Theriologia Ukrainica, **24**: 73–85 (2022)
p-ISSN 2616-7379 • e-ISSN 2617-1120
DOI: 10.15407/TU2408

DETERMINATION OF AGE IN REPRESENTATIVES OF THE GENUS *SYLVAEMUS* BY THE DEGREE OF MOLAR WEAR

Oksana Markovska

Key words

Sylvaemus, age determination, molar wear, odontometry, craniometry

doi

http://doi.org/10.15407/TU2408

Article info

submitted 18.11.2022
revised 18.12.2022
accepted 30.12.2022

Language

Ukrainian, English summary

Affiliations

V. N. Karazin National University of Kharkiv (Kharkiv, Ukraine)

Correspondence

Oksana Markovska; V. N. Karazin National University of Kharkiv, 4 Svobody Square, Kharkiv, 61022 Ukraine; Email: ksenia.markovskaia@gmail.com; orcid: 0000-0002-2573-4524

Abstract

Various methods are used to identify representatives of the genus *Sylvaemus*, most of which are metric. In order to exclude anomalies in further calculations and to minimize allometric variations associated with the growth of animals, it is necessary to take into account age as an important factor of variability. Usually, a number of criteria are used to determine the age and describe the growth of mice: measurements of body and skull parameters, body weight, the degree molar wear, and the weight of the lens of the eye. Length is a more consistent guide for determining the age of mice than body weight, which usually ceases to be directly related to age after reaching adult size. Age can also be determined by the fusion of the epiphysis with the diaphysis in the bones of the limbs and by the degree of development of the thymus. Most often, teeth are used to determine age. Among such age criteria, we distinguish eruption and replacement of teeth sets, tooth growth in length, overgrowth of the tooth pulp cavity, tooth wear, and annual layers in the tooth tissues. Usually, the age of mice is determined by the degree of molar wear. Some authors do not consider this method universal due to individual feeding habits of animals and other environmental factors. The order of wear of tooth rows can sometimes change, and the degree of wear of the right and left tooth rows can also differ. The craniological collection of small mammals of O. V. Zorya, collected in the territory of Kharkiv Oblast, Ukraine, was studied. In total, 198 specimens of three species of the genus *Sylvaemus* were analysed: *Sylvaemus uralensis*, *Sylvaemus sylvaticus*, and *Sylvaemus tauricus*. Analysed were 14 odontometric and 23 craniological characters. Among the metric characters, four odontometric (LM^2, WM^1, LM_2, LM_{123}) and nine craniometrical characters (LIOC, LD, LFI, LPP, WCH, GLS, DI, LLM, LM) made the greatest contribution to the age group differentiation of mice of the genus *Sylvaemus*. Among the features that contributed the most to the differentiation, length measurements prevailed. LLM, LM_{123}, LPP, LIOC, and GLS are the least variable metric characters. It is not possible to divide the sample of mice of the genus *Sylvaemus* into age groups based on odontometric and craniometrical character since the ranges of values of metric characters overlap.

Cite as

Markovska, O. 2022. Determination of age in representatives of the genus *Sylvaemus* by the degree of molar wear. *Theriologia Ukrainica*, **24**: 73–85. [In English, with Ukrainian summary]

Визначення віку у представників роду *Sylvaemus* за ступенем стирання кутніх зубів

Оксана Марковська

Резюме. Для ідентифікації представників роду *Sylvaemus* використовують різні методи, більшість з яких метричні. Щоб виключити аномалії в подальших розрахунках та мінімізувати алло-метричні варіації, пов'язані з ростом тварин, потрібно враховувати вік, як важливий фактор мінливості. Зазвичай для визначення віку та опису росту мишаків використовують ряд критеріїв: виміри параметрів тіла та черепа, маса тіла, ступінь стирання кутніх зубів та вага кришталиків ока. Довжина є більш послідовним орієнтиром для визначення віку мишаків аніж маса тіла, яка зазвичай припиняє бути напряму пов'язана з віком після досягнення розмірів дорослої особини. Вік також можна визначити за злиттям епіфізу з діафізом в кістках кінцівок та за ступенем розвитку тимусу. Частіше за все для визначення віку використовують зуби. Серед таких критеріїв віку виділяють: прорізання та зміну зубів, ріст зуба в довжину, заростання порожнини пульпи зуба, стирання зубів, річні шари в тканинах зуба. Зазвичай, вік мишаків визначають за ступенем стирання кутніх зубів. Деякі автори не вважають цей метод універсальним через індивідуальні звички харчування тварин та інші фактори оточуючого середовища. Порядок стирання зубних рядів може іноді змінюватися, а також може відрізнятися ступінь стирання правого та лівого зубних рядів. Досліджено краніологічну колекцію дрібних ссавців О. В. Зорі, зібрану на території Харківської області. Проаналізовано 198 екземплярів трьох видів роду *Sylvaemus*: *Sylvaemus uralensis*, *Sylvaemus sylvaticus*, *Sylvaemus tauricus*. Для аналізу використано 14 одонтометричних та 23 краніологічні ознаки. Серед метричних ознак найбільший вклад в розподіл на вікові групи мишаків роду *Sylvaemus* вносили чотири одонтометричні ознаки (LM^2, WM^1, LM_2, LM_{123}) та дев'ять краніологічних (LIOC, LD, LFI, LPP, WCH, GLS, DI, LLM, LM). Серед ознак, які вносили найбільший вклад в розподіл, переважали проміри довжини. До найменш мінливих метричних ознак належать LLM, LM_{123}, LPP, LIOC та GLS. Розділити вибірку мишаків роду *Sylvaemus* на вікові групи за одонтометричними та краніологічними ознаками не можна, діапазони значень метричних ознак перекриваються.

Ключові слова: *Sylvaemus*, визначення віку, стирання кутніх зубів, одонтометрія, краніометрія.

Introduction

The issue of species identification of mice of the genus *Sylvaemus* is often discussed in the context of mammalian taxonomy [Canady *et al.* 2014; Sozio *et al.* 2018]. Species of wood mice are taxonomically and phylogenetically close, their ecological features are somewhat different and still overlap, they are in sympatry and even syntopy throughout most of their geographic ranges, and their phenotypes are often so similar that it is very difficult to distinguish them in the field [Ancillotto *et al.* 2017; Michaux *et al.* 2005]. In addition, the lack of a reliable morphological approach to the identification of mice has led to frequent incorrect identification of specimens, causing further confusion and misinterpretation of their taxonomy and distribution [Jojic *et al.* 2014; Sozio *et al.* 2018].

There is a number of methods of identification of representatives of the genus *Sylvaemus*, most of which are metric, and in order to exclude anomalies in further calculations and minimize allometric variations associated with the growth of animals, it is necessary to take into account age as an important factor of variation [Panzironi *et al.* 1993; Reutter *et al.* 1999]. Usually, a number of criteria are used to determine the age and description of the growth of mice: measurements of body and skull parameters, body weight, degree of molar wear, and weight of the lenses of the eye [Frynta & Zizkova 1992].

Body weight is a quick and simple indicator of age that is used in some studies, but Brown [1969] found that length is a more consistent guide for determining the age of mice. Body weight usually ceases to be directly related to age after reaching adult size. The method can be useful for capturing live animals followed by marking and recapture at fixed time intervals [Morris 1972].

