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AGE STRUCTURE OF THE LESSER WHITE-TOOTHED SHREW (*CROCIDURA SUAVEOLENS*) POPULATION IN THE ASKANIA-NOVA BIOSPHERE RESERVE

Igor Zhezherin

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Crocidura suaveolens, age structure, reproductive strategy, life cycle, Askania-Nova

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Affiliations

I. I. Schmalhausen Institute of Zoology, NAS of Ukraine (Kyiv, Ukraine)

Correspondence

Igor Zhezherin; I. I. Schmalhausen Institute of Zoology, NAS of Ukraine; 15 Bohdan Khmelnytsky Street, Kyiv, 01601 Ukraine;
Email: izhezherin@gmail.com;
orcid: 0009-0005-4688-7983

Abstract

The aim of this study was to investigate the age structure and reproductive strategy of the lesser white-toothed shrew (*Crocidura suaveolens* Pallas 1811) population in the Askania-Nova Biosphere Reserve, Ukraine. The age structure of the population of this shrew species was studied in the protected steppe based on specimens collected in 1980–1986. The lesser white-toothed shrew is one of the most abundant species of small mammals in the reserve and a key species of the family Soricidae, which is the main consumer of the local mesofauna. In some periods, its population reaches an abundance of 200–300 individuals per hectare. To determine the age of individuals, we used the degree of tooth wear. The first multicusped tooth of the upper jaw (Pm4) was chosen for age estimation. The ratio of the height of the paracone to its width was used to level out individual variability. An attempt was made to find a correspondence between the relative value of the dental index and the absolute age of the individuals. This was based on the assumption that individuals with the weakest tooth wear (mean index 0.92) correspond to the age of early independent life, i.e. one month. Based on the analysis of the available data, it was found that the rate of decrease in the dental index was 0.026 per 10 days. Pregnant animals were found at the age of 45 days or less, which corresponds to the data of other authors. Based on the data obtained, individuals older than nine months were not captured (dental index mostly 0.26). In the Askania-Nova steppe, the breeding season of the lesser white-toothed shrew mostly begins in April and ends by the first half of October. However, single cases of breeding were recorded beyond this period. In early January, a one-month-old individual was caught. In May, catches of lesser white-toothed shrews aged about five months were recorded. In early July, two individuals aged 6.5 and 7 months were caught. In May, young animals accounted for about half of the captures. By mid-summer, overwintered animals were no longer found. The last cases of catching old animals were noted in the second half of June and early July. The study shows a distinct age structure dynamics of the population of the lesser white-toothed shrew during the year, which is determined by seasonal changes in the reproduction of the population under the conditions of the Askania-Nova protected steppe.

Cite as

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Вікова структура популяції білозубки малої (*Crocidura suaveolens*) у Біосферному заповіднику «Асканія-Нова»

Ігор Жежерін

Резюме. Метою цього дослідження стало вивчення вікової структури та репродуктивної стратегії білозубки малої (*Crocidura suaveolens* Pallas 1811) у Біосферному заповіднику «Асканія-Нова» (Україна). Вікова структура популяції цього виду вивчали в заповідному степу на підставі зборів, зроблених за участі автора протягом 1980–1986 років. Білозубка мала є в цьому заповіднику одним із фонових видів дрібних ссавців і ключовим видом родини Soricidae, який виступає тут основним консументом мезофауни. В окремі періоди її чисельність досягає 200–300 особин на гектар. Для визначення віку особин використовувався показник ступеня стертості зубів. Як об'єкт оцінки віку було обрано перший багатогорбковий зуб верхньої щелепи, Pmp4. Для нівелювання індивідуальної мінливості використовували відношення висоти параконіда зуба до його ширини. Зроблено спробу знайти відповідність відносного значення зубного індексу до абсолютного віку особин. При цьому виходили з того, що особини з найменшою стертістю зубів (індекс у середньому становив 0,92), відповідає віку початку самостійного життя, тобто одному місяцю. На підставі аналізу доступних даних встановлено, що швидкість зменшення зубного індексу становить 0,026 за 10 днів. Вагітні особини зустрічалися у віці не раніше 45 днів, що відповідає даним інших авторів. На підставі отриманих даних, особини старше дев'яти місяців не зустрічалися (зубний індекс здебільшого 0,26). У Новоасканійському степу здебільшого сезон розмноження починається у квітні й закінчується до першої половини жовтня. Однак, поодинокі випадки розмноження відмічені й поза цим періодом. Так, на початку січня була виловлена особина віком один місяць. У травневих виловах зустрічалися білозубки віком близько п'яти місяців. На початку липня були спіймані дві особини віком 6,5 та 7 місяців. У травні на частку молодих особин припадає близько половини відловлених тварин. А до середини літа особини, що перезимували, вже не зустрічаються. Останні випадки вилову старих звірків відмічалося в другій половині червня та на початку липня. Дослідження показує виразну динаміку вікової структури популяції білозубки *Crocidura suaveolens* протягом року, що визначається сезонними змінами в репродукції популяції в умовах заповідного степу Асканії-Нової.

