Boris KRYŠTUFEK and Vladimír VOHRALÍK

Mammals of Turkey and Cyprus

Rodentia I: Sciuridae, Dipodidae, Gliridae, Arvicolinae

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BORIS KRYŠTUFEK & VLADIMÍR VOHRALÍK: MAMMALS OF TURKEY AND CYPRUS. RODENTIA I: SCIURIDAE, DIPODIDAE, GLIRIDAE, ARVICOLINAE

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Foreword by Pat A. Morris

My first involvement with Turkish mammals was in the 1960s. I was part of a student expedition, intent on exploring caves in Anatolia. Whilst my colleagues wriggled through small underground spaces, I set about collecting bats and sub-fossil material from the cave floors. The specimens were later identified by G. B. Corbet at the British Museum (Natural History), and I was amazed that he was able to do so at all. There seemed to be no field guides, no useful books and little else to assist. Yet he managed to put names to my skins, skulls and bones. The leopard skull, from a cave near Elmalı, was obvious enough. So were the porcupine quills, but the bats and rodents all looked the same to me. Latter it transpired that some of the rodent fragments were from a dormouse, *Myomimus*, the first records for Turkey. I was pleased to have found something of note, but also surprised that a mere student expedition, not focused on zoology anyhow, should manage to achieve a “First” for a country as large and important as Turkey.

Since than, much has changed. Available information has vastly increased and reference specimens are now much more numerous. The material now exists to create an authoritative review of the taxonomy and distribution of Turkish mammals, but what a task!

About one third of all known mammal species is a rodent. For Turkey and Cyprus, the figure is over 40%. Moreover, many of them look very similar, so their identification is difficult, and published species lists may not always be fully reliable. Variation among rodent species, especially when they occur on islands, confuses the picture even more. Many taxonomic revisions, surveys and field studies have now been published, but in a bewildering variety of languages. Sorting out a definitive review is a daunting task indeed, especially as the resources are scattered among museums and libraries in many countries.

Few would be brave enough to undertake such a task. The authors of this volume are therefore to be congratulated not only on their scholarship, but also for their bravery and determination to complete this huge and complex challenge. This review will be of service to biologists for decades to come and also serve as an inspiration for others to follow.

Pat Morris

Dr. P. A. Morris
Senior Lecturer in Zoology

Preface and Acknowledgements

Four years passed since we published the 1st volume of, hopefully, the first in a series which was to gather up the present knowledge of the mammals of Turkey and Cyprus (Kryštufek & Vohralík, 2001). After reviewing insectivores, a group of primitive eutherians which is nowadays no longer considered to be a natural group, we focused on rodents. Rodents are by far the largest mammalian group in general and in the region under study in particular. Of the 141 species of mammals listed for Turkey and Cyprus (Kryštufek & Vohralík, 2001), sixty are rodents (= 43%). Yet it is not only the number of species alone, which makes rodents a demanding group for study. More literature accumulated on rodents than on any other mammal group from the study area. Consequently, there are possibly more published papers on rodents than on all the remaining mammals of Turkey and Cyprus combined. Much of valuable information was published in the past in Turkish journals with very limited distribution or in occasional publications. It was thus hard to trace references and even more difficult to obtain papers. Although rodents are mainly well represented in museum collections, many species have very limited ranges or are extremely rare in the study area, or both. Thus, none of the collections in Europe and USA holds a complete and representative collection of all rodents of Turkey and Cyprus. This has caused many troubles and delays in our current work. Nevertheless, we managed to study all the rodents elaborated below and, with the exception of birch mice, at least some of the specimens studied originated from Turkey.

The progress in our work was slow, even slower than we expected. Because of the amount of information to be processed on the one hand, and shortage of time and funds on the other, it took us three years to elaborate approximately one half of rodent species for publication. We were thus forced to publish the rodents in two parts. This volume deals with squirrels, jerboas and jumping mice, dormice and voles, none of these groups having representatives on Cyprus.

Similarly as was the case with our previous publication, we owe gratitude to many people and institutions, which supported us during various phases of our work. Again, our first and deepest thanks go to all those who accompanied us during our field work or provided specimens collected on their independent trips to the study area (in alphabetical order): Dr. Michal Andreas (Prague), Dr. Petr Benda (Prague), MSc. Ebru Buruldağ (Edirne), Dr. Jovana Čiháková (Prague), Dr. Daniel Frynta (Prague), Prof. Dr. Ivan Horáček (Prague), Dr. Bogdan Horvat (Ljubljana), Mr. František Hubínek (Hřebeč), MSc. Eduard Kletečki (Zagreb), Mrs. Alenka Kryštufek (Ljubljana), Asst. Prof. Dr. Miloš Macholán (Brno), Dr. Beytullah Özkan (Edirne), Dr. Antonín Reiter (Znojmo), Dr. Petr Voříšek (Prague), and Prof. Dr. Jan Zima (Brno).

This study would not have been possible without the efforts of numerous other collectors who provided voucher specimens to various museums around the World, as well as curators who preserved them and made them available to us (in alphabetic order of collections; see Material and Methods section for the acronyms of the collections): Dr. Paula Jenkins (Mammal Collection, BMNH), Dr. Andrew P. Currant (Department of Palaeontology, BMNH), Dr. William Stanley (FMNH), Prof. Dr. Hans M. Steiner (HSC), Ing. Ján Obuch (JOC), Dr. Marina I. Baskevič (SIEE), Dr. Petr Benda and Dr. Miloš Anděra (NM), Dr. Linda Gordon (NMNH), Dr. Friederike Spitzenberger, Dr. Barbara Herzig, and Dr. Kurt Bauer (NMW), Prof. Dr. Haluk Kefelioğlu (OMU), Dr. Gerhard Storch and Dr. Dieter Kock (SMF), Prof. Dr. Cengiz Kurtonur and Dr. Beytullah Özkan (TUE and IUBD), Dr. Rainer Hutterer (ZFMK), and Dr. Richard Kraft (ZSM).

Our field trips to Turkey were sponsored by the grants from the Ministry of Science and Technology, Republic of Slovenia (B.K.) and by the Grant Agency of Czech Republic (V.V.); the final work was partly sponsored by the MŠMT ČR, grant 0021620828, and GAČR, grant 206/05/2334 (to V.V.) and by the research programme “Biodiversity” by the Ministry of Education, Science and Sport, Republic of Slovenia (to B.K.). The SYS-RESOURCE grant enabled B.K. in 2002 to stay for almost two months long in the British Museum (Natural History) in London, which considerably accelerated the project. Grants to earlier visits to collections were provided (to B.K.) by the Slovenian Science Foundation (visits to FMNH, NMNH) and the Ministry of Science and Technol-

ogy of the Republic of Slovenia (the remaining trips). Charles University, Prague, supported two visits of B.K., one month each in 2003 and 2004, which allowed us to concentrate on writing the text and preparing drawings.

Many people supported our work in various ways. B.K. wishes to express his gratitude to the late Dr. Gordon L. Kirkland and Mrs. Carol Kirkland (Shippensburg, USA) who helped him in his travels to visit the USA collections. Dr. Darko Darovec, director of the Science and Research Centre, University of Primorska (Koper) and Dr. Breda Činč Juhant, director of the Slovenian Museum of Natural History (Ljubljana) provided continuos support.

In Turkey, both of us enjoyed the hospitality and friendship of Prof. Dr. Cengiz Kurtonur and Dr. Beytullah Özkan (Trakya University, Edirne), and of Prof. Dr. Haluk Kefelioğlu (Ondokuz Mayıs University, Samsun). V.V. wishes to express his particular thanks to the staff of the Faculty of Science and Literature, Çukurova University in Adana, for their hospitality during his study visit in 1993.

Our colleagues and friends with whom we worked in the field during 1993-1995 expeditions to Turkey shared with us their experience and knowledge, and provided their unpublished results, which significantly strengthened our conclusions. We are particularly grateful to Prof. Dr. Jan Zima, Prof. Dr. Ivan Horáček, Asst. Prof. Dr. Miloš Macholán, Dr. Daniel Frynta, and Dr. Petr Benda.

Dr. Jan Hošek (Prague) prepared black-and-white drawings for each genus and Ms. Simona Prokešová (Třebíč) provided dravings of squirrel and dormouse cheek-teeth; the remaining drawings are by B.K. Wherever the illustrations, measurements, or conclusions are based on material not under our surveillance full credit is given to the respective collection.

For their work on final designing and elaborating illustrations, we are most grateful to MSc. Kateřina Svádová (Prague; design of distributional maps), Miss Mia Asta (Ljubljana; design of figures) and Dr. Jakub Prokop (Prague; scanning figures).

Mr. Ciril Mlinar (Ljubljana) photographed skins for colour plates. Specimens on which the plates are based were all photographed in the Natural History Museum of Slovenia (Ljubljana). For loan of the material we express our gratefulness to Prof. Dr. Hans M. Steiner (HSC), Ing. Ján Obuch (JOC), Dr. Marina I. Baskevič and Dr. Boris I. Sheftel (SIEE), Dr. Friederike Spitzenberger and Dr. Barbara Herzig (NMW), Prof. Dr. Haluk Kefelioğlu (OMU), Dr. Gerhard Storch and Dr. Dieter Kock (SMF), Prof. Dr. Cengiz Kurtonur and Dr. Beytullah Özkan (TUE and IUBD), Dr. Rainer Hutterer (ZFMK), and Dr. Richard Kraft (ZSM). Ing. Drago Žepič (Praše) safely transferred *Sicista* material between Moscow and Ljubljana.

Black and white photographs on habitats and animals were provided by Dr. Petr Benda (Prague), MSc. Ebru Buruldaĝ (Edirne), Ing. Jaroslav Červený (Prague), Ing. Alenka Kryštufek (Ljubljana), Prof. Dr. Cengiz Kurtonur (Edirne), Dr. Petr Musil and MSc. Zuzana Musilová (Prague), Dr. Beytullah Özkan (Edirne), and Asst. Prof. Dr. Davorin Tome (Ljubljana).

Our particular thanks go to Dr. Dieter Kock (SMF) who carefully read the publication from 2001 (Kryštufek & Vohralík, 2001), brought our attention to errors and omissions, and provided necessary information to correct them. Comments were also provided by Dr. Gerhard Storch (SMF), Dr. Rainer Hutterer (ZFMK), Dr. Johan Thissen (Wageningen) and Dr. Max Kasparek (Heidelberg). Dr. Peter Praschag (Graz) and Dr. Rüdger Dmoch (Zoo Frankfurt) helped in tracing the origin of captive *Eliomys melanurus* colonies in central Europe. Dr. Ilona Storchová (Prague) provided free translations of Turkish texts which are most greatly appreciated. Dr. Radoslav Obrtel (Brno) improved English and style.

Many people made most helpful comments and suggestions, thought as usual the views and mistakes remain our own responsibility.

INTRODUCTION

The Mammals of Turkey and Cyprus (Rodents: Sciuridae, Dipodidae, Gliridae and Arvicolinae) is another attempt to compile the present knowledge of the mammal fauna in the diverse northeastern corner of the Mediterranean realm: Turkey and the Island of Cyprus.

The work compiles our actual knowledge on the taxonomy, distribution, variation and life history on thirty-one species of squirrels, sousliks, jerboas, jumping mice, dormice and voles, established so far in the region. Lack of time, funds, and personal contacts prevents us to elaborate the entire rodent fauna in a way comparable to this volume.

Each species account contains the following categories of information:

SPECIES NAMES. The valid scientific name (in bold) is followed by the name as it first appeared, together with the name of the authority and the year of publication. We should like to remind the reader that the author's name and the year are in parentheses if the generic name when first used differs from the current one (for the proper use of complete scientific names see Annotated Checklist in Kryštufek & Vohralík, 2001). Given are also the junior synonyms originating from Turkey and Cyprus. In exceptional cases we also listed names and type localities from outside this geographic region. For the nomenclature and taxonomic sources see the Annotated Checklist (Kryštufek & Vohralík, 2001). In the captions to species accounts, the scientific name is given together with the English vernacular name; here we relied on Wilson & Cole (2000). The Turkish names are available in Banoğlu (1953; game species), Demirsoy (1966) and Mitchell-Jones *et al.* (1999; European species only).

TAXONOMY. This category is added for species or species groups with unstable taxonomy, and it includes historical facts and reasons for the actual status. Comparisons with closely related and/or morphologically similar taxa are also provided where necessary. For several species we give more detailed comparisons with the taxa from adjoining regions.

DESCRIPTION. Data on the external characters (colour, size, body proportions, nipple count, genitals) are followed by cranial and dental descriptions and the chromosomal complement. In some cases we were able to provide molecular data derived from recent studies. A table of standard external and selected cranial measurements completes the "Description". Data in the table are given as summarised statistics: sample size (N), arithmetic average (mean) and the observed range (min - max).

VARIATION. While this category is mainly devoted to describe patterns of geographic (*i.e.* interlocal) variation, cases of individual (*i.e.* intrapopulation) variation are also given where appropriate. In general, the geographic variation is poorly understood in Turkish mammals, even at the level of conventional morphological data sets. Particularly evident is the lack of comprehensive statistical elaborations based on representative samples from large geographic areas. Conventional subspecies are considered although we lack proof of any discontinuity for the majority of the trinomials.

DISTRIBUTION. The species range in Turkey follows a description of the general distribution. It is accompanied by a dot distribution map with marginal individual records and the approximate range (shaded).

HABITAT. This category gives information on the habitat selection of a particular species, *i.e.* of the plant communities inhabited, the altitudinal range populated, the co-existing small mammals, and the population densities.

BIOLOGY. The available infirmation on the various aspects of life of Turkish rodents is sufficient to allow the inclusion of a chapter on biology. Covered are the activity, shelters, reproduction, diet, and predation.

Material and Methods

The present review covers squirrels (Sciuridae), jerboas and jumping mice (Dipodidae), dormice (Gliridae), and voles (subfamily Arvicolinae of Muridae). The selection was not based on taxonomy, and thus the above groups do not form a natural unit. In total, 31 species have been elaborated, out of the total of 60 for the region. Any of these groups has representatives on Cyprus, and therefore the present volume deals with Turkey alone.

Similarly as in the case of our previous compilation on the insectivores of Turkey and Cyprus (Kryštufek & Vohralík, 2001), the present review is based on three main sources of information: (i) published data, (ii) voucher specimens in museum collections, and (iii) our own material and data collected in the field.

Published data. The data published on the mammals of Turkey are widely scattered in various journals, books, and reports. Although every attempt was made to include all the papers available on rodents, we are well aware of the fact that our reference list is far from being complete. The most complete bibliographic list of the mammals of Turkey and its neighbouring countries is by Kumerloeve (1986) who already stated that “the number of authors and publications /related to the region/ multiplied to such an extent, that a critical appraisal seems to become more and more necessary.”

Wherever possible, we checked the published information by examining voucher specimens.

Voucher specimens. Voucher specimens were examined by B.K in mammal collections in Europe, Turkey and the United States of America. The institutions and corresponding abbreviations are as follows:

BMNH	Natural History Museum London (formerly British Musem Natural History), London, UK.
FMNH	Field Museum of Natural History, Chicago, USA.
HNM	Hungarian National Museum, Budapest, Hungary.
HSC	Collection of Prof. Dr. Hans M. Steiner, Vienna, Austria.
IUBD	Biology Department, University of İstanbul, İstanbul, Turkey.
JOC	Collection of Ing. Ján Obuch, Botanical Garden of the Commenius University in Bratislava, Blatnice, Slovakia.
NM	Department of Zoology, National Museum, Prague, Czech Republic.
NMNH	United States National Museum of Natural History, Washington, D.C., USA.
NMW	Naturhistorisches Museum Wien, Vienna, Austria.
OMU	Biology Department, Ondokuz Mayıs University, Samsun, Turkey.
SIEE	Severtzov Institute of Ecology and Evolution, Russian Academy of Sciences, Moscow, Russia.
SMF	Forschungsinstitut und Natur-Museum Senckenberg, Frankfurt a. M., Germany.
TUE	Biology Department, Trakya University, Edirne, Turkey.
ZFMK	Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn, Germany.
ZSM	Zoologische Staatssammlung Münnchen, Munich, Germany.

In most cases, the examined specimens were standard museum skins and/or skulls; the rest of the material was conserved either in alcohol or in a 4 % solution of formaldehyde. We also considered owl pellets and subfossil material. External measurements were recorded from specimen tags and cranial parameters were scored by a vernier calliper (see below). Drawings of skulls and/or dentition were made using a *camera lucida*, or scored by the Pixera Visual Communication Suite (Version 2.0). Linear measurements were scored (to the nearest 0.1 mm) for skulls to roughly describe these structures by numerical means, thus allowing further comparisons. See Fig. 1 for definitions of cranial and mandibular measurements. Dental measurements were taken on a stereomicroscope fitted with an eyepiece scale.

Various types of teeth in the heterodont mammalian set are designated by letters. Capitals are used to indicate the maxillary teeth and small letters the mandibular teeth; the position in the tooth-row (anterior → posterior) is indicated by the relevant number.

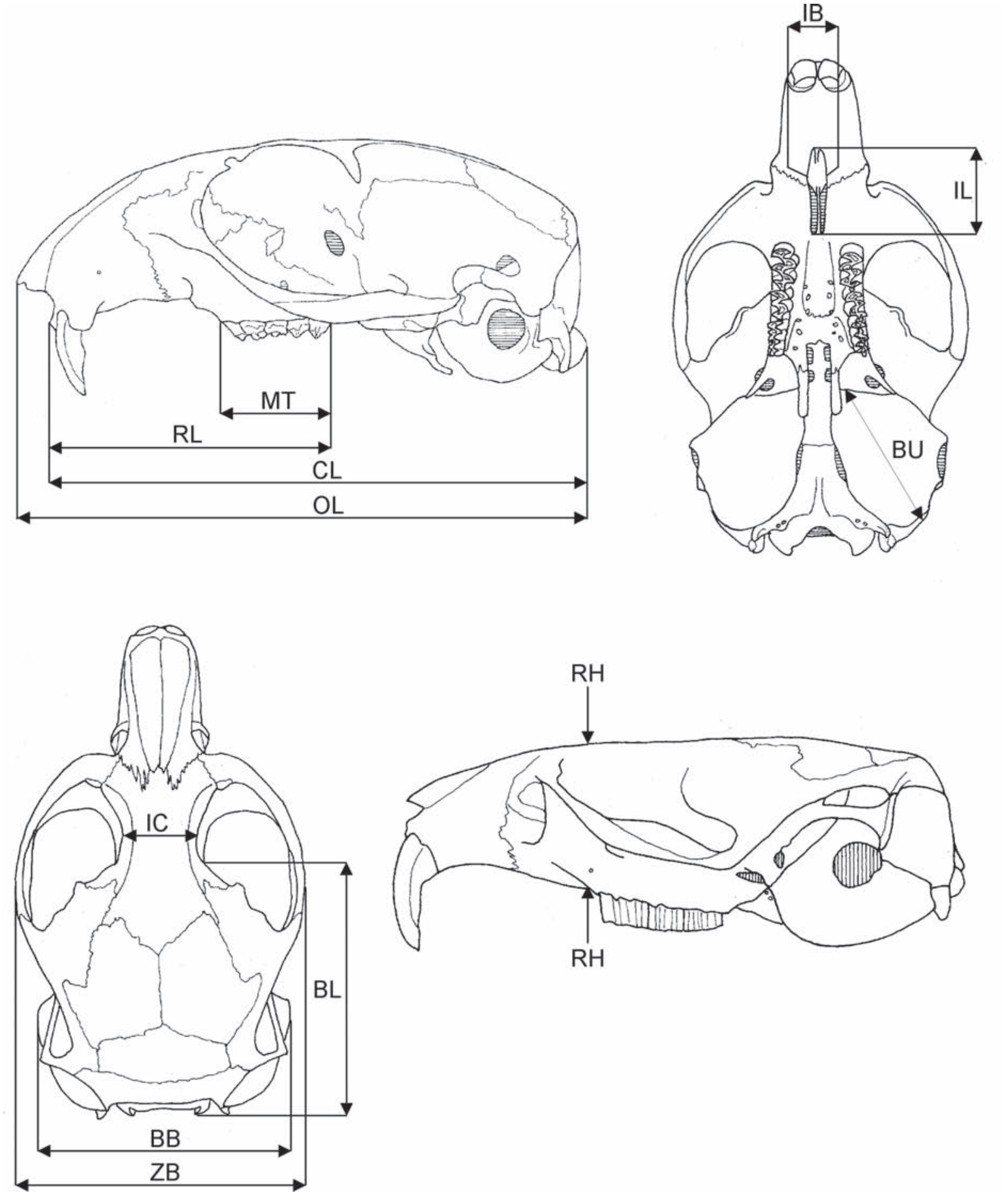


Figure 1. Dimensions measured on the rodent skull (dental measurements are not shown).
CL – condylobasal length of skull; **OL** – occipito-nasal length of skull; **RL** – length of rostrum; **ZB** – zygomatic breadth of skull; **MT** – maxillary tooth-row length (alveolar); **BB** – braincase (neurocranium) breadth; **BL** – length of braincase (neurocranium); **IC** – interorbital constriction; **RH** – height of rostrum; **BU** – length of bullae; **IL** – length of incisive foramen; **IB** – breadth of incisive foramens.

E.g.: M1 and m3 denote the 1st upper and the 3rd lower molar, respectively. Note that rodents lack canines. Abbreviations are as follows:

I/i	upper/lower incisors
P/p	upper/lower premolars
M/m	upper/lower molars

Of the type material, we examined 37 specimens (28 holotypes, four syntypes and five paratypes), representing 23 nominal species. Twenty types were from Turkey. The remaining specimens originated from adjacent regions but were of value in understanding the taxonomic position of rodents in Turkey. The type material is kept in the following collections (number of specimens in parentheses): BMNH (28), ZFMK (3), NMW (2), SMF (2), OMU (1), and ZSM (1). The type material is listed by the name under which it was originally published and reported. Small capital letters denote the valid species names. The collection acronyms and numbers are given as labelled on each specimen; preserved material is given in parentheses.

SCIURUS ANOMALUS

Sciurus historicus
Syntypes: BMNH 60.4.17.3 and 60.4.7.4 (two skins).

Sciurus syriacus* var. *pallescens
Holotype: BMNH 56.9.3.10 (skin and broken skull).

SPERMOPHILUS XANTHOPRYMNUS

Citillus xanthoprymna
Holotype: BMNH 55.12.24.131 (skin (without tail) and broken skull with teeth lost).
Note: the type specimen of unknown sex was captured on June 10, 1835, and subsequently kept in captivity where died on March 11, 1837.

ALLACTAGA ELATER

Allactaga aralychensis
Paratype: BMNH 1.11.27.7 (skin and skull).

ALLACTAGA WILLIAMSI

Allactaga williamsi
Holotype: BMNH 97.6.4.18 (skin and skull).

Allactaga williamsi caprimulga
Holotype: BMNH 47.373 (skin and skull)

ALLACTAGA EUPHRATICA

Allactaga euphratica
Holotype: BMNH 50.10.21.10 (skin and damaged skull).

GLIS GLIS

Glis glis spoliatus
Holotype: BMNH 6.5.1.38 (skin and skull).

MUSCARDINUS AVELLANARIUS

Muscardinus trapezius
Holotype: BMNH 6.5.1.40 (skin and skull).

Muscardinus avellanarius abanticus
Paratypes: ZFMK 83.127 and 83.128 (skins and skulls).

DRYOMYS NITEDULA

Dryomys nitedula phrygius
Holotype: BMNH 5.10.6.1 (skin and slightly damaged skull).

Myoxus pictus
Holotype: BMNH 74.11.21.44 (specimen in alcohol; skull extracted, badly damaged).

Dryomys robustus
Holotype: BMNH 11.16.8.1 (specimen in alcohol; skull extraxted, damaged in the orbital region).

DRYOMYS LANIGER

Dryomys laniger
Holotype: SMF 33,830 (skin and partially damaged skull).

ELIOMYS MELANURUS

Eliomys (Myoxus) melanurus
Holotype: ZSM 154 (stuffed without skull).

MYOMIMUS ROACHI

Philistomys roachi
Holotype: BMNH M15279 (the right half of the anterior portion of a skull).

ELLOBIUS LUTESCENS

Ellobius lutescens
Holotype: BMNH 97.6.4.17 (skin and skull).

Ellobius woosnami
Holotype: BMNH 5.10.4.65 (skin and skull).

CLETHRIONOMYS GLAREOLUS

Evotomys ponticus
Holotype: BMNH 6.3.6.173 (skin and skull).

ARVICOLA TERRESTRIS

Microtus terrestris armenius
Holotype: BMNH 97.6.4.10 (skin and skull).

MICROTUS SUBTERRANEUS

Pitymys majori fingeri
Holotype: NMW 18,789 (skin and damaged skull).

MICROTUS MAJORI

Microtus (Pitymys) majori
Holotype: BMNH 6.3.6.148 (skin and skull).

MICROTUS GUENTHERI

Arvicola guentheri
Two syntypes: BMNH 80.4.9.21 (skin and broken skull); BMNH 80.4.9.22 (broken skull).

Microtus (Microtus) hartingi
Holotype: BMNH 93.4.5.1 (skin and skull).

Microtus lydius
Holotype: BMNH 5.10.6.8 (skin and skull with right bullae missing).

Microtus philistinus
Holotype: BMNH 14.1.16.1 (skin and damaged skull).

MICROTUS DOGRAMACI

Microtus dogramaci
Holotype: OMU 506 (skin and skull).

MICROTUS ANATOLICUS

Microtus anatolicus
Holotype: ZFMK 99.926 (skin and skull).

MICROTUS IRANI

Microtus irani
Holotype: BMNH 20.5.20.9 (skin and skull).

CHIONOMYS NIVALIS

Microtus pontius
Holotype: BMNH 5.10.4.53 (skin and skull).

Microtus (Chionomys) nivalis cedrorum
Paratypes: SMF 36.481, 36.483 (skins and skulls).

Chionomys nivalis spitzenbergerae
Holotype: NMW 13,271 (skin and skull).

CHIONOMYS ROBERTI

Microtus roberti
Holotype: BMNH 6.3.6.132 (skin and skull)

CHIONOMYS GUD

Microtus (Chionomys) gud lasistanius
The holotype (No. 2231), which was deposited in the Berlin Museum, was destroyed during the World War II. The same was the fate of the topotypical material, of which is preserved only a single specimen in BMNH (Steiner, 1972). We saw that specimen (a skin; BMNH 1937.6.22.1) on October 1998. According to a note on the label there should be also a skull and Ellerman (1948) published its condylobasal length (= 27.3 mm).

OWN MATERIAL AND DATA COLLECTED IN THE FIELD. We frequently travelled to Turkey between 1992 and 1995 and again in 2004 and 2005 for at least one month/visit. In addition, the material collected on various expeditions to the Near East by the students of Charles University was at our disposal. This material is kept in the mammal collection of the Department of Zoology, Charles University, Prague, Czech Republic.

Animals were caught using snap traps (commercial kill traps and a modified version of the museum special break back traps) as well as live traps (Elliot, Chmela, Rödl). The traps were invariably set in the late afternoon or in the evening and collected next morning; in exceptional cases they were left in place during the next day. Our aim was to obtain representative samples of the local small mammal faunas.

Consequently, the traps were placed where captures were likely to occur. The traps were usually arranged in lines and spaced *c.* 5–7 m apart. Cotton wick roasted with a mixture of sunflower oil and flour or a mixture of tinned fish and oat flakes was used as bait. Road kills also contributed voucher specimens. Each specimen was measured and then either prepared immediately in the field or stored in a 4% solution of formaldehyde or ethanol for later laboratory processing. Skulls were cleaned by *Dermestes* beetle larvae.

Part of the material was karyotyped; chromosomes were prepared directly from the bone marrow of colchicine-treated animals and flame dried (Ford & Hamerton, 1956). Tissue samples were stored in liquid nitrogen or in alcohol for subsequent electrophoretic and molecular studies.

The following measurements were taken:

H&B	head and body length (from the snout to the anus)
TL	tail length (from the anus; terminal hair excluded)
HF	hind foot length (claws excluded)
E	ear length (terminal hair excluded)
W	weight

The measurements were taken to the nearest millimetre (H&B, TL) or to the nearest 0.1 mm (HF, E); weight was scored to the nearest gram.

All specimens were examined for their reproductive condition. In males we checked the position of testes (scrotal or abdominal). Females were inspected for the presence of nipples, and the condition of their uterus and number and size of embryos were recorded.

When collecting small mammals in Turkey and Cyprus it seemed that there was a substantial variation in the trapping success among regions. During our field research, population densities were high in Thrace, the Pontic Mts., the Marmara and the Aegean regions and in Central Anatolia, but mainly low in the Taurus Mts. With rare exceptions, rodents predominated over insectivores. Among the 2,327 small mammals collected in Turkey between 1993 and 1995, 2,017 were rodents (*i.e.* 86.7%), and we got them in every site trapped.

ORDER: RODENTIA

Rodents are herbivores of predominantly small to medium size; large species with body mass over 20 kg are rare. They are characterised by a peculiar dentition consisting of one pair of ever-growing incisors in each jaw and a set of chewing teeth (premolars and molars); between the incisors and the chewing teeth there invariably is a diastema, and canines are always absent (Fig. 1). There are never more than 22 teeth (up to 20 in Turkish species). The incisors are chisel-like and evergrowing; their enamel is reduced to the outside surface only. The chewing teeth are bunodont and brachiodont in primitive forms, lophodont and hypsodont in more advanced ones, and even evergrowing in the most specialised herbivores. The glenoid fossa is an anterior-posterior, thus allowing fore and aft movements of the mandible. The coronoid process is well developed in primitive forms and reduced in the most evolved ones. The masseter muscles are large, providing most of the power for chewing and mastication. Most species are of generalised saltatorial plan, but rodents have also evolved strictly subterranean, advanced bipedal, and gliding types, the latter being not found among the rodents of Turkey, however. They are mainly terrestrial or semiarboreal; semiaquatic forms are less common. In nearly all the terrestrial ecosystems rodents are the dominant mammalian group. Many species, particularly those of the family Muridae, are r-strategists, short lived and highly prolific, and their populations are prone to great oscillations in numbers.

The monophyly of the Order Rodentia is well supported, both morphologically and genetically. Lagomorphs are its most probable sister group. Conventionally, the orders Rodentia and Lagomorpha are placed in the Cohort Glires and further in the Supercohort Euarchontaglires (Bronner *et al*., 2003). Supraspecific-level clasification of the Order Rodentia remains controversial because of common parallelisms. The division into two suborders (Sciurognathi and Hystricognathi), which dates back to Tullberg (1899), is the most commonly applied (e.g. Wilson & Reeder, 1993).

Rodents are of worldwide distribution, with the exception of the Antarctica and some isolated islands. Wilson & Reeder (1993) list 2021 species, but new species have been described since. For Turkey and Cyprus we list 60 species (Kryštufek & Vohralík, 2001) but this number is certainly not final.

Rodents received greater attention in the study area than any other mammalian group. A considerable amount of information has accumulated therefore. Most of the studies focus on their taxonomy and the distribution, less so on the ecology of individual species. Many species have been studied karyologically and genetic makeup has been investigated in some genera and species groups. No need to say, numerous taxonomy questions remain open for further studies. Sixty new names have been proposed from Turkey and Cyprus, fourteen of which represent valid species. The only comprehensive revisions of Turkish rodents above the generic level are by Osborn (1962, 1964, 1965). Spitzenberger (1978) revised the rodents of Cyprus.

The following general works deal with rodents from the regions adjacent to Turkey and Cyprus:

EUROPE. Niethammer & Krapp (1978, 1982): Comprehensive review of all European species with detailed descriptions, measurements and drawings of skulls and dentition; distributional maps; biological data; out of date in some respects (in German). Mitchell-Jones *et al.* (1999): Distributional atlas with species accounts and drawings of animals (in English).

RUSSIA. Gromov & Erbajeva (1995): Comprehensive review of all rodents living in Russia, with descriptions and determination keys; drawings, photographs and distribution maps for some species; biological data (in Russian).

GREECE. Ondrias (1966): Comprehensive review with descriptions, determination keys, measurements and maps; out of date in some respects (in English).

BULGARIA. Popov & Sedevčev (2003): Popular guide covering all Bulgarian mammals; descriptions, drawings of skulls; colour plates; tentative distributional maps; biological data (in Bulgarian).

THE CAUCASUS. Šidlovskij (1976): Review of all rodents of the Caucasus region, with descriptions, determination keys, detailed maps and biological information; out of date in many respects (in Russian).

GEORGIA. Bukhnikashvili & Kandaurov

(1998): Rare and threatened species of Georgia, with descriptions, biological data and distributional maps (in English).

IRAN. Lay (1967): Report on the Street Expedition of 1962-63; descriptions, distributional and biological data (in English). Etemad (1978): descriptions, drawings of skulls & photographs of animals and habitats; distributional maps (in Farsi).

ARABIA. Harrison & Bates (1991): Detailed and comprehensive work dealing with all rodents of the Arabian Peninsula and also covering parts of Turkey; keys, descriptions, photographs and drawings of animals, skulls, dentition, and habitats; biological information; maps (in English).

EASTERN MEDITERRANEAN REGION: Attalah (1977, 1978): Descriptions, biological and distributional data; measurements. The area covers the Mediterranean coasts just south of Turkey and to the north of Sinai (in English). Qumsiyeh (1996): Detailed and comprehensive treatment of all the rodents of the "Holy land" (*i.e.* Israel and Jordan with the adjacent parts of Syria and Saudi Arabia), with descriptions; photographs of animals; information on biology, local status and genetics; distributional maps (in English).

KEY TO SUBORDERS

1 Coronoid process absent; enlarged angular process bends laterally; size large (over 3 kg) — Hystricognathi

1* Coronoid process present; angular process not pronouncedly bent; size small (less than 3 kg) — Sciurognathi

SUBORDER: SCIUROGNATHI

A dominant group of rodents which also includes all the species in Turkey, with the exception of one indigenous and another exotic species (neither is treated in this volume). Sciurognathous rodents are characterised either by a sciuromorphous or myomorphous zygomasseteric specialisation. Infraorbital foramen is either small, enlarged but slit like or, exceptionally, large and circular. Four families have representatives in Turkey and Cyprus.

KEY TO FAMILIES

1 Infraorbital foramen small; postorbital process well developed — Sciuridae

1* Infraorbital foramen of medium size or large; postorbital process missing — 2

2 One premolar present in maxilla; four pairs of cheewing-teeth in upper jaw — 3

2* Premolars absent in maxilla; three pairs of cheewing-teeth in upper jaw (all molars) — Muridae

3 One premolar present in mandible (four chewing-teeth) — Gliridae

3* Premolars absent in mandible (three chewing-teeth, all molars) — Dipodidae

FAMILY: SCIURIDAE HEMPRICH, 1820

Rodents of medium to fairly large size (small species are rare) with hairy tail. Body slender in arboreal forms and robust in terrestrial ones. Skull frequently deep with a short rostrum; infraorbital foramen small and postorbital processes strong. Palate is broad. Mandible is robust, all the process being powerful. Cheek teeth are brachyodond and rooted; there are 1–2 premolars in upper jaw and one in mandible. Squirrels are predominantly diurnal and only the gliding forms are nocturnal. The family is widely distributed over Europe, Africa, Asia, and both Americas. Squirrels range from the tundra and semideserts to the rainforest. Currently, 273 species are recognised (Hoffmann *et al.*, 1993) in 50 genera and two subfamilies (Sciurinae and Petauristinae). Two genera with two species each occur in Turkey; both belong to the subfamily Sciurinae. These rodents are absent from Cyprus.

So far, the only comprehensive review of squirrels of Turkey is by Osborn (1964).

KEY TO GENERA

1 Form slender, tail longer than half head and body length, flattened and bushy (hairs > 1 cm); ear long (> 20 mm); incisors compressed (the width of anterior face *c*. one half of that of lateral face); 3rd upper premolar minute or absent; crowns of upper molars nearly square *Sciurus*

1* Form more robust, tail shorter than half head and body length, rounded and not much bushy (hairs < 1 cm); ear short (mainly < 10 mm); incisors not compressed (the width of their anterior face about equal to that of the lateral face); 3rd upper premolar well developed; crowns of upper molars more triangular *Spermophilus*

SUBFAMILY: SCIURINAE HEMPRICH, 1820

GENUS: *SCIURUS* LINNAEUS, 1758

These squirrels are strictly arboreal, living in coniferous taiga, deciduous forests, and in rainforests of the Holarctic, Oriental and northern Neotropical region. Of 28 species only three are native to the Palaearctic region; two of them occur in Turkey. Within the frame of the current generic division of Sciuridae, the genus *Sciurus* is likely paraphyletic with respect to *Microsciurus* (Herron *et al*., 2004).

The Turkish squirrels belong to two subgenera (Corbet, 1978; Hoffman *et al*., 1993), the nominate one (*S. vulgaris*) and *Tenetes* Thomas, 1909 (*S. anomalus*). *Tenetes* differs from *Sciurus* (*senso stricto*) in having four instead of five upper cheek-teeth,

Figure 2. European red squirrel *Sciurus vulgaris*. Drawing: J. Hošek.

the extra small premolar being missing (Ellerman & Morrison-Scott, 1951). Ognev (1966) also lists the following characters of *Tenetes* as being distinctive from *S. vulgaris*: (1) colour stable across seasons, (2) belly buff (never white), (3) hind foot with six pads (four in *S. vulgaris*), (4) ten nipples (eight in *S. vulgaris*), (5) differences in a premolar crown structure, and (6) shape of baculum.

KEY TO SPECIES

1 Fur silky; belly white; two upper premolars present (five cheek teeth in each maxillary bone) *S. vulgaris*

1* Fur harsh; belly buff; single upper premolar (four cheek teeth in maxillary bone) *S. anomalus*

EURASIAN RED SQUIRREL – *SCIURUS VULGARIS*

Sciurus vulgaris Linnaeus, 1758. Type loc.: Uppsala, Sweden.

DESCRIPTION

EXTERNAL CHARACTERS. Medium-sized, slender tree squirrel, with long and flattened bushy tail nearly as long as head and body (81–98% in a sample from Turkish Thrace). Head large, convex in profile, with deep and relatively short muzzle. Eyes large and ears fairly long, with pronounced tufts characteristic of the winter fur (Fig. 2). Markov (1960) recorded the tufts in Bulgarian squirrels between October 2nd and May 28th, while specimens collected from June 4th to September 12th lacked them. In summer pelage, the back hairs of Thracian red squirrels are up to 15 mm long (some sparse black-tipped hairs are longer) and tail hairs measure up to *c*. 60 mm; winter pelage is longer. Fore feet long and slender, with four fingers; thumb is reduced. Hind feet much longer than front ones, slender as well and with five fingers. Strong claws are approximately nine millimetres long. Soles are partly bare in summer but heavily furred in winter; four small pads at the toe bases.

COLOUR. Markov (1960, 1961) distinguished two colour phases: the pale and the dark one. The pale phase has upper side chestnut brown to red brown in summer pelage and grey brown, or a mix of chestnut brown and grey in winter coat. The dark phase is dark chestnut brown to black brown in summer and dark chestnut brown to grey brown in winter. Belly ivariably pure white, but frequently there is a reddish stripe along the flanks; the stripe is always paler than the back. The back tends to be indistinctly bi-coloured, greyer in its posterior part (Markov, 1960). The tail is darker than the back, being black brown or blackish in the dark phase and black chestnut or red-brown in the pale phase. Both phases occur in the European Turkey. Ear tuft is chestnut brown, chestnut black, red brown, dark chestnut, or red brown in Bulgarian squirrels (Markov, 1960).

NIPPLES. There are eight nipples, one pair each of pectoral and inguinal and two abdominal pairs between.

BACULUM has a broad base, thick body and an axe-shaped distal spatula. It is 9–10.1 mm long in French red squirrels (Didier, 1952). A sharp, tooth-like projection on the dorsal side of spatula is more prominent than in the Caucasian species (Fig. 3). The baculum has never been described in red squirrels from the Balkans.

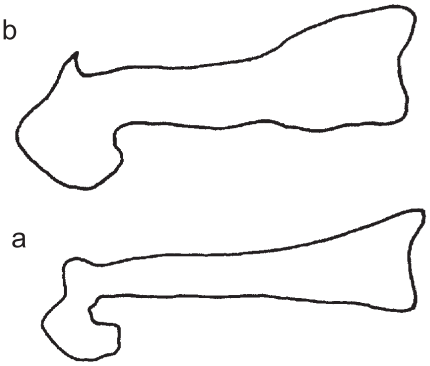


Figure 3. Baculum (in lateral view) of two squirrel species living in Turkey: *Sciurus anomalus* (**a**) and *S. vulgaris* (**b**). Dorsal is up and distal is to the left. Modified from Didier (1952) and Özkurt *et al.* (1999b). Not to scale.

SKULL broad and rounded, with a short, broad and deep rostrum and heavy zygomatic arches (Fig. 4). Zygomatic breadth makes up 60–70% (mainly 65–67%) of condylobasal length. Nasals broad with blunt anterior tips. Interorbital region broad, incisive foramen short and hard palate protrudes posteriorly behind 3rd

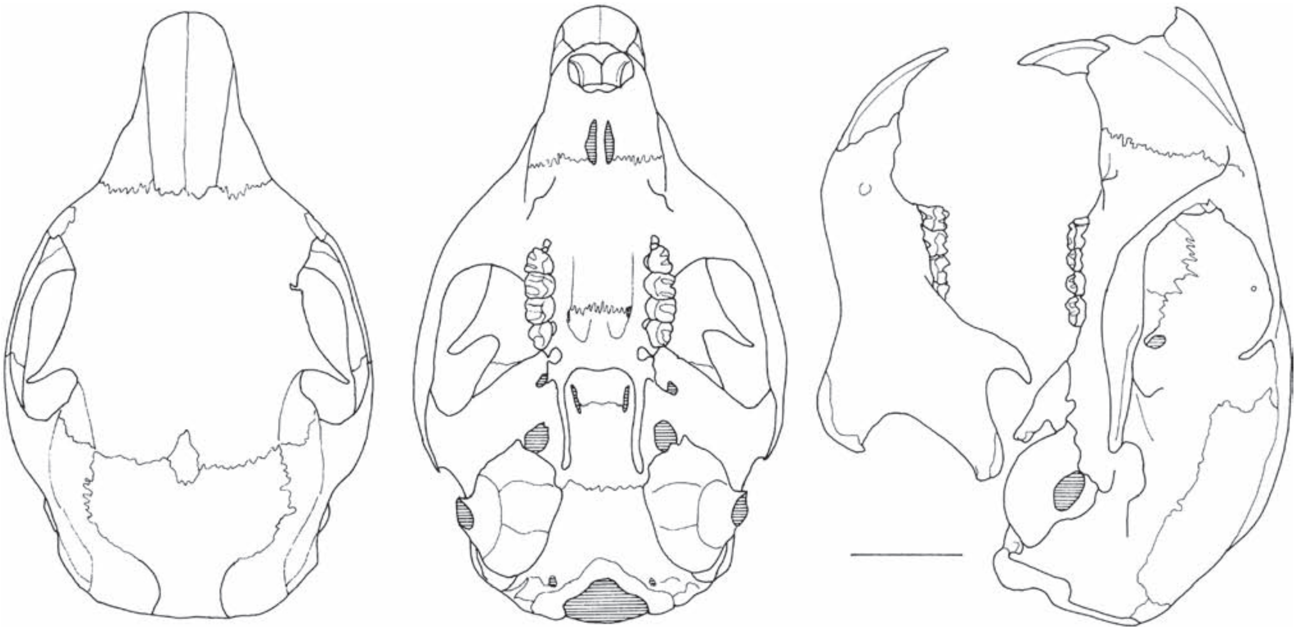


Figure 4. Skull and mandible of *Sciurus vulgaris*, based on an adult male from Velikaköprü, Demirköy district, European Turkey (TUE). Scale bar = 10 mm.

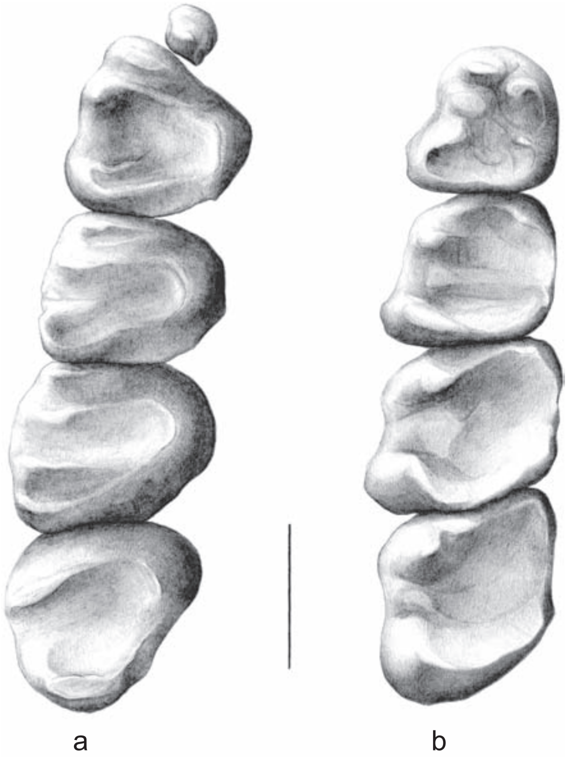


Figure 5. Upper (**a**) and lower cheek-teeth (**b**) in *Sciurus vulgaris*. Same specimen as in Fig. 4. Lingual side is to the right, anterior is at the top. Scale bar = 2 mm. Drawing: S. Prokešová.

molars. Interpterygoid space broad, rounded bullae of moderate size. Dorsal profile rounded and braincase is particularly convex posterior to the postorbital process. Mandible heavy and all three processes well developed.

TEETH. Incisors, the lower ones in particular, short and robust; enamel on front side orange. In the upper jaw the reduced 3rd premolar is followed by four brachyodont molariform teeth (the 4rd premolar and three molars) of fairly similar size and shape. In subadult skulls, with the 4th premolar still emerging through the bone, the 3rd premolar is not always visible. There are four molariform teeth of semi-equal size also in the mandible. Major portion of crown, as viewed on occlusal surface, has a smooth central depression bordered by a buccal and a mesial ridge of fused cusps. Crowns squarish in outline (Fig. 5). Dental formula: 1/1, 0/0, 2/1, 3/3 = 22.

DIMENSIONS. The external and cranial dimensions of Thracian and Bulgarian red squirrels are listed in Tables 1 and 2. In the lack of secondary sexual dimorphism, we pooled the sexes. Slight differences in external characters between the two samples most likely reflect inconsistencies among various collectors in scoring data. Mursaloğlu (1973a) published dimensions of ten Turkish squirrels but she evidently pooled the sample from Thrace with the one from eastern Anatolia which includes descendants of squirrels introduced to the Caucasus from Russian Asia: body mass (in grams): 219–323 (mean = 255.2), total length (in mm): 395–450 (mean = 426.1), tail length: 179–216 (mean = 196.7), hind foot length: 66–70 (mean = 67.7), ear length: 31–36 (mean = 31,6), occipitonasal length: 53.2–57 (mean = 54.6), zygomatic breadth: 31.3–34.1 (mean = 32.4). Heinrich (1936) gives external dimensions of a female from the Bulgarian side of Mt. Istranca (the type of ssp. *istrandjae*; see below): head and body length 218 mm, tail length 200 mm, hind foot length 62 mm, ear length 24 mm.

Sex	N	mean	min–max
Head and body	10	218.6	201–234
Tail	10	195.4	188–210
Hind foot	10	62.3	58–65
Ear	10	30.9	27–34
Weight	6	331.7	250–415
Condylobasal length	6	49.1	47.1–50.3
Zygomatic breadth	6	31.7	30.0–32.7
Maxillary tooth-row	8	9.4	9.1–9.8

Table 1. External and cranial dimensions of *Sciurus vulgaris* from Turkish Thrace. Based on Kurtonur (1972) and TUE material.

	N	mean	min–max
Head and body	135	228.9	180–265
Tail	135	184.0	150–230
Hind foot	135	58.3	50–65
Ear	130	29.7	20–38
Condylobasal length	140	48.0	44.0–51.0
Zygomatic breadth	137	31.8	27.0–34.0
Maxillary tooth-row	140	10.1	9.0–11.0

Table 2. External and cranial dimensions of *Sciurus vulgaris* from Bulgaria. Based on data in Markov (1960).

CHROMOSOMES. The European red squirrel has the diploid number of chromosomes 2N = 40 and the fundamental number of autosomal chromosomal arms NFa = 72 (Zima & Král, 1984). Squirrels from Turkey have not been karyotyped so far.

VARIATION

THRACIAN SQUIRRELS. Markov (1960, 1961) states that the incidence of the two colour phases, which he recognised among Bulgarian squirrels coincide with climatic conditions. The darker phase is increasingly more common with the decrease in mean annual temperature and the increase in precipitation. In the mountains of southern Bulgaria (Mt. Rila, the Rhodope Mts.) the proportion is 80% and 73% respectively. Tail colour follows the same pattern as that on the back. Size is evidently less prone to geographic variation in Bulgaria, and Markov (1960) did not detect appreciable differences among four samples; mean condylobasal length of skull varied between 47.9 and 48.5 mm (sample sizes N = 28–53).

Heinrich (1936) distinguished squirrels from the Strandža Mts. in Bulgaria as a separate subspecies *S. v. istrandjae* (type loc.: Karamlik; note that this is given as Karamlek in the original description). The description was based on two specimens collected on July 30th, 1935, and diagnostic characters involve coloration (brown grey back with reddish tinge, flanks with a yellowish brown belt which intergrades through yellow into a white belly) and the absence of ear tufts. The lack of ear tufts is a normal condition in a summer pelage of *S. vulgaris* (see above), while colouration is highly variable in this species. Miller (1912) distinguished the European subspecies of *S. vulgaris* mainly on the basis of coloration. In his opinion “Though the actual colour shows great differences according to phase and season the pattern is constant and characteristic” (Miller, 1912). Contrary opinions were expressed by subsequent authors; for example, Chaworth-Musters (1932) states: “The phases of *S. v. fuscoater* are so complicated and so variable that without enormous series the splitting up of the common squirrel into races, based on colour alone, is in my opinion exceedingly risky.” The distribution of colour phases and their frequency within populations certainly shows a geographic pattern (Wiltafsky, 1978), the possibility of recognising discrete races on the basis of this trait remains open, however. As is evident from the map in Wiltafsky (1978: Fig. 25), the eastern Balkans, including Bulgaria and Turkish Thrace, is characterised by the “intermediate” colour phase (i.e. the phase between the red and the black extremes) as opposed to the western Balkans where the black and the intermediate phases co-occur. The conclusion by Wiltafsky evidently concurs with the situation in Bulgaria, following data by Markov (1960). Moreover, the eastern Balkan squirrels are characterised by fairly large

	S. v. exalbidus			*S. v. altaicus*		
	N	mean	min-max	N	mean	min-max
Head and body	23	241.9	214-293	15	226.3	200-240
Tail	22	198.2	184-222	15	157.4	140-170
Hind foot	22	62.9	56.1-66.5	14	53.1	50.0-65.0
Ear	22	34.4	30.9-38.8	15	26.2	20.0-30.0
Weight	22	435.9	363-487			
Condylobasal length	24	52.0	50.0-53.2	16	46.5	45.0-48.5
Zygomatic breadth	24	34.9	33.1-36.2	17	29.8	28.2-31.8
Maxillary tooth-row	24	10.4	10.0-11.1	17	9.1	8.8-9.9

Table 3. External and cranial dimensions of two subspecies of *Sciurus vulgaris* which were introduced to the Caucasus. Data are from their original distributional areas, i.e. SW Siberia and the Altai Mts., respectively. Based on Ognev (1966).

skulls (mean condylobasal length = 48.0–49.9 mm; Wiltafsky, 1978), again in accordance with the data by Markov (1960; cf. also Table 2). Markov (1960) recognised only one subspecies in Bulgaria, i.e. *S. v. balcanicus* Heinrich, 1936 (type locality: lower stretches of the Kamčija River, eastern Balkan Mts., eastern Bulgaria) and considered ssp. *istrandjae*, in addition to *S. v. rhodopensis* Heinrich, 1936 (type locality: Čepelare, central Rhodopian Mts., southern Bulgaria) as its junior synonyms. Although this step seems to be well founded, one should not ignore the fact that *istrandjae* has page priority over *balcanicus*. However, in order not to further confuse the subspecific nomenclature of the European red squirrel, we accept Markov's solution on the principle of the first reviser. We therefore consider squirrels from Turkish Thrace to belong to *S. v. balcanicus*.

INTRODUCED SQUIRRELS. Two subspecies were introduced to the Caucasus, similarly as were the squirrels in northeastern Anatolia (see below): *S. v. altaicus* Serebrennikov, 1928 (first translocated in 1928) and *S. v. exalbidus* Pallas, 1778 (in 1951 and 1953; Šidlovskij, 1976). The Teleut squirrel *S. v. exalbidus* (type loc.: "isolated pine forests along the Rivers of Irtysh and Ob; Ognev, 1966) is a large pale-coloured subspecies (cf. Table 3). Winter fur of very long hair is light buff-grey with greyish mottling and the tail is pale grey; summer pelage is pale ochre-yellow, white area of the belly is extensive, and ear tufts are orange-cinnamon (Ognev, 1966). This subspecies occupies an extensive area of pine forests along the Ob River and spreads further east as far as the Yenisey River. The year of Pallas's publication of *exalbidus* is quoted either as 1778 (Trouessart, 1910; Ognev, 1966) or as 1779 (Ellerman & Morrison-Scott, 1951; Pavlinov & Rossolimo, 1987). The year of publishing in the original work by Pallas is 1778, but the reason for the above discrepancy is not know to us.

The Altai subspecies S. *v. altaicus* (type loc.: estuary of the Yamanuch River, Kok-Su River, the Altai Mts.) is only poorly differentiated from *S. v. jenissejensis* Ognev, 1935 (type loc.: Lower Tunguska River, Turuchansk, Siberia). Back is dark grey, occasionally with ash shade and white area of the belly is much restricted. Tail is either black or chestnut in colour. This form is native to the Altai Mts. and the Sayan Mts. of central Asia (Gromov & Erbajeva, 1995).

Colour of Anatolian squirrels is poorly documented. The two individuals, observed by us in September 1995 near Ardanuç, had reddish back and greyish tail. Diker (2003) photographed a specimen near Sarıkamış in pale grey winter hair with orange-cinnamon tufts, which suggests the Teleut squirrel (see p. 50 in Diker, 2003).

On the basis of colour variation and fur length, Kandaurov *et al.* (1994) concluded that hybridisation took place in the Caucasus Mts. Contrary to this, Gromov & Erbajeva (1995) claim that *S. v. altaicus*, introduced to the Caucasus, changed in a similar way as did *S. v. exalbidus*, introduced to the Crimea, i.e. hairs more rough and pelage more reddish.

DISTRIBUTION

The most widely distributed Palaearctic squirrel, ranging from the Atlantic and the Mediterranean coasts of Europe to the Pacific coasts of Russia, China and Korea. Its range mainly coincides with that of deciduous and boreal forests while it is missing from the steppe zone and the tundra.

THRACE. Osborn (1964), who was still not aware of the red squirrel's presence in Thrace, tentatively included it into the list of Turkish mammals on the basis of Heinrich's (1936) report for Karamlik, the Istranca Mts., Bulgaria. Besides, Osborn (l.c.) indicated red squirrels as possibly occurring in the easternmost Thrace on the base of an "unidentified sight record" (cf. Fig. 3 on p. 577 in Osborn, 1964). This record, however, is not commented in the text. First indisputable records were provided by Mursaloğlu (1973a) and Kurtonur (1975): Saka Longos near Demirköy, İğneada, Mahyadağı and Dereköy, all in Kırklareli district of northern Thrace. These data, however, were ignored by Wiltafsky (1978) who excluded the whole of European Turkey from the European range of the red squirrel. Turan (1984) tentatively maps the range to include the entire northern Thrace up to İstanbul, and Demirsoy (1996) includes the whole of Thrace. More noteworthy, Turan (l.c.) indicates the northern Marmara region as well as the adjacent parts of the western Pontic Mts., to be populated by the Eurasian red squirrel. Since maps by both, Turan and Demirsoy are frequently wrong in details, we ignored them in Fig. 6, relying on published localities instead. Doğramacı (1989a) reports the red squirrel from Thrace and for Artvin, and Kurtonur *et al*. (1996) from Erzurum and Artvin, in addition to Thrace (Edirne, Dereköy, and Demirköy).

Although the Atlas of European mammals shows all the 50 x 50 km squares of the UTM grid to include the red squirrel in south-eastern Bulgaria (with the exception of deforested parts of the Marica River valley; Mitchell-Jones *et al*., 1999), a more detailed dot map in Markov (1960) suggests the distribution area to be fragmented, evidently in consequence of the patchy distribution of forest fragments. In Greek Thrace, the red squirrel was recorded in the Evros (Meriç) River valley 5 km west to Turkish border (Vohralík & Sofianidou, 1992).

ANATOLIA. Mursaloğlu (1973a) reports the species for Artvin and Erzurum districts of the eastern Black Sea Mts: Düzkutul near Kutul, Karanlıkmeşe,

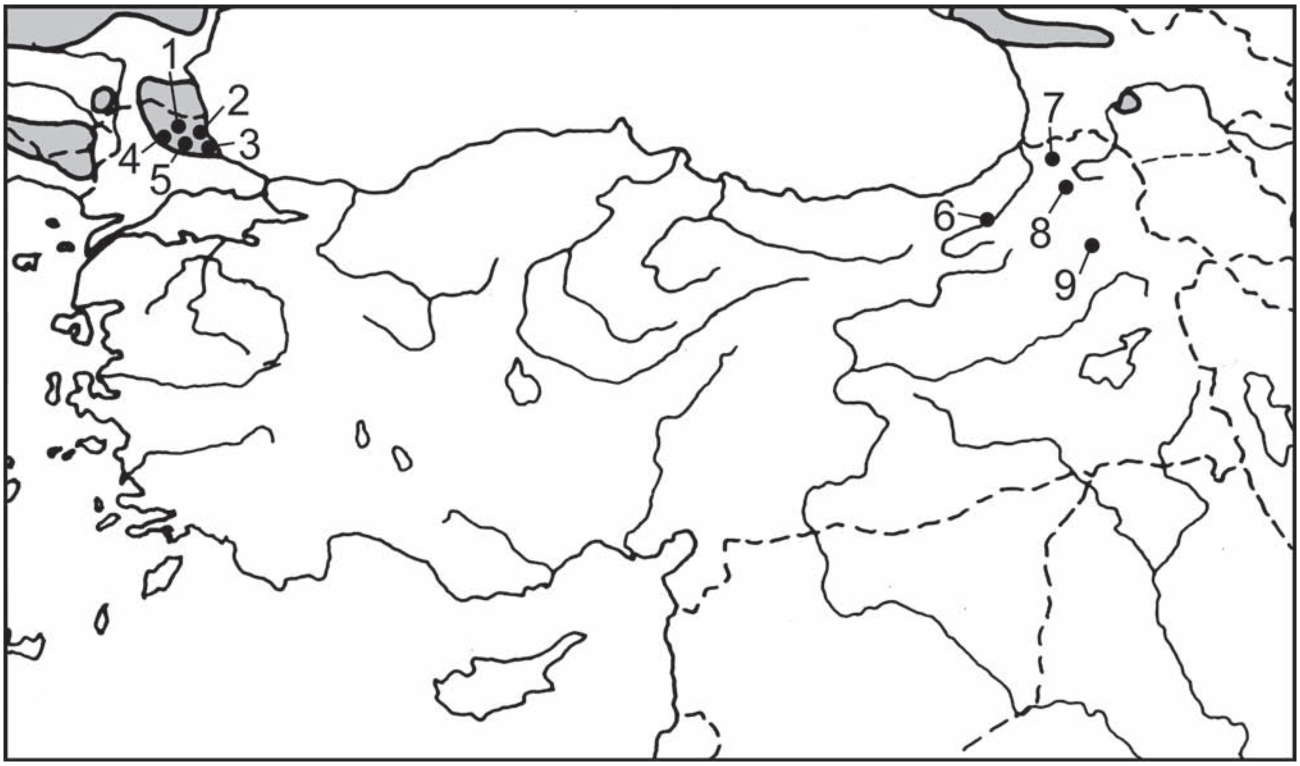


Figure 6. Distribution of *Sciurus vulgaris* in Turkey. Note that the species' presence in Asia is due to introduction. Records: **1** – Dereköy; **2** – Iğneada; **3** - Saka Longos; **4** – Mahyadağı; **5** – Demirköy; **6** – İspir, Erzurum; **7** – Düzkutul, Kutul, Artvin (= Kutul geçidi, Artvin); **8** – 10 km east of Ardanuç, Artvin; **9** – 5 km east of Sarıkamış, Kars. Corresponding references: Mursaloğlu (1973a): 3, 5, 6, 7. Kurtonur (1975): 1, 2, 4. Diker (2003): 9. Own observations: 8.

Kutul geçidi, and İspir. Diker (2003, and personal communication) photographed it near Sarıkamış. On September 1995 we observed two Eurasian red squirrels 10 km east of Ardanuç (district of Artvin). Occurrence of the species in the eastern Black Sea Mts. is a doubtless consequence of the species' introduction to the Caucasus; a conclusion like that was already drawn by Mursaloğlu (1973a).

Of the two subspecies introduced to the Caucasus, *S. v. altaicus* was first translocated in 1928 and *S. v. exalbidus* in 1951 and 1953 (Šidlovskij, 1976). The first introduction in 1936 to the Teberdinski zapovednik reserve (north-western Caucasus) was already successful and the squirrel expanded subsequently over the western part of the Greater Caucasus. Several more introductions followed in Georgia (Kandaurov *et al.*, 1994) and the most recent ones in the Caucasus are mentioned by Šidlovskij (1976) for 1951 in the Boržomski forest and for 1953 to Kabardino-Balkarija.

PALAEONTOLOGY. The Upper Pleistocene squirrels of Europe are mainly ascribed to the recent species (Kowalski, 2001). Records from the Balkan Peninsula are scarce and none is available from European Turkey.

HABITAT

THRACE. Kurtonur (1975) collected specimens in deciduous forests on the Istranca Mts. which are dominated by beech (*Fagus orientalis*), oaks (*Quercus pubescens, Q. cerris*) and *Philyrea latifolia*. This is a humid area receiving >800 mm of rainfall annually. Specimens were collected in elevations from close to the sea level up to 800–850 m (Kurtonur, 1972), but due to the range of forests one can expect this species to go also higher and reaching peaks of the mountain ridge (altitude of the highest peak = 1,030 m). On the Bulgarian side of the Istranca (= Strandža) Mts., Markov (1960) reports mature mountain forests of *Quercus peduncultata* and *Fagus orientalis* as the principal habitat. The red squirrel is apparently rare in the entire district of Burgas (which includes also the Strandža Mts. in Bulgaria) with a total of 6,369 reported kills between 1934 and 1947, i.e. 1.3% of the total harvest in Bulgaria. Such rarity also appears to be the case of this species in the European Turkey.

ANATOLIA. In the easternmost Pontic Mts. the red squirrel is said to live in coniferous forests at the elevation of approximately 1,900 m (Mursaloğlu, 1973a). It is very rare around Sarıkamış (H. Diker, personal communication). The Caucasian squirrel, another tree squirrel living in this part of Anatolia, is restricted to deciduous forests up to 1,000 m of elevation (Mursaloğlu, 1973a).

BIOLOGY

There is evidently no information on biology of the red squirrel in Turkish Thrace. In Bulgaria it feeds mainly on seeds, fungi, lichens, and berries (Markov, 1960). Seeds predominate in winter and in spring, while the summer and autumn food contains a lot of fungi and lichens as well. The nest (drey), constructed of twigs (30–40 cm in diameter, entrance hole 5–8 cm), is situated 3–15 m above the ground. Two litters occur in a year, in April and in July, respectively. Average litter size is 5–6, but can be higher in years of food abundance (6–8) and lower when food is scarce (3–4; Markov, 1960). The species is diurnal with the activity peak in the morning, when squirrels frequently seek for food also on the ground. In winter the activity peak is delayed (Markov, 1960). In his book on the rodents of Transcaucasia, Šidlovskij (1976) provides data on biology, yet it is not evident whether this is based on red squirrels living in the Caucasus or are simply general data.

CAUCASIAN SQUIRREL – *SCIURUS ANOMALUS*

Sciurus anomalus Gueldenstaedt, 1785. Type loc.: Sabeka, 25 km southwest of Kutaisi, Georgia.

TAXONOMY

Vinogradov & Gromov (1984) report this squirrel under the name *S. persicus* Erxleben, 1777.

DESCRIPTION

EXTERNAL CHARACTERS. Similar in size to the European red squirrel, but more robust and with relatively shorter tail (50–85 % of head and body length, mainly 65–76 %). Ears mostly lack tuft, although the ear tip occasionally has long hairs in winter (up to 11 mm); however, the tuft, if present, is sparse. Pelage dense and of coarse texture, 6–8 mm long on shoulders and 12 mm on rump. Winter hair longer, denser and darker (Felten *et al*. 1971b). Fore feet long and slender, with four fingers; thumb reduced. Hind feet longer than the front ones, also slender, and with five fingers. Blackish claws 7.1–8.6 mm long on front feet and 7.5–8.9 mm on hind ones. Bare palms have five pads, three of which are at the toes bases. Soles bare or covered with short hairs, the six pads invariably bare.

COLOUR. Hairs on upper side slate grey at base; tips black with white subterminal band, which gives grizzled appearance. Hairy nose and front of the head reddish, chestnut brown or dark brown. The entire back from between ears to the tail base is uniformly metal grey, but the posterior part is frequently much darker. Such a colour spreads also onto the proximal part of the tail. Shoulders intense red to reddish brown. In one extreme the red colour spreads from shoulders onto the back (thus restricting grey colour of the back to a band as narrow as is the distance between the ears) and along flanks onto the hips up to the heel. Lateral reddish band variable in extent as well as intensity, but there is invariably at least a narrow reddish stripe running from cheeks to heel and separating grey back from cream, yellowish, or buff belly. Storch (in Felten *et al*. 1971b) found colour to be subject to much variation, with the lateral stripe, the head and the shoulders being particularly prone to variation. Belly mainly buff, and hair bases either grey or cream. Bushy tail reddish brown to chestnut brown on dorsal side, frequently darker towards end. Tip blackish while hairs on the very tip are yellowish to buff. Ventral side of the tail is paler.

NIPPLES. On the museum skins we counted four pairs of nipples; Harrison & Bates (1991) and Ognev (1966) report this number to be five pairs.

BACULUM is of complex shape, with a broad and concave base and with an axed shaped tip (Fig. 3). It is approximately 1–1.5 cm long in specimens from the Island of Lesvos (Hecht-Markou, 1999). Özkurt *et al.* (1999b) found no differences in baculum shape between specimens from Anatolia and those from the Caucasus. Hecht-Markou (1999) also described *os clitoridis*.

SKULL approximately of same size and proportions as in the European red squirrel.

TEETH. The 3rd upper premolar is missing in the upper jaw, which gives dental formula 1/1, 0/0, 1/1, 3/3 = 20. Hecht-Markou (1994) gives the following number of roots for the cheeck teeth in *S. anomalus* from the island of Lesbos (anterior → posterior): 3-3-3-3 for the maxillary row and 2-4-4-3 for the mandibular one.

DIMENSIONS. External and cranial dimensions of squirrels from Anatolia are listed in Tables 4–6. In

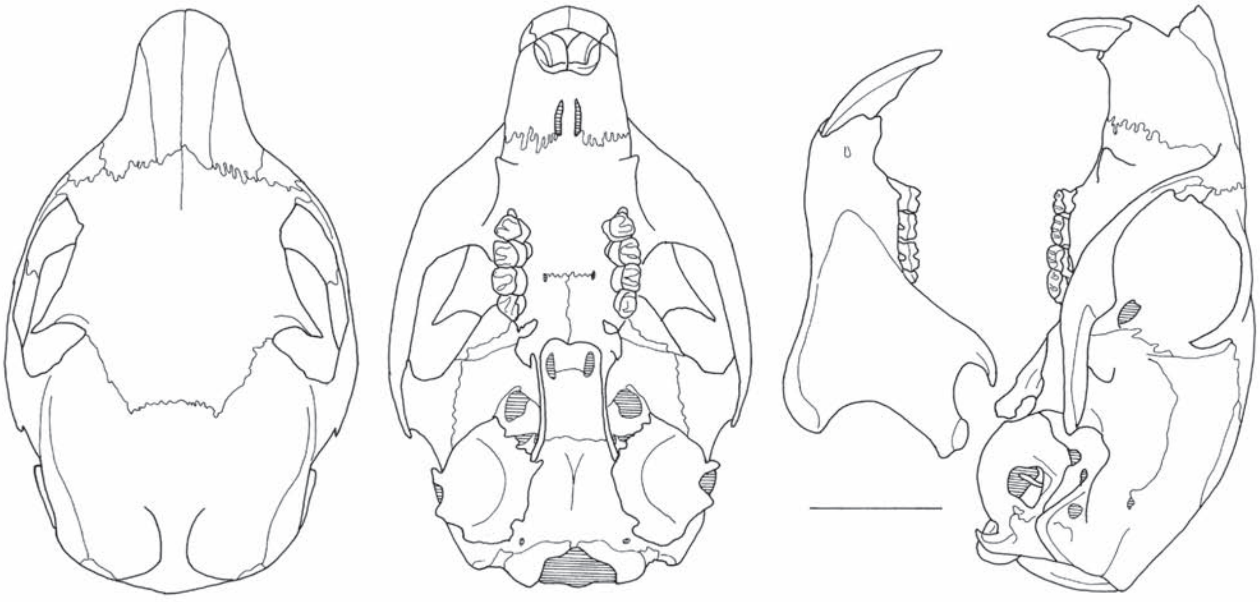


Figure 7. Skull and mandible of *Sciurus anomalus*, based on an adult male from Gölcük, İzmir district (SMF). Scale bar = 10 mm.

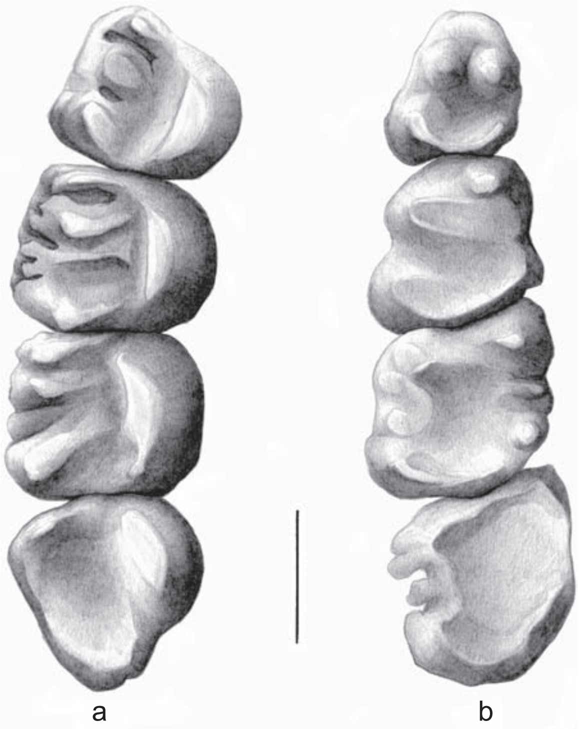


Figure 8. Upper (**a**) and lower cheek-teeth (**b**) in *Sciurus anomalus*. Same specimen as in Fig. 7. Lingual side is to the right, anterior is at the top. Scale bar = 2 mm. Drawing: S. Prokešová.

the absence of secondary sexual dimorphism (Özkan, 1995; cf. Table 4), we pooled the sexes. Özkan (1995) gives data on age variation among three age groups; as seen from Table 6 differences between subsequent age classes are modest.

CHROMOSOMES. The Caucasian squirrel has the diploid number of chromosomes 2N = 40 and the fundamental number of autosomal chromosomal arms NFa = 76. All autosomes are biarmed, the X chromosome is a large submetacentric and the Y chromosme is the smallest metacentric (based on Özkurt *et al*., 1999b). The same diploid number was also reported from Iran and Armenia; chromosomal morphology, however, varies among localities (Özkurt *et al*., 1999b).

	N	mean	min–max
Head and body	52	221.4	180–250
Tail	45	156.2	110–188
Hind foot	53	56.4	49–63
Ear	53	30.3	25–37
Weight	4	335	310–350
Condylobasal length	45	47.0	44.1–50.1
Zygomatic breadth	47	30.5	25.7–32.1
Maxillary tooth-row	51	10.2	8.7–10.9

Table 5. External and cranial dimensions of *Sciurus anomalus* from Anatolia. Based on Özkurt *et al*. (1999) and specimens in BMNH, FMNH, NMNH, SMF, and ZFMK.

VARIATION

Ellerman (1948) recognised three subspecies on the ground of colour variation. Of these, *S. a. pallescens* Gray, 1867 (type loc.: 'Turkey in Asia' on the label; restricted by Harrison, 1972, to 'Mountains of Kurdistan, north-east Iraq') is characterised by paler back and feet and light yellowish brown tail. Ellerman & Morrison-Scott (1951) applied this name to squirrels from "Persia and Palestine". None of the Anatolian skins we examined matched the colour of this race of which we saw the BMNH specimens from southwestern Iran. Of the remaining two races, Ellerman (1948) characterised *S. a. syriacus* Ehrenberg, 1829 (type loc.: Lebanon, Syria) as

	Males			Females		
	N	Mean	min-max	N	Mean	min-max
Head and body	12	233.4	205-250	11	239.4	226-250
Tail	12	143.7	130-160	11	138.9	120-165
Hind foot	12	58.1	48-64	11	58.5	52-61
Ear	12	30.7	28-32	11	30.5	30-31
Weight	12	436	350-500	11	456	400-500
Condylobasal length	10	49.2	47.6-50.5	9	49.5	48.0-50.8
Zygomatic breadth	11	31.7	30.0-33.0	9	32.2	31.3-33.0
Maxillary tooth-row	11	10.3	9.9-10.8	11	10.3	9.8-10.7

Table 4. External and cranial dimensions of adult *Sciurus anomalus* from the Island of Gökçeada, separately for sexes. From Özkan (1995).

having "Tail mottled; almost without red colouring in the majority of specimens" and the nominate race *S. a. anomalus* as having "Tail deep red." Lehmann (1957) ascribed specimens from Adana to ssp. *syriacus*, as did Lewis *et al*. (1967) those from Lebanon. Note that Hatt (1959) assigned squirrels from Iraq to ssp. *anomalus* "because their tails have the deep color of the typical subspecies."

	AG 1–2 (N = 4–5)	AG 3 (N = 13–17)	AG 4 –5 (N = 19–23)
Head and body	198.6	222.8	236.3
	182-220	200-241	205-250
Tail	142.2	146.3	141.4
	136-153	120-170	120-165
Hind foot	59.2	59.3	58.3
	59-60	55-62	48-64
Ear	29.6	30.6	30.6
	28-30	29-33	28-32
Weight	266.2	366.4	445.3
	208-340	215-433	350-500
Condylobasal length	45.5	47.7	49.3
	43.4-47.2	42.4-49.6	47.6-50.8
Zygomatic breadth	29.8	31.4	31.9
	28.2-30.6	30.0-33.1	30.0-33.0
Maxillary tooth-row	10.1	10.5	10.3
	9.7-10.7	9.8-11.2	9.8-10.8

Table 6. External and cranial dimensions of *Sciurus anomalus* from the Island of Gökçeada according to age, from the youngest age group (AG 1–2) to the oldest one (AG 4–5). Age groups are from Özkan (1995) and sexes are pooled. Given are means (first line) and ranges (below). Modified from Özkan (1995).

It is beyond doubt that colour varies individually and geographically. Seasonal variation is possibly less pronounced. A large sample collected between October and May at Trabzon area (BMNH) did not show any differences, which could be linked to seasons. Trabzon squirrels are clearly reddish, a fact already noticed by Osborn (1964). BMNH specimens from north-west Anatolia (İzmir and Çanakkale) clearly differ from those collected around Trabzon in uniformly grey grizzled back, less buff belly and in having tail dark chestnut brown. Furthermore, Özkurt *et al*. (1999b) did not see any colour difference between the few Anatolian squirrels in summer pelage they had in their disposal. These authors believe that their material is identical in colour to the specimens from the Eastern Mediterranean coasts to the south of the Turkish border, which Harrison & Bates (1991) ascribe to *pallescens / syriacus*. Basing on published data and the material we saw, we are unable to draw any firm conclusions on geographical trends in colour, if any present at all.

In western Anatolia, Felten *et al*. (1971b) reported the nominate race from the northern coast and ssp. *syriacus* from the southern one. They distinguished the two forms by cranial characters (frontals broader and postorbital process heavier in *syriacus*) and by the appearance of tail (more bushy with denser hair in the nominate form). The specimens we saw from the Taurus Mts. were within the colour range from the rest of Turkey. Besides, their tail coloration certainly did not match that of the BMNH specimens from Syria and Israel identified as ssp. *syriacus* by Ellerman (1948).

Sample	1 mean min-max (N = 16)	2 mean min-max (N = 6)	3 mean min-max (N = 22)	4 mean min-max (N ≅ 22)	5 mean min-max (N ≅ 3)
Condylobasal length	46.5	45.8	47.8	49.3	44.2
	44.4-47.8	44.1-47.9	46.0-50.1	47.6-50.8	42.4-45.2
Relative zygomatic breadth	63.4	67.0	65.4	64.7*	64.9*
	61.5-65.3	66.0-68.0	63.1-67.4		

Table 7. Variation in condylobasal length and relative zygomatic breadth (= 100 x zygomatic breadth / condylobasal length) in four geographic samples of Turkish *Sciurus anomalus*. Sample designations: **1** – eastern Black Sea Mts. (Trabzon and Kars districts), **2** – Tatvan, **3** – remaining Anatolia, **4** – Island of Gökçeada (based on Özkan, 1995); **5** – Arabia (based on Harrison & Bates, 1991). Samples 1–3 are based on specimens in BMNH, FMNH, NMNH, SMF, and ZFMK. * Relative zygomatic breadth calculated from means.

Özkurt *et al.* (1999b) noticed the larger size of Anatolian squirrels when comparing them with the measurements given by Harrison & Bates (1991) for northern Arabia (Iraq, Jordan and Lebanon; cf. Table 7). Interpopulation differences in cranial dimensions also exist within Anatolia. As already mentioned, Felten *et al.* (1971b) report differences in the least interorbital breadth: 17.3–18.1 mm in ssp. *anomalus* (specimens from northern Anatolia and the Caucasus) and 15.5–17.1 mm in ssp. *syriacus* (southern Anatolia, Lebanon and Syria). In a large sample from the Island of Gökçeada (N = 41), Özkan (1995) reports interorbital width to range between 15.4 and 17.8 mm, and in a collection of nineteen squirrels from northern Anatolia (BMNH specimens) it varied between 15.3 and 18.2 mm. We are thus suspicious whether the width of the interorbital region indicates any interpopulation variation in Anatolia.

We noticed differences in skull size and relative zygomatic breadth. The results are summarised in Fig. 9 and Table 7. Squirrels from northeastern Pontic Mts. are average in size and have a fairly narrow skull. Contrary to them, squirrels from Bitlis are small but with a broad skull. Most of Anatolia appears to be populated by medium-sized squirrels with moderately broad skulls. This kind of cranial variation is not concordant with variation in colour. Thus, the recognition of two subspecies in Anatolia and adjacent regions on the basis of tail colour alone is possibly an oversimplification, which obscures the pattern and trends in other traits.

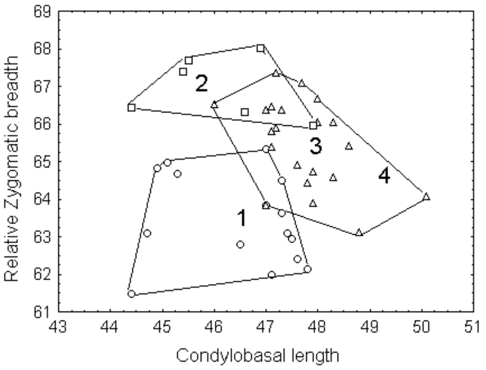


Figure 9. Bivariate plot of relative zygomatic breadth (= 100 x zygomatic breadth / condylobasal length) against condylobasal length of skull in Turkish *Sciurus anomalus*. Polygons enclose all the specimens within a sample and numbers indicate group centroids: **1** (dots) – eastern Black Sea Mts. (vicinity of Trabzon, Kars district), **2** (squares) – Tatvan, **3** (triangles) – remaining Anatolia, **4** – centroid for the Island of Gokçeada. Based on Özkan (1995) and specimens in BMNH, FMNH, NMNH, SMF and ZFMK, in addition to own material.

The island sample from Gökçeada attains larger size than its mainland counterparts (cf. Özkan, 1995) and exceeds Caucasian squirrels from the Island of Lesvos for which Hecht-Markou (1994) gives the body mass range of 350–400 g.

DISTRIBUTION

The Caucasian squirrel is restricted in its distribution to the extreme southwest Asia: Anatolia, the Caucasus (Georgia, Azerbaijan, Armenia), western Syria, Lebanon, northern Jordan, Israel (as far south as the Dead Sea), northern Iraq, and the Zagros Mts in Iran (Šidlovskij, 1976; Harrison & Bates, 1991; Lay, 1967). The range is disjunct rather than contiguous (cf. Šidlovskij, 1976; Harrison & Bates, 1991; Bukhnikashvili & Kandaurov, 1998).

The first distributional map for Turkey is by Osborn (1964), who concluded that the Caucasian squirrel "probably inhabits all the wooded regions of Anatolia." Already Danford & Alston (1877) report the species as being "Generally common, especially among the oak- and beech-woods of the lower mountains." Osborn's dot map actually shows the localities around the Anatolian coasts, in Urfa (based on Misonne, 1957) and at Lake Van. The whole of central Anatolia is left blank, as is also the great majority of eastern and southeastern Anatolia. The tentative map by Turan (1984) roughly follows Osborn's conclusions. On the other hand, Mursaloğlu (1973a) indicated the Caucasian squirrel as widespread across the entire Turkey in Asia, and this was accepted by Demirsoy (1996). Mursaloğlu (1973a) noted that "The *S. anomalus* specimens examined will be listed in a later publication", but to the best of our knowledge this has never been done. Doğramacı (1989a) states this species for central and eastern Anatolia and for Thrace; Kurtonur *et al.* (1996) report it only from Anatolia.

Available records suggest that the Caucasian squirrel is widespread along the coasts of the Black Sea and the Mediterranean Sea (Fig. 10). The majority of central Anatolian plateau, approximately to the east of Lake Akşehir, lacks the Caucasian squirrel, al-

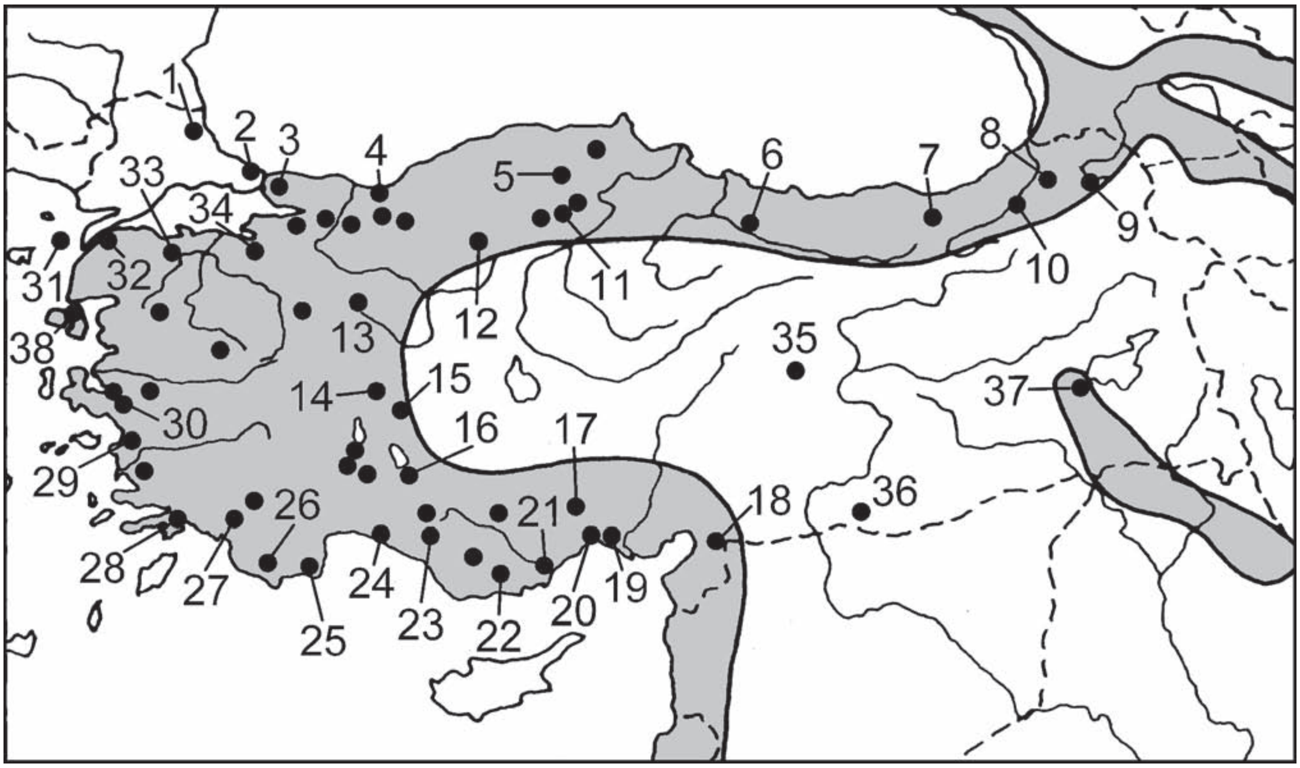


Figure 10. Distribution of *Sciurus anomalus* in Turkey. Records: **1** – Velika, Kırklareli; **2** – Belgrad orman, İstanbul; **3** – Scutari, İstanbul; Üsküdar; **4** – Akçakoca, Bolu; **5** – Kastamonu; **6** – Akkuş, Ordu; **7** – Meryemana; Çosandere, Trabzon; **8** – Ardanuç, Artvin; **9** – Kars district; **10** – Demirkent, Artvin; **11** – 8 km south-west Tosya, Kastamonu; **12** – Kızılcahamam, Ankara; **13** – Gökçekısık, Eskişekir; **14** – Doğanköy, Afyon; **15** – Akşehir; **16** – Seydişehir, Konya; **17** – Cehennem Dere, Bolkar Dağlari; **18** – Akbeş (= Maydän Ikbis); **19** – Gözna (= Gözne), Mersin; **20** – Mersin (= Içel); **21** – Silifke; **22** – Gülnar, Içel; **23** – Inçekum, 26 km north-west of Alanya, Antalya; **24** – Manavgat; **25** – Yalnız, Antalya; **26** – Sütleğen, 50 km south-west of Elmalı, Antalya; **27** – 4 km south of Bozbel, Muğla; **28** –Marmaris, Muğla; **29** – Davutlar; **30** – Bayındır, İzmir; **31** – Island of Gökçeada; **32** – Çanakkale; **33** – Çınarlı village near Gönen, Balıkesir; **34** – Bursa; **35** – Darende, Malatya; **36** – Urfa; **37** – Kurtikan, Bitlis. Extralimital record: **38** – Island of Lesvos, Greece. Corresponding references: Ellerman (1948): 7, 18, 32. Misonne (1957): 36. Osborn (1964): 3, 5, 8, 17, 19, 20, 22, 24, 34, 35, 37. Steiner & Vauk (1966): 16. Corbet & Morris (1967): 25. Felten *et al.* (1971): 4, 23, 26, 28. Hecht-Markou (1994): 38. Özkan (1999a): 31. Özkurt *et al.* (1999b): 6, 12, 33. Hofland (1999): 29. Yiğit *et al.* (2003a): 1, 13, 30, 35. C. Kurtonur (*in litt.*): 2. BMNH: 9. SMF: 10, 15, 21. Own observations: 11, 14, 27.

though the species was recorded in Malatya and from the western coasts of Lake Van. The Van population is probably on the margin of an isolate in the upper Tigris valley (cf. Harrison & Bates, 1991), which focuses in Kurdistan of northern Iraq (Hatt, 1959). Note that Yiğit *et al.* (2003a) do not report it on the eastern side of Lake Van. Another presumed isolate is in Urfa, which "is about 60 km from what might be called forest" (Osborn, 1964). The record from Urfa is based on an observation of a single specimen by Misonne (1957), but has never been confirmed since (cf. Yiğit *et al.*, 2003a).

Based on a personal communication by C. Kurtonur, the Caucasian squirrel also occurs in Belgrad Forest near İstanbul (Thrace) where it was introduced in 1964 (Mitchell-Jones *et al.*, 1999, Kryštufek & Vohralík, 2001). Osborn (1964) notes: "Young squirrels can be purchased from peddlers in some Anatolian towns. When they begin to mature, their attractiveness as pets diminishes. I know of two cases near İstanbul where squirrels which were purchased in Anatolia were turned out of their foster home. This practice could lead to the establishment of *S. anomalus* on the European side of the Bosporus." Yiğit *et al*. (2003a) also report this species from Velika in the Istranca Mts.; we visited this site several times in 1993-1995 and in 2004 but never came across the Caucasian squirrel.

The Caucasian squirrel is also common and widespread on two islands off the west Anatolian coasts: Lesvos (Ondrias, 1966) and Gökçeada (Özkan, 1999a). On Gökçeada, Özkan collected it on eight localities scattered across the island 279 km^2 in land surface.

PALEONTOLOGY. The earliest record from Anatolia is from the Upper Pleistocene / Lower Holocene of Karain near Antalya (Storch, 1988), i.e. within the recent range. Boessneck & Driesch (1975) also report this squirrel from archaeological strata of Korucutepe near Elazığ. Although this suggests a wider historical range in theAnatolian plateau than the recent one, Korucutepe is also close to Malatya where the species is still present (Yiğit *et al*., 2003a).

During the Early Pleistocene, the Caucasian squirrel, or a form closely related to it, also occurred in Greece, i.e. west of the species' actual range: Dodecanese Island of Kalymnos (Kuss & Storch, 1978) and Tourkoubonia near Athens (Meulen & Doukas, 2001). The oldest records from within its present range date back to the Early Upper Pleistocene of Israel, *c*. 120,000 years B.P. (Tchernov, 1975).

HABITAT

The Caucasian squirrel is a tree species although possibly less dependent on the close canopy forest that the European red squirrel. All authors agree that the range of *S. anomalus* depends on the presence of woodland, in Turkey as well as throughout its range: Danford & Alston (1877), Hatt (1959), Osborn (1964), Lewis *et al*. (1967), Felten *et al*. (1971a), Kumerloeve (1975), Šidlovskij (1976), Atallah (1977), Harrison & Bates (1991), Hecht-Markou (1994), Qumsiyeh (1996), Özkan (1999a), Özkurt *et al*. (1999b), and Amr (2000). The habitats in Anatolia can be roughly divided into the following groups (based on Yiğit *et al*., 2003a, other published sources, our own observations, and museum specimen tags):

1. Mediterranean mosaic cultivated areas interspersed with woods and shrubs of olive trees (*Olea europaea*), pine (*Pinus brutia*) and other evergreen / deciduous woody species (*Cistus creticus, Rhus coriaria, Pistacia lentiscus, Quercus coccifera*).
2. Pine forests (*Pinus brutia*, *P. nigra pallasiana*) intermixed with broadleaf trees and shrubs (*Pistacia terebinthus, Quercus* spp., *Cynodon* sp., *Thymus* sp., *Polygonum* sp.).
3. Coniferous forests of *Pinus nigra pallasiana, Cedrus libani, Juniperus excelsa*, and *J. oxycedrus*.
4. Mixed forests of fir (*Abies nordmanniana*) and deciduous trees (*Fagus orientalis, Carpinus betulus, Quercus infectoris, Q. cerris*).
5. Deciduous forests composed of *Quercus pubescens, Cistus laurifolius, Crataegus monogyna*, and *Cotoneaster nummularia.*

At Doğanköy (Afyon) we observed specimens in poplar stands near the village and in the eastern Taurus we saw one in a rocky habitat with scattered cedars. This squirrel also enters orchards with walnut, almond, apple, plum and fig trees. In addition, Yiğit *et al.* (2003a) report it from several localities in Anatolia which are strongly dominated by steppe vegetation: Gökçekısık (Eskişehir), Darende (Malatya), and Kars and Ardahan. Most of the regions inhabited by this squirrel annually receive >550 mm of rainfall. Yiğit *et al.* (2003a) also report *S. anomalus* from a semiarid region at Malatya with as little as 385 mm of annual precipitation.

For the island of Lesvos, Hecht-Markou (1994) reports the Caucasian squirrel from olive, chestnut, oak (*Quercus aegilops, Q. coccifera*), *Juglans regia*, plum (*Prunus dulcis*), cypress, pine (*Pinus brutia, P. nigra*), and *Pyrus amygdaliformis* stands. She distinguishes between summer and winter habitats. The former are said to be in deciduous forests with abundant acorn production, but with a short supply of food resources during winter. Besides, the canopy in deciduous forest provides little cover during wintertime. Characteristic winter habitats of "Roumania type" consist of evergreen trees (olive, pine, dwarf oaks, *Pistacia lentiscus*, *Arutus* sp. etc.) which provide shelter and food even in that season.

In European Turkey, the Caucasian squirrel populates oak forests (*Quercus pubescens, Q. cerris*). If the report by Yiğit *et al.* (2003a) for the Istranca Mts. holds, then this squirrel also lives in beach (*Fagus orientalis*) forests up to 800 m a.s.l.

ALTITUDE. The vertical range of known localities

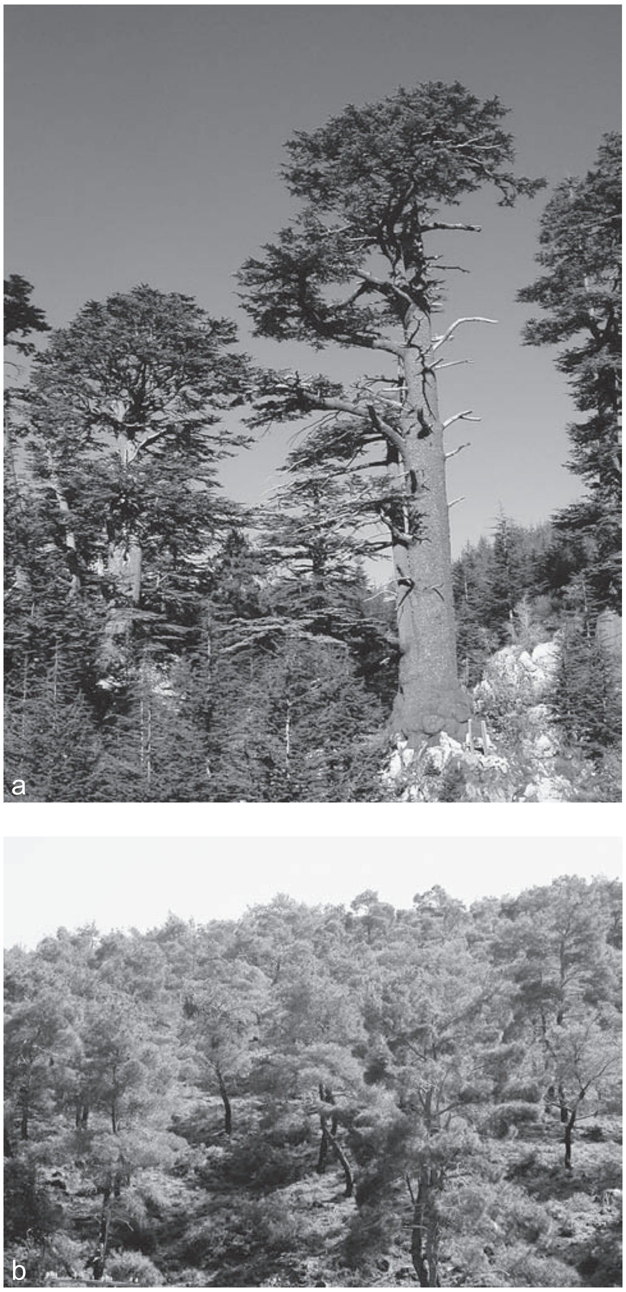


Figure 11. Habitat of *Sciurus anomalus*. **a** – Cedar forest in Çığlıkara, the Taurus Mts; **b** – pine forest south of Çanakkale, the Aegean coast. Photo by A. Kryštufek.

is from close to the sea level up to *c*. 2,000 m a.s.l. in eastern Turkey.

ASSOCIATES. Competitive interactions with the introduced European red squirrel are poorly understood. Bukhnikashvili & Kandaurov (1998) claim that the range of the Caucasian squirrel shrunk in Georgia by 20 % because the species was outcompeted from mixed woods by the European red squirrel. In the easternmost Pontic Mts., Mursaloğlu (1973a) found the red squirrel in coniferous forests at higher altitudes (of approximately 1,900 m a.s.l.; cf. above) and the Caucasian squirrels in deciduous forests at lower altitudes (up to 1,000 m a.s.l.). Around Trabzon, A. Robert collected in 1905 / 1906 (i.e. before the introduction of the European red squirrel) the Caucasian species as high as 1,000–1,300 m a.s.l. Recently, Yiğit *et al.* (2003a) no longer report the Caucasian squirrel from Meryemana south of Trabzon where it was evidently common during the time of Robert's collection. During our several visits to Trabzon area between 1993 and 1995, we saw not a single Caucasian squirrel.

On the European side of the Bosphorus, where the Caucasian squirrel is an alien species, Yiğit *et al.* (2003a) report it to be sympatric with the European red squirrel in deciduous forests at Velika (the Istranca Mts.) at the elevation of 800 m a.s.l.

DENSITY. Population density fluctuates considerably (Šidlovskij, 1976).

BIOLOGY

ACTIVITY. The Caucasian squirrel is strictly diurnal, being most active in the morning and in late afternoon (Šidlovskij, 1976). Gavish (1993) observed squirrels on Mt. Hermon from sunrise until about 11 a.m. and then again in the afternoon as late as 6 p.m. It is frequently active on the ground and in rocky outcrops, but usually seeks shelter in the canopy and more rarely in rocky fissures or in dense thicket. On Mt. Hermon, the time spent in the trees was much longer than on the ground (Gavish, 1993).

THE NEST (drey) is in a tree hollow (3–5 m above the ground), either natural or built by woodpeckers (Šidlovskij, 1976). Nests are also in rock crevices (Atallah, 1977). Contrary to these reports, Gavish (1993) did not succeed to find any dreys on trees.

REPRODUCTION. For the Caucasus, Šidlovskij (1976) reports reproduction taking place all year round, with three peaks: late January to early February, late April to early June, and mid-June to late August. Lewis *et al.* (1967) state that young squirrels are born in late April and early May in Lebanon. In the material of Turkish specimens examined by us, the juveniles were collected on April, 4th (head and body length 167 mm), May, 30th (155 mm), June, 3rd

(160 and 165 mm, respectively), and July, 24–26th (150 mm). The litter size in the Caucasus is 2–4 (Šidlovskij, 1976).

In a sample collected by Özkan (1995) on the Island of Gökçeada, the sex ratio is slightly male skewed (58 %; N = 45).

FOOD. The Caucasian squirrel is predominantly herbivorous and animal food is taken only occasionally (Šidlovskij, 1976). It feeds on nuts, acorns, seeds, berries, mushroom, and buds. Food is stored for winter, frequently under tree roots (Šidlovskij *l.c.*). Piles of gnawed oak acorns under trees are said to be a typical sign of its occurrence (Amr, 2000).

GENUS: *SPERMOPHILUS* BLASIUS, 1884

Ground squirrels (sousliks) are terrestrial squirrels of moderate size, with small ears and short tail (usually shorter than half of head and body length). Claws are long and the thumb is much reduced. Check pouches are present. Skull is arched and the postorbital process is slender. Infraorbital foramen is well developed as squirrels go, and the masseter knob at its lower border is prominent. Cheek teeth are relatively hypsodont, with the lingual portion in the upper row being constricted thus giving teeth a triangular appearance. Dental formula: 1/1, 0/0, 2/1, 3/3 = 22.

Molecular evidence (mitochondrial cytochrome *b* gene sequence) suggests the genus *Spermophilus* to be paraphyletic with respect to the prairie dogs *Cynomys* and to the marmots *Marmota* (Harrison *et al*., 2003; Herron *et al*., 2004). Harrison *et al*. (2003) placed ground squirrels into the subfamily Marmotinae, rather than to Sciurinae.

SCOPE. The genus shows Holarctic distribution with the greatest diversity in the Nearctic. Of the 38 species currently recognised (Hoffmann *et al*., 1993), only 13 occur in the Palaearctic steppes, mountain pastures and tundra (Gromov *et al*., 1965); Corbet (1978) still lists nine species for the Palaearctic region. Two closely related species *S. citellus* and *S. xanthoprymnus*, are native to Turkey.

TURKISH SOUSLIKS. In spite of clear differences in external morphology between ground squirrels living on either side of the Marmara straits, the two were considered as being conspecific for the majority of the 2nd half of the 20th century (cf. Ellerman, 1948; Ellerman & Morrison-Scott, 1951; Osborn, 1964; Kumerloeve, 1975; Šidlovskij, 1976; Corbet, 1978). Their being distinct separate species was generally accepted after chromosomal data become available (Zima & Král, 1984; Doğramacı *et al*., 1994). However, as subsequently shown by Özkurt *et al*. (2002), the 2N = 40 form also lives in the Taurus Mts. Note, however, that the fundamental number of autosomal arms is not the same in samples from Thrace (NFa = 66) and from the Taurus (NFa = 72).

Taxonomic identity of sousliks from the Taurus Mts. is thus puzzling. The only specimens we saw from the region (Balli) are indistinguishable from *S. xanthoprymnus*. In blood serum proteins (globulins and albumins), Çolak & Özkurt (2002) found eight electrophoretic bands in *S. citellus* and nine or ten in the Anatolian sousliks. However, in their con-

Figure 12. Ground squirrel *Spermophilus*. Drawing: J. Hošek.

clusion "the electrophoretic characteristics of blood serum proteins do not separate these two species sufficiently" (Çolak & Özkurt, 2002). Their sample from Akseki (2N = 40) was quite unique in the post-albumin fraction, and did not match perfectly with either the Thracian or the remaining Anatolian material. At this stage, and until more evidence becomes available, we continue to report the samples from the Taurus Mts. as parts of *S. xanthoprymnus*.

The Anatolian ground squirrel *S. xanthoprymnus* is characterised by a more uniform colour with less spotted pattern. Tail is relatively shorter and lacks dark stripe along its dorsal side (Fig. 13). Cranial and dental differences are discussed below. Cluster analysis of eight geographic samples of Turkish sousliks (two samples of *S. citellus* and six of *S. xanthoprymnus*), based on ten skull measurements (data from Mursaloğlu, 1964), did not reveal two clusters based on species (Fig. 14). This possibly reflects the general phenomenon of skull morphology to be of little value for taxonomic purposes in Sciuridae, despite the fact that greater phyletic information is embodied in skull characters in ground squirrels than in tree squirrels (Patterson, 1983). As shown in Fig. 14, the two samples of *S. citellus* formed a cluster with *S. xanthoprymnus* from Van in both sexes. Various attempts to remove the size effect and thus performing the clustering in shape (size-out) data alone failed to construct a tree topology which would be consistent with the current taxonomic division into two species (not shown).

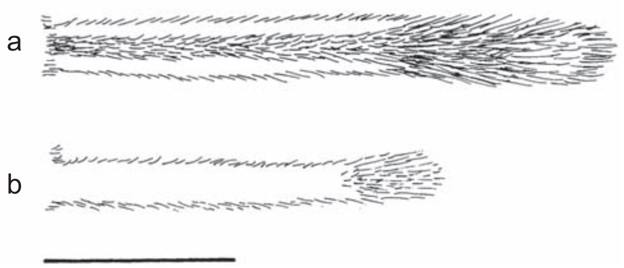


Figure 13. Dorsal side of the tail in *Spermophilus citellus* (**a** – adult male from Karaağaç, Kırklareli, Thrace), and of *S. xanthoprymnus* (**b** – adult male from Çadırkaya, between Niğde and Kayseri). Scale bar = 2 cm.

The figures in Mursaloğlu (1964; Fig. 2), Gromov *et al*. (1965; Figs. 52 & 53) and Ognev (1963; Figs. 58-61 & 63-66) suggest differences between *S. citellus* and *S. xanthoprymnus* in the shape of the anterior portion of zygoma. The skull of *S. xanthoprymnus* appears more angular than that of *S. citellus*. Specifically, in the former the anterior edge of the zygoma forms almost right angle at its junction with the rostrum, whereas in *S. citellus* it forms a smooth curve. In our material, however, the two species cannot be distinguished on this basis (cf. Fig. 15). At present we see no cranial differences which would separate the two species.

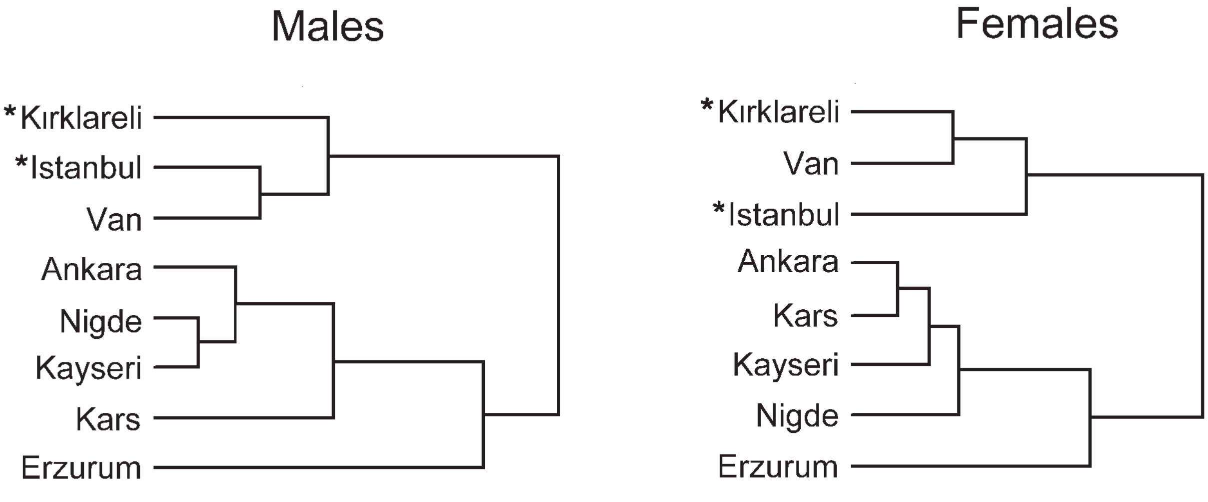


Figure 14. UPGMA tree summarising phenetic distances among ten geographic samples of Turkish ground squirrels belonging to two species: *Spermophilus citellus* (indicated by an asterisk) and *S. xanthoprymnus*. Similarity matrix (Euclidean distances) was derived from ten cranial measurements (means), given by Mursaloğlu (1964). Sexes are treated separately.

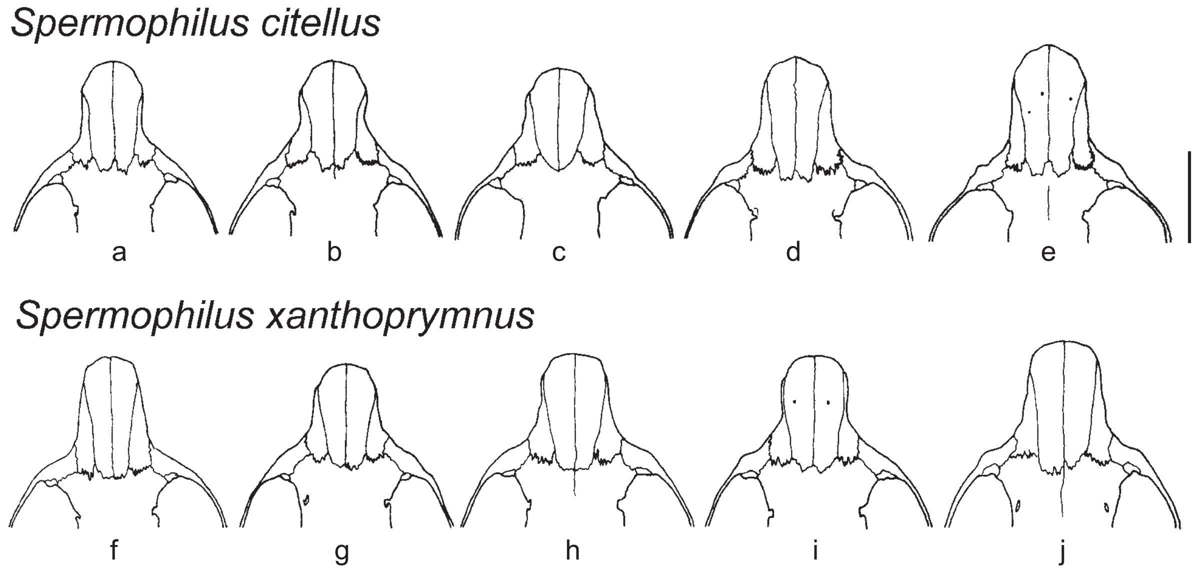


Figure 15. Rostral part of the skull in adult *Spermophilus citellus* (a – e) and *S. xahntoprymnus* (f – j). *Spermophilus citellus*: **a** – female from Titel, Voivodina, Serbia; **b** – male from Samoš, Deliblatska peščara, Voivodina, Serbia; **c** – female from Ak Meidan, European Turkey; **d** – female from Mt. Jakupica, Macedonia; **e** – female from Ačikot, Dojran Lake, Macedonia. *Spermophilus xanthoprymnus*: **f** – female from Erciyes Dağ, Kayseri; **g** – female from Kara Dağ, Konya; **h** – male from Van; **i** – male from Kara Dağ, Konya; **j** – female from Tepeköy, Niğde. Specimens c, g, h, and i are from BMNH collection. Scale bar = 10 mm.

Baculum of the two sousliks was compared by Kaya & Şimşek (1986). Unfortunately, their drawings are too small to show finer details of the bacular structure. What one can deduce from Figs. 3 & 4 (p. 388 in Kaya & Şimşek, 1986) is that *S. citellus* shows a more pointed apex, evidently due to a more pronounce anterior sagital projection on the dorsal side of spatula. The linear dimensions of the baculum overlap in most cases (cf. Kaya & Şimşek, 1986). Baculum, however, varies among the European samples and hardly enables one to satisfactorily distinguish between the two species (cf. Kryštufek & Hrabě, 1996).

The two sousliks "evidently originated along a Balkan-Anatolian axis" (Hosey, 1982). Note that the zoogeographical boundary posed by the straits separating the Balkans and Asia Minor was already fully appreciated by Danford & Alston (1880) who state that "probably the Bosporus is the limit between the ranges of the two species." (i.e. *S. citellus* and *S. xahnthoprymnus*). Anyhow, evolutionary process operating on both sides of the Marmara straits was possibly not simple or unidirectional, and the chromosomal form 2N = 40 has recently been reported for the Taurus Mts. in addition to Thrace (Özkurt *et al.*, 2002).

Osborn (1964) speculated that ground squirrels invaded Anatolia via the Caucasus, yet the fossil remains of *S. xanthoprymnus* found in the Caucasus are of Holocene age only (Vereščagin, 1959). Besides, steppes to the north of the Caucasus are inhabited by *Spermophilus pygmaeus* (Pallas, 1779), while the Anatolian souslik is more closely related to *S. citellus*. Mitochondrial cytochrome *b* gene, however, does not support close relationships between *S. citellus* and *S. xanthoprymnus*. The latter possibly shares the same ancestor with *S. suslicus* and *S. dauricus* (Harrison *et al.*, 2003). As suggested by genetic data (enzyme and structural proteins), *S. xanthoprymnus* diverged from the *pygmaeus* clade (which also includes *S. suslicus* and *S. musicus*) as early as the Lower Pleistocene, i.e. 1.5 million years ago (Mezhzherin *et al.*, 1999).

In comparison with the European souslik, *S. xanthoprymnus* evidently shows several ancestral traits. The Y chromosome is bi-armed (Zima & Kràl, 1984; but see Özkurt *et al.*, 2002, for different results), and this condition is retained in the European souslik only in *S. c. thracius*; all the remaining populations have a more advanced acrocentric condition presumably resulting from a deletion (Soldatović *et al*., 1984; see also below). *Spermophilus xanthoprymnus* also tends towards a retention of a three rooted 4th lower premolar (Storch, 1975), a feature still seen in the ancestral *S. citelloides* Kormos, 1916 up to the Upper Pleistocene, while the recent *S. citellus* has two roots only.

NOMENCLATURE. Until very recently, European and Russian authors refer to sousliks under the generic name *Citellus* Oken, 1816 (Miller, 1912; Ellerman, 1948; Ellerman & Morrison-Scott, 1951; Ognev, 1963; Gromov *et al*., 1965; Vinogradov & Gromov, 1984). *Citellus* Oken, 1816, however, is invalid (Corbet, 1978).

KEY TO SPECIES

1 Back indistinctly spotted; tail longer on average (*c*. 29% of head and body length), with black hairs dorsally (Fig. 13a); diploid number of chromosomes 2N = 40 *S. citellus*

1* Back plane in colour; tail shorter on average (*c*. 21% of head and body length) and lacks black hairs dorsally (Fig. 13b); diploid number of chromosomes 2N = 42 *S. xanthoprymnus*

Note: the diploid number of chromosomes is possibly not a diagnostic trait. See text for further discussion.

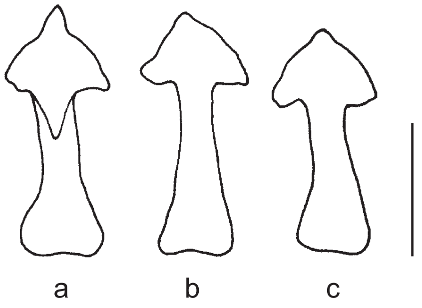


Figure 16. Baculum (dorsal view) in ground squirrels of Turkey: *Spermophilus citellus thracius* (**a**), *S. xanthoprymnus xanthoprymnus* (**b**) and *S. x. gelengius* (**c**). Redrawn from Kaya & Şimşek (1986). Scale bar = 2 mm.

EUROPEAN GROUND SQUIRREL, EUROPEAN SOUSLIK – *SPERMOPHILUS CITELLUS*

Mus citellus Linnaeus, 1766. Type loc.: Wagram, Austria.

Citellus citellus thracius Mursaloğlu, 1964. Type loc.: south-eastern slope of Murattepe near Yenibedir, Lüleburgaz, Turkey.

DESCRIPTION

EXTERNAL CHARACTERS. Medium-sized ground squirrel, with a round body, fairly short tail and reduced ear. Ears are densely covered with short hairs but there is no tuft. Head is convex in profile, eyes are large and vibrissae are relatively short (25 mm). Muzzle pad is naked. Feet are more robust than in *Sciurus* and claws are less curved; the longest claws are up to 8 mm in length. Although the thumb is rudimentary it still bears a nail. There are four fairly large and naked pads on palms and soles. Tail is cylindrical at base; it is densely haired with a short terminal pencil (15 mm). Pelage is short and rough.

COLOUR. Yellowish cream-buff back is indistinctly black and white mottled; the spots are approximately 5 mm in diameter. Head and cheeks are grizzled and muzzle has rusty tinge. Around the eye is a yellowish or whitish ring. Belly is washed with buff. The upper surface of the tail is grizzled, darker towards the tip but pencil has pale margin. Feet are yellowish.

NIPPLES. There are ten nipples: one pair of pectoral, and two pairs of abdominal and inguinal respectively.

BACULUM varies geographically (Kryštufek & Hrabě, 1996). Its spoon-like expanded distal spatula is triangular, with tooth-like projections along its ventral margin (Fig. 16). The base is thickened and the entire baculum is asymmetrical. The baculum is 2.35–3.00 mm long in Thracian sousliks (estimated from Figs. 3–5 in Kaya & Şimşek, 1986).

SKULL is essentially like in *Sciurus* but smaller; the interorbital region is narrower (19.4–22.7 % of condylobasal length), and zygomatic arches less expanded (64.5–70.5 % of condylobasal length). The dorsal profile of the skull is uniformly convex. Supratemporal ridges only exceptionally converge posteriorly to form a low sagital crest. Postorbital processes are shorter than in *Sciurus*. Zygomatic arches diverge gradually and evenly and are never parallel.

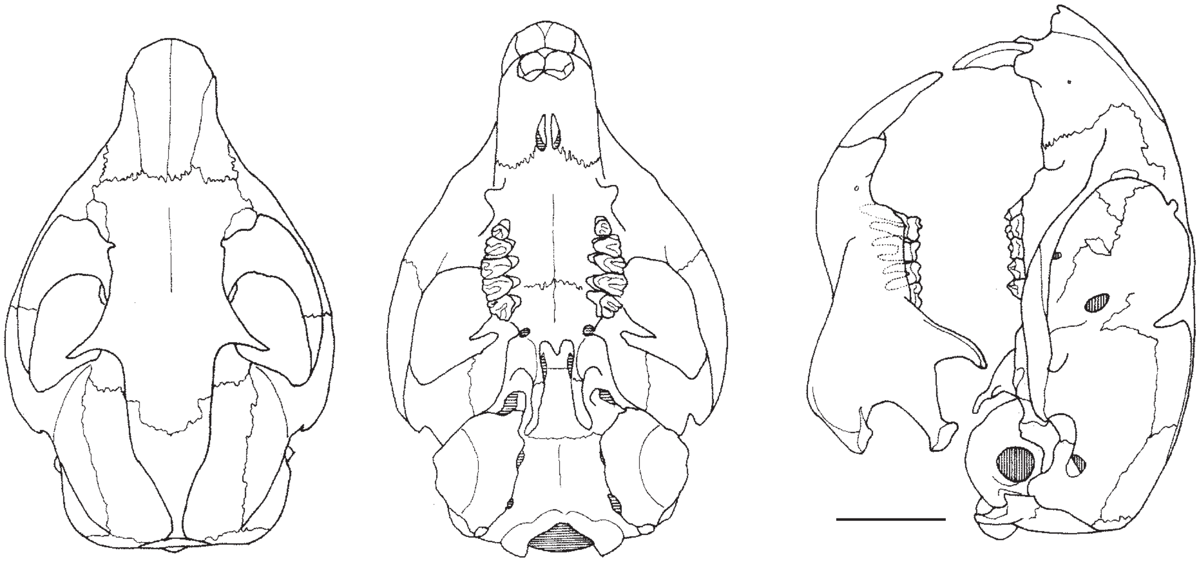


Figure 17. Skull and mandible of *Spermophilus citellus*, based on an adult male from Karaağaç, Kırklareli, European Turkey. Scale bar = 10 mm.

Posterior jugal projection is less evident than in *Sciurus*. Nasals are broad, with a pointed appex. Hard palate stretches well behind the 3rd upper molars, interpterygoid fossae are fairly broad and pterygoid processes diverge only slightly. Incisive foramen is short. Bullae are rounded but still more elongate than in *S. xanthoprymnus*. The mandible is less robust than in *Sciurus*.

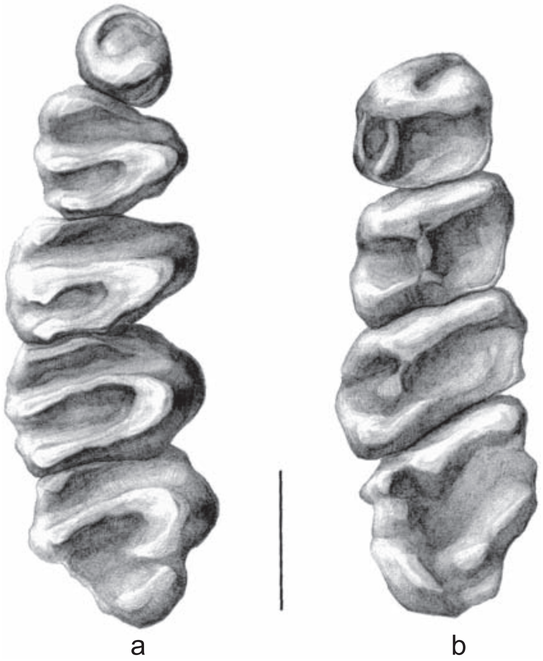


Figure 18. Upper (**a**) and lower cheek-teeth (**b**) in *Spermophilus citellus*. Same specimen as in Fig. 17. Lingual side is to the right, anterior is at the top. Scale bar = 2 mm. Drawing: S. Prokešová.

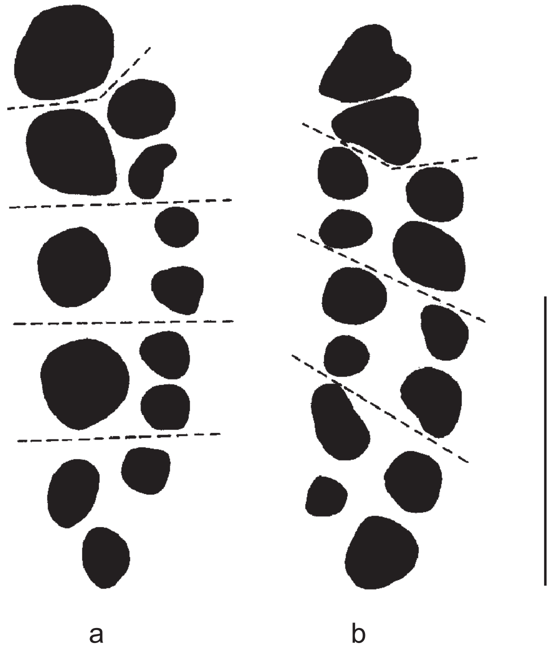


Figure 19. Alveolar pattern in *Spermophilus citellus* from Naipköy, Tekirdağ district (subadult male; IUBD). **a** - upper and **b** – lower row. Lingual side is to the left and anterior is at the top. Scale bar = 5 mm.

TEETH. Incisors are more delicate than in *Sciurus* and not compressed (the width of anterior surface is about that of lateral surface). Enamel on the anterior surface is pale yellow. Cheek teeth are basically as in *Sciurus* but with higher tubercles and ridges; their inner portion is more depressed (which results in molar crowns being triangular in outline) with narrower and higher inner tubercles. The small upper premolar (P3) is larger than in *Sciurus*, with a high cusp. First upper premolar (P3) is a single-rooted while the remaining maxillary cheek-teeth (P4-M3) have three roots each. The only lower premolar is with two roots while the molars have fours roots each (Fig. 19).

DIMENSIONS. For dimensions see Table 8. In Thracian sousliks the condylobasal length is by 2.7% greater in males than in females. Secondary sex dimorphism in cranial size is fairly constant across the species' range (Kryštufek, 1996; but see Fraguedakis-Tsolis & Ondrias, 1985, for a contrary conclusion). Body mass is strongly seasonal: after having emerged from hibernation, the sousliks are lighter than in summer. Adult specimens from Turkish Thrace, collected before May 1st weighted from 119 to 262 g (mean = 192 g, N = 5) and those collected after July 15th weighted between 191 and 340 g (mean = 250 g, N = 8). Females are evidently lighter than males (based on IUBD specimens).

CHROMOSOMES. In the European populations, the diploid number of chromosomes is 2N = 40 and the fundamental number of chromosomal arms is NFa = 66 (Zima & Král, 1984; Özkurt *et al*., 2002). Of autosomes, two pairs are metacentric (a large and a small one, respectively), twelve pairs are submetacentric and five pairs are subacrocentric or acrocentric; the X chromosome is a large metacentric or submetacentric. The Y chromosome is the smallest element in the karyotype, being subacrocentric or acrocentric in the majority of European populations. However, the population from Thrace appears to be unique, as it shows a biarmed Y chromosome (Soldatović *et al*., 1984; Doğramacı *et al*., 1994). Contrary to this, Özkurt *et al*. (2002) report the Y chromosome as acrocentric also in specimens from Turkish Thrace. Soldatović *et al*. (1984) speculate that the biarmed Y chromosome is ancestral, the acrocentric condition being derived by deletion.

VARIATION

Authors as recent as Miller (1912) still considered the European souslik to be monotypic. Eight subspecies have been described since 1929, majority of them from the southern border of the species' range. Subspecies have been diagnosed primarily on the basis of size and colour, and also by peculiarities of proportion and shape. Peshev (1968) expressed doubts as to whether all the races described are valid, whilst Grulich (1960) denied the existence of any clearly defined subspecific taxa within the European souslik. Ružić (1978) diagnosed subspecies on the basis of size, relative tail length and colour, but the characters are vague if present at all. Not surprisingly, Corbet (1978) was sceptical of the validity of the various forms which were "based on slight differences of proportions with no proof of discontinuity." A brief synopsis of the traditional taxonomy is given by Kryštufek (1996). Multivariate analysis of cranial data recognised geographic partitioning across the species' range; however, the traditional division

	Males			Females		
	N	mean	min-max	N	mean	min-max
Head and body	23	200.1	184-228	18	200.0	180-217
Tail	28	55.8	49-65	23	54.5	48-61
Hind foot	12	36.5	34-39	7	36.1	35-41
Ear	28	9.8	7.5-12	26	9.5	8-11
Weight	41	233.2	131-340	39	230.4	170-353
Condylobasal length	45	42.4	40.4-46.3	51	41.3	38.6-44.0
Zygomatic breadth	44	28.4	25.5-31.0	48	27.6	25.5-30.4
Maxillary tooth-row	48	10.4	9.0-11.0[1)]	53	10.3	8.8-10.7[2)]

Table 8. External and cranial dimensions of *Spermophilus citellus thracius*. Based on Mursaloğlu (1964, 1965), Fraguedakis-Tsolis & Ondrias (1985) and specimens in BMNH, HNM, IUBD, and own data. Sample sizes for ranges: [1)]N = 42; [2)]N = 45.

into nine subspecies actually obscured much of the pattern of geographic variation. Skull characters, ratios and coloration were all found to be of low diagnostic value, thus no formal division of the European souslik into subspecies was proposed (Kryštufek, 1996).

In the original description of the Thracian subspecies *S. c. thracius*, Mursaloğlu (1964) gave hardly any characters which would allow its recognition from other geographic forms. The Thracian race, most likely an isolate, was described more in detail by Fraguedakis-Tsolis & Ondrias (1985) on the basis of material from the Greek Thrace. The comparison with another two subspecies living in Greece (*S. c. gradojevici* and *S. c. macedonicus*) revealed *S. c. thracius* to be smaller than *S. c. gradojevici* (Martino & Martino, 1929; type loc.: Gevgelija, Macedonia), which is the largest race of the species, but no clear-cut differences have been given to separate *S. c. thracius* from *S. c. macedonicus* (Franguedakis-Tsolis, 1977; type loc.: Pontokomi near Kozani, Greece). Serological evidence (based on immunoprecipitation of rabbit antisera) for the three Greek races suggests that *S. c. thracius* is more distinct from both, *S. c. macedonicus* and *S. c. gradojevici* than is the mutual distance between the last two (Fraguedakis-Tsolis, 1977). The overall cranial shape (based on size free cranial parameters) suggests that *S. c. thracius* is closer to *S. c. gradojevici* than to any other geographic sample, but this tandem was placed within a large cluster encompassing the majority of souslik samples from the Balkans and the Pannonian plain (Kryštufek, 1996).

Baculum, which was shown to be highly variable among six geographic samples from the western Balkans and adjacent parts of the Pannonian plain yet stable within the samples, is poorly known in the Thracian race. As already mentioned above, figures by Kaya & Şimşek (1986) do not provide enough of details to allow closer comparison.

The colour of the pelage in the Thracian race (mainly based on Fraguedakis-Tsolis & Ondrias, 1985) from the nape to the proximal three fourths of tail is “strong straw-yellowish”; the distal portion of the tail shows indistinct transverse stripes. Chin and throat are yellowish-white, while chests and belly are yellowish-grey. Tail is darker dorsally. Lips, nose and the eye ring are yellowish-white. Cheeks and frontal region are greyish, and ears are light brown; hairs behind the ears are light tawny. For dimensions see Table 8.

DISTRIBUTION

Of the thirteen Palaearctic sousliks recognised by Gromov *et al*. (1965), the European souslik inhabits the westernmost part of the range of this genus. In the 20th century it populated the area from Bohemia in the west to the Black Sea coast in the east, and from eastern Germany and southern Poland in the north as far south as Thessaloniki and Thrace. The species’ range is disjunct, consisting of two large populations (the Pannonian and the Balkan one) separated by the Carpathians and by the Đerdap Canyon of the Danube. Small isolated populations occur around the periphery of the species’ present range (in Germany, Poland, Moldavia, Macedonia, Serbia and northern Greece); some of these isolates, notably those in Germany and Poland, were extinct within the last few decades (Kryštufek, 1996).

In Turkey, the species is restricted to the lowlands of Thrace, from the city of İstanbul in the east to the Meriç River in the west. Southern border mainly coincides with the seashore of the Marmara Sea, and reaches Tekirdağ in the west. The southwestern part of Turkish Thrace is mountainous (Kuru Dağı and Işıklar Dağı) and covered with forests; thus it provides few habitats suitable to sousliks. To the best of our knowledge, no published records are available from this part of the country. Recently we observed souslikes on the Gelibolu Peninsula (15 km south of Gelibolu and 10 km south of Keşan, respectively; Fig. 20). Further north the range extends up to the foothills of the Istranca Mts. In the eastern Greek Thrace, the sousliks are restricted to a narrow stripe along the Meriç (Evros) River (Fraguedakis-Tsolis & Ondrias, 1985; Vohralík & Sofianidou, 1992).

The degree to which the Thracian population is an isolate is not well known. In southeastern Bulgaria, sousliks are present along the Meriç (Marica) River between the towns of Svilengrad and Harmanli. Records are more numerous from further north along the Sazlijka, the tributary of the Marica River (Markov, 1957). However, in the lower basin of the Tundža River, the easternmost tributary of the Marica, sousliks are known only from Krumovo (own observations from 1987).

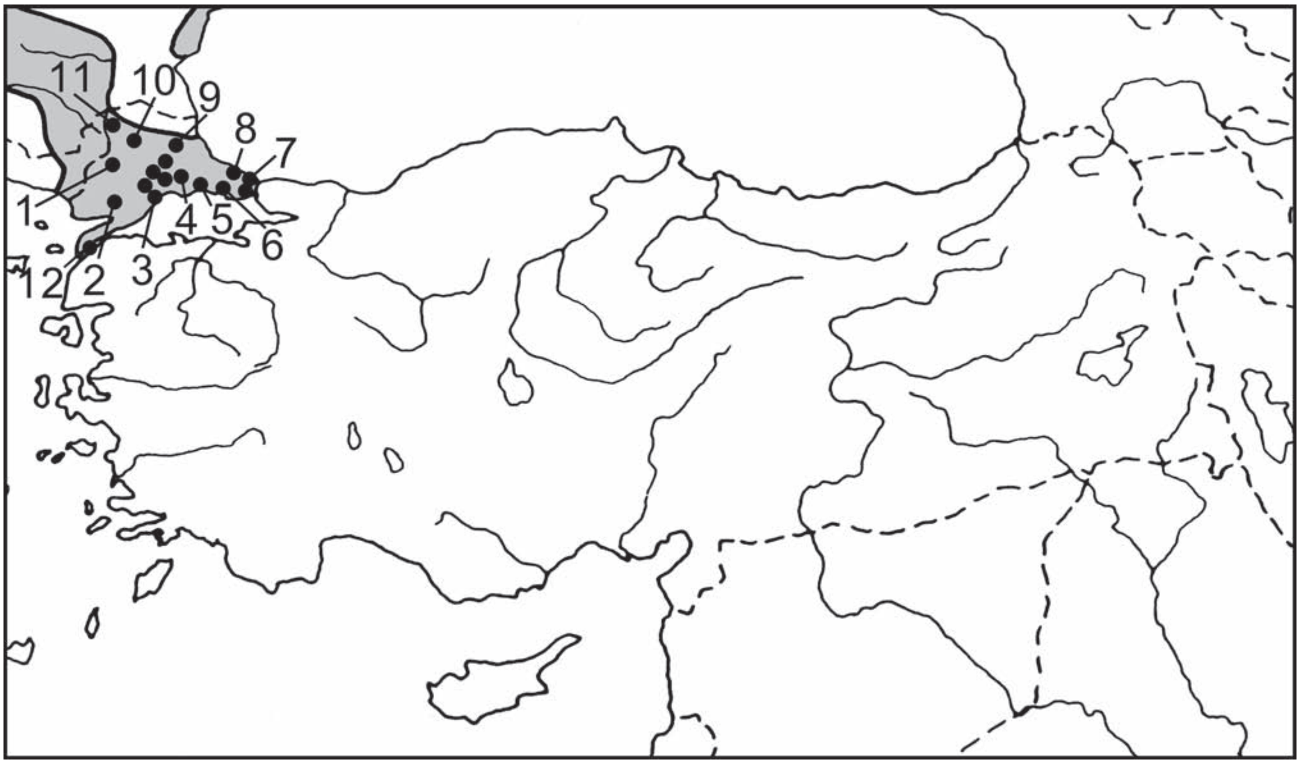


Figure 20. Distribution of *Spermophilus citellus* in Turkey. Range in Bulgaria is shown according to Markov (1957) and our own observations; range in Greece is from Fraguedakis-Tsolis & Ondrias (1985) and Vohralík & Sofianidou (1992). Records: **1** – Harmang köyü, Uzunköprü, Edirne; **2** – 10 km north of Keşan, Edirne; **3** – Kumbağ; Naipköy, Tekirdağ; **4** – Çorlu; **5** – Selimpaşa, İstanbul; **6** – Büyükçekmece, İstanbul; **7** – Uskumruköy, İstanbul; **8** – Terkos, İstanbul; **9** – Hamzabey, Lüleburgaz; **10** – Orhaniye köyü, Edirne; **11** – Edirne; **12** – 15 km south of Gelibolu. Corresponding references: Soldatović *et al.* (1984): 4. Kryštufek (1996): 1, 5, 7, 8, 10. Çolak & Özkurt (2002): 11. IUBD: 3, 6. Own observations and material: 2, 9, 12.

PALAEONTOLOGY. The genus *Spermophillus* s. lat. is known in Europe since the Late Miocene and the fossil species *S. citelloides* (Kormos, 1916), the presumed ancestor of both species dealt with in this volume, appears for the first time in the Vistulian layers (Kowalski, 2001). The 4th lower premolars from the Middle Pleistocene layers of the Yarımburgaz cave (Turkish Thrace) already have only two roots (instead of three as is characteristic of *S. citelloides*) and are ascribed to *Spermophilus* cf. *citellus* (Santel, 1994; Santel & Konigswald, 1998). The European ground squirrel is reported also from the Late Pleistocene layers of the Mecha Dupka Cave in Bulgarian Thrace (Popov & Miltchev, 2001), which possibly suggest its continuous presence in Thrace since the Middle Pleistocene at the latest.

HABITAT

The European souslik is tied to short-grass steppe, pastures and meadows, both natural and anthropogenic, on drained soil (Fig. 21a). It is absent from annually ploughed arable land as well as from tall-grass meadows. In cultivated landscape, it is occasionally able to survive in stripes of grassland between fields and vineyards. Souslik is unable to tolerate high ground water table and is thus absent from wetlands and marshes. It is widespread over the Thracian lowlands and in low hills, although we did not find it abundant anywhere. In the Pannonian plain, densities of up to *c*. 30 sousliks per hectare are considered high (Ružić-Petrov, 1950).

For the Black Sea coast of Bulgaria, Paspaleff & Pescheff (1957) report the following plants as being dominant in souslik's habitat: *Plantago lanceolata, Festuca pseudovina, Marrubium peregrinum, Salvia* *nemorosa, Erodium cicutarium, Medicago orbicularis, M. lupulina, Galium verrum, Convolvus arvensis, Artemisia absinthium, Papaver rhoes, Eragrostis pilosa, Poa angustifolia, Andropogon ischaemum, Thymus marschallianus, Cynodon dactylon, Bromus arvense, Polygonum aviculare, Filipendula hexapetala,* and *Euphorbia rupestris*.