Age can be determined by the level of merger between the epiphysis and diaphysis in the bones of the limbs. In young animals, the diaphysis is separated from the epiphysis by a cartilaginous plate. The next stage of ossification of the growth zone is the formation of a furrow between the epiphysis and diaphysis, which is clearly visible. When the furrow between the epiphysis and diaphysis overgrows, a trace of it remains for some time, which can be found when passing a needle along the bone. The last stage is the complete merger of the epiphysis with the diaphysis. However, it is should be considered that the ossification of the epiphysis is affected by seasonal changes in the growth rate. For example, individuals born at the end of summer/autumn develop slowly during the winter period and only in the second half of the summer of the following year overtake fast-growing individuals from early spring broods. In the second half of winter, one can distinguish this year's late broods, but the cartilaginous plate disappears by this time in the early spring broods of this year and they can be confused with individuals that are more than a year old [Klevezal 2007].

Vertebrae grow like the bones of the limbs, but they are less often used to determine age. With age, the thickness of the epiphyses and cartilaginous intervertebral space decreases and the length of the vertebral body increases [Klevezal 2007]. Hagen [1956] suggested determining the relative age of small rodents by an index (the ratio of the length of two adjacent tail vertebrae to the thickness of their epiphyses), the value of which increases with age. When studying long-tailed rodents, the 15th and 16th vertebrae should be measured.

With age, the shape of the skull changes somewhat: in young animals, the skull is more rounded, the roof of the skull is convex, while in older animals the roof of the skull becomes flatter and the skull itself is more angular. This trait can be used as an additional age criterion. Also, all young animals have a smooth skull, tubercles and roughness appear with age, and then crests develop. The height and length of the crests increase with age. In females, crests develop later and are not as well defined as in males [Klevezal 2007].

Zagorodniuk & Kavun [2000] identified five age groups for the yellow-necked wood mouse (*Sylvaemus tauricus* Pallas, 1811) (juvenilis, subadultus, adultus-1, adultus-2, and senex) based on 4 external and 14 cranial characters.

Another criterion for the relative age of rodents is the degree of development of the thymus. This gland, which is large in young individuals during the period of rapid growth, decreases until it completely disappears in adults. At the same time, it is also necessary to take into account the seasonal changes of the gland, which differ in different generations of rodents [Klevezal 2007]. In combination with the reproductive state of the animal and the presence of the thymus, three age groups are distinguished: adultus (individuals that have overwintered or reproduce with a regressed thymus), subadultus (thymus in a state of regression, reproductive organs are developed, but not active), juvenilis (thymus is functioning, reproductive organs are still developing) [Balciauskiene *et al.* 2004].

Most often, teeth are used to determine age. Among such age criteria, we distinguish: eruption and change of teeth, tooth growth in length, overgrowth of the tooth pulp cavity, tooth wear, annual layers in tooth tissues. In rodents, a fully erupted, but not yet functional, tooth has sharp enamel cusps or tubercles. Over time, these cusps are gradually worn away, and when the enamel in some places is completely worn, exposed dentin appears, which differs in colour from the enamel. Further, with age, the tubercles also wear away, the surface of the teeth flattens, and even later the height of the crown decreases. In the process of wearing, the shape of the teeth also changes [Klevezal 2007].

According to the degree of wear, the material is ranked on the basis of visual inspection and/or measurement of the height of the tooth crown. In mice, age groups are usually distinguished by the degree of wear of enamel and exposure of dentine. The data are presented in figures, and a scoring system is used for assessment. It is also possible to estimate the ratio of the area of the wear surface occupied by dentin and enamel, or the ratio of the exposed area of dentin to the area of the chewing surface [Freudenthal *et al.* 2002]. A possible source of error in determining the age of rodents is an increase in individual variation in the degree of wear in older age groups. From one older age class, two can be made, so the age estimate of older individuals by the degree of wear may be overestimated [Klevezal 2007].

Some authors do not consider this method universal due to individual feeding habits of animals and other environmental factors [Frynta & Zižková 1992]. The order of wear of the tooth rows can sometimes change, and the degree of wear of the right and left tooth rows can also differ. Adamczewska-Andrzejewska [1967] identified four main age classes for the yellow-necked wood mouse: I—about four weeks, II—about two months, III—about five months, and IV—about nine months. Steiner [1968] identified six age classes: I—about one month, II—about two months, III—about three and a half months, IV—about five months, V—about seven months, and VI—about nine months. Tupikova [1964] distinguished four age classes not only for the upper, but also for the lower rows of molar teeth of the yellow-necked wood mouse with notably higher age indicators: I—1 to 1.5 months, II—5 to 10 months, III—12 to 16 months, and IV—1.5 to 2 years.

For craniometrical and dental analyses, individuals are usually selected from the age of five months, when they can be considered adults [Kuncova & Frynta 2009]. Jojic *et al.* [2011] included in the analysis all individuals with complete eruption of the third upper molar, because the most intensive growth occurs during the first four weeks after birth, and then gradually slows down [Niethammer 1969]. Barciova & Macholan [2009] also excluded individuals without well-developed third upper molars from the morphometric analysis.

To determine the age, it is convenient to make transverse sections of the lower jaw so that the longitudinal sections of the second or third molars are visible on the section. Then, on one preparation, one can see the layers in the bone tissue, in the cementum, and sometimes in the secondary dentin. Cementum is deposited around the roots of the tooth to the outside, odontoblasts in the pulp of the tooth produce dentin, which is deposited around the walls of the cavity inside the tooth. The influence of the environment causes fluctuations in the speed and nature of the formation of dentin and cementum; as a result, both tissues acquire a layered, not homogeneous structure [Morris 1972]. The annual layer consists of two zones, a wide zone with low density and a narrow zone with dense tissue. Most authors argue that active growth in the summer months leads to the formation of a wide zone, followed by a narrow zone that slowly accumulates in the winter months. To determine the age, it is recommended to examine the annual layers in the cement, because dentin is deposited inside the tooth and can quickly fill the pulp cavity, besides, it is very sensitive to changes and can show additional growth lines. Annual layers are often visible on cross-sections of the diaphyses of tubular bones and phalanges of the fingers. In annuals, you can see a line, usually somewhat winding, which separates the outer periosteal zone of the bone and is not considered annual. The presence of layers of bone tissue in the diaphyses of the phalanges of the fingers makes it possible to determine the age of living individuals [Klevezal 2007].

The results of research on the mammalian eye show that the lens of the eye grows throughout life due to the formation of new fibres in its equatorial zone. During the period of rapid body growth, the weight of the lens increases along with the body weight [Morris 1972; Hagen *et al.* 1980]. Lens weight is considered a better indicator of age than body and skull dimensions or the degree of molar wear [Andrzejewski & Liro 1977]. However, this method cannot be used for samples obtained from owl pellets [Vukicevic-Radic *et al.* 2005].

Dapson [1968] also proposed a method based on biochemical changes in the lens. According to Dische *et al.* [1956], with age in the lens there is a constant transformation of soluble protein into insoluble protein. Presumably, this occurs due to the oxidation of cysteine to cystine, which leads to the formation of insoluble albuminoid.

Haferkorn [1995] gives the following data on the weight of the lenses in yellow-necked wood mice of different age: 11 weeks—4.56 mg, 4 months—8.69 mg, 6 months—10.98 mg, 8 months—15.07 mg, 10 months—19.00 mg, 16 months—22.40 mg, 18 months—23.43 mg [Klevezal 2007].