Ключові слова: білозубка мала, вікова структура, стратегія розмноження, життєвий цикл. Асканія-Нова.

Introduction

Some of the most important population characters are age structure, timing and strategy of reproduction, and fecundity. Due to a short lifespan and relatively simple population age structure, soricids make an excellent research model. Many studies in the ecology of soricids have been carried out on red-toothed shrews (genus *Sorex*). Although the lesser white-toothed shrew (*Crocidura suaveolens*) is widely distributed across Europe, it is rarely an abundant species. Probably that is why data on the ecology of this species are usually fragmentary and scattered. In the Askania-Nova virgin steppe, the lesser white-toothed shrew is an abundant small-mammal species. Its abundance in different years can reach 200–300 individuals per hectare. This very condition allowed filling the gap in research into the ecology of the lesser white-toothed shrew.

The aim of the present study was to describe the age structure of the lesser white-toothed shrew population that exists in a protected steppe and to analyse its dynamics during the year.

Material and Methods

The study was carried out on materials collected in the Askania-Nova Reserve by employees of the Department of Population Ecology of Terrestrial Vertebrates of Shmalhausen Institute of Zoology (Kyiv, Ukraine). The first upper multicusped tooth was measured and the dental index was calculated in 779 individuals of the lesser white-toothed shrew from samples trapped in October 1980;

May, July, and October 1981; and January, February, April, May, June, July, August, and October 1983 (Fig. 1).

For a long time, there was no approach developed to determine the age of soricids and various, not often reliable, parameters were used. Pearson [1945] noted that there were attempts to determine age based on the state of reproductive organs, presence or absence of scars on the tail and feet, or total body length, whereas some authors estimated age considering the state of the tail and teeth along with body length. Pearson himself considered that the most reliable method to determine the age of soricids is the one based on the degree of enamel wear and he distinguished the following age groups: mature, immature, young, and old. Mature are individuals that reproduce or had reproduced, immature are those that have not yet bred, young individuals have not yet overwintered, and old individuals have already overwintered.

Rood [1965] proposed to determine the age of *C. suaveolens* based on the two posterior cusps of the first lower molar by measuring tooth height from the alveolus to its tip. This method allowed for a more thorough analysis of population age structure. Later, tooth wear as age criterion was used by other authors as well [Mezhzherin & Kyrychuk 1988].

In this study, the age of the individuals was determined based on the degree of wear of the first upper premolar (Pm4). This tooth is actively involved in chewing, unlike the front and intermediate teeth that are involved in grasping the food and thus can more often be damaged. It is also larger so more accurate measurements can be taken. In order to level out individual variability, the ratio between tooth height and tooth width (dental index) was calculated (Fig. 2). For all large samples ($n > 10$), which are indicated by darker colour in Fig. 1, the distribution of individuals by their dental indices was studied (Figs 3–4). The data are presented in detail in Table 1.

Respectively, the older an individual is, the more worn its tooth is and the smaller are the tooth height and dental index. It was also determined that the differences between dental indices of the right and left teeth are insignificant, so measurements were taken only on one side except in cases of damage. Measurements of teeth were taken by using an MBS-9 binocular microscope.

