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Growth of the bank vole *Myodes glareolus* in the non-vegetative period in NE Lithuania

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Abstract. Bank voles (*Myodes glareolus*) were trapped in north-east Lithuania from October to April in 2004–2008. Investigation of 536 individuals showed that winter growth depression for the species was not strongly expressed, except for the body weight of juveniles in December and January. Only a few skull characters showed stunted growth. The wintering juvenile bank voles attained an average body mass of 14.8 ± 0.07 g and an average body length of 84.3 ± 0.32 mm, while the respective parameters in subadult individuals were 17.0 ± 0.09 g and 86.0 ± 0.37 mm. The successful overwintering of such small bank voles suggests a possible influence of warmer winters.

Key words: bank vole, overwintering, body growth, cranial growth.

INTRODUCTION

Most animals live in a seasonal environment, where the number of individuals at the beginning of any one season is dependent on the survivors from the preceding season (Solonen, 2006). Despite occasional winter reproduction, small mammal populations decline in the cold periods (Pucek et al., 1993; Norrdahl & Korpimäki, 2002).

Prolonged unbroken periods of frost or snow are suggested to have a stronger negative impact on animals than several shorter periods interspersed with mild spells, but according to the opinion of many authors, severe winters with a thick snow cover providing shelter from cold and predation could be more favourable for small mammals than mild ones (Hansson & Henttonen, 1985; Solonen, 2006).

In mild winters fluctuation of temperatures around the freezing point may be especially harmful by alternately freezing and wetting the microhabitats of small mammals (Solonen, 2001, 2004). Since shrews and bank voles (*Myodes glareolus*) prefer forests, they are probably less vulnerable to the frost seesaw effect than field voles, which mainly occupy open habitats (Solonen, 2006).

Specifically in bank voles, cohorts formed by the birth time of different litters of the year may have an impact on the growth and attaining sexual maturity

(Zejda, 1971; Bashenina, 1981). Differences in cohorts become less distinct during hibernation and are insignificant towards the end of the subsequent spring (Zejda, 1971).

In Lithuania the majority of small mammal studies are done in the vegetative season of the year, so the winter ecology of small mammals in Lithuania is scarcely known (Balčiauskas & Gudaitė, 2006; Gudaitė & Balčiauskienė, 2006).

The aim of this paper is to provide data on the winter ecology of bank voles in Lithuania, including changes in their age structure and body and cranial growth dynamics.

MATERIAL AND METHODS

The trapping of small mammals in the cold seasons of 2004–2008, from October to April each winter, depended on weather and on the start or end of the vegetative period. The material was collected near Lake Ilgelis, Zarasai District, north-east Lithuania (Balčiauskas & Gudaitė, 2006). The standard method of snap-trap lines was used with 25 to 50 traps for 1–3 nights (Balčiauskas, 2004). A total of 536 bank vole individuals were trapped. After weighing and measuring, voles were dissected and divided into three age categories: juveniles, subadults, and adults, based on their reproductive status and presence of *gl. thymus*. Skulls were cleaned with the *Dermestes* larvae.

For the evaluation of cranial growth we used 17 skull characters (Balčiauskienė, 2006, 2007) measured under a binocular with a micrometric eyepiece with an accuracy of up to 0.1 mm.

The following skull (8 mandibular and 9 cranial) characters were measured: X_1 – total length of mandible at *processus articularis* excluding incisors; X_2 – length of mandible excluding incisors; X_3 – height of mandible at, and including, first molar; X_4 – maximum height of mandible excluding coronoid process; X_5 – coronoid height of mandible; X_6 – length of mandibular diastema; X_7 – length of mandibular tooth row; X_8 – length of molar M_1; X^9 – length of *nasalia*; X^{10} – breadth of braincase measured in the widest part; X^{11} – zygomatic skull width; X^{12} – length of cranial (upper) diastema; X^{13} – zygomatic arc length; X^{14} – length of *foramen incisivum*; X^{15} – length of maxillary toothrow; X^{16} – length of molar M^1; X^{17} – incisor width across both upper incisors (Balčiauskienė, 2006, 2007; Balčiauskienė & Balčiauskas, 2009).

