A C T A T H E R I O L O G I C A

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A Method of Age Determination in *Clethrionomys*

[With 5 Figs. & 6 Tables]

Examination was made of 13,000 individuals of *Clethrionomys glareolus* (Schreber, 1780) and 4,000 individuals of *Clethrionomys rutilus* (Pallas, 1779) obtained in the taiga forests covering the region between the rivers Wiatka and Kama, over a period of 5 years, most often from May to August. Several groups were distinguished on the basis of differences in length of root and height of crown of M^2. After comparing the times of beginning and end of reproduction, periods of appearance of the maximum number of litters in a population with a defined type of tooth structure, it proved possible to establish the absolute age of each of the groups distinguished. A key is given to identification of the absolute age of the two species of vole examined. Up to the second month of life, the teeth consist of prisma only, the neck of the tooth not being formed until the voles are two months old. At the age of 3—4 months the roots form less than $^1/_4$ of the whole height of the tooth. At the age 5—6 months this relation is $^1/_4$, 7—8 months — $^1/_3$, 9—10 months — $^1/_2$ and at the age of 11—12 months — $^2/_3$. In the case of animals over one years old only the roots of the tooth remain, or part of the neck may still be seen.

I. INTRODUCTION

It is necessary to determine accurately the absolute age of animals in order to understand the ecology of species, and to provide bases and ensure correct organization of different practical measures. Only under such conditions can the rate of growth, time of sexual maturation and longevity of animals be studied. The age structure of the population serves as one of the criteria for forecasting population numbers and establishing rational quotas for the fur species trade. Determination of the absolute age of animals is also necessary when studying the regularities of circulation of the causative agents in natural foci of human diseases: animals born in different seasons play various roles in dissemination of infection over the territory and its preservation in time.

The wide range of problems for the solution of which a knowledge of the age of animals is necessary makes the development of methods for age determination important.

Selection of characteristics undergoing changes with growth and ageing of animals is usually not difficult. The main, most complicated and responsible task in developing standards for age determination consists in sufficiently reliable and accurate establishment of the absolute age to which a certain stage of the selected characters corresponds.

For forest voles of the genus *Clethrionomys* (Tilesius, 1850) the structure of molars is considered to be the clearest age characteristic [1]).

Many authors found age changes in molars and associated features of the skull structure but did not use them as criteria for determination of the absolute age of animals (Vinogradov, 1927; Ognev, 1950; Razorenova, 1952; Gromov *et al.*, 1963; and others). Reports by Schreuder (1933) and Mohr (1954) are supplied with photographs and drawings of alveoli in jaws of young and old bank voles. They show that in young animals one large alveola corresponds to each molar, and in old animals two small ones. The work by Gromov *et al.* (1963, p. 535) shows drawings of first lower molars (M_1) of four age groups of bank voles: juvenile, subadults, adults and senile. For *C. rutilus* similar drawings showing the length of roots, also for conventional age groups, are presented in a study by Shaw, Hsia & Lee (1959).

Zimmerman (1937) was the first to determine the age at which the neck the molar (M_1) forms in bank voles and the age in which roots constitute a certain part of the height of the entire tooth (1/6, 1/4, *etc.*). Later, studies concerning the establishment of the age of redbacked voles were published by Wrangel (1940). Prychodko (1951), Wasilewski (1952), Koshkina (1955), Zejda (1960, 1961), Haitlinger (1965). There are no studies on the determination of the absolute age of *C. rutilus* and *C. rufocanus.*

A significant limitation of the majority of age determinations consists in the lack of indications of the size of the materials tested or the lack of descriptions of the methods of age calculation. In both instances one has to take on trust all the author is formulations since it is impossible to form one's own opinion of the extent of validity of the suggested criteria of the absolute age.

The object of our work was to demonstrate the principles of the development of age criteria on the example of *Clethrionomys glareolus* (Schreber, 1780) and *Clethrionomys rutilus* (Pallas, 1779) and to present the key convenient for field work.

II. MATERIAL AND METHODS

1. Material

The material was collected in southern taiga forests between the rivers of Kama and Viatka during the work carried out by encephalitis control epidemiological team (Chief — Kucheruk V. V.) of the Gamaley's Institute of Epidemiology and Microbiology, USSR Acad. Med. Sci. Over a period of 5 years (1960—1964) at a permanent field station estimation of the population numbers of small mammals were carried out from May to August and in 1961 till September inclu-

[1]) Short reviews of methods for age determination of other rodents are presented in a paper by Tupikova (1964) and of *Pinnipedia* in a paper by Tikhomirov & Klevezal (1964).

sive. In addition, teeth of voles caught in February 1960, November 1963, September 1963, September and October 1964 were examined. These materials were kindly presented by V. N. Bolshakov and N. A. Nikitina. For control skulls of marked rodents of relatively accurately known age (223 skulls of common redbacked voles and 39 of northern redbacked voles) were used. Information on marked rodents was given by N. A. Nikitina. A total of 13,000 skulls of common and 4,400 skulls of northern redbacked voles were examined (Table 1).