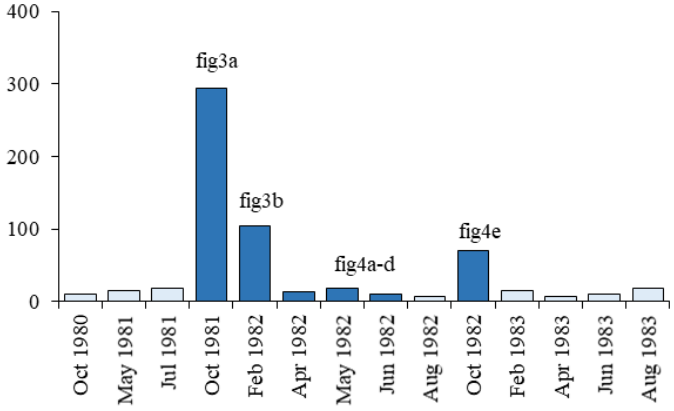

Fig. 1. Distribution of the number of trapped individuals of *Crocidura suaveolens* by periods of capture (see Table 2). Samples for which age groups were determined are indicated in dark.

Рис. 1. Розподіл кількості зловлених особин *Crocidura suaveolens* за періодами відлову (за табл. 2). Темним кольором позначено вибірки, для яких розподіл землерийок за віковими групами показано детально.

Fig. 2. Scheme of measurements of the paracone of Pm4 (1—width; 2—height). Photo courtesy of A. Savarin.

Рис. 2. Схема промірів паракона першого верхнього багатовершинного зуба, Pm4 (1 — ширина, 2 — висота). Фото А. Саваріна.

Table 1. Distribution of *Crocidura suaveolens* specimens by dental index values in all series of captures
Таблиця 1. Розподіл зразків *Crocidura suaveolens* за значеннями зубного індекса у всіх серіях ловів

Dental index	Oct '80	May '81	Jul '81	Oct '81	Feb '82	Apr '82	May '82	Jun '82	Aug '82	Oct '82	Feb '83	Apr '83	Jun '83	Aug '83
				fig 3a	fig 3b	fig 4a	fig 4b	fig 4c	fig 4d	fig 4e				
0.24														
0.26						1								
0.28						2	1	1						
0.30				1			2	1						
0.32				1			1	1						
0.34		1		1		1								
0.36					2	3								
0.38						3	2				2	2		
0.40					4	3	1				2			
0.42				2	5	2		1			2	1	2	
0.44					10			1			1	1		
0.46					5						1			
0.48			1		15						5	1		
0.50				2	9									
0.52			1		7						1			
0.54				2	11					2	1			
0.56				3	9					2				
0.58					5					1	1			
0.60				3	4					3				
0.62			1	2	4									1
0.64				4	1					2				
0.66		1	1	8	2					3				
0.68			1	20	2		1			1				1
0.70		1		38	2					5				
0.72			1	30						7				1
0.74			1	38	1					7				1
0.76	1	3	1	27	3				1	7				1
0.78	3	1	1	28	2				1	11				4
0.80	1		1	27						7			4	4
0.82	1	1	2	23			2			5			1	1
0.84	3		1	16	1		6	2	2	3			1	5
0.86		2		10			2	1	1	4				5
0.88		2	4	3				1	1			1	1	5
0.90		1	1	5		1		1	1				2	6
0.92	1	1		2	1							1		1
0.94	1	1						1						
0.96														
0.98		1												
n	11	16	18	295	105	13	18	11	7	71	16	7	11	18

Results and Discussion

Using the above method, the dental index was calculated in the trapped individuals and the obtained results are presented in bar charts (Figs 3–4). Values of the dental index are indicated on axis X (with an accuracy of 0.02), and the number of specimens for which the dental indices have been calculated in the respected samples are indicated on axis Y.

For the most representative samples of October 1981 and January–February 1982, the mean velocity of tooth wear was calculated according to the following formula:

$$V = (M_{Oct} - M_{Jan\text{-}Feb}) / t,$$

where M_{Oct} is the mean value of dental index in the 9 largest groups in the sample of October 1981 (see Fig. 3*a*), $M_{Jan\text{-}Feb}$ is the mean value of the dental index of the respective 9 groups in the sample of January–February 1982 (see Fig. 3*b*), and t is the time between these trappings, which is about 100 days.

Accordingly, the velocity of tooth wear was 0.026 in ten days or 0.078 in a month.

Considering that the lesser white-toothed shrew starts an independent life at an age of about one month [Vlasak 1970], and, accordingly, from this age these animals start to appear in traps, it can be suggested that shrews having the highest values of dental indices (0.92 and higher) are about one month old. Knowing the initial dental index and the velocity of tooth wear, one can calculate the correspondence between dental indices and age (see Table 2).

