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Research Article

A Study on Taxonomic Status of *Microtus subterraneus* (de Selys Longchamps, 1836) and *Microtus majori* Thomas, 1906 (Mammalia: Rodentia) in Turkey

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Abstract: Specimens collected from Veliköprüsü in Thrace (European Turkey), Akçaalan (Abant, Bolu), Akkuş, (Ordu), and Meryemana (Trabzon), which is the type locality of *M. majori*, were examined according to morphological, external, cranial, bacular, phallic and karyological characters. Specimens from Thrace were included in *Microtus subterraneus.* Populations of *M. subterraneus* in Thrace karyologically differ from those in Anatolia, the former having 2n = 52 chromosomes, NFa = 56, NF =60, and the latter 2n = 54 chromosomes, NFa = 56, NF = 60. The karyotype of *M. majori* at its type locality contains 2n = 54 chromosomes along with NFa = 56 and NF = 60. The tail length, phallus and karyological characters distinguish *M. subterraneus* from *M. majori.*

Key Words: *Microtus subterraneus, Microtus majori,* Karyology, Baculum, Phallus, Turkey.

Türkiye'deki *Microtus subterraneus* (de Selys Longchamps, 1836) ve *Microtus majori* Thomas, 1906 (Mammalia:Rodentia)'nın Taksonomik Durumu Üzerine Bir Çalışma

Özet: Akçaalan (Abant, Bolu), Akkuş (Ordu) ve *Microtus majori*'nin tip yeri olan Meryemana (Trabzon)'dan toplanan örnekler dış, kafatası, baculum, phallus ve karyolojik özelliklerine göre incelendi. Trakya örnekleri *Microtus subterraneus*'a dahil edildi. *M. subterraneus*'un Trakya populasyonları karyolojik olarak Anadolu populasyonlarından ayrılmaktadır ve Trakya örnekleri 2n = 52, NFa = 56 ve NF =60, Anadolu örnekleri ise 2n = 54, NFa = 56 ve NF = 60 karyolojik değerlerine sahiptir. *M. majori*'nin tip yerinde toplanan örnekleri 2n = 54, NFa = 56 ve NF = 60 değerlerine sahiptir. Kuyruk uzunluğu, phallus ve karyolojik özellikler *M. subterraneus*'u *M. majori*'den ayırmaktadır.

Anahtar Sözcükler: *Microtus subterraneus, Microtus majori,* Karyoloji, baculum, Phallus, Türkiye.

Introduction

Microtus subterraneus has been described from Belgium and *Microtus majori* from Trabzon (Turkey). *M. subterraneus* is distributed in Belgium, Holland, France, Germany, Switzerland, Italy, Czechoslavakia, Poland, Hungary, Yugoslavia, Rumania, Caucasia, Asia Minor and Iran, while *Microtus majori* is distributed in Cuacasia and Asia Minor (1, 2, 3). *M. majori* has been described in the Balkans, northern Greece and European Turkey (4, 5, 6, 7). Kıvanç (5) noted that *M. subterraneus* and *M. majori* are found in Soğuksu, Abant (Asiatic Turkey). Recently, Krystufek et al. (8) suggested that there is no reason to include *M. majori* in the list of European fauna, and therefore, the distribution of *M. majori* in Europe remains open. The aim of the present study is to study the taxonomy of voles from Europe and northern Turkey.

Materials and Methods

Twenty-six specimens were collected in four localities: Velikaköprüsü, Demirköy (Kırklareli) in European Turkey; Akçaalan, Abant (Bolu); Akkuş (Ordu); and Meryemana, Maçka (Trabzon) in northern Anatiola. They were examined with regard to morphological, cranial, phallic, bacular, biometric and karyological characters. Eleven specimens (Velikaköprüsü 4, Akçaalan 4, Akkuş 2 and Meryemana 1) were karyotyped in accordance with the technique of Ford and Hamerton (9). Twenty-five methaphase cells were examined from each animal karyotyped. Phalli and bacula were pepared according to Lidicker (10). Twenty-one measurements were taken from each skull, and they were evaulated as well as six external measurements taken in the field.

Results

Microtus subterraneus (de Selys Longchamps, 1836)

Type locality: Belgium

Habitat: *M. subterraneus* lives at the edges of mixed forest, dense brushes and meadows.

Distribution: See Fig. 1.

External characters: The fur on the dorsal aspect is light reddish brown. The demarcation line along the flanks is distinct. Underparts are whitish gray. The tail is bicolor, ventrally whitish brown and dorsally the same as the back. The ears are concealed by the hairs. The hind and forefeet are covered with whitish yellow hairs. The heels are naked. The soles have five pads. Females have four teats. There are marked color variations in *M. subterraneus.*

Cranial characters: The skull is short, broad and slender. The rostrum is bent forward. The interorbital region is long and considerably narrow. The braincase is broad, occipital bones laterally expanded. There is a recess behind the palatine bone (Fig. 2). M1 generally has 6 closed fileds, the first external and first internal triagles of teeth fused with commonfiled (Fig. 3).