Live young yellow-necked wood mice can be distinguished from adults by weight and colouration. Young individuals have a greyish colouration of the back and abdomen, the chest spot is weakly expressed, and, in adults, the ochre–rusty colouration of the back is sharply different from the light abdomen, the chest spot is bright [Klevezal 2007]. Also, young individuals can be distinguished from adults by the condition of reproductive organs [Morris 1972].

The aim of this work is to determine the age of collection samples of mice of the genus *Sylvaemus* based on the degree of molar wear and to compare the age groups according to odontometrical and craniometrical characters.

Materials and Methods

The craniological collection of small mammals of O. V. Zorya, collected in the territory of Kharkiv Oblast, Ukraine, was studied. In total, 272 specimens of three species of the genus *Sylvaemus* were selected: pygmy wood mouse (*Sylvaemus uralensis* Pallas, 1811), European wood mouse (*Sylvaemus sylvaticus* Linnaeus, 1758), and yellow-necked wood mouse (*Sylvaemus tauricus* Pallas, 1811). Only 198 specimens were suitable for odontometric analysis: *Sylvaemus uralensis*—123, *Sylvaemus sylvaticus*—68, and *Sylvaemus tauricus*—7. In total, 120 intact skulls were selected for craniological analysis: *Sylvaemus uralensis*—74, *Sylvaemus sylvaticus*—42, and *Sylvaemus tauricus*—4.

The collection was collected in 7 districts (raions) and 52 settlements of Kharkiv Oblast, Ukraine (Table 1). The specimens are dated to the periods of 1989–1996 and 1999–2012. A considerable number of specimens are dated to 1990, 2004, 2008, and 2011.

The age of the selected specimens was determined using binoculars according to the method of Adamczewska-Andrzejewska [1967], which is based on the degree of molar wear. The degree of wear was determined on the left upper row of molars. It should be mentioned that the degree of wear of the chewing surface was found to be different between the left and right upper rows of molars. Usually, the degree of wear on the right upper row is an order of magnitude lower than on the left. That is why the left upper row of molar teeth was chosen for analysis.

In total, four main age classes are distinguished according to the method. Class I includes individuals aged about four weeks; they lack the third molar (M^3) (Fig. 1).

Class II includes individuals aged about two months. Class II is characterised by weak wear of the tubercles, the chewing surfaces of the tubercles *t1* and *t5* on M^3 can already be combined with each other. On the second molar (M^2), *t6* and *t9* are connected and a complete enamel bow can be formed, which includes the tubercles *t4*, *t5*, *t6*, and *t9*. Wear on the first molar (M^1) is less noticeable, only on the tops of the tubercles (Fig. 2).

Class III includes individuals aged about five months. This age class is characterised by fairly noticeable wear of all three molar teeth, the surfaces of all tubercles of M^3 are connected. An almost closed circle of six tubercles is visible on M^2, only *t1* and *t3* are separate, and tubercles *t7*, *t8*, and *t9* are strongly worn. On M^1, the highest tubercles are preserved, although their chewing surface also forms a closed circle of six tubercles; *t1*, *t2*, and *t3* are also connected to each other (Fig. 2).

Table 1. The number of specimens of mice of the genus *Sylvaemus* collected in the territory of Kharkiv Oblast

Таблиця 1. Кількість екземплярів мишаків роду *Sylvaemus*, зібраних на території Харківської області

Species/District	Kp	Kr	Khr	Bh	Iz	Chh	Lz	Total
Sylvaemus uralensis	23	58	11	18	22	37	3	172
Sylvaemus sylvaticus	1	7	24	23	23	11	1	90
Sylvaemus tauricus	0	2	0	2	0	4	2	10
Total	24	67	35	43	45	52	6	272

* *Bohodukhiv* (Bh): Volodymyrivka, Dovzhik, Kobzarivka, Kolomak, Moyka, Oleksandrivka, Oleksiyivka, Pokrovka, Stepanivka, Tetyushchine, Fesky, Sharivka; *Izium* (Iz): Andriivka, Barvinkove, Donets, Kapytolivka, Oskil, Pidlyman, Snizhkivka, Topolske; *Krasnohrad* (Kr): Vlasivka, Druzhba, Zarichne, Zachepylivka, Novopavlivka, Natalyne, Khrestyshche; *Kupiansk* (Kp): Arkadivka, Dvorichna, Kamianka, Shyshkivka; *Lozova* (Lz): Bratolyubivka, Bulatselivka, Yakovivka; *Kharkiv* (Khr): Bezlyudivka, Bobrivka, Nove, Pytomnyk, Podvirky, Prosyane, Ruska Lozova, Stara Vodolaga, Cherkaski Tyshky, Kharkiv; *Chuhuiv* (Chh): Vvedenka, Verkhniy Saltiv, Gaidary, Gontarivka, Zamulivka, Martove, Staryy Saltiv, Khotimlya.

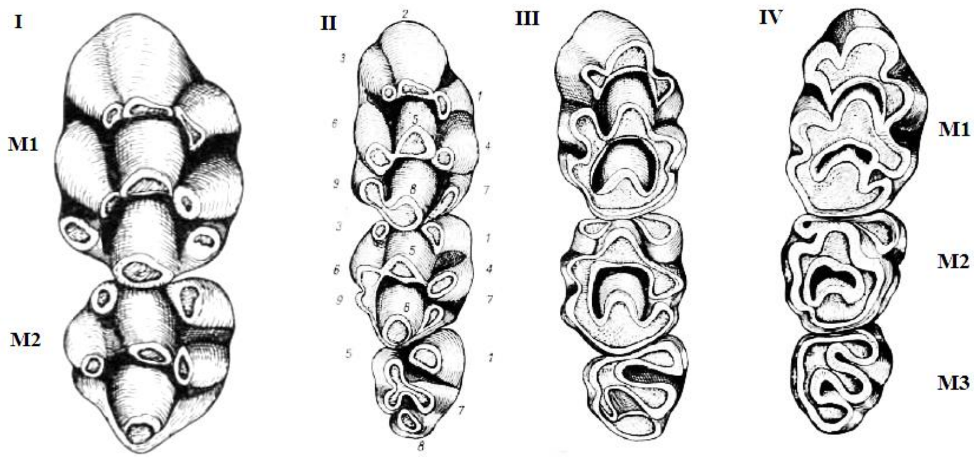


Fig. 1–2. Stages of molar wear in *Apodemus flavicollis* (*Sylvaemus tauricus*): (I) M^1 and M^2 (individuals about four weeks old); (II) M^1, M^2 and M^3 (individuals about two months old), tubercles 1–9 are numbered according to Miller [1912]; (III) M^1, M^2 and M^3 (individuals about five months old); (IV) M^1, M^2 and M^3 (individuals about nine months old) [Adamczewska-Andrzejewska 1967].

