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# Comparison of cranial measurements of the field vole *Microtus agrestis* from the Beskydy Mts. and the Českomoravská vrchovina Highlands

Srovnání lebečních rozměrů hraboše mokřadního, *Microtus agrestis*, z Beskyd a Českomoravské vrchoviny

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**Abstract**. Skull measurements taken in the field vole *Microtus agrestis* specimens coming from natural wet meadows in the Českomoravská vrchovina Highlands and from clearcuts induced by air pollution in the Beskydy Mts. were compared. The results showed that some cranial measurements of females from the Beskydy Mts. were smaller than those of females from the Českomoravská vrchovina Highlands, which can be a consequence of differences in body size. No differences in cranial measurements or body size were observed in males. In some cases differences in measurements between males and females from the Beskydy Mts. were found.

## INTRODUCTION

In general, plant communities with a rich herb layer with cold and wet microclimate are the habitat of the field vole, *Microtus agrestis* (Linnaeus, 1766). Both wet meadows in the Českomoravská vrchovina Highlands and mountain localities in the Beskydy Mts with lower annual temperature, higher precipitation and snowfall are natural biotopes of the field voles (Kratochvíl et al. 1956, Anděra 1979). With the occurrence of large clearcuts induced by air pollution in the mountains the field vole soon inhabited these new habitats and created a strong population with a tendency to become eudominant there (Bryja et. al. 2002). On the other hand some marginal populations at the limit of their ecological tolerance and distribution range with only a few opportunities to migrate to a more suitable habitat are found in the naturally wet meadows in the Českomoravská vrchovina Highlands. These populations with patchy distribution do not undergo larger density oscillations and their abundance is low (Pelikán & Holišová 1985).

Our aim was to answer the question whether these two distant populations differ in the size of their skulls. We presumed that the population from relatively low situated areas of the Bohemian Massif and that from clearcuts of higher elevations of the Beskydy Mts., belonging to the West Carpathians, may differ as their ecological conditions and food supply are different (Bufka 1989, Heroldová 2002).

## MATERIAL AND METHODS

Skulls of field voles from two sites were analysed (Tab. 1). One sample was from natural wet meadows from the Českomoravská vrchovina Highlands, namely Brtnice (49° 18' N, 15° 40' E, 550–650 m a. s. l.), Velké Meziříčí (49° 21' N , 16° 01' E, 450–550 m a. s. l.) and Kameničky (49° 44' N, 15° 58' E, 550–650 m a. s. l.). The other sample was caught on clearcuts induced by air pollution planted with spruce in the Beskydy Mts. (49° 31' N, 18° 22' E, 1000–1200 m a. s. l.).

Only skulls of adult individuals were included in the analysis. Animals in the reproduction phase were taken as adults, such as pregnant or nursing females or females which had already given birth (with spots on their uterus), males with developed testes or individuals which reached the body weight of 28 g and which were caught after the breeding season, thus having no opportunity for reproduction. First the presence of the inner loop on $M^1$, so called "*exsul*-Schlinge am $M^1$" was detected to prove that all samples belong to the same race of the field vole (Krapp & Niethammer 1982). The following measures were taken: condylobasal length (CB), total length of the skull (TLS), nasal length (N), zygomatic breadth (ZY), length of the maxillary diastema (MXD), length of the maxillary tooth row (MXT), length of the mandibular tooth row (MDT), length of the mandibular diastema (MDD, measured from the end of alveoli of the first incisor to the beginning of the tooth row) and mandible length (LMD) (Gebczynska 1964, Garde & Escala 1997). The body length (BL) was used as a measurement indicating the body size. Statistica for Windows Software was used for the evaluation.

## RESULTS

The inner loop on $M^1$ was present in 46.0% of voles from the Českomoravská vrchovina Highlands (specifically, 37.5% from Brtnice, 57.1% from Velké Meziříčí and 47.6% from Kameničky) and in 51.4% of individuals from the Beskydy Mts. No difference in the occurrence of the loop was found between the two sites ($\chi^2$= 0.519; p= 0.471). The values of skull measurements and body length from the localities Brtnice, Velké Meziříčí and Kameničky were analysed using the median test for each sex separately. No differences between these localities were found, so these data were pooled under the Českomoravská vrchovina site.