ALTITUDE. Sousliks live from the maritime coast (on the Black Sea coast of Bulgaria in a distance 20–30 m from the seashore; Paspaleff & Pescheff, 1957) to an altitude of 2,500 m. Thracian records, however, are from the low country and in Gelibolu we observed them close to the sheashore. No altitudinal range has been reported from the European Turkey.

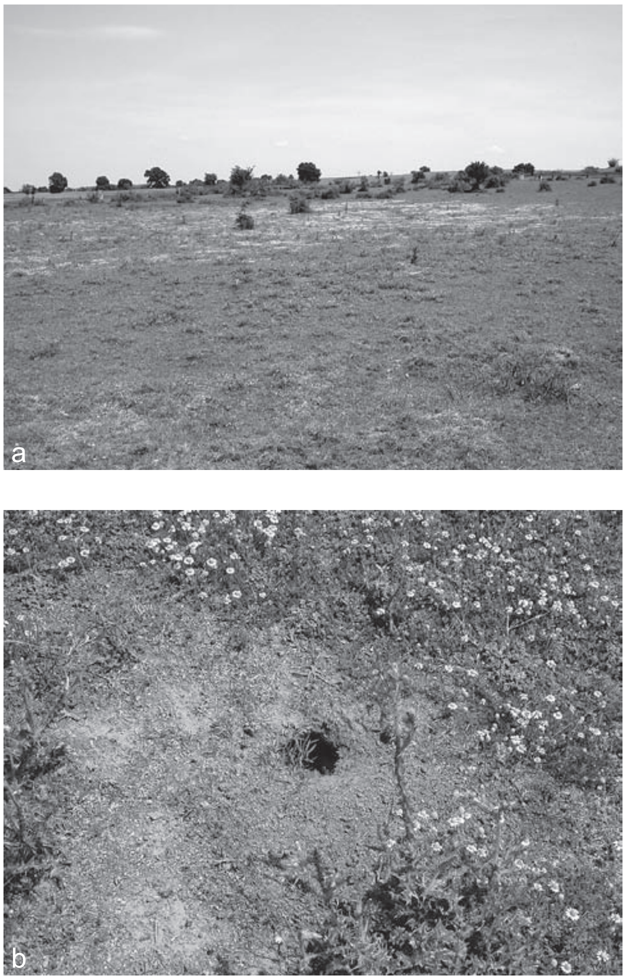


Figure 21. Habitat of *Spermophilus citellus* in Turkish Thrace. **a** – pastures at Arpaç near Hasköy, Edirne. **b** – entrance to the burrow. Photo by A. Kryštufek.

BIOLOGY

ACTIVITY. Like all ground squirrels, the European souslik is strictly diurnal. Its activity is reduced during the midday heath (between midday and 3 p.m.).

Hibernation terminates in early spring. For the Black Sea coast of Bulgaria, the first active sousliks are reported for March 18th and mass emergence starts on April 1st (Peshev, 1955). In Bulgaria the sousliks are still active in mid-August (but these are mainly juveniles) while one month later very few still continue to leave burrows (Peshev, 1955). In arid parts of southern Macedonia (approximately at the same latitude as Turkish Thrace), the sousliks become lathargic during the peak of the summer season, when the water content in plants drops from 70% (May) to as little as 22.5% (August; Ružić, 1965). Museum specimens were collected in Turkish Thrace between March 21st and August 18th.

BURROWS. Animals seek shelter in burrows which are permanent (with a nest) and temporary. The former are deeper, the nest being mainly <100 cm below the surface, but only exceptionally >150 cm deep. Ground squirrels dig up their burrows even in hard soil. Burrows are mainly in open to allow good vision, but are found occasionally also under shrubs (Fig. 21b).

REPRODUCTION starts immediately after the sousliks have finished their hibernation. Females deliver only one litter annually after a gestation of 25–26 days (Ružić, 1965). Litter size varies across the species range, with the southern populations having larger litters. The means, ranges (in parentheses) and sample sizes (N) are as follows: Banat in southern Pannonia 4.9 (2–8, N = 146), southern Dobrogea (Bulgaria) 6.1 (4–9, N = 43), Bulgaria (pooled sample) 6.2 (4–9, N = 37), and southern Macedonia 7.4 (5–9, N = 43; calculated from the data in Ružić, 1965 and Peshev, 1955). A female from Turkish Thrace, collected on May 1st, had eight embryos, and another two from the end of May had nine and ten placental scars, respectively. Juveniles first emerge from burrows at the age of 25 days; the mean body weight of Pannonian juveniles 30 days of age is 61.4 g (Ružić, 1965). Around Keşan we observed juveniles on June 15. Two juveniles collected in Turkish Thrace in the first decade of July had body mass 82 and 95 g, respectively; another three collected from July 13th to 25th weighted 136, 142, and 181 g, respectively.

Food. The European souslik is predominantly herbivorous, consuming green leaves, flowers, seeds, and underground parts of the plants mentioned above. Various insects and other arthropods (both adult and larvae) are consumed in Romanian Dobrogea (Popescu, 1972): grasshoppers (Acrididae), beetles (Elateridae, Scarabeidae, Chrysomelidae, Curculionidae), hymenopterans, chilopods (Geophilidae, Lithobiidae), and lepidopteran larvae.

ANATOLIAN GROUND SQUIRREL – *SPERMOPHILUS XANTHOPRYMNUS*

Citillus xanthoprymna Bennett, 1835. Type loc.: Erzurum, Turkey.
Citellus schmidti Satunin, 1908. Type loc.: Diğor, Kars, Turkey.
Citellus citellus gelengius Mursaloğlu, 1965. 5 km east of Koçaş, Aksaray, Turkey.

TAXONOMY

Although Ellerman (1940) still listed the Anatolian ground squirrel as an independent species, he already noted: "This species is probably no more than a subspecies of *C. citellus*." Shortly afterwards, Ellerman (1948) and Ellerman & Morrison-Scott (1951) included it in *S. citellus* as a junior synonym, which opinion prevailed for most of the 2nd half of the 20th century (see above for details).

Anatolian ground squirrels are not uniform chromosomally (Özkurt *et al.*, 2002). Because of lack of additional information, we continue to consider populations from the Taurus Mts. as part of *S. xanthoprymnus*.

Thomas (1905) distinguished two souslik species in eastern Anatolia, ascribing a single specimen from "Baibort" to "*Citellus xanthoprymnus* Benn." and by identifying a collection from Van area as "*Citellus concolor* Geoff." The reasons for such a division are not given. Ellerman & Morrison-Scott (1951) noted that "*Citellus concolor* Geoffroy" of Thomas is actually *S. xanthoprymnus*, and that *Spermophilus concolor* Geoffroy, 1831 is a junior synonym of *Spermophilus fulvus* (Lichtenstein, 1823). In the BMNH we examined the Van specimens on which Thomas based his identification, and we agree with the above conclusion by Ellerman & Morrison-Scott (*l.c.*).

DESCRIPTION

Colour. The Anatolian ground squirrel closely resembles the European species from which it is most reliably distinguished by colour. Back is nearly uniform reddish buff but varies from nearly greyish to dark brown with hardly any yellowish tinges; there

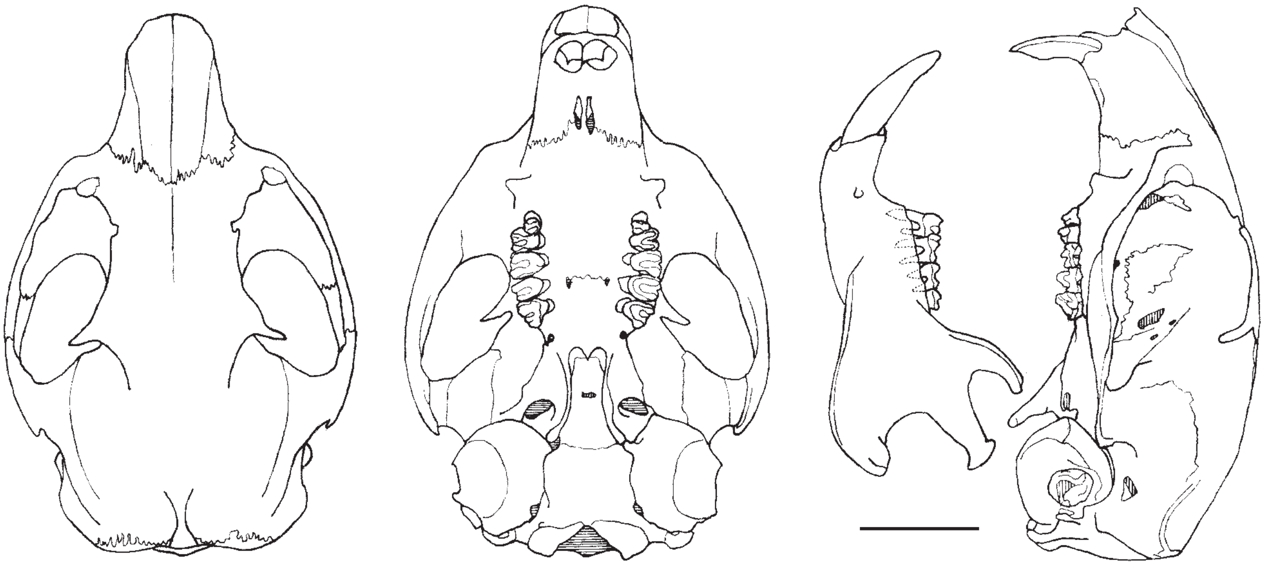


Figure 22. Skull and mandible of *Spermophilus xanthoprymnus*, based on an adult male, collected 10 km to the north-east of Sivrihisar, Eskişehir. Scale bar = 10 mm.

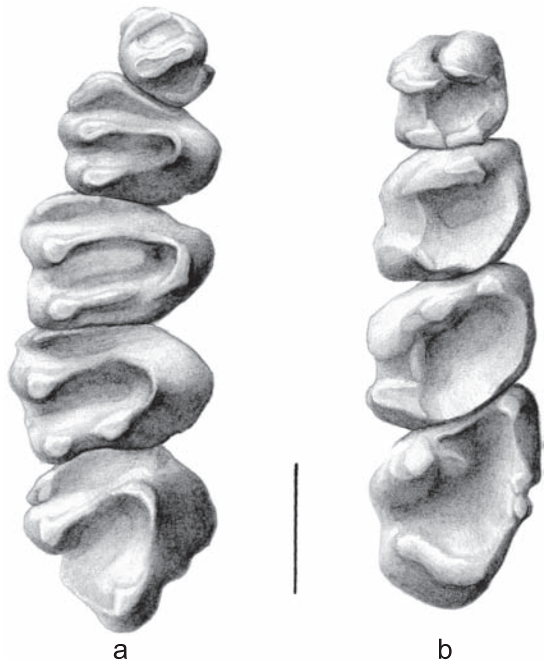


Figure 23. Upper (**a**) and lower cheek-teeth (**b**) in *Spermophilus xanthoprymnus*. Same specimen as in Fig. 22. Lingual side is to the right, anterior is at the top. Scale bar = 2 mm. Drawing: S. Prokešová.

are no spots. Flanks are cream, whitish or yellow, and the belly is whitish or yellowish. Slate grey hair bases frequently give the belly a greyish shade. Throat and chin are frequently pure white. The eye ring is whitish.

The cylindrical tail, which is shorter than in the European souslik, is approximately of the same colour as the back but is more brightly fulvous in some individuals. There are no dark hairs. The terminal tuft is up to 18 mm long. Feet are pale, whitish or yellowish. Dark claws are up to 6 mm long; black whiskers measure at most 25 mm.

Nipples are as in the European souslik.

Baculum. As can be deduced from the figures in Kaya & Şimşek (1986), the baculum is essentially of the same shape as in the European souslik (Fig. 16).

Skull is quite angular in dorsal view. The anterior edges of zygomatic arches frequently form an almost right angle at its junction with the rostrum. The interorbital region is slightly broader than in the European souslik (interorbital constriction up to 26% of condylobasal length, as opposed to at most 22.5% in *S. citellus*). The nasals are blunt at the apex (Fig. 22). Bullae are relatively shorter and more rounded than in the European souslik, the upper incisors are weaker, and the nasals are blunt apically.

Teeth are essentially as in the European souslik but the lower premolar retains three roots.

Dimensions. For dimensions see Table 9. Similarly as in the European ground squirrel, males are larger than females but here this dimorphism is more pronounced. In six geographic samples (cf. Table 10) the condylobasal length was larger in males than in females by 3.1–8.4% and only the Van sample was anomalous in showing hardly any secondary sexual dimorphism (= 1%).

Body weight is poorly documented in the Anatolian ground squirrel. Data from specimen tags gave a range between 180 and 325 g in males and from 258 to 315 g in females. For captive animals, Yiğit *et al.* (2000) report body weights of 250–495 g (mean = 339 g) before the hibernation (August, 24) and 197–309 g (mean = 240 g) at its termination (February, 16). However, captive ground squirrels are known to accumulate excessive fat and therefore the above figures may not hold in nature.

Chromosomes. The diploid number of chromo-

	Males			Females		
	N	mean	min-max	N	mean	min-max
Head and body	15	201.3	180-222	16	193.4	170-210
Tail	15	37.4	30-50	15	38.4	30-50
Hind foot	15	37.5	34.0-41.0	16	35.5	31.0-40.0
Ear	15	13.6	11.0-16.0	16	12.2	8.0-15.0
Condylobasal length	11	41.7	39.3-43.9	14	39.7	36.7-41.8
Zygomatic breadth	10	28.3	26.8-29.4	13	27.5	25.5-28.8
Maxillary tooth-row	13	9.4	8.9-10.0	15	9.4	8.7-10.2

Table 9. External and cranial dimensions of *Spermophilus xanthoprymnus* from Mt. Erciyes Dağ, central Anatolia. Based on specimens in NM and SMF, and our own data.

somes is 2N = 42 (Özkurt *et al*., 2002). There are differences in the evaluation of the number of bi-armed autosomes. Zima & Král (1984) give number of autosomal arms as approximately NFa = 66, but Özkurt *et al*. (2002) report it as 78. In the description by Özkurt *et al*. (2002), the autosomal set contains two pairs of metacentrics, 17 pairs of submetacentrics and one acrocentric pair. The X chromosome is a medium sized metacentric, but there are discrepancies as to the morphology of the Y chromosome, which is the smallest element in the karyotype. Zima & Král (1984) and Doğramacı *et al*. (1994) report it to be bi-armed, while Özkurt *et al*. (2002) state it to be acrocentric.

The sousliks from the Taurus Mts., with the diploid number 2N = 40, are characterised by a higher fundamental number of chromosomal arms (NFa = 72), i.e. having two pairs of metacentrics, 15 pairs of submetacentrics and two pairs of acrocentrics (Özkurt *et al*., 2002). The X chromosome is metacentric and the Y chromosome, which is invariably the smallest element, is either metacentric (Akseki) or acrocentric (Mut and Hadim; Özkurt *et al*., 2002).

VARIATION

On the basis of size, three main groups can be distinguished within the Anatolian souslik. Those from northeastern Anatolia (Kars, Erzurum) are the biggest (mean condylobasal length in males > 45 mm) and those from Van are the smallest (mean condylobasal length of males ≈ 40 mm). The sousliks from the central Anatolian plain are intermediate in this respect. Conventional subspecific division is based on this character and Mursaloğlu (1965) distinguished two subspecific taxa, viz., *S. x. xanthoprymnus* (the bigger one) and *S. x. gelengius* (the intermediate). The sample from the district of Van (Kilisedüzü near Başkale) was not placed in any of the two subspecies, nor was any other formal name applied (Mursaloğlu, 1965).

Although Mursaloğlu (1965) based her study on representative samples, her approach was vague at the best. For example, although the box plot of palatal length for two subspecies suggests categorical differences (Fig. 5 in Mursaloğlu, 1965), closer comparison between Fig. 5 and data in Tables V to IX in Mursaloğlu's paper detects discrepancies. The lack of overlap of the samples, evident from the box plot, is possibly an artefact caused by selection of specimens. Besides, the clustering of samples based on cranial measurements in Mursaloğlu (1965) resulted in a chaining hierarchy rather than in distinct clusters (Fig. 14). In addition, significant differences in size exist even across a short geographic distance,

MALES	1 N=7	2 N=13-14	3 N=11-12	4 N=13	5 N=4	6 N=18
Total length	258.3	260.4	261.1	273.5	277.3	239.3
Tail	46.6	46.8	42.3	48.2	43.5	42.7
Hind foot	41.3	40.9	41.8	41.8	42.5	41.3
Ear	8.0	9.4	9.6	10.6	11.0	11.1
Condylobasal length	43.8	42.6	43.6	45.0	45.3	40.4
Zygomatic breadth	30.3	29.6	30.1	31.2	31.0	27.7

FEMALES	1 N=8	2 N=14	3 N=13	4 N=17-18	5 N=6-8	6 N=9-10
Total length	249.4	247.0	248.9	255.8	249.0	234.5
Tail	42.5	41.5	39.5	44.2	35.4	39.7
Hind foot	38.6	39.0	40.5	40.3	38.6	38.8
Ear	7.9	8.4	9.5	10.5	10.1	9.6
Condylobasal length	41.8	41.3	41.9	42.8	41.8	40.0
Zygomatic breadth	28.9	28.9	28.5	29.4	28.4	27.6

Table 10. Geographic variation in *Spermophilus xanthoprymnus* from Anatolia as evident from means of external and cranial dimensions. Based on Mursaloğlu (1965). Total length = head and body plus tail length; hind foot length includes also claws. Sample identities: **1** – Ankara; **2** – Niğde; **3** – Kayseri; **4** – Erzurum; **5** – Kars, **6** – Van.

which is evident from the mean condylobasal lengths of two nearby samples: one from Mt. Ercyes Dağ and the other from Kayseri at its foothills. Thus, at least part of size differences might be due to the response to local ecological conditions.

Colour varies over a short distance and in BMNH material we did not spot any geographic pattern. Colour variants appear in different parts of the species' range and do not coincide with variation in size. For example, grey animals with whitish hind feet and belly originate from Kayseri and Kars respectively, and golden-coloured skin was seen from Bayburt. Fur texture is mainly shaggy but one specimen from Kars had soft hair.

Kaya & Şimşek (1986) report clear differences between the two subspecies in the dimensions of the baculum. This sezamoid bone is longer in *S. x. xanthoprymnus* (> *c.* 2.40 mm) than in *S. c. gelengius* (< *c.* 2.45 mm; deduced from Figs. 6 & 8 in Kaya & Şimşek, 1986).

Although being aware that the pattern of geographic variation is likely to be a complex one in *S. xanthoprymnus*, we follow taxonomic revision by Mursaloğlu (1965) in proposing two subspecies which are based on size. The Van sample appears anomalous (cf. Fig. 14) but the material examined by us was not sufficient for firm conclusions. For chromosomal divergence, cf. Özkurt *et al.* (2002) and discussion in the above text.

KEY TO SUBSPECIES

1 Larger, condylobasal length of skull greater than 44 mm in males; baculum at least 2.40 mm in length

S. x. xanthoprymnus

1* Smaller, condylobasal length of skull at most 45.5 mm long in males; baculum at most 2.45 mm in length

S. x. gelengius

DISTRIBUTION

The Anatolian ground squirrel is nearly endemic to Turkey, crossing the country borders only slightly in the east and also appearing in Armenia. The bulk of the range is in the central Anatolian highland. In the Taurus Mts. the range approaches the Mediterreanean Sea quite closely. East of the Ceyhan River the southern range border of the range abruptly turns towards the north. Darende (Malatya district) is the southernmost record in the rough terrain between the Ceyhan and the Euphrates rivers. In eastern Anatolia, sousliks are common again along the upper reaches of the Euphrates River, around Lake Van and further north. The population living east of Van is possibly an isolate. Marginally, the sousliks also penetrate into the eastern Pontic Mts. but are absent from the whole Aegean region, from the mesic and forested Marmara, from the western Pontic region as well as from the arid and sandy southeastern Anatolia.

Ainsworth (1842) observed ground squirrels in the Çukurova lowland (Adana district) at the end of November 1839. This isolated report was seemingly confirmed by recent observations of sousliks at Ömer Gölü (Winden & Bosman, 1988). The information, however, is somehow contradictory. While Winden & Bosman (1988) state that sousliks were found, albeit scarcely, in owl pellets from Çukurova plain, this is not evident from the paper on the the barn owl diet in that area (Winden, 1988b).

Turan (1984) mapped the range of the Anatolian ground squirrel as being disjunct, i.e. in three main segments, viz., central Anatolia, eastern Turkey (along the borders with Iran and Armenia), and southeastern Anatolia (along the border with Syria). Contrary to this, Demirsoy (1996) mapped the range as encompassing the entire Turkey in Asia with the exception of a narrow belt along the Black Sea; this possibly reflects the exaggerated range given by Ognev (1963). We consider both these maps to be inaccurate.

The species also occurs in western Armenia where it is restricted to the Alagez region only (Šidlovskij, 1976). The frequently cited occurrence of *S. xanthoprymnus* in Palestine and Jordan, which dates back to Tristram (1885) and was still mentioned in literature as late as 1990s (Hoffman *et al.*, 1993), is by no means erroneous (cf. Lewis *et al.*, 1967). Reports of the Anatolian ground squirrel to the south of the Taurus Mts. most likely result from confusion with the diurnal *Psammomys obesus* (Kock, 1998).

In eastern Anatolia this souslik most closely approaches the Iranian border (e.g. in Başkale and around Doğubayazıt; cf. Fig. 24), but the species has so far not been reported from Iran (Lay, 1967; Morshed & Patton, 2002).

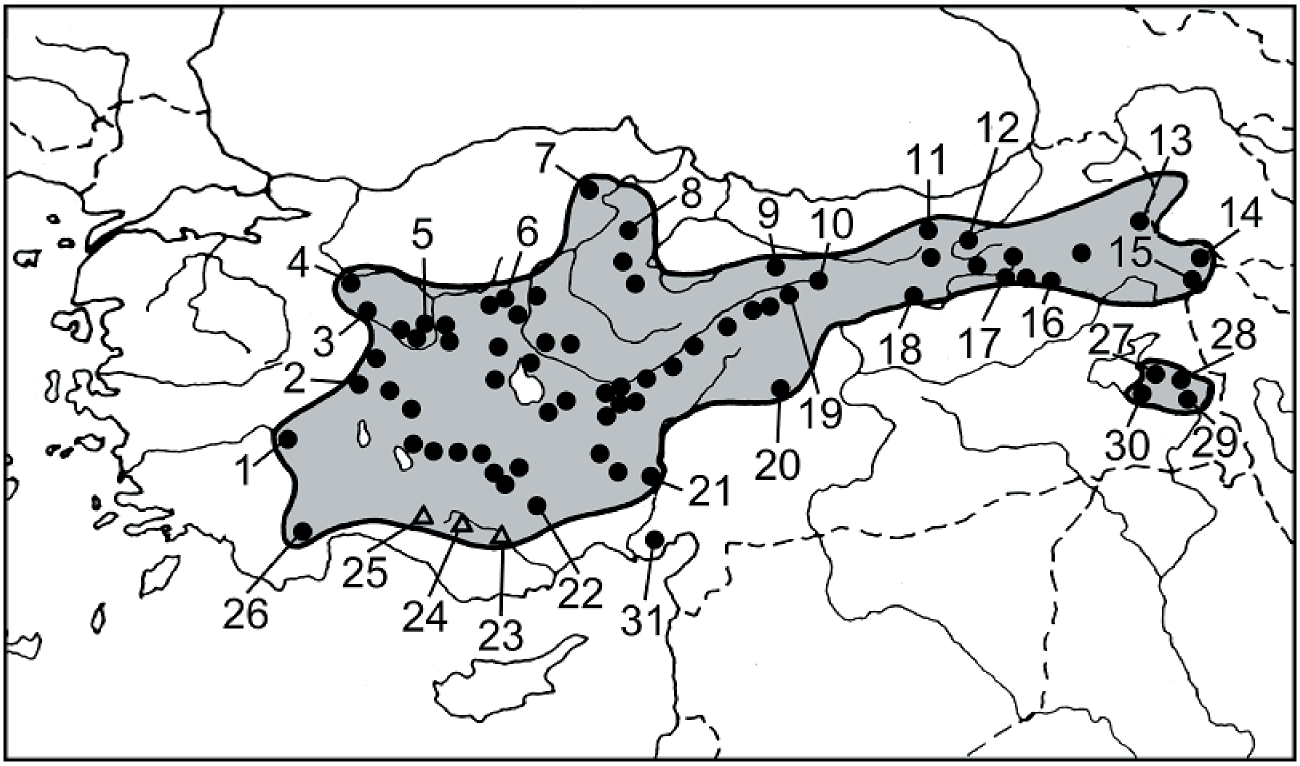


Figure 24. Distribution of *Spermophilus xanthoprymnus*. Extralimital range in Leninakan district (Armenia) is from Šidlovskij (1976). Triangles indicate the 2N = 40 chromosomal form. Records: **1** – Çardak, Denizli; **2** – Bolvadin, Hamidiya; **3** – Gökçekısık, Eskişehir; **4** – Eskişehir; **5** – 19 km north-east of Sivrihisar; **6** – Lake Emir, Ankara; **7** – Tosya, Kastamonu; **8** – Dodurga, Çorum; **9** – between Şerefiye and Güllüali, Sivas; **10** – Sivas; **11** – Furna Bag Dağ (Mts south of Trabzon; near Mereyemana); **12** – Bayburt; **13** – Digor, Kars; **14** – Aralık, Iğdır; **15** – Ishakpaşa Sarai, Doğubayazit; **16** – Çullu köy, Sölemez, Karayazı; **17** – Erzurum; **18** – Dündarlı; **19** – Celalli köyü, Sivas; **20** – Darende, Malatya; **21** – Demir Kaziköyı; **22** – Balli, Içel; **23** – 15 km west of Mut, Içel; **24** – 12 km east of Hadim, Konya; **25** – 15 km east of Akseki, Antalya; **26** – Çatallar, 40 km north-west of Finike; **27** – Van; **28** – Güzeldere, Başkale; **29** – Bast-Kala (= Başkale); **30** – 10 km south of Van; **31** – Ömer Gölü region, Adana. Corresponding references: Danford & Alston (1877): 4. Thomas (1905): 12, 29. Ellerman (1948): 17, 27. Osborn (1964): 6, 11, 13. Mursaloğlu (1965): 10, 16, 28. Corbet & Morris (1967): 26. Winden & Bosman (1988): 31. Doğramacı *et al.* (1994): 8, 19, 20. Obuch (1994): 21. Özkurt *et al.* (2002): 23-25. Yiğit *et al.* (2003a): 1, 3, 7, 13, 14, 30. ZFMK (Fuhrmann's material): 15. Own data: 2, 5, 9, 18, 22.

Karabağ (1953) states that the Anatolian ground squirrel is found extensively in the regions where the annual rainfall is 200–400 mm, and rarely in regions where the annual rainfall is about 400–500 mm. This should not be taken as a strict rule and, as shown by Osborn (1964), the species also lives in regions receiving precipitation up to 1,000 mm annually.

PALAEONTOLOGY. Storch (1988) reports *S. xanthoprymnus* from the Lower Pleistocene layers of Karain near Antalya and also considers the Middle Pleistocene material from the Aegean Island of Chios as possibly representing the same species (Storch, 1975). Both records are outside the actual range of the species in Asia Minor and, the latter in particular, suggest a considerable shrinking of the range. Hír (1991) found subfossil souslik remnants on Mt. Bolkar Dağ (Cilician Taurus, 3,000 m a.s.l.), *c.* 20 km southwest of Ulukişla.

HABITAT

Like its European counterpart, the Anatolian ground squirrel is an inhabitant of a short-grass steppes and pastures on drained soil (Figs. 25 & 26). Since the bulk of the range receives less than 500 mm of precipitation annually, the habitat is dry, frequently in the form of degraded and semiarid steppe with sparse plant cover. Osborn (1964) claims that "In regions of high rainfall and in wet meadows … /sousliks/ … colonized rocky areas, hummocks, and marginal areas where there was adequate soil drainage." It is not clear, however, whether Osborn's statement holds for the European or for the Anatolian species, or both. Anyhow, Ognev (1963) believes that rocky substrate is the essential habitat component for *S. xanthoprymnus*: "The most characteristic habitat is on slopes of small hills and mountain strew with stony rubble half covered with earth; Sviridenko never observed sousliks on flatter terrain or in regions devoid of stones." In Anatolia the species is frequently associated with dry stony landscape (Fig. 26b). Rocky, karstic habitat is populated in the Taurus Mts. (Fig. 26a). Also Corbet & Morris (1967) report sousliks to live "among the boulders and cliffs at Çatallar". On the other hand, we frequently observed the species even on flat ground with no rocks. In Aksaray Ovası, sousliks live on bare ground with scattered clumps of *Juncus* or bushes of *Peganum harmala* (Figs. 26c & d). For *S. xanthoprymnus* habitat, Yiğit *et al*. (2003a) report *Astragalus angustifolius, Salvia aethiopis, Senecio vernalis, Hyoscyamus niger, Centranthus longiflorus, Parietaria judaica, Torilis leptopkyla,* and *Eryngium campestre* as predominating in Central Anatolia, and *Bromus tomentellus, Festuca valesiaca, Astragalus microcephalus, Agroppyron repens, Echinops ritrio,* and *Eryngium campestre* in north-eastern Anatolia.

Altitude. The vertical range is poorly documented, but most of the records are from elevations above 800 m, and mainly over 900 m a.s.l. The highest record seems to be from 2,600 m a.s.l. at Başkale (Mursaloğlu, 1965). This souslik goes up to 2,700 m a.s.l. in Transcaucasia (Gromov *et al*., 1965).

Density. Population densities vary strongly. Danford & Alston (1877) found sousliks "Exceedingly common through the whole of the steppe country of the interior through which Danford passed, the ground being in some districts perfectly honeycombed with their holes." In their subsequent report they state: "The species swarms over the whole barren district of the interior, from Kaisariyeh (= Kayseri) to Eski-Sehir" (Danford & Alston, 1880). More recently, Steiner & Vauk (1966) still report sousliks to be extremely common on salt steppes east of Konya, with every square meter containing several holes. They also recorded high densities on wasteland and on flat meadows, whereas the species was scarcer on hilly slopes. We never came across such high num-

Figure 25. Anatolian ground squirrel *Spermophilus xanthoprymnus* on a high mountain pasture of Mt. Erciyes Dağ, central Anatolia (**a**; Photo by D. Tome) and at Ocaklı, Kars (**b**; Photo by A. Kryštufek).

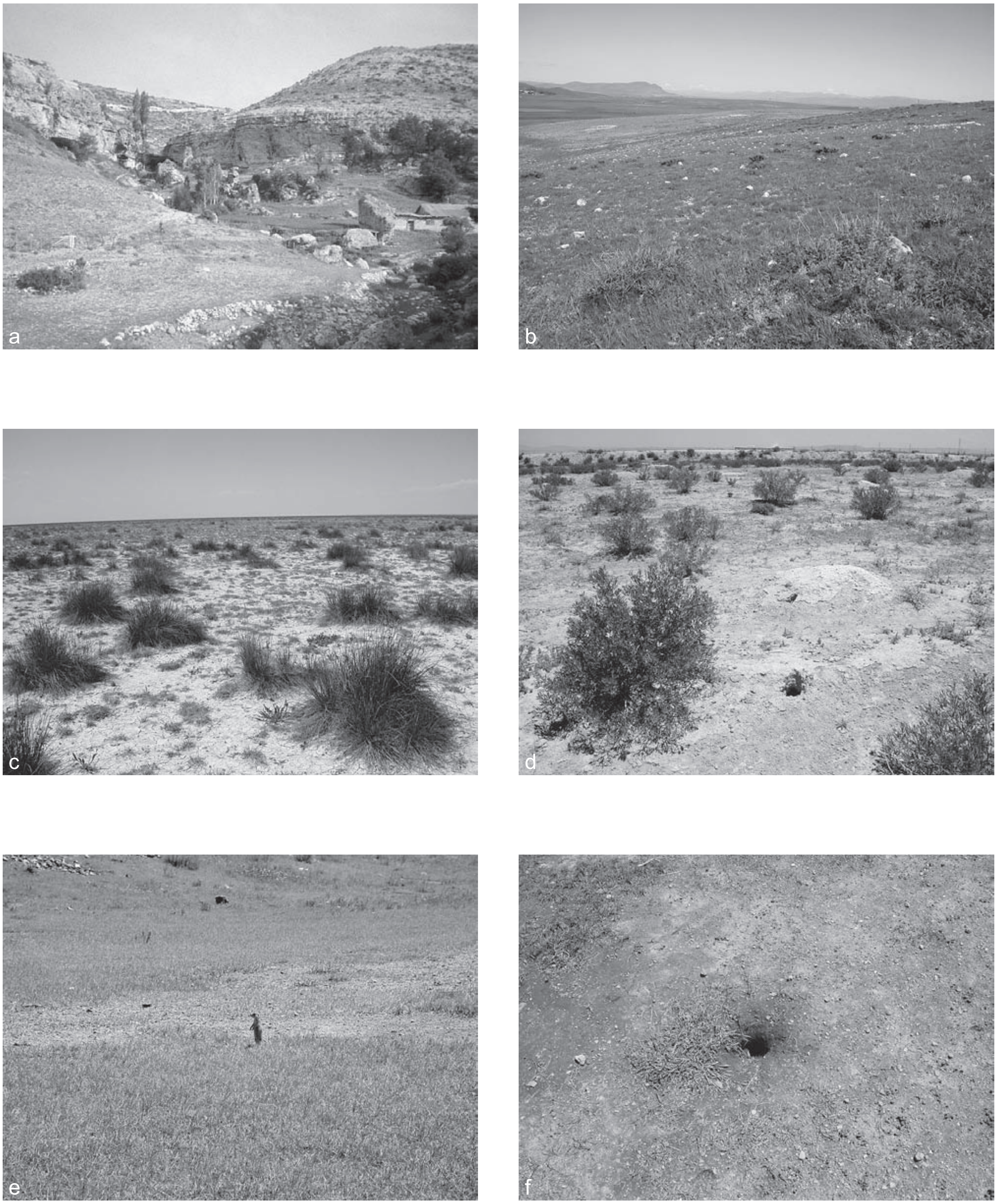


Figure 26. Habitat of *Spermophilus xanthoprymnus*. **a** – Balli, İçel, Taurus Mts.; **b** – vicinity of Erzurum; **c & d** – bare ground of Aksaray Ovası north of Eskil with clumps of *Juncus* (c) and scattered brushes of *Peganum harmala* (d); **e** – Ocaklı, Kars; **f** – entrance to the burrow at Ocaklı. Photo by V. Vohralík (a) and A. Kryštufek (b–f).

bers. For Armenia, Gromov *et al*. (1965) report densities of up to 30 individuals per hectare. As noted on the BMNH specimen tags, the Anatolian ground squirrel lived at high densities also at Lake Van, i.e. on the very eastern border of its range.

BIOLOGY

ACTIVITY. The Anatolian ground squirrel is strictly diurnal, being most active between 10 a.m. and 5 p.m. (Yiğit *et al*., 2000); the activity can decrease during the midday heath.

The Anatolian ground squirrel is a hibernator. In the vicinity of Ankara, the sousliks enter hibernation by the end of August, when the vegetation has dried out (Yiğit *et al*., 2000). In the mountains of Armenia they start hibernation in September, but in more arid lowlands they already aestivate from mid-July. Aestivation may simply continue into hibernation (Gromov *et al*., 1965). During the period of lethargy the entrances to burrows are plugged with earth. Occasionally active specimens are also seen during autumn and winter. Under laboratory conditions, the hibernation ended between late January and mid February (Yiğit *et al*., 2000). In the foothills in Armenia, sousliks appear above ground at the end of March and the beginning of April, but later on at higher elevations (Gromov *et al*., 1965). During hibernation the sousliks loose from 14.6 to 40% (on average 28%) of their body weight (Yiğit *et al*., 2000). Museum specimens were collected in Anatolia between March and August.

BURROWS. Anatolian ground squirrels seek underground shelter (Fig. 26f). Two types of burrows are recognised in Armenia. Temporary burrows are up to 150 cm long and there are between three and five entrances. Permanent burrows are more complex, depending on the substrate. Tunnels are mostly 6–7 cm in diameter and the nest chamber is 15-20 cm wide (Avetisijan, 1950; Gromov *et al*., 1965). In Balli (the Taurus Mts.) we observed sousliks seeking shelter in piles of stones on grain fields.

REPRODUCTION. The sousliks deliver one litter annually. At the Armenian foothills, young start to disperse from natal dens at the end of May. Considering the pregnancy of 27 days and lactation of 20 days (Gromov *et al*., 1965), the copulatory activity takes time around mid-April. Scarce data suggest that reproduction may be delayed in higher elevations. For example, juveniles collected in central Anatolia in mid-June were evidently bigger at the altitude of 1,120 m a.s.l. (body weight = 138–162 g) than at 1,960 m a.s.l. (body weigth = 74 g; own data). Besdies, reproduction is postponed in eastern Anatolia in comparison to the central plateau. Thus, in the first decade of June, juveniles just emerged from nests at Ocaklı, Kars (estimated body mass < 100 g) but were already fully independent around Aksaray and Konya (body mass 148–182 g). Litter size is 4–6 (Ognev, 1963) but there may be up to ten embryos (Gromov *et al*., 1965). A female collected on June 18 at Balli (1,600 m a.s.l.) had four placental scars.

FOOD. Over twenty plants were identified so far in the diet of the Anatolian ground squirrel, the most common being lucerne (*Medicago sativa*), *Poa* sp., *Bromus* sp., *Eremophyrum* sp., *Eryngium* sp., *Allium* sp., and *Merendra trigyna*. Stores of bulbs and seeds contain up to 1,300 g of material (Gromov *et al*., 1965). The daily consumption is given at 44 g, of which 18 g are seeds and 26 g is fresh grass (Yiğit *et al*., 2000).

PREDATION. In central Anatolia, the Anatolian souslik is preyed by falcons (*Falco tinnunculus, F. naumanni, F. vespertinus*; Steiner & Vauk, 1966). On Mt. Ercyies Dağ we observed ground squirrels to monitor the presence of eagles (*Aguila* sp.) very cautiously. As an exception, this souslik is also preyed by the eagle owl *Bubo bubo* (Obuch, 1994).

FAMILY: DIPODIDAE FISCHER, 1817

Although mainly assigned to Myomorpha or to Sciurognathi, the Dipodidae are characterised by a hystricognathous condition of masseter muscles. The powerful medial masseter penetrates the much enlarged infraorbital foramen. These are saltatorial guadripeds of mouse-like appearance or show strong adaptation towards bipedal locomotion. Tail invariably longer than head and body and hind foot long in saltatorial type but much more enlarged in the bipedal one. Cheek-teeth are rooted and there are one or two premolars in the upper jaw.

Although the monophyly of jerboas and jumping mice is well established, taxonomic ranking of the entire group and its further division differ among authorities. Some Russian authors frequently classify dipodids in the superfamily Dipodoidea with a subsequent ranking of Allactaginae and Sicistinae (to mention the only two groups having representatives in the Turkish fauna) as families, Allactagidae and Smithidae (= Sicistinae; cf. below), respectively (Pavlinov & Rossolimo, 1987, 1998; Šenbrot *et al*., 1995). We follow the classification by Holden (1993a) who recognises seven subfamilies within the Dipodidae, including Allactaginae and Sicistinae. Similar taxonomy was also adopted by Ognev (1948), Gromov & Baranova (1981), and Gromov & Erbajeva (1995) although the division into subfamilies differs among authorities. Vinogradov & Gromov (1984) placed *Sicista* in Zapodinae, and *Allactaga* (together with *Pygerethmus*) in Allactaginae. Ellerman (1940) and Ellerman & Morrison-Scott (1951) saw *Allactaga* in the subfamily Dipodinae (within the family Dipodidae which also included Sicistinae), but Bobrinskij *et al*. (1965) and Corbet (1978) divided the group into Zapodidae (with *Sicista*) and Dipodidae (with *Allactaga* in the subfamily Allactaginae or Dipodinae, respectively).

Jerboas and jumping mice are of Holarctic distri-

Figure 27. Five-toed jerboa *Allactaga*. Drawing: J. Hošek.

bution, but with the greatest diversity in the Palearctic region; only three genera (out of the total 15) with five species (out of 51) are Nearctic. Two subfamilies have representatives in Turkey.

KEY TO SUBFAMILIES

1 Size larger (body mass > 30 g); hind foot much enlarged, with three functional digits; tail tufted terminally; incisors pro-odont; infraorbital foramen much enlarged
Allactaginae

1* Size small (body mass < 10 g); hind foot not much enlarged, with five functional digits; tail not tufted terminally; incisors orthodont; infraorbital foramen not much enlarged
Sicistinae

SUBFAMILY: ALLACTAGINAE VINOGRADOV, 1925

Allactaginae include dipodids highly specialised for saltatorial way of life. In spite of this, their hind foot still retains characteristics which are primitive among bipedal jerboas. The three central metatarsal bones are fused to form a cannon bone (Fig. 28) but all five fingers are mainly retained although the lateral two are functionless. There is no baculum.

The subfamily is endemic to the Palaearctic region. Of the three genera, only *Allactaga* has representatives in Turkey.

GENUS: *ALLACTAGA* CUVIER, 1837

Medium-sized to large jerboas with long ears and long tufted tail. Molars are large, robust and semihypsodont. There are still five clawed fingers on hind foot; *A. tetradactyla* (Lichtenstein, 1823) is exceptional in this respect in having four fingers only. Dental formula: 1/1, 0/0, 1/0, 3/3 = 18.

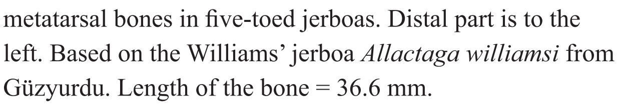


Figure 28. Cannon bone, formed by the fused three central metatarsal bones in five-toed jerboas. Distal part is to the left. Based on the Williams' jerboa *Allactaga williamsi* from Güzyurdu. Length of the bone = 36.6 mm.

Morphology of the male genital tract suggests *Allactaga* to be most closely related to genera *Allactodipus, Pygerethmus*, and *Allactagulus*, which Pavlinov & Shenbrot (1983) classify in Allactaginae (family Dipodidae).

The genus includes twelve species, whose ranges cover deserts and steppes of north-eastern Africa (Libya, Egypt), the Near East and the Middle East, Afghanistan, western Pakistan, the Caucasus, the eastern part of Europe, central Asia and western Siberia, the Altai Mts., Mongolia, Xinjang, and Gansu.

TURKISH JERBOAS. Of the three species recognised in Turkey, the separate status of *A. elater* was never questioned, while the taxonomic relations between *A. williamsi* and *A. euphratica* caused some disagreements. Ellerman (1948) distinguished Williams' jerboa from the closely related *Allactaga euphratica* by size: occipitonasal length at least 30.7 mm in *A.*

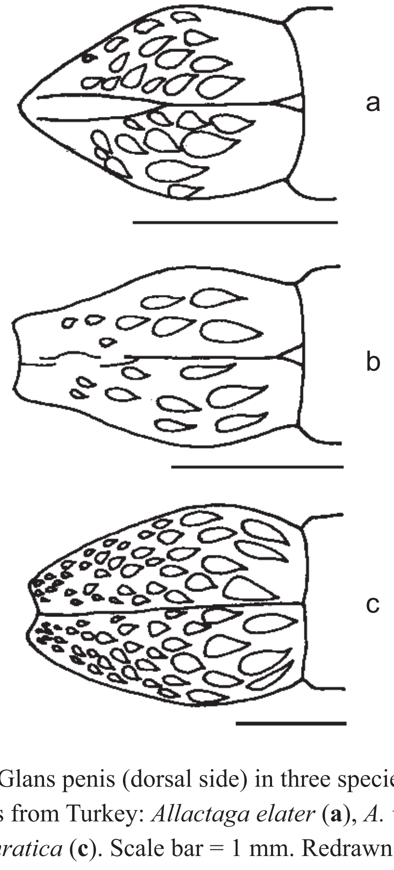


Figure 29. Glans penis (dorsal side) in three species of five-toed jerboas from Turkey: *Allactaga elater* (**a**), *A. williamsi* (**b**), *A. euphratica* (**c**). Scale bar = 1 mm. Redrawn from Çolak *et al.* (1994).

williamsi (not exceeding 29.8 mm in *A. euphratica*), upper tooth-row at least 6.2 mm in *A. williamsi* (usually not more than 6.1 mm in *A. euphratica*) and hind foot > 60 mm in length in *A. williamsi* (< 60 mm in *A. euphratica*). Atallah & Harrison (1968) believe that the small sample of four jerboas collected near Palmyra in Syria was intermediate between the two forms. Consequently, they claim that the types of *williamsi* and *euphratica* represent only extremes along a south-to-north size gradient. As a result, *A. williamsi* was considered to be merely a junior synonym of *A. euphratica*. Such a view was adopted by subsequent authors (Corbet, 1978; Pavlinov & Rossolimo, 1987, 1998; Doğramacı, 1989a; Harrison & Bates, 1991; Šenbrot *et al*., 1995), whereas others did recognise *A. williamsi* as a distinct species (Vinogradov & Gromov, 1984; Kurtonur *et al*., 1996). Within this context, one should underline that Ellerman (1940) considered *A. williamsi* as fairly distinct from *A. euphratica*. Namely,

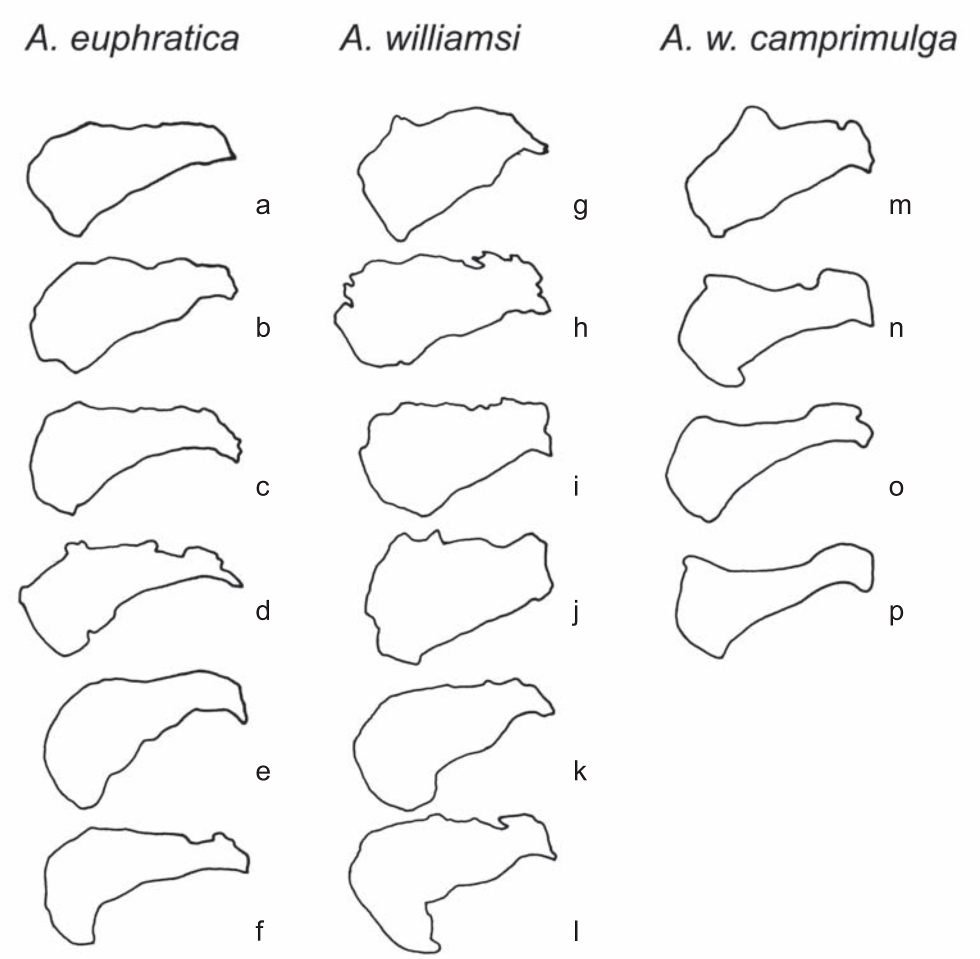


Figure 30. Variation in shape of the left lacrimal bone in *Allactaga euphratica* and *A. williamsi*. Anterior margin is at the top; medial side is to the right. Not to scale. *Allactaga euphratica*: **a, c, e** – 100 miles north of Damascus, Karyatein, Syria; **b** – Baghdad, Iraq; **d** – Şanlıurfa, Turkey; **f** – Amman, Jordan. *Allactaga williamsi*: **g** – 4 km east of Ardebil, Eastern Azerbaijan, Iran; **h** – Norşinç, Bitlis, Turkey; **i–k** – Van, Turkey; **l** – Başkale, Van, Turkey. *Allactaga williamsi caprimulga*: **m–p** – Shiber Pass on the Kabul – Bamian Road, Afghanistan. Specimens (**i**) and (**o**) are types of *williamsi* and *caprimulga*, respectively. Source of material: BMNH (a, b, c, e, f, i, j, k, m–p); FMNH (g, h); ZFMK (l).

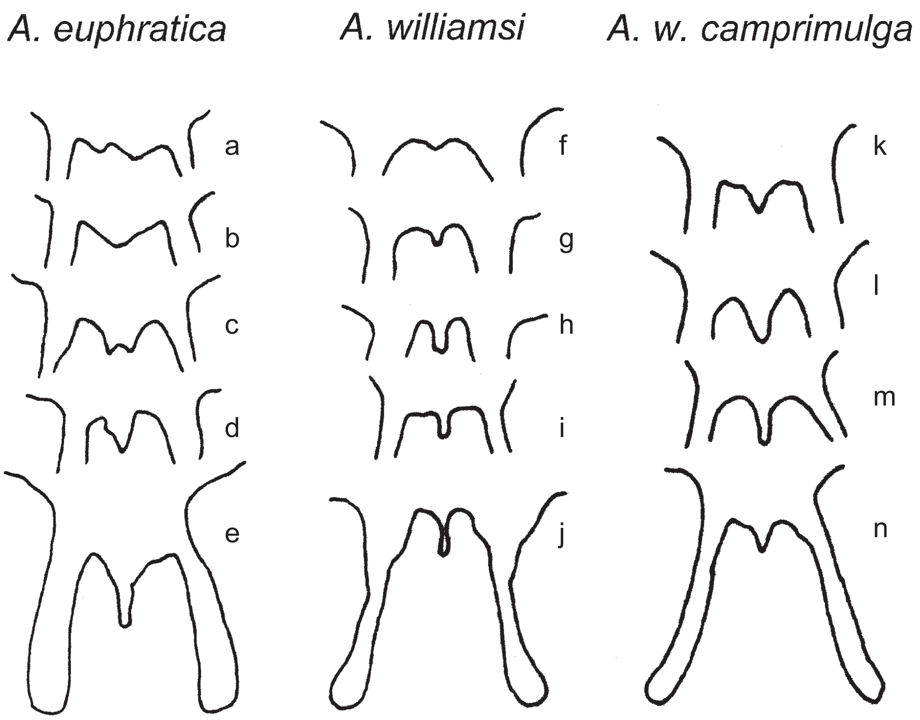


Figure 31. Variation in shape of the protuberance on the posterior margin of hard palate in *Allactaga euphratica* and *A. williamsi*. Anterior is at the top; not to scale. *Allactaga euphratica*: **a, c** – 100 miles north of Damascus, Karyatein, Syria; **b** – Amman, Jordan; **d** – Baghdad, Iraq; **e** – Şanlıurfa, Turkey. *Allactaga williamsi*: **f–h** – Van, Turkey; **i** – 4 km east of Ardebil, Eastern Azerbaijan, Iran; **j** – Başkale, Van, Turkey. *Allactaga williamsi caprimulga*: **k–n** – Shiber Pass on the Kabul – Bamian Road, Afghanistan. Specimens (**g**) and (**k**) are types of *williamsi and caprimulga*, respectively. Source of material: BMNH (a–d, f, g, h, k–n); NMNH (i); ZFMK (j).

he listed Williams' jerboa as the sole representative of the *williamsi* group of *Allactaga* and placed *A. euphratica* in the *elater* group, along with *A. elater* and *A. hotsoni*. Considering the current subgeneric division of *Allactaga* (see below), Ellerman (1940) was most likely wrong in such taxonomic arrangement. However, Ellerman & Morrison-Scott (1951) note that Williams' jerboa "is very close to *euphratica*, possibly merely a further series of larger race of that."

Çolak *et al.* (1994) provide strong evidence against the inclusion of *A. willimasi* in *A. euphratica*. Morphology of glans penis, which is an important taxonomic character in the genus (cf. Šenbrot *et al.*, 995) is particularly diagnostic (cf. Fig. 29 and descriptions under the species). Cranial characters are apparently of minor importance. Çolak *et al.* (1994) list the following traits:

1. lacrimal bone: "small and narrow" in *A. euphratica* and "larger and broad at the base" in *A. williamsi*;
2. posterior palatine foramen: "considerably larger in relation to skull" in *A. euphratica* and comparatively small in *A. williamsi*,
3. protuberance on the posterior margin of the hard palate: description of character states is not clear to us, but as far as we were able to deduce from Fig. 3 in Çolak *et al.* (1994), the base of the protuberance is wide in *A. euphratica* and narrow in *A. williamsi*,
4. lateral margins of the basioccipital: figured by Çolak *et al.* (1994: Fig. 4 on p. 593) as being straight in *A. euphratica* but concave in *A. williamsi*.

We found character no. 4 as difficult to score, since the basioccipital is covered by bullae on the crucial segment where the character state is expressed. We thus hesitate to discuss it further. The relative size of the posterior palatal foramen (character no. 2) is variable. Although *A. williamsi* can probably never reach the largest size of *A. euphratica* the overlap is broad. For that reason we did not use the size of palatine foramen for diagnostic purposes. The shape of the lacrimal bone (character no. 1) is apparently properly defined in Çolak *et al*. (1994). Anyhow, on the one hand the extremes overlap partially and, on the other, the character does not hold over the entire geographic range of *A. williamsi* (as defined e.g. by Šenbrot *et al*. 1995). As a matter of fact, *A. w. caprimulga* Ellerman, 1948, which is an isolate in Afghanistan, roughly covers the range of extremes seen in the two jerboas in the Near East (Fig. 30). The protuberance on the posterior margin of hard palate (character no. 3) is mostly small with a narrow base in *A. williamsi* or even absent in extreme cases. On the other hand, the base is mostly expanded over the entire posterior margin of the hard palate in *A. euphratica*. As a consequence, the protuberance is stick-like in *A. williamsi* and triangular in *A. euphratica*. Anyhow, not all specimens are easily classified (Fig. 31), which makes this character of minor taxonomic value.

The skull size overlaps between *A. williamsi* and *A. euphratica* and does not allow allocation of each specimen to a species. In samples examined by us (which were smaller than those given in Tables 11 and 14), we did not find any overlap in the length of rostrum; 17.7 mm was a cut-off point. Thus this character might be of some help when dealing with taphonomically-altered material.

According to the subgeneric division of *Allactaga*, as proposed by Pavlinov & Rossolimo (1987, 1998) and Šenbrot *et al*. (1995), the Turkish species belong to two subgenera: *Paralactaga* Young, 1927 (*A. euphratica* and *A. williamsi*) and *Allactaga* s. str. (*A. elater*). *Paralactaga* is considered to be more primitive, which is evident from its low molar crowns and a simple medial furrow on the dorsal side of glans penis. Subgenus *Allactaga* has higher crowns (mesodont condition in the terminology of Šenbrot *et al*., 1995) and the furrow bifurcates towards the tip of the glans. Such a division is not generally accepted. Nowak (1999) does not recognise *Paralactaga* and consequently includes all Turkish species in the subgenus *Allactaga*.

KEY TO SPECIES

1 Smaller: condylobasal length of skull <28 mm, maxillary tooth-row <5.7 mm; interorbital constriction wider (>30% of condylobasal length); medial furrow on dorsal side of glans penis bifurcates distally (Fig. 29a) *A. elater*

1* Larger: condylobasal length of skull >27 mm, maxillary tooth-row >5.7 mm; interorbital constriction narrower (<30% of condylobasal length); medial furrow on the dorsal side of glans penis simple and straight (29b, c) 2

2 Larger: hind foot >60 mm; glans penis shorter (<4 mm) and covered with a lower number of denticles (<50) *A. williamsi*

2* Smaller: hind foot <60 mm; glans penis longer (>5 mm) and covered with a higher number of denticles (>100) *A. euphratica*

WILLIAMS' JERBOA – *ALLACTAGA WILLIAMSI*

Allactaga williamsi Thomas, 1897. Type loc.: near Van Gölü, Turkey.

Allactaga williamsi laticeps Nehring, 1903. Type loc.: Köktschi – kissik (= Gökçekısık), Eskişehir, Turkey (Çolak *et al*., 1997d).

DESCRIPTION

EXTERNAL CHARACTERS. William's jerboa is a medium-sized member of the genus; however, it is the largest *Allactaga* in Turkey. Like all its congenerics, this species is highly adapted to jumping. Its body is compact and the rounded tail is much longer than head and body (140–190% of head and body length; 165% on average) with a terminal tuft. The hind foot is also much enlarged (half of head and body on average) and has five fingers all of which bear claws. The claws, which are pale yellowish or amber, are short but robust, up to 4 mm long and 1 mm broad at base. The lateral fingers are also large, even though not functional, and only the central three actually support the foot. The hind foot is essentially of a perissodac-

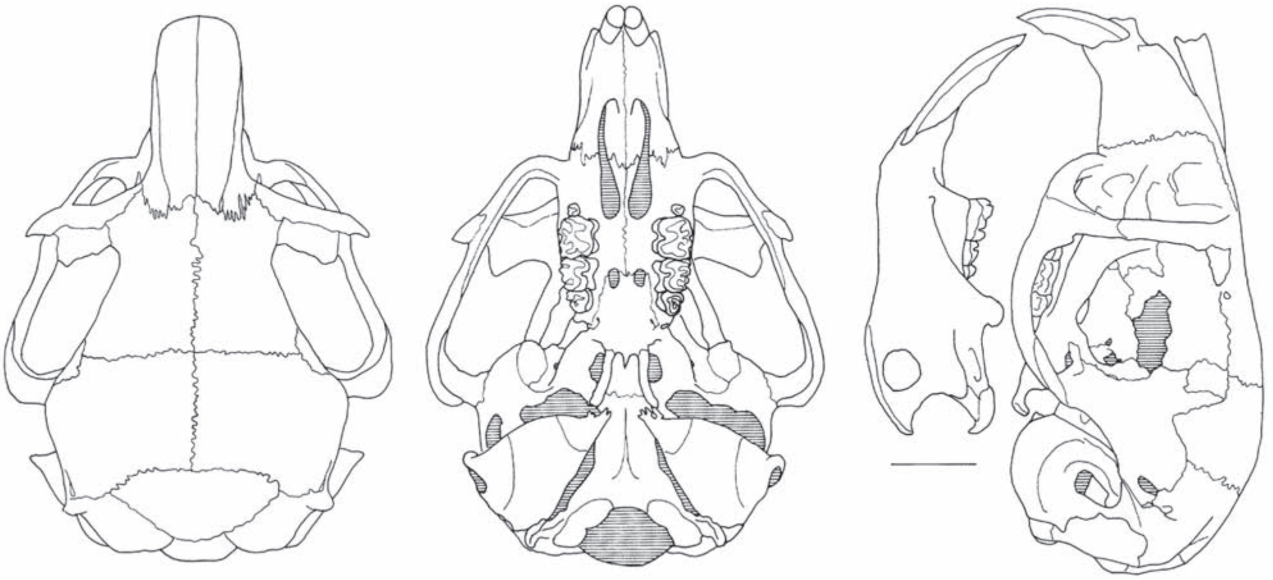


Figure 32. Skull and mandible of *Allactaga williamsi*, based on an adult female from Golbaşı, Ankara. Scale bar = 5 mm.

tyle structure. The soles are bare, with a large pad present under each claw; also, there is a large pad at the base of the central digit. The margins are fringed with white hair. The fore feet are much smaller than the hind ones. The thumb is reduced and there are only four clawed fingers (claws up to 3.7 mm long) on the front foot; fingers 3 and 4 are the longest. The head is comparatively large and rounded, with long oval ears and large eyes. Whiskers are up to 63 mm long, black with white tips.

COLOUR. Hair satiny and long (up to 18 mm on the back) with slate bases and yellowish buff tips; some hairs have black tips. Medial side of back quite dark in some specimens. Rump fawn or buff, flanks cream, buff or fawn: belly hairs entirely white. Demarcation along flanks obscured or fairly distinct, depending on the intensity of flank coloration. A white stripe on hip and thigh of intense buff fawn colour. Head greyish buff or greyish rusty and hairs below eyes form a distinct patch. Ear grey behind, darker at base than at tip; inner side slate grey. Its upper margin grey buff, buff or fawn and the lower one pinkish. Behind the ear is a white tuft. Tail covered with short but dense grey buff hairs above and below; ventral side of tail tends to be paler. The terminal one third of tail tufted (hairs up to 18 mm long). The tuft is fawn at base, followed by a black or dark brown stripe of variable length; tip pure white. Feet are white or cream.

NIPPLES. There are four pairs of mammae.

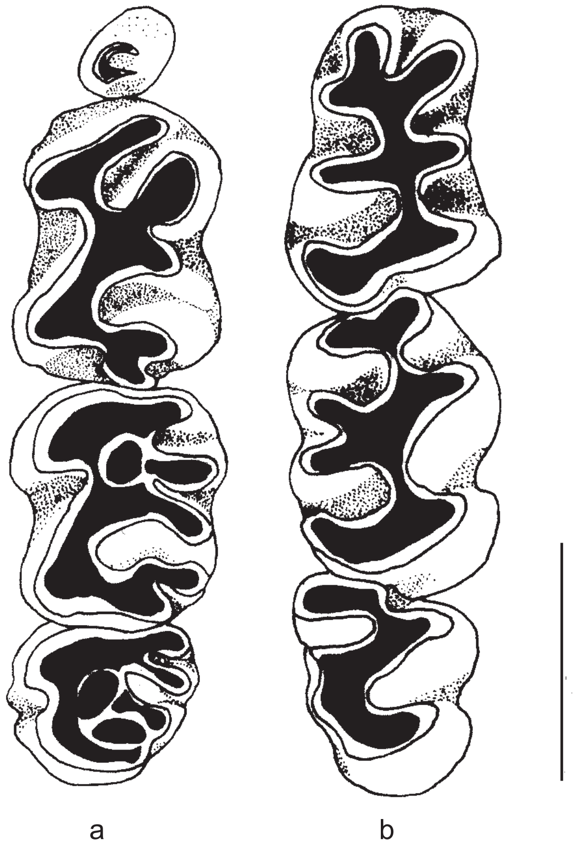


Figure 33. Upper (**a**) and lower cheek-teeth (**b**) in *Allactaga williamsi*. Same specimen as in Fig. 32. Lingual side is left, anterior is at the top. Scale bar = 2 mm.

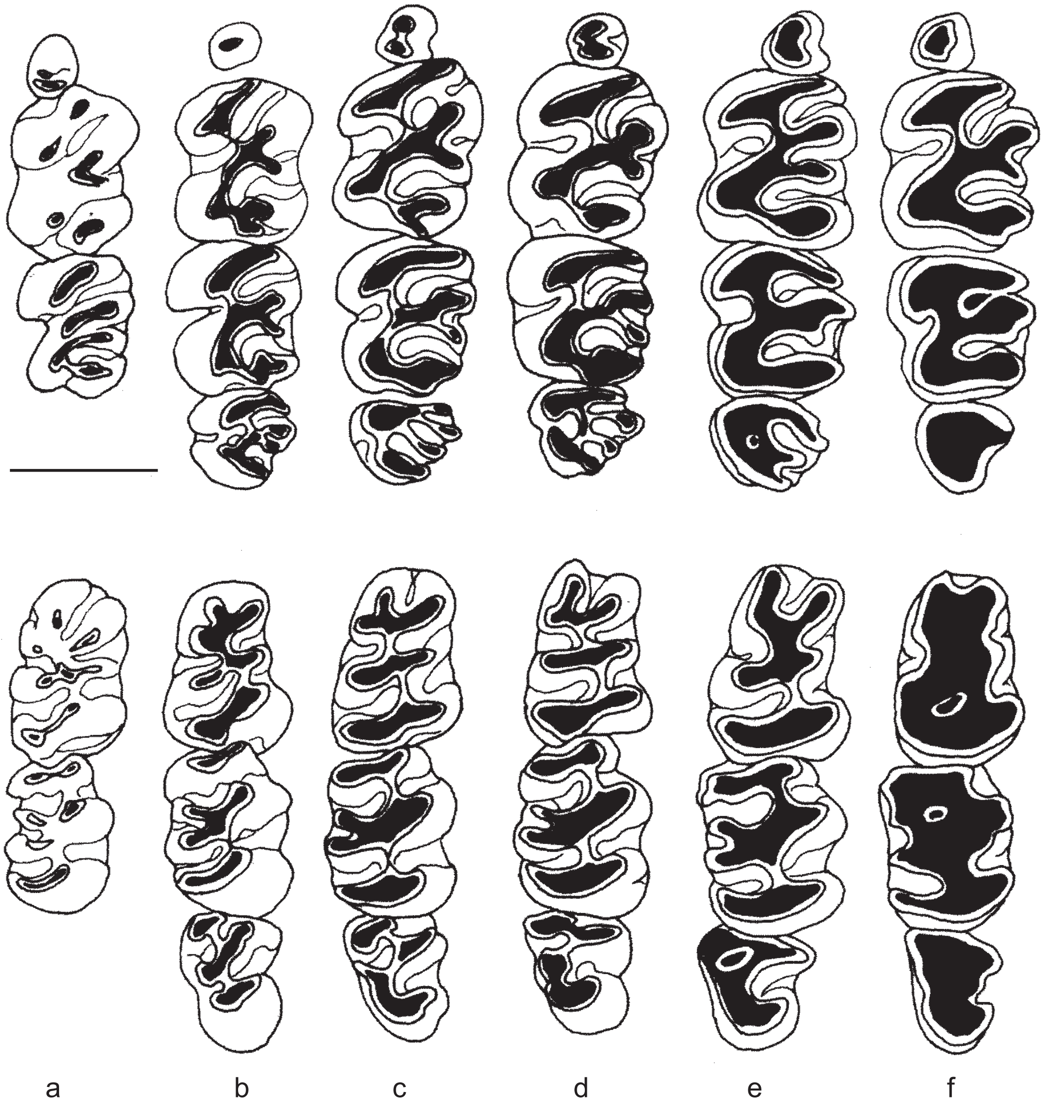


Figure 34. Age-dependent variation in cheek-teeth abrasion in *Allactaga williamsi*. Based on BMNH specimens from Konya (**a**) and Van (the rest); (**f**) is type of *williamsi*. Age is in increase from left (the youngest) to right (the oldest). Note that 3rd molars still did not erupt in specimen (**a**). Scale bar = 2 mm.

PENIS. Glans penis broad bassaly but its tip truncated. There is a medial longitudinal furrow along dorsal side, occasionally interrupted in middle, but mainly reaches the tip (Fig. 29b). Glans covered with 30–40 horny spines, which are absent from tip; it is 2.77–3.88 mm long and 1.77–2.44 mm broad. Penis measures 10–12 mm in length. There is no baculum (Çolak *et al*., 1994, 1997d).

SKULL short, broad and deep. Rostrum fairly narrow and slightly tapering towards tip, which, however, is blunt. Nasals moderately broad and short; their anterior end does not reach alveoli of the upper incisors. Lacrimal bone much enlarged, generally more robust than in *A. euphratica* from Turkey, especially in its medial part. Frontals and parietals are broad. Zygomatic arches much expanded posteriorly (zygomatic breadth 70–78% of condylobasal length; mean = 73.7%). Height of braincase across bullae 42.7–50% of condylobasal length (mean = 46.7%). Interorbital region flat and broad (26-31% of condylobasal length), and infraorbital foramen much enlarged. Jugal in two portions, a horizontal and a vertical. Bullae triangular and of moderate size. Incisive foramina large and broad; posterior palatal foramina expanded. Interpterygoid space broad and posterior margin of hard palate has a narrow protuberance. *Fissura petro-tympanica* and *foramina praelambdoidea* much enlarged. Mandible low and long, with reduced coronoid process; angular process perforated. Root of lower incisor forms an additional process (*processus alveolaris*) below the condyle.

TEETH. Upper incisors clearly proodont; enamel on their front surface white. Molars large and robust, crowns of medium height. Upper premolar small and single rooted. First and 2nd upper molars elongate and complex. Each has three external re-entrant folds (the central one is small) and one inner fold. The circular 3rd upper molar, although reduced in size, still retains the basic pattern of the first two molars. Lower molars narrower than upper ones, 3rd one less reduced. First lower molar with small fold in front and two folds on either side. Second molar resembles first one, except that front fold is absent; besides, there are three re-entrant angles on its lingual side. Third lower molar has two inner and one outer fold. Pattern depends on wear stage and some of the re-entrant angles (particularly on the posterior molars) are worn out in advanced age (Fig. 34). Number of roots: 4 (M1, M2), 2 (M3), 2 (m1), 2, 3 or 4 (m2, m3; Çolak *et al*., 1994).

DIMENSIONS. For dimensions see Table 11. There is no secondary sexual dimorphism (Šenbrot *et al*., 1995).

CHROMOSOMES. The karyotype is conservative in Dipodidae in general (Zima & Král, 1984) and in *Allactaga* in particular. All species of *Allactaga* share the same diploid number (2N = 48) and the fundamental number of autosomal arms (NFa = 92; Šenbrot *et al*., 1995). All autosomes are bi-armed. Of the heretochromosomes, the X is medium-sized submetacentric and the Y chromosome is small acrocentric (Çolak *et al*., 1994).

VARIATION

Atallah & Harrison (1968) recognised four subspecies within *A. euphratica*, as they defined it. Three of them are actually part of *A. williamsi*, as is understood here. In addition to the nominate form, these include *A. w. schmidti* Satunin, 1907 (type loc.: Kasimabad, Geokcai district, Azerbaijan, Caucasus) and *A. w. caprimulga* Ellerman, 1948 (type loc.: Shiber Pass, Afghanistan). The latter, which is a geographic isolate in Afghanistan, is recognisable by longer ears, and possibly by some cranial characters (cf. Fig. 30). As of ssp. *schmidti*, Atallah & Harrison (1968) expressed doubt on its validity. Its distribution, given in a puzzling way, should be in the "Caucasian mountains along the Russian borders with Turkey and western Iran." As a mater of fact, the range of *A. williamsi* (not including ssp. *caprimulga*) outside Turkey and Iran is extremely small (see below) and does not form a single contiguous block. It is thus unlikely that the range in the Trans-Caucasus would be populated by a race not occurring also in either Turkey or Iran, or both.

Recently, the geographic variation and subspecific division of *A. williamsi* in Turkey was revised by Çolak *et al*. (1997d) on the basis of large samples collected from nearly throughout the Turkish range. Three subspecies are recognised, diagnosed and their distributions mapped, viz., the nominate one, *laticeps,* and *schmidti*. They differ in size and colour; cf.

	Central Anatolia			Eastern Anatolia		
	N	mean	min-max	N	mean	min-max
Head and body	23	127.5	117-140	36	130.8	107-145
Tail	23	206.9	192-220	37	214.1	193-255
Hind foot	26	68.5	64-72	41	67.0	53-71
Ear	26	43.6	40-46	41	36.5	31-59
Weight	21	91.2	53-120	20	94.1	61-137
Condylobasal length	24	30.75	29.5-31.8	38	31.54	28.4-34.2
Zygomatic breadth	22	23.04	21.9-24.3	37	23.64	21.0-24.7
Maxillary tooth-row	25	6.89	6.4-7.4	39	6.94	6.2-7.6

Table 11. External and cranial dimensions of *Allactaga williamsi* for two geographical samples in Turkey. Based on Çolak *et al*. (1997d) and specimens in BMNH, FMNH, NMNH, and ZFMK.

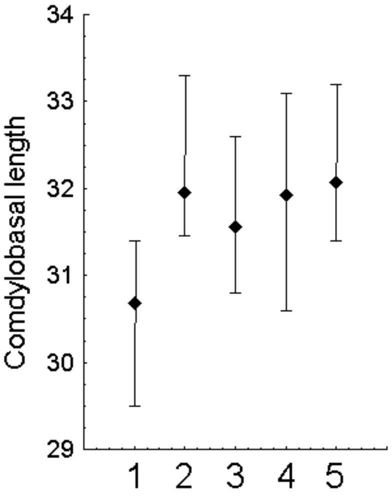


Figure 35. Variation in the condylobasal length of skull in five geographic samples of *Allactaga williamsi* from Turkey and Transcaucasia. Given are range (whiskers) and mean (diamond). Sample identities: **1** – central Anatolia (ssp. *laticeps*; N = 20); **2** – Van area (ssp. *williamsi*; N = 9); **3** – north-east Anatolia (ssp. *schmidti*; N = 10); **4** – Ararat valley, Armenia (N = 11); **5** – Azerbaijan (N = 16). Based on data in Çolak *et al.* (1997d) and Šenbrot *et al.* (1995). Assignation to subspecies is of Çolak *et al.* (1997d)

Table 12 for a summary. The size evidently shows a clear pattern (Fig. 35), with small animals occurring in central Anatolia and large ones in eastern Anatolia and Transcaucasia. Thus, it is reasonable to recognise at least two geographic races. We hesitate to comment on the colour differences given by Çolak *et al.* (1997d).

In our conclusion, the smaller race of central Anatolia (west of the Ceyhan River) is named *A. w. laticeps* and the larger one, which occurs in Turkey east of the Euphrates River, in Armenia and Azerbaijan, *A. w. willimasi*. Since ssp. *schmidti* differs from the nominate race in colour only, it is probably just its junior synonym. Šenbrot *et al.* (1995) synonymised both *laticeps* and *schmidti* with *williamsi*.

DISTRIBUTION

Since *A. williamsi* was confused with *A. euphratica* until very recently, the ranges of the two are poorly defined. Ellerman & Morrison-Scott (1951) report *A. williamsi* from Transcaucasia and Asia Minor (ignoring the Afghanistan isolate) and *A. euphratica* from "Iraq, Transjordania, Syrian Desert, North-Eastern Arabia." Atallah & Harrison (1968) tentatively mapped the ranges of *A. e. euphratica* and *A. e. williamsi* as being allopatric, which is a reasonable approach towards the distribution of two presumably conspecific subspecies. In their map (Fig. 1 on p. 629 in Atallah & Harrison, 1968) the southeastern border of *A. williamsi* mainly follows the Turkish-Iraqi and Iraqi-Iranian borders, respectively. Similarly, the eastern border of *A. euphratica* coincides with the Iraqi-Iranian border, but the range also includes parts of the Bāhtarān and İlām provinces in western Iran, from which no specimens were examined. From Iran, Lay (1967) reports *A. williamsi* only. Similarly, Womochel (1978) ascribed his Iranian specimens to *A. e. williamsi* and not to *A. e. euphratica*, yet the dimensions he gives (Table 2 on p. 70 in Womochel, 1978) evidently comprise those of adult *A. williamsi* plus those of juveniles or *A. euphratica*. A tentative map given by Çolak & Yiğit (1998a) left north-eastern Iraq, i.e. the least understood area in this respect, simply blank. Thus, the southwestern border of *A. willimasi* and the northeastern of *A. euphratica* have not been precisely defined so far.

The bulk of the range of the Williams' jerboa lies in Anatolia and northwestern Iran. Only a small fraction of the range lies in Armenia, Azerbaijan, and Nachičevan, along either the Turkish or Iranian border. For the range in Transcaucasia see Šenbrot *et al.* (1995). An isolate in Afghanistan is ascribed to ssp. *caprimulga* which, however, possibly represents a species distinct from *A. williamsi*.

The range in Turkey covers central and eastern Anatolia, and very marginally also western Anatolia

	laticeps	*williamsi*	*schmidti*
Size	small	medium	large
Colour	pale greyish brown	pale yellowish brown	bright reddish brown
Dorsal line	not pronounced	less pronounced	much pronounced
Dark part of tail tuft	black or brown	brown	light brown
Flanks	whitish grey, pinkish tinge	light reddish yellow	bright reddish brown

Table 12. Distinctive characteristics of the three subspecies of Turkish *Allactaga williamsi*, as given by Çolak *et al.* (1997d).

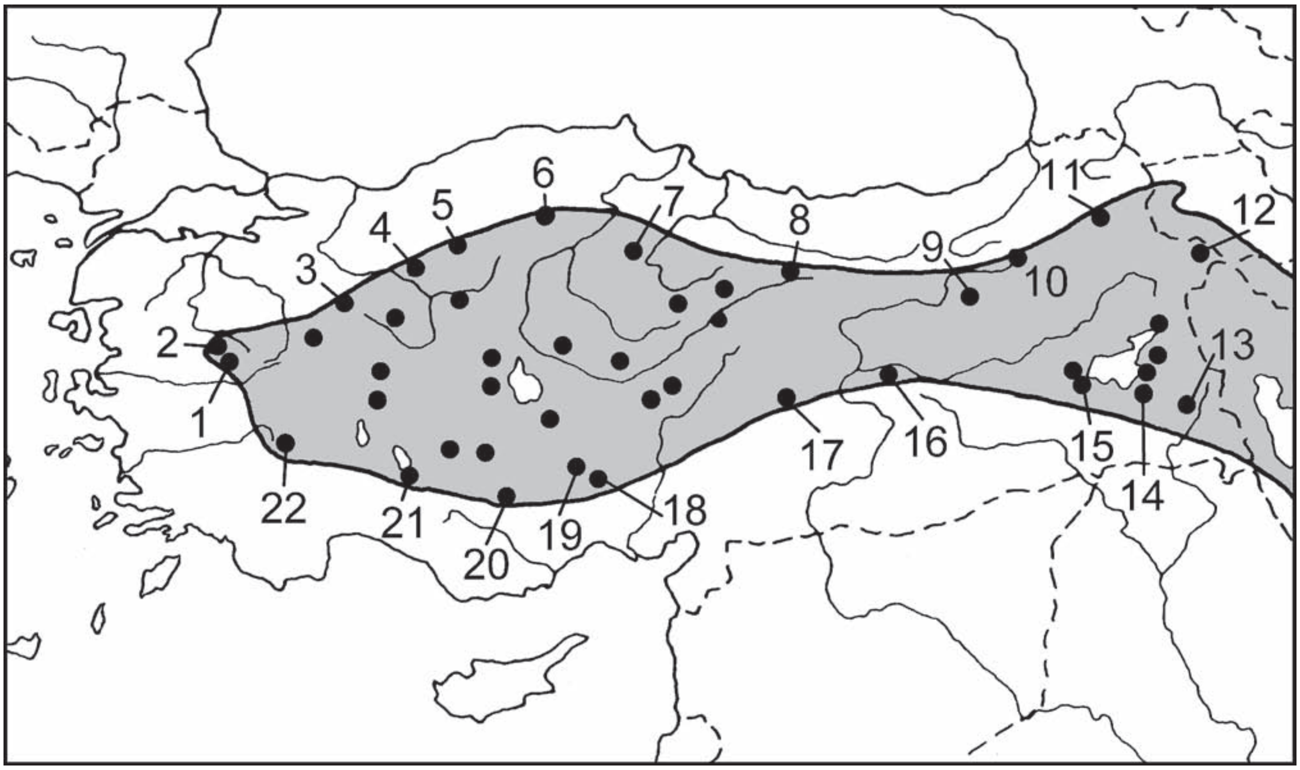


Figure 36. Distribution of *Allactaga williamsi* in Turkey. Records: **1** – Selendi, Manisa; **2** – Demirci, Manisa; **3** – Koktschi–Kissik (= Gökçekisik), Eskişehir; **4** – Beypazarı, Ankara; **5** – Kizilcahamam, Ankara; **6** – Tosya, Kastamonu; **7** – Doğantepe, Amasya; **8** – 4 km south-east of Güzyurdu, Gümüşhane; **9** – Tercan, Erzincan; **10** – Erzurum; **11** – Sarikamiş; **12** – Aralık, İğdir; **13** – Başkale, Van; **14** – 10 km south of Van; **15** – Tatvan; **16** – Elazığ; **17** – Darende, Malatya; **18** – Demir Kaziköyi; Ala Dağları; **19** – Kemerhisar, Niğde; **20** – Kılbasan, Karaman; **21** – road Beyşehir – Seydişehir; **22** – Çardak, Denizli. Corresponding references: Osborn (1964): 3, 5, 10, 15. Steiner & Vauk (1966): 21. Lehmann (1969): 13. Çolak *et al.* (1994, 1997b): 1, 4, 6, 7, 9, 12, 16, 17, 19. Obuch (1994): 11,18. Yiğit *et al.* (2003a): 2, 14, 20, 22. Own material: 8.

(Fig. 36). There is a wide gap between the rivers Ceyhan and Euphrates from which area only a single locality (Darende) is available. We hesitate to comment whether this gap is genuine or is simply a sampling artefact. The distribution shown in Fig. 36 differs in some details from the one by Çolak *et al.* (1994). Note, however, that we reconsidered all the localities listed in their paper and plotted them precisely onto the map. There is inconsistency between the list of localities in Çolak *et al.* (1994) and their plots in the map (cf. Fig. 1 on p. 592 in Çolak *et al.*, 1994).

PALAEONTOLOGY. The earliest record of the genus *Allactaga* in Turkey (Bayırköy on the Gelibolu Peninsula in Thrace) is of the Neogene age (Ünay & Bruijn, 1984). Jerboas from two Middle Pleistocene sites in Anatolia and one of its offshore islands are reported either as *A.* cf. *euphratica* (Chios; Storch, 1975) or are not determined below the generic level (Emirkaya-2; Montuire *et al.*, 1994). The subfossil material from Bolkar Dağ reported by Hír (1991) as *A. euphratica*, is from the southern fringe of the Anatolian range of *A. williamsi* and most likely belong to it; the molar dimensions match pretty well with those of recent Williams' jerboa from Turkey. Note, however, that *A. williamsi* and *A. euphratica* broadly overlap in molar measurements (Table 13). The Middle Pleistocene material, on the other hand, is at the very lowest limit of the variation range of recent Williams' jerboa (Table 13). *Allactaga williamsi* is also reported from the Middle Pleistocene layers on the Apšeron Peninsula, Azerbaijan (Vereščagin, 1959). Late Pleistocene records suggest that it ranged more northwards in the Caucasus than is its current range (Baryshnikov & Baranova, 1983).

	A. williamsi recent	*A. euphratica* recent	Bolkar Dağ subfossil	Emirkaya-2 Middle Pleist.	Chios Middle Pleist.
M1	2.38-2.68^{14}	2.12-2.50^{10}	2.50-2.75^{9}		2.3-2.4^{4}
	1.75-2.25	1.70-2.30	2.12-2.25		1.9-2.0
M2	2.10-2.40^{13}	1.77-2.45^{9}	2.22-2.67^{4}	2.17^{1}	2.0-2.2^{3}
	1.75-2.17	1.77-2.04	1.82-2.07	1.68	1.7-1.8
M3	1.23-1.90^{9}	1.09-1.36^{7}			
	1.38-1.70	1.36-1.63			
m1	2.40-2.90^{13}	2.38-2.95^{9}	2.67-2.90^{7}		
	1.67-2.25	1.43-2.00	1.75-1.87		
m2	2.15-2.68^{12}	2.04-2.55^{8}	2.37-2.50^{3}		2.1-2.2^{3}
	1.59-2.20	1.63-2.00	1.75-1.87		1.6-1.9
m3	1.65-2.03^{8}	1.43-1.90^{9}	1.67-1.88^{8}		
	1.45-1.70	1.29-1.60	1.34-1.47		
Source	BMNH & own material	BMNH & own material	Hír (1991)	Montuire *et al.* (1994)	Storch (1975)

Table 13. Range for molar dimensions in *Allactaga*, both recent and fossil, from Turkey and the island of Chios. Length of a molar is in the upper row and width is in the lower row. Sample size is given in superscript.

HABITAT

Šenbrot *et al.* (1995) consider Williams' jerboa to be eurytopic but avoiding marshy ground, meadows with tall and dense grass, and thicket vegetation. The preferred habitat in Turkey is open steppe with sparse vegetation, but with diverse plant species composition. The dominant plants in western Anatolia include *Astragalus* sp., *Medicago radiata, Festuca* sp., *Cynodon* sp., *Thymmus* sp., and *Polygonum* sp. The following plants prevail in central Anatolia, in addition to the previous ones: *Salvia cryptantha, S. aethiopis, Senecio vernalis, Hyoscyamus niger, Ziziphora capitata, Teucrium polium, Centranthus longiflorus, Parietaria judaica, Torilis leptophylla*, and *Eryngium campestre*. In eastern Anatolia the dominant plant species are *Festuca valesiaca, Eremopoa songarica, Bromus danthoniae, Ornithogallum* sp., *Equisetum ramosissimum, Atraphaxis billardieri, Crucifera* sp., *Crepis* sp., *Medicago* sp., *Euphorbia* sp., *Astragalus microcephalus*, *Agropyron repens, Echinops ritrio*, and *Eryngium campestre* (Yiğit *et al*., 2003a). In Transcaucasia, Williams' jerboa populates semideserts and dry steppes, and more rarely subalpine meadows. Exceptionally, it is also found in clearings in the woodland zone, vineyards and on arable land (Šenbrot *et al*., 1995). Its presence in cul-

Figure 37. Habitat of *Allactaga williamsi*. **a** - near Tuz Gölü, central Anatolia (Photo: J. Červený); **b** – near Tatvan, eastern Anatolia (Photo: Z. Musilová & P. Musil).

tivated land is exceptional also in Turkey (cf. Çolak & Yiğit, 1998b), although Hoogstraal (1959; cited from Osborn, 1964) said that these jerboas "burrowed in weedy fields above lakes and ponds." Çolak & Yiğit (1998b) report an observation from a pine forest.

ALTITUDE. The vertical range of localities in Turkey is between 360 and 1,700 m a.s.l. in central Anatolia and from 1,200 to 2,500 m further east (Çolak *et al*., 1997d). The highest lying locality recorded in Armenia is at 2,500 m a.s.l. (Šenbrot *et al*., 1995) and the vertical range in Afghanistan is between 1,300 and 3,200 m a.s.l. (Hassinger, 1973).

ASSOCIATES. Çolak & Yiğit (1998b) list the following rodents to co-occur with *A. williamsi*: *Meriones tristrami, M. meridianus, Cricetulus migratorius, Mesocricetus brandti, Mus* sp., *Apodemus* sp., *Microtus* sp., and *Spermophilus xanthoprymnus*.

DENSITY. In the steppes of Talyš, Transcaucasia, the population density was estimated at one jerboa per hectare. Night surveys by car, performed in central Kobystan, recorded 2.4 jerboas per 10 km of a transect. During rodent control campaigns (trapping at burrow entrances) in high elevation steppes of Azerbaijan, between 2 and 4 (and up to 10) jerboas were trapped per 100 trap-nights (Šenbrot *et al*., 1995). Near Ankara, Çolak & Yiğit (1998b) counted in September 8–10 individuals on an area of 800 m^2, which may indicate too high population density.

Population density shows regular multiannual oscillations in Azerbaijan, but the amplitude is moderate (2.5–6 fold). Populations from mid-elevation steppes are more stable than those from semideserts and high elevation steppes (Šenbrot *et al*., 1995).

BIOLOGY

ACTIVITY. Williams' jerboa is a nocturnal rodent and starts its activity 1–2 hours after sunset (Çolak & Yiğit, 1998b). During the night it travels by hopping on its hind legs, with the tail serving as a balancing organ in locomotion, but also as a prop when halting. The forelegs are used only when the jerboa moves very short distances in a rabbit-like manner.

In the Ararat valley of Armenia, Williams' jerboa hibernates from the end of October to the end of February, rarely until mid-March. In mountain steppes of Azerbaijan the onset of hibernation is postponed until mid-October and lasts until the beginning of March. Torpor is occasionally interrupted and jerboas were observed outside their burrows at temperatures of –4ºC (Šenbrot *et al*., 1995). In Turkey, the activity period is reported as lasting between April 12th and November 2nd (Çolak & Yiğit, 1998b).

BURROWS. The day is spent in a burrow which is of simple structure. Šenbrot *et al*. (1995) report shorter summer burrows (90–110 cm long) and longer winter ones (length 120–200 cm) in Transcaucasia. The spherical nest (approximately 8 cm in diameter) is located at the deepest point of the burrow. Summer nests are shallower (20 cm below the surface) than the winter ones (45–80 cm). In Anatolia, the burrows are 100–160 cm long and 29–55 cm deep below the surface. The diameter of the tunnels is 5–10 cm and that of the spherical nest chamber 12–14 cm. The nest chamber is lined with dry grass and root fibres, or with goat hairs (Šenbrot *et al*., 1995). Notably, Çolak & Yiğit (1998b) explicitly state that wool was not found in the nests they surveyed in Turkey. Some burrows have side tunnels 12–16 cm long. The entrance is invariably plugged with earth during the day (Çolak & Yiğit, 1998b) in order to keep the heat out and the moisture in, thus maintaining a suitable microclimate inside the burrow during the hottest part of the year (Nowak, 1999).

REPRODUCTION. Çolak & Yiğit (1998b) reported males with scrotal testes from April 25th to July 1st, pregnant females between May 1st and June 28th, and they recorded lactation from June 5th to August 12th. Pregnant females caught in the wild delivered in captivity between May 31st and June 5th. The number of embryos varies in Turkey between 3 and 6 (mean = 4.9, N = 15; based on data in Çolak & Yiğit, 1998b). Young are born naked, with sealed eyes and closed ears. They are weaned at the age of 40–45 days; the first juveniles in Turkey were recorded in a population on July 16th. There are probably two litters annually (Çolak & Yiğit, 1998b). Šenbrot *et al*. (1995) report pregnant females in Transcaucasia from April to October or early November, with a peak between March and end of May; the next peak, even if less pronounced, is again in August. Litters seem to be larger in Transcaucasia, than in Turkey, and they vary from 2 to 8 (mean = 5.3). Mean litter size varies within the same year between 3.0 and 6.3, depending on the month (Šenbrot *et al*., 1995). Maximum life expectancy is most likely two years, but captive animals lived up to three years long (Šenbrot *et al*., 1995).

Sex ratio is balanced in summer but male-biased in spring and autumn (from 1 : 0.7 to 1 : 0.3; Šenbrot *et al*., 1995). Çolak & Yiğit (1998b) found females to make up to 65% of the June sample in Turkey.

FOOD. Seeds are the preferred food, followed by green matter and underground plant parts. Green plants are the staple diet in spring, before seeds are available (Šenbrot *et al*., 1995). Following the results by Çolak & Yiğit (1998b) from Turkey, Williams' jerboa feeds mainly on insects in spring (April–June), on green vegetable food from June to September, and on seeds from September to November. Captive animals took green leaves, roots, flowers, seeds, and apple. This jerboa does not store food.

PREDATION. Obuch (1994) found *A. williamsi* among the prey of the eagle owl *(Bubo bubo)*. The predatory pressure exerted by this owl is evidently insignificant. Namely, in a pooled sample from six Turkish localities (with a total of 2,777 preyed mammals), *A. willimasi* was represented by a mere 0.67% (Obuch, 1994). Williams' jerboa was also recorded in pellets of *Bubo bubo* and *Athene noctua* in Transcaucasia (Vereščagin, 1959).

CONSERVATION. Williams' jerboa is believed to be of conservation concern in Turkey. The main threat is posed by the transformation of pastures and steppes into arable land, but also by the increased use of chemicals in agriculture. The same status is proposed also for the remaining two species in Turkey, the Euphrates and the small five-toed jerboa (Çolak & Yiğit, 1998b).

EUPHRATES JERBOA – *ALLACTAGA EUPHRATICA*

Allactaga euphratica Thomas, 1881. Type loc.: Iraq.
Allactaga euphratica kivanci Çolak & Yiğit, 1998.
Type loc.: Çaylık köyü, Urfa, Turkey.

DESCRIPTION

EXTERNAL CHARACTERS. Apart from being slightly smaller, the Euphrates jerboa resembles most closely *A. williamsi* in shape, colour and body proportions. The tail makes up 150–185% of head and body length (mean = 170%) and claws are slightly shorter: up to 3 mm on the front fingers and up to 3.5 mm on the hind ones. Satiny hairs are up to 17 mm long on the upper fur.

COLOUR. Dorsal side greyish buff, belly pure white and flanks cream with blackish, buff or fawn shades. Demarcation line is indistinct. Rump rusty, stripe on hip white or cream, and thigh fawn with sparse black hairs. The terminal tuft on tail (hairs up to 17 mm long) has alternating white, black and white stripes (Fig. 38).

NIPPLES are as in *Allactaga williamsi*.

PENIS. The glans penis is highly distinctive. Although being of approximately same outline as in *A. williamsi*, it is evidently larger (length: 5.55–6.54 mm, width: 3.33–3.88 mm) and densely covered with numerous (140–150) large spines. The longitudinal furrow is deep and not interrupted in the middle (Fig. 29c). The entire penis is 16–18 mm long (Çolak *et al*. 1994; Çolak & Yiğit, 1998a).

SKULL essentially of same shape and proportions as in the larger species (see above). Zygomatic arches slightly wider (= 73.5–78% of condylobasal length; mean = 76.6%) but interorbital region approximately as broad (28–31% of condylobasal length) as in *A. williamsi*. Lacrimal bone more slender than in *A. williamsi* from Turkey, particularly in its medial part.

TEETH. Dental pattern essentially same as described in Williams' jerboa. Enamel on front surface of incisors pale yellow to nearly white. Number of roots: 4 (M1, M2), 2 or 3 (M3), 2 (m1, m3), and 2 or 3 (m2) (Çolak *et al*., 1994; own observations).

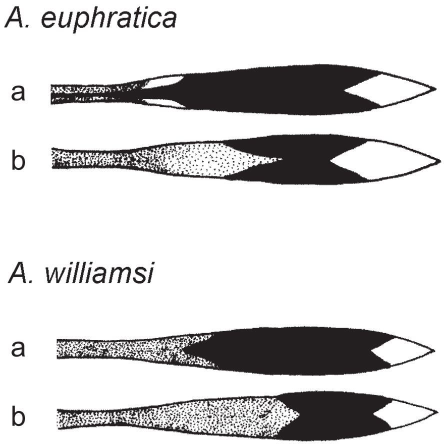


Figure 38. Tail tuft in *Allactaga euphratica* and *A. williamsi* in dorsal (**a**) and ventral view (**b**). Not to scale.

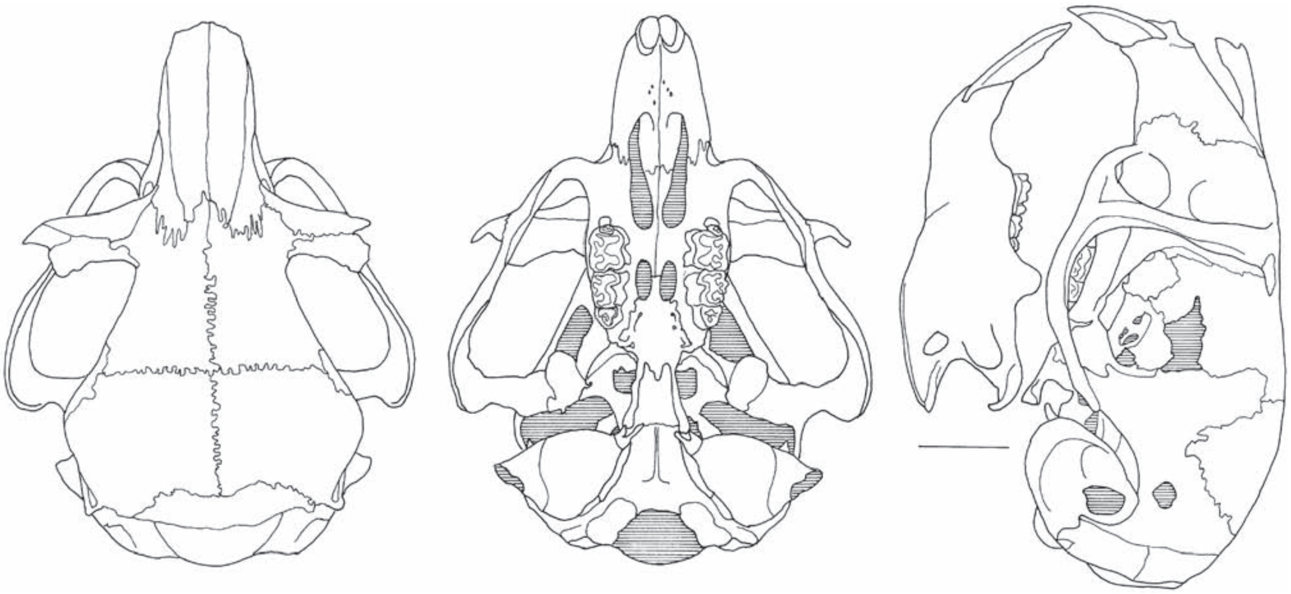


Figure 39. Skull and mandible of *Allactaga euphratica*, based on an adult female from Şanlıurfa. Scale bar = 5 mm.

Dimensions. For dimensions see Table 14. There is no secondary sexual dimorphism (Šenbrot *et al*., 1995). Atallah (1977) and Harrison & Bates (1991) give slightly higher maximum values in several measurements from a series from Iraq, Jordan, Kuwait and Syria than those given in Table 14: hind foot 61 mm, ear length 42 mm, and condylobasal length 31.7 mm. Externall measurements, reported from Lebanon are within the range of *A. williamsi* (N = 11): head and body length 112–154 mm, tail 189–229 mm, hind foot 62.8–71.1 mm, ear 50.5–56.7 mm, weight 49.8–125.2 g (Abi-Said, 2004).

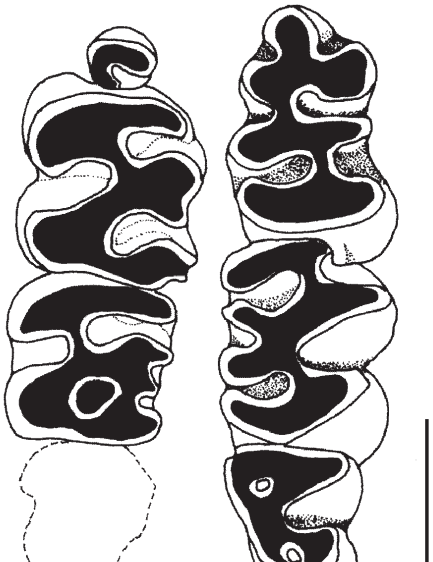


Figure 40. Upper (**a**) and lower cheek-teeth (**b**) in *Allactaga euphratica*. Same specimen as in Fig. 39. Lingual side is left, anterior is at the top. Scale bar = 2 mm.

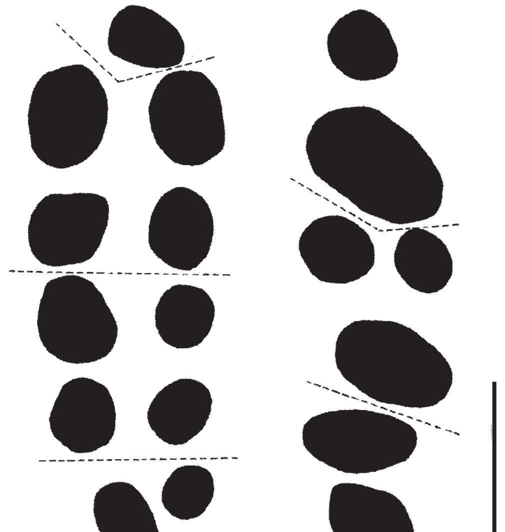


Figure 41. Alveolar pattern in *Allactaga euphratica*, based on a specimen from Şanlıurfa. **a** – upper, **b** – lower tooth-row. Lingual side is to the left and anterior is at the top. Scale bar = 2 mm.

	N	mean	min–max
Head and body	35	115.6	95–129
Tail	35	180.5	159–195
Hind foot	37	51.3	47–59
Ear	37	35.1	29–38
Weight	29	66.3	48–92
Condylobasal length	35	29.01	27.7–30.9
Zygomatic breadth	35	22.68	21.8–23.6
Maxillary tooth-row	36	6.58	5.8–7.0

Table 14. External and cranial dimensions of *Allactaga euphratica* from Turkey, Iraq and Syria. Based on Çolak & Yiğit (1998a) and specimens in BMNH.

CHROMOSOMES. The standard karyotype is the same as in *A. williamsi* (Çolak *et al*. 1994).

VARIATION

In its narrow definition, *A. euphratica* was considered to be a monotypic species and did not even include any junior synonyms (Ellerman & Morrison-Scott, 1951). Recently, Çolak & Yiğit (1998a) described and named a new subspecies, *A.e. kivanci*, diagnosed as follows: "The fur on dorsal is pale buff. The tail is distinctly trizonal on dorsal aspect; a narrow buff zone is succeeded by black subterminal band, and the white tip." Syria and southeastern Turkey are mapped as the range of ssp. *kivanci*; Iraq is denoted as the range of the nominate subspecies. In the BMNH material of *A. euphratica* from Syria, Iraq and Kuwait we found no significant differences among specimens from different localities in tail coloration. After having carefully read the discussion in Çolak & Yiğit (1998a), we strongly assume that some misunderstanding was in question while diagnosing the new race.

DISTRIBUTION

The Euphrates jerboa has a fairly small range in Syria, Jordan, northern Saudi Arabia, Kuwait, Iraq, and very marginally also southeastern Turkey. It was reported recently also from Lebanon (Abi-Said, 2004). Most probably, it also occurs in southwestern Iran. For general distribution see also the discussion above. In Iraq it appears to be relatively local in distribution (Harrison & Bates, 1991).

Turkey lies at the very northern margin of the

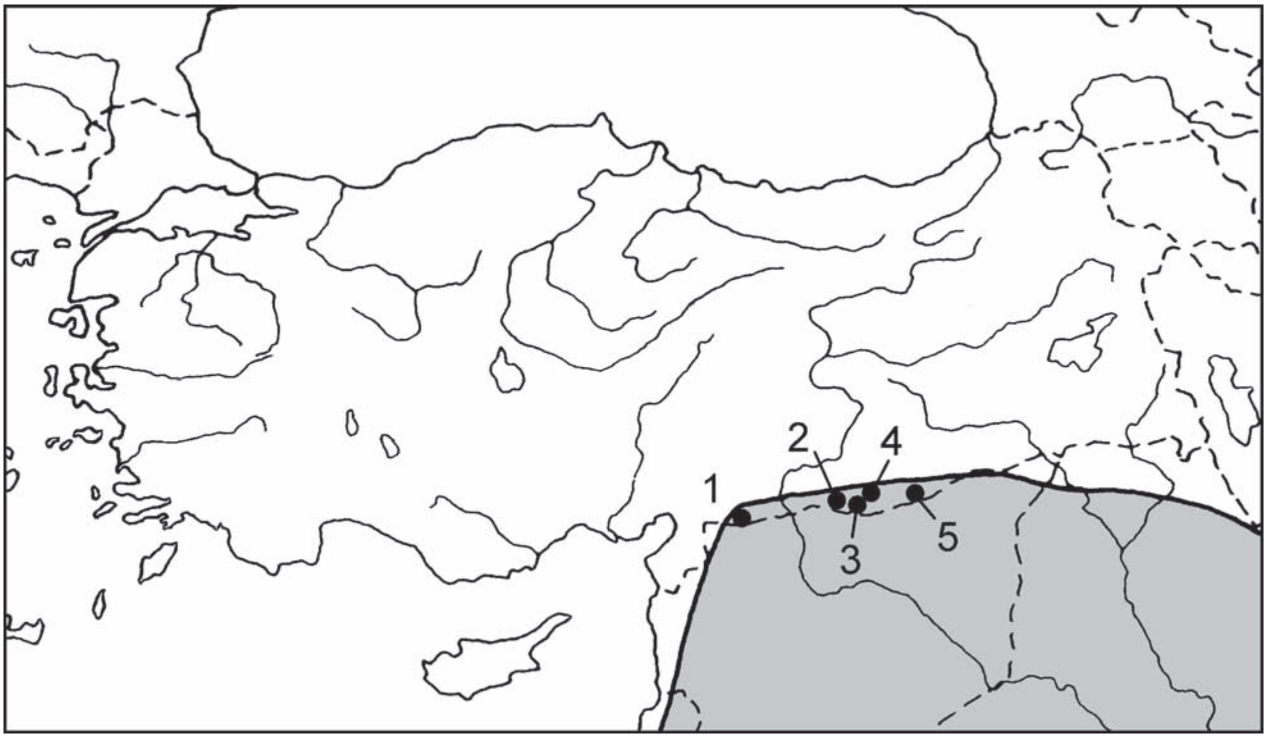


Figure 42. Distribution of *Allactaga euphratica* in Turkey. Records: **1** – 10 km east of Kilis; **2** – Harran, Urfa; **3** – Meydankapı köyü, Urfa; **4** – Çaylık köyü, Urfa; **5** – Ceylanpınar, Urfa. Corresponding references: Misonne (1957): 2. Çolak *et al*. (1994): 4. Çolak & Yiğit (1998a): 3. Yiğit *et al*. (2003a): 1, 5.

species' range. All the localities (five in total) are along the Syrian border, from Kilis in the west to Ceylanpınar in the east. Range strongly resembles the distribution of *Hemiechinus auritus syriacus* (cf. Kryštufek & Vohralík, 2001).

HABITAT

Allactaga euphratica is "an inhabitant of steppe desert terrain, preferring low foothills, the periphery of wadi systems and the grassy parts of the limestone hamada to true sand deserts favoured by *Jaculus*." (Harrison & Bates, 1991). Similarly, Kadhim *et al*. (1979) report it in Iraq from shores of wadis and grassy fragments of hamada-type desert in hilly region. Çolak & Yiğit (1998b) report it from steppes on low plains with sparse grassy cover and with hard substrate. The following plants are reported from spots where the Euphrates jerboa was collected in Turkey: *Hordeum* sp., *Eryngium* sp., *Securigera* sp., *Peganum* sp., and *Agropyron* sp. (Yiğit *et al*., 2003a). Abi-Said (2004) collected specimens on rocky dry land with a predominant flora of *Onobrychis cornuta*. Misonne (1957) also observed the jerboas on cultivated plains.

ALTITUDE. The elevation of two Turkish localities is 400 and 650 m a.s.l. (Yiğit *et al*., 2003a), but the only two Lebanese records are from the highlands: 2327 and 2660 m a.s.l. (Abi-Said, 2004).

ASSOCIATES. The following small mammals were recorded in the same habitat as *A. euphratica*: *Meriones tristrami, M. crassus* (the dominant species), and *Hemiechinus auritus* (Çolak & Yiğit, 1998b). To the south of Turkey, *A. euphratica* shares its habitat with *Jaculus jaculus* (Linnaeus, 1758), but is less common (Atallah, 1978; Kadhim *et al*., 1979; Harrison & Bates, 1991). Contrary to *J. jaculus*, the Euphrates jerboa lacks specialised fringes on the functional toes, which presumably prevents it from colonising sandy areas (Harrison & Bates, 1991).

Figure 43. Habitat of *Allactaga euphratica*. Dry rocky steppe between Gaziantep and Şanlıurfa. Photo: A. Kryštufek.

DENSITY. The population densities of *A. euphratica* are not known. In Turkey, Çolak & Yiğit (1998b) counted 25 burrows in an area of 800 m^2, and report a capture of "17 specimens in same place in Urfa." Misonne (1957) found it to be common in Syria and around Urfa in Turkey. In a sample of 1,879 rodents collected in the northern Syrian desert in spring 1955, *A. euphratica* made up 1.2% of the material from the Turkish part of the area (total number of rodents = 1,295), and 6.2% in the Syrian part (N = 584; Misonne, 1957).

BIOLOGY

ACTIVITY. The species is strictly nocturnal and starts its activity 1.5–2 hours after sunset (Kadhim *et al*., 1979). In Iraq, the Euphrates jerboa is active between February and October (Kadhim *et al*., 1979). The period of its activity in Turkey is not known. As is evident from the list of specimens in Çolak & Yiğit (1998a), their material was collected in all seasons of the year except in January, March, April, and December. Çolak & Yiğit (1998b) also report a captive jerboa which hibernated from November 27th to December 11th. The largest body weight (88 g) is reported, again from captivity, in November (Çolak & Yiğit, 1998b). Atallah (1978) dug out of its burrow a torpid jerboa on May 4th. Under captive conditions, lethargic animals were observed in July and in September (Çolak & Yiğit, 1998b).

BURROWS. The jerboas spend the day in burrows, which are simple in structure. A tunnel (5–11 cm in diameter and 45–120 cm in length) leads to a spherical nest chamber (11–15 cm in diameter) which is the deepest point of the burrow (35–40 cm below the surface). The nest chamber is lined with dry grass and wool. There are occasional short lateral passages leading in various directions. The only entrance is invariably plugged with earth during the day (Çolak & Yiğit, 1998b).

REPRODUCTION. In Iraq, Kadhim & Wahid (1986) recorded sexually active males between February and May. During the hot period (June–September) their testes were small and spermatogenesis was negligible. Sexual activity was recorded again in October. All Turkish records of reproductive activity are from May (Çolak & Yiğit, 1998b). Litter size is 4–9 (mean = 6.4, N = 9; data from Atallah, 1978, and Çolak & Yiğit, 1998b). The cubs are born naked, with sealed eyes and closed ears; body weight at birth is 2.7–2.9 g. The young open their eyes at the age of *c*. 15 days and start eating seeds while still being suckled (Çolak & Yiğit, 1998b).

FOOD. The feeding biology of this jerboa is little known. Çolak & Yiğit (1998b) found the stomachs of jerboas collected in September containing green leaves, stems, roots, and seeds. Captive animals survived on sunflower seeds, green vegetable matter, and flowers. No stored food was found in any of the eighteen burrows dug out in Turkey (Çolak & Yiğit, 1998b). Harrison & Bates (1991) report that the jerboas can forage at distances up to 0.5 km away from their burrows.

PREDATION. In the Near East, the Euphrates jerboa was quite frequently recorded in the diet of owls, but mainly at low frequencies. It was found in the pellets of *Tyto alba* in Syria (Shehab *et al*., 2004) and in Turkey (Harran; own data). Shehab (2004) reports a fairly high incidence of *A. euphratica* (= 19.5% of rodents) in the pellets of *Bubo bubo* from Syria. Nadachowski *et al*. (1990) also found this jerboa in the prey of an unidentified owl species in Iraq.

SMALL FIVE-TOED JERBOA – *ALLACTAGA ELATER*

Dipus elater Lichtenstein, 1825. Type loc.: Inderskij Region, Gur'ev District, western Kazakhstan.

Allactaga aralychensis Satunin, 1901. Type loc.: Aralık, Ağrı Dağı, Turkey.

DESCRIPTION

EXTERNAL CHARACTERS. *Allactaga elater* does not differ much from the two preceding species but is considerably smaller. In our sample the relative tail length was 130–166% of the head and body (mean = 155%); and hind foot was of the same relative size as in the larger species. The hairy fringe on the hind foot is less pronounced than in *A. williamsi*. Whiskers are up to 70 mm long, black with white tips. Hair is up to 16.5 mm long on the back.

COLOUR of the upper-parts is coarsely mixed buff and grey. Flanks are pale fawn to buff, belly pure white and there is no demarcation line along flanks. Thigh is fawn. White stripe on thigh bordered below with dark hairs. Ears are smaller than in the two larger species. Their colour is fawn on the back side and

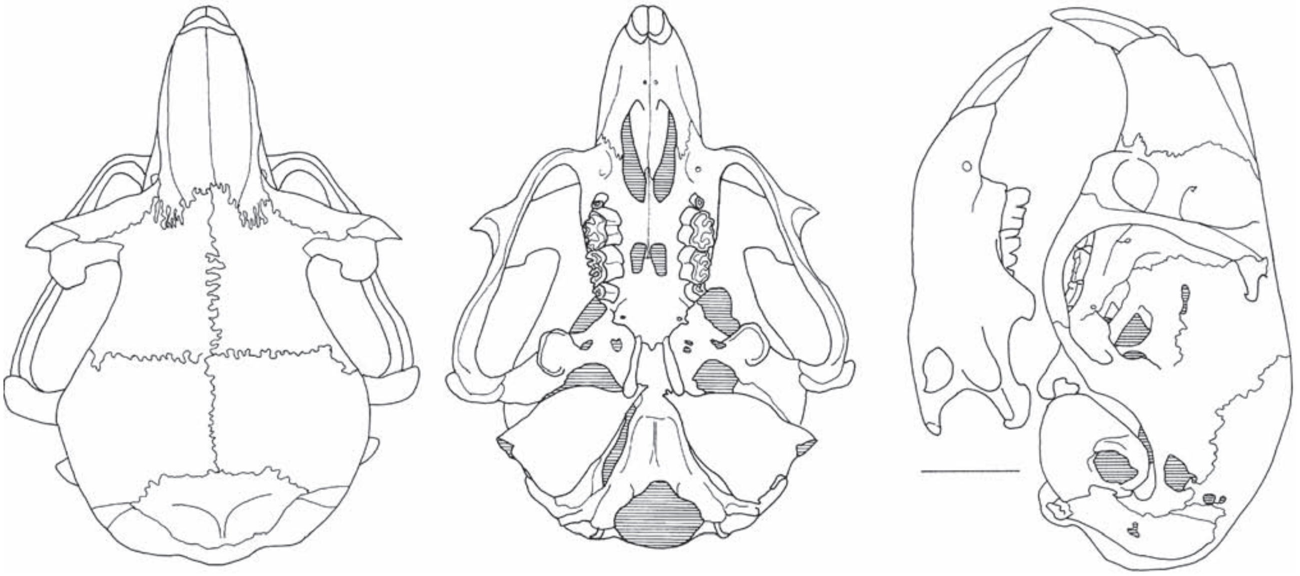


Figure 44. Skull and mandible of *Allactaga elater*, based on an adult male from Aralık, Mt. Ağrı (BMNH). Scale bar = 5 mm.

grey inside. Tail is paler below. The terminal tuft has cream base, black central stripe and white terminal hairs, which are up to 13 mm long.

NIPPLES as in the two preceding species.

PENIS. Glans penis small and relatively broader with a more pointed tip than in *A. williamsi* and *A. euphratica*. Longitudinal furrow deep and bifurcate towards tip of glans (Fig. 29a). Horny denticles (25–30 in number) of fairly large size are absent from base and tip; besides, they are more dense on dorsal side of glans penis (Çolak *et al*., 1994, 1997a). Glans 3.4–4.0 mm long, 1.2–2.5 mm wide and 1.0–1.5 mm deep (Šenbrot *et al*., 1995).

SKULL differs from the condition seen in *A. williamsi* and *A. euphratica* in being comparatively broader across zygomatic arches (74–80% of the condylobasal length; mean = 77.5%) and particularly so in the interorbital region (interorbital constriction equals 33–37% of the condylobasal length). The rostrum, nasals, and incisive foramina are also shorter and relatively broader. The bullae are comparatively larger and the mandibular corpus is deeper.

TEETH. Molars are of essentially the same shape as in the preceding two jerboas, the crown is higher, however. The number of molar roots is: 2 or 3 (M1, M2), 3 (M3), 2 (m1, m2), 2 or 3 (m3).

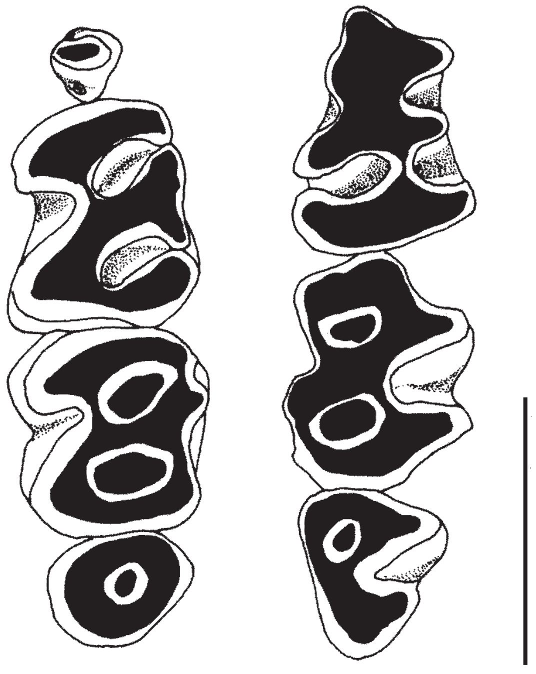


Figure 45. Upper (**a**) and lower cheek-teeth (**b**) in *Allactaga elater*, based on a specimen from Armenia. Lingual side is to the left, anterior is at the top. Scale bar = 2 mm.

DIMENSIONS. For dimensions see Table 15. There is no secondary sexual dimorphism (Šenbrot *et al*., 1995).

	N	mean	min–max
Head and body	47	106.8	95–119
Tail	47	165.5	148–185
Hind foot	47	51.9	46–58
Ear	47	31.6	28–37
Weight	46	52.1	32–62
Condylobasal length	41	26.61	25.6–27.7
Zygomatic breadth	41	20.59	19.7–21.5
Maxillary tooth-row	41	5.19	4.7–5.6

Table 15. External and cranial dimensions of *Allactaga elater* from the Ararat region in Turkey and adjacent Transcaucasia. Based on Šenbrot *et al.* (1995), Çolak *et al.* (1997a) and material in BMNH.

CHROMOSOMES. The standard karyotype is the same as in the remaining two Turkish species (Çolak *et al*., 1997a).

VARIATION

The Turkish population is ascribed to ssp. *aralychensis* and is evidently an isolate (see below). Çolak *et al*. (1997a) compared the dimensions of *A. e. aralychensis* with those of *A. e. caucasicus* Nehring, 1900 (type loc.: Baku and Muganskaja steppe (*sic*!), Azerbaijan; Pavlinov & Rossolimo, 1998) and *A. e. indica* Gray, 1842 (type loc.: Simkoh Hills, Afghanistan) and concluded on this basis that it is a valid subspecies. Such conclusion is somewhat surprising, since Šenbrot *et al*. (1995; not cited by Çolak *et al*., 1997a) report skull dimensions as almost identical among the three races.

Šenbrot *et al*. (1995) place *A. e. aralychensis* in the *indica* group of subspecies, together with *A. e. indica* and *A. e. turkmeni* Goodwin, 1940 (type loc.: Gorgan River, *c*. 60 km east of Astrabad, Gorgan, north Iran), while *A. e. caucasicus* is included, along with three more races, in the *elater* group. Differences between the two groups of races are in length of glans penis and the extent of the surface covered with horny denticles. The *elater* group has shorter glans (2.8–3.8 mm; mean = 3.4), covered with spines all over its surface; in *indica* group, the glans is 3.4–4.0 mm long (mean = 3.7 mm) and lacks spines on its proximal part. If Šenbrot *et al*. (1995) are right in their classification, then *A. e. aralychensis* had its closest relatives along the southern border of the species range and most likely populated eastern Anatolia from the south-east and not across the Caucasus, as presumably did *A. e. caucasicus*.

DISTRIBUTION

The small five-toed jerboa inhabits an extensive range in central and southwestern Asia. It populates dry arid and semiarid regions from Ciscaucasia and the Lower Volga region, across Turkmenistan and Kazakhstan to Xinjang and Gansu. In the south it occurs in Transcaucasia, Iran, Afghanistan, and western Pakistan.

Only a single locality is known in Turkey, lying in the extreme eastern part of the country: Aralık in the Aras basin. This is the place where the type specimen of ssp. *aralychensis* was collected more than a century ago. Recent field activity by Turkish mammalogists did not result in finding new localities (Çolak *et al*., 1997a). Çolak & Yiğit (1998b) explicitly state that no specimens were collected "on the low-hill of Ağrı mountain" (= Mt. Ararat). Contrary to this, Demirsoy (1996) plotted another two localities in the Kars region. Such range extension over the extreme north-eastern Turkey contradicts the actual knowledge of the small five-toed jerboa's range in Transcaucasia (cf. Šidlovskij, 1976, and Šenbrot *et al*., 1995) and is not considered here.

In the opinion of Šenbrot *et al*. (1995), the Ararat population is an isolate. On the eastern side of Turkish border, the range of this isolate evidently spans between the district of Erevan in the west and the village of Jajdži in Nachičevan in the east; the southernmost record is in Maku, northwestern Iran (Lay, 1967; Šenbrot *et al*., 1995). Contrary to this, Šidlovskij (1976) tentatively mapped the Ararat population as being contiguous along the Aras River, and thus connected with the range of the small five-toed jerboa on the western Caspian coast.

PALAEONTOLOGY. *Allactaga elater* is reported from the Middle Pleistocene layers on the Apšeron Peninsula (Vereščagin, 1959).

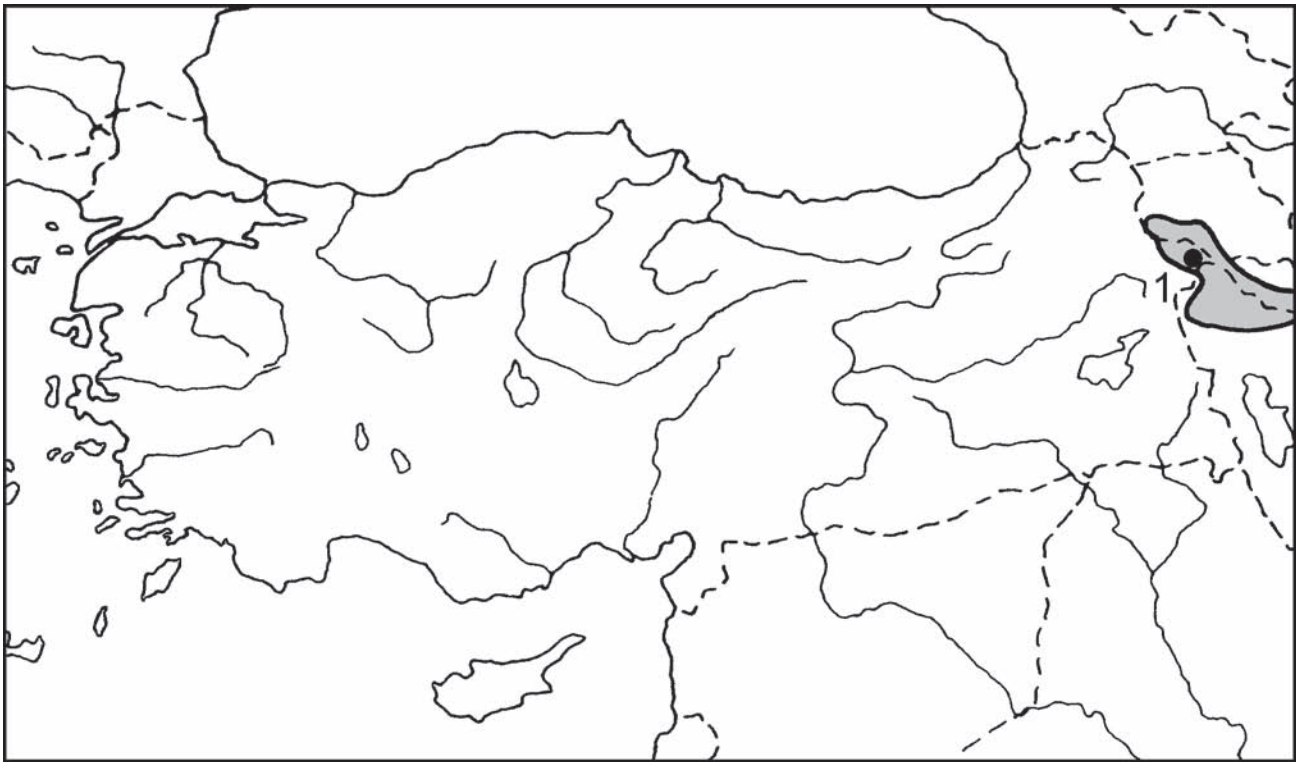


Figure 46. Distribution of *Allactaga elater* in Turkey. Record: **1** – Aralık, İğdır. Corresponding reference: Çolak *et al*. (1994). Extralimital range is from Lay (1967) and Šidlovskij (1976).

Figure 47. Habitat of *Allactaga elater*. Foothills of Mt. Ağrı, eastern Anatolia. Photo: P. Benda.

HABITAT

In arid and semiarid zones, the small five-toed jerboa shows wide habitat selection but avoids sands. In Transcaucasia it populates plains and foothills on saline semidesert rocky substrate and on clays. Dense vegetation cover is also avoided (Šenbrot *et al*., 1995). The vegetation in Turkey includes various halophytic assemblages: *Alhagi camelorum, Artemisetum* sp*., Halocmemum* sp., *Halostachys* sp*., Halidium* sp*.,* and *Salsoletum verrucosae* (Çolak & Yiğit, 1998b).

ASSOCIATES. Collected in the same habitat and along the small five-toed jerboa were *Meriones tristrami* (the dominant species), *M. vinogradovi, Cricetulus migratorius*, and *Mus* sp. (Çolak & Yiğit, 1998b).

DENSITY. Çolak & Yiğit (1998b) report eight burrows in an area of 300 m^2. From eastern Transcaucasia, Šenbrot *et al*. (1995) report densities of up to eleven individuals per hectare. Counts from a driving car during a night gave up to 9–11 individuals observed per 10 km of transect. In preferred habitats in Transcaucasia, the counts occasionally amounted to seven specimens per 1 km of transect. In the estuary of the Terek River, Daghestan, the densities exceptionally amount to 6–9 specimens per ha but average only 0.54 per ha (Šenbrot *et al*., 1995).

BIOLOGY

ACTIVITY. The small five-toed jerboa is nocturnal and spends the day in its burrow. Each burrow is occupied by a single adult jerboa, except during hibernation. In central Asia and Kazakhstan, the small five-toed jerboa hibernates 2.5–4.5 months long. The species does not hibernate in eastern Transcaucasia but its winter activity is reduced (Šenbrot *et al*., 1995).

BURROWS are simple tunnels 40–120 cm in length and end with a spherical nest chamber (diameter 11–15 cm) lying 25–60 cm below the surface. The nest is made of dry grass and occasionally also contains wool. Tunnels are oval in cross-section (5 cm in greatest diameter) and descend at an angle of 15–30°. Occasionally, the burrows have an emergency exit ending 4–5 cm below the surface or plugged with earth. The animal also plugs the main entrance with earth. The above information is summarised from Çolak & Yiğit (1998b) and relates to Turkey. On the basis of fourteen burrows excavated in the Aras valley, the same authors distinguish among four different types of shelter: reproductive, winter, summer, and temporary. Temporary burrows are short and shallow (5 cm below the surface). Lizards, toads and insects were also found in the small five-toed jerboa's burrows (Çolak & Yiğit, 1998b).

REPRODUCTION. Data on reproduction are scarce in Turkey. Çolak & Yiğit (1998b) collected scrotal males and a female with four young on June 25th. From Transcaucasia, Šenbrot *et al*. (1995) report the reproduction period as lasting from February until late October or early November. The number of embryos per female varies between 2 and 8 in the north-eastern Caspian region; the mean (= 4.4) does not differ from the situation found elsewhere (Šenbrot *et al*., 1995). Çolak & Yiğit (1998b) presume the pregnancy lasting 30–35 days; Šenbrot *et al*. (1995) report 20–21 days only.

FOOD. Throughout the species' range, seeds are the staple diet. Along the northwestern Caspian coast the composition of food items is as follows: seeds (79.1%), underground parts of plants (14.0%), insects (4.2%), and green matter (2.7%; Šenbrot *et al*., 1995). Scanty data from Turkey correspond to this. In the stomachs of Turkish specimens, Çolak & Yiğit (1998b) found mainly seeds in addition to some insect remnants. The species does not store food. Captive animals fed on wheat and sunflower seeds, green vegetable material, apple, and carrot. They also drank water (Çolak & Yiğit, 1998b).

SUBFAMILY: SICISTINAE ALLEN, 1901

Russian authors (Ognev, 1948; Pavlinov & Rossolimo, 1987, 1998; Gromov & Baranova, 1981; Gromov & Erbajeva, 1995; Šenbrot *et al*., 1995) refer to this group under the name Smithinae Murray, 1866 (or Smithidae, depending on the taxonomic rank). The Sicistinae being the appropriate name was demonstrated by Holden (1993a). Vinogradov & Gromov (1984) placed *Sicista* in Zapodinae.

This subfamily, as defined by Holden (1993a), includes the only genus, *Sicista*.

GENUS: *SICISTA* GRAY, 1827

Dipodids of murine external form, not adapted to bipedal locomotion. The tail is very long but hind feet are not much enlarged. The foot has five distinct metatarsals. *Sicista* spp., or birch mice, have either a black stripe along the back or are monochromatic. Their skull is little specialised, with relatively small bullae. Cheek teeth are brachyodont, cuspidate and quadrituberculate. The genus is distributed in the Palaearctic, ranging from central Europe and Scandinavia to Sakhalin, and from the Lower Pechora River to China, Kashmir, and the Caucasus (Baskevich, 1996). Thirteen species are currently recognised (Holden, 1993a), one of which is also reported from Turkey (Yiğit *et al*., 2003a).

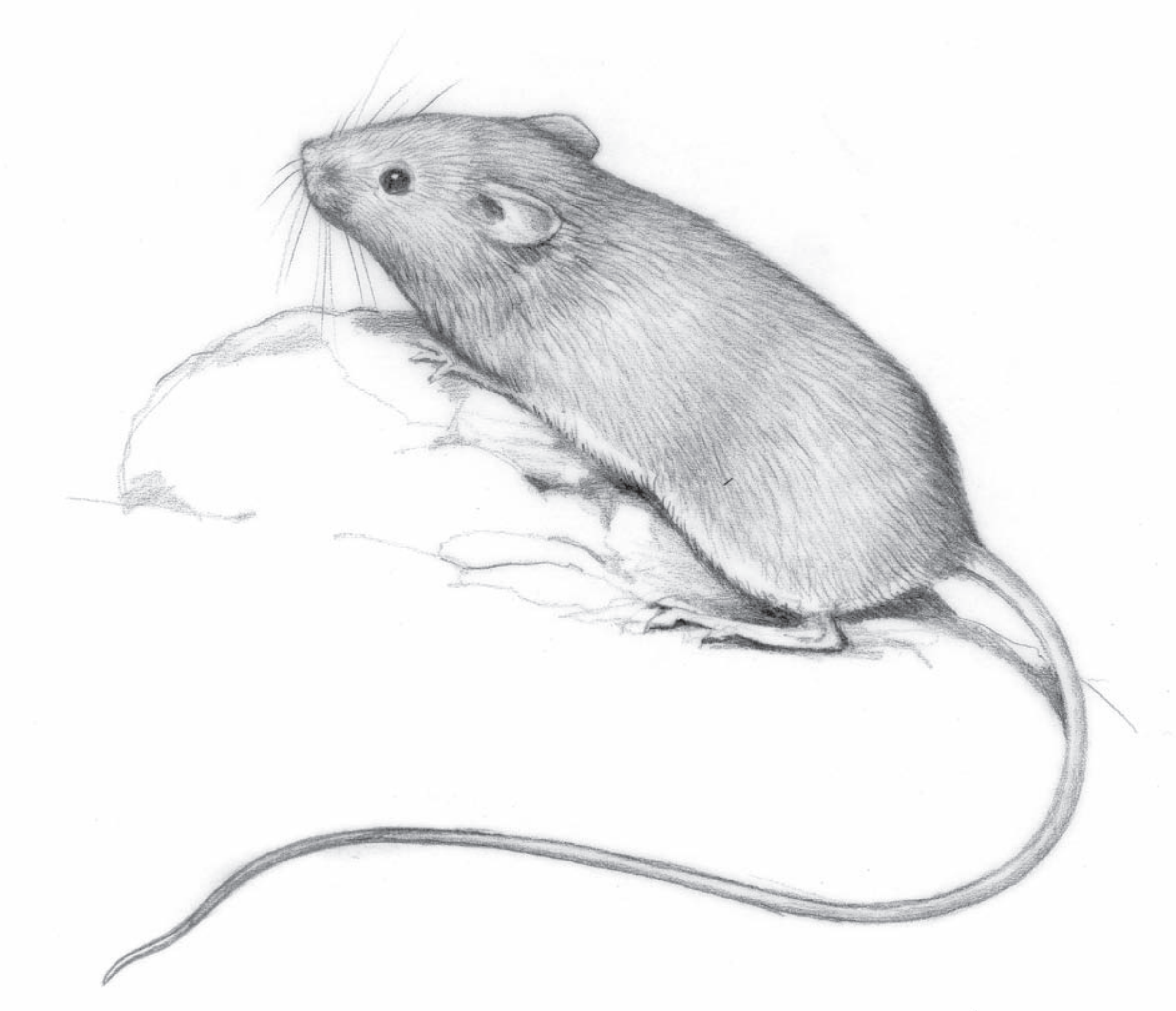


Figure 48. Caucasian birch mouse *Sicista caucasica*. Drawing: J. Hošek.

CAUCASIAN BIRCH MOUSE – *SICISTA CAUCASICA*

Sicista caucasica Vinogradov, 1925. Type loc.: vicinity of Majkop, Krasnodar Region, Caucasus, Russia.

TAXONOMY

The traditional taxonomy of *Sicista*, based on colour, dimensions, and penial morphology, produced contradictory results in the past. The genus abounds with cryptic species (66% of birch mice species in the territory of the former Soviet Union are cryptic taxa; cf. Baskevich, 1996), distinguishable only by their chromosomal sets. Notwithstanding the considerable progress over the last two decades, the specific status of many of the forms needs further documentation and corroborative data sets (Holden, 1993a). Four cryptic and allopatric species are currently reported from the Caucasus. Caucasian birch mice are monochromatic and lack the great horny thorns jutting out of the glottis of glans penis (Baskevich, 1996). In addition to *S. caucasica*, these species include:

- *S. armenica* Sokolov & Baskevich, 1988. Type loc.: head of the Marmarik River, 2,200 m, near Ankavan, Pambakskij Range, Pazdanskij Region, Lesser Caucasus, north-west Armenia,
- *S. kazbegica* Sokolov, Baskevich & Kovalskaja, 1986. Type loc.: upper reaches of the Terek River, 2,200 m, Suatisi Gap, 14 km north-west of Kobi, Kazbegi District, Georgia, and
- *S. kluchorica* Sokolov, Kovalskaja & Baskevich, 1980. Type loc.: upper North Kluhor River at Kluhor Pass, 2,100 m, Karačaevo-Čerkes Region, northern Caucasus in Russia (Vinogradov & Gromov, 1984 report this species as *S. cluchorica*).

