YU ISSN 0351 – 0077

PRIRODOSLOVNI MUZEJ SLOVENIJE

MUSEUM HISTORIAE NATURALIS SLOVENIAE

SCOPOLIA

15

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Boris KRYŠTUFEK, Nikola TVRTKOVIĆ

Insectivores and Rodents of the Central Dinaric Karst of Yugoslavia

Žužkojedi in glodalci osrednjega dinarskega krasa Jugoslavije

SCOPOLIA	No 15	pp. 1–59	Ljubljana	Sept. 1988

SCOPOLIA

Glasilo Prirodoslovnega muzeja Slovenije. Izdaja Prirodoslovni muzej Slovenije, sofinancirali so: Raziskovalna skupnost Slovenije, Kulturna skupnost Slovenije, Znanstveno-raziskovalni center SAZU in Inštitut za biologijo univerze E. Kardelja. Uredniški odbor: Jože BOLE, Ernest FANINGER, Janez GREGORI (urednik), Boris KRYŠTUFEK, Ignac SIVEC, Kazimir TARMAN in Tone WRABER. Lektorja: Cvetana TAVZES (za slovenščino) in Helena SMOLEJ (za angleščino). Naslov uredništva in uprave: Prirodoslovni muzej Slovenije, 61000 Ljubljana, Prešernova 20. Izideta dve številki letno, naklada 500 izvodov. Cena številke za ustanove in podjetja 2000 din, za posameznike 1000 din. Tekoči račun pri LB št. 50 100–603–40115. Tisk tiskarna Kurir, Ljubljana.

SCOPOLIA

Journal of the Natural Historiy Museum of Slovenia, Ljubljana, Edited by Natural History Museum of Slovenia, subsidized by Research Community of Slovenia, Cultural Community of Slovenia, Centre of Scientific Reserach of the SASA and Univ. Institute of Biology E. Kardelj. Editional Staff: Jože BOLE, Ernest FANINGER, Janez GREGORI (Editor), Boris KRYŠTUFEK, Ignac SIVEC, Kazimir TARMAN and Tone WRABER. Readers: Cvetana TAVZES (for Slovene) and Helena SMOLEJ (for English). Address of the Editorial Office and Administration: Prirodoslovni muzej Slovenije, YU 61000 Ljubljana, Prešernova 20. The Journal appears twice a year, 500 copies per issue. Issue price for institution and establishements 2000 din, for individuals 1000 din. Current account at LB No 50100–603–40115. Printed by tiskarna Kurir, Ljubljana.

SCOPOLIA No 15, pp. 1–59, Sept. 1988

Insectivores and Rodents of the Central Dinaric Karst of Yugoslavia

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Received: 29.3.1988
UDC (UDK) 599.32/.33(234.422.1) (045)=20

ABSTRACT – Twenty-nine species of insectivores and rodents are known to occur in Central Dalmatia, southwestern Bosnia and western Herzegovina: *Erinaceus concolor, Sorex minutus, S. araneus, S. alpinus, Neomys fodiens, N. anomalus, Suncus etruscus, Crocidura suaveolens, C. leucodon, Talpa europaea, Clethrionomys glareolus, Dinaromys bogdanovi, Arvicola terrestris, Pitymys subterraneus, P. liechtensteini, Chionomys nivalis, Microtus arvalis, Nannospalax monticola, Apodemus mystacinus, A. flavicollis, A. sylvaticus, Rattus rattus, R. norvegicus, Mus domesticus, M. musculus, Glis glis, Eliomys quercinus, Dryomys nitedula,* and *Muscardinus avellanarius.* The distribution in the study area of each of these is discussed and mapped. Available ecological data are compiled and discussed. Zoogeographic relations are discussed. Special attention is paid to small mammal communities from karstic fields.

IZVLEČEK – ŽUŽKOJEDI IN GLODALCI OSREDNJEGA DINARSKEGA KRASA JUGOSLAVIJE – Za osrednjo Dalmacijo, jugozahodno Bosno in zahodno Hercegovino je poznanih devetindvajset vrst žužkojedov in glodalcev: *Erinaceus concolor, Sorex minutus, S. araneus, S. alpinus, Neomys fodiens, N. anomalus, Suncus etruscus, Crocidura suaveolens, C. leucodon, Talpa europaea, Clethrionomys glareolus, Dinaromys bogdanovi, Arvicola terrestris, Pitymys subterraneus, P. liechtensteini, Chionomys nivalis, Microtus arvalis, Nannospalax monticola, Apodemus mystacinus, A. flavicollis, A. sylvaticus, Rattus rattus, R. norvegicus, Mus domesticus, M. musculus, Glis glis, Eliomys quercinus, Dryomys nitedula* in *Muscardinus avellanarius.* Za vsako vrsto je podana njena razširjenost na preiskovanem območju. Navedeni so tudi razpoložljivi ekološki podatki. V zoogeografski diskusiji posvečamo posebno pozornost malim sesalcem na kraških poljih.

Contents – Vsebina

1. Introduction

From the geographic and faunistic point of view the area of southwestern Bosnia, western Herzegovina and central Dalmatia with its islands represents one of the most versatile and heterogeneous regions in the whole of Europe. Within a distance of about 50 km all types of transitions can be observed, from evergreen maquis to mountain pine forest. The entire area is karstic, although revealing several contrasting facets. On one hand enormous surfaces are covered with an eroded karst in the midst of which lie large karstic fields with a deep layer of soil. On the other hand the areas on which in the past man exerted a less marked influence are as yet overgrown with broad forests. Therefore, the habitats are extremely diverse both in the vertical as well as the horizontal plane.

The oldeset data on the insectivores and rodents of this area can be found in CARRARA (1846–48) and BLASIUS (1857) who listed 13 species for Dalmatia. One of them *(Talpa caeca)* does not live in central Dalmatia. Its presence was later confirmed in the Montenegro littoral (PETROV 1974), which in Blasius's times formed part of the Austrio-Hungarian Dalmatia. Blasius's report of *»Sorex pygmaeus«* (= *Sorex minutus)* in Dalmatia remains unconfirmed. KOLOMBATOVIĆ (1882, 1884, 1893) added further three rodents to the list of Dalmatian mammals. In this period NEHRING (1898) described a new species of mole-rat *(Spalax monticola)* from Bosnia.

The 20th century has seen the publication of numerous faunistic data on the insectivores and rodents of western Bosnia, central Dalmatia with its islands, and western Herzegovina. Mention should be made of the works by WETTSTEIN (1920) on Brač Is., BOLKAY (1924, 1926, 1927) on Bosnia and Herzegovina, DATHE (1934) and PETROV (1939) on Split, WITTE (1964) on Sinjsko polje, DJULIĆ & VIDINIĆ (1967) on Dinara and Šator mountains, and DJULIĆ (1976), as well as DJULIĆ & TVRTKOVIĆ (1979) on the Adriatic islands. KRPAN (1962) wrote of 11 species of insectivores and rodents for the territory of Split and Zagora, his statements however are based above all on uncorroborated observations. Besides the above, there exist a number of publications, mentioning localities in the area, relating to *Talpa europaea, Neomys* spp., *Crocidura* spp., *Dinaromys bogdanovi, Arvicola terrestris, Pitymys subterraneus, Apodeumus* spp., *Mus spp., Nannospalax monticola, Eliomys quercinus, Dryomys nitedula* and *Glis glis.* The corresponding references are published in the systematic part.

In addition to the aforementioned *Nannospalax monticola* (NEHRING 1898) three new taxa were described from this area: *Crocidura leucodon narentae* BOLKAY 1925, *Eliomys quercinus dalmaticus* DJULIĆ & FELTEN 1962 and *Dinaromys bogdanovi longipedes* (DJULIĆ & VIDINIĆ 1967).

In the years from 1980 to 1983 the authors of the article dedicated a most intensive study to the area in question, putting special emphasis on karstic fields. Before that (between 1974 and 1977) N. TVRTKOVIĆ studied Dalmatia and its islands. In the years from 1984 to 1986 they collaborated with other researchers in the study of the mountains of Bosnia, Dalmatia and Herzegovina. By courtesy of J. GREGORI and S. BRELIH we could also include the data collected by our colleagues of the Natural History Museum of Slovenia on their excursion to Dalmatia in April 1974.

Though some fragmentary data had been published previously (DJULIĆ & TVRTKOVIĆ 1979, KRYŠTUFEK 1984, 1985, 1986, KRYŠTUFEK & TVRTKOVIĆ 1984), a need for a complete publication of all collected faunistic data became more and more obvious. We have incorporated all the relevant data from the rather scattered references in the litterature known to us. Twenty-nine species of inserctivores and rodents are known to occur in the area *(Sciurus vulgaris* is not included). The presence of twenty-six species was confirmed in the course of our field work. In the case of four species *(Sorex minutus, Neomys fodiens, Pitymys liechtensteini* and *Muscardinus avellanaraius)* these are the first data for this area.

2. Material and Methods

Material was collected on the following trips:
1974
- April 27–28 : Mt. Opor (S. Brelih, J. Gregori, F. Balat);

1975
- Sept. 2–5 : Brač Is. (N. Tvrtković);
- Oct. 3–10 : Hvar Is., Mt. Opor, Kupreško polje (N. Tvrtković);
- Dec. 6–11 : Mt. Biokovo, Mt. Opor, Marina (N. Tvrtković);

1976
- Aug. 23–30 : Mt. Opor, Mt. Biokovo (N. Tvrtković, B. Jalžić);

1977
- June 10–11 : Livanjsko polje (N. Tvrtković, D. Pelić, O. Vukadinović);

1977
- Date ? : Cetina, Gosposka pećina (B. Jalžić, D. Pelić, O. Vukadinović);

1980
- Sept. 10–14 : Kupreško polje, Mt. Cincar (N. Tvrtković, B. Kryštufek, D. Kovačić);

1982
- Oct. 24–30 : Brač Is., Dugopolje, Mt. Opor (N. Tvrtković, V. Štamol);

1983
- Sept. 6–15 : Cetinsko polje, Duvanjsko polje. Glamočko polje, Kupreško polje, Koprivnica, Mt. Šator (B. Kryštufek, N. Tvrtković, I. Sivec, V. Popov);

1984
- July 14–17 : Mt. Dinara (N. Tvrtković, B. Jalžić, J. Ostojić, P. Kasač);
- July 21 – Aug. 2 : Vis Is. (B. Kryštufek)
- Sept. 4–6 : Mt. Šator, Mt. Raduša (B. Kryštufek, N. Mršić, V. Popov, M. Štangelj);
- Oct. 6–7 : Cetina (N. Tvrtković, B. Jalžić, J. Ostojić);

1986
- June 7–10 : Mt. Čvrsnica (B. Kryštufek, V. Popov).

850 insectivores and rodents belonging to 26 species were collected. The skulls and to some extent also the skins were stored. Some of the material is preserved in alcohol. The material is kept at the Natural History Museum of Slovenia (Ljubljana) and the Croatian Natural History Museum (Zagreb).

Most of the material was collected by snap traps. We used the »Museum Special« traps baited with canned sardines and oat flakes. Traps were laid only at night, mostly (the terrain allowing) in a straight line and about 5 m apart. From 70 to 300 traps were laid daily. To catch moles and mole-rats special traps were used.

Faunistic affinity between small mammal samples is expressed in the form of a coefficient of community (CC):

$$CC = 100\,C / n1 + n2 - C$$

where C represents the number of species common to the two samples, n1 is the total number in the smaller sample and n2 the number in the larger one.

3. Description of the Study Area

3.1. Geography

From the geographic aspect the region is most versatile (Fig. 1). Politically it belongs to two Yugoslav socialist republics: the Socialist Republic of Croatia and the Socialist Republic

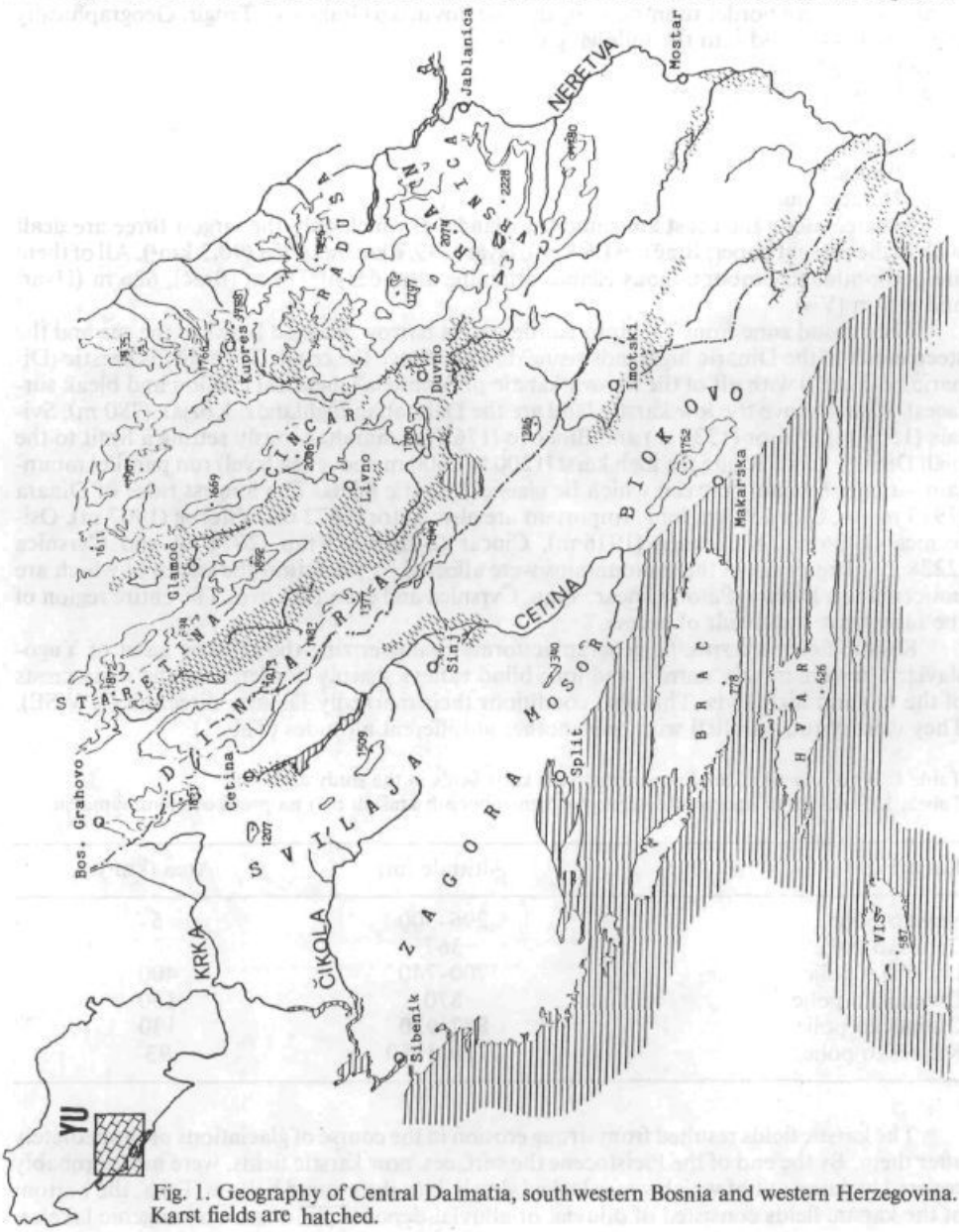


Fig. 1. Geography of Central Dalmatia, southwestern Bosnia and western Herzegovina. Karst fields are hatched.

of Bosnia and Herzegovina. The Croatian part is identical with central Dalmatia and its islands whereas the Bosnian-Herzegovinian part corresponds to the southern part of western Bosnia and western Herzegovina. In the east the region is bounded by the Neretva river representing a very important zoogeographic border (PETROV 1979); in the north the region extends as far as the line Jablanica – Prozor – northern border of Glamočko polje – Bosansko Grahovo; western border running along the line Bosansko Grahovo – Trogir. Geographically the region is divided into the following units:

1. Littoral (Dalmatia)
   a. Coastal zone (seaside)
   b. Islands
2. Continental part
   a. Bosnia
   b. Herzegovina

Situated along the coast are some ten islands, of which only the largest three are dealt with in the present paper: Brač (394.6 km²), Hvar (299.7 km²) and Vis (90.3 km²). All of them are predominantly mountainous islands attaining altitudes of 778 m (Brač), 626 m (Hvar) and 587 m (Vis).

The coastal zone from Trogir to Kardeljevo is narrow, wedged between the sea and the steep crests of the Dinaric highlands rising directly above the coast. The relief is karstic (Dinaric holokarst) with all of the known karstic phenomena (chemical erosion and bleak surfaces). Rising above the low karstic land are the Dalmatian highlands: Kozjak (780 m), Svilaja (1509 m), Mosor (1330 m) and Biokovo (1762 m), simultaneously setting a limit to the high Dinaric karst. Along the high karst (1200 to 1600 m above sea level) run parallel mountain – ridges (»bila«) between which lie classical karstic fields. The longest ridge of Dinara (1913 m a. s. l.) is 150 km long. Important are also: Šator (1872 m), Vitorog (1907 m), Osiječnica (1796 m), Klekovača (1916 m), Cincar (2006 m), Vran (2074 m) and Čvrsnica (2228 m). The peaks of these mountains were affected by glaciation the traces of which are noticeable on Dinara, Šator, Cincar, Vran, Čvrsnica and even Biokovo. The entire region of the high karst is difficult of access.

Karstic fields are specific geographic forms characterizing the Dinaric karst of Yugoslavia. They are mostly narrow and long blind valleys sharply bordered by the steep crests of the Dinaric highlands. This also conditions their markedly Dinaric direction (NW-SE). They usually run parallell with one another at different altitudes (Tab. 1).

Table 1. Area and altitude of most important karst fields in the study area.
Tabela 1. Površine in nadmorske višine najpomembnejših kraških polj na preiskovanem območju.

Karst Field	Altitude (m)	Area (km²)
Sinjsko polje	296–300	5
Cetinsko polje	367	
Livanjsko polje	700–740	400
Duvanjsko polje	870	150
Glamočko polje	882–950	130
Kupreško polje	1120–1150	93

The karstic fields resulted from strong erosion in the course of glaciations or immediately after them. By the end of the Pleistocene the surfaces, now karstic fields, were most probably covered by lakes out of which water leaked slowly into the ground bellow. Thus, the bottom of the karstic fields consisted of diluvial or alluvial deposits put down on neogenic lake se-

diments. Karstic fields were cut deeply into the massifs of the Dinaric highlands, whereby numerous underground channels were brought onto the surface allowing the circulation of water. These sources fed rivers and streams meandering along the level bottom of the fields. Most of them soon sank into subterranean passages. In autumn the quantity of precipitations that fall onto this ground is such that the swallow-holes can no longer accomodate the water so the fields are inundated. Periodic lakes appear. At lower altitudes fields are submerged for longer periods of time and their lakes are deeper. This is due to the fact that lower lying fields are more exposed to autumnal rains. Depending upon the altitude and the quantity of autumnal precipitations, lakes inundate fields in October, November or December, and become dry in April, May, June or even July. Those surfaces from which water flows off but slowly and reluctantly are likely to be boggy throughout the year. Some fields (e. g. Kupreško polje) do not become flooded.

The bottoms of karstic fields are covered by the best cultivable soil in this otherwise rather inhospitable karstic world, however, periodic floods render a more intensive rural exploitation impossible. At the beginning of this century more extensive hydroregulation works were started. The fields became much drier. Before drainage the floods in Livanjsko polje Field lasted from November to June while one third of the entire surface was permanently under water. Of the former Buško blato, presently a reservoire lake, 80 % of the surface was constantly under water. Nowadays the margins of karstic fields are mostly under plough whereas the central parts are occupied by pastures and meadows. Human settlements are concentrated on the margins of the fields.

The above information on geography is summarized from RITER-STUDNIČKA (1954), RODIĆ (1970) and MIKŠIĆ (1972).

3.2. Climate

The coastal region with the islands has a mediterranean climate characterized by mild and short winters and warm summers. Autumn is warmer than spring. The mean yearly temperature on the coast ammounts to 15° C (Table 2). Cold is a rare phenomenon so that days with mean temperature below 0° C are exceptional. The lower karstic fields (Sinjsko, Cetinsko and Imotsko polje) are also under a warm Adriatic influence.

