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

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Morphological Analysis of the Wrocław Population of *Clethrionomys glarelous* (Schreber, 1780).

[With 5 Figs. & 20 Tables]

Morphological analysis was made of 477 individuals of *C. glareolus*, captured in Wrocław from 1959—1963. The material was divided into 7 age groups according to the degree of development of the tooth roots. The development of the population was observed to be limited in the summer, which was compensated by increased reproduction in the autumn. Litters may occur even in December, as is shown by the population structure in January. Bank voles in January 1961 formed 27.8% shows that growth of the tooth roots is not identical in different populations. The rate of development of certain of the skull measurements and of differences in the absolute values of these measurements were found to differ from those of bank voles from the Białowieża population, showing that in certain cases characteristic features are established exclusively for one particular population. Bank voles born in the spring, summer and autumn differ as to intensity of growth of body and skull. Seasonal reduction was found in several measurements. Faintly marked sex dimorphism is a seasonal phenomenon limited, in the case of the Wrocław population, to differences in body weight, length of body and capacity of the skull. The Wrocław population of bank voles in more similar to the Central German populations than to the East Polish ones.

I. INTRODUCTION

A relatively great amount of attention has been paid to biomorphological investigations of the bank vole, one of the commonest European rodents, particularly in Germany, Czechoslovakia and the Soviet Union, yet most often certain aspects of morphological variations only are discussed in these studies (Zimmermann, 1937; Stein, 1938; Ognev, 1952; Razorenova, 1952; Koschkina, 1955; Sviridenko, 1959; Zejda, 1961; Bolschakov & Schwarz, 1962; Rossolimo, 1964). Prychodko (1951) dealt more fully with this question. In Poland, apart from data similar in character to supplementary contributions, and published in the small number of faunistic-ecological papers available (Sagan, 1939; Skuratowicz, 1948; Wilusz, 1952), only the study by Wasilewski (1952) contains a more extensive discussion of the biomorphological problems of this species. Wasilewski (1952) based his findings on the Białowieża population, that is, a population living in an area with different living conditions from the south-western parts of Poland. A comparative analysis has therefore been made of morphological variation in the Wrocław population of *Clethrionomys glareolus* (Schreber, 1780).

II. MATERIAL AND METHODS

Material collected from November 1959 to April 1963 was obtained from an area of poor soil mixed with rubble, densely covered with elder bushes and to some extent by young deciduous trees and herbaceous plants, and from nearby copses and windbreaks situated in one of the districts of Wrocław — Siedlec. A total of 477 individuals were caught, which were divided into 7 age groups according to the classification criterion generally accepted for this species (Prychodko, 1951; Wasilewski, 1952; Zejda, 1961). Since there are fairly considerable age differences in the voles which have not as yet developed tooth roots, this small amount of material was divided into two groups according to Cb. length. This system was used earlier on by Wasilewski (l.c.).

- group I — individuals without roots — Cb.-length up to 20.5 mm — aged about 1 month,
- group II — individuals without roots — Cb.-length over 20.5 mm — age 1—2 months,
- group III — length of root up to 0.30 mm — age 2—4 months,
- group IV — length of root from 0.31—0.90 mm — age 4—7 months,
- group V — length of root from 0.91—1.50 mm — age 6—9 months,
- group VI — length of root from 1.51—2.00 mm — age 8—14 months,
- group VII — length of root over 2.00 mm — age over 13 months.

This is a sufficiently exact division. Attempts have been made (Zejda, 1961) at classifying populations with minute accuracy into age groups according to the increasing length of the tooth roots, every 0.18 mm. While such attempts may be of some importance, particularly when very abundant material is available, where the contrary is the case too minute classification of material may lead to obliteration of the natural picture.

The field voles were measured and weighed immediately after capture. The pregnant females were weighed after the embryos had been removed. Skulls were preserved only in the dry state, and were measured under a measuring microscope. Measurements of height of braincase were made with a vernier calipers, and capacity by filling the brain case with mercury. Weigth of skull without mandible was established with accuracy up to 1 mg.

III. AGE STRUCTURE OF THE POPULATION

The age structure of the vole population is shown in Fig. 1. The first young voles were not caught until May, and they form a negligible percentage of the population. This is a group with fairly considerable morphological variations, despite the similarity of age. I had only 11 individuals available, two of which were very young specimens. It may be assumed that they were caught immediately after leaving the nest. The remainder must have been moving about in the area independently for some time. In principle individuals in which M^3 is not fully formed may be taken as the youngest animals capable of leaving the nest on their own. There were, however, no such voles in my material. The simultaneous finding of young specimens in May in age groups *I* and *II* shows that the youngest voles appear as early as April. This is also shown by the capture at the end of March of the first pregnant females, greater numbers of which do not appear until mid-April (Haitlinger, 1963). The problem here is how to determine the age of the youngest voles. The body length of the smallest individual is 61.2 mm, and the largest 80.6 mm: corresponding body weights are 6.4 g and 11.4 g. Wasilewski (1952) gives similar data. When compared with the investigations made by Sviridenko (1959) these voles should be considered as individuals

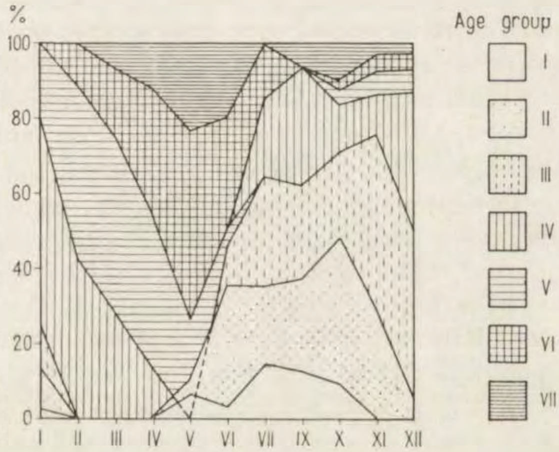

Fig. 1. Comparison of percentages of population composition.

not more than 2 weeks old. Since the results of observations of captive animals can only be related to those under natural conditions with a considerable measure of reserve, the age of the specimens caught is undoubtedly greater, and must come within limits of 3—4 weeks. Sviridenko (1959) draws attention to the important influence of food conditions on the rate of growth of young animals (at the age of 1 month mean differences in body weight may attain a value of 9.3 g, and body length 1.5 mm). Under natural conditions, of course, such variations are very common. In view of the above, differences in estimates of the age of individuals in this group may be considerable.

Young voles (groups *I* and *II*) form a higher percentage of the population in July and September, and particularly in October. This is partly due to the inclusion in reproduction of individuals from the early spring litters, but to an even greater degree it is the result of the old adults dying. In April and May the percentage of females taking part in reproduction is very small (H a i t l i n g e r, 1963), while the majority of the females participate, during the following months, in the process of reproduction, which in principle ends in October. Voles in the first age group gradually cease to be caught during the period from the end of October to the beginning of November, although in exceptional cases litters may occur at the end of November, and even at the beginning of December. Most probably the individual caught in mid-January comes from this period. This is also borne out by the increase in the percentage of individuals in age group *II* in January. Young individuals of this group are caught in December also. In view of the continual captures of young specimens, with accompanying absence during this period of pregnant and lactating females, the possibility must be taken into consideration that the voles without tooth roots caught at this time are older than analogical individuals caught in the spring and summer. It is not impossible that the formation of tooth roots in these voles takes place more slowly, as is the case with the growth of all other elements of the body and skull.