The Armenian birch mouse *S. armenica* is restricted to the Lesser Caucasus, while the remaining three species occur in the Greater Caucasus, *S. caucasica* being the western-most in distribution (Fig. 49). The ranges of all Caucasian birch mice, as documented

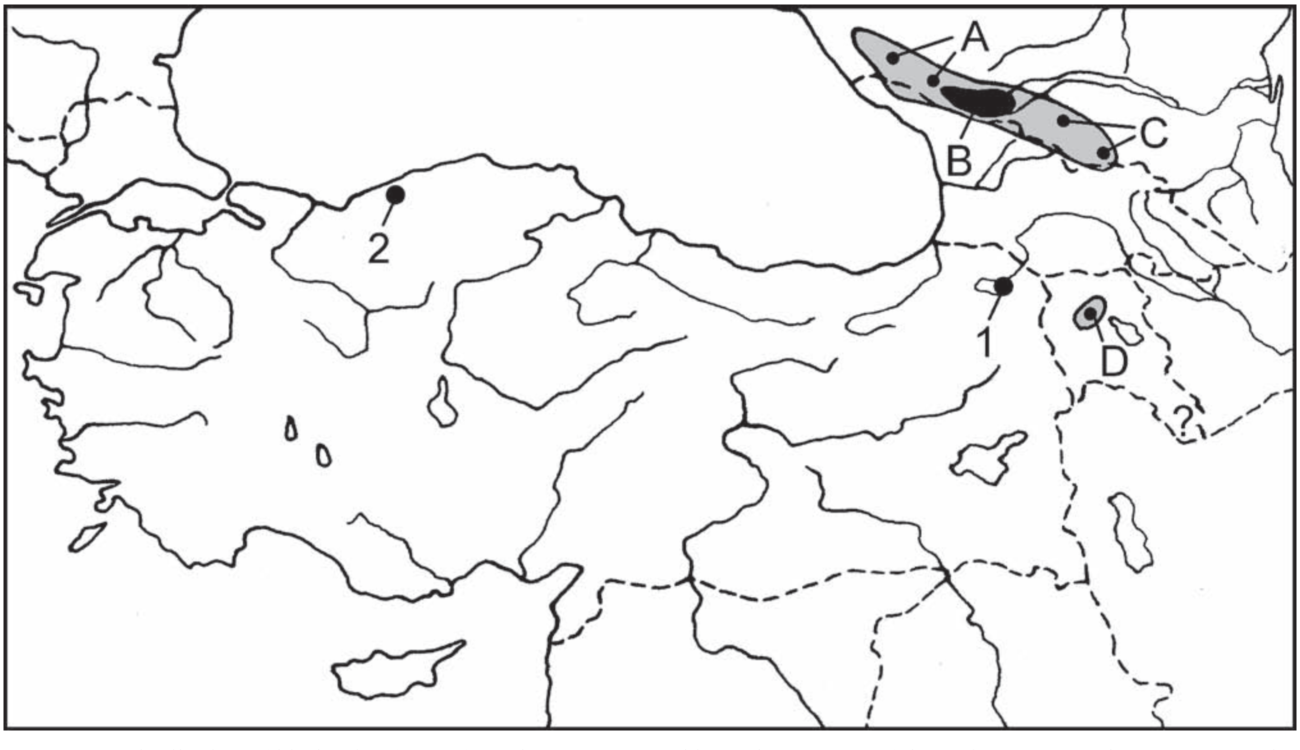


Figure 49. Distribution of birch mice (*Sicista*) on the Caucasus and in Turkey. Range of the entire group on the Caucasus and in Transcaucasia is shaded. Localities with karyotyped specimens are given as small dots or in black. **A** – *Sicista caucasica*; **B** – *S. kluchorica*; **C** – *S. kazbegica*; **D** – *S. armenica*. Question mark indicates uncertain occurrence. Modified from Šenbrot *et al*. (1995). Records in Turkey: **1** – "Kars and Ardahan" (as *Sicista caucasica*; recent; locality not specified); **2** - Cayırköy Mağarasi, Zonguldak (*Sicista* sp.; subfossil). Corresponding references: Horáček *et al*. (1996): 2.Yiğit *et al*. (2003a): 1.

so far, are extremely small and only *S. kluchorica* is known from more than two localities (Šenbrot *et al.*, 1995).

The Caucasian birch mouse is included in the list of Turkish mammals on the basis of a report by Yiğit *et al.* (2003a) for the Kars region. It is not evident on what kind of evidence the identification was based, but from the zoogeographical point of view the presence of *S. caucasica* in northeastern Turkey is most unlikely (cf. Fig. 49). In fact, of all the Caucasian birch mice, this species is geographically the most distant from Kars. *S. armenica* is the species whose range lies closest to the Kars region, and we assume that this birch mouse is also more likely to occur in Turkey. For this reason, we have provided the information on *S. caucasica* and *S. armenica* given below. We have seen no specimen from Turkey.

DESCRIPTION

EXTERNAL CHARACTERS. The Caucasian birch mouse is a small mouse-like rodent. It is easily recognisable by its very long tail (140–180% of head and body length) and relatively long hind foot (> 30% of head and body length). Thumb is reduced in front feet but the blunt rudiment still bears a nail. Hind feet are narrow and pentadactylous.

COLOUR. The fur on back is reddish ochraceous; sparse long hairs have blackish brown tips. There is no dark spinal stripe characteristic of several *Sicista* species. Flanks are of more intense colour due to the lack of black-tipped long hairs. Belly is white to grey and hair bases are slate grey. There is no sharp demarcation line along flanks. Šenbrot *et al.* (1995) state that the tail is distinctly bicoloured, while Bukhnikashvili & Kandaurov (1998) report it as nearly uniform in coloration.

NIPPLES. There are four pairs of nipples.

PENIS AND BACULUM. Glans penis is simple and club-shaped, with a medio-ventral groove in its anterior third; the tip of glans is rounded. The glans is 4.0–4.2 mm long and 1.9–2.1 mm broad. Its surface is covered with keratinous denticles, which are larger and denser in the anterior half. The baculum is simple in structure. It tapers gradually from a wide base and expands again into an arrow-shaped tip (Šenbrot *et al.*, 1995).

SKULL resembles that of *Mus* but is readily recognisable by evidently larger and triangular infraorbital

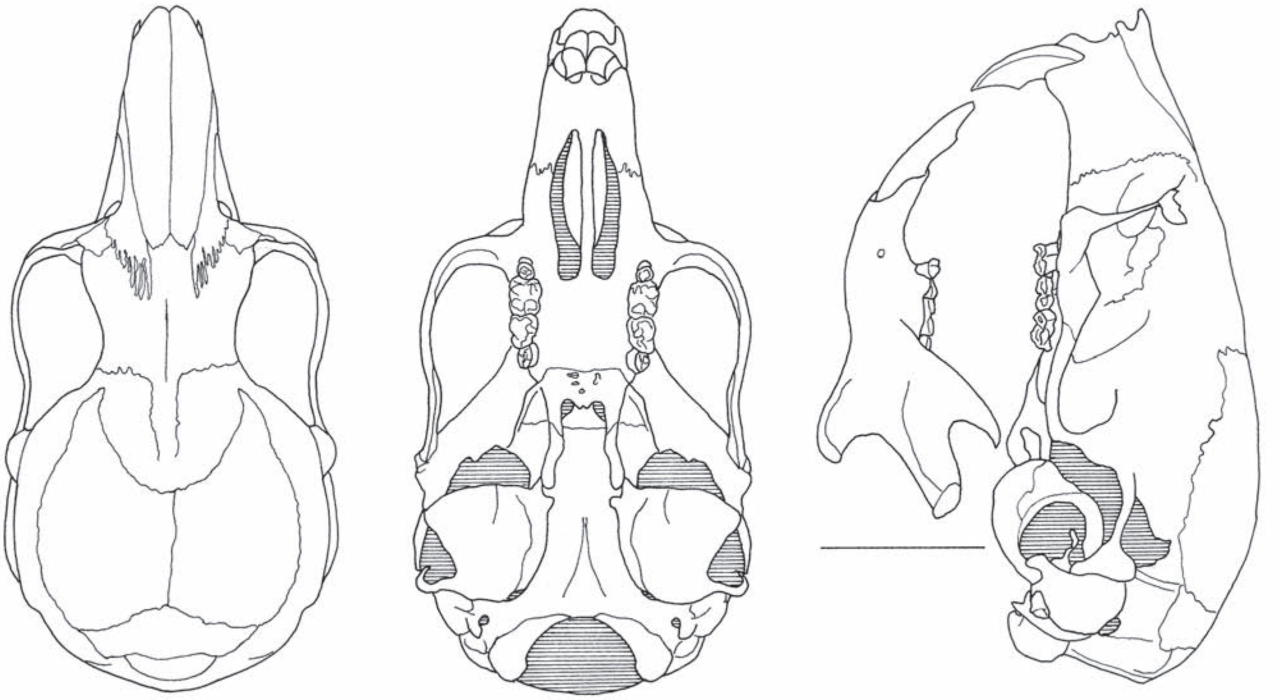


Figure 50. Skull and mandible of *Sicista caucasica*, based on an adult specimen from near Gornij Archiz, Zelenčuk River basin, Karačaevo – Čerkeskij district, north-western Caucasus (SIEE). Scale bar = 5 mm.

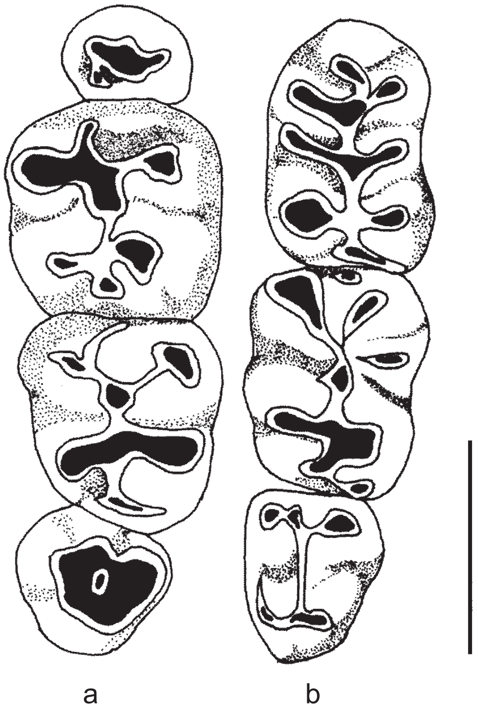


Figure 51. Upper (**a**) and lower cheek-teeth (**b**) in *Sicista caucasica*, (same specimen as on Fig. 50). Lingual side is to the left, anterior is at the top. Scale bar = 1 mm.

foramen which is much wider below than above. The braincase is rather squarish and deep (*c.* one third of the condylobasal length). The infraorbital region is moderately wide (approximately as broad as the rostrum posteriorly), and the skull is convex in dorsal profile. Zygomatic arches are fairly weak and parallel; the zygomatic breadth approximately equals the braincase width. The lower edge of the zygomatic arch is horizontal and lies at the level of the maxillary alveoli. Moderately long and narrow rostrum is tapering anteriorly. Nasals are concave in profile, broader in front than behind; their posterior margin is well in front of the frontal process of the maxillary bone. Incisive foramen is long and broad, stretching approximately to the line of the anterior alveoli of the 1st upper molar. The hard palate is broad, as is also the interpterygoid space. Bullae are moderately small. *Fissura petro-tympanica* and *foramina praelambdoidea* are much enlarged. Mandible is delicate and low, with all three processes well developed.

TEETH. Incisors orthodont and weak; enamel yellow on upper incisors and white on lower ones. Cheek teeth brachiodont, with cusps arranged in two parallel rows. The only premolar is rounded and smaller than any of the molars in the upper tooth-row. The 1st upper molar is approximately of same size as the 2nd one but is more robust. The 3rd upper molar is much reduced and circular in shape. Lower molars are narrower than the upper ones; the 1st and 2nd molars are subequal. The enamel of cusps forms two main transverse folds on each molar with additional accessory folds. Dental formula: 1/1, 0/0, 1/0, 3/3 = 18.

MEASUREMENTS are given in Table 16. There is no secondary sexual dimorphism.

CHROMOSOMES. The diploid number of chromosomes is 2N = 32, and the fundamental number of autosomal arms is NFa = 46. There are eight pairs of biarmed autosomes (four meta- and four submetacentric) and seven pairs of acrocentrics. Both heterosomes are acrocentric (Šenbrot *et al.*, 1995; Baskevich, 1996).

COMPARISON. *Sicista armenica* resembles most closely *S. caucasica* in nearly every aspect of morphology. The former is possibly the least known member of *Sicista* and only three specimens have been karyotyped so far (Šenbrot *et al.*, 1995). The glans penis in *S. armenica* is similar in shape and size (4.4

		S. caucasica		N	*S. armenica*	
	N	mean	min-max	N	mean	min-max
Head and body	12	62.4	43.6-68.9	3	66.2	66.2-66.2
Tail	12	95.5	84.0-105.8	3	98.4	95.5-101.5
Hind foot	12	19.2	17.4-22.0	3	17.5	16.6-18.3
Ear	12	10.4	9.2-12.8	3	10.0	9.4-10.3
Weight	10	6.2	5.8-7.2	3	6.5	6.4-6.7
Condylobasal length	9	18.0	17.5-18.5	2	–	18.8 / 18.2
Zygomatic breadth	7	9.4	9.2-9.7	2	–	9.8 / 9.3
Maxillary tooth-row	9	3.4	3.2-3.6	3	3.2	3.2-3.3

Table 16. External and cranial dimensions of *Sicista caucasica* and *Sicista armenica*. Based on Šenbrot *et al.* (1995).

mm long and 2.0 mm wide) to that in *S. caucasica*. The baculum has a broad base and an expanded tip; cf. Šenbrot *et al*. (1995) for figures of the two. The only morphological character which possibly permits discrimination between the two species is the size of spermatozoa head, which is longer in *S. armenica* (5.1–5.7 mm) than in *S. caucasica* (4.4–5.3 mm; Baskevich, 1996). The diploid number of chromosomes in *S. armenica* is 2N = 36 and the fundamental number of autosomal arms is NFa = 50. Eight pairs of autosomes are biarmed (four metacentric, and two submeta- and subtelocentric, respectively) and the remaining nine pairs are acrocentric. Of the heterochromosomes, the X chromosome is a medium sized acrocentric and the Y chromosome is a small metacentric (Šenbrot *et al*., 1995; Baskevich, 1996).

DISTRIBUTION

The present range of birch mice is summarised in Fig. 49. The Caucasian birch mouse is known from only two localities in the Krasnodarsk Region, northwestern Greater Caucasus. The Armenian birch mouse was karyotyped from a single locality in northern Armenia, but two more records, most probably referable to this species, are known from the same region (cf. Šenbrot *et al*., 1995).

Yiğit *et al*. (2003a) report *S. caucasica* from 'Kars and Ardahan', collected at the elevation of 1,829 m a.s.l. Since the distance between Kars and Ardahan is 65 km in bee-line, the exact statement on elevation appears most puzzling. We thus hesitate to comment this record any further.

PALAEONTOLOGY. Birch mice from the Middle Pleistocene, found so far in Turkey and its close proximity, are reported as *S. subtilis* (Pallas, 1773). Two localities are available: Yarımburgaz in Turkish Thrace (Santel, 1994) and Chios Island (Storch, 1975). Dimensions of the fossil material fit within the range of recent *S. subtilis* from Europe and also fit the only *S. caucasica* which we examined from the Caucasus (Table 17). We thus believe that fossil evidence could point equally well to *S. subtilis* as to one of the Caucasian enedemics. From the northwestern Caucasus (40 km south-west of Krasnodar) Vereščagin (1959) reports birch mice (as *S*. cf. *caucasica*) from the Upper Pleistocene layers (radiocarbon-dated at 39 kyBP).

SPECIMEN FROM CAYIRKÖY. In 1994 I. Horáček excavated, in the cave Çayırköy Mağarasi near Zonguldak, a subfossil left mandible fragment of *Sicista* (Fig. 52) with all three molars firmly sticking in their alveoli (Horáček *et al*., 1996). The length of the 1st lower molar evidently exceeds the range of the recent *S. subtilis* (cf. Table 17). What is perhaps more noteworthy is a short 3rd lower molar (Fig. 53, Table 17), which attains only 58.6% of the length of the 1st molar. In recent *S. subtilis*, this percentage is 63.6–75.2% (calculated from data in Pucek, 1982), and around 70% also in two fossil specimens of *S. subtilis* from Turkey, as well as in *S. caucasica*. *Sicista betulina* has even a smaller 1st lower molar and a relatively longer 3rd lower molar. Thus it is difficult to make any taxonomic conclusion on the Çayırköy specimen, except ruling out the possible occurrence

	S. subtilis Chios (fossil)	*S. subtilis* Yarımburgaz (fossil)	*S. subtilis* Romania (recent)	*S. caucasica* (recent)	*Sicista* sp. Çayırköy (subfossil)
M2L	1.04		0.97-1.07	1.08	
M2B	1.00		0.97-1.08	0.94	
m1L	1.16	1.18	1.08-1.18	1.21	1.33
m1B	0.88	0.89	0.80-0.94	0.81	0.90
m2L	1.16	1.19	1.03-1.20	1.18	1.10
m2B	0.88	0.90	0.83-0.98	0.88	0.92
m3L	0.84	0.83	0.70-0.86	0.84	0.78
m3B	0.76	0.73	0.64-0.78	0.67	0.73

Table 17. Molar dimensions (Length, Breadth) in the Middle Pleistocene birch mice, ascribed to *Sicista subtilis* (Chios – Storch, 1975; Yarımburgaz – Santel, 1994), recent *S. subtilis* from Romania (Pucek, 1982; N = 20), recent *Sicista caucasica* from near Gornij Archiz, Zelenčuk River basin, Karačaevo – Čerkeskij district, north-western Caucasus (specimen from the collection of SIEE), and subfossil *Sicista* sp. from Çayırköy.

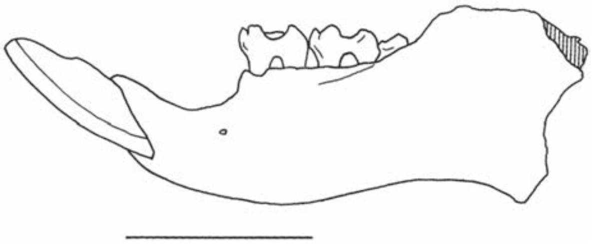


Figure 52. Left mandible fragment of *Sicista* sp. from Çayırköy, Zonguldak. Scale bar = 3 mm.

of *S. betulina*, which would be unlikely already from the zoogeographical point of view.

The vicinity of Zonguldag is a hilly country of low altitude and quite densely covered by mesic deciduous forests. The habitat does not seem to be satisfactory for either *S. subtilis* or *S.* cf. *caucasica*.

HABITAT

On the Caucasus, specimens of *S. caucasica* were collected in meadows and forest clearings with rich grassy vegetation at elevations between 1,400 and 2,000 m a.s.l. The type specimen which, however, was designated before the taxonomic complexity of the Caucasian birch mice had been fully appreciated, comes from between 2,100 and 2,700 m a.s.l. (Šenbrot *et al*., 1995). Bukhnikashvili & Kandaurov (1998) report subalpine meadows with tall grass as the preferred habitat type, and the alpine landscape at the timber line as the marginal one. The specimens of *S. armenica* come from a slope covered with tall grass in the subalpine belt at the timber line (elevation of 2,000 m a.s.l.; Šenbrot *et al*., 1995).

The habitat at "Kars and Ardahan" where the Turkish material was collected is described as high steppe with *Bromus tomentellus, Festuca valesiaca, Astragalus microcephalus, Agropyron repens, Echinops ritrio,* and *Eryngium campestre*. Collected in the same site were also *Allactaga williamsi, Microtus* spp., *Apodemus* sp., *Cricetulus migratorius, Mesocricetus brandti,* and *Spermophilus xanhtoprymnus* (Yiğit *et al*., 2003a).

DENSITY. Data on densities are somewhat contradictory, but *S. caucasica* might be common locally. In the subalpine meadows in the Caucasus (elevation of 1,850 m a.s.l.) it made only 2.4% of the total small mammal catch, but this share was higher (12.5%) in tall grassy woodland at 1,450 m and even more so in the subalpine tall grass meadows at 1,500 m (= 25.5%). The species was virtually absent from a fir forest at 1,500 m a.s.l. (Šenbrot *et al*., 1995). According to Bukhnikashvili & Kandaurov (1998), *S. caucasica* accounts for up to 5% of the total small mammal catch in Georgia.

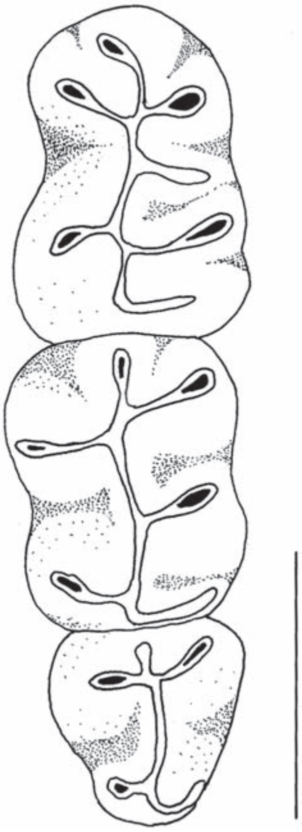


Figure 53. Lower molars in *Sicista* sp. from Çayırköy, Zonguldak. Lingual is to the right and anterior is at the top. Scale bar = 1 mm.

BIOLOGY

Birch mice are hibernators. The peak of their activity is apparently in June and July. In the western Caucasus, at elevations between 1,400 and 2,000 m, the active period of *S. caucasica* lasts only 3–3.5 months (Topilina, 1987). Captive specimens were nocturnal and fed on insects, seeds and berries. Pregnant females were collected between June 16 and July 2, and litter size, based on counts of embryos and placental scars, is 4–6 (mean = 5.1; N = 11; Šenbrot *et al*., 1995).

FAMILY: GLIRIDAE THOMAS, 1897

Dormice are a small and well-defined group of rodents. They are characterised by brachyodont cheek-teeth with transverse crests, by zygomasseteric plate which is of a moderate myomorphous type, and by the absence of caecum and a definite boundary between colon and small gut (Storch, 1995). The family differs from the remaining Myomorpha in three cranial and dental synapomorphies: (1) back edge of posterior palatine foramen is medial to some part of the 3rd molar, (2) bullae are with three primary septa, and (3) premolar is the first tooth in the upper toothrow (Wahlert *et al*., 1993). Fur is mainly thick and soft, tail bushy in great majority of genera, and hind foot broad with large pads. Skin of the tail readily breaks and slips off from the vertebrae; the stump frequently regenerates afterwards into an abnormally thickened pencil. Simple baculum consist only of a stalk which is triangular or cylindrical. The enamel on the labial surface of incisors is more diverse than in most other rodent groups and consists of uniserial Hunter-Schreger bands in its inner layer (Storch, 1995; Koenigswald, 1995). Cheek-teeth are invariably brachyodont, with concave crowns and well-marked cusps in primitive genera, but with flat and ridged occlusal surface in progressive types. Premolars are present in both upper and lower tooth rows. Dental formula: 1/1, 0/0, 1/1, 3/3 = 20; *Selevinia* (extralimital) has no premolars. The zygomatic plate is broadened and tilted upwards (Storch, 1995). Infraorbital foramen is little enlarged and comparatively unspecialised. Angular portion of the mandible is usually pulled inwards and sometimes perforated (Ellerman, 1940). Bullae are mainly large. All dormice hibernate or experience dormancy.

NOMENCLATURE. The family name Gliridae Thomas, 1897 was most commonly applied by the students of the region in question (Kumerloeve, 1975; Atallah, 1978; Kuss & Storch, 1978; Corbet, 1978; Storch, 1978a; Gromov & Baranova, 1981; Kurtonur, 1982; Zima & Král, 1984; Meulen & Kolfschoten, 1986; Pavlinov & Rossolimo, 1987; Lozan *et al*., 1990; Kandaurov *et al*., 1994; Daams & Bruijn, 1995; Gromov & Erbajeva, 1995; Demirsoy, 1996; Kurtonur *et al*., 1996; Qumsiyeh, 1996; Daams, 1999; Amr, 2000; Meulen & Doukas, 2001); Montuire *et al.* (1994) gave this as Gliridae Lyddeker (sic!), 1898. Another name, although applied less frequently, was Myoxidae Gray, 1821 (Ognev, 1947; Šidlovskij, 1976; Vinogradov & Gromov, 1984; Wahlert *et al*., 1993; Wilson & Reeder, 1993; Civitelli *et al*., 1995; Filippucci & Kotsakis, 1995; Koenigswald, 1995; Storch, 1995; Zima *et al*., 1995; Pavlinov & Rossolimo, 1998; Rossolimo *et al*., 2001). The least commonly in use was the name Muscardinidae Gray, 1821 (Miller, 1912; Ellerman, 1940; Bobrinskoy *et al*., 1944; Ellerman & Morrison-Scott, 1951; Osborn, 1964; Bobrinskij *et al*., 1965; Lewis *et al*., 1967; Osborn & Helmy, 1980).

Holden (1993b) and Wahler *et al*. (1993) discuss the priority of the family name Myoxidae (type genus *Myoxus* Zimmerman, 1780) over Gliridae (type genus *Glis*, Brisson, 1762). Namely, Brisson's names are a source of controversy because they are not Linnaean or binomial (Holden, 1996), and his "Regnum animale" was considered 'not available' as a legitimate source of scientific names by many authors. The International Commission for Zoological Nomenclature (Gentry, 1994; Opinion 1894) reviewed the validity of "Regnum animale" and rejected it as a source of scientific names but also ruled out, to avoid further confusion, to preserve certain generic names and declare valid because of their long-established and widespread use. These include *Glis* (and Gliridae). Thus, the names Myoxidae and *Myoxus* are not valid and their use should be abandoned (Morris, 2003).

PALAEONTOLOGY. Dormice are an ancient group and are possibly a sister family to the remaining rodent clade. Their oldest record is from the Early Eocene (*c*. 50 million years back) of Europe where the diversification of the family also culminated in the Early-Middle Miocene (Daams, 1999). Dormice appeared in Anatolia already in the Eocene (Kotsakis & Barisone, 2000).

SCOPE. The family Gliride is confined to the Old World with two centres of distribution. The subfamily Graphiurinae Winge, 1887 is endemic to the sub-Saharan Africa, while the remaining two subfamilies with altogether six genera centre in arid and temperate regions of the western Palaearctic. Further two genera are restricted to Japan (*Glirulus* Thomas, 1906b) and south-eastern China (*Chaetocauda* Wang, 1985), respectively. Holden (1993b) recognised 26 species, but this number is certainly not final. Of the eleven species which are restricted to the western Palaearctic, seven occur in Turkey. Dormice are absent from Cyprus.

Further division of the family is not uniformly accepted. We follow the system by Wahlert *et al.* (1993) who recognised three recent subfamilies, two of which have representatives in Turkey.

KEY TO SUBFAMILIES

1 Occlusal surface of molars concave; cusps well marked; 3rd lower molar not concealed by the coronoid process of the mandible in lateral view
Leithiinae

1* Occlusal surface mainly flat; cusps entirely replaced by ridges; coronoid process of the mandible conceals in lateral view most or all of the 3rd molar
Glirinae

SUBFAMILY: GLIRINAE THOMAS, 1897

The subfamily Glirinae is characterised by the nearly flat occlusal surface of molar crowns with prominent accessory crests in addition to the primary ones (Wahlert *et al.*, 1993). It contains three genera, two of which occur in Turkey.

KEY TO GENERA

1. Size large (head and body >120 mm; condylobasal length of skull >30 mm; maxillary tooth-row >5.5 mm); back grey; mandible without perforation in angular process
Glis

1* Size small (head and body <95 mm; condylobasal length of skull <25 mm; maxillary tooth-row <5.3 mm); back yellow; mandible perforated in angular process
Muscardinus

Figure 54. Edible dormouse *Glis glis*. Drawing: J. Hošek.

GENUS: GLIS BRISSON, 1762

A monospecific genus, reported in the literature either as *Glis* or *Myoxus*; the reasons for the proper use of the former name are explained in the introduction to the family Gliridae (see above).

EDIBLE DORMOUSE – *GLIS GLIS*

Sciurus glis Linnaeus, 1766. Type loc.: Slovenia (Violani & Zava, 1995).
Myoxus glis orientalis Nehring, 1903. Type loc.: Scutari (=Üsküdar), Alan Dağ (= Alem Dağı), İstanbul.
Glis glis spoliatus Thomas, 1906. Type loc.: Khotz (= Çosandere), Trabzon.

DESCRIPTION

EXTERNAL CHARACTERS. General appearance squirrel-like, with rather large head and bushy tail. Muzzle bluntly conical, eye large but the rounded ear fairly short. Whiskers long (up to 52 mm) and nearly black but their tips occasionally whitish. Tail shorter than head and body (*c*. 85% of head and body length; range = 72–95%). Feet robust and broad but fingers long; thumb is reduced. There are six pads on the front feet and five on the rear ones; the pads are large and soles are bare. Claws small, sickle-shaped and sharp. Thick and soft underfur covered with longer guard hairs up to 11–12 mm long. Bushy tail uniformly haired throughout (hairs *c*. 17 mm long) and strictly distichous.

COLOUR. Hair bases slate-grey and tips smoke-grey to yellowish broccoli-brown. Mid-back darker due to a sprinkling of long hairs with blackish tips. Belly hairs entirely white and get a buff shade with advanced age. Cheeks essentially of the same colour as belly. A sharp demarcation line along flanks and on cheeks underlined by a narrow buff stripe. Juveniles plumbeous grey and have pure white belly. Also, their tail is less bushy. Tail of same colour as back or darker, with distinct pale median stripe ventrally. Feet covered dorsally with short silvery hairs. Upper surfaces of front feet white in Anatolian specimens but with indistinct brown metacarpal stripe in Thracian ones. Both populations display a dark metatarsal stripe, however (Fig. 58). Ears approximately of same colour as back. Eyes surrounded with dusky eye-ring.

NIPPLES. Number of teats 10, 11 or 12; ten is the most common condition in the northwestern Balkans (Kryštufek, 2004). One female, collected on September 15, 1981 on the Istranca Mts. had five pairs of nipples (SMF specimen).

PENIS AND BACULUM. Glans penis club-shaped, with a small sharp protrusion. Ventral side creased by longitudinal folds and covered with small spines (Simson *et al*., 1995). In a single specimen from the Istranca Mts., the glans was 10.5 mm long, 3.5 mm wide and 3.4 mm deep (Simson *et al*., 1995). Baculum triangular with pointed peak usually curved laterally. It is 8.4–10.0 mm long and 2.3–2.8 mm wide at its base (Doğramacı & Tez, 1991), but this varies between the two subspecies in Turkey (see below).

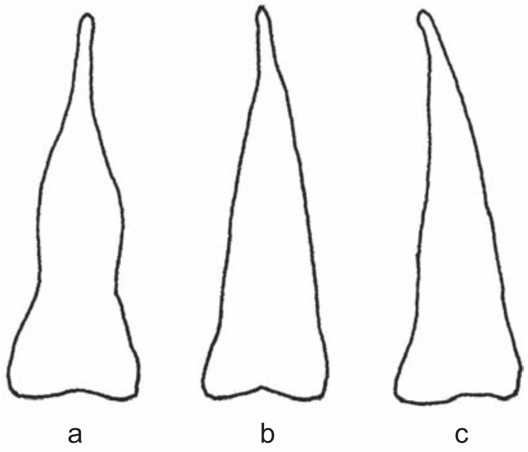


Figure 55. Baculum (in dorsal view) of *Glis glis minutus* from European Turkey (**a, b**) and *G. g. orientalis* from northern Anatolia (**c**). Redrawn from Doğramacı & Tez, 1991 (b, c), and Simson *et al*., 1995 (a). Not to scale.

SKULL rather deep and broad, with widely expanded zygomatic arches (*c*. 63% of condylobasal length; range = 60–66.5%). Interorbital region moderately broad and ridged. Supratemporal ridges become visible at the age of 240 days (Çolak *et al*., 2003). Dorsal profile nearly flat to posterior end of frontal, but nasals are bent down at their tip. Braincase squarish and smooth. Deep rostrum tapers towards point. Incisive foramens are short but broad; their posterior margin well above the line of infraorbital foramen. Hard palate ends before posterior margins of molar alveoli. Pterigoids long and space between them

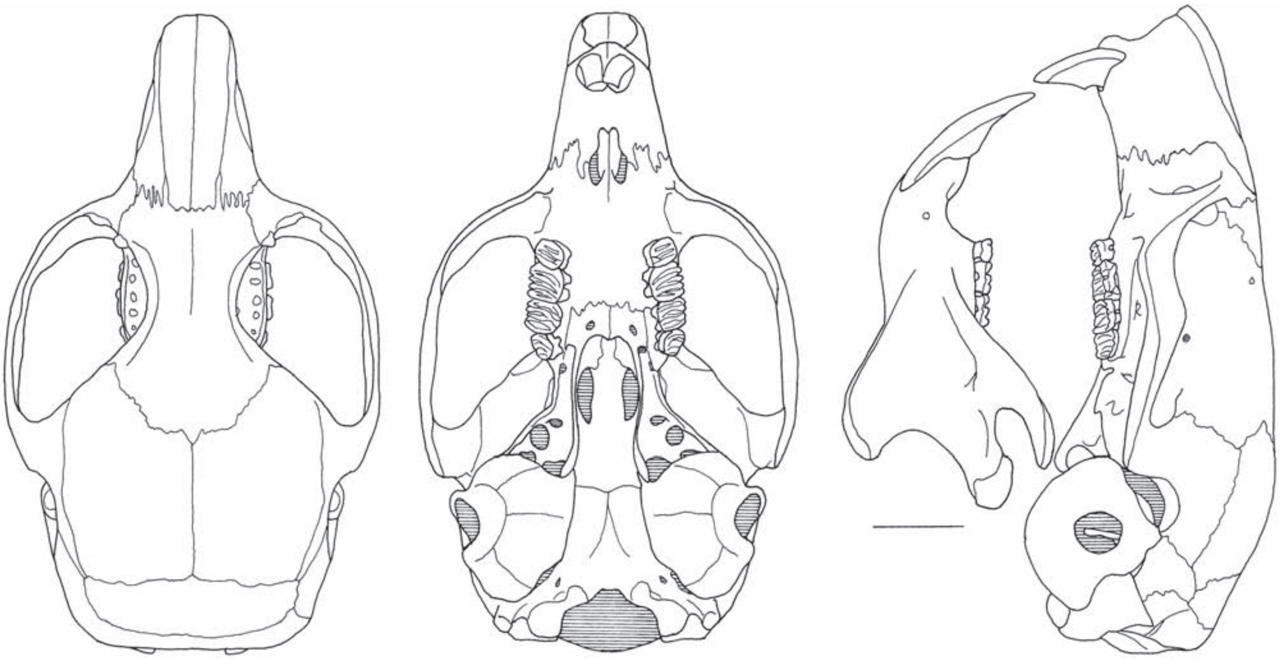


Figure 56. Skull and mandible of *Glis glis*, based on an adult male from Bahceköy, Saray, Tekirdağ, European Turkey (SMF). Scale bar = 5 mm.

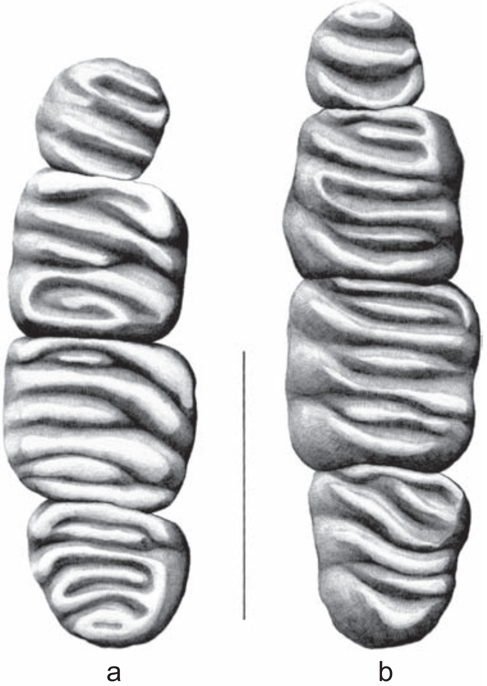


Figure 57. Upper (**a**) and lower cheek-teeth (**b**) of *Glis glis*. Based on a specimen from Mahyadağı, Yeniceköy, Kırklareli, European Turkey (IUBD). Lingual side is to the right, anterior is at the top. Scale bar = 3 mm. Drawing: S. Prokešová.

broad. Rounded bullae fairly small for dormice; in the small Balkan form, they are between 23.0 and 25.8% of condylobasal length (mean = 24.3%, N = 28). Mandible robust and all three processes well developed. The edible dormouse is the only Turkish glirid with no perforation on the angular process.

TEETH. Upper incisors relatively short. Enamel on their front surface orange, but usually lighter (yellow) on lower incisors. Upper cheek-tooth row shorter than diastema, and nearly parallel. Crowns low and occlusal surface nearly flat. Premolars are the smallest teeth; 1st and 2nd molars sub-equal. Each molar crossed by four complete transverse ridges and has three incomplete ridges in between.

Upper premolar has two roots and the lower one has a single one. Lower molars have two roots each, the anterior and the posterior one, respectively. The upper molars are three- rooted, having two smaller roots on the labial side and a single large root on the lingual side. Alveolar pattern in Turkish population does not differ from the condition in Europe (Storch, 1978b; Çolak *et al*., 2003).

DIMENSIONS are given according to geographic races (Tables 18 & 19). There is no secondary sexual dimorphism (Kryštufek, 2001). The largest body weight of captive *G. g. orientalis* is given as 232 g

	Turkish Thrace			Balkans (the rest)		
	N	mean	min-max	N	mean	min-max
Head and body	24	156.9	123-182	53	150.9	123-180
Tail	21	141.9	113-170	43	126.8	109-150
Hind foot	24	29.3	25.0-33.2	53	27.2	23.5-31.0
Ear	24	19.8	17.0-22.0	50	18.0	15.0-21.0
Weight	19	111.9	72-153	8	94.9	76-115
Condylobasal length	19	33.9	30.0-35.4	117	35.5	32.1-37.7
Zygomatic breadth	20	23.4	21.4-25.5	115	22.3	19.4-24.5
Maxillary tooth-row	11	6.5	6.2-6.8	118	6.7	5.6-7.6

Table 18. External and cranial dimensions of *Glis glis minutus*. Based on Ondrias (1966), Doğramacı & Tez (1991), Kurtonur (1992), Peshev & Delov (1995b), and specimens in BMNH and ZFMK in addition to our own material.

	Anatolia			Iran		
	N	mean	min-max	N	mean	min-max
Head and body	14	157.4	140-176	22	184.3	148-211
Tail	9	115.3	90-134	20	154.2	115-187
Hind foot	14	27.5	23-31	24	33.3	28.5-38.0
Ear	13	18.6	13-22	24	23.7	20.0-26.0
Weight	10	89.6	68-110	2		146 / 211
Condylobasal length	13	34.9	33.1-37.2	18	40.0	35.4-44.6
Zygomatic breadth	13	21.5	20.6-22.9	18	25.8	23.9-27.6
Maxillary tooth-row	21	6.4	5.8-7.0	19	8.4	7.3-9.3

Table 19. External and cranial dimensions of *Glis glis* from northern Anatolia and Iran. Based on Nehring (1903), Thomas (1906b), Zimmermann (1953) and Doğramacı & Tez (1991), and specimens in BMNH, FMNH, NMNH and SMF.

(Çolak *et al.*, 1998b). Great changes in body weight occur before hibernation within a short period of time. In captive dormice (ssp. *orientalis*) the body gain of adults over three months (August 14 till November 10) was 1.23 to 2.47-fold (calculated from data in Çolak *et al.*, 1998b).

CHROMOSOMES. The diploid number of chromosomes is 2N = 62 and the fundamental number of chromosomal arms is NFa = 120. With the exception of the Y heterosome, all the chromosomes are biarmed. The X-chromosome is a large sized metacentric, while the Y-chromosome is dot-like (Civitelli *et al.*, 1995). Chromosomes were described in specimens from the Istranca Mts. and from northern Anatolia (Doğramacı & Tez, 1991, Civitelli *et al.*, 1995).

VARIATION

Ten subspecies are tentatively recognised among the edible dormice (Corbet, 1978) which differ primarily in size and, to a lesser extent, in colour details. Geographic variation, however, was never evaluated across the entire species range. Two subspecies are currently listed for Turkey (Doğramacı & Tez, 1991; Kurtonur, 1992; Kurtonur *et al.*, 1996): *G. g. orientalis* and *G. g. pindicus* Ondrias, 1966 (type loc.: Moni Stomiou, near Konitsa, Epirus, Greece).

The two populations of the edible dormouse, separated by the Marmara straits, are of very similar coloration and size (cf. Tables 18 & 19), but differ in bacular measurements and karyotype. The baculum is shorter but more slender in Anatolian specimens (Table 20). Doğramacı & Tez (1991) report differences in the centromeric position of autosomes. The Anatolian race has 26 pairs of metacentric and 30 pairs of submetacentic elements, while this is just the opposite in the Thracian animals; the remaining four autosomal pairs are subtelocentric. Thus, the available data indicate a clear distinction between the two geographic segments of the edible dormouse in Turkey.

COMMENTS ON *G. G. MINUTUS*. *Glis g. pindicus* is of the same size as *G. g. minutus* Martino, 1930 (type loc.: Predejane, 30 km south of Leskovac, Serbia) and the two are evidently synonymous (Kryštufek & Petkovski, 2003). The proper subspecific name for edible dormice of Turkish Thrace is thus *G. g. minutus*.

	Thrace (N=7)		Anatolia (N=5)	
	mean	min-max	mean	min-max
Length	9.3	8.4–10.0	8.8	8.5–9.1
Width	2.6	2.5–2.8	2.4	2.3–2.5

Table 20. Baculum dimensions in two populations of *Glis glis* in Turkey. From Doğramacı & Tez (1991) and Simson *et al.* (1995).

Glis g. minutus is the smallest European subspecies and populates central and eastern parts of the Balkan Peninsula, roughly to the south of the Sava and Danube rivers and to the east of the river Drina. In the Dinaric Alps further west it is replaced by a much larger nominate race *G. g. glis* (condylobasal length = 35.6–40.5 mm; Kryštufek, 1991). The northern border at which *G. g. minutus* meets a small central-European form has never been defined.

Non-metrical cranial traits among Bulgarian samples of *G. g. minutus* suggest low interpopulation divergence (Markov, 2001a). The population from Istranca has a single pair of NOR bearing chromosomes which are medium-sized metacentrics and are also characterised by an evident heterochromatic region (Civitelli *et al.*, 1995). In two other populations from the Balkan Peninsula (Dalmatia and Serbia), heterochromatic regions are present on two pairs of small chromosomes (Dulić *et al.*, 1971). Unfortunately, populations from Macedonia, Greece and Bulgaria were not studied in this respect.

COMMENTS ON *G. G. ORIENTALIS*. Šidlovskij (1976) syonymised ssp. *spoliatus* with *G. g. orientalis*, which was accepted by Corbet (1978) and Kock (1990). Another junior synonym of *G. g. orientalis* is *G. g. tschetschenicus* Satunin, 1920 (type loc.: River Shara-Argun, Chechen region, Caucasus) (Šidlovskij, 1976; Corbet, 1978). We saw no material of the latter, but as can be concluded from published data, the Caucasian material is indistinguishable from the Anatolian one. Descriptive statistics for the condylobasal length of skull in Caucasian material is: mean = 36.7 mm, range = 36.0–38.1, N = 24 (based on Ognev, 1963).

Glis g. orientalis clearly differs from *G. g. persicus* (Erxleben, 1777) (type loc.: Province of Ghilan, Iran; restricted to Rasht by Lay, 1967). Iranian dormice are significantly larger (cf. Table 19) and darker. Distal portion of tail is nearly blackish in *G. g. persicus* and the tail of juveniles is entirely black. Because of dark tail hairs, the ventral medial line appears white and is sharply demarcated. The metatarsal stripe is brown and narrow, if present at all, in Turkish dormice from both sides of the Marmara Strait, but is black-brown and covers nearly the entire surface of hind foot in Iranian material (Fig. 58).

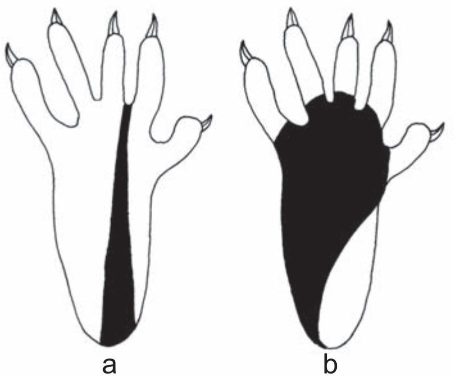


Figure 58. The extent of the metatarsal stripe in *Glis glis minutus* from Turkish Thrace (**a**) and in *G. g. persicus* from Iran (**b**). Not to scale.

The position of the material from Lenkoran district in southeastern Azerbaijan is less clear. Although uniformly ascribed to ssp. *persicus* (or to *caspicus* Satunin, 1906, which is a junior synonym of *persicus*) by Russian authors (Ognev, 1947, 1963; Šidlovskij, 1976, Gromov & Erbajeva, 2001), the Lenkoran material is actually paler and smaller: mean condylobasal length = 37.3 mm, range = 34.9–38.8 mm, N = 14 (based on Ognev, 1963, and BMNH material).

DISTRIBUTION

The range mainly coincides with the deciduous forest zones in the western Palaerctic. Edible dormouse occurs in southern and central Europe, but is absent from most of Iberia, with the exception of the Pyrenees and the northern Atlantic coast. Its northern range limit is in Latvia and the eastern one on the right banks of the Volga River. The range is fragmented in the forest steppe zone of Russia and Ukraine. Another segment of the edible dormouse range is in the Caucasus, along the southern and southeastern shores

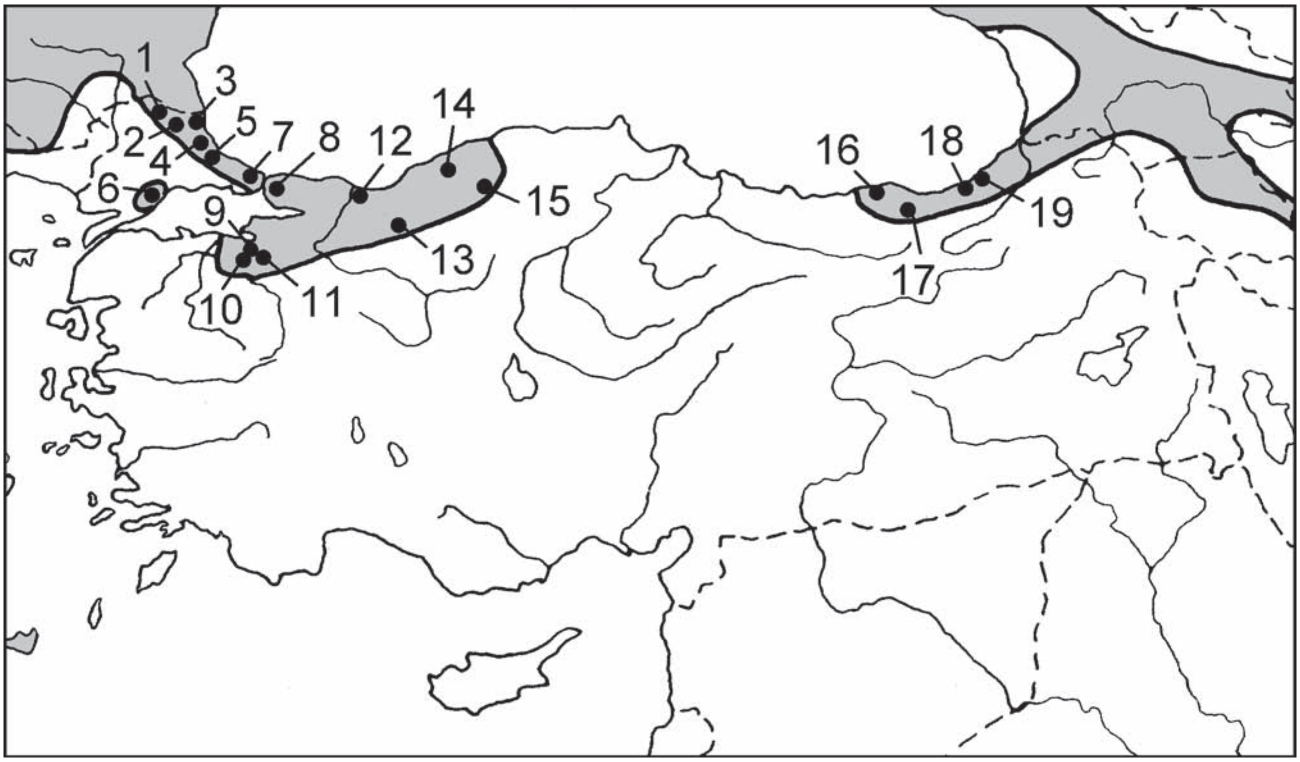


Figure 59. Distribution of *Glis glis* in Turkey. Records: **1** – Dereköy, Kırklareli; **2a** – Mahya Dağı, Yeniceköy, Kırklareli; **2b** – Velikaköpru (= Velika), Demirköy, Kırklareli, 800 m; **2c** – Demirköy, Kırklareli; **3** – İgneada, Kırklareli; **4** – Bahçeköy, Saray, Tekirdağ; **5a** – Güngörmez, Saray, Tekirdağ; **5b** – Istranca, Saray, Tekirdağ; **6** – Ormanli, Inecik, Tekirdağ; **7** – Belgrad forest near İstanbul; **8** – Alem Dağı, north-east of Üskündar, İstanbul; **9** – Soğukpınar, Uludağ, Bursa; **10** – Yenikonak, Bursa, 1,025 m; **11** – 2 km south-west of Safa, south-eastern Uludağ, Kütahya; **12** – 9 km west of Karasu, Adapazarı; **13a** – Abant Gölü, Bolu, 1,100 m; **13b** – Çepni, Bolu (subfossil); **14** – Çayırköy Mağarasi, Zonguldak (subfossil); **15** – Mencilis Mağarası, 5 km north of Safranbolu, Zonguldak (subfossil); **16** – 6 km west of Vakfıkebir, Trabzon; **17a** – Çosandere, Trabzon, 100 m; **17b** – Meryemana (=Sümela), Trabzon, 1,100 m; **18** – Rize; **19** – Çayeli, Rize. Corresponding references: Nehring (1903): 8. Thomas (1906b): 17a. Kahmann (1962): 7. Osborn (1964): 9, 17b, 18. Kock (1990): 11. Doğramaçi & Tez (1991): 1, 2c, 12, 16. Kurtonur (1992): 1, 2a,b, 3, 4, 5a, b, 6. Horáček *et al.* (1996): 13b, 14, 15. Çolak *et al.* (1998b): 19. Yiğit *et al.* (2003a): 2b, 10, 13a, 17b.

of the Caspian Sea and in northern Anatolia. *Glis glis* occurs on some large (Corsica, Sicily, Crete) and several small Mediterranean islands (Storch, 1978b). It was also introduced to the south of England (Rossolimo *et al.*, 2001).

The Turkish range has two parts, the European and the Asiatic. In Thrace the edible dormouse is strictly confined to humid deciduous forests; consequently, its range is bound to the Black sea coast and to the Istranca Mts. There is also an isolate in the Ganos Mts. (Kurtonur, 1992).

The range in Asia Minor is evidently disjunct. The western segment is restricted to the Marmara region. Recently collected subfossil material from the Zonguldak region (Horáček *et al.*, 1996) suggests wider distribution of the edible dormouse in the western Pontic Mts. We considered the subfossil data in the distribution map (Fig. 59), even more so since suitable habitats are available around Zonguldak. In the east, the localities lie on the northern slopes of the Pontic mountains, as far west as the vicinity of Trabzon. The eastern Pontic range is merely the westernmost extension of the Caucasian population (cf. Šidlovskij, 1976). Whether the gap between Zonguldak and Trabzon, *c*. 500 km broad, is genuine or simply a sampling artefact is unknown at present.

The edible dormouse occurs on none of the eastern Aegean islands offshore Turkish coasts.

PALAEONTOLOGY. Ünay (1994) suggests the Asiatic origin of genus *Glis* (known from the Middle Oligocene of Anatolia), although the earliest record is from the Middle Oligocene of Turkish Thrace (Ünay, 1989). *Glis glis* evidently evolved in Europe where it is known since the beginning of the Turingian (the Upper Middle Pleistocene). Recent species is predated by the extinct *G. sackdillingensis* (Heller, 1930) which links it to the Pliocene *G. minor* Kowalski, 1956. Fossil remnants of the modern *G. glis* are common in the Balkans and are mainly of Biharian and Turingian age (Kowalski, 2001), but were not found in the Middle Pleistocene layers of Yarımburgaz in Turkish Thrace (Santel, 1994). There is also complete lack of fossil evidence in Anatolia and in the Caucasus, which suggests that the edible dormouse invaded its present range in Asia quite recently. Several authors (Nehring, 1903; Osborn, 1964; Hosey, 1982) suggested that this colonisation took place via the former Bosporus link. Migration from Europe to Asia Minor could thus occurred as late as during the Upper Pleistocene.

HABITAT

The typical habitats include deciduous and mixed forest with closed canopy, but also mosaic landscape with early successional stages along the forest edges and in forest clearings. Key elements in the habitat are mast seeders (particularly beech *Fagus*) which provide staple food before hibernation, a diverse assembly of shrubs and plants as sources of food in spring and summer before mast crop is available, and old trees with holes for nesting.

Along the Mediterranean coast and on the islands *G. glis* inhabits sclerophylous evergreen forests and tall maquis. Although it also lives in coniferous forests, the population densities are low there. The edible dormouse is occasionally found in orchards and parks, and it also enters houses.

In Turkey, *G. glis* is tied to humid deciduous and mixed forests. In Thrace these include stands of *Fagus orientalis, Quercus cerris, Q. pubescens, Carpinus betulus,* and *Philyrea latifolia*. The ecosystem receives 880–1,400 mm of precipitation annually (Kurtonur, 1982, 1992). It is worth noting that dry forests (mainly of *Pinus brutia*), which form an intermediate belt between the humid forests on the one hand and the steppe habitat on the other, are not populated by the edible dormouse in Thrace (Kurtonur, 1982, 1992).

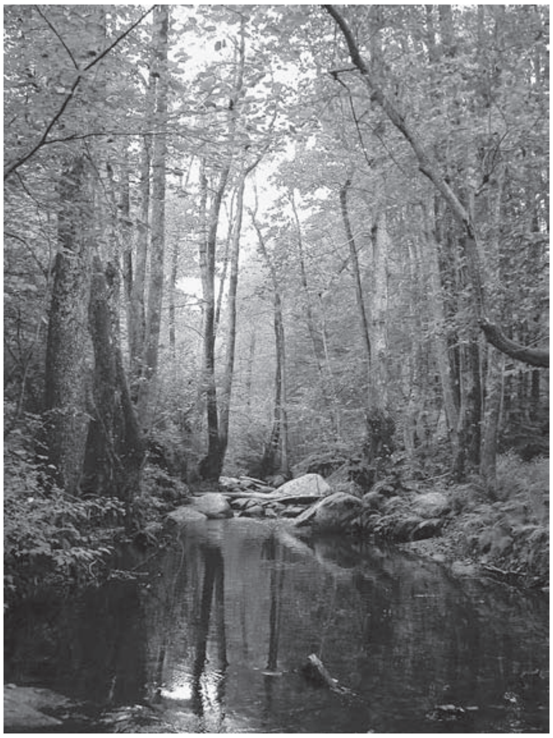


Figure 60. Habitat of *Glis glis*. The Istranca Mts., Turkish Thrace. Photo: A. Kryštufek.

Deciduous forests in northern Anatolia are composed of *Picea orientalis, Abies nordmanniana, Fagus orientalis, Quercus cerris, Q. infectoria, Q. pubescens, Castanea sativa, Carpinus betulus, Juglans regia, Crataegus monogyna*, and *Cistus laurifolius* (Yiğit *et al*., 2003a).

Beech forests are the principal habitat of the edible dormouse across the Balkan Peninsula (own observations) and on the Caucasus (Ognev, 1963). Also Lay (1967) reports the edible dormouse to be common in such habitats along the southern Caspian coast of Iran.

ALTITUDE. The altitudinal records range from sea level up to *c.* 1,100 m a.s.l. As noted by Ognev (1963), the edible dormouse in the Caucasus depends on the presence of "high-trunked and hollow trees" rather than on elevation itself. On the Ganos Mts., the vertical range of distribution is from sea level to 1,000 m (Kurtonur, 1992). In the Caucasus it goes as high as 2,000 m a.s.l. (Rossolimo *et al*., 2001).

ASSOCIATES. Deciduous forests of Thrace support a small mammal assembly that is poor in species. In the Istranca Mts. only two rodents appear to be common in the edible dormouse's habitat: *Sciurus vulgaris* and *Apodemus flavicollis; Dryomys nitedula* is rare.

The small rodent assembly is more species-rich in forests of the Pontic Mts., but again, only *Apodemus* spp. and *Sciurus anomalus* are worth mentioning. Other dormice are rare in the edible dormouse habitats also in Asia Minor.

Density. The average population density in the Caucasus is reported as 30 dormice per hectare (Ognev, 1963) and the maximum is up to 50 per hectare (Rossolimo *et al*., 2001). In beech forests of the northwestern Balkans in Slovenia the densities are estimated at six per hectare (before reproduction) and 15.5 per ha (after weaning; Kryštufek *et al*., 2003).

Biology

The edible dormouse is probably the only western Palaearctic mammal with adaptations to unpredictable ecological dynamics of the deciduous forest ecosystem to which it is closely tied. The key trees (*Quercus* spp., *Fagus* spp.) of the Holarctic deciduous forests are mast seeders, producing large seed crops every two to six years, while in the intervening years this production is low or even fails. Unpredictability and seasonality of the ecosystem determine two basic life history tactics of the edible dormouse: timing of reproduction, and hibernation.

Activity. *Glis glis* is more arboricolous than any other dormouse living in Turkey; its relative brain volume is also higher than in the remaining dormice (Simson *et al*., 1996a). Its activity is strictly nocturnal.

In north-western Balkans the edible dormouse enters hibernation between mid-September and end of October and arouses between late April and May (Kryštufek *et al*., 2003; unpublished results). Özkan *et al*. (2002) report activity in the Istranca Mts. between May and the end of November. Kurtonur (1992) collected specimens in Istranca also in February. The activity period in the northern Caucasus is between mid-June and mid-October, and in Azerbaijan from the end of April (early May) to the end of October (Rossolimo *et al*., 2001).

Reproduction. The edible dormouse produces a single litter annually but reproduction fails in years with no beech mast (Kryštufek *et al*., 2003). In the Istranca Mts., mating occurs between June 15 and August 18, and litters are delivered from July 14 to September 16 (Özkan *et al*., 2002). The litter size in Istranca ranges between 1 and 12 (mean = 6.06, N = 100; Özkan *et al*., 2002) and is higher than in the north-western Balkans (4.9 on average; Kryštufek *et al*., 2003). Data from five females in Çolak *et al*. (1997f) suggest mean litter size in *G. g. orientalis* to be 5.6. In the Caucasus the litter sizes range from two to ten cubs; mean litter size is between four and eight, depending on the region (Rossolimo *et al*., 2001). In four females collected in the 3rd decade of August and at the beginning of September, Lay (1967) found 7, 9, 10, and 10 embryos or placental scars, respectively. In Mazanderan (Iran), juveniles of the year were collected in the 2nd decade of August (FMNH material). Lay (1967) reports Iranian adults to be excessively fat already in August, while in north-western Balkans the dormice do not start accumulating fat before September (our own observations).

Juveniles are altricial. Body mass at birth is 2 grams in the Istranca Mts. (Özkan *et al*., 2002) and 3.4 grams in the district of Rize (Çolak *et al*., 1997f). Mean daily gain of body mass in Thracian dormice during the first month is between 0.83 and 1.19 g (Özkan *et al*., 2002). The body mass of one-month-old animals is 25.2–35.7 grams (Özkan *et al*., 2002). Juveniles collected in the Istranca Mts. in mid-September had body mass of 27–55 grams (mean = 42 g; N = 19) and those from the Ganos Mts. weighed 42–82 g in early October (mean = 57.3 g, N = 16; calculated from data in Kurtonur, 1992). Sexual maturity is achieved in the next vegetation season. Kıvanç *et al*. (1995) recorded spermatogenesis in eight months old captive males of *G. g. orientalis*. Maximum longevity in the north-western Balkans is seven years (Kryštufek *et al*., 2005). Özkan *et al*., (2002) report balanced male (51.8%) to female (48.2%) sex ratio.

Food. Compared to other dormice in Turkish fauna, the edible dormouse has a relatively long intestine, which suggests predominantly vegetarian diet (Simson *et al*., 1996a). Captive individuals of *G. g. orientalis* fed on (in decreasing order of preference) hazel nuts, chestnuts and acorns (Yiğit *et al*., 2001). In the Caucasus, the diet is mainly of various seeds, nuts and fruit; slugs, caterpillars and insects are only rarely eaten (Ognev, 1963). Lay (1967) reports beechnuts, in addition to walnuts and hornbeam seeds, as the principal diet in Iran.

PREDATION. In Anatolia, Kock (1990) and Obuch (2001) found edible dormice in the food of the tawny owl *(Strix aluco)*, but at low frequencies. The tawny owl is possibly an important predator of dormice in the Caucasus, particularly so during summer (Ognev, 1963). Obuch (2001) also found dormice as a common component of the tawny owl's prey (up to 26.2% of total prey) in northern Iran.

DAMAGES. In the Caucasus, the edible dormouse is a pest of orchards and vineyards (Ognev, 1963). Damages done to hazelnuts, walnuts, apples, pears and peaches are also reported from the coastal parts of north-eastern Anatolia (Tunçdemir, 1987).

GENUS: *MUSCARDINUS* KAUP, 1829

A monospecific genus, confined to Europe and northern Anatolia.

HAZEL DORMOUSE – *MUSCARDINUS AVELLANARIUS*

Mus avellanarius Linnaeus, 1758. Type loc.: Sweden.
Muscardinus trapezius Miller, 1908. Type loc.: Khotz (=Çosandere), Trabzon.
Muscardinus avellanarius abanticus Kıvanç, 1983. Type loc.: Abant Gölü, Bolu.

DESCRIPTION

EXTERNAL CHARACTERS. Externally the hazel dormouse resembles the edible dormouse but is much smaller, with relatively larger eyes and with only moderately bushy tail. Tail is slightly shorter than head and body (*c.* 85–95% of head and body length). Fore foot is highly specialised, with fingers closing obliquely inward with a much enlarged inner pad functioning as a thumb. Hind foot is rather short and broad, just like in *Glis*. Digits are relatively long. Yellowish claws are short and sharp. Tail, which is partly prehensile, is short bushy throughout. Blackish whiskers are up

Figure 61. Hazel dormouse *Muscardinus avellanarius*. Drawing: J. Hošek.

to 30 mm long. Fur is thick and soft; hairs are up to 5.5 mm long on the back and distinctly shorter on the belly.

COLOUR. Upper parts buff slate to yellowish brown but mid-back has brownish wash and is inconspicuously sprinkled with black hairs. Hair base slate-coloured. Tail of same colour as back (lighter below), but distal portion turns much darker and terminal pencil black brown. Ventral side of tail light buff and darker than belly. Belly cream-buff to buff, but frequently darkened by slate under colour. Chin, throat and chests have an irregular area of pure white hairs. Blackish eye-ring is very narrow.

NIPPLES. There are four pairs of nipples: one pair of each pectoral and abdominal, and two pairs of inguinal.

BACULUM narrow with long distal shaft. Dimensions in two specimens from Trabzon area are 5.0 and 5.2 mm (length) and 1.0 and 1.1 mm (width), respectively (Doğramacı & Kefelioğlu, 1992).

SKULL deep and moderately wide (zygomatic breadth makes up *c*. 60–65% of condylobasal length). Rostrum and nasals long and narrow. Zygomata, which are mainly parallel, spread very abruptly anteriorly. Interorbital region moderately broad and flat,

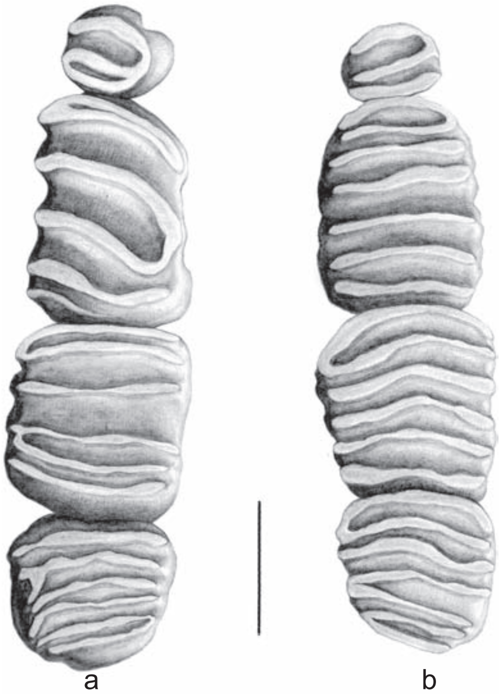


Figure 63. Upper (**a**) and lower cheek-teeth (**b**) of *Muscardinus avellanarius*. Based on a specimen from Soğuksu, Abant, Bolu (ZFMK; paratype of ssp. *abanticus*). Lingual side is to the right, anterior is at the top. Scale bar = 1 mm. Drawing: S. Prokešová.

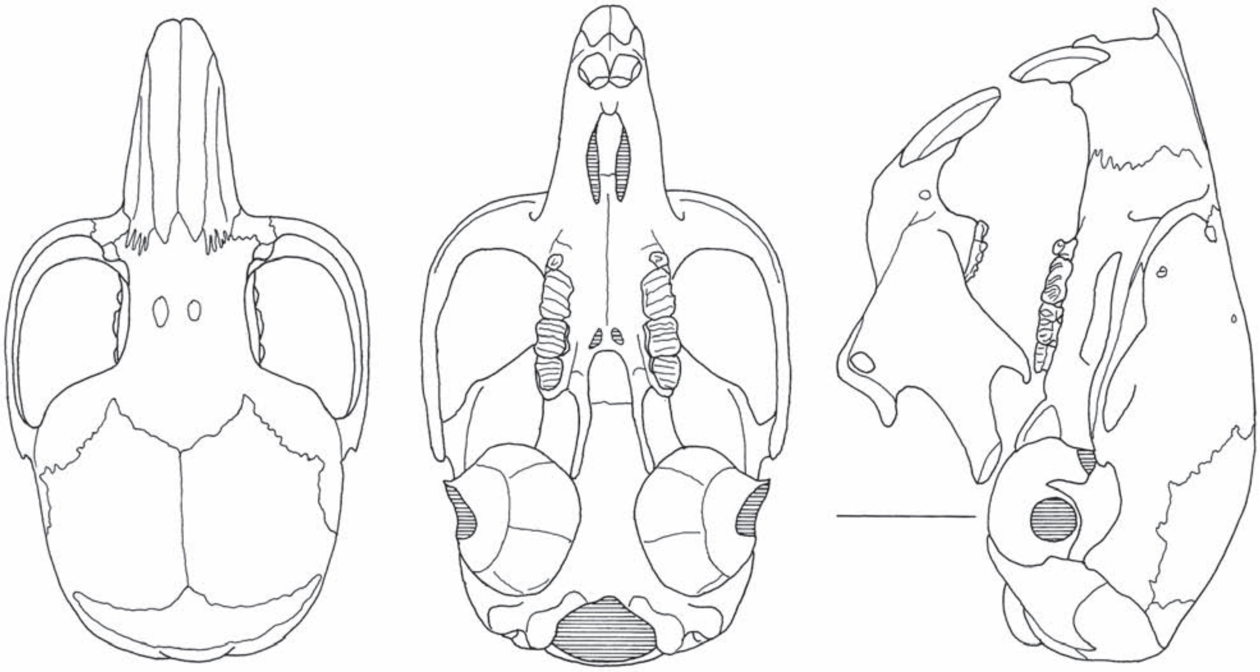


Figure 62. Skull and mandible of *Muscardinus avellanarius*, based on an adult female from Soğuksu, Abant, Bolu (ZFMK). Scale bar = 5 mm.

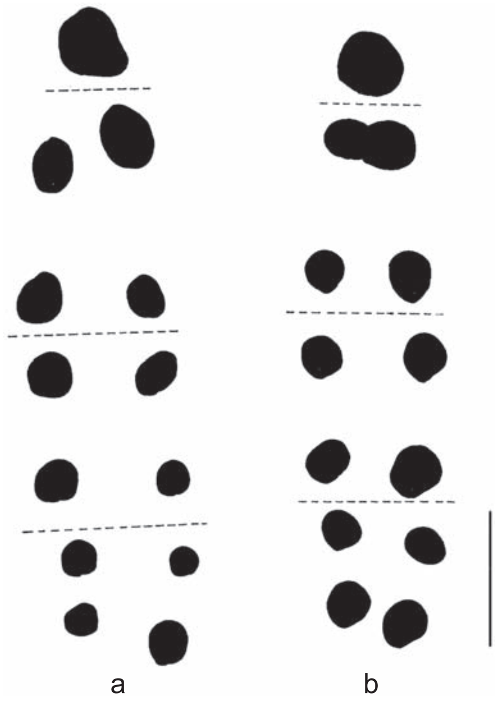


Figure 64. Alveolar pattern in *Muscardinus avellanarius* from Anatolia. Based on specimen from Soğuksu, Abant, Bolu (ZFMK). **a** – upper, **b** – lower row. Lingual side is to the right, anterior is at the top. Scale bar = 1 mm.

with slightly raised edges. Its median portion usually with one or two small irregular perforations. Braincase rounded. Incisive foramina longer and narrower than in *Glis*, with parallel outer borders. Pterygoid fossa is long and parallel-sided. Bullae rounded and fairly small. Mandible robust and deep, but coronoid process weak. Broad angular portion perforated.

Teeth. Incisors short with orange (upper) or yellow (lower ones) enamel on their front surface. Grinding surface of cheek teeth flat. Upper and lower premolars much smaller than any of the subsequent molars. Molars of decreasing size in anterior – posterior direction. There are five main transverse ridges on occlusal surface. For details of molar morphology in Anatolian samples of *M. avellanarius* see Kıvanç & Yardımcı (2000). Premolars single-rooted. Number of roots in the molars varies between three and five (Table 21).

	A	B
M1	4	5
M2	4	
M3	4	3
m1	3	4
m2	4	
m3	4	3

Table 21. Number of molar roots in *Muscardinus avellanarius* from Anatolia (N = 41–44). **A** – prevailing condition; **B** – rare morphotypes. Capitals denote upper molars, low-case letters denote lower molars. Modified from Kıvanç (1989).

Dimensions are given according to subspecies (Table 22). There is no secondary sexual dimorphism.

Chromosomes. The diploid number of chromosomes is 2N = 46 and the fundamental number of autosomal arms is NFa = 86. The karyotype of specimens from Trabzon is the same as in European populations. It contains 18 pairs of meta- and submetacentric autosomes, three pairs of subtelocentrics and one pair of small acrocentrics; the X chromosome is metacentric and the Y chromosome is dot-like acrocentric (Doğramacı & Kefelioğlu, 1992).

	M. a. abanticus			*M. a. trapezius*		
	N	mean	min-max	N	mean	min-max
Head and body	26	80.4	69-89	17	77.1	69-92
Tail	24	66.4	54-81	13	65.8	58-72
Hind foot	26	16.7	14.0-18.5	17	16.2	14.0-19.0
Ear	26	11.9	10.0-15.0	17	11.7	10.0-14.0
Weight	3	16.7	15-18	5	24.0	20-26
Condylobasal length	26	22.4	20.8-24.0	16	21.4	19.7-23.0
Zygomatic breadth	25	13.7	12.8-15.4	14	12.7	11.3-13.6
Maxillary tooth-row	28	4.8	4.5-5.2	16	4.4	4.0-4.9

Table 22. External and cranial dimensions in two subspecies of *Muscardinus avellanarius* from northern Anatolia. Based on Kıvanç (1983), Doğramacı & Kefelioğlu (1992) and specimens in BMNH, FMNH, and ZFMK.

VARIATION

Two subspecies are recognised in Anatolia (Kıvanç, 1983; Kurtonur *et al.*, 1996). As long as samples from both extremes of the Pontic Mts. are confronted, the differences appear to be clear.

KEY TO SUBSPECIES

1 Size on average larger (cf. Table 22); demarcation line along flanks quite distinct; molars larger (cf. Table 23)
M. a. abanticus

1* Size on average smaller (cf. Table 22); demarcation line along flanks less distinct; molars smaller (cf. Table 23)
M. a. trapezius

Kıvanç (1983) reported ssp. *abanticus* from districts of Bolu and Bursa, and ssp. *trapezius* from Trabzon and Ordu (cf. Fig. 66). The properties of populations from a broad gap in between (*c*. 450 km wide) are entirely unknown. Also the relations between hazel dormice from the opposite sides of the Marmara Straits are poorly understood.

When the Anatolian populations are compared to the European material, slight differences appear in darker terminal portion of the tail and in fairly clear demarcation line along flanks which is particularly evident in ssp. *abanticus*. Miller (1908b) based his diagnosis of *trapezius* particularly on the bullar peculiarities. In his words, the small size of bullae is due "chiefly to the absence of the inflatened region between paroccipital process and bullae proper." However, hazel dormice from Europe do not differ much in relative bullae length (24.9–27.8% of condylobasal length; mean = 26.4%, N = 26) from a pooled Anatolian sample (26.4–27.5%, mean = 27.0%, N = 5). *Muscardinus a. trapezius* has shorter 1st upper molars than both *M. a. abanticus* and the European populations (Table 23).

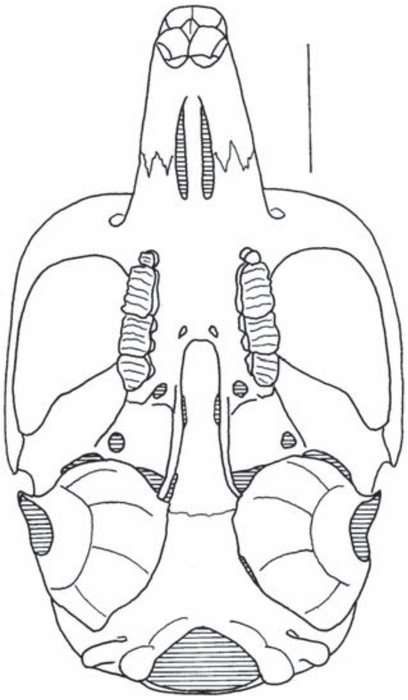


Figure 65. Ventral side of skull of *Muscardinus avellanarius*, based on an adult male from Çosandere, Trabzon (BMNH; type of *M.a. trapezius*). Scale bar = 4 mm.

DISTRIBUTION

The distribution range of the hazel dormouse is quite similar to that of *G. glis*, except that the former is absent from the Caucasus region. The southern border roughly coincides with the Mediterranean coast and the eastern one is along the middle reaches of the river Volga. In the north, *M. avellanarius* reaches the Baltic countries but is absent from Iberia in the west. It is much more rarely present on the Mediterranean islands than is the edible dormouse, but does occur on some islands off the north European coast and is native to southern England (Storch, 1978c).

	M. a. abanticus[1)] N = 21-23		*M. a. trapezius*[1)] N = 10-11		Europe[2)] N = 20	
	mean	min-max	mean	min-max	mean	min-max
m1 – length	1.64	1.5-1.8	1.48	1.4-1.5	1.64	1.56-1.76
m2 – length	1.42	1.3-1.5	1.26	1.2-1.3	1.32	1.24-1.44
m2 – width	1.36	1.3-1.4	1.23	1.1-1.3	1.29	1.20-1.36

Table 23. Dimensions of molars in three samples of *Muscardinus avellanarius*. Selected are traits which permit best differentiation between the two subspecies in Anatolia. Modified from [1)]Kıvanç (1983) and [2)]Storch (1978c).

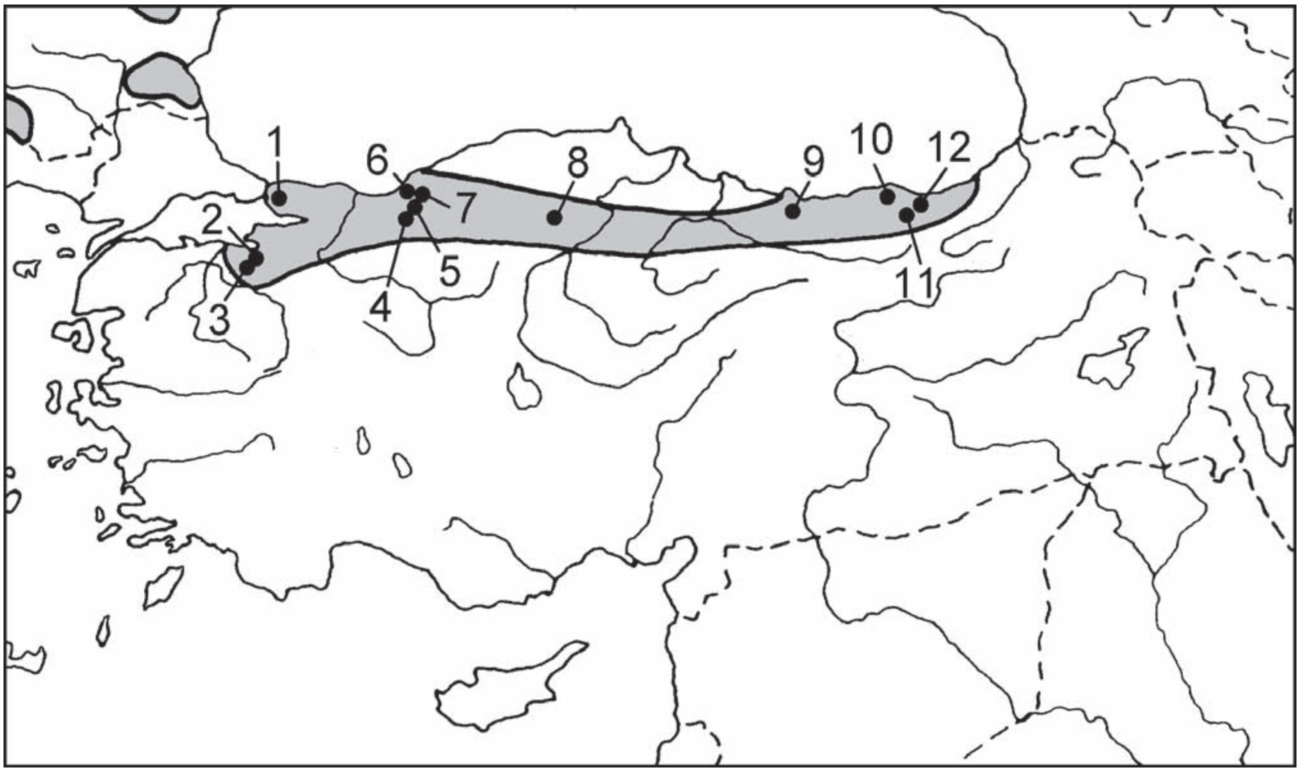


Figure 66. Distribution of *Muscardinus avellanarius* in Turkey. Records: **1** - Alem Dağı, north-east of Üskünder; **2** – Uludağ, Bursa; **3** – Yenikonak, Bursa, 1,025 m; **4** – Abant, Bolu, 1,100 m; **5a** – Soğuksu, Abant, Bolu, 1,100 m; **5b** – Yenicefelakettinköyü, Bolu; **6** – Köseköy, Bolu; **7** – Yığılca, Bolu; **8** – Tosya, Kastamonu, 870 m; **9** – Ulubey, Ordu; **10** – Vakfıkebir, Trabzon; **11a** – Çosandere, Trabzon; **11b** – Sümela (= Meryemana), Trabzon; **12** – Yomra, Trabzon. Corresponding references: Nehring (1903): 1. Miller (1908b): 11a. Kıvanç (1983): 2, 5a, b, 6, 7, 9, 12. Doğramacı & Kefelioğlu (1992): 10, 12. Yiğit *et al*. (2003a): 3, 4, 8, 11b.

In Turkey the hazel dormouse is known only from Anatolia, where its range is again most similar to that of *G. glis*. Not surprisingly, many authors noted this similarity in the past and considered it as indicative of a previous land connection between Europe and Asia Minor (Nehring, 1903; Osborn, 1964; Hosey, 1982). Records stretch along the Pontic mountains from Mt. Uludağ in the west to the vicinity of Trabzon in the east. The hazel dormouse does not cross the Turkish – Georgian border.

The absence of *M. avellanarius* from Thrace, the Istranca Mts. in particular, is puzzling. Simeonov (1985) recorded it in the pellets of a tawny owl *(Strix aluco)* in several localities on the Bulgarian part of Istranca (= Strandža), but at low frequencies (<1% of small mammals).

Palaeontology. The hazel dormouse first appeared in Europe in the Villanyian and survived the Pleistocene in the territory of its recent distribution (Kowalski, 2001). Fossil records from the Balkans are from the Middle and Upper Pleistocene. It is worth noting that Santel (1994) failed to record *M. avellanarius* in the Middle Pleistocene layers of Yarımburgaz in the Istranca Mts. Lack of fossil evidence in Anatolia suggests the hazel dormouse to be quite a newcomer there.

Habitat

The hazel dormouse prefers “woodland edge, overgrown clearings and areas of high diversity of trees and shrubs. The best habitats … have a vigorous, unshaded shrub layer producing plenty of food … and some mature canopy trees. Habitats need a variety of tree species, particularly ones producing berries … or nuts” (Bright & Morris, 1992). Habitat preferences in Anatolia are the same as in Europe. Kıvanç (1983) reports the hazel dormouse from young stands of deciduous trees (*Fagus orientalis, Castanea sati-*

Figure 67. Habitat of *Muscardinus avellanarius*. Mt. Uludağ, north-western Anatolia. Photo: A. Kryštufek.

va, Carpinus spp., *Quercus* spp.), densely grown forest clearings, forest edges, and stripes of trees. In Abant, specimens were also collected in a pine forest (FMNH material).

ALTITUDE. The vertical range of localities is between 900 and 1,500 m a.s.l. in the western Pontic Mts. (Kıvanç, 1983) and from sea level up to 1,100 m in the east.

BIOLOGY

The life of the hazel dormouse was intensively studied in Europe, particularly so along its northern distributional range (e.g. Bright & Morris, 1992; Juškaitis, 2003). Key references for Anatolia are in Kıvanç (1990, 2000) and Kıvanç & Sayar (1998).

ACTIVITY. The hazel dormouse is a hibernator. Specimens in Anatolia were collected between April 19 and the last decade of November (Kıvanç, 1983, 1990). Kıvanç (2000) published observations on four captive dormice. The onset of hibernation was between September and November and arousal from the end of March to start of May. During interruptions, the animals drunk water and eat. Kıvanç (2000) concludes that the hibernation pattern in Anatolia does not differ significantly from the one in Europe.

The hazel dormouse is nocturnal.

NEST. These dormice build spherical woven nests, although they also seek shelter in bird nests, squirrel dreys, in tree holes and behind loose bark (Bright & Morris, 1992). Kıvanç & Sayar (1998) found nests on beech, common ivy, hazel, grape and black berry, from 40 to 120 cm above ground (mainly 60–100 cm high; median = 80 cm, N = 22). The nests were constructed of leaves or grass and herbs, but the animals also used other miscellaneous material. The nests are 6–15 cm in diameter (mainly 8–10 cm, N = 21; Kıvanç & Sayar, 1998).

REPRODUCTION. Litters were recorded in Anatolia between June and late October and the number of young varied between 1 and 7 (mean = 3.0, N = 21; Kıvanç, 1990).

FOOD. Kıvanç & Sayar (1998) report hazel dormice to feed on leaves, buds, fruits, seeds, and bark.

PREDATION. Obuch (2001) found *M. avellanarius* in pellets of the tawny owl *(Strix aluco)* from Abant.

SUBFAMILY: LEITHIINAE LYDEKKER, 1896

The subfamily is characterised by concave occlusal surface of molars with prominent cusps and weak extra ridges. The monophily of Leithiinae is not generally accepted (cf. Daams & Bruijn, 1995; Storch, 1995). Of the genera living in Turkey, some authors prefer to place *Dryomys* and *Eliomys* in the subfamily Dryomyinae Bruijn, 1967, and *Myomimus* in Seleviniinae Bazhanov & Beloslyudov, 1939 (Storch, 1995; Rossolimo *et al*., 2001) or in Myomiminae Daams, 1981 (Daams & Bruijn, 1995). Within the Leithiinae as understood here, *Dryomys* and *Eliomys* share a complex molar pattern and some penial peculiarities (Storch, 1995). As such, they are placed in the tribe Leithiini Lydekker, 1896, as opposed to the tribe Seleviniini Bashanov & Belosludov, 1939 with *Myomimus*, *Selevinia* and *Chaetocauda*. For the appropriateness of the subfamily name Leithiinae and not Dryomyinae, see Holden (1993b).

Of the five genera and ten species of Leithiinae, five species in three genera occur in Turkey.

KEY TO GENERA

1 Tail bushy or with a terminal tuft; *foramina incisiva* broad and short, shorter than palatine 2
1* Tail covered with short sparse hairs; *foramina incisiva* long posteriorly, longer than palatine *Myomimus*

2 Size large: condylobasal length >30 mm, maxillary tooth-row >4.8 mm; tail black posteriorly; bullae much enlarged (length of bullae >32% of condylobasal length) *Eliomys*
2* Size small: condylobasal length <27 mm, maxillary tooth-row <4.9 mm; tail grey throughout its length; bullae smaller (length of bullae <33% of condylobasal length) *Dryomys*

Figure 68. Forest dormouse *Dryomys nitedula*. Drawing: J. Hošek.

GENUS: *DRYOMYS* THOMAS, 1906

A well defined genus with three currently recognised species (Holden, 1996). It is more closely related to *Eliomys* than to any other living dormice group (Montgelard *et al*., 2003). Dentition is more progressive in *Dryomys*, with less concave occlusal surface of cheek-teeth and less cuspidate condition of upper and lower premolars. Two species occur in Turkey.

KEY TO SPECIES

1 Well defined black stripe extends from base of whiskers to ear; brain-case depth across bullae >10.5 mm in majority of animals *D. nitedula*
1* No stripe on the face; brain-case depth across bullae <10.5 mm in majority of animals *D. laniger*

FOREST DORMOUSE – *DRYOMYS NITEDULA*

Mus nitedula Pallas, 1779. Type loc.: Tatar Autonomous Republic, Russia.
Dryomys nitedula phrygius Thomas, 1907. Type loc.: Murat Dağı, Uşak.

TAXONOMY

The two *Dryomys* species living in Turkey are well differentiated and their distinctiveness was never questioned (e.g Corbet, 1978). Besides various aspects of their morphology (Felten & Storch, 1968; Felten *et al*., 1973; Kıvanç *et al*., 1997; Yiğit *et al*., 2003b), they also differ in the diploid number of chromosomes, having 48 (*D. nitedula*) or 46 chromosomes (*D. laniger*), respectively (Kıvanç *et al*., 1997). Genetic differentiation between the two *Dryomys* species is high, with fifteen loci (out of 43 studied) allowing discrimination (Filippucci *et al*., 1996). The divergence between *D. nitedula* and *D. laniger* is estimated at 17 million years ago (Montgelard *et al*. 2003).

DESCRIPTION

EXTERNAL CHARACTERS. Small species, slightly larger that the common dormouse but resembling more closely *Glis* in external form. Tail approximately of same length as head and body or slightly shorter. Its relative length in a sample of 56 Turkish specimens is 85–120% of head and body, but extremes are possibly due to measuring bias. Similarly as in *Glis*, the tail is uniformly and rather long haired throughout. Proximal tail hairs as short as on the back and progressively longer towards tip; terminal pencil *c*. 20 mm long. Whiskers (up to 40 mm long) dark at base, with pale tips. Ears short and rounded and eyes large. Fur dense and short; dorsal hairs hardly exceed 5 mm in length and are even shorter ventrally. Feet long and slim. Plantar pads (six in number) large and soles bare.

The COLOUR of the upper-parts is highly variable and ranges from a light buff-yellowish to yellowish wood-brown, broccoli-brown, hair-brown, dull ochraceous-buff and deep greyish-olive. The mouse-grey colouration of the back does not occur in most specimens from Turkey. The under-parts and feet are whitish to very pale buff. The demarcation line along flanks is sharp. The slate-grey hair base is much less extensive on the ventral side and some specimens nearly lack it. The tail is grey with a faint tinge of buff and thus contrasts with back coloration. Its ventral surface is paler than the upper-side and with a whitish medial stripe. The tip of the pencil is whitish in some animals. Ears are grey. The forest dormouse is characterised by a black mask which extends from the base of whiskers to the ears and surrounds the eyes; behind the eyes the mask is *c*. 5 mm wide.

NIPPLES. There are four pairs of nipples.

Figure 69. Forest dormouse *Dryomys nitedula*. Adult specimen from Edirne. Photo: A. Kryštufek.

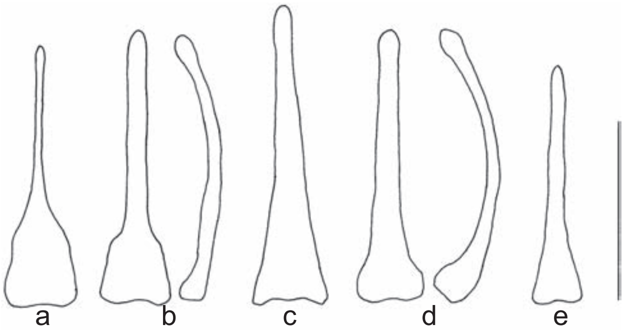


Figure 70. Baculum of *Dryomys nitedula* (**a–d**) and *D. laniger* (**e**) in dorsal view. Specimens **b** and **d** are also shown in lateral view. *Dryomys nitedula*, Turkish Thrace: **a** – Edirne (redrawn from Simson *et al*., 1995); **b** – Karakasım, Edirne; Anatolia: **c, d** – Gücük, Şarkişla, Sivas. *Dryomys laniger* is redrawn from Kıvanç et al. (1997). Distal is at the top. Scale bar = 5 mm.

PENIS AND BACULUM. Glans penis flattened dorsally and has two pad-like structures ventrally; ventral and lateral sides covered with spines. In specimens from European Turkey, glans is 8.8 mm long on average, 3.86 mm wide and 3.2 mm deep (Simson *et al*., 1995). Simson *et al*. (1995) report the baculum in Thracian specimens to consist of a broad and large base (1.88 m wide on average) and of a long and narrow shaft; the mean length of baculum is given as 7.53 mm. We examined four bacula (two from Sivas, central Anatolia, and two from near Edirne, Thrace) but the results were not entirely concordant with that of Simson *et al*. (1995). First of all, there were significant differences between the two samples. The basal part was expanded in Thracian specimens, even if to a lesser degree than in the material by Simson *et al*. (1995), and the shaft was stronger (Fig. 70a, b). The Anatolian specimens were essentially different in shape, with a slight triangular basal expansion (Fig. 70c, d); such a shape corresponds well with Fig. 232 in Ognev (1947, p. 489). Dimensions (length x width) are similar to those given by Simson *et al*. (1995): 7.81 x 2.03 mm and 7.76 x 2.08 mm in two Thracian animals and 7.76 x 1.88 mm and 8.49 x 2.14 mm in the Anatolian sample, respectively.

SKULL moderately deep, with rounded brain-case and tapering rostrum. Dorsal profile nearly flat with slight depression at fronto-maxillary suture. Zygomatic arches rather weak, compressed and expanded in middle. Skull width across zygoma between 58 and

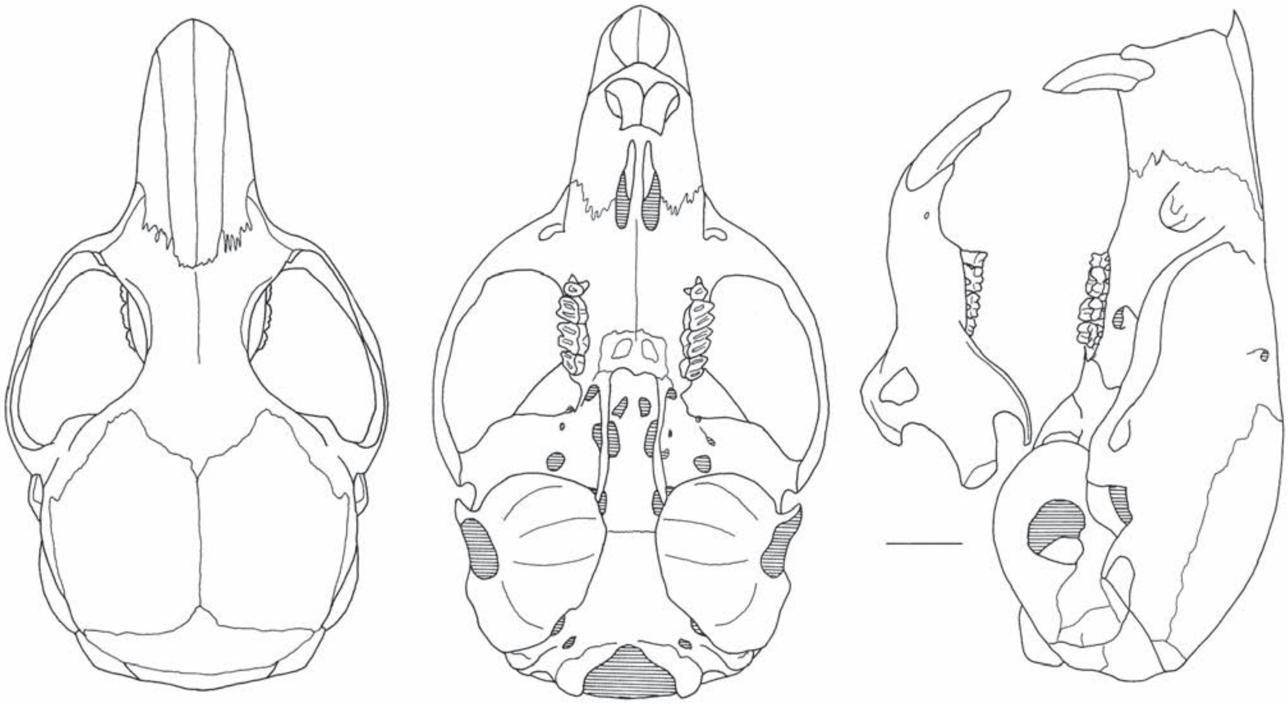


Figure 71. Skull and mandible of *Dryomys nitedula*, based on an adult male from Gücük, Şarkişla, Sivas, Anatolia. Scale bar = 3 mm.

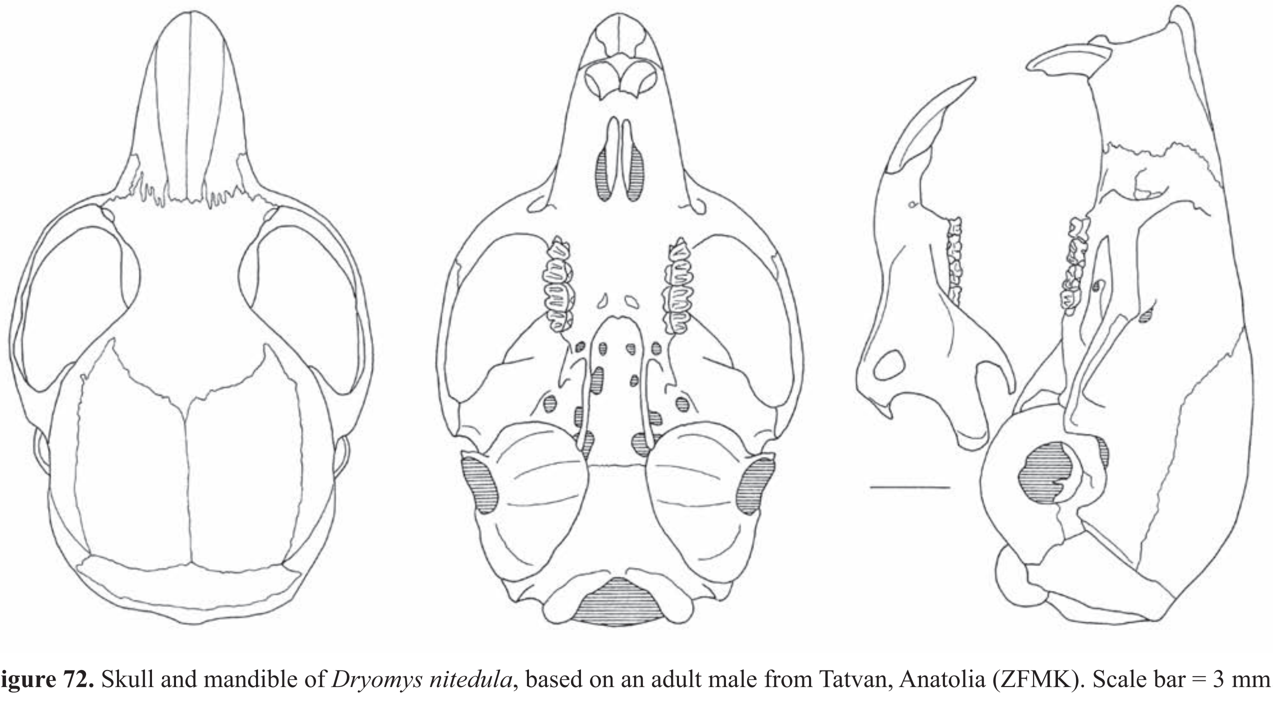


Figure 72. Skull and mandible of *Dryomys nitedula*, based on an adult male from Tatvan, Anatolia (ZFMK). Scale bar = 3 mm.

68% of condylobasal length (mean = 63.5%; N = 69). Nasals long and narrow. Incisive foramens short and broad. Pterygoid processes nearly parallel and space between them wide. Bullae large (up to one third of condylobasal length) and less evenly inflated than in *Glis*. Mandible low and week.

TEETH. Frontal surface of incisors protected by a coat of orange (upper) or yellow to whitish yellow enamel (lower ones). Rows of cheek-teeth nearly parallel. First and 2nd molars sub-equal, the premolar is the smallest cheek-tooth. Occlusal surface concave and cusps clearly evident along outer tooth margins, particularly on upper premolar. Each molar crossed by four complete ridges but the anterior ones are mainly incomplete on lower crowns. There are incomplete ridges in-between. Upper premolar has two roots and the lower one is single-rooted. Upper molars have three roots each, and the lower ones are two-rooted (Storch, 1978a).

DIMENSIONS are given in Table 24. Conclusions on the secondary sexual dimorphism are contradictory; cf. Kryštufek (1985; no dimorphism detected) and Markov (2001b) for the opposite results. In a large sample (N = 122–129) from the Rhodope Mts. in Bulgaria, Peshev & Mitev (1979) found only the head and body length to be dimorphic (larger in males). None of the characters listed in Table 24 was dimorphic in a sample of 17 males and 18 females from Turkish Thrace.

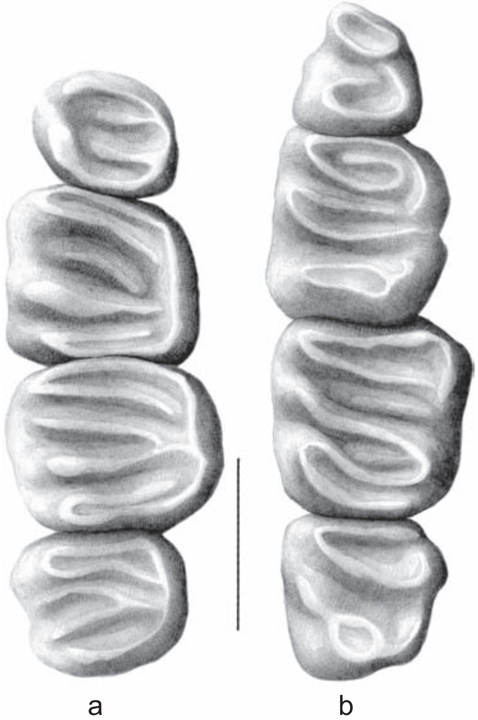


Figure 73. Upper (**a**) and lower cheek-teeth (**b**) of *Dryomys nitedula*. Based on a specimen from Çığlıkara, Antalya. Lingual side is to the right, anterior is at the top. Scale bar = 1 mm. Drawing: S. Prokešová.

CHROMOSOMES. The diploid number of chromosomes is 2N = 48 and the fundamental number of autosomal arms is NFa = 92. Autosomes are bi-armed, including five pairs of elements that are subtelocentric. The X chromosome is submetacentric or metacentric, and the Y chromosome is small acrocentric. The standard karyotype is surprisingly stable across the species range (Zima *et al*., 1995b). In Turkey, the karyotype was studied in specimens from the Trabzon area (Doğramacı & Kefelioğlu, 1990) and from Thrace in European Turkey (Civitelli *et al*., 1995).

VARIABILITY

Across its range the forest dormouse varies in colour, size and skull proportions. Cranial differences are frequently associated with the bullar region (e.g. Kryštufek, 1985; see also below). Although several authors did study the geographic variation in *D. nitedula* from Turkey (e.g. Felten *et al*., 1973; Yiğit *et al*., 2003), the problem was never comprehensively approached. The situation is particularly confusing in eastern Anatolia and further east in Iran, but also in the Caucasus. For example, Kandaurov *et al*. (1994) list no less than seven subspecies for Georgia and its vicinity.

Forest dormice in European Turkey are of moderate size (Table 24) and have buff dorsal fur. Although they differ cranially from western Balkan samples, the two are most close genetically (Filippucci *et al*., 1995). It is thus safe to presume that the Balkan Peninsula is populated by a single geographic race; the oldest name available from the region is *D. n. wingei* (Nehring, 1902) (type loc.: Parnassus region, Greece), *D. n. robustus* Miller, 1910 (type loc.: Rustchuk, Bulgaria) and *D. n. ravijojla* Paspalev, Martino and Pechev, 1952 (type loc.: Senečki Suvati, Mt. Bistra, Macedonia) being its junior synonyms. In the western Balkans, ssp. *wingei* integrates across a broad zone into *D. n. intermedius* (Nehring, 1902) (type loc.: near Lienz, Tyrol, Austria) (Kryštufek, 1985).

	Thrace			Anatolia		
	N	mean	min-max	N	mean	min-max
Head and body	36	94.5	88-105	35	92.4	80-110
Tail	48	90.2	73-110	34	89.0	78-105
Hind foot	60	20.5	18.0-23.2	43	20.9	18.0-24.0
Ear	60	13.8	11.0-15.0	41	14.4	11.0-16.0
Weight	60	28.4	17-42	26	24.1	15-35
Condylobasal length	59	24.4	23.4-25.5	40	23.8	22.0-25.8
Zygomatic breadth	54	15.6	14.2-16.6	42	15.2	13.9-16.2
Maxillary tooth-row	60	3.9	3.6-4.4	43	3.8	3.4-4.2

	Tatvan			Hakkari		
	N	mean	min-max	N	mean	min-max
Head and body	9	101.6	95-113	6	179[1]	170-182
Tail	5	101.0	90-119	6	78.6	70-85
Hind foot	9	22.0	21.0-24.0	6	20.5	19.0-21.0
Ear	9	14.9	12.0-16.0	6	17.2	16.0-18.0
Weight	7	36.7	30-41	6	29.5	28-32
Condylobasal length	9	25.1	23.8-26.5	6		25.8-27.6[2]
Zygomatic breadth	8	16.6	16.1-17.6	6	15.2	14.9-15.5
Maxillary tooth-row	9	4.3	3.8-4.8			

Table 24. External and cranial dimensions of *Dryomys nitedula* from various parts of Turkey. Pooled Anatolian sample comprises material from western and central Anatolia. Based on Felten *et al.* (1973), Mursaloğlu (1973a), Yiğit *et al.* (2003b) and specimens in BMNH, FMNH, IUBD, NMNH, SMF, TUE, and ZFMK, in addition to our own material. [1]total length (169–194 mm in D. *n. phrygius*, N = 25); [2]profile length of skull (24.3–27.8 mm in *D. n. phrygius*, N = 38).

Populations from western and central Anatolia are mainly ascribed to ssp. *phrygius* (Lehmann, 1957; Steiner & Vauk, 1966; Felten *et al.*, 1973; Kumerloeve, 1975; Kandaurov *et al.*, 1994; Kurtonur *et al.*, 1996). These dormice are reasonably uniform in size and resemble closely the Thracian sample in skull measurements (Filippucci *et al.*, 1995). The Anatolian material, however, is slightly smaller and has brighter, more yellowish-buff back fur. Genetic differences, based on electrophoresis of 43 protein loci, suggest relatively high differentiation between the western Anatolian and Thracian samples (Filippucci *et al.*, 1996). The dormice from Anatolia possibly differ from their Thracian counterparts even in the shape of baculum (cf. Fig. 70).

The geographic scope of ssp. *phrygius* is uncertain and there are contradictions among authorities regarding this question. Dormice from the eastern Mediterranean coast in Syria, Lebanon, and Israel were ascribed to this race on the basis of colour and size (Atallah, 1978; Harrison & Bates, 1991; Qumsiyeh, 1996; Shehab *et al.*, 2003). In any case, the dormice from Israel are genetically well differentiated from the European ones and possibly deserve the rank of independent species (Filippucci *et al.*, 1995).

Two samples from eastern Anatolia deserve particular attention, since both of them are distinct morphologically from what is believed to represent *D. n. phrygius*. Mursaloğlu (1973a,b) distinguished a sample from Hakkari from the remaining Turkish dormice and reported it as an independent species *D. pictus* (originally described from northern Iran). Differences are reported in several bacular parameters, including mass of the baculum. Baculum is lighter in the Hakkari sample than in what Mursaloğlu (1973b) ascribed to *D. nitedula*; the cut-off point is 2.6 milligrams. Ear is also reported to be significantly longer in the Hakkari material and 16 mm is given as the cut-off point (Fig. 74). At this point we trust Mursaloğlu (1973a), since the range she gave for *D. nitedula* in Turkey fits perfectly with our data (cf. Table 24). We saw no specimens from Hakkari.

The subspecific taxonomy of *D. nitedula* in Iran,

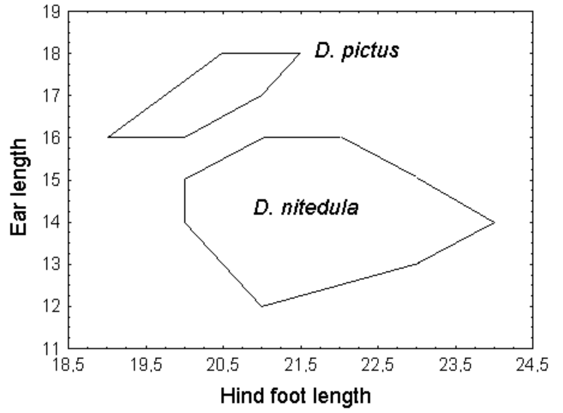


Figure 74. Projection of ear length against hind foot length in two forest dormouse (*Dryomys*) samples. Polygons enclose extreme specimens in a group. Nomenclature as in Mursaloğlu (1973a, b), thus a sample from Hakkari is designated as *D. pictus*. See text for further explanation. Redrawn from Mursaloğlu (1973b).

Afghanistan and Pakistan is chaotic, and Lay (1967) did not address this issue in his revision of the Iranian material. The type of *pictus* is in such a poor condition (see Material and Methods) that does not allow many conclusions to be drawn. We examined specimens from the area between Iran and Pakistan in the collections of BMNH, FMNH, NMNH, SMF, and ZFMK. Ear is long in the NMNH material from Pakistan (range = 18–21 mm, N = 8), short in ZFMK specimens from Afghanistan (13–15.5 mm, N = 6), and intermediate to long in Iran (15–20 mm, N = 7). Mursaloğlu (1973a) reports the Hakkari specimens as being grey. Although the Iranian material we saw is not uniform in colour, grey or dull shades are more expressed than in the Anatolian animals. And *vice versa*, we did not trace the yellowish-buff fur in regions to the east of Anatolia. Thus, we believe that Mursaloğlu (1973a,b) was right in reporting Hakkari dormice under a distinct name. However, due to confused state of the subspecific taxonomy of *D. nitedula* in this part of its range, we prefer to consider *pictus* at the level of subspecies.

Lehmann (1969) applied for a sample from Tatvan the subspecific name *D. n. tichomirowi*. We saw Lehmann's specimens and agree that the Tatvan material differs clearly from ssp. *phrygius*. The former animals are much duller, nearly deep greyish-olive, and the tail does not contrast the back in colour. Bullae are also shorter in the Tatvan animals (Table 25). We saw another two specimens from Çamlik, Rize, with similarly short bullae (26.9 and 27.7% of condylobasal length, respectively) but their colour was somewhere–between the true *phrygius* and the dark Tatvan animals. Also, their grey tail contrasted the dull buff dorsal fur. Gromov & Erbajeva (1995) placed ssp. *tichomirowi* in their Transcaucasian group of races, together with *D. n. ognevi* Heptner & Formozov, 1928 (type loc.: Akhty, River Samur, Southern Daghestan) and *D. n. kurdistanicus* Ognev & Turov, 1935 (type loc.: River Terter, Western Azerbaijan). The group is characterised by grey to grey-olive colour, but conclusions contradict among various authors. E.g. Ognev (1947) synonymised ssp. *kurdistanicus* with *D. n. caucasicus* Ognev & Turov, 1935 (type loc.: environs of Tarskaja Station, Vladikavkaz, northern Cuacasus), which Gromov & Erbajeva (1995) included in their Ciscaucasian group. Since we consider it pointless to search at this stage for the proper subspecific name for the forest dormice of eastern Turkey, we follow Lehmann (1969) in reporting them under the oldest available name from the region, i.e. *tichomirowi*. We are well aware of the fact that our designation violates the diagnoses by Russian authors. Namely, Ognev (1947) and Šidlovskij (1976) diagnosed ssp. *tichomirowi* as being buff and ssp. *ognevi* as grey-olive. Also, Rossolimo (1971) failed to base the subspecific taxonomy of *D. nitedula* on cranial characters and relied on colour instead.

Region	Zygomatic width (%)			Length of bullae (%)		
	N	mean	min-max	N	mean	min-max
Thrace	29	63.4	59.8-67.1	35	30.8	29.0-32.7
Anatolia	30	62.8	58.2-67.5	30	30.6	28.3-32.8
Tatvan	8	65.6	61.9-68.5	9	27.1	25.1-28.2

Table 25. Relative zygomatic width and relative length of bullae (ratios with condylobasal length as denominator and multiplied by 100) in three samples of *Dryomys nitedula* from Turkey. Geographic scope of Anatolian sample is same as in Table 24. Based on specimens in BMNH, FMNH, IUBD, NMNH, SMF, TUE, and ZFMK, in addition to our own material.

Key to subspecies

1 Ear at least 16 mm long
D. n. pictus

1* Ear short, at most 16 mm long
2

2 Bullae short (<28.3% of condylobasal length); dorsal fur usually deep greyish-olive
D. n. tichomirowi

2* Bullae long (>28.2% of condylobasal length); dorsal fur buff
3

3 Larger on average (cf. Table 24); back usually more reddish; basal expansion of baculum spoon-like (Fig. 70a,b)
D. n. wingei

3* Smaller on average (cf. Table 24); back usually brighter, more yellow; basal expansion of baculum triangular (Fig. 70c,d)
D. n. phrygius

Dryomys nitedula wingei

Myoxus wingei Nehring, 1902. Type loc.: Parnassus region, Greece.

Dryomys robustus Miller, 1910. Type loc.: Rustchuk (= Ruse), Bulgaria.

Dryomys nitedula ravijojla Paspalev, Martino and Pechev, 1952. Type loc.: Senečki Suvati, Mt. Bistra, Macedonia.

Description. Back mainly buff reddish, and grey tail contrasts its colour. Bullae relatively long (Table 25), body size moderately large. Basal expansion of baculum spoon-like. Cranially and externally this subspecies is weakly differentiated from ssp. *phrygius*.

Distribution. Widespread in European Turkey. Occurs also in Bulgaria, Greece, and Macedonia. Samples from Montenegro and Bosnia & Herzegovina are morphologically transitional towards ssp. *intermedius* (Kryštufek, 1985), but those from Herzegovina already show genetic makeup of true *wingei* (Filippucci *et al.*, 1995).

Dryomys nitedula phrygius

Description. Morphologically most similar to the previous race but tends towards more buff yellowish dorsal fur, and is smaller on average (Table 24). Basal expansion of baculum is triangular.

Distribution. Widespread in Anatolia, and possibly further to the south along the eastern Mediterranean coast. The eastern and southern borders are not known.

Dryomys nitedula pictus

Myoxus pictus Blanford, 1875. Type loc.: Kohrud, south of Caspian Sea, Iran.

Description**.** A small subspecies with long ears (at least 16 mm). Dimensions are summarised in Table 24. Fur on back is grey.

Distribution. In Turkey reported from the Cilo Mts. in Hakkari. The range further east is not known.

Dryomys nitedula tichomirowi

Dryomys nitedula tichomirowi Satunin, 1920. Type loc.: Tiflis (= Tbilisi), Georgia.

Description. A large form with small bullae (cf. Tables 24 & 25). Fur on back is duller, from brown to greyish-olive.

Distribution. Eastern (Van region) and north-eastern Turkey (Rize). The range in Transcaucasia and in the Caucasus unknown. Šidlovskij (1976) reports it for Transcaucasia.

Distribution

The forest dormouse is distributed over a wider range than any other Palaearctic glirid. Its European range stretches from the Swiss Alps to the river Volga, and goes as far north as Latvia and Kazan. The southern border is in Calabria and on the Peloponnesos; it is absent from the islands (Kryštufek & Vohralík, 1994). The range in Asia covers Anatolia, the Caucasus, Iran, Afghanistan, northern Pakistan, Turkmenistan, Uzbekistan, Kirghistan, southern Kazakhstan, western Mongolia, the Chinese Xinjiang, and Turkestan. In the south the species occurs in Iraq, Syria, Lebanon, and Israel (Harrison & Bates, 1991; Rossolimo *et al.*, 2001).

In Turkey, the forest dormouse is the most wide-

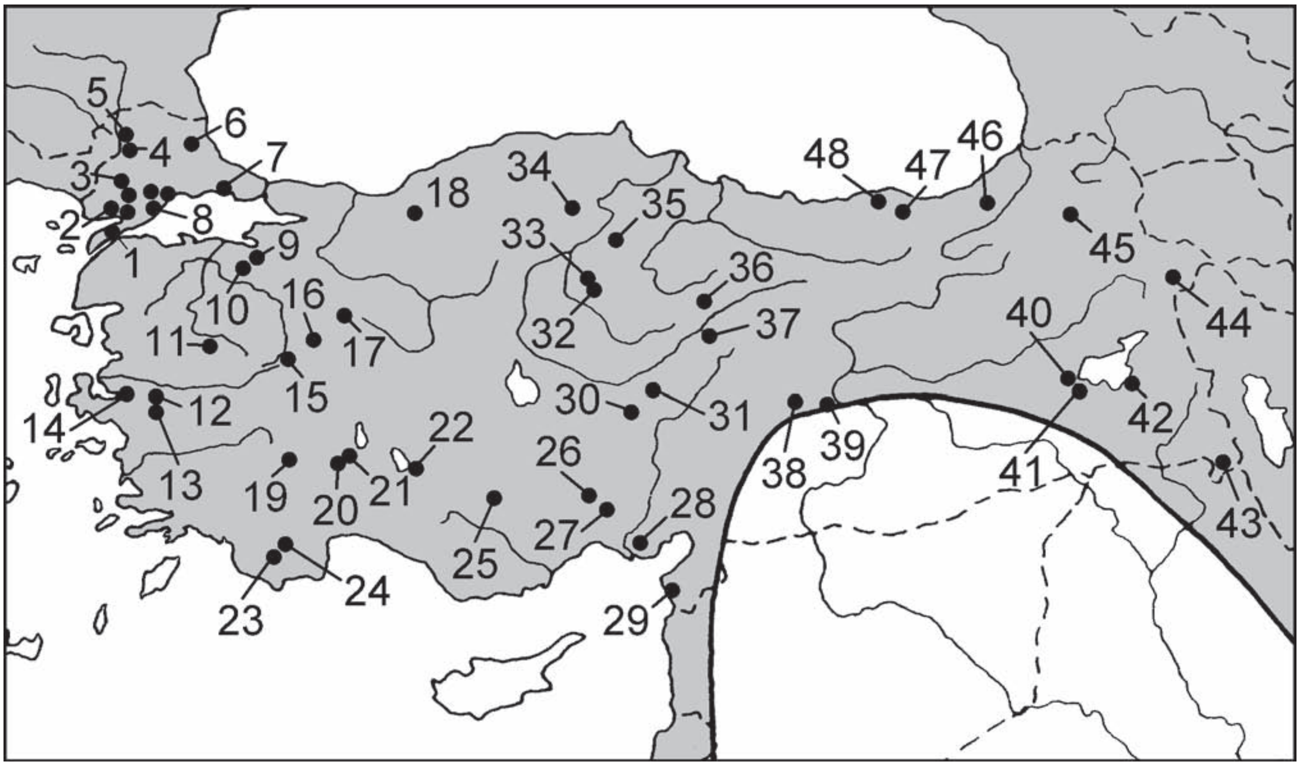


Figure 75. Distribution of *Dryomys nitedula* in Turkey. Records: **1** – Gelibolu, Çanakkale; **2** – Orhaniye, Edirne; **3** – Teofikiye, İpsala; **4** – Karakasım, Edirne, 40 m; **5** – Edirne; **6** – Velika, Kırklareli, 800 m; **7** – Selimpaşa, Silivri; **8** – İnecik, Tekirdağ; **9** – Uludağ, Bursa, 1,500m, 1,800 m; **10** – Yenikonak, Bursa, 1,025 m; **11** – Demirci, Manisa, 1,350 m; **12** – Ovacık, İzmir, 1,150 m; **13** – Bayındır, İzmir, 100 m; **14** – İzmir; **15** – Murat Dağı, Uşak, 7,500 ft; **16** – Kütahya; **17** – Gökçekısık, Eskişehir, 900 m; **18** – Abant, Bolu, 1,100 m; **19** – Çardak, Denizli, 920 m; **20** – Suludere, Çendik, Burdur; **21** – Pazarköy, 22 km southe-east of Eğidir, Isparta, 1,400 m; **22** – Beyşehir, Konya; **23** – Çığlıkara, Antalya, 1,700 m; **24** – Elmali, Antalya; **25** – Kılbasan, Karaman, 1,050 m; **26** – Ulukışla, Niğde; **27** – vicinity of Pozanti, 1,400 m; **28** – Adana region; **29** – Çevlik, near Samandağı, Hatay; **30** – Yeşilhisar, 3 km north-west of Akköy, Kayseri, 1,350 m; **31** – Kayseri; **32** – Issa-fakyr, 20 km north-west of Yozgat; **33** – Hattuşaş, Çorum; **34** – Tosya, Kastamonu, 870 m; **35** – Çorum; **36** – Yıldızeli, Sivas, 1,415 m; **37** – Gücük, Şarkişla, Sivas, 1,400; **38** – Darende, Malatya, 1,200 m; **39** – Malatya; **40** – Tatvan, 1,700 m; **41** – 6 miles south-east of Tatvan, Bitlis, 5,800 ft; **42** – 10 km south of Van, 1,700 m; **43a** – Gölsivrisi, Cilo Mts., Hakkari, 2,500-2,650 m; **43b** – Cafer Geçidi, Cilo Mts., Hakkari, 2,930 m; **44** – Ishak Paşa Sarayi, near Doğubayazit, Ağrı; **45** – 3 km west of Handere, Kars, 2,600 m; **46** – Çamlik, Rize, 1,380 m; **47** – Sümela, Trabzon, 1,100 m; **48** – Küçüdere köyü, Vakfıkebir, Trabzon. Corresponding references: Danford & Alston (1877): 32. Thomas (1907b): 15. Osborn (1964): 9, 40. Lehmann (1957): 28. Lehmann (1966): 27. Lehmann (1969): 40. Steiner & Vauk (1966): 22. Felten *et. al.* (1973): 21, 23. Mursaloğlu (1973a): 43a, b. Mursaloğlu (1973b): 39. Kurtonur (1975): 3, 7, 8. Doğramacı & Kefelioğlu (1990): 48. Obuch (2001): 29, 33, 44. Yiğit *et al*. (2003a): 6, 10-13, 17-19, 25, 34, 36, 38, 42, 47. Yiğit et al. (2003b): 1, 5, 14, 24, 26, 31, 35. FMNH: 41. Own data: 2, 4, 16, 20, 30, 37, 45, 46.

spread and common glirid species. Yiğit *et al.* (2003a) found it in fifteen out of twenty localities sampled across Turkey. *Dryomys nitedula* populates the whole of Thrace as well as the most part of Turkey in Asia, with the exception of south-eastern Anatolia (Fig. 75).

PALAEONTOLOGY. *Dryomys nitedula* first appeared in the fossil record as late as during the Middle Pleistocene. Specimens from that period are known from Poland and Romania (Kowalski, 2001), the Aegean Island of Chios (Storch, 1975), Apšeron Peninsula in Transcaucasia (Vereščagin, 1959) and from Emirkaya-2 near Seydişehir, Anatolia (Montuire *et al*., 1994).

HABITAT

Although the northern border in Europe fits quite well with the distribution of deciduous forests, the western border cannot be simply explained by climatic, topographic or vegetational factors (Kryštufek & Vohralík, 1994). In Europe, the forest dormouse populates a wide variety of habitats, but beech and /or spruce forests with rich herb layer and high moisture levels are preferred, at least in central Europe. Other habitats include mountain pine stands, stony fields far from forests, stands of aspen as well as mixed aspen and oak forests in the forest steppe zone, *Robinia* gallery forests along rivers, orchards and, exceptionally, the Mediterranean maquis (Kryštufek & Vohralík, 1994). Along the eastern Mediterranean coast, the forest dormouse inhabits evergreen forests dominated by *Quercus calliprinos* and *Pistacia palestina*, and orchards (Atallah, 1978; Harrison & Bates, 1991; Shehab *et al*., 2003). In Iran, it is known to live in gardens, orchards and among boulders with only scant, low vegetation (Lay, 1967). Šidlovskij (1976) reports deciduous forests and shrubby woodland as the main habitat type in Transcaucasia.

The forest dormouse was also found in a wide range of habitats in Turkey. In Thrace it is particularly common in dense vegetation along streams flowing through cultivated areas and lined with elm, lime, plum, mulberry and hazel trees thickly intertwined with wild vines and honeysuckles and blackberries (Kurtonur, 1975). It also occurs in orchards and vegetable gardens and in pine *(Pinus brutia)* forests (Kurtonur, 1975), but is very rare in humid beech forests in the Istranca Mts.

In the lowlands along the Aegean coast, Yiğit *et al*. (2003a) collected *D. nitedula* in a Mediterranean mosaic of cultivated areas with olive trees and shrubs (*Quercus coccifera, Pistacia lentiscus, Cistus creticus, Rhus coriaria*). In the mountains of western Anatolia, forests and woodland are the main habitat types, frequently on rocky ground and with boulders. These include forests of fir (*Abies nordmanniana*), beech (*Fagus orientalis*), or mixed stands, as well as pine (*Pinus brutia*) and oak stands. Spitzenberger (in Felten *et al*., 1973) also reports stands of birch and *Populus tremula*. Records from the western Taurus Mts. are from cedar *Cedrus libani* stands on rocky substrate (Felten *et al*., 1973). In the highlands of Central Anatolia, we mainly caught the forest dormice close to water (lakes or streams) where they were tied to bushes or to poplar and willow stands with humid undergrowth of *Gallium* sp. and *Urtica* sp. Specimens were also collected along brooks with banks sparsely grown with willows. Steiner

Figure 76. Habitat of *Dryomys nitedula*. **a** – Karakasım, Turkish Thrace, **b** – Yeşilhisar, Akköy, central Anatolia, **c** – Gücük, Şarkişla, Sivas, central Anatolia. Photo: B. Kryštufek.

& Vauk (1966) report a specimen obtained from a small woodland fragment (*Pinus, Juniperus*, *Thuia*) in a steppe landscape of central Anatolia.

Little is known about the habitat preferences of this species in north-eastern Anatolia. Our specimens were obtained on a steep slope with sparse fir trees (near Rize) and among boulders with dense herbaceous and bushy (*Rubus* sp.) vegetation above the timber line (Kars district). Around Van, specimens were collected in a stunted oak forest (Osborn, 1964) and in Hakkari among boulders on alpine pastures (Mursaloğlu, 1973a).

ALTITUDE. The vertical range in Thrace is from near the sea level (40 m a.s.l.) up to 800 m in Mt. Istranca. Anatolian records are from altitudes between 100 and 2,930 m a.s.l. This varies significantly among regions: 900–2,450 m a.s.l. in western and north-western Anatolia, 1,400–1,700 m in the Taurus Mts., 900–*c.* 1,400 m in central Anatolia, 1,100–2,600 m in the western Pontic Mts., and 1,200–2,930 m in eastern Anatolia. Records below 800 m of altitude are exceptional in Anatolia and are restricted to the Aegean coast, and possibly also to the vicinity of Adana and Hatay.

The forest dormouse also inhabits a wide altitudinal range elsewhere: 50–2,300 m a.s.l. in Europe (Kryštufek & Vohralík, 1994) and up to 3,500 m in central Asia (Rossolimo *et al*., 2001).

ASSOCIATES. Because of its broad habitat selection, the forest dormouse was collected along with various small mammal species in Turkey. Besides the field mice (*Apodemus* spp.), which are its most common associates, it shares the habitat with various shrews (*Sorex* spp., *Crocidura* spp.) and rodents (*Cricetulus migratorius, Mesocricetus brandti, Clethrionomys glareolus, Microtus rossiaemeridionalis, M. subterraneus, M. majori,* and *Mus macedonicus*). In Syria, *Rattus rattus* lives in the same habitat as the forest dormouse (Shehab *et al*. 2003).

In forests populated in Turkey by *Glis glis* and *Muscardinus avellanarius*, the forest dormouse seems to be rare. The Taurus Mts. are populated by both *Dryomys* species. Spitzenberger (in Felten *et al*., 1973) notes that *D. nitedula* is tied to forested habitats whenever sympatric with *D. laniger*.

BIOLOGY

ACTIVITY. Although the forest dormouse does live in forests and build nests above ground it is by far less arboreal than are either the hazel or the fat dormouse. It is nocturnal and a hibernator. Dormice accumulate fat before hibernation. Specimens of forest dormice were collected in Thrace from April 18 (Kurtour & Özkan, 1990) to October 31, and in Anatolia between April 18 (Pozanti) and November 2 (Burdur). In central Anatolia, juveniles of the same year thus remain active until the beginning of November, when air temperatures drop far below freezing point at night but fruits and seeds are still available at that time. In the western Balkans the activity was documented between April 1 and October 11 (Kryštufek, 1985), while *D. nitedula* is active throughout the year in Israel, with occasional short periods of lethargy (Nevo & Amir, 1964). Hibernation lasts from mid-October to the end of April in the Caucasus (Ognev, 1947) and between November and early March in Syria (Shehab *et al*., 2003).

NEST. Characteristic spherical nests (*c*. 20 cm in diameter) were not recorded so far in Turkey. South of Edirne we found a populated nest built of fresh leaves in a shallow hole in an old mulberry tree, *c*. 1.5 m high. From Moldavia, Lozan (1970) reports nests located among branches, in holes and rocky crevices. The nests were mainly found up to 3 m above ground, both in Europe (Lozan, 1970) and Israel (Nevo & Amir, 1964).

REPRODUCTION. Pregnant females were collected in Thrace between May 3 and August 24 (Kurtonur, 1982; Kurtour & Özkan, 1990), while the entire relevant evidence in Anatolia is from June. There are evidently two litters annually in Thrace and juveniles are represented in samples obtained from July 29 to October 15 (Kurtonur, 1982). Body mass of young in October varied significantly and was between 10 and 23 g (Kurtonur, 1982). Spitzenberger (in Felten *et al*., 1973) reports blind juveniles (body mass of 6.25 g) on July 9 (Cığlıkara). In the ZFMK sample from Tatvan (altitude 1,750–1,850 m) which was obtained during the 1st half of July, the presence of two generations is clear; adults weighted 30–41 g, and juveniles 14–28 g. The number of embryos in Thrace varies between 3 and 7 (mean = 4.0, N = 16; Kurtonur & Özkan, 1990). Litters in Israel range between 1 and 4 (median = 3; Nevo & Amir, 1964), but females deliver two to three litters annually there. In Thrace, the count of embryos is higher in spring and early summer (May – June: mean = 5.2, range

= 4–7, N = 5) than later one (July – August: mean = 3.5, range = 3–4, N = 11; based on data in Kurtour & Özkan, 1990).

FOOD. The forest dormouse has a relatively short intestine (Simson *et al.*, 1996a) which suggests omnivorous diet. No information on the diet is available from Turkey. From Israel, Nevo & Amir (1964) reported acorns, fruits, bird eggs, and insects. Lay (1967) found stomach content of a single specimen from Iran only to contain insects, mainly grasshoppers. Arthropods (particularly insects, incl. larvae, and millipedes) predominated in central Europe as well, but vegetable matter and fur were also found (Holišová, 1968).

PREDATION. Obuch (2001) found forest dormice in several localities across Turkey in pellets of the eagle owl *(Bubo bubo)* and the tawny owl *(Strix aluco)*, but at low frequencies (mainly <1% of preyed items). Shehab *et al.* (2003) report the barn owl *(Tyto alba)* to prey rarely on the forest dormouse in Syria.

WOOLLY DORMOUSE – *DRYOMYS LANIGER*

Dryomys laniger Felten & Storch, 1968. Type loc.: Cığlıkara, Bey Mts., Antalya, Turkey.

DESCRIPTION

EXTERNAL CHARACTERS. Resembling the forest dormouse but easily recognised by smaller size, shorter tail and lack of facial mask. Tail *c.* 75% of head and body length on average (range = 53–89%; Yiğit *et al.*, 2003b). Whiskers of approximately the same length as in the forest dormouse (*c.* 42 mm; Spitzenberger, 1976).

Figure 77. Woolly dormouse *Dryomys laniger* from Çığlıkara. Photo: B. Özkan.

COLOUR. The fur coloration is ash grey above and creamy below. Demarcation line along flanks is distinct. Hair bases slate grey throughout. Dorsal fur of adults tinged with buff, a shade which is absent in juveniles (Spitzenberger, 1976). The woolly dormouse lacks the broad facial mask typical of *D. nitedula*. Instead, eyes are encircled by a thin brownish-black ring. Tail more distinctly bicoloured than in the forest dormouse. Its upper side is grey while it is white beneath.

NIPPLES. There are four pairs of nipples, two pectoral and two abdominal (Spitzenberger, 1976).

PENIS AND BACULUM. Glans penis tapered and covered with spines on sides; its tip however, is naked. Glans 6–7 mm long and 2–3 mm wide. Baculum has an expanded base (1.5 mm) and long narrow shaft; its greatest length is *c.* 7 mm (Kıvanç *et al.*, 1997). Except its smaller size, the baculum of *D. laniger* matches perfectly the condition seen in Anatolian *D. nitedula* (Fig. 70).

SKULL closely resembles that of the forest dormouse but is more delicate. Zygomata slightly less arched in *D. laniger* (zygomatic breadth averages 61% of condylobasal length), interorbital region tends to be broader, rostrum narrower and tip of nasals more pointed. In dorsal view, the inflated mastoid region results in a wide brain-case posteriorly. Because of enlarged bullae, basiocipital and basisphaenoid regions are narrower. The large size of bullae in the woolly dormouse is also readily seen in lateral view.

TEETH. Upper incisors have yellow enamel which is nearly white on lower ones. Molars of the same shape as in *D. nitedula*. Felten *et al.* (1973) found some size differences between the two *Dryomys* species in several molars (M3, m1, m2) but Yiğit *et al.* (2003b) report widely overlapping data.

DIMENSIONS are given in Table 26. There is no secondary sex dimorphism (Felten *et al.*, 1973).

CHROMOSOMES. The diploid number of chromosomes is 2N = 46 and the fundamental number of autosomal arms is NFa = 88. All autosomes are metacentric or submetacentric. The X chromosome is large metacentric and the Y chromosome is very small metacentric (Kıvanç *et al.* &. 1997).

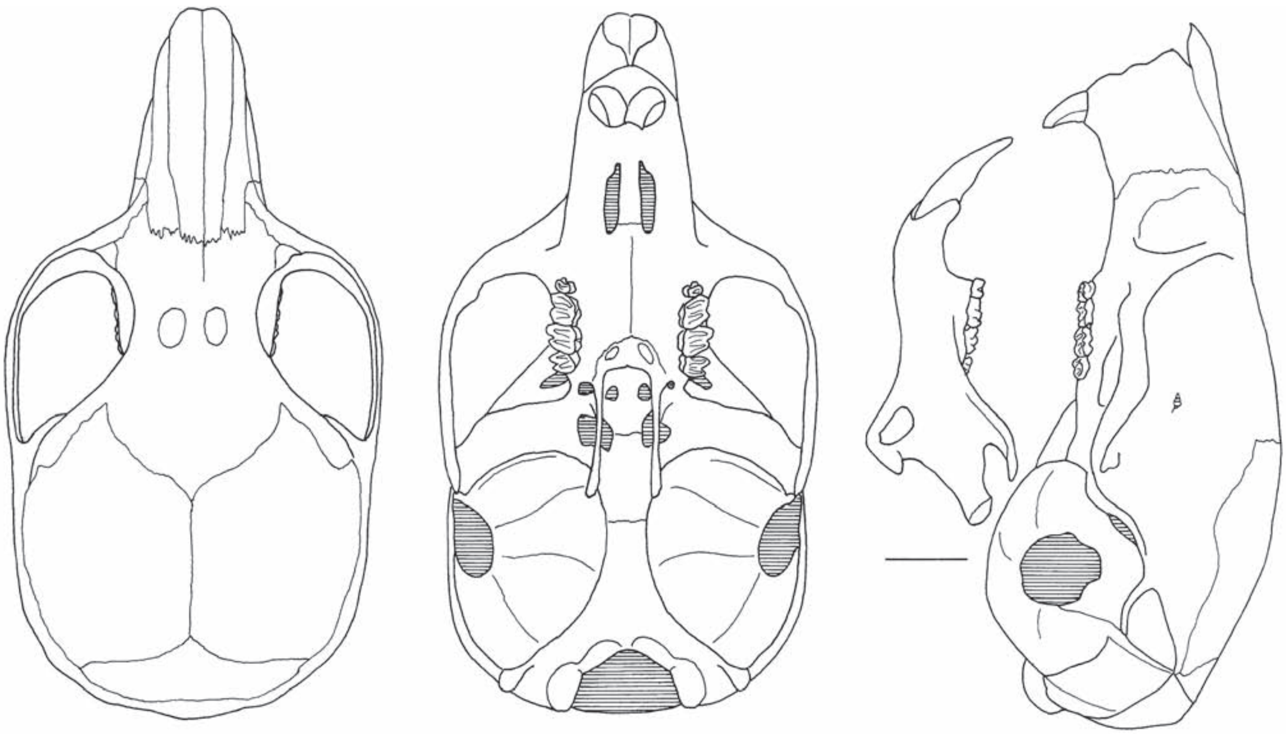


Figure 78. Skull and mandible of *Dryomys laniger*, based on an adult male from Çığlıkara, Antalya. Scale bar = 3 mm.

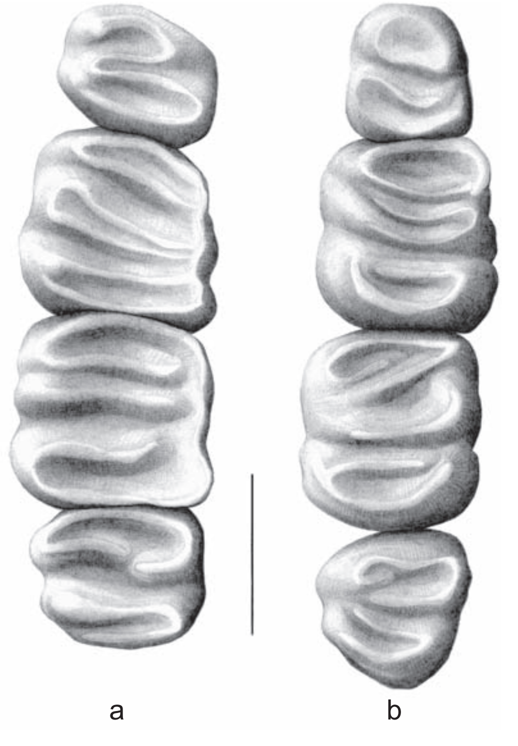


Figure 79. Upper (**a**) and lower cheek-teeth (**b**) of *Dryomys laniger* (same specimen as in Fig. 78). Lingual side is to the right, anterior is at the top. Scale bar = 1 mm. Drawing: S. Prokešová.

