SPECIES OF THE SUBFAMILY MICROTINAE (RODENTIA) IN LEBANON

Sana I. Atallah

Submitted in partial fulfillment of the requirements of the degree of Master of Science in the Biology Department of the American University of Beirut, Beirut, Lebanon.

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ABSTRACT

Species of the rodent subfamily Microtinae from Lebanon are reviewed. Discussions of species include their description, variation, ecology, and general distribution. Microtus guentheri specimens from above 1,600 meters altitude are smaller in size and possess a distinctly different pattern of coloration from that of the typical subspecies reported from Lebanon. Microtus nivalis specimens were collected from only one locality near Faraya. No specimen referrable to Microtus socialis were collected during the course of this study, suggesting its absence from the Lebanon Mountains. A key based on one hundred and six specimens from Lebanon and twelve from Syria and Turkey is included. Dental enamel pattern alone is not reliable for the differentiation of these species.

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Thanks are due to Mrs. J. H. Lewis for translating three of the most significant publications on the subject from German to English, and to Dr. D. L. Harrison, Sevenoaks, Kent, England, for identifying M. socialis specimens from Syria and Turkey.

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INTRODUCTION

Microtine rodents of the family Muridae are represented in the Palaearctic Region by fifteen genera (Ellerman and Morrison-Scott, 1951). Of these, the holoarctic genus Microtus Schrank, 1798 is the largest, including twenty-five recognized species and approximately one hundred and thirty described sub-species. While the validity of many of these forms is doubtful, the majority of species can be easily recognized. In some cases recognition is possible by utilization of external characters alone but usually accurate identification requires the study of cranial characteristics. Color, as a species character, is of little or no value.

Voles are characteristically animals of cold climates and, with one exception, are not known at low altitudes south of about 35° N. latitude. A few species are recorded from mountainous regions farther to the south but most species are found in northern Europe and Asia.

Despite its predominantly Mediterranean climate, Lebanon possesses three indigenous species of the genus Microtus. Two species, Microtus guentheri (Danford & Alston, 1880) and Microtus nivalis (Martins, 1842) have frequently been reported from Lebanon (Allen, 1915; Aharoni, 1932; Bate, 1945; Kowalski, 1958). The third species Microtus socialis (Pallas, 1773) was recorded in 1945 by Bate from the Lebanon Mountains.

It is also possible that Arvicola terrestris may occur

here. I. Aharoni (1930; in Bodenheimer, 1958) recorded this species as being common near Banyas, Syria, although there appear to be no collection records from this locality. In 1932, B. Aharoni described Arvicola terrestris hintoni from her father's collections made around Lake Antioch in "Northern Syria". Bodenheimer (1958) reported water voles from Lake Hula in Syria, but was unable to trap or shoot them. However, it is highly unlikely that this species could occur there without having been collected at some time.

A brief historical review of the three microtine species definitely known to occur in Lebanon is given below.

Microtus nivalis (Martins, 1842) - Snow Vole

Microtus nivalis was first reported by Tristram (1884) from western Palestine as Arvicola nivalis. Later, Miller (1908) described a vole from Mt. Hermon, in the Anti-Lebanon Mountains as Microtus hermonis. The latter was subsequently reduced to a sub-species of M. nivalis (Ellerman & Morrison-Scott, 1951). Bate (1945) reported this vole from the Lebanon Mountains, her determination was based on the analysis of skeletal fragments found in owl pellets, a most unsatisfactory record as the locality in which the pellets were found need bear no relationship to the locality where the animals were actually captured by the owl.

B. Aharoni (1932), reported three sub-species of the nivalis group from three separate mountain chains: hermonis

from the Anti-Lebanons, syriacus from the Lebanons, and pontius from the Nussarijeh Mountains. The latter species is not included in this study. The form syriacus is ignored by Ellerman and Morrison-Scott (1951), Bodenheimer (1958), Kowalski (1958) and others. B. Aharoni (1932) lists this sub-species on the basis of the type specimens of Hypudaeus syriacus Brants, 1827, which was later found to be identical to M. nivalis (Kowalski, 1958). Thus Microtus nivalis hermonis is the only known form from this region of the world.

Aharoni's explanation for the occurrence of these three sub-species in such close proximity lies in the fact that they are high mountain inhabitants and are thus zoogeographically isolated on mountain peaks. This isolation supposedly explains their development into different races.

Microtus guentheri (Danford & Alston, 1880)

Günther's Vole

Microtus guentheri was described from Marash, Asia Minor (Turkey) as Arvicola guentheri. Allen (1915) reported it from "the valley west of Mt. Hermon" (Bekaa Valley). He gave no reference to its sub-species, but did point out its similarity to M. socialis. Bodenheimer (1949; in Kowalski, 1958) referred this form to M. guentheri guentheri (Danford & Alston, 1880). Thomas (1917) described Microtus philistinus from Palestine, and B. Aharoni (1932) accepted this as a distinct species. However,

she suggested that philistinus might be a sub-species of M. lydius. Ellerman and Morrison-Scott (1951), included both philistinus and lydius as sub-species of M. guentheri. Ognev (1950) suggested that philistinus, guentheri, and lydius were all sub-species of Microtus socialis, but Osborn (1962) collected both socialis and guentheri from the same region indicating that guentheri is a distinct species and not a race of M. socialis.

Microtus socialis (Pallas, 1773) - Social Vole

Microtus socialis was first reported from Lebanon by Bate (1945), whose records were again based on owl pellets collected from Laklouk and Becharré. Bodenheimer (1958) stated that Microtus socialis paradoxus Ognev & Heptner, 1928 inhabits the higher altitudes of the Lebanon and Anti-Lebanon Mountains.

Kowalski (1958) collected Microtus socialis from the Lebanon Mountains, specifically Mt. Sanine and Jebel Kammouha. His specimens were smaller then the geographically proximal races, M. socialis binominatus Ellerman, and M. socialis paradoxus Ognev and Heptner. Thus, M. socialis from Lebanon shows greater similarities to the small more northern sub-species of socialis than to those geographically related forms.

The study of the Lebanese microtine rodents is of particular interest since two species, Microtus socialis and Microtus nivalis, apparently reach the southermost limit of their range

within the political boundaries of the country. The third species Microtus guentheri is of considerable economic importance in parts of its range. This study was initiated in an effort to determine the variation, distribution, and ecological preferences of these voles in Lebanon. The following discussion is the result of this investigation.

MATERIALS AND METHODS

Dead-fall type (Museum special) traps were used in field collecting. In cases where a burrow system had numerous entrances, only those openings which appeared to be definitely in current use were used as set-sites. Criteria used to determine current burrow-use were:

A. Trimmed vegetation surrounding the opening.

B. Freshly heaped soil at the burrow entrance, especially noticable after rain. This indicated that the rodent was actively digging, cleaning, or enlarging its burrow system.