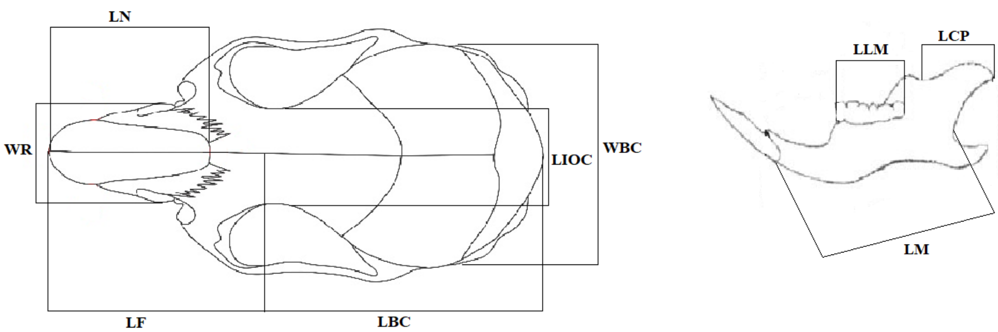
Рис. 1–2. Класи стирання кутніх зубів у *Apodemus flavicollis* (*Sylvaemus tauricus*): (I) M^1 та M^2 (особини віком близько чотирьох тижнів); (II) M^1, M^2 та M^3 (особини віком близько двох місяців), 1–9 горбки пронумеровані за Міллером [Miller 1912]; (III) M^1, M^2 та M^3 (особини віком близько п'яти місяців); (IV) M^1, M^2 та M^3 (особини віком близько дев'яти місяців) [Adamczewska-Andrzejewska 1967].

Class IV includes individuals aged about nine months. Class IV is characterised by a flat, worn chewing surface of molars. The enamel forms loops that limit the bases of the tubercles. Only the first three tubercles on M^1 are still quite high (Fig. 2).

For further measurements of odontometrical characters in the collection specimens, photos of tooth rows were taken using electronic binoculars. Measurements were made in the Toup View program. The left lower and upper rows of molars were selected for taking measurements. Odontometrical characters were measured according to Lashkova & Dzeverin [2002]. Thus, the following odontometrical measurements were taken for analysis: LM^1, LM^2, and LM^3—length of the first, second, and third upper molars; WM^1, WM^2, and WM^3—width of the first, second, and third upper molars; LM^{123}—length of the upper molar row; LM_1, LM_2, and LM_3—length of the first, second, and third lower molars; WM_1, WM_2, and WM_3—width of the first, second, and third lower molars; LM_{123}—length of the lower molar row. The largest width and length of the molars were measured.

Based on literature data, 23 characters were selected for craniometrical analysis. Of the cranial measurements, condylobasal length (CBL) and length of the upper molar row (LUM) [Demeter & Lazar 1984] have the greatest influence on the distribution of species of the genus *Sylvaemus* and are among the least variable characters [Canady & Mosansky 2015]. Length of the diastema (LD) and length of *bulla tympanica* (LBUL) were also the most significant for differentiation [Reutter *et al.* 1999]. Although Steiner & Raczyski [1976] did not include the length of the *bulla tympanica* in the analysis due to the inaccuracy of measuring this cranial character.

Other important measurements that affect the distribution of samples include the greatest length of skull (GLS), length of *foramen incisivum* (LFI), width of braincase (WBC), least interorbital constriction (LIOC), depth of incisor (DI) [Demeter & Lazar 1984], height of rostrum (HR), width of rostrum (WR), distance between incisor and M^3 (LIM3), length of lower molar row (LLM) [Canady *et al.* 2014], length of first upper molar (LM1), length of mandible (LM), height of skull including *bulla tympanica* (HBCB) [Canady & Mosansky 2015], length of braincase (LBC), length of rostral part (LF), palatal length (LPP), length of condyle (LCP), length of nasals (LN) [Reutter *et al.* 1999], width of choana (WCH), and width between *bulla tympanica* (WBB) [Frynta *et al.* 2001] (Fig. 3). Cranial characters were measured using an electronic calliper.



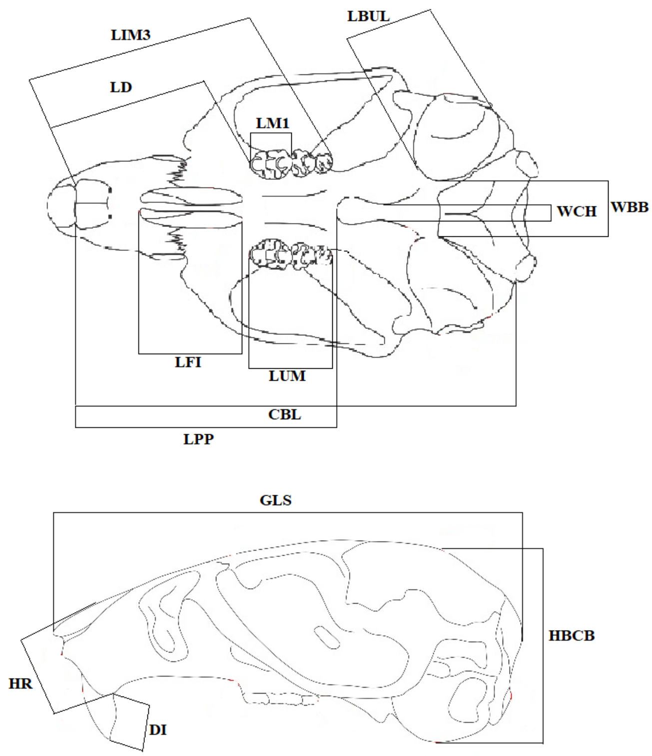


Fig. 3. Craniometrical characters analysed: LN—length of nasals, WR—width of rostrum, LF—length of rostral part, LBC—length of braincase, LIOC—least interorbital constriction, WBC—width of braincase, LIM3—distance between incisor and M^3, LD—length of diastema, LM1—length of first upper molar, LBUL—length of *bulla tympanica*, LFI—length of *foramen incisivum*, LUM—length of upper molar row, CBL—condylobasal length of skull, LPP—palatal length, WCH—width of choana, WBB—width between *bulla tympanica*, GLS—greatest length of skull, HBCB—height of skull including *bulla tympanica*, HR—height of rostrum, DI—depth of incisor, LLM—length of lower molar row, LCP—length of condyle, LM—length of mandible. Scheme of measurements after Barkaszi [2019] with modifications.

Рис. 3. Ознаки для краніометричного аналізу: LN—довжина носових кісток, WR—ширина роструму, LF—довжина обличчя, LBC—довжина черепної коробки, LIOC—міжочноямкова ширина, WBC—ширина мозкової коробки, LIM3—довжина верхнього зубного ряду, LD—довжина діастеми, LM1—довжина першого верхнього моляру, LBUL—довжина *bulla tympanica*, LFI—довжина піднебінного отвору, LUM—довжина верхнього молярного ряду, CBL—кондилобазальна довжина, LPP—довжина піднебіння, WCH—ширина хоан, WBB—ширина між *bulla tympanica*, GLS—найбільша довжина черепу, HBCB—висота черепної коробки, включаючи *bulla tympanica*, HR—висота роструму, DI—глибина різця, LLM—довжина нижнього молярного ряду, LCP—довжина виростку, LM—довжина нижньої щелепи. Схема промірів за Barkaszi [2019] зі змінами.

Results and Discussion

Selected collection specimens of mice of the genus *Sylvaemus* were classified into three age groups according to the degree of molar wear [Adamczewska-Andrzejewska 1967] (Table 2).

According to odontomertical characters, the morphospaces of age groups II, III, and IV largely overlap, without forming specific separate clusters (Fig. 4). That is, there are no clear differences between the age groups of each species by the measurements of molar teeth. However, the difference between species is clearly visible. The correctness of the classification of specimens based on odontometrical characters selected in the analysis is 81.73%. Wilks' lambda has a low value (0.119), indicating a reliable separation into groups. All odontometrical characters contribute almost equally to the distribution, but the length of the second upper molar (LM^2), the width of the first upper molar (WM^1), and the length of the lower molar row (LM_{123}) have the largest contributions.