	N	mean	min–max
Head and body	33	90.0	83–96
Tail	29	68.8	48–76
Hind foot	31	17.4	15.1–19.0
Ear	31	14.1	11.3–17.4
Weight	32	22.3	17–32
Condylobasal length	30	23.5	22.0–26.7
Zygomatic breadth	33	14.3	13.3–15.5
Maxillary tooth-row	33	3.5	3.2–3.8

Table 26. External and cranial dimensions of *Dryomys laniger*. Based on Felten *et al.* (1973), Yiğit *et al.* (2003b) and our own material.

VARIABILITY

The woolly dormouse is a monotypic species. Spitzenberger (1976) reports character displacement in the case of sympatric occurrence with *D. nitedula*, the mandibular traits being the most affected (Felten *et al.*, 1973). This species displays lower mean value of heterozygosity (*He* = 0.017) than *D. nitedula* (*He* = 0.082; Filippucci *et al.*, 1996)

DISTRIBUTION

The woolly dormouse is endemic to Turkey and is believed to be mainly constrained in distribution to the Taurus Mts. Entirely ignored are two reports from eastern Anatolia which considerably extend the range towards north-east. Namely, Mursaloğlu (1973b) reports a collection of five specimens on Munzurdağları near Erzincan and an additional specimen from the vicinity of Elazığ. A brief note on the external appearance of specimens and comparison with *D. nitedula* in Mursaloğlu (1973b) leaves little doubt as to the proper identification of the material. Mursaloğlu's paper is entirely in Turkish, which makes the ignorance by foreign scientists understandable to some degree, but this information has not been considered by Turkish authors either (e.g. Demirsoy, 1996; Kıvanç *et al*. &. 1997). Recently, Obuch (2001) published another record of the woolly dormouse further northeast (Horasan), based on three specimens from owl pellets.

EVOLUTION. Spitzenberger (1976) suggests that *D. laniger* did not evolve *in situ*, thus its presence and that of *D. nitedula* in the Taurus Mts. was considered to be only secondary. In her opinion the divergence between the two recent species dates back to the Lower Oligocene when south-western Anatolia was isolated as an island, which situation triggered speciation in allopatry. The Taurus Mts. emerged only during the Pliocene. No fossil evidence is available in support of this hypothesis. Besides, the hypothesis was formulated at the time when *D. laniger* was believed to be endemic to the Taurus Mts.

PALAEONTOLOGY. Fossils are not known. Hír (1992) reports subfossil material from the Bolkar Dağ to the west of Pozanti. This record is within the recent range.

HABITAT

This is a rock dwelling species, heavily depending

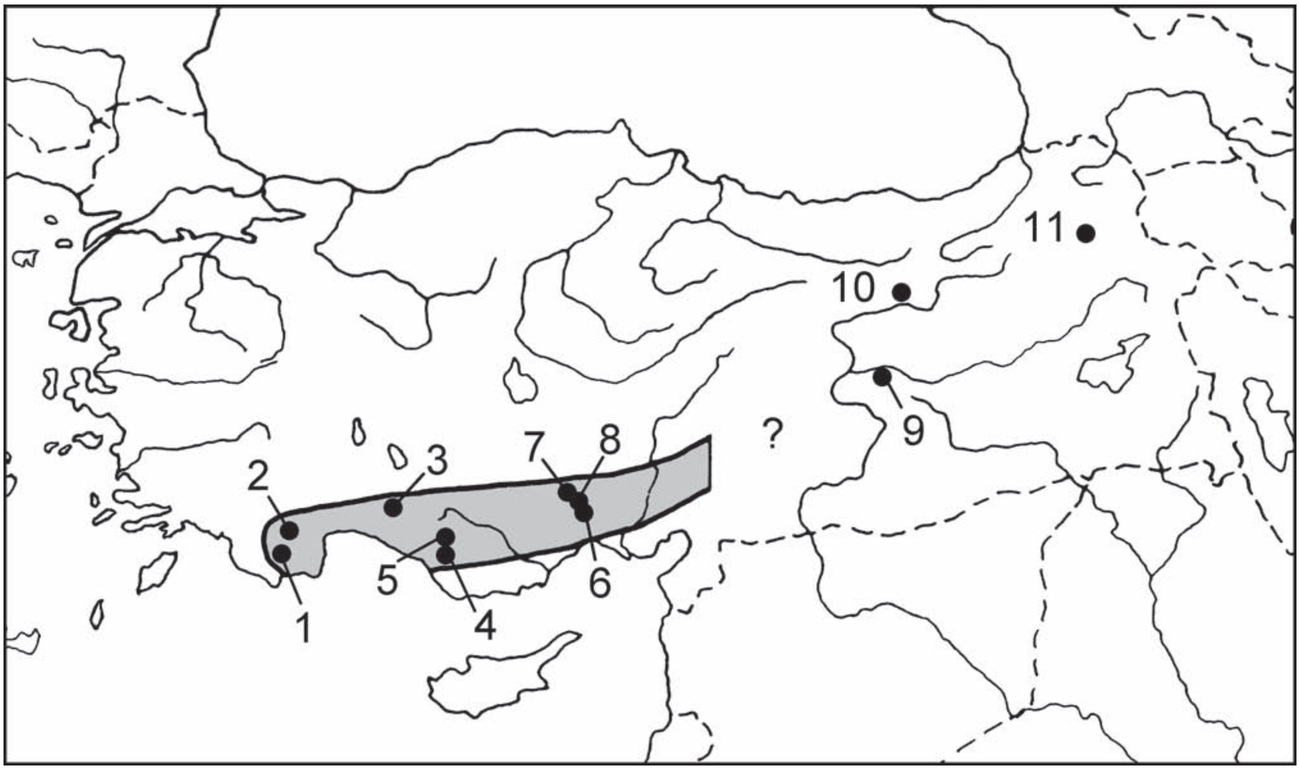


Figure 80. Distribution of *Dryomys laniger*. Records: **1** – Çığlıkara, Bey Mts. (*c*. 20 km south-south-east of Elmalı), Anatalya, 2,000 m; **2** – Elmalı, Antalya; **3** – Akseki, Salamut Plateau, Antalya; **4** – 39 km north-east of Demirtaş, Antalya; **5** – 25 km south of Hadim, Konya; **6a** – mountains south of Madenköy, 20 km east-south-east of Ulukışla, Niğde; **6b** – Madenköy, Bolkar Mts., Niğde; **7** – Ulukışla, Niğde; **8** – between Meydantöl and Kara Göl, near Madenköy, Niğde (subfossil); **9** – vicinity of Elazığ; **10** - Munzurdağları near Erzincan; **11** – Horasan, Erzurum. Corresponding references: Felten & Storch (1968): 1. Felten *et al*. (1973): 4, 5, 6a. Mursaloğlu (1973b): 9, 10. Hír (1992): 8. Kıvanç *et al*. (1997): 3, 6b. Obuch (2001): 11. Yiğit *et al*. (2003b): 2, 7.

on a rocky substrate with fissures and crevices. In the opinion by Spitzenberger (1976), the woolly dormouse is better adapted to a petricolic mode of life than any other western Palaearctic mammal. Adaptations involve grey colour, flat skull with pointed rostral portion, small and slim body, woolly fur and a peculiar structure of pads and palms. Large palmar pads are arranged in a circle and act as suckle when pressed against the rocky wall. Also, the digital pads are much enlarged. Lower surface of fingers and toes is ridged, similarly as in geckos (Spitzenberger & Eberl-Rothe (1974).

The woolly dormouse habitat includes crevices in corroded limestone bedrock, stone fields, small caverns and fissures below rocky outcrops and boulders (Fig. 81). Bushy vegetation is mainly scarce or entirely absent in such places. Most of the localities are above the timber line. Similar habitat requirements are also shown by the two snow voles, *Chionomys nivalis* and *C. gud*.

ALTITUDE. Vertical records range between 1,620 and 2,000 m a.s.l. (Spitzenberger, 1976).

Figure 81. Habitat of *Dryomys laniger* in Çığlıkara. Photo: A. Kryštufek.

ASSOCIATES. Other small mammals occurring in the same habitat as *D. laniger* are *Crocidura* sp., *Cricetulus migratorius*, *Chionomys nivalis*, *Apodemus* cf. *iconicus*, and *A. mystacinus* (Felten *et al*., 1971a).

Dryomys laniger is sympatric with *D. nitedula* only in Çığlıkara (Felten *et al*., 1973; Spitzenberger, 1976). While the former inhabits treeless rocky landscape, the latter is tied to rich undergrowth in forests and in clearings (Spitzenberger, 1976).

DENSITY. Population densities of small mammals are generally low in rocky karstic habitats in the Taurus Mts. (mainly <10% of trap nights), consequently the woolly dormouse was trapped in less than *c*. 2.5% of trap nights. Nevertheless, this little dormouse is occasionally the dominant small mammal species in its habitats (Spitzenberger, 1976).

BIOLOGY

The biology of *D. laniger* has not received much attention so far and what little is known has been summarised by Spitzenberger (1976).

ACTIVITY. The woolly dormouse is an agile climber over rocks (Spitzenberger, 1976) and has relatively the largest brain-case capacity among dormice of the region (Simson *et al*., 1996a). Hibernation period is not known, however, in Çığlıkara we failed to collect this species in late October.

REPRODUCTION. Gravid females were only found in June and the first juveniles were trapped in the 1st decade of August. Males with swollen testes were present in mid-June but testes regressed by mid-August. There is evidently a single litter per year. The number of embryos varies between 3 and 5 (mean = 4.0, N = 5; Spitzenberger, 1976).

FOOD. This dormouse is omnivorous with a strong tendency towards insectivorous diet. Of the nineteen stomach examined by Spitzenberger (1976), thirteen contained arthropods only (mainly beetles and grasshoppers). Berries of *Daphne oleoides* were also found in the remaining samples.

GENUS: *ELIOMYS* WAGNER, 1840

Eliomys is closely related to *Dryomys* but differs in more primitive character states of dentition which include more convex crowns with higher main cusps and less reduced the upper premolar and 3rd molar. Two species are currently recognised (Holden, 1993b; Rossolimo *et al*., 2001) but there are disagreements as to their scope (cf. Filippucci *et al*., 1988a; and Kryštufek & Kraft, 1997). It is generally accepted, however, that all Asiatic populations belong to *E. melanurus*.

From western and central Anatolia, Demirsoy (1996) also reports the European garden dormouse *Eliomys quercinus* (Linnaeus, 1766) which identification, however, is most likely incorrect (Kryštufek & Vohralík, 2001).

ASIAN GARDEN DORMOUSE – *ELIOMYS MELANURUS*

Eliomys (Myoxus) melanurus Wagner, 1839. Type loc. Sinai. Restricted to the vicinity of Mt. Sinai by Nader *et al*. (1983).

DESCRIPTION

A long-eared dormouse of medium size. General form slender and tail slightly shorter than head and body (62–103%). Head rather large and muzzle bluntly conical. Ears large, approximately of same length as hind foot. Front foot with four fingers and five tubercles. Hind foot has five digits and six pads; palms and soles are naked. Whiskers up to 50 mm long and black. Fur soft but longer than in other Turkish dormice (on upper side up to 15 mm). Hairs on tail base sparse and short (less than 5 mm); posteriorly they gradually grow denser and longer to form a distinct tuft with terminal hairs up to 20 mm long.

COLOUR. Upper parts pale grey with brown tinged back, middle of neck, forehead and muzzle. Belly, chests, chin and cheeks white and demarcation along flanks distinct. Hair bases slate throughout. Face has conspicuous black spectacles which start at roots of whiskers, surround the eye and extend beneath and slightly behind the ears. There is a small tuft of white hair at the anterior margin of each pinna. Short hairs on the proximal tail white, grey or black, and then darken sharply into a black tuft which extends over distal half to two thirds of tail. The distal black part more extesive in males than in females (Nader *et al*., 1983). Ear grey (darker dorsally) and feet white.

NIPPLES. There are four pairs of nipples.

PENIS AND BACULUM. In Israeli specimens, the glans penis is narrow (8.6 mm long and 3.3 mm wide)

Figure 82. Asian garden dormouse *Eliomys melanurus*. Drawing: J. Hošek.

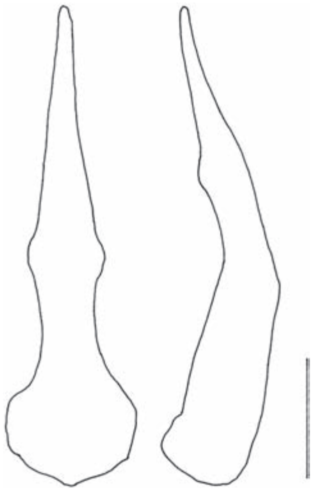


Figure 83. Baculum of *Eliomys melanurus* in dorsal and lateral view. Based on an adult from Tadmor, Syria (NM 90,204). Scale bar = 2 mm.

with a long protrusion, which is longer in *E. melanurus* than in *E. quercinus* (Simson *et al*., 1995). Baculum (length 7.52 mm) has a narrow base (1.87 mm; Simson *et al*., 1995) and two lateral expansions with a concavity in between. Narrow apex extends over the terminal one third of the baculum. A single specimen from Syria, examined by us, was 8.29 mm long and 2.27 mm broad across the basal expansions. In comparison with the drawing by Simson *et al*. (Fig. 4 on p. 238), it was slimmer in its medial part and shallower in lateral view (Fig. 83).

SKULL deep, with expanded zygomata (zygomatic width = 58–64% of condylobasal length). Brain-case squarish in dorsal view; broadest posteriorly due to the much expanded mastoid portion. Rostrum long and gradually tapers towards apex. Insicive foramens short and broad. Pterygoid processes long with fairly narrow space between. Because of much enlarged bullae (approximately one third of condylobasal length), the basioccipital is constricted and thus narrower than interpterygoid space. Mandible slender with long coronoid process and perforated angular portion.

TEETH. The anterior surface of incisors yellow, paler below than above. Cheek-teeth rows wider apart anteriorly than posteriorly. Crowns deeply concave with prominent cusps along outer border. Upper molars sub-equal; 3rd molar the smallest and 2nd one the largest. In the mandibular row, 3rd molar relatively smaller and the remaining two sub-equal. Both premolars, upper and lower, not much reduced in size. Molars have four complete transverse ridges;

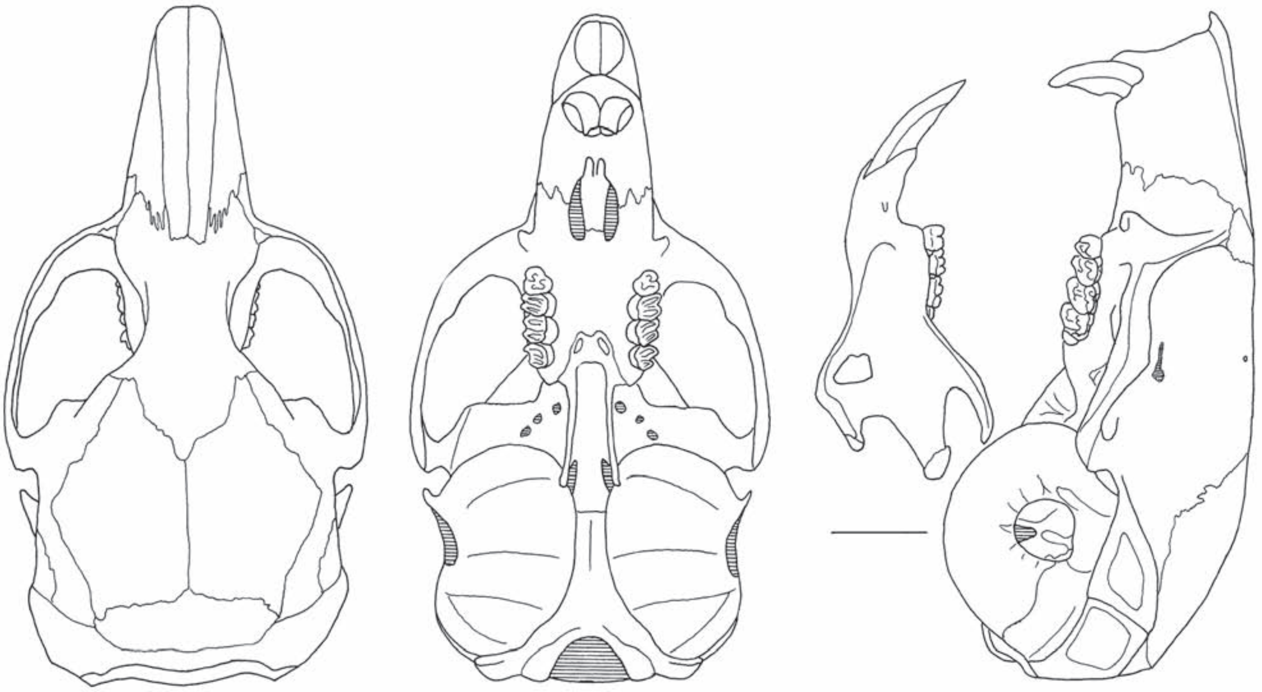


Figure 84. Skull and mandible of *Eliomys melanurus*, based on an adult female from Tadmor, Syria (NM 90,205). Scale bar = 5 mm.

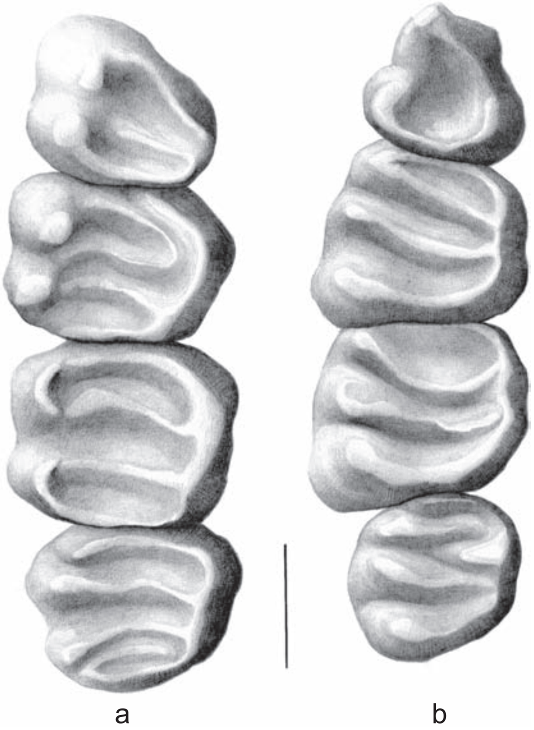


Figure 85. Upper (**a**) and lower cheek-teeth (**b**) of *Eliomys melanurus* (same specimen as in Fig. 84). Lingual side is to the right, anterior is at the top. Scale bar = 1 mm. Drawing: S. Prokešová.

the anterior one on the lower molars is frequently interrupted. There are incomplete ridges in-between.

Dimensions are given in Table 27. Males and females are subequal in dimensions (Osborn & Helmy, 1980).

Chromosomes. The diploid number of chromosomes in the Negev population is 2N = 48 and the fundamental number of chromosomal arms is NFa = 86. With the exception of three pairs, all the autosomes are bi-armed (Filippucci *et al.*, 1988b).

Variability

Garden dormice are highly variable morphologically (Kryštufek & Kraft, 1997), chromosomally (Zima *et al.*, 1995b) and genetically (Filippucci *et al.*, 1988a). In the Near East, their colour varies from pale brownish-grey to darker grey-brown (Nader *et al.*, 1983). Facial mask tends to be less dark and extensive in specimens from more arid environments.

No subspecies were recognised in the Asiatic part of the range.

Distribution

The range is mainly contiguous along the Eastern Mediterranean coast from Lebanon to Sinai, although the populations are highly localised (Atallah, 1978) and the actual distributional pattern is most likely disjunct (Nader *et al.*, 1983). Clear isolates are in northern Egypt and the adjacent Cyrenaica, in Saudi Arabia (as far south as the vicinity of Abha; Nader *et al.*, 1983), in Iraq (Nadachowski *et al.*, 1978), and in south-eastern Anatolia.

The Asian garden dormouse is included in the list of Turkish mammals on the basis of a report on this dormouse sighted at Harran (south of Urfa) in spring 1955 (Misonne, 1957). No further records have been published ever since. The Department of Zoology, National Museum in Prague keeps a stuffed specimen and its extracted skull (NM 55,183), which was acquired in 1999 from the Municipal Arboretum

	Eastern Mediterranean			Turkey (?)
	N	Mean	min-max	NM 55183
Head and body	31	124.4	105-140	
Tail	27	103.6	81-125	
Hind foot	31	25.4	22.2-27.0	
Ear	31	27.2	20.0-30.0	
Weigth	14	54.0	47-67	
Condylobasal length	29	32.4	30.4-35.0	29.9
Zygomatic breadth	30	19.7	18.4-21.8	±19
Maxillary tooth-row	30	5.4	4.9-6.0	5.0

Table 27. External and cranial dimensions of *Eliomys melanurus* from the eastern Mediterranean coast (Syria, Lebanon and Israel). Specimen of doubtful Turkish origin is given in the right hand column. Based on Kahmann (1981), Nader *et al.* (1983) and NM specimen. Note: the geographic origin of a subadult male from Turkey is uncertain.

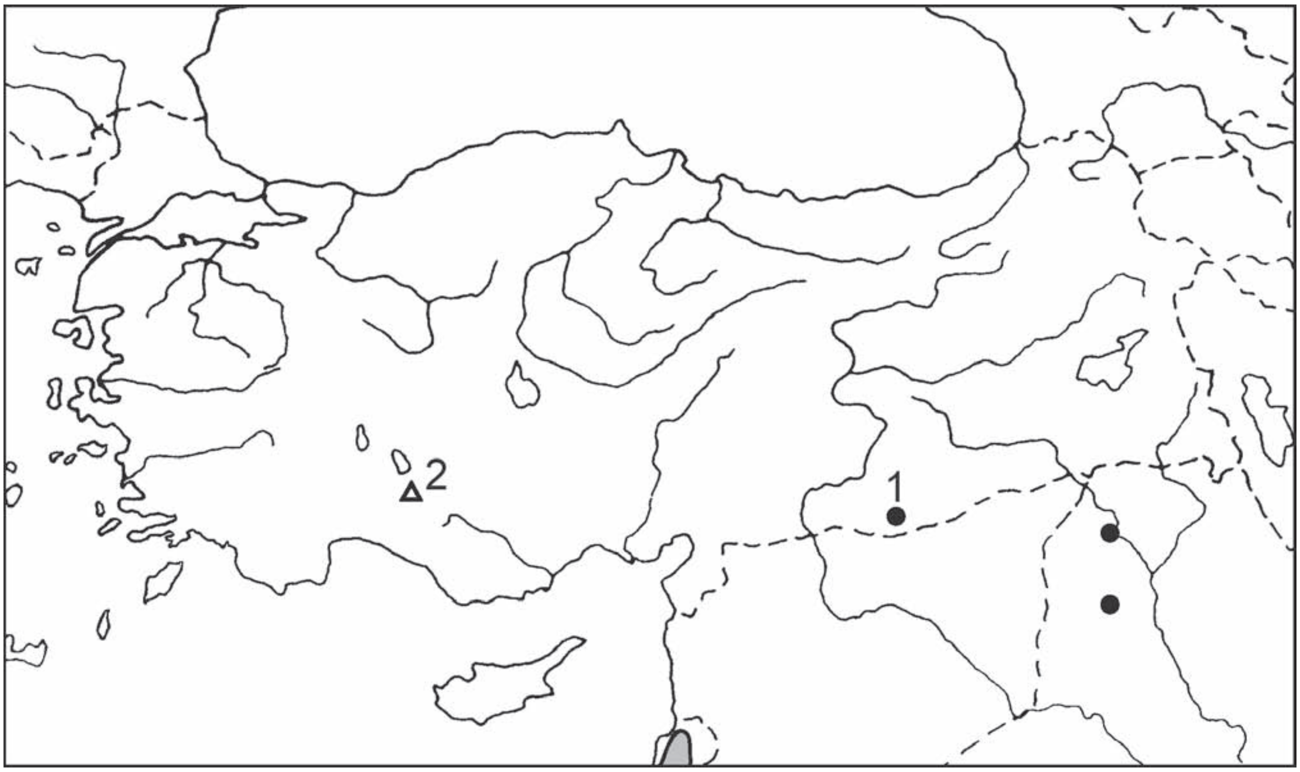


Figure 86. Past and present distribution of *Eliomys melanurus* in Turkey. Recent extralimital range is from Nader *et al.* (1983). Recent record: **1** – Harran; Middle Pleistocene record (triangle): **2** – Emirkaya-2, Seydişehir. Corresponding references: Misonne (1957): 1. Montuire *et al.* (1994): 2.

of Opava, and presumably originated from Turkey. The Arboretum maintained a small display of animals, and their dormice are said to originate from two captive stocks obtained from the Zoological Garden Frankfurt, and from a private pet keeper in Vienna. Apparently, the Viennese stock was also obtained from Germany, but the keeper, who was unfamiliar with their exact origin, assumed that the animals had possibly been collected in Syria (P. Praschag, personal comm.). Dr. R. Dmoch (in litt.), Curator of Mammals at the Zoo Frankfurt, was also unable to trace precisely the origin of their stock, obtained in 1982. In any case, these animals were, at least partly, from a private colony as well and all the owner could memorise was that they were obtained from another private breeder. Besides, in 1981 the Zoo Frankfurt obtained several Israeli rodents (*Sekeetamys*, *Acomys*, *Eliomys*) from Mendelsson's captive stock; one of *E. melanurus* specimens was acquired by SMF in 1986 (D. Kock, pers. comm.). We thus consider the origin of the NM specimen as unknown.

Figure 87. Stuffed specimens of *Eliomys melanurus*, labelled as originating from Turkey (NM 55,183). See text for more information. Photo: A. Kryštufek.

Palaeontology. *Eliomys* first appeared in the Middle Miocene of western Europe where it underwent a rapid adaptive radiation since the Upper Miocene (Daams & Bruijn, 1995; Nadachowski & Daoud, 1995). During the Early Pliocene, *Eliomys* was of short presence in north Africa as well (Rossolimo *et al*., 2001). Montuire *et al*. (1994) report the Middle Pleistocene record of *E. melanurus* from Emirkaya-2 in southern Anatolia, which is outside the current species' range (Fig. 86). In Israel, the genus *Eliomys* was evidently absent until the Upper Palaeolithic and the Natufian-Neolithic when, however, it was represented by two forms, both of which are distinct from *E. melanurus* (Tchernov, 1968). Thus, *Eliomys melanurus* has only recently appeared in Israel (Tchernov, 1975).

HABITAT

Many authors (e.g. Harrison & Bates, 1991; Qumsiyeh, 1996; Amr, 2000) claim that the Asian garden dormouse is originally and arboreal animal. It seems more likely to us that the species is adapted to a wide range of habitats (Nader *et al*., 1983), much like its European counterpart, *Eliomys quercinus*. Rocky boulders and outcrops are evidently an essential component of its habitat (Atallah, 1978) and the animal is also capable of surviving in a treeless landscape (Harrison & Bates, 1991). Specimens were collected in the Near East in a black lava rocky habitat (Amr, 2000), from crevices in sandstone outcrops (Harrison & Bates, 1991), and in limestone cliffs (Osborn & Helmy, 1980). Reports are also from a loose sand habitat (Osborn & Helmy, 1980), from gardens and along stone walls in oases (Syrian specimens in BMNH and our own observations), and among boulders with a light scrub acacia forest (Nader *et al*., 1983). *Eliomys melanurus* also enters Bedouin tents and huts (Osborn & Helmy, 1980; Harrison & Bates, 1991). Misonne (1957) sighted a specimen among the Babylonian ruins of Harran.

Figure 88. Town of Harran where Misonne (1957) sighted *Eliomys melanurus* specimen. Photo: B. Kryštufek.

ALTITUDE. Vertical records range from a low desert up to 2,450 m a.s.l. (Atallah, 1978) and Israeli localities are between 600 and 2,100 m a.s.l. (based on data in Kahmann, 1981). At high elevations the Asian garden dormouse inhabits the alpine belt.

BIOLOGY

ACTIVITY. The Asian garden dormouse in the Negev Highlands is active throughout the year in spite of low winter temperatures which are frequently close to 0° C (Haim & Rubal, 1995). Museum specimens, reported by Kahmann (1981), were collected between February 25 and December 5. Peak of activity in Negev is from the beginning of March until the beginning of June. The dormice are capable of entering torpor even at high ambient temperatures, which allows them to save up to 65% of the average daily energy expenditure of a normothermic individual. Even the resting metabolic rate of active dormice is only 40% of that expected from their body mass according to allometric equations (Haim & Rubal, 1995).

REPRODUCTION is little known and data are also contradictory. Sexually active females were collected in January, April and May, males with swollen testes in January and at the end of April, and immatures from May to July (compiled from various sources). Mean litter size in captivity is 2.8 (Kahmann, 1986); Kingdon (1990) gives a range between 2 and 9. Body mass of captive immatures, which is 15 g at the age of 30 days, reaches 42 g at the age of 90 days and stabilises at 65 g in 200 days old dormice (Kahmann, 1981).

FOOD. Authors agree that stomach contents they examined contained more animal than vegetable matter (e.g. Atallah, 1978; Nader *et al*., 1983), viz., insects, snails, centipedes and vertebrate remnants (mammals and a gecko).

PREDATION. In Syria, the Asian garden dormouse was found at low frequencies of occurrence in the pellets of three owls: *Tyto alba*, *Asio otus* (Obuch, 2001) and *Athene noctua* (Shehab *et al*. 2004).

GENUS: *MYOMIMUS* OGNEV, 1924

Mouse-tailed dormice are the only European glirids which lack a bushy tail and thus resemble murids in external appearance. They are small to medium in size. The infraorbital foramen is much compressed and bullae are large. The incisive foramina are long. Cheek-teeth have concave crowns and a simple occlusal pattern.

Myomimus was created by Ognev (1924) for a single specimen collected in 1923 close to the Turkmenistan-Iran border near the Caspian Sea. Shortly after the discovery by Ognev (1924), Bate (1937a) established a new dormouse species and genus, *Philistomys roachi*, on the basis of fossil material from strata associated with the Palaeolithic industries (Acheulean and Levalloiso-Mousterian) in the Tabun Cave on Mt. Carmel, Israel. However, it was not until the 1960s when Corbet & Morris (1967) demonstrated that *Myomimus* and *Philistomys* were congeneric. The generic name *Myomimus* holds priority over *Philistomys*.

Myomimus (frequently reported as *Philistomys* in the past) appeared to be common in the fossil material which has lead to a description of six new species, all extinct. The range of the fossil taxa extends from Spain in the west to Pakistan and Inner Mongolia in the east (Daams & Bruijn, 1995). Recent material, however, accumulated very slowly and in the 1970s the genus was still believed to have a single surviving species, *M. personatus* Ognev, 1924 (e.g. Corbet, 1978). Three species are recognised currently, all of them with extremely small ranges in south-western Asia (Rossolimo *et al.*, 2001). Two species occur in Turkey.

KEY TO SPECIES

1 Size large: head and body >85 mm, condylobasal length >22 mm, maxillary tooth-row >3.5 mm; upper fur grey
M. roachi

1* Size small: head and body <85 mm, condylobasal length <22 mm, maxillary tooth-row <3.5 mm; upper fur yellow-brown
M. setzeri

Figure 89. Roach's mouse-tailed dormouse *Myomimus roachi*. Drawing: J. Hošek.

ROACH'S MOUSE-TAILED DORMOUSE – *MYOMIMUS* ROACHI

Philistomys roachi Bate, 1937. Type loc.: Tabun Cave, Mt. Carmel, Israel (Late Pleistocene).

TAXONOMY

Myomimus roachi was recognised as a living species as late as 1959, first in Bulgaria, but was reported under the name *M. personatus* (Peshev *et al*., 1960a). Subsequent authors continued to use Ognev's name until the late 1970s (Heptner, 1960; Angermann, 1966; Corbet & Morris, 1967; Mursaloğlu, 1973a; Kurtonur, 1975; Corbet, 1978). Rossolimo (1976a) separated the Bulgarian population from *M. personatus* and described it as a new species, *M. bulgaricus* (type loc.: Svilengrad, south-eastern Bulgaria). Almost simultaneously, Storch (1975) applied the species name *roachi* for the eastern Mediterranean mouse-tailed dormice, both the Middle Pleistocene and the recent ones. Consequently, *M. bulgaricus* is a junior synonym of *M. roachi*, which is now widely accepted (Corbet, 1984; Storch, 1978d; Holden, 1993b; Rossolimo *et al*., 2001). Daams & Bruijn (1995) erroneously synonymised *M. bulgaricus* with *M. personatus*.

It is noteworthy, however, that the first specimen of the recent Roach's mouse-tailed dormouse was collected near Mesembri (= Nesebăr, Black Sea Coast in Bulgaria) already on July 14, 1935, i.e. two years before Bate's discovery in Israel (Bate, 1937a). However, this animal was misidentified as *Eliomys quercinus* (Heinrich, 1936) and recognised as a member of *Myomimus* three decades later (Angermann, 1966).

DESCRIPTION

EXTERNAL CHARACTERS. A stocky dormouse with a fairly short (78% of head and body on average) and virtually naked tail. Head relatively large, ears short as are also whiskers (*c*. 27 mm). Feet broad and fairly short. Thumb reduced and there are five fingers on hind feet. Number of pads is five on front feet and six on hind ones. Palms and plants are naked. Fur more shaggy than in other Turkish dormice and hairs are short (*c*. 7–8 mm dorsally). Tail broad at base, then tapers gradually toward tip. Terminal pencil minute (< 2 mm long).

Figure 90. Adult Roach's mouse-tailed dormouse *Myomimus roachi* from Turkish Thrace. Photo: B. Özkan.

COLOUR. Fur on back mouse grey in juveniles, with distinct blackish mid-dorsal clouding. Region between ears also nearly black, but snout buff tinged. Belly grey but paler than back and demarcation line along flanks faint. Hairs on chin and cheeks pure white throughout. Feet pale, nearly white. Sparsely haired tail white-grey with distinct grey mid-dorsal stripe. Subadults get brownish tinged fur but gradually loose buff shaded muzzle and white hairs on chin and cheeks. Demarcation line quite distinct in some specimens. Adults dull ochraceous-buff above with blackish hairs between ears and along spine, spreading as far back as tail base. Belly cream-grey but ventral hairs lack slate bases which are typical on dorsal side. Chin yellowish-cream. Hind feet turn slightly darker in comparison with subadults. Ears grey and nearly blackish at tip.

NIPPLES. The number of nipples is the highest in the family Gliridae: 2 pairs of pectoral, 3 pairs of abdominal and 2 pairs of inguinal = 14 (Buruldağ & Kurtonur, 2001). Pechev *et al*. (1964) report a female with a single posterior pectoral nipple, thus having 13 nipples altogether.

PENIS AND BACULUM. Glands penis short (6.3 mm), club-shaped and expanded anteriorly (2.0 mm wide). Most of the surface covered with spines. Baculum small, with two basal protuberances, a shallow dorsal longitudinal groove and a delicate shaft. It is 4.48 mm long and 1.46 mm wide (Simson *et al*., 1995).

SKULL relatively narrow in full-grown adults; zygomatic breadth equals 58.2% of condylobasal length (range = 56.0–61.2%, N = 16). Zygomata robust in comparison with *Dryomys* and nearly parallel; rostrum less deep. Nasals long with blunt apex.

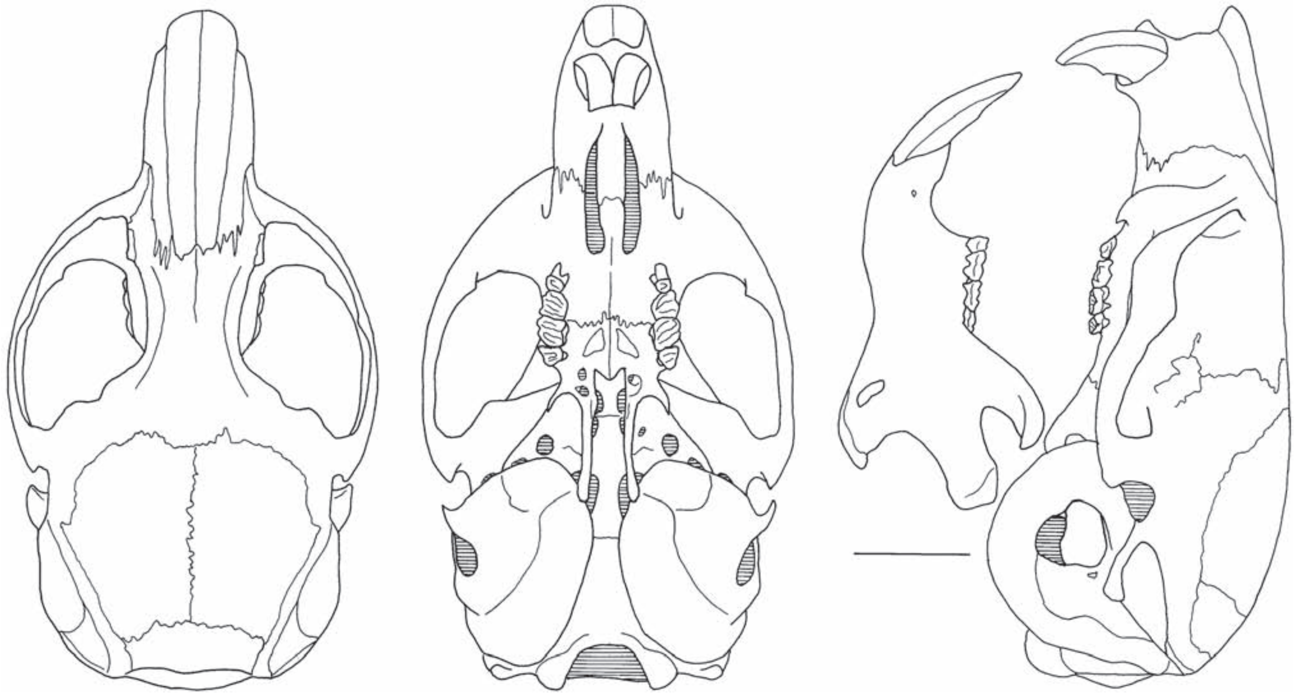


Figure 91. Skull and mandible of *Myomimus roachi*, based on an adult female from Karakasım, Edirne. Scale bar = 5 mm.

Interorbital region approximately as wide as rostrum and hardly ridged at all. Braincase squarish. Bullae inflated and large (approximately one third of condylobasal length). Pterygoid processes long and interpterygoid space narrow. Incisive foramina long (longer than palatine posterior to them), slightly oval in shape but with nearly parallel side margins. Mandible heavy with robust processes; its angular portion perforated.

TEETH. Enamel on incisors yellow, but frequently paler (whitish-yellow) on lower ones. Cheek-teeth row comparatively short and diverges posteriorly. Crowns low with concave occlusal surface. Molars nearly squarish in outline and have four main transverse ridges. Incomplete ridges in-between weak and short. 2nd molar more robust than first one. Premolars are the smallest cheek-teeth, followed by 3rd molars; these differences are more obvious in the mandibular row. Upper cheek-teeth and lower molars have three roots each (P4 is occasionally two-rooted), while the lower premolar is single-rooted (Fig. 93). For detailed description of molar and crown pattern see Kurtonur & Özkan (1992).

DIMENSIONS are given in Table 28. Males and females are subequal in external dimensions. Dental dimensions are given in Kurtonur & Özkan (1992).

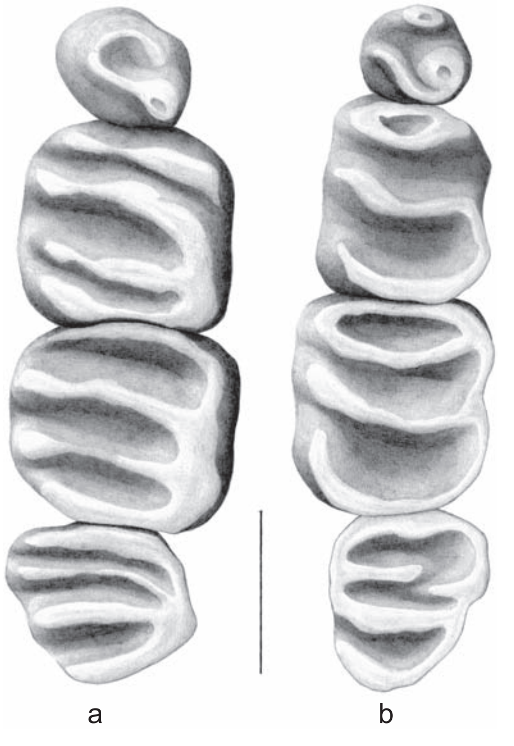


Figure 92. Upper (**a**) and lower cheek-teeth (**b**) of *Myomimus roachi* (same specimen as in Fig. 91). Lingual side is to the right, anterior is at the top. Scale bar = 1 mm. Drawing: S. Prokešová.

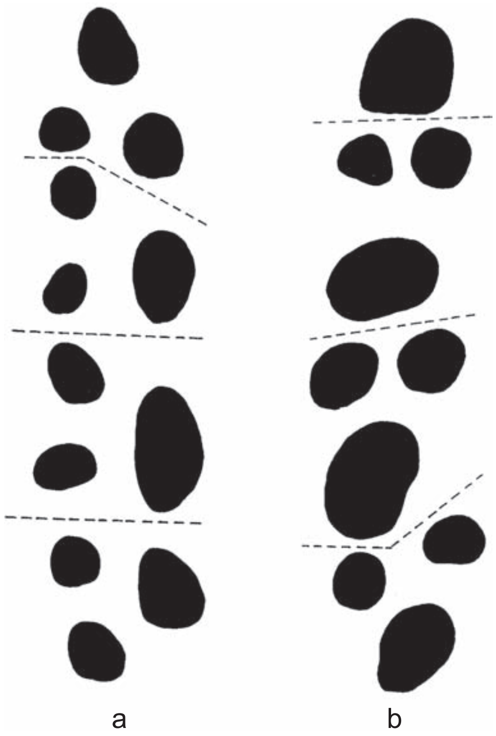


Figure 93. Alveolar pattern in *Myomimus roachi*. Based on specimens from Tabun Cave, Israel (**a**; Upper Pleistocene material; upper row) and near Finike, Antalya (**b**; subfossil; lower row). Source of material: BMNH. Lingual is to the right and anterior is at the top. Not to scale.

CHROMOSOMES. The diploid number of chromosomes is 2N = 44 and the fundamental number of chromosomal arms is NFa = 84. All chromosomes are bi-armed, of decreasing size. The X chromosome is a medium-sized metacentric, while the Y chromosome is the smallest one (Civitelli *et al*., 1995).

VARIABILITY

Myomimus roachi is a monotypic species and there is no evidence of differentiation between populations. Measurements of the only adult specimen available from the west coast of Anatolia approach the upper limits for the Thracian series. Pešev & Spasov (1985) used a subspecific name *M. r. bulgaricus*, but reasons for this are not clear.

Kryštufek *et al*. (2004) describe an abnormal skull.

DISTRIBUTION

The range of Roach's mouse-tailed dormouse is one of the smallest among rodents in the western Palaearctic. The bulk of the area is apparently in Thrace, where the species is known from Turkey and Bulgaria, but almost certainly it also occurs in eastern Greece. The northern-most record is from the vicinity of Nesebâr on the Black Sea coast in Bulgaria and the southern ones are from the Mediterranean coasts in Turkish Thrace. In European Turkey the records cluster along the southern coast and in the lowlands of the Meriç River catchment area. Surprisingly, no specimens were collected to the east of Tekirdağ.

All records in western Anatolia are from the Aegean coast and range between Çanakkale in the north to Lake Bafa in the south (Fig. 94).

PALAEONTOLOGY. *Myomimus roachi*, or a closely related form, was much more widespread in the eastern Mediterranean during the Pleistocene. Its presence is continuous in Israel since the Early Middle Pleistocene (Tchernov, 1968, 1975) and it was common on the eastern Aegean islands since the Early Rus-

	Thrace			W Anatolia
	N	mean	min-max	
Head and body	25	106.9	86-136	131
Tail	23	82.4	65-94	73
Hind foot	25	20.5	19.0-23.0	22
Ear	25	15.3	13.0-17.7	15
Weight	20	42.3	21-70	51
Condylobasal length	16	26.1	24.0-28.1	29.2*
Zygomatic breadth	25	15.2	13.6-16.2	15.9
Maxillary tooth-row	25	4.1	3.7-4.8	

Table 28. External and cranial dimensions of a sample of *Myomimus roachi* from Turkish and Bulgarian Thrace, and a single male from western Anatolia. Based on Pechev *et al*. (1964), Mursaloğlu (1973a), Kurtonur (1982), Kurtonur & Özkan (1991), Storch (1978d) and our own data. *Occipitonasal length (up to 29.1 mm in Turkish Thrace).

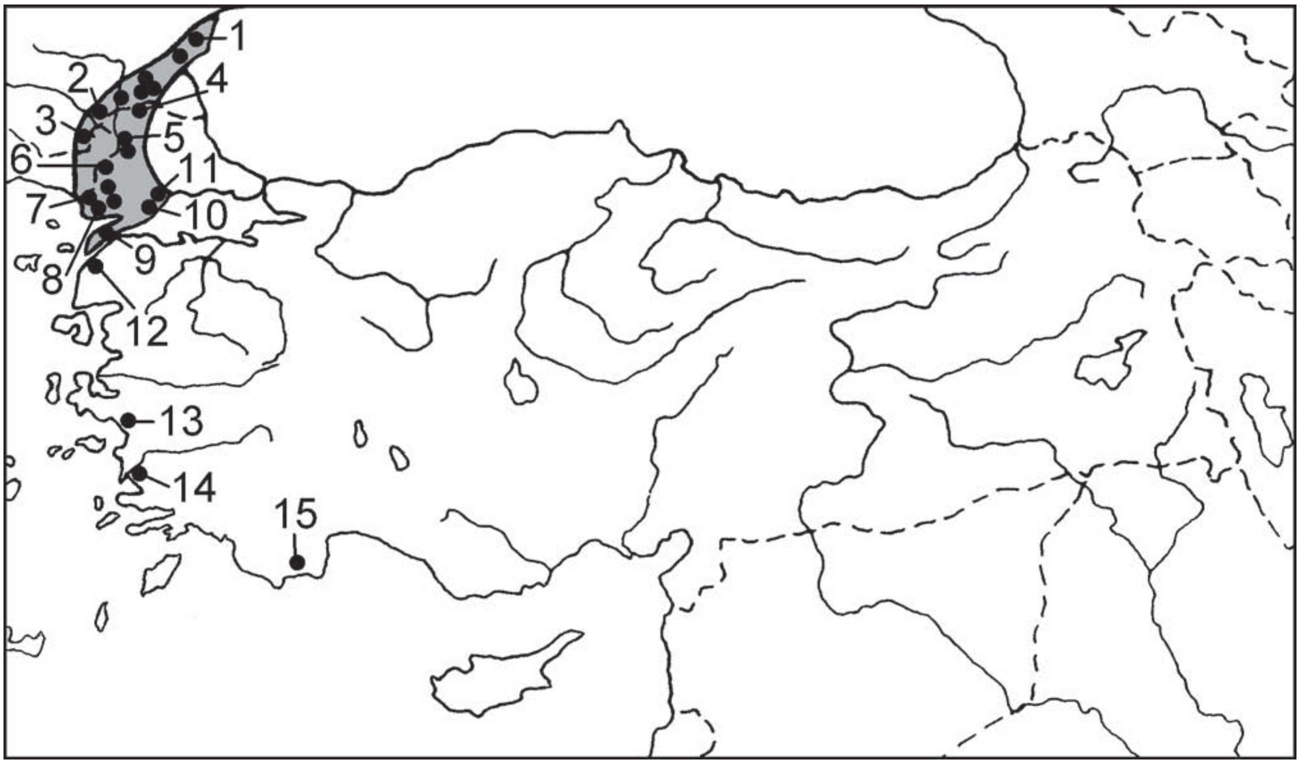


Figure 94. Distribution of *Myomimus roachi*. Records: Bulgaria: **1** – Nesebăr, Burgas; **2** – Svilengrad; **3** – Ivajlovgrad. Turkey: **4** – Vaysal, Lalapaşa, Edirne; **5** – Karakasım, Edirne, 40 m; **6** – Olacak, Meriç, Edirne; **7** – Enez, Edirne; **8** – Vakıf, Enez, Edirne; **9** – Sültüce, Gelibolu, Çanakkale; **10** – Gaziköy, Şarköy, Tekirdağ; **11** – Kumbag, Tekirdağ; **12** – Troy (= Truva), Çanakkale; **13** – Ephesus, İzmir; **14** – Lake Bafa, Aydın; **15** – 3 km west of Finike, Antalya (subfossil). Corresponding references: Peshev *et al*. (1960a): 2. Angermann (1966): 1. Corbet & Morris (1967): 15. Peshev & Angelova (1968): 3. Mursaloğlu (1973a): 12, 13. Kurtonur (1975): 11. Kasparek (1988): 14. Kurtonur & Özkan (1991): 4, 6-8, 10. Filippucci & Kotsakis (1995): 9. Own data: 5. Bulgarian records, other than nos. 1-3, are from Pešev & Spasov (1985).

cinian (Meulen & Kolfschoten, 1986; Kotsakis, 1990). Middle-Pleistocene records are reported from Yarımburgaz in Turkish Thrace (Santel, 1994) and in Emirkaya-2, south-central Anatolia (Montuire *et al*., 1994). Storch (1988) also found it in the Middle Palaeolithic strata at Finike near Antalya from where the species disappeared subsequently. Not far from Finike, Corbet & Morris (1967) came across subfossil material of *M. roachi* which was presumably less than 7,000 years old. This dormouse also survived in Israel until late Bronze Age 1,600–1,300 BC (Corbet & Morris, 1967). It is evident that Roach's mouse-tailed dormouse disappeared from much of its previous Asiatic range and that the considerable shrink of its range was quite a recent event. The causes are not known, but habitat degradation is one of the possible clues.

HABITAT

Information on habitat is available mainly from the European part of the species' range, both from Turkey (Kurtonur & Özkan, 1991) and Bulgaria (Peshev *et al*., 1960a,b; Pechev *et al*., 1964). Since the landscape is similar in these two countries, we summarised available information from both of them.

Myomimus roachi prefers open landscape, but mainly occurs in hedgerows (*Crategus* sp., *Pirus malus*, *P. communis*, *Rubus* sp.) with groups or rows of trees along the edges of cereal and sunflower fields and near vineyards (Kurtonur & Özkan, 1991). The entire area has a steppe-like character but is mainly cultivated. Peshev *et al*. (1960a) list the following herbs and grasses as being dominant in the mouse-tailed dormouse habitat: *Setaria viridis*, *Trifolium arvense*, *T. diffusum*, *Xeranthemum annuum*, *Centaurea cyanus*, and *C. diffusa*; more rarely present are *Hor-*

deum murinum, *Delphinium aviculare*, and *Nigella arvensis*. Mouse-tailed dormice were also collected in orchards and in vegetable gardens, but they were never found in forests in Turkish Thrace (Kurtonur & Özkan, 1991). Abandoned fields with oak and fig trees are reported to be the habitat of Roach's mouse-tailed dormouse also at Truva and Ephesus in western Anatolia (Mursaloğlu, 1973a).

Figure 95. Habitat of *Myomimus roachi*. **a** – Karakasım, Thrace, **b** – Ephesus, Aegean Anatolia. Photo: B. Kryštufek.

ALTITUDE. No data are available on the elevations of the localities. In any case, all the records are from low country and in Turkish Thrace mainly below 100 m a.s.l.

ASSOCIATES. In the same habitat near Edirne, we also collected *Crocidura leucodon, C. suvaeolens, Microtus rossiaemeridionalis, Apodemus sylvaticus* and *A. flavicollis*. Kurtonur & Özkan (1991) noted that *M. roachi* was rarely trapped in densely grown banks of rivers flowing through open country where *Dryomys nitedula* was very abundant.

DENSITY. Roach's mouse-tailed dormouse is occasionally common. Near Edirne we collected, in 182 traps, 36 small mammals in the night from 7th to 8th July, six of which were Roach's mouse-tailed dormice (only two, however, were adults). Peshev *et al*. (1960a) obtained thirteen specimens between July 30 and August 4, and seven between July 7 and 18. Not much new information was gathered in Bulgaria since the report by Pechev *et al*. (1964). According to Pešev & Spasov (1985), just a single record comes from the post-1975 period. Kurtonur & Özkan (1991) obtained seven specimens near Edirne in a short period of August 10-11. On the whole, *Myomimus roachi* is a rare animal. Only 22 specimens altogether are known to have been collected in Bulgaria (Pechev *et al*., 1964), and Kurtonur & Özkan (1991) got only 30 mouse-tailed dormice in four years of trapping small mammals in Turkish Thrace.

BIOLOGY

The life of Roach's mouse-tailed dormouse is very little known. The best source of information are the observations by Buruldağ & Kurtonur (2001) on five captive animals and their two offspring. The animals were kept in large outdoor cages in an orchard near Edirne, i.e. under semi-natural conditions.

ACTIVITY. Roach's mouse-tailed dormouse is mainly reported to be a ground-dwelling species (Peshev *et al*., 1960a; Storch, 1978d). Kurtonur & Özkan (1991), however, collected more specimens on trees (willow, walnut, wild pear, oak, and particularly mulberry) than on the ground. Observations by Buruldağ & Kurtonur (2001) also suggest predominant arboreal activity. Captive specimens preferred nest boxes on the wall of the cage and did not burrow in the ground. The reluctance of captive animals to burrow contradicts the earlier report by Peshev *et al*. (1960a) on a complex of underground burrows supposedly used by *M. roachi* (see Fig. 9 on p. 311 in Peshev *et al*., 1960a).

Myomimus roachi is a hibernating species. Kurtonur & Özkan (1991) collected specimens between April 25 and August 24. Peshev *et al*. (1960a) got animals only in July and August, but failed to capture them during the first half of May and at the end of September and early October. Since we collected approximately one month old juveniles in the first decade of July (see below), we assume that the end of hibernation roughly coincides with the date of collection of the first specimens by Kurtonur & Özkan (1991), i.e. late April. In captive dormice the onset of hibernation was between November 17 and 20 and arousal date between April 5 and 11, which has lead to the conclusion that hibernation under natural conditions might last between the second half of November and the first half of May (Buruldağ & Kurtonur, 2001). The hibernation of four captives lasted 131–142 days and was interrupted at an early phase in a single individual. The hibernacula were 12 cm deep in the ground. No nesting material was used and several animals were hibernating together (Buruldağ & Kurtonur, 2001).

Mouse-tailed dormice accumulate subcutaneous fat (Peshev *et al*., 1960a) and are significantly lighter in spring after hibernation than in summer (Fig. 97). Captive dormice entered hibernation at the body mass of over 44 grams and Buruldağ & Kurtonur (2001) report a subadult female with a pre-hibernation mass of 37 grams which hardly survived the winter. During hibernation the dormice lost 18–33% of body mass, but this share was much higher in the above-mentioned lightweight female (i.e. 50%; Buruldağ & Kurtonur, 2001). The weight of 40 grams is possibly close to the lowest minimum for successful hibernation.

NEST. Captive dormice did not construct spherical nests nor did they use any nesting material in non-breeding nests. Females started bringing soft material into the nest-box a week or less before parturition (Buruldağ & Kurtonur, 2001).

REPRODUCTION. We collected juveniles, which were evidently just weaned, on July 8; their body weight was 8.5–13 g (N = 4). Based on estimated pregnancy of 30 days and additional 30 days for weaning, this would place the parturition date in the first decade of May. A pregnant female was collected on May 19 (Buruldağ & Kurtonur, 2001). Buruldağ & Kurtonur (2001) got two litters in captivity, on May 19 and June 1, respectively, i.e. 44 and 51 days after the arousal from hibernation. Data on litter size are scarce: 5 and 6 born young, respectively (Buruldağ & Kurtonur, 2001), 14 embryos (Buruldağ & Kurtonur, 2001), and 6 and 10 placental scars, respectively (our own observations). A tentative estimation thus gives a litter size of 5–14 (mean = 8.2).

Body weight at birth is 1.9–2.4 g. Mean daily gain of 0.245 g brings juveniles to 8.6–10.4 g at the weaning (age of 29–31 days) and to a mean adult weight of 33.2 g at the age of 120 days (Buruldağ & Kurtonur, 2001). The weight of wild caught juveniles was 8.5–25 g in July (N = 7) and 28–36 g in August (N = 9).

Figure 96. Juvenile Roach's mouse-tailed dormice *Myomimus roachi* from Turkish Thrace. Animals are climbing on mulberry tree. Photo: E. Buruldağ & C. Kurtonur.

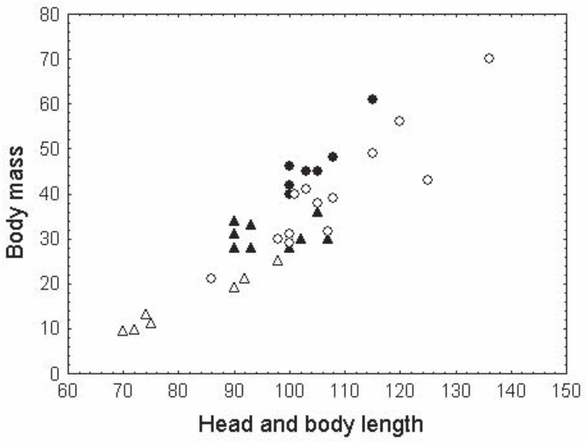


Figure 97. Bivariate plot of body mass against head and body length for *Myomimus roachi* from Turkish Thrace. Triangles are juveniles in July (empty symbols) and August (closed symbols), respectively. Adults from April to July are denoted by circles and those in August by dots. Based on Kurtonur & Özkan (1991) and our own data.

FOOD. Roach's mouse-tailed dormouse is omnivorous but shows a strong inclination towards eating insects such as mole-crickets, grasshoppers, butterflies, and moths. Insects are readily detected and skilfully killed. Buruldağ & Kurtonur (2001) provide a detailed list of food consumed by dormice in captivity. Peshev *et al*. (1960a) found only seeds of *Setaria viridis* in their stomachs.

PREDATION. In the barn owl *(Tyto alba)* pellets from Lake Bafa, a single Roach's dormouse was found among 601 preyed small mammals (Kasparek, 1988).

SETZER'S MOUSE-TAILED DORMOUSE – *MYOMIMUS SETZERI*

Myomimus setzeri Rossolimo, 1976. Type loc.: 4 km west of Bane, Kurdistan, Iran.

TAXONOMY

Quite recently, *Myomimus setzeri* has been separated from *M. personatus*. The dormouse is extremely rare and the original description was based on merely three specimens (Rossolimo, 1976b). It is generally accepted to be a valid species (e.g. Holden, 1993b; Rossolimo *et al*., 2001), Daams & Bruijn (1995), however, synonymised it with *M. personatus*.

DESCRIPTION

EXTERNAL CHARACTERS. Setzer's mouse-tailed dormouse is the smallest Turkish dormouse. At first sight it is easily confused with the Macedonian mouse, *Mus macedonicus*. Externally it resembles its larger relative in shape and proportions, but differs in size and colour. Tail is relatively short (69–82% of head and body length), with hardly any pencil. Ears are short and rounded. Whiskers are up to 17 mm long. Fur is long, dense, and silky; hairs are up to 8 mm long.

COLOUR. Upper parts wood-brown, grey shaded in middle and becoming more buff along flanks and on muzzle. Belly and cheeks grey shaded white. Demarcation along flanks quite distinct. Basal portion of hairs slate-grey throughout, except short hairs on chin and cheeks. Ears grey and feet whitish-grey. Tail whitish-grey, indistinctly bi-coloured and gets slightly darker dorsally in distal third.

SKULL small and delicate. Zygomatic width equals *c*. 58% of condylobasal length. Rostrum slightly broader than interorbital constriction. In comparison with *M. roachi*, brain-case tends to be more rounded, bullae appear slightly shorter (29.6% of condylobasal

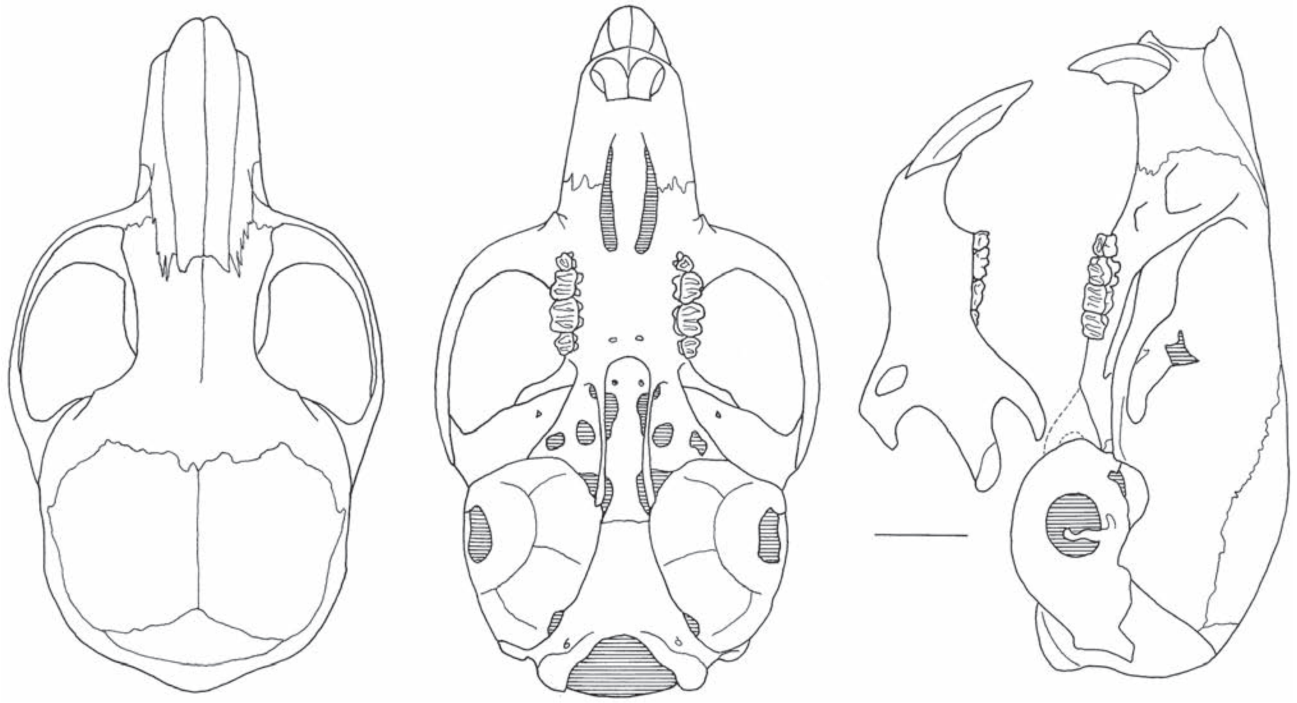


Figure 98. Skull and mandible of *Myomimus setzeri*, based on an adult male from Sarıkamış (JOC). Scale bar = 3 mm.

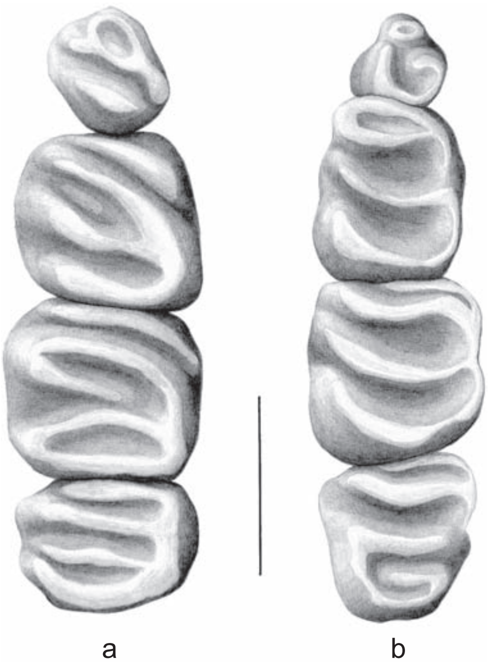


Figure 99. Upper (**a**) and lower cheek-teeth (**b**) of *Myomimus setzeri*. Based on a specimen from Sarıkamış (JOC). Lingual side is to the left, anterior is at the top. Scale bar = 1 mm. Drawing: S. Prokešová.

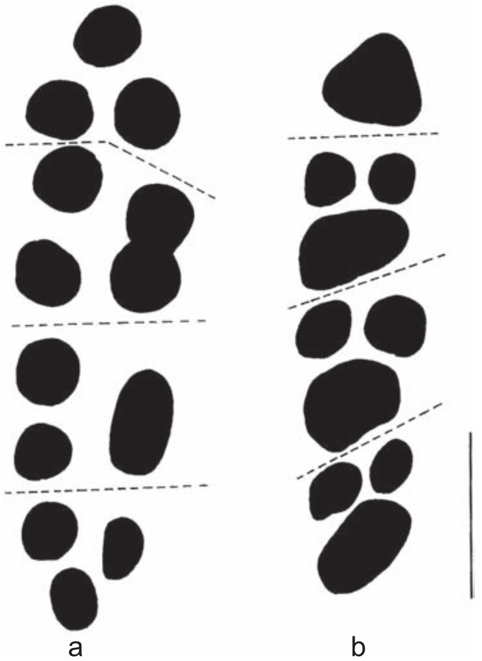


Figure 100. Alveolar pattern in *Myomimus setzeri*. Based on specimens from Bendimahi, Muradiye (**a**; upper row), and İshak Paşa Sarayi, Doğubayazıt (**b**; lower row, JOC). Scale bar = 1 mm.

length), zygomata more expanded and nasals more pointed terminally. Also, the mandible is less robust.

TEETH. Cheek-teeth and alveolar pattern essentially of same form as in *M. roachi*. Enamel on frontal surface of incisors pale yellow to white-yellow.

DIMENSIONS are given in Table 29.

	Turkey			Iran
Sex	F	F	M	
Head and body	74	76	81	142-148*
Tail	51	62	62	60-67
Hind foot	14	16	17	15
Ear	11	11	13	
Weight	9	8	10	
Condylobasal length			20.6	20.4-20.7
Zygomatic breadth			12.0	12.0
Maxillary tooth-row	3.3	3.3	3.4	3.0

Table 29. External and cranial dimensions of three specimens of *Myomimus setzeri* from Sarıkamış, Turkey (JOC) and summary statistics for Iran (N=3, Rossolimo, 1976b). M – male, F – female. *Total length (the corresponding values for the Turkish sample are 125, 138, and 143 mm, respectively).

VARIABILITY

Myomimus setzeri is a monotypic species (Rossolimo *et al*., 2001).

DISTRIBUTION

This species is extremely rare in zoological collections and only few records are known from its entire range (Obuch, 2001; Rossolimo *et al*., 2001). Thus the extent of its range is not known (Rossolimo *et al*., 2001). Setzer's mouse-tailed dormouse inhabits Zagros Mts. (provinces of Kordestan, Azerbaygan-Garbi, and Lorestan) in north-western Iran and the adjacent parts of eastern Anatolia. Three localities are reported altogether from Turkey (Obuch, 1994, 2001). In all three of them, Setzer's mouse-tailed dormouse was recorded in owl pellet material, some of which was presumably up to 50 years old. However, in Sarıkamış three specimens were collected on June 4, 1992.

HABITAT

Three specimens, found in Sarıkamış, were under the same large stone in a sparse forest of old pines, loosely covered with grass. Rossolimo *et al*. (2001)

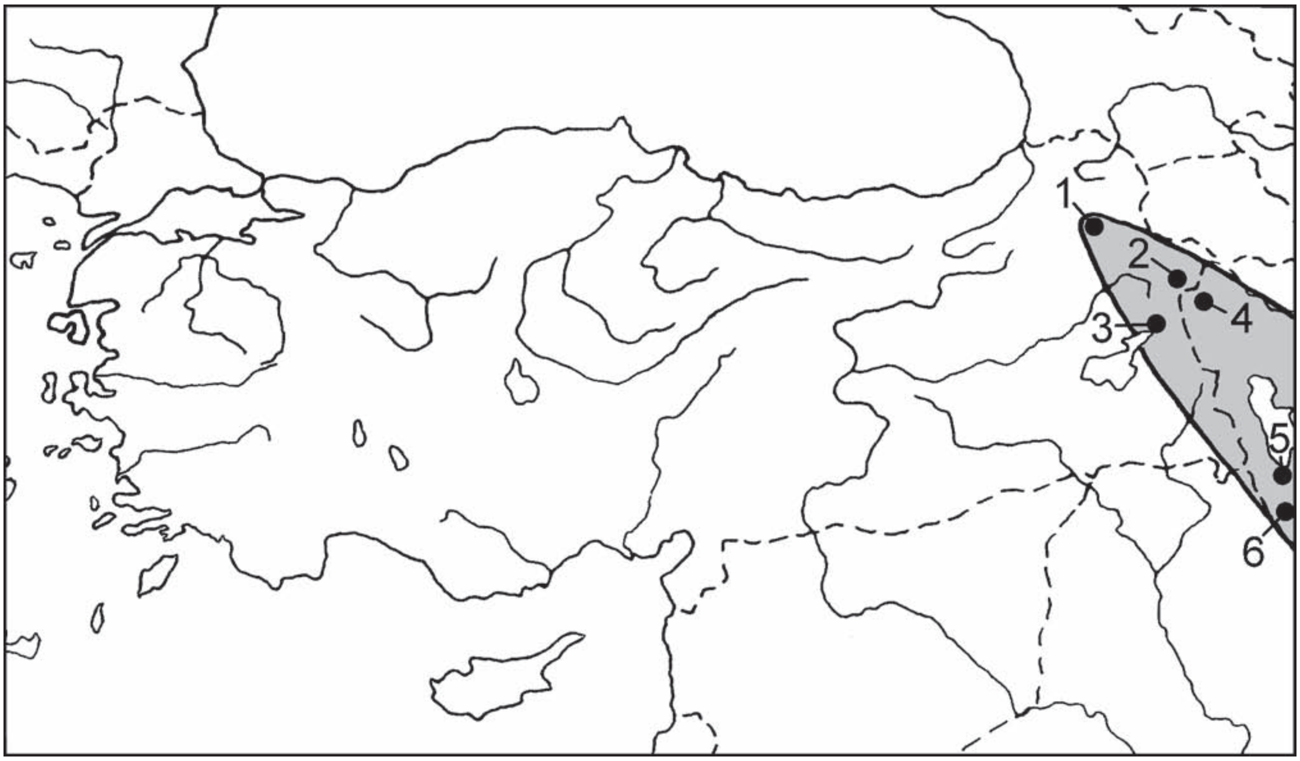


Figure 101. Distribution of *Myomimus setzeri* in Turkey and adjacent parts of Iran. Records: **1** – Sarıkamiş, Kars, 1,800 m; **2** – İshak Paşa Sarayi, Doğubayazıt, Ağrı; **3** – Bendimahi, Muradiye, Van, 1,900 m. Iran: **4** – Qare Kelisa, Maku, Azarbaygan Garbi; **5** – Mahabad, Azarbaygan Garbi; **6** – 4 km west of Bane, Kordestan. Corresponding references: Rossolimo (1976b): 6. Obuch (1994): 1, 3. Obuch (2001): 1-5.

report *Pistacia* savannah as a typical habitat but note also that habitat selection is similar in *M. setzeri* as is in *M. personatus*.

Altitude. Turkish records are from altitudes of 1,800–1,900 m a.s.l. (Obuch, 1994). The highest record (2,800 m a.s.l.) is from Takht-e Suleyman, north-western Iran (Obuch, 2001).

Figure 102. Habitat of *Myomimus setzeri*. Vicinity of İshak Paşa Sarayi, Doğubayazıt, Ağrı. Photo: P. Benda.

Associates. In Işak Paşa Sarayi, *Dryomys nitedula* was also found in owl pellets besides *M. setzeri*.

Biology

The life habits of Setzer's mouse-tailed dormouse are virtually unknown. Obuch (2001) analysed large owl pellet samples from the Near and Middle East, but found Setzer's mouse-tailed dormouse only in the pellets of the eagle owl *(Bubo bubo)*. In Turkey, twelve dormice were obtained among the remnants of 3,280 (= 0.4%) individual vertebrates preyed by owls. The share of *M. setzeri* was slightly higher in a pooled sample from four Iranian localities, i.e. 1.8% (N = 2,237).

FAMILY: MURIDAE ILLIGER, 1815

Family Muridae is a heterogeneous assembly of various life forms, from strictly subterranean to bipedal ones. Most of them, however, are of a generalised saltatorial plan. It is by far the largest mammal group both worldwide (1,326 species; Musser & Carleton, 1993) and in the region of Turkey and Cyprus (44 species; Kryštufek & Vohralík, 2001). As murids predominate in the number of species (28.6% of global and 31% of regional mammal richness), they also outnumber any other group of mammals in the number of individuals. The family is nearly cosmpolitan in distribution.

Murids are characterised by large infraorbital foramen which is wider above than below. A splint-like jugal bone is supported by long zygomatic processes of maxillary and squamosal bones. There are never more than three cheek-teeth in each jaw. The dental formula: 1/1, 0/0, 0/0, 3/3 = 16; some tropical genera have lost one or even two molars in each jaw, thus having 14, 12 or only 8 teeth altogether. The molars may be rooted or rootless and cuspidate, laminate or prismatic.

The taxonomic scope of the family varied tremendously over time, but this was mainly due to changes in the level of the five main groups, considering them either independent families, or subfamilies of Muridae (Table 30). We follow Musser & Carleton (1993) who split Muridae intro seventeen subfamilies, five of which have representatives in the study area.

KEY TO SUBFAMILIES

1 Highly modified for subterranean life: no external tail, eyes vestigial and covered with skin; occipital shelf abruptly sloping forward — Spalacinae
1* Not adapted to subterranean life, or modifications less extreme: external tail always present and frequently long, eye orifices always present; occipital region mainly vertical — 2

2 Upper incisors each with one longitudinal groove on anterior surface — Gerbilinae
2* Upper incisors not grooved — 3

3 Molars prismatic, hypsodont or rootless; crowns flat with a pattern of deep re-entrant angles — Arvicolinae
3* Molars brachyodont and rooted; crowns tuberculate — 4

4 Tubercles of upper molars arranged in three primary longitudinal series — Murinae
4* Tubercles of upper molars arranged in two primary series — Cricetinae

No. 1	No. 2	No. 3	No. 4	No. 5
Muridae	**Muridae**	**Muridae**	**Muridae**	**Muridae**
Murinae	Murinae			
		Cricetidae	**Cricetidae**	**Cricetidae**
Cricetinae	Cricetinae	Cricetinae	Cricetinae	
Arvicolinae	Microtinae	Arvicolinae[1]	Arvicolinae	**Arvicolidae**
Gerbillinae	Gerbillinae	Gerbillinae	**Gerbillidae**	**Gerbillidae**
Spalacinae	**Spalacidae**	**Spalacidae**	**Spalacidae**	**Spalacidae**

Table 30. Summary of taxonomic divisions proposed for rodents which are included in this volume in the family Muridae. Given are families (in boldface type) and subfamilies. Corresponding references for various taxonomic systems are: System No. **1** – Musser & Carleton (1993); Kowalski (2001); Kryštufek & Vohralík (2001). System No. **2** – Miller (1912; not covering Gerbillinae); Neuhäuser (1936b); Ellerman (1948); Ellerman & Morrison-Scott (1951, 1966); Bobrinskij *et al.* (1965). System No. **3** – Corbet (1978); Gromov & Baranova (1981); Vinogradov & Gromov (1984); Doğramacı (1989; not using subfamily names); Harrison & Bates (1991); Gromov & Erbajeva (1995); Kurtonur *et al.* (1996). System No. **4** – Pavlinov & Rossolimo (1987, 1998); Demirsoy (1996; Arvicolinae included into Cricetidae but with no subsequent ranking of the family). System No. **5** – Kumerloeve (1975); Šidlovskij (1976); Niethammer & Krapp (1978, 1982a; not covering Gerbillinae); Qumsiyeh (1996). Note: [1]also reported as Microtinae.

SUBFAMILY: ARVICOLINAE GRAY, 1821

Herbivorous murids with high crowned and prismatic (hypsodont) molars whose pulp cavities remain open throughout life in the majority of living species. Rooted molars are characteristic in some primitive forms. The third upper molar is longer than the first one. The body robust and thickset, with broad, more or less flattened head and short, bluntly rounded muzzle. The eyes and ears are small and the tail is mainly shorter than half of head and body length. The appearance is short-legged, since the limbs are hidden to a great extent in the integument of the trunk. The normal mammary formula includes two pairs of pectoral and two pairs of inguinal teats, but pectoral mammae tend towards reduction and are lost in some groups. The skull is usually robust and broadly arched. A sagittal crest develops in some groups with advanced age. The rostrum is mainly short, and the interorbital region is clearly defined.

Molars are highly characteristic, displaying a pattern of alternating triangles (which are arranged in two parallel series) and transverse loops. Each loop or a triangle is formed by dentine which is bounded externally by a sheet of enamel. The enamel-covered sides of the crowns form a series of anticlines (salient angles) with the synclines (re-entrant folds) lying in between. In most genera cementum is present in the synclines. The grinding surfaces of the molars are flat, composed of alternating dental triangles surrounded by transverse enamel ridges. See Fig. 103 for the nomenclature of the molar pattern.

The majority of species are terrestrial and well adapted to burrowing, but some are fossorial, strictly subterranean, semi-aquatic or rock-dwelling. Their distribution is Holarctic. Twenty-six genera with approximately 130 species are recognised at present; 16 species in six genera occur in Turkey, while Cyprus lacks members of this subfamily.

The voles of Turkey were already reviewed by Neuhäuser (1936b) and later on by Osborn (1962) who recognised ten species. Felten *et al.* (1971b, 1973) reviewed western Anatolian species, while Steiner (1972) dealt in detail with voles of north-eastern Turkey.

In the past, the subfamily was frequently placed in Cricetidae Fischer, 1817 (Corbet 1978, 1984; Aksenova, 1980, 1983; Pavlinov & Rossolimo, 1987, 1998; Gromov & Poljakov, 1992; Kurtonur *et al.*, 1996), but was more exceptionally treated as a family on its own right, either called Arvicolidae Gray, 1821 (Meulen, 1973; Šidlovskij, 1976; Niethammer & Krapp, 1982a; Chaline & Graf, 1988) or Microtidae (Kratochvíl *et al.*, 1959). As a subfamily, it is commonly reported in the literature under the name Microtinae Cope, 1891 (Miller, 1912; Hinton, 1926; Ognev, 1950; Ellerman & Morrison-Scott, 1951; Spitzenberger, 1971; Gromov & Poljakov, 1977; Corbet, 1978, 1984; Harrison & Bates, 1991; Kefelioğlu & Kryštufek, 1999).

KEY TO GENERA

1 Molars rooted in adults
2

1* Molars rootless in adults
4

2 Subterranean voles with reduced eyes; 3rd upper molar much reduced: antero-labial dental field (T3) integrated into anterior loop, posterior cup short and simple (Figs. 109 & 114)
3

2* Terrestrial voles with normal eyes; 3rd upper molar complex, with at least three alternating triangles posterior to anterior loop; antero-labial triangle not integrated into dental field of the anterior loop
Clethrionomys

3 Front claws greatly enlarged; tail much longer than hind foot; external pinnae present; upper incisors orthodont; 3rd lower molar simple, with single re-entrant angle on either side
Prometheomys

3* Front claws of normal size; tail shorter than hind foot; external pinnae absent; incisors strongly proodont; 3rd lower molar with two re-entrant angles on either side
Ellobius

4 Large voles (head and body >150 mm, condylobasal length >35 mm); 1st lower molar with three alternating triangles between the anterior cup and the posterior loop
Arvicola

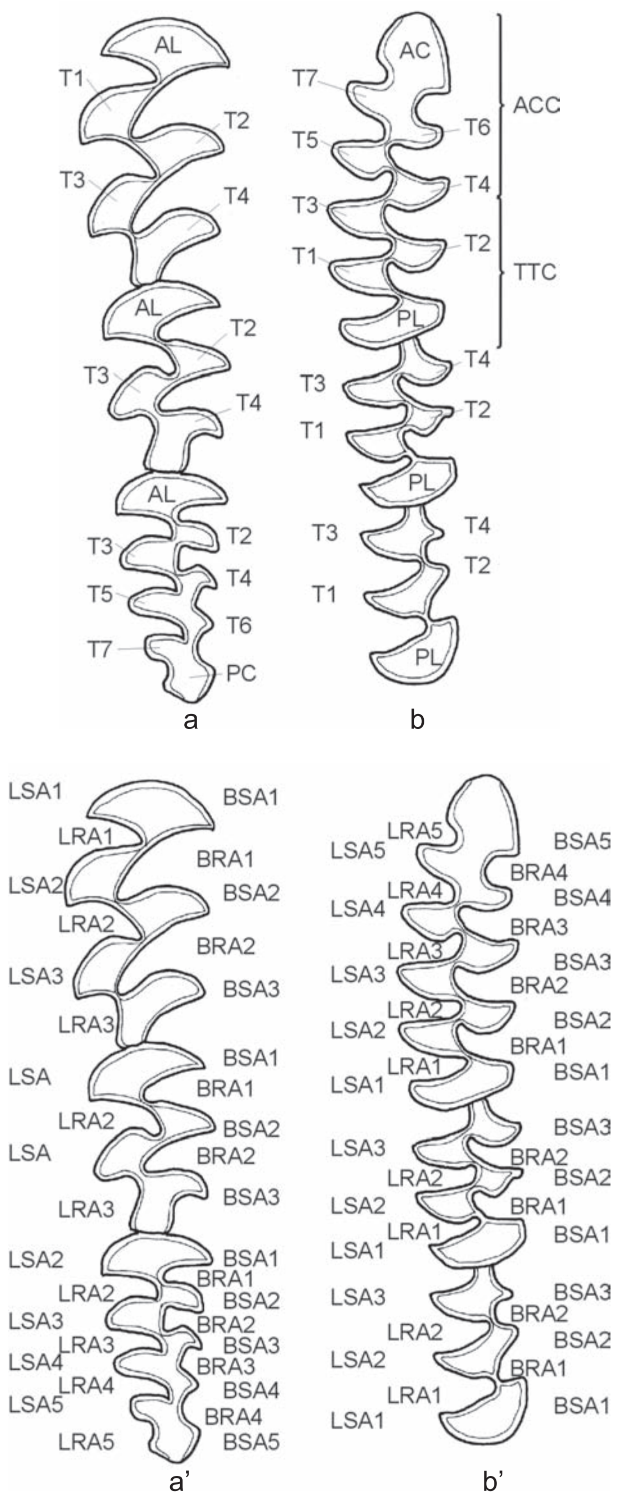


Figure 103. Occlusal surface of upper (**a**) and lower molar series (**b**) of *Microtus* vole to show terminology of the elements (from Meulen, 1973). Lingual side is to the left, anterior is at the top. Cusps and triangles: **AC** – anterior cup; **ACC** – anteroconid complex; **AL** – anterior lobe; **PC** – posterior cup; **PL** – posterior lobe; **T** – triangle; **TTC** – trigonid – talonid complex. Angles: **BRA** – buccal (labial) re-entrant angle (= syncline); **BSA** – buccal (labial) salient angle (= anticline); **LRA** – lingual re-entrant angle (syncline); **LSA** – lingual salient angle (anticline).

4* Size smaller (head and body <160 mm, condylobasal length <33 mm); 1st lower molar with at least five alternating triangles between anterior cusp and posterior loop
5

5 Mystacial vibrissae >35 mm long; tail usually about one half of head and body and more; 5th triangle on 1st lover molar frequently confluent with anterior cup (if closed, anterior cup likely to be arrow-headed)
Chionomys

5* Mystacial vibrissae <30 mm long; tail always less than half of head and body length; 5th triangle of 1st lower molar always closed
Microtus

GENUS: *ELLOBIUS* FISCHER, 1814

Small subterranean voles with strongly proodont incisors and much simplified molar pattern. Molars are rooted. The monophyly of *Ellobius* is well supported morphologically and genetically (Conroy & Cook, 1999). The genus is usually placed in a tribe on its own right (Ellobiini Gill, 1872) but within Arvicolinae it is a most unique member (Musser & Carleton, 1993). Because of its aberrant molar pattern, some authors (Gromov, 1972; Gromov & Poljakov, 1977; Gromov & Erbajeva, 1995) placed *Ellobius* in Cricetinae s. str. (not including arvicolins), i.e. together with the genera *Cricetus*, *Mesocricetus*, *Cricetulus* etc.

Five species are currently recognised, belonging to two subgenera: the nominate one and *Afganomys* Topachevsky, 1965 (also including *lutescens*). The voles of this genus populate steppes, alpine meadows and semideserts from eastern Europe to central Asia, and from Ukraine, Kazakhstan and Mongolia to Turkey and Iran. A single species occurs in Turkey.

SOUTHERN MOLE-VOLE – *ELLOBIUS LUTESCENS*

Ellobius lutescens Thomas, 1897. Type loc.: near Van Gölü, Turkey.

TAXONOMY

Thomas (1897) described *E. lutescens* on the basis of a collection obtained at "Van, Kurdistan, eastern Asia Minor" and submitted to the British Museum (Natural History) by Major W. H. Williams. In the original description, Thomas defines *lutescens* as being "very distinct from any previously described" mole-vole, but resembling *E. fuscocapillus* (Blyth, 1843) by the "complicated shape of the last upper molar". For molar variation see Fig. 105. Besides, *E. lutescens* was said to differ from *fuscocapillus* "by its smaller size, loose fur, and dull coloration". *E. lutescens* was considered as a species on its own right for several decades following its discovery by the major-

Figure 104. Southern mole-vole *Ellobius lutescens*. Drawing: J. Hošek.

ity of authorities (Neuhäuser, 1936b; Ellerman, 1948; Osborn, 1962; Ellerman & Morrison-Scott, 1951; Šidlovskij, 1976; Vinogradov & Gromov, 1984). Bobrinskoy *et al.* (1944), however, synonymised it with *E. fuscocapillus*, a view adopted by Ognev (1964), Lay (1967), Kumerloeve (1975a), Morlok (1978), Corbet (1978), and Kurtonur *et al.* (1996). Karyological evidence provided by L'apunova *et al.* (1974) speaks in favour of *E. lutescens* (2N = 17) to be a species distinct from *E. fuscocapillus* (2N = 36), and this view is now widely accepted (Gromov & Baranova, 1981; Corbet, 1984; Pavlinov & Rossolimo, 1987, 1998; Musser & Carleton, 1993; Gromov & Erbajeva, 1995; Panteleyev, 1998; Demirsoy, 1996; Coşkun, 1997; Nowak, 1999; Coşkun & Ulutürk, 2003; Moradi Gharkheloo & Kıvanç, 2003); Doğramacı (1989a), Harrison & Bates (1991) and Kurtonur *et al.* (1996) continue to consider *E. lutescens* as a junior synonym of *E. fuscocapillus*. Coşkun (2001) shows that mole-voles from the vicinity of Van display the same karyotype as specimens from Armenia, which were earlier ascribed to *E. lutescens* by L'apunova *et al.* (1974).

The morphological differences between *E. lutescens* and *E. fuscocapillus* are vague. Ognev (1964) distinguished the two by three cranial characters (the shape of the posterior part of the nasals, the form of zygomata, and the shape of the coronoid process) and by colour (duller in *E. lutescens*), and Ellerman & Morrison-Scott (1951) relied on the extent of the sagittal crest (reaching the lambdoid crest in *E. fuscocapillus* but being shorter in *E. lutescens*). Lay (1967) found skull traits to vary strongly and based his taxonomy on coloration. According to Vinogradov & Gromov (1984) and Gromov & Erbajeva (1995), the palmar soles are much larger in *E. lutescens* than in *E. fuscocapillus*. Anyhow, the scope of *E. lutescens* has become clear only very recently due to extensive karyotyping in Iran (Moradi Gharkheloo & Kıvanç, 2003). Their paper has also clarified the status of further two names from Iran: *Ellobius woosnami* Thomas, 1905 (type loc. Dumbeneh near Isfahan, Iran; junior synonym of *E. lutescens*) and *Ellobius fuscocapillus legendrei* Goodwin, 1940 (type loc. *c.* 60 km east of Astrabad, Iran; junior synonym of *E. fuscocapilus*). Ellerman & Morrison-Scott (1951) consider both *woosnami* and *legendrei* as junior synonyms of *lutescens*, while Lay (1967; in his paper *woosnami* is misspelled as *woosmani*) listed

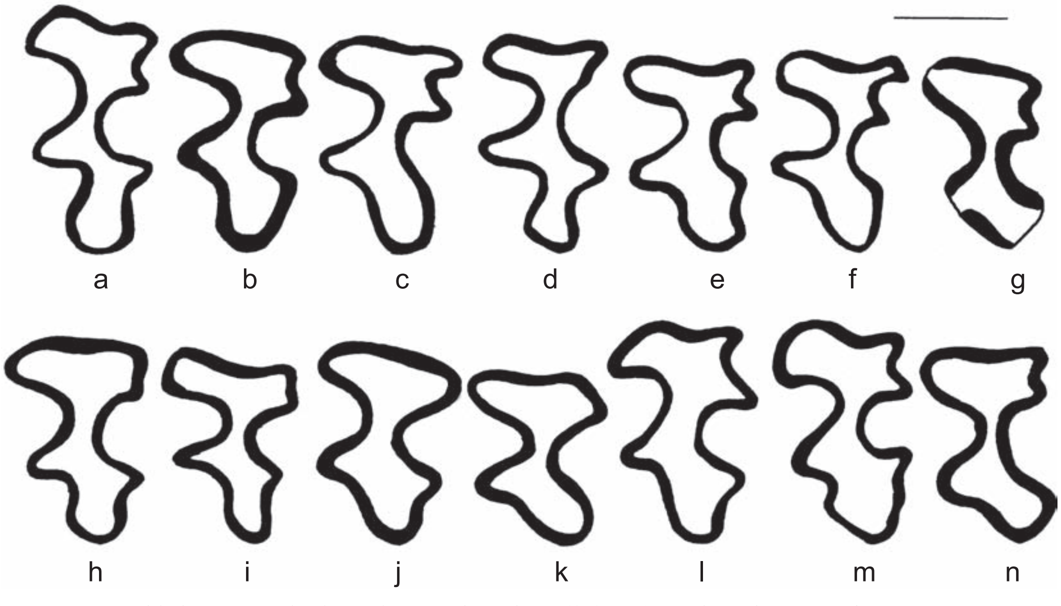


Figure 105. Third upper molar in various mole-voles *Ellobius* from the subgenus *Afganomys*. **a–k**: *Ellobius lutescens*; **l–n**: *E. fuscocapilus*. **a–g**: type series of *E. lutescens* (**b** – type specimen); **h** – Baku, Talysch Mts.; **i** – Hamedan, Iran; **j** – west of Isfahan, Iran; **k** – type of *E. woosnami*; **l** – Mach, Baluchistan; **m** – Karal Khara, Afghanistan; **n** – Guhran, Afghanistan. Lingual side is to the right, anterior is at the top. Based on BMNH material. Scale bar = 1 mm.

them under *E. fuscocapillus*. Musser & Carleton (1993) did not allocate either *woosnami* or *legendrei* to species. *Ellobius woosnami* is of the same colour as the type series of *lutescens* and, as shown by Moradi Gharkheloo & Kıvanç (2003), it also displays the same diploid number of chromosomes.

TYPE LOCALITY. Coşkun (2001) states that the type locality of *E. lutescens* is Erçek (*c*. 30 km northeast of Van), but provides no arguments. Thomas (1897) clearly wrote that the type series was collected "in the neighbourhood of that place" (i.e. of the city of Van); this is also evident from the BMNH specimen labels: "Lake Van, 5,000 ft". The vicinity of the city of Van certainly is populated by mole-voles, which is furthermore evident from FMNH specimens labelled as "Van, Van, 5,700 ft".

DESCRIPTION

EXTERNAL CHARACTERS. Small subterranean voles with a round head and a short, hairy tail (Figs. 104 & 106). Terminal pencil of the tail is up to 7 mm long. Rhinarium is large (*c*. 5.5 mm wide and 5 mm high) and hard, surrounded by short and stiff mystacial vibrissae (up to 14.5 mm in length) which are directed forward. Fore and hind feet are of moderate size, broad and robust, with naked palms and soles; their lateral borders are fringed with stiff hairs. The thumb is not reduced to such a degree as is in the majority of rodents. The 2nd and 3rd fingers are the longest. Claws are strong, but short. Pelage is short (up to 8 mm on the upper-side), fine and dense. Eyes are minute and pinnae are reduced to a mere naked skinfold around the external meatus.

Figure 106. Transcaucasian mole-vole *Ellobius lutescens* from Van, Turkey. From Coşkun (2001; Zoology in the Middle East, Vol. 23, p. 7) by permission from Kasparek Verlag.

COLOUR. Fur is dull slate buff, slightly darker above than below, and there is no clear demarcation line along flanks. The dorsal hairs have buff tips and the ventral ones are tipped silver. Pelage is the darkest on the head, forming an inconspicuous facial mask on the front, around the eyes and around rhinarium where the colour is the darkest. Lay (1967) states that the summer pelage in the Iranian series is considerably greyer than is the buffy winter coat.

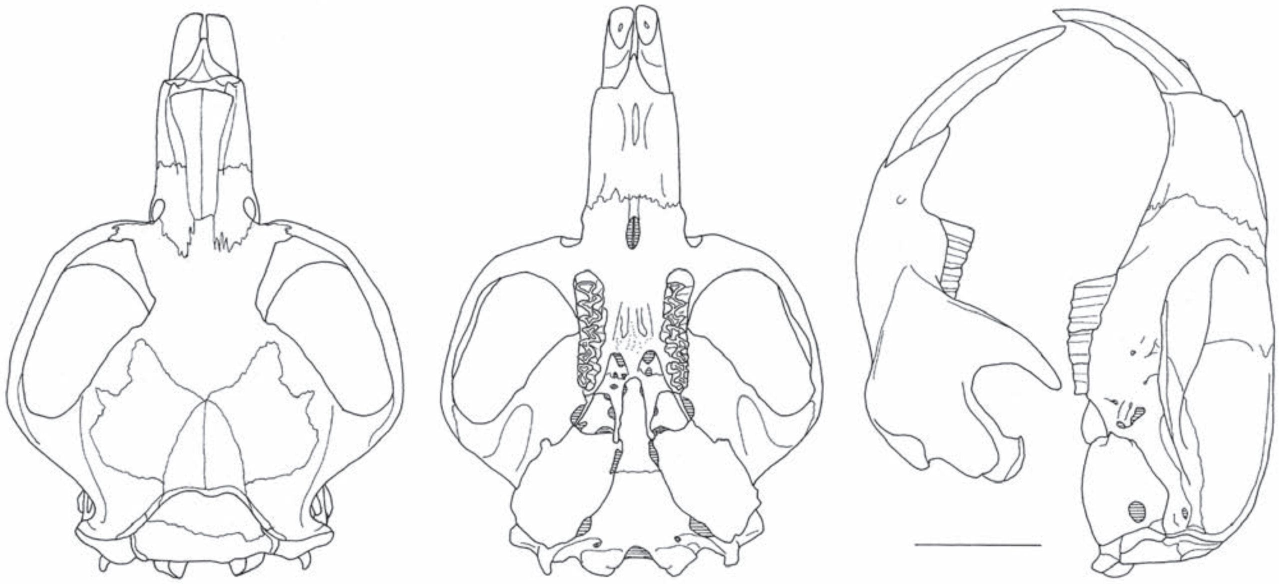


Figure 107. Skull and mandible of *Ellobius lutescens*, based on and adult female from Erçek, Van district (SMF). Scale bar = 8 mm.

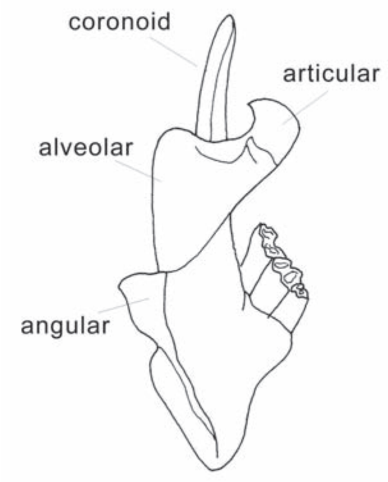


Figure 108. Caudal view of ramus mandibulae of *Ellobius lutescens* (same specimen as on Fig. 107). Indicated are the processes.

SKULL is deep and slightly convex in profile; the zygomatic arches are widely arched (Fig. 107). Occipital region is moderately inclined anteriorly. Rostrum is long and incisive foramina are distinctly short and shifted posteriorly. Bullae are of moderate size, with *porus acusticus* nearly obliterated. Posterior margin of the hard palate is *Microtus*-like. The mandible is heavy, with a strong articular and coronoid processes, the angular process, however, is small and folded laterally. The lower incisor forms an additional (alveolar) process on the labial side of the ramus mandibula, just like in mole-rats *Nannospalax* (Fig. 108).

TEETH. The upper incisors are strongly proodont, with whitish enamel on their front surface. Diastema is very long. Molars are rooted in adults and their grinding surfaces show a simple pattern with broadly confluent dental fields; this pattern, however, is worn out with advanced age. Last upper molar is reduced and shorter than the second one, which is atypical in voles. Re-entrant angles lack cementum (Fig. 109).

First lower molar has three deep re-entrant angles on both sides, in addition to a shallow anterior lingual synclinale. All the remaining molars have two re-entrant angles on either side, but the 3rd upper molar shows three synclinals on the labial side in unworn condition (Fig. 105e). Third upper molar has three triangles, but the antero-labial one (T2) is integrated into the anterior lobe.

DIMENSIONS are given in Table 31. There is no secondary sexual dimorphism (Moradi Gharkheloo & Kıvanç, 2003). Moradi Gharkheloo & Kıvanç (2003) gave measurements taken from a large sample (N = 99) from Iran: total length 100–140 mm (mean = 125.7 mm), tail length 9–19 mm (13.4 mm), hind foot 17–26 mm (22.3 mm), body mass 24.8–81 g (62.05 g), condylobasal length of skull 22.0–30.9 mm (28.34 mm), zygomatic breadth 19.3–22.6 mm (22.35 mm), and maxillary tooth-row 6.7–8.6 mm (7.8 mm).

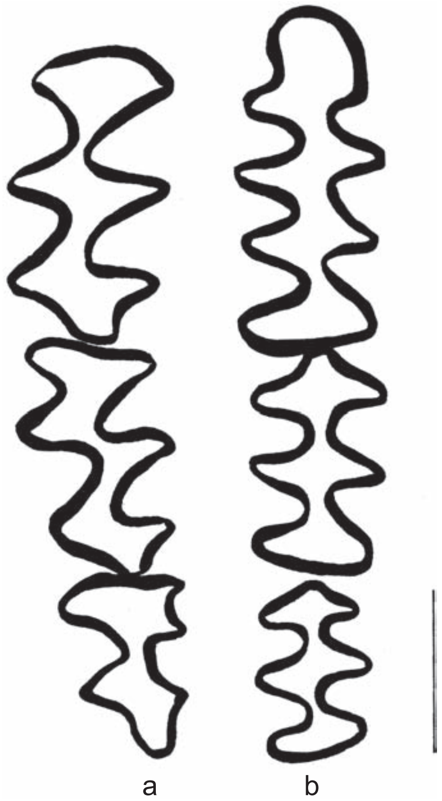


Figure 109. Upper (**a**) and lower molars (**b**) in *Ellobius lutescens* (same specimen as in Fig. 107). Lingual side is to the left, anterior is at the top. Scale bar = 2 mm.

	N	mean	min-max
Head and body	26	119.1	105–130
Tail	17	11.2	7–15
Hind foot	27	22.6	20–26
Weight	10	70.4	58–84
Condylobasal length	21	29.6	27.1–32.3
Zygomatic breadth	20	22.9	21.3–24.7
Maxillary tooth-row	23	7.2	6.4–8.2

Table 31. External and cranial dimensions of *Ellobius lutescens* from Turkey. Based on Morlok (1978), Coşkun (2001) and specimens in BMNH and FMNH.

CHROMOSOMES. The diploid number of chromosomes is 2N = 17 and NF = 34. The karyotype consists of eight bi-armed pairs and a single submetacentric heterosome (Coşkun, 2001); both sexes have the sex chromosome constitution XO (Zima & Král, 1984). The entire Y chromosome has been lost from this species and the sex determination gene is located either on the X chromosome or has an autosomal location (Vogel *et al.*, 1998). Specimens from western Iran share the same standard karyotype as those from Turkey (Moradi Gharkheloo & Kıvanç, 2003).

VARIATION

No subspecies are currently recognised (Gromov & Baranova, 1981; Pavlinov & Rossolimo, 1987; Musser & Carleton, 1993). Individual variation is evident in coloration, some specimens having a white throat spot or transverse stripe. Molar pattern seems to be stable, but the pattern is strongly affected by the degree of wear (Fig. 105).

DISTRIBUTION

Armenia, north-western Iran, and eastern Turkey (Musser & Carleton, 1993; Gromov & Erbajeva, 1995). In Iran it goes as far east as the line Isfahan – Kazvin; Kazvin is also the southernmost record (Moradi Gharkheloo & Kıvanç, 2003). The presence of this species in Iraq is dubious (Gromov & Baranova, 1981); for details see Harrison & Bates (1991). However, Coşkun (2001) has recently collected this vole at Yüksekova (region of Hakkari), only about 30 km off the border with Iraq, and Moradi Gharkheloo & Kıvanç (2003) also found the southern mole-vole along the northern part of the Iraqi – Iranian border (Nekede, Sekkız, and Hemedan).

In Turkey the southern mole-vole is restricted to the easternmost part of the country (Fig. 110). Until very recently, it has been only known from the vicinity of Van, but Obuch (1994), Coşkun (2001), and Coşkun & Ulutürk (2003) provide more localities which contribute considerably to a better

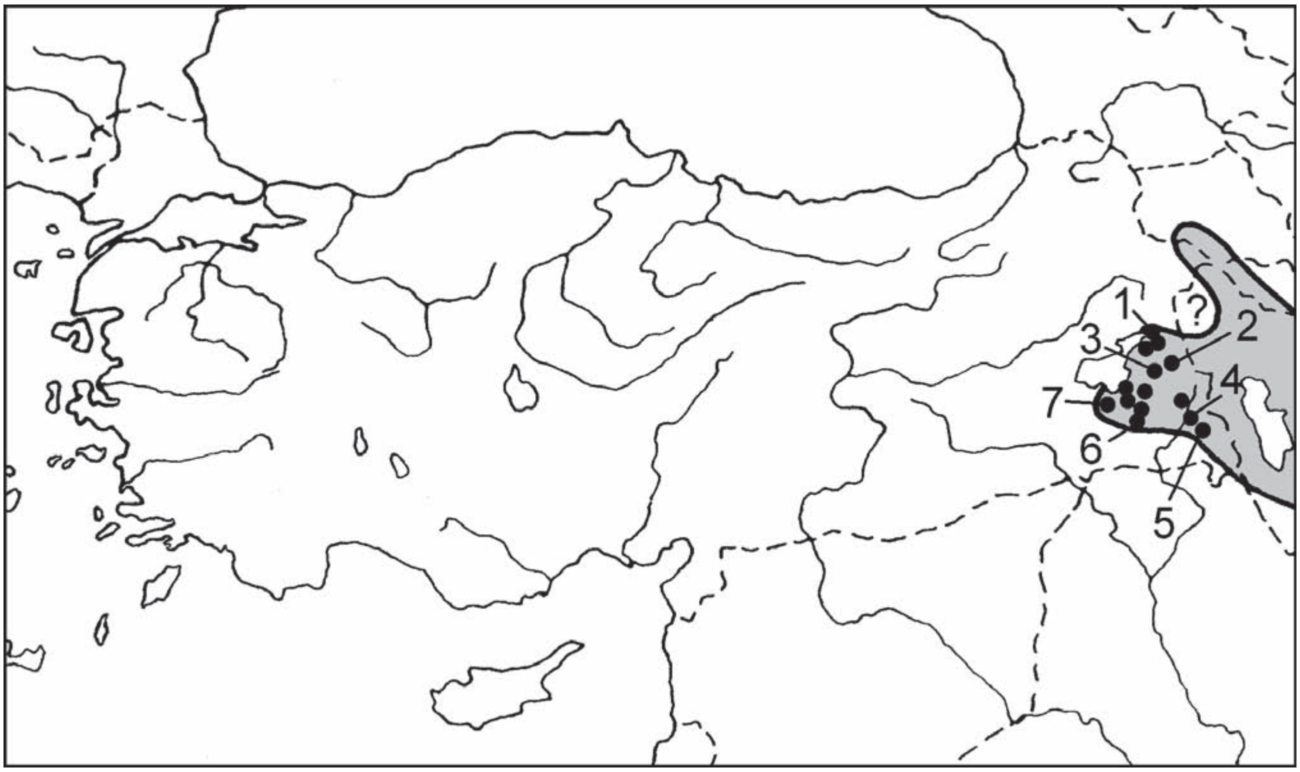


Figure 110. Distribution of *Ellobius lutescens* in Turkey. Records: **1** – 2 km south of Gönderme village, Muradiye, Van; **2** – Saray, Van; **3** – Erçek, Van; **4** – Hane Musa between Başkale and Yüksekova, Van; **5** – Suüstü village, Yüksekova, Van; **6** – Kayaboğaz village, Çatak, Van; **7** – 2 km east of Güzelkonak village, Gevaş, Van. Corresponding references: Morlok (1978): 3. Coşkun (2001): 4, 5. Coşkun & Ulutürk (2003): 1, 2, 6, 7.

understanding of its distribution. All the records are approximately to the east and southeast of Lake Van, the one at Gönderme (near Muradiye) being the most northerly exposed. However, considering the range in adjacent Armenia (Šidlovskij, 1976), the species might also be present around Mt. Ağrı (= Ararat).

Palaeontology. In the Middle Pleistocene, the range of *E. lutescens* probably extended as far north as the Apšeron peninsula, and to Palestine and possibly Cyrenaica (Libya) in the south (Gromov & Baranova, 1981). Pleistocene mole-vole remnants were also reported from Anatolia (Konya-Akşehir-Dursunlu; Coşkun & Ulutürk, 2003). In the opinion of Coşkun & Ulutürk (2003) the actual range in eastern Turkey results from a competitive exclusion of the mole-vole by the larger mole-rat *Nannospalax nehringi*.

Habitat

This mole-vole populates dry grassy habitats and semi-deserts of various soil types, including sandy ones (Gromov & Erbajeva, 1995), but avoids moving sand (Coşkun, 2001). In Iran, Lay (1967) noted mole-voles on barren peneplain and in the thin soil of rocky mountain sides. Around Van, at the elevation of 1,700 m a.s.l., the main plants in the southern mole-vole habitat include *Festuca valesiaca, Eremopoa songarica, Bromus danthoniae*, and *Ornithogallum* spp. (Yiğit *et al*., 2003a). In Iran, Lay (1967) found it particularly common around cultivated or grassy fields, and Coşkun & Ulutürk (2003) report highest densities in eastern Turkey to be in beet fields.

Figure 111. Steppe habitat at Başkale (Van province), Turkey, with mounds of *Ellobius lutescens*. From Coşkun (2001; Zoology in the Middle East, Vol. 23, p. 7) by permission from Kasparek Verlag.

Altitude. The altitudinal range in Armenia varies from 700 to 2,500 m a.s.l. (Gromov & Baranova, 1981). For Iran, Moradi Gharkheloo & Kıvanç (2003) report the southern mole-rat as being common and widespread in open habitats, including agricultural areas, but absent locally from altitudes between 600 and 1,800 m a.s.l. Coşkun (2001) states the altitude in eastern Turkey to range between 1,500 and 3,000 m a.s.l., yet it is not evident whether this refers to elevational range of actual captures. The only Turkish records with the altitude recorded are from between 1,580 (Coşkun, 1997) and 1,850 m a.s.l. (FMNH specimens).

Associates. Near Van, Yiğit *et al*. (2003a) collected, along with the southern mole-vole, also *Spermophilus xanthoprymnus*, *Allactaga williamsi,* hamsters (*Cricetulus migratorius* and *Mesocricetus brandti*) and voles *Microtus socialis* and *M.* ex gr. *arvalis*. Subterranean rodents have evident difficulty in sharing an ecological niche and thus the sympatry of two such species is rare. Not surprisingly, Coşkun & Ulutürk (2003) demonstrate that the ranges of mole-rats (*Nannospalax*) and mole-voles are mutually exclusive in eastern Turkey, with a gap of 5–8 km in between. Contrary to this, Yiğit *et al*. (2003a) report the southern mole-vole along with *Spalax leucodon (= Nannospalax nehringi*) from 10 km south of Van.

Density. Coşkun & Ulutürk (2003) give the home range of a family (two adults plus at least one pup and up to five animals altogether) to be approximately 108 m^2 and estimate the population density at up to 240 individuals per hectare.

Biology

Activity and Burrows. The southern mole-vole is strictly subterranean, digging extensive tunnels in the same way as mole-rats (Spalacinae), thus using proodont incisors and skull as a powerful shovel and drill (Hinton, 1926). Due to convergent development, the mandible is similar to the one seen in mole-rats rather than in other subterranean voles from north-eastern Turkey (i.e. *Prometheomys schaposchnikowi*). The southern mole-vole loosens the soil with its incisors, then pushes it behind its body with its fore and hind limbs, and later transports it to the surface, using its hind feet (Lay, 1967; Coşkun, 2001). The mounds of excavated soil are 24–50 cm in diameter and 9–14 cm in height (Coşkun & Ulutürk, 2003; Šidlovskij, 1976, gives the diameter of 20–25 cm); they are spaced 4–70 m apart (Coşkun & Ulutürk, 2003). The tunnels (vertical diameter 5–8, horizontal one 6–9 cm) are 16–48 cm below the surface (27 ± 5.8 cm; Coşkun & Ulutürk, 2003). Coşkun & Ulutürk (2003) also describe emergency tunnels descending at an angle of 45° and going as deep as 54–90 cm. Šidlovskij (1976) reports nest chamber, food storage room and latrine at a depth of 60–90 cm below the surface, but Coşkun & Ulutürk (2003) state that the nests are closer to the surface. In eastern Turkey the mole-vole stores food in expanded nest chambers lined with dry grass and other soft material (plastic, textile; Coşkun & Ulutürk, 2003). At higher elevations of Iran the molehills are more common in summer, but the opposite holds for the lowlands (Moradi Gharkheloo & Kıvanç, 2003). The species is also active on the surface (Lay, 1967).

REPRODUCTION. Coşkun & Ulutürk (2003) collected juveniles in May and also got a pregnant female in October. In Armenia, Šidlovskij (1976) found pregnant females from March to April, while young appeared in May; this is in accordance with the Iranian data (cf. Harrison & Bates, 1991). Nevo (1999) reports three litters per year, with three young on average. In Armenia the number of embryos is from three to four (Dahl, 1954), and Morlok (1978) collected at Erçek a female with two embryos in mid-June. Coşkun & Ulutürk (2003) report a female that contained four embryos.

FOOD. The southern mole-vole is strictly herbivorous, feeding mainly on bulbs, tubers, roots and other underground plant organs. Reported from Turkey are the genera *Geranium, Bunium,* and *Allium,* in addition to potatoes, carrots (preferred) and onions in cultivated regions (Coşkun, 2001; Coşkun & Ulutürk, 2003). In eastern Turkey the underground parts of plants are damaged at depths of 10 to 12 cm (Coşkun & Ulutürk, 2003). Under laboratory conditions the daily consumption varied between 0.57 and 1.08 g (mean = 0.74 g) of food per gram of body mass; the correlation between body mass and plant consumption was positive and significant (r = 0.63). Females consumed more food than did males and the amount per animal was lower when mole-voles were in couples (Coşkun & Ulutürk, 2003).

PREDATION. Obuch (1994) found mole-voles in eagle owl *(Bubo bubo)* pellets.

GENUS: *PROMETHEOMYS* SATUNIN, 1901

A monospecific genus, characterised by many primitive characters (Hinton, 1926), whose fossil record dates back to the Middle Pleistocene (Gromov & Baranova, 1981). Being of very isolated position within Arvicolinae (Corbet, 1978), it is usually placed in a tribe of its own, the Prometheomyini Kretzoi, 1955 (Gromov & Poljakov, 1977; Pavlinov & Rossolimo, 1987, 1998; Musser & Carleton, 1993). Repenning (1990) aligned *Prometheomys* with *Ellobius* in a separate subfamily Prometheomyinae.

Figure 112. Long-clawed mole-vole *Prometheomys schaposchnikowi*. Drawing: J. Hošek.

LONG-CLAWED MOLE-VOLE – *PROMETHEOMYS SCHAPOSCHNIKOWI*

Prometheomys schaposchnikowi Satunin, 1901. Type loc.: Gudaur, south of Krestovyj Pass, Dušeti District, Georgia.

NOMENCLATURE

There is inconsistency regarding the spelling of the specific name of the long-clawed mole-vole, which is given either as *schaposchnikovi* (Bobrinskij *et al*., 1944; Ognev, 1948; Spitzenberger & Steiner, 1962; Vorontsov, 1966; Steiner, 1972; Šidlovskij, 1976; Pavlinov & Rossolimo, 1987, 1998; Vinogradov & Gromov, 1984; Gromov & Baranova, 1981; Zima & Král, 1984; Gromov & Erbajeva, 1995; Bukhnikashvili & Kandaurov, 1998; Panteleyev, 1998; Çolak *et al*., 1999b; Nevo, 1999; Kryštufek & Vohralík, 2001; Yiğit *et al*., 2003a) or as *schaposchnikowi* (Hinton, 1926; Ellerman & Morrison-Scott, 1951; Kumerloeve, 1975; Corbet, 1978; Doğramacı, 1989; Musser & Carleton, 1993; Kurtonur *et al*., 1996; Çolak *et al*., 1999a; Nowak, 1999). Originally, this species was described as *schaposchnikowi* (Satunin, 1901). According to the International Code of Zoological Nomenclature (4th ed., London, 1999; Article 11.2) the letter 'w' can be used in the name of a species. Consequently, the proper spelling is *P. schaposchnikowi*.

DESCRIPTION

EXTERNAL CHARACTERS. A medium-sized vole with very small eyes (2.1 mm in diameter; Spitzenberger & Steiner, 1964) and conspicuous ears, equipped with an antitragus. Ears are sparsely covered by hairs and there are long hairs in front of the ear lobe (Ognev, 1948). The stout tail with a broad base (*c*. 5.5 mm) is densely covered by hairs; it equals approximately one third of head and body length (26.7–43.0%; mean = 33.9%). Terminal pencil measures up to 6 mm long. Palms and soles are naked among pads, and front toes have long claws (length 6.2–7.2 mm; Spitzenberger & Steiner, 1964); those on the middle toes are particularly large. Hind claws are less than 4 mm in length. There is no pad on rhinarium. Mystacial vibrissae are short and frequently pale. Fur is silky and up to 6 mm long.

COLOUR. Upper parts are snuff brown with pinkish cinnamon shades on the belly. Coat of juveniles is more greyish. Tail is uniformly brown but its tip is frequently white (nine cases among the 78 animals collected on the Caucasus). Feet are dark brown.

NIPPLES. There are eight nipples.

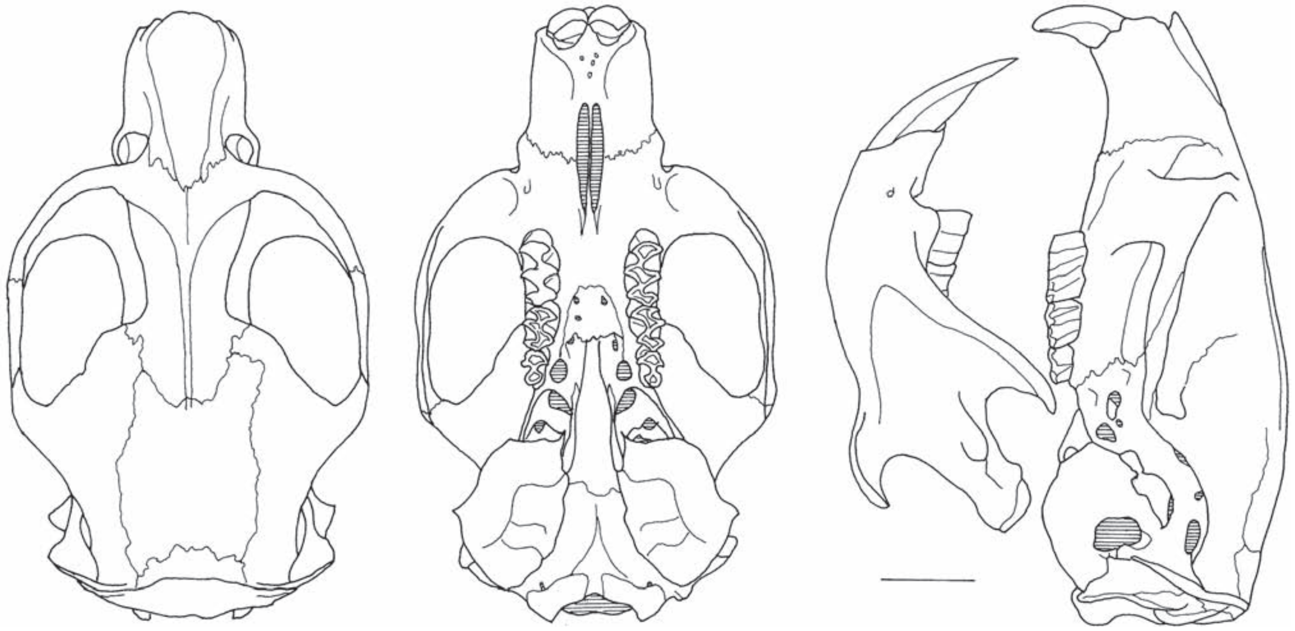


Figure 113. Skull and mandible of *Prometheomys schaposchnikowi*, based on an adult specimen from the Caucasus (BMNH). Scale bar = 5 mm.

Penis and baculum. Glans penis is simple and oval (Ognev, 1948), 15.9 mm long and covered with spines (Çolak *et al.*, 1999). The baculum is composed of corpus (length = 3.74 mm) and three distal processes (length of the medial process = 1.51 mm; Çolak *et al.*, 1999).

Skull is robust and squarish (Fig. 113). Rostrum is broad and moderately long, the interorbital constriction is well pronounced and the brain-case is quadratic in dorsal outline. The sagittal suture persists into an advanced age, a condition not common among voles. The interparietal is particularly small and diminishes with age. In adults, the supraorbital ridges are fused to produce a crest. Incisive foramina are moderately large. The posterior margin of hard palate shows broad and complete postero-lateral bridges and a broad, irregular medial spine between prominent lateral pits. Bullae show no peculiarities and the *porus acusticus* is of normal size. The mandible has well developed processes; the alveolar process, however, is small.

Teeth. Upper incisors are orthodont with shallow longitudinal grooves, and the molars are rooted, with two roots each. Re-entrant folds lack cementum. Enamel is thick. The enamel patter is simple with no sharp salient angles and dental fields of alternating triangles are frequently confluent (Fig. 114). The enamel pattern is so unusual for voles that in the original description of the species by Satunin (1901) A. Nehring made an editorial note to express doubt whether the pattern is correctly figured. The 1st lower molar has only three alternating triangles. Posterior molars are of particularly simple structure and the posterior lobe of the 3rd upper molar is small and oval (Fig. 114).

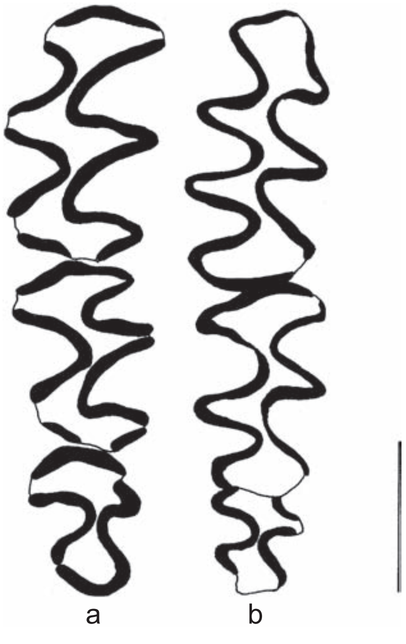


Figure 114. Upper (**a**) and lower molars (**b**) in *Prometheomys schaposchnikowi* (same specimen as on Fig. 113). Scale bar = 2 mm.

Dimensions. Males are slightly larger than females (mean condylobasal length in males = 32.29 mm, in females = 31.56 mm; Steiner, 1972), the difference is not significant, however. For dimensions see Table 32.

	N	mean	min-max
Head and body	35	137.5	126–156
Tail	33	46.0	36–58
Hind foot	35	22.3	20–25
Ear	35	12.6	10–15
Weight	17	71.3	59.5–87.8
Condylobasal length	34	32.1	29.9–33.3
Zygomatic breadth	33	18.6	17.6–19.6
Maxillary tooth-row	34	7.8	7.0–8.5

Table 32. External and cranial dimensions of *Prometheomys schaposchnikowi* from Turkey and the Caucasus. Based on Spitzenberger & Steiner (1964), specimens in BMNH and NMNH, and our own data.

Chromosomes. The diploid number of chromosomes is 2N = 56, while the opinion on the fundamental number of chromosomal arms differ among authorities. Zima & Král (1984) state this to be NFa = 70 and the Y chromosomes to be acrocentric, while Çolak *et al.* (1999a,b) report for two Turkish samples the NFa = 100 and the Y chromosome as metacentric. Such a divergence in opinions possibly reflects different counts of acrocentrics, all of which possess clear short arms (Zima & Král, 1984).

VARIATION

No subspecies are recognised (Gromov & Erbajeva, 1995) and Spitzenberger & Steiner (1964) did not find any differences separating the Turkish sample from the Caucasian ones. Ognev (1948) reports melanistic specimens from the Caucasus, but no such specimens have been found in Turkey so far (Spitzenberger & Steiner, 1964).

Distribution

The species occupies a small range (less than 5,000 km^2 in total; Bukhnikashvili & Kandaurov, 1998), restricted to the Caucasus and the adjacent parts of Turkey. The area is in three fragments (Šidlovskij, 1976). Two of them are in the Greater Caucasus, where the long-clawed mole-vole ranges from Abkhazia (Avadkhara) to the springs of the river Aragvi. In the Lesser Caucasus it is restricted to western Georgia whence the range continues into north-eastern Turkey. Turkey is thus on the very margin of the range, and the species was reported from only four localities in the districts of Artvin and Ardahan (Fig. 115). Steiner (1972) failed to confirm its presence further west in the districts of Rize and Giresun.

Palaeontology. The long-clawed mole-vole is reported to occur in the Caucasus since the Middle Pleistocene (Baryshnikov & Baranova; 1983).

Habitat

Preferred habitats in the Caucasus are mesic tall-grass meadows on slopes where extensive snow cover lasts for >200 days in a year (Gromov & Erbajeva, 1995). The long-clawed mole-vole is also found in meadows inside forests and on arable land (fields of barley and potatoes), but avoids steep slopes (angle >25º) and rocky places (Gromov & Erbajeva, 1995). In Turkey, Spitzenberger & Steiner (1964) collected specimens in mesic meadows and pastures with *Urtica* sp., *Rumex* sp, and *Ranunculus elegans*. We found small and widely scattered colonies on a short grass mountain pastures. Yiğit *et al.* (2003a) give the following list of plants as being dominant: *Bromus tomentellus, Festuca valesiaca, Astragalus microcephalus, Agroppyron repens, Echinops ritrio*, and *Eryngium campestre*.

Altitude. The long-clawed mole-vole is a species of flat high mountain meadows, with elevations ranging between 1,500 and 2,800 m a.s.l. (Nowak, 1999); the Turkish records are from 2,000–2,500 m a.s.l. (Spitzenberger & Steiner, 1964; Steiner, 1972; own data).

Associates. Along with the long-clawed mole-

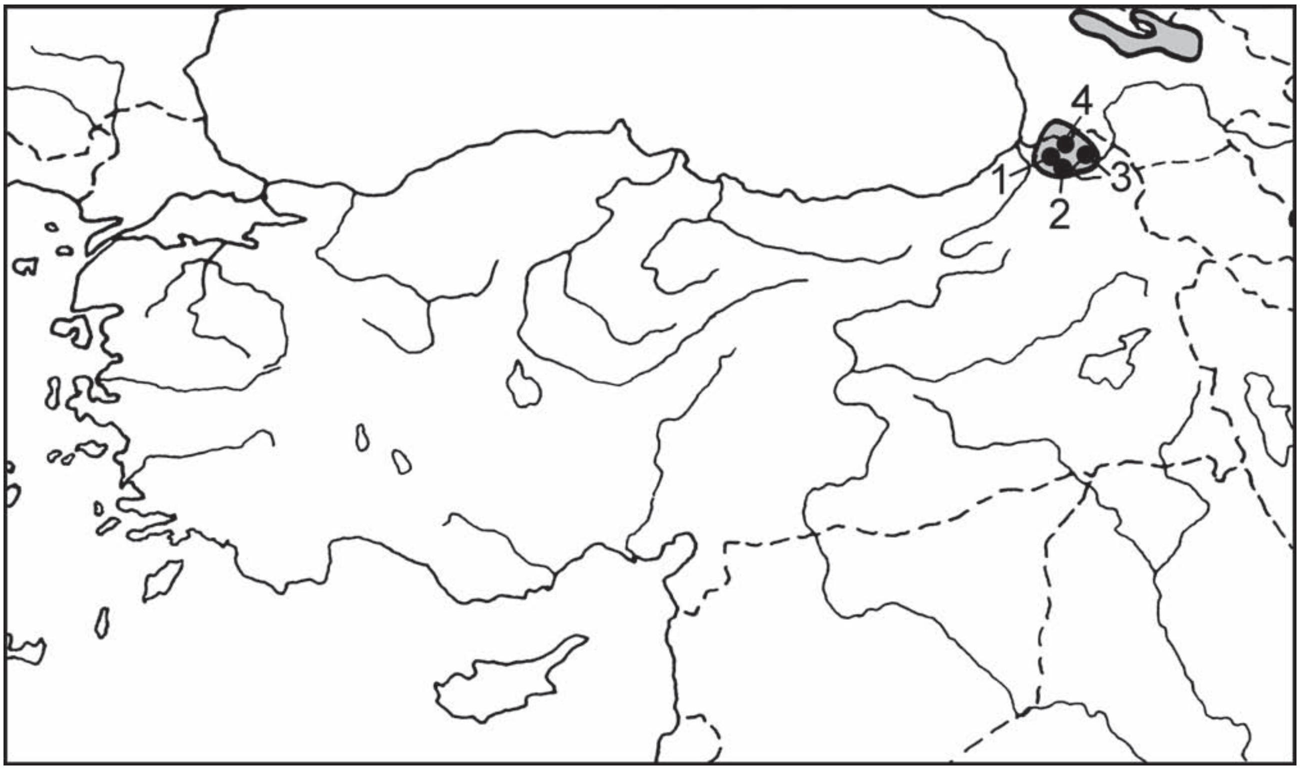


Figure 115. Distribution of *Prometheomys schaposchnikowi* in Turkey. Records: **1** – Kutul plateau, Ardanuç, Artvin; **2** – 15 km east of Ardanuç, Artvin; **3** – 15 km north of Ardahan, Kars; **4** – Çam Geçidi, Ardahan, Kars. Corresponding references: Spitzenberger & Steiner (1964): 2. Çolak *et al.* (1999a,b): 1, 3. Own data: 4.

vole, Spitzenberger & Steiner (1964) also collected *Talpa levantis, Microtus* ex gr. *arvalis* (possibly *M. obscurus*), and *M. majori*. Although Šidlovskij (1976) has shown the long-clawed mole-vole to be allopatric with the mole-rats (Spalacinae) in the Caucasus, Yiğit *et al.* (2003a) report *Prometheomys* along with *Spalax leucodon (= Nannospalax nehrigi*) in Kars and Ardahan; see also comments under *Ellobius lutescens*. In our observation from the mountains between Artvin and Ardahan, the two subterranean rodents are segregated by elevation, with *Prometheomys* being restricted to elevations above 2,000 m.

DENSITY. The population densities in Abkhasia are up to 150–200 mole-voles per hectare (Gromov & Erbajeva, 1995). Spring densities on a high mountain pastures at Çam Geçidi were considerably lower, roughly one per hectare. The densities are prone to oscillations. Mortality during spring, when tunnels are flooded with water which freezes subsequently, is considered to be a significant cause of mortality in Georgia (Bukhnikashvili & Kandaurov, 1998).

BIOLOGY

ACTIVITY AND BURROWS. This is another subterranean vole of Turkey. However, the long-clawed mole-vole performs its burrowing activity in a quite different way from that of the southern mole-vole *Ellobius lutescens*, using its hands similarly as the zokors (*Myospalax*) and the pocket gophers (*Geomys*) do. The front claws are thus much enlarged, while the upper incisors are orthodont. Soil is loosened by long claws of the powerful front limbs and pushed on to the surface; up to 10% of soil surface can be covered with mounds of excavated soil.

The grass-lined nest chamber (35 x 45 x 16–18 cm; Šidlovskij, 1976) is up to 1 m below the surface (Gromov & Erbajeva, 1995) and up to 12–14 narrow tunnels (diameter between 2.5 and 4 cm) radiate from it. Small colonies of long-clawed mole-voles dig extensive underground systems of main radial burrows from which numerous short tunnels branch upwards towards the surface. The surface opening is covered with a mound of excavated soil (Vorontsov, 1966). The tunnels are wider (7–8 cm) at depths of 7–15 cm than just at the surface (Gromov & Erbajeva, 1995) and Šidlovskij (1976) suggests that narrow tunnels prevent predators from entering into the burrow system.

REPRODUCTION lasts from late May to early August with two successive litters in a season (Gromov & Erbajeva, 1995). In Turkey, the litter size varies from three to six (mean = 3.8) and one pectoral pair of nipples can remain inactive during lactation (Spitzenberger & Steiner, 1964). It is not certain whether or not mole-voles of the same year participate in reproduction; Šidlovskij (1976) states body length of 125 mm and body mass of 47 grams as the lowest in sexually active females. The species is likely to survive two winters (Spitzenberger & Steiner, 1964).

FOOD. The long-clawed mole-vole is strictly herbivorous, feeding both above and below ground. Above-ground feeding occurs in warm weather and the feeding bout lasts 5–20 minutes. Food is stored

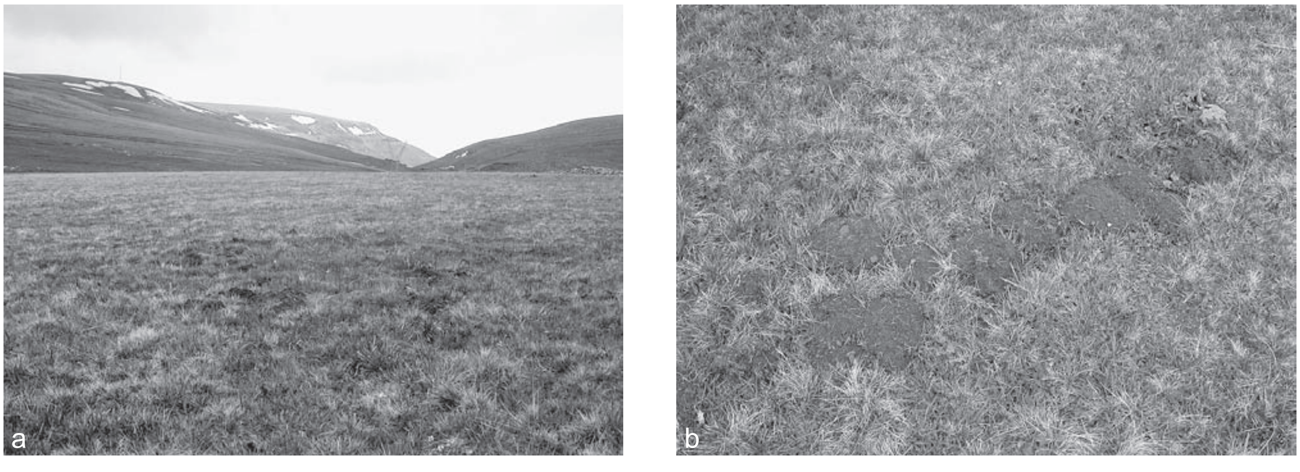


Figure 116. Habitat of *Prometheomys schaposchnikowi*. **a** – Çam Geçidi, Ardahan, at c. 2,500 m a.s.l. **b** – Mole hills by long-clawed mole-vole. Photo: A. Kryštufek.

for winter, and a store can contain up to 3.5 kg of roots and bulbs (Vorontsov, 1966).

CONSERVATION. Although the long-clawed mole-vole occurs close to human settlements, it is sensitive to habitat transformation and Bukhnikashvili & Kandaurov (1998) call for its protection in Georgia.

GENUS: *CLETHRIONOMYS* TILESIUS, 1850

Small scansorial voles with a rusty back and rooted molars. Tail is fairly long for voles, ears and eyes are relatively large and the snout is not as blunt as is common in the subfamily (Fig. 117). The bony palate terminates posteriorly as a simple transverse shelf. This genus is usually placed in the tribe Clethrionomyini together with some other Asiatic genera (*Alticola, Eothenomys,* and *Hyperacrius*). Molecular evidence suggests *Clethrionomys* to be paraphyletic within its present scope (Conroy & Cook, 1999). Currently, seven species are recognised within *Clethrionomys* (Musser & Carleton, 1993), which populate temperate and boreal regions of the entire Holarctic; a single species occurs in Turkey.

BANK VOLE – *CLETHRIONOMYS GLAREOLUS*

Mus glareolus Schreber, 1780. Type loc.: Island of Lolland, Denmark.

Evotomys ponticus Thomas, 1906. Type loc.: Sumela (= Meryemana), Trabzon, Turkey.

TAXONOMY

The first specimens in Turkey were collected by A. Robert in 1905 south of Trabzon and described subsequently by Thomas (1906a) as a species in its own right. Hinton (1926) still considered *ponticus* to be a full species but all subsequent authors have treated it as a junior synonym of *C. glareolus* (Neuhäuser, 1936b; Ellerman, 1948; Ognev, 1950; Ellerman & Morrison-Scott, 1951, etc.), a view also generally accepted at present (e.g. Musser & Carleton, 1993; Gromov & Erbajeva, 1995; Demirsoy, 1996; Pavlinov & Rossolimo, 1998; Doğramacı, 1989; Kurtonur *et al.*, 1996).

DESCRIPTION

EXTERNAL CHARACTERS. Fairly slim vole with the tail approximately one half of head and body length (43–61% of head and body; mean = 52%); terminal

Figure 117. Bank vole *Clethrionomys glareolus*. Drawing: J. Hošek.

pencil is quite distinct. Ears are sub-circular, slightly overtopping the fur. Dorsal hair is up to 10 mm long. Whiskers (length <27 mm) are dark with white tips. Eyes are small. Feet are narrow, front ones with four, hind ones with five toes. There are five palmar and six plantar pads.

COLOUR. Fur on the back is reddish, indistinctly delimited flanks are more buff or grey. Greyish belly is fairly well demarcated; it has silvery tinges or is washed with buff. Feet are greyish to whitish and tail is clearly bi-coloured, black brown above and grey below. Claws are small and whitish.

NIPPLES. There are four pairs of nipples.

BACULUM. The corpus of baculum is figured and described by Çolak *et al.* (1997e). Mean measurements in two specimens from north-western Anatolia are: length = 2.88 mm, basal width = 1.39 mm. Çolak *et al*. (1997e) claim that the baculum of Anatolian bank voles differs from the condition found in southern and western Europe and rather resembles the form observed in northern Europe. No evidence is provided in support of such a conclusion.

SKULL is small and lightly built, without pronounced ridges (Fig. 118). Zygomatic arches are not much expanded (50.8–58.2% of condylobasal length; mean = 54.2%), rostrum is fairly short and the braincase is broadly oval. Adult skull is quite shallow. Interorbital region is wide and smooth. Bullae are of medium size, incisive foramina are fairly long and wide. The posterior margin of the hard palate is a simple shelf. Mandible is slender and the coronoid process is weak.