In table 1 the negligible number of individuals in age group *I* and *II* caught from June to September inclusively is remarkable (these individuals forming respectively from 35.5% to 36.6% of the population for July and September jointly), which points to the stabilisation of the reproduction process on a low level during these months. As the material under discussion is based chiefly on collections from 1960, variations in the age structure of the population from both this and the late autumn winter and spring periods of other years are given in table 2 (in %). There is no doubt that it is a case here of a certain process considerably limiting reproduction, which to some extent affected the development of the population. T u r č e k (1954) drew attention to the inhibition of the reproduction process in voles in the summer. This limitation in the case of the Wrocław population was compensated by increased reproduction in the autumn. Z e j d a (1961) gives instances from Czechoslovakia of prolongation of the reproduction period, as the result of which specimens with small roots form 28% of the population in January. In January 1961 in Wrocław voles without tooth roots formed 27.8% of the population. It is possible that the presence of young voles during this time is connected with the mildness and prolongation of the preceding period — the autumn of 1960. The absence of voles in age groups *II* and *III* in February and March is evidence that the majority of individuals born in the late autumn died. It must therefore be concluded that the observed state of age

Table 1.
Complete list of field voles captured.

Age group	Months												Total
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
I	1				2	1	2		2	3			11
II	5				1	10	3		4	12	19	3	57
III	5					3	4		4	7	31	19	73
IV	26	24	26	7			3		5	4	7	36	118
V	9	25	43	22	5	2				1	4	3	114
VI		6	16	18	15	9	2			1	3	2	72
VII			6	6	7	6			1	3	2	1	32
Total	46	55	91	53	30	31	14		16	31	66	44	477

Table 2.
Age structure of the population in different years (in %).

Year	Age	Month									
		I	II	III	IV	V	VI	VII, IX	X	XI	XII
1959	I									14.3	
	II									42.9	31.9
	III									35.7	50.0
	IV									7.1	13.6
	V										4.5
1960	I					8.7	35.5	36.6	44.4	61.0	14.3
	II						9.7	26.7	16.7	16.7	57.1
	III	90.9	44.4	35.5	17.3			26.7	11.1	5.6	23.8
	IV	9.1	48.2	51.0	48.3	8.7	6.5		5.6	5.6	
	V		7.4	13.7	34.4	82.6	48.3	10.0	22.2	11.1	4.8
1961	I	27.8								11.1	
	II	22.2								77.8	
	III	44.4	58.3	36.4						5.6	
	IV	5.6	41.7	63.6							—
	V									5.6	
1962	I								53.9	20.0	
	II	5.9							30.8	53.4	
	III	52.9	29.4	13.3					15.3		
	IV	41.2	47.1	36.7	23.7					13.3	
	V		23.5	50.0	76.3					13.3	

structure of the population in the autumn of 1960 and winter of 1961 differs greatly from the "average", as is borne out by results from analogical periods: November 1959, 1961, 1962 and the winter-spring period of 1960 and 1962.

Mortality among old adults is particularly distinctly evident in July and in the following months only very small numbers are caught (Tab. 1).

Voles are generally estimated to live very short lives (P r y c h o d k o, 1951; W a s i l e w s ki, 1952; K o s c h k i n a, 1955; Z e j d a, 1961), their age under natural conditions rarely attaining the 15-month limit.

Few animals in age group *VII* were obtained at Wrocław. Voles with tooth root length over 2 mm appear for the first time in March. Of the 6 individuals in this case, 3 have roots of more than 2.40 mm in length. Assuming the monthly rate of growth of roots given by W a s i l e w s k i (l.c.) as 0.15 mm, these voles must be considered as having attained the age of approximately 19 months, and they must therefore have been born at the end of August and beginning of September. The vole with the smallest root length (2.09 mm) would have been born in the autumn months (November?). Everything therefore points to the old adults coming mainly from the autumn litters. In April and May, however, individuals with shorter roots are caught, which, when the above means of estimating age is applied, leads to the conclusion that the population is mainly derived from winter litters! This is confirmed by data taken from individuals in age group *VI*. In 6 field voles (group *VI*) from February tooth root length varied within limits of 1.52—1.77 mm. As has been mentioned above, in Wrocław the spring reproduction season begins in April, and therefore the maximum age of these voles cannot exceed 10—11 months, while the measurement suggests a greater age. Hence it is clear that increase in length of the tooth roots must take place slightly more rapidly than W a s i l e w s k i (1952) suggests, bearing in mind, of course, the individual variations of this element.

Z e j d a (1961) assumes an age of at least 20 months for an individual in which the length of tooth root was 2.61 mm. Like P r y c h o d k o (1951) he considers it possible to accept a greater age in connection with the slower rate of growth of the root as age increases.

In the Wrocław material the longest tooth root was 2.83 mm. In view of the reservations given above it is difficult to establish the age of this individuals or of other individuals with similar dimensions of tooth roots.

IV. MORPHOLOGICAL ANALYSIS

Different rates of increase are observed among measurements of different elements of the body and bones of the skull (Fig. 2, 3, 4).

Since the observations made are in general in agreement with those given by W a s i l e w s k i (1952), only certain aspects of this problem have been extensively discussed.

As mentioned previously, individuals in age group *I* are older than the youngest individuals obtained by W a s i l e w s k i (l.c.) and therefore the mean length of different measurements approximately correspond to his 2nd class voles from age group *I*. On this account the increase in the

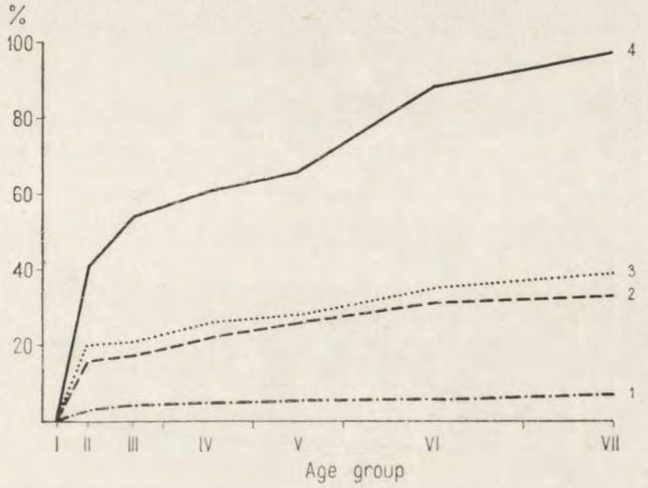

Fig. 2. Increase in length of body, tail, foot and of body weight in age groups. 1 — length of foot, 2 — length of body, 3 — length of tail, 4 — weight of body.

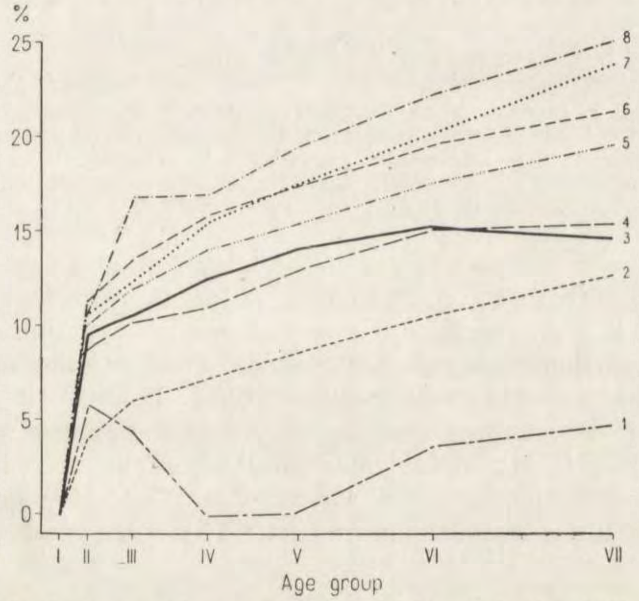

Fig. 3. Increase in measurements of length in the skull. 1 — length of sagittal suture, 2 — length of frontal bone, 3 — length of maxillary tooth row, 4 — head & body, 5 — Cb.-length, 6 — basal length, 7 — diastem, 8 — length of nasal bone.

measurements made (Fig. 2, 3, 4) of voles from the Wrocław population will be approximately smaller. Extreme values obtained from the Wrocław material show (e.g. minimum Cb.-length — 17.93 mm) that young voles in many cases leave the nest far earlier than is generally assumed.

