-Austrian lynx population, Šumava, Bohemian Forest ecosystem, biometrics, individual growth

### INTRODUCTION

The variability of body dimensions and weight are one of the basic characteristics of the lynx as a species. Although (or just because) that it is so elementary descriptive information, in many cases only the older and not always adequate data are repeatedly used. Sometimes, especially in conservation practice and some popular materials, fallacious numbers without citation appear. Until now the only study, which dealt seriously and widely with the variability of skull dimensions and also body dimensions of the lynx in Bohemian Forest was published in 2000 (ČERVENÝ & KOUBEK 2000). Since that time the sample of measured lynx individuals from this study area markedly increased. Moreover, the newly measured individuals are of known status and age, or it is possible at least to estimate the minimal age and/or to classify them to the age categories. The data of juveniles and subadults represent an important addition to the better knowledge of the individual growth process in the wild. Therefore, we find these data important and useful to publish them separately in this short contribution.

## **MATERIAL AND METHODS**

### **Study area, material**

The data were collected from the reintroduced Bohemian-Bavarian-Austrian („BBA“) lynx population. This population was established (reintroduced) within the period 1970–1989, all reintroduced lynx were from the Slovakian Carpathians. The number of founders were (according to the different sources) from 22 to 26 (5–9 reintroduced in Bavaria and 17 in the Czech Republic) (ČERVENÝ & BUFKA 1996, ČERVENÝ et al. 1999, VOLFOVÁ & TOMAN 2018).

This study is focused on the body dimensions and growth and elaborates the available data collected during the complex research and monitoring of the lynx in Bohemian Forest in the period 1996–2018. Compared to previous study (ČERVENÝ & KOUBEK 2000), it distinguishes the individual age in more detail.

Main part of the material was obtained from measurements of the captured individuals during telemetry studies from 1996 to 2012, additional data come from the measurements of lynx killed by car and also illegally shot. In total, 48 individuals were examined. The overview of the sample is shown in Table 1.

In each individual lynx the sex was determined. The age was estimated with the accuracy of months in individuals until the age of 2 years and of years in adults older than 2 years. The age was determined on the basis of knowledge of the concrete individuals from the long-term monitoring with use of telemetry and camera trapping or estimated as a minimum age in the case that the precise age of adults was not known. Based on the average of all known cases in the study area and the study period, the parturition time falls into the last week of May (pers. observation, unpubl. data). The age of juveniles and subadults, where the precise date of birth was not known, this assumed usual parturition time was used for the calculations. For the analyses of adults the data of individuals of 2 years and older were used.

### **Measurement and analyses**

We used the standard methods for measuring weight and body dimensions (recorded to the nearest 0.5 kg and 0.5 cm respectively): body weight (G), body length (LC), tail length (LCd), hind foot length (LTP), ear length (LA), body height (AC). The difference in the body weight and body dimensions in the adult male and female lynx was tested using a two sample t-value test. We used a nonlinear model of the asymptotic growth curve to describe the increase (development) of body weight and dimensions with the increasing age, estimated with the least-squares minimizing algorithm of Gauss-Newton (BATES & CHAMBERS 1992). The program STATISTICA (version 7.0, www.statsoft.com) was used to analyse all statistics.

## **RESULTS AND DISCUSSION**

The basic statistical data on the measured body dimensions of the adult lynx is shown in Table 2. The obtained values correspond with the previous study (ČERVENÝ & KOUBEK 2000) and are obviously comparable with the values reported for the source Carpathian population (ŠTOLLMANN 1963, HELL & SLÁDEK 1975, HELL 1978), except the maximum weight, which is sometimes reported as 36 kg for the Carpathians (e.g. HELL et al. 2004). Such high values were never registered in the BBA population.

**Table 1.** Sex and age distribution of the lynx sample size.

Age category (years)	Male	Female	Σ
0–1	5	7	12
1–2	5	5	10
2+	17	9	26
<b>Total</b>	<b>27</b>	<b>21</b>	<b>48</b>

**Table 2.** The weight and body dimension of the adult lynx (n = 26; 9 females and 17 males); body weight (G), body length (LC), tail length (LCd), hind foot length (LTP), ear length (LA), body height (AC).

	Female		Male		t-value	p	SD		F-ratio variance	p variance
	mean	max	mean	max			female	male		
G (kg)	17.5	19.5	21.5	26.0	-5.2666	0.0000	1.2836	2.0364	2.5173	0.1898
LC (cm)	96.0	100.0	101.1	110.0	-2.4301	0.0233	2.8284	5.8363	4.2578	0.0447
LCd (cm)	17.6	19.0	20.5	27.0	-3.1805	0.0043	0.7440	2.4766	11.0796	0.0036
LTP (cm)	22.7	24.0	24.5	28.0	-2.7645	0.0128	1.2199	1.4925	1.4969	0.6448
LA (cm)	8.4	9.0	8.7	10.0	-0.5809	0.5674	0.5630	1.0293	3.3427	0.1145
AC (cm)	56.8	62.0	57.3	66.0	-0.1821	0.8571	4.3237	7.0285	2.6425	0.1681

Adult males show bigger values in all main measured parameters. Adult males and females lynx differed significantly in their weight – G ( $t = -5.267$ ,  $p < 0.001$ ), with an average body weight of 21.5 and 17.5 kg respectively. The biggest weight values registered in the sample were 26 kg in male lynx and 19.5 kg in female lynx.