TEETH. The incisors are slender and weak. Colour of the enamel varies from orange-yellow to pale yellow and to yellowish-white.

Molars are rooted in adults and the pulps start closing early in life (Fig. 119). The 1st upper molar has three roots and all the remaining cheek-teeth have only two (Fig. 120). Salient angles lack the sharp angularity which is so evident in *Microtus*. Re-entrant angles are filled with cementum. The 1st upper molar has four triangles posterior to the anterior loop and the 2nd molar is with three triangles in addition to the anterior loop. The 3rd upper molar has three (Fig. 122b, c) or rarely two (Fig. 122a) re-entrant angles on the inner side and two or three on the outer side (cf. Figs. 121 and 122). Osborn (1962) states that the complex 3rd upper molar (with four salient angles on the lingual side) is the norm in Anatolia; he found three exceptions in a pooled sample of 63 specimens.

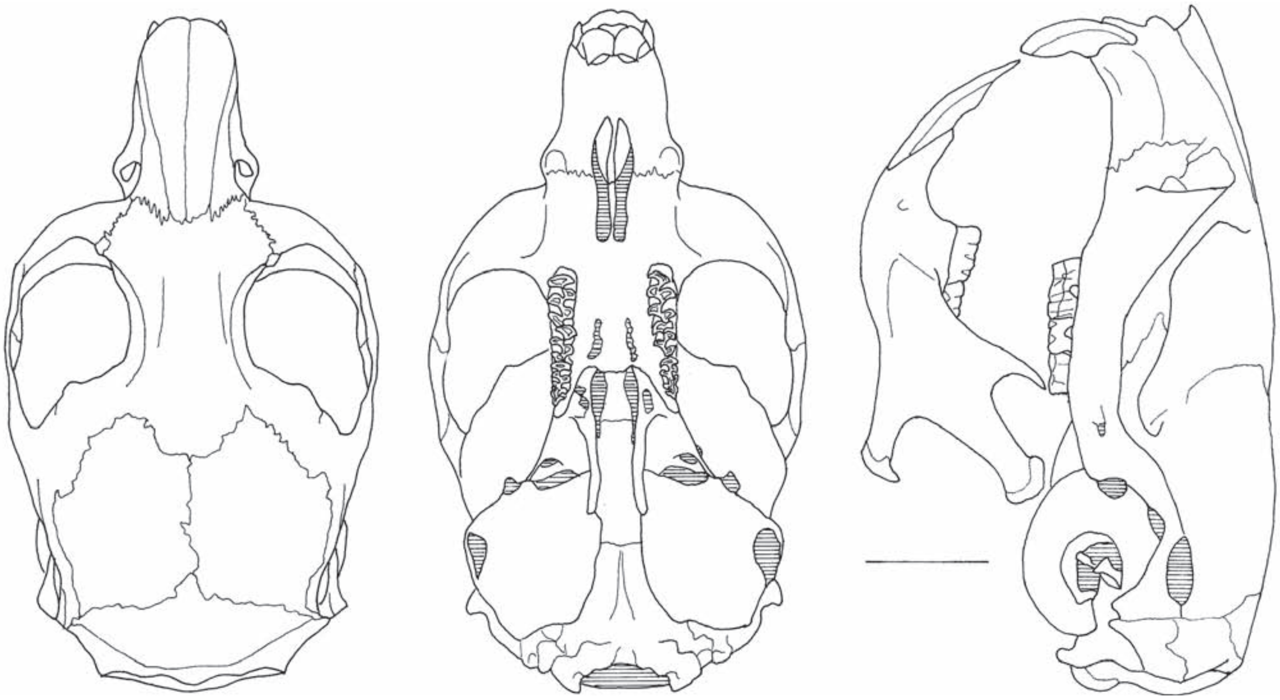


Figure 118. Skull and mandible of *Clethrionomys glareolus*, based on an adult male from 7 km south of Çaycuma, Zonguldak district. Scale bar = 5 mm.

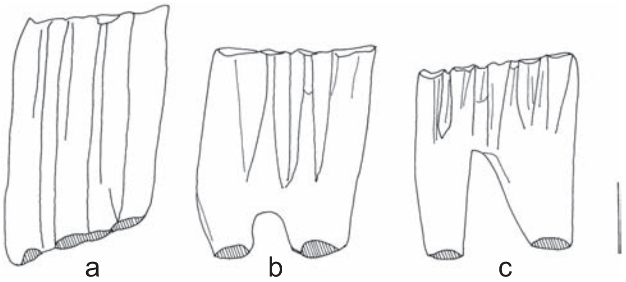


Figure 119. First lower molar in specimens of *Clethrionomys glareolus* of different age. Specimens of advanced age are arranged from left to right. Note that juvenile molar (**a**) still lacks roots. Anterior is to the left and dorsal is at top. Based on SMF specimens from Abant Gölü, Bolu. Scale bar = 1 mm.

The anteroconid complex of the 1st lower molar is highly variable. Triangles T4 and T5 are invariably present. The latter is either integrated into the anterior cup (Fig. 123a,b) or, more rarely, entirely isolated from it (Fig. 123c,d). The anterior cup is rarely simple and oval (and, as such, isolated from T5; Fig. 123c), but mostly broadly confluent with triangle T5. There are three or four re-entrant angles on the inner side and three on the outer one. The 2nd and 3rd lower molars show broadly confluent dental fields of the alternating triangles. Labial triangles are much reduced on the last lower molars.

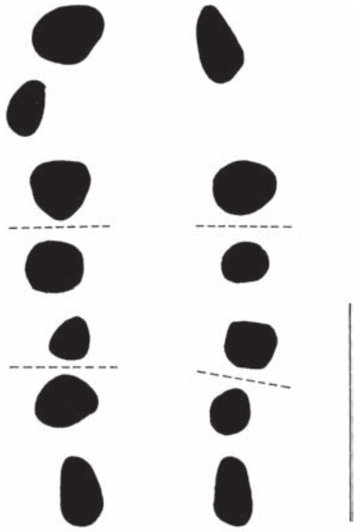


Figure 120. Upper (**a**) and lower (**b**) alveoli of an adult *Clethrionomys glareolus* from Abant Gölü, Bolu (SMF). Lingual side is to the left and anterior is at the top. Scale bar = 2 mm.

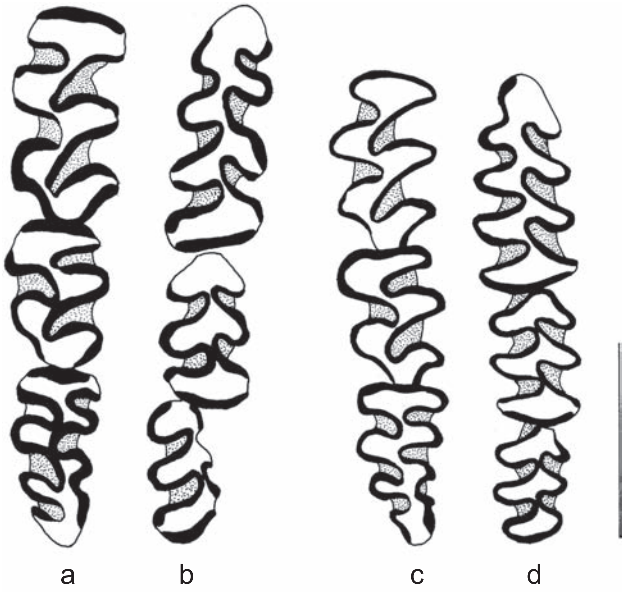


Figure 121. Upper (**a, c**) and lower molars (**b, d**) of *Clethrionomys glareolus*, based on a male from 7 km south of Çaycuma, Zonguldak (**a, b**; same specimen as on Fig. 118) and on a male from İlgazdağ Geçidi, Kastamonu (**c, d**). Lingual side is to the left, anterior is at the top. Scale bar = 2 mm.

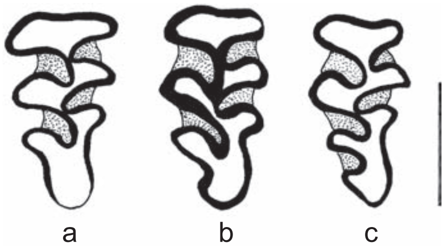


Figure 122. Different morphotypes of the 3rd upper molar of *Clethrionomys glareolus* from Abant Gölü, Bolu. Lingual side is to the left and anterior is at the top. Scale bar = 1 mm. See text for further explanation.

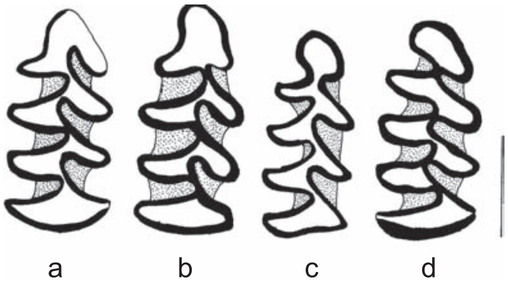


Figure 123. Different morphotypes of the 1st lower molar in *Clethrionomys glareolus* from Abant Gölü (**a–c**) and Uludağ (**d**). Lingual side is to the left and anterior is at the top. Scale bar = 1 mm. See text for further explanation.

Sample		1			2			3	
	N	mean	min-max	N	mean	min-max	N	mean	min-max
Head and body	35	100.0	90-114	9	100.1	96-105	6	104.2	100-107
Tail	32	52.6	46-60	8	50.3	47-55	6	55.7	51-60
Hind foot	35	18.2	17.0-17.9	9	17.6	16.8-19	6	18.8	18.3-19.5
Ear	35	13.3	12.0-15.0	9	13.2	12.5-14.2	6	14.8	13.0-16.3
Weight	18	26.8	21-35	9	21.6	19.5-22.5	6	28.3	24-34
Condylobasal length	27	24.10	22.9-26.2	8	23.4	22.6-23.9	13	24.83	24.0-25.6
Zygomatic breadth	27	13.20	12.3-14.5	8	12.5	12.0-12.8	13	13.60	12.6-14.3
Maxillary tooth-row	31	5.55	4.9-5.8	9	5.3	4.9-5.7	6	5.62	5.0-6.2

Table 33. External and cranial dimensions of *Clethrionomys glareolus* for three Turkish samples. Sample identities: **1** – North-eastern Anatolia (Uludağ; Abant Lake; Düzce; Sakarya; Zonguldak area); **2** – central Pontic Mts. (İlgaz Dağ; Amasya); **3** – eastern Pontic Mts. (districts of Trabzon, Giresun and Bayaburt). Based on Spitzenberge & Steiner (1962), Steiner (1972), own material and specimens in BMNH, NMNH, SMF and ZFMK.

Dimensions are given in Table 33. There is no apparent secondary sexual dimorphism in size.

Chromosomes. The diploid number of chromosomes in specimens from north-western Anatolia is 2N = 56, and the fundamental number of chromosomal arms is NFa = 56. The X chromosome is large acrocentric and the Y chromosome is small metacentric (Çolak *et al.*, 1997e). The Y chromosome in European populations is either bi-armed or acrocentric (Zima & Král, 1984).

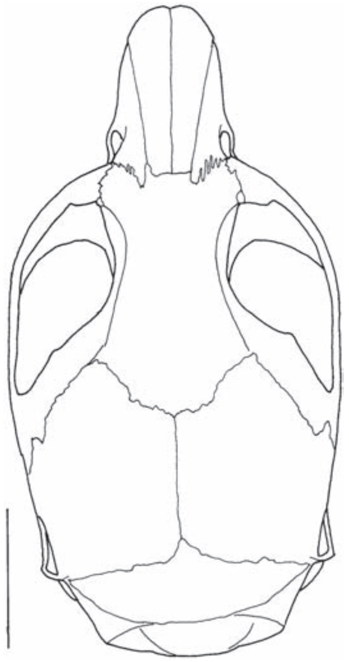


Figure 124. Dorsal aspect of the skull of the type specimen of *Clethrionomys glareolus ponticus* (BMNH). Scale bar = 5 mm.

Variation

The Turkish bank vole populations are not uniform morphologically (see Osborn, 1962, for a thorough discussion). Animals around Trabzon are the largest, with nearly uniformly dark tail and dark pelage. Their skull is also narrower across zygomatic arches than is in bank voles from north-western Anatolia (Figs. 124 & 125). The bank voles from the central Pontic Mts. are small and have a narrow skull. Populations from the north-western Anatolia are seemingly fairly uniform, intermediate in size and with bi-coloured tail. The samples are too small and also likely biased by several sources of variation to allow any firm conclu-

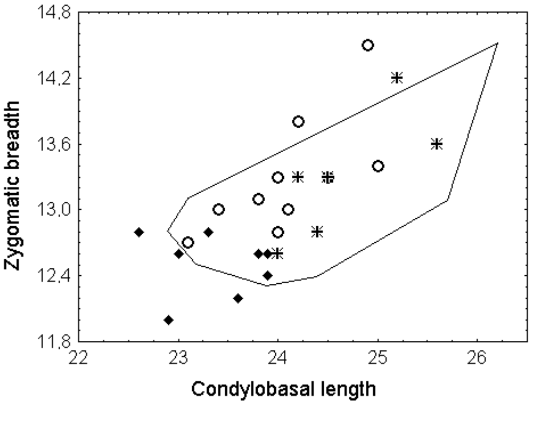


Figure 125. Bivariate plot of zygomatic breadth against condylobasal length of skull for Turkish *Clethrionomys glareolus*. Polygon encloses all the specimens from north-western Anatolia, except sample from Uludağ. Circles – Uludağ; asterisks – eastern Pontic Mts. (Trabzon; Giresun; Bayaburt); diamonds – central Pontic Mts. (İlgazdağ and Amasya).

sions. To the best of our knowledge, the Anatolian bank voles, which area is an isolate (see below), have not been carefully compared with their European counterparts so far (but cf. Zimmermann, 1950).

Çolak & Kıvanç (1991) paid attention on the shape of the posterior palatal margin which they found to be pointed backwards and with lobes in its middle in the majority of Anatolian specimens (46 out of the 58 specimens examined).

DISTRIBUTION

The range of the bank vole covers broadleaved and coniferous forests from the west of Europe as east as Lake Baikal. It is widespread in Europe, except the Iberian Peninsula and the rest of the Mediterranean coast.

In Turkey the bank vole populates northern Anatolia in the Marmara region and the Pontic Mts. (Çolak & Kıvanç, 1991). The range is probably contiguous in the mountains along the Black Sea, but the population on Mt. Uludağ is most probably an isolate. The gap between the records to the east of the Kızılırmak River possibly reflect low sampling effort (Fig. 126). The Anatolian population is isolated from the rest of the contiguous range of the bank vole.

Doğramacı (1989) reports the bank vole also from Thrace, which is certainly erroneous (Çolak & Kıvanç, 1991; cf. also the European distribution in

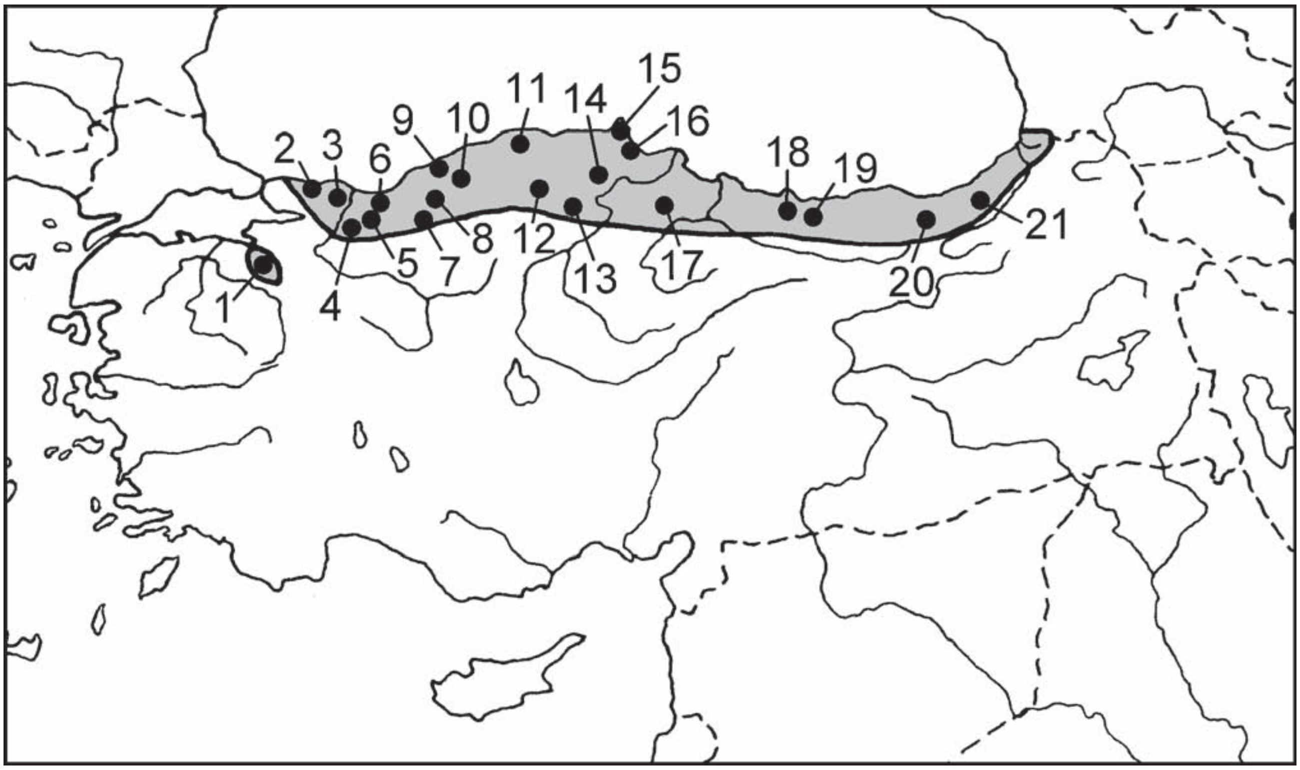


Figure 126. Distribution of *Clethrionomys glareolus* in Turkey. Records: **1a** – Uludağ, 1,400-2,000 m; **1b** – Uludağ, 1,800-2,100 m; **1c** – Yenikonak, Bursa, 1,025 m; **2** – Şile, İstanbul district, 200 m; **3** – Kandıra, Kocaeli; **4** – Hanyatak köyü, Kapıorman Dağları, Sakarya; **5** – Karadere, Adapazari; **6** – Kocaman forestry station (= 10 km east of Akçakoça; at sea level), Düzce; **7a** – Abant, Bolu; **7b** – Soğuksu, Abant, Bolu; **7c** – 25 km south of Düzce, Bolu, 1,400-1,450 m; **8a** – Karadere, Zonguldak; **8b** – Fındıkli, Karadere, Zonguldak; **9** – Çatalağzı, Zonguldak; **10** – 7 km south of Çaycuma, Zonguldak; **11** – Küre, Kastamonu; **12** – İlgazdağ Geçidi, Kastamonu; **13** – Tosya, Kastamonu; **14** – Bürnük, Boyabat, Kastamonu, 1,000 m; **15** – Bektaşaga, Sinop, 100-200 m; **16** – Gerze, Sinop; **17** – 2 km east of Seyfe, Amasya, 1,400 m; **18** – Çorakdüzü, Ulubey, Ordu; **19** – Biçik, Yavuzkemal, Giresun, 1,500 m; **20** – Mereyem Ana (= Meryemana) Trabzon, 1,000-1,200 m; **21** – Çat, Rize, 1,250 m. Corresponding references: Neuhäuser (1936b): 7a, 8a, 13. Osborn (1962): 1a, 6, 14, 15, 20. Spitzenberger & Steiner (1962): 19. Felten *et al.* (1971b): 1b, 7c. Steiner (1972): 19, 21. Çolak & Kıvanç (1991): 5, 7b, 8b, 9, 11, 16, 18. Kıvanç (1991): 2. Çolak *et al.* (1997e): 3. Yiğit *et al.* (2003a): 1c. Own data: 4, 10, 12, 17.

Mitchell-Jones *et al*., 1999); this possibly reflects the supposition by Osborn (1962) that the bank vole "might occur in the Istranca Mountains."

The easternmost records of Anatolian bank vole population are from Georgia, where it is confined to a small area along the border with Turkey. Only two localities are known in Georgia (environs of Bakhmaro and Mt. Did Maghali, respectively), from the elevation of 1,800–2,000 m a.s.l.; only four specimens have been collected there so far (Bukhnikashvili & Kandaurov, 1998).

PALAEONTOLOGY. It is beyond doubt that the Pontic bank vole population owes its presence in Anatolia to immigration from Europe via the Bosporous bridge (Hosey, 1982; Neuhäuser, 1936b; Osborn, 1962). Although being recently absent from Thrace (Mitchell-Jones *et al*., 1999, see also below), the bank vole is reported from the Middle Pleistocene layers of Yarımburgaz Cave in Turkish Thrace (Santel & Koenigswald, 1998). Another Middle-Pleistocene record at Emirkaya-2 (northern slopes of the Taurus Mts.) indicates its much wider past presence in Anatolia (Montuire *et al*., 1994). During the Middle Pleistocene, the bank vole or a form closely related to it also occurred in the Caucasus (Baryshnikov & Baranova, 1983).

HABITAT

Figure 127. Habitat of *Clethrionomys glareolus*. Abant, Bolu. Photo: B. Kryštufek.

In Turkey the preferred habitats of the bank vole include deciduous, mixed, and coniferous forests. The greatest variety of habitats and elevations is utilised in the Marmara region, where the species was collected as low as the sea level at Kocaman (Osborn, 1962), and up to 2,100 m a.s.l. on Mt. Uludağ (Felten *et al*., 1971). In the lowlands, the bank vole populates mesic forests of beech, hornbeam, oak and platan trees as well as patches of hardwood coppice. In the mountains, forests of fir, spruce and beech are the main habitat. Mixed forests in Marmara consist of *Abies nordmanniana, Fagus orientalis, Carpinus betulus, Populus tremula, Quercus infectoria*, and *Q. cerris*, and those in the eastern Pontic Mts. of *Picea orientalis, Castanea sativa, Alnus glutinosa, Fagus orientalis, Juglans regia,* and *Carpinus betulus* (Yiğit *et al*., 2003a). Kıvanç (1991) reports the following plants to dominate in the bank vole habitat: trees: *Fagus orientalis, Carpinus betulus, Abies* spp., *Corylus avellana, Platanus* spp., and *Quercus* spp.; shrubs: *Daphne pontica, Rosa* spp., *Rubus* spp., *Pyracantha coccinea, Ilex colchica, Sambucus nigra, Ligustrum vulgare, Viburnum opulus, Rhododendron luteum*, and *R. ponticum*; herbs and grasses: *Fragaria vesca, Pteridium* spp., *Festuca* spp., *Brachypodium pinnatum,* and *Galium odoratum*.

ALTITUDE. From the sea level up to 2,100 m a.s.l.

ASSOCIATES. Collected in the same habitat with the bank vole were also wood mice (mainly *Apodemus uralensis* but also *A. flavicollis* and *A. mystacinus*), pine voles *Microtus* spp., *Chionomys roberti*, and, very exceptionally, *Arvicola terrestris*.

DENSITY. Nowhere in Anatolia did we find the bank vole as abundant as the wood mice (*Apodemus*).

BIOLOGY

The bank vole was studied extensively in Europe (e.g. Viro & Niethammer, 1982) but its life is little known in Anatolia. Kıvanç (1991) collected pregnant females from April 25 to September 10 and lactating females between April 24 and September 25. The number of embryos varies between 2 and 6 (mean = 4.1; N = 16; based on Spitzenberger & Steiner, 1962, Kıvanç, 1991, and our own data). Scrotal males have testes up to 10.5 x 7.2 mm in size.

GENUS: *ARVICOLA* LACÉPÈDE, 1799

Large, robust voles with dense shaggy pelage (Fig. 128). Head is large and robust, and the skull is widely arched and angular in adults. Pulps remain open in molars which do not develop roots but continue to growth throughout the life. The molars are thus highly crowned and prismatic, very similar to those seen in *Microtus*, but the 1st lower and 3rd upper molars are of more simple structure. This genus is considered as part of *Microtus* by some authorities. Molecular data, however, do not support close affinity between the two (Conroy & Cook, 1999). *Arvicola* is wholly Palaearctic in distribution.

The number of species caused long-lasting confusion and disagreement. The current taxonomic division into two species (*e.g*. Musser & Carleton, 1993), *A. sapidus* Miller, 1908, of south-western Europe and a highly polymorphic *A. terrestris* of widely Palaeractic distribution, is almost certainly an oversimplification and contradicts molecular data (Wust Saucy, 1998). In a recent revision, Panteleyev (2001) recognises three species, viz., *A. scherman* (Shaw, 1801), in addition to the two species mentioned above. Besides, he gives priority to *A. amphibius* (Linnaeus, 1758) over *A. terrestris*. As shown by Corbet (1978), such solution of this problem of nomenclature follows Blasius (1857) as the first reviser, and it is strictly correct. Notwithstanding this, we follow the well-established usage of the name *A. terrestris*, as was also recommended by Corbet (1978).

WATER VOLE – *ARVICOLA TERRESTRIS*

Mus terrestris Linnaeus, 1758. Type loc.: Uppsala, Sweden.
Microtus terrestris armenius Thomas, 1907. Type loc.: near Van Gölü, Turkey.
Arvicola terrestris hintoni Aharoni, 1932. Type loc.: Tell el Sultan Island, Amik Gölü, Antakya, Turkey.

Figure 128. Water vole *Arvicola terrestris*. Drawing: J. Hošek.

Description

External characters. The largest vole in the area, with head and body length over 150 mm and body mass up to 250 grams. Tail is long for voles (55–78% of head and body length; 67% on average). Head is large and blunt, eyes are fairly small and ears do not protrude from the fur. Rhinarium is small and mystacial vibrissae are fairly short (black or white). Underfur is soft and very dense, covered with long coarse guard hairs. Hind feet are strong with powerful claws. There are five plantar pads which are reduced in size; soles are nude.

Colour of the upper side ranges from yellowish brown to dark brown or almost blackish; median hairs are frequently black-tipped. Flanks are always more buff. Belly is greyish with various shades of white but is frequently washed with yellow or yellow-brownish shades. Tail is dark brown above, paler below, thus indistinctly bicoloured; young animals frequently have tail uniformly blackish brown or grey. Feet are mainly pale in adults, with silvery hair; juveniles and subadults have blackish brown feet.

Nipples. There are four pairs of nipples.

Penis and Baculum. Özkurt *et al.* (1999a) described the glans penis and baculum of Central Anatolian water voles. The glans has an expanded apex and is covered with horny spikes on the surface. The distal medial process of the baculum is 0.75 mm long; the stalk is 2.5 mm long and 1.6 mm wide across its proximal shaft.

Skull is strongly built, well ridged and widely arched; zygomatic breadth is 54.4–59.9% of the condylobasal length (mean = 57.9%). Rostrum is short but deep and nasals are expanded anteriorly. Postorbital squamosal crest is well marked and the temporal ridges form a sagittal crest in full grown adults; Turkish specimens with the condylobasal length around 40 mm occasionally still have ridges up to 2 mm apart. Interorbital region is short with a well marked postorbital constriction. Braincase is nearly rectangular. Bullae are of moderate size, diastema is long and incisive foramina are short. The posterior margin of the hard palate is like that in *Microtus*, with a short, broad and low median septum. Mandible is heavy, short and deep, with all three processes well developed.

Teeth. Incisors are strong but orthodont, with orange enamel on the front surface. Molars are robust and hypsodont; re-entrant angles are filled with cementum. Triangles posterior to the anterior loop of the 1st and 2nd upper molars alternating (Fig. 131). Third upper molar consists of an anterior loop followed by two or three altnernating triangles; the postero-labial triangle T4 is frequently fused with a much reduced posterior cup (Fig. 132a), but its dental field is closed in some animals (Fig. 132b, c). There

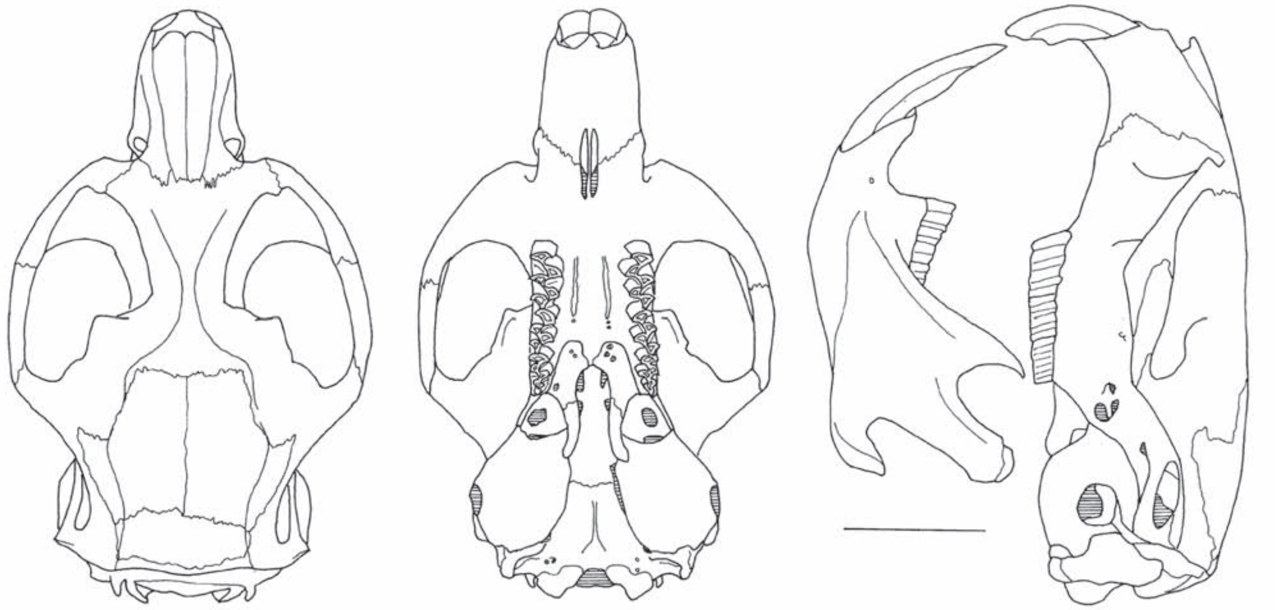


Figure 129. Skull and mandible of *Arvicola terrestris*, based on an adult female from Tatvan (ZFMK). Scale bar = 10 mm.

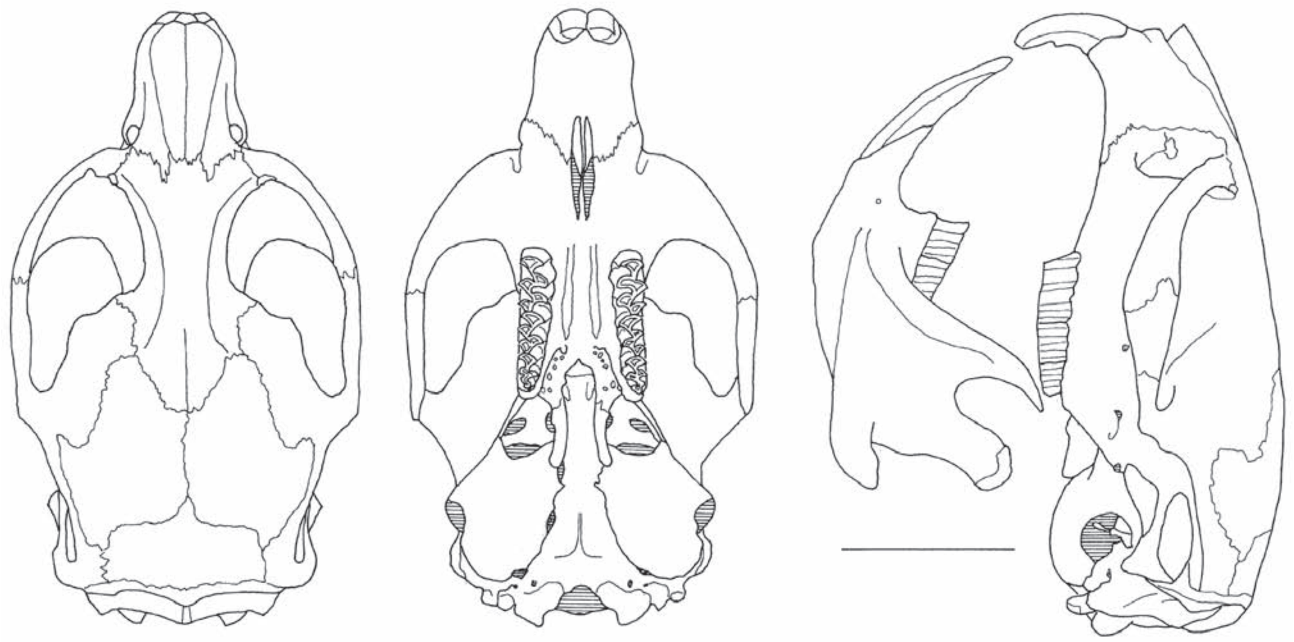
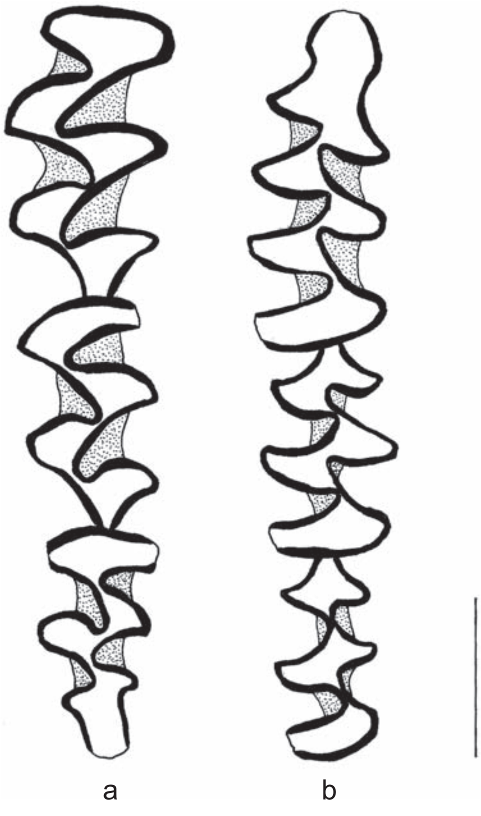


Figure 130. Skull and mandible of *Arvicola terrestris*, based on a subadult female from Abant Lake, Bolu. Scale bar = 10 mm.



a b

Figure 131. Upper (**a**) and lower molars (**b**) of *Arvicola terrestris*, based on a female from Tatvan (same specimen as on Fig. 129). Lingual side is to the left. Scale bar = 2 mm.

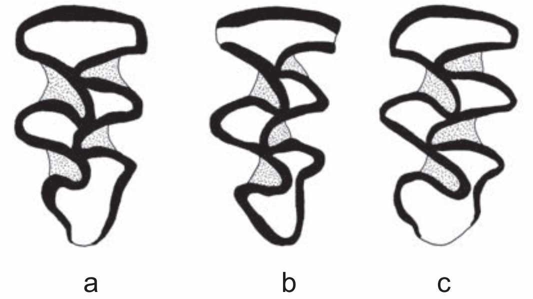


Figure 132. Morphotypes of the 3rd upper molar of *Arvicola terrestris* from Turkey. **a** – Abant Lake, Bolu; **b** – 10 km east of Erence, Erzurum; **c** – 12 miles east of Izmit (FMNH). Lingual side is to the left and anterior is at the top. Not to scale. See text for further explanation.

are never more than two deep re-entrant angles on either side of the 3rd upper molar. First lower molar has three alternating triangles with closed dental fields (T1 to T3). The anterior triangles T4 and T5 are always broadly confluent with the anterior cup. There are four lingual and three buccal re-entrant angles and the antero-labial re-entrant angle (BRA3) is frequently very shallow or even absent (Fig. 133a). Triangles of the 2nd and 3rd lower molars are confluent, although first two triangles of the 2nd molar tend towards alternation.

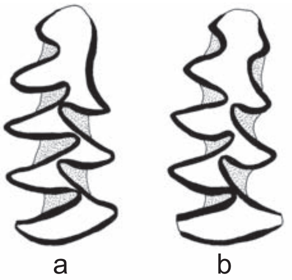


Figure 133. Two different morphotypes of the 1st lower molar of *Arvicola terrestris* from Turkey. **a** – 12 miles east of Izmit (FMNH); **b** – Abant Lake. Lingual side is to the left and anterior is at the top. See text for further explanation.

DIMENSIONS are given in Table 34. In a sample from the Caucasus, collected in August, males attained larger body mass (175 ± 2.5 g, N = 45) than females (167 ±2.5 g, N = 30; Panteleyev, 2001).

CHROMOSOMES. The diploid number of chromosomes in Central Anatolian water voles corresponds to the situation elsewhere in Europe and the Caucasus (Özkurt *et al.*, 1999a): 2N = 36, NFa = 60; the X chromosome is medium-sized biarmed and the Y chromosome is medium-sized acrocentric. Four autosomal pairs are acrocentric and the remaining elements are biarmed.

VARIABILITY

Two main morphotypes are distinguished within recent *A. terrestris*, aquatic and fossorial. The fossorial water voles are smaller, with softer pelage, more reduced plantar and palmar tubercles, and the upper incisors strongly projecting forwards (Miller, 1912). Panteleyev (2001) classified such voles as *A. scherman*. Only the aquatic form occurs in Turkey.

Mitochondrial phylogeny based on sequences of 800–1,200bp of the mitochondrial cytochrome *b* gene distinguishes three main groups within *A. terrestris*: (1) strictly fossorial water voles from the mountain regions of Europe, (2) aquatic and transitional populations living south of the Alps, and (3) the remaining aquatic populations (Wust Saucy, 1998). The last of the three groups is far from being uniform, and a single specimen from Turkey (Abant Lake), which was analysed by Wust Saucy, suggests that the Turkish water voles may be a sister group to the main aquatic clade.

Apparently, the first water voles collected in Turkey were those from Van in 1896, which were submitted to the BMNH by W. H. Williams and subsequently reported by Barrett-Hamilton (1899) as *Microtus persicus*. Light-coloured belly was given as the main diagnostic character. Shortly afterwards, Thomas (1907a) applied the name *Microtus terrestris persicus* to denote water voles from the lowlands along the southern coast of the Caspian Sea, with sharply angular molar re-entrant and salient angles. Thomas (1907a) distinguished water voles from Van and from the Elburz Mts. as a new subspecies *armenius* on the basis of rounded ("often almost circular") molar angles. The subspecies *armenius* was synonymised with *Arvicola terrestris persicus* de Filippi, 1865 (type loc.: Sultanieh, on the plateau of the Elburz Mts.) already by Hinton (1926) and this opinion has been followed by all subsequent authorities.

Röttger (1987) shows that *A. t. persicus* from Van and adjacent Iran has retained the ancient pattern of the molar enamel thickness. The primitive pattern of thick enamel on the convex (lee) side and the thin-

Sample	1			2			3		
	N	mean	min-max	N	mean	min-max	N	mean	min-max
Head and body	7	190.6	174-205	15	174.0	151-195	18	172.1	153-195
Tail	7	122.3	106-132	15	122.3	111-136	19	119.5	104-139
Hind foot	8	36.9	33-39	15	35.6	34-38	19	33.1	29-37
Ear	8	17.8	16-20	15	17.7	17-20	16	16.7	13-21
Weight	1		236	15	130.0	110-144	3	170.0	140-200
Condylobasal length	7	41.3	40.1-43.0	15	37.1	36.3-38.2	14	40.1	36.8-42.8
Zygomatic breadth	7	24.1	22.6-25.2	15	23.0	21.9-24.1	12	23.1	20.0-25.4
Maxillary tooth-row	7	10.7	10.5-11.1	10	9.9	9.6-10.3	15	10.2	9.6-10.9

Table 34. External and cranial dimensions in three geographic samples of *Arvicola terrestris* from Turkey and adjacent Iran. Sample identities: **1** – Turkish Thrace; **2** – Kırşehir province, central Anatolia; **3** – Lake Van and north-western Iran (ssp. *persicus*). Based on Özkurt *et al.* (1999a; sample 2) and specimens in BMNH, FMNH, NMNH and ZFMK.

ner enamel on the concave (luff) one, characteristic of the fossil *Arvicola cantiana* (Hinton, 1910) and its predecessor *Mimomys* (Rekovets, 1990), actually survived in *A. sapidus* and in *A. t. persicus*. The remaining European *A. terrestris* populations show just the reverse pattern, *i.e.* a thick luff and thin lee side. It is thus difficult to distinguish between extant *A. terrestris* and fossil *A. cantiana* in Turkish water voles (Santel & Koenigswald, 1998).

It would be of prime interest to take a closer view on the geographic variation of the enamel wall pattern in water voles from the Balkans and western and central Anatolia. Röttger (1987) suggests a clinal decrease from the west of Europe to eastern Turkey and Iran in the enamel band width of the luff side (and a similar increase of the lee side), but there is a gap in evidence to support such a cline.

The water voles of Turkey and adjacent Iran are remarkably stable morphologically, possibly a reminiscence of strong selective pressure imposed by their semi-aquatic mode of life. Data in Table 34 suggest size variation to occur, but the Central Anatolian values might be underestimates due to a possible addition of subadults to full grown animals. In fact, water voles continue to grow late into advanced age, and consequently full-grown specimens are uncommon in collections. There seems to be no interpopulation variation in relative tail length or in relative zygomatic breadth in Turkish water voles.

Panteleyev (2001) reports considerable size variability in the Caucasus, where the body mass of males varied among localities between 173 ± 6.5 g to 210 ± 4.3 g. Body size also correlates positively with elevation (Panteleyev, 2001).

The colour of water voles undergoes considerable interpopulation variability in Turkey. Among specimens we saw, those from Van (and also from adjacent Iran) were the palest, while dark water voles were common in Thrace and possibly in Hatay (the only specimen we saw was a subadult). Ventral colour varies individually, some specimens having plain greyish belly, whereas in others it is occasionally washed with brown. Panteleyev (2001) reports the frequency occurrences of main colour types among various Caucasian subspecies. The grey-brown type predominates in *A. t. persicus* from Azerbaijan (100 and 91.9% in summer and in autumn of 1977, respectively; sample sizes were N = 93 and N = 211, respectively). The remaining animals were grey, brown, or reddish. The grey brown morphotype predominates, or co-dominates with the grey one also in another two Caucasian subspecies, *A. t. turovi* Ognev, 1933 (type loc.: near Kotljarevskaja, Černaja River, Kabarda district, northern Caucasus) and *A. t. ognevi* Turov, 1926 (type loc.: village of Kalaki, near Mamissonchen Pass, Osetiya Road, Caucasus). The incidence of colour morphs varies even between years.

Dental pattern is stable; individual variants are shown in Figs. 132 & 133.

Anatolian water voles, most likely ascribable to the subspecies *persicus*, appear to be a well-differentiated race, albeit their limits are not known. The subspecies is tentatively characterised, besides the peculiar molecular makeup, also by the primitive pattern of the molar enamel band width, by the large size and by the relatively long tail. The subspecies *hintoni*, on the other hand, is doubtfully valid; Aharoni (1932) diagnosed it by its large size: the head and body length of the type is 180 mm, tail 120 mm, hind foot 35 mm, ear 14 mm, skull profile length 41.5 mm. Measurements are within the range of other Turkish samples (cf. Table 34). Profile length of skull in the type of ssp. *hintoni* is within the range of the Thracian series (40.3–43.0 mm) and also fits to specimens from north-western Iran (up to 42.8 mm). Neuhäuser (1936b), on the other hand, states that *hintoni* is characterised by more expanded zygomata.

DISTRIBUTION

The water vole has a broad Palaearctic range from western Europe and British Isles, across middle and eastern Europe to Siberia and further east nearly to the Pacific coast. It goes as far north as 70° and the southern border reaches 30° of northern latitude.

Turkish records are few in number but, as already pointed out by Osborn (1962), also widely scattered. The species has been collected so far in Thrace, Marmara, the Pontic Mts., in central and eastern Anatolia, and in Hatay (Fig. 134). The population in Hatay is possibly an isolate. As of Thrace, Osborn (1961) presumes the species to be "probably found … wherever permanent sources of water and adequate food supplies are available." The same statement possibly holds for Anatolia, providing also the availability of adequate shelter and a substrate suitable for burrowing. Demirsoy (1996) and Panteleyev (2001) ten-

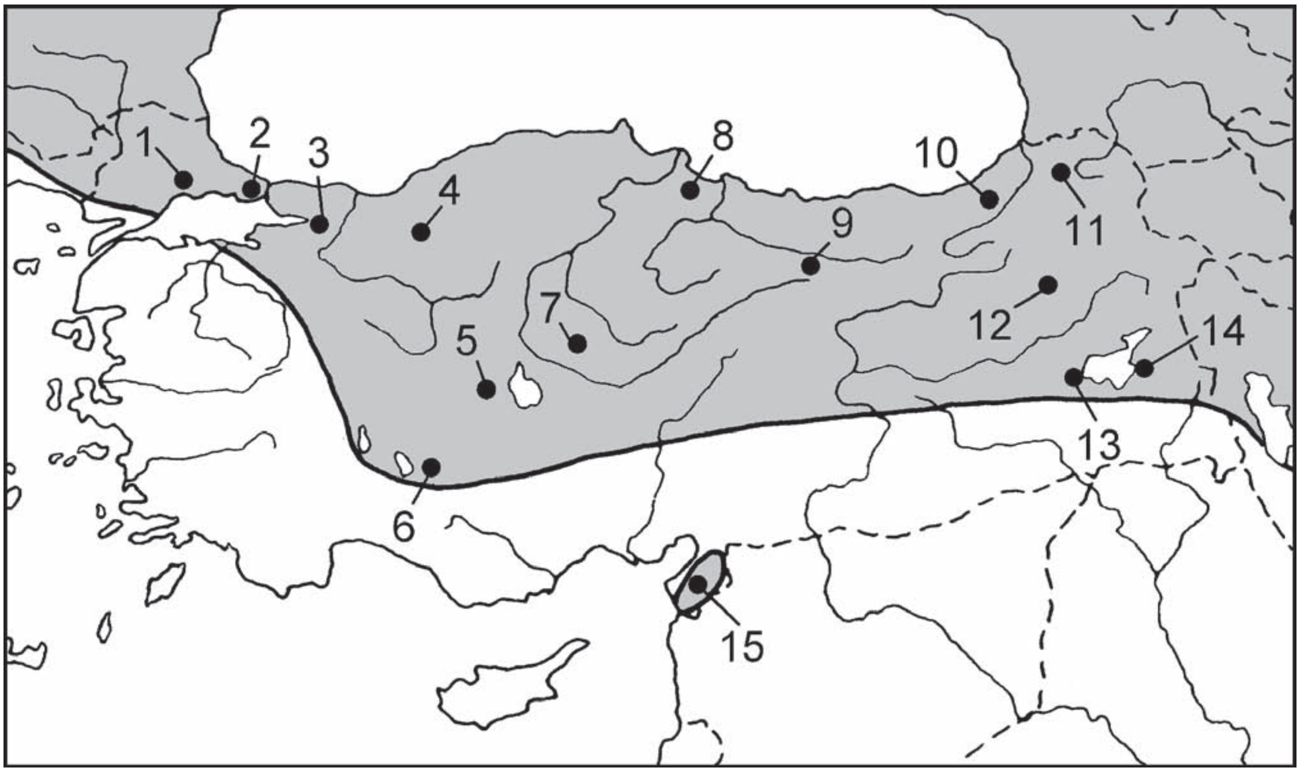


Figure 134. Distribution of *Arvicola terrestris* in Turkey. Records: **1** – Çorlu River, 4 km west of Çorlu, Tekirdağ; **2a** – Kağithane Dere, near Kemerburgaz, İstanbul; **2b** – Alibey Dere, 4 km west of Kemerburgaz, İstanbul; **3** – 12 miles east of Izmit, 100 feet; **4** – Abant Lake, Bolu, 1,200 m; **5** – Insuyu (= Insuyuköyü), Konya; **6** – 18 km north-east of Beyşehir, Konya; **7** – Kırşehir; **8** – Dikmen, Sinop; **9** – between Şerefiye and Güllüalı, Sivas, 1,620 m; **10** – Ovitdağı Geçidi, Rize, 2,450 m; **11** – 5 km west of Bağdaşan, Kars, 2,600 m; **12** – 1 km north of Erence, Erzurum; **13** – Tatvan; **14** – Van; **15** – Tel el Sultan, Amik Lake, Hatay. Corresponding references: Hinton (1926): 14. Aharoni (1932): 15. Neuhäuser (1936b): 5, 8. Osborn (1961): 1, 2a, b. Felten *et al*. (1971b): 6. Röttger (1987): 13. Özkurt *et al*. (1999a): 7. FMNH: 3. Own data: 4, 9, 10, 11, 12.

tatively indicate the entire Turkey as the range of the water vole.

PALAEONTOLOGY. The past range of the genus *Arvicola* was larger in Anatolia than is the recent one but only fossil forms are reported from the Pleistocene strata. For the Middle Pleistocene, *Arvicola cantiana* is reported for Emirkaya-2 (Montuire *et al*., 1994), and *A. praeceptor* Hinton, 1926 from the Island of Chios (Storch, 1975), which at that time was a part of the Aegean Anatolia. Santel & Koenigswald (1998) ascribe the Middle Pleistocene remnants from Yarımburgaz Cave (Turkish Thrace) to the recent species, as did Baryshnikov & Baranova (1983) in the case of the contemporary material from the Caucasus.

HABITAT

All over the Near and Middle East, the water vole is closely associated with streams, irrigation ditches and marshy vegetation around water bodies (Lay, 1967; Harrison & Bates, 1991; Qumsiyeh, 1996), and habitat selection in Turkey follows this general pattern. On overgrazed alpine pastures of the eastern Pontic Mts. we trapped a single specimen in a short grass around a small pond, hardly providing any shelter, and obtained another one along a mountain stream in a mixed forest on Abant.

ALTITUDE. The elevation data range from close to the see level (*c.* 30 m a.s.l. near Izmit; specimens in FMNH) up to well above 2,000 m a.s.l. in the eastern Pontic Mts.: 2,450 m at Ovitdağı Geçidi and 2,600 m at 5 km west of Bağdaşan. Water voles were recorded up to 3,210 m a.s.l. in Armenia (Panteleyev, 2001).

DENSITY. Nowhere in Turkey we found water vole to be abundant.

Figure 135. Habitat of *Arvicola terrestris*. **a** – Lake Abant, Bolu (Photo: P. Benda); **b** - between Şerefiye and Güllüalı, Sivas (Photo: B. Kryštufek).

BIOLOGY

Data on biology are scanty in Turkey.

ACTIVITY. Harrison & Bates (1991) report water vole as being diurnal, Šidlovskij (1976), however, claims it to be most active at down and dusk and the least during the daytime.

Water voles swim well and seek shelter in burrows which are dug into the banks. In tall, lush vegetation along the shores, its presence is readily noticeable by characteristic runways.

REPRODUCTION. Juveniles were collected in Turkey between June and September. According to Šidlovskij (1976), there are up to four litters annually in Transcaucasia with up to 10 cubs each. For the northern Caucasus, Azerbaijan and lowlands along the Terek River, Panteleyev (2001) reports the 3rd litter to be rare, delivered by *c.* 10–20% of females in their 2nd calendar year. Females can already reproduce in their first year and may have up to two litters before winter. The litter size on the Terek River varies between 2 and 9 (mean = 5.2, N = 81) and is slightly larger in Kabardino Balkaria (range = 2–10, mean = 5.8, N = 120; Panteleyev, 2001).

FOOD. Osborn (1961) reports piles of sedge leaves (*Carex* sp.) and the pith of rushes (*Juncus* sp.) on hummocks of a swampy portion of a creek (near Kemerburgaz), which evidently indicate leftovers from feeding. We also came across such piles in the Pontic Mts. Water vole also preys on molluscs and crabs in the Balkans (our own observations).

PREDATION. Obuch (1994) found water vole bones in the pellets of the eagle owl (*Bubo bubo*) in central and eastern Anatolia.

GENUS: *MICROTUS* SCHRANK, 1798

The genus *Microtus* comprises voles with rootless molars which show a complex dental pattern and an advanced structure of enamel. Most of the species are small or medium-sized arvicolines with a fairly short tail. They are mainly terrestrial but also tend towards fossorial habits. *Microtus* includes many more species than any other recent genus in the subfamily Arvicolinae and is still in a process of rapid diversification and speciation. Musser & Carleton (1993) list 58 species, 38 of which are of Palaearctic occurrence. However, in the past decade new names have been added to this number. Snow voles were traditionally reported under *Microtus* but are now mainly included in *Chionomys* (see further discussion under that genus).

Nine species are currently recognised in Turkey, but this number is probably not final. Traditional taxonomy is strongly based on dental pattern which undergoes rapid changes. Current taxonomy benefited much from karyological studies which uncovered cryptic diversity within the genus and firmly defined sibling species. Turkish species can be classified in three main groups, viz., pine voles, social voles, and the *arvalis* group.

KEY TO SPECIES

1 1st lower molar with broadly confluent dental fields of the two triangles anterior to the trigonid – talonid complex (T4 and T5); two or three pairs of nipples
(pine voles) 2

1* 1st lower molar with alternating dental fields of the two triangles anterior to the trigonid – talonid complex (T4 and T5); four pairs of nipples
4

2* Two pairs of nipples (both inguinal)
M. subterraneus

2 Three pairs of nipples (pectoral one in addition to two inguinal)
3

3 Interorbital constriction at most 3.9 mm broad; height of skull across molars <7.6 mm; dorsal profile of skull concave in the interorbital region (Fig. 139)
M. daghestanicus

Cont. on p. 150

Figure 136. Guenther's vole *Microtus guentheri*. Drawing: J. Hošek.

3* Interorbital constriction at least 3.9 mm broad; height of skull across molars >7.5 mm; dorsal profile of skull not concave in the interorbital region (Fig. 139)
M. majori

4 Bullae not much enlarged; mastoid chambers small; *fenestrae prealambdoideae* never entirely filled with bony tissue (Fig. 187); six plantar pads
(*arvalis* group) 5

4* Bullae much enlarger; mastoid chamber enlarged; *fenestrae prealambdoideae* frequently filled with bony tissue; five plantar pads
(social voles) 6

5 Hind foot at least 17 mm in adults; length of neurocranium >54.5% of condylobasal length; incisive foramens mainly wider than 0.9 mm; diploid number of chromosomes 2N = 54
M. rossiaemeridionalis

5* Hind foot less than 18 mm in adults; length of neurocranium <56% of condylobasal length; incisive foramens mainly narrower than 1.0 mm; diploid number of chromosomes 2N = 46
M. obscurus

6 Height of rostrum mainly >7.5 mm
7

6* Height of rostrum <7.5 mm
8

7 Length of bullae <35% of condylobasal length
M. guentheri

7* Length of bullae >35% of condylobasal length
M. anatolicus

8 Larger: condylobasal length of skull mainly >26.5 mm; length of neurocranium mainly > 15.0 mm; short tailed (tail mainly <25 mm)
M. dogramaci

8* Smaller: condylobasal length of skull mainly <26.5 mm; length of neurocranium <15.0 mm; long tailed (tail mainly >25 mm)
M. socialis

PINE VOLES

This is a group of *Microtus* characterised by the pitymoid condition of the 1st lower molar, i.e. by dental fields of the two triangles lying just anterior to the trigonid-talonid complex (T4 and T5) being broadly confluent. All pine voles show a tendency towards fossorial mode of life which has left traces in their morphology. Fur is short and dense, eyes are small, external pinnae are short and hidden in the fur, plantar pads are only five in most species (such a condition is found in all Turkish taxa: Fig. 137a), skull is mainly flattened and incisors are proodont in some species (not in Turkish representatives). Living in a more stable and predictable environment than other *Microtus* species, pine voles are shifted on the r-K continuum towards K-strategy, with the consequence of smaller litter sizes and number of nipples reduced to three pairs or even to only two inguinal pairs. Because of the strong selective pressure posed by the mode of life, morphologic diversity among species is frequently negligible and siblings are a norm. It was not until the application of karyological studies

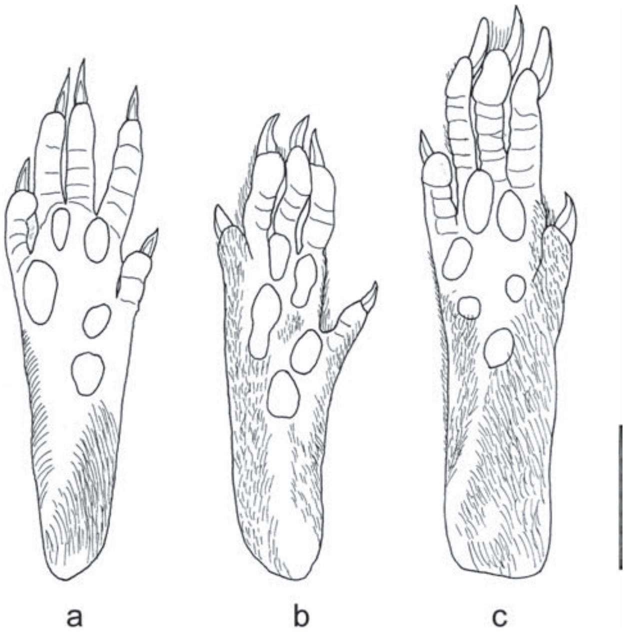


Figure 137. Right hind foot palm in three *Microtus* voles from Turkey: **a** – *Microtus majori* from Meryemana, Trabzon; b - *M. guentheri* from Diyarbakır (redrawn from Coşkun, 1991); **c** - *M. rossiaemeridionalis* from Kürtler, Samsun. Note the differences in pad number. Scale bar = 5 mm.

that the taxonomy of the group was solved satisfactorily (cf. Zima & Král, 1984). Pine voles are mainly associated with more mesic conditions and are more common with increasing altitude.

NOMENCLATURE. Palaearctic pine voles were traditionally grouped in an independent genus *Pitymys* McMurtrie, 1831, with the Nearctic *Psammomys pinetorum* Le Conte, 1830 as the type species (Miller, 1912; Neuhäuser, 1936b; Ellerman, 1948; Osborn, 1962; Ellerman & Morrison-Scott, 1951; Kratochvíl, 1970; Felten *et al*., 1971; Steiner, 1972; Kumerloeve, 1975; Šidlovskij, 1976; Corbet, 1978; Doğramacı, 1989; Yardımcı & Kıvanç, 1998). Some authors preferred to treat *Pitymys* as a subgenus within *Microtus* (Ognev, 1964; Niethammer & Krapp, 1982; Aksenova, 1983; Pavlinov & Rossolimo, 1987). Chaline *et al*. (1988) separated the western Palaearctic pine voles from the Nearctic *Pitymys* (mainly considered as a subgenus of *Microtus* by American authors; cf. Musser & Carleton, 1993) under the name *Terricola* Fatio, 1867 (not of Flemming, 1828, which is an unavaiblae name for molluscs; Kryštufek *et al*., 1996). Again, *Terricola* is regarded to be either a subgenus of *Microtus* (Gromov & Erbajeva, 1995; Musser & Carleton, 1993; Pavlinov & Rossolimo, 1998; Kowalski, 2001) or, more rarely, a genus on its own right (Achverdjan *et al*., 1992; Akhverdyan *et al*. 1997; Zagorodnyuk, 1990; Baskevich, 1997; Baskevich *et al*., 2000; Malygin *et al*., 2000). *Terricola* Fatio, 1867 is an available name (Kryštufek *et al*., 1996); however, within its present frame it lacks clear synapomorphies (Kryštufek *et al*., 1996). Recently, Jaarola *et al.* (2004) advocate the monophilly of *Terricola* on the base of mitochondrial cytochrome *b* sequences, although the bootstrap support was fairly low.

The three species which occur in the region used to be clumped under the name *Pitymys subterraneus* at the times when the most simplistic view of the western Palaearctic pine voles was applied (Ellerman, 1948; Ellerman & Morrison-Scott, 1951). Such an attitude was followed by some authors as recent as Doğramacı (1989). Kratochvíl (1970) was seemingly the first to recognise, on the basis of Turkish material collected by H. M. Steiner, the specific status of *M. majori* and *M. daghestanicus*. Steiner (1972) compared the two closely and mapped their ranges in north-eastern Anatolia. Ivanov & Tembotov (1972) simultaneously provide karyological data which indisputably confirmed their status as independent species. Kumerloeve (1975) already reports all three species for Turkish fauna. In contrast to this, Corbet (1978), similarly as Šidlovskij (1976), did separate *M. majori* from *M. subterraneus*, but synonymised *M. daghestanicus* with the former.

GENETICS. Available genetic evidence is contradictory. Among 31 loci investigated, Macholán *et al.* (2001) found only one locus (*G6pd*) to be diagnostic between *M. subterraneus* and *M. majori*. Even more so, some interspecific genetic differences among *M. subterraneus* samples exceed those between *M. subterraneus* and *M. majori*. Macholán *et al*. (2001) speculate that *M. subterraneus* is paraphyletic, with *M. majori* and *M. daghestanicus* being possibly its constituents. The time of divergence between *M. subterraneus* and *M. majori* is estimated at 170,000-350,000 years (Macholán *et al*., 2001). Contrary to this, mitochondrial cyochrome *b* sequence suggests close relationship between *M. subterraneus* and *M. daghestanicus*, while *M. majori* possibly represents a separate evolutionary lineage (Jaarola *et al*., 2004).

RELATIONS. *Microtus majori* was placed in a *majori* group by Pavlinov & Rossolimo (1998), as opposed to the *subterraneus* group which contains *M. subterraneus* and *M. daghestancius*. On the basis of karyological evidence, Baskevich (1997) considers *M. daghestanicus* to be more closely related to *M. majori* than to *M. subterraneus*. She further suggests that the rates of morphological and karyological evolution were not concordant in these three pine voles. In karyological evidence, as interpreted by Baskevich (1997), *M. daghestanicus* is of more recent origin than are *M. majori* and *M. schelkovnikovi* (Satunin, 1907). The latter is endemic to the Talysh and Elburz Mts. (Baskevich, 1997). Zagorodnyuk (1990) placed all three Turkish pine voles in *Terricola* s. str. without further splitting. As mentioned above, mitochondrial cyochrome *b* sequence suggests *M. daghestanicus* to be closer to *M. subterraneus* than to *M. majori* (Jaarola *et al*., 2004).

Microtus majori and *M. daghestanicus* presumably evolved *in situ*, and, as suggested by Baskevich (1997), in allopatry. Vereščagin (1959) believes that *M. apsheronicus* from the Middle Pleistocene of the Caucasus is a possible ancestor of these two voles.

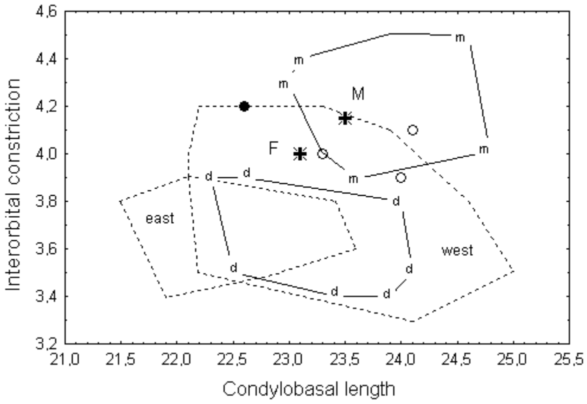
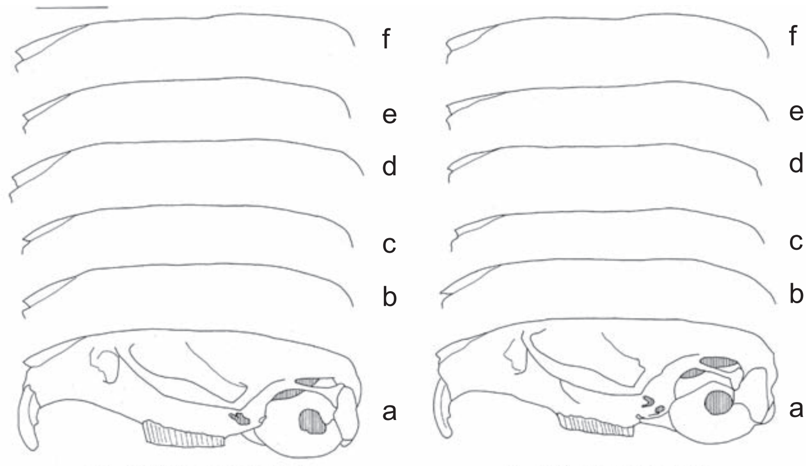
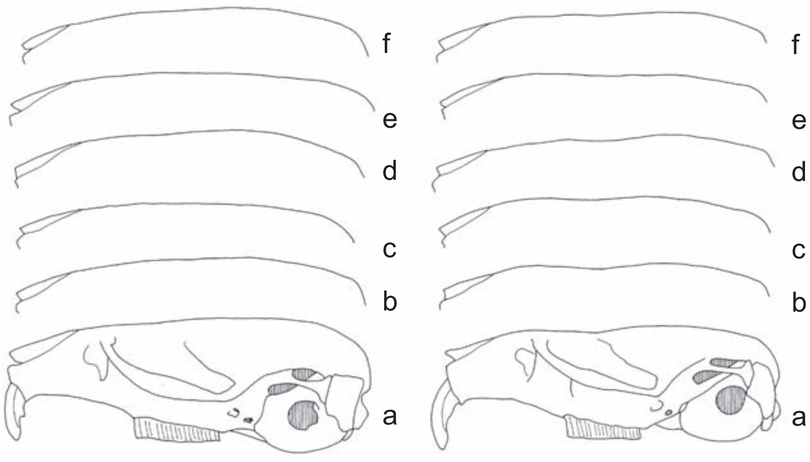


Figure 138. Bivariate plot of interorbital constriction against condylobasal length for Turkish pine voles. Polygons enclose extremes within a group or are individual specimens indicated by symbols. Broken line – *Microtus subterraneus* from eastern (Seyfe, İlgazdağ, Giresun and Güzyurdu) and western Anatolia (Abant Lake, Uludağ, Düzce, and vicinity of Zonguldak), respectively. Straight line indicates *M. majori* (**m**) and *M. daghestanicus* (**d**), respectively. Asterisks – types of *M. majori* (**M**) and *M. subterraneus fingeri* (**F**), respectively. Circles – Uludağ; dot – Tatvan. Based on specimens in BMNH, FMNH, NMNH, NMW, SFM, ZFMK, and ZSM, and our own material.



M. subterraneus (West)   *M. subterraneus* (East)



M. majori   *M. daghestanicus*

Figure 139. Variation in the dorsal profile of the skull in pine voles from Turkey. *Microtus subterraneus* – (west): **a** – Velika Köy, Kırklarelı district, Thrace; **b** – İlgazdağ Gecidi; **c, f** – Uludağ; **d, e** – Abant Lake. *Microtus subterraneus* (east): **a, b** – 2 km east of Seyfe, Amasya; **c–f** – 4 km south-east of Güzyurdu. *Microtus majori*: **a, b** – Çamlik, Rize; **c** – Cankurtaran Geçidi, Artvin; **d, e** – Damar, Artvin; **f** – Meryemana, Trabzon. *Microtus daghestanicus*: **a–f** – 5 km west of Bağdaşan, Kars district. Scale bar = 5 mm.

The history of pine voles in the Caucasus dates back to the Early Pleistocene at the latest (Agadžanjan & Jacenko, 1984).

Distinguishing of Species. The group has been recently revised in Turkey by Çolak *et al.* (1997c) and Macholán *et al.* (2001), but only *M. subterraneus* and *M. majori* were studied in more detail. The species are satisfactorily diagnosed electrophoretically and chromosomally, but not morphologically. Thus, the identification of standard museum specimens continues to be difficult. We based the above determination key and the descriptions given below upon examination of extensive samples. Part of the material available to us was also karyotyped and/or studied electrophoretically. Differentiation between *M. majori* and *M. daghestanicus* was easy but *M. subterraneus* appeared much more variable in Anatolia than any of the remaining two species.

Macholán *et al.* (2001) consider the easternmost populations of *M. subterraneus* in Anatolia to approach morphologically *M. majori*. Our results are just the opposite, and the eastern Anatolian *M. subterraneus* resembles very closely *M. daghestanicus*, at least cranially. This is evident from the dimensions of the interorbital constriction (Fig. 138), the dorsal profile of the skull (which lacks the interorbital concavity in the western *M. subterraneus* and in *M. majori*) and the deeper skull of *M. subterraneus* from western Anatolia. Thus, we found the east Anatolian populations of *M. subterraneus* to be easily separable from *M. majori*, but to resemble more closely *M. daghestanicus* (Figs. 138 &139). However, on the basis of our evidence, *M. subterraneus* and *M. daghestanicus* are not sympatric (cf. Figs. 150 and 166).

Several other characters were mentioned by different authors to distinguish the three species. Achverdjan *et al.* (1992) suggest molar shape as a taxonomic character between *M. majori* and *M. daghestanicus*, but their characters (cf. Fig. 3 on p. 101 in Achverdjan *et al.*, 1992) did not prove stable in our Turkis material. Gromov & Erbajeva (1995) separate *M. majori* from *M. daghestanicus* on the basis of tail colour (bicoloured in the former, which however, we could not confirm in Turkish material) and on the basis of eye orifices length (>2.2 mm in *M. majori* and <2.2. mm in *M. daghestanicus*). Çolak *et al.* (1997c) state in the abstract to their paper that *M. majori* and *M. subterraneus* differ in tail length and in the shape of phallus. Bivariate plot of tail length against head and body length does result in very marginal overlap between the two; *M. daghestanicus* resembles *M. majori* more closely in this respect (Fig. 140). Since different collectors frequently do not measure external parameters in a consistent way, we considered in Fig. 140 only the specimens measured by one of us. As concerns phallus, Çolak *et al.* (1997c) provide drawings for both species, but do not comment on possible differential characters. For this reason we hesitate to use this structure for diagnostic purposes.

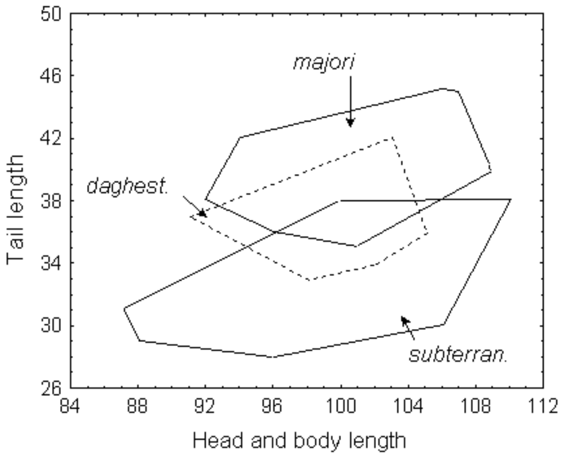


Figure 140. Bivariate plot of tail length against head and body length for Turkish pine voles. Polygons enclose extremes within a group. *Microtus subterraneus* and *M. majori* are indicated by straight line and *M. daghestanicus* by broken line.

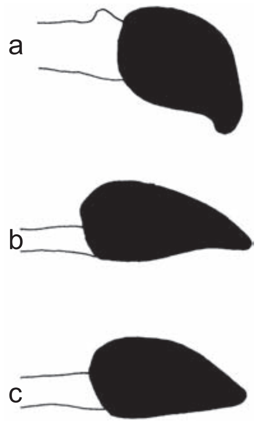


Figure 141. Sperm head in three pine voles occurring in Turkey: **a** – *Microtus subterraneus*; **b** – *M. majori*; **c** – *M. daghestanicus*. Redrawn from Baskevich (1997).

Baskevich (1997) found differences among the three pine vole species in the shape of spermatozoa; her *M. subterraneus* sample originates from Ukraine and the remaining two pine vole species from the Caucasus. For a summary of results see Table 35 and Fig. 141.

	Length	Breadth
M. subterraneus	6.2–7.4	2.8–3.7
M. majori	5.6–6.7	2.1–2.9
M. daghestanicus	6.7–8.3	2.8–3.6

Table 35. Dimensions (range; in µm) for the spermatozoa head in three pine vole species. Modified from Baskevich (1997).

EUROPEAN PINE VOLE – MICROTUS SUBTERRANEUS

Arvicola subterraneus de Sélys Longchamps, 1836. Type loc.: Waremme, Liége, Belgium.
Pitymys majori fingeri Neuhäuser, 1936a. Type loc.: Karadere, Bolu, Turkey.

TAXONOMY

Microtus subterraneus has been known from the European Turkey since the report by Kurtonur (1975). Until the karyological evidence became available (Zima *et al.*, 1995a), the Anatolian populations of *M. subterraneus* were linked taxonomically to *M. majori*. Thus, Neuhäuser (1936b) described *fingeri* as a subspecies of *M. majori* and saw the Caucasus as a source of Turkish taxa. She even speculated that *M. thomasi* Barret-Hamilton, 1903 (in her terminology *Pitymys atticus*), a species endemic to the Balkans, and *M. savii* (de Sèlys Longchamps, 1838) of Italy, colonised Europe from Asia Minor.

Felten *et al.* (1971b) and Storch (1982) ascribed pine vole populations from several Balkan localities to *M. majori*. The conclusion was derived from their examination of western Anatolian pine voles, which are now included in *M. subterraneus*. Thus, although the above authors did recognise the actual relations among pine voles from the opposite sides of the Marmara straits, their solution of nomenclature was not appropriate. Nevertheless, such a view induced Kıvanç (1986) to ascribe specimens from Turkish Thrace to *M. majori*. As was shown later (Kryštufek *et al.*, 1994), *M. majori* does not occur in Europe.

DESCRIPTION

EXTERNAL CHARACTERS. Small pine vole with a relatively short tail (*c.* one third of head and body length; range = 30–36%) and minute eyes. Tail ends in a short pencil (<2 mm). Ears are moderately long for a pine vole and are covered with short dense hair. Mystacial vibrissae are fairly short (<25 mm) and pale. Fur is dense but less than in *M. majori*. Dorsal hairs are up to 8 mm long in summer pelage, those on the belly are evidently shorter. There are only five plantar pads.

Figure 142. European pine vole *Microtus subterraneus* from Cığlıkara, Bey Dağlari, Antalya. Photo: A. Kryštufek.

COLOUR. The fur on back is nearly uniform yellowish brown, brownish buff, or dark brown. Coloration within local populations seems to be fairly stable and major differences are among localities. Belly is rarely pure grey but is mainly washed with brown. There is no demarcation line along flanks; note however, that Neuhäuser (1936b) and Kıvanç (1986) report sharp demarcation. Basal portion of hair is slate black. Tail is indistinctly bicoloured. Hind feet are drab, dusky grey or even whitish.

NIPPLES. Females have only two inguinal pairs of nipples.

PENIS AND BACULUM. Glans penis is simple cylindrical and naked; it is 10 mm long and 2.3 mm wide (Çolak *et al.*, 1997c). Baculum consists of a basal part and three distal cartilaginous processes. The basal bone (length 1.75–2.30 mm; mean = 2.11 mm) is expanded at its base (width 0.86–1.43 mm; mean =

1.28 mm; Çolak *et al*., 1997c). For spermatozoa see Table 35 and Fig. 141.

SKULL is lightly built, smooth and with flattened braincase (Figs. 143 & 144). It is shallower (height across bullae makes 31.7–37.9% of the condylobasal length) than in any other *Microtus* vole living in Turkey, except *M. daghestanicus*. Zygomatic arches are widely expanded (= 56.0–61.5% of the condylobasal length) and the interorbital region is broad and smooth. Supraorbital ridges do not develop with advanced age and consequently there is no sagital crest. The dorsal profile is nearly straight but occasional eastern specimens (east of the Kızılırmak River) show depressed orbital region. Short nasals are expanded anteriorly. Rostrum is relatively weak while the neurocranium is large in comparison to the skull in front of it. Bullae are fairly large. Pterygoid processes are either parallel or slightly divergent posteriorly. *Squama carina media* is broad and low and lateral pits on the posterior hard palate are shallow. Incisive foramens are fairly long but narrow. Maxillary tooth-row is shorter than the diastema. Mandible is slender. Of the three processes, the articular one is moderately heavy and the other two are weak.

TEETH. Upper incisor is strongly curved and orthodont. Enamel on the front surface is orange on the upper incisors and yellow on the lower ones. First upper molar consists of the anterior lobe and four alternating triangles; 2nd upper molar has three triangles posterior to the anterior lobe. Dental fields of the loop and individual triangles are closed. The first two upper molars show some variation in their posterior region which tends to form an additional postero-lingual syncline (LRA4), a trend particularly noticeable on the 2nd molar. Although an additional triangle (T5) is occasionally present on the 2nd molar, its dental field is invariably broadly confluent with T4 (Fig. 146b, c). Third upper molar consists of an anterior lobe, five triangles and a posterior cup. Dental fields of T2 and T3 are either isolated (Fig. 147b, d) or mutually confluent (Fig. 147a). Similarly, the dental field of T4 is either isolated (Fig. 147b-d) or confluent with T5 and the posterior cup (Fig. 147a). Posterior cup is mainly simple and short, rarely prolonged. Very exceptionally, there are additional triangles (T6 and T8) on the labial side (Fig. 147d). Depending on the complexity of the posterior region of the 3rd upper molar, there are three (most commonly) or four re-entrant angles on the lingual side, and three (predominantly) or four on the labial side.

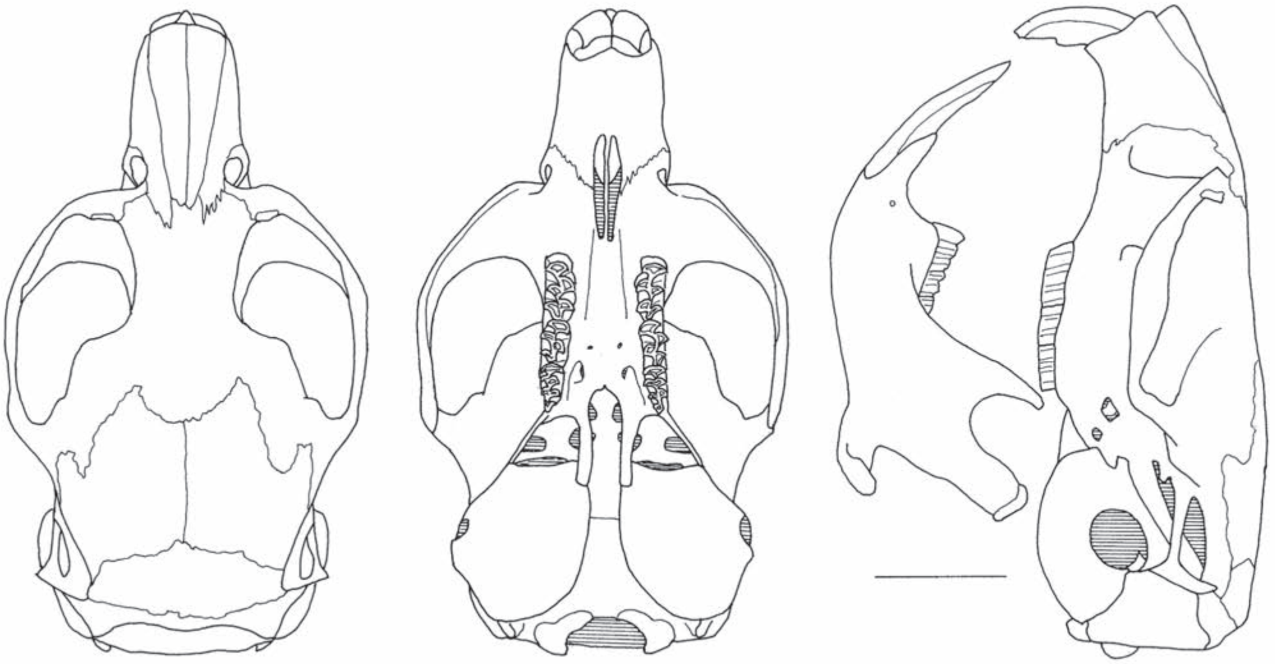


Figure 143. Skull and mandible of *Microtus subterraneus*. Based on an adult female from 5 km north of Safranbolu, Zonguldak district. Scale bar = 5 mm.

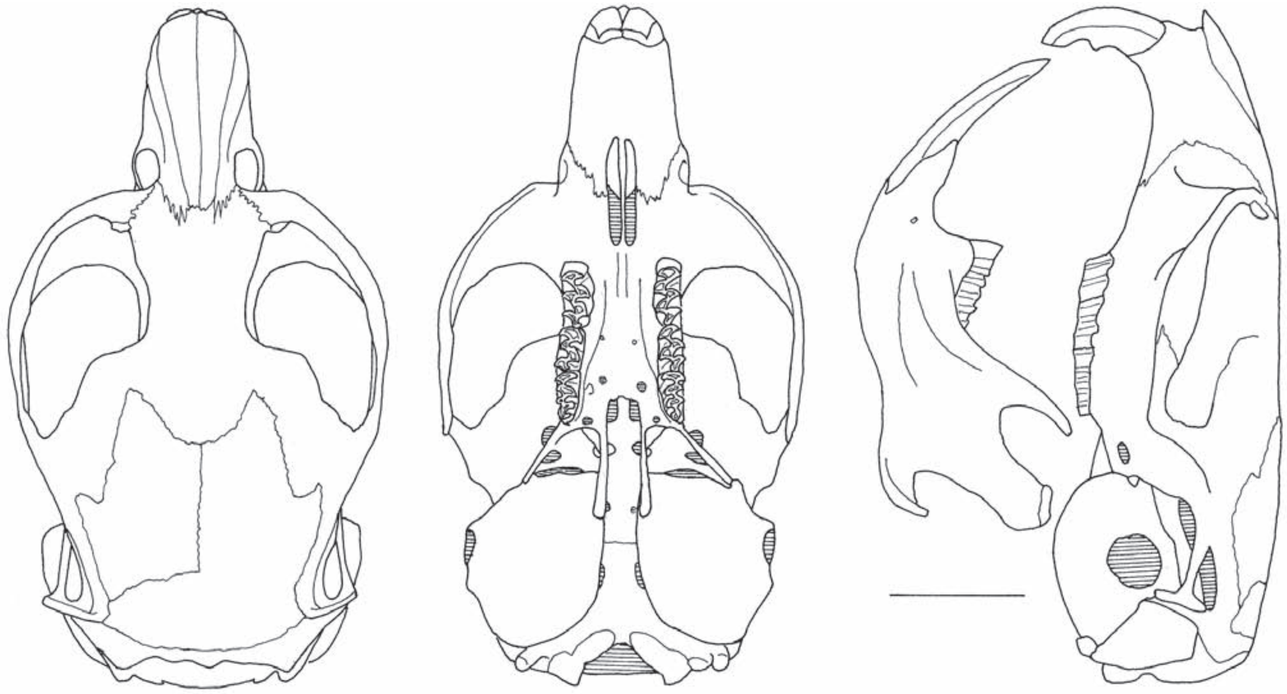


Figure 144. Skull and mandible of *Microtus subterraneus*, based on an adult male from Tamdere, Giresun. Scale bar = 5 mm.

The trigonid-talonid complex of the 1st lower molar is stable in shape (Fig. 148). Of the anteroconid complex, dental fields of T4 and T5 are broadly confluent (pitymoid condition). Triangles T6 and T7 are always mutually confluent and opened into the anterior cup. The constriction separating T6–T7 from the more anterior elements is nearly always broad. Triangles T8 and T9 are developed in most specimens but their dental fields are broadly integrated into the anterior cup. As a consequence, there are five re-entrant angles on the lingual side and four (exceptionally five) on the labial side. The 2nd and 3rd lower molars

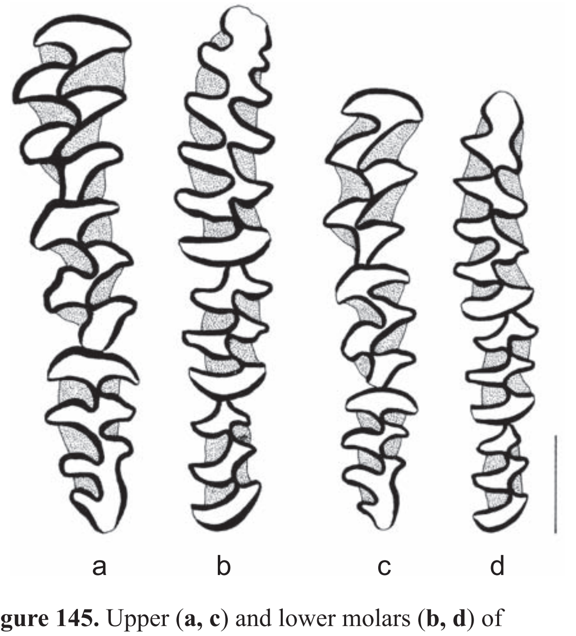


Figure 145. Upper (**a, c**) and lower molars (**b, d**) of *Microtus subterraneus*, based on specimens from Velika Köy, Kırklarelı, Thrace (**a, b**), and from 4 km south-east of Güzyurdu, Gümüşhane, Erzurum (**c, d**). Lingual side is to the left, anterior is at the top. Scale bar = 1 mm.

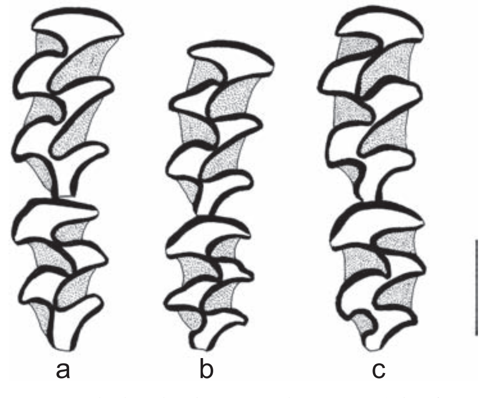


Figure 146. Variation in the posterior part of the first two upper molars in *Microtus subterraneus* from Turkey. **a** – Uludağ; **b** – Güzyurdu; **c** – Bozdağ, İzmir. Based on NMW specimen (c) and own material. Lingual side is to the left and anterior is at the top. Scale bar = 1 mm.

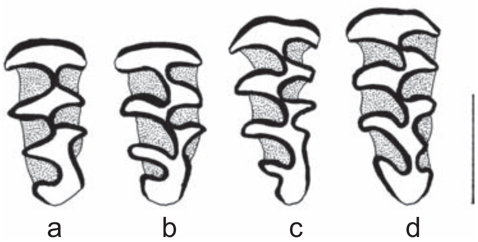


Figure 147. Different morphotypes of the 3rd upper molar in *Microtus subterraneus* from Turkey. **a, b, d** – Balikli (SMF); **c** – Güzyurdu. Lingual side is to the left and anterior is at the top. Scale bar = 1 mm.

are small and their elements reduced, but their structure is similar. They consist of a posterior lobe and four triangles in front of it. Dental fields of T1–T2 and T3–T4 are invariably mutually confluent on the 3rd molar, while T1–T2 fields mainly alternate on the 2nd molar.

Dimensions are given in Table 36. There is no apparent secondary sexual dimorphism.

Chromosomes. The European pine vole is polytypic in karyotype, with two distinct diploid numbers: 2N = 52 and 2N = 54 (Sablina *et al*., 1989). Both karyotypes are present also in Turkey: the 52 form is restricted to Thrace while the 54 form is widespread in Asia Minor (Çolak *et al*., 1997c; Macholán *et al*., 2001). The fundamental number of chromosomal arms, which is the same in both karyotypic forms (NF = 60), suggests the difference in the diploid number to result from a single centric fusion of two acrocentric pairs of autosomes. One (2N = 54) or two (2N = 52) pairs of the largest chromosomes are bi-armed (one submetacentric and, in the 52 form, also one subtelocentric). With the exception of a pair of small metacentrics, the remaining autosomes are acrocentric. The X chromosome is medium-sized metacentric and is larger in 2N = 54 form. The Y chromosome is small acrocentric. There are some disagreements between the results by Çolak *et al.* (1997c) and those by Macholán *et. al.* (2001); the former report the Y chromosome as a small metacentric in the 54 form. *Microtus majori* shows a similar karyotype (see below), but differences have been reported between

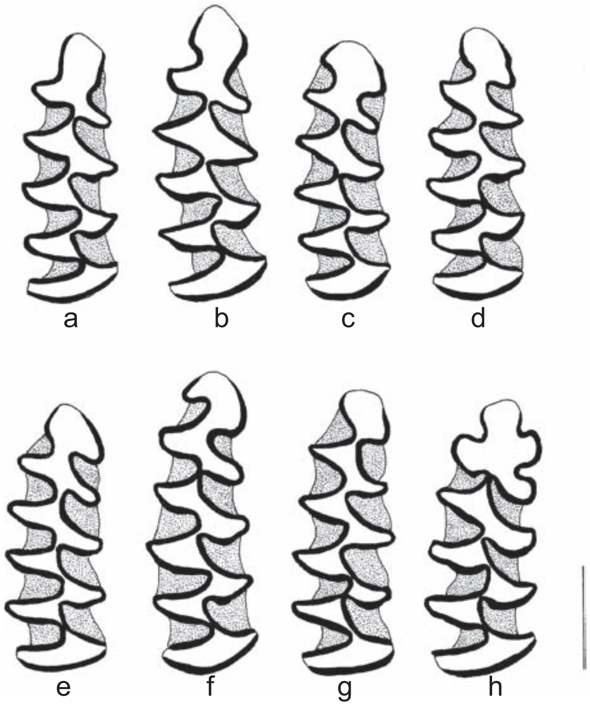


Figure 148. Different morphotypes of the 1st lower molar in *Microtus subterraneus* from Turkey. **a–e, g** – Balikli (SMF); **f** – Cığlıkara (NMW); **h** – Abant Lake, Bolu. Lingual side is to the left and anterior is at the top. Scale bar = 1 mm.

Sample	1			2			3		
	N	mean	min-max	N	mean	min-max	N	mean	min-max
Head and body	14	95.4	86-104	38	93.0	87-110	18	94.9	87-100
Tail	14	28.5	26-32	38	35.1	28-44	18	32.1	28-38
Hind foot	14	16.4	15.7-17.0	38	15.5	14.3-17.0	18	15.0	14.0-16.6
Ear	14	8.3	8.0-9.0	37	9.9	7.2-11.5	17	10.0	9.0-11.0
Weight	14	18.5	15-25	20	20.4	18-25	18	17.7	13-25
Condylobasal length	13	23.1	22.5-24.0	42	22.9	22.0-25.0	17	22.2	21.4-23.6
Zygomatic breadth	14	13.9	13.3-15.2	42	13.5	12.7-14.7	18	12.9	12.2-13.8
Maxillary tooth-row	14	6.1	5.7-6.4	43	6.0	5.3-6.4	18	5.7	5.2-6.1

Table 36. External and cranial dimensions of *Microtus subterraneus* for three Turkish samples. Sample identities: **1** – Turkish Thrace; **2** – Düzce and Abant; **3** – Tamdere and Güzyurdu. Based on Kıvanç (1986), specimens in FMNH, NMNH, SMF, ZSM, and our own material.

the two species in the G-banding pattern of the 3rd autosomal pair in addition to one of the smallest autosomes (Macholán *et al*., 2001). These differences most likely result from a centromeric shift. Zima (2004) believes that the 54-chromosome karyotype represents a primitive, plesiomorphic state, and that the 52-chromosome complement originated after a new mutation from somewhere within the centre or eastern part of its range, spreading outwards successively thereafter. The Marmara Strait is a natural border between the two races and the interruption of the Bosporous land bridge at the end of the last glaciation can be used as an approximation of the timescale for the range expansion of the 52-chromosomes race (Zima, 2004).

Among the three pine voles considered in this volume, *M. subterraneus* has the lowest content of heterochromatin (Baskevich, 1997). Baskevich *et al*. (2000) report C- and G-bands of the 52-chromosomal form from the Bulgarian part of the Istranca (Strandža) Mts. In their conclusion the Y chromosome is metacentric, thus corroborating the report by Çolak *et al*. (1997c).

Variation

The European pine voles from the Istranca Mts. appear genetically closer to their European counterparts (both, 2N = 52 and 2N = 54 ones) than to conspecifics from Asia Minor. Furthermore, as evident from a study of allozyme variation at 31 loci, there is little, if any, geographic structuring of the species as a whole (Macholán *et al*., 2001). On the other hand, populations are strongly subdivided genetically and more than half of the total genetic variation in the species is due to interpopulation differentiation (Macholán *et al*., 2001). Considering poor dispersal abilities of the European pine vole, as well as the mosaic structure of its habitat, such a pattern of variation is not surprising.

Morphological variation among samples is con-

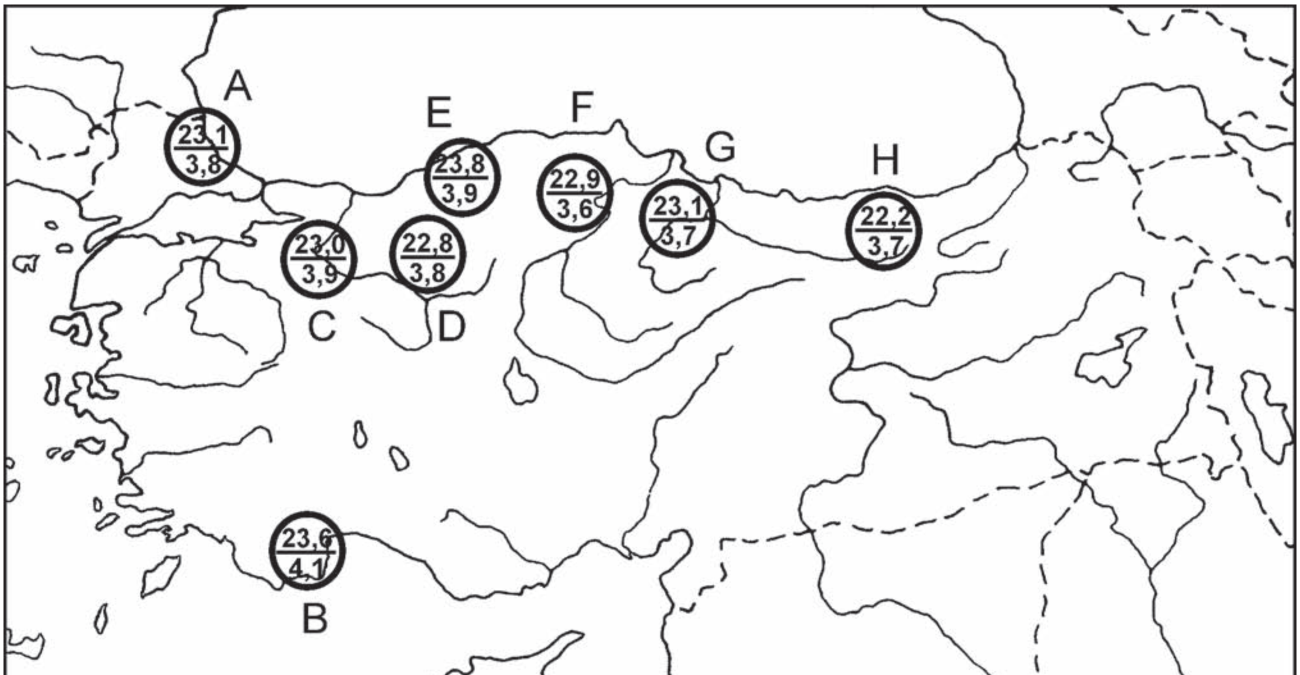


Figure 149. Geographic variation in condylobasal length (above the line) and interorbital constriction (below the line) in eight geographic samples of *Microtus subterraneus* from Turkey. Mean values are given. Sample identities (sample size is in parenthesis): **A** – Turkish Thrace (N = 13-14); **B** – Cığlıkara (N = 3); **C** – Uludağ (N = 19); **D** – Abant Lake and Düzce (N = 48-50); **E** – vicinity of Zonguldak (N = 7-8); **F** – İlgazdağ (N = 3); **G** – Seyfe near Amasya (N = 3); **H** – Giresun and Güzyurdu (N = 17-18). Based on Kıvanç (1986), specimens in FMNH, NMNH, NMW, SMF, ZSM, and our own material.

siderable and concerns size, colour, and skull shape. Local populations differ in being either darker or paler, but we failed to recognise clear pattern in colour, however. Size variation is summarised in Fig. 149. Samples from northwestern Turkey are large and have a broad interorbital region. Note, however, that taxonomic identity of southwestern Anatolian voles has so far not been confirmed by karyological data. The dorsal profile of the skull is straight or even slightly convex in both these groups. Pine voles from the eastern border of the range (sample H on Fig. 149) show small condylobasal length and occasional concavity on the dorsal profile of the skull. Samples collected to the east of Zonguldak (samples F–H on Fig. 149) are also characterised by their narrower interorbital region. The two groups of samples (western *vs*. eastern) differ clearly in the length of 1st lower molar (Table 37; Kryštufek & Vohralík, 2004). In this trait the pine voles from west Anatolia closely resemble recent samples from Turkish Thrace and from Macedonia (Table 37). West Anatolian *M. subterraneus* is morphologically much more variable than are the east Anatolian conspecific populations, as well as the other two pine vole species.

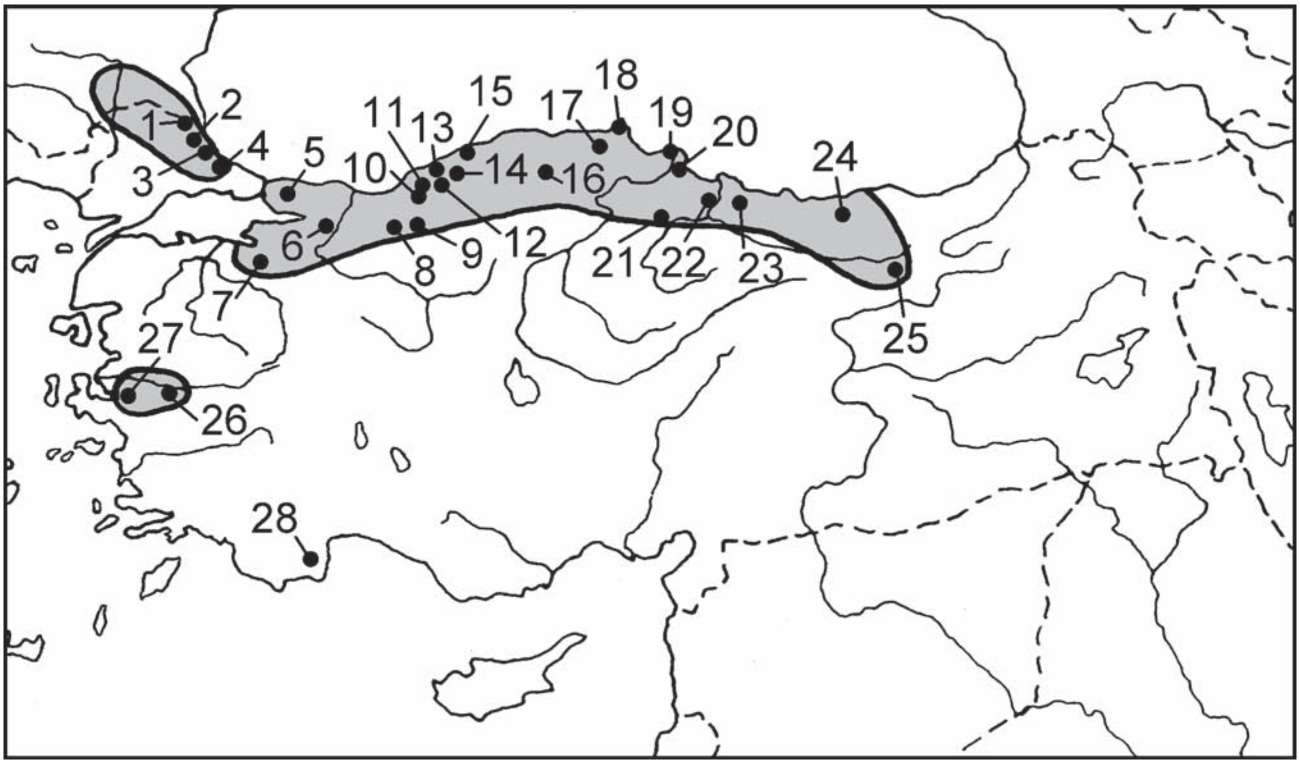


Figure 150. Distribution of *Microtus subterraneus* in Turkey. Records: **1** – Dereköy, Kırklareli, 550 m; **2** – Velikaköprüsu, Demirköy, 650 m; **3** – Mahyadagi, Kırklareli, 800-1,000 m; **4** – Danamandara, Silivri; **5** – Ömerli, İstanbul; **6** – Sapanca, Izmit; **7** – Uludağ, Bursa, 2,300 m; **8** – Orman Bölge, 42 km south of Düzce, Bolu; **9a** – Abant Lake, Bolu, 950-1,250 m; **9b** – Akçaalan, Abant, Bolu; **9c** – Soğuksu, Abant, Bolu; **10a** – Elemen Yaila (= Elemen Yayla), north of Bolu; **10b** – Krk Yaila (= Krk Yayla), 1,600 m; **11** – Karadere, between Bolu and Devrek; **12** – 8 km north-west of Yenice, Zonguldak, c. 100 m; **13** – Çayır, Çaycuma, Zonguldak; **14** – 5 km north of Safranbolu, Zonguldak, *c.* 500 m; **15** – Cankraz, 16 km east of Amasra, Zonguldak; **16** – İlgazdağ Geçidi, Kastamonu, 1,650 m; **17** – Bürnük, Kastamonu; **18** – Bektaşağa, Sinop; **19** – Ikeztepe, Bafra, Samsun; **20** – Samsun; **21** – 2 km east of Seyfe, Amasya, *c.* 1,100 m; **22** – Borabay Lake, Taşova, Amasya; **23** – Akkuş, Ordu; **24** – Tamdere, Giresun, 1,550 m; **25** – 4 km south-east of Güzyurdu, Gümüşhane, *c.* 2,300 m; **26** – Bozdağ near Ödemiş, İzmir; **27** – İzmir; **28** – Cığlıkara, Bey Dağlari, Antalya. Corresponding references: Neuhäuser (1936b): 9a, 10a,b, 11, 27. Osborn (1962): 5, 17, 18, 22. Lehmann (1966): 7. Felten *et al.* (1971b): 8, 26, 28. Kurtonur (1975): 1, 3, 4. Kıvanç (1986): 9c. Çolak *et al.* (1997c): 2, 9b, 23. Macholán *et al.* (2001): 12, 13, 14, 21, 25. BMNH: 19, 20. FMNH: 6. SMF: 15. Own data: 2, 7, 9a, 12, 14, 16, 21, 24, 25.

In terms of conventional subspecific division, the name *fingeri* is applicable to the big pine voles with a broad interorbital region. No name is available for other segments of Anatolian pine voles and we are reluctant to propose new ones. In any case, current genetic evidence does not support any partitioning of the species' range into discrete taxonomic units.

Kıvanç (1986) reports, from Turkish Thrace, an aberrant colour morph with a yellow blotch.

Distribution

The European pine vole is nearly endemic to Europe and only a tiny part of its range is in Asia Minor. Its range mainly overlaps with broadleaved forests and with forest steppe.

In Turkish Thrace the European pine vole is known from a fairly narrow belt along the Black Sea coast (Kurtonur, 1975). In Asia Minor the range is contiguous in the Marmara region and in the Black Sea Mts. as east as Güzyurdu (Fig. 150). Isolated localities in southwestern Anatolia are in the İzmir area (Aegean Anatolia) and on Mt. Cığlıkara (the Taurus Mts.), respectively.

Palaeontology. Fossil history of the species in Turkey is not known. Santel (1994) reports pitymyoid 1st lower molars from the Middle Pleistocene sediments of Yarımburgaz in Turkish Thrace as possibly representing *M. majori*. His sample shows longer 1st lower molar than any recent pine vole sample from Turkey (Table 37). The constriction separating triangles T6 and T7 from the anterior cup is frequently narrow in Santel's material and thus resembles more closely the situation in *M. subterraneus*. From the Bulgarian Thrace (Mecha Dupka Cave near Stoilovo) Popov & Miltchev (2001) report *M. subterraneus* found in the Late Pleistocene layers. Mountuire *et al*. (1994) report pitymoid voles from the Middle Pleistocene layers of Emirkaya-2, central Anatolia. As can be judge from m1 length, these animals correspond in size to recent *M. majori* and are bigger than recent *M. daghestanices* (Table 37). The only m1 figured by Mountuire *et al*. (1994: Fig. 33 on p. 124) shows triangles T6 and T7 as being broadly confluent with the anterior cup, a condition which is common in *M. majori*. Subfossil molars from Bolkar Dağ (the Toros Mts.; i.e. outside the range of recent pine voles), which Hír (1991) ascribes to *M. majori*, fit well in the recent populations of this species (Table 37). Anyhow, since molar length of recent *M. subterraneus* overlaps broadly with the remaining two species (Kryštufek & Vohralík, 2004) , we cannot draw firm taxonomic conclusions on the base of this trait alone.

Habitat

The European pine vole is found in a wide range of habitats although it evidently prefers mesic and disturbed environment, preferably with dense lush herbaceous vegetation. In Thrace it was found in mixed forests with *Philyrea latifolia, Fagus orientalis* and *Quercus* spp., along the forest edges and on forest clearings. Records from Anatolia are from a broad elevational range. In the lowlands, pine voles were collected in swampy and riparian vegetation as well as in mesic broadleaved forests (*Alnus* sp., *Platanus* sp., *Quercus* spp., *Fagus orientalis*) along the rivers. In the hilly country and in low mountains the species populates stands of ferns or of *Urtica* sp., hedgerows and dense shrubs of *Quercus* spp., *Rosa* sp., *Corylus avellana*, *Ligustrum* sp., and *Rubus* sp., as well as dry

	Age	Locality	min-max	N	Source
M. subterraneus	recent	Macedonia	2.60–2.80	11	Santel (1994)
M. subterraneus	recent	Turkish Thrace	2.55–3.00	13	Santel (1994)
M. subterraneus	recent	NW Anatolia	2.52–3.04	65	SMF
M. subterraneus	recent	E Anatolia	1.98–2.63	21	Own material
M. majori	recent	Trabzon	2.38–2.92	37	BMNH
M. daghestanicus	recent	E Anatolia	2.31–2.72	55	Own material
M. majori	subfossil	Bolkar Dağ	2.62–2.90	4	Hír (1991)
M. (Terricola) sp.	Middle Pleistocene	Yarımburgaz	2.65–3.50	38	Santel (1994)
M. (Terricola) sp.	Middle Pleistocene	Emirkaya-2	2.53–2.69	3	Mountuire *et al.* (1994)

Table 37. Range for the length of the 1st lower molar (in mm) in various samples of pine voles from the Balkans and Anatolia, both recent and fossil.

pastures, broadleaved (beech, oak) and coniferous forests (with or without undergrowth) and hardwood coppices. With the increasing elevation, broadleaved (*Quercus infectoria, Q. cerris, Fagus orientalis, Populus tremula*), coniferous (*Picea orientalis, Abies nordmannia*) and mixed forests became to be the main habitat, but the species evidently prefers edges and small clearings. The only record from above the timberline is from Mt. Uludağ (1,700–2,250 m a.s.l.) where the European pine vole was collected among rocky outcrops on alpine pastures with scattered fir trees, or in juniper and blueberry shrubs with exposed rocks.

Various habitats are utilised on Mt. Bozdağ (east of İzmir) at the elevations from 1,100 to 1,360 m: hedgerows of *Rubus* sp. and *Rosa* sp., meadows overgrown with *Urtica* sp., chestnut (*Castanea* sp.) stands, and village gardens. In Cığlıkara, specimens were collected from the karstic dolines at the elevation of 1,750 m a.s.l. (Felten *et al*., 1973).

Altitude. Thracian records are from the altitudes between 550 and 1,000 m a.s.l. In Asia Minor, the elevational range varies depending on the region. To the west of the Yeşil River the records are from close to the sea level and up to 2,250 m (Mt. Uludağ). However, further east no records are known from low altitudes and the elevational range is 800–1,800 m a.s.l.

Associates. We never collected *M. subterraneus* in the same trap line together with another pine vole species. For ecological displacement with *M. majori* see under that species. Such segregation suggests pine voles to be ecologically incompatible. Besides, the European pine vole was only rarely found in open grassland populated with *M. rossiaemeridionalis* or *M. obscurus*. In rare cases of syntopy, the European pine vole seeks shelter in denser and taller herbaceous cover or among rocks.

We collected the European pine vole in the same habitat along with various shrews (*Crocidura* spp.,

Figure 151. Habitat of *Microtus subterraneus*. **a** – Çayır, Çaycuma, Zonguldak; **b** – vicinity of Safranbolu, Zonguldak; **c** – Uludağ, Bursa; **d** – Cığlıkara, Bey Dağlari, Antalya. Photo: B. Kryštufek (a, b) and A. Kryštufek (c, d).

Sorex spp. and *Neomys* spp.) and rodents (*Arvicola terrestris, Clethrionomys glareolus, Chionomys nivalis, Apodemus* spp., *Mesocricetus brandti*). Yiğit *et al*. (2003a) report as its associates also *Cricetulus migratorius, Microtus guentheri, Dryomys nitedula, Muscardinus avellanarius*, and *Glis glis*.

BIOLOGY

REPRODUCTION. Reproductive activity is documented in Turkey for May-July, and September-October. Sexually active males show scrotal testes 5–10 mm in length. Number of embryos varies between one and four (mean = 2.5, N = 31).

MAJOR'S PINE VOLE – *MICROTUS MAJORI*

Microtus (Pitymys) majori Thomas, 1906. Type loc.: Sumela (= Meryemana), Trabzon, Turkey.

Microtus (Arbusticola) rubelianus. Shidlovsky, 1919. Type loc.: Mountains of Transcaucasia, near Trabzon, Turkey.

TAXONOMY

Taxonomic history and relations of *M. majori* with the remaining two pine voles of Turkey are dealt with in the introduction to pine voles and under *M. subterraneus*. Although this vole is presumably close to *M. daghestanicus*, Baskevič *et al*. (1984) did found no evidence of hybridisation in sympatric populations on the Caucasus Mts.

Macholán *et al*. (2001) suggest Trabzon to be the probable western limit of *M. majori* in Anatolia and thus discredit records by Steiner (1972) between Trabzon and Akkuş. However, we trust Steiner's conclusions for several reasons. First of all, his review, although based entirely on morphological characters, is very carefully done and thus convincing. Next, as shown in this volume, *M. subterraneus* samples from the east of Ordu are easily distinguished from *M. majori* on morphological ground alone. And, finally, we have at our disposal a female from Amasya district, which clearly shows a pectoral pair of nipples in addition to two inguinal pairs. Thus we believe that *M. subterraneus* and *M. majori* are sympatric in the Pontic Mts. between the River Kızılırmak in the west and Güzyurdu in the east. However, it is unlikely that the two species are syntopic.

The identity of pine voles in eastern Anatolia is uncertain. The two records given by Obuch (1994)

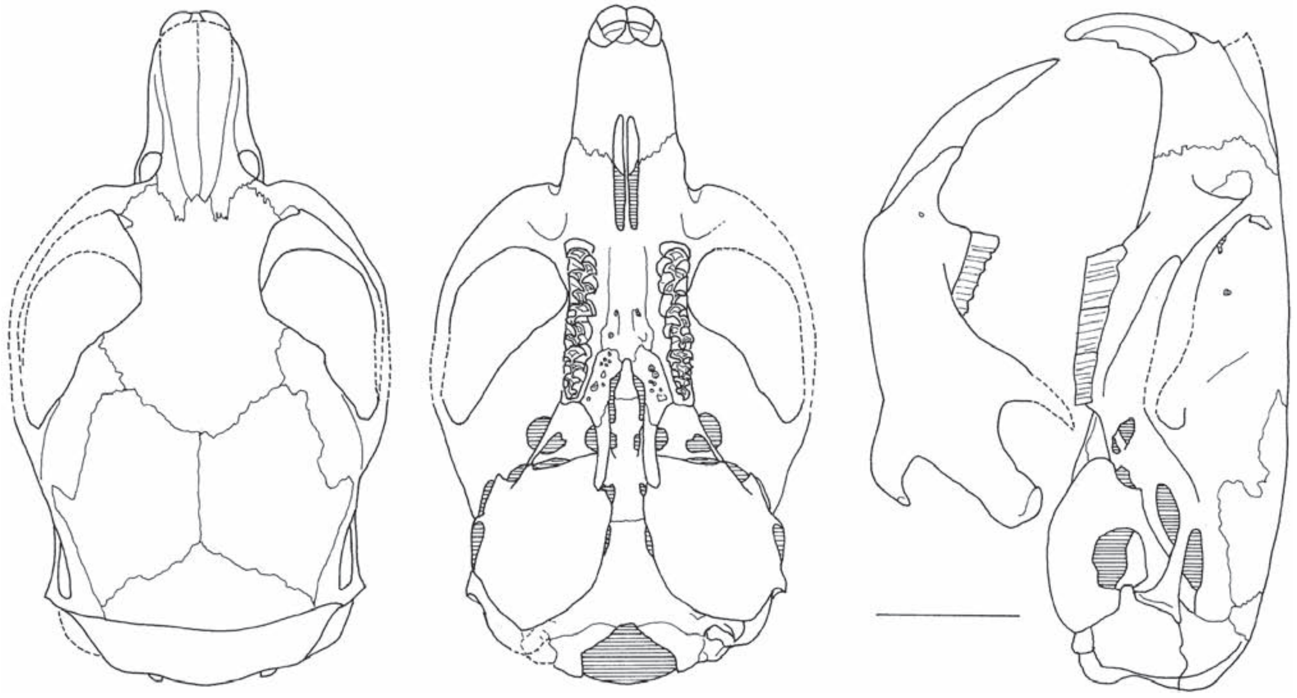


Figure 152. Skull and mandible of a pine vole from 30 km east of Tatvan, reported as *Microtus majori* by Morlok (1978). Based on a partially damaged skull in SMF. Scale bar = 5 mm.

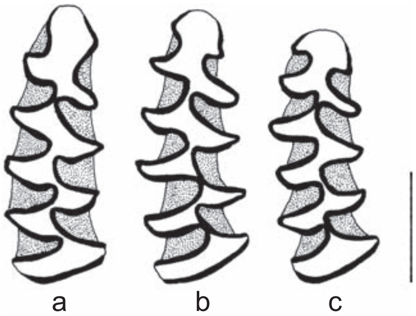


Figure 153. First lower molar variability in pine voles from 30 km east of Tatvan, reported as *Microtus majori* by Morlok (1978). Lingual side is to the left. Scale bar = 1 mm.

as localities of *M. majori* (cf. Fig. 159) are based on material from owl pellets. Because of fragmentary nature of the owl pellet material on the one hand, and difficulties in identification of Turkish pine voles on the other, we are suspicious whether the identification could be correct. The Senckenberg Museum in Frankfurt holds four specimens from Tatvan (skins and broken skulls of which only one is not too badly damaged; cf. Fig. 152) which were reported as *M. majori* (Morlok, 1978). Note, however, that Morlok (1978) considered all the Anatolian pine voles, including those from Zonguldak, as belonging to *M. majori*. Tatvan voles are small (head and body lengths in three specimens are 87, 90, and 91 mm, respectively), fairly short-tailed (tail length as percentage of head and body length = 33, 35, and 39%, respectively) and also pale. Back is yellowish brown and belly is whitish grey; tail is pale brown above and dirty pale below (cf. the description of *M. majori* below). The only unbroken skull is fairly small (condylobasal length = 22.6 mm) but with a broad interorbital region (= 4.2 mm). The available evidence does not allow firm inclusion of the Tatvan material neither into *M. majori* nor *M. subterraneus*.

Description

External characters. Externally, the Major's pine vole resembles *M. subterraneus*, but there are important differences between the two in tail length and in colour. Tail is relatively longer (= 40% of head and body length; range = 35–45%; cf. also Fig. 140) in *M. majori*.

Colour. Thomas (1906a) described colour in an extensive sample from Trabzon area as mummy-brown above, slaty grey below or almost clay-coloured in some specimens. Upper surface of hands and feet is dull whitish. Tail's upper surface is blackish brown, its lower side rather dull whitish and becoming rather darker terminally.

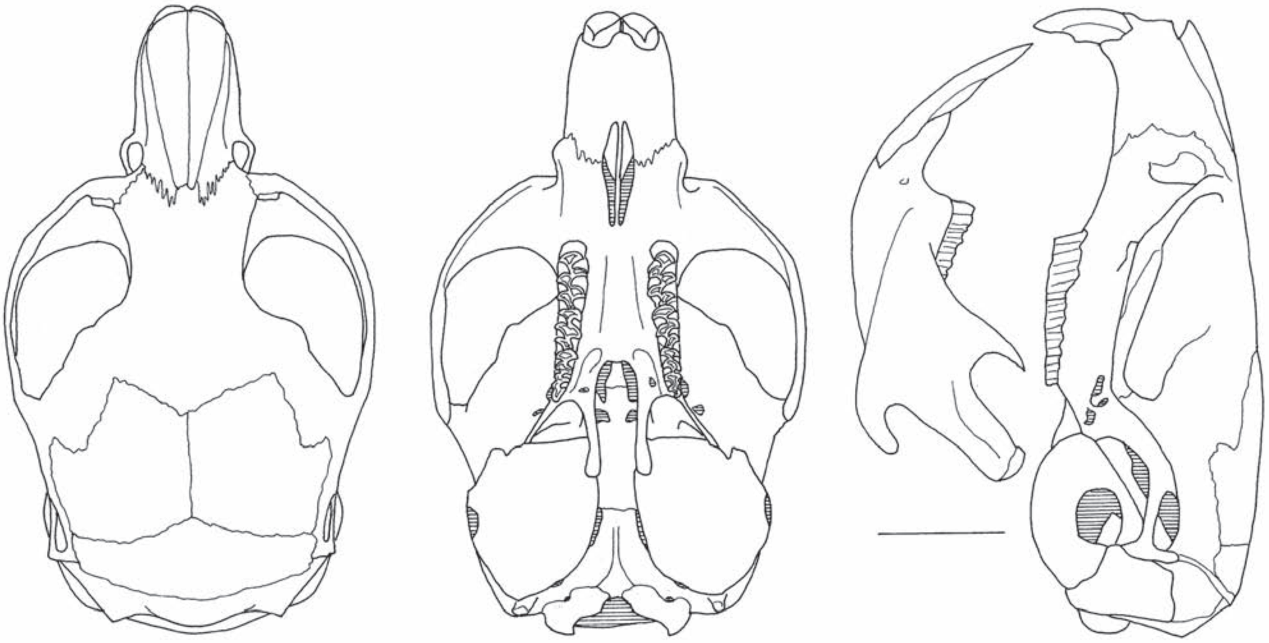


Figure 154. Skull and mandible of *Microtus majori*, based on an adult female from Damar, 3 km south-east of Murgul, Artvin. Scale bar = 5 mm.

Nipples. There are three pairs of nipples, two inguinal and one pectoral.

Penis and Baculum. Glans penis is 10 mm long and 2.5 mm broad, with a small notch at its tip (Çolak *et al*. 1997c). Baculum is similar as in *M. subterraneus*. Basal stalk is 2.33–2.52 mm long (mean = 2.42 mm) with 1.21 mm broad basal expansion (Çolak *et al*. 1997c). Aksenova (1983) gives similar values for a sample of twenty specimens from Georgia: length 2.05–2.60 mm (mean = 2.26 mm) and width 1.15–1.55 mm (mean = 1.29 mm). For spermatozoa morphology see Table 35 and Fig. 141.

Skull resembles that of the European pine vole but it is generally deeper in Major's pine vole and with a broader interorbital region (cf. Fig. 138). Zygomatic arches make up 59.2% of the condylobasal length (range = 56.3–62.7%) and braincase breadth across bullae is 36.1% of the condylobasal length (range = 35.9–39.5%). Dorsal profile is invariably slightly convex or flat, never clearly depressed. Wherever *M. majori* is sympatric with either *M. subterraneus* or *M. daghestanicus*, we found it to be easily distinguished by cranial characters.

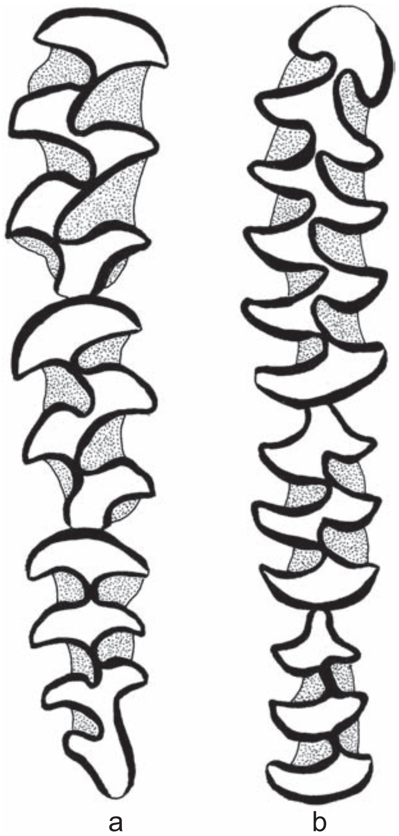


Figure 155. Upper (**a**) and lower molars (**b**) of *Microtus majori* (same specimen as on Fig. 154). Lingual side is to the left, anterior is at the top.

Teeth. Incisors are orthodont. The enamel is yellow or orange on the upper incisors and yellow on the lower ones. Molars are essentially as in *M. subterraneus* (Fig. 155). Second upper molar clearly tends towards the formation of an additional posterior triangle (T5) which is present in approximately one third of specimens. Dental field of T5 is mainly broadly open towards T4 and is never completely isolated. Third upper molar is fairly simple, with three or exceptionally four re-entrant angles on either side. The posterior re-entrant angles are invariably shallow. The constriction on the 1st lower molar between the dental fields of T6-T7 and the more anterior elements is either narrow or broad, but the anterior cup is only exceptionally entirely closed. Anterior cup tends to be symmetrical and mushroom-shaped (Fig. 158a, b); deviations from the described pattern are rare.

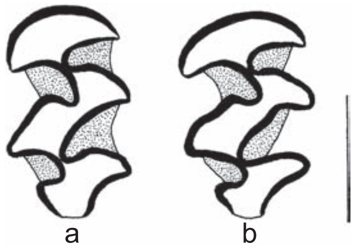


Figure 156. Variation in the posterior part of the 2nd upper molar in *Microtus majori* from Turkey. **a** – Meryemana, Trabzon (type of *M. majori*; BMNH); **b** – Cankurtaran Geçidi, Artvin. Lingual side is to the left and anterior is at the top. Scale bar = 1 mm.

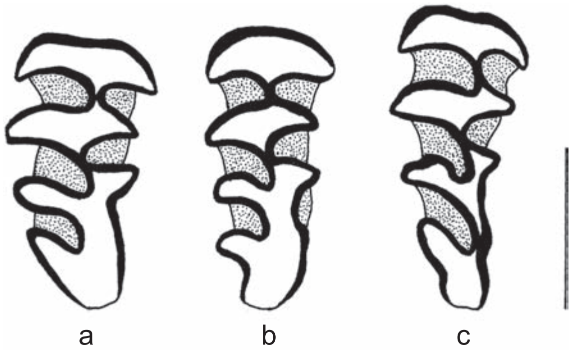


Figure 157. Different morphotypes of the 3rd upper molar in *Microtus majori* from Turkey. **a, b** – Cankurtaran Geçidi, Artvin; **c** – 2 km east of Seyfe, Amasya. Lingual side is to the left and anterior is at the top. Scale bar = 1 mm.

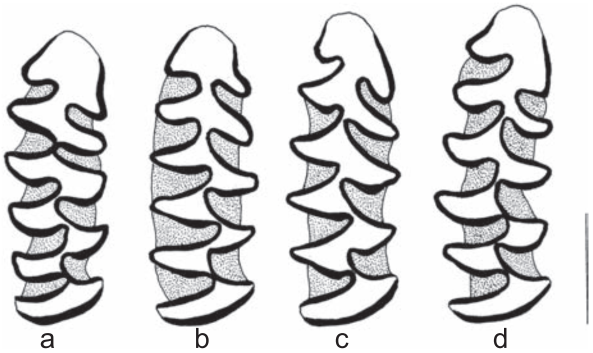


Figure 158. Different morphotypes of the 1st lower molar in *Microtus majori* from Turkey. **a, b** – Cankurtaran Geçidi, Artvin; **c, d** – Meryemana, Trabzon (**c** – type of *majori*; BMNH). Lingual side is to the left and anterior is at the top. Scale bar = 1 mm.

Dimensions are given in Table 38. There is no apparent secondary sexual dimorphism.

	N	mean	Min–max
Head and body	63	100.1	90–112
Tail	63	40.0	32–49
Hind foot	63	16.75	15.5–17.6
Ear	58	10.20	9.0–12.0
Weight	62	23.8	20–29
Condylobasal length	63	23.57	22.5–24.9
Zygomatic breadth	64	13.90	12.8–15.6
Maxillary tooth-row	65	6.12	5.7–6.7

Table 38. External and cranial dimensions of *Microtus majori* from Turkey. Based on specimens in BMNH, FMNH, NMNH, NMW, ZFMK, and our own material.

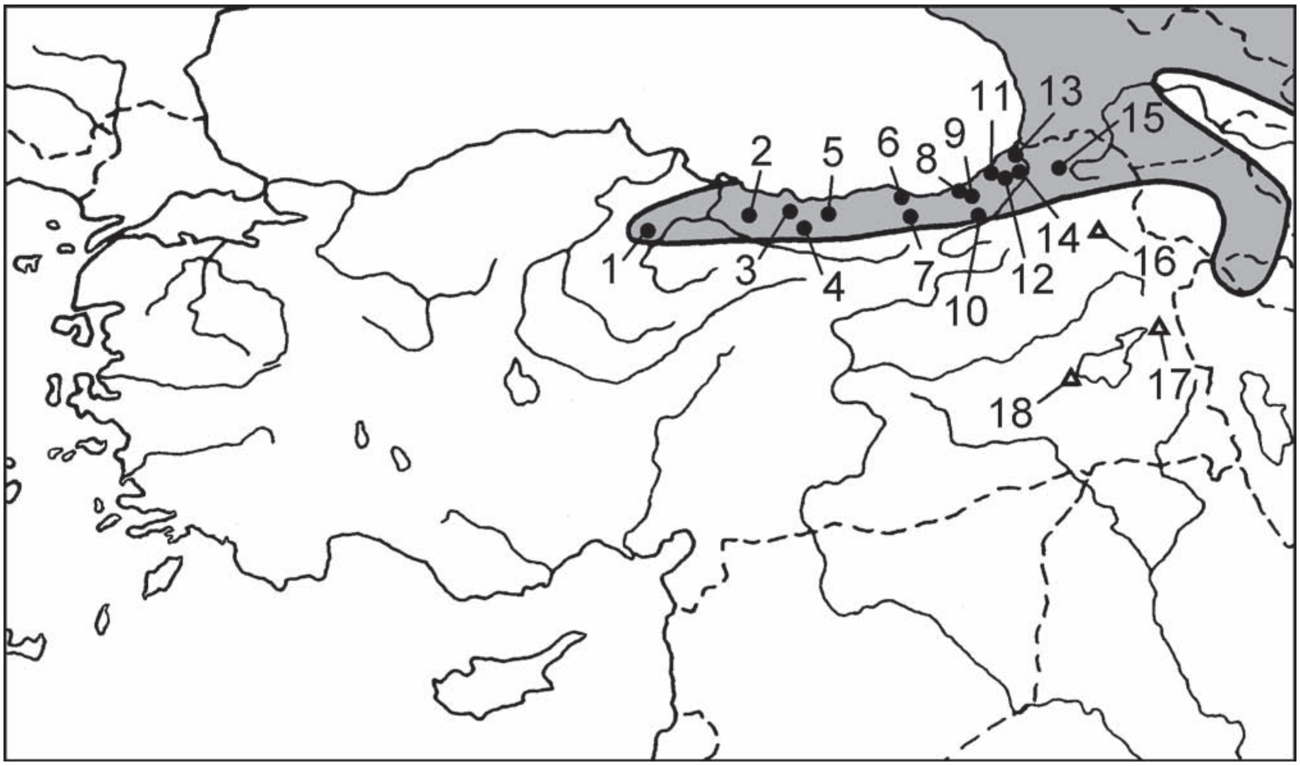


Figure 159. Distribution of *Microtus majori* in Turkey. Triangles indicate taxonomically uncertain reports. See text for further discussion. Records: **1** – 2 km east of Seyfe, Amasya, 1,400 m; **2** – Akkuş, Ordu; **3** – Ulubey, Ordu; **4** – Yeşilce, Mesudiye, Ordu; **5** – Biçik, Giresun district; **6** – Trapezunt (= Trabzon); **7a** – Sumela (= Meryemana), Trabzon; **7b** – Khotz (= Coşandere), Trabzon; **8** – Rize; **9** – Ayder Ilıcası, Rize, 1,300 m; **10** – Çamlik, Rize, 1,380 m; **11** – Ülkü, Rize, 500 m; **12a** – Elevit, Rize; **12b** – Çat, Rize; **13** – Cankurtaran Pass, 12 km east of Hopa, Artvin, 1,050 m; **14a** – Damar, Murgul, 15 km south-west of Borçka, Artvin, *c.* 1,100 m; **14b** – Kabaca, 25 km south-west of Borçka, Artvin, *c.* 800 m; **15a** – Karanlık-Meşe, Ardanuç, Artvin; **15b** – Kutul, Ardanuç, Artvin; **16** – Sarıkamış, Kars, 1,700 m; **17** – Muradiye, Bendimahi, Van; **18** – Tatvan. Corresponding references: Thomas (1906a): 7a. Neuhäuser (1936b): 7b, 8. Spitzenberger & Steiner (1962): 3, 5, 15a,b. Lehmann (1966): 6. Steiner (1972): 2, 3, 4, 5, 9, 11, 12a, 12b, 15a, b. Morlok (1978): 18. Obuch (1994): 16, 17. Macholán *et al.* (2001): 13, 14a, 14b. Own data: 1, 10, 13, 14a, 14b.

Chromosomes. The diploid number of chromosomes is 2N = 54, and the number of autosomal arms is NFa = 56. There is one pair of large submetacentric and one pair of medium-sized subtelocentric autosomes in the karyotype; the remaining autosomal chromosomes are acrocentric. The X chromosome is medium-sized metacentric and the Y chromosome is acrocentric (Çolak *et al*., 1997c; Macholán *et al*., 2001). The same karyotype as in Turkey was also reported from the Caucasus (Achverdjan *et al*., 1992; Baskevič *et al*., 1984; Baskevich, 1997).

Akhverdyan *et al*. (1997) report an aberrant karyotype (2N = 53, NF = 60), found in a single specimen from Georgia, which resulted from Robertsonian translocation accompanied by a single amplification of satellite sequences in centromeric heterochromatin.

With respect to the heterochromatin content, *M. majori* is intermediate between *M. subterraneus* and *M. daghestanicus* (Baskevich, 1997).

Variation

A geographically marginal specimen from Seyfe, Amasya, is paler and has a shorter tail, which makes it similar to *M. subterraneus*. In this respect it also resembles SMF specimens from Tatvan, which we did not align taxonomically. From the rest of the Turkish range we recorded no significant variation.

Gromov & Erbajeva (1995) recognise three subspecies in the Caucasus, of which the palest is *M. m. suramensis* Heptner, 1948 (new name for *Microtus (Arbusticola) rubelianus intermedius* Schidlovsky, 1919 with the type locality near Suram, northern Central Caucasus; Corbet 1978).

Distribution

Major's pine vole is endemic to the Caucasus and the adjacent eastern Pontic Mts. of Turkey. Gromov and Erbajeva (1995) give the range as follows: "between Krasnodar area and south-western Transcaucasia as far as northern Armenia, western and central parts of the Greater Caucasus, and the Lesser Caucasus in the south-east where the range encompasses also Azerbaydzhan; north-western Iran" (we are not aware of any published record from Iran, however). Isolates are said to occur in Stavropol and Pjatigorsk regions (Gromov & Erbajeva, 1995). The most detailed dot map available from the Caucasus is by Achverdjan *et al*. (1992). Šidlovskij (1976), who provides detailed maps for Transcaucasian rodents, did not distinguish between *M. majori* and *M. daghestanicus*.

The range of *M. majori* in Turkey is in the form of a narrow belt in the eastern Pontic Mts. between the border with Georgia in the east and approximately the river Kızılırmak in the west (Fig. 159). None of the records to the west of Trabzon is supported by karyological or genetic evidence. The border in the south-east is uncertain. As noted above, records for Sarıkamiş and Muradiye (Obuch, 1994) need further taxonomic verification; the assignment of the Tatvan sample is also dubious.

Habitat

Turkish records are mainly from mixed forests (*Picea orientalis, Alnus glutinosa, Castanea sativa, Fagus orientalis, Juglans regia, Carpinus orientalis*) where the vole lives among moss-covered rocks and along streams. Major's pine vole also lives among

Figure 160. Habitat of *Microtus majori*. Çamlik, Rize. Photo: B. Kryštufek.

Rhododendron shrubs, in abandoned fields and along forest edges.

In the Caucasus and in Transcaucasia, Major's pine vole inhabits montane broadleaved forests where it is the most common in clearings due to gaps in canopy. It is also found in alpine pastures (where it forms colonies), particularly during summer. Above the timber line, *M. majori* seeks shelter in shallow tunnels and among rocks, where *Chinomys nivalis* and *C. gud* also occur (Gromov & Erbajeva, 1995).

ALTITUDE. Most of the records are from between 800 (Kabaca near Borçka) and 1,400 m a.s.l. (near Seyfe). Steiner (1972) gives a record also for 500 m a.s.l. (Ülkü).

ASSOCIATES. Although the range of Major's vole overlaps with those of both pine voles in Turkey (with *M. subterraneus* in the west and with *M. daghestanicus* in the east), we never found two pine vole species to live in syntopy. Elevational segregation between *M. majori* (lower altitudes) and *M. daghestanicus* (higher elevations) in eastern Turkey was already noted by Steiner (1972). Further evidence from our field work in support of Steiner's conclusion is summarised in Table 39. Contrary to this, Baskevič *et al.* (1984) collected *M. majori* together with *M. daghestanicus* in four out of eight localities sampled in the Caucasus of Russia, Georgia and Armenia. Sympatric records were from a broad elevational range of 1,150–2,100 m a.s.l.

Locality	*M. subterraneus*	*M. majori*	*M. daghestanicus*
Ovitdağ	–	1,380	2,450
Seyfe	1,100	1,400	–

Table 39. Altitudinal segregation between the three pine vole species of Turkey. Given is the altitude (m a.s.l.) where the species was collected.

Wood mice (*Apodemus* spp.) and Robert's snow vole *Chionomys roberti* are common rodents in mesic forests of the Pontic Mts., where *M. majori* also occurs. The same habitat type is frequented by three endemic shrews (*Sorex satunini, S. volnuchini, S. raddei*).

BIOLOGY

REPRODUCTION. Data on reproduction are scarce in Turkey. Body mass of sexually active females is 20–25 g (mean = 22.3 g, N = 11) and males with scrotal testes have body mass of 20–29 g (mean = 22.9 g, N = 9). Litter size (based on count of embryos) range from 2 to 4 in Turkey (mean = 2.8, N = 6). For the former USSR, Gromov & Erbajeva (1995) report five litters in overwintered females and up to two in females of the same year; the mean number of embryos is given as 3–4. Reproduction starts in April (in the foothills) or in May (at higher altitudes) in the Caucasus, but all-year-round reproduction was documented in Armenia (Gromov & Erbajeva, 1995). At Ulubey, Turkey, Spitzenberger & Steiner (1962) found juveniles of two generations as early as the last decade of May.

FOOD. During summer, Major's pine vole feeds on green plants but collects seeds (also beech and oak mast) in autumn. Damage done to roots of young oak trees by Major's vole was reported to be of economic significance in Armenia (Gromov & Erbajeva, 1995).