Table 2. Temperature regime (°C) in the study area.
Tabela 2. Temperaturni režim (v °C) preiskovanega območja.

	Altitude	Jan.	July	Yearly	Amplitude
Vis	10	9.8	25.1	16.7	15.3
Split–Marjan	122	7.3	25.9	16.2	18.6
Sinj	298	3.9	22.4	12.7	18.5
Mosor – Ljuvač	853	2.4	20.1	10.8	17.8
Kupres	1190	–4.3	15.1	5.9	20.4

The total rainfall in Split amounts to about 859 mm, heaviest in November (120 mm) and least in July (26 mm). The Island of Vis has an annual average of 676 mm of precipitations. Due to a higher temperature and a higher degree of evaporation, July is the driest month of the year. The maximum of precipitations comes at the end of autumn. Summer droughts last from May to September. Snow falls but rarely.

The border between the mediterranean and the continental climate is represented by the limit of the yearly amplitude of 20° C. The continental climate is characterized by moderately warm summers and cold winters. Autumns are longer and warmer than springs. At higher locations summers are short and fresh, and winters long, cold and snowy. At Kupres (1190 m) mean monthly temperatures below zero last for 5 months of the year, from November to May. The coldest months are January and February, and the warmest July and August. Due to temperature inversions, winters are even more severe on high karstic fields.

Precipitations are abundant. The most rainy season is autumn with the maximum of precipitations in October and November. The minimum falls in July and August. The total rainfall at Kupres is 1007 mm, 142 mm thereof in October and 42 mm in July. Characteristic is also an abundance of snow. On the central Bosnian highlands it persists for 215 days a year.

The above information on climate is summarized from RITER-STUDNIČKA (1954), RODIĆ (1970) and BERTOVIĆ (1975).

3.3. Vegetation (Fig. 2)

The islands are overgrown with xerothermic evergreen and mixed decidous – evergreen communities *Oleo-Lentiscetum adriaticum, Quercetum ilicis adriaprovincialis, Orno Quercetum ilicis* and at higher sites *Ostryo-Quercetum ilicis.* As a result of intensive millennial human interventions these forests are degraded to maquis and garrigues, or else, completely thinned and changed into fields, pastures or naked fields of stones (»kamenjari«).

On the shore the eumediterranean mixed forest *Orno-Quercetum ilicis* grows on a narrow coastal zone only. It is a xerothermic mixed decidous – evergreen forest community dominated by *Quercus ilex.* In the maquis the dominant role is taken over by *Cistus salviifolius, C. incanus, Erica arborea, Rosmarinus officinalis* and *Pinus halepensis.* Great surfaces are covered with vineyards, plantations of olive – trees and fig – trees, and more or less rocky pastures (frequently overgrown with *Juniperus oxycedrus),* and finally by naked fields of stones.

Associated directly with the region of mediterranean vegetation is the community *Querco-Carpinetum orientalis croaticum.* It reaches deep into the continent (as far as Livno) and up to an altitude of about 600 m (exceptionally even higher). The forests are mostly degraded into *Paliuretum adriaticum, Festuco-Seslerietum splendeatis* and *Stipo-Salvietum* or naked karst. Dominating at higher sites is the climatozonal community *Ostryo-Quercetum pubescentis.* It grows in the zone between 400 and 950 m and reaches as far as the foot of the high Dinaric mountains (e. g. Šator). These forests are mostly degraded. Wide surfaces are transformed into pastures *(Carici-Centaureetum rupestris)* which, too, are partly ruined so as to become naked karst.

The montane zone of the submediterranean region (800 – 1000/1100 m) is overgrown with *Seslerio-Fagetum.* This forest spreads on the steep sides of Mts. Mosor and Biokovo reaching deep into the interior. Where forests have been thinned there have developed graminaceous communities *Bromo-Chrysopogonetum grylli, Danthonio calycinae-Scorzoneretum villosae, Bromo-Brachypodietum pinnati* and *Carici humilis-Centaureetum rupestris.*

Seslerio-Fagetum already points to the transition from submediterranean to Dinaric vegetation. The zone from 900 to 1400/1500 m is overgrown with *Abieti-Fagetum* s. lat.. Steep slopes and mountain – ridges at a height of 1500 to 1750 m are covered with characteristically bent sabre – shaped trunks of low (1 to 10/15 m high) beech trees.

The lower slopes of *Abieti-Fagetum* merge into *Fagetum montanum* growing in the zone between 300 and 1200/1400 m. Encountered locally between 1000 and 1700 m are pine forests *(Piceetum excelsae montanum),* whereas the peaks and the steep sides of the Dinaric mountains are covered with mountain pine *(Pinetum mugi dinaricum).* The latter community is often degraded to *Cythisantheum radiatae, Sorbetum chamaemespilli, Juniperetum nanae intermediae,* mountain pastures and naked fields of stones.

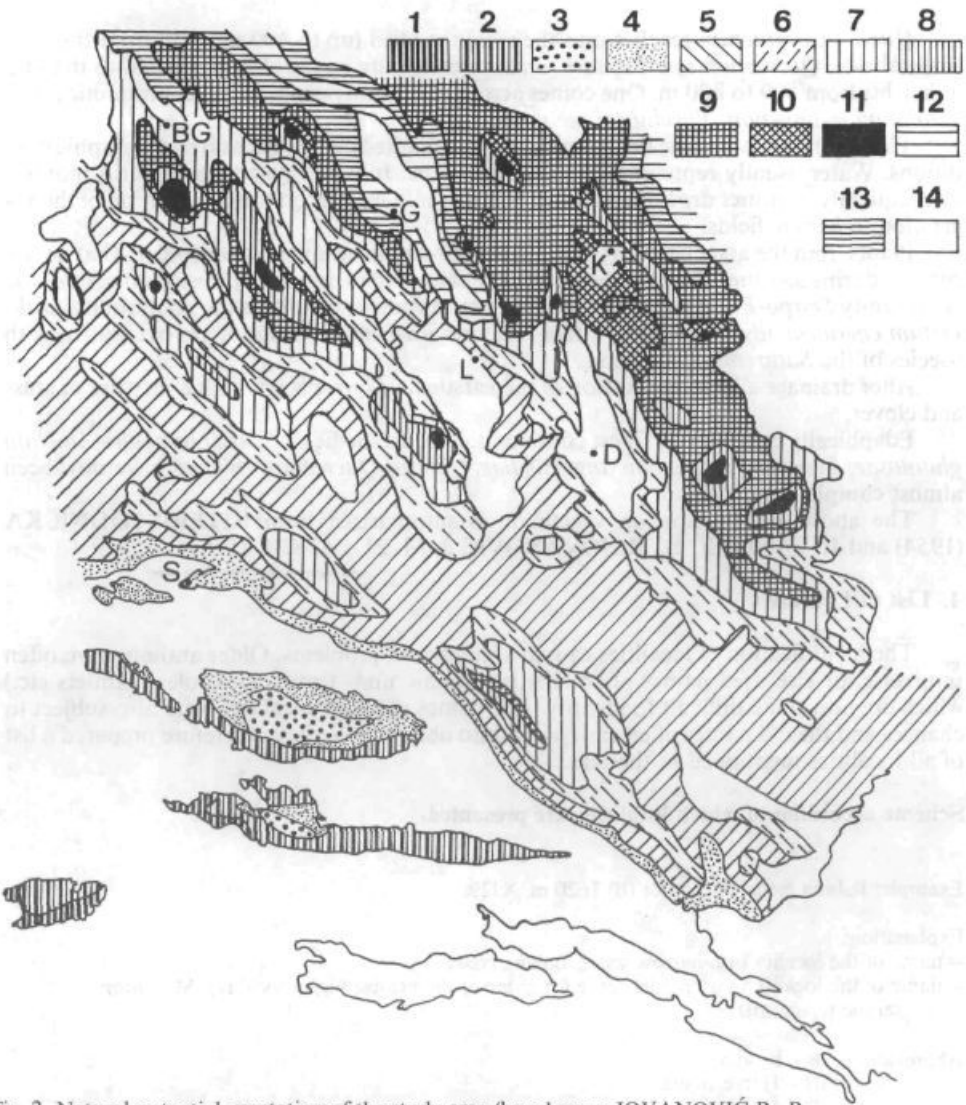


Fig. 2. Natural potential vegetation of the study area (based upon JOVANOVIĆ B., R. JOVANOVIĆ & M. ZUPANČIČ 1986).
Sl. 2. Naravna potencialna vegetacija preiskovanega območja.

Abbrevations: BG – Bosansko Grahovo, D – Duvno, G – Glamoč, K – Kupres, L – Livno, S – Split.
Symbols:

1: *Oleo-Lentiscetum adriaticum,*
2: *Quercetum ilicis adriaeprovincialis,*
3: *Ostryo-Quercetum ilicis,*
4: *Orno-Quercetum,*
5: *Querco-Carpinetum orientalis,*
6: *Ostryo-Quercetum pubescentis,*
7: *Seslerio-Fagetum,*
8: *Fagetum subalpinum,*
9: *Abieti-Fagetum,*
10: *Piceetum excelsae montanum,*
11: *Pinetum mugi,*
12: *Querco-Carpinetum,*
13: *Ostryo-Fagetum,*
14: Edaphically conditioned sylvan communities of karstic fields.

Querco-Carpinetum reaches into the region studied (up to 400 m a.s.l.) from the continental side. *Quercetum cerris dinaricum* appears locally on the slopes exposed to the sun, at heights from 500 to 800 m. One comes across edaphically conditioned communities: *Luzulo albidae-Fagetum, Vaccinio-Fagetum* and *Blechno-Abietetum.*

The vegetation of karstic fields developed in a marked dependence on hydrographic conditions. Water usually represents the limiting factor, July and August being arid months. Consequently, summer droughts exert an essential influence upon the constitution of the vegetation in karstic fields.

Plants from the association *Nymphaeion* grow along the larger water courses that do not run dry during summer. On muddy banks of streams and in deeper depressions one finds the community *Scirpo-Phragmitetum.* The first true meadows belong to the community *Molinietum coeruleae illyricum.* The surfaces that are unaffected by floods are overgrown with species of the *Satureion* association.

After drainage a large proportion of the karstic fields were sown with a mixture of grass and clover.

Edaphically conditioned forest communities of karstic fields *(Carici brizoidis-Alnetum glutinosae, Leucoio-Fraxinetum angustifoliae, Genisto-Quercetum roboris)* have now been almost completely cut down.

The above information on vegetation is summarized from RITER-STUDNIČKA (1954) and JOVANOVIĆ B., R. JOVANOVIĆ & M. ZUPANČIČ (1986).

4. List of Localities

The identification of localities caused a number of problems. Older authors were often imprecise, or else used names of smaller geographic units (caves, sinkholes, hamlets etc.) which are now quite difficult to identify. The names of bigger localities were also subject to changes and the old names often easily sank into oblivion. We have therefore prepared a list of all localities mentioned in the text.

Scheme according to which localities are presented.

Example: Babina greda, Mt. Šator (B) 1620 m, XJ29

Explanation:
- name of the locality in a narrow sense: Babina greda
- name of the locality in a broader sense (or name of the nearest bigger locality): Mt. Šator
- geographic region: (B)

Abbrevations: B – Bosnia
H – Herzegovina
D – Dalmatia
- altitude: 1620 m
- 10 km square of UTM grid: XJ29

Where several names are in use for the same locality, the synonyms include a designation under which name further data can be found. Example: Županjac → Duvno

The current names are accompanied by their synonyms (in brackets). Example: Duvno (= Županjac), Duvanjsko polje (B) 870–900 m, XJB4

Survey:

Babina greda, Mt. Šator (B) 1620 m, XJ29;
Babin grad, Mt. Dinara (B) 1380 m, XJ27;

Bačina, Kardeljevo (= Ploče) (D) 20 m, XH97;
Biokovo Mt. (D)
Bjeli Brig, Poklečani (H) 1368 m, XJ92;
Blatca, Split (D) 5 m, XJ21;
Bol, Brač Is. (D) 5 m, XH39;
Brač Is. (D)
Brazza → Brač Is.;
Brusje, Hvar Is. (D) 340 m, XH28;

Castella → Kaštela;
Cetina, Cetinsko polje (D) 370 m, XJ17;
Cincar Mt. (B) 1700 m, XJ66;

Čapljina (H) 10 m, YH17;
Čatrna voda (= Rupe, Koliba Petra Četnika), Mt. Dinara (D) 1400 m, XJ27;

Ćejića ravne, Mt. Cincar (B) 1420 m, XJ66;

Dol, Hvar Is. (D) 120 m, XH38;
Dolac → Tarlin dolac;
Dugopolje (D) 270 m, XJ32;
Duvno (= Županjac), Duvanjsko polje (B) 870–900 m, XJ84;

Fantovi dolac, Brač Is. (D) 620 m, XH39;

Gabela (H) 20 m, YH17;
Gornji Malovan (= Malovan gornji), Kupreško polje (B) 1140 m, XJ76;
Gospodska pećina, Cetina (D) 440 m, XJ17;
Gradina, Čapljina (H) 290 m, YH17;

Han Vrba, Glamočko polje (B) 897 m, XJ57;
Hrbljina Mt. near Glamoč (B) 1040 m, XJ58;
Hvar Is. (D)

Imotski (D) 260 m, XJ71;
Imotska krajina → vicinity of Imotski;

Jablanica (H) approx. 180 m, YJ23;
Jelsa, Hvar Is. (D) 10 m, XH38;

Karaotok, Čapljina (H) 10 m, YH27;
Kardeljevo (= Ploče) (D) 10 m, XH96;
Kaštela, Split (D) 50 m, XJ02/XJ12;
Kazanci (B) 720 m, XJ37;
Klečarski vrhovi, Mt. Dinara (B) 1740–1786 m, XJ27;
Kloštar, Stipančić bei Bol, Brač Is. (D) UTM grid?
Koprivnica – Poriče (B) 880 m, XJ87;
Kosa, Mt. Mosor (D) 940 m, XJ32;
Kovačića stan, Mt. Dinara (D) 1300 m, XJ26;
Kozjak Mt. (D) ca 700 m, XJ02;
Kupres, Kupreško polje (B) 1200 m, XJ87;
Kupreška vrata → Koprivnica – Poriče;
Kurlaja, Mt. Dinara (B) 1375 m, XJ27;

Lice, Mt. Dinara (B) 1300 m, XJ26;
Lištica (= Široki Brijeg) (H) 300 m, YJ10;
Ljuvac → Ljuvač?
Ljuvač, Mt. Mosor (D) 860 m, XJ32;
Lokva, Vis Is. (D) WH96;
Lučice, Milna, Brač Is. (D) 30 m, XH19;

Makarska (D) 50 m, XH69;
Makljen, Mt. Raduša (B) 1120 m, YJ05;

Mali Šator, Mt. Šator (B) 1768 m, XJ39;
Malovan gornji → Gornji Malovan;
Marina, Trogir (D) 160 m, WJ92;
Marjan, Split (D) 100 m, XJ11;
Metković (D) 5 m, YH17;
Mosor Mt. (D)
Mostar (H) 59 m, YJ02;
Mrtvica, Fatelj, Kupreško polje (B) 1135 m, XJ87;

Nadselca → Selca?
Nerežišće, Brač Is. (D) 380 m, XH29;

Občevina, Kupreško polje (B) 1134 m, XJ87;

Pisak (D) 100 m, XJ50;
Ploče → Kardeljevo;
Podšpilje, Vis Is. (D) 200 m, WH96;
Poklečani (H) 1368 m, XJ92;
Posušje (H) 687 m, XJ81;
Pražnice, Brač Is. (D) 390 m, XH39;
Prusačka reka, Prusac (B) 900 m, XJ88;

Radovan Mt., above Posušje (H) 1134 m, XJ81;
Risovac, Mt. Čvrsnica (H) 1300 m, YJ03;
Rupe, Kolibe Petra Četnika → Čatrna voda;
Salona → Solin;
Selca, Brač Is. (D) 120 m, XH49;
Sinj, Sinjsko polje (D) 300 m, XJ34/XJ33;
Solin, Split (D) 10 m, XJ22;
Sošići, Gornje Igrane, Mt. Biokovo (D) 750 m, XH79;
Spalato → Split;
Split (D) 30 m, XJ11;
Stara sniježnica, Mt. Biokovo (D) 1400 m, XH69;
Sućuraj, Hvar Is. (D) 10 m, XH77;
Sv. Martin, Brač Is (D) 235 m, XJ20;
Svinjača, Blidinje jezero (H) 1170 m, YJ03;

Šatorsko jezero, Mt. Šator (B) 1490 m, XJ29;
Široki brijeg → Ličtica;
Šuica – Mt. Ljubuša (B) 1000 m, XJ75;

Tarlin dolac, Mt. Dinara (D) 1300 m, XJ26;
Trilj, Sinjsko polje (D) 300 m, XJ33;
Turjaci, Sinjsko polje (D) 300 m, XJ33;

Vaganj, Mt. Dinara (B) 1200 m, XJ44;
Vidilica – Malačka, Mt. Opor (D) 480 m, XJ02;
Vidova gora, Brač Is. (D) 600–770 m, XH39;
Vis, Vis Is. (D) 10 m, WH96;
Vošac, Mt. Biokovo (D) 1400 m, XH69;
Vran Mt. (B) alt. ?, YJ03;
Vrnjača cave (D) 440 m, XJ32;
Vrlika (D) 400 m, XJ16;

Ždralovac, Livanjsko polje (B) 710 m, XJ28;
Županjac → Duvno.

5. Survey of Species

In presenting the species we have applied the following scheme:
1. Scientific name
2. Synonyms

Given are names used by older authors for the species in the study area.

3. Material

Listed are the basic data on the collected material examined by the authors. The following data are given:

- locality
- altitude (in brackets)
- date
- number of specimens according to sex (males, females, or sex unknown)
- collector (in brackets): the authors are referred to by initials (B.K. –B. Kryštufek; N.T. – N. Tvrtković) otherwise the surename is written out in full.

Personal statements are exceptionally also included and are indicated »in litt.«.

4. References
5. Notes and commentary concerning the species
6. Data on reproduction

Abbrevations: E – embryos (number)
p.s. – placental scars (number)

5.1. Insectivora

5.1.1. Erinaceidae

***Erinaceus concolor* MARTIN 1838**

Syn.: *Erinaceus europaeus* CARRARA 1846–48
Erinaceus europaeus KOLOMBATOVIĆ 1882
Erinaceus europaeus KRPAN 1962
Erinaceus europaeus italicus DJULIĆ 1972
Erinaceus roumanicus DJULIĆ 1972

Material:
– Cetina, Cetinsko polje, (370 m) –.09.1983, 1 sex? (I. Sivec); – Vis, Vis Is. (10 m) 23.07.1984, 1 ♀ (B.K.); 01.08.1984, 1 ♀ (Mojca Kryštufek);

References:
– Pražnice, Brač Is. (390 m) DJULIĆ 1976; DJULIĆ & TVRTKOVIĆ 1979; – Dol, Hvar Is. (120 m) DJULIĆ & TVRTKOVIĆ 1979; – Podšpilje, Vis Is. (200 m) DJULIĆ & TVRTKOVIĆ 1979.

The hedgehog populates the entire study region though it is more frequent in the parts under the influence of the Mediterranean. It is particularly common on the Adriatic islands. The upper limit of its distribution is not known.

5.1.2. Soricidae

***Sorex minutes* LINNAEUS 1766**

Syn.: *Sorex pygmaeus* BLASIUS 1857
Sorex pygmaeus KOLOMBATOVIĆ 1882

Material:
– Občevina, Kupreško polje (1134 m) 11.09.1980, 1 ♀ (B.K.); – Ćejića ravne, Mt. Cincar (1420 m) 14.09.1980, 1 sex? (N.T.); – Gornji Malovan, Kupreško polje (1140 m) 11.09.1983, 1 ♀ (N.T.); – Babina greda, Mt. Šator (1620 m) 13.09.1983, 1 sex? (N.T.).

References:
– Dalmatia. BLASIUS 1857

Blasius's report for Dalmatia had never been confirmed. Our data are the first ones concerning the pigmy shrew in this region.

It was found in Bosnia only, in the montane and the subalpine belt. All locations were between 1134 and 1620 m a.s.l.. It has been found in the following habitats: pasture, mountain meadow and live-hedge.