Baculum: The baculum of *M. subterraneus* is shown in Fig. 4. It consists of two parts, a proximal bone and a distal part connected to the proximal bone. The proximal bone has a laterally expanded base and a tapered shaft. It measures 2.11mm (1.75-2.30mm) in length, 1.28mm (0.86-1.43mm) at the base and 0.30mm (0.24-3.7mm) at the tip. The distal part contains three cartilageous processes. We examined and compared the bacula of *M. subterraneus* from three localities, Velikaköprüsü, Akçaalan and Akkuş, and found considarable variation in the baculum of *M. subterraneus,* between adult and young specimens. The specimens from Velikaköprüsü have three different types of bacula. In adults, in two specimens, the base of the baculum is pointed laterally and basally, the shaft is basally expanded. In the others,

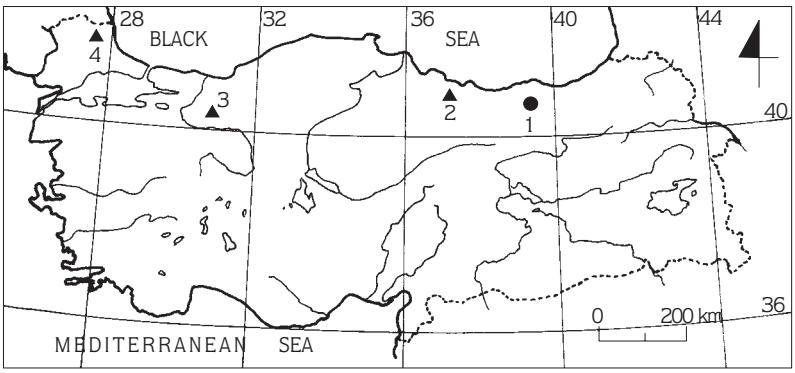

Figure 1. Showing map of distribution of *M. subterraneus* (▲) and *M. majori* (●). 1. Meryemana, 2. Akkuş, 3. Akçaalan, 4. Velikaköprüsü

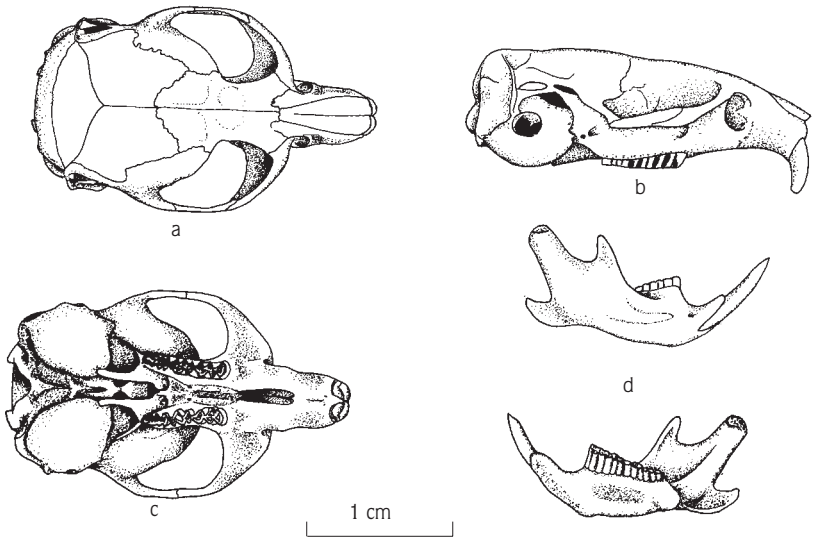

Figure 2. The skull of *M. subterraneus* from Velikaköprüsü a. Dorsally, b. Ventrally, c. Laterally, d. Mandible.

the base of the baculum is expanded and laterally and basally, the shaft is basally expanded. In the others, the base of the baculum is expanded and laterally recessed in the ventral view. In young specimens, the base is moderately expanded, with a marked concavity, and the shaft is tapered with a bulbous tip. Two bacula from Akçaalan and one from Akkuş were examined. The base is considerably expanded with a large recess, and the shaft is tapered with a lightly bulbous tip.

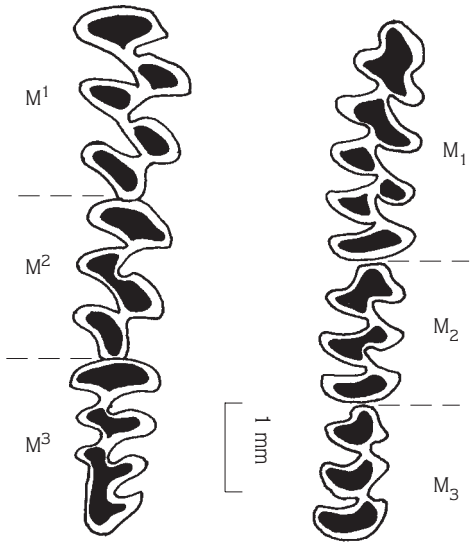

Figure 3. Cheekteeth of *M. subterrareus* from Velikaköprüsü A. Maxillary B. Mandibular

Glans penis: Specimens from Velikaköprüsü, Akçaalan and Akkuş showed an identical glans penis. The glans penis is naked. It measures 10mm in length and 2.3mm in width (Fig. 5).

Karyology: We have determined two different karyoypes belonging to *M. subterraneus,* one from Velikaköprüsü and the other from Akçaalan and Akkuş.