PREDATION. Obuch (1994) found pine voles, most likely *M. majori*, in the eagle owl *(Bubo bubo)* pellets in eastern Anatolia.

DAGHESTAN PINE VOLE – *MICROTUS DAGHESTANICUS*

Microtus (Arbusticola) rubelianus daghestanicus Shidlovsky, 1919. Type loc.: Near Khiso, Daghestan, Caucasus.

TAXONOMY

See comments in the introductory chapter to pine voles and under *M. majori*. Achverdjan *et al.* (1992) and Gromov & Erbajeva (1995) report seven different chromosomal forms with diploid numbers varying between 2N = 38 and 2N = 54, but having a stable fundamental number of autosomsal arms NFa = 58. Hybrids were also detected among chromosomal forms 2N = 54 and 52, 2N = 44 and 46, and 2N = 42 and 44, respectively (Achverdjan *et al*., 1992). Within the context of *M. daghestanicus*, Pavlinov & Rossolimo (1987, 1998) and Musser & Carleton (1993) recognise *M. nasarovi* (Schidlovsky, 1938) as a separate species. Baskevič *et al.* (1984) report several diploid numbers for *M. daghestanicus* (2N = 52 and 2N = 54) and for *M. nasarovi* (2N = 42 and 2N = 38). Zagorodnyuk (1990) connects *M.*

nasarovi with the karyotypic form 2N = 42, while Gromov & Erbajeva (1995) and Bukhnikashvili & Kandaurov (1998) report for *M. nasarovi* the lowest diploid number in the group, i.e. 2N = 38. Crossbreeding experiment between 2N = 40 male and 2N = 38 female resulted in 2N = 40, NF = 58 hybrids which showed synaptonemal complexes in males. Meiotic disruption of synapses become more evident, however, in the offspring of a hybrid female (*M. majori* 2N = 54, NF = 60 female x *M. daghestanicus* 2N = 54, NF = 58 male) which was interpreted as an evidence of deeper isolation between *M. daghestanicus* and *M. majori* than between different chromosomal forms of *M. daghestanicus* (Malygin *et al*., 2000).

DESCRIPTION

EXTERNAL CHARACTERS. The Daghestan pine vole resembles most closely *M. obscurus*, with which it is syntopic, and the two are easily confused in the field. Tail length makes up approximately 37% of the head and body length (range = 33.3–40.0%, N = 16), which places *M. daghestanicus* between *M. majori* (tail longer) and *M. subterraneus* (tail shorter; cf. Fig. 140). Gromov & Erbajeva (1995) state that eye orifices are smaller in *M. daghestanicus* than in *M. majori*, which suggests the former to be more fossorial.

COLOUR is similar to that of *M. subterraneus*, albeit slightly darker. The Daghestan pine vole, however, is never as dark as *M. majori*.

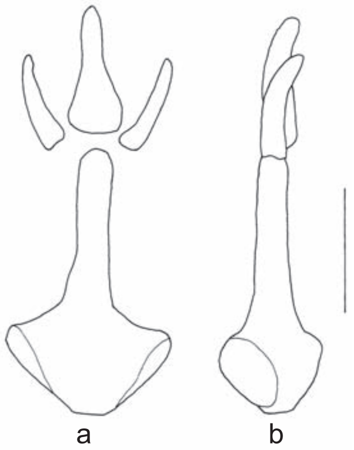


Figure 161. Baculum of *Microtus daghestanicus* in dorsal (**a**) and lateral view (**b**). Based on an adult male from Ovitdağı Geçidi, Rize. Scale bar = 1 mm.

NIPPLES. There are three pairs of nipples (two inguinal and one pectoral).

BACULUM is similar as in *M. subterraneus*; in an adult male from Ovitdağı Geçidi the stalk was 2.17 mm long with basal expansion 1.37 mm broad (Fig. 161). For spermatozoa morphology see Table 35 and Fig. 141. Glans penis is on average 3.4 mm long and 2.0 mm wide (Zorenko & Aksenova, 1989).

SKULL is essentially as in *M. subterraneus*, but rostrum tends to be longer in *M. daghestanicus* (Fig. 162). In addition, depression in the orbital region, as seen in the dorsal profile, is a norm in adult Daghestan pine voles (Fig. 139). Zygomatic arches make on average 58.2% of condylobasal length (range = 55.8–62.7%, N = 16). Skull is shallow and braincase height across bullae is 34% of the condylobasal length (range = 31.7–36.6%, N =16).

TEETH. Upper incisors tend to be more proodont than those of the other two pine voles. Enamel on the front surface of the upper and lower incisors is yellow. Molars do not differ essentially from the condition seen in *M. subterraneus* (Fig. 163). The constriction between dental fields T6-T7 and the more anterior elements on the 1st lower molar, however, tends to be narrower and occasionally even separates the two parts entirely (Fig. 164d); on the other hand, a wide constriction is seen only exceptionally (Fig. 164a). Gromov & Erbajeva (1995) claim the anterior lobe of the 1st lower molar to be long and narrow; however, we traced no such condition in our Turkish material. The 2nd upper molar is frequently more complex in its posterior part with an additional triangle (T5), its dental field, however, is never isolated from T4 (Fig. 165).

DIMENSIONS are given in Table 40. There is no apparent secondary sexual dimorphism.

	N	mean	min–max
Head and body	16	99.4	91–105
Tail	16	36.8	33–42
Hind foot	16	14.98	14.2–16.4
Ear	16	10.47	10.0–12.0
Weight	16	22.2	15–25
Condylobasal length	24	22.92	21.7–24.1
Zygomatic breadth	23	13.35	12.2–14.6
Maxillary tooth-row	23	5.59	5.1–6.3

Table 40. External and cranial dimensions of *Microtus daghestanicus* from Turkey. Based on our own material.

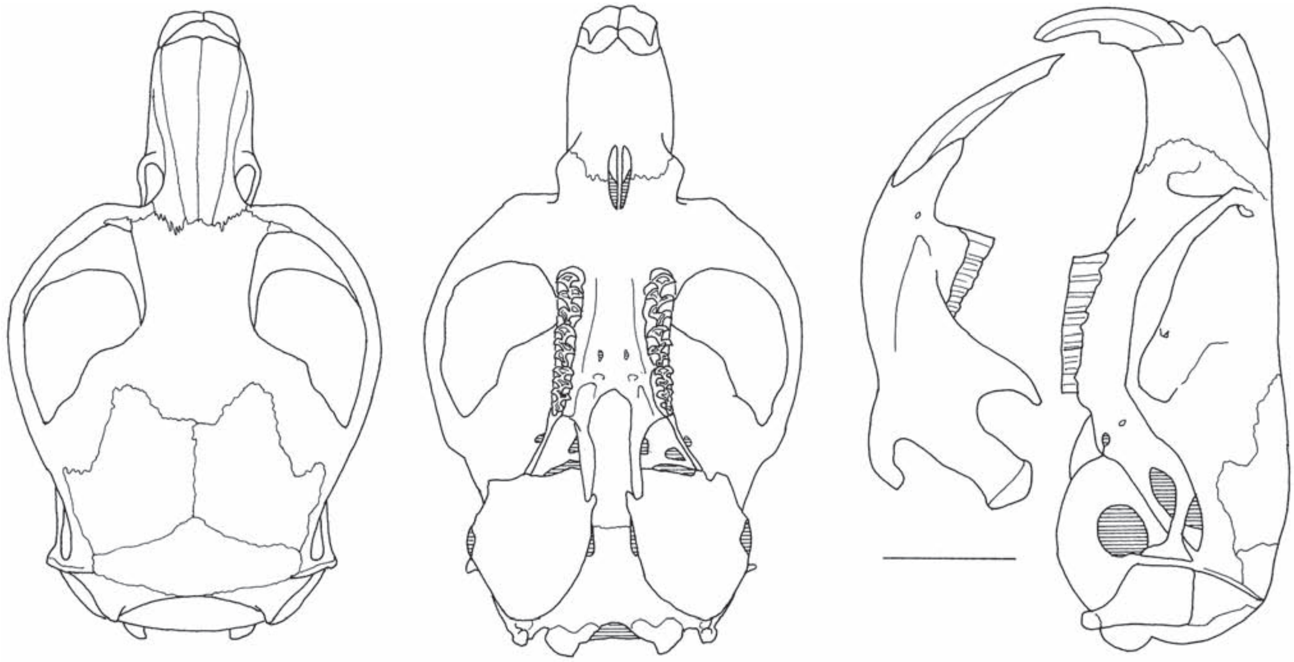


Figure 162. Skull and mandible of *Microtus daghestancius*, based on an adult male from Ovitdağı Geçidi, Rize. Scale bar = 5 mm.

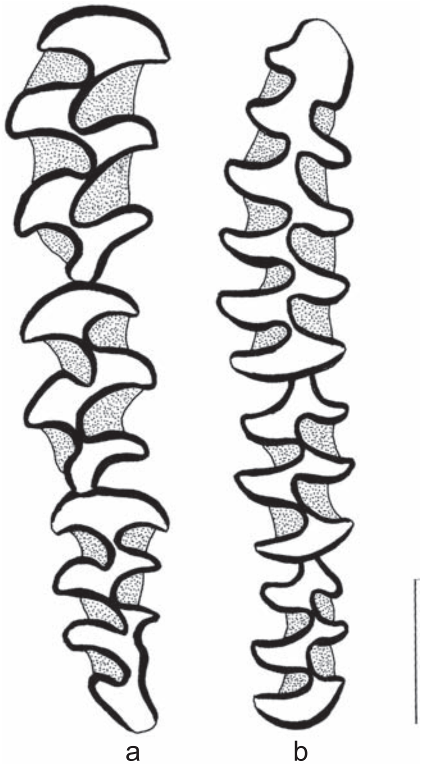


Figure 163. Upper (**a**) and lower molars (**b**) of *Microtus daghestancius* (same specimen as in Fig. 162). Lingual side is to the left, anterior is at the top. Scale bar = 1 mm.

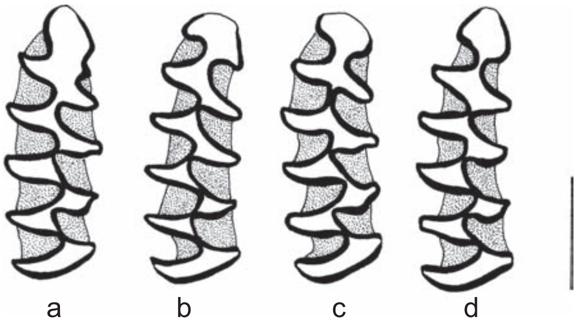


Figure 164. Different morphotypes of the 1st lower molar in *Microtus daghestanicus* from Turkey. **a, b, d** – 5 km west of Bağdaşan, Kars; **c** – 3 km north of Sirbasan, Kars. Lingual side is to the left and anterior is at the top. Scale bar = 1 mm.

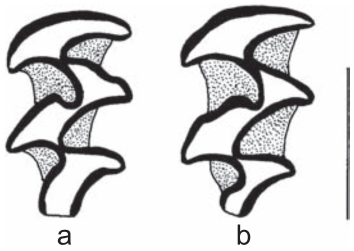


Figure 165. Variation of the posterior part of the 2nd upper molar in *Microtus daghestanicus* from Turkey. **a** – Ovitdağı Geçidi, Rize; **b** – 5 km west of Bağdaşan, Kars. Lingual side is to the left and anterior is at the top. Scale bar = 1 mm.

CHROMOSOMES. Zima & Král (1984) and Baskevich (1997) report the diploid number 2N = 54 and the fundamental number of autosomal arms NFa = 54. The X chromosome is large submetacentric and the Y chromosome is medium sized acrocentric. This chromosomal race is evidently widespread in the western and central Caucasus (Achverdjan *et al*., 1992). Baskevič *et al*. (1984) and Zagorodnyuk (1990) report for *M. daghestanicus* the karyotype 2N = 52 and NFa = 56. For chromosomal variation see the chapter on Taxonomy above. Our specimens from Turkish localities (Bağdaşan and Handere) had the diploid chromosome number 2N = 54 and the fundamental number of autosomal arms NFa = 54 (M. Macholán, personal communication). The Daghestan pine vole has a higher content of heterochromatin than the other two pine voles dealt with in this volume (Baskevich, 1997).

VARIATION

As noted by Gromov & Erbajeva (1995), *M. daghestanicus* is a highly variable species, a fact particularly evident from the number of chromosomal forms (see above). In their opinion, the high level of interpopulation variation is a consequence of habitat dynamics during the Pleistocene and the Lower Holocene, which fragmented the contiguous range and accelerated the divergence among vicariant populations.

We detected no interpopulation variation among Turkish populations. Considering the small range in Turkey, such a result is not surprising.

DISTRIBUTION

The Daghestan pine vole is endemic to the Caucasus and occurs very marginally in Turkey (Fig. 166). Gromov & Erbajeva (1995) give its range as encompassing the mountains of the eastern and central Greater Caucasus and of the Lesser Caucasus in Armenia and Azerbaijan. The most detialed dot map available from the Caucasus is by Achverdjan *et al*. (1992), indicating a wide overlap of the ranges of *M.*

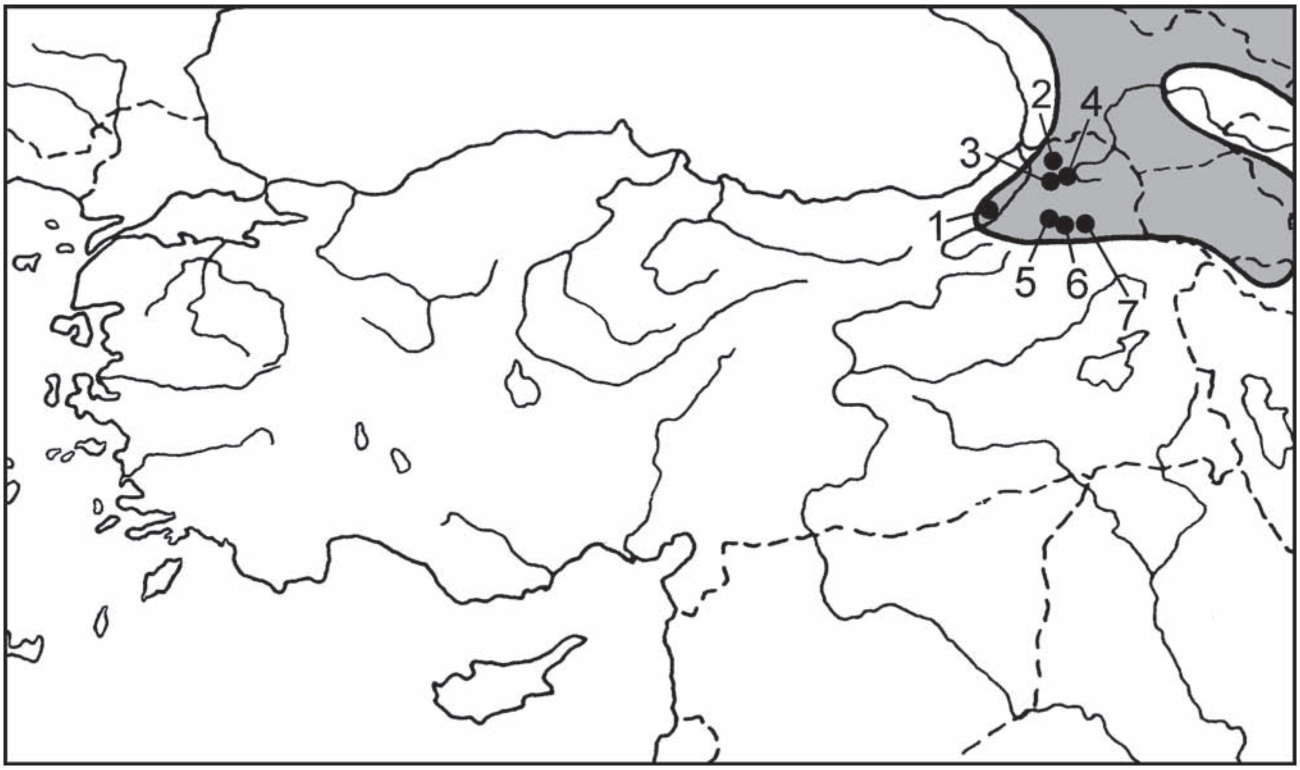


Figure 166. Distribution of *Microtus daghestanicus* in Turkey. Records: **1** – Ovitdağı Geçidi, Rize, 2,450 m; **2** – Kutul, Artvin; **3** – Yalnızçam Gecidi, Artvin, 2,300-2,500 m; **4** – 5 km west of Bağdaşan, Kars, 2,600 m; **5** – 3 km north of Sirbasan, Kars, *c.* 2,200 m; **6** – 3 km west of Handere, Kars, *c.* 2,600 m; **7** – 3 km south of Sarıkamış, Kars, *c.* 2,400 m. Corresponding references: Steiner (1972): 2, 3. Own data: 1, 4-7.

daghestanicus and *M. majori*. Šidlovskij (1976), who provides detailed maps for Transcaucasian rodents, did not distinguish between *M. majori* and *M. daghestanicus*.

Microtus daghestanicus is known in Turkey from seven localities clumped in north-eastern Anatolia (Fig. 166). The westernmost record is from Mt. Ovitdağ.

HABITAT

In Turkey the Daghestan pine vole populates alpine meadows, both mesic and dry, at elevations above 2,000 m a.s.l. Steppe and dry meadows at high altitudes are also the principal habitat in the Caucasus. As reported by Gromov & Erbajeva (1995), this vole was also collected from the edge of a cereal field in Daghestan.

Figure 167. Habitat of *Microtus daghestanicus*. Ovitdağı Geçidi, Rize. Photo by Z. Musilová & P. Musil.

ALTITUDE. All reliable Turkish localities are from elevations between 2,200 and 2,600 m a.s.l..

ASSOCIATES. The Daghestan pine vole was found in the same habitat as *Sorex satunini, S. volnuchini, Apodemus spp.,* and *Mesocricetus brandti*, in addition to several other vole species. In open dry meadows also inhabited by *M. obscurus*, *M. daghestanicus* digs its own underground burrows. In wet situations the Daghestan pine vole can find shelter among rocks in spaces inhabited by snow voles (*Chionomys nivalis* and *C. gud*).

DENSITY. At the beginning of September 1995 we found, on dry alpine meadows at Bağdaşan (elevation 2,600 m a.s.l.), *M. daghestanicus* to be the dominant species together with *M. obscurus*. The two voles, which were equally common (28 specimens of *M. daghestanicus vs.* 27 *M. obscurus*), accounted for 66% of all small mammals trapped.

BIOLOGY

The biology of this species is virtually unknown throughout its range (Gromov & Erbajeva, 1995), apparently as a consequence of its confusion with Major's pine vole in the past (*cf.* Šidlovskij, 1976). The embryo counts in three females from Turkey were 4, 4 and 5. Sexually active females had body mass of 22.0 g (range = 18–24 g, N = 10) and males with scrotal testes (maximal size 10 x 7 mm) weighed 19.7 g on average (N = 6).

THE *ARVALIS* GROUP

In terms of traditional taxonomy (Ellerman & Morrison-Scott, 1951; Ognev, 1950; Kratochvíl *et al*., 1959), *Microtus arvalis* (Pallas, 1779) used to be a collection of several sibling species and was believed to populate extensive parts of the Palaearctic from northern Spain in the west to Mongolia in the east. Within such a broad scope, the two species which are currently recognised for Turkey have been reported as *M. arvalis transcaucasicus* Ognev, 1924 (type loc.: Santa village, Borchalinsk subdistrict, Tiflis, Caucasus; Lehmann, 1966, 1969; Felten *et al*., 1971; Steiner, 1972), *M. a. muhlisi* (Neuhäuser, 1936b; Ellerman, 1948), *M. a. relictus* (Neuhäuser, 1936b; Kratochvíl *et al*., 1959; Lehmann, 1966), or simply as *M. arvalis* (Osborn, 1962; Steiner & Vauk, 1966; Turan, 1984; Kefelioğlu & Doğramacı, 1988; Doğramacı, 1989a; Doğramacı & Kefelioğlu, 1989). Note that the name *M. arvalis*, as applied by the above authors, is not to be confused by its latter usage in Kefelioğlu (1995).

SIBLING SPECIES. The first in a series of sibling species within *M. arvalis* group was recognised by Mejer *et al*. (1969) and subsequently described under the name *M. subarvalis* Mejer, Orlov & Skholl', 1972 (type loc.: Leningrad region, Russia). The newly named species differed from *M. arvalis* s. str. in its diploid number of 2N = 54 (2N = 46 in *M. arvalis*; Zima & Král, 1984). Following this discovery, the entire *M. arvalis* group was subjected to careful karyological studies and various crossbreeding experiments (for reviews see Král *et al*., 1980; Sokolov & Bashenina, 1994, and Meyer *et al*., 1996).

The new name, as proposed by Mejer *et al*. (1972), is preoccupied by *M. subarvalis* Heller, 1933, based on the Pleistocene fossil material from Germany (Corbet, 1984). Besides, it has appeared that *M. subarvalis* of Mejer *et al*. (1972) is a junior synonym of *M. epiroticus* Ondrias, 1966 (type loc.: Perama, near Ioannina, Epirus, Greece; Petrov *et al*., 1975), which, however, is pre-dated by *M. rossiaemeridionalis* (Musser & Carleton, 1993). Both *epiroticus* and *rossiameridionalis* Ognev, 1924, were originally described as the subspecies of *M. arvalis*.

Masing (1999) suggests that the type of *M. levis* Miller, 1908 (type loc.: Gageni, Prahova, Romania) actually represents the 2N = 54 species. The possibility that the name *M. levis* is applicable to the 2N = 54 voles, as the oldest valid name, has already been mentioned by Zima *et al*. (1980). However, Zima *et al*. (1980) also express the opinion that "the problem of the exact specific pertinence of Miller's type material can hardly be solved at present, particularly if both species should occur in the *terra typica* of Miller's species." (= *M. levis*). Masing (1999) based his conclusion on the taxonomic identity of *M. levis* type specimen solely on cranial characters, which, in our opinion, are far from being diagnostic (see below). For this reason we continue to use, for 2N = 54 voles, the established name *M. rossiaemeridionalis*.

Malygin & Orlov (1974) distinguished two allopatric forms within *M. arvalis* (2N = 46), *viz.,* "*obscurus*" (with ten pairs of acrocentrics), and "*arvalis*" (with four pairs of acrocentrics). Zagorodnyuk (1991a) considers the two chromosomal forms to be independent species. This has been accepted in Musser & Carleton (1993) and is also followed here. Anyhow, Russian authors (Vinogradov & Gromov, 1984; Sokolov & Bashenina, 1994; Gromov & Erbajeva, 1995; Meyer *et al*., 1996; Pavlinov & Rossolimo, 1998) mainly continue to include the "*obscurus*" chromosomal form with *M. arvalis*. In any case, genetic distance between the two is slight (Jaarola *et al*., 2004).

Microtus rossiaemeridionalis and *M. arvalis* do hybridise under laboratory conditions. Meyer *et al*. (1996) report that litters were produced by voles involved in 10–100% of interspecific trials. When allopatric partners were used in intraspecific trails, the success was 69–100% for *M. rossiaemeridionalis* and 90-100% for *M. arvalis*. The females used in interspecific crossbreeding experiments produced smaller litters and had lower overall reproductive success (Meyer *et al*., 1996). The hybrids, which are bigger due to heterosis, were invariably sterile. Hybridisation evidently does not occur under natural conditions (Meyer, 1978).

Voles showing the diploid chromosome number of 2N = 54 were reported from Turkey (Samsun) for the first time by Doğramacı & Kefelioğlu (1989), yet they employed the name *M. arvalis* for this population. Nevertheless, it was in the very same year when Doğramacı (1989b) corrected this by ascribing the population to *M. epiroticus*. The group was thoroughly studied in Turkey by Kefelioğlu (1995) who confirmed the presence of two species, *viz., M. rossiaemeridionalis* (under the name *M. epiroticus*) and *M. obscurus* (as *M. arvalis*). Recently, Yiğit *et al*. (2003a) reported from Turkey only *M. rossiameridionalis* (under the name *M. epiroticus*) and listed records from throughout the country. From their paper it is not evident, however, whether or not the specimens were karyotyped or identified by some other sound method or methods.

Morphological differences between the sibling species of the *arvalis* group are slight at their best. Both species which occur also in Turkey are characterised by high individual variation on the one hand and by just slight interspecific differences on the other. Kratochvíl (1983) distinguished the two voles in the Bulgarian material by the neurocranium volume scaled to the condylobasal length. A subsequent study from the same area, however, suggests a wide overlap of *M. rossiaemeridionalis* and *M. arvalis* on the plot of the neurocranium capacity against the length of skull (Gerasimov *et al*., 1984). A set of cranial and dental characters (fifteen in total) is proposed as diagnostic by Zagorodnyuk (1991b), Sokolov & Bashenina (1994), and Masing (1999). We have checked all these traits on our specimens with known karyotype. In the way they are defined, any of them has a diagnostic weight. These characters are only exceptionally discrete and mainly represent extreme variants of a continuos variation range. In any case, we found both the extreme variants and the mutually exclusive character states to be present in both species.

We propose here two metrical cranial characters which, in spite of some overlap, could nevertheless distinguish fairly well between the two voles in our Turkish material. *Microtus rossiaemeridionalis* has a longer neurocranium. Its relative length (given as a quotient with the condylobasal length and multiplied by 100) is mainly >54.5% in *M. rossiaemeridionalis* (range = 54.3–59.6%, N = 20) and <56% in *M. obscurus* (range = 52.0–55.9%, N = 13). The character is meaningfully applicable on adult skulls only. Bivariate plot of the two variables (Fig. 168) suggests a very limited overlap.

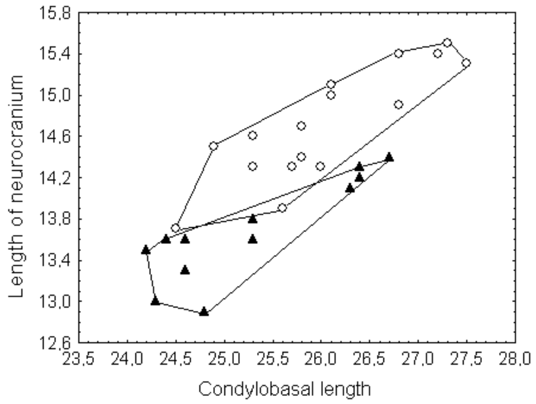


Figure 168. Bivariate plot of neurocranium length against condylobasal length of skull for adult Turkish *Microtus rossiaemeridionalis* (dots) and *M. obscurus* (traingles).

As noted by Teslenko (1986), the two voles differ in the shape of their incisive foramen, which is short and broad in *M. rossiaemeridionalis*, while it is long and narrow in *M. arvalis* (Fig. 169). Bivariate plot of the breadth of *foramina incisiva* against their length is shown in Fig. 170. In our material, the greatest width of the two foramina combined ranged from 0.71–1.01 mm in *M. obscurus* (N = 41) and from 0.88–1.22 mm in *M. rossiaemeridionalis* (N = 49). This character is not age-dependent.

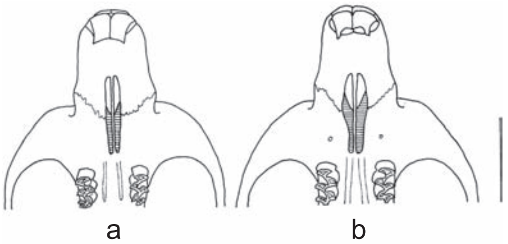


Figure 169. Ventral side of rostrum to show differences in the shape of incisive foramens in *Microtus obscurus* (**a**) and *M. rossiaemeridionalis* (**b**). Based on specimens from Sirbaşan, Kars (**a**), and Tanir, Kahramanmaraş (**b**). Scale bar = 5 mm.

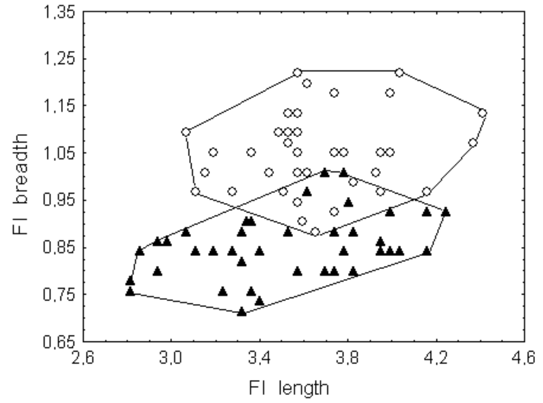


Figure 170. Bivariate plot of incisive foramina (FI) breadth against FI length for Turkish *Microtus rossiaemeridionalis* (dots) and *M. obscurus* (traingles). All age groups are considered.

So far, none of the authors have paid attention to the diagnostic value of external characters in distinguishing the two sibling voles. We found the hind foot to be evidently longer in *M. rossiamerіdionalis* than in *M. obscurus* (cf. Tables 42 and 44). Bivariate plot of hind foot length against head and body length sorted adults in our Turkish sample in accordance with their taxonomic affiliation (Fig. 171). Only the measurements taken by one of us, i.e. in a consistent way, have been used.

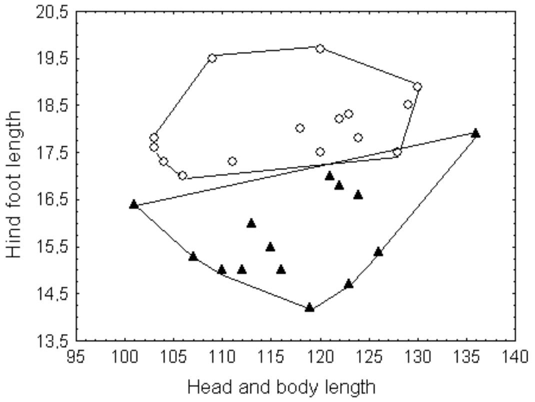


Figure 171. Bivariate plot of hind foot length against head and body length for adult Turkish *Microtus rossiaemeridionalis* (dots) and *M. obscurus* (traingles).

The two species differ in spermatiozoid morphology. Their head is bigger in *M. rossiaemeridionalis* with a more pronouncedly sickle-shaped acrosome (Meyer *et al*., 1996). For dimensions see Table 41.

	Length		Width	
M. arvalis s. lat.	8.63	7.74–9.72	4.22	3.50–4.95
M. rossiaemerid.	7.21	6.48–7.92	3.57	3.15–3.78

Table 41. Dimensions (length and width; in µm) of the spermatozoa head in *Microtus arvalis* s. lat. and *M. rossiaemeridionalis*. Given are mean and range; sample size is N = 100 in each species. From Aksenova (1978).

RANK. The voles of the *arvalis* group (called 'grey voles' by Russian authors; *cf*. Meyer *et al*., 1996; Golenischev *et al*., 1999) are frequently included in the subgenus *Microtus* Schrank, 1798 (Ognev, 1950; Ellerman & Morrison-Scott, 1951; Gromov & Poljakov, 1977; Aksenova, 1980; Gromov & Baranova, 1981; Niethammer & Krapp, 1982a; Zagorodnyuk, 1990; Gromov & Erbajeva, 1995, Meyer *et al*., 1996; Pavlinov & Rossolimo, 1998; Golenischev *et al*., 1999). Note, however, that the scope of the subgenus has changed over time; e.g. Ellerman & Morrison-Scott (1951) include in it also the snow voles, now placed in the genus *Chionomys*. The Turkish taxa have been placed by some authors in the species group '*arvalis*'(within the subgenus *Microtus*; Gromov & Baranova, 1981; Zagorodnyuk, 1990; Gromov & Erbajeva, 1995, Meyer *et al*., 1996; Pavlinov & Rossolimo, 1998).

ALTAI VOLE – *MICROTUS OBSCURUS*

Hypudaeus obscurus Eversmann, 1845. Type loc.: probably near Čujskij trakt (a road), Altai Mts, Siberia.

DESCRIPTION

EXTERNAL CHARACTERS. The Altai vole is a medium-sized member of the *arvalis* group, with tail shorter than half the head and body together (28.3–40.6%; mean = 34.2%). Head short, stout and large, muzzle blunt, eyes moderately large, and ears longer than in pine voles. Legs short, six plantar pads. Fur shaggier than in pine voles. Dorsal hairs up to 9.5 mm long in summer pelage, but sparse black-tipped hairs grow up to 12.5 mm long. Whitish mystacial vibrissae up to 22 mm long.

COLOUR. Upper parts dark brown and dorsal hairs slate black basally. Yellowish brown or brownish buff specimens are rare. Buff and yellow-brown colour

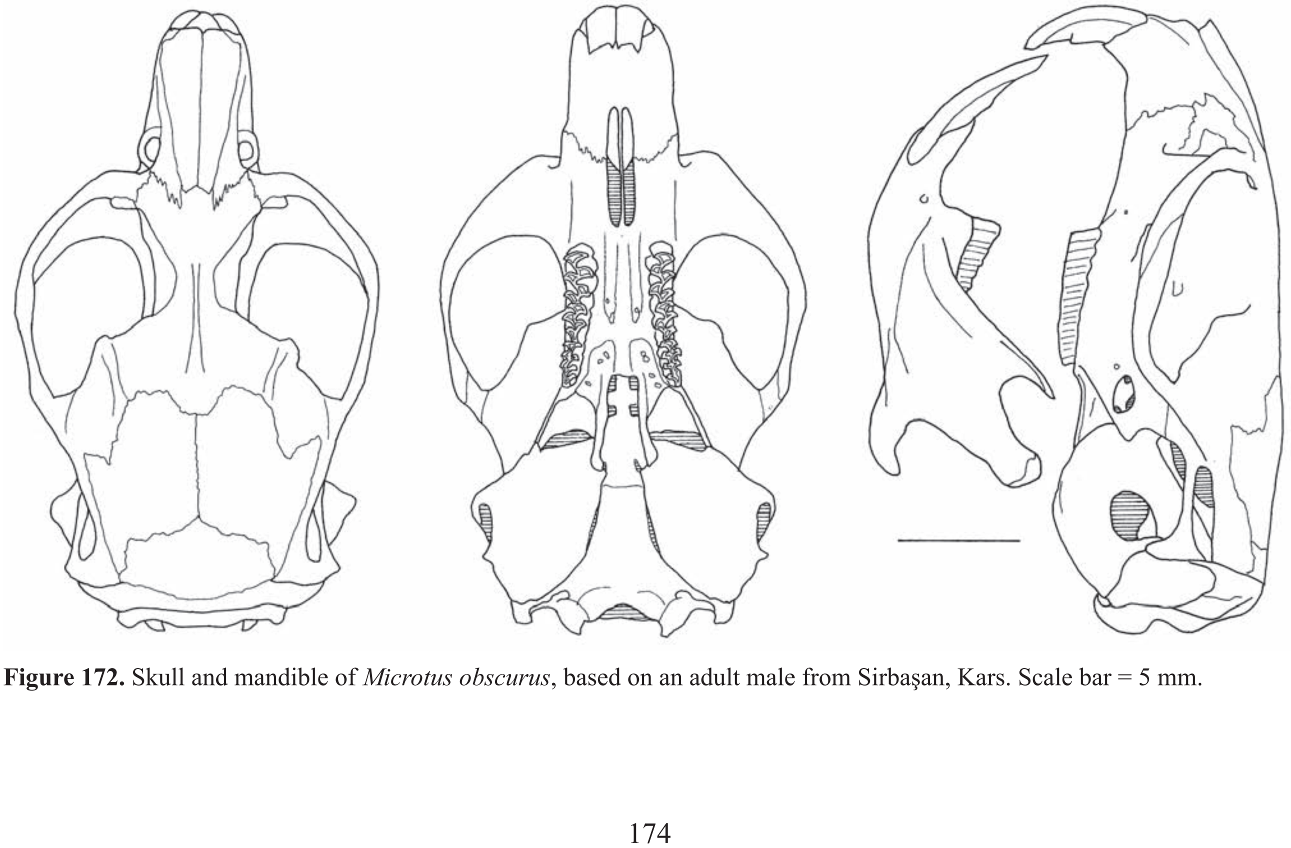


Figure 172. Skull and mandible of *Microtus obscurus*, based on an adult male from Sirbaşan, Kars. Scale bar = 5 mm.

more evident along flanks. Demarcation line mainly faded, but rather distinct in some specimens. Grey belly invariably washed with white, yellow or buff. Tail indistinctly bicoloured, grey brown above, buff white below. Terminal pencil, which is frequently black brown, is up to 4.5 mm long. Feet white buff.

NIPPLES. There are eight nipples, two pairs of each, pectoral and inguinal.

BACULUM is described by Meyer *et al*. (1996). Similarly as in pine voles, it consists of a basal part and three distal processes. As evident from Figs. 17 and 18 in Meyer *et al*. (1996), the distal processes are smaller in *M. rossiaemeridionalis* than in *M. arvalis* (note however, that Russian authors do not recognise *M. obscurus* as a distinct species). Besides, the central distal process is subequal to two lateral ones in *M. rossiaemeridionalis*, while it is bigger in *M. arvalis*. Contrary to Meyer *et al*. (1996), Petrov & Ružić (1982) found distal processes in *M. rossiaemeridionalis* to be of the same shape and proportions as in *M. arvalis*. The basal baculum of Turkish voles was figured by Kefelioğlu (1995). As can be deduced from his Figures 23 and 26 (p. 45 in Kefelioğlu, 1995), this structure is evidently of the

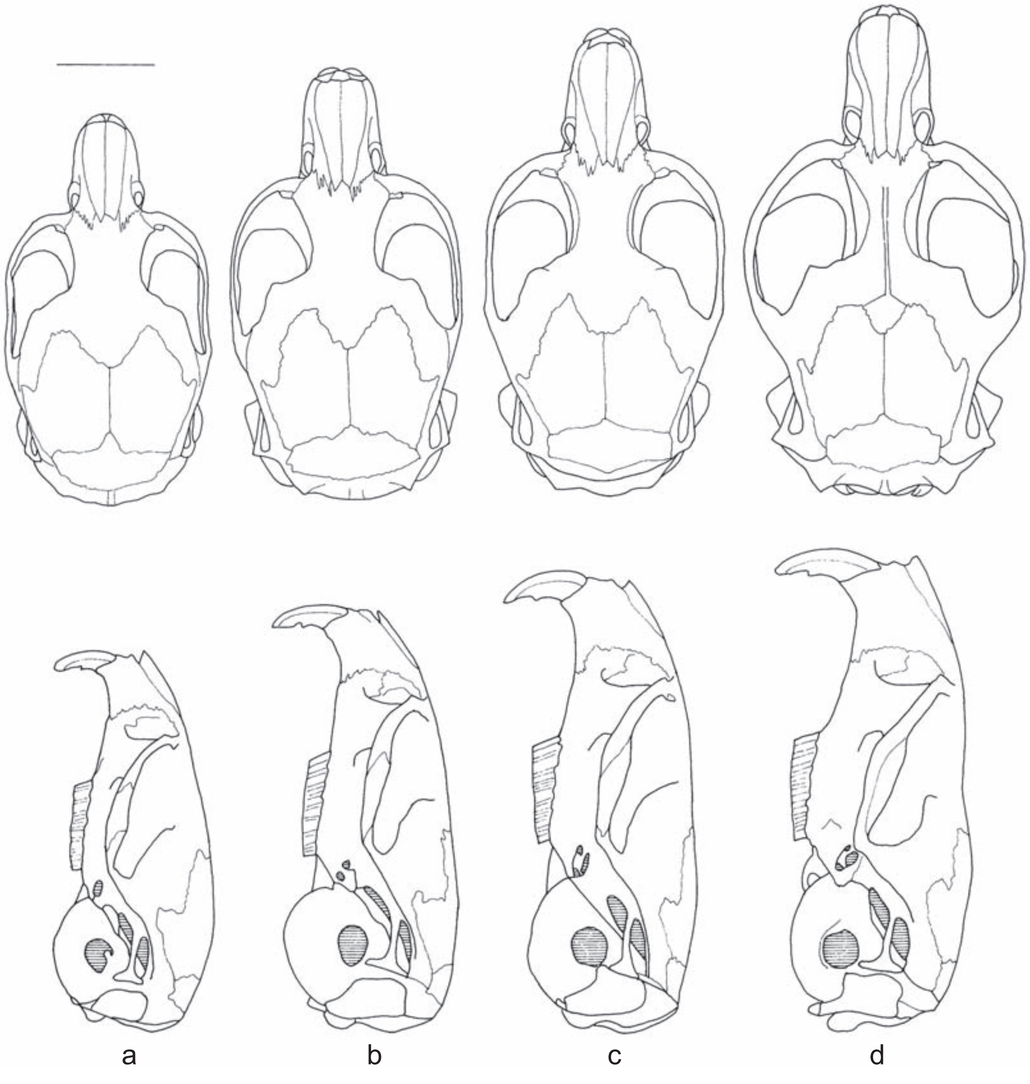


Figure 173. Age-dependent variation in the dorsal (upper row) and lateral (lower row) skull shape in *Microtus obscurus*. Specimens were collected in September 1995 at Sirbaşan (**a, b**), and Bağdaşan (**c, d**). **a** – juvenile male with abdominal testes (body mass = 16 g); **b** – sexually inactive subadult female (17 g); **c** – subadult female with embryos (25 g); **d** – sexually active adult female (34 g). Scale bar = 5 mm.

same size and shape in both *M. rossiaemeridionalis* and *M. obscurus*. In contrast to this, the figures in Aksenova (1980) suggest the basal part to be more triangular in *M. obscurus* (her specimens reported as *M. arvalis* originate from Armenia, the Altai Mts., and eastern Kazakhstan) and nearly shovel-shapped in *M. rossiaemeridionalis* (specimens from Sankt Petersburg, Sverdlovsk & Belgorod, and Finland).

SKULL, although being of similar shape as in pine voles, is more pronouncedly angular, with more expanded zygomatic arches (53.7–58.3% of the condylobasal length; mean = 55.9%), and with narrower interorbital region. Besides, it is also deeper. Incisive foramina long and narrow, mainly with parallel lateral margins. *Squama carina media* narrow and fairly high, and lateral pits next to it deep (Fig. 172). Age variation is much expressed in skull shape; that of the juveniles being distinctly convex in dorsal profile, with relatively short rostrum, long braincase, parallel zygomatic arches and broad interorbital region. Young adults develop supratemporal ridges which fuse into a sagittal crest in full grown adults. In our sample, however, the crest was low even in the largest animals. With the development of the sagittal crest, the interorbital region is progressively constricted. The dorsal profile of the skull becomes more flat with advanced age and is even convex in the interorbital region in fully developed adults (Fig. 173). Postorbital tubercles of *squamosum* are visible already in young animals but become well pronounced in old ones; markedly pronounced tubercles are rarely seen in *M. rossiaemeridionalis*.

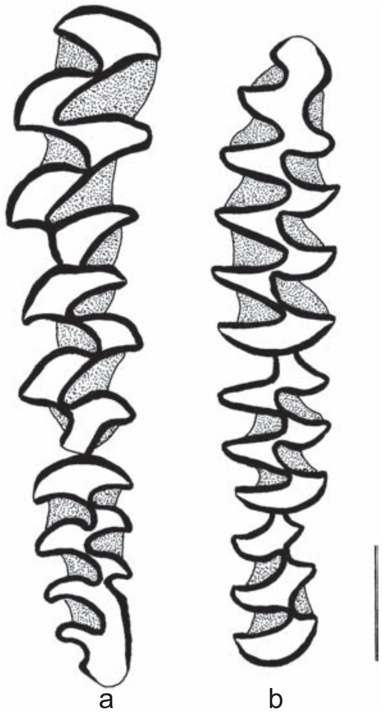


Figure 174. Upper (**a**) and lower molars (**b**) of *Microtus obscurus* (same specimen as in Fig. 172). Lingual side is to the left, anterior is at the top. Scale bar = 1 mm.

TEETH. Upper incisors orthodont. Enamel yellow to orange on upper incisors and yellow on lower ones. Molars basically of same pattern as in pine voles. The main difference, however, is on the 1st lower molar with alternating dental fields of triangles T4 and T5 (Fig. 174). First and 2nd upper molars hold the same elements as in pine voles. Anyhow, *M. obscurus* does not tend to form a postero-lingual triangle (T5) on the 2nd molar. The prevailing morphotype of the 3rd upper molar shows three lingual and three labial re-entrant angles (Fig. 175a-c). Dental field of T4 either closed posteriorly (prevailing condition) or confluent with triangle T5. The latter is rarely closed posteriorly. Additional posterior re-entrant angles are exceptional and, when present, they are invariably shallow. In its most complex form, the 3rd upper molar has four re-entrant angles on both sides (Fig. 175e). First lower molar has a small oval anterior cup which either communicates with the posterior triangles T6 and T7 (which are invariably confluent) or is isolated from them. Of the re-entrant angles, the 4th buccal and 5th lingual ones are only exceptionally shallow, thus allowing broad connection of the anterior cup with dental fields T6 and T7. In conclusion, the 1st lower molar has four labial and five lingual re-entrant angles. Labial traingles are slightly smaller than are the lingual ones (Fig. 176). Triangles of the 2nd lower

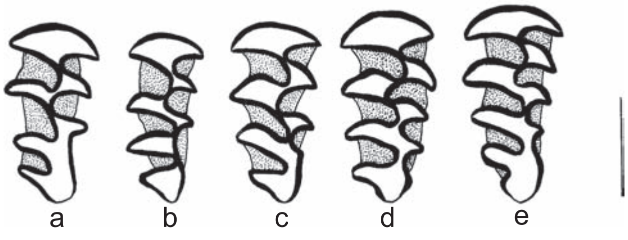


Figure 175. Variation in the shape of the 3rd upper molar of *Microtus obscurus*. Based on specimens from Sirbasan (**a–c**, **e**), and Bağdaşan (**d**). Lingual side is to the left, anterior is at the top. Scale bar = 1 mm.

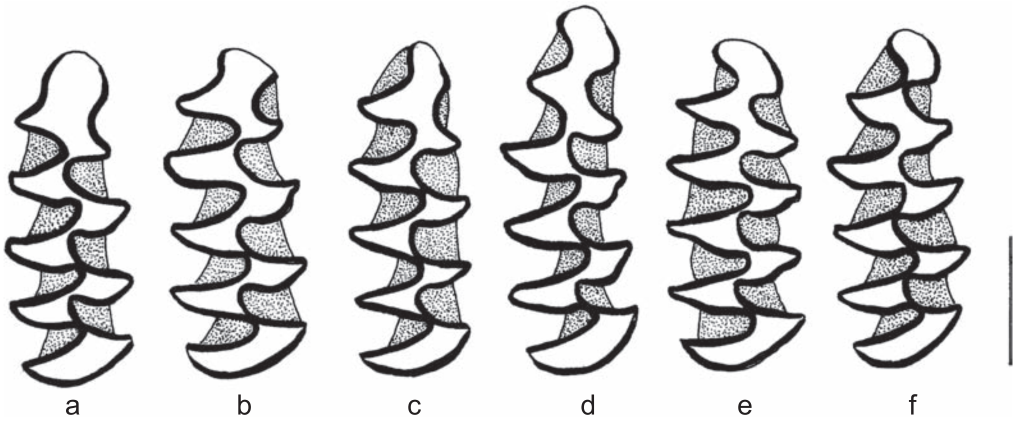


Figure 176. Variation in the shape of the 1st lower molar of *Microtus obscurus*. Based on specimens from Sirbaşan (**a**), Bağdaşan (**b–e**), and Handere (**f**). Lingual side is to the left, anterior is at the top. Scale bar = 1 mm.

molar are isolated. On the 3rd lower molar, T1 is confluent to T2, and T3 is confluent with T4.

Dimensions. In our autumn sample from north-eastern Anatolia, males were larger than females (Fig. 177), which is consistent with the results obtained in European *M. arvalis* (Niethammer & Krapp, 1982b). Although secondary sexual dimorphism is evidently present in *M. arvalis* s.lat., we pooled the sexes in Table 42 because of the small sample size of full-grown adults.

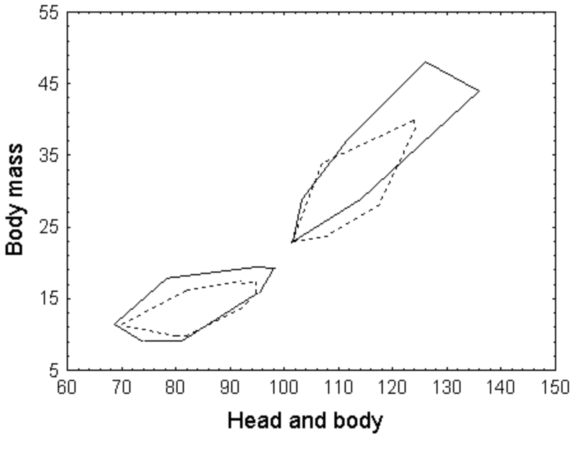


Figure 177. Bivariate plot of body mass against head and body length for *Microtus obscurus*, collected at the beginning of September 1995 at Bağdaşan and at Sirbasan, north-eastern Anatolia. Polygons enclose extreme specimens within a group. Straight line indicates males and broken line indicates females. Large sized animals were sexually active, while small-sized ones did not participate in reproduction.

	N	mean	min–max
Head and body	16	117.5	101–136
Tail	16	40.2	32–51
Hind foot	16	15.2	14.2–17.9
Ear	16	11.7	10.5–13.0
Weight	15	36.4	23–48
Condylobasal length	13	25.2	24.2–26.7
Zygomatic breadth	12	14.1	13.1–15.4
Maxillary tooth-row	16	6.2	5.8–6.6

Table 42. External and cranial dimensions of *Microtus obscurus* from Turkey. Based on own material.

Chromosomes. In Turkey, the diploid number of chromosomes is 2N = 46 and the fundamental number of autosomal arms is NFa = 68. The karyotype consists of four pairs of large meta- and submetacentrics, one pair of large subtelocentrics, seven pairs of small meta- and submetacentrics and ten pairs of small acrocentrics. X chromosome is medium sized metacentric and the Y chromosome is small metacentric (Kefelioğlu, 1995). The Y chromosome shows interpopulation variation in Armenia and Georgia, being either acrocentric or metacentric (Meyer *et al.*, 1996).

VARIATION

We did not detect any variation in the material from Turkey.

DISTRIBUTION

The Altai vole ranges from Crimea and the Caucasus across Siberia as east as Lake Baikal. The northern border is on the upper Yenisei River and the southern

Figure 178. Distribution of *Microtus obscurus* in Turkey. Record no. 1b is based on morphological identification; all the remaining records are supported by karyological data. Records: **1a** – 5 km west of Bağdaşan, Kars, 2,600 m; **1b** – 6 km south of Çamlica, Kars, 2,600 m; **2** – 3 km north of Sirbasan, Kars district, 2,200 m; **3** – 3 km west of Handere, Kars, 2,600 m; **4** – 3 km west of Asağı Söylemez, Erzurum; **5** – Hinis, Erzurum; **6** – Güzeldere köyü, Özlap, Van, 2,480 m. Corresponding references: Kefelioğlu (1995): 5, 6. Own data: 1a,b, 2-4.

margin is in north-western Mongolia, Chinese Xinjiang, the Altai Mts., northern Iran, Transcaucasia, and Anatolia (Musser & Carleton, 1993; Kefelioğlu, 1995). Although the range overlaps with that of *M. arvalis* (s. str.), Zagorodnyuk (1991a) reports the two forms to be parapatric in the contact zone.

Only seven localities are known from Turkey and the animals were karyotyped in six of them; the specimens from Çamlica were identified by morphological characters. The range covers north-eastern Anatolia as far west as Aşağı Söylemez and Hınıs, and up to the Van area in the south (Fig. 178).

Of the two grey voles, *M. obscurus* is seemingly more widespread in the Caucasus region than is *M. rossiaemeridionalis*. For example, Král *et al.* (1980) report 36 localities for the former and only a single one for the latter. A similar picture emerges from the data in Meyer *et al.* (1996; Table 43).

ALTITUDE. The elevational range of Turkish records is between 2,200 and 2,600 m a.s.l.; however, Kefelioğlu (1995) does not give the altitude for Hınıs, which is most likely below 2,000 m a.s.l.

ASSOCIATES. In Turkey, *M. obscurus* is sympatric with *M. rossiaemeridionalis*.

Administration unit	*M. obscurus*	*M. rossiaemeridionalis*
Karačevo – Čerkesk	3	–
Kabardino – Balkar	4	–
Čečnija	3	–
Dagestan	6	1
Armenia	14	1
Azerbaijan	9	–
Georgia	6	–
Total	45	2

Table 43. Number of records for *Microtus obscurus* and *M. rossiaemeridionalis* in the Caucasian region, as deduced from Meyer *et al.* (1996: Tables 19 and 20 on pp. 130–136). Records are given according to administration units.

Figure 179. Habitat of *Microtus obscurus*. Saç Gecidi, Ağrı, eastern Anatolia. Photo: V. Vohralík.

HABITAT

We collected the Altai vole in high elevation steppe. This habitat is dominated by *Bromus tomentellus, Festuca valesiaca, Astragalus microcephalus, Agroppyron repens, Echinops vitrio,* and *Eryngium campestre*. At Bağdaşan and at Sirbasan, the Altai voles lived in large colonies in rocky pastures with short grass due to grazing. In Asağı Söylemez the voles were found under hay coils left after haymaking. They seeked such shelters in large numbers. More towards north the Altai vole also populates lowlands; however, short grass meadows remain the preferred habitat throughout its range.

BIOLOGY

REPRODUCTION. At the beginning of September 1995 we recorded intensive reproduction at Bağdaşan and Sirbasan. All the animals at least 24 g in body mass were sexually active. This included males with scrotal testes (dimensions of testis up to 10.5 x 6.4 mm) as well as pregnant or lactating females. The reproductive population was separated from sexually inactive animals by a clear gap in size (Fig. 177). The number of embryos varied between 4 and 6 (mean = 4.8, N = 8).

SOUTHERN VOLE – *MICROTUS ROSSIAEMERIDIONALIS*

Microtus arvalis rossiaemeridionalis Ognev, 1924. Type loc.: Novyj Kurlak, Bobrov District of Voronež Govt., Russia.

Microtus arvalis muhlisi Neuhäuser, 1936b. Type loc.: Bartin, Turkey.

Microtus arvalis relictus Neuhäuser, 1936b. Type loc.: Inevi (= Cihanbeyli), Turkey.

DESCRIPTION

EXTERNAL CHARACTERS. The southern vole does not differ much from *M. obscurus*, except that its hind foot is evidently longer (cf. Fig. 171 and Tables 42 and 44) and this character is of diagnostic value in Turkey. It also shows a relatively longer tail (31.7–44.0% of head and body; mean = 37.2%).

COLOUR. The upper parts are more yellowish brown or brownish buff than in the Altai vole.

NIPPLES as in the Altai vole.

BACULUM. See the Altai vole.

SKULL. In cranial characters the southern vole most closely resembles the Altai vole. However, neurocranium is relatively longer in *M. rossiaemeridionalis* and incisive foramina are shorter and broader, frequently with bottle-shaped lateral margins. Postorbital tubercles of *squamosa* are rarely well pronounced (Fig. 180). The greatest breadth of skull (across zygomatic arches) is 51.6–60.7% of the condylobasal length (mean = 56.2%), i.e. approximately as in the southern vole.

TEETH. Molars do not differ much from the pattern seen in *M. obscurus* (Fig. 181). The 2nd upper molar is only exceptionally complex in its posterior part (Fig. 182). The 3rd upper molar frequently has only two deep buccal re-entrat angles (Fig. 183), in addition to three lingual ones. In exceptional cases there are up to four re-entrant angles on either side (Fig. 183d). Zagorodnyuk (1991b) reports the number of buccal re-entrant angles as constant and also diagnostic in the two voles (three in *M. rossiaemeridionalis* and two in *M. arvalis*). This character, however, is subject to considerable variation. First lower molar essentially as in *M. obscurus*. The anterior loop is only exceptionally closed and the 4th buccal re-entrant angle is nearly always present (Fig. 184).

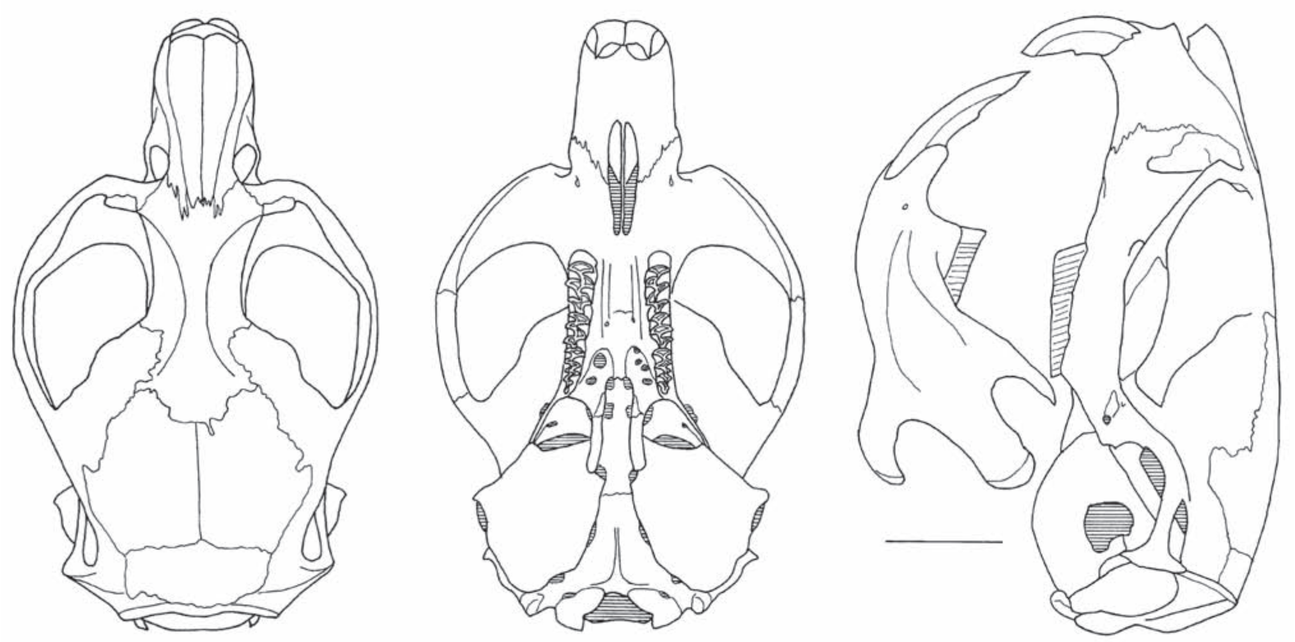


Figure 180. Skull and mandible of *Microtus rossiaemeridionalis*, based on an adult male from Karabulut, Konya. Scale bar = 5 mm.

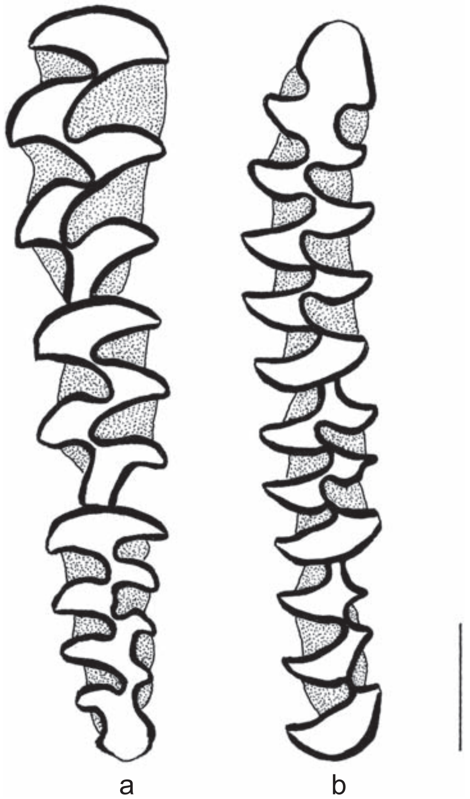


Figure 181. Upper (**a**) and lower molars (**b**) of *Microtus rossiaemeridionalis* (same specimen as in Fig. 180). Lingual side is to the left, anterior is at the top. Scale bar = 1 mm.

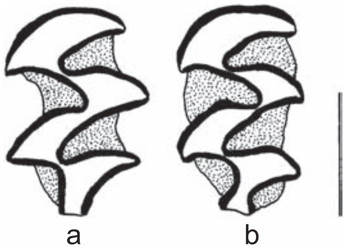


Figure 182. Two morphotypes of the 2nd upper molar in *Microtus rossiaemeridionalis*. Based on specimens from Kürtler, Samsun (**a**), and Karabulut, Konya (**b**). Lingual side is to the left, anterior is at the top. Scale bar = 1 mm.

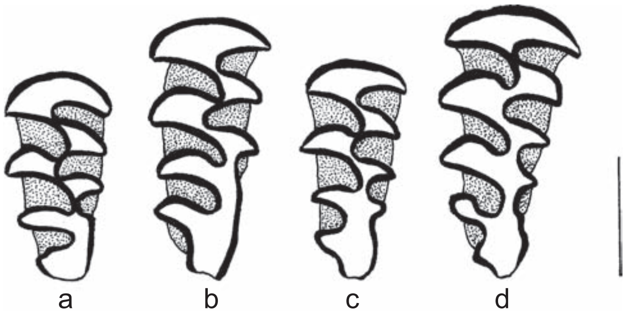


Figure 183. Variability of the 3rd upper molar of *Microtus rossiaemeridionalis*. Based on specimens from Muradiye, Van (**a**), Tanir, Kahramanmaraş (**b**), and Karabulut, Konya (**c, d**). Lingual side is to the left, anterior is at the top. Scale bar = 1 mm.

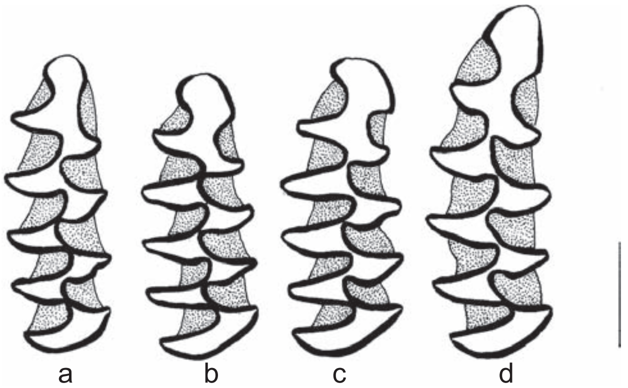


Figure 184. Variability of the 1st lower molar of *Microtus rossiaemeridionalis*. Based on specimens from Karabulut, Konya (**a, d**), and Doganköy, Eber Gölü, Afyon (**b, c**). Lingual side is to the left, anterior is at the top. Scale bar = 1 mm.

DIMENSIONS are given in Table 44.

	N	mean	min–max
Head and body	16	115.8	102–130
Tail	17	43.7	33–55
Hind foot	17	18.1	17.0–19.7
Ear	17	12.0	11.0–13.4
Weight	14	38.4	21–58
Condylobasal length	15	26.1	24.9–27.5
Zygomatic breadth	16	14.7	13.3–16.5
Maxillary tooth-row	17	6.4	6.0–6.9

Table 44. External and cranial dimensions of *Microtus rossiaemeridionalis* from Anatolia. Based on own material.

CHROMOSOMES. The diploid number of chromosomes is 2N = 54 and the fundamental number of autosomal arms is NFa = 54. The smallest autosomal pair is metacentric, while all the remaining autosomes are acrocentric. Sex chromosomes are the largest acrocentrics in the set (Kefelioğlu, 1995).

VARIATION

Neuhäuser (1936b) described from Anatolia two subspecies, which Kefelioğlu (1995) placed in the synonymy of *M. rossiaemeridionalis*. Subspecies *M. a. muhlisi* was diagnosed by dark colour and large size (condylobasal length of the type = 26.6 mm) and ssp. *M. a. relictus* as being paler than any other subspecies described so far (back buffy brown). Ellerman (1948) made an interesting note in connection with ssp. *muhlisi*: "These Turkish specimens stand apart from all other races of the species known to me by their proportionately shortened palatal foramina (i.e. *foramina incisiva*), which average only 16 per cent. of the occipitonasal length." Most likely, Ellerman referred to the character of *M. rossiaemeridionalis*.

We did not detect any variation among Turkish localities and thus we doubt whether the names given by Neuhäuser (1936b) are of any taxonomic validity.

Temporal variation in the length of 1st lower molar in voles from central and western Anatolia, mainly reported as *M. arvalis* but most likely representing *M. rossiaemeridionalis*, does not suggest much variation in size since the Middle Pleistocene (Table 45). On the other hand, the 3rd upper molar was evidently simpler in shape during the Pleistocene, frequently with only two deep lingual re-entrant angles (cf. Storch, 1975, 1988).

DISTRIBUTION

Europe from Finland in the north to the Balkans in the south; European and Asiatic Russia as east as Lake Baikal. The southern border is on the Caucasus and in Anatolia. The southern vole has also been introduced to Svalbard (Musser & Carleton, 1993). For more details on the range in the Caucasus see under *M. obscurus*. The southern vole is almost certainly present also in Iran. Throughout its range, *M. rossiaemeridionalis* is sympatric with either *M. arvalis* or *M. obscurus* (cf. Fig. 58 on p. 129 in Meyer *et al*., 1996).

The southern vole is the only species of the *arvalis* group in European Turkey (Kefelioğlu, 1995), where it is possibly widespread. However, with one exception, records are missing from the coastal stripe. In the Asiatic part of the country, the density of localities allows a fairly safe conclusion to be drawn about its range (Fig. 185). The southern vole is evidently absent from the Aegean region, the majority of the Taurus Mts., and from south-eastern Anatolia. In 2004 we collected two specimens at Çığlıkara; this record is possibly an isolate. The western range in Anatolia is along the River Koca Çay, and around the springs of the Rivers Gediz and Menderes.

There are extralimital reports from Milet in the Aegean Anatolia, all based on barn owl *(Tyto alba)* pellets. Niethammer (1989) reports *M. arvalis* for the Menderes Delta (Mäandertal) and for Milet, and

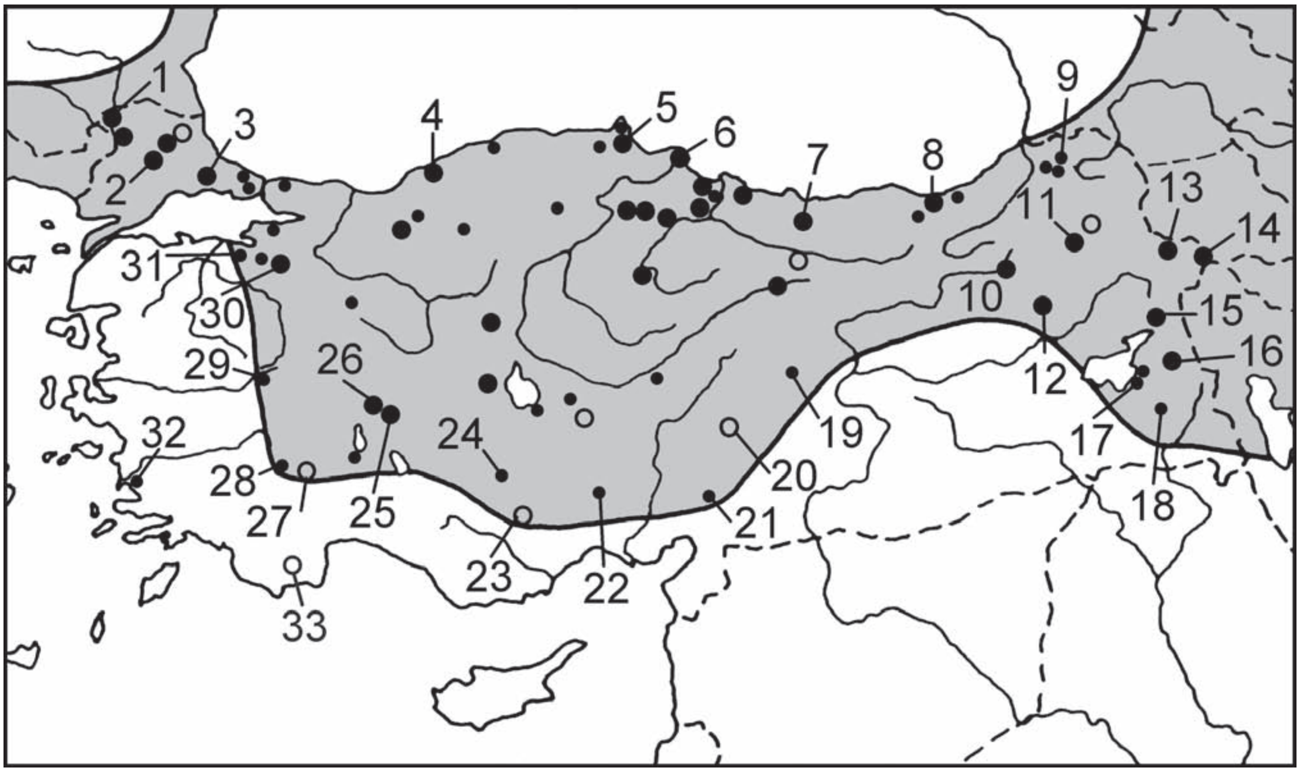


Figure 185. Distribution of *Microtus rossiaemeridionalis* in Turkey. Identity of material was based on karyotype (large dots) or on morphological determination (circles). Small dots denote various records of uncertain identity but mots likely representing *M. rossiaemeridionalis*. Records: **1** – 3 km west of Edirne; **2** – Lüleburgaz, Kırklareli; **3** – Silivri, İstanbul; **4** –Ziraat fidanlığı, Bartın, Zonguldak; **5** – Sarayköy, Gerze, Sinop; **6** – Kürtler, Samsun, sea level; **7** – Çambaşı yaylası, Ordu, 1,850 m; **8** – Şana, Trabzon; **9** – Kutul, Artvin, 2,200-2,400 m; **10** – Atatürk Üniv. kampüsü, Erzurum; **11** – Horasan, Erzurum; **12** – Hınıs, Erzurum; **13** – Iğdır, Kars; **14** – Aralık, Kars; **15** – Muradiye, Van; **16** – Güzeldere köyü, Özlap, Van, 2,480 m; **17** – 10 km south of Van; **18** – Başkale, Van, 2,500 m; **19** – Darende, Malatya; **20** – Tanir, Kahraman Maraş, 1,200 m; **21** – Haruniye (= Düziçi), Bahçe, Adana; **22** – Pozantı, Adana; **23** – 1 km west of Balli, İçel, 1,450 m; **24** – Kılbasan, Karaman; **25** – Karabulut, Akşehir Gölü, Konya, 1,000 m; **26** – Doğanköy, Eber Gölü, Afyon, 995 m; **27** – Suludere, Çendik, Burdur; **28** – Çardak, Denizli; **29** – Uşak; **30** – Inegöl, Bursa; **31** – Nilüfer River, north-west of Bursa; **32a** – Menderes Delta, Aydın; **32b** – Milet and near Menderes River, Aydın; **33** – Çığlıkara, Bey Mts. (*c.* 20 km south-south-east of Elmalı), Anatalya. Corresponding references: Lehmann (1969): 18. Felten *et al.* (1971b): 29. Steiner (1972): 9. Niethammer (1989): 32b. Brinkmann *et al.* (1990): 32a. Kefelioğlu (1995): 1, 2, 3, 4, 5, 7, 8, 10, 11, 12, 13, 14, 16, 30. Yiğit *et al.* (2003a): 17, 19, 24, 28. FMNH: 21. SMF: 31. ZFMK: 22. Own data: 6, 15, 20, 23, 25, 26, 27, 33.

Brinkmann *et al.* (1990) for the former locality. Owl pellet samples studied by these authors were evidently not the same. It is worth noting that none of the authors mentioned *M. guentheri*, the only *Microtus* vole whose presence in this part of Turkey is beyond doubt. Besides, in one of his earlier papers, Niethammer (1974) denied the possibility of distinguishing between the two voles in owl pellet material. Hence, we assume that misidentification is most likely in this case.

The southern border is on the northern slopes of the Taurus Mts. Between the Rivers Ceyhan and the Euphrates, the border sharply turns northwards towards the spring of the Ceyhan River and then descends again southwards to Van. In the north, the southern vole is present all along the Black Sea coast.

Palaeontology. Voles, reported as *M. arvalis, M.* cf. *epiroticus*, or *M.* cf. *rossiaemeridionalis*, but presumably representing *M. rossiaemeridionalis*, were found in European and Asian Turkey since the Middle Pleistocene (Table 45). It is worthwhile to note that

Locality	Age	Mean	Range	Source
Yarımburgaz	Middle Pleistocene	2.79	2.62-3.00	Santel (1994)
Chios	Middle Pleistocene	2.65	2.2-2.9	Storch (1975)
Emirkaya-2	Middle Pleistocene	2.68	2.43-3.00	Montuire *et al.* (1994)
Antalya	Upper Pleistocene	2.7	2.4-3.0	Storch (1988)
Balkans & W Anatolia	Recent	2.78	2.40-3.10	Santel (1994)

Table 45. Temporal variation in the length of 1st lower molar (given as mean and range) in fossil and subfossil voles, possibly representing *Microtus rossiaemeridionalis*, since the Middle Pleistocene.

Storch (1988) documents in Antalya their continuous presence since the Middle Pleistocene when they suddenly disappeared in the Upper Epipalaeolithic. Recently, no vole from the *M. arvalis* group occurs at the foothills of the Taurus Mts.

HABITAT

The southern vole is found in tall and dense herbaceous vegetation and in shrubs. Wet and even marshy places are evidently preferred. We collected specimens in tussocks and in shrubs on sandy substrate at the sea level near Kürtler (Black Sea coast), in dense and lush herbaceous vegetation along ditches and around lakes (central Anatolia), among reeds (*Phragmites communis*; central Anatolia), in dense herbaceous vegetation along a river in a poplar stand as well as under a dense weedy cover on abandoned fields (central Anatolia) and in densely grown gardens (the Toros Mts.). The southern vole was never found on open short grass meadows, the habitat of the Altai vole in high elevations of north-eastern Anatolia.

Osborn (1962) stated for Turkish *M. arvalis* (which included both species recognised in this volume): “It has been trapped in beech and fir forests.” We never came across the southern vole, nor the Altai vole, in mature closed canopy forests, and therefore we assume that Osborn’s report might be either exceptional or due to some error.

ALTITUDE. The vertical range of localities is from close to the sea level (along the Black Sea shore) up to well over 2,480 m a.s.l. in the east.

BIOLOGY

REPRODUCTION. We collected sexually active animals between June and the beginning of November, but in central Anatolia reproduction evidently starts in April or May (cf. data in Steiner & Vauk, 1966), if not earlier. Litter size, as estimated from the number of embryos and placental scars, is 3–6 (mean = 4.3, N = 18). Scrotal males had testes up to 10 x 6.4 mm in size. Body mass of reproductive animals was 17–58 g (males) and 15–50 g (females).

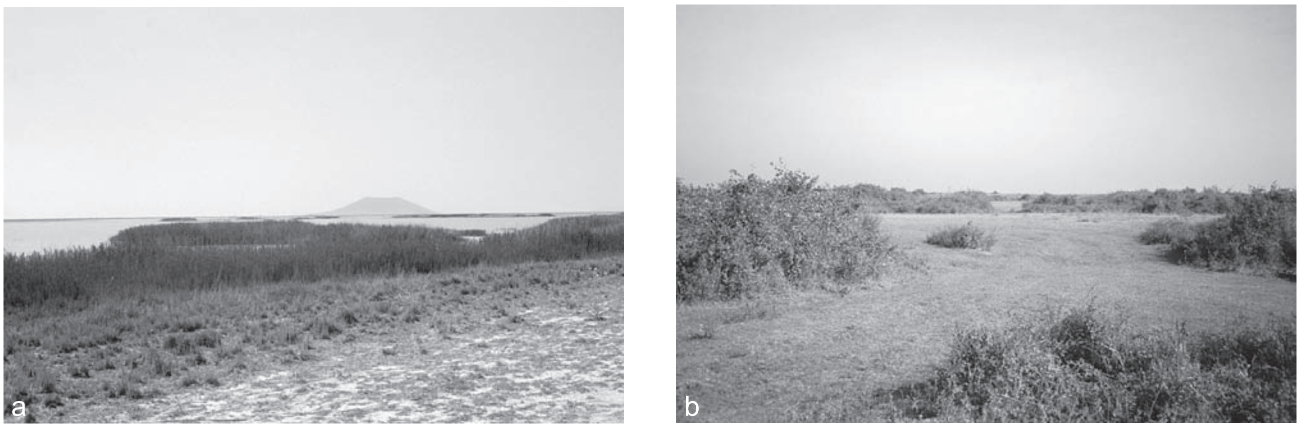


Figure 186. Habitat of *Microtus rossiaemeridionalis*. **a** – Central Anatolia (Photo: P. Benda); **b** - Kürtler, Samsun (Photo: B. Kryštufek).

SOCIAL VOLES

Social voles are inhabitants of dry steppes and semi-deserts of eastern Europe, western and central Asia (from the River Dnieper and Crimea to Dzungaria in the east and to Iran and Israel in the south), south-eastern Europe (the Balkans) and, very marginally, of northern Africa (Cyrenaica in Lybia), where they are the only representatives of Arvicolinae.

Taxonomic Rank. Opinions differ among authorities on the rank of social voles in the genus *Microtus*. Russian authors in particular nearly uniformly rank them as a subgenus *Sumeriomys* Argyropulo, 1933, with *M. socialis* as its type species (Neuhäuser, 1936b; Gromov & Poljakov, 1977; Gromov & Baranova, 1981, Aksenova, 1983; Pavlinov & Rossolimo, 1987, 1998; Gromov & Erbajeva, 1995; Golenishchev *et al.*, 1999, 2000). Ognev (1950) synonymised *Sumeriomys* with the Nearctic *Chilotus* Baird, 1857, which opinion did not receive support, however. More frequently are social voles placed in the subgenus *Microtus* (Miller, 1912; Niethammer & Krapp, 1982), occasionally in its *socialis* group (Zagorodnyuk, 1990) or simply in *Microtus* with no subsequent ranking (Aharoni, 1932; Ellerman, 1948; Ellerman & Morrison-Scott, 1951; Corbet, 1978; Vinogradov & Gromov, 1984; Musser & Carleton, 1993; Kurtonur *et al.*, 1996; Amr, 2000). Some authors evidently do not accept social voles to be a natural group. Thus, Ellerman (1948) placed *M. guentheri* in the *ar-*

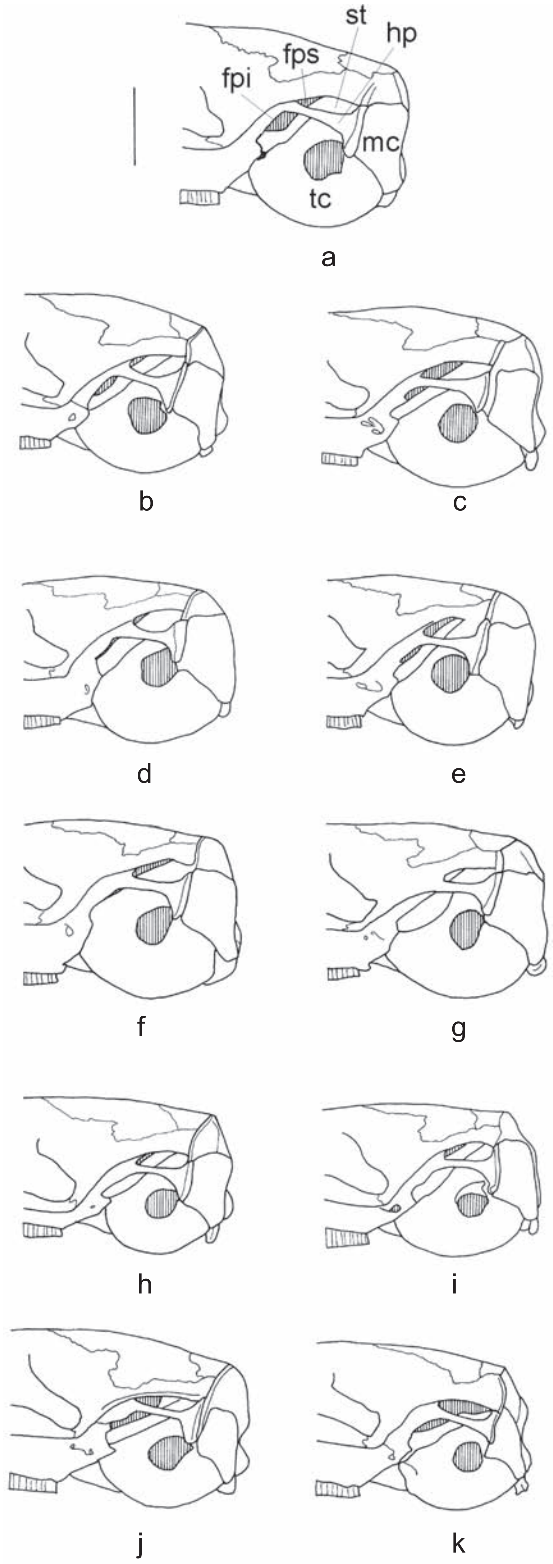


Figure 187. Occipital region of skull in various *Microtus* voles to show differences in the development of the mastoid portion. **a** – *M. guentheri* from the Vardar Valley, Macedonia; **b** – *M. guentheri* from Harput, Elazığ; **c** – *M. guentheri* from Harran, Urfa; **d** – *M. dogramaci* from Cıhanbeyli, Konya; **e** – *M. dogramaci* from Boyali, Amasya; **f, g** – *M. anatolicus* from Yapalı köyü, Konya; **h, i** – *M. socialis* from Aşkale, Erzurum; **j** – *M. rossiaemeridionalis* from Afyon; **k** – *M. obscurus* from Asaği Söylemez, Erzurum. Abbreviations: **fpi** – *fenestra praelambdoidea inferior*; **fps** – *fenestra praelambdoidea superior*; **hp** – hamular process (*processus postglenoideus squamosi*); **mc** – mastoid chamber; **st** – supramental triangle; **tc** – tympanic chamber. Note that both fenestrae are filled by the bony tissue of the supramental triangle in specimens **g** and **i**. Scale bar = 5 mm.

valis group of *Microtus* (*vs. M. irani* and *M. socialis* which were not ranked within the genus) and Zima & Král (1984) report *socialis* as a member of the genus *Sumeriomys*, considering *M. guentheri* to be part of *Microtus* s. str. Mitochondrial cytochrome *b* sequence suggests social voles to be a monophyletic group, however, Jaarola *et al*. (2004) place them within *Microtus*.

Definition. Argyropulo (1933) defined *Sumeriomys* as containing small and medium sized voles with dense and soft pelage, relatively short ears and tail, five plantar pads, shallow skull with broad and rounded brain-case, flat interorbital region with no crest, enlarged *os petromastoideum* and bullae, and with molars closely resembling the pattern seen in *Microtus arvalis*. Size of *pars mastoidea* is still in use to key the subgenus *Sumeriomys* from the remaining *Microtus* (Gromov & Erbajeva, 1995).

All Turkish social voles show a larger mastoid chamber than the two species from the *arvalis* group (Fig. 187). Besides, both *praelambdoid fenestrae* are to a lesser or greater degree filled with a bony tissue of the supramental triangle. In Turkish social voles with the largest bullae (*M. socialis, M. dogramaci, M. anatolicus*), the *fenestrae* are entirely closed by bone in extreme cases; *M. guentheri* is much variable in this respect, however. Five plantar pads are seemingly the only categorical character separating social voles from the *arvalis* group (Fig. 137b). There are no distinctive characters on dentition and isolated molars are distinguishable only by size (cf. Hír, 1991).

Species Richness. Ellerman (1948) recognised three species of social voles and keyed them as follows (given with slight modifications):

Bullae enlarged, averaging or approximating 30% of the occipitonasal length.
  Large species, length of the occipitonasal not less than approximately 25.3 mm, usually more *M. irani*
  Smaller animals; the occipitonasal length not exceeding 24.3 mm *M. socialis*
Bullae less enlarged, averaging below 30% of the occipitonasal length *M. guentheri*

Such taxonomic division was followed by Ellerman & Morrison-Scott (1951). Contrary to this, Bobrinskij *et al*. (1965) and Lay (1967) clumped all social voles into *M. socialis*, and their view was adopted by a number of subsequent authors (Harrison, 1972; Gromov & Baranova, 1981; Harrison & Bates, 1991; Šidlovskij, 1976). Such oversimplification violated so patently the karyological evidence at least that *M. guentheri* had to be separated from *M. socialis* (Gromov & Poljakov, 1977; Zima & Král, 1984; Niethammer, 1982; Corbet, 1984).

On the other hand, Kock *et al*. (1972) followed the earlier opinion of Ellerman (1948) on the existence of the third species of social vole, intermediate in size and certain cranial characters between *M. socialis* and *M. guentheri* (see also Morlok, 1978; Kock & Nader, 1983). The name *M. irani* was applied to these intermediate voles. Tripartite taxonomy received considerable attention and was accepted by a number of subsequent authors, including the most recent review by Musser & Carleton (1993). *Micortus irani* and *M. socialis* have also been reported by some Russian authorities (Pavlinov & Rossolimo, 1987, 1998) as the only social voles living in the territory of the former Soviet Union.

As has recently become evident, Ellerman (1948) and Kock *et al*. (1972) were right in that a two-species solution cannot adequately describe the species richness of the social voles. However, most recent evidence suggests that the group abounds with cryptic species, a case so common in *Microtus*. Morphology alone cannot solve the complex taxonomy of social voles in its entirety. Karyological data indicate that *M. irani*, as understood by Kock *et al*. (1972), is most likely a collection of several species, including the eastern populations of *M. guentheri*. Thus, some Anatolia populations with *M. guentheri* karyotype (2N = 54) are morphologically identical with *M. irani* (Kryštufek & Kefelioğlu, 2001a). Similarly, Golenishchev *et al*. (1999, 2002b) has shown that Iranian voles share the same diploid number as *M. guentheri*, albeit *M. irani*, rather than *M. guentheri* has been reported so far for the country. It has also been suggested that *M. irani* Thomas, 1921 is known only from its type locality near Shiraz in Iran (Kryštufek & Kefelioğlu, 2001b).

The number of species of social voles increased considerably over the last few years. Considering all the names used by various authors in the last decade, there are possibly five more species of social voles, in addition to the traditionally recognised *M. guentheri*, *M. socialis* and *M. irani*, *viz., M. paradoxus* (Gromov & Erbajeva, 1995), *M. schidlovskii* (Achverdjan *et al*., 1991a,b; Gromov & Erbajeva, 1995; Golenishchev *et al*., 2000), *M. dogramaci* (Kefelioğlu & Kryštufek, 1999), *M. anatolicus* (Kryštufek & Kefelioğlu, 2001b), *M. qazvinensis* (Golenishchev *et al*., 2002b), and *M. philistinus* (Shehab *et al*., 2004).

Social voles of Turkey. The most simplistic view of the taxonomy of social voles, recognising just one species, was only rarely adopted by students of Turkish rodents. Already Danford & Alston (1880; year of publication incorrectly given as 1887 in Osborn, 1962), while describing *M. guentheri*, a species not known by then, also report *M. socialis* for Turkey. These two species were recognised also by Neuhäuser (1936b), Osborn (1962), Lehmann (1966), Kıvanç (1978), Doğramacı (1989a), Kefelioğlu (1995), and Kurtonur *et al.* (1996); Atallah (1978) applied the same taxonomy also for the entire eastern Mediterranean region. Other students preferred the tripartite taxonomy, i.e. they recognised also *M. irani*: Kumerloeve (1975), Obuch (1994), Nadachowski *et al.* (1990), Demirsoy (1996), Çolak *et al.* (1997b), Yardımcı & Kıvanç (1998), and Yiğit *et al.* (2003a). Those authors who recognise a single species of social vole in Turkey, nearly invariably report it as *M. guentheri*: Misonne (1957), Çağlar (1967), Corbet & Morris (1967), Felten *et al.* (1971b), Coşkun (1991), Çolak *et al.* (1998a), Sözen *et al.* (1999), and Yiğit & Çolak (2002). The only deviation in this respect is Lehmann's paper (Lehmann, 1969) which reports *M. socialis (guentheri) philistinus* for Ceylanpınar, and *M. socialis (socialis) paradoxus* for Van Lake.

Recently, several papers have appeared in which the taxonomy of social voles in Turkey is based on chromosomal data (Kefelioğlu, 1995; Çolak *et al*., 1997b; Kefelioğlu & Kryštufek, 1999; Kryštufek & Kefelioğlu, 2001b). The classification proposed in this volume mainly follows their results. Nevertheless, none of the revisions is comprehensive and there still exist large gaps in our knowledge as regards the actual number of species, their karyological and morphological properties, and their ranges. The taxonomic situations seems to be particularly complex on the one hand and little understood on the other in eastern and south-eastern Anatolia, and possibly also in the Taurus Mts. We have seen all the species recognised here, and at least some specimens of each species have also been karyotyped (cf. Kefelioğlu & Kryštufek, 1999). Nevertheless, samples of standard museum specimens whose karyotype is known are small.

The identification key below applied only to adult specimens, but in many cases it is difficult to accurately estimate individual age. Single specimens from little known regions are thus frequently keyed with great difficulty. But even when a large sample is available from a single locality, age identification may cause troubles. Since *M. guentheri* (and, presumably, also other social voles) is a prolific breeder (Cohen-Shlagman *et al*., 1984a,b; Çolak *et al*., 1998a), prone to considerable fluctuations in population densities (Bodenheimer, 1949, and our own observations; but see Çolak *et al*., 1998a, for a contrary view), we frequently found large museum samples to be uniform in skull appearance, presumably in consequence of a single cohort being sampled. Bias is thus likely to occur, since different samples were collected in different seasons and thus presumably at different phases of a population cycle. As a result,

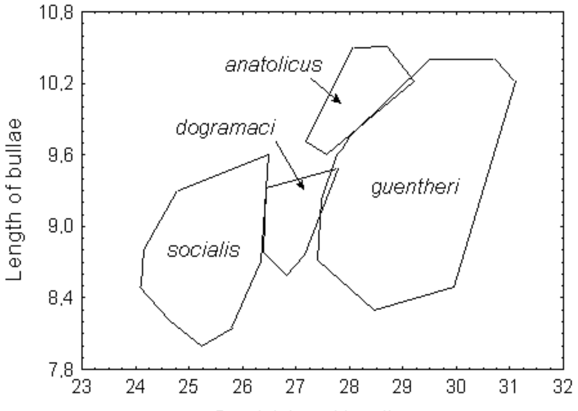


Figure 188. Bivariate plot of bullae lengtht against condylobasal length for Turkish social voles. *Microtus socialis* includes also material from East Azerbaijan, Iran. Polygons enclose extremes for a species. Based on our own material and specimens in BMNH, FMNH, NMNH, OMUS, SMF and ZFMK.

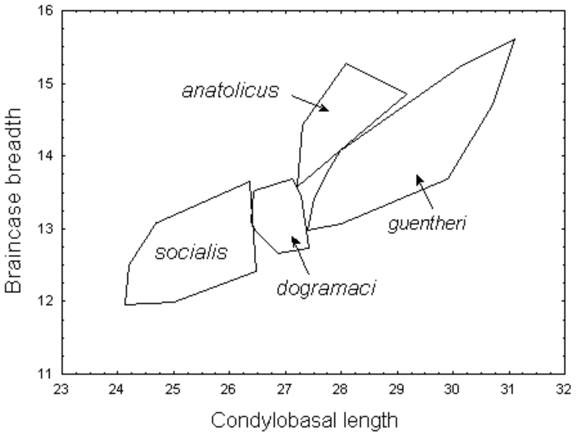


Figure 189. Bivariate plot of braincase breadth against condylobasal length for Turkish social voles. See explanation in Fig. 188.

a uniform sample of subadult specimens can be erroeously assumed to contain adults.

Taxonomic uncertainties. We recognise and diagnose in this volume four species of social voles. Each of them is well characterised by its unique chromosomal set (Table 46). Their distinctiveness on the basis of selected cranial dimensions is summarised in Figs. 188 & 189. Taxonomy proposed here is almost certainly not the final one. Çolak *et al*. (1997b) reported from Kilis (south-eastern Anatolia) social voles with a unique karyotype (2N = 46) which they ascribed to *M. irani*. Their chromosomal set consisted of 42 acrocentrics and four metacentics; the X chromosome being a large metacentric and the Y chromosome a small metacentric. These voles were sympatric with *M. guentheri* (2N = 54) and were also of much the same size (cf. Table 1 on p. 393 in Çolak *et al*., 1997b; note however, that their samples evidently contain also subadults), but differed in a narrower width across zygomatic arches (mean = 14.83 mm *vs*. 15.96 mm in *M. guentheri*), deeper brain-case as measured across bullae (10.07 mm *vs*. 9.94 mm in *M. guentheri*) but in a shallower rostrum (7.06 mm *vs*. 7.34 mm) and shorter bullae (8.35 mm *vs*. 8.72 mm). Besides, these enigmatic voles have more reddish backs and a distinct demarcation line along the flanks. 2N = 46 voles certainly do not represent *M. irani*, but their identity is not understood. Shehab *et al*. (2004) linked them with *M. philistinus*. Genetically, material from Israel is very close to *M. guentheri* (Jaarola *et al*., 2004), consequently we doubt whether *philistinus* deserves a specific rank.

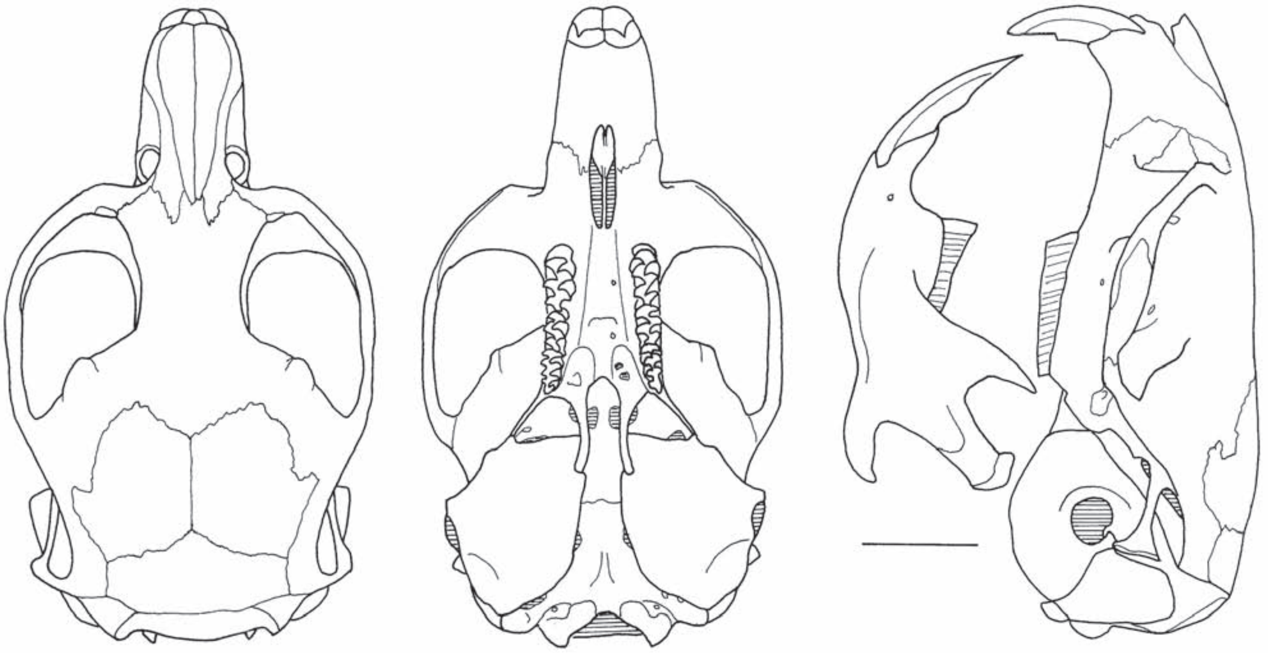


Figure 190. Skull and mandible of an unidentified social vole from Balkusan (district of Konya). See text for further explanation. Scale bar = 5 mm.

Species	2N	NFa
M. socialis	62	60
M. anatolicus	60	60
M. guentheri	54	52
M. dogramaci	48	46, 48, 50
M. "irani"	46	46

Table 46. Summary of chromosomal sets (diploid number 2N and fundamental number of autosomal arms NFa) in four Turkish species of social voles. Modified from Çolak *et al.* (1997b) and Kefelioğlu & Kryštufek (1999). For the chromosomal form 2N = 46 see text.

Not all museum specimens we examined could be allocated to species. Of special note is a small sample, collected by one of us on August 12-13, 1993, at Balkusan (district of Konya). The voles lived in dense reed on the banks of a mountain brook at 1,550 m a.s.l. (cf. Fig. 13 on p. 20 in Kryštufek & Vohralík, 2001, where these voles were reported as *M. guentheri*). The only adult female was pregnant and all the males had scrotal testes (size up to 7.3 x 4.9 mm). Summer reproduction is anomalous in *M. guentheri* from central Anatolia (see under that species). In colour and body proportions, the adults resemble most closely *M. guentheri* (with the exception of a fairly distinct demarcation line along flanks) but the skull is too small and too shallow to be ascribed to that species (Fig. 190). The specimens from Balkusan do not fit any other species of social voles recognised in this volume, but match fairly closely the description for 2N = 46 sample from Kilis (Çolak *et al.*, 1997b). Our Balkusan sample has not been karyotyped and its taxonomic identity is left open.

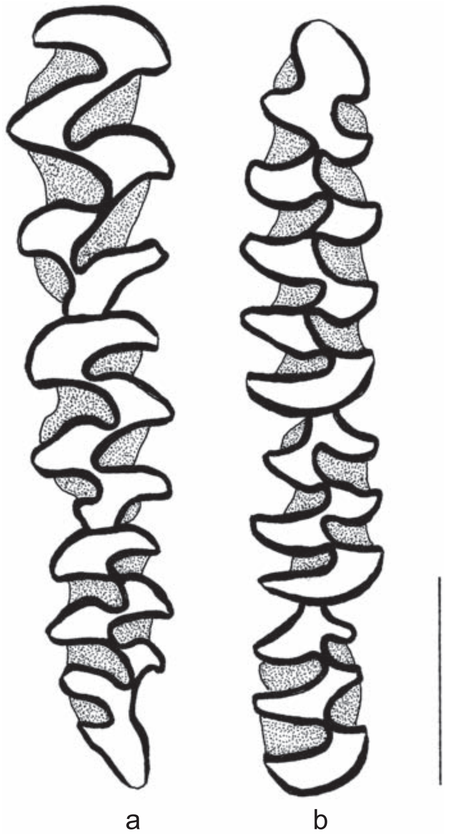


Figure 191. Upper (**a**) and lower molars (**b**) of an unidentified social vole from Balkusan (district of Konya; same specimen as on Fig. 190). Lingual side is to the left, anterior is at the top. Scale bar = 2 mm.

Coll. No.	TU-326	TU-327	TU-339	TU-340	TU-351
Sex	M	F	M	M	M
Head and body	113	107	116	112	112
Tail	31	-	31	28	31
Hind foot	16.5	16.6	17.7	17.1	17.8
Ear	11	10	11	10	10
Weight	41	-	37	34	40
Condylobasal length	27.0	-	-	-	26.9
Zygomatic breadth	15.5	15.6	-	16.6	15.3
Maxillary tooth-row	6.5	6.0	6.4	6.0	6.3
Braincase breadth	13.6	-	-	-	13.2
Height of rostrum	7.1	7.1	7.2	6.6	7.0
Length of bullae	8.0	7.7	8.1	8.4	8.4

Table 47. External and cranial dimensions of adult social voles from Balkusan (district of Konya). Note that this sample was not allocated to species. See text for further discussion.

GÜNTHER'S VOLE – *MICROTUS GUENTHERI*

Arvicola guentheri Danford & Alston, 1880. Type loc.: Maraş (= Kahramanmaraş; Yiğit & Çolak 2002), Asia Minor.
Microtus lydius Blackler, 1916. Type loc.: İzmir, Turkey.
Microtus (Sumeriomys) güntheri shevketi Neuhäuser, 1936a. Type loc.: Tarsus, Adana, Turkey.
Microtus lydius ankaraensis Yiğit & Çolak 2002. Type loc.: Sarayköy, 15 km north of Ankara.

TAXONOMY

Traditionally, *M. guentheri* was considered to include large, short tailed social voles with a deep rostrum, small bullae, and low incidence of the postero-lingual triangle on the 2nd upper molar (so-called *agrestis* morphotype) (Ellerman, 1948; Osborn, 1962; Felten *et al*., 1971; Kock *et al*., 1972; Morlok, 1978; Niethammer, 1982; Kock & Nader, 1983). Smaller voles from eastern Anatolia and adjacent regions, with a shallower skull, large bullae, and high frequency of the *agrestis* morphotype, were mainly ascribed to *M. irani*. In our opinion, *M. irani*, as it was understood in the last several decades, actually includes several species, among them *M. guentheri* from eastern Anatolia (see discussion under introduction to social voles).

The taxonomic scope of *M. guentheri* in Turkey was clearly defined by Kefelioğlu (1995) on the basis of chromosomal evidence (for subsequent contributions see also Çolak *et al*., 1997b; Kefelioğlu & Kryštufek, 1999, and Yiğit & Çolak, 2002). Karyological analyses covered specimens from all four type localities, i.e. Kahramanmaraş (Kefelioğlu, 1995; Çolak *et al*., 1997b; Kefelioğlu & Kryštufek, 1999), İzmir (Kefelioğlu, 1995; Kefelioğlu & Kryštufek, 1999), Tarsus (Kefelioğlu, 1995; Kefelioğlu & Kryštufek, 1999), and the vicinity of Ankara (Yiğit & Çolak, 2002). Following this evidence we thus allocated to Günther's vole all specimens with the diploid number of chromosomes 2N = 54, as well as the museum material which match the morphology of the karyotyped material we have examined.

The height of rostrum separates well *M. guentheri* from other Turkish social voles, except from *M. anatolicus* (for a closer comparison of these two species see under the latter). Rostrum height of 7.5 mm is given here as a cut-off point. Anyhow, as already stated above, the character is applicable only to adult skulls. Sözen *et al*. (1999) described in detail the postnatal development of skull in captive-bred *M. guentheri* from the vicinity of Ankara, however, they did not measure the height of their rostrum. In their conclusion, most of the cranial dimensions attain adult size at the age of two months. Anyhow, a closer look at their data does not suggest the logarithmic best-fit curve to be asymptotic already at that age (Fig. 192). Thus, the age of over three months seems to be a more accurate estimate for adult size.

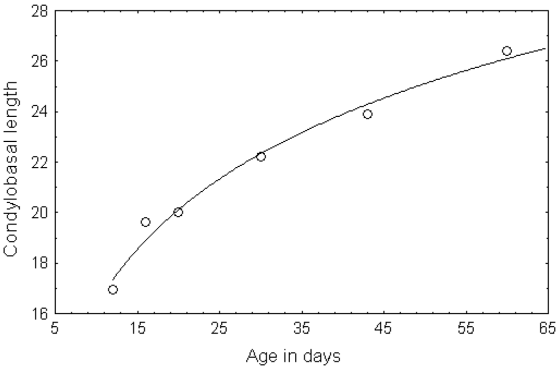


Figure 192. Plot of mean condylobasal length in *Microtus guentheri* against age. Note that logarithmic best fit curve is still not asymptotic at the age of 60 days. Based on data in Sözen *et al*. (1999).

Yiğit & Çolak (2002) point out the morphological differences between social voles from the Kahramanmaraş area and those occurring in central and western Anatolia, and they consider them as two distinct species. They claim that *M. guentheri* is restricted to south-eastern Anatolia, but as a matter of fact only four localities are reported from a fairly small area in between Kahramanmaraş and Hatay. In their opinion, further spreading of *M. guentheri* into central Anatolia is prevented by the high mountains of the so called "Anatolian diagonal". Voles from central and western Anatolia are reported under the name *M. lydius*. No cranial characters are proposed to distinguish between the two species, but baculum is said to allow discrimination (base concave ventrally and flat dorsally in *M. guentheri* but biconcave in *M. lydius*; Yiğit & Çolak, 2002). Althought this character can be of taxonomic importance, one should bear in mind that shape of baculum is not necessarily of evolutionary significance. After having examined the genitalia in *M. guentheri* and a number of *M. socialis* forms (none from Turkey), Zorenko (2000) concludes that genital morphology correlates with body size and does not serve as a mechanism of prezygotic isolation.

Although we agree with Yiğit & Çolak (2002) as regards considerable differences among *M. guentheri* populations in Turkey, in the lack of evidence which would prove a hiatus between the two morphological extremes, we do not accept their taxonomic conclusions. For example, mitochondrial cytochrome *b* sequences suggests fairly close relations between *M. guentheri* from Israel and Syria on the one hand, with Greek material on the other (Jaarola *et al*., 2004). Besides, the nomenclature solution, as proposed by Yiğit & Çolak (2002) is almost certainly incorrect. As a matter of fact, Günther's voles of central and western Anatolia resemble most closely their European counterparts and it has never been questioned whether or not the two are conspecific. Osborn (1962) explicitly states that *M. guentheri* "has similar characteristics in the populations of Thrace and Anatolia" and we fully agree with his conclusion. If the voles from central and western Anatolia and from the Balkans should prove to be a distinct species from the true *M. guentheri* of Kahramanmaraş, then the oldest available name for them would be *M. hartingi* Barrett-Hamilton, 1903 (type loc.: Larissa, Greece).

DESCRIPTION

EXTERNAL CHARACTERS. Günther's vole is a moderately large but robust vole with a short tail, which is always shorter than one third of head and body length (mean = 23% of head and body length; range = 18–30%). In northern, central and southern Anatolia, *M. guentheri* is the largest *Microtus species*. Head large with blunt muzzle; eyes moderately large. Ears very thinly clad with hairs along outer edges. Hind foot broad and densely haired along margins; soles bare. There are only five plantar pads. Pelage soft and dense; dorsal hairs up to 9.5 mm long in summer and slightly longer in winter (11.5 mm). White whiskers up to 26 mm long. Pencil at tip of tail invariably short (< 3 mm).

COLOUR. Upper parts mainly pinkish buff or light fawn and grizzled by blackish tips of long hair. This varies geographically; the palest specimens being greyish buff and the darkest brownish buff. Belly whitish, greyish white or buff white and irregularly clouded by slate-coloured bases of hairs. Demarcation line either obscured or fairly distinct; some specimens have clearly yellowish flanks. Feet pale fawn to light dull buff in dark animals and nearly white in pale ones. Tail indistinctly bi-coloured, fawn, buff white or brownish above, which depends on the colour of dorsal fur.

NIPPLES. Females have four pairs of nipples (two pectoral and two inguinal, respectively).

PENIS AND BACULUM. Glans penis simple, club-shaped, covered with minute bubbles. Small anterior protrusion visible on dorsal side (Yiğit & Çolak, 2002). Baculum was described and figured by Kıvanç (1978), Kefelioğlu (1995), Çolak *et al*. (1997b), and Yiğit & Çolak (2002); Sözen *et al*. (1999) provide details on age variability. The baculum does not differ from the general pattern seen in other Turkish *Microtus* species (Fig. 205). For dimensions see Table 48.

SKULL resembles the condition seen in the *arvalis* group, but is more robust and deeper (braincase height across bullae equals 35.3–41.5% of condylobasal length; mean = 38.3%). Rostrum particularly deep

Locality	N	Length	Breadth	Source
İzmir; Aydın	7	2.3 ± 0.5	1.0 ± 0.4	Yiğit & Çolak (2002)
Ankara	14	2.9 ± 0.3	1.5 ± 0.3	Yiğit & Çolak (2002)
Kahramanmaraş	4	2.5 ± 0.1	1.5 ± 0.1	Yiğit & Çolak (2002)
	13	2.48 – 3.18	1.19 – 1.57	Kıvanç (1978)
Diyarbakır	6	2.44 ± 0.18	1.34 ± 0.10	Coşkun (1991)
	6	2.14 – 2.57	1.21 – 1.46	

Table 48. Summary statistics for the dimensions of baculum in four geographic samples of *Micortus guentheri* from Turkey. Given are mean ± standard deviation and range (for two samples only). Note that mean and range estimates for Kahramanmaraş are based on different samples.

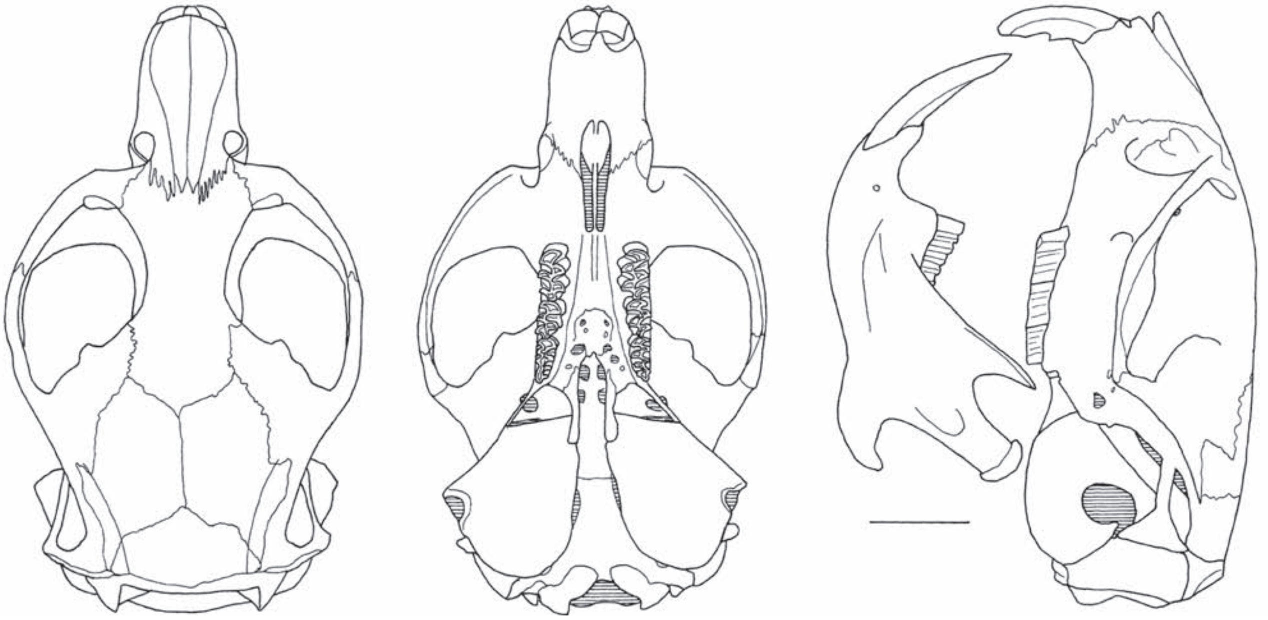


Figure 193. Skull and mandible of *Microtus guentheri*, based on an adult male from Suludere, Burdur. Scale bar = 5 mm.

(27.5–31.7% of condylobasal length; mean = 29.4%) and zygomatic arches widely expanded (53.7–61.3% of condylobasal length; mean = 58.0%). Interorbital constriction fairly broad and smooth; supraorbital ridges are formed only in advanced age, but they never fuse into a crest. Bullae more inflated than in voles from the *arvalis* group, and are also longer.

TEETH. Incisors as in *M. obscurus* or *M. rossiaemeridionalis*, enamel pattern of molars also essentially the same (Fig. 195). Triangle T4 of 1st upper molar tends to be prolonged backwards, and in rare cases a postero-lingual triangle is formed, which, however, is never entirely closed (Fig. 196b). Second upper molar frequently has an additional postero-lingual

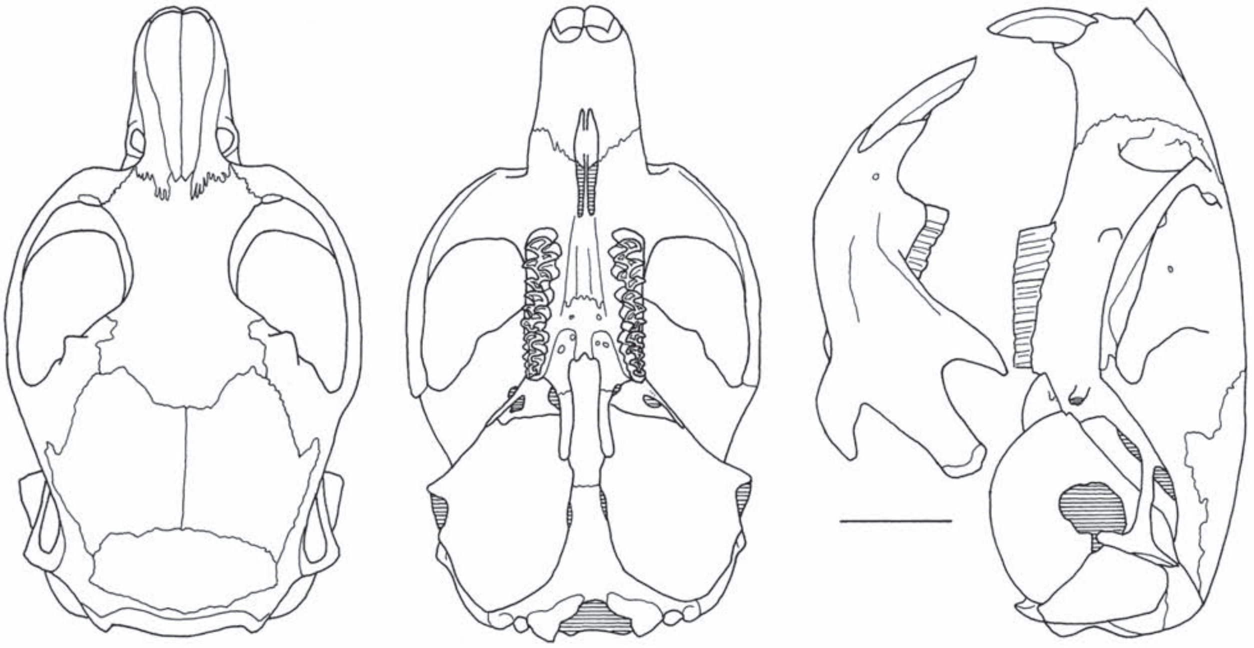


Figure 194. Skull and mandible of *Microtus guentheri*, based on an adult female from Harput, Elazığ. Scale bar = 5 mm.

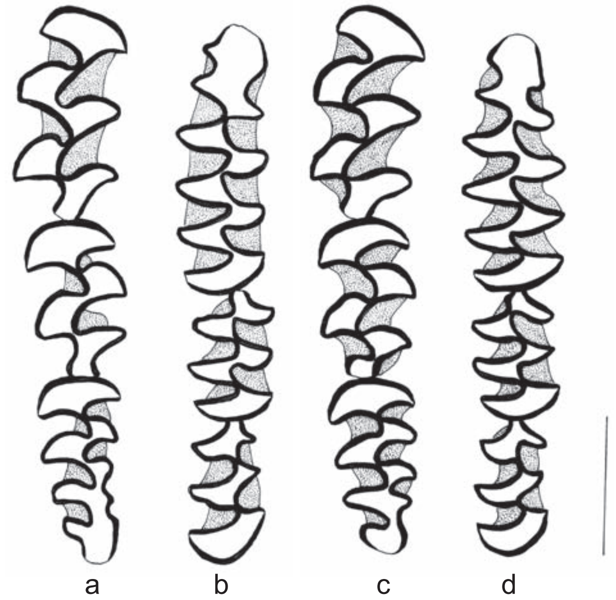


Figure 195. Upper (**a, c**) and lower molars (**b, d**) of *Microtus guentheri*. Based on specimens from Burdur (**a, b**; same specimen as in Fig. 193) and Elazığ (**c, d**; same specimen as in Fig. 194). Lingual side is to the left, anterior is at the top. Scale bar = 2 mm.

triangle (T5) which is either confluent to dental field of T4 or closed, thus resulting in the *agrestis* morphotype (Fig. 196b). The incidence of an additional triangle T5 varies among localities in Turkey from being entirely absent to *c.* 65% (Table 49). The 3rd upper molar has in its typical form three inner and four outer re-entrant angles. Some specimens show only two or three outer re-entrant angles (Fig. 197a, b). In extreme cases there are four re-entrant angles on either side of the molar (Fig. 197d-e). The 1st lower molar does not vary much. There are invariably four buccal and five lingual re-entrant angles. The anterior cup communicates broadly with the dental fields of T6 and T7, yet this connection is frequently narrow due to the deep re-entrant angles LRA5 and BSA5 (Fig. 198c). Exceptionally the anterior cup is entirely closed. Labial triangles of the 2nd lower molar are nearly the same size as the lingual ones; quite exceptionally the triangles alternate.

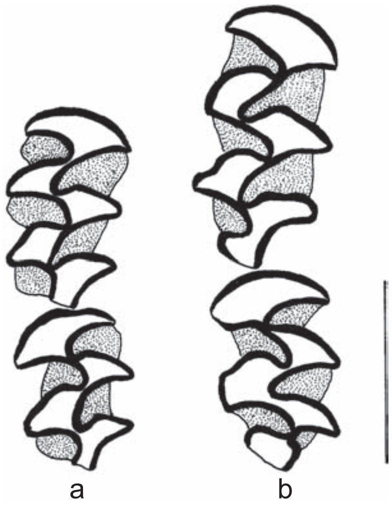


Figure 196. Variation in the shape of the first two upper molars in *Microtus guentheri* Harran, Urfa. Lingual side is to the left, anterior is at the top. Scale bar = 2 mm.

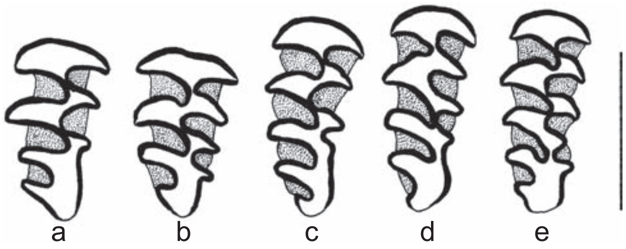


Figure 197. Variation in the shape of the 3rd upper molar in *Microtus guentheri* from Harput, Elazığ (**a, b**), and Harran, Urfa (**c–e**). Lingual side is to the left, anterior is at the top. Scale bar = 2 mm.

Dimensions are given in Table 50. Niethammer (1982) did not detect any significant sexual dimorphism in linear external and cranial measurements in a representative sample from Greece. This contradicts our observations made on another sample

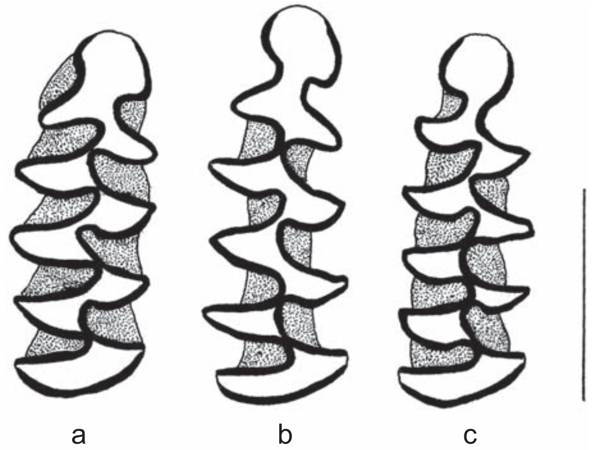


Figure 198. Variation in the shape of 1st lower molar in *Microtus guentheri* from Harput, Elazığ (**a**), Aydın (**b**), and Harran, Urfa (**c**). Lingual side is to the left, anterior is at the top. Scale bar = 2 mm.

Region	morphotype				
	N	*arvalis*	intermediate	*agrestis*	% *agrestis*
İstanbul	3	3			
Abant Lake	12	11	1		
Kastamonu	10	10			
Ankara	31	31			0.0
İzmir	46	43	3		0.0
Antalya	2	1	1		
Mersin	9	1	1	7	
Kahramanmaraş	5	4	1		
Hatay	5	4	1		
Elazığ	4	1	2	1	
Diyarbakır	3			3	
Harran, Urfa	84	4	26	54	64.3
Ceylanpınar	28	9	14	5	17.9

Table 49. Incidence of morphotypes of the 2nd upper molar in various geographic samples of *Microtus guentheri* across Turkey. Frequency of the *agrestis* morphotype is given only for samples N > 25. For morphotypes see Figs**.** 195 & 196 and text. Note, that the *arvalis* morphotype lacks the postero-lingual triangle (T5; cf. Fig. 196a). The İstanbul sample comes from the European coast of Bosporus. Based on our own material and specimens in BMNH, FMNH, NMNH, OMUS, SMF, and ZFMK.

	1	**2**	**3**	**4**
Head and body	116.0 (48)	122.6 (36)	122.7 (6)	120.0 (9)
	103-129	110-138	112-128	109-130
Tail	26.4 (46)	28.0 (36)	28.0 (5)	27.3 (9)
	22-31	24-35	25-34	23-32
Hind foot	18.2 (48)	19.5 (29)	19.3 (6)	20.1 (9)
	15.2-21.0	18.0-21.5	18.0-22.0	17.0-24.0
Ear	11.9 (47)	11.5 (29)	13.2 (6)	11.8 (9)
	10.3-13.0	10.0-14.0	12.0-14.0	9.0-14.0
Weight	44.5 (43)	41,3 (12)	60.0 (3)	37.2 (9)
	33-65	31-49	57-66	26-47
Condylobasal length	28.2 (7)	29.3 (16)	29.2 (8)	28.2 (10)
	27.2-28.8	28.1-31.1	28.1-30.6	27.4-29.4
Zygomatic breadth	16.4 (7)	17.2 (16)	17.0 (9)	16.2 (8)
	15.5-17.1	15.3-18.2	15.6-17.6	16.0-16.6
Maxillary tooth-row	7.22 (8)	7.14 (16)	7.05 (11)	6.69 (10)
	6.5-8.0	6.8-7.5	6.7-7.5	6.2-7.0
Height of rostrum	8.34 (7)	8.89 (16)	8.44 (10)	7.93 (10)
	7.8-8.8	8.4-9.6	7.9-9.0	7.7-8.2
Length of bullae	8.90 (7)	9.44 (16)	9.13 (11)	9.03 (10)
	8.6-9.4	8.3-10.4	8.5-9.6	8.09-9.75

Table 50. External and cranial dimensions of *Microtus guentheri* for four Turkish samples. Given are mean (upper row), sample size (in parentheses) and range (lower row). Sample identities: **1** – western Anatolia (districts of İstanbul, İzmir and Aydın); **2** – central and northern Anatolia (Burdur; Ankara; Kırşehir; Kastamonu; Abant Lake); **3** – southern Anatolia (Antalya; Mersin; Hatay; Amik Lake); **4** – eastern Anatolia (Kahramanmaraş; Elazığ; Ceylanpınar; Diyarbakır; Harran). Based on own material and specimens in BMNH, FMNH, NMNH, SMF and ZFMK.

from the Balkans (the Vardar valley in Macedonia), in which nine out of fifteen linear cranial measurements showed significant heterogeneity between sexes, with males achieving higher means in all the pairwise comparisons (unpublished results). Cohen-Schlagman *et al.* (1984b) claim that males are born 27% heavier but the weight differences diminish later. Cohen-Shlagmann *et al.* (1984a) also report seasonal differences in Israeli vole populations with both sexes being heavier during winter. Anyhow, because of paucity of our material from Turkey, we pooled the sexes.

Lehmann (1966) reports body weight of 80 g in a female (with 12 embryos) from Hatay. This is so evidently outside the range for Turkish Günther's voles which we saw that this extreme record was not considered in Table 50.

Chromosomes. The diploid number of chromosomes is 2N = 54 and the fundamental number of autosomal arms is NFa = 52. All autosomes are acrocentrics of decreasing size. The X chromosome is one of the largest elements and has a variable centromeric position and, consequently, its shape varies from metacentric to telocentric. The Y chromosome is the smallest acrocentric. The karyotype was reported from a number of localities across Turkey (cf. Fig. 200; Kefelioğlu, 1995; Çolak *et al*., 1997b; Kefelioğlu & Kryštufek, 1999; Yiğit & Çolak, 2002). Balkan populations have the same karyotype (Zima & Král, 1984).

VARIATION

In the past, the great geographic variability of *M. guentheri* caused considerable confusion regarding its taxonomic scope (see the above chapter on Taxonomy). As judged from the condylobasal length of skull, a measure which is less prone to bias than are external variables, the largest voles populate central and southern Anatolia. Populations from central and western Anatolia (and presumably also those from the European Turkey) are characterised by a deep rostrum (Fig. 199). Besides, voles from eastern Anatolia show a more complex enamel pattern, which is perhaps best evident from the high incidence of the *agrestis* morphotype of the 2nd upper molar. Nevertheless, a complex 2nd upper molar is frequently associated with a complex pattern of other molars as well (M1, M3, m1). As suggested by Yiğit & Çolak (2002) samples also differ in the shape of baculum.

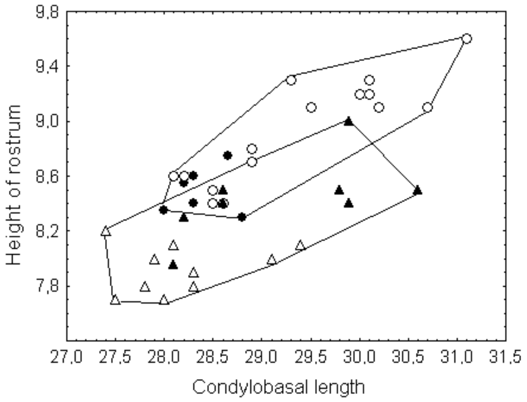


Figure 199. Bivariate plot of rostral height against condylobasal length in *Microtus guentheri* from Turkey. Circles – central and northern Anatolia (Burdur; Abant Lake; Ankara; Kastamonu); dots – western Anatolia (İstanbul; İzmir); filled triangles – southern Anatolia (Antalya; Mersin; Hatay); empty triangles – eastern Anatolia (Kahramanmaras; Elazığ; Ceylanpınar; Diyarbakır; Harran). Based on our own material and specimens in BMNH, FMNH, OMUS, NMNH, ZFMK and SMF.

Voles from eastern Anatolia are certainly most distinctive. They are smaller, with a shallower rostrum, longer bullae and have a more complex enamel pattern. As such, they are fairly well recognisable and worth to be treated as a separate subspecies (ssp. *guentheri*). Populations from the Mediterranean (but not the Aegean) coast of Turkey show similarities with other coastal sites of the Near East. They are large, their skull is shallow and dental pattern is mainly simple. If one would prefer to treat them as a formal subspecies, then *M. g. philistinus* Thomas, 1917 (type loc.: Ekron, south-east of Jaffa, Israel) is an available and proper name for them. The differences between *M. g. lydius* (western Anatolia) and *M. g. ankaraensis* (central and possibly northern Anatolia) are the slightest. The central Anatolian animals appear slightly larger and tend to be paler.

Lewis *et al.* (1967) report significant variation in size and colour along an elevational gradient in Lebanon; his specimens from low altitudes were the largest and the darkest.

DISTRIBUTION

Günther's vole inhabits the Balkan Peninsula (southernmost Serbia, Macedonia, Greece, Bulgaria, European Turkey), Asia Minor, north-western Iran, and the Mediterranean coasts of Syria, Lebanon, and Israel. An isolated population in Cyrenaica in Libya, known as *M. mustersi* Hinton, 1926 (type loc.: Merg, Cyrenaica), closely resembles *M. guentheri* but its exact taxonomic identity is not firmly established.

Microtus guentheri is presumably widespread in Turkish Thrace. In Anatolia it is of wide occurrence in the western parts of the peninsula. Along the Black Sea coast it goes as far east as the Kelkit çayı River. In the south it follows the Taurus Mts. and the Mediterranean coast down to the Tigris (Dicle) River in the east. There is great lack of records from the driest parts of central Anatolia between Konya and Tuz Gölü, and further east down to the Euphrates (Fırat) River. The eastern border in central Anatolia, as shown in Fig. 200, is thus tentative. No records are available from the north-eastern part of the country where the absence of *M. guentheri* is almost certain.

Günther's vole is also known from the island of Lesvos (Stamatopoulos & Ondrias, 1995) off the shore of western Asia Minor, which is the only record from any Mediterranean island so far.

Palaeontology. Günther's vole is known from the Middle Pleistocene layers of Yarımburgaz in Thrace (Santel, 1994). A contemporary record is also avail-

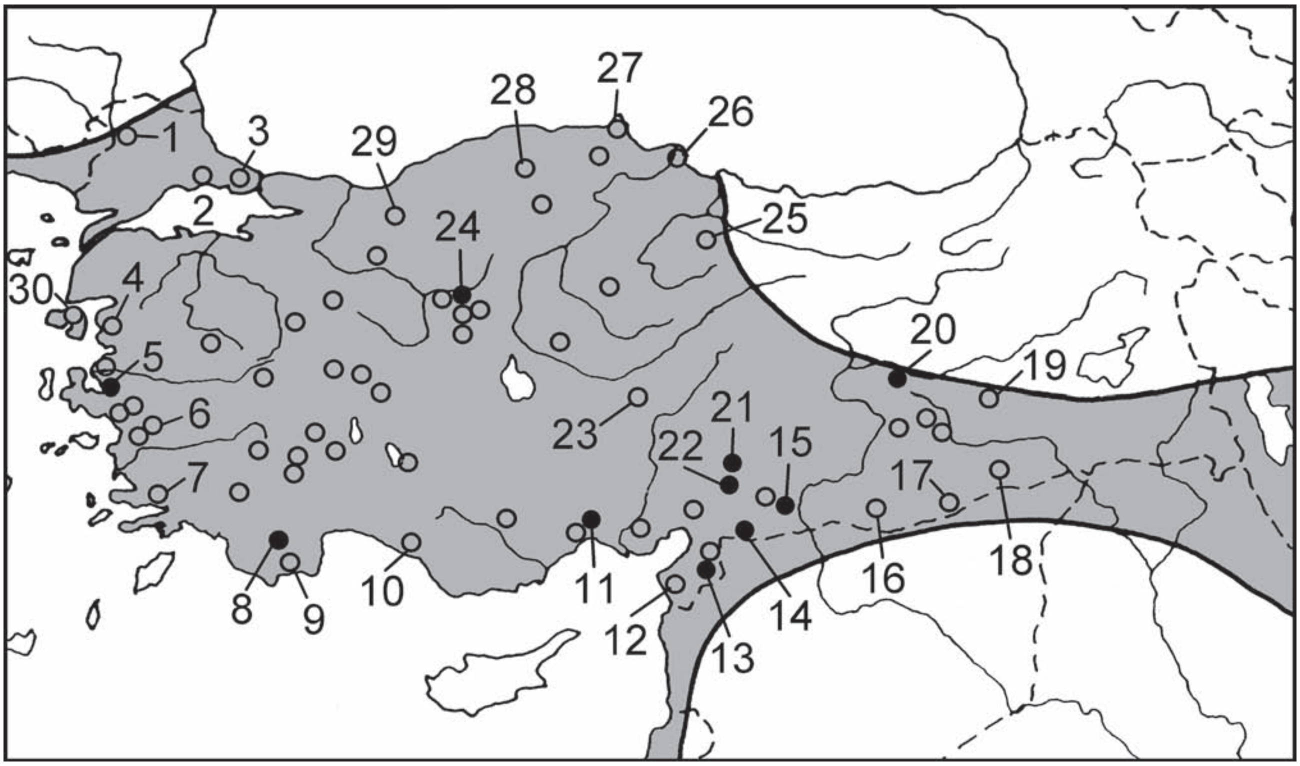


Figure 200. Distribution of *Microtus guentheri* in Turkey. Karyotyped localities are shown by dots. Marginal and karyotyped records: **1** – Havsa, Edirne; **2** – Silivri, İstanbul; **3** – Ali Bey dere (near Piringei Köy), İstanbul; **4** – Bergama, İzmir district; **5** – Kemalpaşa, Bornova, İzmir; **6** – 2 km south of Akçaköy, Aydın; **7** – Mugla; **8** – 3 km south of Elmali, Antalya; **9** – Finike, the "Cliff Cave", Antalya (subfossil); **10** – near İncekum (= 26 km north-west of Alanya); **11** – Zebil, Tarsus, Mersin; **12** – Hatay; **13** – Reyhanlı, Hatay; **14** – Kilis; **15** – Nizip, Gaziantep; **16** – Harran, Urfa; **17** – Ceylanpınar; **18** – Mardin; **19** – Bağcılar köyü, Kulp, Diyarbakır; **20** – Buzluk, Harput, Elazıg; **21** – Kahramanmaraş; **22** – Türkoğlu, Kahramanmaraş; **23** – Sultanssümpfe (= Sultan Sazlıgı Milli Parkı, Yeşilhisar, Kayseri); **24** – vicinity of Ankara; **25** –Tokat; **26** – Halys (= Bafra), Samsun; **27** – Sinop; **28** – Kastamonu; **29** – Abant Gölü, Bolu. Extralimital island record: **30** – Island of Lesvos, Greece. Corresponding reference: Neuhäuser (1936b): 1, 2, 7, 18, 25, 26, 27. Corbet & Morris (1967): 9. Felten *et al.* (1971b): 4. Kasparek (1985): 23. Coşkun (1991): 19. Kefelioğlu (1995): 5, 8, 11, 22. Stamatopoulos & Ondrias (1995): 30. Çolak *et al.* (1997b): 13, 14, 15, 21. Yiğit & Çolak (2002): 24. BMNH: 28. NMNH: 3. SMF: 10. ZFMK: 12, 17, 29. Own data: 6, 16, 20.

able from the Aegean island of Chios (Storch, 1975). The species does not occur on Chios any longer, but was still present in subfossil material (Besenecker *et al.*, 1972). Interesting enough, Montuire *et al.* (1994) did not come across this species in the Middle Pleistocene layers of Emirkaya-2 in central Anatolia. In Antalya, Storch (1988) documented a continuous presence of *M. guentheri* throughout the Upper Pleistocene, when the species suddenly disappeared and was subsequently absent during the Holocene until very recently.

In Israel, *M. guentheri* was continuosly present since the Late Middle Pleistocene, i.e. during the last 120,000 years (Tchernov, 1975).

Habitat

Günther's vole is most commonly found in well drained meadows and exposed hill slopes grown with sparse vegetation. The most common annual and perennial plants in central Anatolia belong to the genera *Astragalus, Medicago, Festuca, Cynodon, Thymmus, Polygonum, Salvia, Ziziphora,* and *Teucrium*. In semiarid south-eastern Anatolia, the main plants associated with Günther's vole habitats are *Cyperus longus, Carex otrubae, Bolboschoenus maritimus, Scilla bifolia, Hordeum* sp., *Eryngium* sp., *Securigera* sp., *Peganum* sp., and *Agropyron* sp. Rocks and stones are a frequent constituent of Günther's vole habitat. The voles also frequent grain fields, particularly their edges, but also move deeper inside. Since the species cannot tolerate ploughing, which destroys its shallow nests, the presence inside the fields is only temporary. Lucerne fields are also favoured. Günther's voles were also collected along riverbanks and in marshes (central Anatolia, Tarsus). Already Danford & Alston (1880) found them common in the swamps south of Kahramanmaraş. This vole was also collected in somewhat atypical habitats, e.g. in a eucalyptus forest area with dense blackberry bushes (Tarsus) and in reeds (around Lake Burdur). Along the Aegean coast it is common in olive plantations.

Altitude. At Inçekum, Felten *et al.* (1971b) collected specimens of Günther's vole just a few meters above the sea level, while the highest record in Turkey is at 1,350 m a.s.l. (Manisa; Yiğit *et al.*, 2003a). In the European part of its range, Günther's vole lives exclusively in low elevations (Niethammer, 1982).

Figure 201. Habitat of *Microtus guentheri*. **a** – southern Taurus Mts. (photo: J. Červený); **b** – vicinity of Kayseri, central Anatolia (Photo: P. Benda); **c** – Hatay (Photo: P. Benda).

