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Collembola of the Pieniny National Park in Poland

[17 text-figs., pls. XIX—XXII]

Collembola Pienińskiego Parku Narodowego*

Abstract. In the Pieniny Mts., 191 species of *Collembola* have been found, of which 18 are new for the fauna of Poland. The soil fauna and epigeon were classified and analysed in detail, while corticophilous, ripicolous and synanthropic faunas were described only briefly. The soil samples were grouped according to the microhabitat relations within the particular plant associations. The author distinguished four zoogeographical groups in the fauna of springtails: widely distributed species, montane species, Boreal-alpine species and southern species. The fauna of the Pieniny Mts. is strongly related to the fauna of the whole Carpathian Range, with a relatively great share of southern forms. An attempt has been made to identify the relicts from the particular climatic periods, basing on the analysis of paleographic and biogeographic relations. The oldest elements in the fauna of Pieniny Mts. seem to originate from the Tertiary; glacial, interglacial, postglacial and recently migrating elements also occur.

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* Praca wykonana w ramach problemu MR. II. 3.

I. INTRODUCTION

The data concerning the fauna of *Collembola* from the Pieniny Mts. are available in a few publications. It was STACH (1920), who conducted the first study in this area. His elaboration provides many valuable informations, even though it includes only 65 species. The particular volumes of STACH's monography (1947, 1949a, 1949b, 1951, 1954, 1956, 1957, 1960, 1963) provide subsequent data from the Pieniny Mts., while his catalogue of Polish fauna (STACH, 1964) enlists 75 species. The preliminary elaboration of mine (WEINER, 1976), even though it was limited to a single season, contained further 52 species. The remaining publications concern either the descriptions of the new species for the knowledge (RUSEK, 1978, RUSEK and WEINER, 1978; WEINER, 1973; 1977a), or they indicate the new stands of already known species (WEINER, 1977b). Hitherto, 132 species have been found in the Pieniny Mts. Some of them have been reported in result of erroneous identification. In my papers (1976, 1977b), there were: *Hypogastrura breviempodialis* (STACH, 1949), *Odontella lamellifera* (AXELSON, 1903), *Onychiurus pavlovskyi* NOSEK & VYSOCKAYA, 1965, *H. tullbergi* (SCHÄFFER, 1900), *variabilis* STACH, 1954, *Mesaphorura sensibilis* RUSEK, 1973, *Isotoma intermedia* SCHÖTT, 1902. The first three, as juvenal specimens, were practically not suitable for identification, while the last one is probably a new species (FJELLBERG, pers. comm.). A few species mentioned by STACH (1964) could not have been checked, because some of the items from his collection have been lost. These species were: *Onychiurus burmeisteri* (LUBBOCK, 1837), *Tetracanthella pilosa* SCHÖTT, 1891, *Pseudosinella wahlgreni* (BÖRNER, 1907), and *Sminthurinus niger* (LUBBOCK, 1868).

The whole material collected in the Pieniny Mts. included 55. 000 specimens belonging to 191 species, from which 18 are new for the fauna of Poland. Other 12 species are probably new for the science (*Xenylla* sp., *Willemia* sp., *Friesea* sp., *Pseudachorutes* sp., *Lathriopyga* sp., *Appendisotoma* sp., *Isotoma* sp., *Isotomurus* sp., *Orchesella* sp., *Entomobrya* sp., *Bourletiella* sp. and *Heterosminthurus* sp.), but due to the scarcity of material they cannot be properly distinguished. For an accurate identification of *Lepidocyrtus* spp., a recent revision of the genus would be necessary. It seems, however, that in the Pieniny Mts. there occur some 4—6 species besides *Lepidocyrtus ruber* SCHÖTT, 1902.