C. Cuttings of vegetation in the burrow entrance. These included both remnants and whole pieces of vegetation which the rodent had pulled into its burrow for food.

D. White urine deposit and fecal deposits around the aperture.

Although microtine rodents do not seem to be especially attracted to bait, a mixture of peanut butter, fat, raisins, and ground nuts was used to bait traps. This mixture is aromatic enough to attract most rodents. Furthermore, it does not readily dry out remaining sticky enough to stay on the trap even after the trap has been thrown.

Traps were set just before dark using trap markers consisting of long pieces of wire with a strip of white cloth

attached at one end to allow checking of sprung traps during the night. The wire was either pushed into the soil or hung on trees or shrubs. The white cloth provided an excellent markers in that it was picked out in the beam of the flashlight fairly easily. Wires with short and thin cylindrical blocks of wood covered with reflecting tape were also used.

To retain ectoparasites, rodents were collected as soon as possible after they were trapped. With this in mind, three regular trap checks were made each night, two before midnight, the third at around 0500 hours, when the traps were collected. The collected rodents were then transfered very quickly into separate plastic bags which were kept tightly closed. In the laboratory a piece of cotton wetted with chloroform was introduced into each of the plastic bags. When chloroformed the ectoparasites were picked up and placed in vials carrying the hosts' field number, and containing 70% alcohol.

The external measurements of the specimens were then recorded in a field catalogue. This catalogue consisted of separate sheets, two pages each, bound in a loose leaf file. On the sheet's outer surface field notes were recorded, while on the inner surface the collector's field number, sex, name or determination, locality, altitude, measurements of total length, tail, hindfoot, ear, forearm, and finally remarks were included in columns in the preceeding arrangement. The following is a list of abbreviations and definitions of the measurements, as they are used in this paper.

L = Total Length, from the tip of the nose to the tip of the tail, omitting terminal hair.

T = Tail, from the dorsal base of the tail to its tip omitting terminal hair.

HB = Head and Body Length, from the tip of the nose to the base of the tail.

HF = Hind Foot, from the tip of the largest claw to the extremity of the heel.

E = Ear, from the tip of the pinna to the lowest part of the auricle.

These measurements were taken in mm. and a label carrying this information was prepared. The specimens were then ready to be skinned. Study skins (stuffed skins) were prepared from all specimens trapped except in those few cases where more material was collected than could be skinned. Such specimens were preserved in a liquid medium of 75% alcohol. Study skins were preferred to flat or cased skins since they were easier to handle and study, gave a better idea of the animal's size, and the possibility of damaging the skin or loosing one of the appendages was minimized.

The following list includes the essential tools and materials used in making study skins.

- One scalpel (with replacable blades).
- Three pairs of forceps, one with fine points, one with blunt points and a very long pair with blunt points.
- One surgical needle, medium size.

- One roll of white cotton thread, colored thread might discolor the skin thus spoiling it.
- One pair of pliers.
- Two pairs of scissors, one with pointed ends, the other with blunt ends.
- Absorbent surgical cotton.
- Powdered Borax

The specimen was laid on its back, and the fur parted at the mid-ventral line. A slit was then made along this line beginning at the sternum and extending to the anus. For voles a two inch cut was satisfactory. With blunt forceps, fingers, or the blunt end of the scalpel the skin was then loosened from around the cut and around the proximal part of the hind legs. This part of the leg was then detached from the body with a pair of scissors (detachement was along the femur-tibia articulation), and the leg bone cleaned of flesh. Great care was taken not to puncture the abdominal wall. Borax was added continuously to keep the skin clean and to prevent the hair from sticking to the body. It also provided a non-slippery surface by which the animal was held.

The skin was then worked back towards the base of the tail. Holding the first tail vertebra with a pair of forceps the tail skin was pulled with the fingers until the tail vertebrae slipped out of the skin. The skin was then worked forward. The front legs were cut off and the remaining bones treated as for the hind legs. The skin was then pulled further back over the skull, and the ears

were detached at their base with a pair of scissors very close to the skull. The skin was loosened and cut around the eyelids, care being taken not to cut through the eyelids themselves. This process was done by using a sharp scalpel to cut the membrane connecting the eyelid to the skull. The lips were then cut along the inner edge of the gums and the nose cartilage severed, thus freeing the skin from the carcass.

Before turning the skin fur-side-out, the lips were stitched by running a thread from the inside of the middle of the lower lip, through the left and right sides of the upper lip. The threads free ends were then tied together forming a sort of a traingular stitch. Leg bones, left attached to the skin, were covered with cotton in a way as to replace the flesh which had been removed. The skin was then turned fur-side-out.

To make a body a rectangular piece of cotton was rolled to the approximate size and shape of the carcass and the loose ends of the cotton folded inwards. This was then held with the long pair of forceps and pushed gently into the skin. The skin was gradually slipped over it by gently pulling the hind legs, forelegs, and the ears. A strong straight piece of wire was then measured and cut to extend from the tip of the tail to about one centimeter infront of the anterior end of the slit. One end of this wire was tapered by wrapping a thin piece of absorbent cotton around it. The wire was then pushed into the tail and the free end was slipped under the skin. The two sides of the slit were then sewn together.

The label prepared earlier was attached with a double knot to the left hind foot, just above the heel. The animal was then placed on its abdomen on a piece of plywood and the tail anchored with two pins slanted in order to hold the tail rigid. The front legs were then stretched forward and pinned as close to the head as possible. Likewise, the hind legs were stretched backwards and pinned close to the tail. Additional pins were needed to support the upper hind legs and two more pins were used to support the tip of the tail. Pins used were number five and six insect pins. These are preferred since they do not rust and have very fine points. The finished skin was then left to dry for a week or so.

If the specimen was a female the carcass was examined for embryos, while if it was a male the length and width of testes were measured and recorded in the field catalogue. The penis was kept attached to the skin and later removed and treated as in the following paragraph. Skulls were also kept to be prepared for study (p.12), and the rest of the body was discarded.

Directions for preparing the os-penis for study

The penis was removed and treated as such for cleaning and staining the os-penis:

1. 5% KOH until cleared (overnight). This dissolves the muscle and connective tissue and renders them transparent.
2. 0.002% Alizarin Red in absolute ethyl alcohol until stained (12 hrs.). If muscle or connective tissue were overstained, they were destained in a solution of 4% KOH and 1% Ammonia.

3. Three changes of 100% Glycerine.
4. The os-penis was then stored in 100% glycerine in a vial carrying the animal's field number.