Specimens from Velikaköprüsü have a karyotype consisting of 2n = 52, NFa = 56, and NF = 60. The autosomes contain 22 pairs of acrocentrics, a large subtelocentric, a submetacentric and a small metacentric pair. The X chromosome is a medium-sized metacentric and the Y chromosome is a small metacentric (Fig. 6).

The specimens collected in Akçaalan and Akkuş showed identical karyotypes with values of 2n = 54, NFa = 56 and NF = 60. There are two subtelocentric pairs and a small metacentric pair and 23 pairs of acrocentrics in the autosomal set. The Y chromosome is a large metacentric and the Y chromosome is a medium-sized acrocentric (Fig. 7).

Microtus majori Thomas, 1906

Type locality: Meryemana, Trabzon, Turkey

Habitat: *M. majori* lives at the edge and inside of mixed forests.

Distribution: We found it only in the type locality (Fig. 1).

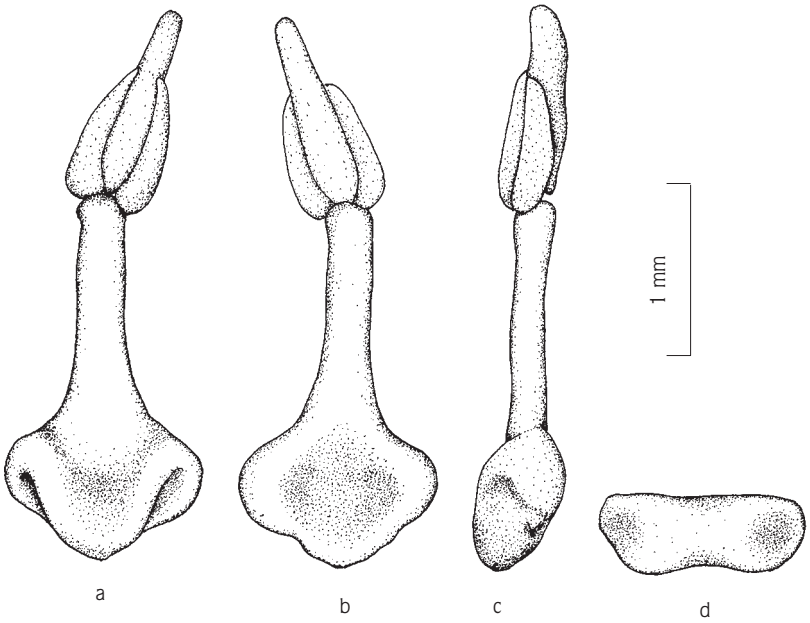

Figure 4. Baculum of *M. subterraneus* from Velikaköprüsü a. Dorsally, b. Ventrally, c. Laterally, d. Basally.

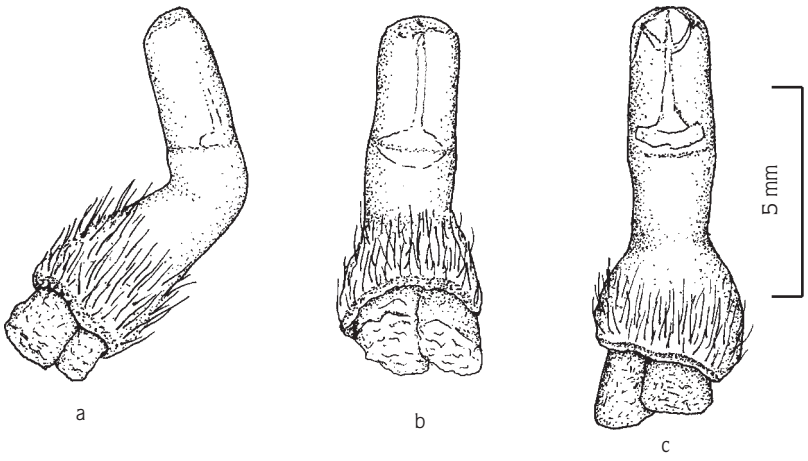

Figure 5. Glans penis of *M. subterraneus* from Akçaalan a. Laterally, b. Ventrally, c. Dorsally.