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II. STUDY AREA

The Pieniny Mts. (Fig. 1) belong to the northern aprt of Carpathian Mountain Range (long. $20^{\circ}19'$ — $20^{\circ}27'$ E, lat. $49^{\circ}20'$ — $49^{\circ}22'$ N). This range constitutes a part of the Pieniny Rocky Belt, which extends for 600 km, from the Castle of Brench upon Myjava River (western Slovakia), across the Wag River Valley, Orava, Podhale Basin, Spisz, and as far as to Marmory (Transcarpathian Russia). West from the Castle of Brench Pieniny Rocky Belt takes cover

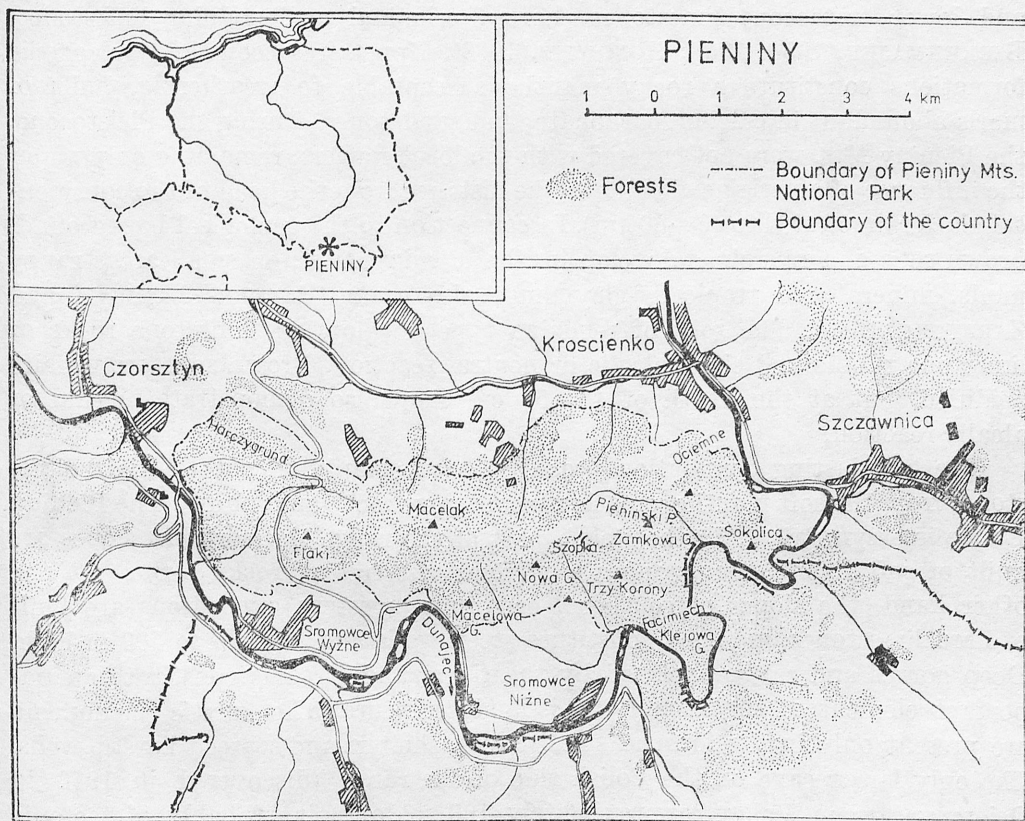


Fig. 1. Map of the Pieniny National Park

underneath the Tertiary sediments of the Vienna basin and emerges again above the ground surface near Vienna. From there on, it sweeps away along the Eastern Alps (Gersten Rocks) (BIRKENMAJER, 1958; SMÓLSKI, 1960).

As concerning to the climate, Pieniny Mts. belong to the submontane calm zone (ROMER, 1949). The climate is milder than in adjacent mountain ranges (DYLIKOWA, 1973; SMÓLSKI, 1960). As a characteristic example, the following table based on Meteorological Yearbook (Rocznik Meteorologiczny) 1961—1965 is given:

Locality	Temperatures			Precipitation
	summer maxima	winter minima	annual mean	annual mean
Krościenko	30.6 ÷ 34.1°C	— 22.1 ÷ — 33.2°C	5.8°C	773 mm
Czorsztyn-Nadzamcze	28.3 ÷ 33.8°C	— 23.9 ÷ — 23.7°C	0.9°C	647 mm

The rock core of the Pieniny Mts. is build of resistant to weathering jurassic and lower cretaceous limestones (horny, crinoidal and nodular limestones; BIRKENMAJER, 1958, 1959; HOROWITZ, 1963). Upper cretaceous and paleogenic formations constitute a rocky mantle susceptible to weathering, built of marls abundant in calcium carbonate, and sandstones. During the Pleistocene, the Pieniny Mts. were not covered with the local glaciers, remaining only under the influence of a periglacial climate (the distance from the head of the continental glacier amounted to 40—50 km). In connection to the geological background, brown soils and rendzinas develop in the Pieniny Mts.; on small areas rangy muds, mineral and tropically-gley muds also occur (PANCER-KOTEJOWA and ZARZYCKI, 1976). The soils of rendzina type develop on limestone rocks or limestone rubble and show alcalic or neutral reaction. Brown soils are usually acidified, but at the depth of 40—50 cm they also demonstrate neutral or alcalic reaction.