Directions for preparing skulls for study

Skulls were treated in the following manner:

1. Boiled for 15 minutes.
2. Flesh was removed with a pair of forceps.
3. Bleached in H_2O_2 for 3-5 minutes, and then washed in tap water.
4. Bleached in Chlorox (dilute solution) for 3 minutes, then washed under tap water.
5. Dried.

When dry the skull was marked with China ink indicating field number and sex. Cranial measurements were then taken. The following is a list of abbreviations and definitions used for skull measurements in this work:

GL = Greatest Length of Skull, from the most projecting point of the incisors to the most projecting region at the posterior extremity, regardless of the structure under question.

CBL = Condylo-Basal Length, from the most projecting point of the incisors to the extremity of the occipital condyle.

ZB = Zygomatic Breadth, taken across the greatest width of the zygomatic arches.

BB = Breadth of Braincase, taken across the widest point of the braincase.

IC = Interorbital Constriction, taken across the narrowest width of the interorbital region.

UM = Upper Molars or Maxillary Teeth, from the front of the first upper molar to the end of the crown of the last upper molar.

LM = Lower Molars or Mandibular Teeth, from the front of the first lower molar to the end of the crown of the last lower molar.

M = Mandible, from the tip of the incisor teeth to the extremity of the mandibular condyle.

Colors mentioned in the text follow the system of Maerz and Paul. Localities are based upon the standard 1/50,000 topographical maps of Lebanon. Generic and sub-generic synonomy is according to Ellerman and Morrison-Scott (1951), Miller (1912), and Ognev (1950). Specific synonomy is partly according to Aharoni (1932), and Neuhäuser (1936).

RESULTS AND DISCUSSION

Family Muridae

Subfamily Microtinae

1906 Microtinae Miller, North American Fauna, No. 12, p. 8.

Diagnosis: Murine rodents with rootless, flat crowned molars; tail always shorter than head and body length.

Remarks: This subfamily is represented by three species of the genus Microtus in Lebanon.

Genus Microtus Schrank, 1798

1798. Microtus Schrank, Fauna Boica, I, p. 72.
1817. Mynomes Rafinesque, Amer. Monthly Magazine, II, p. 45.
1836. Hemiotomys de Sélys-Longchamps, Essai monographique sur les Campagnols des environs de Liege, p. 7 (part).
1857. Paludicola Blasius, Säugethiere Deutschlands, p. 333 (part).
1857. Agricola Blasius, Säugethiere Deutschlands, p. 334 (part).
1857. Chilotus Baird, Mamm. North. Amer. p. 516 (valid as a sub-genus).
1867. Praticola Fatio, Les Campagnols du Bassin du Léman, p. 34.
1867. Sylvicola Fatio, Les Campagnols du Bassin du Léman, p. 63.
1883. Microtus Lataste, Le Naturaliste, II, p. 348.
1887. Lasiopodomys Lataste, Ann. Mus. Civ. Stor. Nat. Genova, 2a, 4:268. (Valid as a sub-genus.)
1890. Campicola Schulze, Schriften Naturwiss. Viereins d. Harzes in Weringerode, V, p. 24 (part).
1894. Tetramerdon Rhoads, Proc. Acad. Nat. Sci. Philadelphia, p. 282.
1894. Aulacomys Rhoads, Amer. Nat., 28:182.
1896. Microtus Miller, North American Fauna, No. 12, p. 62.

1899. Euarvicola Acloque, Faune de France, Mamm., p. 49.
1901. Stenocranius Kastschenko, Ann. Mus. St. Pétersb., 6:167. (Valid as a sub-genus.)
1908. Chionomys Miller, Ann. Mag. N. H., I:97. (Valid as a sub-genus.)
1911. Proedromys Thomas, P. Z. S., p. 177. (Valid as a sub-genus.)
1914. Alexandromys Ognev, Moskva Dnev. Zool. otd. obsc. liub. jest. 2:109.
1933. Sumeriomys Argyropulo, Z. Sauget., 8:180.
1941. Lemmimicrotus Tokuda, Biogeog. Tokyo, 4, I:68.

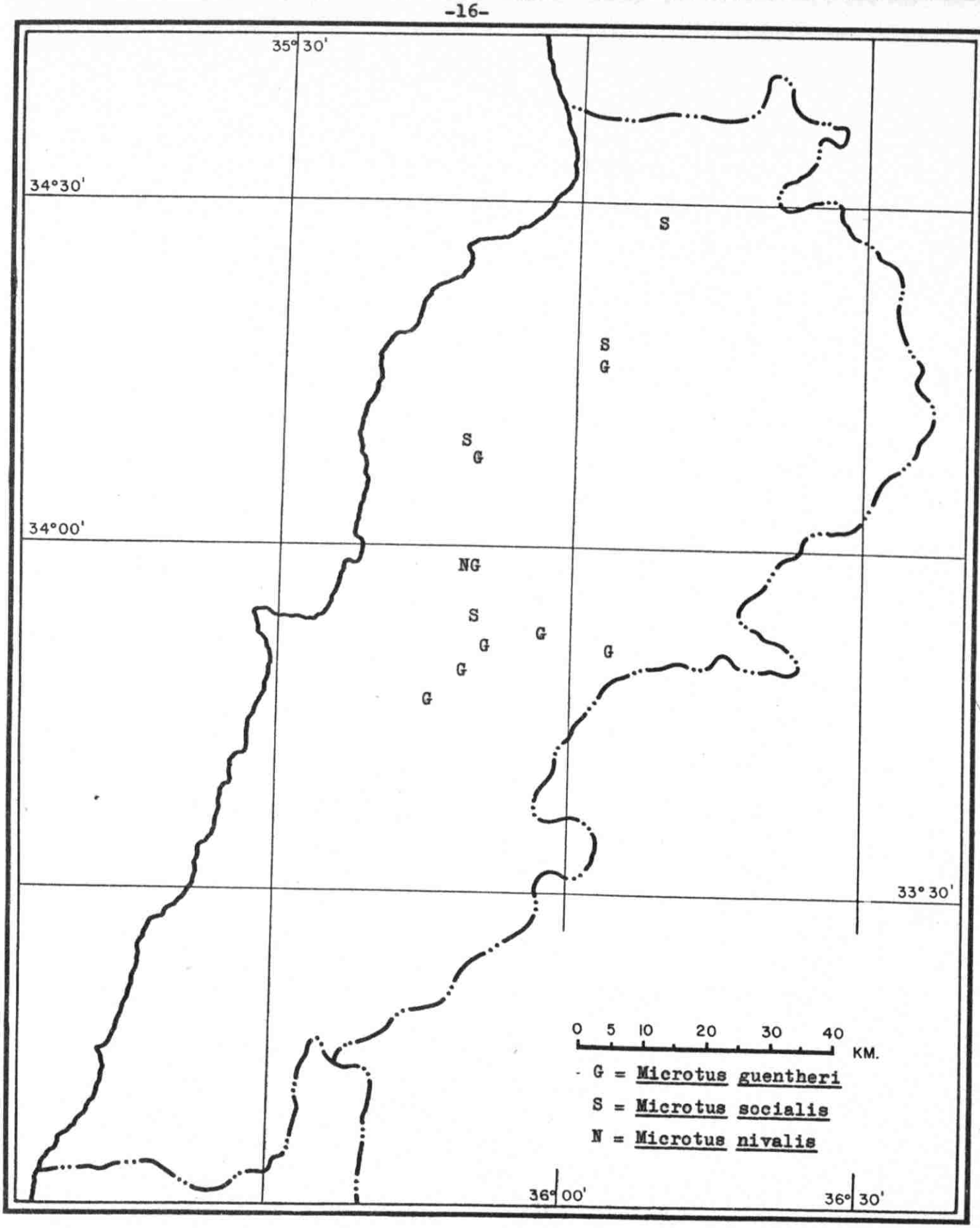
Type species: Microtus terrestris Schrank = Mus arvalis Pallas.