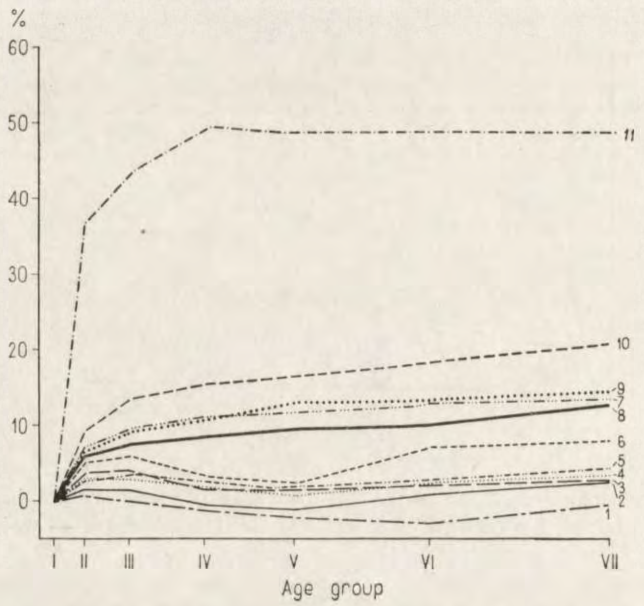

Fig. 4. Increase in measurements of breadth and height in the skull.
1 — breadth of interparietale, 2 — height between *bullae tympanici*, 3 — height measured on the bases of *bullae tympanici*, 4 — breadth of the occiput measured on squamosal sutures, 5 — interorbital breadth, 6 — capacity, 7 — palatal height, 8 — breadth of occiput, 9 — breadth measured on *procc. zygomatici*, 10 — breadth measured on sutures, 11 — weight of skull.

The maximum increase in length of body, tail and foot and in body weight is observed in the second month of life. In voles in age group *III* the increase in body length undergoes considerable inhibition, while the tail length remains unaltered. The increase in each of these measurements is uneven and depends on the period of birth. Bank voles born in the spring and in the summer very rapidly attain the dimensions characteristic of old individuals. Individuals from the autumn litters increase their body measurements relatively slowly. More intensive growth is not evident until the voles reach age group *VI*. This is the result of the grouping of these individuals in the spring and summer months, in which the growth of old adults born in the autumn takes place most rapidly. This problem will be discussed in greater detail later on in this paper.

Among the measurements of the skull Wasilewski (1952) distinguishes three groups differing from each other as to the character and intensivity of variations connected with age and seasons, and we shall adhere to this arrangement of analysis in this study. The problems of seasonal reduction and the morphological development of the spring-summer and autumn generations will be dealt with separately.

Condylobasal length and basal length belong to measurements constantly and evenly increasing. Both the course taken by this process and the absolute values are almost identical with the results obtained from the Białowieża population (Tab. 3, 4). The increase in total length takes place more slowly and unevenly, this being particularly distinctly observable in individuals in age group *IV*. Total length attains its final value in field voles in age group *VI*, no further increase being observed in the oldest voles (0.04 mm). It is difficult to establish whether the same applies to voles from the Białowieża population, since age group *V* in Wasilewski's material (1952) corresponds to combined groups *VI* and *VII* in my material, which does not always permit of drawing the correct conclusions.

Only the growth of the diastem in the young voles takes place as intensively as the growth of Cb.-length, and as from age group *IV* its rate of growth is more rapid than that of Cb.-length. Increase in the length of the nasal bone takes place as rapidly as that of the diastem only in the second month of the voles' life, then slows down slightly. The complete cessation of growth of the nasal bone in voles of age group *IV* is remarkable. Approximately 80% of the material in this group is formed by voles caught in the winter and spring. The limitation of growth during the winter and early spring therefore affected the mean value. The mean length of the nasal bone from December to March in this age group was respectively: 6.07, 5.93 and 5.87 mm. In the spring the length of the nasal bone increases, but its growth is slower than that of the diastem. As a result the difference between the mean length of the nasal bone and the diastem in the youngest and oldest field voles is almost identical (0.26 and 0.21 mm) — table 3. The diastem therefore exhibits more even growth than the nasal bone, which does not agree with the results obtained by Wasilewski (1952), the length of the nasal bone of voles from the Wrocław population being clearly smaller than the analogical measurement in voles from the Białowieża population (Tab. 4). This bone is shorter even in the youngest individuals, and the difference is accentuated with age. The mean length (6.40 mm) of the nasal bone in the oldest voles is smaller by 0.15 mm than the mean value of this measurement in 2-month old voles and by 0.58 mm than that in the oldest specimens from Białowieża. No voles in which the length of nasal bone exceeded 7 mm were found in the Wrocław material, although this is frequently observed in young voles from the Białowieża population.

Increase in the frontal bone takes place slowly but evenly. No differences were found in the development of this bone in comparison with the Białowieża material (Tab. 4). Measurements of breadth (occipital breadth, breadth measured on *procc. zygomatici* and zygomatic breadth on the sutures) reveal more or less even growth (Fig. 4). In comparison with the

Table 3.
Growth of body and

Age group	I /n=11/			II /n=57/			III /n=58/		
	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.
Cb.-length	17.93	19.86	20.35	20.57	21.85	23.55	20.65	22.24	23.63
Length of skull	18.50	20.64	21.50	21.28	22.43	23.76	21.21	22.75	23.97
Basal length	15.65	18.16	19.76	18.92	20.21	22.41	19.08	20.63	21.92
Diastema	4.60	5.41	6.02	5.18	5.99	6.56	5.49	6.08	6.62
Length of nasalia	4.37	5.15	5.54	5.05	5.70	6.44	5.15	6.02	6.46
Length of frontale	7.67	8.24	8.44	8.00	8.59	9.56	7.65	8.74	9.42
Length of sut. sagitt.	2.52	3.65	4.35	2.92	3.86	4.69	3.06	3.81	4.53
Breadth of interparietale	3.01	3.40	3.76	2.85	3.43	3.99	2.94	3.40	4.05
Maxillary tooth-row	4.01	4.64	5.08	4.56	5.10	5.58	4.68	5.14	5.56
Occip. breadth /on s. squamosa/	8.41	8.63	9.08	8.18	8.88	9.31	8.33	8.90	9.48
Occipital breadth	9.57	10.10	10.69	10.22	10.83	11.60	10.27	11.06	11.92
Zyg.-zyg.	10.80	11.44	11.98	11.46	12.22	12.92	11.85	12.52	13.15
Breadth of sut. zyg.	10.13	11.00	11.62	11.02	12.00	13.14	11.66	12.45	13.09
Interorbital constriction	3.49	3.74	3.99	3.60	3.84	4.07	3.49	3.89	4.29
Height of skull between bullae	6.6	6.94	7.5	6.7	7.05	7.6	6.6	7.05	7.6
Height of skull per bullae	8.2	8.80	9.4	8.5	9.08	9.6	8.7	9.12	9.6
Palatal depth	5.2	5.50	5.8	5.3	5.81	6.5	5.5	5.91	6.5
Volume of the skull	420	469	510	410	494	555	440	496	555
Skull weight	121	167	220	164	229	285	186	239	277
Head & Body	61.2	72.7	80.6	70.4	84.5	99.4	67.7	85.5	99.5
Tail	27.1	34.2	37.4	34.8	41.2	46.9	33.8	41.4	47.9
Hind foot	15.3	16.5	17.4	16.2	16.9	18.7	15.5	17.25	18.7
Body wt.	6.4	9.5	11.4	10.0	13.9	26.4	10.5	14.5	23.8

Białowieża material the smaller range of difference between breadth measured on the sutures and the zygomatic breadth is remarkable. In principle the absolute values of the different mean values do not differ from those given by W a s i l e w s k i (1952) — table 4.

