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THE TAXONOMIC VALUE OF TEETH MEASUREMENTS IN THE SUBGENUS *SYLVAEMUS* OGNEV & VOROBIEV, 1923

TAKSONOMICZNA WARTOŚĆ POMIARÓW ZĘBÓW W PODRODZAJU *SYLVAEMUS* OGNEV & VOROBIEV, 1923

In view of the considerable difficulties in identifying skulls belonging to the subgenus *Sylvaemus* Ognev & Vorobiev, 1923, and in particular the remains of such skulls (rostral parts) taken from the pellets of owls and predatory birds, an attempt was made at finding teeth measurements which would make identification possible. The sagittal breadth of the upper incisors (I^1) increases with age and this makes it possible almost completely to distinguish the skulls of *A. tauricus* in the older age classes (III—V) from the other two species. It is impossible to distinguish *A. sylvaticus* from *A. microps* on the basis of this character. The breadth of the crown of M^1 and length of the maxillary tooth-row tend to decrease with increasing age of the animals. Relatively good effects are obtained by the use of these measurements, particularly of the ratio of the maxillary tooth-row length to the breadth of the crown of M^1, applied simultaneously.

Considerable difficulty is often encountered in taxonomic practice with regard to distinguishing between the skulls of mice of the subgenus *Sylvaemus* Ognev & Vorobiev, 1923 particularly those obtained from the pellets of owls and predatory birds, in which only the rostral parts are as a rule preserved. This difficulty increases in the case of identification of young specimens which differ very little morphologically. In practice it is simple to distinguish the skulls of *Apodemus agrarius* (Pallas, 1771) from the skulls of representatives of the subgenus *Sylvaemus* owing to the occurrence of marginal lineae on the *os frontale* in *A. agrarius* (Richter, 1961), even if the dental cusps are considerably worn.

According to Kowalski (1964) skulls of the subgenus *Apodemus* Kaup, 1829 have the two anterior alveoli of M^3 fused together, as distinct from the skulls of the subgenus *Sylvaemus*, which have three normally separate alveoli of teeth M^3. In view of the results obtained by Zejda (1965) this cannot be taken as a rule. This author examined the system of alveoli of the upper molar teeth in 4 species of the genus *Apodemus* and found different combinations of the alveolus system to occur in them, the system being common to all the above species to a lesser or greater degree. It would therefore seem that this character is of value as a supplementary aid to identification.

When comparing skulls of *Apodemus tauricus* (Pallas, 1811), *Apodemus sylvaticus* (Linnaeus, 1758) and *Apodemus microps* Kratochvil et Rosický, 1952, it is possible to descry certain differences in the shape of their diastem (cf. also Kahmann, 1953). It would however appear that this is not of great importance as a systematic character, especially as it exhibits considerable individual variation.

Measurements of certain teeth (I^1, M^1) used in the present study, would appear far more useful. Measurement of the maxillary tooth-row

length, relatively often referred to in literature (Ursin, 1956; Haitlinger, 1962; Zimmermann, 1962; Delany, 1964) would also seem to be of some value, but an analysis of its taxonomic usefulness has been made comparatively rarely (Kratochvil & Zejda, 1960; Amtmann, 1965). Ursin (1956) measured the maxillary tooth-row length and length of crowns of various molars in *A. sylvaticus* and *A. tauricus*, but did not give his opinion as to the taxonomic value of the character for distinguishing between the two species.

Table 1.

Comparison of measurements of teeth in *Sylvaemus*.

