International Journal of Natural and Engineering Sciences 3(3): 103-110, 2009
ISSN: 1307-1149, www.nobel.gen.tr

Biology and Ecology of the Species of the Genus *Microtus* (Schrank, 1798) in Kırıkkale Province (Mammalia: Rodentia)

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Received: July 03, 2009
Accepted: August 12, 2009

ABSTRACT

This study is based on 94 specimens belonging to two species of the genus *Microtus* collected from the Kırıkkale province between 2001 and 2003. The specimens were obtained by kill and live traps. Some features concerning habitat, pelage colour, feeding, breeding, hair morphology, skull, baculum and karyology of the species were recorded for finding out their ecological and biological aspects. 17 animals were fed with some seeds and fruits in a glass cage at the laboratory to observe their feeding behaviours and carry out karyological analyses. Informations on their feeding and reproduction were recorded both in the field and laboratory. It has been determined that two species of the genus *Microtus* live in the Kırıkkale province, *Microtus guentheri* and *Microtus levis* . Pregnant individuals of *Microtus guentheri* were encountered in April, June, July and September. It was determined that the diploid number of *Microtus guentheri* and *Microtus levis* is 54. The fundamental number, is 54 and the number of autosomal arms, is 52 in both species.

Key Words: *Microtus guentheri, Microtus levis,* Ecology, Biology, Kırıkkale, Turkey.

INTRODUCTION

Some records concerning the genus *Microtus* were given in Turkey [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15].

Corbet [11] included 5 species, *Microtus socialis, Microtus arvalis, Microtus roberti, Microtus gud, Microtus nivalis* in to the genus *Microtus* in Turkey. Then Wilson. *et al.* [16] also included 9 species, *Microtus as Microtus anatolicus, Microtus arvalis, Microtus daghestanicus, Microtus dogramacii, Microtus guentheri, Microtus levis, Microtus majori, Microtus socialis, Microtus subterraneus,* in to the same genus, in Turkey.

The purpose of this study is to determine some biological, ecological and karyological characteristics of the species of *Microtus* existing in the Kırıkkale province.

MATERIAL and METHODS

This study based on 94 specimens belong to genus *Microtus* obtained between September 2001 and August 2003 in the Kırıkkale province. 17 animals were fed in laboratory, for feeding behaviour and karyotype, 94 specimens were prepared as conventional museum type according to Mursaloğlu [17].

In addition to weight and four standart measurements, 15 cranial and dental measurements were taken from each specimens by using vernier caliper. The measurements are: total length, length of head and body, length of tail, length of hind foot length, length of ear, occipitonasal length, condylobasal length, basilar length, palatal length, length of palatal foramina, nasal breadth, nasal length, zygomatic breadth, interorbital breadth, breadth of braincase, height of skull, length of diastema, length of maxillary toothrow length of mandibular toothrow, length of mandible, weight (g).

The specimens were divided into three age groups as infant, juvenile and adult based on degree of tooth wear, clearence of sagittal and lambdoidal crests, fur colour and field notes. Statistically significant differences between females and males were tested for according to parker [18]. Since no differences was detected between the mail and female, both groups were evaluated together in tables. Diagnostic characters, habitat, feeding and reproduction features, karyotype and fur colour of species were recorded. No statistically significant between sexes was found. For the comparision and evaluation, only adult specimens were used.

Definitions of fur colour were made according to Ridgway [19], bacula were prepared according to Lidicker [20] and karyologic analyses was prepared according to Patton [21]. The guard hairs were taken from the shoulder blades dorsally and prepared according to Hayat [22].

The specimens were deposited at the University of Kırıkkale, Faculty of Science and Art Department of Biology.

RESULTS

Two species of the genus *Microtus Microtus guentheri* and *Microtus levis* were found in Kırıkkale Province.

Microtus guentheri (Danford and Alston, 1880) Levant Vole

1880. *Arvicola guentheri* Danford and Alston, Proc. Zool. Soc. 62-63.

Type locality: Kahramanmaraş, Turkey

1936. *Microtus guentheri* Neuhäuser, Zeith. Säuget. 11:199-201.

Diagnostic characters: Fur colour is yellowish brown in dorsal part and smoky gray in ventral part. Five plantar tubercles of hind feet are present. Tail lenght is about % 21-36 of head and body lenght, tail length 27.0-44.0, skull height 10.6–13.0, occipitonasal length 27.0–31.37 mm. Dorsally the sides of the interorbital region is concave towards median line. There is a slight hallowness through the median line of the interorbital region (Figure 1). Bacula lenght is 2.23-3.20, at proximal width 0.76-1.66, at distal width 0.26-0.53 mm (Figure 2).