We found significant differences between adult males and females also in the body length – LC ( $t = -2.430$ ,  $p = 0.023$ ) with an average of 101 and 96 cm, tail length – LCd ( $t = -3.180$ ,  $p = 0.004$ ) with an average 20.5 and 17.6 cm, hind foot length – LTP ( $t = -2.765$ ,  $p = 0.013$ ) with an average 24.5 and 22.7 cm respectively.

Males were only slightly (and not statistically significantly) taller than females in height at the shoulder – AC (average 57.3 cm for males and 56.8 cm for females) and practically no differences were registered in the ear length (average values around 8.5 cm for both sex).

Statistically significant differences between males and females in the weight and body length are known also from other studies and in other Eurasian lynx populations (e.g. MATJUSHKIN 1978, HEPTNER & SLUDSKIJ 1980).

The models of the individual growth expressed as the development in weight and body length is visualised in Fig.1. The estimated non-linear models of asymptotic growth explained about 88% and 72% of the variation in body weight (G) growth and about 92% and 77% of the variation in body length (LC) growth in female and male lynx respectively.

The linear character of the growth is apparent in kittens of both sexes during the first ca.  $\frac{3}{4}$  year of life. This corresponds well with the published data from captivity (HUCHT-CIORGA 1988). There are more or less the same body length values in this period. The model indicates that the different development (slower growth of both sexes and the bigger

body length value in males comparing females) starts to appear between 10th and 12th months of life (i.e. during March to May of the second calendar year of lynx life). The body length growth gradually slows down during the second year of life, and it is finished at about the age of 2 years in both sexes.

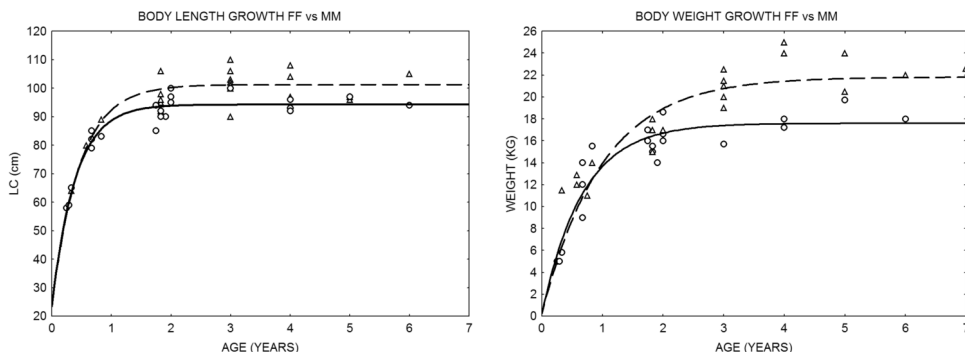
Similarly to the body length, the increase of body weight of kittens during their first year shows practically a linear character. Kittens reach the weight of about 14 kg at the age of 1 year. The following development is different in females and males. During second year of life and later the weight increases more rapidly in males than females. Males are growing to their bigger body weight more rapidly but also for a longer time. The model indicates clearly, that the body weight growth is basically finishing already in the age of 2–3 years in female lynx, whereas in the age of 3–4 (5) years in male lynx.

From the data analysis is apparent that the development of main body dimensions proceeds rapidly during the first year and it is practically finished in the age of 2 years. The trend of development of the body weight has a similar character during the first year, but the process is longer, especially in the males. This corresponds with our long-term field visual experience from camera trapping that already adult lynx males older than 2 years grow heavier and bulk up successively with age in following years.

## CONCLUSIONS

The weight of adult lynx in reintroduced Bohemian-Bavarian-Austrian (BBA) population reaches maximally 26 kg in males and 19.5 kg in females. Adult males show bigger values in main basic external body dimensions. The difference between sexes is significant in body weight as well as in the body length, tail length and hind foot length of adult lynx. The values of body weight and dimensions of adults in this study corresponds well with the previous published data and do not differ to the source Carpathian population.

The individual growth of body weight and body length has a linear character during the first  $\frac{3}{4}$  year of life. The growth of body length finished approximately in the age of 2 years in both sexes, while the increase of weight of individual lynx has more successive character. The adult weight is forming longer and it is finished in females till the age of 3 years and in males till the age of 4 (5) years.



**Fig. 1.** The growth of body length (left graph) and the weight (right graph) in female (n = 21; circles, continuous line) and male lynx (n = 27; triangles, dashed line).

The study collects the data from a certain period of the reintroduced population. So the description of body dimensions variability and the characteristics of individual body growth in the wild may be important for future comparing and monitoring of reintroduced BBA lynx population, which is highly isolated and relatively small.

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