The long-lasting denudation processes have sculptured out the hard limestones from the soft mantle, creating scenic spiry rocks and humps. The Pieniny Range is asymmetrical. In the Polish part of the range the northern slopes are built of soft flysch rocks, sloping kindly, almost free of rocky forms. On the other hand, the slopes of southern, eastern or western expositions are built of hard limestones and they constitute steep walls and jags up to 300 m high. Deep gorges and ravines formed by the rivers and streams constitute an important element of the Pieniny Mts. land sculpture. The karstic phenomena are present only in the form of small caves, shelters and scarced karstic wells. The only larger cave on the Polish side of the range (discovered in 1976 in Ociemny Stream Valley, approximately 100 m long) is probably of tectonic origin, and it is relatively young.

The Pieniny Mts. are placed almost entirely within the lower zone of subalpine forests (440—882 m a. s. l.), and in spite of the substantial denivelations (440—982 m a. s. l.), the vertical differentiation of vegetation is not markedly pronounced. However, the diverse land sculpture together with climatic conditions have brought about a great variety of habitats, and consequently — the richness of flora and fauna. PANCER-KOTEJOWA and ZARZYCKI (1976) have distinguished three large complexes of habitats: the complex of southern slopes, and the complex of azonal habitats and associations, most often connected with the valleys of Dunajec River and larger streams. The habitats included to these complexes correspond with the characteristic plant associations

(PANCER-KOTEJOWA, 1973; PANCER-KOTEJOWA and ZARZYCKI, 1976, also: K. GRODZIŃSKA and E. PANCER-KOTEJOWA, personal communication).

On the slopes of southern exposition, xerothermic associations are developed. On limestone rocks saxicolous mountain grasslands — *Dendranthemo-Seslerietum* (Central Pieniny Mts. — Pl. XIX), and saxicolous xerothermic grasslands — *Festucetum pallentis typicum* (Central Pieniny Mts.) and *Festucetum pallentis potentilletosum* (Western Pieniny Mts.) occur. *Dendranthemo-Seslerietum* is an endemic association, characterised by the occurrence of *Sesleria varia*, *Helianthemum rupifragum*, *Centaurea axillaris*, *Erysimum wittmani*, *Thymus carpaticus*, *Dendranthema zawadzkii*, *Ranunculus oreophyllus*, and others. This association develops on rock shelves, alternately with crevice association (association with *Alyssum arduini*) and with the patches of *Festucetum pallentis*. This last community develops on steep slopes in Central Pieniny Mts. and at the border of Western Pieniny Mts. *Festuca pallens*, *Sempervivum soboliferum*, *Allium montanum*, *Lithanotis montana*, *Tortella tortuosa* and *Ditrichum flexicaule* are the typical plant species. Many species characteristic for *Dendranthemo-Seslerietum* also appear in this community, e. g. scarcely occurring *Dendranthema zawadzkii*. In the Western Pieniny Mts. a variation of this association develops — *Festucetum pallentis potentilletosum*. The main part of vegetation consists here of the elements typical for *Festucetum pallentis*, but without the elements of *Dendranthemo-Seslerietum*, and with an addition of *Potentilla puberula*, *Teucrium montanum*, *Salvia verticillata*, *Bupleurum falcatum*, *Melica transsilvanica*, and others. The patches of relict saxicolous pine woods: association *Pinus silvestris-Calamagrostis varia* (Pl. XIX) have survived on rock terraces. Pine constitute the major tree species while beech and fir also occur on the rims. The typical herbs are *Sesleria varia*, *Calamagrostis varia*, *Epipactis atropurpurea*, *Pirola secunda*, and *Carex digitata*. Fairly large patch of this association has survived in relatively good condition on Czerwone Skały Crags. On screes and taluses with the soil rich in calcium carbonate a xerothermal grassland — *Origano-Brachypodietum* develops, often with a great share of brushes: *Cornus sanguinea*, *Prunus spinosa* and *Juniperus communis*. Among herbs, *Origanum vulgare*, *Calamintha acinos*, *Coronilla varia*, *Hypericum perforatum* contribute in this association. In the Pieniny Mts. *Origano-Brachypodietum* occurs in the two sub-communities. *Origano-Brachypodietum laserpitietosum* (Pl. XX) develops in the Central Pieniny Mts. and it is of a natural character there. The typical plant species are *Laserpitium latifolium*, *Vicia silvatica*, *Thymus carpaticus*, *Gallium mollugo*. *Origano-Brachypodietum stachyetosum*, with *Stachys germanica*, *Inula conyza*, *Agrinaria eupatoria* and *Scabiosa ochroleuca* is the other sub-community. On the steep limestone slopes a thermophilous beechwood — *Carici-Fagetum cephalantheretosum* occurs, while on limestone shales a thermophilous fir wood — *Carici-Fagetum abietetosum* grows. *Carici-Fagetum cephalantheretosum* in its typical form occurs only in the Central Pieniny Mts., where it usually occupies fixed screes. The tree stand consists of beech and fir, with an admixture of *Tilia platyphyllos*, *Acer pseudoplatanus*, *Picea excelsa* and *Carpinus betulus*.