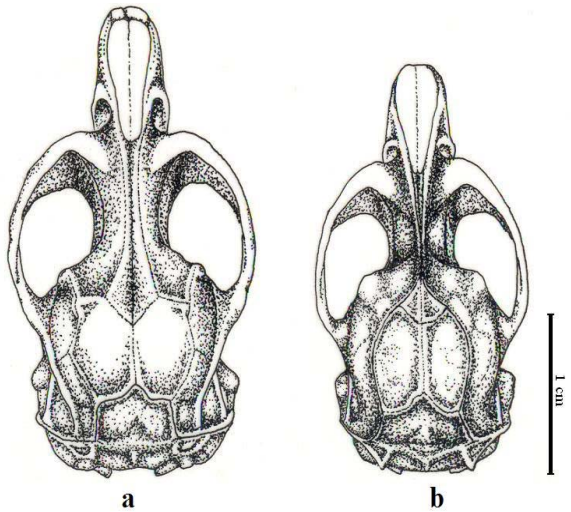

Figure 1. Skulls of *Microtus guentheri* (a) and *Microtus levis* (b).

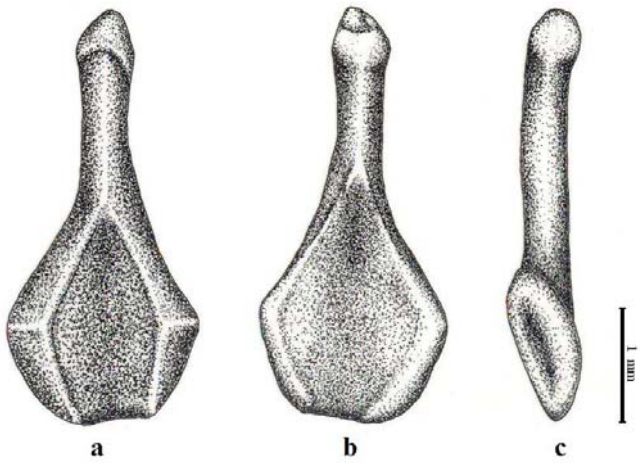

Figure 2. The shape of baculum of *Microtus guentheri*; dorsal view (a), ventral view (b) and lateral view (c)

Measurements: Statistical data of adult males and females of *Microtus guentheri* are given in Table 1.

Table 1. Statistical data of weight (g), external and cranial measurements (mm) of adult *Microtus guentheri* (n: number of individuals, r: range, m: mean and ±Sd: standard deviation)

Measurements	n	r	m	±Sd
Total length	59	134-167	150	7.5429
Length of head and body	59	105-133	117.2034	6.8601
Length of tail	59	27-44	32.8135	4.1625
Length of hind foot	59	18-31	21.3389	1.7080
Length of ear	58	11-15	12.4827	1.2029
Occipitonasal length	46	27-31.37	29.0502	1.0920
Condylobasal length	46	26.4-31.05	28.5441	1.1357
Basilar length	46	23.5-27.82	25.4376	1.0864
Palatal length	62	11.78-16	14.3462	0.7276
Length of palatal foramina	62	4.23-5.74	4.8859	0.3051
Nasal breadth	64	2.95-3.9	3.3854	0.1946
Nasal length	63	7.4-9.4	8.2353	0.4773
Zygomatic breadth	54	15.28-19.7	17.085	0.9551
Interorbital breadth	58	3.48-4	3.7468	0.1168
Breadth of braincase	50	5.6-13.55	9.1808	3.0727
Height of skull	44	10.6-12.40	11.4818	0.4248
Length of diastema	62	7.5-9.4	8.3875	0.4193
Length of maxillary toothrow	63	5.54-7.3	6.5257	0.3380
Length of mandibular toothrow	64	5.8-7.46	6.5296	0.3471
Length of mandible	62	13.44-19.23	17.2706	1.0739
Weight	59	32-71	49.4889	8.6519