The second measurement exhibiting significant divergences from the Białowieża material is the palatal height. The increase in this measurement takes a similar course in both populations, but the mean value even in the youngest voles attains a value of 5.5 mm which corresponds to the mean value not attained by specimens from the Białowieża population until class 5 of age group *I*. The difference between the mean values of this skull in age groups.

IV /n=116/			V /n=114/			VI /n=70/			VII /n=32/		
Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.
21.30	22.66	24.39	21.73	22.93	24.50	22.08	23.35	24.89	22.92	23.69	24.67
21.52	22.93	24.61	21.49	23.33	24.64	22.28	23.79	25.08	23.12	23.83	25.05
19.63	21.03	22.55	19.56	21.31	22.79	20.20	21.73	23.12	21.25	22.05	22.98
5.78	6.25	7.00	5.71	6.36	6.99	5.63	6.52	7.28	6.21	6.71	7.25
5.30	6.03	6.78	5.41	6.16	6.93	5.65	6.30	6.80	5.87	6.40	6.95
8.18	8.84	9.71	8.09	8.96	9.95	8.48	9.12	9.79	8.71	9.21	9.91
2.70	3.64	4.50	2.83	3.66	4.56	3.04	3.78	4.51	3.23	3.82	4.70
2.74	3.36	4.23	2.67	3.34	4.15	2.43	3.30	3.88	2.92	3.39	3.98
4.70	5.23	5.73	4.75	5.30	5.80	4.86	5.35	5.94	4.84	5.33	5.71
8.31	8.82	9.45	8.22	8.79	9.47	8.22	8.82	9.38	8.10	8.91	9.48
10.46	11.20	12.18	10.50	11.26	11.95	10.80	11.39	12.08	11.02	11.46	11.96
11.53	12.70	13.62	12.17	12.86	13.66	12.23	12.94	13.68	12.60	13.15	13.79
12.00	12.72	13.68	11.95	12.83	13.61	12.26	13.06	13.83	12.82	13.27	13.85
3.49	3.85	4.30	3.44	3.84	4.22	3.22	3.87	4.15	3.64	3.90	4.12
6.3	6.92	7.3	6.2	6.88	7.9	6.4	7.04	7.6	6.6	7.14	7.9
8.0	8.98	9.6	8.1	8.98	9.8	8.4	8.98	10.0	8.5	9.20	10.1
5.5	5.95	6.6	5.4	6.01	6.5	5.5	6.05	6.5	5.8	6.24	6.8
425	485	550	390	480	550	410	502	560	440	505	580
196	252	321	195	253	307	208	258	295	223	262	342
77.8	89.0	100.0	75.4	91.4	101.5	84.1	95.7	106.8	82.0	96.8	107.0
34.9	42.9	52.9	38.6	44.05	52.6	38.6	46.3	56.5	42.6	47.3	51.5
16.0	17.3	19.0	16.1	17.4	19.1	15.9	17.5	18.6	16.7	17.6	18.6
10.1	15.3	23.3	11.1	15.8	28.6	11.9	18.0	28.8	12.9	18.9	29.0

measurement in the oldest specimens from the Wrocław and Białowieża populations is 0.5 mm. This mean is equal to the maximum dimensions of palatal height attained by the Białowieża specimens (Tab. 4).

Among the measurements which do not exhibit any growth at all after the second month of life is the interorbital breadth. Zimmermann (1937) and Prychodko (1951) accept the possibility that this breadth may decrease with age, and Wasilewski (1952) does not exclude the possibility, merely stating that he did not find such decrease in his material. On the other hand he emphasises that interorbital breadth is not smaller in individuals from 3—5 weeks old than it is in adult or old

Table 4.
Comparison of ranges and mean values of measurements of field voles from the Wrocław and Białowieża populations.

Age group	Białowieża*						Wrocław					
	IV			V			VI			VII		
Measurement	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.
Cb.-length	22.3	23.3	24.5	22.1	23.6	24.9	22.88	23.35	24.89	22.92	23.69	24.67
Length of skull	22.7	23.4	24.1	22.7	23.8	24.5	22.28	23.79	25.08	23.12	23.83	25.05
Basal length	21.1	21.8	23.1	20.9	22.2	23.5	20.20	21.73	23.12	21.25	22.05	22.98
Diastema	5.8	6.60	7.1	5.7	6.71	7.3	5.63	6.52	7.28	6.21	6.71	7.25
Length of nasalia	6.2	6.85	7.5	6.0	6.98	7.8	5.65	6.30	6.80	5.87	6.40	6.95
Length of frontale	8.2	9.01	9.6	8.2	9.13	10.0	8.48	9.12	9.79	8.71	9.21	9.91
Length of sut. sagitt.	3.4	4.10	4.7	3.3	4.14	4.9	3.04	3.78	4.51	3.23	3.82	4.70
Breadth of interparietale	2.7	3.24	3.8	2.6	3.29	4.2	2.43	3.30	3.88	2.92	3.39	3.98
Maxillary tooth-row	5.15	5.47	5.80	5.0	5.39	5.95	4.86	5.35	5.94	4.84	5.33	5.71
Occipital breadth	10.1	11.7	11.7	10.3	11.32	11.8	10.80	11.39	12.08	11.02	11.46	11.96
Zyg.-zyg.	12.5	12.95	13.7	12.3	13.05	13.9	12.23	12.94	13.68	12.60	13.15	13.79
Breadth of sut.zyg.	12.3	13.20	14.3	12.7	13.35	14.7	12.26	13.06	13.83	12.82	13.27	13.85
Interorbital constriction	3.55	3.86	4.10	3.40	3.85	4.15	3.22	3.87	4.15	3.64	3.90	4.12
Height of skull between bullae	6.6	7.20	7.7	6.6	7.31	7.9	6.4	7.04	7.6	6.6	7.14	7.9
Height of skull per bullae	8.5	9.11	9.6	8.4	9.18	9.7	8.4	8.98	10.0	8.5	9.20	10.1
Palatal depth	5.2	5.64	6.1	5.4	5.74	6.2	5.5	6.05	6.5	5.8	6.24	6.8

* Acc. to Wasilewski (1952).

individuals. In this connection it is a remarkable fact that this measurement in specimens from the Wrocław population still continues to increase in the second month of life (Tab. 3). This difference is statistically significant (Student's test).

Increase in the breadth of the brain-case measured at the point of junction of the angular with the squamosal sutures exhibits a different course from that of growth of the measurements of breadth discussed previously. After the period of growth a very slight decrease in the dimensions is observed in field voles in age groups *III* and *IV*, then renewed increase, particularly evident in the oldest individuals. The course taken by increase in this measurements corresponds to the course taken by increase in measurements revealing seasonal reduction. Wasilewski (1952) made a similar measurement at the bases of the zygomatic arches, demonstrating their slight decrease in the oldest individuals. Variations of this type are of course masked by the occurrence of individuals from the summer and autumn period.

Measurements revealing seasonal reduction include: length of the sagittal suture, height measured per bullae and between bullae, and capacity of the skull. Increase in these measurements takes an almost identical course (Fig. 3, 4). Attainment of the first maximum in the second month of life is followed by reduction in absolute dimensions, particularly evident in individuals in age groups *IV* and *V*. In the oldest specimens these measurements increase again to attain the maximum mean value (with the exception of the length of the sagittal suture). Total increase is, however, very small (Tab. 3, Fig. 4). The mean capacity of the skull in the oldest individuals does not greatly exceed this value in specimens in age groups *II* and *III*. The data obtained do not confirm Wasilewski's observations (1952) as to attainment of maximum capacity by young individuals (2 months old), and they indicate that the capacity of the brain-case is smaller in the Wrocław voles.