The shrub layer is multispecies and well developed, including *Cornus sanguinea*, *Cotoneaster integerrima*, *C. melanocarpa*, *Corylus avellana*, *Daphne mezereum*, and others. In the herb layer one encounters *Poa stiriaca*, *Calamagrostis varia*, *Campanula persicifolia*, *Laserpitium latifolium*, *Cephalanthera alba*, *C. longifolia*, *Convallaria majalis*. *Carici-Fagetum abietetosum* grows on southern slopes and rocky ridges with various expositions. Under the shelter of fir scarced exemplars of beech and spruce occur. In mature stands raspberry bushes commonly grow. *Carex alba* is an characteristic and distinguishing species for this community. On the stands of *Carici-Fagetum cephalantheretosum* and *Carici-Fagetum abietetosum*, especially in Western Pieniny Mts., one can find thermophilous beech-fir woods which are defined as patches of *Carici-Fagetum*. These stands are deformed by forest cutting, shepherdism or artificial introduction of spruce. On the slopes of Macelowa Peak at the elevation of appr. 550 m a. s. l., small relict xerothermic pine woods — association *Pinus silvestris* — *Carex alba* — have survived. The occurrence of this association is limited to a narrow belt, less than 100 m in wide. Among trees pine predominates, and from the adjacent *Carici-Fagetum abietetosum* also firs enter. The typical herbs are: *Carex alba*, *C. digitata*, *Melica nutans*, *Hieracium murorum*. On flate slopes, in the stands exploited by farmers, dry pastures (association with *Salvia verticillata*: Pl. XX) occur, commonly overgrown with juniper bushes and small pines and spruces.

Carpathian beechwoods, covering the northern slopes of the Pieniny Mts. develop in two forest types: *Fagetum carpaticum typicum* (Pl. XXI) and *Fagetum carpaticum oxalidetosum*. The tree stand is composed of beech and fir, or of only one of these species. As an admixture *Picea excelsa*, *Acer pseudoplatanus*, *Ulmus scabra*, *Tilia platyphyllos* also occur. The characteristic species of the herb layer are *Dentaria glandulosa*, *Symphytum cordatum*, *Polystichum braunii*, *Mercurialis perennis*, *Oxalis acetosella*, *Galeobdolon luteum*, *Dryopteris filix-mas*, *Asperula odorata*, *Asarum europaeum*; among bushes: *Lonicera xylosteum*, *Corylus avellana*, *Ribes grossularia*, *Daphne mesereum*, and others. Species composition of *Fagetum-carpaticum oxalidetosum* is similar, however in the forest layer *Oxalis acetosella* or *Asperula odorata* prevail. Unfortunately, large parts of the Carpathian beechwood have been destroyed by the forest management and nowadays they constitute an oligotrophic variant, to a large extent artificially planted with spruce. In gorges and on rock rubble the patches of sycamore wood (*Phyllitido-Aceretum*) develop (Pl. XXI), usually constituting a mosaic together with the patches of beechwood. Several species make up the tree stand: *Acer pseudoplatanus*, *Fagus sylvaticus*, *Carpinus betulus*, *Tilia platyphyllos*, *Acer platanoides* and *Abies alba*. The herb species characteristic for sycamore wood are *Lunaria rediviva* and *Phyllitis scolopendrium*. At wet situations one can find single, small patches of mountain marsh alderwood — *Caltho-Alnetum*. *Alnus incana*, *Picea excelsa*, *Acer pseudoplatanus*, and other species constitute the tree stand, and among herbs *Cardamine amara*, *Caltha laeta*, *C. palustris* are the characteristic ones.