Specimens examined (83) and localities: Bahşılı, 3 (2 ♂♂, 18 July 2003; 1 ♂, 23 July 2003); Balışeyh, Kulaksız, 2 (2 ♂♂, 11 July 2003); Balışeyh, 2 (2 ♀♀, 15 September 2003); Çelebi, 5 (5 ♂♂, 21 July 2003); Delice, Tatlıcak village, 7 (1 ♂, 27 April 2003; 6 ♂♂, 28 April 2003); Delice River, 9 (3 ♂♂, 15 July 2003; 3 ♂♂, 1 ♀, 19 August 2003; 1 ♂, 20 August 2003; 1 ♂, 25 August 2003); Çömelekkaya, 1 (1 ♂, 30 September 2003); Karakeçili, 5 (4 ♂♂, 4 June 2003; 1 ♂, 5 June 2003); Karakeçili, 1 (1 ♀, 5 June 2003); Keskin, Cankurtaran village, 5 (2 ♂♂, 3 ♀♀, 18 September 2003); Merkez, Hasandede, 1 (1 ?, 18 September 2003); Sulakyurt, 3 (1 ♂, 1 ♀, 15 September 2003, 1 ♂, 17 September 2003), Faraşlı village, 3 (1 ♂, 2 ♀♀, 30 September 2003); Yahşihan, Kırıkkale University campus, 36 (1 ♂, 4 ♀♀, 24 January 2001; 1 ♂, 30 January 2001; 3 ♂♂, 1 ♀, 6 February 2003; 1 ♂, 2 ♀♀, 7 February 2001; 2 ♂♂, 2 ♀♀, 9 February 2001; 1 ♂, 3 ♀♀, 14 February 2001; 2 ♀♀, 28 February 2001; 1 ♀, 14 Mart 2001; 1 ♂, 1 ♀, 5 April 2001; 1 ♀, 18 April 2001; 1 ♀, 26 April 2001; 1 ♂, 23 May 2001; 1 ♂, 2 July 2002; 1 ♂, 18 February 2002; 1 ♂, 1 ?, 26 February 2003; 1 ♂, 2 May 2003; 2 ♂♂, 5 May 2003).

Tooth structure: M^3 has three salient angles internally and externally in all samples (Figure 3).

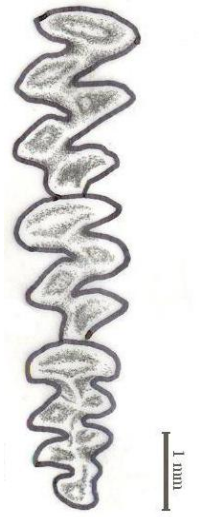

Figure 3. Maxillary toothrow of *Microtus guentheri*.

Hair morphology: The base part of guard hairs is "chevron" type, shaft and tip parts of guard hairs are "annular" type on *Microtus guentheri* (Figure 4).

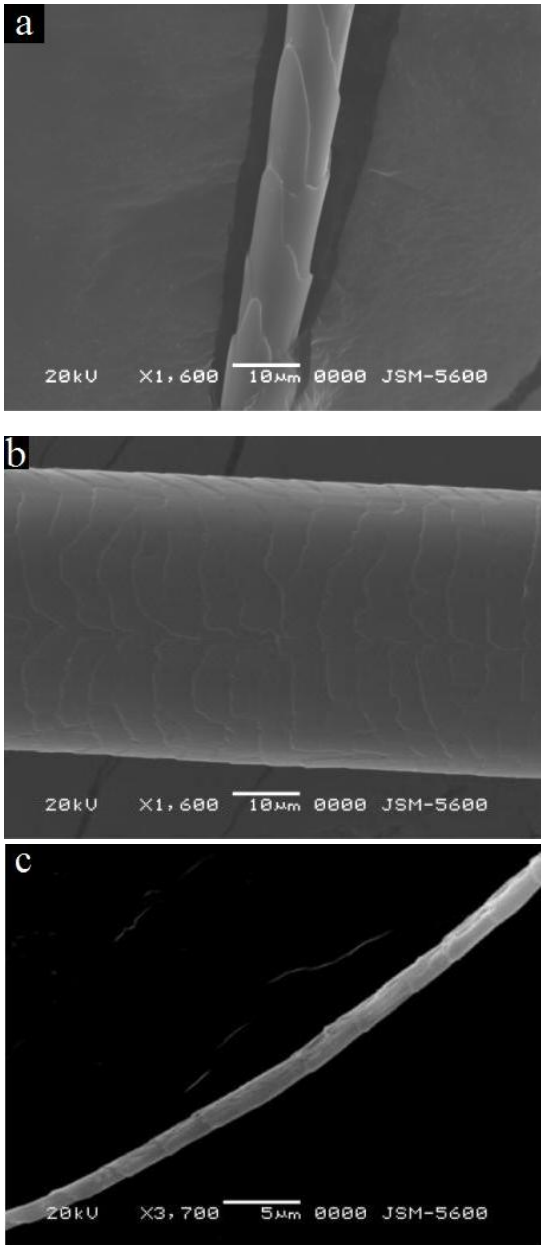

Figure 4. Hair morphology of *Microtusguentheri.* base (a), shaft (b), and tip (c).

Fur colour: Dorsal colour (sometimes being an pale blackish grey, irregular narrow strip from the tip of the nose to tail) varies from light yellowish light grey to pale yellowish light brown. In dorsal part, hair bottoms are grayish black, hair tips yellowish light brown. Ventral fur colour is very light whitish pale grey. Sometimes greyish pale dirty yellow. In ventral part, hair bottoms are pale grayish black, hair tips are almost yellowish dirty white. Boundary where dorsal and ventral colours interfere in lateral is not clear. Tail colour in dorsal part is dorsal fur colour, in ventral part its tone is lighter ventral fur colour.