Diagnosis: Eight mammae (two maxillary, two thoracic, two abdominal, and two inguinal); molars rootless growing continuously from a persistant pulp; dental enamel folded into acute salient angles; os-penis tripartite distally, shaft terminating in three separate ossicles.

Remarks: The three species of this genus recorded from Lebanon (Map I) belong to two different subgenera.

a. Sub-genus Chilotus Baird, 1858. Represented by Microtus guentheri and Microtus socialis.
b. Sub-genus Chionomys Miller, 1908. Represented by Microtus nivalis.

Classification: A specific key to the Lebanese microtine rodents based on the specimens obtained for this study is given below.



Map I. Distribution of Microtus species recorded from Lebanon, including records of authors mentioned in the text.

1. Tail 1/2 HB; hind feet soles with six tubercles each; Os penis distally trifid with the middle ossicle twice the size of any of the lateral ossicles (Fig. 4C); ear length 15 mm. or more. (Subg. Chionomys) .... Microtus nivalis hermonis

1. Tail 1/5 to 1/4 HB; hind feet soles with five tubercles each; Os penis distally trifid with the middle ossicle only slightly larger than the lateral ossicles (Fig. 4B, Fig. 5 A,B,C,D,E,F); ear length 14 mm. or less. (Subg. Chilotus)..... 2

2. Tympanic bullae length 10 mm. or more; mastoid portion of bullae highly inflated conspicuous from the dorsal surface of skull..... Microtus socialis

2. Tympanic bullae length 10 mm. or less; mastoid portion of bullae poorly developed, not easily seen from dorsal surface of the skull..... Microtus guentheri

Sub-genus Chionomys Miller, 1908

Snow Voles

1857. Paludicola Blasius, Säugethiere Deutschlands, p. 334 (part).
1867. Praticola Fatio, Les Campagnols du Bassin du Léman, p. 34 (part).
1896. Microtus Miller, North American Fauna, No. 12, p. 62 (part).
1908. Chionomys Miller, Ann. and Mag. Nat. Hist., 8th series, I p. 97.

Type species: Arvicola nivalis Martins, 1842.

Diagnosis: Tail about 1/2 HB; fur soft and light; soles of hind feet with six tubercles each.

Remarks: This sub-genus is represented in Lebanon by M. nivalis hermonis.

Microtus nivalis hermonis Miller, 1908

1827. Hypudaeus syriacus Brants, Muizen, p. 92, "Syria".

1884. Arvicola nivalis Tristram, Fauna and Flora of Western Palestine, p. 13.

1908. Microtus hermonis Miller, Ann. Mag. N. H., I:103 (Mt. Hermon, Palestine).

1932. Chionomys nivalis hermonis Miller, 1908. Aharoni, B., Zeit. Säugetierk 7(2):211. NEW SYNONYMY.

1932. Chionomys nivalis syriacus Brants, 1827. Aharoni, B., Zeit. Saugetierk, 7(2):212. NEW SYNONYMY.

1951. Microtus nivalis hermonis Miller, 1908. Ellerman and Morrison-Scott, Checklist of Palaearctic & Indian Mammals 1758-1946, British Museum (Nat. Hist.), p. 693.

Diagnosis: Tail about 1/2 HB; ear length 15 mm or more; greyish general appearence.

Description: The hair bases on the dorsal side of these rodents are dark gray (C 1, plate 32), tips are light yellowish brown (E 6, Walnut Taffy, Plate 12) or light yellowish brown with protruding black tips. The latter hairs are somewhat longer and stiffer than the former, and decrease in frequency along the sides of the body. The hairs on the ventral surface have dark gray (C 1, plate 32) bases and white tips. There is a distinct demarkation between the colors of the dorsal and ventral surfaces. Nevertheless, individual color patterns are variable according to age and

season. For example, immature specimens have a much lighter over all gray color with less reddish-brown on the dorsal surface.

Six specimens of snow voles were collected at the Natural Bridge 7 Km. S. E. of Faraya. Their external and cranial measurements are (variation and mean are given): L 149-190(175); T 53-70(60); HF 20-22(21); E 15-18(17); GL 27.9-29.8(29.0); CBL 27.9-29.8(29.0); ZB 15.3-16.2(15.7); IC 4.3-4.4(4.2); UM 6.6-7.0(6.7); LM 6.6-6.8(6.7); M 19.9-20.4(20.1).

The Os penis (Fig. 4C) is distinctly different from that of M. socialis (Fig. 5A and D) or M. guentheri (Fig. 5 B,C,E &F) in that the middle ossicle is twice the size of any of the lateral ossicles. Fig. 3C illustrates the upper and lower left tooth rows in M. nivalis, when compared with the tooth rows of the other two Lebanese species, show no significant differences. Thus, teeth are not reliable characters for the taxonomic differentiation of Lebanese voles.

Ecology: The sub-genus Chionomys includes animals which are mostly found above 1500 meters, and only rarely found in lower mountain ranges below 1500 m. The specimens from Lebanon were collected at the Natural Bridge, elevation 1650 m. An area covered by snow for about four months of the year.

Where they occur they are not very abundant and

unlike the other Lebanese species they are not conspicuously colonial. Burrow entrances are concealed under rocks and huge boulders which are characteristic of the natural habitat for these voles.