On the deforested areas so called "Pieniny meadow" (*Anthylli-Trifolietum*;

Pl. XXII) has developed, reaching the elevation of about 850 m a. s. l.; higher stands are occupied by tall herbs meadow (association with *Veratrum lobelianum* and *Laserpitium latifolium*; Pl. XXII). Pieniny meadow is an antropogenic association, maintained permanently by mowing. The characteristic species here are: *Anthyllis vulneraria*, *Orchis ustulata*, *Trifolium montanum*, *Ononis arvensis*, *Centaurea scabiosa*, *Sanguisorba minor*. At the water leakings, eutrophic swamps — *Valeriano-Caricetum flavae* — develop, emerging commonly after cutting down the alderwoods. The characteristic and distinguishing species of plants are: *Valeriana simplicifolia*, *Carex Davalliana*, *C. flava*, *Eriophorum latifolium*, *Orchis latifolia*, and mosses: *Drepanocladus revolvens*, *Calliergon cuspidatus*, *Camptothecium nitens* and *Bryum ventricosum*.

The Carpathian alderwood — *Alnetum incanae*, occurring on temporarily inundated river alluvias, belongs to the azonal associations. The tree stand consists of *Alnus incana* with an admixture of *Salix incana*, *S. fragilis*, *Fraxinus excelsior*, and sometimes *Acer pseudoplatanus*. Characteristic species are: *Chaerophylus chirsutum*, *Matteucia struthiopteris*, *Humulus lupulus*, *Rubus caesius*, *Festuca gigantea*, *Aegopodium podagraria*, and *Glechoma hirsuta*. At the mouth of Pieniński Stream, a variation with *Petasites* develops in connection with the young stony soil. In touch with the Carpathian alderwood small patches of oak-hornbeam forests (*Tilio-Carpinetum*) remain, reaching an elevation up to 480 m a. s. l., with *Tilia platyphyllos* and *Carpinus betulus* as major tree species. The dominating herb layer plants are *Carex pilosa*, *Stellaria holostea*, *Hepatica nobilis*. Along the Dunajec River and larger streams, on riverside gravels frequently inundated associations of *Myricarietalia* order occur. The characteristic species for these communities are *Myricaria germanica*, *Chamaenerion palustre* and *Calamagrostis pseudophragmites*. Synanthropic habitats (poorly studied) and caves also belong to azonal habitats.

III. MATERIAL AND METHODS

To collect *Collembola* I have applied the methods commonly used in all systematic and faunistic studies (STACH, 1955). I used the TULLGREN's apparatus (RAJSKI, 1961) as well as the method with paradichlorobenzene (TAMURA, 1967) in the field conditions. However, even superficial observations show that paradichlorobenzene affects differently on various species; this phenomenon could influence the species composition of particular samples. The soil samples are not of a quantitative character, however, for the sake of terminological clarity, I have calculated the dominance when describing the characteristics of species occurrence. Only qualitative terms of dominance are given, according to the following criteria: $0 \div 1.0\%$ — slightly; $1.1 \div 4.0\%$ — not numerous; $4.1 \div 10\%$ — quite numerous; $10.1 \div 30\%$ — numerous; more than 30.1% — very numerous.

Extensive materials were also collected by the techniques of direct capturing.

For the species collected with this last method I use the following terminology of abundance: very common — if the species has occurred in almost all samples from a given habitat; common, when it has occurred at least in 3/4 of samples.

Altogether, I have gathered 475 samples, including 135 soil samples.