Measurement	Age class	Apodemus microps /n=32/			Apodemus sylvaticus /n=107/			Apodemus tauricus /n=125/		
		n	Min.-Max.	$\bar{x}$	n	Min.-Max.	$\bar{x}$	n	Min.-Max.	$\bar{x}$
Sagittal breadth of I^1	I.							30	0.80 - 1.20	0.97
	II.	8	0.85 - 1.05	0.99	30	0.75 - 1.20	0.98	30	1.00 - 1.30	1.13
	III.	7	1.00 - 1.10	1.05	30	1.00 - 1.20	1.06	30	1.20 - 1.75	1.47
	IV.	7	1.00 - 1.15	1.10	30	1.05 - 1.25	1.12	30	1.45 - 1.85	1.64
	V.	10	1.00 - 1.20	1.11	17	1.05 - 1.20	1.12	5	1.55 - 1.70	1.64
Breadth of crown of M^1	I.							30	1.15 - 1.40	1.26
	II.	8	0.90 - 1.05	1.00	30	1.00 - 1.20	1.12	30	1.15 - 1.35	1.26
	III.	7	1.00 - 1.05	1.04	30	1.05 - 1.20	1.12	30	1.20 - 1.40	1.30
	IV.	7	1.00 - 1.05	1.02	30	1.00 - 1.20	1.10	30	1.20 - 1.40	1.28
	V.	10	1.00 - 1.10	1.02	17	1.00 - 1.15	1.07	5	1.20 - 1.25	1.24
Maxillary tooth-row	I.							30	3.80 - 4.35	4.08
	II.	8	3.30 - 3.55	3.40	30	3.60 - 4.10	3.76	30	3.85 - 4.35	4.13
	III.	7	3.30 - 3.60	3.43	30	3.45 - 4.05	3.75	30	3.90 - 4.45	4.18
	IV.	7	3.20 - 3.45	3.34	30	3.40 - 3.85	3.63	30	3.85 - 4.50	4.13
	V.	10	3.15 - 3.55	3.32	17	3.40 - 3.95	3.64	4	3.85 - 4.25	4.01

In view of the foregoing a search was undertaken for measurements which would make it possible to distinguish between *A. tauricus*, *A. sylvaticus* and *A. microps* obtained from owl pellets. As the rostral parts of skulls are on the whole best preserved efforts were concentrated on an analysis of teeth measurements.

The material examined consisted of 107 skulls of *A. sylvaticus* from Wrocław, 125 skulls of *A. tauricus* from the Białowieża National Park and 67 skulls of the latter species from Wrocław, and also 32 skulls of *A. microps* from various parts of Poland (13 from the Wrocław district) and Czechoslovakia. Material was examined in five age groups, established on the basis of the degree of wear of the dental cusps. In the case of the specimens of *A. tauricus*, *A. sylvaticus* and *A. microps* from Wrocław only individuals in age groups II—V were available. Measurements were made by means of a vernier calipers with accuracy of 0.05 mm.

The following measurements of teeth were made:

1. Sagittal breadth of I^1, measured in the middle of the curve of the teeth,
2. Breadth at the crown of M^1 measured in its widest place,
3. Maxillary tooth-row length.

At first work was carried out on the material separately for the various age groups. The dimensions of the teeth increase with age in a barely perceptible way, only the sagittal breadth of I^1 exhibiting distinct growth. Measurements of the maxillary tooth-row length (cf. also H a i t l i n g e r, 1962) and breadth at the crown of M^1 have a tendency to decrease with the age of the animals (Table 1). As a result it proved to be only partly useful to keep to the division into age classes when distinguishing the different species.

Table 2.

Ranges of variation in teeth measurements in *Sylvaemus*.

Species	n	Sagittal breadth of upper incisors /I^1/ in mm.											
		0.75	0.85	0.95	1.05	1.15	1.25	1.35	1.45	1.55	1.65	1.75	1.85
A. microps	31		1		20	7	3						
A. sylvaticus	107	1	6	6	38	47	9						
A. tauricus	125		3	12	17	16	14	6	8	17	17	12	3
	n	Breadth of crown of M^1 in mm.											
		0.90	0.95	1.00	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	
A. microps	32	1		17	13	1							
A. sylvaticus	107			5	22	44	27	9					
A. tauricus	125						2	19	41	45	14	4	
	n	Maxillary tooth-row in mm.											
		3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5
A. microps	32	1	5	12	8	5	1									
A. sylvaticus	107				9	8	27	30	23	7	2	1				
A. tauricus	124								4	14	29	30	29	14	3	1

The values of measurements are given in Tables 1—2. In all cases the dimensions overlap each other to a greater or lesser degree and none of them individually enable the species of the subgenus *Sylvaemus* to be completely separated from each other. Measurement of the sagittal breadth of I^1 did not give a positive result and only permits of distinguishing the older specimens of *A. tauricus* from the other two species. Relatively the best results were obtained by measurements of the breadth of the crown of M^1 and maxillary tooth-row length together