Snow voles appear to be strictly nocturnal. They appear to breed in the spring, however, additional collections are needed to indicate whether or not breeding continues throughout the summer and autumn.

Callopsylla caspia Ioff & Argyropulo, 1934 is the only siphonapteran ectoparasite known for this vole in Lebanon (Lewis, 1962).

Sub-genus Chilotus Baird, 1858

1858. Chilotus Baird, Mammals, in Repts. Expl. Surv., 8(1):516, July 14.
1900. Chilotus Bailey, Revision of American Vole of the Genus Microtus, North American Fauna, No. 17, p. 70-71.
1933. Sumeriomys Argyropulo, Zeit. Säugetierkunde, 8(3):180-183.
1941. Microtus "Socialis Group" Ellerman, J. R., The Families and Genera of Living Rodents, p. 606.

Type species: Arvicola oregoni Backman, 1839 Microtus (Chilotus) oregoni.

Diagnosis: Tail about 1/4 HB; soles of hind feet with five tubercles each.

Remarks: This sub-genus is represented in Lebanon by two species, M. guentheri and M. socialis. These species can be separated

on the basis of their tympanic bullae. Those of M. socialis are larger, with the mastoid process highly inflated and conspicuous projecting posteriorly, M. guentheri specimens possess smaller bullae with the mastoid portion poorly developed and not conspicuously protecting.

Microtus guentheri (Danford & Alston, 1880)

1880. Arvicola guentheri Danford & Alston, P.Z.S., p. 62. (Marash, Asia Minor).

1917. Microtus philistinus Thomas, Ann. Mag. Nat. Hist., (8)19:450.

1932. Microtus guentheri Danford & Alston, 1880. Aharoni, B., Zeit Säugetierkunde, 7(2):211.

1936. Microtus guentheri shevketi Neuhauser, Zeit. Säugetierkunde, 11:160.

1936. Microtus guentheri guentheri Danford & Alston, 1880, Neuhäuser, Zeit. Säugetierkunde, 11(2):199.

1951. Microtus guentheri philistinus Thomas, 1917. Ellerman & Morrison-Scott, Checklist of Palaearctic and Indian Mammals 1758-1946, British Museum (Nat. Hist.), p. 696.

Diagnosis: Tail 1/5 to 1/4 HB; mastoid portion of tympanic bullae poorly developed; bullae less than 10 mm. in length.

Remarks: M. guentheri specimens were collected from seven different localities in Lebanon throughout the year. With respect to size and coloration they fall into three groups.

Group A. Large sized voles, with a gradual transition of color from the dorsal to the ventral surface (A.U.B. Farm, 10 Km. N. E. Rayak, Bekaa valley, elevation 400 meters. Sample size = 36 specimens).

Group B. Intermediate between groups A and C in size. The transition of color from the dorsal to the ventral surface is gradual and shows greater similarities to group A. (2 Km. N. N. W. Dahr El-Baidar elevation 1550^{m}. Sample size = 16; South Jebel Sanine, elevation 1,700^{m}. Sample size = 2).

Group C. Small sized voles, with an abrubt change in color from the dorsal to the ventral surface. Moreover, a reddish tinge of color is apparent on the dorsum of most of the specimens. (Refuge of Akl, Laklouk, elevation 1950^{m}. Sample size = 32; 6 Km. E. Faraya or Natural Bridge, Faraya, elevation 1650^{m}. Sample size = 10; 5 Km. E. Becharre, near Cedars, elevation 1,950^{m}. Sample size = 1; South slope of Jebel Sanine, elevation 2,000^{m}. Sample size = 9).

Description: The hair bases on the dorsal surface of members of all groups are gray (C1 plate 32) while the tips are yellowish brown (H5, plate 15) in members of groups A and B, or yellowish brown with a reddish tinge (H9, plate 15) in members of group C. On the ventral surface the hair roots of all groups are gray (A1, plate 15), while the tips are yellowish to white (A1, plate 12 & E1, plate 11) in group A and B, or white (A1, plate 9) in group C with few exceptions. The transition between the dorsal and ventral

surfaces is either distinct (group C) or gradual (group A and B). It should be stressed, however, that color varies according to age and season within a given population and is not normally considered to be a valid specific character if unaccompanied by other differences.

Table 1 gives the variation and mean of external as well as cranial measurements of all the populations. When examined thoroughly it becomes clear that group A includes large sized voles, group B intermediates, and group C includes the small sized voles (Figs. 1 and 2).

Considerable variations are found in the Os penis of M. guentheri (Fig. 4B, Fig 5B,C,E,& F). However, the apex is always trifid and incompletely ossified forming three separate apical ossicles which are attached to the main shaft by cartilagenous tissue. Unlike M. nivalis the middle ossicle is only slightly larger than the lateral ossicles. The two extremes of M. guentheri molar patterns are shown Fig. 3A and B, M^3 has either three or four prominent salient angles and M^2 with or without an additional fourth posterior salient angle. The same variation was recorded from M. guentheri in Turkey (Osborn, 1962) and M. socialis in U.S.S.R. (Ognev, 1950). The writer has examined six M. socialis specimens from Adana, Turkey and Aleppo, Syria, both with a molar pattern similar to that of M. guentheri from Lebanon. Kowalski (1958) used the teeth as

Table 1. Variation and mean of external and cranial measurements of different M. guentheri populations. (Parenthetical numbers are means.)

Locality	L	T	HF	E	GL=CBL	ZB	BB	IC	UM	LM	M
Group A											
AUB Farm Bekaa	(143) 120-165	(24) 20-29	(20) 18-21	(13) 11-14	(27.7) 25.5-29.7	(16.3) 14.9-17.8	(11.5) 10.8-12.4	(3.7) 3.3-4.0	(6.5) 6.0-7.0	(6.4) 6.0-6.9	(19.4) 17.2-21.6
Group B											
Dahr El-Baidar	(133) 117-146	(24) 21-28	(20) 19-21	(13) 12-14	(27.8) 270-28.7	(15.8) 14.9-16.5	(11.5) 11.0-12.0	(3.8) 3.6-4.0	(6.4) 5.8-7.0	(6.5) 5.9-7.0	(19.4) 16.9-20.4
S. Mt. Sanine	(147) 145-149	(26) 25-27	19	14	28.0	15.8	11.7	(3.8) 3.6-3.9	(6.8) 6.7-6.9	(6.8) 6.7-6.8	(19.7) 19.4-20.0
Total	(134) 117-149	(24) 21-28	(20) 19-21	(13) 12-14	(27.8) 270-28.7	(15.8) 14.9-16.5	(11.5) 11.0-12.0	(3.8) 3.6-4.0	(6.5) 5.8-7.0	(6.5) 5.9-7.0	(19.4) 16.9-20.4
Group C											
Laklouk	(131) 118-145	(26) 21-29	(18) 17-19	(11.5) 10-12	(26.2) 25.1-27.0	(14.7) 14.4-16.8	(11.6) 11.1-12.7	(4.0) 3.6-4.4	(6.2) 5.7-6.8	(6.2) 5.7-6.8	(18.9) 17.6-20.5
Becharré	135	25	17	13	25.8	15.4	10.7	3.7	5.9	5.9	19.5
Faraya	(130) 114-140	(24) 21-27	(18) 16-19	(11.5) 11-12.5	(26.1) 25.8-26.5	(15.4) 15.2-15.7	(11.1) 11.0-11.5	(4.0) 3.9-4.1	(6.1) 5.9-6.5	(6.0) 5.9-6.5	(18.6) 18.1-19.2
S. Slope Mt. Sanine	(136) 127-145	(26) 24-29	(19) 18-19	(12) 11-13							
Total	(132) 114-145	(25) 21-29	(18) 16-19	(12) 10-13	(26.1) 25.1-27.0	(14.8) 14.4-16.8	(11.5) 10.7-12.7	(4.0) 3.6-4.4	(6.2) 5.7-6.8	(6.1) 5.7-6.8	(8.9) 17.6-20.5