A total of four specimens were cought (all of them by means of snap-traps). If this figure is compared with the forty specimens of *Sorex araneus*, one gets the impression that *S. minutus* is much less common. However, this apparent scarcity is most probably due to the poor effectiveness of snap-traps in capturing this shrew species which has also been observed elsewhere in Yugoslavia (KRYŠTUFEK 1983).

Sorex araneus LINNAEUS 1758

Material:
– Ždralovac, Livanjsko polje (710 m) 11.06.1977, 1 sex? (N.T.); – Mrtvica, Fatelj, Kupreško polje (1135 m) 12.09.1980, 1 sex?; 09.09.1983, 2 sex? (B.K.); – Cincar Mt. (1700 m) 13.–14.09.1980, 1 ♂, 2 ♀♀, 4 sex? (N.T., B.K., D. Kovačić); – Koprivnica–Poriče (880 m) 10.09.1983, 3 ♂♂, 5 sex? (N.T., B.K., V. Popov); – Gornji Malovan, Kupreško polje (1140 m) 11.09.1983, 1 ♂, 1 ♀, 1 sex? (N.T., B.K., V. Popov, I. Sivec); – Šatorsko jezero, Mt. Šator (1490 m) 12.–14.09.1983; 12 sex? (N.T., B.K., V. Popov); 05.09.1984, 1 sex? (B.K., V. Popov); – Babina greda, Mt. Šator (1620 m) 13.09.1983, 3 ♀♀ (N.T.); – Makljen, Mt. Raduša 1120 m) 06.09.1984, 1 sex? (B.K.).

References:
– Klečarski vrhovi, Mt. Dinara (1786 m) DJULIĆ & VIDINIĆ 1967; – Lice, Mt. Dinara (1300 m) DJULIĆ & VIDINIĆ 1967; – Kurlaja, Mt. Dinara (1375 m) DJULIĆ & VIDINIĆ 1967; – Šatorsko jezero, Mt. Šator (1490 m) DJULIĆ & VIDINIĆ 1967.

The common shrew lives exclusively in the continental part of the region studied. We can also expect to find it in the border territory, on the Dalmatian side of Dinara and possibly also in Svilaja.

It populates the submontane, the montane and the subalpine belt. In the montane belt it is confined to beech and pine forests, and in the subalpine belt to *Fagetum subalpinum, Pinetum mugi* and fields of stones. In Kupreško polje Field it was found in dense hydrophilous vegetation on the river Mrtvica, otherwise dominated by water shrews (*Neomys* spp.), and in Livanjsko polje Field in swampy meadows on a bog.

Vertical distribution of localities was between 740 and 1786 m a.s.l..

Sorex alpinus SCHINZ 1837

Material:
– Ćejića ravne, Mt. Cincar (1420 m) 13.09.1980, 1 ♀ (B.K.); – Koprivnica–Poriče (880 m) 10.09.1983, 1♂, 1 sex? (B.K., N.T.); – Šatorsko jezero, Mt. Šator (1450 – 1490 m) 12.–14.09.1983, 3 ♂♂, 1 ♀, 3 sex? (N.T., B.K., V. Popov); 05.09.1984, 1 sex? (B.K., V. Popov); – Babina greda, Mt. Šator (1620 m), 14.09.1983, 1 ♀ (N.T.).

References:
– Šatorsko jezero, Mt. Šator (1490 m) DJULIĆ & VIDINIĆ 1967; – Mali Šator, Mt. Šator (1600 m) DJULIĆ & VIDINIĆ 1967; – Čatrna voda, Mt. Dinara (1490 m) DJULIĆ & VIDINIĆ 1976; – Babin Grad, Mt. Dinara (1380 m) DJULIĆ & VIDINIĆ 1967; – Prusačka reka, Prusac (900 m) BRELIH & PETROV 1978 (leg.: N.T.).

The alpine shrew lives in the continental part of the region studied whereas on Dinara it was found also on the Dalmatian side (Čatrna voda) near the border with Bosnia and Herzegovina (DJULIĆ & VIDINIĆ 1967). In the montane belt it is confined to beech and pine forests, and in the subalpine belt to *Fagetum subalpinum, Pinetum mugi* and fields of stones.

It was found mostly syntopically with *Sorex araneus* (Table. 3). On the coastal side of Dinara it lives in sinkholes together with *Dinaromys bogdanovi, Chionomys nivalis* and *Eliomys quercinus.* The finds were distributed within a range of 880 to 1620 m a.s.l.. On the Dalmatian side it was found at a height of 1400 m.

Table 3. Dominance of *Sorex araneus* and *S. alipinus* in three Bosnian localities.
Tabela 3. Dominantnost vrst *Sorex araneus* in *S. alpinus* s treh nahajališč v Bosni.

Locality	Altitude	S. alpinus	S. araneus	% S. alpinus
Koprivnica	880	2	8	20.0
Cincar	1700	1	7	12.5
Šator	1450–1620	8	16	33.3
Total		11	31	27.9

Neomys fodiens (PENNANT 1771)

Material:
– Mrtvica, Fatej, Kupreško polje (1135 m) 09.09.1983, 14 ♂♂, 11 ♀♀ (N.T., B.K.); – Koprivnica–Poriće (880 m) 10.09.1983, 3 ♂♂, 6 ♀♀, (N.T., B.K., V. Popov);

We know of no previous data for this region referring to the water shrew. In the course of our investigations it was found only in the continental part i.e. Bosnia. It is confined exclusively to the montane belt. Vertical distribution of localities was between 800 and 1135 m a.s.l..

In the night from Sept. 11–12, 1980, no *N. fodiens* was found on the Mrtvica river, Kupreško polje Field, though 16 specimens of *Neomys anomalus* were caught in the same night. Three years later (Sept. 8–9, 1983) 57 water shrews were caught in the same place, 25 thereof (i.e. 44%) were *N. fodiens.* On other, lower lying, karstic fields no *N. fodiens* were found.

At Koprivnica *N. fodiens* was found in a habitat typical of it, namely: a fast flowing mountain stream in a forest of *Abieti–Fagetum.* Along about 100 m of the water stream (2 m broad) 5 specimens of this species were caught. *N. anomalus* was not found here.

Neomys anomalus CABRERA 1907

Syn.: *Crossopus vulgaris* CARRARA 1846–48
Crossopus fodiens KOLOMBATOVIĆ 1882
Neomys fodiens DJULIĆ 1971

Material:
– Mrtvica, Fatelj, Kupreško polje (1135 m) 12.09.1980, 9 ♂♂, 6 ♀♀, 1 sex? (N.T., B.K., Darko Kovačić); 09.09.1983, 12 ♂♂, 18 ♀♀, 1 sex? (N.T., B.K., I. Sivec, V. Popov); – Cetina, Cetinsko polje (370 m) 07.09.1983, 1 ♀ (N.T.); – Duvno, Duvanjsko polje (870 m) 08.09.1983, 11 ♂♂, 18 ♀♀ (B.K., N.T., I. Sivec,

V. Popov); – Gornji Malovan, Kupreško polje (1210 m) 11.09.1983, 1 ♀ (V. Popov); – Han Vrba, Glamočko polje (897 m) 12.09.1983, 14 ♂♂, 22 ♀♀ (B.K., N.T.).

References:
– Blatca (5 m) KOLOMBATOVIĆ 1882; – Trilj (300 m) KOLOMBATOVIĆ 1882; – Salona (20 m) KOLOMBATOVIĆ 1882; – Turjaci (300 m) WITTE 1964; Gabela, DJULIĆ 1971.

N. anomalus was usually one of the dominant small mammals in the karstic fields of the continental part of the region, while it was less frequent in Dalmatia. It was confined to dense hydrophilous vegetation along (permanent or periodic) water streams in karstic fields. Where water runs dry during droughts, *N. anomalus* was able to spend the summer in the vegetation of the *Scirpo–Phragmitetum* association. In such a habitat it was found in a great number between September 7 and 8, 1983 in Duvanjsko polje Field. Its ability to spread outside the primary habitat was indicated also by finding this species in the xerophilous vegetation in the *Piceetum* zone at Gornji Malovan, about 5 km away from the nearest water and at an altitude of about 80 m higher than the level of the stream.

The species was found in the lowlands and the montane belt, at an altitude ranging from 20 to 1210 m a.s.l..

Among 113 *N. anomalus* caught in September 1980 and 1983 the females (59%) prevailed over the males, which gives a ratio of 142 ♀♀ per 100 ♂♂.

Suncus etruscus (SAVI 1822)

Syn.: *Crocidura suaveolens* BLASIUS 1857
Pachyura etrusca KOLOMBATOVIĆ 1882

References:
– Dalmatia. BLASIUS 1857; – Spalato, Castella. KOLOMBATOVIĆ 1882; – Imotska krajina. KOLOMBATOVIĆ 1883; – Kamen; Marjan; Žrnovica. KRPAN 1962.

The pygmy white-toothed shrew was included in our list on the basis of an old account that KOLOMBATOVIĆ (1882) wrote 105 years ago. There exist no newer data from this region. Krpan's statements (KRPAN 1962) referring to this species are problematic fot they are based primarily on observations while the relating material has not been preserved.

Crocidura suaveolens (PALLAS 1811)

Syn.: *Crocidura araneus* CARRARA 1846–48
Leucodon araneus KOLOMBATOVIĆ 1882

Material:
– Vidova gora, Brač Is. (600 m) 04.09.1975, 1 sex? (N.T.); – Sućuraj, Hvar Is. (10 m) –.08.1976, 1 sex? (B. Borčić); – Cetina, Cetinsko polje (370 m) 07.09.1983, 4 ♂♂, 3 ♀♀ (B.K., N.T.); – Duvno, Duvanjsko polje (870 n) 08.09.1983, 2 ♀♀ (B.K., N.T.).

References:
– Brazza Is.; KOLOMBATOVIĆ 1884; – Sinj (300 m) DJULIĆ 1971; VESMANIS 1976; – Mosor; VESMANIS 1976; – Nerežišće, Brač Is. (380 m) DJULIĆ 1976a; – Nadselca, Brač Is.: DJULIĆ 1976a; – Metković (? 30 m) DJULIĆ 1976a; – Biokovo; DJULIĆ 1976a; – Karaotok, Čapljina (10 m) BRELIH & PETROV 1978.

C. suaveolens was common in nearly all types of habitats in Dalmatia. In Cetinsko polje Field it was caught along live-hedges, stony enclosures and margins of cultivated land. It lived in similar habitats on the islands.

With increasing distance from the coast (i.e. as the mediterranean and the submediterranean influences, resp., grow weaker), *C. suaveolens* became less frequent. Duvanjsko polje Field represented the only place where it has been found in the continental part. In the aforementioned Field we caught two specimens in a dry habitat also populated by *Microtus arvalis* and *Apodemus sylvaticus.*

Vertical range of localities was between 10 and 870 m a.s.l..

***Crocidura leucodon* (HERMANN 1780)**

Syn.: *Lucodon micrurus* KOLOMBATOVIĆ 1882

Material:
– Vidilica – Malačka, Mt. Opor (480 m) 08.09.1975, 1 ♂, 1 ♀ (N.T.);

References:
– Čapljina, Mogorjelo (= Loc. typ. of *Crocidura leucodon narentae* BOLKAY 1925); – Karaotok (10 m) BRELIH & PETROV 1978; – Gabela. DJULIĆ 1971; – Biokovo. DJULIĆ 1976a.

With respect to the last two mentioned localities there exists a justified suspicion that an error must have been committed in labelling the material.

C. leucodon was found only on the Dalmatian side, more precisely, in a narrow coastal zone. Though it is quite probable that it is also more widely distributed in the region studied, it was caught (by snap-traps) in one locality only. It was found in the same habitat as *Glis, glis, Apodemus mystacinus* and *Apodemus sylvaticus.*

5.1.3. Talpidae

***Talpa europaea* LINNAEUS 1758**

Material:
– Gornji Malovan, Kupreško polje (1140 m) 07.10.1975, 1 ♂, 1 ♀ (N.T.); 11.09.1983, 1 ♂, 1 ♀ (N.T., B.K); – Občevina, Kupreško polje (1134 m) 11.09.1980, 1 ♂ (B.K.); – Koprivnica–Poriče (880 m) 10.09.1983, 1 ♂ (N.T.); – Babina greda, Mt. Šator (1620 m) 14.09.1983, 1 ♂ (N.T.); – Duvno, Duvanjsko polje (870 m) 08.09.1983, 1 ♀ (B.K.); – Makljen, Mt. Raduša (1120 m) 06.09.1984, 1 ♀ (B.K.); – Risovac, Mt. Čvrsnica (1300 m) 08.06.1986, 1 ♀ (B.K.); – ? Marjan, Split (100 m) (T. Rađa in litt.).

References:
– Čatrna voda, Mt. Dinara (1420 m) DJULIĆ & VIDINIĆ 1967; – Vaganj, Mt. Dinara (1200 m) PETROV 1974; – Svinjača, Blidinje jezero (1170 m) BRELIH & PETROV 1978; – Bjeli Brig, Poklečani (1368 m) BRELIH & PETROV 1978.

Talpa eurpaea is the only mole species living to the west of the Neretva river (PETROV 1974) i.e. also in the region studied.

The sole reported sighting for Split has not been substantially confirmed. The mole was not recorded by KRPAN (1962) for the region around Split. As the only data on the mole for this part of the Adriatic coast is in question, its existence is considered unproved. *Talpa europaea* was found at altitudes as low as 2 m a.s.l. on the northern Adriatic coast (TVRT-

KOVIĆ 1984), where it is much less frequent in the mediterranean than the continental zone. KRPAN (1962) records it as rare in the northern parts of Zagora.

All sites where the mole was found were within the continental part of the region at altitudes ranging from 870 to 1620 m a.s.l..

5.2. Rodentia
5.2.1. Arvicolidae

***Clethrionomys glareolus* (SCHREBER 1780)**

Material:
– Ćejića ravne, Mt. Cincar (1420 m) 13.–14.09.1980, 4 ♀♀, 2 ♂♂ (B.K.); – Koprivnica–Poriče (880 m) 10.09.1983, 7 ♂♂, 10 ♀♀ (N.T., B.K., V. Popov); – Babina greda, Mt. Šator (1620 m) 13.09.1983, 1 ♀ (N.T.).

References:
– Lice, Mt. Dinara (1300 m) DJULIĆ & VIDINIĆ 1967; – Babin grad, Mt. Dinara (1380 m) DJULIĆ & VIDINIĆ 1967; – Šatorsko jezero, Mt. Šator (1490 m) DJULIĆ & VIDINIĆ 1967.

Bank vole populates the montane and the lower subalpine belt of the region. On Dinara it was found only on the continental and not on the Dalmatian side (DJULIĆ & VIDINIĆ 1967). We found it in the following habitats: *Abieti-Fagetum, Fagetum subalpinum* and *Piceetum excelsae montanum*. It occured exceptionally in mountain pine forest. No other voles were caught syntopically with it.

The vertical range is from 880 to 1620 m a.s.l..

Reproduction: (Data for September): Koprivnica E 3,4,4; p.s. 3,4,4 ($\bar{x} = 3,7$); Cincar E4; Šator p.s. 6.

***Dinaromys bogdanovi* (V. et E. MARTINO 1922)**

Syn: *Dolomys bogdanovi MIRIĆ & DJULIĆ 1962*
Dolomys bogdanovi DJULIĆ & VIDINIĆ 1967

Material:
– Vidilica–Malačka, Mt. Opor (480 m) 28.04.1974, 3 ♂♂, 2 ♀♀ (J. Gregori, S. Brelih); 06.10.1975, 4 ♂♂ (N.T.); Sošići, Mt. Biokovo (750 m) 07.12.1975, 1 ♂ (N.T.); – Stara snježnica, Mt. Biokovo (1400 m) 27.08.1976, 1 ♀ (N.T., B. Jalžić); – Čejića ravne, Mt. Cincar (1420 m) 13.09.1980, 4 ♂♂, 12 ♀♀, 12 ♂♂ (N.T., B.K., D. Kovačić); – Mt. Cincar (1700 m) 13.09.1980, 1 ♂ (N.T., D. Kovačić); – Šatorsko jezero, Mt. Šator (1490 m) 13.09.1983, 1 ♀ (V. Popov); – Babina greda, Mt. Šator (1620 m) 14.09.1983, 2 ♂♂, 1♀, 1 sex? (N.T.).

References:
– Biokovo (1400 m) MIRIĆ & DJULIĆ 1962; – Čatrna voda, Mt. Dinara (1400 m) DJULIĆ & VIDINIĆ 1967; – Kurlaja, Mt. Dinara (1375 m) DJULIĆ & VIDINIĆ 1967; – Šatorsko jezero, Mt. Šator (1488 m) DJULIĆ & VIDINIĆ 1967; – Mt. Cincar. PETROV & TODOROVIĆ 1982; – Mt. Kozjak (= Malačka) PETROV & TODOROVIĆ 1982; – Poklečani (1368 m) PETROV & TODOROVIĆ 1982; – Karaotok (10 m) PETROV & TODOROVIĆ 1982; – Kardeljevo (= Ploče) (20 m) PETROV & TODOROVIĆ 1982.

Localized populations of Martino's vole are known from Kozjak, Opor, Biokovo, Dinara (Troglav), Šator and Cincar. The altitude exerts no influence upon the distribution of this species (the heights at which it was found range from 10 to 1700 m a.s.l.). Decisively important however is the presence of fields of stones with deep fissures which this markedly petricolic trogloxene requires for its existence. Its occurence is thus azonic.

Special attention should be paid to localities where another petricolic vole appears syntopically, namely *Chionomys nivalis*. The following are such localities:

– Dinara, Čatrna voda, Rupe (1420 m)

DJULIĆ & VIDINIĆ (1967) present the following statement: The animal *(Ch. nivalis)* was caught in one of the sinkholes, 30 to 40 m deep, with thick layers of snow on its southern side (July 19, 1962). In the same valley we also caught a specimen of *Dolomys* genus (= *Dinaromys bogdanovi)*.

– Šator

In the screes partly overgrown with *Pinus mugo* above Šatorsko jezero Lake *Ch. nivalis* was dominant (1 *D. bogdanovi* : 16 *Ch. nivalis)* whereas at higher altitudes (1620 m) *D. bogdanovi* was relatively more common (4 *D. bogdanovi* : *5 Ch. nivalis)*.

– Cincar

In sinkholes and ice-caves in the midst of pine forests *(Piceetum excelsae montanum)*, at a height of 1420 m (Ćejića ravne), Martino's vole played a dominant role (16 *D. bogdanovi* : *5 Ch. nivalis)* whereas in the rather termophilous habitats on the upper margin of *Fagetum subalpinum* (1700 m) the ratio *D. bogdanovi* : *Ch. nivalis* was 1 : 4.

In Dalmatia *D. bogdanovi* lives syntopically with another petricolic rodent *Apodemus mystacinus*. On Mt. Opor they were both caught in the same trap line, *Apodemus mystacinus* being dominant. Caught in the same locality on Mt. Biokovo (Sošići) were *D. bogdanovi, Apodemus mystacinus* and *Eliomys quercinus*.

Reproduction: p.s. 2,2,3,3,3; $\bar{x} = 2{,}6$. Sexually active females weighed from 68 to 84 g ($\bar{x} = 79$ g; n = 5).

Arvicola terrestris (LINNAEUS 1758)

Syn: *Arvicola amphibius* KOLOMBATOVIĆ 1882

Material:

– Mrtvica, Fatelj, Kupreško polje (1140 m) 11.–12.09.1980, 18 ♂♂, 23 ♀♀ (N.T., B.K., D. Kovačić); 08.–09.09. 1983, 13 ♂♂, 9 ♀♀, 12 sex? (B.K., N.T., I. Sivec, V. Popov); – Cetina, Cetinsko polje (370 m) 07.09.1983, 2 ♂♂, 1 ♀ (B.K.); – Han Vrba, Glamočko polje (897 m) 12.09.1983, 4 ♂♂ (B.K., N.T.).

References:

– Valle del Cetina. KOLOMBATOVIĆ 1882; – Cetina, »na području Vrlike« (380 m) DJULIĆ 1971; – Gornji Malovan. SOLDATOVIĆ et al. 1967.