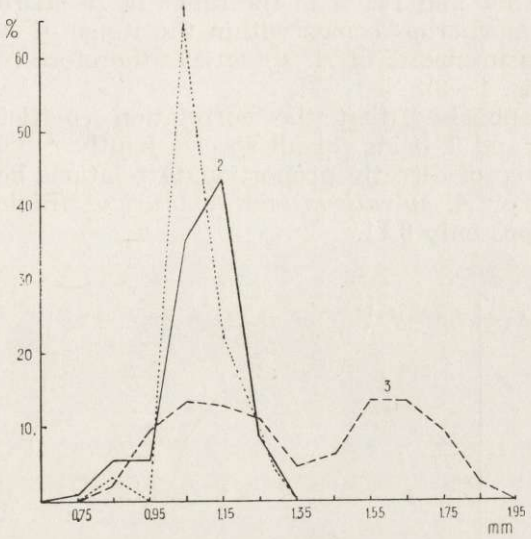

Fig. 1. Variations in sagittal breadth of upper incisors (I^1) in the subgenus *Sylvaemus*.
1 — *A. microps*, 2 — *A. sylvaticus*, 3 — *A. tauricus*.

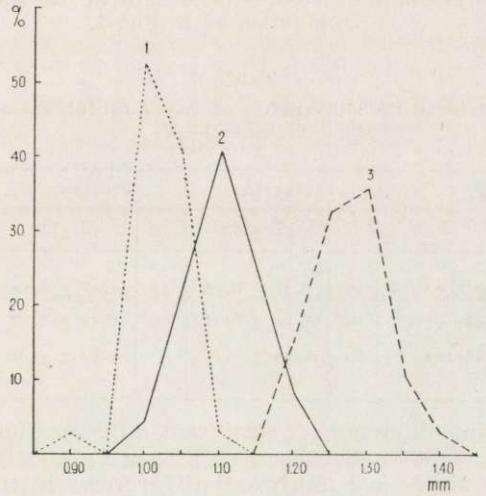

Fig. 2. Variations in breadth of crown of M^1 in the subgenus *Sylvaemus*.

(Fig. 4). The dividing line between *A. sylvaticus* and *A. tauricus* is clearly visible in this case, and this applies to a lesser degree to *A. sylvaticus* and *A. microps* also. The Wrocław series of *A. tauricus* is clearly distinguishable from the Białowieża specimens and to a lesser degree overlaps the range of variation of *A. sylvaticus* (respectively — 4.5% and 16.1%). Similarly, 13.1% of *A. sylvaticus* comes within the range of *A. tauricus* from Białowieża, but only 4.7% in the variation range of *A. tau-*

ricus from Wrocław and 14.0% in the range of *A. microps*. On the other hand 43.7% of *A. microps* comes within the range of *A. sylvaticus*. Absolute teeth measurements of *A. sylvaticus* therefore come between the other species (Fig. 1—3).

It must be emphasised that the correlation coefficient is high for measurements 2 and 3, being for all species jointly $r = 0.89$ which points to the high degree of directly proportionate relations between these two measurements. For *A. sylvaticus* and *A. tauricus* (Białowieża) it is 0.52 and for *A. microps* only 0.11.

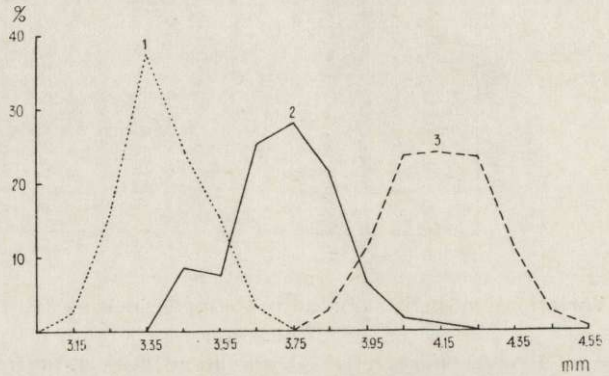

Fig. 3. Variations in maxillary tooth-row length in the subgenus *Sylvaemus*. Explanation as in Fig. 1.

Table 3.

Comparison of the teeth measurements of two populations of *A. tauricus* in age classes II—V.