Reproduction: A pregnant female captured on May, gave birth to seven young in lab. Four embryos for a 46.5 g weight female captured in June, fifteen newborns together with an adult female were encountered in excavated field in July. Seven embryos for 62 g weight a pregnant individual, four embryos for 52 g weight a female individual, four embryos for 51 g weights two female individual, four embryos for 63 g weights female individual was determined. Females have four pair mammaes. The newborn youngsters were coloured light pink, blink and naked and hair, tooth and claws have not been develop yet.

Karyological features: It was determined that the diploid chromosome number (2n) was 54, and the fundamental number (FN) 54, and number of autosome arms (FNa) 52. In the chromosome set there were 26 pairs acrocentrics, decreasing in size from large to small. X and Y chromosomes were acrocentric (Figure 5, 6).

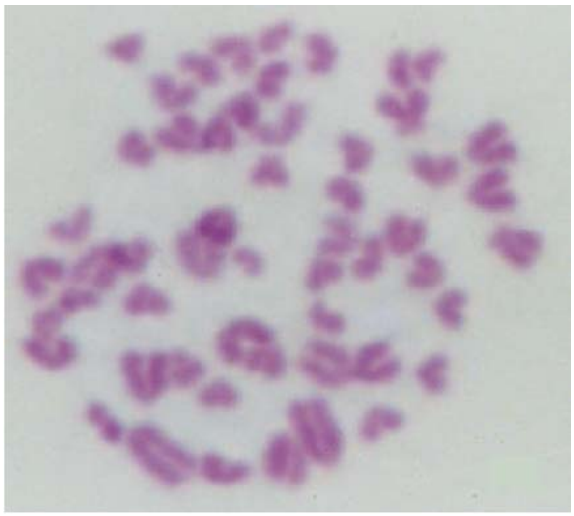

Figure 5. Metaphase spread of *Microtus guentheri*

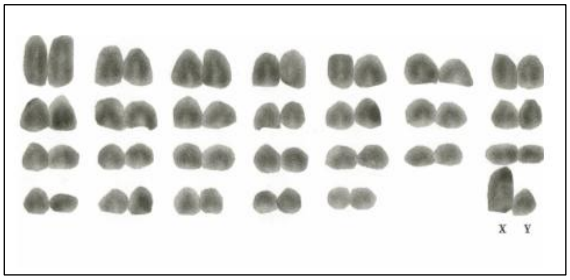

Figure 6. Idiogram of a male *Microtus guentheri*

Ecological notes: Levant vole was found to live at the field cultivated wheat, barley, sunflower, melon,watermelon and white beet with a pond, dam lake, river and stream adjacent to them and, at thicket areas covered with oleaster, willow, poplar, oak and rocky fields, at the altitude between 650-1200 m.

At the study area, black snake (*Coluber* sp.), water snake (*Natrix* sp.) within reptilia, falcon (*Buteo* sp.), stork (Ciconia sp.) within birds, hedgehog (*Erinaceus europaeus*), bicoloured white-toothed shrew (*Crocidura leucodon*), within insectivora, water vole (*Arvicola terrestris*), Tristram's jird (*Meriones tristrami),* rock mouse (*Apodemus mystacinus),* small wood mouse (*Apodemus hermonensis),* house mouse (Mus musculus) and jerboa (*Allactaga williamsi*) within rodentia, fox (V*ulpes vulpes),* stone marten (*Martes foina),* badger (*Meles meles*) and wild boar (*Sus scrofa*) were found.

Plant species recorded in the study area in the form of grass, thicket and tree were; Plantago lanceolata, *Poa annua, Triticum vulgare, Hordeum murinum, Euphorbia arvalis, Cuscuta planifolia*, *Brassica elongata, Alyssum hirsutum, Verbascum* sp., Phlomis armeniaca, Bolboschaenus *maritimus, Plantago major, Echinops sp., Mentha sp., Ononis spinosa, Cirsium sp., Salvia sp., Trifolium compeste, Syringa vulgaris, Linum hirsutum, Pisum sativum, Vicia sativa, Peganum harmala, Plumpago europaea, Euphorbia macrocleek, Cerastium dichotomum, Malva sylvestris, Alcea setosa, Chenopodium album, Adonis aestivalis, Ranunculus arvensis, Echinops ritro, Consolida orientalis, Thymus sipyleus, Stipa holosericea, Alyssum hirsutum, Dianthus zonatus,Geranium tuberosum, Convolvulus holosericeus, Capsella bursa pastoris, Daucus carrota, Epilobium sp., Thypa sp., Ornithogalum narbonense, Iris glatica, Crocus sp, Papaver dubium, Ranunculus arvensis, Echinops ritro, Senecio vernalis, Polygonum lapathifolium, Salsola cali, Chenopodium album, Malva sylvestris, Convolvulus sp., Tamarix smyrnensis, Astragalus densifolius, Astragalus homosus, Astragalus microcephalus, Astragalus plumosci, Cerasus mahalep, Vitis* sp., Atriplex sp., Crataegus sp., Paliurus spina - *christii, Elaeagnus angustifolia, Salix alba, Populus nigra, Quercus infectoria, Juniperus oxycedrus, Chordina orientalis and Silene atites are* occure.