In the case of the interparietale, in older individuals as from age group *IV* its mean breadth is smaller than that of the youngest individuals. In the oldest voles the value of this measurement is identical with its value in voles in age group *I* (Tab. 3). It is worthy of emphasis that the mean length of the sagittal suture in voles from the Wrocław population is greater by 0.32 mm than the analogical measurement in the oldest individuals from the Białowieża material, and the breadth of interparietale by 0.10 mm (Tab. 4).

The last of the measurements made is the weight of the skull, which increases very intensively in the second month of life. Increase at this time is 36.5% and is over three times greater than the intensivity of increase in Cb.-length. This ratio in rate of growth is maintained until the animal attains the age of 4—7 months. In individuals in age group *V* increase in weight is halted, and increases only very slightly in older animals (Fig. 4).

V. MORPHOLOGICAL DEVELOPMENT OF DIFFERENT GENERATIONS

All the problems hitherto discussed were concerned with observations of the development of certain dimensions and elements of the skull from the age aspect. It must be emphasised that table 3 containing collective data showing the course taken by this process presents only an approximate picture of its real character. Each age group, and in particular the older groups, have representatives at different seasons of the year, which is connected with the relatively long reproduction period in voles, which may last from April to November inclusively. During this period a number of generations may be formed, which can be roughly divided into three groups: the spring, summer and autumn generations. This is not of course an exact division, but is sufficient to grasp differences in the development of young animals born at different seasons of the year. This can be done, especially in the initial stages of development, but as result of the reservations discussed previously in regard to determination of age, this process becomes very difficult, or even impossible, to trace in scanty material, on account of the very small percentage in the population of individuals from the spring or early summer litters. As is well known, the growth process in these generations takes a different course and the spring and early summer generations very rapidly attain the dimensions characteristic of adult animals (Wasilewski, 1952; Adamczewska, 1959; Haitlinger, 1962; Schwarz and others, 1964). Voles from the autumn litters are characterised by slower growth. In an analysis of age, regardless of the period at which the animal was born, all individuals are classified in one age group. In such a case, of course, the value of the mean depends on the reciprocal ratio of representatives of different generations, and these by the very nature of things are caught in greater numbers in the autumn. In the case of older animals, which may be captured throughout the majority of the months of the year, the process of uneven growth and seasonal reduction of certain measurements is completely masked, while in others, chiefly concentrated in the winter months, this process is particularly strongly emphasised.

It may be said that the table covering this question exclusively in age groups without splitting into separate generations forms in principle a picture of the development of the late summer and autumn generation (this of course refers to the older groups of animals). It is only in the case in which material is split into separate generations, and their development discussed according to season, that it is possible to convey a correct picture of the course taken by morphological development of these generations.

Age groups *VI* and *VII* have here been combined in one joint group, since the small number of older voles, together with their even number of captures over the whole year, made it impossible to analyse them separately.

As has already been found in bank voles (Wasilewski, 1952) or striped field mice (Haitlinger, 1962) body length in young individuals born in the first half of the year is greater than in animals from later litters (Tab. 5). In the Wrocław population the largest young specimen had attained a body length of 99.4 mm. I had somewhat scanty material at my disposal, but Wasilewski (l.c.) states that in July 21% of the young individuals exceeded 90 mm in body length. The problem here is what course is taken by increase in body length in these voles, which at so early an age had attained dimensions exceeding the mean length in the oldest specimens. The mean increase in this measurement in voles in age group *VII* (in relation to individuals in age group *II*) is 12.3 mm. The oldest individuals (groups *VI* and *VII*) exceeding 100 mm in length form 29.8% of the whole of this group, the mean value varying within limits of 101—102 mm (n = 31). Young voles in September (group *III*) aged about 3 months attain on an average a length of 95.8 mm! The absence in the material of individuals exceeding 107 mm in body length indicates that in the case of voles born in the spring and summer there is a jump in increase in length, and after attainment of considerable dimensions in the second month of life there is very little increase afterwards. The regular course of this process can only be traced when abundant material is available from the whole year, since in view of the very small participation in reproduction of females in the spring-summer period (in the Wrocław population) the number of young from this season is small, and as the result of different natural factors their numbers are subject to constant reduction in later periods.

The mean body length in the autumn is reduced, reaching a minimum in January (group *II* — table 5). This is due to individuals being caught which originate from increasingly late litters, the growth of which is increasingly slower, the later the period at which the animals were born. The attainment by voles of higher ages (age groups *II*, *III*) during the autumn-winter period (and thus transition from one age group to another) conceals the very slight growth process. If such growth did not take place we should find, for instance in age group *IV*, in the winter months a decrease in mean body length, in view of the "jump" into the group of part of the voles born in the autumn, but this is not observed. Thus the winter is a period of very slow growth only. Body length increases intensively at the end of March and beginning of April, this applying primarily to voles from the autumn litters. The animals attain their greatest dimensions in June, July and September, hence the conclusion must be reached that voles attain maximum body length as early as June and that it does not increase any further (Table 5).

Table 5.
Variations with age in the mean values of body length from the seasonal aspect.

Age group	Month									
	I	II	III	IV	V	VI	VII	IX	X	XI	XII
II	79.5					83.9	93.7	87.0	84.3	94.3	81.4
III	82.2					93.2	89.2	95.8	86.4	82.9	85.8
IV	87.9	88.9	88.9	90.5			92.7	92.4	87.8	88.3	89.3
V	89.0	89.5	92.1	93.8	89.5	95.0				87.2	91.3
VI/VII		93.7	92.9	94.9	97.8	99.7	99.6	99.3	98.8	92.3	

Increase in tail length from the seasonal aspect takes a more distinct course than increase in body length. The maximum dimensions of the tail are observed in each age group in voles from the spring and early summer generations, e.g. in age group *V*, in November and December, mean tail lengths are greater than in the later winter months. More intensive growth is not observed until April and May (age groups *VI* and *VII*) — table 6.

Cb.-length attains a high value in voles in age group *III* (Table 7) as early as June. These are individuals from the spring litters. The minimum Cb.-length is observed in voles of this age in January. In age group *IV* the mean Cb.-length continually decreases, reaching a minimum in March. In voles in age group *V* this dimension continues to increase as from January. Apart from this one month, the mean values in the older age groups in different months are higher than the means from the same months from the lower groups. It would seem that the reason for the decrease in mean Cb.-length in voles from 4—7 months old lies in the "entry" into this category of autumn voles, in which increase in Cb.-length takes place particularly slowly and to the partial "disappearance" of the older voles "entering" in turn group *V*. Higher mean values in older voles in the various months point to continual increase of this measurement in younger voles. It would seem that the fact mentioned above of reduction of mean values in group *IV*, compared with the "stabilisation" in the same period of, for instance, body length, points to specially marked limitation of increase in Cb.-length.

Measurements revealing seasonal reduction will be discussed in turn.

Body weight is subject to considerable seasonal fluctuations. In the autumn and particularly in the winter continuous decrease in body weight is observed in voles in all age groups. As a result, in January and February in the oldest voles the mean weight is about 6 g lower than that

Table 6.

Variations with age in the mean values of tail length from the seasonal aspect.

Age group	Month										
	I	II	III	IV	V	VI	VII	IX	X	XI	XII
II	38.6					40.4	42.8	41.8	41.6	41.7	40.3
III	39.4					45.3	43.1	43.2	39.3	42.0	40.5
IV	42.5	42.5	42.5	43.7			47.7	44.2	45.2	43.9	42.6
V	44.8	42.9	44.3	43.7	44.0	46.9				45.4	46.7
VI/VII		45.1	45.0	45.5	47.6	47.8	52.0		47.7	48.3	48.3

Table 7.

Variations in mean values of Cb.-length from the seasonal and age aspects.