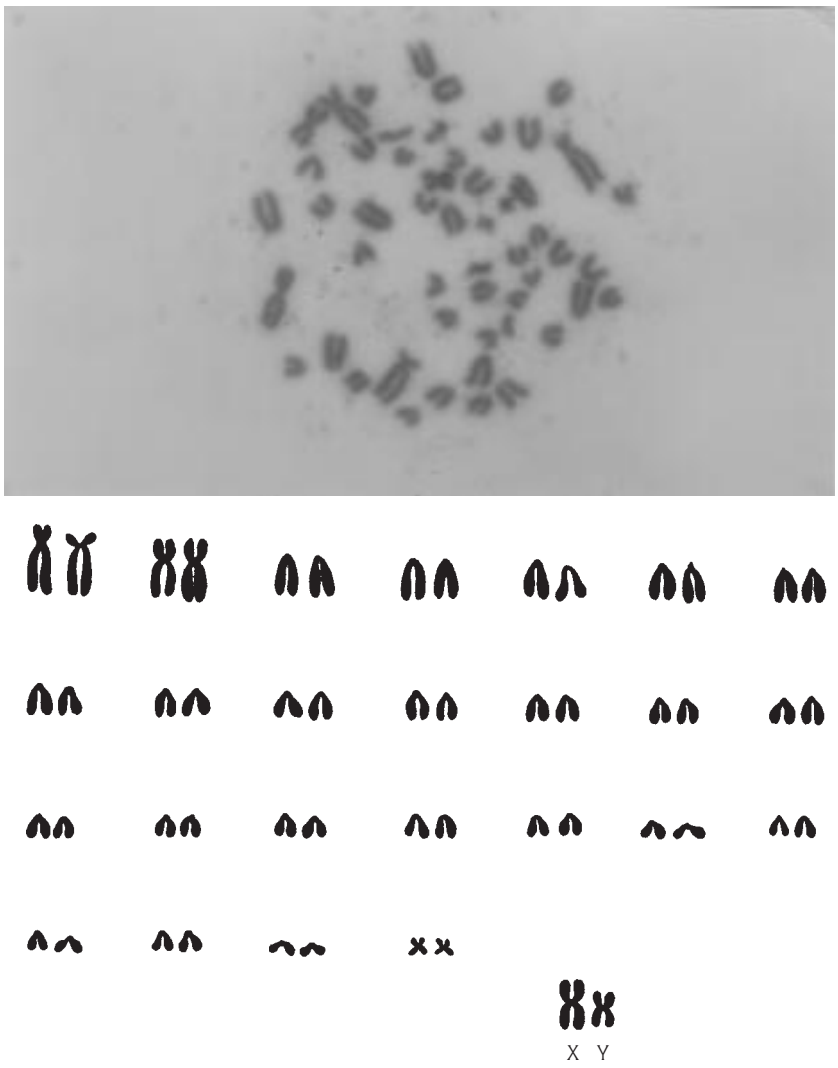

Figure 6. The karyotype of *M. subterraneus* from Velikaköprüsü 2n = 52, NFa = 56, NF = 60.

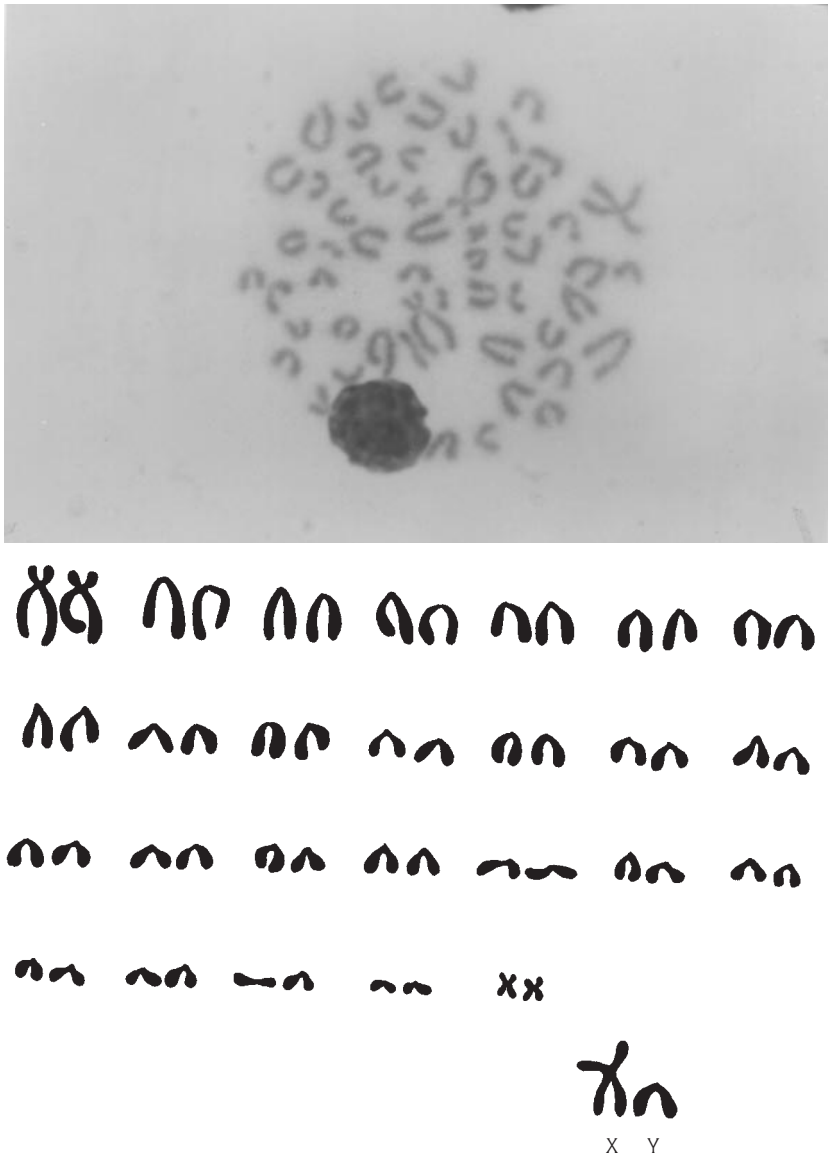

Figure 7. The karyotype of *M. subterraneus* from Akçaalan 2n = 54, NFa = 56, NF = 60.