Microtus levis Miller , 1908 East European Vole

1908. *Microtus levis* Ann. and Mag.Nat.Hist. 8th p. 197.

Type locality: Romania , Prahova, Gageni,

1993. *Microtus rossiaemeridionalis* , Musser and Carleton, Family Muridae Pp. 529. *in*: Mammals Species of the World: A Taxonomic and Geographic Reference (Don E., Wilson and D. M. Reeder, eds.). Second ed., Smithsonian Institution Press, Washington, 1-1207.

Diagnostic characters: Dorsal fur colour is blackish brown, ventral fur colour grayish dirty white. Six plantar tubercles of hind feet are present. Tail lenght of specimens exceed to % 40 of head and body lenght. Skull height 9.22-10.5, basilar lenght 22.10-23.0 mm.

Bone on the median line is slightly extended dorsally upwards as compared to the sides of the interorbital region (Figure 1). Baculum lenght is 2.73-3.0, the proximal width 1.53-1.86, the distal width 0.30-0.50 mm (Figure 7).

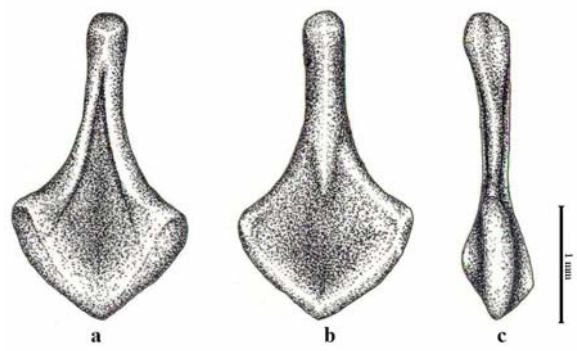

Figure 7. The shape of baculum of *Microtus levis* ; dorsal view (a), ventral view (b) and lateral view (c)

Figure 8. Maxillary toothrow of *Microtus levis*

Measurements: In this study, only male individuals were encountered. Therefore only statistical data of adult males of *Microtus levis* are given in Table 2.

Table 2. Statistical data of weight (g), external and cranial measurements (mm) of adult *Microtus levis* (n: number of individuals, r: range, m: mean, ±Sd: standard deviation).

Measurements	n	r	m	±Sd
Total length	5	155-168	162.2	5.4498
Length of head and body	5	109-121	115.6	4,4497
Length of tail	5	44-51	46,6	2,9665
Length of hind foot length	5	19-20	19,4	0,5477
Length of ear	5	9-14	12,6	2,0736
Occipitonasal length	5	25,3-27,3	26,28	0,7294
Condylobasal length	5	24,95-26,66	25,834	0,6313
Basilar length	5	22,1-23,54	22,8	0,5289
Palatal length	6	12,84-13,55	13,123	0,2826
Length of palatal foramina	5	4-4,75	4,412	0,3391
Nasal breadth	6	3-3,4	3,155	0,1579
Nasal length	6	6,72-8,26	7,6183	0,5918
Zygomatic breadth	5	14,6-15,2	14,96	0,2191
Interorbital breadth	6	3,34-3,76	3,5667	0,1527
Breadth of braincase	5	6,54-10,55	7,61	1,6765
Height of skull	5	9,22-10,5	9,952	0,5011
Length of diastema	6	7,1-7,7	7,3717	0,2345
Length of maxillary toothrow	6	5,7-6,25	5,8916	0,2010
Length of mandibular toothrow	6	5,68-6,2	5,8883	0,1789
Length of mandible	6	14,5-16,35	15,483	0,6129
Weight	5	33,5-42,5	36,9	3,4533

Specimens examined (11) and localities: Sulakyurt, 3 (2 ♂♂, 16 September 2001; 1 ♂, 14 July 2003); Merkez, Hasandede, 8 (3 ♂♂, 08 July 2003; 1 ♂, 09 July 2003; 3 ♂♂, 10 July 2003; 1 ♂, 20 July 2003, 1♀**)**.