RESULTS AND DISCUSSION

The trapped rodents (1168 individuals in total) were represented by 10 species. The most abundant were bank voles – 536 individuals comprising 45.9% of all trapped rodents. Monthly changes in the community structure are shown in Table 1. At the beginning of the non-vegetative period, the number of trapped rodent species was greater (6–10 species) than towards spring (4–5). The decrease in the number of trapped bank voles towards the end of winter was followed by changes

Table 1. Seasonal changes in the bank vole proportion in the rodent community in the non-vegetative seasons of 2004–2008

	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Number of species (*S*)	6	10	9	4	8	5	4
Number of individuals (*N*)	201	246	309	137	109	52	114
Bank vole %	37.8	53.3	59.2	36.5	58.7	21.2	18.4

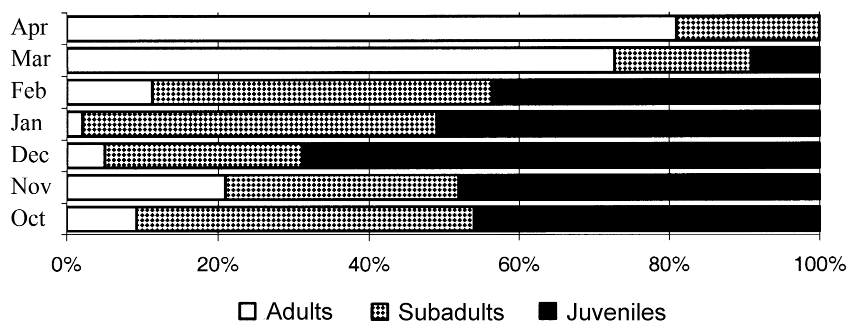

Fig. 1. Dynamics of the age structure of the bank vole population in the non-vegetative periods of 2004–2008.

in the age structure. Towards April, juveniles were replaced by subadults and adults in bank vole populations (Fig. 1).

Monthly averages of body mass and length were compared for juveniles and subadults (Table 2). The growth of the body mass of juvenile individuals in the non-vegetative period was stunted from November to January, yet no stunting was observed in their body length. Compared to October, the greatest depression of juvenile body weight was observed in December ($t = 2.56$, $p = 0.01$) and January ($t = 1.88$, $p < 0.10$). In subadult individuals no stunting of growth was expressed (Table 2).

Table 2. Monthly averages of body mass (*Q*, g) and body length (*L*, mm) in the bank vole in the non-vegetative periods of 2004–2008

Month	Juveniles			Subadults		
	N	*Q*	*L*	*N*	*Q*	*L*
October	35	15.2±0.21	79.5±0.69	34	16.8±0.18	82.4±0.50
November	62	14.8±0.19	81.5±0.54	40	17.1±0.16	85.0±0.64
December	124	14.7±0.10	86.4±0.40	47	17.1±0.19	87.1±0.79
January	25	14.7±0.21	85.0±1.10	23	16.9±0.26	86.6±1.20
February	25	15.2±0.22	87.4±1.16	28	17.1±0.21	88.5±0.68
March	1	13.5	81.0	2	17.3±1.75	89.9±7.00
April	n.d.	n.d.	n.d.	4	16.3±0.66	90.5±2.32

n.d. – no data.

We also studied the cranial growth of bank vole juveniles and subadults in October–April. Cranial growth in juveniles (Table 3) was different from that in subadult bank voles (Table 4). The following skull elements in juvenile bank voles were found to keep growing throughout the non-vegetative period: X_1, X_2, X_4, X_8 (Fig. 2a), X^{11}, X^{16}, and X^{17}. Other skull characters were stunted in growth (X^{10}) or grew until a certain month and then their growth stopped (X_7 – Fig. 2b and X^{14}). Growth of characters X_3, X_5, and X_6 was observed at the beginning of the non-vegetative period, then it stopped but renewed towards spring. We did not observe any growth regularities for X^9, X^{10}, X^{12}, X^{15}, and X^{13} in juvenile bank voles (Table 3).

The growth process of subadult bank voles in the non-vegetative period was different. Only a few skull characters grew uninterruptedly (X_1, X_2, and X^{13}), renewed growth in spring (X_4), or remained stable (X_3, Fig. 2d). Others exhibited depression either throughout the non-vegetative period (X_7 (Fig. 2c) and X^{14}) or towards spring (X_8, X^{12}, X^{16}, and X^{17}). Long-lasting growth depression was characteristic of X^{10}. No expressed growth regularities were recorded for X_5, X_6, X^9, X^{11}, and X^{15}. Thus, the growth of the skull of immature bank vole individuals was at least partially stunted in the non-vegetative period.