The water vole is closely associated with permanent, slow-running rivers of karstic fields. The fact that on Duvanjsko polje Field we did not find it in the bed of the river that had run dry leads to the conclusion that it requires permanent water and cannot survive drainage. In this region the water vole is strictly aquatic. Its presence is easily noticeable due to the traces (paw prints) left in the mud, big heaps of plants that have been chewed, and heaps of excrement. It is also active during the daytime, so one can often see it swimming or hear it feeding in the dense river vegetation. In September 1980 leftovers of stream crayfish that had obviously been consumed by *A. terrestris* were found by the river Mrtvica.

Finds range between 370 and 1140 m a.s.l.. Like *Neomys anomalus A. terrestris* is an azonic species.

Reproduction: E 5.6; p.s. 4,8; $\bar{x} = 5.8$. The females showing signs of reproduction weighed from 40 to 196 g, which means that even the youngest females are capable of reproduction.

***Pitymys subterraneus* (DE SELYS-LONGCHAMPS 1836)**

Material:
– Ćejića ravne, Mt. Cincar (1420 m) 14.09.1980, 2 ♀♀ (N.T., B.K., D. Kovačić); – Koprivnica – Poriče (880 m) 10.09.1983, 4 ♂♂, 2 ♀♀ (B.K., N.T., V. Popov); – Risovac, Mt. Čvrsnica (1300 m) 09.06.1986, 1 ♂, 1 ♀ (B.K.).

References:
– Vaganj, Mt. Dinara (1200 m) PETROV & ŽIVKOVIĆ 1979; – Cincar Mt.. PETROV & ŽIVKOVIĆ 1979; – Prusačka reka, Prusac (900 m) TVRTKOVIĆ et. al. 1979.

P. subterraneus was found in the montane belt of the continental part. No data are available on the subalpine region. On Mt. Cincar specimens were caught in a large clearing in a pine forest *(Piceetum excelsae montanum)* and at Koprivnica by a meadow stream on the margin of *Abieti-Fagetum,* while on Čvrsnica Mt. in a rocky pasture.

The finds range between 880 and 1420 m a.s.l..

***Pitymys liechtensteini* WETTSTEIN 1927**

Material:
– Makljen, Raduša Mt (1120 m) 05.09.1984, 1 ♂ (B.K.).

The only specimen of *P. liechtensteini* was caught in a meadow on the edge of *Fagetum montanum.* Details on the first finding of this species in Bosnia are published in a separate paper (KRYŠTUFEK 1985).

***Chionomys nivalis* (MARTINS 1842)**

Syn.: *Microtus nivalis* DJULIĆ & VIDINIĆ 1967;

Material:
– Ćejića ravne, Mt. Cincar (1420 m) 13.–14.09.1980, 1 ♂, 4 ♀♀ (N.T., B.K., D. Kovačić); – Mt. Cincar (1700 m) 13.09.1980, 2 ♂♂, 2 ♀♀ (N.T., D. Kovačić); – Šatorsko jezero, Mt. Šator (1490 m) 13.09.1983, 7 ♂♂ (B.K., N.T., V. Popov); 05.09.1984, 4 ♂♂, 2 ♀♀ (B.K., V. Popov); – Babina greda, Mt. Šator (1620 m) 13.–14.09.1983, 2 ♂♂, 3 ♀♀ (N.T.); – Kovačića stan, Mt. Dinara (1300 m) 16.07.1984, 2 ♂♂ (N.T., B. Jalžić, J. Ostojić, P. Kasač); – Risovac, Mt . Čvrsnica (1300 m) 08.06. 1986, 1 ♀ (B.K.);

References:
– Čatrna voda, Mt. Dinara (1420 m) DJULIĆ & VIDINIĆ 1967; – Mt. Čvrsnica. PETROV 1968.

Ch. nivalis populates fields of stones in the higher belt of beech forests and above the tree line. The choice of habitats is described above in the section *D. bogdanovi.*

The established vertical range is between 1300 and 1700 m a.s.l..

Reproduction: E 3,3; p.s. 5. Sexually active females weighed from 42 to 53 g.

***Microtus arvalis* (PALLAS 1779)**

Syn.: *Arvicola arvalis* CARRARA 1846–48
Arvicola arvalis BLASIUS 1857
Arvicola arvalis KOLOMBATOVIĆ 1882

Material:
– Ždralovac, Livanjsko polje (710 m) 11.06.1977, 2 sex? (N.T.); – Občevina, Kupreško polje (1134 m) 11.09.1980, 18 ♂♂, 20 ♀♀ (N.T., B.K., D. Kovačić); – Mrtvica, Fatelj, Kupreško polje (1135 m) 12.09.1980, 1 ♂, 2 ♀♀, 12 sex? (N.T., B.K., D. Kovačić); – Cetina, Cetinsko polje (370 m) 07.09.1983, 5 ♂♂, 8 ♀♀, 8 sex? (B.K., N.T.); – Duvno, Duvanjsko polje (870 m) 08.09.1983, 3 ♂♂, 3 ♀♀ (N.T.); – Koprivnica–Poriče (880 m) 10.09.1983, 1 ♀ (B.K.); – Gornji Malovan, Kupreško polje (1140 m) 11.09.1983, 14 ♂♂, 11 ♀♀ (B.K., N.T., I. Sivec, V. Popov); – Han Vrba, Glamočko polje (897 m) 12.09.1983, 4 ♂♂ 2 ♀♀ (B.K., N.T.); – Risovac, Mt. Čvrsnica (1300 m) 09.06.1986, 1 ♀ (B.K.).

References:
– Sinj (300 m) KOLOMBATOVIĆ 1882; DJULIĆ 1971; – ? Imotski. DJULIĆ 1971; – ? Biokovo. DJULIĆ 1971; – ? Metković, vicinity. DJULIĆ 1971.

The common vole lives on the Dalmatian and the continental side. It was found in karstic fields only in Dalmatia, whereas in Bosnia it populates not only karstic fields, where it is most frequent but also meadows in the montane zone. The records of some Dalmatian localities (Imotski, Biokovo, Metković) might be ascribed to a labelling error (the material most probably originating from Slavonia, NE Croatia).

In karstic fields it is best suited by meadows with *Agrostis alba* where large colonies can be encountered. It is much rarer in humid waterside vegetation which is dominated by *Arvicola terrestris*.

Vertical range of the finds is from 300 to 1300 m a.s.l..

Reproduction (see Table 4): Sexually active females weighed from 21 to 61 g.

Table 4. Reproduction of *Microtus arvalis* in the study area. The data refer to September 1980 and 1983. See text for the abbrevations.
Tabela 4. Razmnoževanje vrste *Microtus arvalis* na preiskovanem območju. Podatki so za mesec september 1980 in 1983. Okrajšave: E – število zarodkov; p.s. – število placentalnih brazgotin.

No	E/p.s.	3	4	5	6	7	8	9	10	$\bar{X}$	n
	E	2	3	5	2	–	–	–	1	5.00	13
	p.s.	1	5	5	5	1	–	–	–	5.00	17
Total		3	8	10	7	1	0	0	1	5.00	30

5.2.2. Spalacidae

***Nannospalax monticola* (NEHRING 1898)**

Syn.: *Spalax monticola* NEHRING 1898
Spalax monticola BOLKAY 1924, 1926, 1928
Spalax leucodon monticola DJULIĆ & MIRIĆ 1967
Spalax monticola SOLDATOVIĆ 1971, 1977
Spalax (Mesospalax) leucodon SAVIĆ & SOLDATOVIĆ 1974
Microspalax leucodon SAVIĆ 1982
Mesospalax leucodon monticola TOPAČEVSKIJ 1969

Material:
– Gornji Malovan, Kupreško polje (1210 m) 10.–11.09.1983, 2 ♂♂, 2 ♀♀ (B.K., N.T.); – Risovac, Poljice, Mt. Čvrsnica (1350 m) 09.06.1986, 2 ♂♂ (B.K., V. Popov).

References:
– Kupres (1100 m) NEHRING 1898; MEINZEL 1922; BOLKAY 1924, 1926, 1928; – Hrbljina Mt. near Glamoč (1040 m) BOLKAY 1924, 1927, 1928; – Županjac (930 m) BOLKAY 1924, 1928; – Vran Mt. (1300 – 2074 m) BOLKAY 1926; – Malovan gornji (1131 m) BOLKAY 1926, 1927, 1928; – Radovan Mt., above Posušje (1134 m) BOLKAY 1928; SAVIĆ 1982; – Šuica (1000 m) SAVIĆ 1982; – Šuica–Mt. Ljubuša (1000 m) SAVIĆ & SOLDATOVIĆ 1984.

The mole-rat has not been found in the region of Kupres since August 1922 when A. Meinzel collected one (BOLKAY 1928). It is probable that older collectors were not precise in defining the locality, designating the nearest bigger town (Kupres) as locality. Since the research carried out by BOLKAY (1926) the mole rat in Kupreško polje Field is known to inhabit the area around Gornji Malovan where its appearence is local but not infrequent. Farmers kill it as it is harmful to field-produce, potatoes in particular.

On Mt. Čvrsnica the mole rat is locally frequent, especially on smaller cultivated areas. People believe its bite to be poisonous and dangerous to cattle.

From the zoogeographic point of view, the *»leucodon«* (s.lat.) taxon reaches the western limit of its present distribution in the region studied. With respect to their karyotype the populations from this region having 2n = 54 and N.F. = 84 differ from other European populations. This confirms their status of an independent species (SAVIĆ & SOLDATOVIĆ 1984).

The height range is between 1000 and 2074 m a.s.l., with most of the localities occurring between 1000 and 1300 m a.s.l..

5.2.3. Muridae

Apodemus mystacinus (DANFORD & ALSTON 1877)

Material:
– Vidilica–Malačka, Mt. Opor (480 m) 28.04.1974, 4 ♂♂, 2 ♀♀ (J. Gregori, S. Brelih); 06.10.1975, 2 ♂♂, 2 ♀♀ (N.T.); 08.12.1975, 3 ♂♂, 3 ♀♀ (N.T.); 24.08.1976, 2 ♂♂, 2 ♀♀ (N.T.); – Sošići, Biokovo Mt. (750 m) 07.12.1975, 1 ♂ (N.T.); – Marina, Trogir (160 m) 11.12.1975, 1 ♂, 7 ♀♀ (N.T.); – Gospodska pećina, Cetina (400 m) 1977, 4 sex? (D. Pelić, O. Vukadinović); 07.10.1984, 1 ♂, 2 ♀♀, 2 sex? (N.T., B. Jalžić, J. Ostojić); – Dugopolje (270 m) 29. 10. 1982, 1 ♂, 1 ♀ (N.T., V. Štamol).

References:
– Gradina (290 m) SCHIDLOVSKI 1953; – Mostar; SCHIDLOVSKI 1953; – Bačina, Ploče (50 m) DJULIĆ 1960; – Makarska; MIRIĆ 1966; – Pisak; SOLDATOVIĆ et. al. 1972.

The rock mouse lives only in Dalmatia and the adjacent parts of Herzegovina. Deepest into the continent it reaches at the root of Dinara Mts. (the source of the Cetina river) and along the Neretva river as far as Mostar (it has been found recently on Mt. Velež) and probably even higher. As a petricolic species it is bound up with fields of stones covered either with degraded forest *(Quercus pubescens, Ostrya carpinifolia, Carpinus betulus)*, pastures, or eventually naked. On Opor and Biokovo it was found syntopically with *Dinaromys bogdanovi*. In the habitats where it lives syntopically with *Apodemus sylvaticus* it always dominates. Near Trogir (Marina) and at the source of the Cetina it was found in larger numbers at cave entrances than in the surroundings.

The distribution of localities is between 50 and 750 m a.s.l.. Findings may be expected as high as at least 1000 m.

Reproduction: p.s.: 2,3,3,5,7.

Apodemus flavicollis (MELCHIOR 1834)

Syn.: *Apodemus tauricus* DJULIĆ & VIDINIĆ 1967

Material:
– Koprivnica–Poriče (880 m) 10.09.1983, 16 ♂♂, 18 ♀♀ (B.K., N.T., V. Popov); – Gornji Malovan, Kupreško polje (1140 m) 11.09.1983, 1 ♂, 3 ♀♀ (B.K., N.T., I. Sivec, V. Popov); – Han Vrba, Glamočko polje (897 m) 12.09.1983, 12 ♂♂, 11 ♀♀ (B.K., N.T.); – Šatorsko jezero, Mt. Šator (1470–1490 m) 13.–14.09.1983, 12 ♂♂, 9 ♀♀, 4 sex? (B.K., N.T., V. Popov); – Babina greda, Mt. Šator (1620 m) 13.09.1983, 3 ♂♂, 6 ♀♀ (N.T., V. Popov); – Makljen, Mt. Raduša (1120 m) 06.09.1984, 5 ♂♂, 4 ♀♀ (B.K.); – Risovac, Mt. Čvrsnica (1300 m) 09.06.1986, 5 ♂♂, 3 ♀♀ (V. Popov).

References:
– Tarlin Dolac, Mt. Dinara (1300 m) DJULIĆ & VIDINIĆ 1967; – Lice, Mt. Dinara; DJULIĆ & VIDINIĆ 1967; – Šatorsko jezero, Mt. Šator (1488 m) DJULIĆ & VIDINIĆ 1967; – Mali Šator; DJULIĆ & VIDINIĆ 1967; – Gornji Malovan; SOLDATOVIĆ et al. 1972.

The statements for Tarlin Dolac and Lica are the only ones from the Dalmatian side of Dinara Mts., so it would be most desirable to attend to a revision of determination. *A. flavicollis* appeared to be confined to the continental part of the study area.

The distribution of localities is between 850 and 1620 m.

The species was found mostly in the forests of *Abieti-Fagetum* and *Fagetum montanum* types. It was collected also in *Pinetum mugi* and fields of stones (Šator), willow forests (Glamočko polje) and live-hedges (Gornji Malovan).

Reproduction: Koprivnica: p.s. 6; Han Vrba p.s. 5,6,6; Šator E 3,6; p.s. 2,4,6,6; Gornji Malovan p.s. 4; Makljen p.s. 5,5; Čvrsnica E 6,6.

Apodemus sylvaticus (LINNAEUS 1758)

Syn.: *Mus sylvaticus* KOLOMBATOVIĆ 1882, 1888;
Sylvaemus sylvaticus KRPAN 1962

Material:
– Brusje, Hvar Is. (340 m) 04.10.1975, 1 ♂, 1 ♀ (N.T.); – Vidilica–Malačka, Mt. Opor (480 m) 06.10.1975, 1 ♀ (N.T.); – Vidova gora, Brač Is. (600 m); 03.–05.09.1975, 21 ♂♂, 14 ♀♀ (N.T.); Vidova gora (770 m) 26.10.1982, 7 ♂♂, 2 ♀♀ (N.T., V. Štamol); – Podšpilje, Vis Is. (200 m) 08.–09.1975, 2 ♂♂, 1♀♀ (N.T.); – Sučuraj, Hvar Is., (10 m) –.08.1976 (B. Borčić in litt.); – Vošac, Mt. Biokovo (1400 m) 27.08.1976, 5 ♂♂, 6 ♀♀ (N.T.); – Fantovi dolac, Brač Is. (620 m) 25.10.1982, 1 ♂, 1 ♀ (N.T., V. Štamol); Sv. Martin, Brač Is. (135 m) 27.–28.10.1982, 4 ♂♂, 2 ♀♀ (N.T., V. Štamol); – Dugopolje (270 m) 29.10.1982, 6 ♂♂, 1 ♀ (N.T.); – Cetina, Cetinsko polje (370 m) 07.09.1983, 14 ♂♂, 7 ♀♀ (B.K., N.T.); – Duvno, Duvanjsko polje (870 m) 08.09.1983, 9 ♂♂, 10 ♀♀ (B.K., N.T., I. Sivec, V. Popov); – Mrtvica, Fatelj, Kupreško polje (1135 m) 09.09.1983, 1 ♂ (B.K.); – Gornji Malovan, Kupreško polje (1140 m) 11.09.1983, 5 ♂♂, 7 ♀♀ (B.K., N.T., I. Sivec, V. Popov); – Han Vrba, Glamočko polje (897 m) 12.09.1983, 3 ♂♂, 2 ♀♀ (B.K., N.T., I. Sivec); – Risovac, Mt. Čvrsnica (1300 m) 09.06.1986, 1 ♂ (B.K.).

References:
– Dolac (1300 m) DJULIĆ & VIDINIĆ 1967; – Čatrna voda, Mt. Dinara (1420 m) DJULIĆ & VIDINIĆ 1967; – Klečarski vrhovi, Mt. Dinara (1740 m) DJULIĆ & VIDINIĆ 1967; – Babin grad, Mt. Dinara (1380 m) DJULIĆ & VIDINIĆ 1967; – Lice, Mt. Dinara. DJULIĆ & VIDINIĆ 1967; – Kurlaja, Mt. Dinara (1375 m) DJULIĆ & VIDINIĆ 1967; – Šatorsko jezero, Mt. Šator; DJULIĆ & VIDINIĆ 1967; – Metković; TVRTKOVIĆ, 1976, 1979; Brač Is.; DJULIĆ 1976; TVRTKOVIĆ 1976, 1979.

Apodemus sylvaticus is widely distributed on the islands where it lives free of competition with *A. flavicollis* and *A. mystacinus*. In Dalmatia it is common in mediterranean and submediterranean forests and all of their degradational stadia to naked fields of stones. It appears in the largest numbers in cultivable areas. *A. sylvaticus* is rare in Bosnia for in continental forests it quite likely cannot sustain the competition with *A. flavicollis*. It is frequent only in the open habitats of karstic fields. In the montane belt it is limited to cultivable areas (Čvrsnica).

Vertical distribution of localities is between 20 and 1400 m.

DJULIĆ & VIDINIĆ (1967) drew attention to the difficulties in discriminating *A. flavicollis* and *A. sylvaticus* from Šator and Dinara Mts.. This has been corroborated also by our own observations. Taking into account the possibility of incorrect determination we believe that no reliable data have so far been gathered on the presence of *A. sylvaticus* in the mountain pine forest above the tree line (see DJULIĆ & VIDINIĆ 1967).

Reproduction: Opor E5; Brač p.s. 4,5; Vis p.s. 5; Dugopolje E 4; Gornji Malovan p.s. 4,5,5,7; Duvanjsko polje p.s. 4,5,5,6; Čvrsnica p.s. 3.

***Rattus rattus* (LINNAEUS 1758)**

Syn: *Mus rattus* KOLOMBATOVIĆ 1882
Mus rathus KOLOMBATOVIĆ 1888

Material:
– Vidova gora, Brač Is. (600 m) 04.09.1975, 1 ♂, 1 ♀ (N.T.); – Podšiplje, Vis Is. (200 m) 08.10.1975, 1 ♂ (N.T.); – Lučice, Milna, Brač Is. (30 m) 27.10.1982, 3 ♂♂, 2 sex? (N.T., V. Štamol); – Sv. Martin, Brač Is. (200 m) 28.10.1982, 2 ♂♂, 1 ♀ (N.T., V. Štamol); – Gornji Malovan, Kupreško polje (1140 m) 11.09.1983, 2 ♂♂ (N.T.); – Vis, Vis Is. (10 m) –.07.1984, 1 sex? (B.K.); – Sučuraj, Hvar Is. (10 m) (Borčič in litt., 1986).

References:
– Split, Matjan. PETROV 1939; Brač Is.. DJULIĆ 1971, 1976.

The ship rat appears as a commensal and feral animal in Dalmatia (on the islands on particular). Thus, on the islands of Vis (Podšpilje) and Brač rats were caught along vineyards and fields far away from human settlements. Exclusively commensal animals were stated on the continental side. At Gornji Malovan two rats were caught in a building populated also by a house mouse.

Two colour types can be distringuished among ship rats from the study area: *frugivorus* type (common in the whole study area) and *alexandrinus* type (Dalmatia with the islands).

***Rattus norvegicus* (BERKENHOUT 1769)**

Syn.: *Mus decumanus* KOLOMBATOVIĆ 1882, 1888;
Epymys norvegicus BOLKAY 1926

References:
– Posušje (687 m) BOLKAY 1926; – Široki brijeg. BOLKAY 1926; – Split. DATHE 1934; – Marjan, Split. PETROV 1939.

Genus *Mus*

In the taxonomy and nomenclature of the genus *Mus* we followed MARSHALL & SAGE (1981) and SAGE (1981). Two species are native to the study area: *Mus domesticus*

and *M. musculus*. It was not always possible to bring the data from the literature in accordance with the actual nomenclature. All such data are referred to as *Mus* sp..