Table 1.

Number of animals examined.

Year	1960	1961	1962	1963	1964
Common redbacked voles					
February	22	—	—	—	
May	—	43	117	57	178
June	961	275	1222	445	408
July	972	341	1339	1138	797
August	186	982	742	476	973
September	—	531	—	—	205
October	—	—	—	—	437
November	—	—	—	70	—
Northern redbacked voles					
May	—	20	26	16	—
June	545	88	300	95	53
July	1027	142	228	135	71
August	768	324	165	75	148
September	—	170	—	—	—

Statistically large summer material collected for many years permitted of establishing quite accurate criteria of age for young and old animals. Small samples from autumn and winter populations probably will not give a very definite determination for animals of average age, constituting the bulk of the population in winter.

2. Selection of Conventional Age Groups

For determination of the absolute age the first and inevitable stage of work consists in selecting of conventional age groups by means of morphological characters. The second stage consists in establishing the absolute age of each conventional group.

Morphological characteristics include the extent of development of the neck and roots of the 2nd upper molar (M^2). In the first year of work 12 conventional groups were chosen by means of these characters and schematic drawings of teeth in each group were made. In every caught animal the gum and maxillar bone were exposed for the entire height of M^2 and by comparing its structure with the drawing the animal was placed in one of conventional groups.

Conventional groups were arranged according to characters well distinguished visually and requiring no special measurements: stages of formation of the tooth neck, portion which the root formes of the whole height of the tooth (1/4, 1/3, 1/2, *etc.*). For checking the correctness of visual determination of the root portion of the lenght of the entire tooth, series of teeth from each group were measured. Teeth were measured under a stereoscopic microscope MBS-1 with the help of an ocular micrometer with magnification 16 × within 0.05 mm (the size of one point). These measurements confirmed that portions such as 1/4, 1/3, 1/2, *etc.* were quite accurately determined visually. Table 4 and Fig. 3 present average measurements of the lengths of roots and teeth for each age (see page 109).

3. Information on Population Reproduction Necessary for the Determination of the Absolute Age

In order to obtain information on reproduction potential of the population, the sexual maturity of rodents was determined, and in females lactation, generations of placental scars, *corpora lutea* of pregnancy, numbers of embryos and age thereof were recorded (Tupikova, 1964).

In order to determine the absolute age it is necessary to compare the time of existence and numbers of animals of each conventional age group with the trend of replenishment of the population with young, that is to determine the beginning, the end and the time of maximum emergence of litters. It was done on the basis of counting the time and number of born litters. In the presence of embryos in females, the date of the appearance of a litter was determined by the age of embryos: taking the duration of pregnancy to be 20—21 days and the age of embryos, the time of parturition was calculated. In those cases in which females had only *corpora lutea* of pregnancy and embryos were not yet seen, it was assumed that the litter would born in 18 days. This figure was accepted on the basis that *corpora lutea* of pregnancy appear 24 hours after copulation, visible embryos in 5—6 days. Consequently, a female having only *corpora lutea* may give birth within a minimum of 15 days and maximum of 20 days. To simplify calculations it was taken the average of 18 days. If, in addition to embryos, the female had placental scars of the previous litter but no milk it was assumed that the previous litter had been born two weeks before repeated copulation [2]). If the female was still nursing the previous litter it was assumed

[2]) These calculations were based on the fact established by many investigators and showing that *post partum* oestrus occur in either immediately on the day of parturition or in two weeks, when suckling of the litter ends.

that it appear on the day of repeated copulation. These calculations did not take into account the prolongation of repeated pregnancy while nursing the previous litter, but as the time of the beginning, peak and end of the appearance of litters was established with accuracy of 10 days, incomplete determination of the duration of repeated pregnancy did not distort the results. The number of litters registered during a month among animals caught in standard trapping (10 catching ditches daily, 2500 trap-nights in the first 10 days of each month) was taken as the index of the intensity of incoming of young animals. A total of 1405 data

Table 2.
Number of litters appearing in different months and years in common and northern redbacked voles.

Year	1960	1961	1962	1963	1964
Common redbacked vole					
May	1	21	32	47	42
June	86	25	223	91	97
July	65	46	84	87	151
August	30	72	48	9	96
September	2	33	2	—	—
October	—	1	—	—	—
Northern redbacked vole					
April	10	—	2	5	1
May	66	8	18	13	7
June	102	24	54	35	20
July	77	37	50	44	31
August	42	68	39	27	20
September	4	17	—	4	1

concerning the time of appearance of litters of *C. glareolus* and 826 data for *C. rutilus* were used for calculations of the population trends (Table 2). For the control time of birth of first litters was measured by the appearance of young animals in the capture: in all the years it began in the third 10-day period after the estimated beginning of parturition.