Age groups of mice were also compared according to craniometrical characters; for this purpose 120 intact skulls were measured (Table 3). Age groups do not form separate morphospaces (Fig. 5), and there is no visible difference in craniometrical characters either. However, as in the previous case, there is a noticeable interspecific differentiation. The correctness of the classification of specimens based on craniometrical characters selected in the analysis is 92.37%, which is somewhat higher in comparison with that based on odontometrical characters. The largest contribution to the distribution have the length of *foramen incisivum* (LFI), length of mandible (LM), depth of incisor (DI), least interorbital constriction (LIOC), width of choana (WCH), and length of lower molar row (LLM).

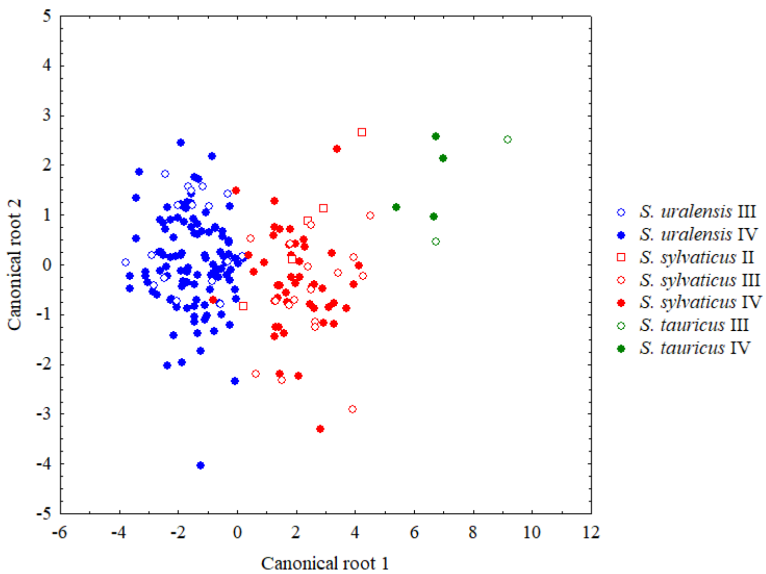


Fig. 4. Distribution of mice of the genus *Sylvaemus* into age groups based on odontometrical characters.

Рис. 4. Розподіл мишаків роду *Sylvaemus* на вікові групи за одонтометричними ознаками.

Table 2. Age groups of collection specimens of *Sylvaemus* determined by the degree of molar wear

Таблиця 2. Вікові групи колекційних зразків *Sylvaemus*, визначені за ступенем стирання кутніх зубів

Species/Age group	II	III	IV	Total
Sylvaemus uralensis	0	17	106	123
Sylvaemus sylvaticus	5	17	46	68
Sylvaemus tauricus	1	2	4	7
Total	6	36	156	198

Table 3. Age groups of collection specimens of *Sylvaemus* determined by the degree molar wear taken for craniometrical analysis

Таблиця 3. Вікові групи колекційних зразків *Sylvaemus*, визначені за ступенем стирання кутніх зубів, взяті для краніометричного аналіз

Species/Age group	II	III	IV	Total
Sylvaemus uralensis	0	9	65	74
Sylvaemus sylvaticus	2	9	31	42
Sylvaemus tauricus	1	2	1	4
Total	3	20	97	120

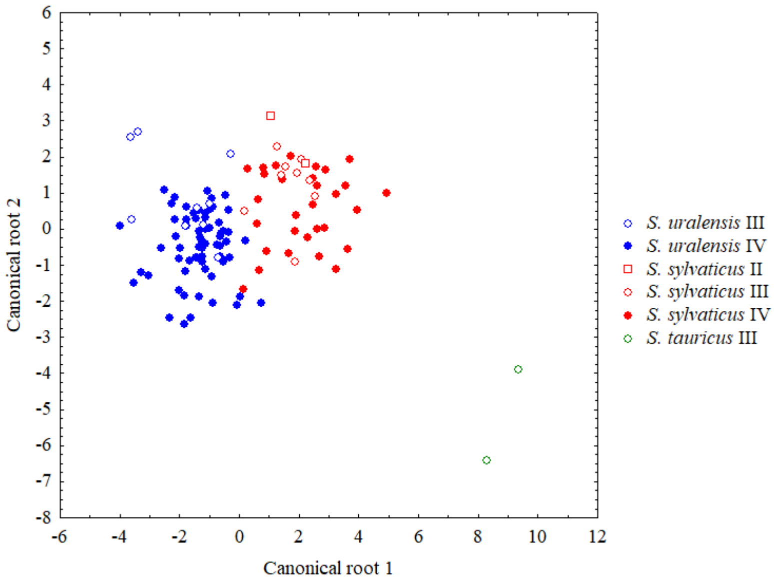


Fig. 5. Distribution of mice of the genus *Sylvaemus* into age groups based on craniometrical characters.

Рис. 5. Розподіл мишаків роду *Sylvaemus* на вікові групи за краніологічними ознаками.

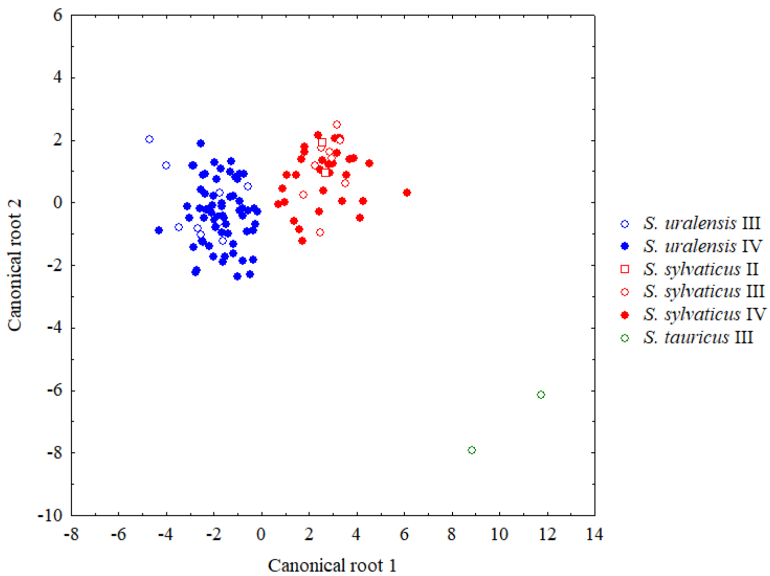


Fig. 6. Distribution of mice of the genus *Sylvaemus* into age groups based on odontometrical and craniometrical characters.

Рис. 6. Розподіл мишаків роду *Sylvaemus* на вікові групи за одонтометричними та краніологічними ознаками.

When comparing the age groups of mice based on odontometrical and craniological characters together, the correctness of the classification of specimens according to the characters selected in the analysis is 96.61%. One can see the clearest distribution of specimens by species (Fig. 6). The largest contribution to the distribution have the length of *foramen incisivum* (LFI), length of mandible (LM), length of diastema (LD), width of choana (WCH), length of second lower molar (LM_2), greatest length of skull (GLS), depth of incisor (DI), and and palatal length (LPP).