Measurement	Białowieża		Wrocław		Difference[y]
	n	$\bar{x} \pm SD$	n	$\bar{x} \pm SD$	
Sagittal breadth of I^1	95	1.42 ± 0.28	67	1.47 ± 0.14	-
Breadth of crown of M^1	95	1.28 ± 0.10	67	1.29 ± 0.17	-
Maxillary tooth-row	94	4.14 ± 0.22	67	4.03 ± 0.22	+

[1]) — non-significant difference, + significant difference (in both cases $P = 0.05$).

In view of the above we analysed differences in maxillary tooth-row length and breadth of the crown of M^1 in two populations of *A. tauricus*, in age classes II—V, taking into consideration the possibility of geographical differences demonstrated in relation to the first measurement by Ursin (1956). It proved that the Wrocław specimens of *A. tauricus* have a shorter tooth-row (difference statistically significant) than the Białowieża mice. Differences in the breadth of the crown of M^1, however, were non-significant in the age classes compared (Table 3). This might suggest that the breadth of the crown of M^1 in *A. tauricus* does not exhibit such distinct geographical variation as the maxillary tooth-row

length. The shorter tooth-row in Wrocław specimens of *A. tauricus* did not have any important effect on the percentage of this species which overlaps the range of *A. sylvaticus* and proved to be lower than in *A. tauricus* from Białowieża, the higher percentage of overlapping of which depended on the participation of age class I animals, the tooth-rows of which were in the growth phase.

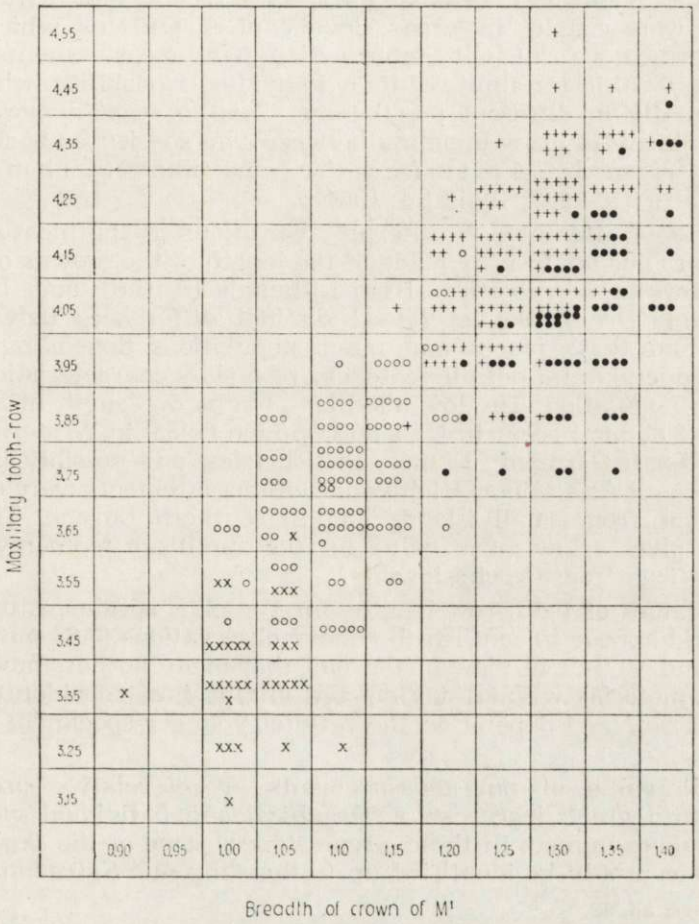

Fig. 4. Dependence of maxillary tooth-row on breadth of crown of M^1 in the subgenus *Sylvaemus*.
x — *A. microps* (Wrocław and Czechoslovakia), o — *A. sylvaticus* (Wrocław), • + — *A. tauricus* (Wrocław, • and Białowieża, +).