4. Calculation of the Absolute Age of Conventional Groups

During summer it was observed incoming of animals having the »youngest« teeth and sequential appearance of animals with »older« teeth. The time of appearance in the population of animals with teeth belonging to the various groups was established on the basis of daily examinations of animals caught in ditches.

Monthly surveys of rodents by means of snap-traps gave information on the population numbers of animals of each conventional age group, that is on the number of their catches per 100 trap-nights. These data permit of determining the time of the peak numbers of individual age groups and facilitate estimations of the time of appearance and disappearance of the given group from the population. When analysing the age structure of the population some authors frequently use not the data of population numbers but the per cent age ratio of animals from different age groups (Z e j d a, 1961, p. 252; H a i t l i n g e r, 1965, p. 245). The latter data are not suitable for age estimation since the frequency of the group may decrease without changes or even increase in its numbers on account of intensive appearance of young animals, and, conversely, the participation of the group may increase even with loss in its numbers on account of higher mortality among the oldest specimens.

The data obtained on the time of appearance, the greatest numbers and disappearance from the population of animals of different conventional age groups were compared with times of the beginning, maximum and the end of production of litters.

The absolute age of each group can obviously be established most accurately and completely on the basis of two data: time elapsing from the beginning of production of litters to the first appearance of animals with teeth of a given group, and time elapsing from the end of appearance to disappearance of this group from the population. These two data permit of establishing the limits of the absolute age of each group (for example, from 3 to 5 months) and show the longevity of each group (in this case — two months).

For clearness and convenience of age calculations, all data referring to animals born the same year are presented graphically. Because of the shortage of space we do not present graphs for all five years of observation, but as an example show only one graph for 1961/1962 (Fig. 1 A).

When observing the longevity of conventional age groups of animals in the population we had no complete data for practically any of them due to material not being collected all the year round. Therefore for some groups we regularly fixed the time of their appearance, for others — the time of their maximum population numbers, for yet others — the time of their disappearance. Fig. 1 B, draw up on the basis of data from Fig. 1 A, shows the longevity of each group. The length of time during which the presence of the group was established is shown by the solid line, while the broken line shows the conjectural time of the existence of each group. Fig. 2 presents data on the longevity of age groups for each of five years of observation.

In estimating the conjectural longevity of each group we started with the following prerequisites and data. Animals in which the neck of the tooth begins to form (II—III groups) appear, as a rule, two months after

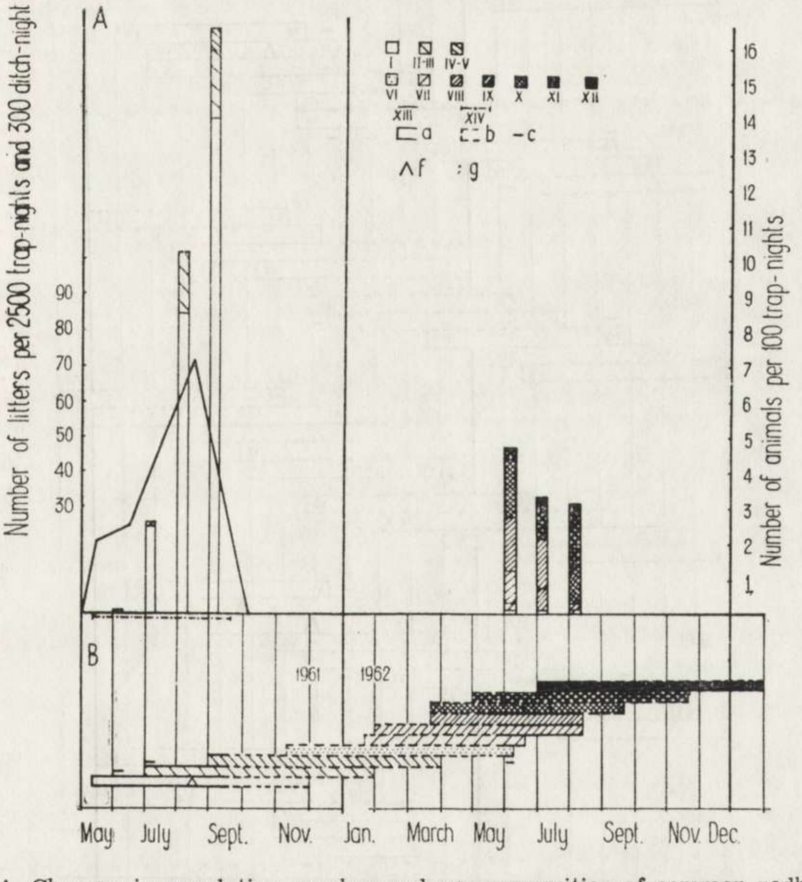

Fig. 1. A. Changes in population number and age composition of common redbacked voles born in 1961. B. Time and longevity of each conventional age group, I—XII — numbers of age groups, XIII — number of litters in monts, XIV — time during which catching ditches operated. For explanation of letters a, b, c, d, e, f see Fig. 2.