Associates. Across Turkey, Günther's vole was collected along with numerous other rodent species, such as *M. rossiaemeridionalis, Chionomys nivalis, Cricetulus migratorius, Mesocricetus brandti, M. auratus, Cricetulus migratorius, Meriones tristrami, Gerbillus dasyurus, Allactaga williamsi, A. euphra-*

tica, Nannospalax spp., *Apodemus* spp., *Mus macedonicus, Dryomys nitedula,* and *Spermophilus* spp. In the cases of syntopic occurrence of Günther's vole with *Microtus rossiaemeridionalis*, the latter usually selects more mesic habitats (cf. also Felten *et al*., 1971b). In Jordan, *M. guentheri* shares burrows with *Cricetulus migratorius* and *Meriones tristrami* (Amr, 2000).

Density. The population densities of Günther's vole fluctuate considerably over time and incidences of large-scale economic damages have been reported from Turkey (Figs. 202 & 203). Between 1936 and 1940, when the damages were modest at the national scale, central and south-eastern Turkey were the most affected, in addition to Thrace (Fig. 203; note that damages in the Karst region were most likely caused by vole species other than *M. guentheri*). The areas most affected in Turkey included the Mediterranean plains of southern Anatolia, namely districts of Gaziantep, Urfa, Mardin, Siirt, Hatay, and Seyhan (Bodenheimer, 1949). The scarcity of major outbreaks in central Anatolia was ascribed to scanty and extremely unsteady rainfall (Bodenheimer, 1949). Misonne (1957) reports on rodent control campaigns in the Urfa province, which resulted in up to 27 metric tonnes of voles destroyed annually. In a sample of 1,879 rodents collected in the northern Syrian desert in spring 1955, *M. guentheri* accounted for 14.1% of the material from the Turkish part of the area (total number of rodents = 1,295), and only 0.3% in the Syrian part (N=584; Misonne, 1957).

Figure 202. Fluctuations in area infested by *Microtus guentheri* in Turkey between 1925 and 1939. Based on data in Bodenheimer (1949).

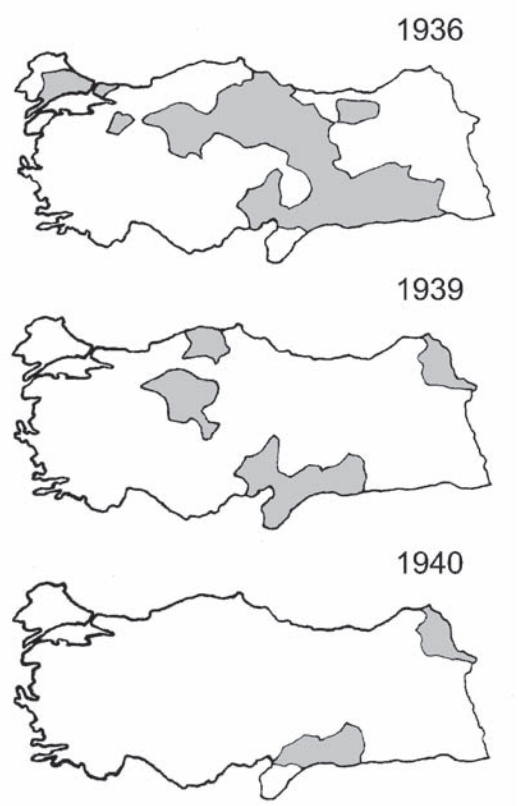


Figure 203. Provinces of Turkey damaged by *Microtus guentheri* in 1936, 1939, and 1940 when the extent of damage was modest (cf. Fig. 202). Note that not all the areas are likely to be infested by *M. guentheri* alone. Redrawn from Bodenheimer (1949).

Biology

The biology of Günther's vole was intensively studied in the Near East, both in the field and under laboratory conditions (Bodenheimer, 1949; Cohen-Shlagman *et al.* 1984a, b), and ample information is also available from Turkey.

Activity. Günther's vole is a social and colonial animal. At high densities the voles would sit on their haunches and emit squeaking noises, both in the Near East (Lewis *et al*., 1967) and in the Balkans (our own observations). They are active at any time of the day but avoid summer temperatures over 25ºC, at least in Israel (Cohen-Shlagman *et al*., 1984a).

Burrows. The voles dig their own underground system of burrows which extends over a distance of 10 m or more in central Anatolia. Ondrias (1965) reports from Greece burrows covering areas from three up to 150 m^2, and Amr (2000) claims that there may be more than 40 burrow systems per 1,000 m^2 in Jordan. Entrances (5–7 cm in diameter) to the burrows are exposed and characterised by a considerable amount of excavated soil. In this respect they differ from the burrows of *M. rossiaemeridionalis.* The entrances are interconnected by a surface network of runways through the vegetation. The distance between entrances varies from 20 to 100 cm in Greece (Ondrias, 1965). Active holes are easily recognisable by the accumulations of excrements around the entrance to the burrow and by cuttings of vegetation found on nearby runways. Lewis *et al.* (1967) report from Lebanon characteristic white urine deposits in and near the entrances. The tunnels are mainly 10–15 cm (rarely 30–40 cm) below the surface, but some descend as deep as 50–80 cm. Several entrances lead to the underground system but some tunnels have blind ends. Each system usually contains several nest chambers (13 x 9 x 7 cm) which are lined with dry grass. Nest chambers are located either at the end of a tunnel, or the tunnel continues through the chamber. There are no storage chambers or latrines. The above information is mainly summarised from Çolak *et al.* (1998a) and relates to central Anatolia. Ondrias (1965) suggests that complex burrow systems are extensions of simple burrows constructed by a single animal.

Figure 204. Entrance to the burrow of Günther's vole. Kırşehir, cetral Anatolia. Photo: A. Kryštufek.

Reproduction. Günther's vole is a prolific breeder. Its high breeding potential assures rapid recycling at the population level. Under laboratory conditions the females show no regular oestrous cycles, but there are a post-partum and a post-lactation oestrus (Cohen-Shlagman *et al.*, 1984b). The litter size in Güther's voles from around Ankara and bred under laboratory conditions was 2–10 (mean = 5.5). In the laboratory, up to seven litters were recorded per female within a season with 42 cubs in total (Çolak *et al.*, 1998a). As noted by Cohen-Shlagman *et al.* (1984b), the mean litter size and the total reproductive potential in free living social voles exceed the one in captivity. In a pooled Turkish sample of voles, collected in nature, the number of embryos varied between 5 and 12 (mean = 8.9; N = 26). The highest count of embryos in Lebanon is 13 (Lewis *et al.*, 1967). On the other hand, the litter size seems to be smaller in the Balkans; e.g. in Greece the number of embryos varies between 4 and 8 (mean = 5.6; Ondrias, 1965). Ondrias (1965) reports communal nesting.

Microtus guentheri is a nidicolous rodent with an altricial pattern of development (Cohen-Shlagman *et al.*, 1984b). The young are born naked, with sealed eyes and closed ears; their body mass at birth is 2.8–4.4 g (Çolak *et al.*, 1998a). Lactation lasts 15–21 days. The infants start to eat green food on day 10 (Cohen-Shlagman *et al.*, 1984a) and are weaned after 21–24 days at a body mass of 10.3–15.9 g. Sexual maturity is attained at the age of 30–35 days (body mass = 13.8–20.3 g; Çolak *et al.*, 1998a). Although a juvenile breeding phenomenon was reported in Günther's vole, with females being pregnant at the age of 21 days (Bodenheimer, 1964), the females mainly start breeding at the age of two months and give birth to their first litter at the age of 85 days. Males became sexually active at the age of 85 days (Cohen-Shlagman *et al.*, 1984b). The sex ratio is female biased during reproduction (Cohen-Shlagman *et al.*, 1984a). In a sample of adult voles (body mass > 30 g) collected at the start of April near İzmir, the male : female ratio was 1 : 2.8 (N = 49).

Günther's vole is a seasonal breeder. In central Anatolia, reproduction takes place from September to June (Çolak *et al.*, 1998a) and coincides with a relatively humid season (cf. the climagram for Ankara in Kryštufek & Vohralík, 2001: Fig 15 on

p. 21). Similarly, in Israel the breeding starts at the end of October and ends in April (Cohen-Shlagman *et al*., 1984a). Scattered records available to us from various parts of Turkey mainly correspond with this. For example, juveniles were collected at Ceylanpınar in mid May, in Mersin in March, and in Kastamonu in January. Sexually active females are available from March (near İstanbul; Hatay), early April (near İzmir), late May (Ankara), and late October (Kırşehir). There is one case of evidence which, however, violates the above pattern. Namely, the SMF sample from Abant Lake, collected in the first decade of September, contains mainly juveniles.

Food. The staple diet of Günther's vole consists of annual plants which flourish during the rainy season. Pieces of vegetable material (4–5 cm long) are frequently taken into the underground tunnels and consumed close to the exit hole. The species does not store food. In central Anatolia, Çolak *et al*. (1998a) found, in the burrows, various grasses in addition to plants of the genera *Circium, Silene* and *Alyssum*. Green, succulent vegetation is the preferred food in Lebanon (Lewis *et al*., 1967). The weight of a full stomach is said to vary between 3 and 5 g. Under captive conditions, the voles prefer green plants to seeds (Çolak *et al*., 1998a). Bodenheimer (1949) mentions insects to be consumed as well.

Predation. Common in many parts of Turkey, *M. guentheri* is one of the key prey species of owls in various regions. Thus, Corbet & Morris (1967) found it to be the most abundant species in the subfossil deposits in the "Cliff Cave" near Finike, which are most likely accumulations from owl pellets. Near Aydın we found this vole to be nearly the only small mammal in the pellets of an unknown owl, and in the pellets of barn owl *Tyto alba* from Harran it accounted for 70–80% of all small mammals present. Barn owl is known to prey on *M. guentheri* also in Syria (Shehab *et al*., 2004).

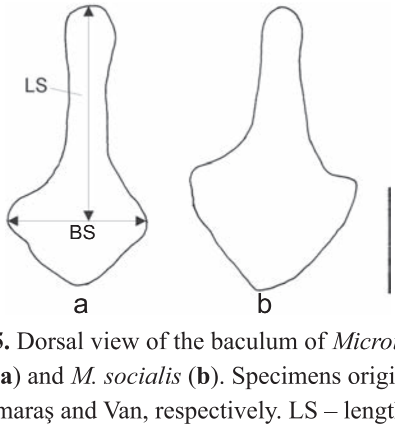


Figure 205. Dorsal view of the baculum of *Microtus guentheri* (**a**) and *M. socialis* (**b**). Specimens originate from Kahramanmaraş and Van, respectively. LS – length of schaft, BS – breadth of schaft. Redrawn from Kıvanç (1978). Distal is to the top. Scale bar = 1 mm.

Social vole – *Microtus socialis*

Mus socialis Pallas, 1773. Type loc.: probably Inderskij Region, Gur'ev District between the Volga and Ural Rivers, Kazakhstan.

Taxonomy

Most of the students of Turkish rodents did recognise *M. socialis* as a distinct species from *M. guentheri*, the separation of the two having caused some confusion, however. Thus, Neuhäuser (1936b) ascribed to the former all social voles with condylobasal length not exceeding 27.9 mm, while Ellerman (1948) considered 24.3 mm to be the maximum value. In Turkish material which we examined, the greatest condylobasal length of skull was 26.5 mm (Table 51). Kıvanç (1978) carefully compared the bacula of the two social voles. Although *M. guentheri* has a larger baculum on average, most of the dimensions broadly overlap. The main difference between the two species is in the relative length of the basal shaft of the corpus, which is relatively larger in the smaller *M. socialis*. The ranges for the shaft length (see Fig. 205 for definition) are: 1.81–2.47 mm in *M. guentheri* and 1.44–1.83 mm in *M. socialis*. Bivariate plots among various bacular dimensions clearly separate the two social voles (for details see Kıvanç 1978).

Morphologically, the social vole closely resembles *M. dogramaci*. External differences are in the tail length, which is evidently longer in *M. socialis* (Fig. 206). The measurements we used, however, were scored by various collectors, which almost certainly caused some incompatibilities. As for the skull, *M. dogramaci* has a longer braincase (Fig. 207).

The taxonomic scope of *M. socialis* in the Near East is most complex. Voles from Armenia are considered to be an independent species, *M. schidlovskii* Argyropulo, 1933 (type loc.: Leninakan district, north-western Armenia). As shown by Achverdjan *et al*. (1991a), their diploid chromosome number is

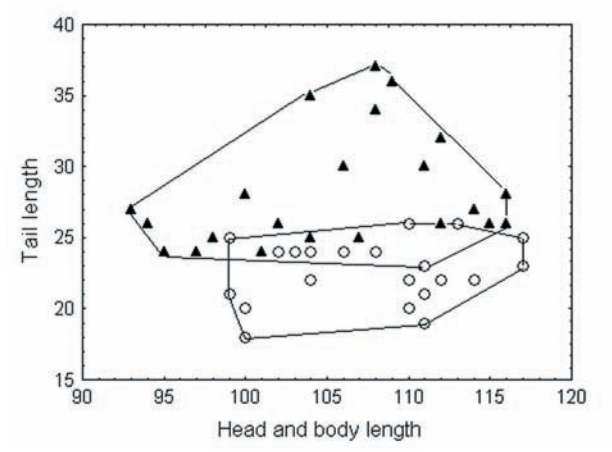


Figure 206. Bivariate plot of tail length against head and body length in *Microtus socialis* from the Near East (triangles) and *M. dogramaci* (circles). Based on specimens in BMNH, OMUS, SMF and ZFMK.

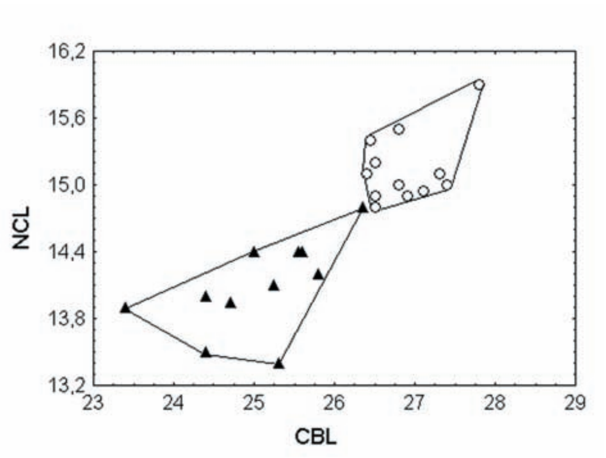


Figure 207. Bivariate plot of braincase length against condylobasal length in *Microtus socialis* (triangles) and *M. dogramaci* (circles) from Turkey. Based on specimens in BMNH, OMUS, SMF and ZFMK.

2N = 60, and in captivity they produce sterile male offspring with *M. socialis binominatus* Ellerman, 1941 (type loc.: near Tiflis, Transcaucasia; Achverdjan *et al*., 1991b). *Microtus schidlovskii* has smaller bullae than *M. s. binominatus*, it develops suprorbital ridges (Achverdjan *et al*., 1991a) and shows a very long medial process of baculum (Argyropulo, 1933; Golenishchev *et al*., 2002a). It is recognised as a species distinct from *M. socialis* by most recent Russian authors (e.g. Gromov & Erbajeva, 1995; Golenishchev *et al*., 2000, 2002a). *Microtus schidlovskii* possibly occurs also in Turkey.

Neuhäuser (1936b), Ellerman (1948), and Lehmann (1969) ascribe the social voles from Turkey to the subspecies *M. s. paradoxus* Ognev & Heptner, 1928 (type loc.: near Askabad, Kopet Dagh Mts., Turkmenistan). This vole is now considered by some Russian authors to be a distinct species (Zykov & Zagorodnjuk, 1988; Gromov & Erbajeva, 1995; Golenishchev *et al*., 2002a), but its presence in Turkey is unlikely. *Microtus paradoxus* has the same conventional karyotype as *M. socialis* (Zykov & Zagorodnjuk, 1988).

DESCRIPTION

EXTERNAL CHARACTERS. This is a small social vole with tail longer than any other member of the group living in Turkey. With its relatively long tail it externally resembles more closely the voles of the *Microtus arvalis* group. The social vole is also less robust in appearance than *M. guentheri*. Its fur is long (up to 9 mm) and sparse longer dorsal hairs attain the length of up to 11.5 mm. White whiskers are up to 23 mm long. Moderately long ears protrude from the pelage.

COLOUR. Upper parts are dark brown to yellowish brown or brownish buff, occasionally washed with red. The fur is slate black basally and protruding dorsal hairs are black tipped. The flanks are greyish brown or buff and the belly is silvery grey, occasionally washed with buff. There is no sharp demarcation line along the flanks. The tail is indistinctly bicoloured (brownish above, greyish below), with a short pencil (< 3 mm) at the tip. Feet are dull buffy white.

NIPPLES. There are eight nipples, two pairs of each, pectoral and inguinal.

BACULUM is figured by Kıvanç (1978) and Kefelioğlu (1995). The former author also provides a detailed description and comparison with *M. guetheri*. The baculum bone is 2.07–2.90 mm long (mean = 2.59 mm), its basal shaft is 0.90–1.57 mm wide (mean = 1.24 mm).

SKULL resembles that of *M. guentheri*, but the brain-case is relatively longer and the bullae with their mastoid portion are bigger (Fig. 208). In this respect *M. socialis* resembles more closely Günthers' voles from eastern Anatolia. *Fenestrae praelambdoideae* are frequently entirely filled by the bony tissue of the supramental triangle of bullae. The dorsal profile of the skull is more flat and the nasals do not

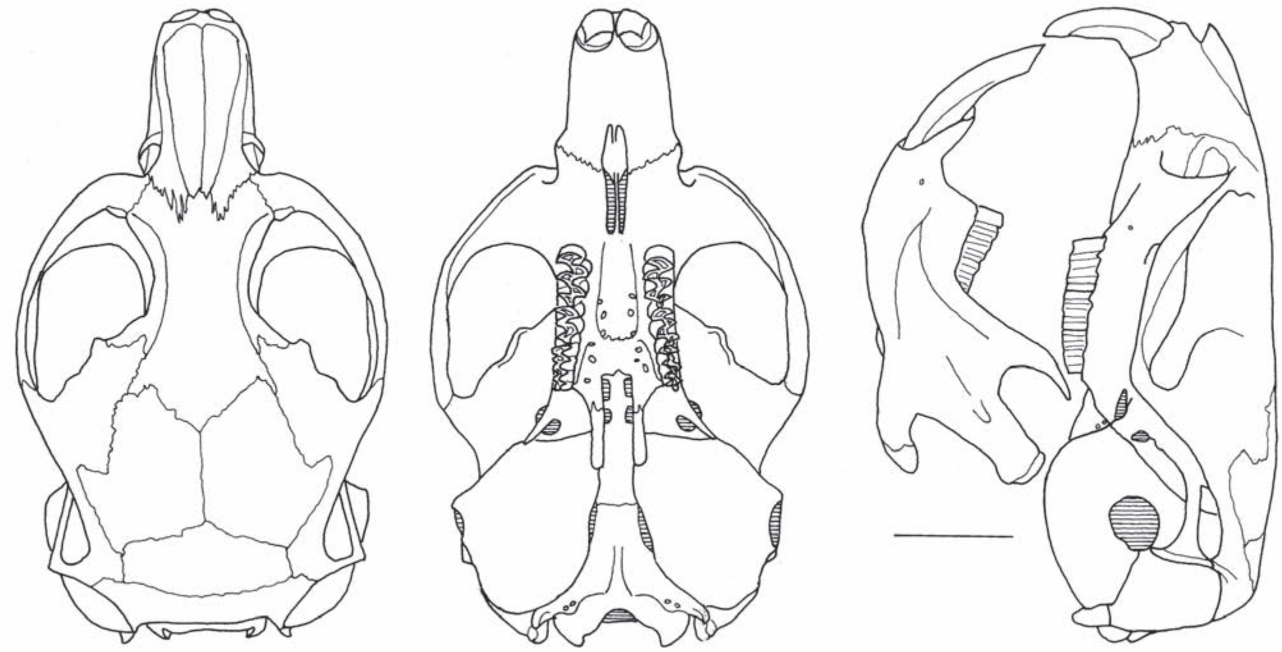


Figure 208. Skull and mandible of *M. socialis*, based on an adult female from Aşkale, Erzurum (OMUS). Scale bar = 5 mm.

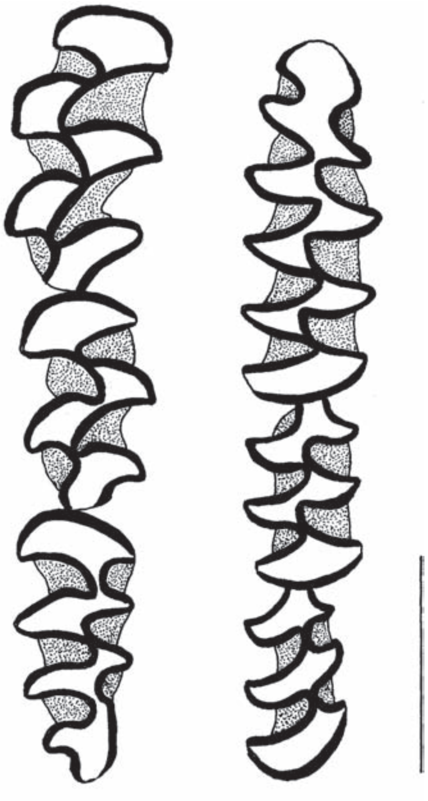


Figure 209. Upper (**a**) and lower molars (**b**) of *Microtus socialis* (same specimen as in Fig. 208). Lingual side is to the left, anterior is at the top. Scale bar = 2 mm.

slope abruptly as is the case in Günther's vole. Incisive foramen is fairly long but does not reach posteriorly the alveoli of the 1st molars.

Teeth. The upper incisors are orange yellow and the lower ones are paler (yellow to pale yellow). The molar pattern does not deviate much from the one seen in other social voles from Turkey. The 2nd upper molar frequently shows an enamel postero-lingual fold, but the additional triangle T5 (*agrestis* morphotype) is rare (four cases among 21 specimens; Fig. 210c). The 3rd upper molar has mostly three re-entrant angles on each side. The 1st lower molar has four outer and five inner re-entrant angles.

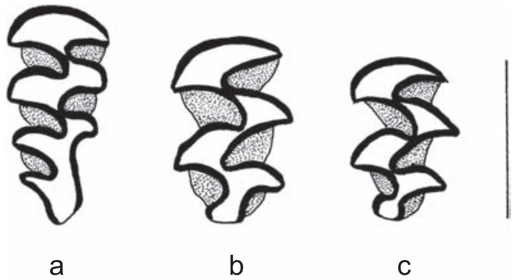


Figure 210. Variation in the shape of the 3rd (**a**) and 2nd upper molar (**b, c**) in *Microtus socialis* (OMUS). **a** – Aşkale, Erzurum; b – Demirözü, Bayburt; **c** – Kesiktaş köyu, Nizip, Gaziantep. Lingual side is to the left, anterior is at the top. Scale bar = 2 mm.

DIMENSIONS are given in Table 51.

	N	mean	min–max
Head and body	24	105.8	93–116
Tail	26	28.6	23–37
Hind foot	23	16.8	14.0–20.0
Ear	26	10.0	8.0–12.0
Weight	24	27.9	20–38
Condylobasal length	14	25.25	23.4–26.5
Zygomatic breadth	15	14.88	13.2–15.8
Maxillary tooth-row	17	6.02	5.6–6.5
Braincase length	14	14.20	13.4–14.8
Height of rostrum	16	6.78	6.1–7.2
Length of bullae	16	8.39	7.65–9.25

Table 51. External and cranial dimensions of *Microtus socialis* from Turkey. Based on specimens in OMUS, SMF and ZFMK.

KARYOTYPE was described by Kefelioğlu (1995) and Kefelioğlu & Kryštufek (1999). The diploid number of chromosomes is 2N = 62 and the fundamental number of autosomal arms is NFa = 60. All the autosomes are acrocentrics of decreasing size; the X chromosome is the largest acrocentric in the set and the Y chromosome is one of the smallest acrocentrics. Such a karyotype has also been reported from outside of Turkey (Zima & Král, 1984).

VARIATION

The material examined by us is quite scanty and does not allow any conclusions regarding geographic variation. What we saw suggests that the tail tends to become shorter towards the Syrian border, but this might be a misperception due to inconsistency among collectors in scoring external measurements.

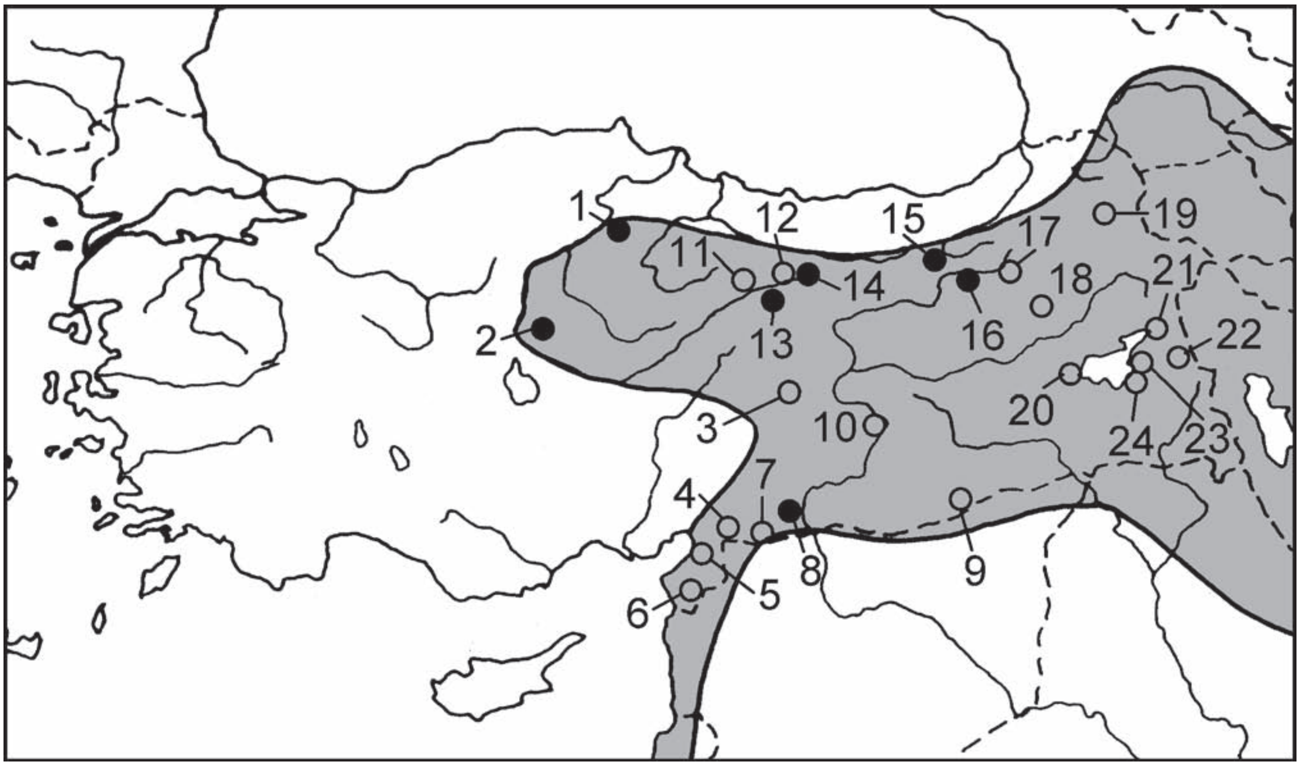


Figure 211. Distribution of *Microtus socialis* in Turkey. Karyotyped records are shown as dots. Records: **1** – Çaytarla, Çorum; **2** – Kaman, Kirşehir; **3** – Darende, Malatya; **4** – Akbeş, Gaziantep; **5** – Belem, above Topboğazi Geçidi, Hatay; **6** – border station Yayladağı, Hatay; **7** – 10 km east of Kilis; **8** – Kesiktaş köyü, Nizip, Gaziantep; **9** – Ceylanpınar, Şanlıurfa; **10** – Karadut, Adıyaman; **11** – Yıldızeli, Sivas; **12** – 25 km east of Zara, Sivas; **13** – Celalli köyü, Hafik, Sivas; **14** – Zara, Sivas; **15** – 5 km east of Demirözü, Bayburt; **16** – Aşkale, Erzurum; **17** – Erzurum; **18** – Hınıs, Erzurum; **19** – Sarıkamış, Kars; **20** – Tatvan; **21** – Bendimahi, Muradiye, Van; **22** – Güzeldere köyü, Özalp, Van; **23** – Van; **24** – 10 km south of Van. References: Neuhäuser (1936b): 23. Obuch (1994): 5, 10, 19, 21. Kefelioğlu (1995): 8, 13-16. Kefelioğlu & Kryštufek (1999): 1, 2. Kryštufek & Kefelioğlu (2001a): 4, 17, 18, 20, 22. Yiğit *et al.* (2003a): 3, 7, 9, 11, 24. SMF: 6, 12.

In the Near East, the social vole populations from Turkey and Iran (provinces of Azerbaijan, Isfahan and Teheran) are seemingly quite uniform, while the marginal ones, from Lebanon and Syria, and from the Caucasus, are most distinct in terms of craniometry (Kryštufek & Kefelioğlu, 2001a). In the case of the Caucasian social voles, such perception could be biased by the incompletely understood taxonomy in the region (see chapter on Taxonomy above).

Distribution

The species is distributed over the steppes between the Dneper River in the west and Lake Balkhash and north-western Xinjiang in the east (Musser & Carleton, 1993); Turkey, Syria, Lebanon, Iraq, and Iran in the south (Kryštufek & Kefelioğlu, 2001a). Anatolia is on the very western fringe of the range of *M. socialis* in Asia. Scattered records are available from the highlands east of the Kızılırmak and the Ceyhan Rivers and again from Hatay. The species is probably absent from the semiarid south-eastern Anatolia. Yiğit *et al.* (2003a), however, report it for Ceylanpınar. In a large collection from Ceylanpınar in ZFMK, which mainly contains subadults, we recognised *M. guentheri*. Several specimens match *M. socialis* cranially, but had longer braincases than the remaining Turkish samples. Besides, their skins did not differ from those of Günther's voles, i.e. the tail was very short. Hence, we feel that the evidence which would undoubtedly prove the existence of the social vole in south-eastern Anatolia is still scanty. The actual distributional borders are very imperfectly known in Turkey.

Habitat

According to Šidlovskij (1976), the social vole populates grasslands, pastures, steppes and semi-deserts, but is also found in fields, orchards and in clearings inside xeric forests. In Turkey, steppe habitats of *M. socialis* are assemblages of various grasses and herbaceous plants: *Astragalus angustifolius, A. microcephalus, Salvia aethiopis, Senecio vernalis, Hyoscyamus niger, Hordeum* sp.*, Eryngium* sp.*, Securigera* sp.*, Peganum* sp.*, Agropyron* sp.*, Centranthus longiflorus, Parietaria judaica, Torilis leptophyla, Festuca valesiaca, Eremopoa songarica, Bromus danthoniae, B. tomentellus, Ornithogallum* sp.*, and Echinops ritrio* (*cf.* Yiğit *et al*., 2003a). It has also been recorded from cereal fields.

Altitude. The vertical range of localities in Turkey is between 650 m (400 m if Ceylanpınar proves as a locality of this species) and 2,480 m a.s.l. The bulk of localities in Turkey appear to lie above 1,000 m a.s.l.

Biology

Burrows. Šidlovskij (1976) reports the social vole to live in burrows which descend down to 80 cm below ground. Numerous entrances (10–20, exceptionally as many as 70 or more) led to underground tunnels. The holes are 4–5 cm in diameter.

Reproduction of the social vole has not been studied in Turkey. For Transcaucasia, Šidlovskij (1976) states up to eight litters per year. Pregnancy lasts 20 days and average litter size is 5–6; litters of 11–12 cubs are exceptional. On May 17, two females collected on the Elburs Mts. contained four embryos each and a juvenile was collected in the Iranian Azerbaijan on May 23 (SMF).

Predation. In eastern Anatolia, Obuch (1994) found *M. socialis* in the pellets of the eagle owl (*Bubo bubo*). In Syria, the social vole is also preyed by *Athene noctua* and *Tyto alba* (Shehab *et al*., 2004)

Doğramaci's vole – *Microtus dogramaci*

Microtus dogramaci Kefelioğlu & Kryštufek, 1999.
Type loc.: Boyali köyü, Sulova, Amasya, Turkey.

Taxonomy

Microtus dogramaci is primarily characterised by its distinctive karyotype. Mitochondrial cytochrome *b* sequence placed it closer to *M. guentheri* than to *M. socialis* (Jaarola *et al*., 2004).

Description

External characters. *Microtus dogramaci* closely resembles *M. socialis* both externally and cranially. The most obvious difference is in the much shorter tail of the former.

Colour. In comparison with *M. socialis* from Erzurum, *M. dogramaci* tends to be slightly more yellowish brown, and its feet as well as the underside of the tail are paler, nearly whitish. The tail also tends to

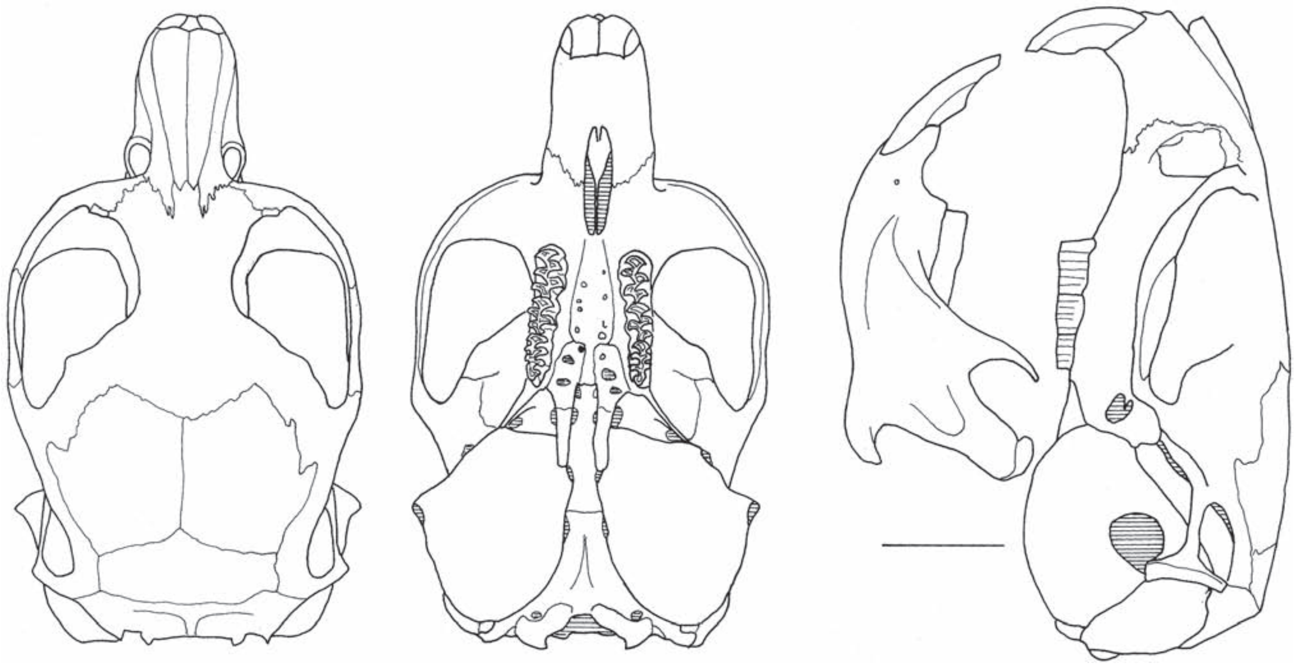


Figure 212. Skull and mandible of *Microtus dogramaci*, based on an adult male from 2 km north of Cihanbeyli, Konya (OMUS). Scale bar = 5 mm.

be quite distinctly bicoloured and its terminal pencil is very short (*c.* 1.5 mm).

SKULL of *M. dogramaci* is distinuishable from *M. socialis* mainly by size; interorbital constriction is also relatively narrower.

TEETH. Molars more complex in *M. dogramaci* than in *M. socialis*. First upper molar occasionally shows postero-lingual fold (Fig. 214a). Second upper molar has an additional postero-lingual triangle

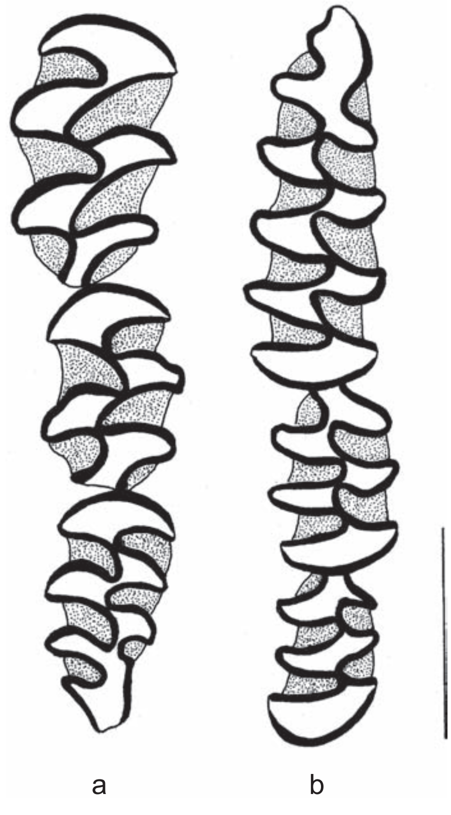


Figure 213. Upper (**a**) and lower molars (**b**) of the Doğramacı's vole (same specimen as in Fig. 212). Lingual side is to the left, anterior is at the top. Scale bar = 2 mm.

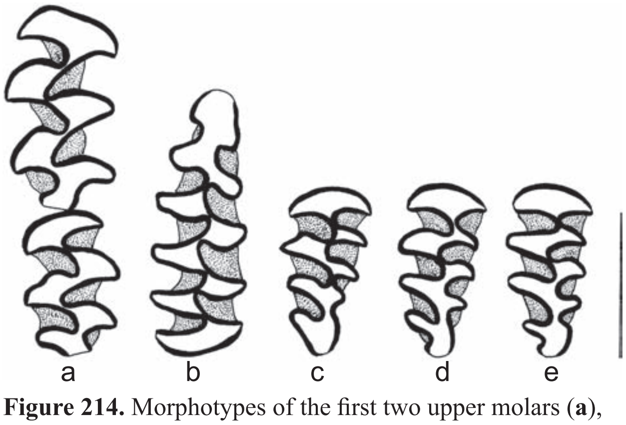


Figure 214. Morphotypes of the first two upper molars (**a**), 1st lower molar (**b**), and 3rd upper molar (**c–e**) in *Microtus dogramaci* (OMUS). Based on specimens from Boyali köyü, Amasya. Lingual side is to the left, anterior is at the top. Scale bar = 2 mm.

(T5 or *agrestis* loop), present in approximately half of the specimens, but dental field of T5 rarely entirely closed. In the remaining specimens, the base of T4 tends to be expanded into an enamel fold which forms a clearly recognisable third salient angle. The 3rd upper molar has three or four re-entrant angles on either side. The 1st lower molar is basically the same as in *M. socialis*, i.e. with four outer and five inner re-entrant angles. Exceptionally it has three outer or four inner re-entrant angles.

DIMENSIONS are given in Table 52.

KARYOTYPE is highly distinctive. The diploid number of chromosomes is 2N = 48 and the fundamental number of chromosomal arms varies, being 46, 48 or 50. The X chromosome is invariably a large metacentric and the small Y chromosome is submetacentric (prevailing condition), or acrocentric. An acrocentric Y chromosome was established only in the NFa = 46 form. The autosomal set contains one (NFa = 48) or two (NFa = 50) pairs of metacentrics, while the remaining autosomes are acrocentrics of decreasing size; in the NFa = 46 form all the autosomes are acrocentric (Kefelioğlu & Kryštufek, 1999). The fundamental number of chromosomal arms in *M. dogramaci* is almost the lowest in the genus (see Zagorodnyuk, 1990 for a review). Variation in the fundamental number of chromosomal arms is probably due to pericentric inversions (Kefelioğlu & Kryštufek, 1999).

	N	mean	min–max
Head and body	26	108.2	99–125
Tail	21	22.6	18–26
Hind foot	26	18.7	16.0–21.0
Ear	26	9.9	8.0–12.0
Weight	21	26.9	19–37
Condylobasal length	12	26.87	26.4–27.8
Zygomatic breadth	12	15.31	14.5–15.9
Maxillary tooth-row	12	6.29	5.7–6.6
Braincase length	12	15.15	14.8–15.9
Height of rostrum	12	7.30	7.0–7.5
Length of bullae	11	9.03	8.6–9.5

Table 52. External and cranial dimensions of *Microtus dogramaci* from Turkey. Based on specimens in BMNH and OMUS.

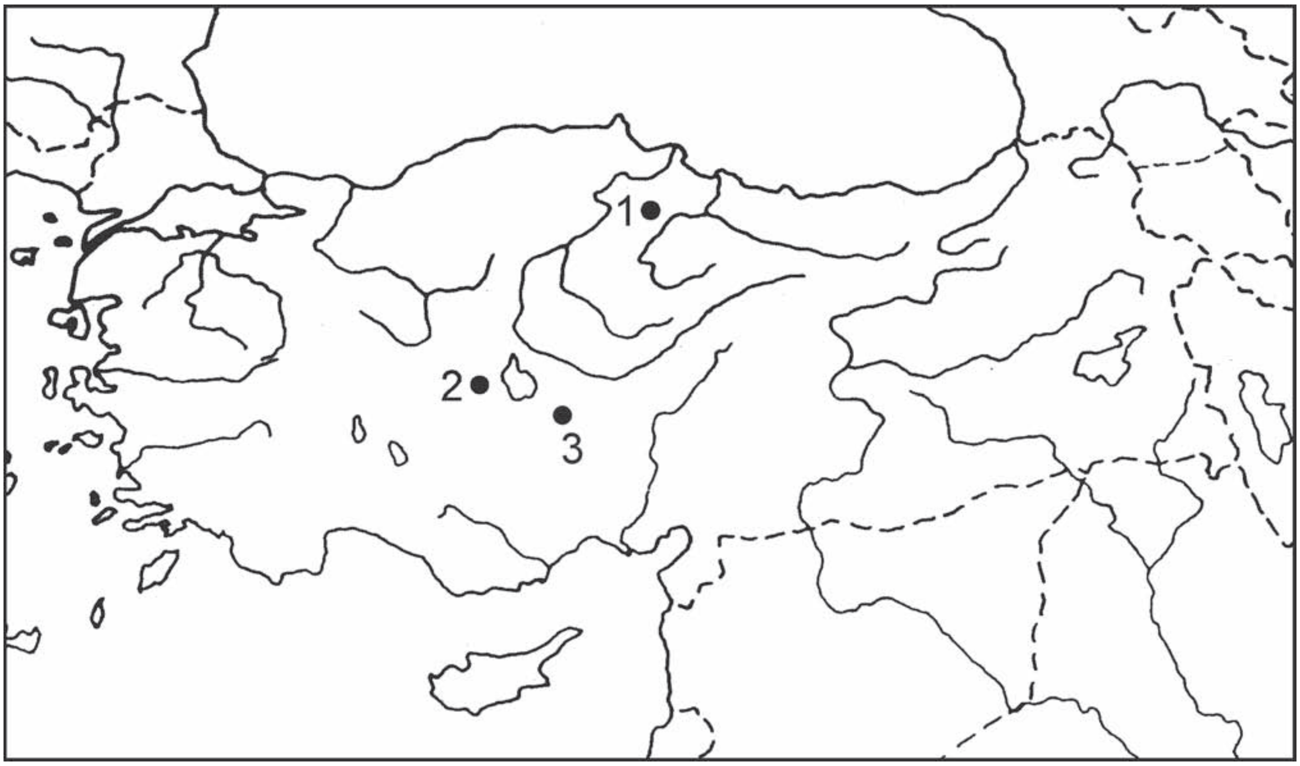


Figure 215. Records of *M. dogramaci*: **1a** – Boyali köyü, Suluova, Amasya; **1b** – Amasya; **2** – Cihanbeyli, Konya; **3** – Ortaköy, Aksaray. Corresponding references: Kefelioğlu & Kryštufek (1999): 1a, 2. Jaarola *et al.* (2004): 3. BMNH: 1b.

Variation

So far only the lowest fundamental number (NFa = 46) has been found in the population from Konya, while the Amasya sample exhibited a whole range of variation in this respect (NFa = 46, 48, and 50). Besides, the Y chromosome of voles from Amasya is either acrocentric or submetametacentric, while it is invariably submetacentric in Konya.

Distribution

Microtus dogramaci is only known from three localities in central Anatolia, which are approximately 450 km apart (Fig. 215).

Habitat

No aspects of biology are known in the case of this newly recognised species. Like other social voles, it populates grasslands. In the BMNH material, a perforated female and a juvenile suggest winter reproduction. One female gave birth to three cubs on November 20 (H. Kefelioğlu, personal communication).

Anatolian vole – *Microtus anatolicus*

Microtus anatolicus Kryštufek & Kefelioğlu, 2001b. Type loc.: Yapalı köyü, Cihanbeyli, Konya, Turkey.

Description

External characters. *Microtus anatolicus* resembles *M. guentheri* but is smaller.

Figure 216. Anatolian vole *Microtus anatolicus*. Adult specimen from Yapalı köyü, Cihanbeyli, Konya. Photo: A. Kryštufek.

Colour. Contrary to *M. guentheri*, which is normally brown with buff, yellow or reddish shades, the type series of *M. anatolicus* is pale greyish buff in colour. Among many *M. guentheri* which we examined from the entire range of the species, we saw only a single specimen from the vicinity of Burdur, which approached the colour of the Anatolian vole. Belly is whitish in *M. anatolicus* and tinged with buff, or greyish due to the slate blackish bases of hairs. Flanks are yellowish buff and the demarcation line is obscured. Feet are whitish and tail is indistinctly bi-coloured (greyish above, whitish below) or uniformly whitish.

Skull deep, with heavy zygomatic arches and large bullae. Mastoid portion particularly enlarged. *Microtus anatolicus* can be readily separated from central Anatolian *M. guentheri* by the height of rostrum which is evidently shallower in *M. anatolicus* (7.1–8.2 mm) than in *M. guentheri* (8.3–9.6 mm). The relative breadth of brain-case distinguishes well between *M. guentheri* from its entire range in Anatolia and *M. anatolicus* (Fig. 217).

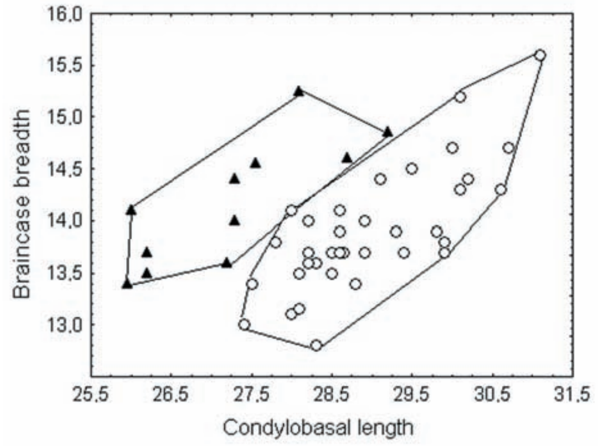


Figure 217. Bivariate plot of braincase breadth against condylobasal length in *Microtus guentheri* (circles) and *M. anatolicus* (triangles). Considered are all age groups of *M. anatolicus*. Based on specimens in BMNH, OMUS, SMF and FMK.

Teeth. The enamel on the upper incisors is yellow-orange and yellow to nearly whitish yellow on the lower ones. The molar pattern is similar to that in *M. guentheri*, but with hardly any complexities on the first two upper molars. The 2nd upper molar has three triangles and only exceptionally forms an addi-

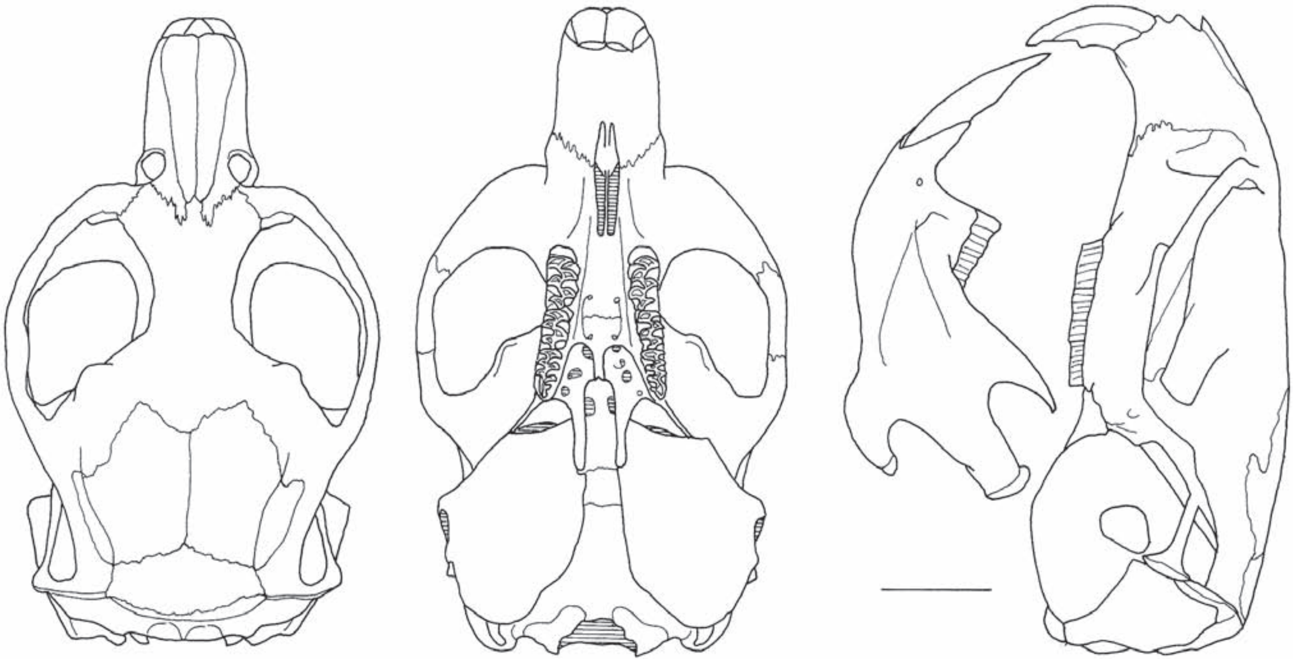


Figure 218. Skull and mandible of *Microtus anatolicus*, based on an adult female from Yapalı köyü, Cihanbeyli, Konya. Scale bar = 5 mm.

tional postero-lingual triangle T5 which, however, is never entirely closed. The 3rd upper molar has three re-entrant angles on either side; additional posterior re-entrant angles, when developed at all, are shallow. The 1st lower molar has four outer and five inner re-entrant angles.

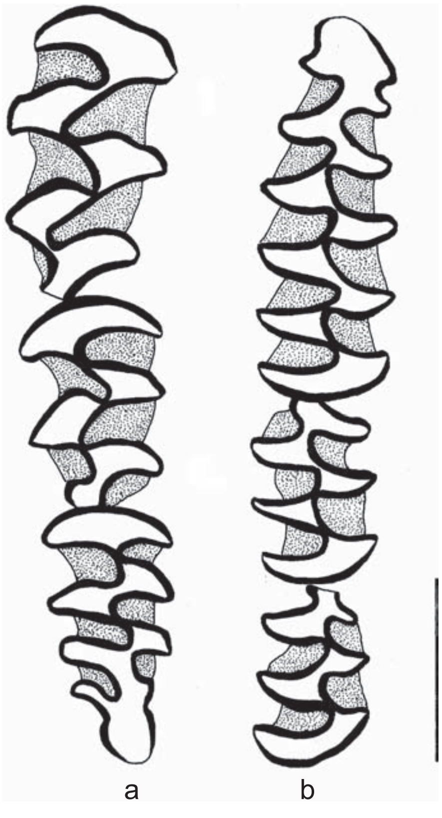


Figure 219. Upper (**a**) and lower molars (**b**) of *Microtus anatolicus* (same specimen as in Fig. 218). Lingual side is to the left, anterior is at the top. Scale bar = 2 mm.

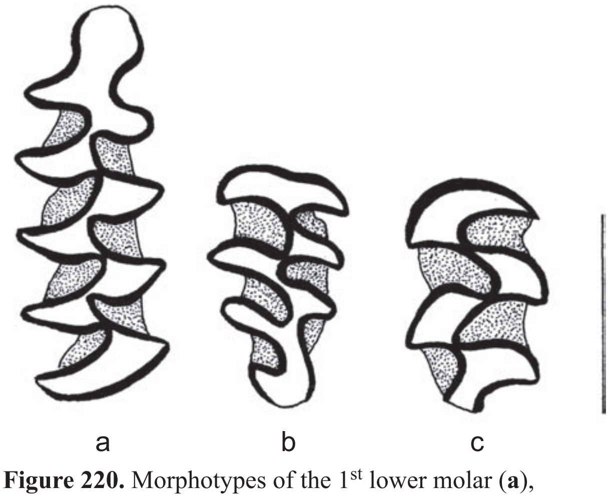


Figure 220. Morphotypes of the 1st lower molar (**a**), 3rd upper molar (**b**) and 2nd upper molar (**c**) in *Microtus anatolicus*. Based on specimens from Yapalı köyü, Cihanbeyli, Konya. Lingual side is to the left, anterior is at the top. Scale bar = 2 mm.

DIMENSIONS are given in Table 53.

	N	mean	min–max
Head and body	20	113.4	105–125
Tail	20	27.2	21–34
Hind foot	20	19.5	16.6–23.0
Ear	20	10.1	9.0–11.0
Weight	20	34.2	23.5–53
Condylobasal length	9	27.51	26.0–29.2
Zygomatic breadth	9	15.92	14.5–17.7
Maxillary tooth-row	9	6.34	5.95–6.95
Braincase breadth	9	14.32	13.5–15.2
Height of rostrum	9	7.81	7.1–8.2
Length of bullae	9	9.86	9.2–10.5

Table 53. External and cranial dimensions of *Microtus anatolicus* from its type locality. Based on Kryštufek & Kefelioğlu (2001b), specimens in OMUS and own material.

CHROMOSOMES. The diploid number of chromosomes is 2N = 60 and the fundamental number of autosomal arms is NFa = 60. Except for one small biarmed pair, all the remaining autosomes are acrocentric. The X chromosome is a large acrocentric and the Y chromosome is submetacentric.

DISTRIBUTION

The Anatolian vole is only known from its type locality, which lies in Aksaray Ovası, one of the driest parts of Turkey (Fig. 221). In June 2005 we failed to find any voles in another region of this saline depression to the south of the Lake Tuz, i.e. around Eskil.

HABITAT AND BIOLOGY

Around Yapalı köyü, the Anatolian vole forms small colonies (<20 m in diameter) on dry alkaline soil sparsely covered with halophytes and *Juncus* sp. (Fig. 222a). We also collected specimens in mesic depressions which were densely overgrown with *Juncus* sp. The same habitat was also populated by *Nannospalax nehringi* and *Meriones tristrami*; among dense vegetation lived *Crocidura suaveolens*.

Colonies are easy to spot due to large entrances (diameter 4–7 cm) interconnected by runways (Fig. 222b). Approximate density of holes was 2.5 per 10 m^2. Animals are active all the day long

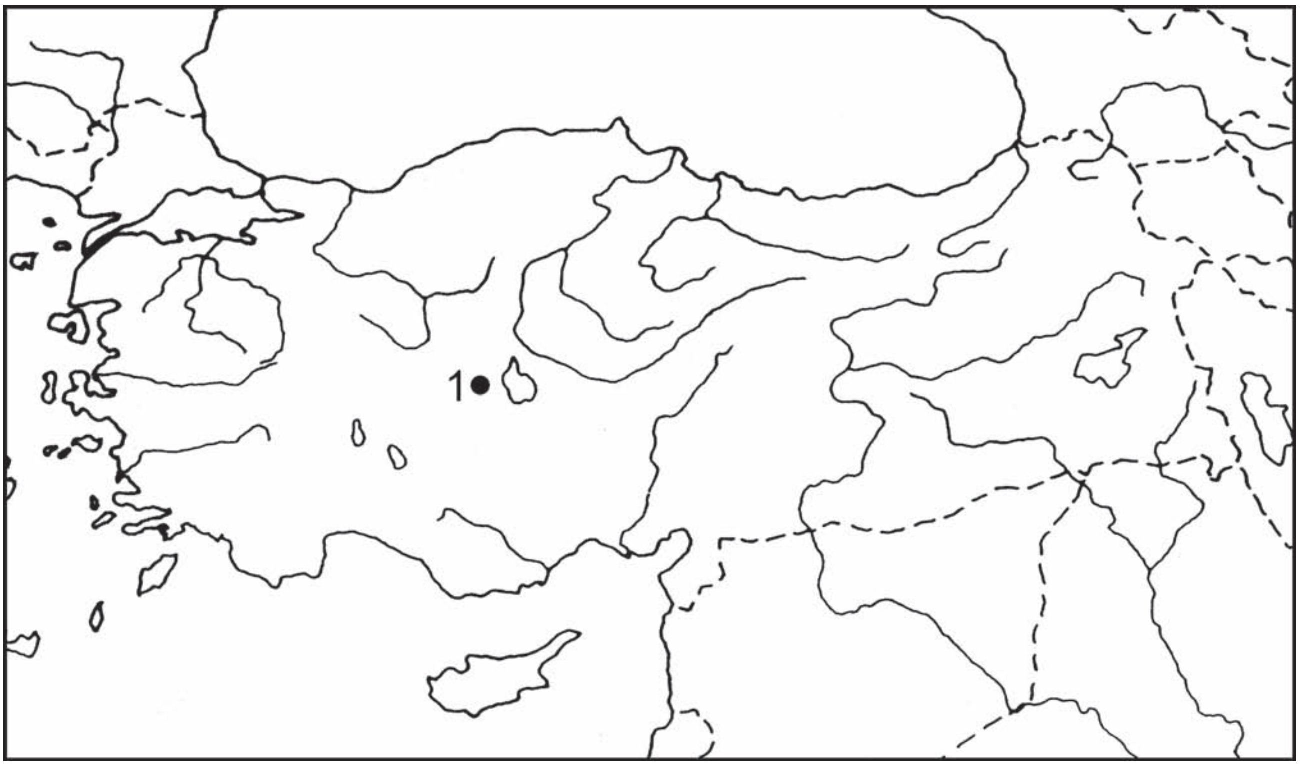


Figure 221. Record of *Microtus anatolicus*: **1** – Yapalı köyü, Cihanbeyli, Konya. Corresponding reference: Kryštufek & Kefelioğlu (2001b).

Two generations could be recognised in our material from mid October: juveniles (body weight 16–21.5 g) and sexually active adults (weight >25 g). One female was pregnant (5 embryos) and further three had placental scars (2, 4 and 4, respectively).

Figure 222. Habitat of *Microtus anatolicus* (**a**) and entrace to its burrow (**b**). Yapalı köyü, Cihanbeyli, Konya. Photo: A. Kryštufek.

Genus: *Chionomys* Miller, 1908

The collective name *Chionomys* was created by Miller (1908a) as a subgenus of *Microtus* (and not as a genus, as claimed by Musser & Carleton, 1993) for several snow vole taxa, all of which are now junior synonyms of *C. nivalis*. Numerous subsequent authors continue to consider *Chionomys* as a subgenus (Miller, 1912; Neuhäuser, 1936a,b; Ognev, 1950, 1964; Vereščagin, 1959; Spitzenberger & Steiner, 1962; Bobrinskij *et al*., 1965; Spitzenberger, 1971; Felten *et al*., 1973; Steiner, 1972; Niethammer & Krapp, 1982; Demirsoy, 1996; Yardımcı & Kıvanç, 1998). Some others, however, prefer to treat it as an independent genus (Aharoni, 1932; Kumerloeve, 1975; Gromov & Poljakov, 1977; Aksenova, 1980; Gromov & Baranova, 1981; Vinogradov & Gromov, 1984; Zima & Král, 1984; Pavlinov & Rossolimo, 1987, 1998; Nadachowski *et al*., 1990; Zagorodnyuk, 1990; Hír, 1991; Musser & Carleton, 1993; Kandaurov *et al*., 1994; Gromov & Erbajeva, 1995; Bukhnikashvili & Kandaurov, 1998; Kryštufek, 1999; Mitchell-Jones *et al*., 1999; Nowak, 1999; Kryštufek & Vohralík, 2001; Jaarola *et al*., 2004). Again, many authors ascribe snow voles to the genus *Microtus* with no subsequent ranking (Ellerman, 1948; Osborn, 1962; Lewis *et al*., 1967; Felten *et al*., 1971a; Storch, 1975, 1988; Atallah, 1977, 1978; Šidlovskij, 1976; Corbet, 1978; Doğramacı, 1989; Kryštufek, 1990; Harrison & Bates, 1991; Obuch, 1994; Kefelioğlu, 1995; Kurtonur *et al*., 1996; Quimsiyeh, 1996; Yiğit *et al*., 2003a). Ellerman & Morrison-Scott (1951) included the three currently recognised species in the subgenus *Microtus*.

The distinction of *Chionomys* from *Microtus* s. str. is supported by various data sets: cranial (Pietsch, 1980), dental (Nadachowski, 1991), chromosomal (Agadžanjan & Jacenko, 1984), and genetic (Graf, 1982; Jaarola *et al*., 2004).

Miller (1908a) defined *Chionomys* by a simple structure of the 3rd upper molar (two re-entrant angles on either side), by a broad, rather flat and smooth brain-case, a broad interorbital region and by elements of the posterior termination of palate, which are less defined than in true *Microtus*. It is worth noting that Miller (1908a) did not consider *C. roberti* to be a member of *Chionomys*, although this vole was described two years earlier by Thomas (1906a). Most likely, Miller was mislead by the complex structure of the 3rd upper molar in *C. roberti* and possibly also by the external appearance in which Robert's vole resembles the water vole. Similarly, Neuhäuser (1936b) included *nivalis* and *gud* in *Chionomys*, but considered *roberti* to be a part of *Microtus* s. str. The complex condition of the 3rd upper molar, which is the norm in *C. gud* and *C. roberti* and which also occurs at various frequencies in *C. nivalis* (Kryštufek, 1990; Nadachowski, 1990a, 1991), violated Miller's diagnosis to such an extent that it caused some confusion among palaeontologists as well (e.g. Tchernov, 1968).

RELATIONS. Externally, *C. gud* most closely resembles *C. nivalis*, but shares with *C. roberti* a complex 3rd upper molar. Although the diploid number of chromosomes is stable across the genus (2N = 54), *C. roberti* and *C. gud* have a higher fundamental number of autosomal arms (NFa = 54) than *C. nivalis* (NFa = 52; for details see under the respective species). Pavlinov & Rossolimo (1987, 1998) thus recognise two groups within the genus, the *nivalis* group (with *C. nivalis*) and the *roberti* group with the remaining two species. Nadachowski (1990b) suggests, on the basis of the 3rd upper molar morphology, that *C. nivalis* possibly evolved from the European fossil species *C. burgundiae*, while *C. gud* and *C. roberti* share their ancestor in the Asiatic fossil vole *C. jordanica.* As one can deduce from the available fossil record, *Chionomys* separated from *Microtus* approximately one million years ago; however, molecular evidence suggests this event to have taken place more than 2.4 million years ago (Chaline & Graf, 1988).

PALAEONTOLOGY. Snow voles of the *roberti* group evidently evolved in the region of the Caucasus. Vereščagin (1959) reports the oldest evidence of *C. gud* in the Caucasus from the Lower Pleistocene and of *C. roberti* since the Middle Pleistocene onwards. According to Gromov & Poljakov (1977) and Nadachowski & Baryshnikov (1991), the material, ascribable to *C. gud-roberti*, is known in the northern Caucasus and in Transcaucasia since the Middle Pleistocene. Contrary to this, *C. nivalis* is not known from the Caucasus earlier than the Early/Middle Weischselian, which corresponds to the last glaciation (Nadachowski & Baryshnikov, 1991). Thus, while *C. gud* and *C. roberti* were evidently unable to spread outside the broader Caucasian region to which they are still endemic, *C. nivalis* is quite a newcomer there. The evolutionary divergence between *C. nivalis* and the ancestor of *C. gud-roberti* possibly occurred during the Early Pleistocene, while the two Caucasian endemics presumably separated sometimes during the Middle Pleistocene (*cf.* Nadachowski, 1991). The first divergence was possibly due to a vicariation which could have been caused by frequent disruptions at the Bosporus landbridge due to the sea level oscillations during the Pleis-

Figure 223. Snow vole *Chionomys*. Drawing: J. Hošek.

tocene. *Chionomys nivalis* possibly evolved in Europe (where it is already known from the Holsteinian; Kowalski, 2001) and later invaded Anatolia via Bosporus (Kryštufek, 1999). Such a hypothesis, however, does not fit the Middle Pleistocene record of *C. nivalis* in Emirkaya-2 (Montuire *et al*., 1994) and on the island of Chios (which at that time was a part of Anatolian mainland; Storch, 1975).

SCOPE. Three species are now recognised within *Chionomys*, all of which also occur in Turkey. Such taxonomic arrangement remained surprisingly stable over the last century. The only apparent exception was Bobrinskij *et al*. (1965) who synonymised *C. gud* with *C. nivalis*, a step which received no support, however.

Neuhäuser (1936b) was already familiar with all three species in Turkish fauna, and such perception was followed by subsequent students of mammals in the region (Ellerman, 1948; Osborn, 1962; Steiner, 1972; Kumerloeve, 1975; Doğramacı, 1989; Nadachowski, 1991; Demirsoy, 1996; Kurtonur *et al*., 1994; Yardımcı & Kıvanç, 1998; Kryštufek, 1999; Kryštufek & Vohralík, 2001). The scope of *C. gud* caused some confusion in Turkey (Spitzenberger, 1971; Storch, 1988), but this was solved by Nadachowski (1990a). In this volume we follow the revisions by Nadachowski (1990a) and Kryštufek (1999). Steiner (1972) provides a detailed comparison of the three species in the eastern Pontic Mts. Additionally, Nadachowski (1991) described the molar pattern of all three Turkish species and Kefelioğlu (1995) reported karyotypes for two of them (*C. nivalis* and *C. roberti*).

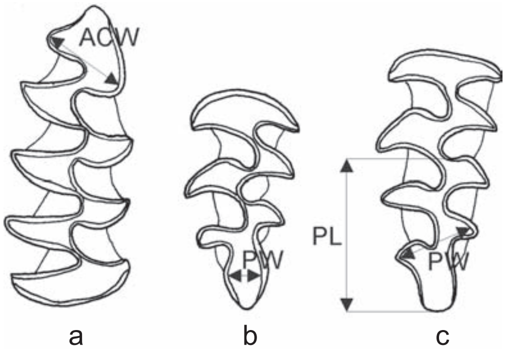


Figure 224. Dimensions measured on the 1st lower (**a**) and 3rd upper molar (**b, c**) of *Chionomys*. **ACW** – width of anteroconid complex; **PL** – length of posteroconid complex; **PW** – width of posteroconid complex.

KEY TO SPECIES

1 Back dark brown; tail mainly >65% of head and body length — *C. roberti*

1* Back greyish or yellowish; tail mainly <65% of head and body length — 2

2 Tail mainly >55% of head and body length; skull shallower; breadth of posteroconid complex of 3rd upper molar at least 0.60 mm; lateral processes of distal baculum large and well ossified (Fig. 237) — *C. gud*

2* Tail <55% of head and body length; skull deeper; breadth of posteroconid complex of 3rd upper molar at most 0.60 mm; lateral processes of distal baculum inconspicuous and frequently cartilaginous (Fig. 225) — *C. nivalis*

EUROPEAN SNOW VOLE – *CHIONOMYS NIVALIS*

Arvicola nivalis Martins, 1842. Type loc.: Faulhorn, Bernese-Oberland, Switzerland.

Microtus pontius Miller, 1908. Type loc.: 25 miles north of Bayburt, Turkey.

Microtus (Chionomys) nivalis olympius Neuhäuser, 1936a. Type loc.: Mt. Uludağ, Bursa, Turkey.

Microtus (Chionomys) nivalis cedrorum Spitzenberger, 1973. Type loc.: Kohu Dağ, Antalya, Turkey.

Chionomys nivalis spitzenbergerae Nadachowski, 1990. Type loc.: south of Maden Köy, Middle Taurus Mts., Turkey.

TAXONOMY

Spitzenberger (1971) reports *Chionomys gud* and *C. nivalis* to be sympatric in the eastern Taurus Mts. (districts of Niğde and Mersin). She based her taxonomy on the morphology of the 1st lower and the 3rd upper molar and on the tail length (longer in *C. gud*). As subsequently shown by Nadachowski (1990a), snow voles in Spitzenberger's material with a complex condition of the 3rd upper molar belong to *C. nivalis*, which is thus the only *Chionomys* species in the Taurus Mts. Similarly, Storch (1988) identified as *C. gud* the Upper Pleistocene material from Karain B in Antalya, which was also shown subsequently to represent *C. nivalis* (Nadachowski, 1990a).

Satunin (1907) reports the European snow vole from Oltu (near Erzurum) under the name *Microtus leucurus* (Gerbe, 1852) (Kumerloeve, 1975).

Aharoni (1932) and Neuhäuser (1936b) list *Hypudaeus syriacus* Brants, 1827 (type locality: Syria) as a junior synonym of *C. nivalis*. Brandts' name predates *Arvicola nivalis* by Martins (1842), however, as shown by Atallah (1977), the type (left upper molar) evidently belongs to an unidentifiable social vole; Tchernov (1968) still synonymised *nivalis* and *syriacus*.

DESCRIPTION

EXTERNAL CHARACTERS. Medium-sized and fairly long-tailed vole. Tail approximately half of head and body length (range in Turkey is 42–62.5%) but this varies among populations. Muzzle more pointed than in *Microtus* voles, and ears longer, mainly concealed in long fur. Mystacial vibrissae also longer, attaining the length of up to 40 mm; they are either black or white. Hind foot is broad and its sole is hairy, with six pads; the posterior pad is much larger than in *Microtus*. Hairs are long (up to 13 mm), soft and dense. Dense and long fur gives the animal a chunky appearance. Ears, feet and tail covered with short whitish hairs and the tail terminates in a pencil (up to 5 mm long); bristles on hind foot exceed claws in length.

COLOUR. Colour varies among populations, with back being either pale straw grey (drab) to smoke grey. Belly dull white, irregularly clouded by slaty under-colour. There is no demarcation line along flanks.

NIPPLES. There are eight nipples, two pairs of pectoral and inguinal ones.

BACULUM. Aksenova (1980) described the baculum in European snow voles from the vicinity of Lake Sevan, Trans-Caucasia. What is worth noting are the short distal processes, particularly the lateral two which remain mainly cartilaginous, while the medial one is well ossified (Anderson, 1960). In six Sevan specimens, the length of the stalk was 3.00–3.55 mm (mean = 3.30 mm), of the medial distal process 1.00–1.25 mm (mean = 1.10 mm), and of the lateral process 0.20–0.35 mm (mean = 0.30); the greatest breadth of the stalk was 1.70–2.20 mm (mean = 2.00 mm; Aksenova, 1980). The basal part of baculum in *C. n. pontius*, as figured by Kefelioğlu (1995), does not deviate in shape from the one described by Aksenova (1980). We examined a single adult specimen from the vicinity of Elazığ (Fig. 225b). Dimensions of the stalk (length x basal breadth) were 2.93 x 1.58 mm and the medial distal process was 1.13 mm long.

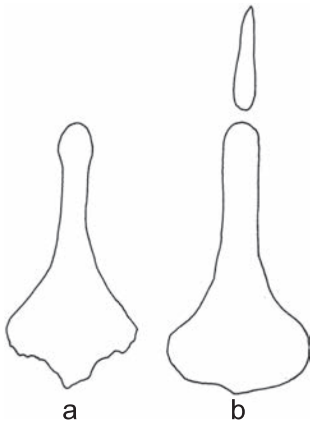


Figure 225. Dorsal view of the baculum of *Chionomys nivalis* from (**a**) the type locality of ssp. *pontius* (redrawn from Kefelioğlu, 1995) and from (**b**) Harput, Elazığ. Distal is to the top. Not to scale.

SKULL is essentially as in *Microtus* but the zygomatic arches are less expanded (53.7–58.6% of condylobasal length) and the brain-case is shallow (average rostral height is 27.0% of the condylobasal length; range = 25.6–28.8%; N = 23). Bullae are relatively large, longer than in any other *Chionomys* species, but there are great interpopulation differences (average length of bullae is 31.0% of the condylobasal length; range = 27.6–36.6; N = 24). Interorbital region is broad and flat. There are no clear supraorbital ridges and no sagittal crest. Dorsal profile is nearly straight or slightly convex. Rostrum and incisive foramina are moderately long. Nasals tend to be bottle-shaped. Brain-case is relatively longer than in *Microtus* species. Pterygoid processes are mainly parallel and the interpterygoid space is relatively broad. *Squama carina media* is hardly pronounced and the lateral pits on the posterior hard palate are shallow. Rostrum is long and slender and the maxillary toothrow is shorter than diastema. Mandible is slender. Of the three processes, the articular one is moderately heavy and the remaining two are weak.

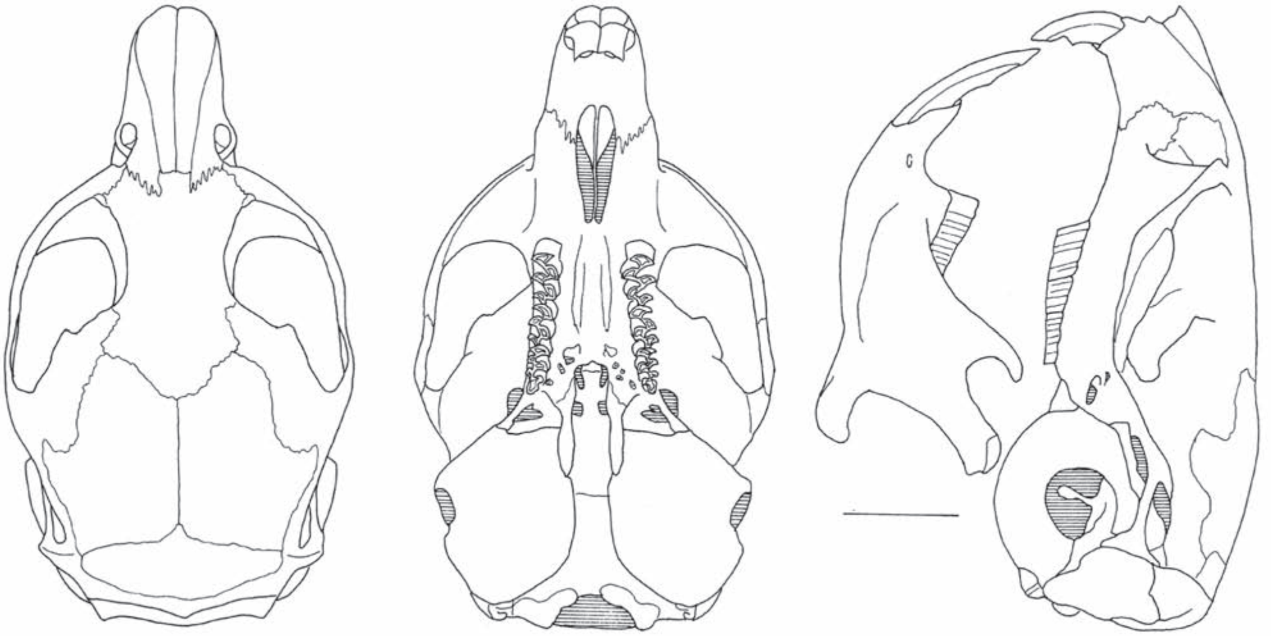


Figure 226. Skull and mandible of *Chionomys nivalis olympius*, based on an adult female from Mt. Uludağ. Scale bar = 5 mm.

TEETH. Upper incisors are essentially as in *Microtus* voles but slightly weaker. Enamel on front surface yellow to orange yellow on upper incisors and yellow on lower ones. First upper molar consists of an anterior lobe and four alternating triangles; 2nd upper molar has three triangles posterior to anterior lobe. Dental fields of loop and individual triangles closed. In this respect the European snow vole most

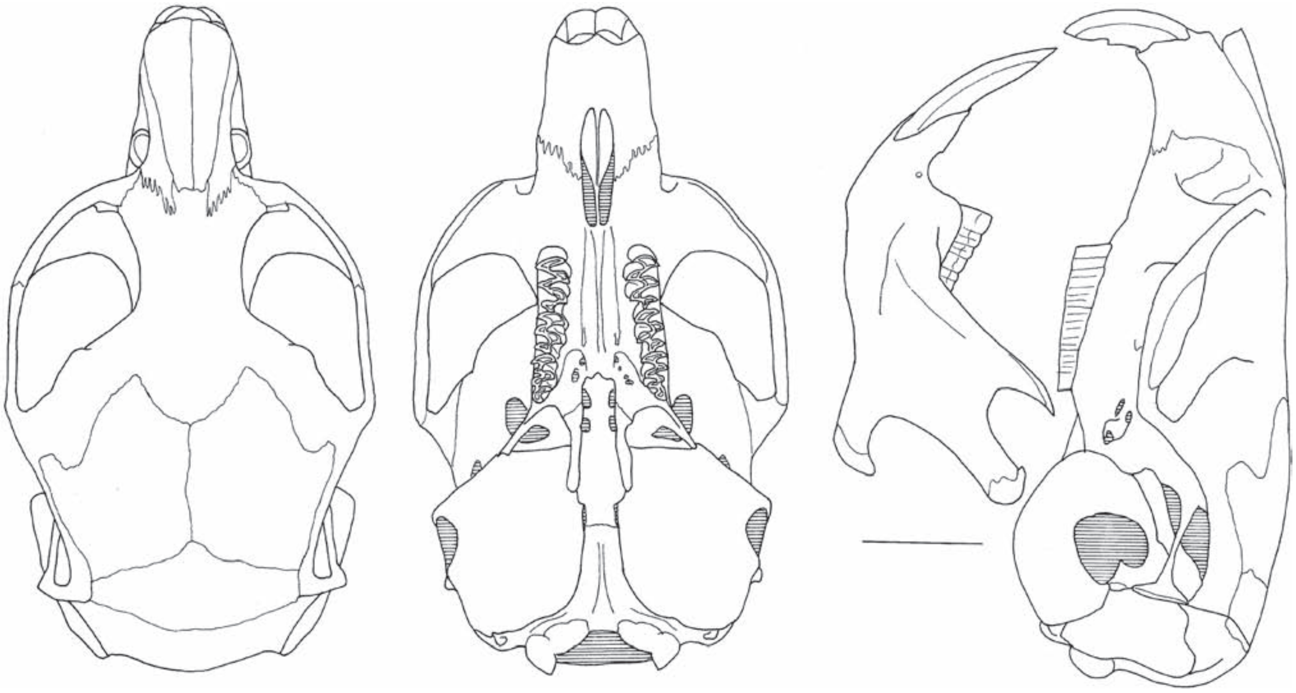


Figure 227. Skull and mandible of *Chionomys nivalis pontius*, based on an adult male from the vicinity of Güzyurdu. Scale bar = 5 mm.

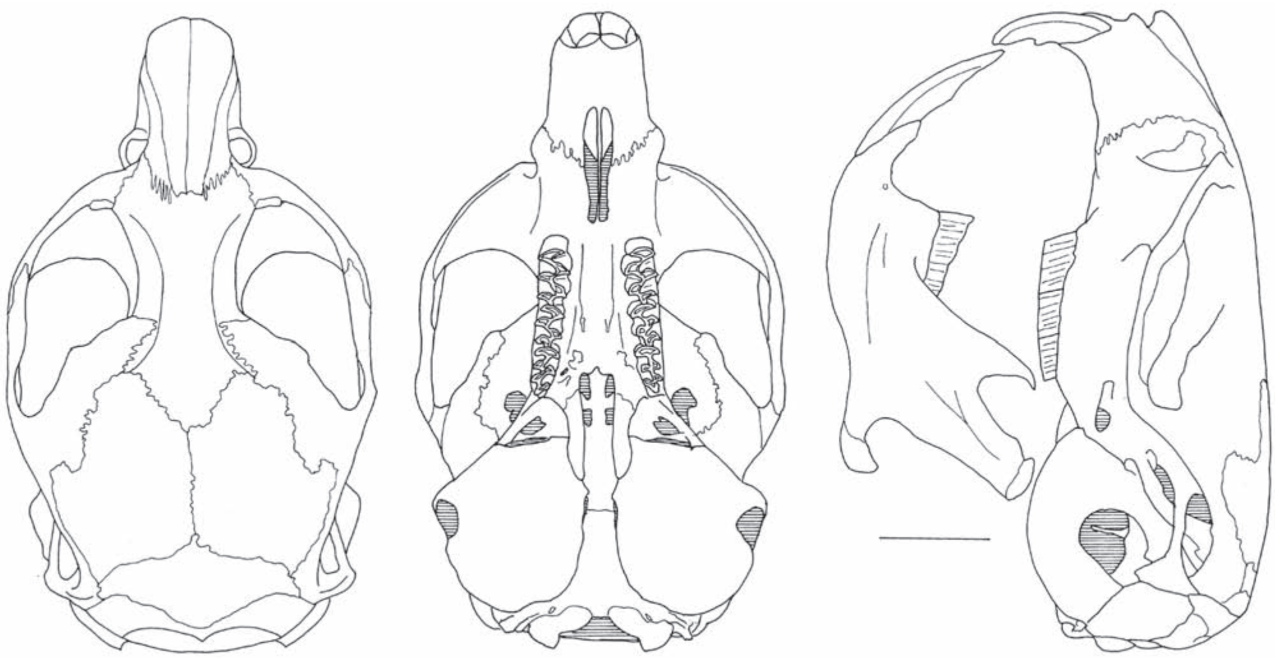


Figure 228. Skull and mandible of *Chionomys nivalis*, based on an adult female from Mt. Ercyes near Kayseri. Scale bar = 5 mm.

closely resembles other *Microtus* species. Exceptionally, the 2nd upper molar shows variation in its posterior region which tends towards an expansion of the basal enamel, the additional triangle (T5), never develops, however (Fig. 230b, c). Such complexities are even rarer on the 1st upper molar. The 3rd upper molar consists of the anterior lobe and four alternating triangles; triangle T5 is always broadly confluent

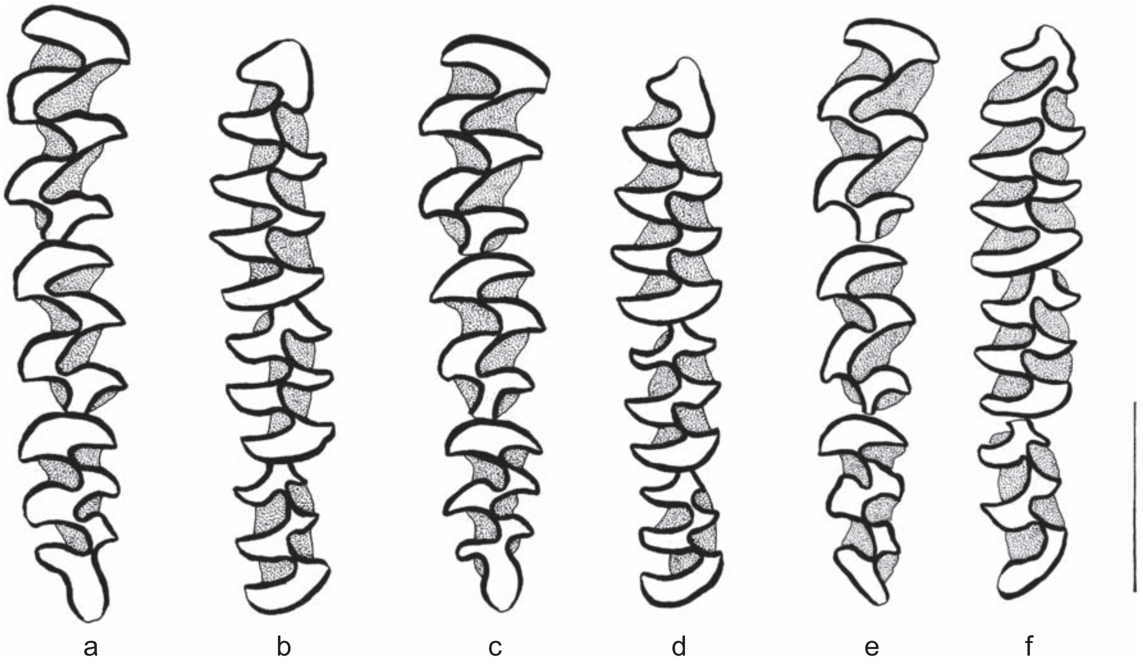


Figure 229. Upper (**a, c, e**) and lower molars (**b, d, f**) of the European snow voles from Mt. Uludağ (**a, b**), vicinity of Güzyurdu (**c, d**), and Mt. Ercyes (**e, f**). Lingual side is to the left, anterior is at the top. Scale bar = 2 mm.

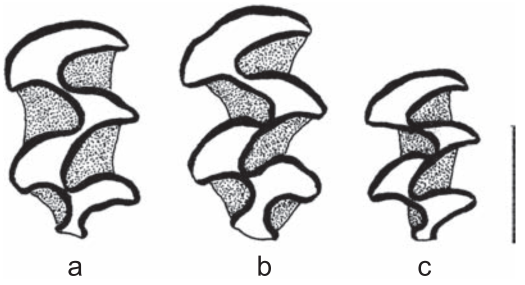


Figure 230. Variability of the 2nd upper molar of *Chionomys nivalis*. Based on specimens from: **a** – 25 miles north of Bayburt (type of *pontius*; BMNH); **b** – vicinity of Güzyurdu; **c** – Harput, Elazığ. Lingual side is to the left, anterior is at the top. Scale bar = 1 mm.

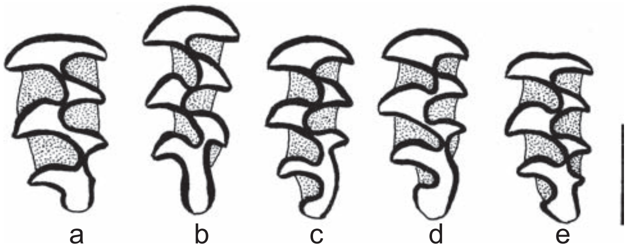


Figure 231. Variability of the 3rd upper molar in *Chionomys nivalis*. Based on specimens from: **a** – Ercyes Dağı; **b** – vicinity of Çamlica, Kars; **c, d** – Madenköy (NMW); **e** – 19 km north of Arslanköy, Mersin (NMW). Lingual side is to the left, anterior is at the top. Scale bar = 1 mm.

with the posterior cup. Dental field of T4 is either closed (prevailing condition) or communicates with the posterior cup (Fig. 231c). The posterior cup is either short or elongate. Additional postero-lingual salient angle (T7; Fig. 231c–e) is common in voles from the eastern Taurus, but extralabial salient angles (T6 and T8; Fig. 231e) are very rarely seen. The posteroconid complex of the 3rd upper molar is shorter than in any other snow vole from Turkey. Its relative length against the length of the molar (see Fig. 224 for definition of parameters) ranges between 47.5 and 55.5%; the corresponding values in the remaining two *Chionomys* species in Turkey are: 51.0–61.0% in *C. gud* (Kryštufek, 1999) and 55.7–65.0% in *C. roberti*. Dental fields T4 and T5 of the 1st lower molar alternate and thus resemble most closely the condition seen in social voles and the *arvalis* group of *Microtus*. In its typical form (nivalid morphotype), triangles T6 and T7 are absent and the anterior cup is arrowhead or oval in shape (Fig. 232a, b). In the advanced nivalid morphotype, the 5th lingual re-entrant angle is deep, and triangles T6 and T7 are present (Fig. 232c). Dental fields of the anterior cup and, when present, of T6 and T7, are separated from T5 in the above morphotypes. Contrary to this, the dental field of T5 is confluent with the anterior loop in the next two morphotopyes. The 4th buccal re-entrant angle (BRA4) is absent in a more primitive nivalid-ratticeps morphotype (Fig. 232d) but is present in the gud morphotype (Fig. 232e, f). Occasionally, one can come across a more advanced anterior portion of the 1st lower molar (Fig. 232g). The nivalid and the advanced nivalid forms are the predominant morphotypes in northern and in central Anatolia, but the nivalid-ratticeps morphotype predominates in the Taurus Mts. The 2nd and 3rd lower molars are of the same shape as in the genus *Microtus*. Triangle tandems T1-T2 and T3-T4 on the 2nd molar either alternate or are confluent. Lingual re-entrant angles are deeper than the labial ones, which

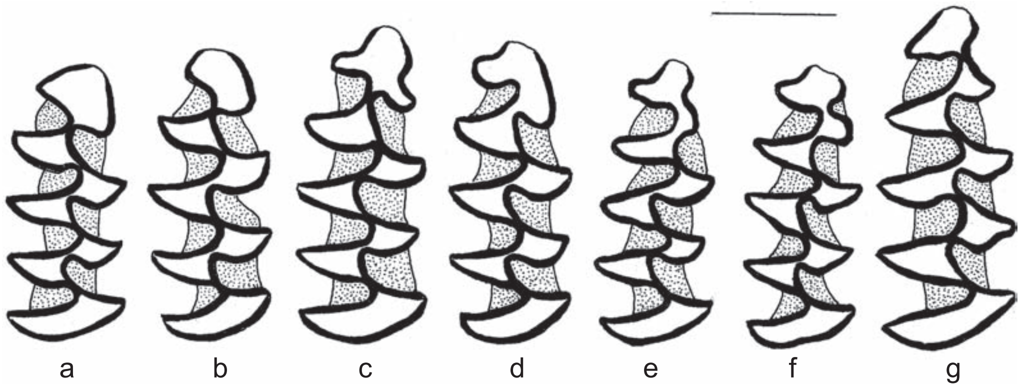


Figure 232. Variability of the 1st lower molar in *Chionomys nivalis*. Based on specimens from: **a** – Bağdaşan, Kars; **b, d–f** – vicinity of Güzyurdu; **c** – vicinity of Çamlica, Kars; **g** – Ercyes Dağı, Kayseri. Morphotypes: **a, b** – nivalid; c – advanced nivalid; **d** – nivalid-ratticeps; **e, f** – gud. Lingual side is to the left, anterior is at the top. Scale bar = 1 mm.

	olympius	*pontius*	*cedrorum*	*spitzenbergerae*	C-Anatolia
Head and body	117.9 (7)	116.7 (14)	118.8 (18)	115.9 (9)	122.4 (5)
	107–129	108–124	107–127	108–124	108–135
Tail	53.9 (7)	56.4 (13)	53.1 (18)	64.5 (8)	59.2 (5)
	46–61	47–67	40–60	54–75	55–71
Hind foot	19.3 (7)	18.9 (14)	19.0 (18)	18.5 (9)	21.2 (5)
	18.0–21.2	18.2–19.8	17.4–20.1	16.8–20.4	20.0–22.3
Ear	13.3 (7)	15.4 (14)	14.0 (12)	15.5 (4)	16.0 (5)
	11.0–17.0	14.0–17.5	11.0–16.0	14.0–17.0	15.0–18.0
Weight	36.6 (6)	39.4 (13)	36.7 (12)	41.8 (5)	46.0 (4)
	33–41.5	32–48	29.5–54	34.6–48.3	35–52
Condylobasal length	26.9 (8)	27.6 (13)	26.9 (12)	28.5 (7)	29.2 (4)
	25.1–29.0	26.1–28.9	25.6–28.9	27.0–30.1	27.9–30.5
Zygomatic breadth	15.0 (7)	15.7 (14)	15.5 (13)	16.2 (7)	16.3 (3)
	14.7–15.5	14.7–16.9	14.7–16.6	15.2–17.3	15.6–16.8
Maxillary tooth-row	6.6 (8)	6.7 (14)	6.6 (14)	6.7 (8)	7.2 (5)
	6.1–7.0	6.4–7.1	6.0–7.2	6.3–7.3	6.8–7.9

Table 54. External and cranial dimensions in five geographic races of *Chionomys nivalis* from Turkey. Given are the mean (upper row), sample size (in parentheses), and range (lower row). Based on Neuhäuser (1936b), Spitzenberger (1971), Felten *et al.* (1973), Nadachowski *et al.* (1990), Kefelioğlu (1995), specimens in BMNH, HSC, NMNH, NMW, and SMF, and our own material.

is particularly evident on the lower molar row and on the 3rd upper molar.

DIMENSIONS are given according to geographic races (Table 54). There is no apparent secondary sexual dimorphism.

CHROMOSOMES. The diploid number of chromosomes is 2N = 54 and the fundamental number of autosomal arms is NFa = 52. All the autosomes are acrocentrics of decreasing size. The X chromosome is large submetacentric and the Y chromosome is the smallest acrocentric (Zima & Král, 1984; Zagorodnyuk, 1990). Kefelioğlu (1995) found the same standard karyotype in the topotype material of sspp. *pontius*, *olympius*, and *cedrorum*. The karyotype is surprisingly stable across the species' range. From the western Caucasus, Kur'atnikov & Čopikašvili (1978) report two distinct karyotypes, differing in the centromeric position of the smallest pair of autosomes (acrocentric or metacentric). However, their material may have included *C. gud*.

VARIATION

The only comprehensive study of the geographic variation in the European snow vole throughout its entire range is by Nadachowski (1991) and is based on enamel tooth pattern. In her attempt to distinguish among races on the basis of the mean relative tail length, Spitzenberger (1971) concluded that Anatolian samples vary in this character and show both extremes as were seen from the entire species' range. Kratochvíl's revision (Kratochvíl, 1981) was based on means of several variables in addition to the relative tail length: condylobasal length and absolute as well as relative zygomatic breadth. On the basis of the relative tail length, he divided the Anatolian subspecies into two groups: the short-tailed ones (ssp. *cedrorum*), and those with tails of medium length (sspp. *ponticus* and *olympius*). Neither the relative tail length, nor the additional characters as used by Kratochvíl (1981), did suggest some geographic structuring across the entire species' range.

The results obtained by Nadachowski (1991) are more conclusive. On the basis of the 1st lower molar morphology, he shows that three Anatolian subspecies (*olympius, cedrorum, spitzenbergerae*) cluster together and are thus probably a monophyletic group. Furthermore, their position within *C. nivalis* is a basal one, which may suggest that they are a sister group to the cluster of all the remaining subspecies, with the exception of *C. n. mirhanreini* from the Tatra Mts. The Anatolian voles are characterised by a primitive condition of the 1st lower molar with high incidence of confluent dental fields of T5 and the anterior cup (i.e. the nivalid-ratticeps and the gud morphotypes in the above terminology). Among Turkish populations, Nadachowski (1991) furthermore distinguished two groups, *viz.* "*cedrorum*" (including sspp. *cedrorum* and *olympius*) and "*spitzenbergerae*" (including ssp. *spitzenbergerae*); the latter was characterised by a complex posterior part of the 3rd upper molar.

Allozyme variation revealed a very peculiar position of snow voles from Israel (*C. n. hermonensis*), which are so distinct from European samples to possibly deserve a specific rank (Filippucci *et al.*, 1991). Genetic makeup of any other sample from the Near and Middle East is known so far.

Multivariate comparison of cranial variables among four Anatolian samples revealed differences, but the results are highly tentative because of small sample sizes (Kryštufek, 1999). As will be shown subsequently, the European snow vole is tied to islands of bare rocks with fissures and crevices, and consequently its range is disjunct. Local populations are thus isolated, both in Anatolia and across the remaining range of the species, and frequently show quite a unique morphology. As a consequence, the fairly large number of subspecies is not surprising. The subspecies occurring in Anatolia can be tentatively keyed as follows:

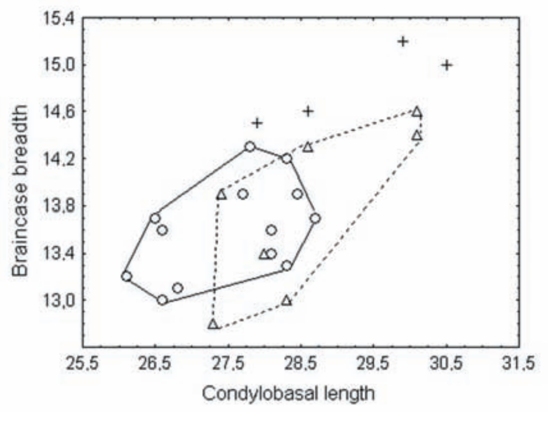


Figure 233. Bivariate plot of braincase breadth against condylobasal length in *Chionomys nivalis* from Anatolia to show interpopulation divergence. Polygons enclose extremes for the group. Dots (solid line): Pontic Mts. (sspp. *olympius* and *pontius*); triangles (dot line): Taurus (sspp. *cedrorum* and *spitzenbergerae*); crosses: Ercyes Dağı and Harput, Elazığ. Based on Nadachowski *et al.* (1990), own material and specimens in BMNH, HSC, NMNH, NMW and SMF.

KEY TO SUBSPECIES

1 Braincase broad (at least 14.5 mm; Fig. 233) Central Anatolian population
1* Braincase narrow (at most 14.6 mm) 2
2 Pelage on back smoke grey; nivalid morphotype of 1st lower molar present in *c.* 50% of specimens *C. n. pontius* *C. n. olympius*
2* Pelage on back pale straw grey; nivalid morphotype of 1st lower molar present in <20% of specimens 3
3 Third upper molar complex, frequently (in *c.* 80% of specimens) with 4th lingual re-entrant angle and a well pronounced triangle T7 *C. n. spitzenbergerae*
3* Third upper molar simple, rarely (<10% of specimens) with 4th lingual re-entrant angle and a well pronounced triangle T7 *C. n. cedrorum*

Chionomys nivalis pontius **(Miller, 1908)**

DESCRIPTION. Tail approximately half of head and body length; size small (condylobasal length up to 29.0 mm); brain-case narrow (13.0–14.3 mm); bullae short (7.4–9.0 mm); back grey without pronounced yellow or brown tinges. First lower molar mainly of nivalid or advanced nivalid morphotypes; triangle T5 mostly closed and not confluent with the more anterior parts of the tooth; 3rd upper molar mainly of simple structure, i.e. with only two deep re-entrant angles on lingual side.

DISTRIBUTION. The eastern Pontic Mts. as far west as the Trabzon area. If this subspecies includes *C. n. olympius* (see below) then its range encompasses the entire northern Anatolian mountains as far west as Uludağ.

NOTES. The relations between *pontius* on the one hand and the Caucasian subspecies *C. n. trialeticus* (Shidlovskij, 1919) and *C. n. loginovi* (Ognev, 1950) on the other are poorly understood. See Steiner (1972) for comparison of ssp. *pontius* with *C. n. trialeticus*. Data in Nadachowski (1990a) indicate that the 1st lower molar is longer in *pontius* (≥

2.9 mm) than in *loginovi* (≤ 2.85 mm). Besides, the skull of *C. n. loginovi* is shorter (condylobasal length 25.8–26.3 mm; Ognev, 1964). *Chionomys n. trialeticus* shows a fairly sharp transition of colour along flanks but is approximately of the same size as ssp. *pontius* (Ognev, 1964).

Chionomys nivalis olympius (Neuhäuser, 1936)

Description. This subspecies is most similar to *C. n. pontius* in size, colour, body proportions and molar pattern.

Distribution. Besides Mt. Uludağ, it was reported also from Seben Dağ (Felten *et al*., 1973).

Notes. Neuhäuser (1936a) diagnosed *olympius* by its colour. In the opinion of Kratochvíl (1981), the subspecies is only poorly differentiated from *pontius*, and Kefelioğlu (1995) synonymised the two.

Chionomys nivalis cedrorum (Spitzenberger, 1973)

Description. Tail short (approximately 45% of head and body length); size small (condylobasal length up to 29.0 mm); braincase narrow (13.4 and 13.9 mm respectively in two specimens); bullae of moderate length (9.2 mm in a single specimen); fur on back pale straw grey. First lower molar with triangle T5 frequently confluent with the more anterior parts of the tooth; third upper molar mainly simple in structure, i.e. with only two deep re-entrant angles on its lingual side.

Distribution. The western Taurus Mts.: Cığlıkara and possibly also Honaz Dağ. Spitzenberger (in Felten *et al*., 1973) reports *cedrorum* also for the vicinity of Arslanköy, but Nadachowski (1990a) demonstrates differences between the two in the morphology of the anteroconid complex of the 1st lower molar.

Chionomys nivalis spitzenbergerae Nadachowski, 1990

Description. Tail long (*c*. 55% of head and body length); size slightly larger than in the above subspecies (condylobasal length up to *c*. 30 mm); braincase narrow (12.8–14.6 mm); bullae fairly long (8.3–9.9 mm); colour as in ssp. *cedrorum*. First lower molar essentially as in ssp. *cedrorum*, but the anterior cup is wider in *spitzenbergerae* (up to 0.60 mm; mean = 0.42 mm) than in *cedrorum* (up to 0.36 mm; mean = 0.34 mm; Nadachowski, 1990a). Third upper molar is complex, frequently with a deep 4th re-entrant angle on the lingual side.

Distribution. Nadachowski (1990a) reported this subspecies from recent localities on the Bolkar Dağları and ascribed to it also the late Pleistocene material from Karain B, Antalya.

Chionomys nivalis from Central Anatolia

Description. Tail approximately half of head and body length; size large (condylobasal length 27.9–30.5 mm); brain-case broad (14.5–15.2 mm); bullae long (9.1–10.2 mm); colour approximately as in the two subspecies from the Taurus Mts. First lower molar is rarely of the nivalid morphotype. Fourth lingual re-entrant angle (LRA4) is mainly deep and in extreme cases even isolates the triangle T6 (Fig. 232g). Triangles T5 and T6 mostly alternate and are only exceptionally confluent. Third upper molar simple (Ercyes Dağı; Fig. 231a) or with three lingual re-entrant angles (Elazığ).

Distribution. This form is known from Central Anatolia (Ercyes Dağı and Talas) and from the western part of eastern Anatolia (Elazığ). Snow voles from various localities in Iran (Mt. Demavend, Tehran; 11 km east-north-east of Fashan, Tehran; 5 miles north-west of Kuh Range, Isfahan; material in FMNH and NMNH) are of approximately the same colour and size (condylobasal length 27.9–30.4 mm) but have narrower braincase (13.5–14.6 mm) and shorter bullae (8.3–9.6 mm).

Note. This race has not been formally named so far.

Distribution

The European snow vole typically inhabits mountain ranges of southern and central Europe (as far north as the Tatra Mts.), in Asia Minor, the Caucasus, the Kopet Dagh, western Iran, Lebanon, Syria, and Israel. The report from northern Africa (Gromov & Erbajeva, 1995) is evidently erroneous. The bulk of its range is in Europe where low elevation records are also reported from the south facing foothills of mountains (e.g. Malec & Storch, 1964; Jones & Carter, 1980; Kryštufek & Kovačić, 1989).

In Turkey it is the most widespread *Chionomys* species, but localities are mainly isolated and widely scattered. The most extensive contiguous range is in

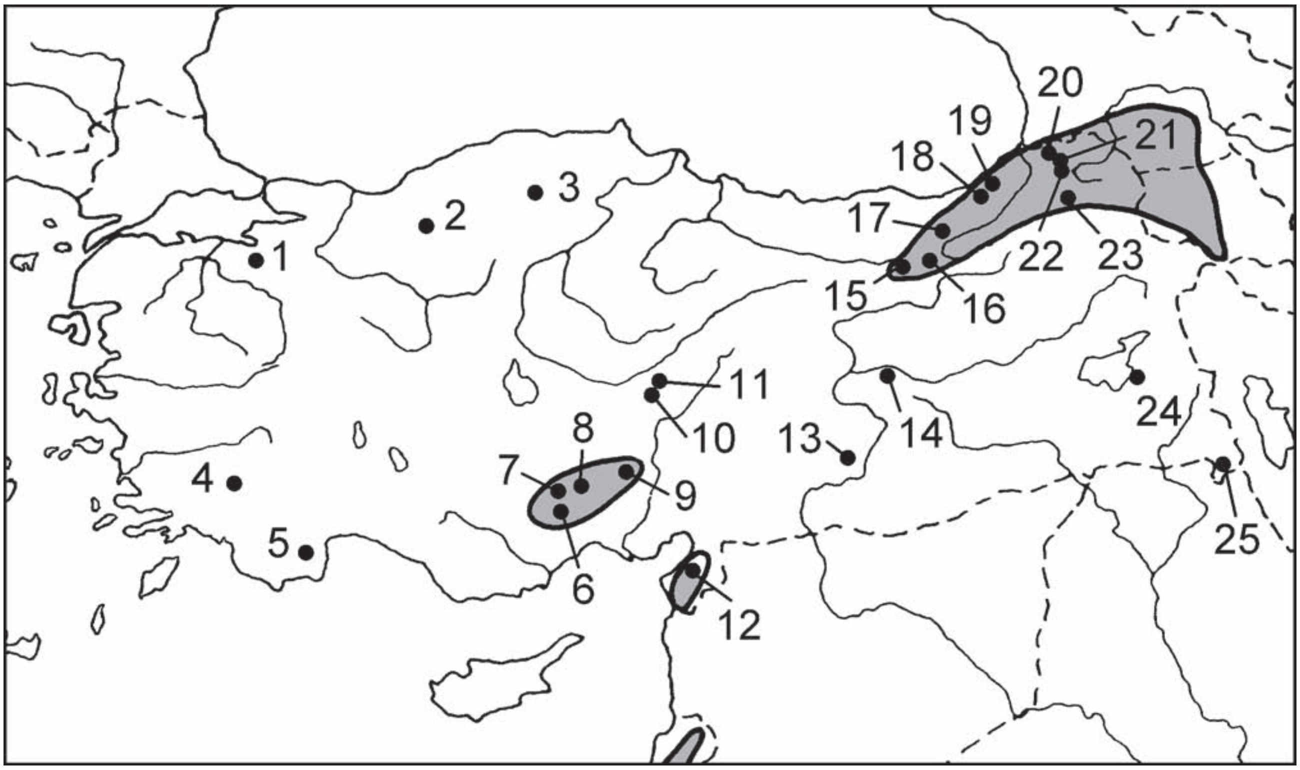


Figure 234. Distribution of *Chionomys nivalis* in Turkey. Records: **1a** – Uludağ, Bursa, 2,000 m; **1b** – Çobantaşı, Uludağ, Bursa; **1c** – Uludağ, Bursa, 1,700 m; **2** – Seben Dağ, Bolu; **3** – Ilgaz Dağ; **4** – Honaz Dağ, Denizli; **5a** – Kohu Dağ, Cığlıkara, Antalya, 1,750 m; **5b** – Kohudağı, Cığlıkara, Elmalı, Antalya, 2,480 m; **5c** – Cığlıkara, 1,250 m; **6** – Arslanköy, Mersin, 2,000 m; **7** – Bolkar Dağ, above Zanapa, Middle Taurus, 2,400 m; **8a** – Maden Köy, Niğde, 1,600 m, 2,000 m; **8b** – Bolkar Dağ, near Darboğaz and Madenköy villages, 3,000 m (subfossil); **9** – 4 km north of Darilik, Ala Dağları, A dana; **10a** –Ercyes Dağı, Kayseri, 1,900 m; **10b** –Ercyes Dağı, Kayseri, 1,800 m; **11** – Talas, Kayseri, 1,100; **12** – Topboğazi Geçidi, Belem, Hatay, 1,000 m; **13** – Karadut, Adiyaman, 1,300 m; **14** – Harput, Elazığ, 1,850 m; **15** – 4 km south-east Güzyurdu, Gümüşhane, 2,300 m; **16** – Demirözü, Bayburt; **17** – c. 25 mi. north of Bayburt, 7,000 ft.; **18** – Ovit Yaylasi, Rize; **19** – Elevit, Rize; **20** – Kutul, Artvin; **21** – Yalnızçam Geçidi, Kars; **22a** – 5 km west of Bağdaşan, Kars, 2,600 m; **22b** – 5 km south of Çamlica, Kars, 2,750 m; **23** – Yayla Tarpank, north of Oltu, Erzurum; **24** – Van; **25** – Cilo Dağ (Cilo-Sat-Massiv), east of Hakkari, Hakkari. Corresponding references: Miller (1908a): 17. Neuhäuser (1936a): 1a. Ognev (1950): 23. Osborn (1962): 1a, 11. Spitzenberger (1971): 1a, 2, 4, 5a, 6, 8a. Steiner (1972): 18-21. Peus (1978): 25. Doğramacı (1989): 24. Nadachowski *et al.* (1990): 7. Nadachowski (1991): 3. Hír (1991): 8b. Kefelioğlu (1995): 1b, 5b, 16. Obuch (1994): 12, 13. Kryštufek (1999): 1c, 10a, 14. Yiğit *et al.* (2003a): 5c. NM: 10b. Own data: 9, 15, 22a, b.

the eastern Pontic Mts. This range continues into Transcaucasia in Georgia and Armenia where the range is restricted by the rivers Kura and Araks (Šidlovskij, 1976; Bukhnikashvili & Kandaurov, 1998). The remaining Turkish records are mainly isolated. The European snow vole was recorded in all the regions of Turkey, except south-eastern Anatolia (Fig. 234). It is also absent from Turkish Thrace, albeit Popov & Miltchev (2001) report it from the Late Pleistocene of Mecha Dupka Cave near Stoilovo, the Bulgarian part of the Istranca Mts. It is worth noting that Santel (1994) did not come across the snow vole in the Middle Pleistocene layers of the Yarimburgaz Cave in Turkish Thrace.

PALAEONTOLOGY. As already mentioned above (see the introductory chapter to the genus *Chionomys*), the oldest fossil record of the European snow vole in Anatolia is from the Middle Pleistocene layers of Emirkaya-2 (Montuire *et al.*, 1994) and from the island of Chios which was at that time a part of Anatolia (Storch, 1975). During the Late Pleistocene the species was continuously present in the layers of Karain B near Antalya (Storch, 1988; Nadachowski, 1991) but disappeared before the onset of the Holocene. Nevertheless, the European snow vole is now present in the western Taurus above Antalya. Hír (1991) reports subfossil *C. nivalis* at Bolkar Dağ (near Darboğaz and Madenköy villages; 3,000 m a.s.l.); the species is still present in that region. The morphology of the 1st lower molar in all southern Anatolian localities, from the Middle Pleistocene Emirkaya-2 to the subfossil findings on Bolkar Dağ, most closely resembles the condition seen in recent *C. n. spitzenbergerae* (cf. Nadachowski, 1991, for the Karain B material).

The morphotype with the dental field of triangle T5 confluent to the anterior lobe induced Montuire *et al*. (1994) to identify such specimens as *M*. cf. *oeconomus*. In our opinion, their Fig. 32 (p. 124 in Montuire *et al*., 1994) shows *C. n. spitzenbergerae*.

HABITAT

The European snow vole is morphologically adapted to a petricolic way of life (Ognev, 1964; Kratochvíl, 1956; Šidlovskij, 1976; Krapp, 1982) and inhabits fissures typical of stony habitats in which stenothermal cavernicolous conditions can be expected. It is suggested to be a troglophilic animal (Kryštufek & Kovačić, 1989) and a fractured rocky substrate is thus essential for its occurrence. In Turkey the voles were invariably associated with rocky outcrops and boulders on mountain pastures (Fig. 235), on slopes sparsely grown with dwarf junipers or scattered trees, and also in woodland near the timber line. In Cığlıkara (western Taurus Mts.) a characteristic habitat are cool funnel-shaped karstic valleys at the upper timber line (*Pinus nigra, Cedrus libani*), which still contain snow in June (Felten *et al*., 1973).

Quite surprisingly, Lay (1967) states for Iran that snow voles “occurred in habitat seemingly identical to that occupied by *Microtus arvalis*” i.e. “along the grassy streamside situations … and the more barren higher clay slopes”. This is certainly erroneous, since specimen tags contain the following information on the habitat: ‘stone garden wall’ and ‘rocky hillside’ (11 km east-north-east of Fashan, Tehran Province; NMNH) and ‘fractured limestone ridge’ (Zagros Mts.; BMNH). From Lebanon, Lewis *et al*. (1967) report very rough rocky ground as the habitat of snow voles. Rocks, screes and boulders on mountain pastures are also populated in the Caucasus (Ejgelis, 1980; Bukhnikashvili & Kandaurov, 1998). In the Near and Middle East, the European snow vole is more tolerant of arid conditions than any other *Chionomys* species (Kryštufek, 1999).

In the eastern Black Sea Mts., Steiner (1972) frequently collected the European snow vole (but not *C. gud*) in houses.

ALTITUDE. The altitudes of records in Turkey range from 1,250 to 2,480 m a.s.l. in the Taurus Mts., 1,100–1,960 m in Central Anatolia, 1,200–1,900 m in eastern Anatolia, 1,700–2,250 m on Mt. Uludağ, and 1,500–2,750 m in the eastern Pontic Mts. In Hatay, Obuch (1994) found it in owl pellets at 1,000 m a.s.l. which is the lowest record in Turkey. The altitudinal range is wider in Europe (30–4,700 m; Krapp, 1982; Kryštufek & Kovačić, 1989), yet in the Alps the voles prefer intermediate elevations (Chiarenzi *et al*., 1997). The localities in Georgia lie between 1,500 and 2,500 m a.s.l. (Bukhnikashvili & Kandau-

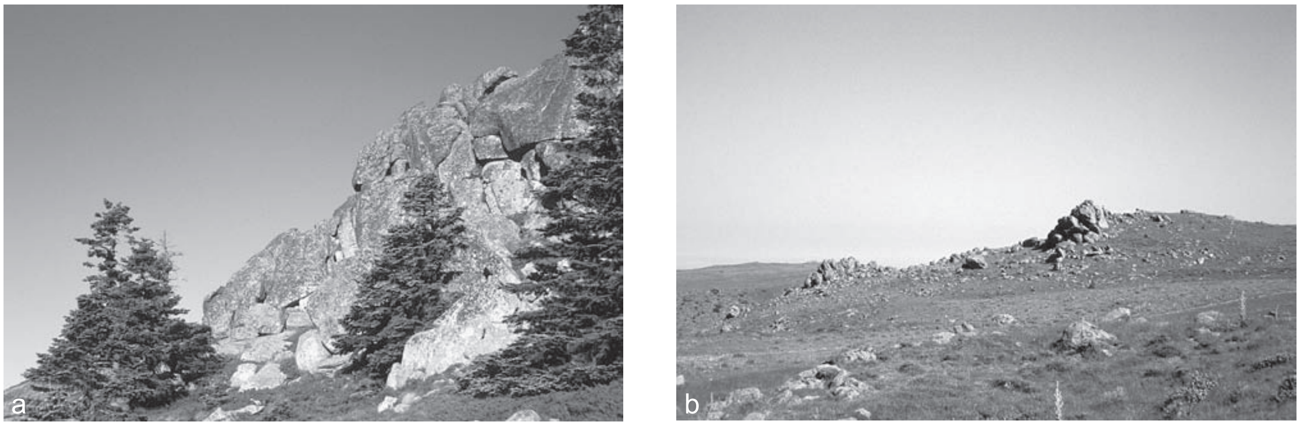


Figure 235. Habitat of *Chionomys nivalis*. **a** – Uludağ, Bursa; **b** – Ercyes Dağı, Kayseri. Photo: B. Kryštufek.

rov, 1998). The lowest records in Talyš (south-eastern Azerbaijan) are from 1,200 m, and in Armenia at 700 m a.s.l. (Ejgelis, 1980). Atallah (1978) reports snow voles from Lebanon between 1,150 and over 2,700 m a.s.l. However, records below 1,300 m are said to be exceptional. Iranian localities are between 2,590 and 3,500 m a.s.l. (specimens in BMNH and FMNH).

ASSOCIATES. Steiner (1972) collected *C. nivalis* together with *C. gud* in three localities in north-eastern Turkey. Sympatric occurrence is further discussed under the latter species. Contrary to this, the European snow vole is not sympatric with any *Chionomys* vole on the Caucasus (Šidlovskij, 1976). In the eastern Caucasus, the snow vole populates Talyš and Nachičevan, both of which regions support large numbers of rodent species (16 and 18 species, respectively), but is absent from the Šemacha region (seven rodent species). The Caucasian vole *C. gud* is tied only to Šemacha (Ejgelis, 1980).

Collected in the same habitat in Turkey were *Crocidura leucodon, Cricetulus migratorius, Mesocricetus brandti, Microtus majori, M. subterraneus, Apodemus mystacinus*, and *A. iconicus*.

DENSITY. The European snow vole is locally the most abundant inhabitant of rocky habitats in the Taurus Mts. (Spitzenberger, 1971). We found it particularly common among boulders with rich herbs and low junipers near Güzyurdu (elevation 2,300 m a.s.l.) where half of small mammals collected were snow voles. Snap trapping on an area of 0.5 ha gave 22 snow voles which suggests the autumn density of *c.* 45 per hectare; figure is comparable with an estimated 20–40 individuals per hectare in the Alps (Nieder & Bocchini, 1995). The snow vole is believed not to be abundant in Lebanon (Atallah, 1978) and Israel (Qumsiyeh, 1996).

BIOLOGY

ACTIVITY. Atallah (1978) claims that this vole is strictly nocturnal in Lebanon. In Central Anatolia (Ercyes Dağı) we observed specimens even during daytime in June. Diurnal activity is also common in Europe (our own observations). Martirosjan (1970) provides more details. The European snow vole is active even on the warmest sunny days during spring and autumn, but is nocturnal during summer, with two activity peaks (at sunset and sundown).

SHELTERS. Information on the burrowing activity of snow voles is contradictory. For Lebanon, Atallah (1978) claims that burrow entrances are always concealed under rocks and boulders, and Lewis *et al.* (1967) state: "burrows are unknown since we have trapped them under large boulders and in rock sides." Küsthardt (1941) reports and figures snow vole burrows in Europe. Burrows with mounds of excavated soil in front of the entrances are also known from the Caucasus (Ognev, 1964; Šidlovskij, 1976). Contrary to this, Martirosjan (1970) denies burrowing activity in the European snow vole.

The nesting chamber is placed shallow and is lined with dry grass (Šidlovskij, 1976).

REPRODUCTION is restricted to the snow-free period. Juveniles were collected in Turkey at the beginning of June. In Lebanon young are born in May and in early June (Atallah, 1978). Gravid females first appear in the eastern Caucasus in the 2nd half of March and were subsequently found until November; up to 62% of females are pregnant in June (Ejgelis, 1980). In the first half of September, we did not record any pregnant females in the eastern Pontic Mts. In a pooled sample from various Turkish localities, the number of embryos varied between 2 and 6 (mean = 4.1; N = 16; Kryštufek, 1999, and additional own data). Lower counts are reported from the Alps: range 2–4; mean = 3-3.1, depending on the region (Krapp, 1982). On the other hand, Ejgelis (1980) gives much higher values for the eastern Caucasus: range = 3–11 (mainly 5–7); mean = 6.2. By arvicoline standards, the European snow vole is a K-strategist and does not exhibit cyclic oscillations in population density (Martirosjan, 1970; Nieder & Bocchini, 1995). Sexual maturity is postponed to the 2nd season, the survival rate of females is high and the maximum observed life span is 36 months in the Alps (Yoccoz, 1996).

FOOD. The European snow vole is herbivorous. Russian authors (Martirosjan, 1970; Šidlovskij, 1976) state that this vole dries grass and stores it in the autumn. Supplies are deposited between rocks and in fissures beyond reach of rain. Mosses and lichens form a significant part in its diet (Martirosjan, 1970).

PREDATION. Obuch (1994) found snow voles in the pellets of *Strix aluco* and of *Bubo bubo*, but at low frequencies (< 3% and < 1% of all small mammals, respectively). In Central Anatolia (Ercyes Dağı), we observed weasels *Mustela nivalis* in the snow vole habitat.

CAUCASIAN SNOW VOLE – *CHIONOMYS GUD*

Microtus gud Satunin, 1909. Type loc.: Gudaur, near Krestovskii Pass, Georgia, Caucasus.
Microtus (Chionomys) gud lasistanius Neuhäuser, 1936a. Type loc.: Varsambeg Dağ, Rize, Turkey.

TAXONOMY

For misconceptions in applying the name *C. gud* for Turkish snow voles see under *C. nivalis*.

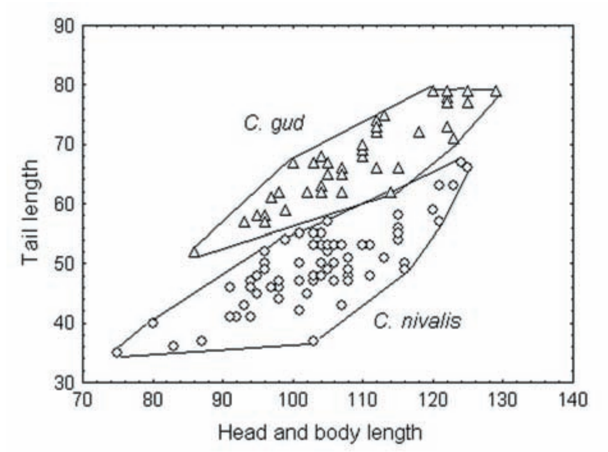


Figure 236. Bivariate plot of tail length against head and body length in *Chionomys nivalis* and *C. gud* from the eastern Pontic Mts. All age groups are considered. Polygons enclose extremes for the group. Based on HSC and our own material.

DESCRIPTION

EXTERNAL CHARACTERS. Externally, the Caucasian snow vole resembles most closely *Chionomys nivalis* from the Black Sea Mts. in size, proportions, and colour. However, the former has a longer tail (54.4–67.0% of head and body length; mean = 62.2%; N = 33) and sympatric populations do not overlap in relative tail length (Steiner, 1972). Bivariate plot of tail length against head and body length thus allows a reliable differentiation between the two species, regardless of their age (Fig. 236). Whiskers are long (up to 40 mm) and white. Ears, densely covered with short hairs, protrude above the hairs which are up to 15 mm long on the mid-back. Hind foot is similar as in the European snow vole, but the pad at the base of the outer toe is larger in *C. gud* (Dukelski, 1927).

COLOUR. Pelage on back smoke grey with some brown shades, belly dull white, irregularly clouded by the slaty undercolour. There is no demarcation line along flanks. Tail pale, uniform or indistinctly bicoloured, and ends in a pencil up to 4 mm long; hind feet grey.

NIPPLES. There are eight nipples, two pairs of pectoral and inguinal ones.

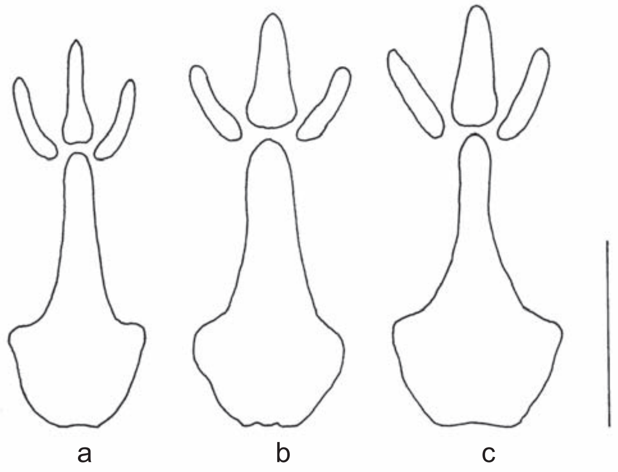


Figure 237. Dorsal view of the baculum of *Chionomys gud* from Giresun Dağları (**a, b**) and Ovitdağ Geçidi (**c**). Distal is to the top. Scale bar = 2 mm.

BACULUM. Aksenova (1980) described the baculum of two specimens from the Caucasus and we examined four adults from Şehitler Geçidi on Giresun Dağları, Turkey. Data are summarised in Table 55 and Fig. 237. The stalk has a well developed and broad base. Aksenova (1980) reports a notch on its proximal base, which, however, was not seen in Turkish material. The three distal processes are much larger than in any other snow vole. The central processus is also more robust than in any other *Chionomys* species and the lateral processes are the longest in the genus. The central process is longer in the material from the Caucasus (*cf.* Table 55).

Glans penis is on average 4.8 mm long and 2.7 mm wide (Zorenko & Aksenova, 1989).

Region	Caucasus	Turkey	
N	2	4	
Stalk – length	3.05 / 3.20	3.06	2.76 – 3.21
Stalk – breadth	1.80 / 1.90	1.83	1.69 – 1.92
Medial process	1.50 / 1.60	1.32	1.24 – 1.35
Lateral process	0.95 / 1.05	1.01	0.96 – 1.13

Table 55. Dimensions of the baculum (in mm) in two samples of *Chionomys gud* from the Caucasus (from Aksenova, 1980) and from Giresun Mts., Turkey, respectively. Mean and range (min-max) are given for the Turkish sample.

Skull is essentially as in *C. nivalis* but differs in having shorter bullae (29.3% of the condylobasal length; range = 27.7–32.8%; N = 17) and in being shallower (height of rostrum averages 29.3% of the condylobasal length; range = 27.7–32.8; N = 17). Supraorbital ridges tend to be more clearly developed. Postorbital tubercles of *squamosum* are more pronounced, as is also the post-tympanic hook. Dorsal profile is nearly straight. Nasals tend to be bottle-shaped. *Squama carina media* is low and the lateral pits on the posterior hard palate are shallow.

Teeth. Upper incisors as in *Chionomys nivalis*. Enamel on the front surface is yellow to orange

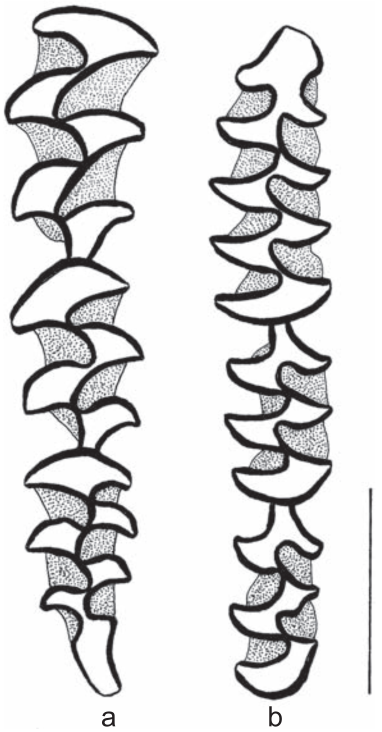


Figure 239. Upper (**a**) and lower molars (**b**) of *Chionomys gud*, based on an adult female from Şehitler Geçidi, Giresun Dağları (same specimen as in Fig. 238). Lingual side is to the left, anterior is at the top. Scale bar = 2 mm.

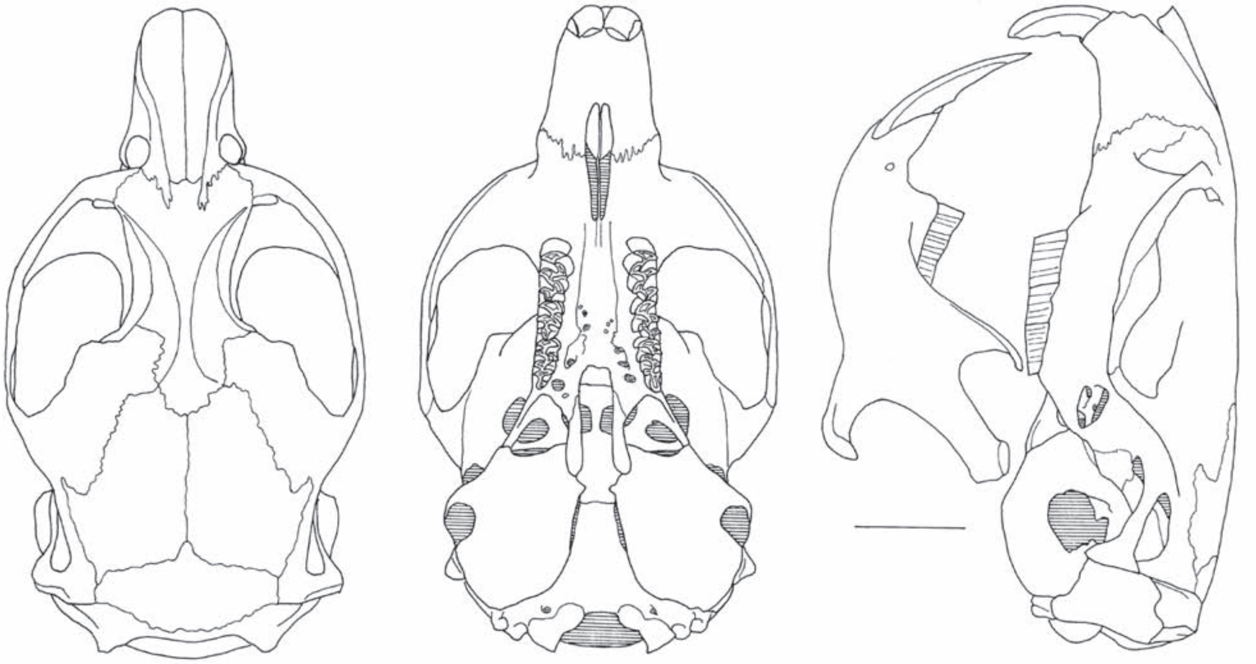


Figure 238. Skull and mandible of *Chionomys gud*, based on an adult female from Şehitler Geçidi, Giresun Dağları. Scale bar = 5 mm.

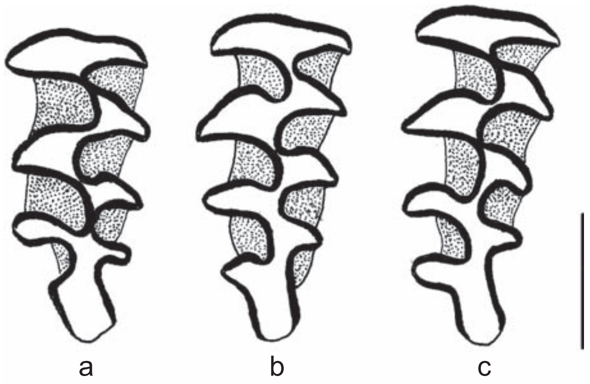


Figure 240. Variation in the shape of 3rd upper molar in *Chionomys gud*. Based on specimens from Giresun Dağları (**a, b**) and Ovitdağ Geçidi (**c**). Lingual side is to the left, anterior is at the top. Scale bar = 1 mm.

yellow on upper incisors and palle yellow on lower ones. The 3rd upper molar is of complex structure with three deep re-entrant angles on either side. The posterior triangles T6 and T7 are well pronounced in the majority of specimens but their dental fields are confluent with the posterior cup (Fig. 240). The 1st lower molar mainly shows four re-entrant angles on either side. Dental fields of triangles T5 and T6 are confluent with the anterior cup; exceptions are rare, and in a sample of 38 animals we only saw two specimens with the anterior cup separated from the posterior two triangles. The remaining molars are of the same shape as in the European snow vole.

DIMENSIONS are given in Table 56. There is no apparent secondary sexual dimorphism.

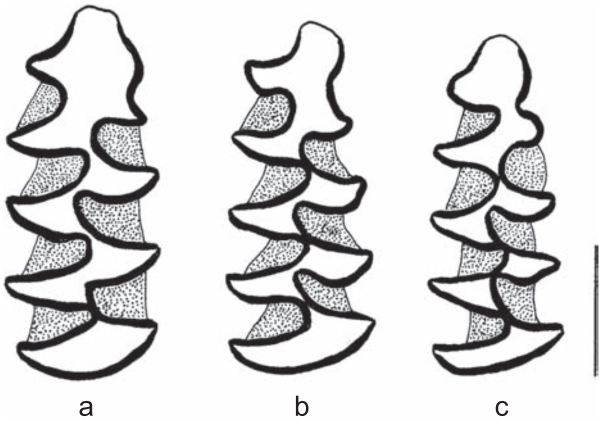


Figure 241. Variation in the shape of 1st lower molar in *Chionomys gud*. Based on specimens from Giresun Dağları (**a, c**) and Ovitdağ Geçidi (**b**). Lingual side is to the left, anterior is at the top. Scale bar = 1 mm.

	N	mean	min–max
Head and body	21	121.1	112–130
Tail	19	71.9	57–79
Hind foot	21	20.4	19.0–21.2
Ear	21	17.2	15.1–19.0
Weight	21	44.8	34–63
Condylobasal length	16	28.8	27.3–30.1
Zygomatic breadth	17	16.3	15.4–17.4
Maxillary tooth-row	17	7.3	6.7–7.8

Table 56. External and cranial dimensions of *Chionomys gud* from Turkey. From Kryštufek (1999).

CHROMOSOMES. The diploid number of chromosomes is 2N = 54 and the fundamental number of autosomal arms is NFa = 54. The autosomes are acrocentrics of decreasing size, but the smallest pair is bi-armed (Sablina *et al*., 1988). The X chromosome is large submetacentric and the Y chromosome is acrocentric of varying size (Kulijev, 1979). The karyotype was reported from Azerbaijan, Daghestan, Georgia, and Northern Osetia but is not known in Turkish populations.

VARIATION

In addition to *C. gud lasistanius*, to which the Turkish populations are invariably ascribed (Neuhäuser, 1936b; Kumerloeve, 1975; Šidlovskij, 1976; Nadachowski, 1991; Demirsoy, 1996; Kurtonur *et al*., 1996), Ognev (1964) and Gromov & Erbajeva (1995) recognise three more subspecies in the Caucasus, viz., *C. g. gud* (Satunin, 1909), *C. g. ighesicus* (Shidlovskij, 1919), and *C. g. nenjukovi* (Formosov, 1931). Neuhäuser (1936a) based the diagnosis of *lasistanius* on size (much smaller than in sspp. *gud* and *nenjukovi*) and on colour. Comparisons among subspecies on the basis of published data appear difficult because of clear contradictions. For instance, Ognev (1964) reports the nominate race as being small (condylobasal length of skull = 25.0–29.2 mm) and ssp. *nenjukovi* to be large (condylobasal length = 26.4–28.6 mm; cf. Table 56). Furthermore, Neuhäuser (1936a) states that *oseticus* (a junior synonym of the nominate race in the opinion of Ognev, 1964) is reddish in colour, but Ognev (1964) reports *C. g. gud* as being "from straw gray to more saturated grayish or even mouse gray." Not surprisingly, Steiner (1972) was not quite convinced of the validity of *lasistanius* and suggested it to be most likely a junior synonym of the nominate form. Contrary to this, Gromov & Polyakov (1977, 1992) believe that the four subspecies, as listed above, are sufficiently defined, but they also claim that subspecific affinities are unknown in the Transcaucasian populations. In spite of such confusion as regards the delimitation of geographic races, *lasistanius* has been reported as occurring in the Trialetskij ridge of the Smaller Caucasus in Georgia as well (Šidlovskij, 1976; Kandaurov *et al*., 1994).

Variation of the enamel molar pattern does not suggest much interpopulation divergence among the recent populations of *C. gud*, but the fossil material is fairly distinct in this respect (Nadachowski, 1991).

DISTRIBUTION

The Caucasian snow vole is endemic to the Caucasus and the easternmost part of the Pontic mountains of Turkey. The bulk of its distribution is in the Great Caucasus, from Abkhazia in the west down to western Azerbaijan and Daghestan. The range is most likely fragmented in Transcaucasia with isolates in the Meskheta and Trialetskij ridges (Bukhnikashvili & Kandaurov, 1998). There are isolates also in Ciscaucasia (Pyatigorye and the valley of the river Terek; Gromov & Polyakov, 1992).

Likewise, the Turkish range is possibly an isolate (e.g. Gromov & Polyakov, 1992). Five localities are known so far, stretching in a narrow belt along the Black Sea coast between the Turkish – Georgian border in the east and Giresun Mts. in the west (Fig. 242).

Steiner (1972) claims that the type locality of ssp. *lasistanius* (Varsambeg Dağ) most likely relates to Vercenik Dağ, to the west of Elevit. This does not agree with the position of Varsambeg Dağ in the map in Neuhäuser (1936b; *Tafel* 57; not paginated). Another record which has never been properly located is Kaçkar range; Osborn (1962) credited Ognev (1950) for it. We did not find this locality either in Ognev's text or in the map (Ognev, 1950).