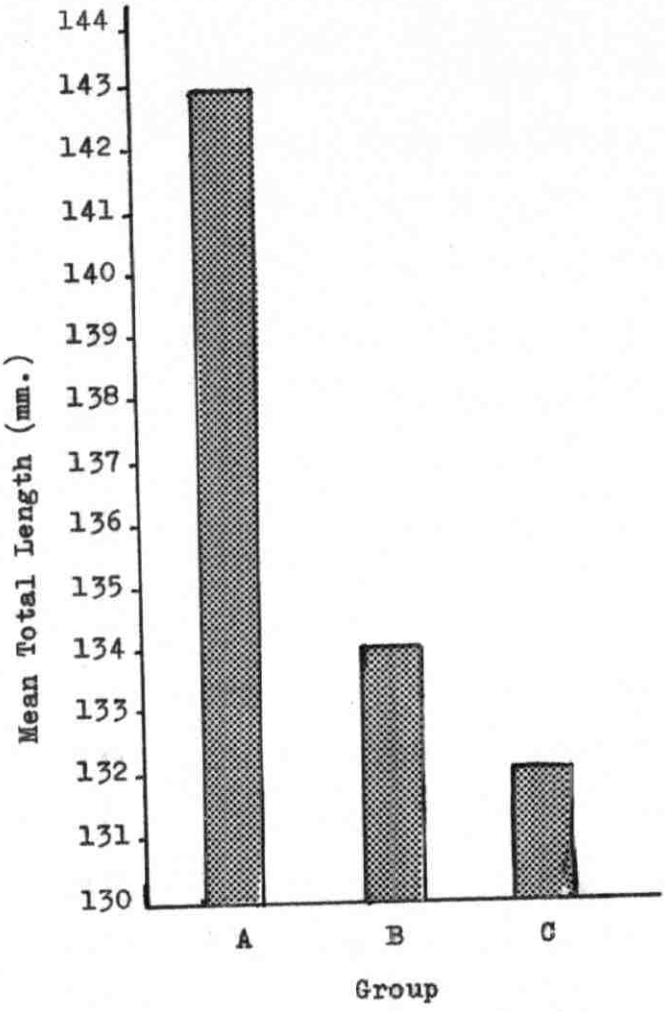


Fig. 1. Representation of variation in total body length between populations A, B, and C.

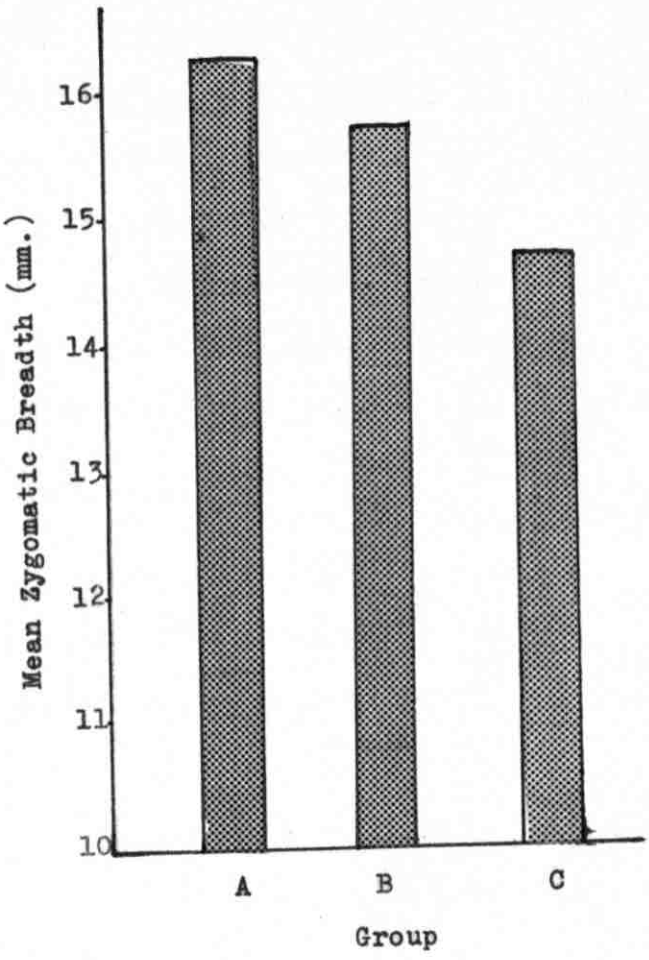


Fig. 2. Representation of variation in zygomatic breadth, indicating skull size variations among populations A, B, and C.

a taxonomic characteristic in reporting M. socialis from Lebanon. However, the dental similarities between M. guentheri and M. socialis appear to be so great as to preclude the use of molar patterns in taxonomic discrimination.

There appear to be two sub-species of M. guentheri

represented in Lebanon. The Bekaa form, representing the typical, large sub-species Microtus guentheri guentheri (Danford & Alston, 1880) and the populations at Becharré. Laklouk, Faraya, and Sanine representing a high altitude form of M. guentheri which has either not yet been described or is M. guentheri philistinus Thomas, 1917. Materials has been sent to the British Museum (Natural History) for comparison with the holotype of M. g. philistinus.

Ecology: Guenther's voles are the most common microtine rodents in Lebanon, occurring from the coastal plain to above 2000 meters in the mountains. They tend to be associated with grassy areas and agricultural fields but also occur with almost equal frequency in uncultivated mountain valleys in close approximation with Berberis cretica L. 1753 and other mountain shrubs.