the birth of first litters (Fig. 2). If the data on the time of birth of last litters are available, it may be assumed that the last animals born in this year will pass on to the second-third group also in two months time and then the first group will disappear from the population.

Thus, animals of the first group (with rootless teeth) appear in the population with the emergence of young animals and disappear two months after birth of last litters. Errors in these calculations may arise only in respect of some decrease of the longevity of the first group. We assume that all animals develop at a similar rate and that all pass on to the second group two months after birth. But it is quite possible that

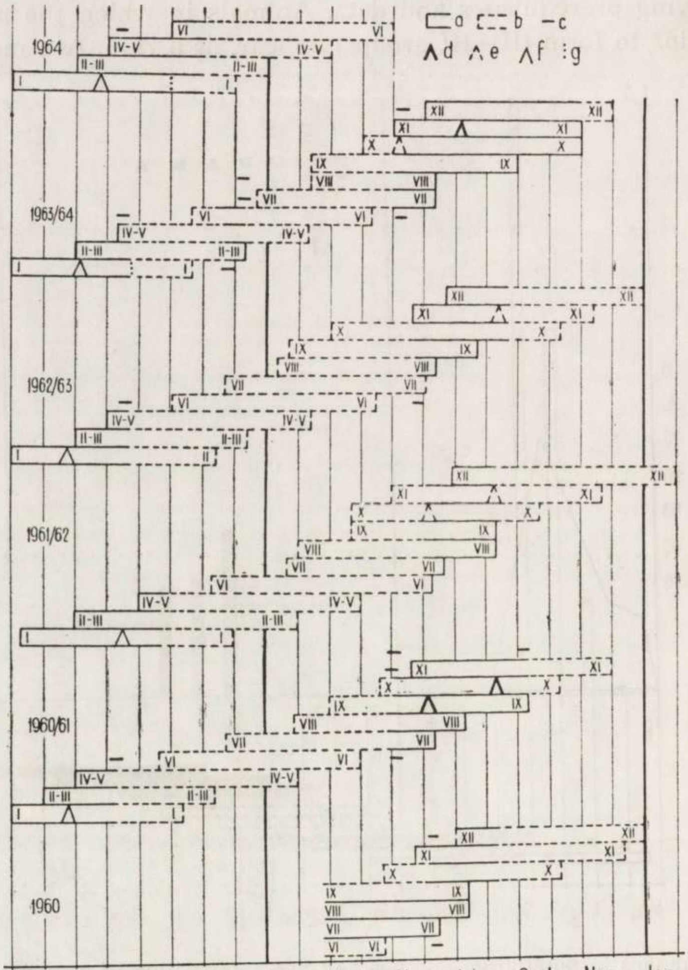

Fig. 2. Time and longevity of conventional age groups in the population of common redbacked voles in different years.
I—XII — numbers of age groups, a — actual existence of the group, b — estimated existence of the group, c — actual absence of the group, d — actual peak of population numbers in the group, e — peak of the appearance of litters, f — end of reproduction.

weak specimens and those born in autumn develop at a slower rate, due to which the total longevity of the group increases. Catches of animals in late November 1963, that is three months after the end of reproduction (Fig. 2), showed no animals with rootless teeth in the population

Table 3.

Absolute age of conventional groups of common redbacked voles (in months and days) in different years.