Tooth structure: M^3 structure has four salient angles internally and externally in all specimens (Figure 8).

Hair morphology: The base part of guard hairs is "chevron" type, shaft and tip parts of guard hairs are "annular" type on *Microtus levis* (Figure 9).

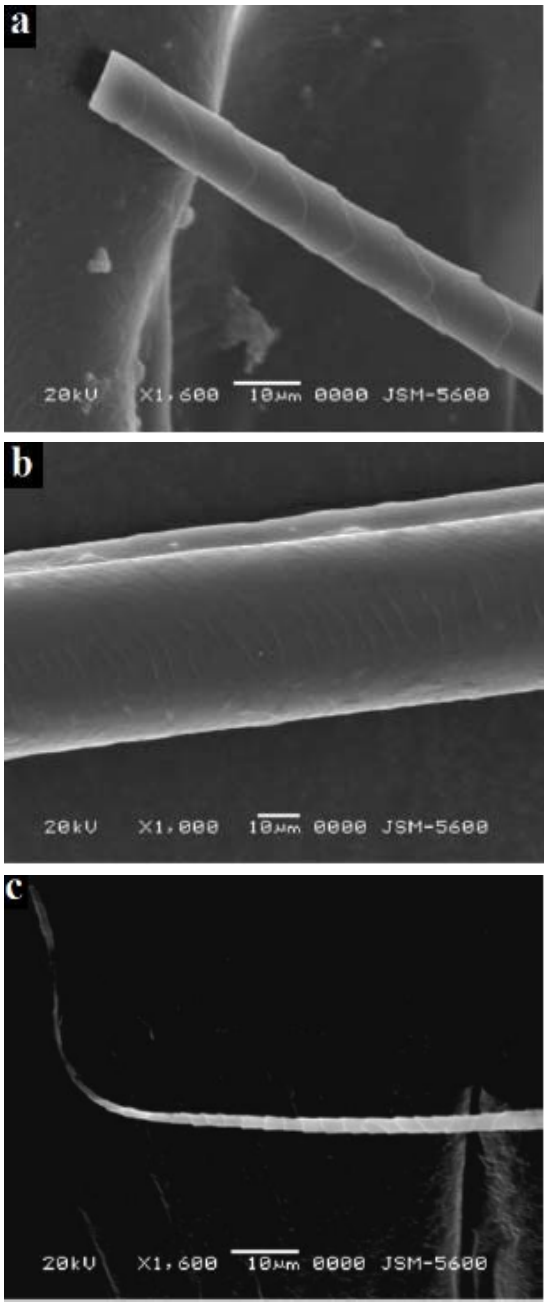

Figure 9. Hair morphology of *Microtus levis;* base (a), shaft (b), and tip (c)

Fur colour : Dorsal colour in adult males is very light yellowish greyish brown. In dorsal part hair bottoms are black, hair tips are light yellowish brown. Ventral fur colour, very light dirty yellowish pale grey. Bottoms of hair in ventral are pale grayish black while the tips are occasionally yellowish dirty white. Boundary where dorsal and ventral colours interfere in lateral is not clear. Tail colour in dorsal part its tone is darker dorsal fur colour, in ventral part is ventral fur colour.

Karyological features: It was determined that the diploid chromosomes number is 54, the fundamental number 54, and number of autosomal arms 52. In the diploid set there were 26 pairs of gradually decreasing acrocentrics. X chromosomes are acrocenric (Figure 10, 11).

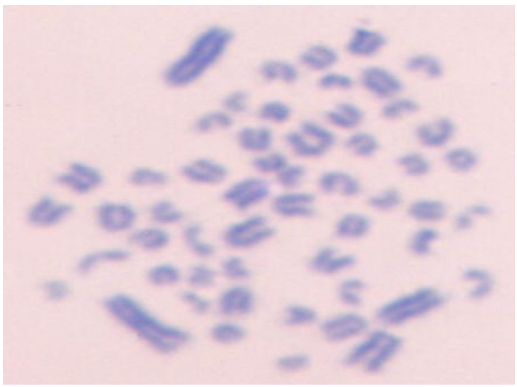

Figure 10. Metaphase spread of *Microtus levis*

Figure 11. Idiogram of a female *Microtus levis*

Ecological notes: *Microtus levis* usually lives at river and stream share, with poplar and oleaster trees, presented and at stony, rocky and marshy areas, alls being surrounded with water. Plant species found in the form of grass, thicklet and tree, in the study area were, *Rubus canescens, Ephedra major, Achillea setacea, Astrodaucus* sp., Cirsium arvense, *Galium* sp., *Melilotus officinalis, Phragmites amistralis, Ballota nigra, Typha latifolia, Juncus gerardi, Rumex crispus, R. acetosella, Tamarix smyrnensis, Syringa vulgaris,Trifolium arvense T. compeste, Salix babylonica and Quercus cerris.* The animal species in the study area were identical to those of previous records.