We also checked if regressions describing the relation of body mass to cranial measurements in the warm season are valid for bank voles trapped in the winter period. The average body mass of 528 bank vole individuals trapped in the non-vegetative season was 16.4±0.10 (7.0–25.0) g. The average body mass calculated

Table 3. Dynamics of the growth of skull characters (mm) in bank vole juveniles in the non-vegetative periods of 2004–2008

Character	Oct	Nov	Dec	Jan	Feb	Mar
X_1	11.2±0.07	11.3±0.05	11.5±0.03	11.4±0.10	11.7±0.06	11.4
X_2	10.3±0.07	10.5±0.05	10.6±0.03	10.6±0.09	10.9±0.07	10.7
X_3	4.1±0.03	4.2±0.02	4.2±0.01	4.2±0.03	4.3±0.02	4.2
X_4	5.6±0.04	5.7±0.03	5.8±0.03	5.9±0.08	6.0±0.04	5.6
X_5	5.7±0.04	5.8±0.03	5.8±0.02	5.9±0.05	5.9±0.04	n.d.
X_6	2.9±0.02	2.9±0.02	2.9±0.01	2.9±0.03	3.0±0.03	3
X_7	4.5±0.03	4.5±0.02	4.5±0.02	4.5±0.03	4.5±0.04	4.2
X_8	2.0±0.01	2.1±0.01	2.1±0.01	2.1±0.02	2.1±0.01	2.3
X^9	5.8±0.06	5.7±0.11	6.0±0.02	5.9±0.05	5.8±0.04	n.d.
X^{10}	10.4±0.05	9.6±0.52	10.4±0.03	10.4±0.05	10.4±0.06	n.d.
X^{11}	11.8±0.06	11.6±0.30	12.1±0.03	12.2±0.10	12.4±0.08	n.d.
X^{12}	5.9±0.05	5.9±0.11	6.1±0.02	6.2±0.05	6.2±0.04	n.d.
X^{13}	6.5±0.05	6.4±0.18	6.7±0.03	6.6±0.08	6.7±0.07	n.d.
X^{14}	4.1±0.04	4.1±0.03	4.2±0.02	4.2±0.03	4.2±0.04	n.d.
X^{15}	5.0±0.02	5.0±0.02	5.1±0.01	5.1±0.04	5.1±0.03	n.d.
X^{16}	1.6±0.01	1.7±0.01	1.7±0.01	1.7±0.04	1.7±0.02	n.d.
X^{17}	2.0±0.02	2.0±0.04	2.0±0.01	2.0±0.01	2.1±0.02	1.9

n.d. – no data.

Table 4. Dynamics of the growth of skull characters (mm) in subadult bank voles in the non-vegetative period

Character	Oct	Nov	Dec	Jan	Feb	Mar	Apr
X_1	11.5±0.06	11.5±0.06	11.6±0.05	11.6±0.06	11.7±0.07	12.0	11.2±0.06
X_2	10.6±0.05	10.7±0.06	10.7±0.05	10.8±0.06	10.9±0.07	11.2	10.6±0.09
X_3	4.3±0.02	4.2±0.03	4.3±0.02	4.3±0.03	4.3±0.05	4.2±0.23	4.2±0.03
X_4	5.9±0.03	5.8±0.05	5.9±0.04	5.8±0.07	6.1±0.04	6.3	6.1
X_5	5.9±0.03	5.9±0.05	5.8±0.03	5.8±0.05	5.9±0.06	5.8±0.05	5.8±0.04
X_6	2.9±0.03	2.9±0.08	2.9±0.02	3.0±0.03	3.1±0.02	3.0±0.14	2.9±0.04
X_7	4.6±0.03	4.5±0.03	4.6±0.02	4.5±0.03	4.5±0.04	4.3±0.09	4.4±0.07
X_8	2.1±0.01	2.1±0.02	2.1±0.01	2.1±0.02	2.2±0.02	2.1±0.05	2.1±0.07
X^9	6.0±0.03	5.8±0.17	6.0±0.04	6.0±0.06	5.8±0.06	5.7±0.05	5.9±0.09
X^{10}	10.7±0.09	10.6±0.08	10.5±0.04	10.4±0.06	10.5±0.06	10.6±0.37	10.3±0.23
X^{11}	12.2±0.06	12.2±0.05	12.3±0.06	12.4±0.09	12.5±0.06	12.4	12.1±0.26
X^{12}	6.1±0.04	6.2±0.04	6.2±0.03	6.3±0.03	6.3±0.04	6.3±0.18	5.8±0.12
X^{13}	6.8±0.06	6.7±0.05	6.8±0.05	6.9±0.07	6.9±0.07	7.0	6.7±0.26
X^{14}	4.3±0.03	4.3±0.04	4.3±0.03	4.2±0.03	4.2±0.04	4.4	4.0±0.13
X^{15}	5.1±0.03	5.0±0.02	5.1±0.03	5.1±0.04	5.1±0.03	5.0	5.1
X^{16}	1.7±0.01	1.7±0.04	1.7±0.01	1.8±0.01	1.7±0.04	1.7±0.05	1.7±0.06
X^{17}	2.0±0.02	2.0±0.02	2.1±0.01	2.0±0.01	2.0±0.01	2.0±0.05	1.9±0.07