	Years	1960/61		1961/62		1962/63		1963/64		1964		Avg.		Min.		Max.	
	Mode of calculation	B. a.	B. d.	B. a.	B. d.	B. a.	B. d.	B. a.	B. d.	B.a.	B.d.	B. a.	B. d.	B. a.	B. d.	B a.	B. d.
Conventional age groups	II—III	*1m*	2m	*1m20d*	3m20d	*2m*	3m	*2m*	3m20d	*2m*	3m	*2m*	3m	*1m*	2m	*2m*	3m20d
	IV—V	*2m*	4m20d	*3m20d*	6m	*3m*	5m	*3m10d*	5m20d	*3m*	5m	*3m*	5m10d	*2m*	4m20d	*3m20d*	6m
	VI	4m20d	6m20d	6m	*8m*	5m	7m	5m20d	8m	5m	7m	5m10d	7m10d	4m20d	6m20d	6m	*8m*
	VII	6m20d	*9m*	8m10d	*8m10d*	6m20d	*8m20d*	7m20d	*9m20d*	—	—	7m10d	*9m*	6m20d	*8m10d*	8m10d	*9m20d*
	VIII	9m	*10m*	8m20d	*10m*	8m10d	9m	9m10d	*9m20d*	—	—	9m	*9m20d*	8m10d	*9m*	9m10d	*10m*
	IX	10m	*12m*	10m10d	*10m*	8m20d	10m20d	9m10d	12m	—	—	9m20d	11m	8m20d	*10m*	10m10d	12m
	X	11m20d	13m	10m10d	*11m10d*	10m	13m	11m	14m10d	—	—	10m20d	13m	10m	*11m10d*	11m20d	14m10d
	XI	*12m20d*	*14m20d*	11m20d	13m10d	*12m20d*	14m	12m	14m10d	—	—	12m	14m	11m	13m10d	*12m20d*	*14m20d*
	XII	—	—	*13m20d*	15m20d	*13m20d*	15m20d	*13m*	15m10d	—	—	*13m10d*	15m20d	*13m*	15m10d	*13m20d*	15m20d

B.a. (Before apperance) — From the beginning of reproduction till the appearance of the group.
B.d. (Before disappearance) — From the end of reproduction till the disappearance of the group.
Italics — actual data; normal print — estimated data.

at that time. This demonstrated that even if we do make errors in the estimations of the longevity of the first group, they are less than a month. Similarly, proceeding from the time necessary for transition of animals from the previous group to the next one, we determined the time of disappearance of the II, III, IV, V and XI groups.

For groups in which we registered the time of their disappearance the calculations were made in order to establish the time of their appearance in the population (VII, VIII — IX groups). The longevity of the VI group is very approximate because its disapearance in spring was observed only once, while in winter rodents of this group form a large portion in the population as was shown by observations in October, November and February.

On the basis of these data on the longevity of different groups in the population, the absolute age of this group was estimated directly from Fig. 2. Results of these calculations are summarized in Table 3.

III. RESULTS

Primary accepted conventional age groups are not similar in size (Fig. 2, Tab. 3). Thus, the age of the VIII and IX groups differs by less than a month. With presented methods of calculations such differences can hardly be considered significant, therefore it is advisable to combine these groups. Groups XI and XII differ only by a month, whereas the difference in other groups is 2 months. It should be stated that in the first stages of treatment of the material we combined group II with group III and group IV with group V, as there was less than a month's difference between them. Fig. 1 and 2 and Table 5 therefore show not 12 but 10 groups, but with their original numbering.

The absolute age of northern redbacked voles was established by the same method. A comparison of age determination of *C. glareolus* and *C. rutilus* showed that practically speaking these species do not differ in the rate of formation and wearing of teeth.

The error in age determination appears not to exceed one at most two months in both directions. Annual variations in the time of appearance of each group for the five years of observation fall within these limits.

It will be seen in Fig. 2 that the duration and time of reproduction varied very insignificantly in all years of our observations in the south taiga forests in the area between the rivers of Kama and Viatka. The duration ranged from 3 months and 20 days to 5 months, the beginning of reproduction shifted in different years by not more than half a month, and the end by 1 month and 20 days. Accordingly, patterns of age groups in the same seasons of different years are quite similar, that is the age structure of forest vole populations in the south taiga forests of this area is quite constant. The maximum longevity of voles here is 12—16 months. Within this time complete renewal of the population takes place.

Table 4.

The average lengths of roots, crown and neck and the entire tooth M^2 (in mm) in animals of different ages.

C. glareolus	Age in months								
	1	2	3—4	5—6	7—8	9—10	11—12	12—13	13—15
Number of teeth measured	10	35	64	10	14	4	30	19	9
Height of the entire tooth	3.4	2.9	2.8	2.6	2.5	2.4	3.3	2.2	2.0
Height of the crown and neck	3.4	2.9	2.5	2.0	1.7	1.2	0.8	0.6	0
Length of roots	0	0	0.3	0.6	0.8	1.2	1.5	1.6	2.0
C. rutilus									
Number of teeth measured	16	64	18	4	9	28	19	10	3
Height of the entire tooth	2.9	2.8	2.7	2.3	2.2	2.2	2.2	2.1	2.0
Height of the crown and neck	2.9	2.8	2.4	1.7	1.4	1.2	0.8	0.5	0
Lenght of roots	0	0	0.3	0.6	0.8	1.0	1.4	1.6	2.0

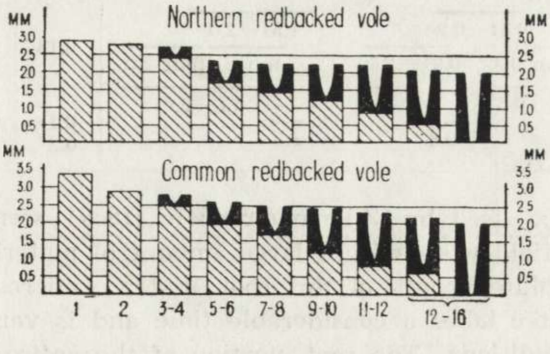

Fig. 3. Changes with age of the height and ratio of the roots and the crown to the neck of M^2.