As noted by Zagorodniuk & Kavun [2000], in the process of growth, there is a gradual increase in all metrical characters. During the life, in *Sylvaemus tauricus*, length of skull (CBL, GLS) increases, although its growth slows down with age. In the process of growth, least interorbital constriction (LIOC), length of tooth rows (LIM3, LUM, and LLM) and length of *bulla tympanica* (LBUL) change the least. Width of braincase (WBC), height of rostrum (HR), length of diastema (LD), length of nasals (LN) and length of *foramen incisivum* (LFI) increase significantly with age. In older age groups, width of tooth rows increases (WM^1, WM^2, WM^3, WM_1, WM_2, and WM_3).

Metric characters having the largest contribution to the distribution of species in the abovementioned analyses were studied separately (Table 4). The age groups of *Sylvaemus tauricus* and the II age group of two other species are not considered due to the small sample size.

When comparing the III age group in the pair *uralensis*–*sylvaticus*, the range of characters do not overlap or overlap minimally: WM^1 *uralensis* (0.79–0.91) vs *sylvaticus* (0.91–1.06), LM_{123} *uralensis* (3.20–3.65) vs *sylvaticus* (3.67–4.13), LFI *uralensis* (3.19–4.38) vs *sylvaticus* (4.33–5.48), LPP *uralensis* (10.00–11.82) vs *sylvaticus* (11.57–12.79), LLM *uralensis* (3.18–3.50) vs *sylvaticus* (3.48–3.95), LIM3 *uralensis* (9.61–11.40) vs *sylvaticus* (11.09–12.16), LBUL *uralensis* (3.62–4.42) vs *sylvaticus* (4.13–4.61), LUM *uralensis* (3.01–3.63) vs *sylvaticus* (3.52–3.88), CBL *uralensis* (17.70–20.49) vs *sylvaticus* (20.22–21.91), HR *uralensis* (3.18–3.85) vs *sylvaticus* (3.52–4.16). LLM, LM_{123}, WBC, and CBL were the least variable of these characters in both species.

Table 4. Comparison of metric characters between age groups of mice of the genus *Sylvaemus*

Таблиця 4. Порівняння метричних ознак у вікових групах мишаків роду *Sylvaemus*

Character	II				III				IV			
	Mean	Min	Max	CV	Mean	Min	Max	CV	Mean	Min	Max	CV
Sylvaemus uralensis												
LM^2	–	–	–	–	1.14	1.01	1.25	6.24	1.10	0.88	1.26	6.89
WM^1	–	–	–	–	0.86	0.79	0.91	5.11	0.86	0.70	0.96	4.72
WM^2	–	–	–	–	0.80	0.73	0.91	5.25	0.81	0.63	0.91	5.62
WM^3	–	–	–	–	0.59	0.52	0.67	7.38	0.59	0.45	0.71	8.34
WM_1	–	–	–	–	0.76	0.70	0.80	**4.82**	0.76	0.70	0.89	4.54
WM_2	–	–	–	–	0.77	0.70	0.88	6.58	0.76	0.69	0.85	4.58
WM_3	–	–	–	–	0.65	0.57	0.78	7.65	0.64	0.56	0.79	6.53
LM_2	–	–	–	–	1.07	0.99	1.15	**4.02**	1.07	0.90	1.19	4.53
LM_{123}	–	–	–	–	3.45	3.20	3.65	**3.29**	3.46	3.14	3.69	**3.25**
LN	–	–	–	–	7.91	6.87	8.46	7.62	8.43	7.05	9.23	5.33
LIOC	–	–	–	–	3.95	3.72	4.15	**4.02**	3.92	3.62	4.37	**3.98**
WBC	–	–	–	–	10.78	10.20	11.27	**3.06**	10.99	10.36	11.63	**2.57**
LIM3	–	–	–	–	10.79	9.61	11.40	5.48	11.39	10.56	11.96	**2.72**
LD	–	–	–	–	7.17	6.33	7.60	5.80	7.78	6.76	8.33	**3.92**
LBUL	–	–	–	–	3.95	3.62	4.42	7.02	4.06	3.59	4.52	5.06
LFI	–	–	–	–	3.82	3.19	4.38	10.66	4.12	3.55	4.75	6.39
LUM	–	–	–	–	3.38	3.01	3.63	5.59	3.41	2.96	3.70	**3.68**
CBL	–	–	–	–	19.52	17.70	20.49	**4.96**	20.49	18.98	21.82	**2.92**
LPP	–	–	–	–	11.11	10.00	11.82	5.36	11.67	10.91	12.38	**2.92**
WCH	–	–	–	–	1.06	0.86	1.24	11.71	1.00	0.73	1.26	12.16
GLS	–	–	–	–	22.52	19.90	23.64	6.19	23.37	21.96	24.43	**2.73**
HR	–	–	–	–	3.54	3.18	3.85	6.56	3.71	3.28	4.14	4.28
DI	–	–	–	–	2.03	1.72	2.32	9.91	2.29	1.97	3.01	8.80
LLM	–	–	–	–	3.36	3.18	3.50	**3.26**	3.35	2.32	3.61	4.75
LM	–	–	–	–	8.67	7.88	9.14	5.33	9.05	8.47	9.67	**3.19**
Sylvaemus sylvaticus												
LM^2	1.19	1.11	1.30	5.88	1.21	1.09	1.40	7.60	1.17	1.01	1.30	6.40
WM^1	0.94	0.90	1.02	5.00	0.97	0.91	1.06	4.22	0.95	0.84	1.03	4.80
WM^2	0.88	0.82	0.95	5.85	0.90	0.81	0.98	4.21	0.87	0.73	0.95	5.45
WM^3	0.65	0.52	0.78	14.4	0.65	0.55	0.70	6.82	0.64	0.54	0.73	6.52
WM_1	0.81	0.80	0.85	2.69	0.85	0.73	1.01	7.85	0.83	0.70	0.89	4.77