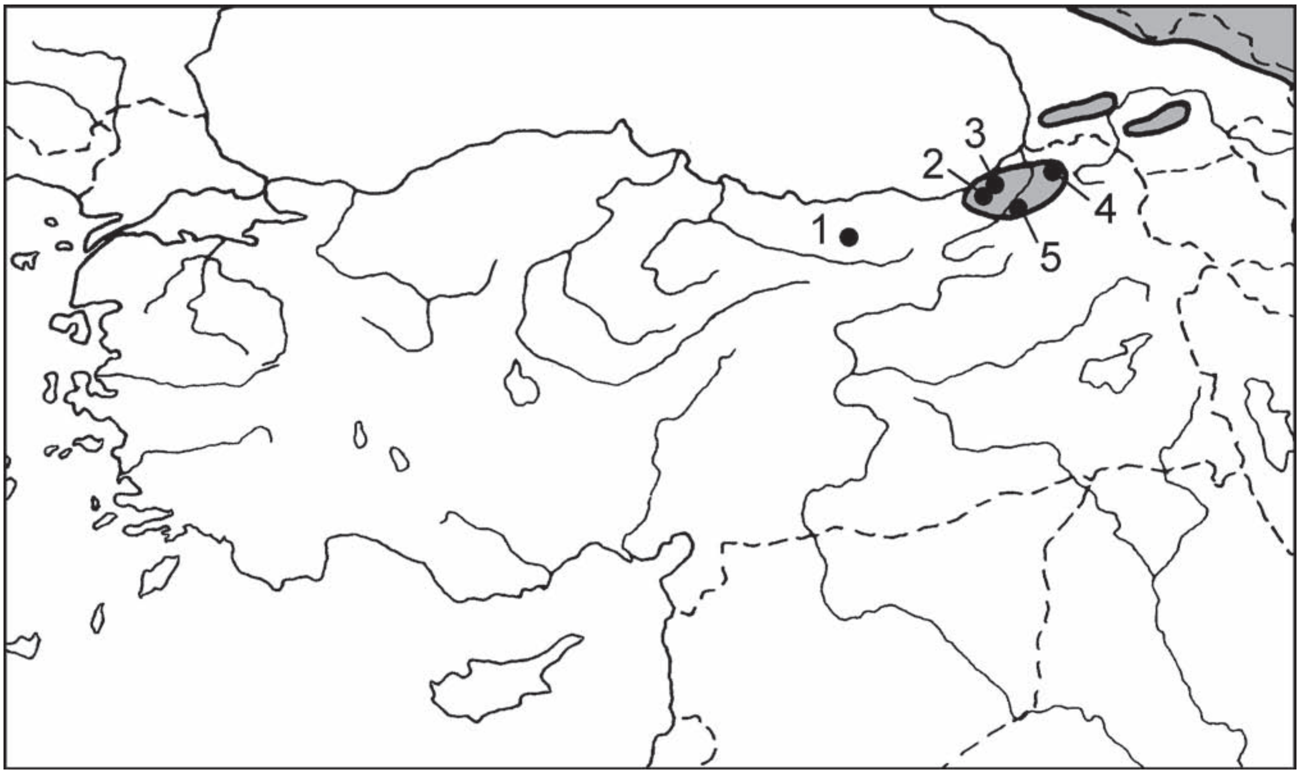


Figure 242. Distribution of *Chionomys gud* in Turkey. Records: **1** – Tamdere, Kümbet, Şehitler Geçidi, Giresun, 1,550 m; **2a** – Ovit Yaylasi, Rize; **2b** – Ovitdağ Geçidi, Rize, 2,450 m; **2c** – Rize Dağları, east of road from Rize to Ispir, 3,200 m; **3** – Elevit, Rize; **4** – Yalnızçam Geçidi, Kars; **5** – Varsambeg Dağ, Rize, 3,000 m. Corresponding references: Neuhäuser (1936a): 5. Steiner (1972): 2a, 3, 4. Kryštufek (1999): 1, 2b, c.

HABITAT

The species is closely associated with rocky habitats where it seeks shelter in crevices and among boulders. It occurs on alpine meadows, in sparse fir and spruce forests, and in valleys of brooks and small rivers. It prefers more humid conditions than *C. nivalis* (Steiner, 1972; our own observations). On Giresun Mts. we collected specimens along a mountain brook in a spruce forest. The voles were evidently seeking shelter among rocks inside the forest and under dense growth of *Tussilago* sp. Steiner (1972) found this vole to be common along stony walls in humid mountain pastures. However, *C. nivalis* was also collected in the same habitat and along with the Caucasian snow vole. For further details about the habitat in Turkey see Steiner (1972). Similar habitat requirements as in Turkey are also reported from the rest of the range, where the Caucasian snow vole is the most common in the alpine and subalpine belt (Gromov & Erbajeva, 1995).

ALTITUDE. Turkish records are from elevations between 1,550 and 2,500 m a.s.l. (Steiner, 1972, and our own data). The vertical range in Transcaucasia is from 500 up to 3,000 m a.s.l. (Gromov & Erbajeva, 1995). For the eastern Caucasus, Ejgelis (1980) reports this vole from 1,300 m up to the permanent snow.

Figure 243. Habitat of *Chionomys gud*. Ovitdağ Geçidi, Rize. Photo: B. Kryštufek.

ASSOCIATES. In the eastern Pontic Mts. of Turkey, *C. gud* is broadly sympatric with the European snow vole. However, the two species are quite rarely found syntopicaly. All the cases of syntopy were reported by Steiner (1972). Of approximately eight localities, both species were found only in three (Table 57). Steiner (1972) believes that *C. gud* is also in sharp competition with *C. roberti*. In his opinion, the latter out-competes *C. gud* from the forest belt.

In Turkey the Caucasian snow vole was collected along with *Sorex satunini, S. volnuchini, S. raddei, Neomys teres, Microtus daghestanicus, M. subterraneus,* and *Apodemus* sp.

Locality	Elevation (m a.s.l.)	*C. nivalis*	*C. gud*
Tamdere	1550 m		8
Ovit	2300 – 2450	2	12
Elevit	1750 – 1850	6	18
Elevit	2200	1	
Kutul	2200 – 2400	3	
Güzyurdu	2300	24	
Çamlica	2750	7	
Yalnızçam	2300 – 2500	12	8

Table 57. Numbers of *Chionomys nivalis* and *C. gud* collected at various localities in the north-eastern Pontic Mts., where the two species are broadly sympatric. Based on Steiner (1972) and our own data.

BIOLOGY

The life habits of the Caucasian snow vole are little known. Because of poor burrowing capabilities, its burrows are short and of simple structure (Gromov & Erbajeva, 1995). According to Vinogradov & Gromov (1984) it also seeks shelter among tree roots in the forest belt. The Caucasian snow vole is able to climb bushes up to 1.5 m above ground (Gromov & Erbajeva, 1995).

REPRODUCTION is said to be more intense than in the European snow vole, with up to four litters annually. The voles attain sexual maturity in the year of birth, and young females can produce up to two litters before their first winter. Reproduction depends on elevation and lasts from May to October in the western part of the Great Caucasus (Gromov & Erbajeva, 1995). Šidlovskij (1976) believes that there are 2–3 litters annually of up to six cubs. Counts of embryos in Turkey suggest the litter size to be 3–4 (mean = 3.6, N = 5; Kryštufek, 1999). At the end of June, we collected on Giresun Mts. pregnant females along with the cubs of the same year. The body mass of juveniles was 19.5–22 grams, as opposed to 38–49 grams in adults. According to Gromov & Erbajeva (1995), the population densities of the Caucasian snow vole do not fluctuate cyclically.

Food. The diet of this vole species is strictly herbivorous. According to Gromov & Erbajeva (1995) it starts hoarding food for winter already in June. This involves drying of plants and storing them in piles, which can contain up to six kilograms of dry material. The daily activity shows two peaks.

Robert's snow vole – *Chionomys roberti*

Microtus roberti Thomas, 1906. Type loc.: Sumela (= Meryemana), Trabzon, Turkey.

Description

External characters. This is the largest *Chionomys* species with relatively the longest tail (70.7% of head and body length; range = 56.8–81.0%; N = 62; Steiner, 1972, and our own data). Whiskers are up to 45 mm long and mainly black. Hind foot is longer than in the remaining snow voles of Turkey. Upper side is clouded by short white hairs but the heel is black-brown; soles are bare. Fur is of medium texture and shorter than in either *C. gud* or *C. nivalis*; hairs of the mid-back are up to 12 mm long.

Colour. The back is brown (nearest to mummy-brown; Thomas, 1906) and the belly is smoke grey with a slight drabby suffusion. Demarcation along flanks is fairly distinct. The tail is indistinctly bicoloured, blackish above and grey below; pencil at its tip is 4–5 mm long. Juveniles are darker, with slate-coloured belly, grey hind feet and nearly uniformly dark tail.

Nipples. There are eight nipples, two pairs of pectoral and inguinal ones.

Baculum is more variable than in the remaining snow voles (Fig. 244). The proximal expanded part of the stalk varies in shape and extent. Of the distal baculum, the medial process is slightly shorter in *C. roberti* than in *C. gud*, but is also less robust. The two lateral processes are either entirely absent, small and just feebly ossified, or fairly well developed and up to 0.75 mm long (Table 58).

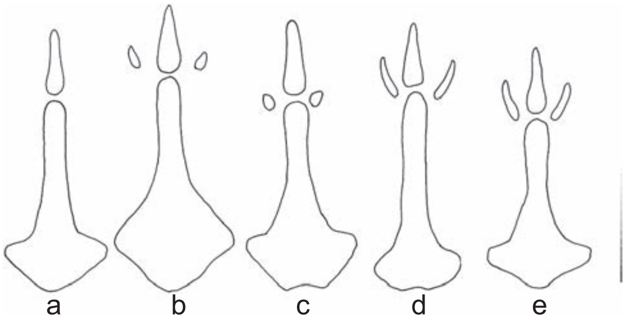


Figure 244. Dorsal view of the baculum of *Chionomys roberti* from Çamlik, Rize (**a–c**), Meryemana (**d**), and Topçam (**e**). Distal is to the top. Scale bar = 2 mm.

N = 7	mean	min – max
Stalk – length	3.23	2.87 – 3.77
Stalk – breadth	1.78	1.58 – 2.08
Medial process	1.13	0.90 – 1.30

Table 58. Dimensions of the baculum (in mm) in *Chionomys roberti* from Turkey. Based on own material.

Skull is essentially as in *C. gud* but differs in shorter bullae (25.8% of the condylobasal length; range = 22.9–28.9%; N = 30) and in being slightly shallower on average (height of rostrum averages 27.8% of condylobasal length; range = 26.4–29.2; N = 30). Bivariate plot of bullae length against height of rostrum clearly separates *C. roberti* from the remaining two snow voles (Fig. 245). Supraorbital ridges are evident but they never fuse to form a crest; instead, they remain *c.* 1 mm apart even in the oldest specimens. Postorbital tubercles of *squamosum* and the post-tympanic hook are less pronounced in *C. roberti* than in *C. gud*. Besides, *C. roberti* has shorter incisive foramina and more robust articular process of mandible. Dorsal profile of the skull is nearly straight. *Squama carina media* is clearly defined and the lateral pits on the posterior hard palate are fairly deep.

Teeth. Upper incisor and molars are as in *Chionomys gud*. Enamel on the front surface is yellow to yellow orange on the upper incisors and yellow on the lower ones. The structure of the 3rd upper molar is

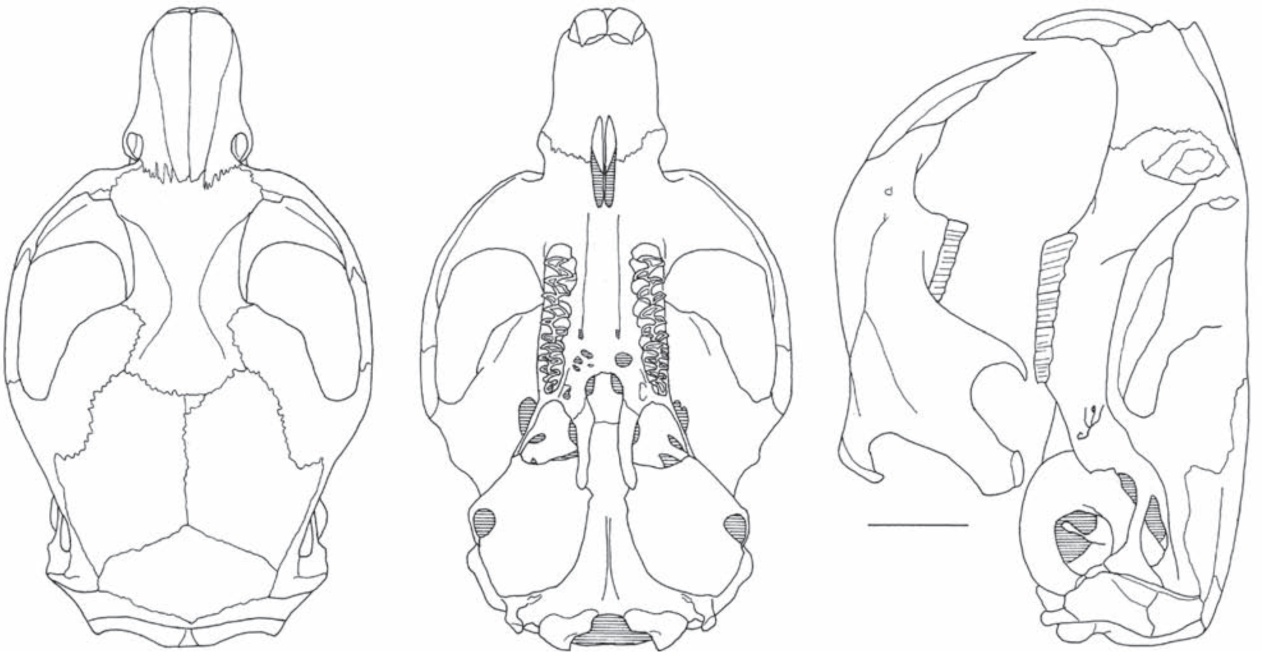


Figure 245. Skull and mandible of Robert's snow vole *Chionomys roberti*, based on an adult male from Çamlik, Rize. Scale bar = 5 mm.

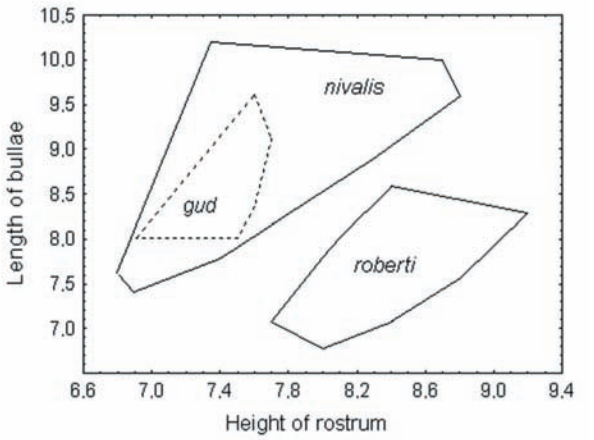


Figure 246. Bivariate plot of bullae length against height of rostrum in three *Chionomys* species from Turkey. Only adults are considered. Polygons enclose extremes for the group. Based on own material and specimens in BMNH, HSC, NMNH, NMW and SMF.

complex, with at least three deep re-entrant angles on either side. In a large majority of specimens there is an additional postero-lingual re-entrant angle (LRA5; Fig. 248b–d), which is deep enough in some extreme cases to nearly close the posterior cup (Fig. 248d). Triangles T6 and T7 are invariably pronounced and their dental fields are either confluent or isolated

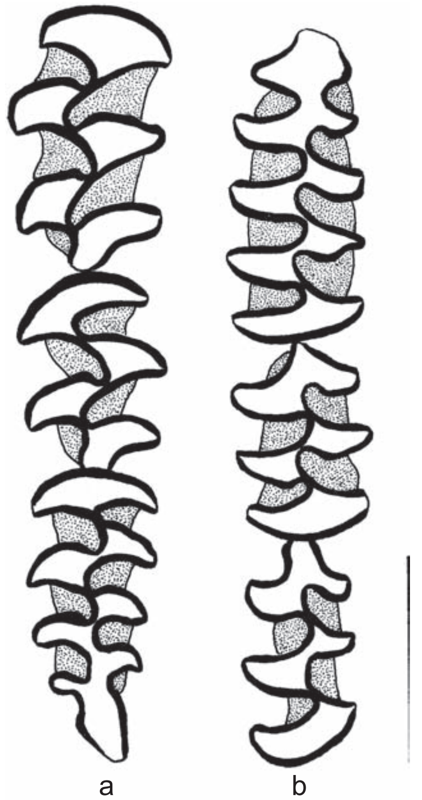


Figure 247. Upper (**a**) and lower molars (**b**) of *Chionomys roberti*, based on same specimen as in Fig. 245. Lingual side is to the left, anterior is at the top. Scale bar = 2 mm.

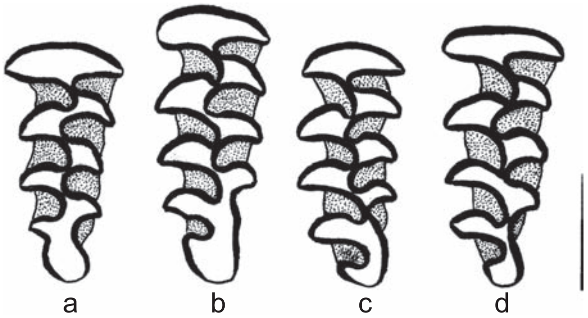


Figure 248. Variation in the shape of 3rd upper molar of Robert's snow vole. Based on specimens from Topçam (**a**), Çamlik, Rize (**b, d**), and Meryemana (**c**). Lingual side is to the left, anterior is at the top. Scale bar = 1 mm.

due to a deep lingual re-entrant angle LRA4. The 1st lower molar shows four re-entrant angles on either side. Dental fields of triangles T5 and T6 are confluent to the anterior cup and only rarely is T5 nearly closed by a deep re-entrant angle LRA4 (Fig. 249c). The lingual salient angle LSA5 is well developed but broadly confluent with the anterior cup. The remaining molars are of the same shape as in the Caucasian snow vole.

Dimensions are given in Table 59. There is no apparent secondary sexual dimorphism.

	N	mean	min–max
Head and body	72	136.8	125–156
Tail	71	96.0	80–108
Hind foot	72	24.2	21.7–26.9
Ear	72	16.4	14.0–20.0
Weight	34	59.5	40–78
Condylobasal length	70	30.3	28.8–32.9
Zygomatic breadth	64	17.2	15.5–18.5
Maxillary tooth-row	75	7.4	6.7–8.6

Table 59. External and cranial dimensions of *Chionomys roberti* from Turkey. From Spitzenberger & Steiner (1962), Steiner (1972), Kryštufek (1999), and additional own data.

Chromosomes. The diploid number of chromosomes in a topotypical material is 2N = 54 and the fundamental number of autosomal arms is NFa = 54. With the exception of one small biarmed pair, all the remaining autosomes are acrocentrics of decreasing size. The X chromosome is a large submetacentric and the Y chromosome is a small acrocentric (Kefelioğlu, 1995). The results from the Caucasus are much the same but the Y chromosome is large acrocentric (Sablina *et al*., 1988).

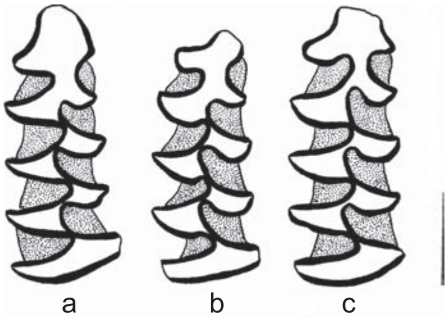


Figure 249. Variation in the shape of 1st lower molar in Robert's snow vole. Based on specimens from Meryemana (**a**) and Çamlik, Rize (**b, c**). Lingual side is to the left, anterior is at the top. Scale bar = 1 mm.

Variation

Gromov & Polyakov (1992) list three subspecies in addition to the nominate one, based on differences in colour. Applying subspecific taxonomy, the Turkish populations are ascribed to the nominate form (e.g. Kumerloeve, 1975; Kurtonur *et al*., 1996).

Nadachowski (1991) compared the enamel tooth pattern of a pooled Turkish sample with that of *C. roberti occidentalis* (Turov, 1928) from the Caucasus. The main difference seems to be in a tendency towards a more complex anteroconid part of the 1st lower molar in the Turkish material. That is to say, 12.5% of Turkish specimens had closed anterior cup due to deep re-entrant angles LRA4 and BRA4, a morphotype which was absent from the Caucasus.

Spitzenberger & Steiner (1962) and Steiner (1972) suggest size differences in Turkish specimens, with smaller ones in the west and larger ones in the east. The trend was supposedly evident from the mean condylobasal length: Ulubey (mean = 29.6 mm; N = 8), Biçik (= 29.76 mm; N = 3), and Meryemana (= 30.77 mm; N = 4). A more representative sample from the latter of the tree localities gave mean condylobasal length of 29.7 mm (N = 26). Thus, the apparent size gradient is most likely an artefact of small samples.

Steiner (1972) reports colour differences among localities. The specimens from Rize and Ülkü tend to show rather darker bellies, and those from Akkuş and Kutul are paler in general.

DISTRIBUTION

Robert's snow vole is endemic to the Caucasus and the Pontic Mts. of Turkey and its entire range is even more restrained than that of the Caucasian snow vole. In the Caucasus, it is mainly restricted to the central and western parts of the main ridge from western Azerbaijan in the east as far north-west as Soči. It is worth noting that the ranges of *C. roberti* and *C. gud* do not overlap much and the area of the former species is shifted more towards south. In Turkey, *C. roberti* is restricted to a narrow belt in the eastern Pontic Mts. as far west as the Yeşilırmak River. The large majority of records are from the north-facing coastal slopes of the Pontic Mts. and none of them lie across the rivers Yeşilırmak or Çoruh in the south (Fig. 250).

HABITAT

The most characteristic habitats of Robert's snow vole in Turkey are humid forested places with lush undergrowth along mountain streams. Rocks, frequently water-splashed and covered with mosses and rhododendron shrubs, are also common features of its habitat. Robert's vole inhabits deciduous, mixed and coniferous forests composed of *Fagus orientalis, Juglans regia, Castanea sativa, Alnus glutinosa, Picea orientalis,* and *Abies nordmanniana*. This species seems to depend less on accumulations of rocks and narrow fissures between them than on water or, at least, on humid conditions. It has also been collected away from water, e.g. among moss covered rocks in a forest (Spitzenberger & Steiner, 1962), along stony walls in a meadow (Steiner, 1972), and in runways in dense vegetation in abandoned fields (Osborn, 1962). From Transcaucasia, Robert's snow vole is reported also to inhabit ruins and orchards around villages (Bukhnikashvili & Kandaurov, 1998) and even to enter mountain lodges (Šidlovskij, 1976).

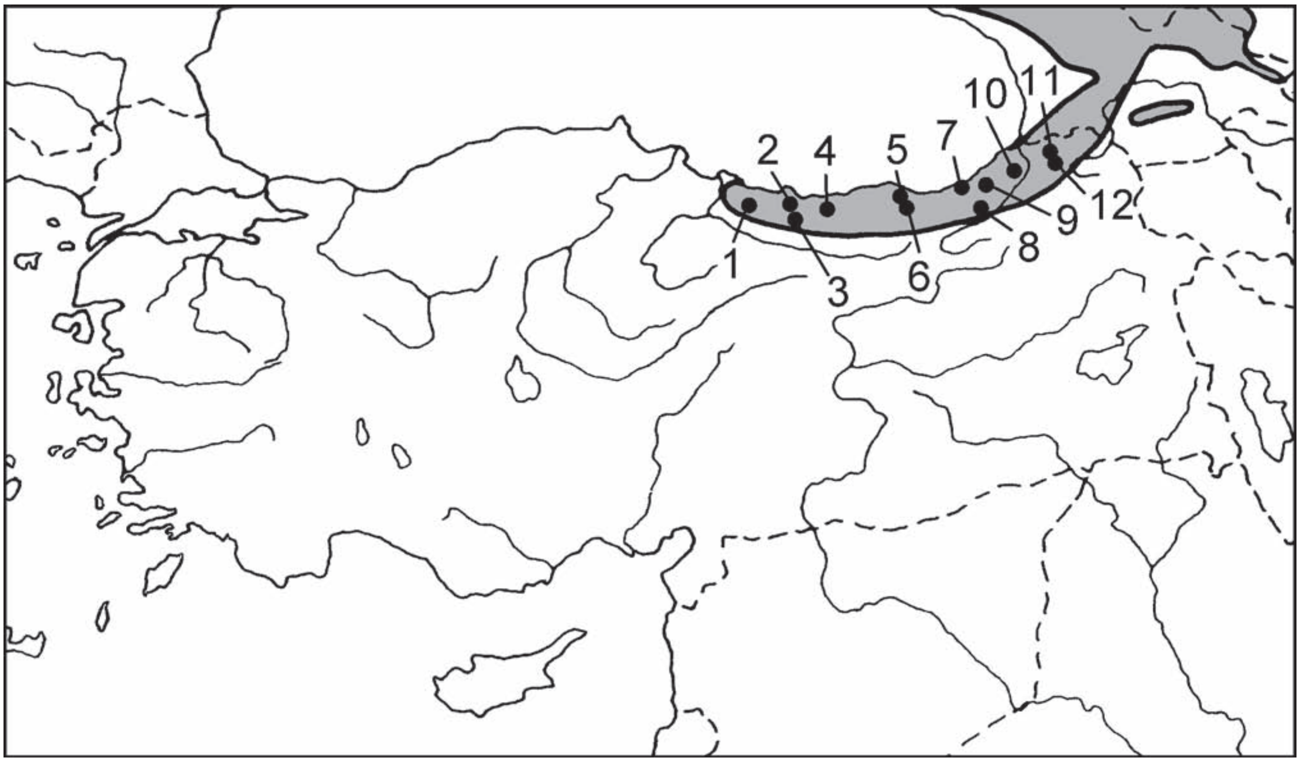


Figure 250. Distribution of Robert's snow vole *Chionomys roberti* in Turkey. Records: **1** – Akkuş, Ordu; **2** – Ulubey, Ordu; **3** – Topçam, Ordu, 850 m; **4** – Biçik, Giresun; **5** – Maçka; **6a** – Meryemana and Altindere, Trabzon, 700-1,300 m; **6b** – Meryemana, 1,100 m; **7** – Rize; **8** – Çamlik, Rize; **9a** – Ülkü, Rize; **9b** – Çat, Rize; **9c** – Ayder Ilıcası, Rize; **10** – Damar, Artvin, 1,100 m; **11** – Kutul, Artvin; **12** – Yalnızçam Geçidi, Artvin, 2,600 m. Corresponding references: Thomas (1906a): 6a. Spitzenberger & Steiner (1962): 2, 4. Steiner (1972): 1, 5, 7, 9a–c, 11. Kryštufek (1999): 3, 8. Yiğit *et al*. (2003a): 6b. Own data: 10, 12.

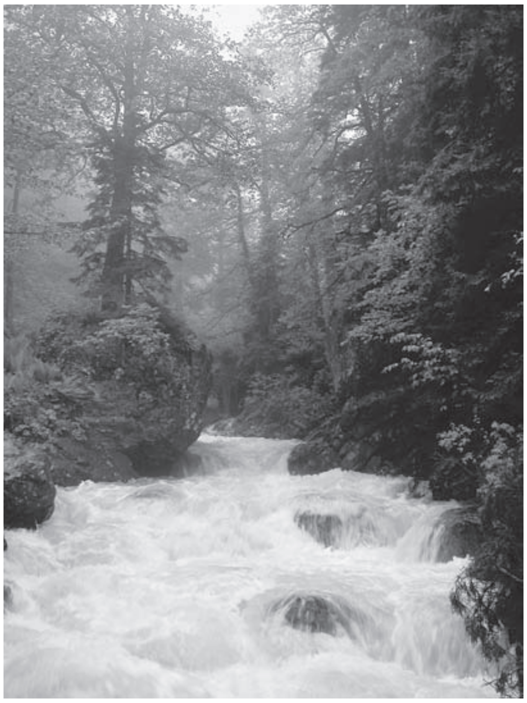


Figure 251. Habitat of *Chionomys roberti*. Meryemana, Trabzon. Photo: A. Kryštufek.

ALTITUDE. The altitudes of localities in Turkey range from 500 to 2,600 m and the optimal altitude is probably between 1,000 and 1,500 m a.s.l. (Steiner, 1972). Robert's vole inhabits areas up to the upper timber line but avoids subalpine and alpine meadows. From the Caucasus it is reported from the sea level up to 3,200 m a.s.l. (Gromov & Polyakov, 1992). The altitudinal range, however, is narrower in the eastern Caucasus (800–2,000 m a.s.l.; Ejgelis, 1980). Outside Turkey, Robert's vole is also reported to inhabit subalpine meadows (Bukhnikashvili & Kandaurov, 1998).

ASSOCIATES. In the same habitat as Robert's snow vole, we also collected *Sorex raddei, S. satunini, S. volnuchini, Neomys teres, Microtus majori, Apodemus mystacinus,* and *A. uralensis*. Robert's vole is rather rare and usually represents *c.* 5% of the small mammal catch (Bukhnikashvili & Kandaurov, 1998). In Turkey its share in twenty small mammal samples (Spitzenberger & Steiner, 1962; Steiner, 1972; our own data) was between 6.7 and 33.3% (median = 12.4%).

BIOLOGY

ACTIVITY. In the opinion of Pecheniuk (1974), Robert's vole is a semi-arboreal animal. In spite of its external resemblance to the water vole, it avoids swimming and will cross streams by jumping from stone to stone. In this way it is also capable of colonising small islands in a river.

Robert's snow vole is predominantly nocturnal.

SHELTERS. Nests are burrowed between tree roots or under stones (Pecheniuk, 1974).

REPRODUCTION. Spitzenberger & Steiner (1962) collected sexually active animals at the end of May. In scrotal males, the testes are 7.8–11.5 mm long and weight 120–330 mg (Spitzenberger & Steiner, 1962). The number of embryos in the Turkish material varied between 1 and 4 (mean = 2.5; N = 15; Kryštufek, 1999, and additional own data). Gromov & Erbajeva (1995) give the mean litter size to be around three, but Šidlovskij (1976) reports up to seven embryos per female. The first juveniles of the year (body mass = 22 g) were collected in Turkey in the last third of June (Kryštufek, 1999) and females from Meryemana still had visible nipples in the last third of October. Gravid females are found until August in the Caucasus and as late as October along the Black Sea coast (Gromov & Erbajeva, 1995).

FOOD. Robert's vole is strictly herbivorous and stores fresh food under stones along river banks. Prefered food items include ferns, which are browsed at the ground level, and leaves of black elder (*Sambucus nigra*), which to collect the vole will climb up to 3–4 meters above ground (Pecheniuk, 1974).

APPENDIX

Shortly after the “Mammals of Turkey and Cyprus” were issued in 2001, errors and omissions began emerging. This appendix is aimed to correct them as well as to update the information published four years ago.

ERRATA TO KRYŠTUFEK & VOHRALÍK (2001)

FIG. 49 ON P. 63

Proper figure caption reads:
Fig. 49: First left upper molar in Sorex raddei *(Tamdere, Giresun Dağları). m = hypoconus. Anterior is to the left, lingual is below. Scale bar = 1 mm.*

Caption to Plate VI/2 on page 138

Proper text reads:
Alpine meadow with rocks on the Ovitdağı mountain Pass, eastern Black sea Mts. (altitude 2,450 m asl). Habitat of *Sorex satunini, Neomys teres, Arvicola terrestris, Microtus daghestanicus*, and *Chionomys gud.* Photo: B. Kryštufek.

NOMENCLATURE

G. Fischer, not Fischer von Waldheim, is the authority for the family names Erinaceidae, Soricidae, and Talpidae (pages 5, 32, 33, 54, 95 in Kryštufek & Vohralík, 2001) and the subfamilies Erinaceinae, Soricinae, and Talpinae (pages 32, 33 in Kryštufek & Vohralík, 2001). Although the same person is in question, Fischer achieved his nobility title (von Waldheim) only after 1817 when the above names were used for the first time (Hutterer, 1993, 2003).

TAXONOMY AND DISTRIBUTION

HEMIECHINUS AURITUS (GMELIN, 1770)

Compiling the distribution map (Fig. 46 on p. 60 in Kryštufek & Vohralík, 2001), we assumed that the desert regions between the rivers Euphrates and Tigris in Syria and Iraq were not inhabited by *H. auritus*. Benda & Obuch (2001) published a considerable number of new records throughout Syria. This hedgehog is present all along the river Euphrates and its tributary Al-Khabour, as far north as the Turkish-Syrian border. The Syrian records from Hassake province are very close to the Turkish border and suggest the presence of the species in south-eastern Turkey as far east as Cizre. Benda & Obuch (2001) also provide noteworthy biological data on *H. auritus*.

SOREX RADDEI (SATUNIN, 1895)

Biltueva *et al*. (2000) report the banded karyotype of *S. raddei* collected in Turkey and in the Caucasus. The interpretation of the results suggests a basal phylogenetic position of this shrew species.

CROCIDURA LEUCODON (HERMANN, 1780)

Biltueva *et al*. (2001) found differences between populations from Europe and Georgia in combinations of individual arms of four metacentric chromosomes. This was interpreted either as a presence of a local chromosomal race in Georgia or the indication of the existence of two distinct species.

SUNCUS ETRUSCUS (SAVI, 1822)

We reported only ten, widely scattered localities from Turkey (cf. Fig. 95 on p. 93 in Kryštufek & Vohralík, 2001), but overlooked several published records: (1) Sultanssumpfe (= Sultan Sazlığı Milli Parkı, Yeşilhisar, Niğde; Kasparek, 1985); (2) Lake Bafa (= Çamiiçi Gölü; Kasparek, 1988), and (3) Menderes delta (Brinkmann *et al*., 1990). We were also informed that the Staatliches Museum Oldenburg, Germany, is in possession of a voucher specimen collected on May 2000 at Kuzyaka near Antalya (altitude 180 m a.s.l.).

TALPA LEVANTIS THOMAS, 1906

Popov & Miltchev (2001) showed the Levant mole *T. levantis* to be fairly common on the Bulgarian side of the Istranca (Strandža) Mts. All marginal (not identified) localities are along the Sredecka River and the northernmost one lies at the latitude of the Bay of Burgas. The marginal range slightly exceeds the tentative one shown on our map. The climate of this region is warm and humid. The Levant mole is sympatric with *T. europaea* along its north-western range. In the Fakijska River – Black Sea coast – Turkish border triangle, *T. levantis* is the more common of the two moles. The dimensions given by Popov & Miltchev (2001) fit the range reported by us (Kryštufek & Vohralík, 2001): condylobasal length 31.0–32.5 mm (mean = 31.57; N = 5), rostral breadth 8.3–9.1 mm (mean = 8.80; N = 11), maxillary tooth-row 11.8–12.7 mm (mean = 12.08, N = 9). Size alone allows to distinguish between the Levant vole and the sympatric *T. europaea* (condylobasal length in the latter = 33.0–36.2 mm).

Talpa davidiana (Milne-Edwards, 1884)

Talpa chthonia Bate, 1937 is among the many new species which Bate (1937a, b) described on the basis of fossil material from Tabun Cave in Israel. This species was found in the Upper Acheulean strata and was considered to have become extinct subsequently. Examination of the type material in BMNH leads us to the conclusion that *T. chthonia* is almost identical with *Scaptochirus davidianus*, described by Milne-Edwards (1884). Close affinities between the two taxa are evident from their robust rostrum, particularly across the canines. For drawing of *T. chthonia* see Fig. 2m (p. 162 in Bate, 1937b) and for *T. davidiana* see Fig. 107 (p. 103 in Kryštufek & Vohralík, 2001). The differences between the Milne-Edwards' type and two rostral specimens from Tabun are only slight (*cf.* Table 60). We thus propose *T. chthonia* to be a junior synonym of *T. davidiana*.

The type of *S. davidianus* and a small sample from Tabun Cave differ in size from their conspecifics in south-eastern Anatolia and the adjacent parts of Iran. Although moles respond rapidly to environmental conditions by size adjustments (e.g. Stein, 1959; Grulich, 1969), which is a possible explanation for the above observation, we suppose that differences in size may also be of taxonomic importance. Therefore, we propose the existence of two subspecies within *T. davidiana*. The larger *T. d. streeti* Lay, 1965 is known from high elevations around Lake Van, in Hakkari, and the Iranian Kurdistan. The smaller subspecies *T. d. davidiana* (Milne-Edwards, 1884) is known from two localities only. The historical record by Milne-Edwards (1884) from Akbes is an isolate and was never confirmed since the type specimen was collected. The Upper Pleistocene material from Mt. Carmel in Israel documents a more extensive past distribution of this mole in the Near East.

Talpa chthonia is already the third in a line of species described by Bate (1937a, b) on the basis of fossil material and discovered subsequently to be still extant. The first one is the Roach's mouse-tailed dormouse *Myomimus roachi* (see this volume). The next is *Crocidura katinka* Bate, 1937, a small shrew which was only recently found in owl pellet samples from Syria (Hutterer & Kock, 2002). Two of these species, the mole and the dormouse, underwent range constriction during the Holocene, most likely as a response to habitat deterioration. It would be of prime interest to verify whether ssp. *davidiana* possibly survived in the high mountain habitats along the eastern Mediterranean coast between Akbes and Mt. Hermon.

	Iran N = 7		Turkey N = 6		*Scaptochirus davidianus*	*Talpa chthonia*	
	mean	min-max	mean	min-max	Type	Type	
MxT	12.3	10.8–13.2	12.3	11.3–13.2	10.6	10.3	10.3
RoC	5.25	4.8–5.6	4.97	4.5–5.6	4.2	4.2	3.8
RoM	9.97	9.7–10.7	9.83	8.9–10.8	8.2	8.2	8.3

Table 60. Measurements on the rostrum of three recent and one fossil samples of *Talpa davidiana*. Measurements of *T. chthonia* are based on specimens in BMNH. For other sources see Kryštufek *et al.* (2001). MxT – maxillary tooth-row (alveolar); RoC – breadth of rostrum over canines; RoM – breadth of rostrum over molars.

TAPHOZOUS NUDIVENTRIS CRETZSCHMAR, 1830

Karataş & Sözen (2002) confirmed the previous report from the vicinity of Nizip (Sachanowicz *et al*., 1999).

RHINOLOPHUS MEHELYI MATSCHIE, 1901

Occurs also on Cyprus (Felten *et al*., 1977).

MYOTIS EMARGINATUS (GEOFFROY, 1806)

Reported from Cyprus by Heller *et al*. (2001).

MYOTIS CAPACCINII (BONAPARTE, 1837)

This bat is more widespread in Anatolia; Karataş *et al*. (2003) report it also for central, eastern, and south-eastern Anatolia.

PIPISTRELLUS PYGMAEUS (LEACH, 1825)

Vespertilio pygmaeus Leach, 1825. Type loc.; Dartmoor, Devonshire, England.

Pipistrellus pygmaeus has recently been separated from *P. pipistrellus* (Barrat *et al*., 1997) and the distribution of the two siblings is not quite known as yet (Mayer & Helversen, 2001). Nevertheless, *P. pygmaeus* was confirmed for Cyprus (Hanák *et al*., 2001; Mayer & Helversen, 2001), European Turkey (Benda *et al*., 2003), central and western Anatolia (Mayer & Helversen, 2001), and Marmara region (Dietz *et al*. 2005).

PIPISTRELLUS NATHUSII (KEYSERLING & BLASIUS, 1839)

Occurs also in central Anatolia (Kock *et al*., 1972)

GENUS: *PLECOTUS* GEOFFROY, 1818

The taxonomy of long-eared bats changed fundamentally in the last years and has not become stabilised (Kiefer & Veith, 2002; Kiefer *et al*., 2002; Spitzenberger *et al*., 2001, 2002, 2003; Benda *et al*., 2004). Additional two species have recently been reported fromTurkey, which increases the number of long-eared bat species in the region to four.

PLECOTUS KOLOMBATOVICI ĐULIĆ, 1980

Plecotus austriacus kolombatovici Đulić, 1980. Type loc.: Island of Korčula, Dalmatia, Croatia.

Previous Anatolian records of *P. austriacus* actually belong to *P. kolombatovici* (Spitzenberger *et al*., 2002; Benda & Ivanova, 2003; Benda *et al*., 2004; Juste *et al*., 2004). Four records of *P. kolombatovici* are known so far from Anatolia: Myra (Antalya), Hatay, Muğla, and Içel.

As suggested by Benda *et al*. (2004), *P. kolombatovici* is merely a subspecies of *P. teneriffae*.

PLECOTUS AUSTRIACUS (FISCHER, 1829)

This bat is evidently absent from Anatolia (see above), but is certainly present in Thrace. To wit, *P. kolombatovici* is absent from Bulgaria (Benda & Ivanova, 2003), which means that the earlier reports of *P. austriacus* from Turkish Thrace (Benda & Horáček, 1998) remain valid.

PLECOTUS MACROBULLARIS KUZYAKIN, 1965

Plecotus auritus macrobullaris Kuzyakin, 1965. Type loc.: Ordzhonikidze (= Vladikavkaz), North Ossetian ASSR, Russia, Caucasus.

Spitzenberger *et al*. (2003) report three localities from Anatolia, viz., district of Bitlis, Cilician Taurus, and Nevşehir. Identification was based on partial sequences of the mitochondrial control region and of the *tRNA-Phe* gene. Benda *et al*. (2004) reported additional specimen from Van.

TADARIDA TENIOTIS (RAFINESQUE, 1814)

Occurs also on Cyprus (Boye *et al*., 1990).

SUS SCROFA LINNAEUS, 1758

Introduced to Cyprus in 1990 and subsequently illegally released in 1994. In 1995 the population in the Limassol Forest was estimated at 60–90 animals, but another introduction followed in 1996 to the Troodos National Forest. See Hadjisterkotis (2000) for details.

GENUS: *GAZELLA* DE BLAINVILLE, 1816

Although Turan (1984) states only *Gazella subgutturosa* for Turkey, we followed Harrison & Bates (1991) and also included *G. dorcas* in the list of Turkish mammals. It was indicated, however, that the distributional range of the latter species in eastern Mediterranean needs thorough revision.

Ölçer (2001) claims that *G. subgutturosa* is the only gazelle species in Turkey. In his view, reports of *G. dorcas* from the Adana region have not been confirmed and are thus erroneous. As a consequence, *Gazella dorcas* is to be deleted from the country's list of mammalian species. For a historical report, however, see Danford (1880) who stated *G. dorcas* for Ceyhan plains near Adana. This problem was discussed also by Kumerloeve (1975).

Ölçer (2001) states that *G. subgutturosa* was historically restricted to south-eastern Anatolia, but not to the vicinity of Adana, to Hatay (both in the Taurus region) and to easternmost Anatolia, as reported by Turan (1984). The conclusions of Ölçer (2001) contradict historical records given by Kasparek (1986), according to which gazelles did occur in Central Anatolia as late as 1800s. At present, *G. subgutturosa* populates only a small area around Ceylanpınar.

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SESALCI TURČIJE IN CIPRA
Rodentia I: Sciuridae, Dipodidae, Gliridae, Arvicolinae

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POVZETEK

Glodalci (Rodentia) so najobsežnejši sesalčji razred, tako globalno, kot na proučevanem območju. Od 141 vrst sesalcev, zabeleženih za Turčijo in Ciper (Kryštufek & Vohralík, 2001), jih 60 (= 43%) sodi med glodalce. Pričujoče delo obravnava približno polovico glodalcev (31 vrst) iz družin veveric (Sciuridae), skakačev (Dipodidae) in polhov (Gliridae) ter iz poddružine voluharic (Arvicolinae), ki sodi v družino miši (Muridae). Vse skupine uvrščamo v podred Sciurognathi, nobena od njih pa nima predstavnikov na Cipru.

Delo temelji na materialu, ki sta ga avtorja, skupaj s sodelavci, zbrala na terenu v letih 1992 – 2005 (prek 2000 primerkov), na pregledu študijskega gradiva v petnajstih muzejih in zasebnih zbirkah v Evropi, Turčiji, Rusiji in ZDA, ter na študiju literature (prek 500 referenc). Avtorja sta pregledala tudi tipske primerke 33 nominalnih taksonov iz Turčije in sosednjih območij. Vsaka vrsta je predstavljena z opisom (zunanje značilnosti, obarvanost, posebnosti genitalnega aparata, opis lobanje in zobovja, kariotip, dimenzije), podatki o spremenljivosti, razširjenosti (vključuje tudi poznavanje fosilnega materiala), z dejstvi o izbiri habitata in s podatki o življenju (skrivališča, dejavnost, populacijska gostota, razmnoževanje, prehrana, plenilci itd.). Besedilo dopolnjuje 251 črno-belih ilustracij (risbe lobanje in zobovja, točkovne arealne karte itd.) in fotografij habitatov. Vsaka vrsta je predstavljena tudi z barvno fotografijo muzejskega primerka.

Veverice so v Turčiji zastopane z dvema rodovoma in s štirimi vrstami. Bosporske ožine so naravna meja, ki ločuje dve vrsti drevesnih veveric in dve tekunici. Navadna veverica (*Sciurus vulgaris*) je avtohtona v gozdovih turške Trakije, njena prisotnost v Anatoliji pa je posledica naselitev na Kavkaz, ki so se začele leta 1928. Kavkaška veverica (*Sciurus anomalus*) je dokaj razširjena v Anatoliji, po razpoložljivih podatkih pa jo je človek zanesel tudi v Trakijo. Čeprav je manj kot prejšnja vrsta odvisna od gozda s sklenjeno plastjo krošenj, v stepskih habitatih brez dreves, ne more obstati. Kavkaška veverica živi tudi na dveh otokih v vzhodnem Egejskem morju: Lesbos in Bozcaada.

Tekunice so čokate veverice, prilagojene na odprte travniške ekosisteme. Evropska tekunica (*Spermophilus citellus*) živi v Trakiji, kjer je zastopana z endemično podvrsto (ssp. *thracius*), katera se odlikuje po nekaterih starinskih značilnostih. Anatolska tekunica (*Spermophilus xanthoprymnus*) je endemit Male Azije; le neznaten del njenega areala se nahaja v zahodni Armeniji. Morfološko in kromosomsko vrsta ni enotna.

Skakači imajo v Turčiji tri vrste. Williamsov skakač (*Allactaga williamsi*) naseljuje suha območja osrednje in vzhodne Anatolije, odkoder seže še v Armenijo, Azerbajdžan, Nahičevan in zahodni Iran; majhen osamelec nejasne taksonomske opredelitve (ssp. *caprimulga*) se nahaja tudi v Afganistanu. Preostali dve vrsti sta v Turčiji le obrobni. Eufratski skakač (*Allactaga euphratica*) živi v puščavskih območjih vzdolž meje s Sirijo in Irakom, mali petprsti skakač (*Allactaga elater*) pa je znan z enega samega nahajališča v vzhodni Anatoliji (Aralık v bazenu Aras).

Kavkaz je bil pomemben center speciacije, številne vrste ki so endemične za to pogorje pa obrobno segajo tudi v severovzhodno Turčijo. Nedavno so turški raziskovalci (Yiğit *et al.*, 2003a) navedli kavkaško brezovo miš (*Sicista caucasica*) za 'Kars in Ardahan'. Rod *Sicista* je na Kavkazu zastopan s štirimi endemičnimi in alopatričnimi vrstami, ki se razlikujejo le v posebnostih kariotipa. Citirana navedba je vprašljiva, saj iz objave ni razvidno, na čem temelji določitev. Poleg tega se areal kavkaške vrste nahaja najdlje od turške meje, zato domnevamo, da je v Turčiji verjetnejša prisotnost armenske brezove miši (*Sicista armenica*).

V Turčiji živi več vrst polhov, kot v katerikoli drugi državi. Navadni polh (*Glis glis*) naseljuje gozdove Trakije in črnomorskega obrežja. Čeprav so populacije, razmejene z bosporskimi ožinami, formalno uvrščene v dve različni podvrsti, pa so morfološke razlike med njimi majhne. Podlesek (*Muscardinus avellanarius*) je znan samo z obrežja Črnega morja, medtem ko v turški Trakiji doslej še ni bil najden. Drevesni polhi so zastopani z dvema vrstama. Navadni drevesni polh (*Dryomys nitedula*) je široko razširjen v Anatoliji in Trakiji, je pa presenetljivo redek v pogorju Istranca. Med populacijami obstajajo znatne razlike v obarvanosti, velikosti, telesnih razmerjih in v velikosti bobničnega mehurja. Najbolj samosvoje so živali iz visokogorskega pasu v Hakarriju. Anatolski drevesni polh (*Dryomys laniger*) je endemičen za Malo Azijo. Največ nahajališč te redke vrste je znanih iz pogorja Taurus, areal pa se na vzhodu razteza vse do Erzincana in Elazığa. Edini podatek o prisotnosti azijskega vrtnega polha (*Eliomys melanurus*) v Turčiji sega v leto 1955, ko je Misonne (1957) opazoval primerek v Harranu, južno od mesta Urfa. V Turčiji živita tudi dve, od skupno treh vrst izjemno redkih tankorepih polhov. Roachov tankorepi polh (*Myomimus roachi*) je znan iz nižinske Trakije (od koder seže tudi v sosednjo Bolgarijo) in iz zahodne Anatolije. Vse do bronaste dobe je naseljeval tudi Taurus. V pleistocenu je areal vrste na jugu segal do Izraela, njegovo krčenje v zadnjih tisočletjih pa je verjetno posledica degradacije okolja. Setzerjev tankorepi polh (*Myomimus setzeri*) je še redkejši od svojega sorodnika iz Trakije. Znan je z vsega nekaj nahajališč v pogorju Zagros (severozahodni Iran) in iz sosednjih območij vzhodne Anatolije.

Voluharice so v Turčiji z vrstami najbogatejša skupina družine Muridae. V stepah vzhodne Anatolije, severozahodnega Irana in Armenije živi južna podzemna voluharica (*Ellobius lutescens*), ena od dveh podzemskih voluharic, značilnih za turško favno. Druga vrsta je šapošnikovova voluharica (*Prometheomys schaposchnikowi*), kavkaški endemit, ki je v Turčiji znan samo z omejenega goratega območja med Artvinom in Ardahanom. Gozdna voluharica (*Clethrionomys glareolus*) ima podoben areal kot podlesek. Naseljuje vlažne gozdove na območju Marmornega morja in v črnomorskih gorah; izolirana populacija se nahaja še na gori Uludağ. Morfološko vrsta ni enotna, razlike med populacijami pa so očitne v velikosti, obarvanosti in v razmerjih lobanje. Veliki voluhar (*Arvicola terrestris*) je v Trakiji in Anatoliji sicer široko razširjen, vseeno pa je znanih razmeroma malo nahajališč. Vrsta je vezana na gosto rastlinje ob vodah.

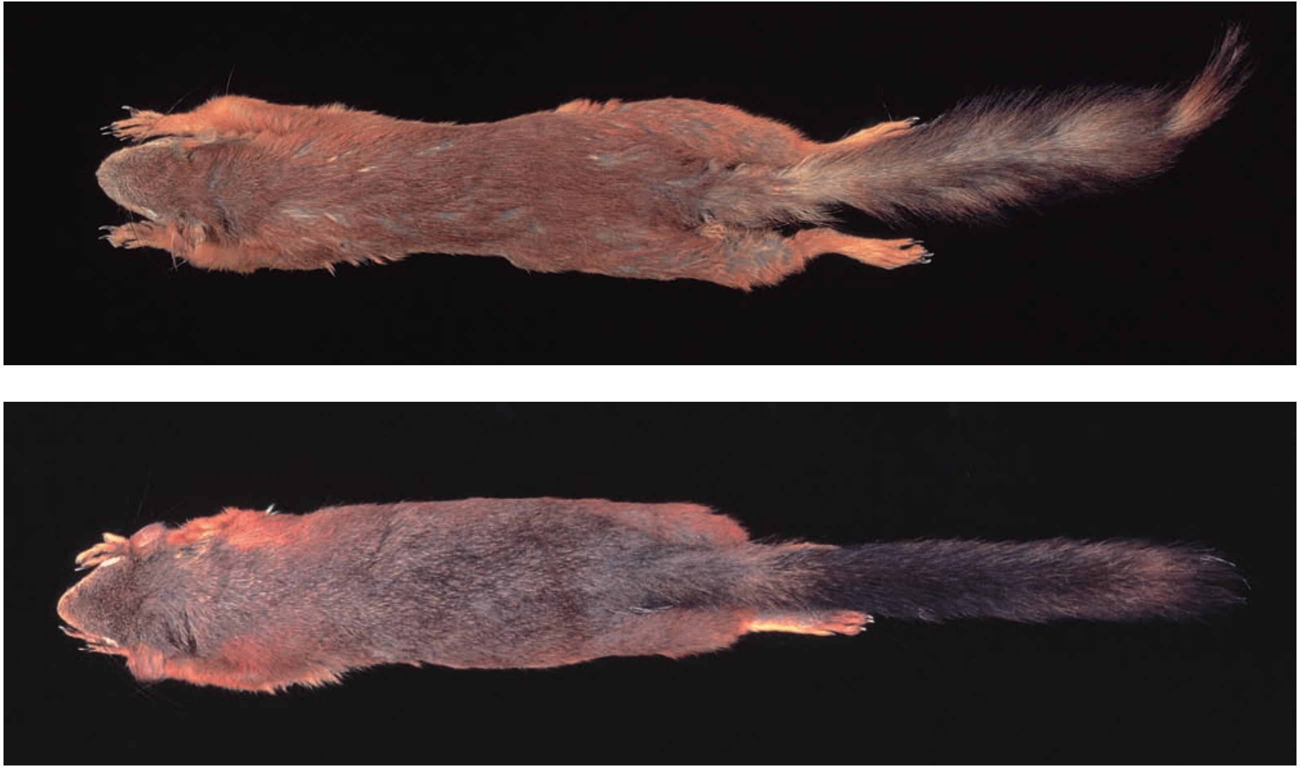
Večino voluharic turške favne uvrščamo v rod *Microtus*, ki ga delimo na tri skupine: vrtne voluharice, poljske voluharice in na socialne voluharice. Morfološko razlikovanje med vrstami je težavno, zato sistematika v veliki meri temelji ne značilnostih kariotipa. Vrtne voluharice imajo v Turčiji tri vrste. Navadna vrtna voluharica (*Microtus subterraneus*) živi sklenjeno v severni Trakiji in v gorah črnomorskega obrežja, izolirane populacije pa so v zahodni Anatoliji in v pogorju Taurus. Majorjeva vrtna voluharica (*Microtus majori*) je endemit Kavkaza in severovzhodnih črnomorskih gora. V Turčiji seže na zahodu do reke Kızılırmak. Južna meja razširjenosti ni zanesljivo znana, verjetno pa vrsta živi do jezera Van in naprej v severozahodnem Iranu. Dagestanska vrtna voluharica (*Microtus daghestanicus*), ki je prav tako endemična za Kavkaz, seže samo v skrajno severovzhodno Turčijo. Skupina poljskih voluharic je v Turčiji zastopana z dvema vrstama dvojčicama. Altajska voluharica (*Microtus obscurus*) je zelo sorodna poljski voluharici (*Microtus arvalis*) in morda z njo tudi identična. V Turčiji se pojavlja v visokih legah vzhodne Anatolije. Južna poljska voluharica (*Microtus rossiaemeridionalis*) je splošno razširjena v Trakiji, v osrednji in vzhodni Anatoliji ter vzdolž črnomorske obale. Leta 2004 smo na Taurusu odkrili izolirano populacijo. Sistematska ureditev socialnih voluharic je vse prej kot dokončna. Za Turčijo navajamo štiri vrste, ki so jasno opredeljeni z diploidnim številom kromosomov. Güntherjeva voluharica (*Microtus guentheri*) naseljuje Trakijo in večino Male Azije, z izjemo severovzhodne Anatolije. Med populacijami obstajajo jasne morfološke razlike; živali na vzhodu so manjše, imajo nižjo lobanjo, večji bobnični mehur in kompleksnejši vzorec skleninskih pentelj na drugem zgornjem meljaku. Socialna voluharica (*Microtus socialis*), ki je manjša in bolj dolgorepa, živi v vzhodnem delu Anatolije, do Kirşehirja na zahodu. Preostali dve vrsti socialnih voluharic sta endemični za osrednjo Anatolijo. Dogramacijeva voluharica (*Microtus dogramaci*) je znana s treh nahajališč, anatolska voluharica (*Microtus anatolicus*) pa z enega samega kraja, ki se nahaja v najbolj sušnem območju ob jezeru Tuz (Aksaray Ovası).

Kavkaz in črnomorske gore so očitno center razvoja snežni voluharic; tam tudi živijo vse tri vrste rodu. Nahajališča evropske snežne voluharice (*Chionomys nivalis*) so raztresena po celotni Mali Aziji. Ker je vrsta vezana na skalnata mesta, navadno v višjih legah, so posamezne populacije izolirane. Podoben način življenja ima tudi gudavrska snežna voluharica (*Chionomys gud*), ki živi samo v gorah na severovzhodu Anatolije. Robertova snežna voluharica (*Chionomys roberti*) je vezana na gozdni pas vzhodnih črnomorskih gora; na zahodu seže do reke Yeşilırmak.

V dodatku avtorja podajata popravke, dopolnila in nove podatke za vrste, ki sta jih obravnavala v prvem zvezku »Sesalcev Turčije in Cipra« (Kryštufek & Vohralík, 2001). V sklop vrste *Talpa davidiana* uvrščata *Talpa chthonia* iz zgornjega pleistocena Izraela.

COLOR PLATES

Plate I/1



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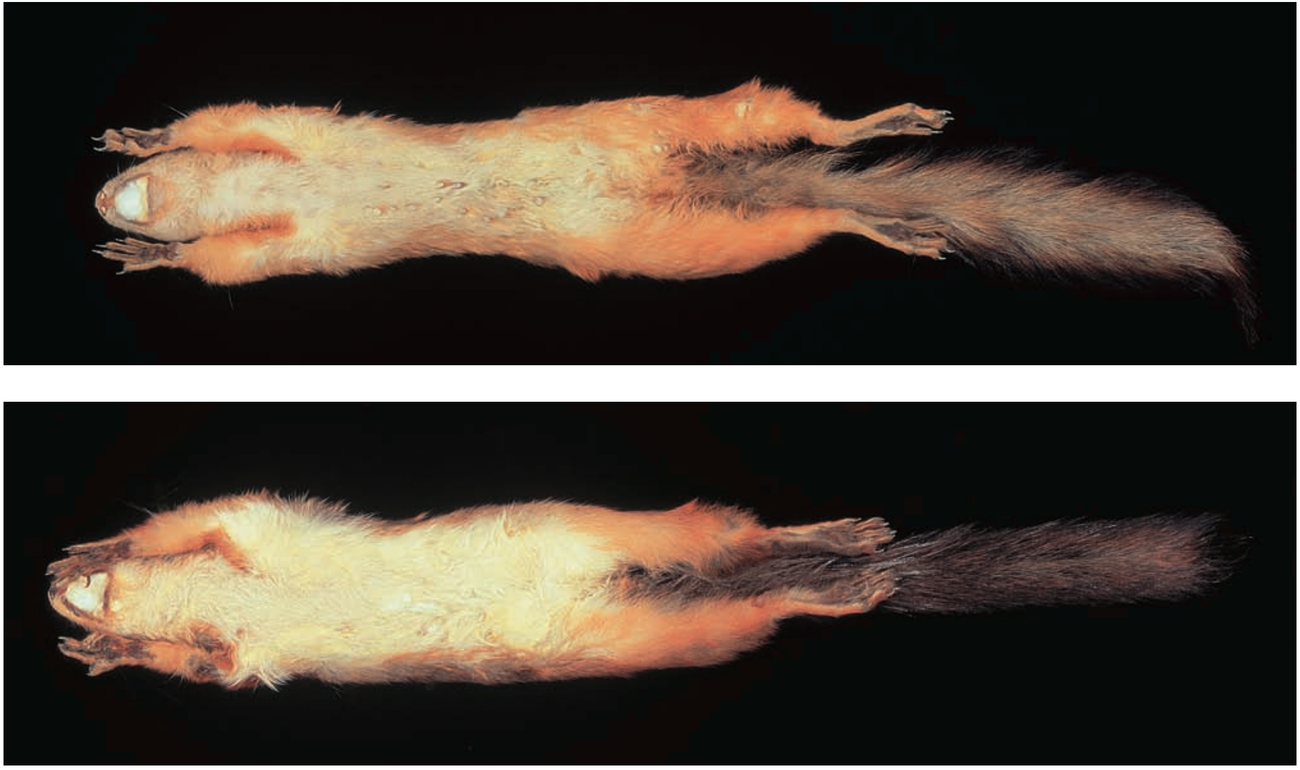

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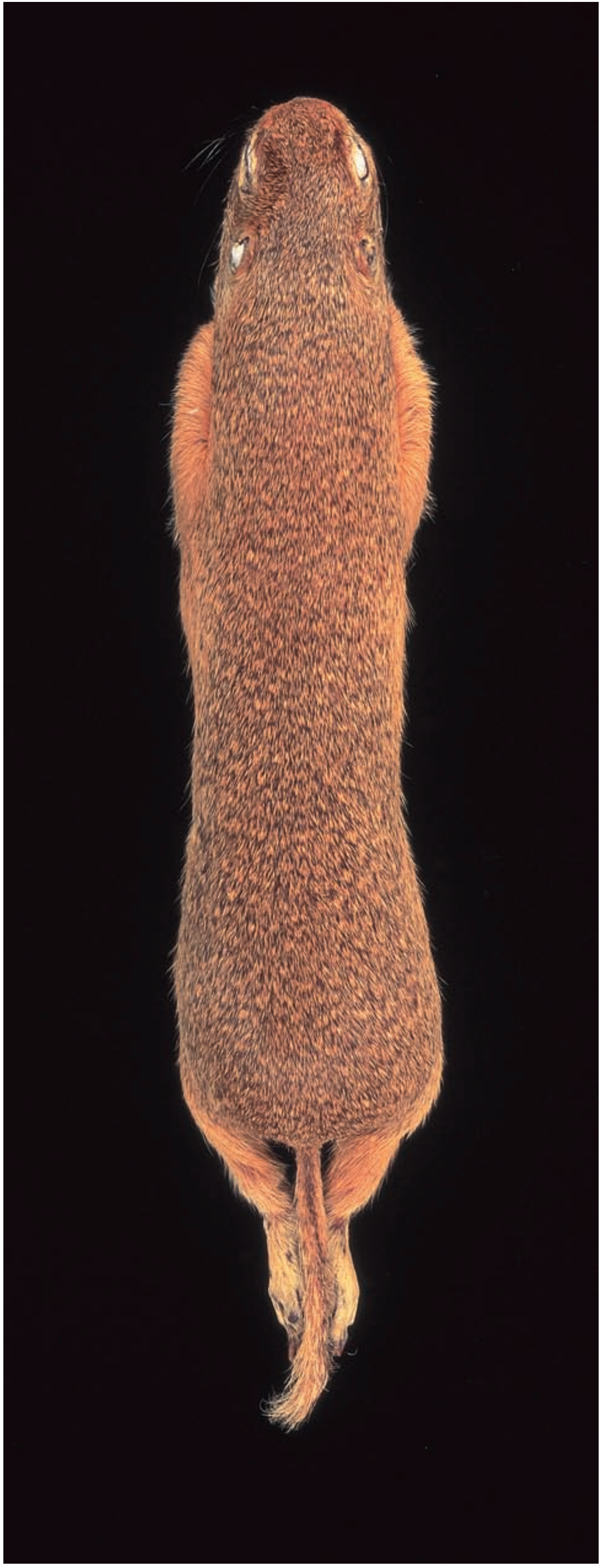

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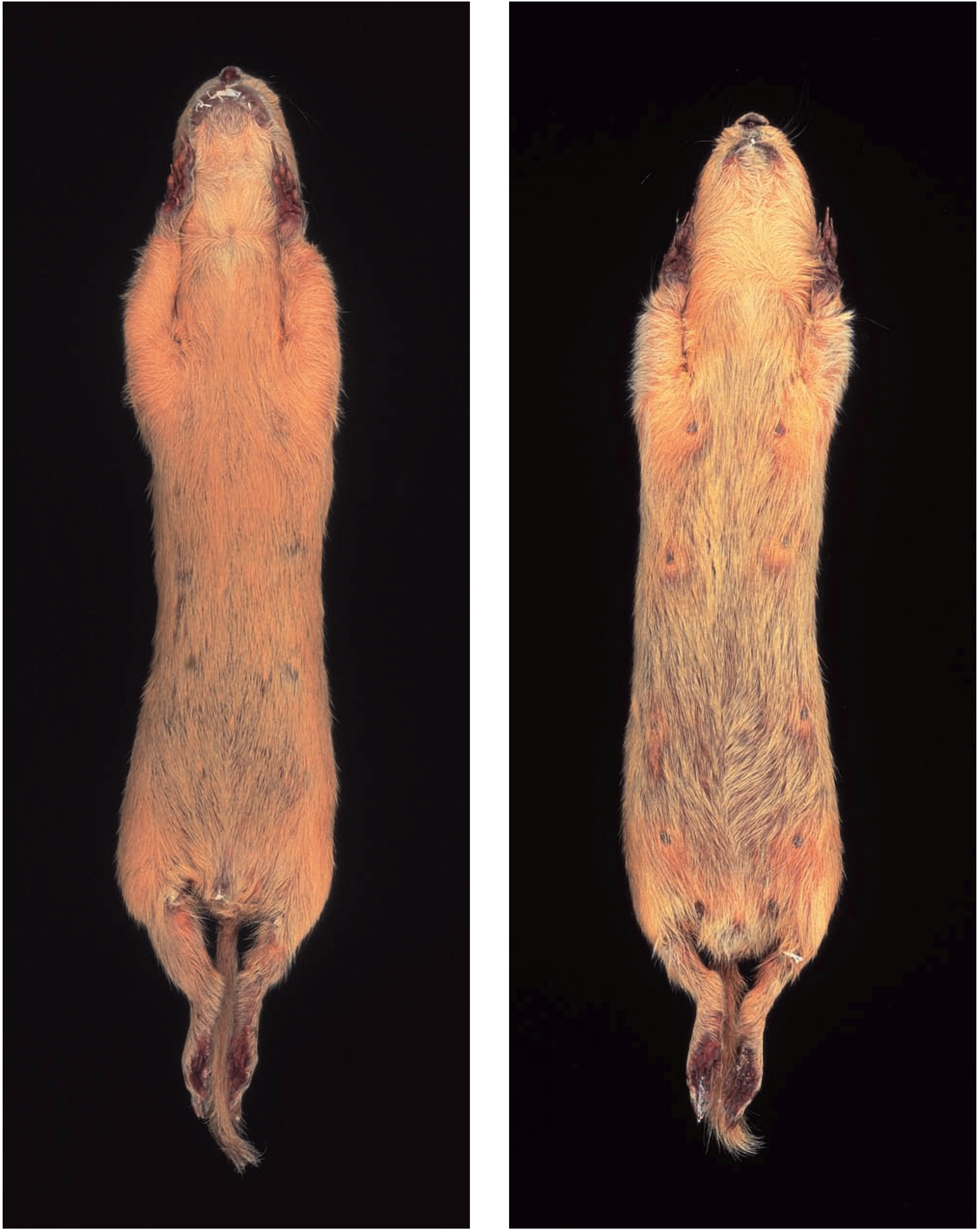

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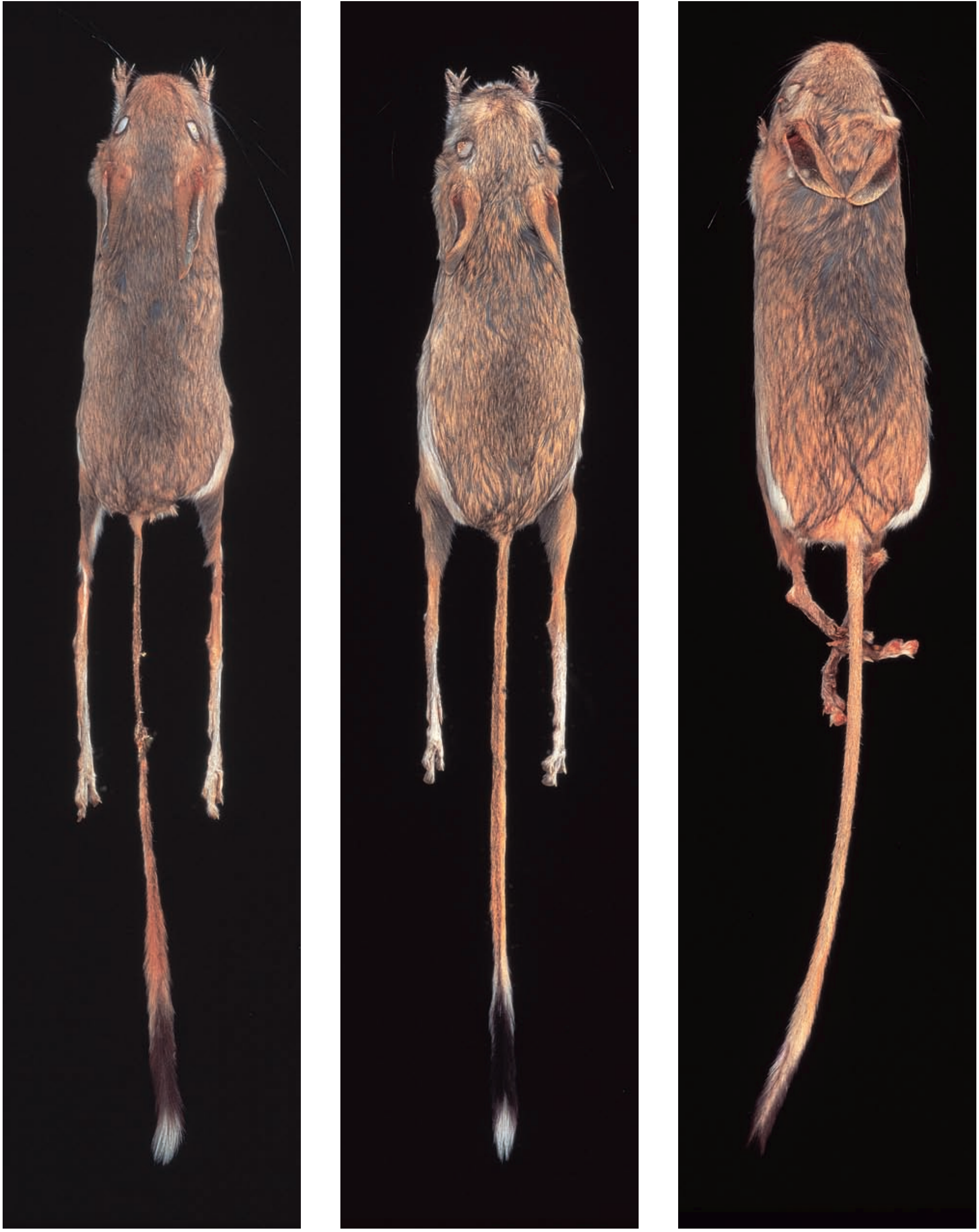
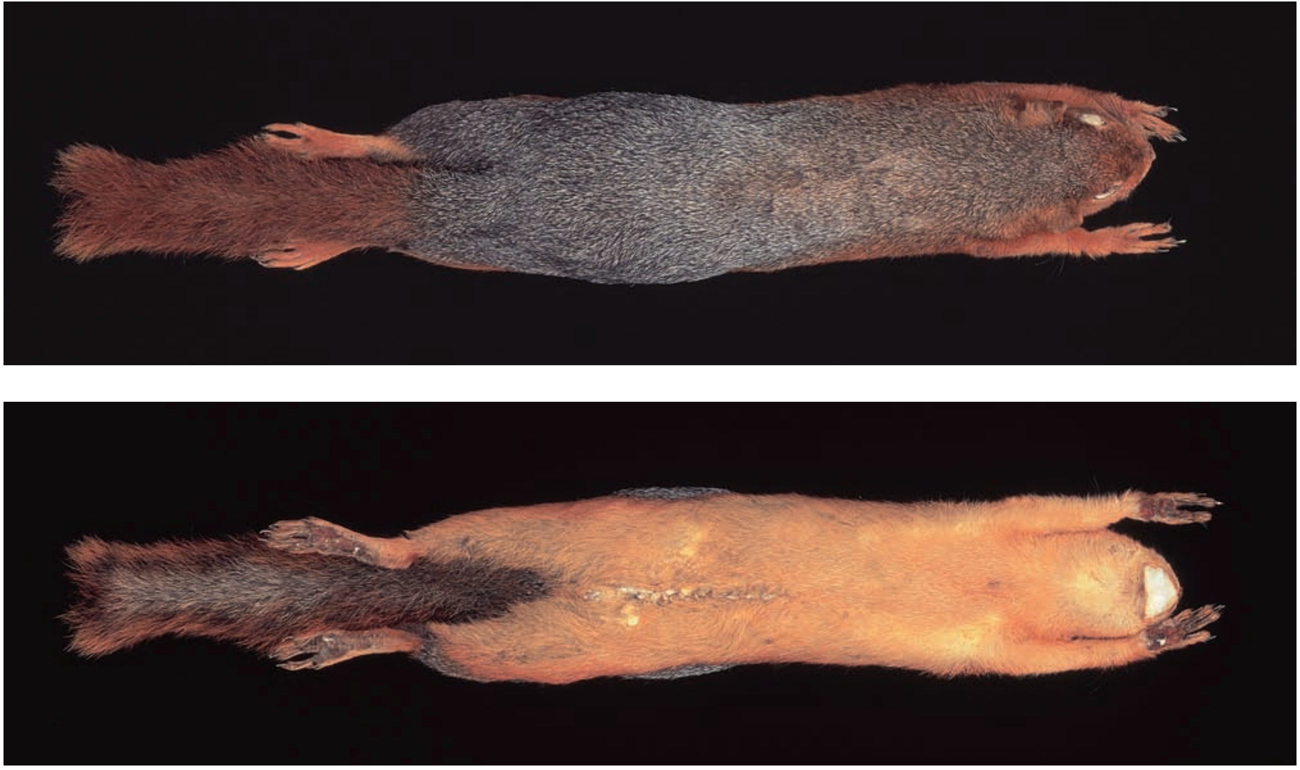


PLATE V

Plate VI/1



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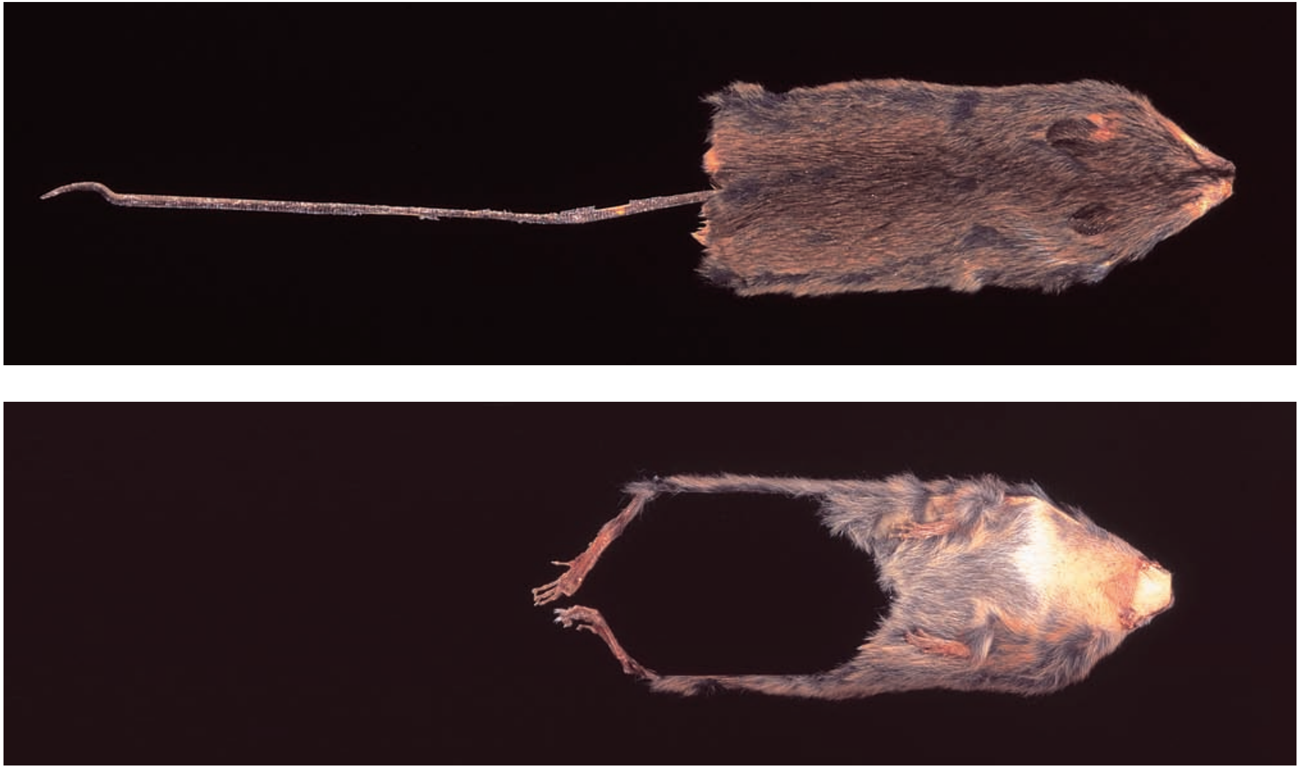

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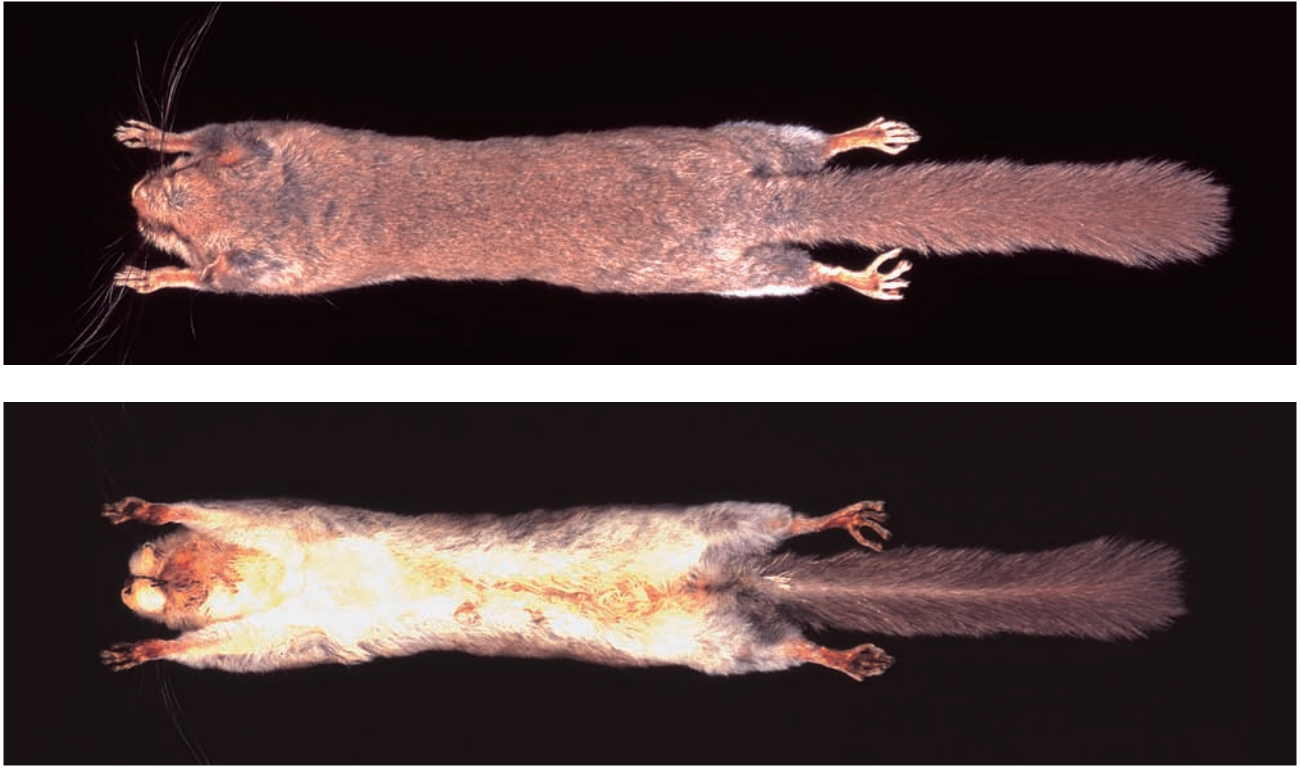

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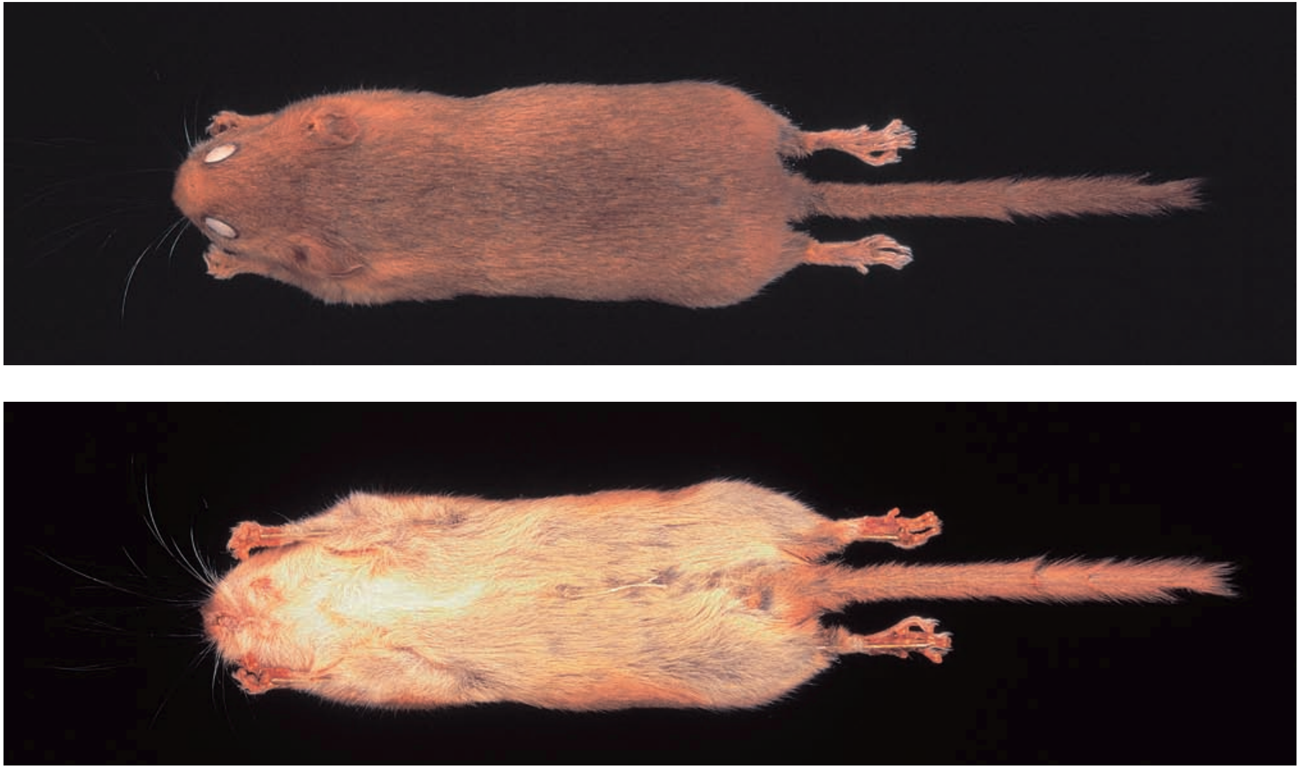

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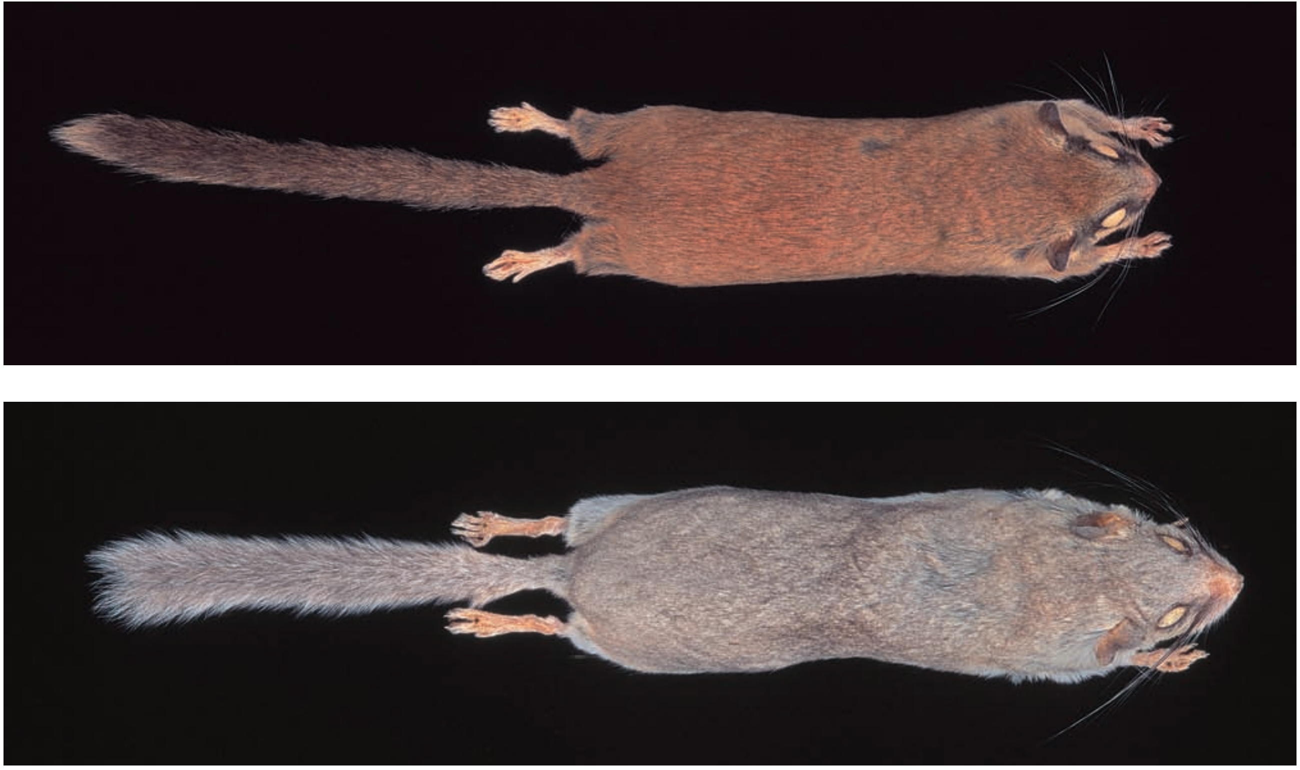

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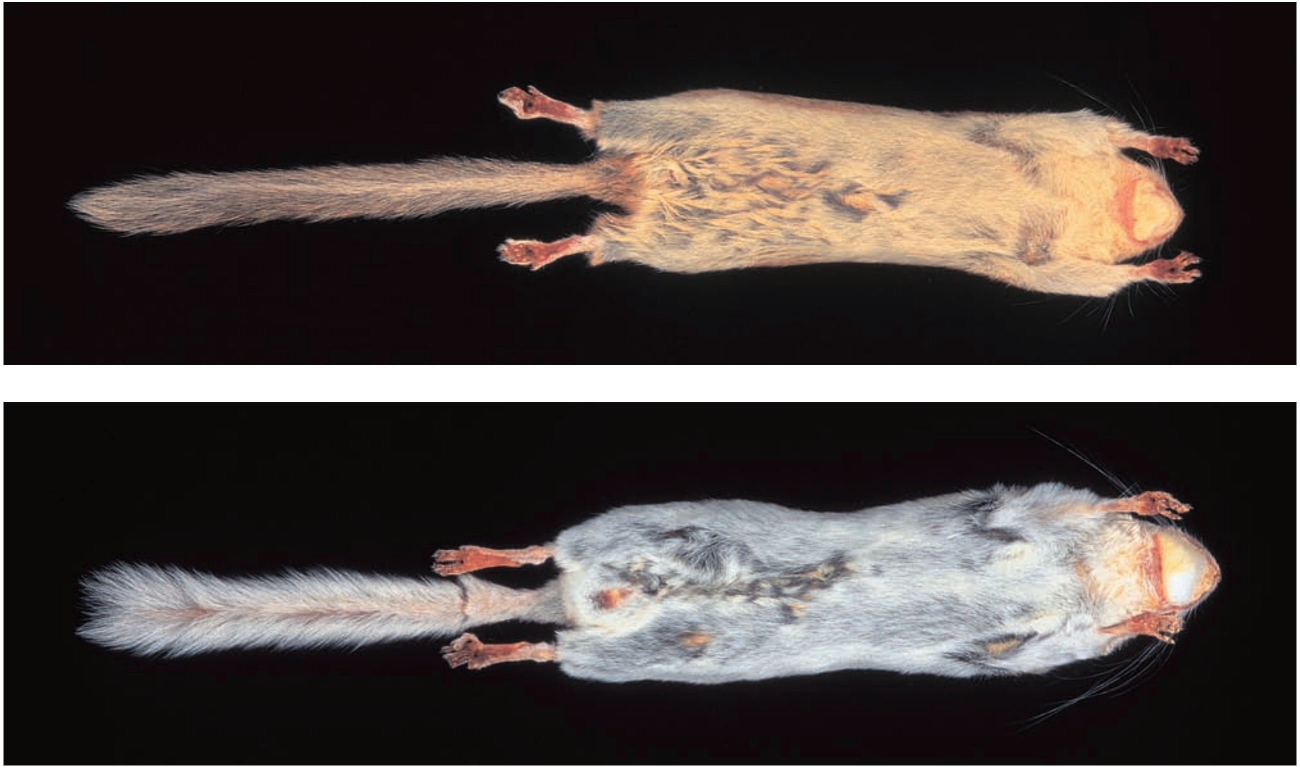

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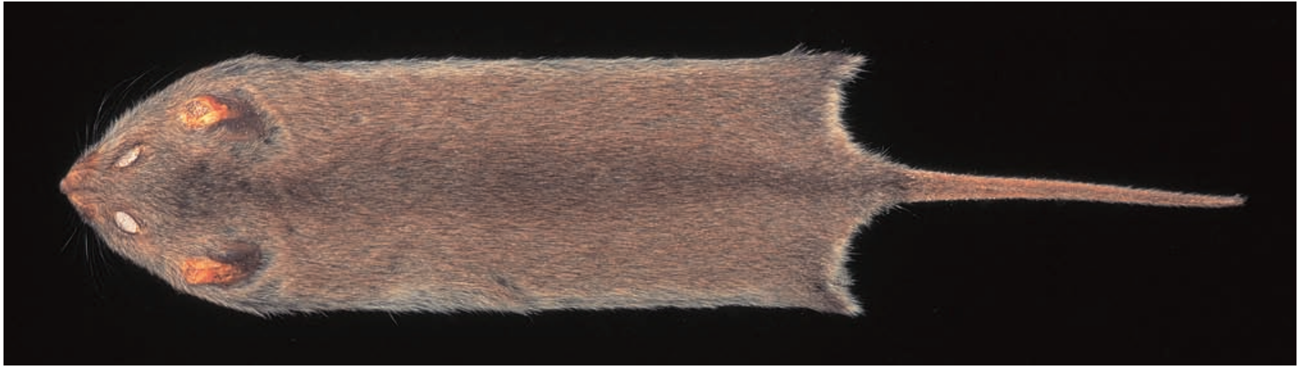

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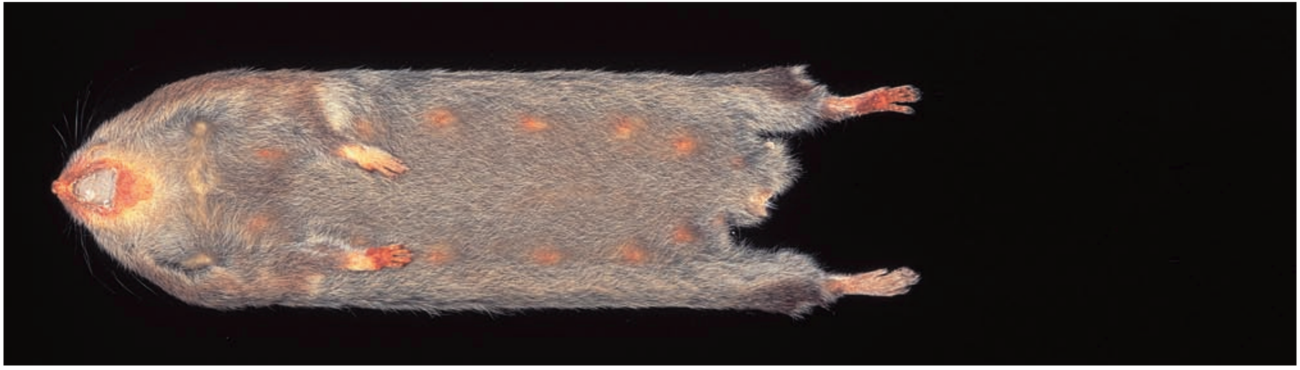

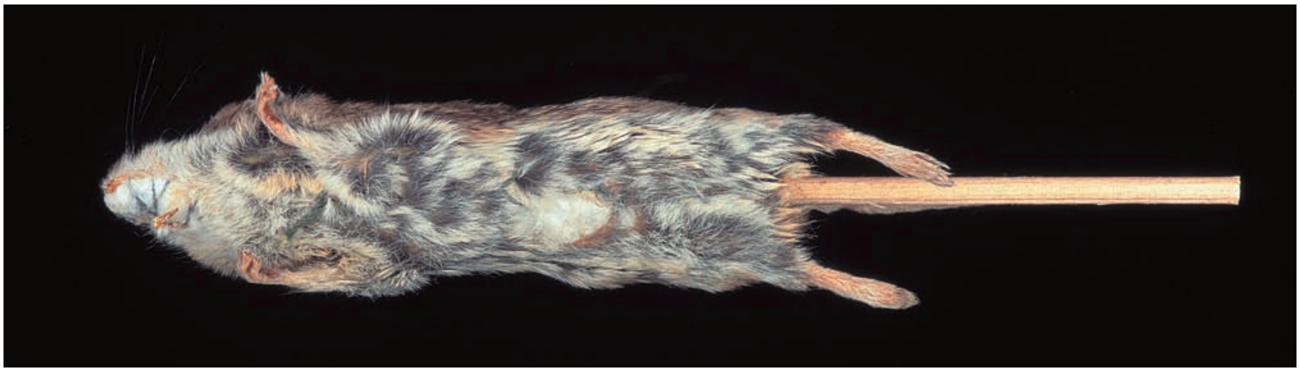

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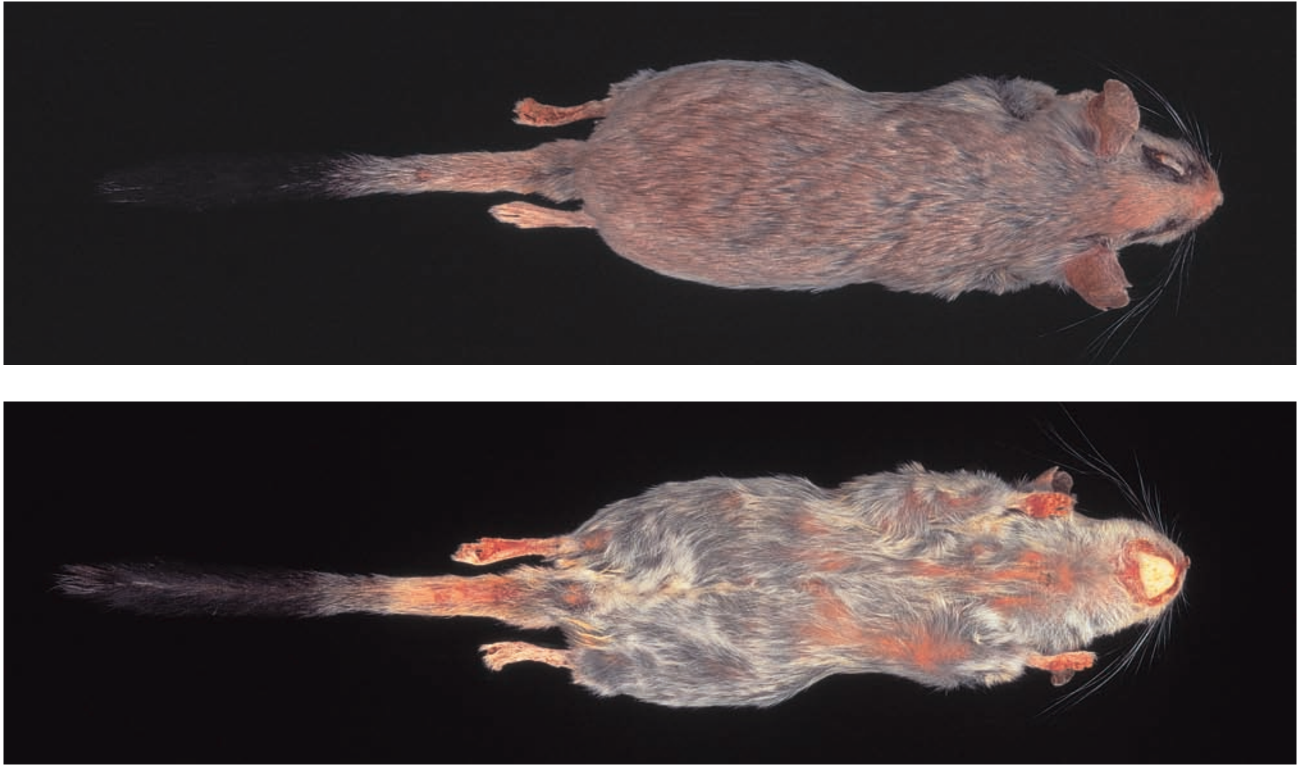

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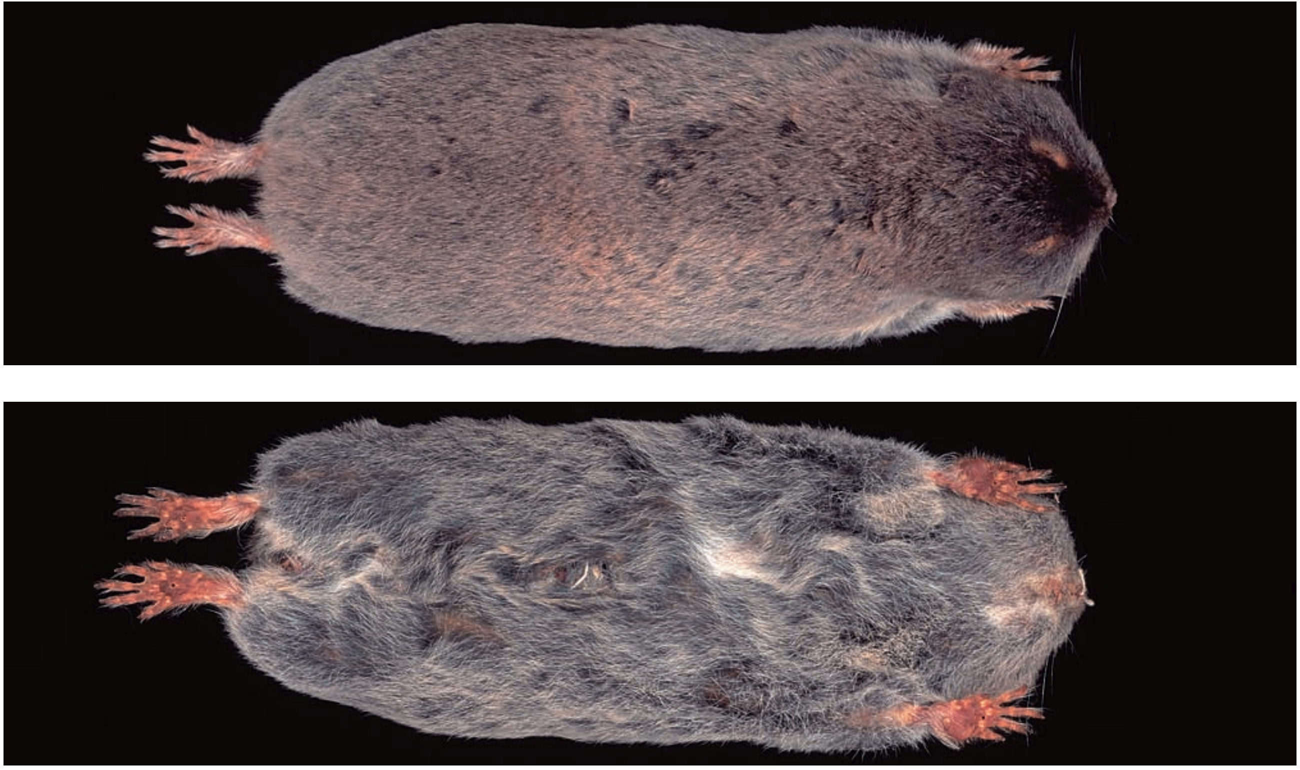

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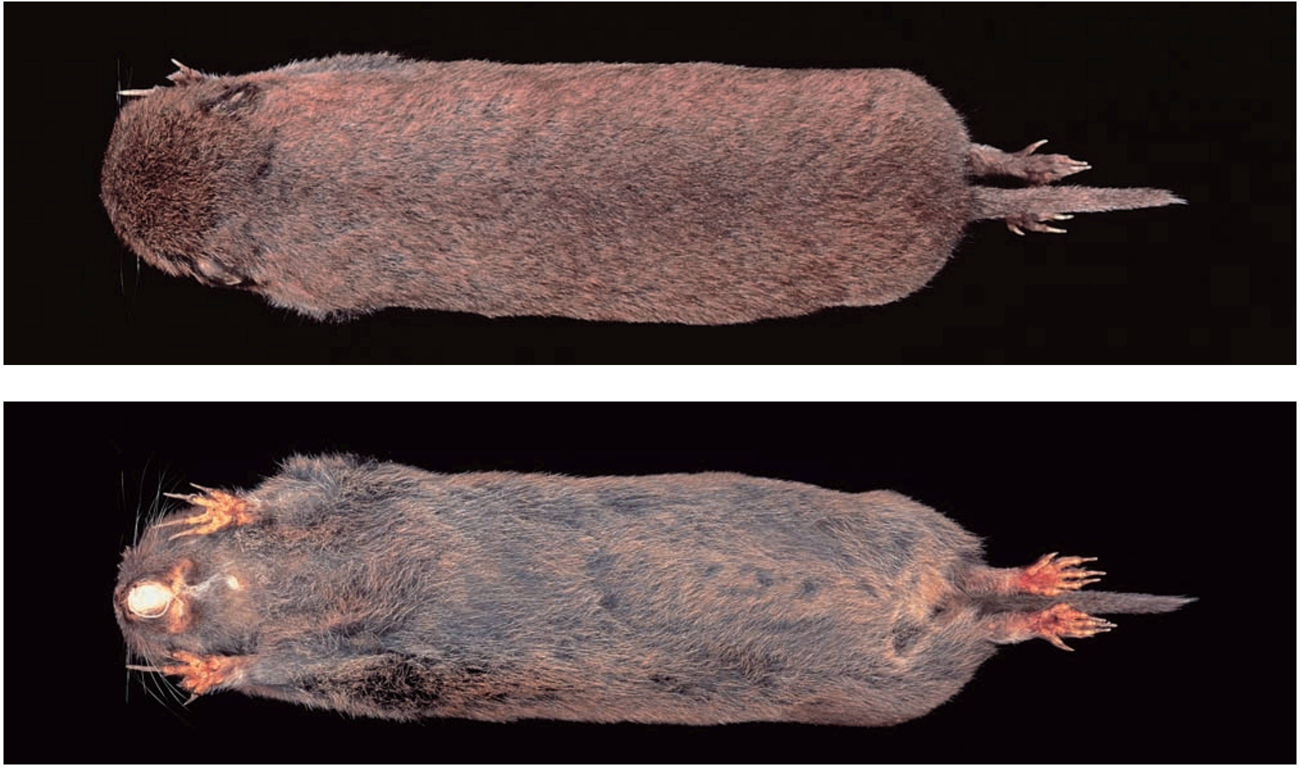

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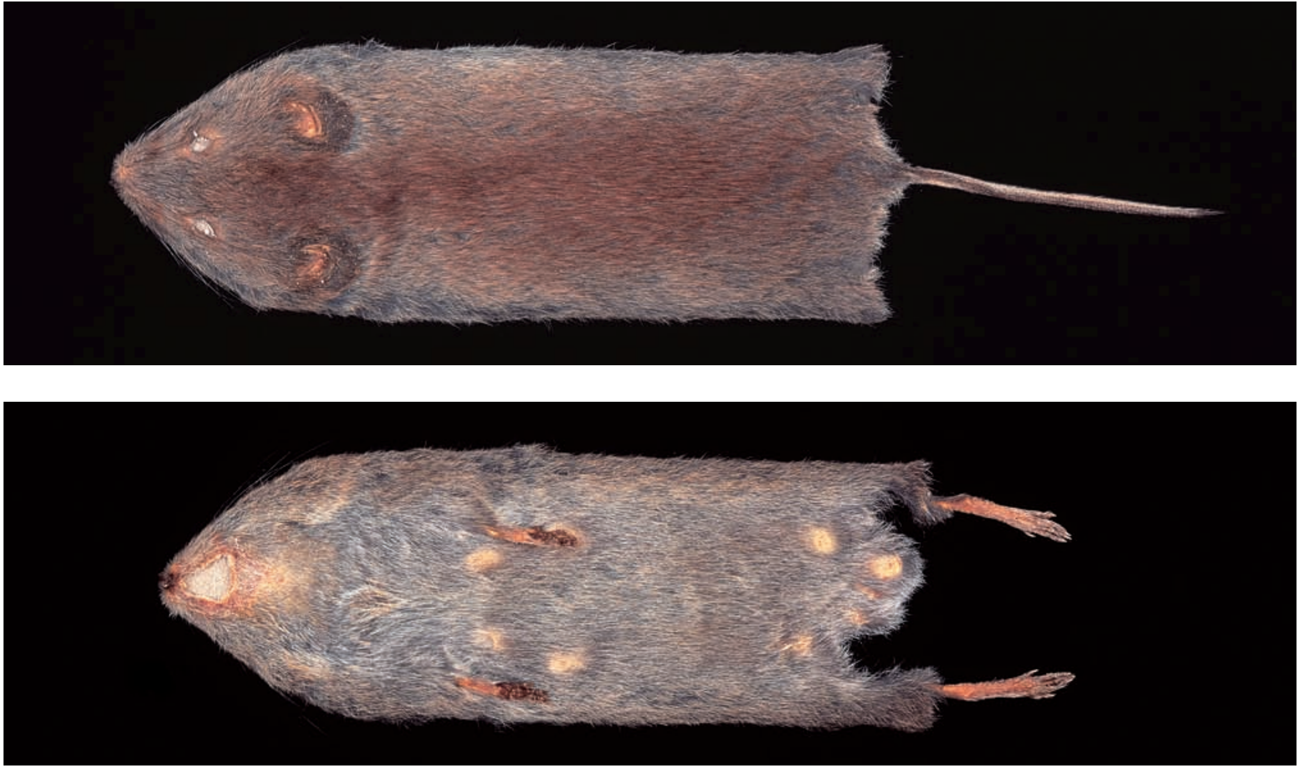

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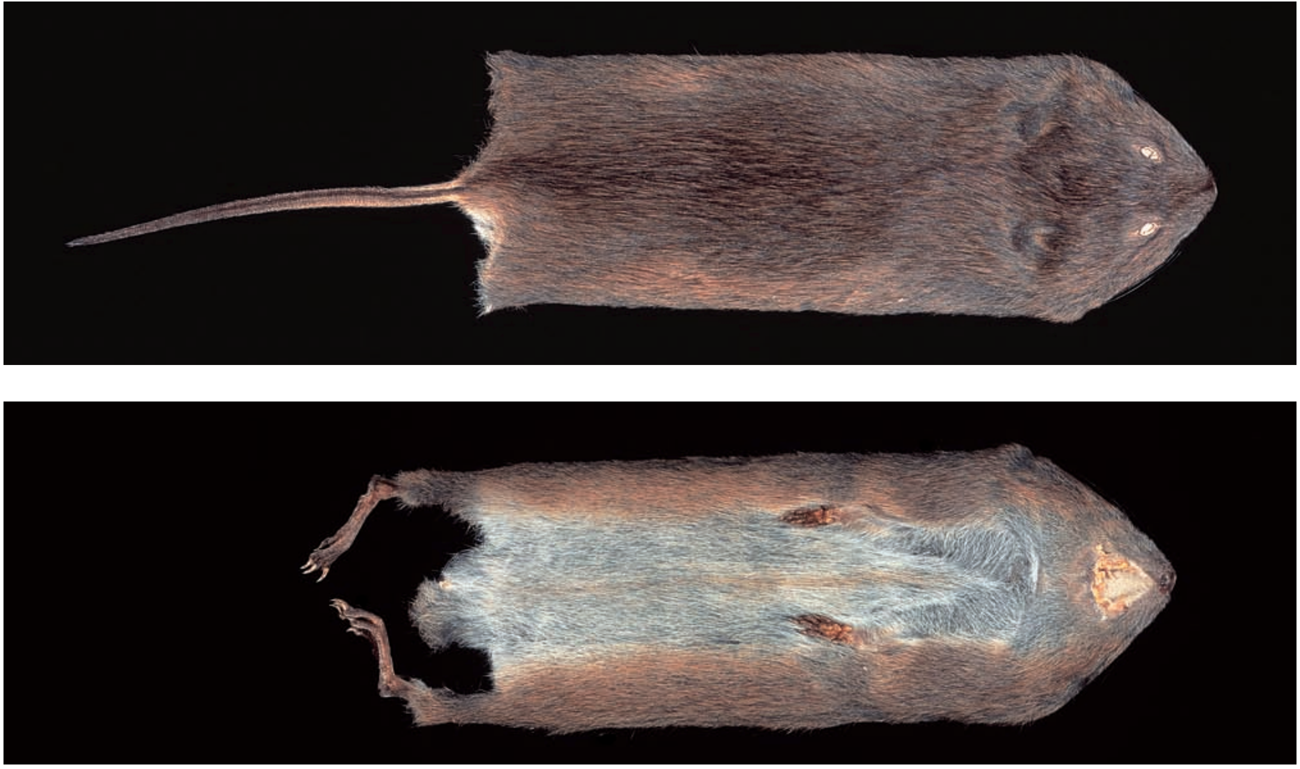

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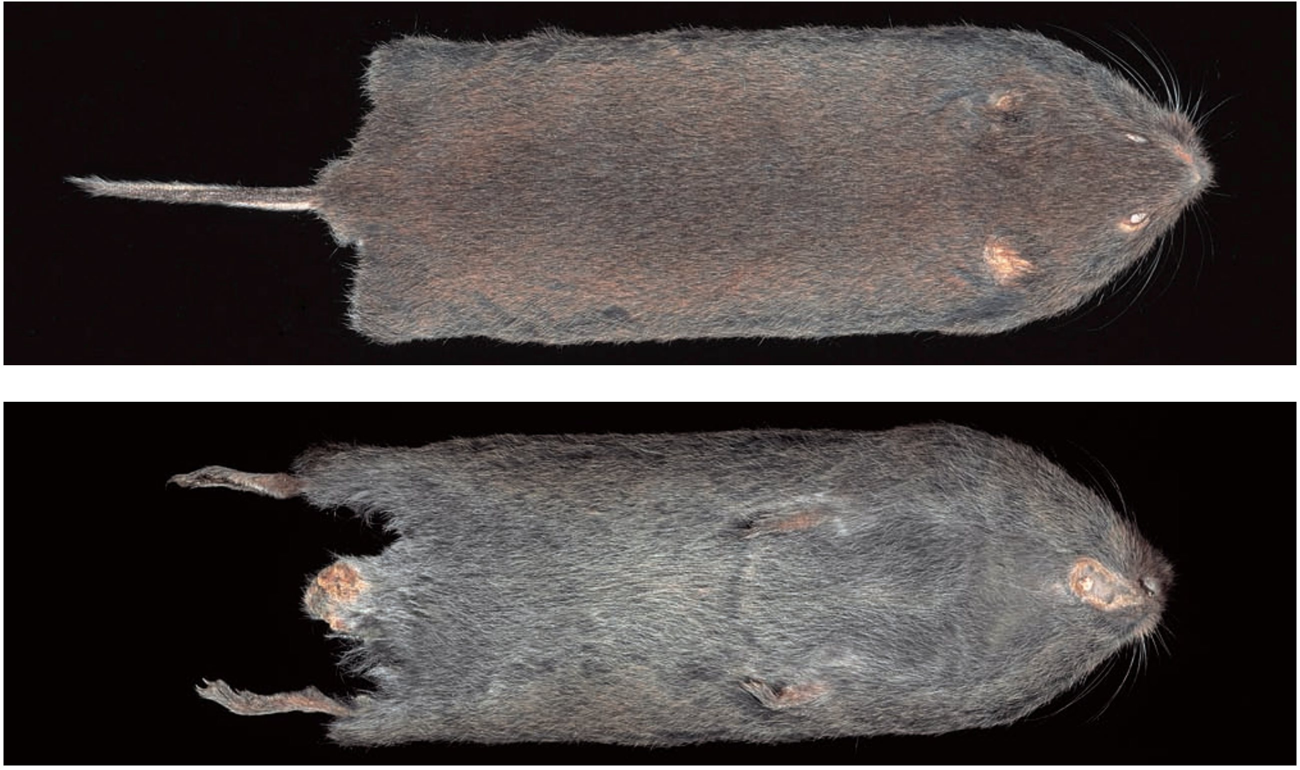

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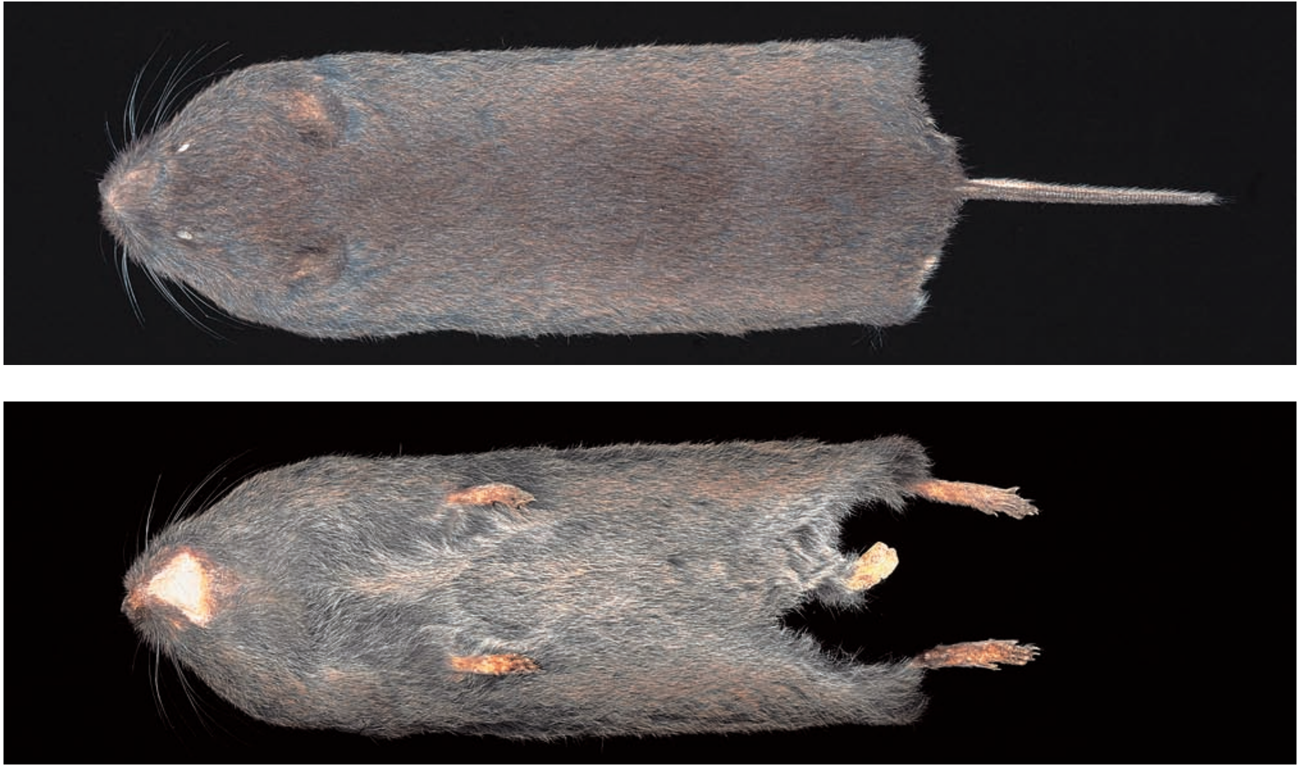

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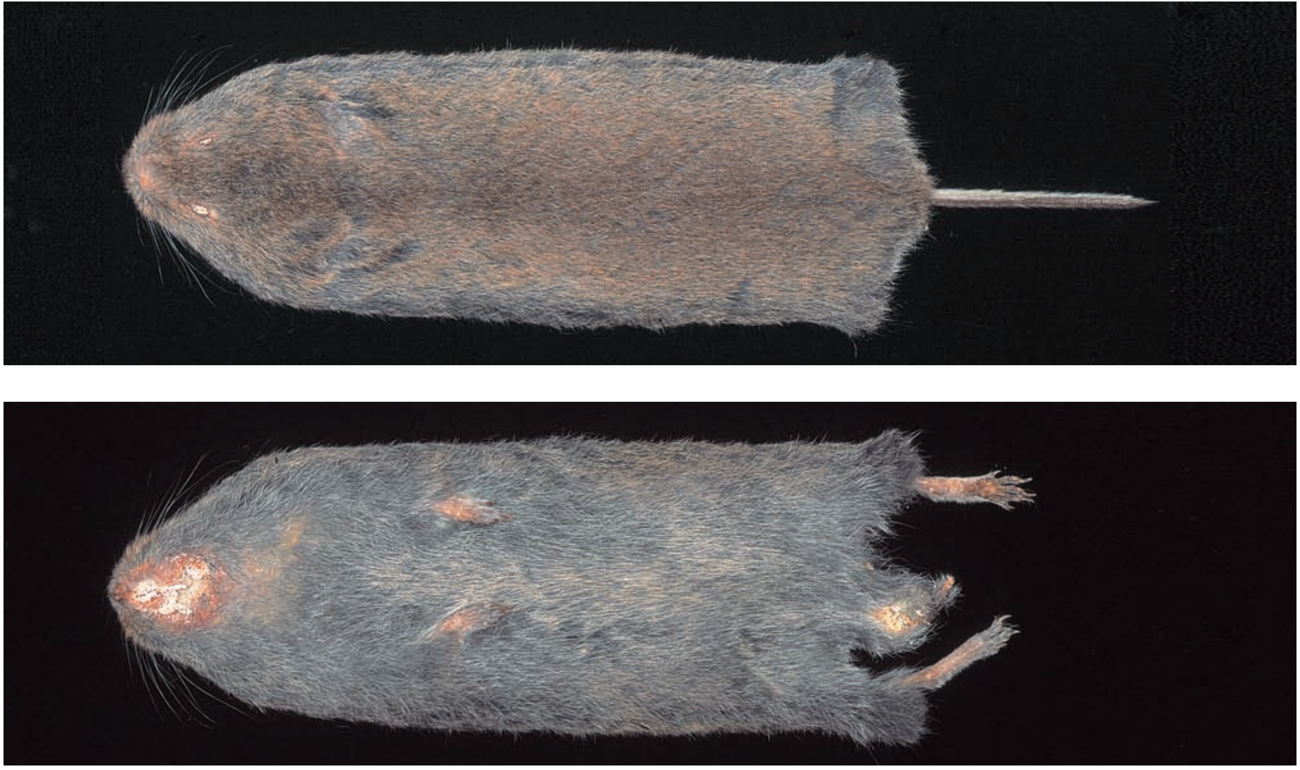

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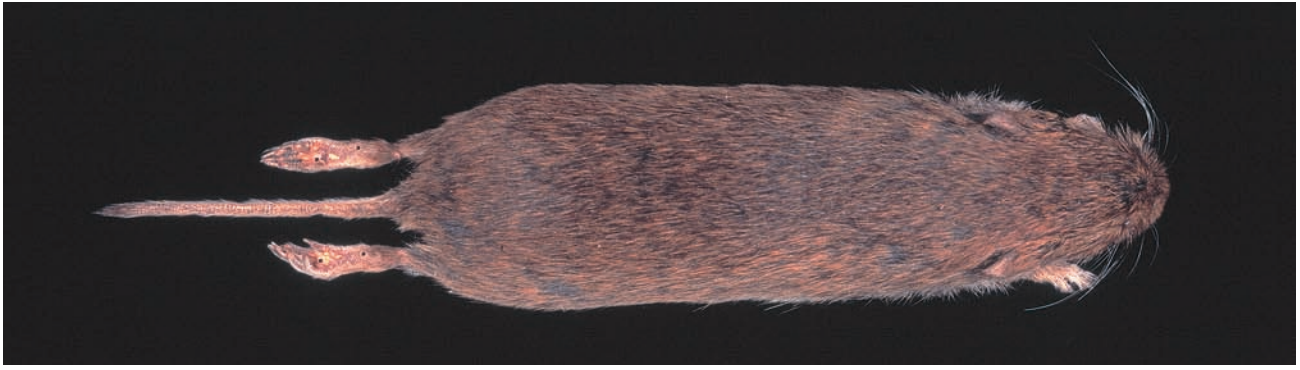


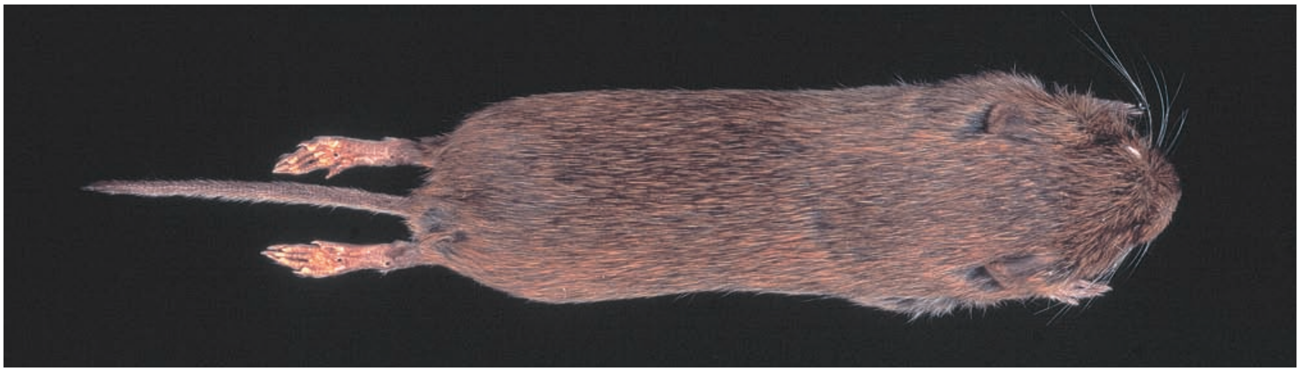


PLATE XIV/2

Plate XV/1

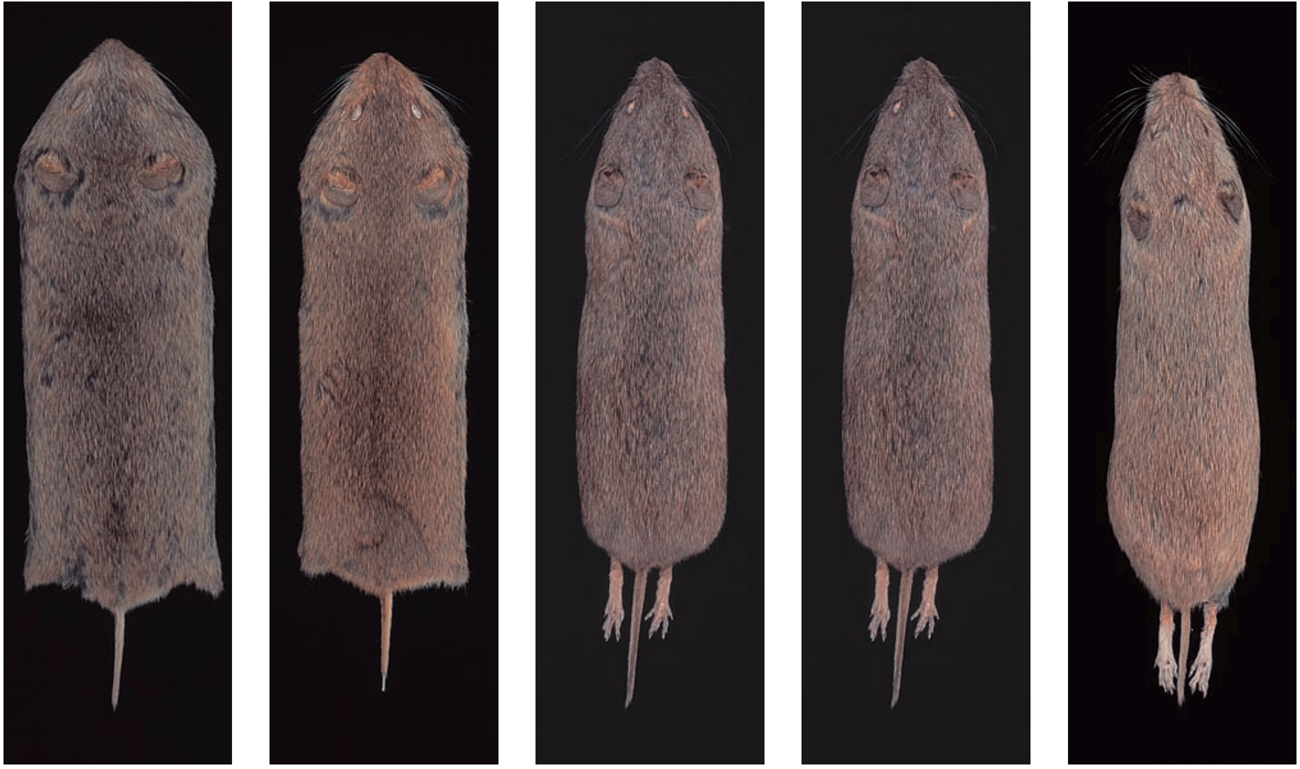
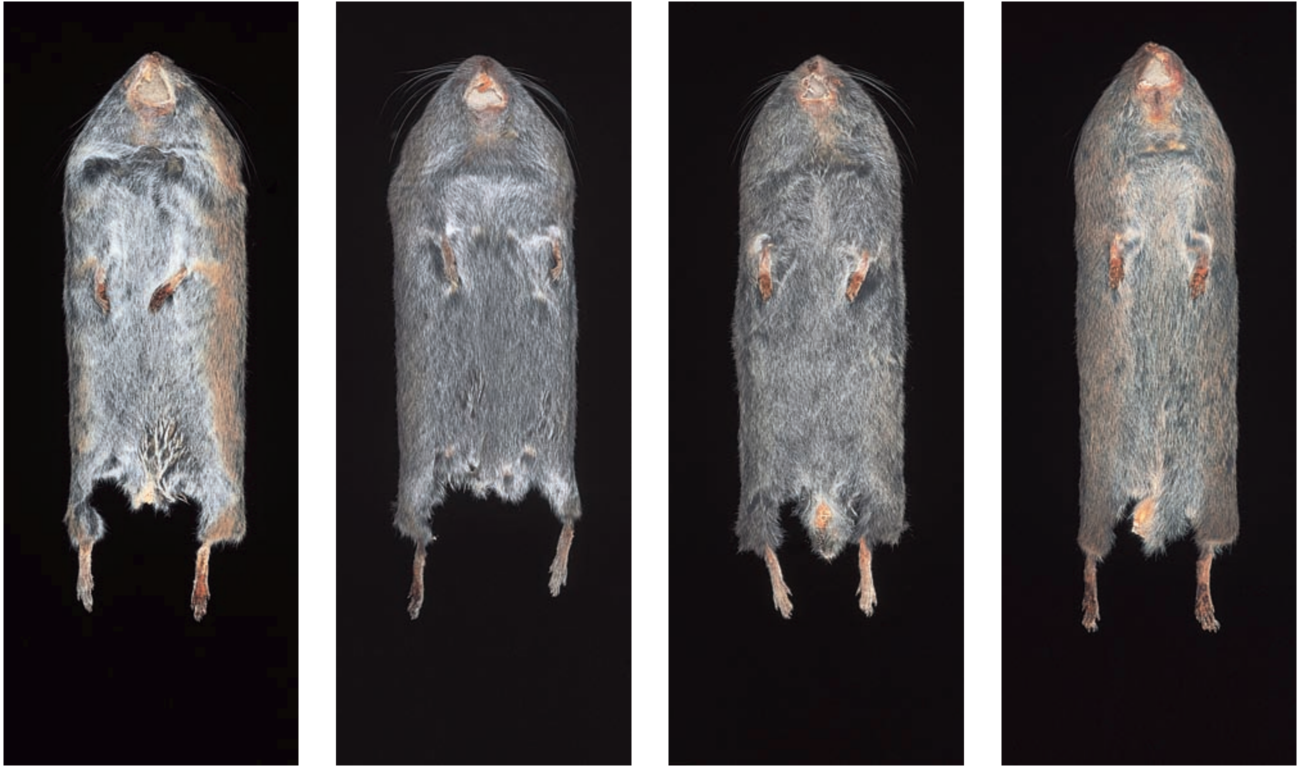


Plate XV/2

Plate XVI/1

Plate XVI/2



CAPTIONS TO COLOUR PLATES

PLATE I/1
Skins of *Sciurus vulgaris* from Velikaköprü, Demirköy, Turkish Thrace, in dorsal view: pale (above) and dark phase (below). TUE collection. Photo: C. Mlinar.

PLATE I/2
Skins of *Sciurus vulgaris* from Velikaköprü, Demirköy, Turkish Thrace, in ventral view. See caption to Plate I/1 for the identity of specimens. Photo: C. Mlinar.

PLATE II
Skins of Turkish ground squirrels in dorsal view: *Spermophilus citellus* (left; from Karaağaç, Edirne, Turkish Thrace) and *S. xanthoprymnus* (right; from Gücük, Sivas, cenral Anatolia). Photo: C. Mlinar.

PLATE III
Skins of Turkish ground squirrels *Spermophilus* in ventral view. See caption to Plate II for the identity of specimens. Photo: C. Mlinar.

PLATE IV
Skins of Turkish five toed jerboas in dorsal view: *Allactaga williamsi* (left; from Gölbaşı, Ankara), *A. euphratica* (middle; from Çavlıköyü, Urfa), and *A. ellater* (right; from environs of Šachvarud, Armavir district, Armenia). Photo: C. Mlinar.

PLATE V
Skins of Turkish five toed jerboas *Allactaga* in ventral view. See caption to Plate IV for the identity of specimens. Photo: C. Mlinar.

PLATE VI/1
Skin of *Sciurus anomalus* from the Island of Gökçeada in dorsal (above) and ventral view (below). Photo: C. Mlinar.

PLATE VI/2
Skin of *Sicista caucasica* from near Gornij Archiz, Karačevo – Čerkeskij district, north-western Caucasus, in dorsal (above) and ventral view (below). SIEE collection. Photo: C. Mlinar.

PLATE VII/1
Skin of *Glis glis* from Bahceköy, Saray, Tekirdağ, Turkish Thrace, in dorsal (above) and ventral view (below). SMF collection. Photo: C. Mlinar.

PLATE VII/2
Skin of *Muscardinus avellanarius* from Soğuksu, Abant, Bolu, in dorsal (above) and ventral view (below). ZFMK collection. Photo: C. Mlinar.

PLATE VIII/1
Skins of Turkish forest dormice in dorsal view: *Dryomys nitedula* (above; from Edirne, Turkish Thrace) and *D. laniger* (below; from Çığlıkara, Antalya). Photo: C. Mlinar.

Plate VIII/2
Skins of Turkish forest dormice *Dryomys* in ventral view. See caption to Plate VIII/1 for the identity of specimens. Photo: C. Mlinar.

Plate IX/1
Skins of Turkish mouse-tailed dormice in dorsal view: *Myomimus roachi* (above; from Karakasım, Edirne, Turkish Thrace) and *M. setzeri* (below; from Sarıkışla; IOC collection). Photo: C. Mlinar.

Plate IX/2
Skins of Turkish mouse-tailed dormice *Myomimus* in ventral view. See caption to Plate IX/1 for the identity of specimens. Photo: C. Mlinar.

Plate X/1
Skin of *Eliomys melanurus* from Mitzpeh, Ramon, Negev, Israel, in dorsal (above) and ventral view (below). ZSM collection. Photo: C. Mlinar.

Plate X/2
Skin of *Ellobius lutescens* from Mergantoma, Sila Sat, Hakkari, in dorsal (above) and ventral view (below). NMW collection. Photo: C. Mlinar.

Plate XI/1
Skin of *Prometheomys schaposchnikowi*, collected between Kutul and Yalnızcam, in dorsal (above) and ventral view (below). HSC collection. Photo: C. Mlinar.

Plate XI/2
Skin of *Clethrionomys glareolus* from Abant, Bolu, in dorsal (above) and ventral view (below). Photo: C. Mlinar.

Plate XII/1
Skin of *Arvicola terrestris* from Abant Lake, Bolu, in dorsal (above) and ventral view (below). Photo: C. Mlinar.

Plate XII/2
Skin of *Microtus subterraneus* from Çayır, Çaycuma, Zonguldak, in dorsal (above) and ventral view (below). Photo: C. Mlinar.

Plate XIII/1
Skin of *Microtus majori* from Meryemana, Trabzon, in dorsal (above) and ventral view (below). Photo: C. Mlinar.

Plate XIII/2
Skin of *Microtus daghestanicus* from Ovitdağı Geçidi, Rize, in dorsal (above) and ventral view (below). Photo: C. Mlinar.

Plate XIV/1
Skins of Turkish voles form the *Microtus arvalis* group in dorsal view: *Microtus obscurus* (above; from Sirbasan, Kars); *M. rossiaemeridionalis* (below; from Karabulut, Akşehir Gölü, Konya). Photo: C. Mlinar.

Plate XIV/2
Skins of Turkish voles form the *Microtus arvalis* group in ventral view. See caption to Plate XIV/1 for the identity of specimens. Photo: C. Mlinar.

Plate XV/1
Skins of Turkish social voles in dorsal view. From left to right: *Microtus guentheri* from Suludere, Burdur, central Anatolia; *M. guentheri* from 2 km south of Akçaköy, Aydın, Aegean coast; *M. socialis* from Aşkale, Erzurum (OMU); *M. dogramaci* from Boyali köyü, Suluova, Amasya (OMU); *M. anatolicus* from Yapalı köyü, Cihanbeyli, Konya (OMU). Photo: C. Mlinar.

Plate XV/2
Skins of Turkish social voles in ventral view. See caption to Plate XV/1 for the identity of specimens. Photo: C. Mlinar.

Plate XVI/1
Skins of Turkish snow voles in dorsal view. Frome left to right: *Chionomys nivalis* from Harput, Elazığ; *C. nivalis* from Uludağ, Bursa; *C. gud* from Tamdere, Kümbet, Şehitler Geçidi, Giresun; *C. roberti* from Çamlik, Rize. Photo: C. Mlinar.

Plate XVI/2
Skins of Turkish snow voles in dorsal view. See caption to Plate XVI/1 for the identity of specimens. Photo: C. Mlinar.

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