DISCUSSION

In our specimens external and cranial measurements were in consistent with the values given by Neuhäuser [4], Çağlar [9], Felten *et* al., [10], Morlok [12], Kefelioğlu [14] and Kryštufek, Kefelioğlu [23], who were given the distrubution records and morphometric measurements for *Microtus guentheri,* except for the tail to head and body length ratio for which values recorded between % 21-36 in our study. This differences could have been resulted from the measure methods.

Our karyological data were compared with karyological data given Turkey and Europe (Table 3).

A pair of metacentric chromosome was not observed our samples.

Table 3. Karyotypic characteristics of *Microtus guentheri* from Europe and Turkey; 2n: diploid chromosome number, FN: Fundamental number, NFa: autosomal arm number, A: acrocentric, X: X chromosome, Y: Y chromosome

Country	Species and subspecies	2n	FN	NFa	M	A	X	Y
EUROPE, [24]	*M. guentheri*	54	54	52		52	M/A	A
EUROPE, [25]	*M. guentheri*	54	-	-	-	-	M/A	-
TURKEY, [14]	*M. g. guentheri*	54	54	52	-	52	A	A
	M. g. lydius	54	55	52	-	52	M/St	A
TURKEY, [15,26,27]	*M. guentheri*	54	-	-	2	50/52	M/A	A
TURKEY, This study	*M. guentheri*	54	54	52	-	52	A	A

Mazurok *et* al. [28] were recorded that scientific name of *Microtus rossiaemeridionalis* was yet indefinite and *Microtus subarvalis* and *Microtus epiroticus* were synonymous of *Microtus rossiaemeridionalis.* Mitchell - Jones et al. [25] recorded that *Microtus rossiaemeridionalis* were distrubuted in Asia Minor and *Microtus subarvalis and Microtus epiroticus is being* synonimous for this species.

Ognev [29] stated *Microtus rossiaemeridionalis* from Russia had nasal processes of interparietal bones extending far to rear compared to back parts of nasals. The external and cranial characteristics of our specimens are in accord with the definitions of *Microtus rossiaemeridionalis* by Ognev.

There were no differences morphometric and chromosomal features of our samples were compared with synonym instead of *Microtus levis*, *Microtus epiroticus* in Turkey.

While recording the distrubution of *Microtus rossiaemeridionalis* in Lithuania Mažeikytė *et* al. [30] included the North of Turkey within the distrubution area. There were no differences our morphometric data with those from Lithuania.

Karyological data *of Microtus levis* were compared with those obtained from Turkey, Europa and Lithuania (Table 4).

Table 4. Karyotypic characteristics of *Microtus rossiaemeridionalis* from Europe and Turkey; 2n: diploid chromosome number, FN: Fundamental number, NFa: autosomal arm number, A: acrocentric, X: X chromosome, Y: Y chromosome

Country	Species and subspecies	2n	FN	NFa	M	A	X	Y
Europe, [24]	*M. epiroticus*	54	56		2	50	A	A
Lithuania, [30]	*M. rossiaemeridionalis*	54	56		2	50	A	
Turkey, [14]	*M. epiroticus*	54	56				A	A
Turkey, This study	*M. levis*	54	54	52		52	A	

ACKNOWLEDGMENT

This work was supported by the Scientific Research Projects Unit of Kırıkkale University (Project No: 01/03-04-17). The authors thank Prof. Dr. Hayri Duman for identifications of plant species and for karyological analyses to Dr. Nursel Aşan.

REFERENCES

[1] Danford CG, Alston ER. 1880. On the Mammals of Asia Minor. Proc. Zool. Soc., London, 50-64.

[2] Thomas O. 1906. On new Insectivores and Voles. The Annals and Magazine of the Natural History, London, Vol XVII (7): 415-421.

[3] Blackler G. 1916. On a New Species of the *Microtus* from Asia Minor. The Annals and Magazine of the Natural History, London, Vol XVII (8): 426-427.

[4] Neuhäuser G. 1936. Die Muriden Von Kleinasien, Zeits. Saugetierk., 11: 161-236.

[5] Ellerman JR. 1948. Key to the Rodents of South-West Asia in the British Museum Collection. Proceedings of the Zoological Society of London, 118: 765-816.

[6] Misonne X. 1957. Mammiferes de la Turquie Sud-Orientale et du Nord de la Syrie. Mammalia, 21: 53-67.

[7] Steiner H, Vauk G. 1966. Säugetiere aus dem Beyşehir-Gebiet (Vil. Konya Kleinasien). Zool. Anz., 176: 97-102.