***Mus domesticus* RUTTY 1772**

Syn.: *Mus musculus brevirostris* DJULIĆ & TVRTKOVIĆ 1979;

Material:
– Lučice, Milna, Brač Is. (30 m) 1986 (V. Štamol in litt.).

References:
– Brač Is., DJULIĆ 1976; – Jelsa, Hvar Is. (10 m) DJULIĆ & TVRTKOVIĆ 1979; Podšpilje, Vis Is. (200 m) DJULIĆ & TVRTKOVIĆ 1979; – Metković. SAGE 1981; – Karaotok. PETROV & RUŽIĆ 1985; – Jablanica. PETROV & RUŽIĆ 1985; – Bačina. PETROV & RUŽIĆ 1985.

***Mus musculus* LINNAEUS 1758**

Material:
– Gornji Malovan, Kupreško polje (1140 m) 11.09.1983, 6 ♂♂, 1 ♀ (N.T.).

All specimens were caught in a building, together with two ship rats.

Mus sp.

Syn.: *Mus s. spicilegus* DATHE 1934;
Mus musculus brevirostris DJULIĆ & VIDINIĆ 1967;
Mus musculus praetextus DJULIĆ & TVRTKOVIĆ 1979;
Mus musculus praetextus × *M.m. brevirostris* DJULIĆ & TVRTKOVIĆ 1979.

References:
– Vranjača–Höhle; DATHE 1934; – Lice, Mt. Dinara (1300 m) DJULIĆ & VIDINIĆ 1976; – Kazanci, Livanjsko polje (720 m) DJULIĆ & VIDINIĆ 1967; – Lokva, Vis Is.. DJULIĆ & TVRTKOVIĆ 1979; – Podšpilje, Vis Is.. DJULIĆ & TVRTKOVIĆ 1979.

5.2.4. Gliridae

***Glis glis* (LINNAEUS 1766)**

Syn.: *Myoxus glis* CARRARA 1846–48
Myoxus glis BLASIUS 1857
Myoxus glis KOLOMBATOVIĆ 1882

Material:
– Vidova gora, Brač Is. (600 m) 03.09.1975, 8 ♂♂, 3 ♀♀ (N.T.); 05.09.1975, 1 ♂ (N.T.); – Dugopolje (270 m) 29.10.1982, 1 ♂ (N.T.); – Koprivnica–Poriče (880 m) 10.09.1983, 1 ♀ (B.K.); – Šatorsko jezero, Mt. Šator (1490 m) 14.09.1983, 1 ♂ (B.K.); 05.09.1984, 1 ♂ (B.K.); – Sućuraj, Hvar Is. (10 m) –.08.1976 (B. Borčič in litt.).

References:
– Brazza Is.. KOLOMBATOVIĆ 1882; – Brazza Is., Kloster Stipančić bei Bol. WETTSTEIN 1920; – Kosa, Mosor Mt. (940 m) DJULIĆ & FELTEN 1962; – Lice, Mt. Dinara (1300 m) DJULIĆ & VIDINIĆ

1967; – Babin grad, Mt. Dinara (1380 m) DJULIĆ & VIDINIĆ 1967; – Bačina, Ploče (= Kardeljevo) (20 m) DJULIĆ et al. 1971; – Pražnice, Brač Is. (390 m) DJULIĆ 1976; – Vidova gora, Brač Is. (770 m) DJULIĆ 1976.

Fat dormouse populates the entire study area from the coast to the upper margin of the montane zone. The distribution of localities is between 10 and 1490 m a.s.l..

It was found in beech forests: *Abieti–Fagetum* (Koprivnica) and *Fagetum montanum* (Šator). DJULIĆ & VIDINIĆ (1967) state it for beech forests on Mt. Dinara. Fat dormouse often comes into buildings on Mts. Dinara and Šator.

In Dalmatia (Opor) the fat dormouse was caught in a forest of *Querco–Carpinetum orientalis* type. On October 6, 1975, one of us (N.T.) listened to their noises on the trunks of *Quercus ilex* on Opor (480 m). On the island of Brač it was caught in a *Quercus ilex* forest.

***Eliomys quercinus* LINNAEUS 1776**

Syn.: *Myoxus nictela* KOLOMBATOVIĆ 1882
Eliomys pallidus PETROV 1939

Material:
– Brusje, Hvar Is. (340 m) 04.10.1975, 1 ♀ (N.T., I. Trinajstić); – Vošac, Mt. Biokovo (1400 m) 27.08.1976, 1 ♀ (N.T., B. Jalžić); – Sošići, Gornje Igrane, Mt. Biokovo (750 m) 10.08.1976, 1 sex? (N.T., B. Jalžić).

References:
– Castella (50 m) KOLOMBATOVIĆ 1882; – Spalato; MILLER 1912; – Split (0 m) DATHE 1934; – Marjan, Split (100 m) PETROV 1939; – Makarska (50 m) MIRIĆ 1966; – Kosa, Mt. Mosor (940 m) (= loc. typ. of *dalmaticus)* DJULIĆ & FELTEN 1962; – Ljuvac, Mt. Mosor (860 m) DJULIĆ & FELTEN 1962; – Tarlin dolac, Mt. Dinara (1300 m) DJULIĆ & VIDINIĆ 1976; – Čatrna voda, Mt. Dinara (1400 m) DJULIĆ & VIDINIĆ 1967; – Kurlaja, Mt. Dinara (1375 m) DJULIĆ & VIDINIĆ 1967; – Gradina, Čapljina (290 m) PETROV 1968; – Brač Is.; DJULIĆ 1976. – Hvar Is.; DJULIĆ 1971.

A fairly common species in Dalmatia. One locality is known also on the Bosnian side of Dinara Mt. (Troglav) – Kurlaja. The vertical range extends from 30 to 1400 m. *Eliomys quercinus* is linked above all with fields of stones that are often perfectly naked. Found in the same habitats were also *Apodemus sylvaticus, A. mystacinus, Dinaromys bogdanovi, Glis glis* and *Rattus rattus.*

Reproduction: Brusje: p.s. 6.

***Dryomys nitedula* (PALLAS 1779)**

Material:
– Koprivnica–Poriče (800 m) 10.09.1983, 1 ♂ (B.K., V. Popov); – Šatorsko jezero, Mt. Šator (1490 m) 05.09.1984, 1 ♂ (B.K.); – Risovac, Mt. Čvrsnica (1300 m) 09.06.1986, 1 ♀ (V. Popov).

References:
– Šatorsko jezero, Mt. Šator (1490 m) (DJULIĆ & VIDINIĆ 1967).

Dryomys nitedula lives in the montane and the subalpine belts of the continental side. Distribution of localities is between 880 and 1490 m. It is interesting to note that it was not found on Mt. Dinara, where *Eliomys quercinus* lives.

DJULIĆ & VIDINIĆ (1967) mention that it was caught »on a border between a *Pinus nigra* forest and young beeches« on Mt. Šator. Twenty years after their statement we could trace no *Pinus nigra* forest in this area. Since it was Z. Vidinić, in 1967 a student of veterinary medicine, who collected teh material and took care of the field notes, it may be presumed

that most probably the question was of a border between a *Pinus mugo* forest and subalpine beech forest (*Fagetum subalpinum*).

A specimen of *Dryomys nitedula* was caught in a stony habitat overgrown with the mountain pine forest on Šator, whereas at Koprivnica another was found in *Abieti–Fagatum* forest. On Čvrsnica a female was caught in a mountain beech forest (*Fagetum montanum*).

Reproduction: Čvrsnica E4.

Muscardinus avellanarius (LINNAEUS 1758)

Material:
– Cincar Mt. (1700 m) 13.09.1980, 1 ♂ (N.T., D. Kovačić); – Šatorsko jezero, Mt. Šator (1470 m) 14.09.1983, 2 ♀♀ (B.K.).

No documented findings of the hazel dormouse had been known from this area. We found it only in the upper montane and the lower subalpine belts of the continental side. Distribution of localities is from 1470 to 1770 m. KRPAN (1962) states it for the forest of pubescent oak with eastern hornbeam or European hophornbeam in the hinterland of Split. However no evident material has so far been available from this region.

In *Fagetum montanum* on Šator Mt. (1470 m) we found, on September 19, 1983, a nest with three juvenile hazel dormice. They wighed about 16.5 g; their skulls had not been wholly ossified. The nest was hidden in the shrubs of *Fagus silvatica, Rubus ideus,* and *Cirsium* sp., in a smlaller clearing. It was set up on shrub–like ramifications of a beech three, about 80 cm from the ground. It was of a spherical shape, with a diameter of 10–11 cm. The interior was constructed of the blossoms of *Cirsium* sp., while the more solid external part of the leaves of *Fagus silvatica, Cirsium* sp., and *Luzula* sp..

On Cincar Mt. (1700 m) *M. avellanarius* was caught in a mountain pine forest.

6. Distribution Maps

The Universal Transverse Mercator (UTM) geographic grid with 10 km squares was chosen for the presentation of the distribution of small mammals in the study area. We applied a map prepared for the needs of mapping the insect fauna of Yugoslavia (MILOŠEVIĆ 1976).

The study area covers the entire 100 km square XJ and parts of 100 km squares WJ, WH, YJ, and YH (Fig. 3). Small mammals were recorded for 45 10–km squares.

The presence of a species in a 10 km square is designated by means of a closed circle. If a reference is dubious (see the commentary of the relevant species), it is accompanied by a question mark in the map.

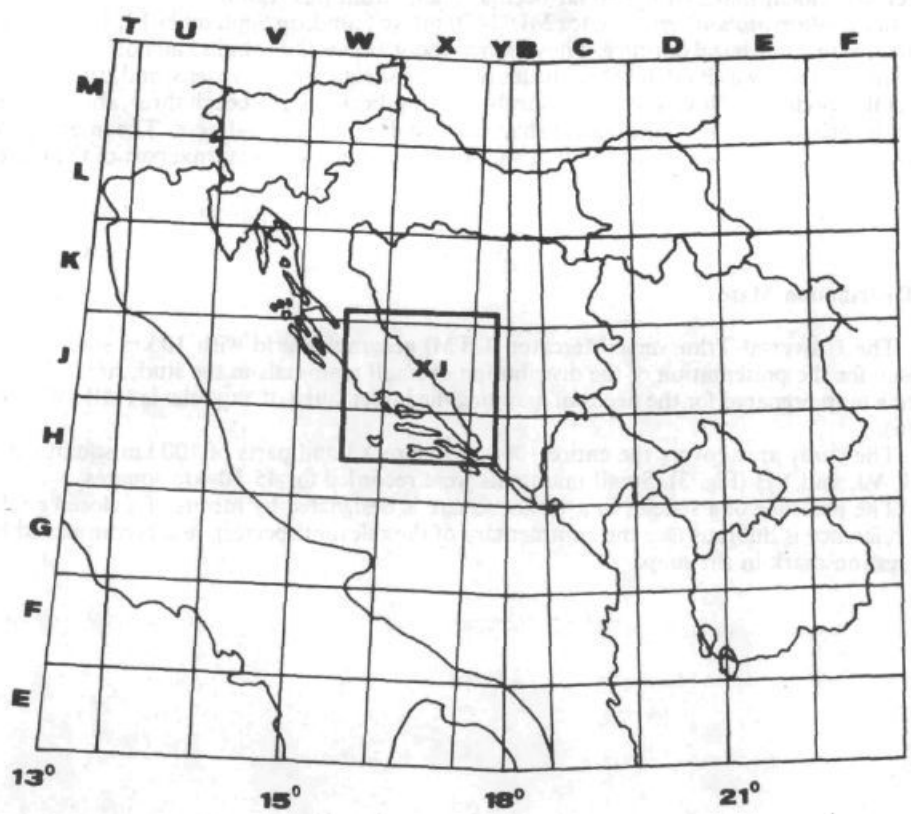


Fig. 3. Map of Yugoslavia with the UTM grid. Study area is indicated by a heavy line.
Sl. 3. Karta Jugoslavije z UTM mrežo. Preiskovano območje je omejeno z debelo črto.

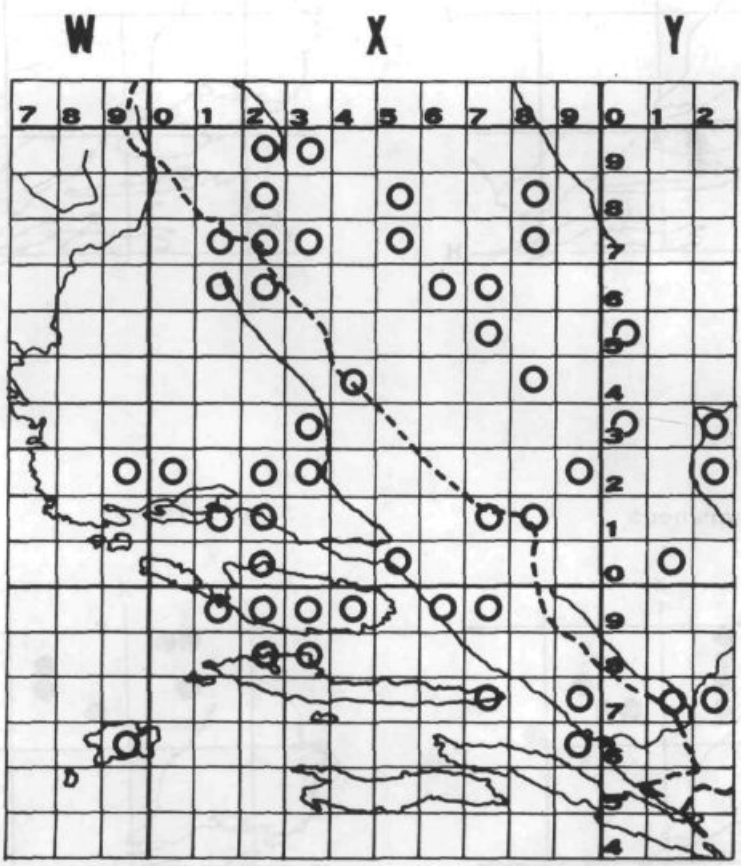
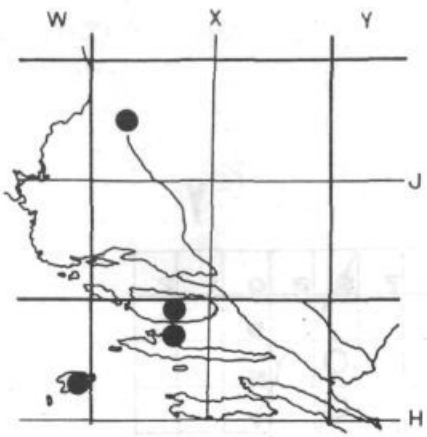


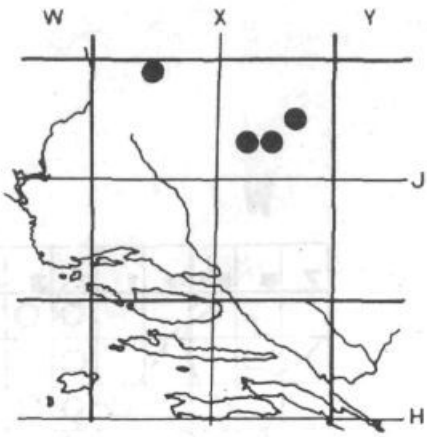
Fig. 4. Map of the study area with the UTM grid (squares 10 × 10 km). Sampling points are indicated by circles.
Sl. 4. Karta preiskovanega območja z UTM mrežo (10 × 10 km). Kvadrati, s katerih obstaja material, so označeni s krogi.

Fig. 5. – 33. Distribution of inserctivores and rodents in the study area. The presence of a species in a 10 × 10 km square of UTM grid is shown by a dot. Question mark is used when the information is doubtful.
Sl. 5. – 33. Razširjenost žužkojedov in glodalcev na preiskovanem območju. Prisotnost vrste v 10 – kilometrskem kvadratu je označena s piko. Kadar je podatek dvomljiv, je označen z vprašajem.