Observations of the changes in the size of teeth with age in forest voles showed that the height of tooth decreases steadily because tooth wear occurs more intensely than the increase of the root. Within the life time of the animal tooth height is reduced about $1^1/_2$ (Table 4, Fig. 3).

In summer in common redbacked voles the crown shortens, on an average, by 0.4 mm in two months (maximum 0.5 mm, minimum 0.3 mm), the root increases on the average by 0.3 mm (maximum 0.5 mm, minimum 0.2 mm).

IV. DISCUSSION

Some authors used the absolute length of the root, others the portion which roots form of the entire length of teeth, for the determination of the age of *C. glareolus*. Data of the former are summarized in Table 5, those of the latter in Table 6.,

Table 5.

The length of M_1 and M^2 roots (in mm) in common redbacked voles of different ages according to different authors.

Tooth	Age in months 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Monthly increase in mm	Authors
M_1	0															0.18	Wrangel, 1939
M_1	0																Prychodko, 1951
M_1	0	less than 0.3			0.31—0.9				1—1.5			more than 1.5				0.15	Wasilewski, 1952
M_1	0	less than 0.3			0.31—0.95				0.96—1.50			more than 1.5				0.15	Zejda, 1960, 1961
M_1	0	less than 0.3			0.31—0.90			0.91—1.50			1.51—2.0	more than 2.0				0.18	Haitlinger, 1965
M^2	0		0.3		0.6			0.8		1.2	1.5	1.6—2.0				0.1—0.2	Ours data

The age index used by Zimmerman (1937) seems to be more convenient for field work with a large amount of material. Determination of the absolute length of the root under a microscope using an ocular micrometer takes a considerable time and is very inconvenient under field conditions. The root portion of the entire tooth may be determined visually with sufficient accuracy, particularly if a good drawing is available with which the tooth under study is compared. Such determination of the age facilitates work considerably and permits of establishing the age of an animal immediately after autopsy.

Koshkina (1955) studied the second upper molar (M^2), all the other authors the first lower (M_1). It is much more convenient to work with M^2: it is easier to expose because the maxillar bone here is thinner than around M_1: the anterior and posterior roots of M_1 differ in length and width and are inclined backwards, while in M^2 both these phenomena are less marked. For this reason we thought it more rational to study M^2 in order to prepare the age standard reference tooth.

Comparison of data by different investigators shows that the neck of the tooth is formed at the same age, during the third month of life, in animals from quite distant and differing in natural conditions areas of Western, Central and Eastern Europe, including Kola Peninsula. The average length of teeth roots was also similar in rodents of the same age living in Western and Central Europe and in the area between the Kama and the Viatka rivers (Table 5). Attention should be paid to the

Table 6.
The portion formed by roots of the height of the entire tooth in common redbacked voles according to different authors.

<table>
<tr><th rowspan="2">Tooth</th><th colspan="15">Age in months</th><th rowspan="2">Authors</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>M_1</td><td colspan="6">0</td><td>$^1/_6$</td><td colspan="5">$^1/_4$—$^1/_2$</td><td></td><td></td><td></td><td>Zimmermann, 1937</td></tr>
<tr><td>M^2</td><td colspan="2">0</td><td colspan="2">$^1/_8$</td><td colspan="2">$^1/_7$</td><td></td><td></td><td colspan="2">$^1/_4$—$^1/_3$</td><td colspan="3">$^1/_2$</td><td colspan="2">$^2/_3$</td><td>Koshkina *), 1955</td></tr>
<tr><td>M^2</td><td colspan="2">0</td><td colspan="2">less than $^1/_4$</td><td colspan="2">$^1/_4$</td><td colspan="2">$^1/_3$</td><td colspan="2">$^1/_2$</td><td colspan="2">$^2/_3$</td><td>$^2/_3$-$^3/_4$</td><td colspan="2">1</td><td>Our data</td></tr>
</table>

*) The paper presents only drawings without stating either the age of the animals or the percentage of roots, the latter was calculeted by measuring teeth in the drawing, the age of the animals was supplied by T. V. Koshkina.

fact that the absolute length and increase of M_1 and M^2 roots are practically similar (Table 5). A quite different time of tooth neck formation (7 months) was observed by Zimmerman (1937). This figure is clearly erroneous and is associated with the small amount of material used for age calculations. The same explains the difference between our data and those of Zimmerman (1937) and Koshkina (1955) concerning the indices of age for teeth with similar portions of roots (Table 6).