These skulls measurements coming from unaffected wet meadows were compared with those of voles coming from clearcuts induced by air pollution in the Beskydy Mts., using nonparametric Mann-Whitney test, again each sex separately (Tab. 2). The comparison showed that females in the Beskydy Mts. tend to have smaller body size and some skull measurements than females in the Českomoravská vrchovina Highlands. In the case of N, ZY, MXT, MDD and LMD the differences were significant, in the case of CB, TLS and MXD they were not. No relevant differences in the cranial measurements were found in males. Furthermore, differences in measurements between males and females were analysed only in the Beskydy Mts. due to the small sample size in the Českomoravská vrchovina Highlands (Tab. 3). There were

Tab. 1. Number of sampling skulls per locality and the year of collecting
Tab. 1. Množství zkoumaných lebek z každé lokality a roky sběru

| sample<br>years | Velké Meziříčí<br>1990–1993 | Brtnice<br>1977–1994 | Kameničky<br>1973–1978 | Beskydy<br>1987–1993 |
|---|---|---|---|---|
| females | 13 | 24 | 11 | 73 |
| males | 4 | 14 | 10 | 50 |
| Σ | 17 | 38 | 21 | 123 |

Tab. 2. Variations in body and skull measurements for each locality and sex, the number of specimens, mean, standart deviation (SD) and differences between populations (Mann-Whitney test z, p)
Tab. 2. Proměnlivost tělesných a lebečních rozměrů pro každou lokalitu a pohlaví, množství vzorků, průměr, směrodatná odchylka (SD) a rozdíly mezi populacemi (Mann-Whitney test z, p)

| | | Českomoravská vrchovina Hlds | | | Beskydy Mts. | | | Mann-Whitney | |
|---|---|---|---|---|---|---|---|---|---|
| | | n | mean | SD | n | mean | SD | z | p |
| BL | females | 46 | 110.97 | 9.092 | 73 | 107.18 | 6.749 | 2.783 | **< 0.01** |
| | males | 26 | 107.00 | 11.052 | 50 | 109.12 | 9.976 | –0.356 | >0.05 |
| CB | females | 12 | 25.44 | 1.361 | 22 | 25.56 | 0.710 | 0.181 | >0.05 |
| | males | 14 | 25.83 | 1.533 | 16 | 26.08 | 1.112 | –0.292 | >0.05 |
| TLS | females | 12 | 25.58 | 1.179 | 21 | 25.25 | 0.712 | 1.613 | >0.05 |
| | males | 13 | 26.01 | 1.406 | 16 | 25.67 | 1.020 | 1.120 | >0.05 |
| N | females | 43 | 7.08 | 0.494 | 60 | 6.67 | 0.422 | 4.070 | **< 0.01** |
| | males | 26 | 6.91 | 0.657 | 41 | 6.85 | 0.528 | 0.161 | >0.05 |
| ZY | females | 25 | 14.72 | 0.705 | 28 | 13.93 | 0.549 | 4.070 | **< 0.01** |
| | males | 12 | 14.87 | 0.736 | 24 | 14.56 | 0.894 | 1.327 | >0.05 |
| MXD | females | 35 | 7.41 | 0.440 | 56 | 7.28 | 0.388 | 1.923 | >0.05 |
| | males | 23 | 7.40 | 0.497 | 37 | 7.55 | 0.550 | –1.198 | >0.05 |
| MXT | females | 45 | 6.41 | 0.285 | 69 | 6.29 | 0.295 | 2.141 | **< 0.05** |
| | males | 26 | 6.39 | 0.427 | 48 | 6.28 | 0.366 | 0.718 | >0.05 |
| MDT | females | 46 | 6.07 | 0.272 | 72 | 6.21 | 0.309 | –1.463 | >0.05 |
| | males | 26 | 6.05 | 0.278 | 46 | 6.12 | 0.296 | –0.933 | >0.05 |
| MDD | females | 44 | 3.88 | 0.205 | 70 | 3.76 | 0.258 | 2.436 | **< 0.05** |
| | males | 27 | 3.77 | 0.219 | 46 | 3.90 | 0.258 | –1.668 | >0.05 |
| LMD | females | 46 | 16.00 | 0.631 | 70 | 15.55 | 0.566 | 4.528 | **< 0.01** |
| | males | 26 | 15.75 | 0.77 | 47 | 15.68 | 0.745 | 0.235 | >0.05 |

differences between the sexes in the size of N, MXD, ZY and MDD, females being smaller than males in all cases.

## DISCUSSION

The skulls of females from the Beskydy Mts. were smaller in some measurements than skulls of females from the Českomoravská vrchovina Highlands, such as in the case of body length. These differences were absent in males. Smaller skulls of mountain females can correspond with their smaller body size. The growth of body length is not uniform and it depends on season (*Microtus agrestis*, Anděra 1979; *Clethrionomys glareolus*, Zejda 1971). This can cause the differences in the body length of individuals from mountains and highlands, however seasonal variations do not influence the growth of skull measurements (Anděra 1979), therefore it is not possible to explain different cranial measurements in this way. The differences in the size of females cannot be a result of different season of data collection, because sampling was done from April to October in all localities. The measured values fully correspond to those reported for an adult population of *Microtus agrestis* (Kratochvíl et al. 1956, Gebczynska 1963). However, the growth of the skull of *Microtus agrestis* has to be taken into account, including CB and TLS which grow (even though very slowly) till the ninth month of life (Gebczynska 1964), or till the end of life (Anděra 1979), and MXT which grows only till the fourth or the fifth month of age