Month	I	II	III	IV	V	VI	VII	IX	X	XI	XII
III	21.64					23.16	23.19	22.72	21.90	22.08	22.24
IV	22.64	22.59	22.30	22.39			23.57	23.40	24.12	23.04	22.78
V	22.58	22.79	22.93	23.01	22.65	23.93	-			23.12	23.79
VI/VII		23.32	23.14	23.36	23.58	23.86			23.58	23.87	

attained by young voles from the spring generations and by old adults in the summer. Distinct increase in weight is observed in March: maximum weight is attained in June and July (Table 8). This table reveals the specially intensive development of individuals born in the spring. Individuals from the summer litters do not attain so great a weight. The difference between individuals of the same age (age group *III*) from the spring and late autumn generations may be as much as 10 g. This problem has been examined recently by S c h w a r z et al. (1964), who find that in animals from the autumn generations growth is stoped at the age of 1.5—2 months, and does not begin to increase again until the spring. The range of variation in this measurement in voles during the winter is, however, very considerable, for instance in age group *IV*, in February, in principle only individuals from the summer and early autumn occur, but not all of them exhibit a drop in body weght. The lightest individual

Table 8.
Variations in mean values of body weight from the seasonal and age aspects.

Month	I	II	III	IV	V	VI	VII	IX	X	XI	XII
II	10.8					15.6	16.7	16.2	13.4	13.3	12.1
III	11.9					22.1	16.6	17.6	15.0	13.8	14.1
IV	14.5	14.3	14.4	15.4				20.4	19.5	15.2	15.3
V	14.3	14.5	15.7	17.6	14.05					17.4	17.2
VI/VII		15.6	16.1	17.7	18.8	21.1	21.7		19.9	17.8	

Table 9.
Variations in mean values of height of brain-case measured between *bullae tympanici* from the seasonal and age aspects.

Month	I	II	III	IV	V	VI	VII	IX	X	XI	XII
III	6.8					7.3	7.1	7.2	7.3	7.0	7.0
IV	6.9	6.9	6.9	7.0			7.1	7.0	7.15	6.9	7.0
V	6.9	6.9	6.9	7.0	7.1					7.1	6.8
VI/VII		6.8	6.8	7.1	7.1	7.3	7.4	7.3	7.2	7.35	7.3

Table 10.
Variations in the height of the brain-case measured between *bullae tympanici* in individuals in age groups *IV* and *V* in different months.

Height of skull between bullae	5.2	6.3	6.4	6.5	6.6	6.7	6.8	6.9	7.0	7.1	7.2	7.3	7.4	7.9	n	Avg.
November					1	3	2	1	1		1	1		1	11	7.00
December						3	3	2	6	1	2	2			19	7.00
January			1	2		2	10	5	8	6	1				35	6.90
February					6	5	10	7	11	2	3	2			46	6.90
March	2			1	2	3	19	15	11	6	6	3	1		69	7.00
April						1		7	9	1	2	4			24	7.00
May					1					2	1	1			5	7.10

weighs 11.5 g and the heaviest 21.3 g, thus the difference can be as much as 10 g. In March in this same age group this difference had risen to 14.6 g (10.1 to 24.7 g). These data were chosen as examples, but of course cases such as these occur in each age group. All of the above goes to prove how greatly the course taken by the decrease, inhibition or increase of body weight may differ in different individuals.

The phenomenon of winter depression of the skull is weakly expressed in the bank vole. W a s i l e w s k i (1952) accentuates this in his study, but on account of the scanty winter material available he did not enlarge on this subject. The height of the brain-case measured between *bullae tympanici* exhibits considerable individual variation, fluctuations in this measurement in voles in age group *II* being: 6.6—7.6 mm (from the summer months). Analysis of variations in the height of the brain-case (combined groups *IV* and *V*) from November to May split into classes of size (Table 10) does not provide an explanation of this problem. The table was divided into two parts, taking 7 mm as the dividing line, as corresponding to the mean height attained by voles in age group *II*. In November 72.7% of the specimens are found to be below 7.1 mm, and this percentage increases in February to 84.8, then decreases. This state of affairs may to a certain extent be due to the entry into group *IV* in February of individuals born in the autumn, and therefore having a lesser heigth of brain-case, but this does not in any way alter the fact that in December and January the mean height decreases, and that in principle voles from the spring and summer generations are included in the composition of group *V* in these months. This is even more clearly evident in February and March in the case of voles in age groups *VI* and *VII* (Tables 9, 10). These differences are statistically significant.

The range of differences in measurements is considerable, being from 6.2 mm to 7.4 mm in March. Since from November to May we encounter a similar percentage of bank voles with high skulls it is possible that this process does not affect all the individuals. P u c e k (1963) makes several remarks on investigations not as yet published of the variations in weight of the brain in bank voles, from which it is clear that a drop in the weight of the brain is similar in character to fluctuations which do not take place every year. It is not unlikely that this is the explanation of the distribution of measurements between bullae, nevertheless it is only in the winter that old voles are encountered with skulls lower than the lowest of individuals in age groups *I*, *II* and *III*. In January voles with skulls lower than 6.6 mm form 8.6%, and in March 2 specimens were caught with skulls 6.2 mm in height! The solution of this problem therefore remains to be found.

The phenomenon of winter depression is more clearly visible in the capacity of the skull. A decided minimum is reached in February, and this level is maintained until March (Table 11). Nevertheless here as well we are concerned with individuals with considerable capacity of the brain-case (equal to the maximum for voles from the Wrocław population) throughout the whole winter period (Table 12). The differences are statistically significant.

Table 11.
Variations in mean values of capacity of the skull from the seasonal and age aspects.

Age group	Month										
	I	II	III	IV	V	VI	VII	IX	X	XI	XII
III	459					543	524	517	515	484	498
IV	484	474	473	505			542	507	535	487	493
V	476	473	486	491	479					478	501
VI/VII		479	472	503	505	532			496	502	

Table 12.
Variations in capacity of the skull in individuals in age groups *IV* and *V* in different months.

Month	<390	400	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	n	Avg.
November	1				1				1	2	1		2	1	2			11	484
December								2		5	4	4	2		1		2	20	495
January						1	2	5	3	9	2	2	7		3			34	482
February						2	6	6	11	10	1	3	1	3			1	44	474
March		2			3	4	5	5	10	9	12	7	4	2	1	2		66	482
April								2	1	2	5	2	7	2	1			22	499

The length of the sagittal sutures decreases in the autumn and winter months (Tables 13, 14). The mean values for February and March (groups *VI* and *VII*) are far smaller than the analogical ones for the summer and autumn months for young individuals. For instance, the mean length of this suture in voles in age group *II* in July is 3.89 mm, in September 3.86 mm, October 3.99 mm and November 3.85 mm. This measurement therefore exhibits a similar rate of development in different generations. Decrease in the length of the sagittal suture can be observed as early as

Table 13.
Variations in mean values of length of the sagittal suture from the seasonal and age aspects.

Age group	Month									
	I	II	III	IV	V	VI	VII	X	XI	XII
III	3.69						4.02	3.92	3.69	3.77
IV	3.67	3.48	3.68	3.79					3.65	3.69
V	3.43	3.53	3.74	3.75	3.65				3.65	
VI/VII		3.52	3.65	3.75	3.82	3.91		3.88	3.92	

Table 14.
Variations in length of the sagittal suture in individuals in age groups *IV* and *V* in different months.

Month	<2.83	3.09	3.35	3.61	3.87	4.13	4.39	4.52	n	Avg.
Nov.			2	5	2	3			12	3.65
Dec.			3	7	3	2	1	1	17	3.68
Jan.		2	6	12	6	8	1		35	3.60
Feb.	1	1	11	17	12	4	1		47	3.50
March		1	9	19	17	15	6	1	68	3.72
April			5	4	5	11	2		27	3.76

November (group *IV*), the minimum being reached in February. In individuals of group *V* the minimum length of this suture is reached in January (Table 13). It may be assumed that the process of reduction in length of the sagittal suture takes place slightly more rapidly in specimens from the autumn generation.