Their burrow systems are extensive, with many entrances and interlacing tunnels. These tunnels are five to eight centimeters beneath the surface of the soil. The burrow systems of these colonial voles overlap each other so thoroughly that it is virtually impossible to separate one system from another, individuals use each others tunnels extensively.

Field observation showed that this species tends to be active throughout the day as well as the night, peaks of activity occurring in the morning and evening. The majority of their surface activity is associated with short,

rapid forays away from the entrance of the burrow to obtain food. This food, consisting of succulent vegetation, when available, is then drug into the burrow to be eaten. Although an abundance of succulent vegetation seems necessary for peak population, colonies at higher altitudes, where water may be lacking during the late summer months, seem to be able to subsist to a large extent on straw and other dry vegetable material. At low altitudes large populations may be found around rivers and other water sources.

This species has occasionally been referred to as the "Plague Vole", a name applied to it by virtue of its high fecundity. Collections in Lebanon indicate that reproduction takes place throughout the year at lower altitudes and seems to be interrupted only breifly during the cold season at higher altitudes. Dissections of seventeen pregnant females show an average of 8 embryos per individual but as many as 13 have been found in some specimens. This latter number is exceptional and with but eight mammae on the adult female, more young would probably perish.

The nests of these species are usually located at the terminus of a lateral branch of the burrow system at a depth which appears to be determined by the drainage of the soil. In wet areas, the nests may be situated within five to eight centimeters below surface, while in drier soils, they may occur at depths up to one meter. The nest is

constructed of finely shredded grass with a lining of similar but more finely shredded material.

A large population of these voles may become of economic importance through their voracious feeding habits and unless some effort is made to control them they can rapidly denude large areas of such cultivated crops as alfalfa. This has certainly been the case in such locations as the A.U.B. Farm in the Bekaa valley, where a combined program of irrigation and poisoning has failed to eliminate the population from the alfalfa fields.

From field observation, there is little doubt that this species is heavily preyed upon by hawks, owls, snakes and carnivorous mammals and they probably constitute the bulk of these predator's diets.

Siphonapteran ectoparasites collected from this species in Lebanon are Ctenophthalmus congener asiaticus Argyropulo, 1935; Nosopsyllus durii Hubbard, 1956; Amphipsylla rossica Wagner, 1912 (Lewis, 1962, 1964).

Microtus socialis (Pallas, 1773)

1773. Mus socialis Pallas, Reise Russ. Reichs, 2:705 (grassy regions of desert by the Ural River).
1777. Mus astrachanensis Erxleben, Syst. Nat., 403.
1901. Microtus parvus Satunin, Mitt Kaukas Mus., I:117.

Diagnosis: Tail about 1/4 HB; mastoid portion of tympanic bullae highly inflated; bullae more than 10.0 mm. in length, extending past the posterior end of the skull.

Remarks: Kowalski (1958) reported this vole from Jebel Sanine and Jebel Kammouha. Bate (1945) recorded its presence in owl pellets collected at Laklouk and the Becharré Cedars. The writer has either trapped or examined collections from Jebel Sanine, Becharré, and Laklouk but only M. guentheri was found. It is probable that what Kowalski (1958) and Bate (1945) referred to as M. socialis is actually M. guentheri. They both employed tooth enamel pattern as a taxonomic character and it has been shown here that teeth are not a satisfactory character in separating M. socialis from M. guentheri since the pattern varies to a great extent in both.

Four specimens of M. socialis collected near Adana, Turkey and six from near Aleppo, Syria collected by Dr. R. E. Lewis and identified as M. socialis by Dr. D. L. Harrison have been examined and compared with M. guentheri specimens from Lebanon. There is no doubt that these are two distinctly different species on the basis of the auditory bullae contrary to the suggestion of Ognev (1950) in considering M. guentheri as a sub-species of M. socialis. M. socialis from Aleppo is of particular interest since the closest point to Lebanon from which this form was previously recorded is Lake Van in eastern Anatolia (Neuhäuser, 1936) and Ser Amadia in northern Iraq (Harrison, 1956).

SUMMARY

1. Microtus nivalis hermonis Miller, 1908, is reported from the area around the Natural Bridge, Faraya.
2. Microtus guentheri specimens from the Bekaa represent the typical sub-species Microtus guentheri guentheri (Danford & Alston, 1880).
3. A high altitude form of M. guentheri is reported from Becharré, Laklouk, Faraya and Sanine.
4. The possibility that M. socialis may not occur in the Lebanon Mountains is suggested.
5. It is postulated that tooth pattern alone can not be used as a taxonomic character in the separation of M. guentheri and M. socialis.