Amtmann (1965), in analysing the phenomenon of hybridisation between *A. tauricus* and *A. sylvaticus*, attributes great importance to measurement of the maxillary tooth-row length in addition to other body and skull measurements. He observed the most varied transitional forms, which could not be fully classified, in the populations from Ersdorf and Grosses Cent which he compared. The number of animals with transitional values of all the measurements analysed was, however, relatively

small. This author found by comparing populations of different West European mice of the genus *Apodemus* that the south-west populations of mice of the subgenus *Sylvaemus* exhibit a greater percentage of individuals with intermediate characters. Our material, taken from places significantly distant from each other, also contains specimens with intermediate teeth measurements. There are no specimens of *A. sylvaticus* in the Białowieża National Park, in Wrocław representatives of this species were caught in areas devoid of *A. tauricus*, which shows that the presence of forms with intermediate teeth measurements in both species comes within the limits of their individual variability, which may fluctuate greatly in different populations. This does not, however, rule out the possibility of cross-breeding between two species, as is shown by the results given by Amtmann (*l. c.*) and others (Kahmann & Bothschafter, 1963; Witte, 1964).

Ursin (1956) attempted to interpret variations in the measurements of tooth-rows. The analysis he made of the length of the crowns of molars and tooth-rows in *A. sylvaticus* from Lithuania (Antini) and Denmark (the Skaro and Drejo islands) reveal distinct differences between populations from these places and other populations depending on the degree of reduction of a definite category of molars characteristic in type of the given population. The low maxillary tooth-row length in *A. sylvaticus* (about 3.85 mm) occur in Ursin's opinion (1956) in Western Europe (Denmark, North Germany, France, British Isles) and possibly in south-east Europe and Asia Minor. High values of measurements were observed in populations from small islands and in southern Europe. The same author also gives a low mean value for the maxillary tooth-row length for *A. sylvaticus* from Czechoslovakia.

The low values of tooth-row lengths for Wrocław specimens of *A. sylvaticus* would appear to confirm the above observations (3.63 mm for age groups IV and V), but in view of the fact that many authors have elaborated their material without taking age groups into consideration, the mean values obtained depend on the ratio of younger specimens to older specimens.

Taxonomic value of our measurements are of relative usefulness, depending to a great degree on geographical and individual variability of the animals examined. In these circumstances some of the skulls taken from pellets can only be identified up to the subgenus *Sylvaemus*.

Note in proof added.

Similar results has been recently obtained by D. C. Fielding (J. Zool., Lond., *150*: 498—500, 1966), who used the relation between the maxillary tooth-row (from I to M^3) and antero-posterior length of upper incisors for distinguishing two British species of *Apodemus*.

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ADDITIONAL TRIANGLE ON M^2 IN *MICROTUS OECONOMUS* (PALLAS, 1776)

WIELOPĘTLOWOŚĆ ZĘBA M^2 U *MICROTUS OECONOMUS* (PALLAS, 1776)

The anomalies of teeth in microtines are not rare as indicated by the reports of many authors (Rörig & Börner, 1905; Ognev, 1950; Reichstein & Reise, 1965; Reichstein, 1966 and others). The most variable molars in *Microtidae* are M_1 and M^3 (Guthrie, 1965).

Reichstein & Reise (1965) were analysing the dentition of *Microtus agrestis* (Linnaeus, 1761) from north-west Germany and Denmark and found a variation in the structure of enamel angles in the teeth M^1, M^2 and M^3 of this species. An additional salient angle in M^1 was observed in 0.5 per cent of individuals of this species. This angle is somewhat characteristic for the *Microtus agrestis exul* Miller, 1908 (see Miller, 1912, p. 670). However, this additional angle has a tendency to disappear and different stages of this process can be followed on sufficiently large material of skulls of *M. agrestis*. In M^2 Reichstein & Reise (*l. c.*) found separate phases of the disappearance of the fourth salient angle. Consequently, this tooth has only 3 triangles of enamel and approaches the *arvalis* — type. Rörig & Börner (1905) reported that in some specimens of *Microtus arvalis* (Pallas, 1779) there is a tendency to form a fourth angle in M^2, similarly to *M. agrestis*. They also reported the occurrence of individuals *M. agrestis* with more or less advanced disappearance of the fourth salient angle in M^2.

Rörig & Börner (1905) stated that in *M. oeconomus* teeth M^1 and M^2 as well as M_2 and M_3 are only slightly variable and all the variants of their form are within the limits described for *M. arvalis*. Considerable stability of M^2 structure in *M. oeconomus* was also reported by Miller (1912) and Dehnel (1946).