Tab. 3. Significance of differences in cranial and body measurements between sexes in the Beskydy Mts., the number of specimens (Mann-Whitney test z, p)
Tab. 3. Rozdíly v lebečních a tělesných rozměrech mezi pohlavími v Beskydech, velikost vzorku (Mann--Whitney test z, p)

| | $n_F$ / $n_M$ | z | p |
|---|---|---|---|
| BL | 73 / 49 | –1,453 | > 0.05 |
| CB | 22 / 16 | –1.804 | > 0.05 |
| TLS | 21 / 16 | 0.104 | > 0.05 |
| N | 60 / 41 | –2.140 | **< 0.05** |
| ZY | 28 / 24 | –2.671 | **< 0.01** |
| MXD | 56 / 37 | –2.805 | **< 0.01** |
| MXT | 69 / 48 | –0.030 | > 0.05 |
| MDT | 72 / 46 | 1.170 | > 0.05 |
| MDD | 70 / 46 | –2.461 | **< 0.05** |
| LMD | 70 / 46 | –1.177 | > 0.05 |

(Anděra 1979). We assume that females at the two sites may have just different age structure. Males are sexually active earlier than females at the beginning of the breeding season and the difference in their body length (greater body length of males than that of females) can also influence the values of our material. Naturally the reproduction started earlier in the Českomoravská vrchovina Highlands than in the Beskydy Mts. and therefore the body size of females from the highlands females is probably more advanced. The certain phenological shift can be probably connected with a shift in the onset of reproduction and consequently with body size. Another explanation lies in the fact that females in the stage of pregnancy, when they are still growing, can be more sensitive to the variation of weather, which is stronger in the mountains than in the highlands and consequently their growth can stop.

In addition these females have shorter time for reproduction depending on the short period of warmer weather. The very intensive reproduction during this short period imposes big metabolic requirements on the body, which can possibly affect the growth of the females.

Size differences between geographically separate populations have been found by *Microtus agrestis* (Anděra 1979), animals in lowlands having wider skulls than a population from near highlands and longer skulls than population from highlands about 400 km away. No variations in size were observed between skulls of *Arvicola sapidus* from northern Spain and those from the Ebro Delta 300 km far away (Garde & Escala 1997). In *Clethrionomys glareolus*, differences in skull size were found between populations in the south-west, east and north of Austria (Spitzenberger et al. 1999), which can be connected to altitude, because skulls of individuals from higher altitude have tendency to be larger. The size of BL, CB, TLS, N and MXD of individuals from lowlands were smaller than thosae of individuals from mountains in *Clethrionomys glareolus*, in addition, at lower altitudes of the Krkonoše Mts. skulls were smaller than an higher localities (Haitlinger 1970).

Some cranial measurements show significant differences between males and females in the Beskydy Mts., especially measurements which were different between the two groups of females. This can indicate the significantly small body and skull size of females from the Beskydy Mts. The differences between sexes have been observed in CB and ZY in *Microtus agrestis* (Anděra 1979). In other cases these sexual differences were not found – in *Microtus agrestis*

in CB, MXT (Gebczynska 1964), by *Clethrionomys glareolus* in CB, N and MXT (Spitzenberger et al. 1999) and *Microtus subterraneus* (Zimová 1985).

According to the presence of the inner loop on $M^1$, all samples belonged to the same subspecies *Microtus agrestis agrestis* (Krapp & Niethammer 1982). Moreover, no differences in measurements were found between the populations (when sexes were pooled), and therefore there is no reason to suppose that animals from the Českomoravská vrchovina Highlands and the Beskydy Mts. belong to different races, as opposed to the case of marmots from the High Tatra Mts. and the Alps, which were divided into different geographical subspecies according to different sizes of nasal length and nasal width (Kratochvíl 1961), however the influence of geographical factors must be considered. The other possible reason for the differences in skull measurements can be different food supply in the two sites. Clearcuts in the Beskydy Mts. are highly dominated by grasses and consequently the food of voles is less varied than in meadows in the highlands (Bufka 1989, Heroldová 2002). The differences are probably caused by different habitat conditions – altitude, geomorphology, weather condition and consequently food supply and vegetation cover.

## SOUHRN

Byly porovnávány rozměry lebek hraboše polního (*Microtus agrestis*) z přirozených podmáčených luk Českomoravské vrchoviny a z imisních holin v Beskydech. Některé lebeční rozměry byly u samic z Beskyd menší než u samic z Českomoravské vrchoviny, což může být následkem rozdílu ve velikosti těla. Žádné takové rozdíly ovšem nebyly zjištěny u samců. V některých případech byli zjištěny rozdíly v tělesných a lebečních rozměrech těla mezi pohlavími.

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