External characters: The fur in the dorsal aspect is dark reddish brown. The demarcation line along the flanks is distinct. The belly is blackish gray with yellowish tinge, including a yellowish narrow line extending from the neck to the base of the tail. The tail is bicolor, ventrally yellowish gray and dorsally dark brown. The ears are relatively large. The hind and forefeet are dorsally covered with whitish yellow hairs, the heels are naked, and the soles have five pads. Females have four abdominal teats.

Cranial characters: The skull of *M. majori* is the same as in *M. subterraneus* (Fig. 8). Upper and lower teeth rows are shown in Fig. 9.

Baculum: The baculum of *M. majori* is similar to that of *M. subterraneus.* The base of the baculum is expanded, the shaft is slender and tapered. The bacula of two specimens from Meryemana were examined and there was be a considerable difference between adults and young, as in *M. subterraneus.* In adults, the base of the baculum is triangular. In young, the base is highly expanded, and the shaft is basally expanded. The baculum is 24.2mm (2.33-2.52mm) in length, 1.21mm (1.13-1.30 mm) across base, and 0.30mm (0.29-0.31mm) at the tip in width (Fig. 10).

Glans penis: There is a modarete notch at the tip of the glans penis. It measures 10mm in length and 2.5mm in width (Fig. 11).

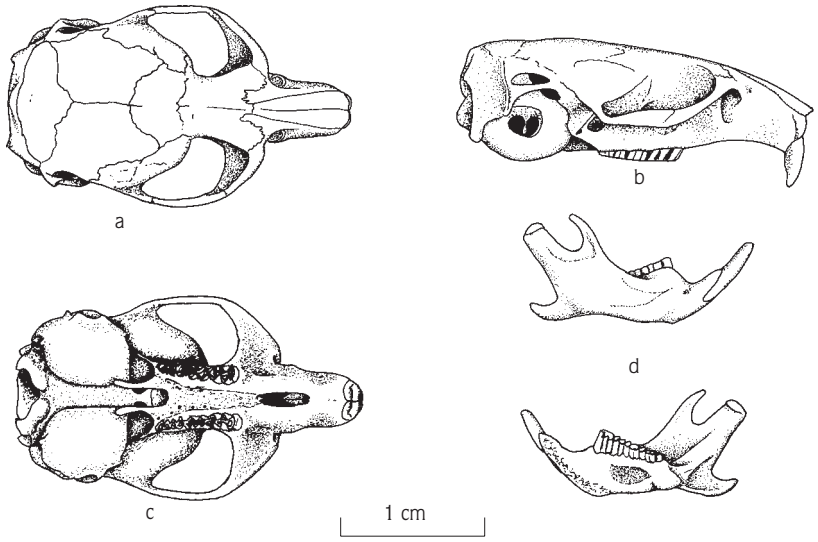

Figure 8. The skull of *M. majori* from Meryemana a. Dorsally, b. Ventrally, c. Laterally, d. Mandible.

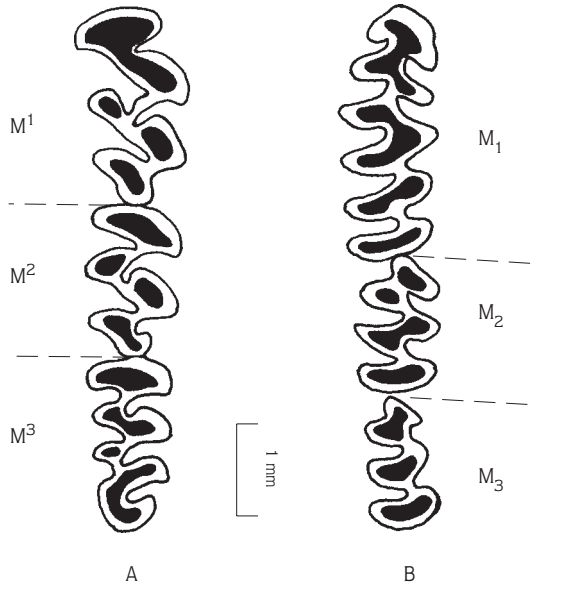

Figure 9. Cheekteeth of *M. majori* from Meryemana A. Maxilarry B. Mandibular.

Karyology: We karyotyped only a female from the type locality of *M. majori. M. majori* has 2n = 54, NFa = 56 and NF = 60. The autosomal set contains a large submetacentric and subtelocentric pair, and 24 pairs of acrocentrics. The X chromosome is a medium-sized subtelocentric (Fig. 12).