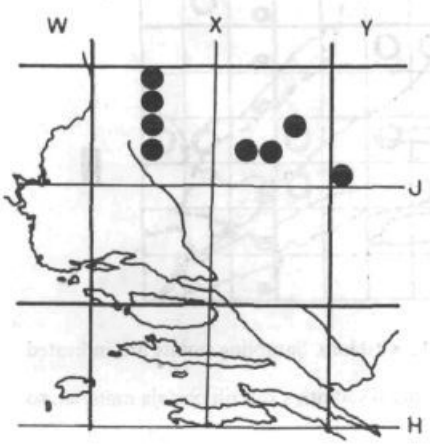
Erinaceus concolor



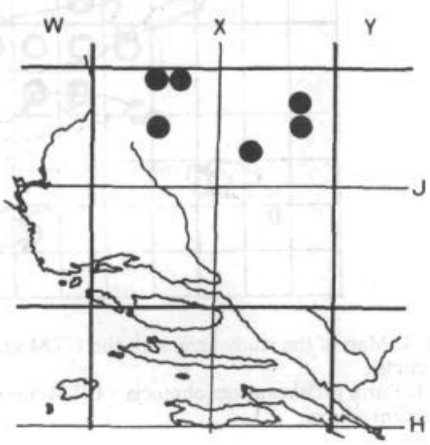
Sorex minutus



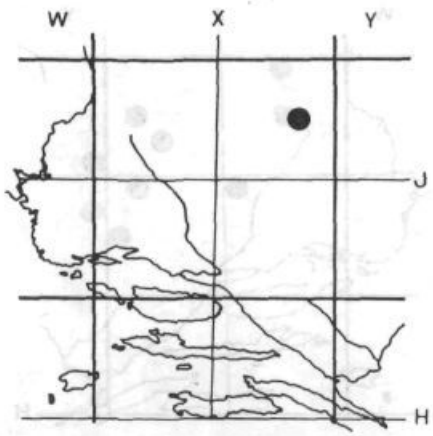
Sorex araneus



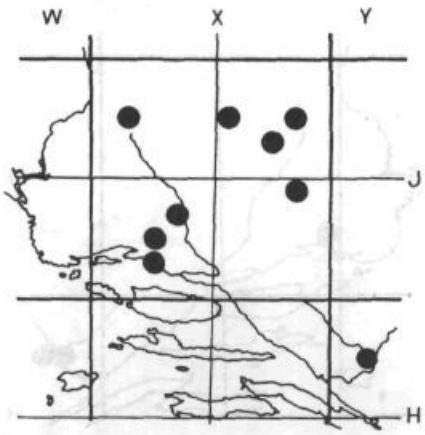
Sorex alpinus



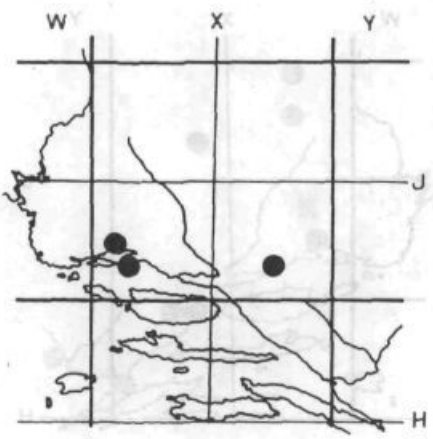
Neomys fodiens



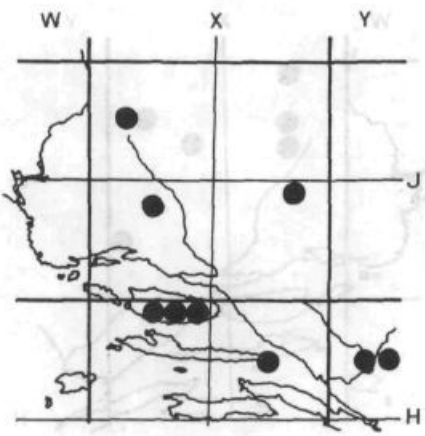
Neomys anomalus



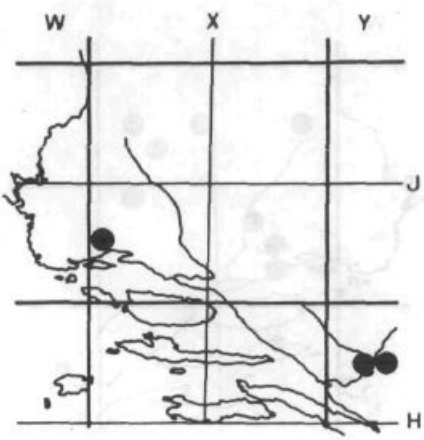
Suncus etruscus



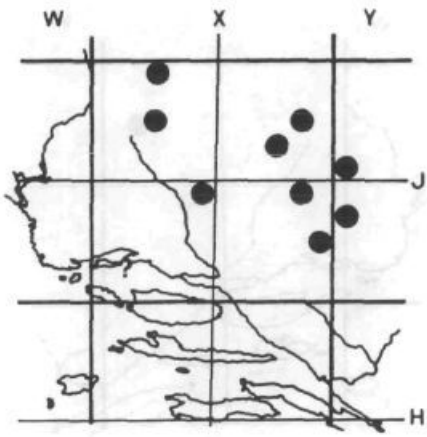
Crocidura suaveolens



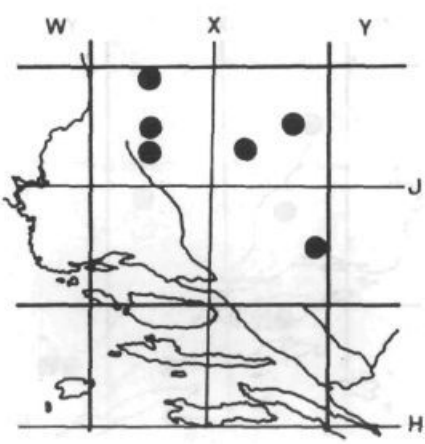
Crocidura leucodon



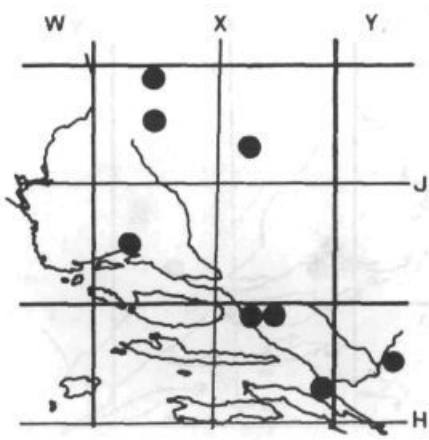
Talpa europaea



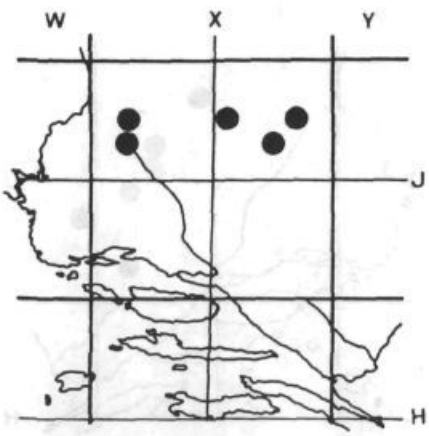
Clethrionomys glareolus



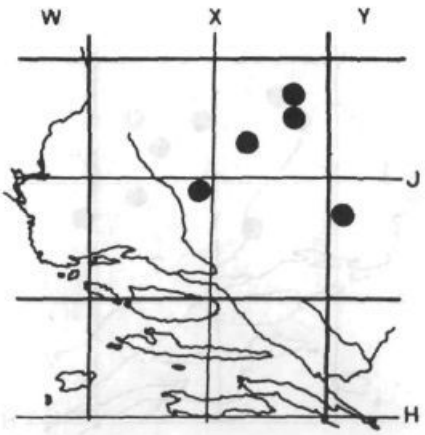
Dinaromys bogdanovi



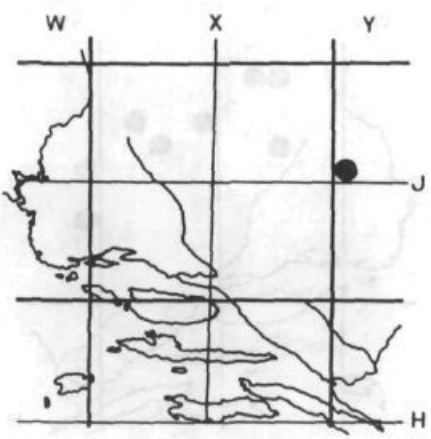
Arvicola terrestris



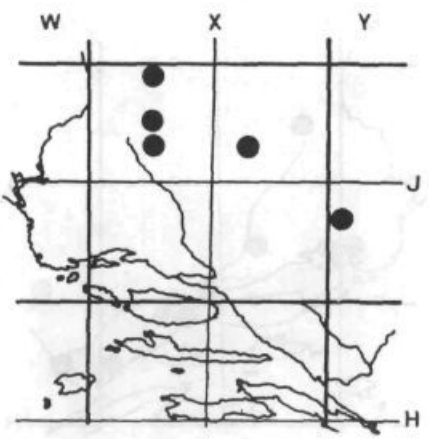
Pitymys subterraneus



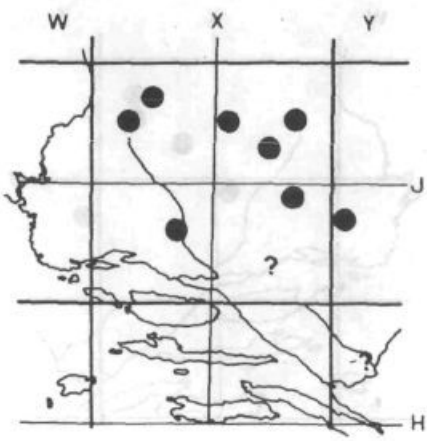
Pitymys liechtensteini



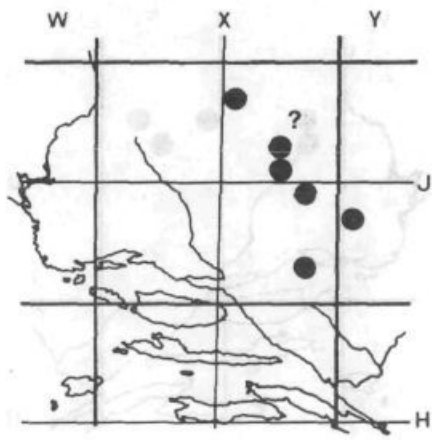
Chionomys nivalis



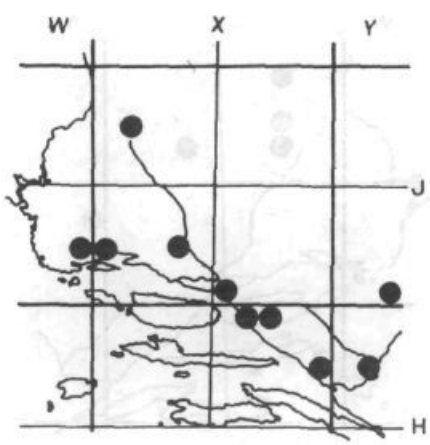
Microtus arvalis



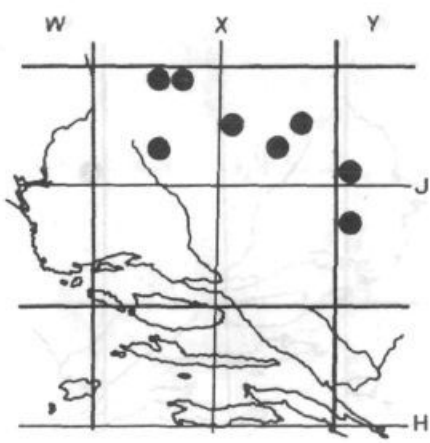
Nannospalax monticola



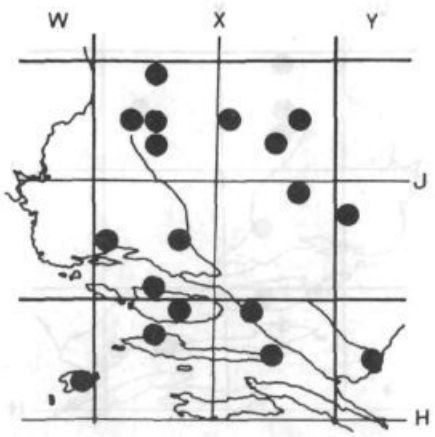
Apodemus mystacinus



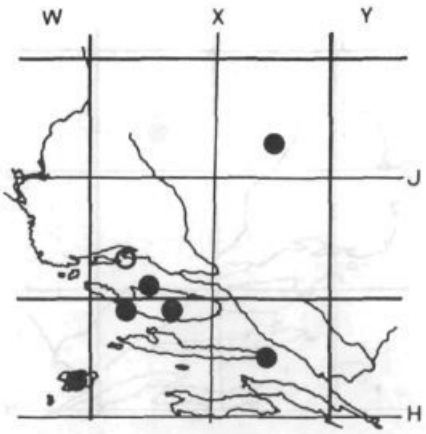
Apodemus flavicollis



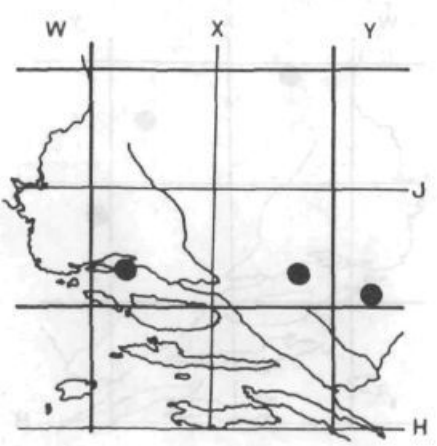
Apodemus sylvaticus



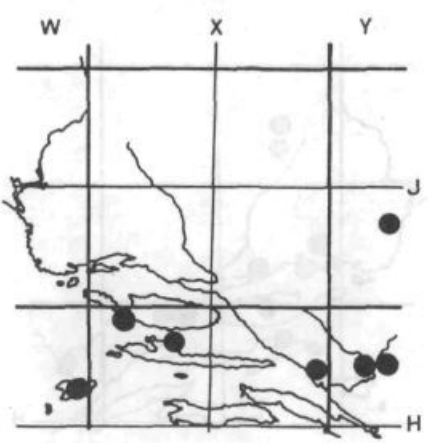
Rattus rattus



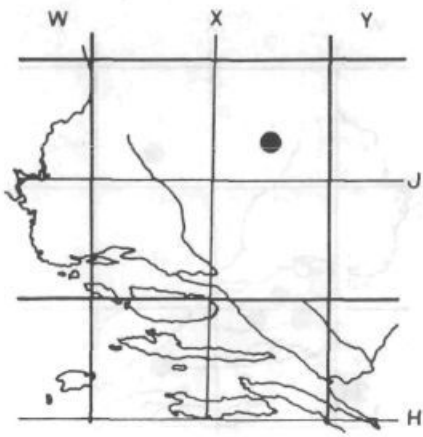
Rattus norvegicus



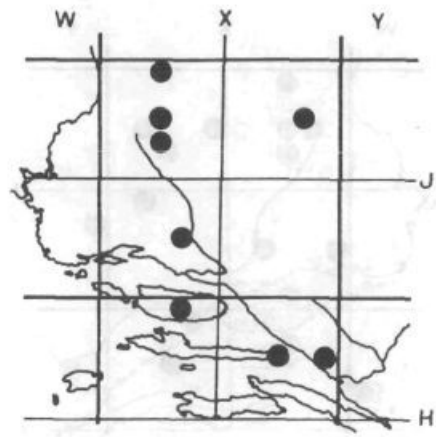
Mus domesticus



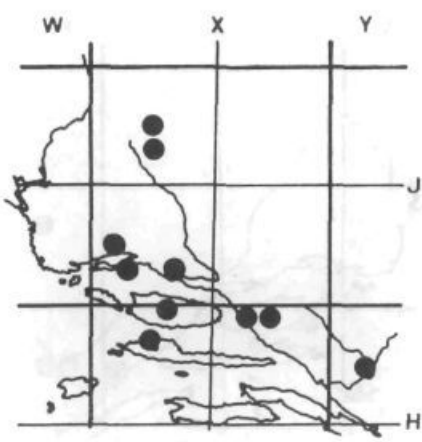
Mus musculus



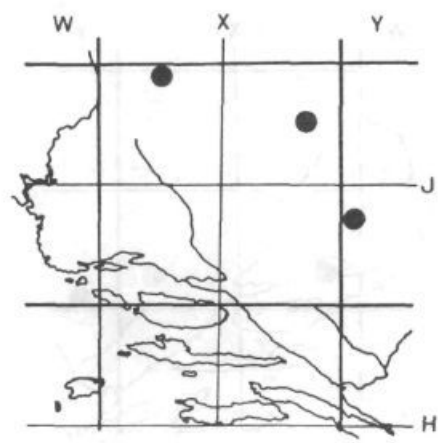
Glis glis

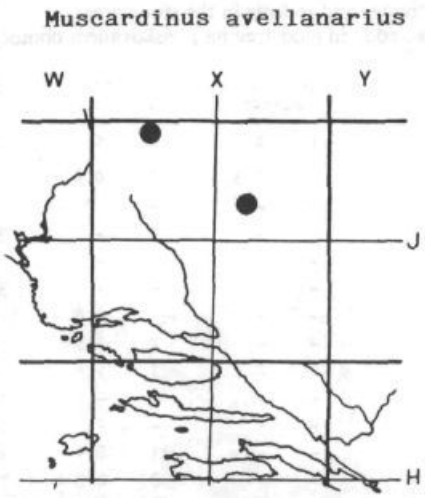


Eliomys quercinus



Dryomys nitedula





7. Dominance

The dominance (D) of small mammals is studied separately in three larger natural units of the study area, namely: the islands, Dalmatia, and the mainland (Table 5). As dominance is not presented with respect to single habitats, the conclusions are of a general nature, offering only a global insight into the fauna of a larger region.

The dominance of five species (*Sorex minutus, Pitymys liechtensteini, Nannospalax monticola, Dryomys nitedula, Muscardinus avellanarius*) does not exceed 1%, consequently, these species are considered very rare. *Pitymys liechtensteini* is known on the basis of a single individual. Mole-rat is locally frequent, but such populations are strictly localized.

Further six species (*Sorex alpinus, Clethrionomys glareolus, Chionomys nivalis, Pitymys subterraneus, Mus hortulanus, Eliomys quercinus*) do not exceed the value of 5%, so they are considered rare. It is interesting to note the rarity of *Cl. glareolus* – one of the dominant species of the continental part of Yugoslavia. It attains a dominance between 29 and 41% in small mammal communities of the forests in the extreme northwestern part of the Dinarids (KRYŠTUFEK unpublished).

Dominance values reveal the following trends:

– in the direction: islands → Dalmatia → continent, the dominance of *Apodemus sylvaticus, Glis glis* and *Rattus rattus* in on the decrease;

– in the direction: Dalmatia → continent, the dominance of *Crocidura suaveolens* and *Dinaromys bogdanovi* is on the decrease.

A marked dominance of Muridae is obvious in small mammal communities of the islands. Muridae are still a dominant group in Dalmatia while high values are attained also by Arvicolidae. Soricidae have low dominance values in both abovementioned regions. Dominant in the continental part are above all Soricidae and Arvicolidae.

Obvious are also the following trends:

– in the direction: island → Dalmatia → continent, the dominance of murids and glirids is on the decrease;

– in the opposite direction (continent → Dalmatia → islands) the dominance of soricids and arvicolids is on the decrease. On the islands the latter disappear completely.

Table 5. Dominance of insectivores and rodents in the study area.
Tabela 5. Dominantnost žužkojedov in glodalcev na preiskovanem območju.

	Dalmatia Islands		Dalmatia littoral		Continental part		Total	
	N	%	N	%	N	%	N	%
Erinaceus concolor	2	2.3	1	0.8	-	-	3	0.4
Sorex minutus	-	-	-	-	4	0.6	4	0.5
Sorex araneus	-	-	-	-	37	5.8	37	4.3
Sorex alpinus	-	-	-	-	12	1.9	12	1.4
Neomys fodiens	-	-	-	-	34	5.4	34	4.0
Neomys anomalus	-	-	1	0.8	113	17.8	114	13.4
Crocidura leucodon	-	-	2	1.5	-	-	2	0.2
Crocidura suaveolens	2	2.3	7	5.4	2	0.3	11	1.3
Talpa europaea	-	-	-	-	10	1.6	10	1.2
Clethrionomys glareolus	-	-	-	-	24	3.8	24	2.8
Dinaromys bogdanovi	-	-	11	8.4	22	3.5	33	3.9
Arvicola terrestris	-	-	3	2.3	79	12.5	82	9.6
Microtus arvalis	-	-	21	16.1	84	13.3	105	12.4
Chionomys nivalis	-	-	1	0.8	29	4.5	30	3.5
Pitymys subterraneus	-	-	-	-	10	1.6	10	1.2
Pitymys liechtensteini	-	-	-	-	1	0.2	1	0.1
Mus musculus	-	-	-	-	7	1.1	7	0.8
Rattus rattus	12	14.0	-	-	2	0.3	14	1.6
Apodemus mystacinus	-	-	40	30.8	-	-	40	4.7
Apodemus flavicollis	-	-	-	-	112	17.7	112	13.2
Apodemus sylvaticus	57	66.3	40	30.8	38	6.0	135	15.9
Nannospalax monticola	-	-	-	-	4	0.6	4	0.5
Glis glis	12	14.0	1	0.8	3	0.5	16	1.9
Dryomys nitedula	-	-	-	-	3	0.5	3	0.4
Eliomys quercinus	1	1.1	2	1.5	-	-	3	0.4
Muscardinus avellanarius	-	-	-	-	3	0.5	3	0.4
Total	86	100.0	130	100.0	634	100.0	850	100.0

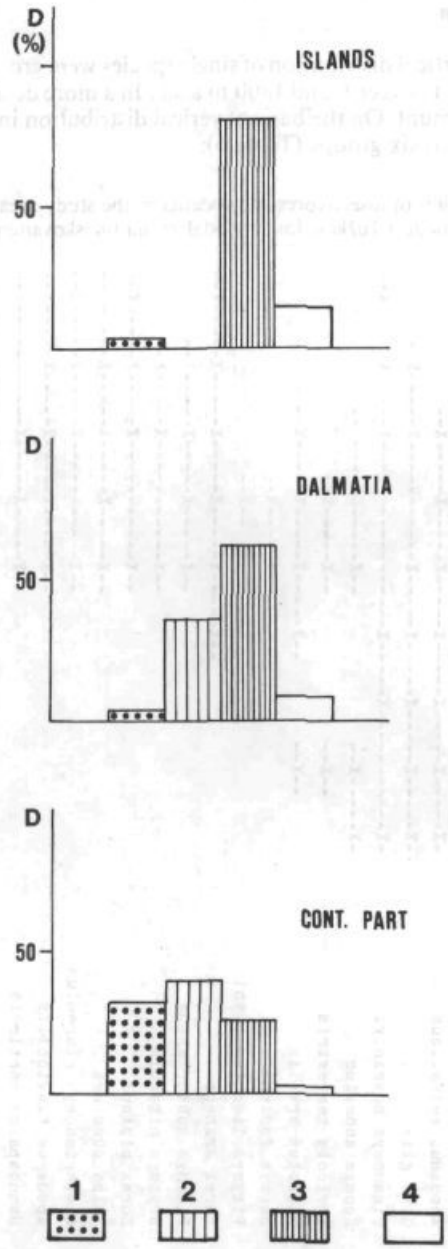
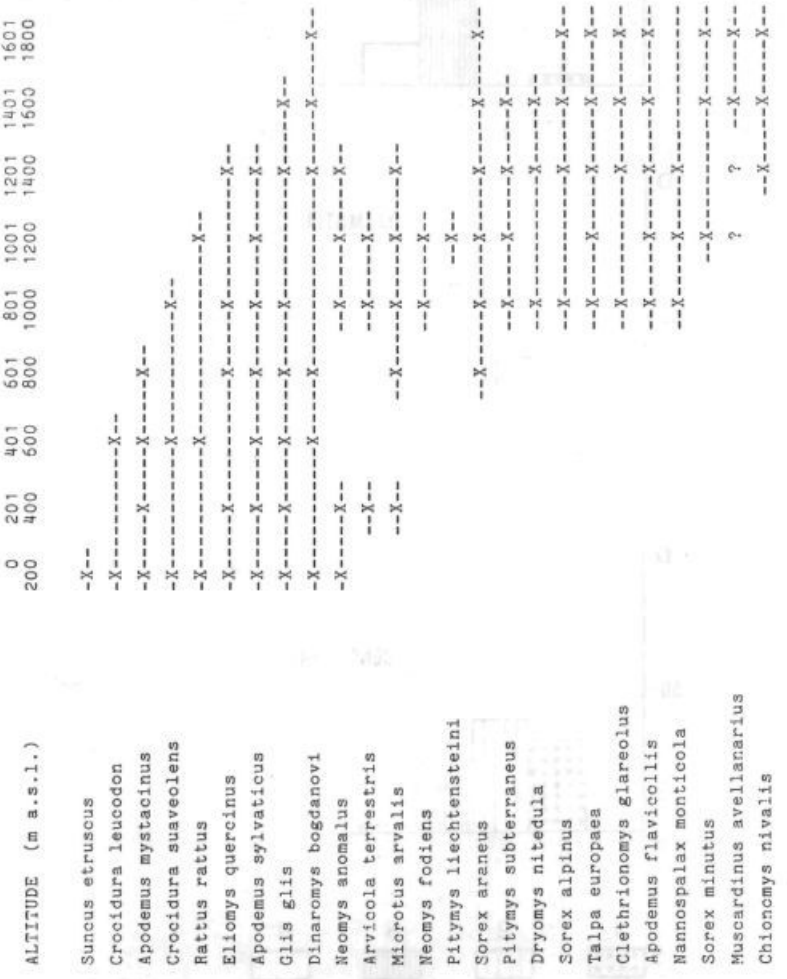


Fig. 34. Dominance of small mammals in the study area (above: islands; middle: Dalmatia littoral; below: continental part). Symbols: 1 – Insectivora, 2 – Arvicolidae, 3 – Muridae, 4 – Gliridae.
Sl. 34. Dominantnost malih sesalcev na preiskovanem območju (zgoraj: otoki; sredina: obalna Dalmacija; spodaj: kontinentalno območje).