According to these calculations, the life expectancy of the lesser white-toothed shrew in the Askania-Nova virgin steppes is about nine months, since animals having a dental index lower than 0.26 were not recorded in the catches. This calculated life expectancy is shorter than the one presented in the literature [Vlasak 1970], which can be related either to the conditions of the steppe zone or to the specifics of the method based on indirect age determination.

The breeding season of the lesser white-toothed shrew in the Askania-Nova begins in late February–early March. In the third decade of April 1982, a young pregnant female was caught having a dental index of 0.88, while on 10 April 1983 a pregnant female with a dental index of 0.89 was trapped (age of about 45 days, i.e. born in the first decade of March).

Table 2. The correspondence between dental index and absolute age of shrews

Таблиця 2. Відповідність зубного індексу до абсолютного віку землерийок

Dental index	0.92	0.84	0.76	0.69	0.61	0.53	0.45	0.37	0.30	0.22
Age (months)	1	2	3	4	5	6	7	8	9	10

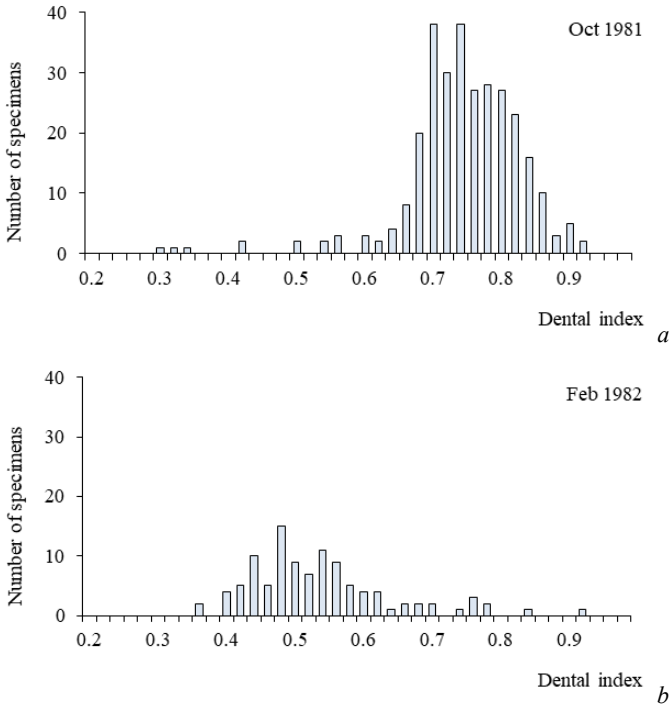

Fig. 3. Dental index values at the beginning of the studied population cycle in autumn (October) and winter periods (February), when there was a significant aging of the population (there are no individuals with a low degree of tooth wear).

Рис. 3. Значення зубного індексу на старті дослідженого популяційного циклу восени (жовтень) та у зимовий період (лютий), коли відбулося значне старіння популяції (відсутні особини з малим ступенем стирання зубів).