according to the regression equations composed for the warm season significantly differed from the actual body mass of winter-trapped individuals. According to different regressions, the body mass calculated in the non-vegetative season was 19.2±0.11 g ($t = 18.3$, difference from the real average significant at $p < 0.001$), 18.7±0.08, 19.3±0.12, 18.8±0.08, and 18.8±0.09 g (all differences significant at $p < 0.001$). The error of the calculated averages was in the range of 14.1–18.0% of the actual body mass of winter-trapped individuals. Thus, for appropriate prognosis, regressions should be calculated from winter-trapped individuals.

In this paper we do not analyse the impact of winter temperature and snow cover on the growth of bank voles. It was presumed that all four trapping seasons were mild (temperatures above average) with light snow cover. We only checked the correctness of the opinion of Wasilewski (1953) that the body length of bank voles probably decreases during winter and the opinion of Haitlinger (1965) that negative skull growth during winter is obvious (both authors cited after Bashenina, 1981 and Zejda, 1971). Other possible factors influencing the growth of bank vole individuals, like population density in autumn (Solonen, 2006), predation (Erlinge et al., 1983), or integrated influence of these factors (Hansson & Henttonen, 1985; Huitu et al., 2004), were not analysed.

Our data widen the knowledge of the winter ecology of the bank vole. It was found that under the conditions of Central Europe, the body weight of 20 g (and the body length of 90 mm) appears to be the optimum condition for the survival