Discussion

We examined and compared three populations of *M. subterraneus* and one population of *M. majori,* finding marked differences between specimens from European Turkey and those from Anatolia of *M. subterraneus.* Specimens From European Turkey have a small recess behind the palatal bone, those from Akçaalan and Akkuş. The fur on the dorsal aspect of specimens from European Turkey is darker than that of specimens from Anatolia. Specimens from European Turkey have 2n = 52 chromosomes, whereas there are 2n = 54 in specimens from Anatolia. The Y chromosome is metacentric in European Turkey and acrocentric in Anatolia. This showed that specimens of *M. subterraneus* in European Turkey differ from those in Anatolia. However, a specimen series is needed in order to resolve the taxonomic status of Anatolian and European Turkish *subterraneus.*

M. majori has a dark reddish brown dorsal coloration which is different from the light reddish brown dorsal coloration of *M. subterraneus.* The tail is longer than that in *M. subterraneus* (Table 1 and 2). *M. majori* has 2n = 54 chromosomes, whereas *M. subterraneus* has 2n = 52/54 chromosomes. The X chromosome is subtelocentric in *M. majori,* and metacentric or acrocentric in *M. subterraneus.* The glans penis of *M. majori* differs from that of *M. subterraneus.* These findings show that *M. majori* and *M. subterraneus* are two valid taxa.

Thomas (11), Ognev (12), Ondrias (13), Niethammer (14) and Storch (15) suggested that *M. subterraneus* and *M. majori* have, as a diagnostic character, 4 and 6 teats, respectively. We examined three females of *M. subterraneus* and one female of *M. majori* and found four teats in both species. This shows that the teat number is not a diagnostic character for two species, as noted by

Table 1. External and crainal measurements of *M. subterraneus*

	Demirköy (n=10)	Abant (n=6)	Akkuş (n=4)
	(126.5)	(128.75)	(115.75)
Total length	122 - 132	126 - 132	105 - 120
	(96.42)	(86.5)	(96.25)
Head and Body	89 - 107	76 - 90	95 - 98
	(30.5)	(32.5)	(29.25)
Tail	28 - 35	30 - 34	29 - 30
	(30.28)	(33.5)	(33.20)
Relative tail length	28 - 39	31 -38	31 - 36
	(16.85)	(17.40)	(16.0)
Hind foot	16 - 17	16 - 19	15 - 17
	(10.71)	(10.20)	(11.75)
Ear	10 - 11	11 - 12	11 - 12
	(20.28)	(21.20)	(13.5)
Weight (g)	18 - 22	18 - 26	12 - 16
	(13.93)	(13.3)	(13.15)
Zygomatic breadth	13.5 - 14.3	13.3 - 14.02	12.5 - 13.8
	(22.63)	(22.40)	(21.47)
Condylobasal length	22.4 - 23.1	21.5 - 23.3	20.6 - 22.5
	(3.08)	(3.82)	(3.57)
Interorbital constriction	3.7 - 3.9	3.6 - 4.0	3.4 - 3.7
	(20.93)	(21.06)	(20.25)
Basilar length	20.2 - 21.9	20.3 - 21.4	19.9 - 20.8
	(11.40)	(11.20)	(10.92)
Occipital width	11.2 - 11.9	1.7 - 11.6	10.6 - 10.9
	(23.46)	(23.54)	(22.45)
Skull length	22.2 - 24.2	22.5 - 24.2	21.5 - 23.4
	(8.03)	(8.14)	(7.65)
Height of braincase	7.8 - 8.3	7.8 - 9	7.5 - 7.9
	(10.83)	(10.7)	(10.2)
Braincase breadth	10.3 - 11.3	10.4 -11.0	9.7 - 11.5
	(7.06)	(7.08)	(6.62)
Diastema	6.7 - 7.4	6.8 - 7.2	6.1 - 6.3
	(6.33)	(6.7)	(6.17)
Nasal length	6.0 - 6.7	6.4 - 7.1	5.8 - 6.7
	(2.82)	(2.76)	(2.5)
Nasal width	2.6 - 3.1	2.5 - 3.3	2.5 - 2.6
	(6.45)	(6.36)	(5.97)
Tympanic bulla	6.1 - 6.8	5.8 - 7	5.7 - 6.4
	(13.38)	(13.22)	(12.66)
Length of facial region	12.9 - 14.7	12.6 - 13.7	11.9 - 13.2
	(9.63)	(9.36)	(9.0)
Length of braincase	9.2 - 10.3	8.8 - 9.8	8.5 - 9.7
	(4.10)	(4.16)	(4.01)
Foramen insisiva	4.08 - 4.34	3.77 - 4.32	3.72 - 4.10
	(8.35)	(7.66)	(7.6)
Mastoid width	8.1 - 8.7	7.3 - 8.2	7.5 - 7.9
	(6.28)	(5.88)	(5.65)
Rostral height	6.0 - 6.8	5.6 - 6.1	5.5 - 5.7
	(7.7)	(7.5)	(7.3)
Rostral height (M2)	7.4 - 8.1	7.3 - 7.7	7.0 - 7.3
	(14.76)	(14.46)	(14.4)
Mandible	14.1 - 15.8	13.9 - 15	13.7 - 16
	(5.65)	(5.56)	(5.37)
Upper toothrow	5.3 - 6.3	5.3 - 5.9	5.2 - 5.6
	(5.86)	(9.82)	(5.32)
Lower toothrow	5.6 - 6.3	5.7 - 5.88	5.3 - 5.5