The mean value obtained for voles in age groups *IV* and *V* demonstrates the decrease in this measurement during the winter more clearly (Table 14). The fact of the occurrence in these groups from January to March of voles in which the length of the sagittal suture is smaller than the minimum values of the measurement in voles from 1—2 months old is remarkable. The minimum length of the sagittal suture in these individuals from June to October does not fall below 3.15 mm. It increases distinctly in March and attains its final dimensions in June. To a certain extent the range of variation of this measurement in different months is shown by table 14 (combined groups *IV* and *V*). From November to January individuals with suture length below 3.88 mm form from 75 % to 74.3 %, in February 89.4%, then in March form 67.7% and in April 51.9%.

Table 15.
Variations in the mean weight of the skull from the seasonal and age aspects.

Age group	Month										
	I	II	III	IV	V	VI	VII	IX	X	XI	XII
II	214					209	261	230	217	233	217
III	218					246	244	246		236	242
IV	252	261	234	236			275	288	290	261	255
V	261	260	250	246	228				238	259	275
VI/VII		277	267	256	255	256				258	

Table 16.
Variations in the weight of the skull in individuals in age groups *IV* and V in different months.

Month	<215	225	235	245	255	265	275	285	295	320	n	Avg.
Nov.				2	3	2	2	2			11	260
Dec.	1				5	8	2	2	1		19	259
Jan.		1	3	6	11	4	5	3	1		34	255
Febr.	2	2	3	3	11	8	9	2	2	3	45	261
March	5	7	8	19	10	6	7	2	2		66	244
April	4	1	2	5	5	2			1	2	22	244
May	2	1			1	1					5	228

It is not impossible that similar variations take place in the interparietale, since in the winter, in February and March, the breadth of this bone is observed to be slight in the oldest voles (3.29 mm), but this still needs to be confirmed.

The way in which the weight of the skull varies is interesting. Individuals from the earliest litters attain a high weight early (this weight in voles in age group *IV* fluctuating within limits of 280 mg from July to

October) which by far exceeds the highest mean values for the oldest individuals. Decrease in this weight in this group during the following months is undoubtedly due to a certain extent to the entry into this group of voles born in the autumn (Table 15). An analogical process is observed, however, in the oldest individuals, which on account of the qualitative composition (voles from the autumn) of the population during this period leads to the conclusion that the weight of the skull has decreased in specimens caught in the spring. The impression gained is that this process lasts as from March onwards up to May inclusive. From November to February individuals with skull weights below 266 mg (age group *IV* and *V*), form from 63% to 74% of this group, in March 83.3%, April 86.4% and in May 100% (Table 16). In specimens from the combined groups *VI* and *VII*, analogical participation is 33.4% for February, 40% for March, 65% for April and 69.3% for June. As the skull increases in length, breadth and height, while the weight of the skull decreases, it is probably a case here of a process reducing the thickness of the skull (or its demineralization?). On an average the weight of the skull decreases in individuals in age groups *IV* and *V* from February to May by 12.6%, and in groups *VI* and *VII* during the same period by 8.3%, but there are specimens with very high skull weights, e.g. exceeding 300 mg in April (Table 16). It is as yet impossible to interpret the phenomena described.

The measurements last discussed point to the existence of seasonal reduction, but only weakly expressed. This process intensifies, particularly in the final phase of the winter (February), and takes place in representatives of all generations, and thus animals in which age differences may be as much as 7—8 months. It would seem that the true course taken by all the processes described could be traced if a suitably large number of individuals were available, particularly from the spring and early-summer generations, and after analysing them exclusively within each particular generation, which, however, on account of the methodical difficulties discussed earlier on (estimation of age in the older groups) is a difficult task.

VI. SEX DIMORPHISM

Little attention has hitherto been devoted to this problem. Stein (1938) and Ognev (1950) find that it is impossible to demonstrate sex dimorphism in the bank vole. Wilusz (1952) gives enormous differences in the body weight of the two sexes, attaining maximum value in June. Sviridenko (1959) found that females grew bigger while still in the nest. Koschkina (1955) records seasonal differences in the rate of growth of body weight in the two sexes. Apart from Wilusz (1953), whose observations are difficult to accept uncritically on account of the incorrect segregation of his material, the results obtained by Stein (1938) and Koschkina (1955) must be taken as close to reality. My investigations show that sex dimorphism, faintly expressed in this species, is a seasonal phenomenon. The material was, however, too scanty to make a more comprehensive analysis possible. Body length in age groups exhibits a more or less even increase. Body weight increases more rapidly in males from age groups *IV* and *V*. In the case of females increased growth is evident in group *V*, which is undoubtedly connected with the preparation of the organism for reproductive functions (Fig. 5). It is par-

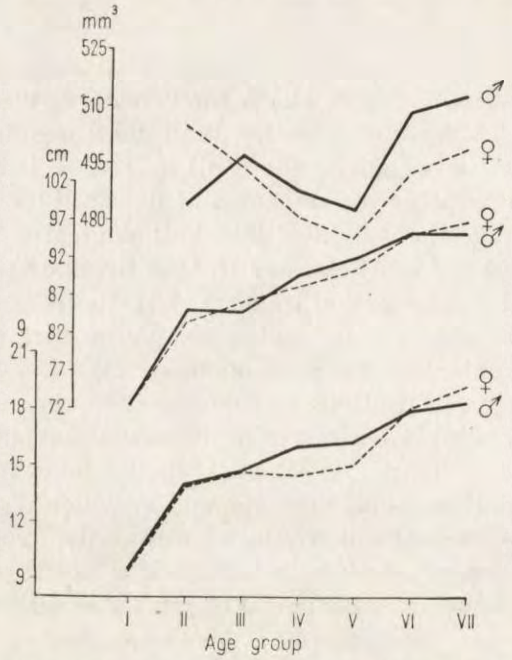

Fig. 5. Sex dimorphism in length and weight of body and capacity of the skull.

ticularly from the seasonal aspect that the difference in rate of weight increase and body length is distinctly evident (Tables 17, 18). From November to January the mean values are almost identical. In February the body weight of males increases rapidly, and in extreme cases (mean values) exceeds the body weight of females by 2.7 g. In May the females attain a higher body weight than males, which is due to females participating in reproduction being caught (weight calculated without embryos). Koschkina (1955) gives mean values from 2—4.5 g higher for males in May, and according to her females are not heavier than the males until July. It is possible that this is connected with the different times at which females participate in reproduction.

Sex dimorphism in dimensions of the skull is unusually difficult to grasp in the material discussed, and therefore I have given only differences in increase in both sexes of one measurement only — capacity of the skull (Fig. 5). Capacity of the skull in young females (age group *II*) is

Table 17.
Sex dimorphism in body weight.

Age group		Month						
		XI	XII	I	II	III	IV	V
III	♀	13.6	14.0					
	♂	13.9	14.2					
IV	♀	15.3	14.9	14.2	13.5	13.1	14.7	
	♂	15.1	15.7	14.7	15.0	16.5	16.2	
V	♀				13.8	14.8	15.7	
	♂				15.2	16.4	18.4	
VI	♀				14.4	14.6	15.7	19.6
	♂				16.9	15.2	17.9	17.7

Table 18.
Sex dimorphism in body length.

Age group		Month						
		XI	XII	I	II	III	IV	V
III	♀	84.0	86.0					
	♂	82.0	85.7					
IV	♀		87.2	88.6	88.4	86.3	90.1	
	♂		91.4	87.5	89.3	91.4	91.3	
V	♀				89.6	91.5	91.0	
	♂				89.3	92.6	95.1	
VI	♀					91.4	93.8	98.3
	♂					90.1	96.4	96.9

greater than that of males. As from the time that males attain the age of 2—4 months a more rapid increase in the capacity of the skull of males can be observed. The greatest differences were found in voles in age group *VI* (16 mm^3). W a s i l e w s k i (1952) describes a similar course of this process in voles from the Białowieża population.