As has already been mentioned above, we measured teeth collected in summer, therefore figures given in Table 4 characterize the average rate of growth of roots and wear of the crown in summer. No data are available to permit of judging the seasonal features of growth and wear of teeth. Similar figures for the average annual growth rate of the root are reported by Wasilewski (1952). Koshkina (1955) mentioned that in the Kola Peninsula the speed of the root growth begins to slow down already since August, but the author has not given any concrete data.

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APPENDIX

A GUIDE TO THE DETERMINATION OF AGE OF COMMON AND NORTHERN REDBACKED VOLES ON THE BASIS OF THE STRUCTURE OF THE SECOND UPPER MOLAR (M^2)

The age of 1 month *)

The tooth has no roots and consists only of the crown. Longitudinal grooves between prisms cover the entire height of the tooth; they are open at basis of the tooth (Fig. 4, 1, lower; Fig. 5, 1, lower). Examination of the tooth removed from the jaw at the root part reveals that its basis is completely open and the opening has the same angular form as the gnawing surface (Fig. 4, 1, upper; Fig. 5, 1, upper). At the age of nearly 2 months the bases of the prisms begin to grow together, but the grooves between them are not yet completely closed. Angels at the opening at the root part of the tooth become obliterated. The average height of the tooth in *C. glareolus* is 3.4 mm, in *C. rutilus* 2.9 mm.

The age of 2 months

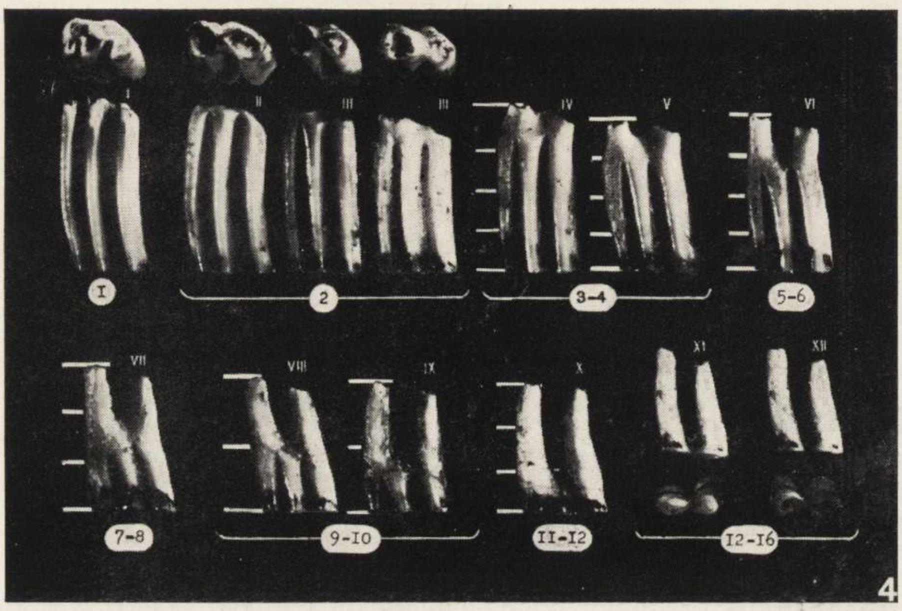
At this age the neck of the tooth is formed. The tooth has no roots, it consists of a prismatic crown and of a just appearing (Fig. 4, II, lower; Fig. 5, II, lower) or completely formed neck (Fig. 4, III, lower; Fig. 5, III, lower). Grooves at the base of the tooth are completely closed and rest against the neck of the tooth. Examination of the tooth removed from the jaw at the root end shows that at early stages of the neck formation there is still one opening but its angular shape is already lost. Now it is similar in to the figure 8: rounded in the front and back, but in the middle its edges are very close and from them towards each other bone bridges grow (Fig. 4, II, upper; Fig. 5, II, upper). Formation of the neck ends in their knitting and formation of the two completely separated openings (Fig. 4, III, upper; Fig. 5, III, upper). The average height of the tooth in both species is 2.8—2.9 mm.

The age of 3—12 months

At the age of about 3 months roots of the tooth begin to grow. In animals of 3—12 months of age the tooth consists of the crown (prismatic part), neck and two roots. The age of such animals is established more definitely by the ratio of the root length to the height of the entire tooth. These ratios are shown below:

Age in months	3—4	5—6	7—8	9—10	11—12
Portion of the root in relation to the entire tooth	$^1/_4$	$^1/_4$	$^1/_3$	$^1/_2$	$^2/_3$
Group No. in Figs. 4 & 5	IV—V	VI	VII	VIII—IX	X

*) At the age of 25—30 days the animals change juvenile for adult fur. It is easy to differentiate between animals younger and older than one month by the state of their fur (juvenile, moult, adult) (Tupikova, 1964).