Characters (mm)	n	(Mean	Range	± SD
Total length	6	132	128 - 147	7.04
Head and Body	6	95	87 - 105	6.72
Tail	6	41.0	40 - 42	1
Relative tail length	6	43	40 - 47	3.0
Hind foot	6	17.6	17 - 18	0.54
Ear	6	11.6	11 - 12	0.54
Weight (g)	6	18.20	15 - 24	3.56
Zygomatic breadth	6	13.77	13.2 - 14.5	0.56
Condylobasal length	6	22.90	22.1 - 23.9	0.76
Interorbital constriction	6	3.72	3.4 - 4.1	0.33
Basilar length	6	21.20	20.9 - 21.7	0.38
Occipital width	6	11.52	11.2 - 11.8	0.25
Skull length	6	23.85	22.7 - 24.7	0.82
Height of braincase	6	8.15	7.9 - 8.3	0.17
Braincase breadth	6	10.37	9.9 - 11	0.51
Diastema	6	7.17	7 - 7.4	0.20
Nasal length	6	6.92	6.10 - 7.4	0.57
Nasal width	6	2.67	2.6 - 2.8	0.09
Tympanic bulla	5	6.7	6.4 - 7	0.25
Length of facial region	5	13.12	12.7 - 14	0.59
Length of braincase	5	9.72	9.0 - 10.2	0.52
Foramen insisiva	5	4.17	4.02 - 4.36	0.58
Mastoid width	5	7.97	7.7 - 8.3	0.32
Rostral height	5	6.05	5.8 - 6.1	0.20
Rostral height (M2)	5	7.45	7.4 - 7.6	0.10
Mandible	6	14.50	13.7 - 15.3	0.65
Upper toothrow	6	5.02	5.62 - 5.99	0.18
Lower toothrow	6	5.68	5.32 - 5.99	0.27

Table 2. External and cranial measurements of *M. majori* in the type locality.

Krystufek et al. (8). We compared external and cranial measurements of *M. subterraneus* and *M. majori* with those given by Thomas (11) for the type of *M. majori,* Ognev (12) for *M. majori* in Caucasia, Ondrias (13) for *M. subterraneus* in Greece, Niethammer (14) for *M. subterranues* and Storch (15) for *M. majori.* The tail length (29-39 mm) given by Ondrios (13) for *M. subterraneus* is near that in *M. subterraneus* in Turkey (Table 1). Head and body (81-96mm), tail length (28-41mm) and hind foot (14-16mm)measurements in the present study those taken (Table 1). This difference in measurements of *M. majori* may distance and differences in measuring techniques.

We compared the bacula of *M. subterraneus* from three locilities (Velikaköprüsü, Akçaalan and Akkuş) with those described by Niethammer (14) for *M. subterraneus* and *M. tatricus.* The bacula of adult specimens from European Turkey seem to be similar to that of *M. tatricus* rather than that of *M. subterraneus* in Niethammer (14). It is not possible for *M. tatricus* to be among specimens collected in European Turkey because the specimens examined in this study have 2n = 52 chromosomes, whereas *M. tatricus* has 2n = 32 chromosomes. The

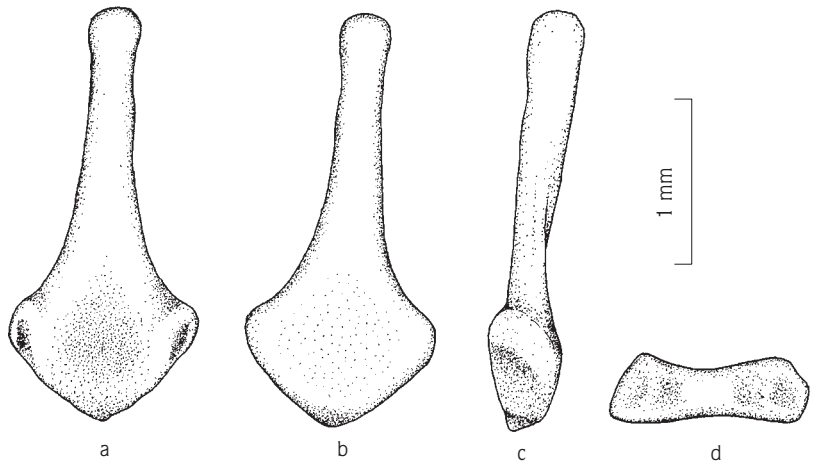

Figure 10. Baculum of *M. majori* from Meryemana a. Ventrally, b. Dorsally, c. Laterally, d. Basally.

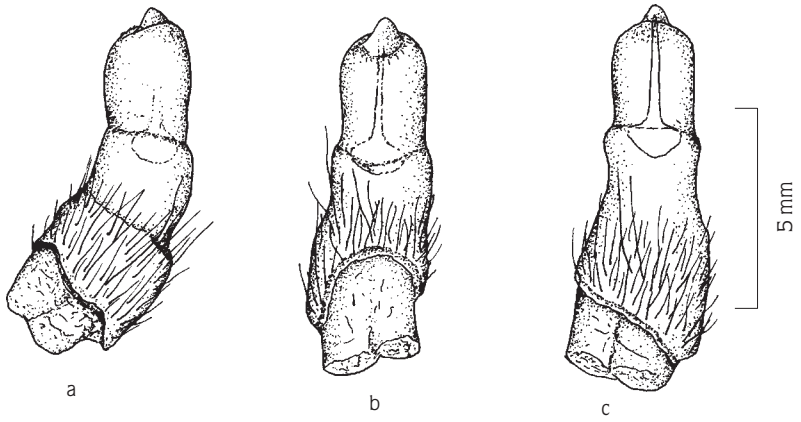

Figure 11. Glans penis of *M. majori* from Meryemana a. Laterally, b. Ventrally, c. Dorsally.

baculum and glans penis of *M. majori* from the type locality are similar to those described by Ognev (12) for specimens of *M. majori* from Asia Minor and Transcaucasia, respectively.