8. Vertical Distribution

The data on the vertical distribution of single species were grouped into 200 m heigh zones. We covered a range between 0 and 1800 m a.s.l.. In a more detailed analysis only 24 species were taken into account. On the basis of verical distribution in the area the small mammals can be devided into six groups (Table 6):

Table 6. Vertical distribution of insectivores and rodents in the study area.
Tabela 6. Vertikalna razširjenost žužkojedov in glodalcev na preiskovanem območju.



1a. Lowland species: *Suncus etruscus, Crocidura leucodon, Apodemus mystacinus.*
In the study area all three species are known only in connection with Dalmatia. *C. leucodon* possibly has a wider distribution.

In the rest of Yugoslavia *Suncus etruscus* is likewise known only from a narrow coastal belt up to 380 m (KOVAČIČ et al. 1984). *Apodemus mystacinus,* found in the study area only as high up as 750 m, attains higher altitudes in other parts of Yugoslavia (MIRIĆ 1966).

2a. Species with an extensive vertical distribution: *Erinaceus concolor, Crocidura suaveolens, Dinaromys bogdanovi, Rattus rattus, Apodemus sylvaticus, Glis glis, Eliomys quercinus.*

The above seven species have quite different habitat requirements. Most of them (*E. concolor, C. suaveolens, R. rattus, A. sylvaticus, E. quercinus*) are more frequent at lower altitudes (i.e. in Dalmatia) while their frequency decreases with an increasing altitude.

3a. Montane species: *Neomys fodiens, Pitymys liechtensteini..*

The vertical range of these two species is quite narrow. In the rest of Yugoslavia they have a more pronounced vertical distribution. *N. fodiens* lives between 150 and 1300 m a.s.l. in Slovenia *(KRYŠTUFEK 1983) and P. liechtensteini* between 20 and 1560 m in Yugoslavia (KOVAČIĆ 1984; TVRTKOVIĆ et al. 1979).

4a. Species of the montane and the subalpine belts: *Sorex minutus, Sorex araneus, Sorex alpinus, Talpa europaea, Clethrionomys glareolus, Apodemus flavicollis, Nannospalax monticola, Dryomys nitedula, Muscardinus avellanarius.*

Seven species living above 800 m a.s.l. spread from the montane also to the subalpine belt. One of them *(Sorex araneus)* was found also in the submontane belt in an azonal habitat (karst field Livanjsko polje).

All species of this group are known only from the continental part of the study area, though they exceptionally appear also on the Dalmatian side of Mt. Dinara (e.g. *Sorex alpinus).*

Species which are connected with the montane and the subalpine zone of the study area are more widely distributed in the rest of Yugoslavia. The vertical range of *Sorex minutus* is between 162 and 1666 m in Slovenia (KRYŠTUFEK 1983), of *Sorex araneus* – likewise in Slovenia – between 156 and 1900 m (KRYŠTUFEK l.c.), of *Clethrionomys glareolus* – in Slovenia – between 80 and 2000 m (KRYŠTUFEK unpublished), and of *Nannospalax* cf. *leucodon* between 60 and 2400 m in Yugoslavia (SAVIĆ 1982).

5a. Montane species appearing in Dalmatia in azonic habitats only (i.e. karst fields): *Neomys anomalus, Arvicola terrestris, Microtus arvalis.*

An interesting group of three species appear in karst fields only in Dalmatia. They are connected either with deep soil *(Microtus arvalis)* or banks of water streams *(Neomys anomalus, Arvicola terrestris).*

For the species of the montane belt karst fields render it possible to penetrate into the lowland of Dalmatia. These problems are dealt with in detail in a separate chapter (9.2.).

6a. Subalpine species: *Chionomys nivalis.*

Ch. nivalis lives in the subalpine belt in the study area, whereas in Europe it is more widely distributed (KRAPP 1982; KRYŠTUFEK & KOVAČIĆ in press).

The widest vertical range in the study area is that of *Dinaromys bogdanovi,* which results from its connection with azonic habitats (fields of stones, caverns, sinkholes). The narrowest vertical distribution is expressed by two montane species and *Suncus etruscus* known only from a narrow coastal strip.

The small mammal faunae of single 200 m vertical belts are compared with one another by applying the coefficient of community. As shown in Fig. 36, approximately 800 m a.s.l.

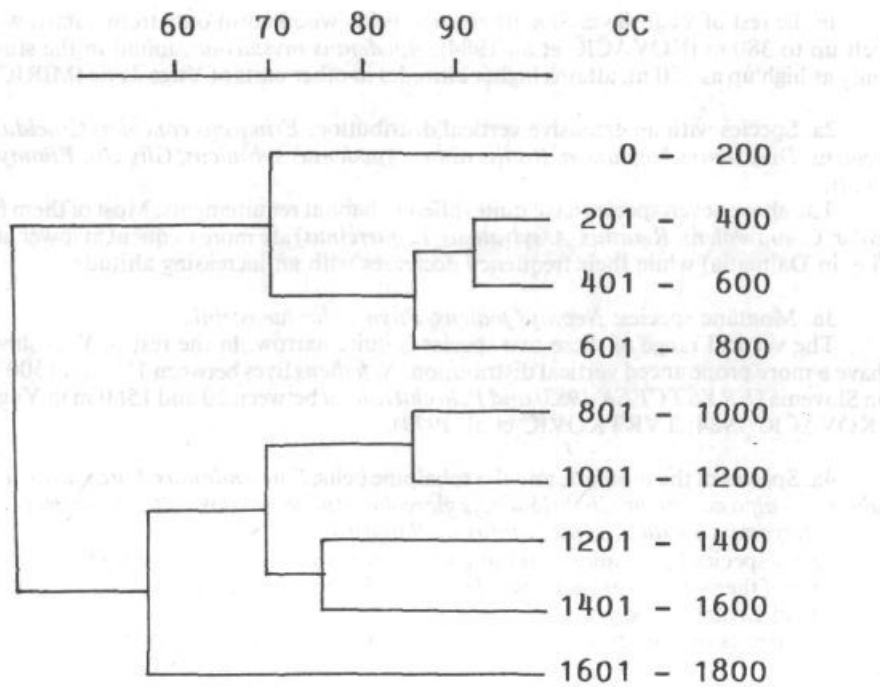


Fig. 35. Phenogram of similarity for small mammal faunae in individual 200-m height zones. (CC – coefficient of community).
Sl. 35. Fenogram podobnosti med favnami malih sesalcev posameznih 200 – metrskih višinskih pasov. (CC – koeficient podobnosti).

represents a sharp border line. This is the lower limit of the majority of montane and montane-subalpine species. The species having crossed that limit succeded in doing so due to the azonic habitats of karst fields.

With respect to the vertical distribution of small mammals the study area can be divided into three belts:

1b. Lowland belt: 0 – 800 m a.s.l.

It is inhabited by the lowland species (see Pt. 1a), the generally spread species (Pt. 2a) the majority of which are more frequent here, and some species of the montane and the subalpine belt that are linked with karst fields only (Pt. 5a).

13 species of insectivores and rodents are to be found in the lowland belt, 7 of which are widely spread.

2b. Montane belt (s. lato): 800 – 1400 m a.s.l.

It is inhabited by the generally distributed species (Pt. 2a). and the montane, the montane-subalpine, and partly also the subalpine species.

21 species are to be found in the montane belt, 10 of which live also in the lowland belt. A number of species frequent in Dalmatia are rare here *(Crocidura suaveolens, Rattus rattus, Eliomys quercinus).*

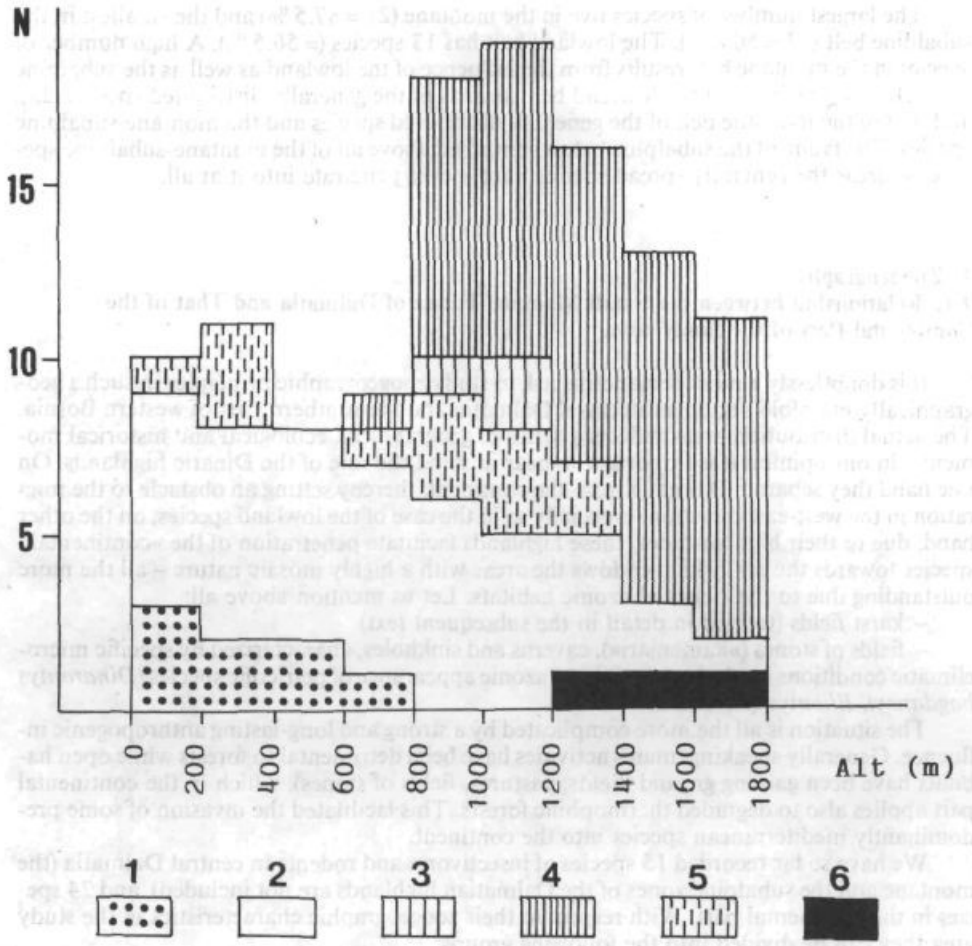


Fig. 36. Composition of small mammal fauna in individual 200-m height zones of the study area.
N – number of species; 1 – lowland species; 2 – species with an extensive vertical distribution; 3 – montane species; 4 – species of the montane and subalpine belts; 5 – montane species appearing in Dalmatia in azonaic habitats only (i.e. karst fields); 6 – subalpine species.
Sl. 36. Sestava favn malih sesalcev posameznih 200 – metrskih višinskih pasov na preiskovanem območju.
N – število vrst; 1 – nižinske vrste; 2 – vrste z obsežno vertikalno razširjenostjo; 3 – montanske vrste; 4 – montanske in subalpinske vrste; 5 – montanske vrste, ki se pojavljajo v Dalmaciji samo v azonalnih habitatih (t.j. kraških poljih); 6 – subalpinske vrste.

3b. Subalpine belt: above 1400 m a.s.l.

Of the generally spread species (Pt. 2a) only *Glis glis* and *Dinaromys bogdanovi* penetrate into this belt. Present, however, are all montane-subalpine species (Pt. 4a) and the only subalpine species (Pt. 6a) i.e. *Chionomys nivalis.*

Twelve species can be encountered in the subalpine belt.

The largest number of species live in the montane (21 = 87.5 %) and the smallest in the subalpine belt (12 = 50.0 %). The lowland belt has 13 species (= 56.5 %). A high number of species in the montane belt results from the influence of the lowland as well as the subalpine belt. Most of the fauna of the lowland belt consists of the generally distributed species (2a), and that of the montane belt of the generally distributed species and the montane-subalpine species. The fauna of the subalpine belt is composed above all of the montane-subalpine species, whereas the generally spread species hardly ever penetrate into it at all.

9. Zoogeography

9.1. Relationship between the Small Mammal Fauna of Dalmatia and That of the Continental Part of the Study Area

It is doubtlessly a most demanding task to study zoogeographic principles in such a geographically mainfold region as a central Dalmatia and the southern part of western Bosnia. The actual distribution areas reflects a series of geographical, ecological and historical moments. In our opinion it is important to bear in mind the role of the Dinaric highlands. On one hand they separate Dalmatia from the continent, thereby setting an obstacle to the migration in the west-east direction, especially so in the case of the lowland species; on the other hand, due to their high altitudes, these highlands facilitate penetration of the »continental« species towards the sea, which endows the areas with a highly mosaic nature – all the more outstanding due to the riches of azonic habitats. Let us mention above all:

– karst fields (treated in detail in the subsequent text)

– fields of stones (»kamenjari«), caverns and sinkholes, characterized by specific microclimatic conditions rendering possibly an azonic appearance of petricolic species *(Dinaromys bogdanovi, Eliomys quercinus).*

The situation is all the more complicated by a strong and long-lasting anthropogenic influence. Generally speaking, man's activities have been detrimental to forests while open habitats have been gaining ground (fields, pastures, fields of stones), which in the continental part applies also to degraded thermophilic forests. This facilitated the invasion of some predominantly mediterranean species into the continent.

We have so far recorded 15 species of insectivores and rodents in central Dalmatia (the montane and the subalpine zones of the Dalmatian highlands are not included), and 24 species in the continental part. With respect to their zoogeographic characteristics in the study area they can be divided into the following groups:

1. Mediterranean species living exclusively in Dalmatia (true only of the study area): *Suncus etruscus, Crocidura leucodon, Apodemus mystacinus.*

2. Species living preponderantly in Dalmatia but frequenting also the continent: *Eliomys quercinus, Rattus rattus.*

3. Species more or less generally distributed in the study area but more frequent in Dalmatia *(Erinaceus concolor, Crocidura suaveolens, Apodemus sylvaticus, Mus domesticus)* and generally distributed species *(Dinaromys bogdanovi, Glis glis).*

4. Typically continental species: *Sorex minutus, S. araneus, S. alpinus, Neomys fodiens, Clethrionomys glareolus, Pitymys subterraneus, P. liechtensteini, Apodemus flavicollis, Mus musculus, Nannospalax monticola, Dryomys nitedula, Muscardinus avellanarius.*

5. »Continental« speices which are bound up with azonal habitats (karst fields in particular) in Dalmatia: *Neomys anomalus, Arvicola terrestris, Microtus arvalis.*

The classification reveals a marked similarity to the classification of vertical zones. The category under Pt. 1 is identical with the lowland species, the categories under Pts. 2 and 3 with the generally distributed species, whereas the typically continental species with the montane, the montane-subalpine and the subalpine species. By analogy with the analysis of the vertical distribution it can be concluded that the border line of the »mediterranean« small mammal fauna runs at the altitude of approximately 800 m. Up to it reach the lowland i.e. mediterranean species while above it there begin appearing the montane species. On the costal slopes of the Dinaric highlands the continental influence finds its expression no sooner than at higher altitudes (on Dinata Mt., for instance, at 1400 m), and the positions above 800 m a.s.l. are inhabited by the generally spread species. The zone populated preponderantly by this group of species can be designated as a transition to the continental fauna. On the coastal slopes of the dinaric highlands the first continental species appear at 1400 m a.s.l. only, and on the continental side already at the height of 740 m a.s.l.. This means that the »transitional zone« is broader on the NW slopes of the Dinaric highlands and narrower on their NE slopes.

Fig. 37. Roots of a limestone rock wall. Mt. Kozjak, about 700 m a.s.l., Dalmatia. Habitat of *Dinaromys bogdanovi* and *Apodemus mystacinus.* (Photo by J. Gregori).
Sl. 37. Vznožje apnenčaste stene. Kozjak, približno 700 m n. m., Dalmacija. Habitat vrst *Dinaromys bogdanovi* in *Apodemus mystacinus.*

9.2. Karst Fields

The geologic and pedologic structure, the hydrographic regime and the vegetation point to the fact that karst fields are azonic formations. This is corroborated also by the data concerning small mammals. The exceptional nature of karst fields finds its strongest expression in the areas under a marked mediterranean influence. In Dalmatia Karst fields become oases of a richer fauna. When comparing small mammal fauna of karstic fields with their surrounding we can draw the following conclusions:

1. In the karst fields of Dalmatia there live at least as many species of small mammals as in their surroundings, but usually more. The composition of the species between these two environments is not identical (CC = 29%). Mammals bound up with karst fields only are characteristic of the karst fields of the continentall part of the study area, as well as the continental region of Yugoslavia in general.

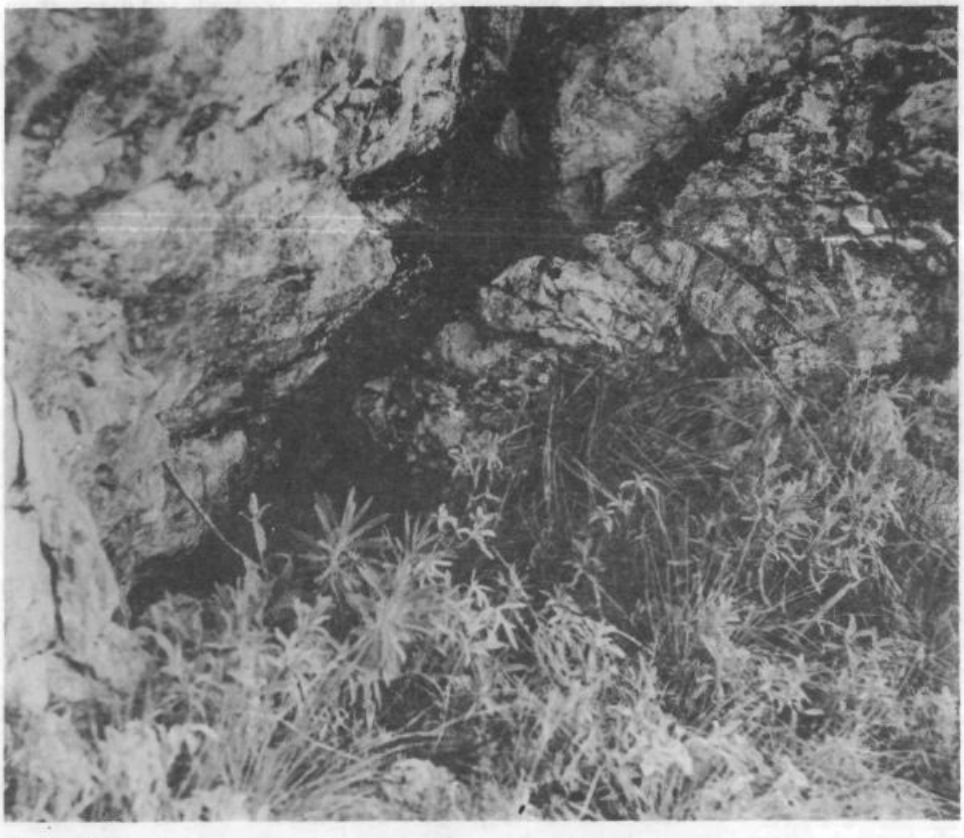


Fig. 38. Narrow fissure leading to a karst underground (Kozjak Mt.). Habitat of *Dinaromys bogdanovi* and *Apodemus mystacinus*. (Photo by J. Gregori).
Sl. 38. Ozka razpoka, ki vodi v kraško podzemlje (Kozjak). Habitat vrst *Dinaromys bogdanovi* in *Apodemus mystacinus*.