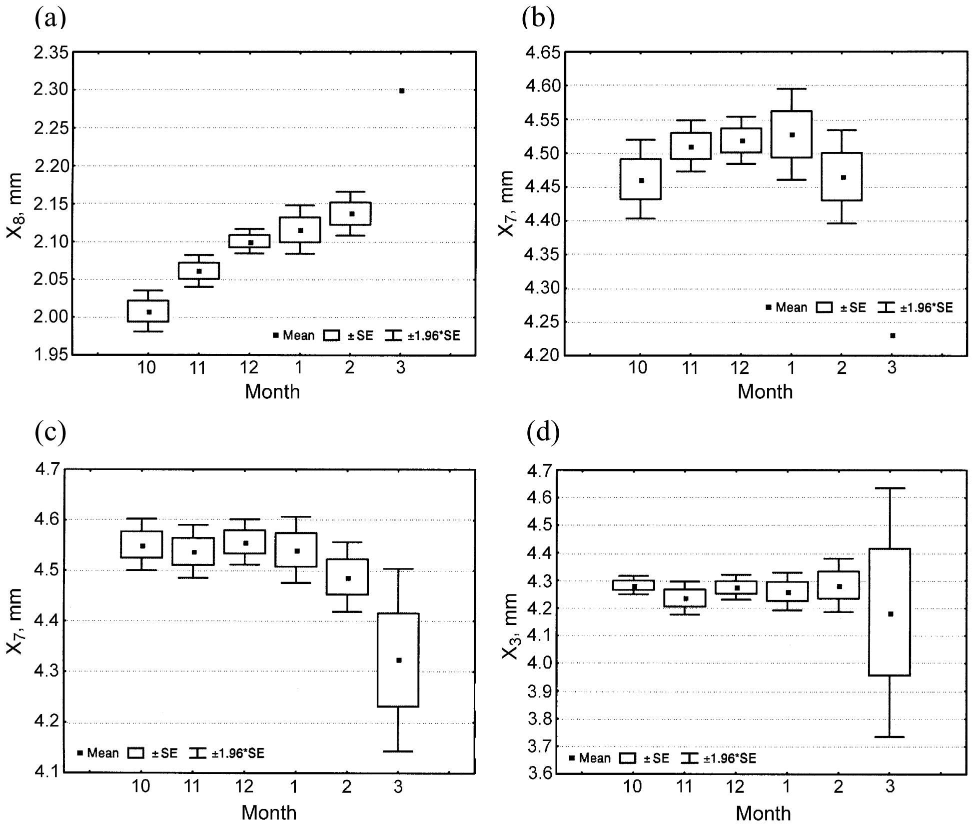

Fig. 2. Growth patterns of bank vole juveniles (a, b) and subadults (c, d) in non-vegetative months (X_8 – length of molar M_1, X_7 – length of mandibular tooth row, X_3 – height of mandible including first molar).

of bank voles in an unfavourable season (Zejda, 1971). The same author also pointed out that the weight at which growth stagnates shows geographic variation and that the phenomenon of skull depression is weakly expressed.

In Lithuania wintering juvenile bank voles attained an average body mass of 14.8±0.07 g and an average body length of 84.3±0.32 mm, while the respective parameters in subadult individuals were 17.0±0.09 g and 86.0±0.37 mm (for separate months see Table 2).

Such small successfully overwintered bank vole individuals fell out of the body mass range expected according to the data of other authors (e.g., Zejda, 1971; Bashenina, 1981). In England, where the climate is milder, the range of bank vole body mass in the winter period was found to be 13–16 g, and the average weight loss was 14.6% for males and 16.7% for females, compared to September (Tanton, 1969). As the winters of 2006–2007 and 2007–2008 were exceptionally mild (http://www.vtv.lt/naujienos/lietuvoje/si-kalendorine-ziema-silciausia.html), we may suspect the influence of climate change. The influence of winter temperatures and snow regime on the bank vole will be analysed later.

CONCLUSIONS

– The growth depression of bank voles in the non-vegetative periods of 2004–2008 in NE Lithuania was not strongly expressed, with the exception of the body weight of juveniles in December and January.
– Several growth patterns of bank vole skull characters were found, including the stunted growth of the breadth of the braincase measured in its widest part in juveniles and the length of the mandibular tooth row and of *foramen incisivum* in subadult animals.
– The stunted growth of bank voles in the non-vegetative period did not allow using regressions in describing the relation of body mass to cranial measurements that were composed from the data on bank voles in the warm period.
– In NE Lithuania, wintering juvenile bank voles attained an average body mass of 14.8 ± 0.07 g and an average body length of 84.3 ± 0.32 mm, while the respective parameters of subadult individuals were 17.0 ± 0.09 g and 86.0 ± 0.37 mm. These values are smaller than those reported for Central Europe, but close to the wintering bank vole body mass in England, where the climate is milder.

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Leethiire (*Myodes glareolus*) kehamõõtmete kasv talveperioodil Kirde-Leedus

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Pisiimetajate kehamõõtmete muutumise selgitamiseks talveperioodil püüti Kirde-Leedus oktoobrist aprillini 2004–2008 leethiiri (*Myodes glareolus*). 536 tabatud leethiirt kaaluti ja lisaks kehamõõtmetele võeti 17 koljumõõdet. Analüüsitud loomadel ei avaldunud selgelt talvist kängunud kasvu, välja arvatud juveniilsete loomade kehamassi osas detsembris ja jaanuaris. Vaid mõne koljumõõtme puhul ilmnes kasvu pidurdumist. Talvituvate juveniilsete leethiirte keskmine kehamass oli 14,8 ± 0,07 g ja keskmine kehapikkus 84,3 ± 0,32 mm. Subadultsete leethiirte vastavad parameetrid olid 17,0 ± 0,09 g ja 86,0 ± 0,37 mm. Sellised väikesekasvulised isendid on iseloomulikud Inglismaal, kus kliima on pehmem. Tõenäoliselt on nii väikeste isendite edukat talvitumist Leedus soodustanud keskmisest soojemad talved.