Character	II				III				IV			
	Mean	Min	Max	CV	Mean	Min	Max	CV	Mean	Min	Max	CV
WM_2	0.85	0.81	0.93	5.70	0.86	0.77	0.92	4.60	0.84	0.70	0.91	5.63
WM_3	0.73	0.65	0.82	8.70	0.73	0.67	0.80	5.40	0.71	0.59	0.79	7.54
LM_2	1.19	1.10	1.27	5.29	1.19	1.02	1.29	5.53	1.17	1.08	1.26	4.00
LM_{123}	3.88	3.59	4.05	4.58	3.88	3.67	4.13	**3.70**	3.84	3.50	4.05	**3.41**
LN	8.19	8.04	8.34	2.59	8.57	7.93	9.01	4.71	8.80	7.94	9.68	5.14
LIOC	3.93	3.91	3.95	0.72	3.88	3.25	4.08	6.35	4.06	3.80	4.50	**3.79**
WBC	11.27	11.11	11.42	1.95	11.21	10.96	11.63	**1.79**	11.28	10.51	11.98	**2.92**
LIM3	11.44	11.09	11.79	4.33	11.64	11.09	12.16	**3.45**	12.05	11.12	13.12	4.03
LD	7.61	7.31	7.90	5.49	7.70	7.11	8.22	4.52	8.03	7.30	8.73	4.96
LBUL	4.18	3.96	4.39	7.28	4.32	4.13	4.61	**3.94**	4.23	3.78	4.76	5.70
LFI	4.81	4.79	4.83	0.59	4.75	4.33	5.48	7.86	4.70	3.77	5.22	8.12
LUM	3.69	3.55	3.82	5.18	3.71	3.52	3.88	**3.32**	3.75	3.53	4.10	**3.67**
CBL	20.83	20.32	21.33	3.43	21.10	20.22	21.91	**2.86**	21.61	19.92	23.10	**3.81**
LPP	11.92	11.60	12.24	3.80	12.11	11.57	12.79	**3.54**	12.44	11.40	13.27	**3.67**
WCH	1.04	0.99	1.08	6.15	1.01	0.77	1.31	17.59	0.93	0.66	1.17	12.85
GLS	23.98	23.45	24.50	3.10	24.07	23.00	25.02	**2.99**	24.76	22.56	26.48	**3.45**
HR	3.66	3.50	3.81	5.98	3.81	3.52	4.16	4.99	3.96	3.42	4.36	6.88
DI	2.04	2.01	2.07	2.08	2.26	1.94	2.47	8.07	2.33	1.85	2.83	9.83
LLM	3.72	3.68	3.75	1.33	3.70	3.48	3.95	**3.88**	3.68	3.37	3.97	**3.52**
LM	9.23	9.18	9.27	0.69	9.16	8.55	9.71	**3.82**	9.25	7.57	9.98	4.85
Sylvaemus tauricus												
LM^2	1.43	1.43	1.43	–	1.41	1.36	1.46	5.01	1.33	1.04	1.48	15.13
WM^1	1.02	1.02	1.02	–	1.06	1.04	1.07	2.01	1.04	1.00	1.07	2.83
WM^2	1.03	1.03	1.03	–	0.99	0.99	0.99		0.99	0.93	1.04	4.73
WM^3	0.77	0.77	0.77	–	0.76	0.72	0.79	6.56	0.76	0.68	0.83	8.53
WM_1	0.90	0.90	0.90	–	0.91	0.89	0.92	2.34	0.90	0.81	0.96	7.33
WM_2	0.93	0.93	0.93	–	0.94	0.93	0.94	0.76	0.92	0.87	0.97	4.48
WM_3	0.86	0.86	0.86	–	0.81	0.79	0.82	2.64	0.79	0.71	0.83	6.62
LM_2	1.39	1.39	1.39	–	1.40	1.34	1.45	5.58	1.35	1.33	1.36	0.96
LM_{123}	4.51	4.51	4.51	–	4.56	4.39	4.72	5.12	4.31	4.18	4.36	2.00
LN	9,47	9,47	9,47	–	10,44	9,99	10,89	6,10	10,35	10,35	10,35	–
LIOC	4.09	4.09	4.09	–	4.37	4.25	4.48	3.73	4.05	4.05	4.05	–
WBC	11.66	11.66	11.66	–	12.18	11.88	12.47	3.43	11.64	11.64	11.64	–
LIM3	12.63	12.63	12.63	–	14.10	13.96	14.23	1.35	13.48	13.48	13.48	–
LD	8.10	8.10	8.10	–	9.35	9.13	9.56	3.25	9.23	9.23	9.23	–
LBUL	4.79	4.79	4.79	–	5.23	5.02	5.44	5.68	4.65	4.65	4.65	–
LFI	4.94	4.94	4.94	–	5.06	4.98	5.14	2.24	5.19	5.19	5.19	–
LUM	4.43	4.43	4.43	–	4.39	4.37	4.40	0.48	4.23	4.23	4.23	–
CBL	22.54	22.54	22.54	–	25.68	25.08	26.28	3.30	24.01	24.01	24.01	–
LPP	12.97	12.97	12.97	–	14.74	14.70	14.77	0.34	13.87	13.87	13.87	–
WCH	1.25	1.25	1.25	–	1.06	1.03	1.08	3.35	1.25	1.25	1.25	–
GLS	25.89	25.89	25.89	–	29.33	28.78	29.87	2.63	27.62	27.62	27.62	–
HR	3.89	3.89	3.89	–	4.79	4.75	4.82	1.03	4.60	4.60	4.60	–
DI	2.34	2.34	2.34	–	2.97	2.66	3.27	14.55	2.80	2.80	2.80	–
LLM	4.35	4.35	4.35	–	4.41	4.29	4.53	3.85	4.17	4.17	4.17	–
LM	10.20	10.20	10.20	–	11.25	10.69	11.80	6.98	11.00	11.00	11.00	–

When comparing the specimens of the IV age group in the pair of *uralensis–sylvaticus*, the ranges of all metrical characters overlap, only one character overlaps minimally: LUM *uralensis* (2.96–3.70) vs *sylvaticus* (3.53–4.10). The least variable characters for both species are LM_{123}, LIOC, WBC, LUM, CBL, LPP, and GLS. The ranges of metrical characters of age groups III and IV in both *Sylvaemus uralensis* and *Sylvaemus sylvaticus* also overlap. Age group IV has slightly higher minimum and maximum values, in particular, the greatest increase is characteristic of CBL, GLS, LIM3, and LPP. In addition, in *Sylvaemus uralensis*, the growth of metrical characters between the III and IV age groups is more noticeable than that in *Sylvaemus sylvaticus*.

Comparing the obtained results with the data of Zagorodniuk & Kavun [2000] for *Sylvaemus tauricus*, the least variable metrical characters for the pair *uralensis–sylvaticus*, in addition to LIOC, LIM3, LUM, LLM, and LBUL, included LPP, WBC, CBL, and GLS. In contrast to the metrical characters for *Sylvaemus tauricus* CBL, GLS, WBC, HR, LD, LN and LFI, the greatest increase for the pair *uralensis–sylvaticus* in the process of growth was characteristic of CBL, GLS, LIM3, and LPP. There was also no increase in width of tooth rows in older age groups.

Thus, according to the obtained results, it is not possible to differentiate the sample into age groups based on odontometrical and craniological characters, particularly in the case of older age groups (III and IV) for the pair *uralensis–sylvaticus*.

Conclusions

1. Based on the degree of molar wear, specimens of mice of the genus *Sylvaemus* collected in the east of Ukraine, were divided into three age groups (II, III, and IV).

2. Among metrical characters, four odontometrical characters (LM^2, WM^1, LM_2, and LM_{123}) and nine craniological characters (LIOC, LD, LFI, LPP, WCH, GLS, DI, LLM, and LM) have the largest contribution into the differentiation of age groups of mice of the genus *Sylvaemus*.

3. Among the characters that contributed the most to the differentiation of samples, characters of length prevail. The least variable metrical characters are LLM, LM_{123}, LPP, LIOC, WBC, CBL, LUM, and GLS.

4. The sample of mice of the genus *Sylvaemus* cannot be divided into age groups based on odontometrical and craniological characters; the ranges of values of metrical characters overlap.

Acknowledgements

I sincerely thank the zoologists of the Kharkiv Regional Sanitary and Epidemiological Station O. V. Zorya, V. O. Naglov and G. E. Tkach for the opportunity to use their craniological collection of small mammals in this study. I also thank Z. Barkaszi for discussing research materials and editing the manuscript.

References

Adamczewska-Andrzejewska, K. A. 1967. Age reference model for Apodemus flavicollis (Melchior, 1834). *Ekologia Polska, Seria A*, **15** (41): 787–790.