The karyotype of *M. subterraneus* was described as 2n = 52 - 54, NFa = 54-58 and NF = 58-62 in Europe (14, 16, 17), southern Bulgaria (18) and Slovenia (8) and all the karyotypes have the standard X and Y chromosome. Kral and Mitev (18) noted another medium-sized submetacentric, apart from the three pairs of biarmed autosomes in the Pirin mountains, which is absent in the specimens karyotyped from Turkey. In contrast, we found the metacentric Y chromosome in specimens from European Turkey but not in specimens from Anatolia, which showed the standard X and Y chromosome.

The karyotype of *M. majori* from Caucasia has been described (16, 17), displaying 2n = 54 chromosomes, NFa = 56, NF = 60. The autosomes contain the largest two pairs of chromosomes as well as 24 pairs of acrocentrics, while the X chromosome is metacentric among the largest chromosomes, which is different from the medium-sized subtelocentric X chromosome of *M. majori* from its type locality.

M. majori has been recorded by Kıvanç (5) from European Turkey and Niethammer (6) from northern Greece. We examined and compared specimens from European Turkey and evaluated these specimens as *M. subterraneus.* This finding is consistent with the result of Krystufek et al. (8). Kıvanç (5) collected specimens of both *M. majori* and *M. subterraneus* from Soğuksu (Abant), with an additional locality, Akçaalan for *M. subterraneus.* We were not able to find any specimens

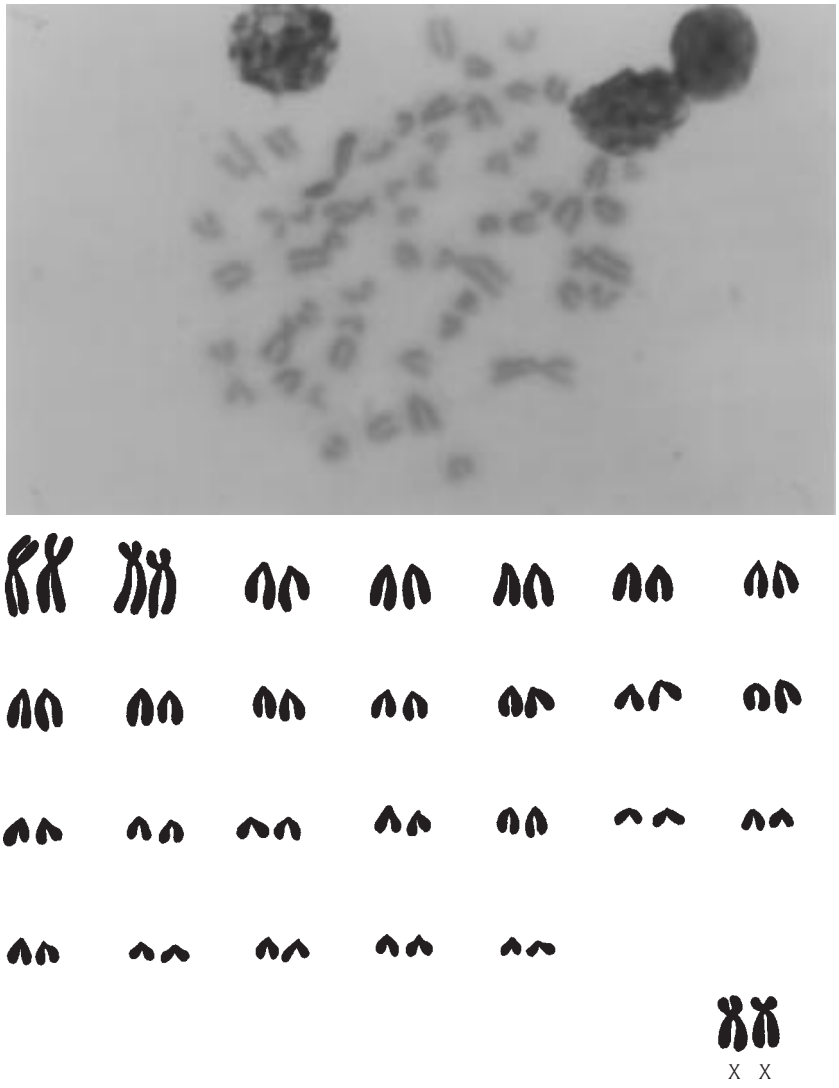

Figure 12. The karyotype of *M. majori* from Meryemana 2n = 54, NFa = 56, NF = 60.

from Soğuksu, but recorded specimens of *M. subterraneus* from Akçaalan. Thus it is evident that *M. subterraneus* and *M. majori* are not in sympatry in Abant (Bolu).

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