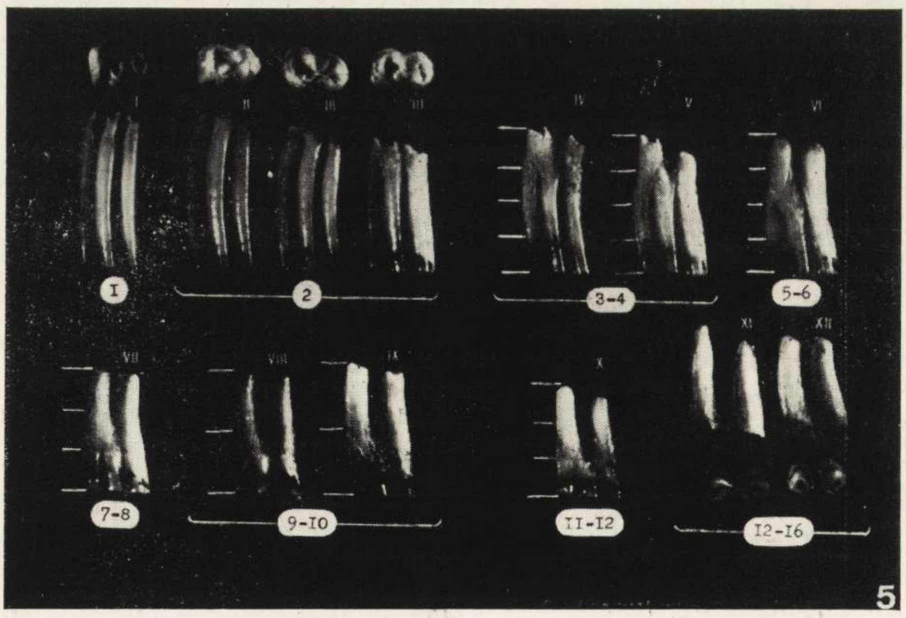


Fig. 4 & 5. M^2 in *C. glareolus* (Fig. 4) and *C. rutilus* (Fig. 5) of certain ages. I—XII — numbers of conventional age groups, 1—16 — age in months.

For the age of 1 and 2 months a side-view (lower) and an upper view from the root part (upper) are presented.

For the age of 12—16 months side-views (upper) and views from below, from the gnawing surface (lower) of the tooth are presented.

The age of 12—16 months

The crown of the neck is completely worn. The tooth consists either of the roots and neck (Fig. 4, XI; Fig. 5, XI) or only of roots (Fig. 4, XII; Fig. 5, XII). The neck has no cusps and grooves characteristic of the crown; by these features teeth of animals over one year of age are easily differentiated from those of younger ones. In animals of 12—16 months jaws need not be exposed: it can be from the gnawing surface that M^2 and M^3 no longer have an angular shape but look more like a figure 8 or consist of two separate rounded formations (Fig. 4, XII, lower). The average length of teeth at this age in *C. glareolus* is 2.0—2.2 mm and in *C. rutilus* 2.0 to 2.1 mm.

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METODYKA OKREŚLANIA WIEKU NORNIC

Streszczenie

W lasach tajgowych międzyrzecza Wiatki i Kamy w ciągu 5 lat, najczęściej od maja do sierpnia, przebadano 13 000 nornic *Clethrionomys glareolus* (Schreber, 1780) i 4 400 osobników *Clethrionomys rutilus* (Pallas, 1779). Na podstawie zróżnicowanej długości korzenia i wysokości korony M^2 wyróżniono kilka grup. Po zestawieniu terminów rozpoczęcia i zakończenia rozmnażania, okresów pojawiania się maksymalnej ilości miotów w populacji, z określonym typem budowy zęba, ustalono absolutny wiek każdej z wydzielonych grup.

Przedstawiono klucz do oznaczenia bezwzględnego wieku obu badanych gatunków nornic. Do drugiego miesiąca życia zęby zbudowane są tylko z listew i dopiero u dwumiesięcznych nornic kształtuje się szyjka zęba. W wieku 3—4 miesięcy korzenie stanowią mniej niż $^1/_4$ całej wysokości zęba. W wieku 5—6 miesięcy stosunek ten wynosi $^1/_4$, 7—8 miesięcy — $^1/_3$, 9—10 — $^1/_2$, w wieku 11—12 miesięcy — $^2/_3$. U zwierząt starszych niż rok w zębie pozostają tylko same korzenie, lub zachowuje się jeszcze część szyjki.