Andrzejewski, R., A. Liro. 1977. Effect of different kinds of feed on wear of the teeth in individuals of a field mouse population. *Acta Theriologica*, **22** (29): 393–395. CrossRef

Ancillotto, L., E. Mori, G. Sozio, E. Solano, S. Bertolino, D. Russo. 2017. A novel approach to field identification of cryptic Apodemus wood mice: calls differ more than morphology. *Mammal review*, **47** (1): 6–10. CrossRef

Balciauskiene, L., L. Balciauskas, J. R. Mazeikyte. 2004. Sex- and age-related differences in tooth row length of small mammals: mice. *Acta zoologica Lituanica*, **14** (3): 54–65. CrossRef

Barciova, L., M. Macholan. 2009. Morphometric key for the discrimination of two wood mice species, Apodemus sylvaticus and A. flavicollis. *Acta zoologica Academiae Scientiarum Hungaricae*, **55** (1): 31–38.

Barkaszi, Z. 2018. Sibling mice species of the genus Sylvaemus Ognev, 1924 (Mammalia, Rodentia) in the Ukrainian Carpathians. *The Journal of V. N. Karazin Kharkiv National University. Series Biology*, **31**: 59–71. CrossRef

Brown, L. E. 1969. Field experiments on the movements of Apodemus sylvaticus L. using trapping and tracking techniques. *Oecologia*, **3**: 198–222. CrossRef

Canady, A., L. Mosansky, M. Hybelova, P. Pavelkova. 2014. Morphometric variability of Apodemus uralensis in Slovakia (Rodentia: Muridae). *Lynx, n. s. (Praha)*, **45**: 5–14.

Canady, A., L. Mosansky. 2015. Craniometric data of Apodemus sylvaticus in Slovakia. *Biologia*, **70** (7): 974–981. CrossRef

Dapson, R. W. 1968. Reproduction and age structure in a population of short tailed shrews Blarina brevicauda. *Journal mammalogy*, **49**: 205–214. CrossRef

Dapson, R. W., J. M. Irland. 1972. An accurate method of determining age in small mammals. *Journal of Mammalogy*, **53** (1): 100–106. CrossRef

Demeter, A., P. Lazar. 1984. Morphometric analysis of field mice Apodemus: character selection for routine identification (Mammalia). *Annales Historico-Naturales Musei Nationalis Hungarici*, Budapest, **76**: 297–322.

Dische, Z., E. Borenfreund, C. Zelmenis. 1956. Changes in lens proteins of rats during aging. *Archives of Ophthalmology*, **55**: 471–483. CrossRef

Freudenthal, M., E. Martin-Suarez, N. Bendala. 2002. Estimating age through tooth wear. A pilot study on tooth abrasion in Apodemus (Rodentia, Mammalia). *Mammalia*, **66** (1): 275–284. CrossRef

Frynta, D., M. Zižková. 1992. Postnatal growth of wood mouse (Apodemus sylvaticus) in captivity. *In:* Horáček, I., V. Vohralik (eds). *Prague Studies in Mammology.* Charles University Press, Praha, 57–69.

Frynta, D., P. Mikulova, E. Suchomelova, J. Sadlova. 2001. Discriminant analysis of morphometric characters in four species of Apodemus (Muridae: Rodentia) from eastern Turkey and Iran. *Israel journal of zoology*, **47** (3): 243–258. CrossRef

Hagen, B. 1956. Alterbestimmung an einiger Muriden-Arten. *Zeitschrift für Säugetierkunde*, **21**: 39–43.

Hagen, A., N. Chr. Stenseth, E. Ostbye, H. J. Skar 1980. The eye lens as an age indicator in the root vole. *Acta Theriologica*, **25** (4): 39–50. CrossRef

Jojic, V., J. Blagojevic, M. Vujosevic. 2011. B chromosomes and cranial variability in yellow-necked field mice (Apodemus flavicollis). *Journal of Mammalogy*, **92** (2): 396–406. CrossRef

Jojic, V., V. Bugarski-Stanojevic, J. Blagojevic, M. Vujosevic. 2014. Discrimination of the sibling species Apodemus flavicollis and A. sylvaticus (Rodentia, Muridae). *Zoologischer Anzeiger*, **253**: 261–269. CrossRef

Klevezal, G. A. 2007. *Principles and methods of age determination of mammals*. KMK, Moscow, 1–285. [In Russian]

Kuncova, P., D. Frynta. 2009. Interspecific morphometric variation in the postcranial skeleton in the genus Apodemus. *Belgian Journal of Zoology*, **139** (2): 133–146.

Lashkova, E. I., I. I. Dzeverin. 2002. Odontometric variation and species identification of wood mice Sylvaemus (Muridae, Rodentia) from Ukraine fauna. *Vestnik zoologii*, **36** (3): 25–33. [In Russian]

Michaux, J. R., R. Libois, M. G. Filippucci. 2005. So close and so different: comparative phylogeography of two small mammal species, the yellow-necked fieldmouse (Apodemus flavicollis) and the woodmouse (Apodemus sylvaticus) in the Western Palearctic region. *Heredity*, **94**: 52–63. CrossRef

Miller, G. S. 1912. *Catalogue of the mammals of Western Europe (Europe exclusive of Russia) in the collection of the British museum.* British Museum of Natural History, London, 1–1019. URL: https://bit.ly/3H85y7i

Morris, P. A. 1972. A review of mammalian age determination methods. *Mammal Review*, **2** (3): 69–104. CrossRef

Niethammer, J. 1969. Zur Frage der Introgression bei den Walmäusen Apodemus sylvaticus und A. flavicollis (Mammalia, Rodentia). *Zeitschrift für Zoologische Systematik und Evolutionsforschung*, **7**: 77–127. CrossRef

Panzironi, C., G. Cerone, M. Cristaldi, G. Amori. 1993. A method for the morphometric identification of southern Italian populations of Apodemus (Sylvaemus). *Hystrix, the Italian Journal of Mammalogy*, **5** (1-2): 1–16.

Reutter, B. A., J. Hausser, P. Vogel. 1999. Discriminant analysis of skull morphometric characters in Apodemus sylvaticus, A. flavicollis, and A. alpicola (Mammalia; Rodentia) from the Alps. *Acta Theriologica*, **44** (3): 299–308. CrossRef

Sozio, G., V. Curini, I. Pascucci, C. Camma, M. Di Domenico. 2018. A new fast real-time PCR method for the identification of three sibling Apodemus species (A. sylvaticus, A. flavicollis, and A. alpicola) in Italy. *Ecology and evolution*, **8**: 4807–4814. CrossRef

Steiner, H. M. 1968. Untersuchungen über die variabilität und bionomie der gattung Apodemus (Muridae, Mammalia) der Donau-Auen von Stockerau (Niederösterreich). *Zeitschrift für wissenschaftliche Zoologie*, **177**: 1–96.

Steiner, H. M., J. Raczynski. 1976. Wiederholbarkeit von messungen und individueller messfehler bei craniometrischen untersuchungen an Apodemus. *Acta Theriologica*, **21**: 535–541. CrossRef

Tupikova, N. V. 1964. The study of reproduction and age composition of the population of small mammals. Methods for studying natural foci of human diseases. *Medicine*, Moscow, 154–208. [In Russian]

Vukicevic-Radic, O., T. B. Jovanovic, R. Matic, D. Kataranovski. 2005. Age structure of yellow-necked mouse (Apodemus flavicollis Melchior, 1834) in two samples obtained from live traps and owl pellets. *Arch. Biol. Sci.*, Belgrade, **57** (1): 53–56. CrossRef

Zagorodniuk, I. V., K. Yu. Kavun. 2000. Age-related variation as basis for emergence of interspecific differences in rodents (Muriformes). *Reports of the National Academy of Sciences of Ukraine*, **3**: 174–180. [In Ukrainian]