[8] Lehmann E. 1966. Taxonomische Bemerkungen Zur Saegerausbeute Der Kummerloeve'schen Orientreisen, 1953-1965. Zool. Beitr. (N.F), 12: 251-317.

[9] Çağlar M. 1967. Türkiye'nin Gömülgen Fareleri (Microtin). Türk Biol. Derg., 17: 103-117.

[10] Felten H, Spitzenberger F, Storch G. 1971. Zur Kleinsäugerfauna West Anatoliens. Teil I, Senckerbergiana Biologica, 52(6): 393-424.

[11] Corbet GB. 1978. The Mammals of the Palaearctic Region. A Taxonomic Review, B. M. (Natural History), London, 1-314.

[12] Morlok WF. 1978. Nagetiere aus der Türkei (Mammalia: Rodentia). Senckenbergiana Biologica, 59: 155-162.

[13] Kumerloeve H. 1980. I. Anadolu Memeli Hayvanları Üzerinde Yapılmış olan Araştırma ve Buluşların Tarihsel Gelişimi. II. Anadolu Rodentia: Kemiriciler. İstanbul Üniv. Orman. Fak. Derg., 30/B (2): 197-223.

[14] Kefelioğlu H. 1995. The taxonomy of the genus of *Microtus* (Mammalia: Rodentia) and its distribution in Turkey. Turk. J. Zool., 19: 35-63.

[15] Kefelioğlu H, Kryštufek, B., 1999. The taxonomy of *Microtus socialis* group (Rodentia: Microtinae) in Turkey, with the description of a new species. Journal of Natural History, 33: 289-303.

[16] Musser GG, Carleton MD. 2005. Family: Cricetidae Pp. 955-1189. in: Mammals Species of the World A Taxonomic and Geographic Reference (Don E, Wilson and DM. Reeder eds). Third ed., Johns Hopkins University Press, Baltimore., 1-2142.

[17] Mursaloğlu B. 1965. Bilimsel Araştırmalar için Omurgalı Numunelerinin Toplanması ve Hazırlanması. Ankara Üniversitesi Fen Fakültesi Yayınları, Ankara, 1-60.

[18] Parker RE. 1979. Introductory Statistics for Biology. The Institue of Biology's Studies in Biology. London, (43): 1-222.

[19] Ridgway RA. 1886. Nomenclature of colours for naturalists and compendium of useful knowledge for ornithologists. Boston, 1-129.

[20] Lidicker WZ. 1968. A Phylogeny of New Guinea Rodent Genera Based on Phallic Morphology. Journal of Mammalogy, 49(4): 609-643.

[21] Patton JL. 1967. Chromosome studies of certain Pocket mice. Genus *Perognathus* (Rodentia: Heteromyidae). Journal of Mammalogy, 48 (1): 27-37.

[22] Hayat MA. 1972. Basic Electron Microscopy Techniques. Litton Educational Publishing Inc., New York.

[23] Kryštufek B, Kefelioğlu H. 2001. Redescriptions and species limits of *Microtus irani* Thomas 1921, and descriptions of a new social vole from Turkey (*Microtus*: Arvicolinae). Bonn. Zool. Beitr. 50: 1-14.

[24] Zima J, Kral B. 1984. Karyotypes of European Mammals II. Act. Sc. Nat., Brno, 18 (8):1-62.

[25] Mitchell-Jones AJ, Amori G, Bogdanowicz W, Kryštufek B, Reijnders PJH, Spitzenberger F, Stubbe M, Thissen, JBM, Vohralik V, Zima J. 1999. The Atlas of European Mammals. Academic Press, London, 1-484.

[26] Çolak E, Yiğit N, Sözen M, Özkurt Ş. 1997. Distrubution and Taxonomic Status of the Genus *Microtus* (Mammalia:Rodentia) in Southern Turkey. Israel Journal of Zoology, 43:391-396.

[27] Yiğit N, Çolak E. 2002. On the distrubution and taxonomic status of *Microtus guentheri* (Danford ve Alston, 1880) and *Microtus lydius* Blackler,1916 (Mammalia: Rodentia) in Turkey. Tr. J. of Zoology, 26:197-204.

[28] Mazurok N, *et* al. 1995. Editorial comment on the nomenclature of the East European vole. Hereditas, 123: 95.

[29] Ognev SI. 1964. Mammals of the U.S.S.R. and Adjacent Countries. Translated from Russian. Rodents. Moscow, VII: 1-626.

[30] Mažeikytė R, Baranauskas K, Morkūnas V, Mickevičius E, 1999. Distrubution of the Sibling Vole (*Microtus rossiaemeridionalis* Ognev, 1924) (Rodentia, Cricetidae) in Lithuania. Acta Zoologica Lituanica. Vol. 9:1 3-15.