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Fig. 3. Tooth rows 9X

1st row left upper molars

2nd row left lower molars

A. M. guentheri

B. M. guentheri

C. M. nivalis

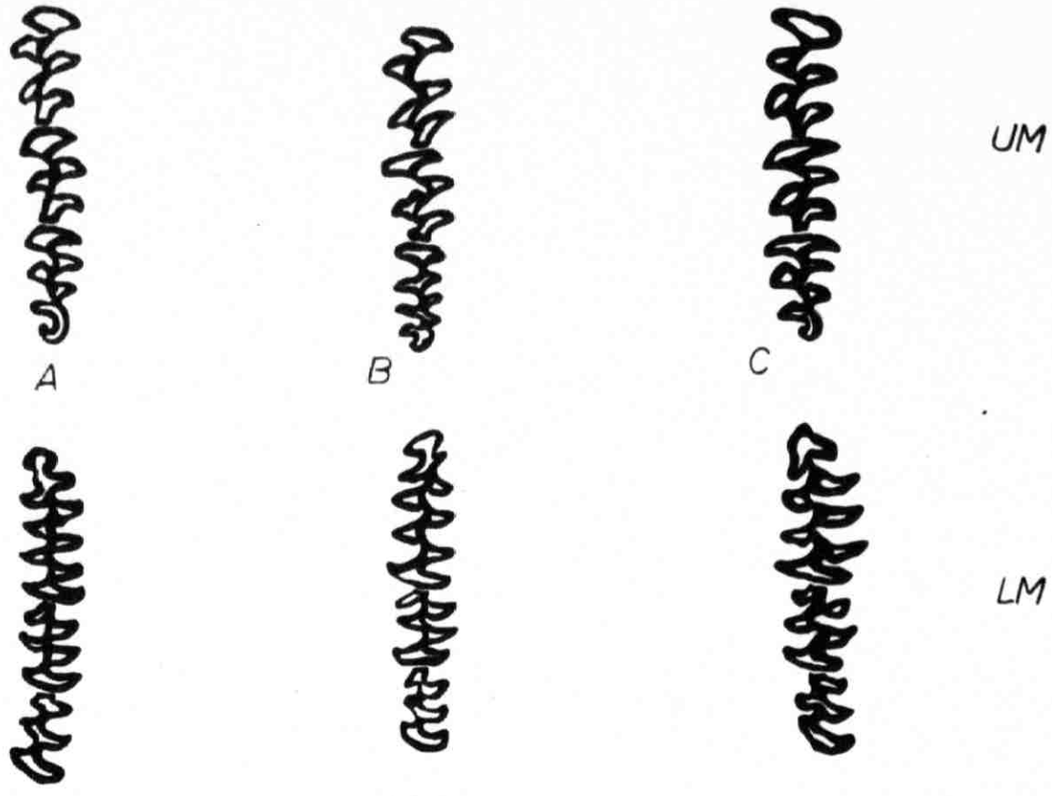

FIG.3

Fig. 4. Os penis 15X

A. M. arvalis (Lake Abant, Turkey)

B. M. guentheri (Bekaa, Lebanon)

C. M. nivalis (Faraya, Lebanon)

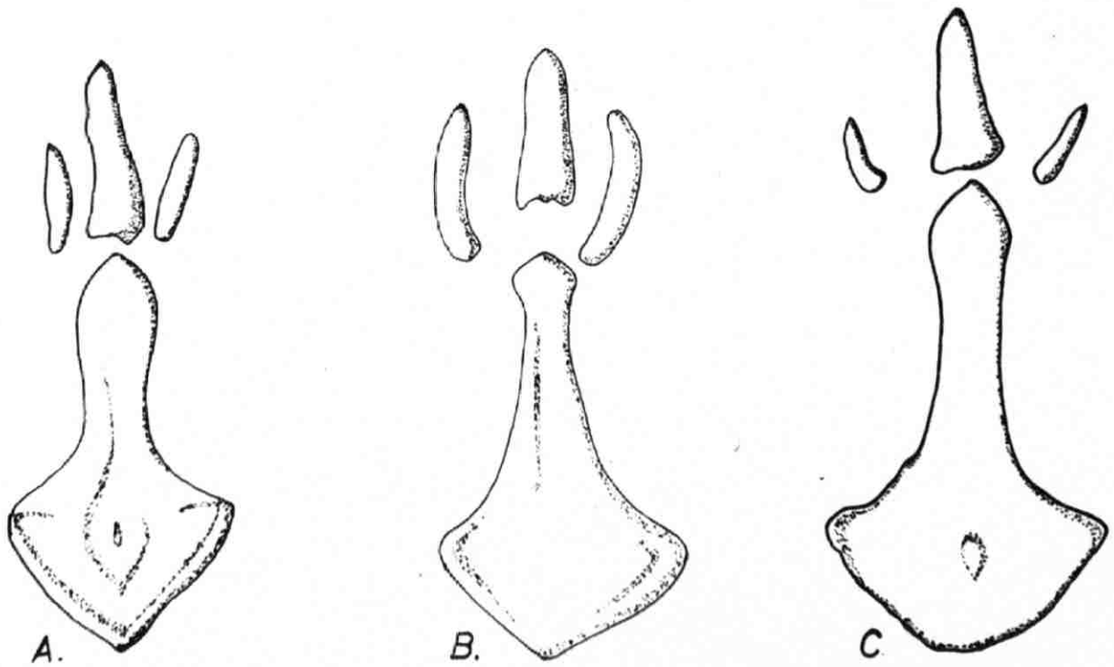

FIG.4

Fig. 5. Os penis 15X

A. M. socialis (Adana, Turkey)

B. M. guentheri (Faraya, Lebanon)

C. M. guentheri (Lake Abant, Turkey)

D. M. socialis (Adana, Turkey)

E. M. guentheri (Bekaa, Lebanon)

F. M. guentheri (Laklouk, Lebanon)

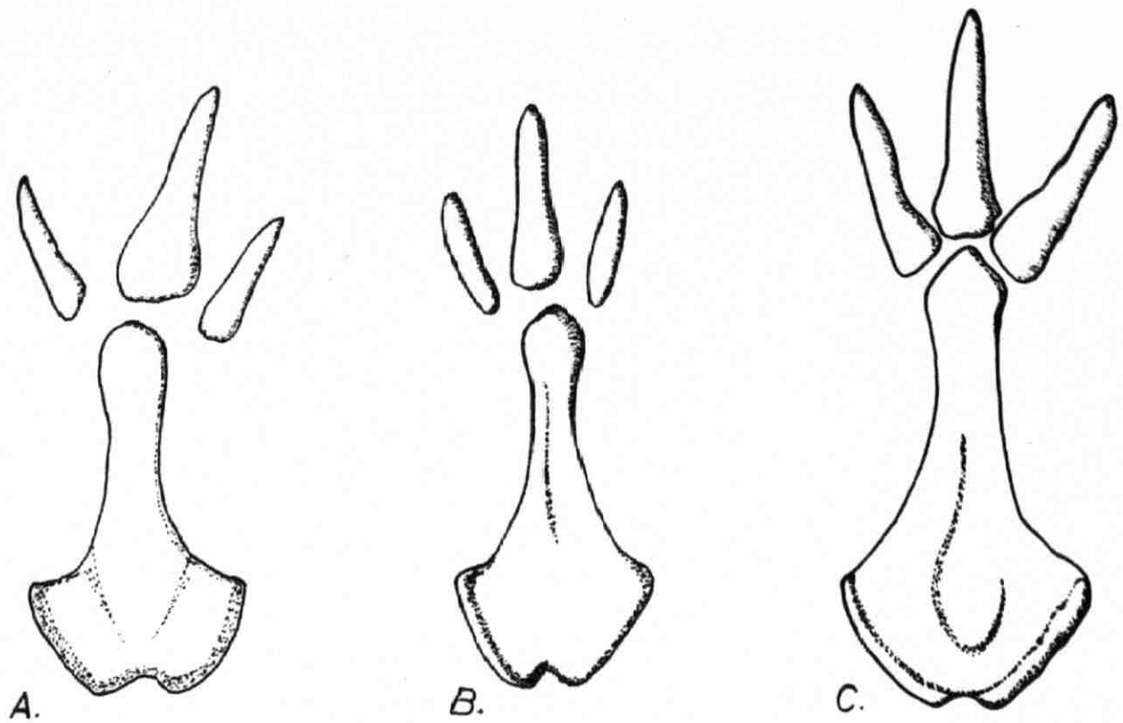

FIG. 5