2. The number of small mammals is smaller in karst fields than in their immediate vicinity in the continental part of the study area. The composition of the two is more similar (CC = 50%). Only one species was not found outside the karst fields (*Arvicola terrestris*).

Karst fields thus represent enclaves of the »continental« fauna in the mediterranean region. If acquinted with the habitat seleciton of three characteristic species *(Neomys anomalus, Arvicola terrestris, Microtus arvalis)* one can see that there exist no recent linkings between their enclave in Cetinsko polje and Sinjsko polje in Dalmatia and their more or less continuous distribution in Bosnia. Such linkings are not possible due to the following reasons:

1. The enclave in Dalmatia is separated from the continent by an almost 2000 m heigh and 150 km long crest of Mt. Dinara where lives none of these species.

2. The enclave is surrounded with thermophilic and xerophilous vegetatin of *Quercо-Carpinetum orientalis* type offering to the species no conditions to survive.

Fig. 39. *Dinaromys bogdanovi* captured in its habitat on Mt. Kozjak (1700 m a.s.l.), Dalmatia. (Photo by J. Gregori).
Sl. 39. *Dinaromys bogdanovi,* ujet v značilnem habitatu na planini Kozjak (700 m n.m.), Dalmacija.

3. There exist no surface water connections between the water streams of the enclave and of Bosnia, which would facilitate an eventual spreading of *Neomys anomalus* and *Arvicola terrestris*.

Recent distribution areas on the Balcan Peninsula are explained in the light of events in the course of the Pleistocene. Namely, in the periods between glaciations the climate of this area was more continental, which in particular made possible the spreading of the steppe (MATVEJEV 1961). The fact that the study area used to be under a strong influence of the steppe is evident from the recent distribution of the genus *Nannospalax* attaining in this very place one of the extreme western limits of its distribution. Thus, we may presume that it was as early as in the Pleistocene that *Microtus arvalis* attained the area of Cetinsko polje and Sinjsko polje fields. Later on, as a result of a change in the climate and the vegetation, and possibly also as a result of strong erosive processes during the glaciations themeselves, making thinner the shallow layer of soil on the limestone ground, the population remained isolated in the deep soil layer of karst fields.

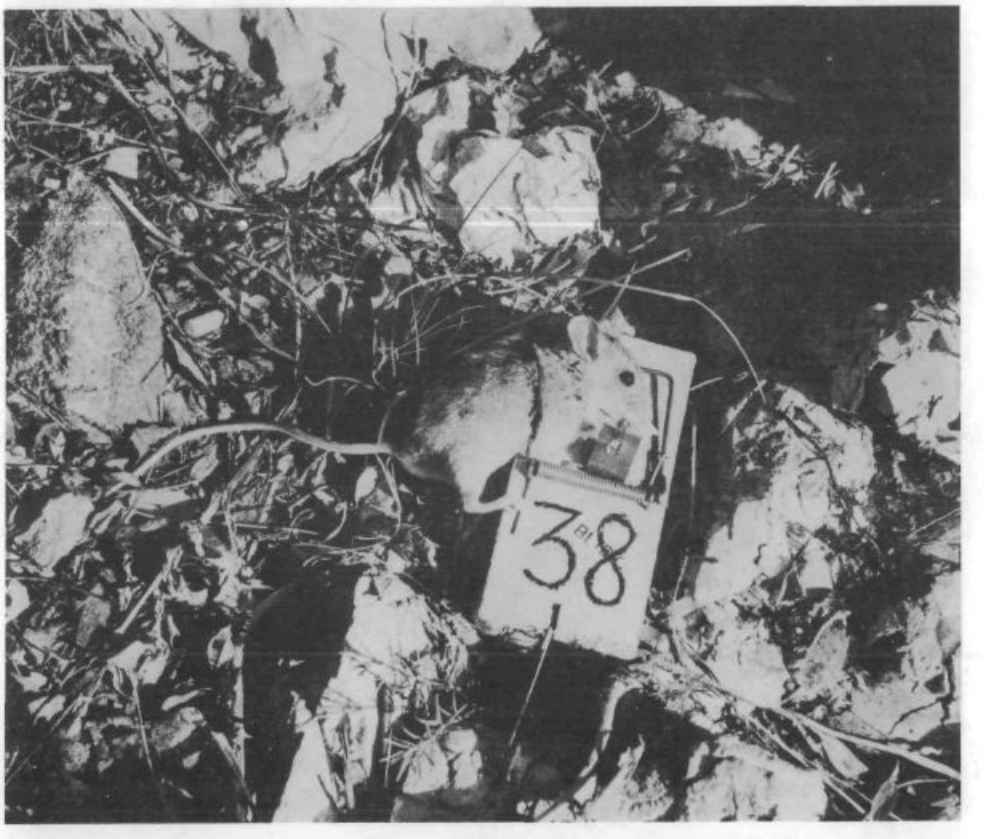


Fig. 40. *Apodemus mystacinus* captured in its habitat on Mt. Kozjak (700 m a.s.l.), Dalmatia. (Photo by J. Gregori).
Sl. 40. *Apodemus mystacinus*, ujet v značilnem habitatu na planini Kozjak (700 m n.m.), Dalmacija.

The recent distribution of plant communities of karst fields shows that the Würm glaciation, at least, saw the spreading of hygrophilous and hydrophilous forest associations (e.g. *Carici brizoides–Alnetum glutinosae*), nowadays revealing a relict character. It can be expected that moving parallelly with these and such plant communities were also hygro- and hydrophilous mammals. In our case this is true only of *Neomys anomalus* and *Arvicola terrestris*. This means that the mammals of the Dalmatian karst fileds have been isolated for no less than about 10.000 years.

9.3. Islands

From 4 to 7 species of small mammals were found on three the largest central Dalmatian islands studied (Table 7). Four species (*Erinaceus concolor, Mus domesticus, Rattus rattus, Apodemus sylvaticus*) can be encountered on all three islands. All of the species found on the-

Fig. 41. Šatorsko jezero Lake, Mt. Šator, Bosnia (1490 m a.s.l.). Habitat of *Sorex araneus, S. alpinus, Dinaromys bogdanovi, Chionomys nivalis, Apodemus sylvaticus,* and *Dryomys nitedula.* (Photo N. Tvrtković).
Sl. 41. Šatorsko jezero, Šator, Bosna (1490 m n.m.). Habitat vrst *Sorex araneus, S. alpinus, Dinaromys bogdanovi, Chionomys nivalis, Apodemus sylvaticus* in *Dinaromys bogdanovi.*

se islands live also on the neighbouring mainland that possesses a richer fauna of small mammals. We can confirm the statement of DJULIĆ (1972) that the Adriatic islands are populated by an impoverished continental fauna of small mammals.

Most of the similarities to the continent are obvious on Brač and Hvar (closest to the mainland) and the least on Vis which is the most distant from the shore (Table 7). The largest number of species lives on the largest two islands, and the lowest number on Vis (the smallest of them).

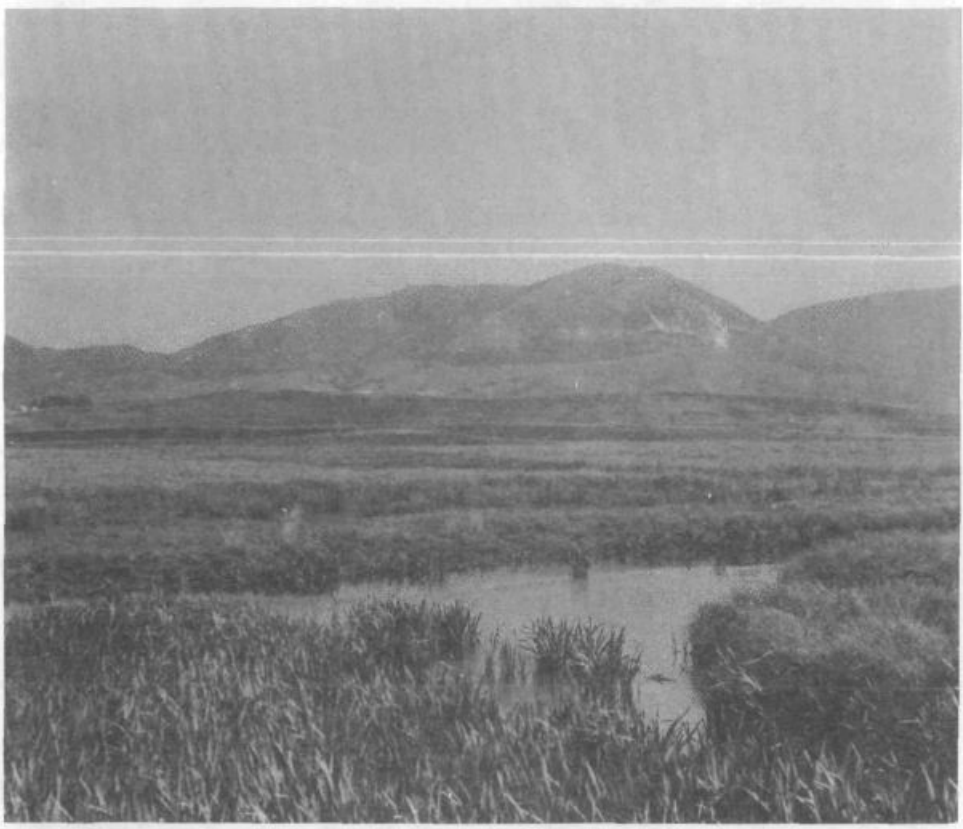


Fig. 42. Swamp vegetation by the Mrtvica river in the karst field Kupreško polje. Habitat of *Neomys fodiens, N. anomalus,* and *Arvicola terrestris.* (Photo by B. Kryštufek).
Sl. 42. Močvirska vegetacija ob reki Mrtvici na Kupreškem polju. Habitat vrst *Neomys fodiens, N. anomalus* in *Arvicola terrestris.*

Fig. 43. Characteristic meanders of the Mrtvica river in the karst field Kupreško polje. Habitat of *Neomys fodiens, N. anomalus,* and *Arvicola terestris.* Drier meadows are populated by *Microtus arvalis.* (Photo by N. Tvrtković).
Sl. 43. Značilni meandri reke Mrtvice na Kupreškem polju. Habitat vrst *Neomys fodiens, N. anomalus* in *Arvicola terrestris.* Suhe travnike poseljuje *Microtus arvalis.*

Fig. 44. Meadows and fields on the margins of Kupreško polje. Gornji Malovan, 1140 m. Habitat of *Talpa europaea, Sorex araneus, Microtus arvalis, Apodemus sylvaticus, A. flavicollis,* and *Nannospalax monticola.* (Photo by N. Tvrtković).
Sl. 44. Travniki in polja na robu Kupreškega polja. Gornji Malovan, 1140 m. Habitat vrst *Talpa europaea, Sorex araneus, Microtus arvalis, Apodemus sylvaticus, A. flavicollis in Nannospalax monticola.*

Fig. 45. Cadaver of the Bosnian mole-rat *Nannospalax monticola* captured at Gornji Malovan, Bosnia. (Photo by I. Sivec).
Sl. 45. Mrtvo bosansko slepo kuže *Nannospalax monticola,* ujeto pri Gornjem Malovanu v Bosni.

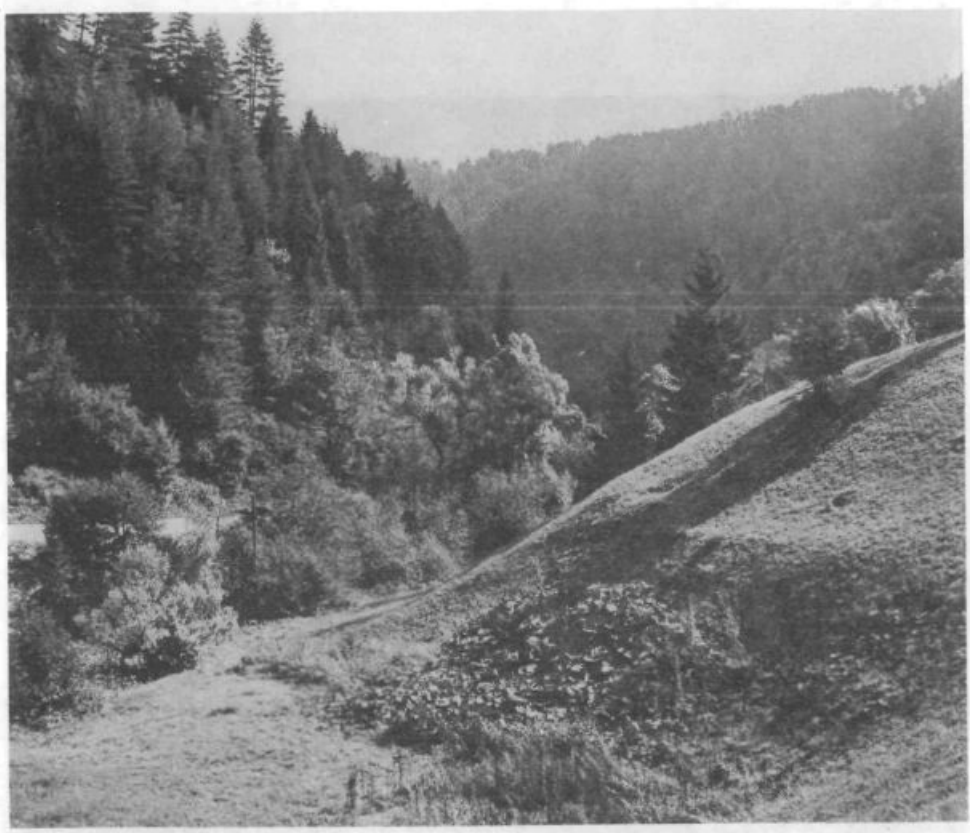


Fig. 46. Koprivnica-Poriče (880 m a.s.l.), Bosnia. Habitat of *Talpa europaea, Sorex araneus, S. alpinus, Neomys fodiens, Clethrionomys glareolus, Microtus arvalis, Pitymys subterraneus, Apodemus flavicollis, Dryomys nitedula* and *Glis glis.* (Photo by N. Tvrtković).
Sl. 46. Koprivnica–Poriče (880 m), Bosna. Habitat vrst *Talpa europaea, Sorex araneus, S. alpinus, Neomys fodiens, Clethrionomys glareolus, Microtus arvalis, Pitymys subterraneus, Apodemus flavicollis, Dryomys nitedula* in *Glis glis.*

Table 7. Small mammals on three adriatic islands and Dalmatia littoral. Coefficient of community (CC) expresses the similarity with the Dalmatia littoral.
Tabela 7. Mali sesalci na treh jadranskih otokih in sosednjem dalmatinskem kopnu. Koeficienti podobnosti (CC) izražajo podobnost otočne favne z obalno Dalmacijo.

	Dalmatia littoral	Island of Brač	Island of Hvar	Island of Vis
Erinaceus concolor	+	+	+	+
Crocidura suaveolens	+	+	+	-
Crocidura leucodon	+	-	-	-
Suncus etruscus	+	-	-	-
Dinaromys bogdanovi	+	-	-	-
Apodemus mystacinus	+	-	-	-
Apodemus sylvaticus	+	+	+	+
Rattus rattus	+	+	+	+
Mus domesticus	+	+	+	+
Glis glis	+	+	+	-
Eliomys quercinus	+	+	+	-
Number of species	11	7	7	4
CC	100	64	64	36

The majority of the species living on the islands are widely distributed on the coast. This means that ubiquitous species are concerned.

No real continental species (see Chapter 9.1., Pt. 5) can be found on the islands. The same is true of mediterranean species, although *Apodemus mystacinus* lives on some other Adriatic islands (DJULIĆ 1972). Obvious is also the absence of voles.

Acknowledgements

We thank J. Gregori and S. Brelih (Natural History Museum of Slovenia) who provided us with unpublished data on small mammals from central Dalmatia. Sincere thanks to Dr. L. Marinček and A.. Seliškar, MSc., for their advices and assistance in preparing the chapter on the vegetation of the study area. We are grateful also to our colleagues who helped us to collect in the filed and whose names are mentioned in the survey of the material.

POVZETEK

Za kraška območja osrednje Dalmacije, jugozahodne Bosne in zahodne Hercegovine navajava 29 vrst žužkojedov in glodalcev: *Erinaceus concolor, Sorex minutus, S. araneus, S. alpinus, Neomys fodiens, N. anomalus, Suncus etruscus, Crocidura suaveolens, C. leucodon, Talpa europaea, Clethrionomys glareolus, Dinaromys bogdanovi, Arvicola terrestris, Pitymys subterraneus, P. liechtensteini, Chionomys nivalis, Microtus arvalis, Nannospalax monticola, Apodemus mystacinus, A. flavicollis, A. sylvaticus, Rattus rattus, R. norvegicus, Mus domesticus, M. musculus, Glis glis, Eliomys quernicus, Dryomys nitedula in Muscardinus avellanarius.* Prisotnost štirih vrst *(Sorex minutus, Neomys fodiens, Pitymys liechtensteini, Muscardinus avellanarius)* je prvič za to območje dokazana. Pri vsaki vrsti navajava zbrani material, dosedanje podatke iz literature s sinonimiko ter osnovne ekološke podatke, zlasti izbiro habitata in razmnoževanje. Razširjenost vrst je predstavljena z zemljevidi. Identificirala sva tudi geografska mesta, s katerih so poznani sesalci, in jih opremila z odgovarjajočimi UTM kvadrati.

Zoogeografsko je področje zelo razgibano. V smeri otoki → Dalmacija → kontinent upada dominantnost miši (Muridae) in polhov (Gliridae), narašča pa dominantnost voluharic (Arvicolidae) in rovk (Soricidae). Glede na vertikalno razširjenost na raziskovanem območju smo razdelili male sesalce na 6 skupin: nižinske vrste *(Suncus etruscus, Crocidura leucodon, Apodemus mystacinus),* vrste z veliko vertikalno razširjenostjo *(Erinaceus concolor, Crocidura suaveolens, Dinaromys bogdanovi, Rattus rattus, Apodemus sylvaticus, Glis glis* in *Eliomys quercinus),* montanske vrste *(Neomys fodiens, Pitymys liechtensteini),* vrste montanskega in subalpinskega pasu *(Sorex minutus, S. araneus, S. alpinus, Talpa europaea, Cl. glareolus, Apodemus flavicollis, Nannospalax monticola, Dryomys nitedula* in *Muscardinus avellanarius),* montanske vrste, ki se pojavljajo v Dalmaciji le v azonalnih biotopih kraških polj *(Neomys anomalus, Arvicola terrestris* in *Microtus arvalis),* in na subalpinske vrste *(Chionomys nivalis).* Glede na horizontalno razširjenost malih sesalcev lahko govorimo o mediteranskih vrstah, vrstah, ki so vezane predvsem na Dalmacijo, dobimo pa jih tudi v kontinentalnem delu, splošno razširjene vrste, kontinentalne vrste in pa kontinentalne vrste, ki so v Dalmaciji vezane na kraška polja. Kraškim poljem pripisujeva velik zoogeografski pomen, saj predstavljajo enklave kontinentalne favne v Dalmaciji. To je mogoče zaradi hidrografskih razmer na kraških poljih in globokega sloja prsti. Dalmatinski otoki so poseljeni z osiromašeno celinsko favno malih sesalcev. Število vrst na otokih je v negativni korelaciji z velikostjo otoka in njegovo oddaljenostjo od celine.

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