VII. GENERAL REMARKS

Comparison of the Wrocław population of voles with the Białowieża material reveals the presence of several characters differing considerably from the corresponding characters in the other population. This applies chiefly to measurements of the length of the nasal bone, sagittal suture and palatal height. It must be emphasised that the data which I have given from age group *VII* are as a rule, as comparative material, higher than the mean values quoted from literature, since often young individuals, which had attained sexual maturity, were also used for calculating mean values. In the case of the nasal bone not only the mean value of its length but also extreme values are smaller than those given by Miller (1912) and Ognev (1950) for European and Asiatic subspecies. Only individuals from the subspecies *C. g. saianicus* Thomas (1911) exhibit a simliar nasal length.

In connection with the considerable differences in the mean values of certain measurement, the proportions of the skull of course differ in such cases from those given by Wasilewski (1952). In the first place the differences apply to the index $\frac{\text{length of diastem}}{\text{length of nasal bone}}$ and $\frac{\text{palatal height}}{\text{Cb.-length}}$ Apart from differences in the mean values of different indices (means calculated directly from the mean measurements of the characters taken into consideration) reaching in the case of age groups *VI* and *VII* 7.6 and in the youngest voles 15.1, the course taken by this process as the animals grow older is different (index $\frac{\text{diastem}}{\text{length of nasal bone}}$). The mean values of the index: $\frac{\text{palatal height}}{\text{Cb.-length}}$ are higher than those given from the Białowieża material, but the course taken by the process of variations in proportions is very similar. In the case of the remaining indices no divergences are observed (Tab. 19).

The problem of variation in the dimensions of the skull of voles from different geographical points has been examined by Rossolimo (1964). Analysis of the measurements chosen by her of adult individuals shows that bank voles allocated to separate subspecies *C. g. glareolus* Schreber, 1780, *C. g. istericus* Miller, 1909, *C. g. suesicus* Miller, 1900 do not differ morphologically from each other, which throws some doubt on the subspecies systematics in force at present, and is evidence of the considerable geographical uniformity of the species.

Measurements of the body are of lesser comparative value on account of the considerable influence of subjective treatment in making them,

Table 19.
Increase in the absolute values of certain skull indices.

Age group	I	II	III	IV	V	VI	VII
Diastema / Nasalia-length	107.2	105.7	101.0	103.6	103.2	103.5	104.5
Palatal depth / Cb.-length	27.8	26.8	26.6	26.3	26.2	25.9	26.3
Interorbital constriction / Cb.-length	18.7	17.6	17.5	17.0	16.8	16.6	16.5
Diastema / Cb.-length	27.4	27.4	27.3	27.6	27.7	27.9	28.2
Occipital breadth / Cb.-length	50.9	49.6	49.7	49.4	49.1	48.8	48.4
Nasalia-length / Cb.-length	25.9	26.1	27.1	26.6	26.9	27.0	27.0
Height of skull per bullae / Cb.-length	44.3	41.5	41.0	39.6	39.1	38.4	38.8

Table 20.
Ratio of tail length to body length (in %).

	Author	Population	%
1.	Haitlinger	Wrocław	48.8
2.	Zimmermann	Berlin	48.0
3.	Skuratowicz	Lublin Palatinate	46.5
4.	Zejda	Tatry Mtns.	46.3
5.	Zimmermann	Kurische Nahrung	46.0
6.	Zimmermann	Ostalpen	45.8
7.	Tatarinov	Ukrainian S.S.R.	45.8
8.	Ognev	Central part of U.S.S.R.	41.1

Attention should nevertheless be directed to the fact that voles from eastern areas are characterised by greater weight and body length (Ognev, 1950; Bolschakov & Schwarz, 1962) than those of individuals from Central Europe (Western Poland, West and South Germany). In the case of Central European voles the tails form a higher percentage of the body length than in the case with Eastern European voles

(Table 20). This also applies to voles caught in mountains (Zimmermann, 1938; Zejda, 1955). Prychodko (1951) in the case of voles from the mountains in the Königsee district, gives an average body length of 115 mm, from the Munich district 101.6 mm, and from Augsburg only 93.4 mm. At Białowieża individuals with body lengths exceeding 106 mm were not infrequently caught. The maximum length of a vole from the Wrocław population was 107 mm, but of 31 specimens with body lengths over 100 mm, length usually comes within limits of 101—102 mm. Voles from the Wrocław population are therefore far more similar to the Central German populations than to the Eastern Polish ones.

More extensive analysis of this problem continues to be impossible at present on account of the scanty comparative material at our disposal.

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ANALIZA MORFOLOGICZNA WROCŁAWSKIEJ POPULACJI *CLETHRIONOMYS GLAREOLUS* (S C H R E B E R, 1780)

Streszczenie

1. Przeprowadzono analizę morfologiczną 477 nornic zebranych we Wrocławiu w latach 1959—1963. Materiał został podzielony na 7 grup wiekowych według stopnia rozwoju korzeni zębowych (Tab. 1, Ryc. 1).

2. Zaobserwowano ograniczenie rozwoju populacji w okresie letnim, co zostało skompensowane wzmożonym rozrodem jesienią. Mioty miały miejsce prawdopodobnie w grudniu, o czym świadczyć może struktura wiekowa populacji ze stycznia. Nornice pozbawione korzeni zębowych stanowią w styczniu 1961 roku 27,8% populacji. Jednak całkowity brak samic ciężarnych i karmiących już od początku listopada, skłania ku wnioskowi, iż kształtowanie się korzeni zębowych u nornic urodzonych późną jesienią przebiega wolniej, niż u pochodzących z wcześniejszych miotów (Tab. 2).

3. Analiza struktury wiekowej materiału wrocławskiego wskazuje, że wzrost korzeni zębowych przebiega niejednakowo w różnych populacjach.

4. Przebieg rozwoju analizowanych pomiarów czaszki jest na ogół zgodny z opisywanym u tego gatunku. Jednak stwierdzenie odmiennego tempa rozwoju niektórych wymiarów czaszki (długość kości nosowej, wysokość podniebienna) jak i różnic w wartościach bezwzględnych tych pomiarów w porównaniu z nornicami z populacji białowieskiej, świadczy o ustalaniu się w pewnych przypadkach cech charakterystycznych wyłącznie dla określonej populacji (Tab. 3, 4; Ryc. 3, 4).

5. Nornice urodzone wiosną, latem i jesienią różnią się intensywnością wzrostu ciała i czaszki. Osobniki z generacji wiosennych i wczesnoletnich bardzo szybko osiągają duże wymiary, które w późniejszym okresie zwiększają się tylko nieznacznie. Nornice z generacji jesiennych rosną wolniej. Intensywny ich wzrost obserwuje się dopiero w kwietniu i w maju. W czerwcu osiągają ostateczne rozmiary (Tab. 5—16).

6. Sezonową redukcję pomiarów stwierdzono w wysokości puszki mózgowej mierzonej między *bullae tympanici*, na podstawach *bullae tympanici*, pojemności czaszki, długość szwu strzałkowego i ciężarze czaszki. Proces ten obejmuje nornice pochodzące z różnych generacji, lecz nie obserwuje się go u wszystkich osobników (Tab. 9—14).

7. Stwierdzono interesujący fakt obniżania się w okresie wiosennym ciężaru czaszki (Tab. 15, 16).

8. Dymorfizm płciowy słabo u tego gatunku zaznaczony jest zjawiskiem sezonowym, ograniczonym w badanej populacji do różnic w ciężarze ciała, długości ciała i pojemności czaszki (Tab. 17, 18; Ryc. 5).

9. Wrocławska populacja nornic bliższa jest populacjom środkowoniemieckim, niż wschodniopolskim. Różni się od nich mniejszymi rozmiarami i ciężarem ciała oraz stosunkiem długości ogona do długości ciała (Tab. 20).