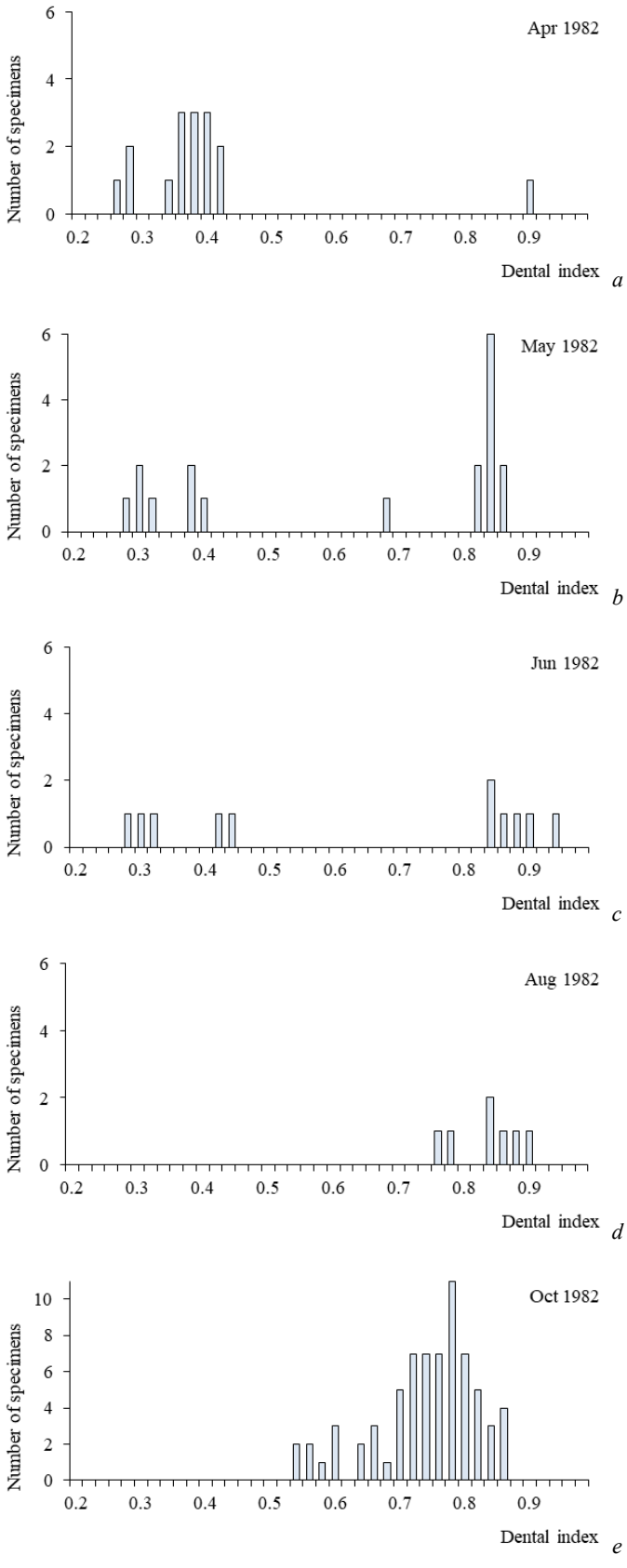

Fig. 4. Dental index values in different periods after the winter: spring (April), summer (May–June, and autumn (October).

Рис. 4. Значення зубного індексу у різні терміни після зимівлі: весною (квітень), влітку (травень і червень) та восени (жовтень).

In May, at least half of the trapped animals are three-month-old or younger. According to the analysis of the age of animals trapped in October, mass reproduction continues during summer with a peak in June–July. The breeding period usually ends in October, although single cases of reproduction might occur even in winter. For instance, in early February 1982, an individual was caught with a dental index of 0.93, meaning that it was less than a month old. Similarly, in May 1981 and 1982, 5-month-old individuals were trapped, whereas in July 1981 a number of 6.5-month-old or younger individuals were found. In early July 1983, a seven-month-old female was caught. Additionally, among the white-toothed shrews trapped in January–February 1982, there were individuals born in November–December.

Based on these data it can be stated that the lesser white-toothed shrew breeds in Askania-Nova all-year-round, including the winter period, though less actively. The number of embryos in the trapped females varied from 2 to 9, most often 4 to 7 (in average 5.73).

The life cycle of the lesser white-toothed shrew looks as follows. In spring, the old (overwintered) individuals start to reproduce. In May, the young shrews also begin to reproduce actively. At this time, the proportion of old individuals decreases and makes up about 50% of the population. By early July, the old generation disappears entirely (the last overwintered individuals having an age of 7–9 months were trapped on 16–21 June 1983). In summer and the first half of autumn, the current year's young reproduce actively and the shrews that are born in this period overwinter and will produce the next generation in spring.

Conclusions

1. The method of absolute age determination of white-toothed shrews allowed establishing that they became mature and begin to reproduce at the age of 40–45 days.

2. It has been revealed that the number of embryos in females from the studied population varies notably from 2 to 9, with the most common value 4–7 per female (in average 5.73).

3. The age structure of the population during the years changes as follows: in spring and the first half of summer, both age groups are represented in the population—old (overwintered) and young (of the current years). The proportion of the latter gradually increases and the old generation completely disappears by early July.

4. The maximum life expectancy of an individual is about 9–10 months and, respectively, overwintered shrews reproduce and die by early July.

5. The reproduction of the lesser white-toothed shrew under conditions of the Askania-Nova protected steppe continues almost incessantly all-year-round but notably less actively in winter; reproduction peaks in June–July.

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