IV. LIST OF SPECIES

Discussing the world distribution of springtails I follow SALMON (1964) quoting, however, the original reports regarding to rare species. Specifying the Polish distribution of *Collembola* I use the Catalogue by STACH (1964), and subsequent original reports. The sequence of the genera I have adopted after STACH (1964) and SZEPTYCKI (1967). The nomenclature was corrected in accordance with the recent concepts (BETSCH, 1977; DALLAI, 1972; LAWRENCE, 1973; RICHARDS, 1968). Within the genera, the species are listed in an alphabetic order.

(*) denotes species new for the Pieniny Mts.,

(**) — species new for Poland;

* *Podura aquatica* LINNAEUS, 1758. Probably, a holarectic species. In Poland common in the whole lowland and in lower submontane stands (STACH, 1964; KACZMAREK, 1973; SZEPTYCKI, 1964, 1967). On the water surface covered with duckweed, on wet meadows and swamps.

I have found only one specimen on the water surface of an eversion pot-hole at the Dunajec River bank. Most probably, it was imported with the river from the Nowy Targ Basin, where it was previously recorded (STACH, 1964). Due to the lack of appropriate habitats, this species does not occur elsewhere in the Pieniny Mts.

* *Hypogastrura acquipilosa* (STACH, 1959) (*Hypogastrura tullbergi*: WEINER, 1976). Some authors (GISIN, 1961a; PALISSA, 1964) consider this species as synonymic with *boldorii* DENIS, 1931. However, when comparing the figures given by GISIN (1961a: figs 6 and 7) with those of STACH (1949a: Pl. X) one can see some differences in chaetotaxy on the abdominal tergite IV, and the setae are dissimilar in shape. The specimens from the Pieniny Mts. agree closely with the description and figures of STACH.

Reported from Zaryte, Piwniczna, Tatra Mts., Ojców vicinity, Montenegro, Styria and Spitsbergen (STACH, 1949a, 1964; SZEPTYCKI, 1967). Probably a Boreal-alpine species. Under detached coniferous tree bark, in the forest litter and mosses.

In *Fagetum carpaticum typicum* (WEINER, 1976). Commonly on fallen trees in *Fagetum carpaticum typicum*, *Carici-Fagetum cephalantheretosum* and *abietetosum*, in *Phyllitido-Aceretum*.

* *Hypogastrura assimilis* (KRAUSBAUER, 1898). A cosmopolitan, or almost cosmopolitan species. In Poland known from West Beskidy Range, Tatra Mts. (STACH, 1964) and from Ojców region (SZEPTYCKI, 1967). Most often found in compost and humus.

Numerously in *Myricarietalia* association (on the Dunajec riverside in Czorsztyn) and in an association with *Salvia verticillata* (Podlaźce); singly in *Festucetum pallentis potentilletosum* (Gorczyński Gully).

* *Hypogastrura crassaegranulata* (STACH, 1949), (Fig. 2a, 13). Species recorded in Carpathians, Alps, Bavaria, Burgundy, Dinara Mts., Dalmatian Coast, Pyrenees, Cantabrian Mts. and Caucasus (SALMON, 1964; CVIJOVIĆ & ŽIVADINOVIĆ, 1970; PALISSA, 1964; SELGA, 1971; ŽIVADINOVIĆ, 1973b). In Poland, from Tatra Mts. (STACH, 1949a) and from Ojców region (SZEPTYCKI, 1967). The specimens from Pieniny Mts. are similar to ssp. *dobsinensis* STACH, 1949. Alpine species, found in mosses and at the entrances to caves.

In the Pieniny Mts. it occurred not numerously in the soil samples of *Dendranthemo-Seslerietum* (Trzy Korony Peak — Okraglica) and of *Festucetum pallentis potentilletosum* (Gorczyński Gully).

* *Hypogastrura purpurescens* (LUBBOCK, 1867). Widely distributed in Europe, reported also from South America (CASSAGNAU & RAPOPORT, 1962; IZARRA, 1972a) and from South and Central Africa (PACIL, 1959; 1967). In Poland known from Lower Silesia, East Sudeten, Cracow region, West Beskidz Range, Nowy Targ Basin, Tatra Mts. (STACH, 1964). Most often encountered in the vicinity of human settlements, under pieces of wood, under stones, in humus and in caves.

In the Pieniny Mts. I have found 7 specimens on bracket mushrooms growing on willows, close to the farmhouses on Palenica.

* *Hypogastrura socialis* (UZEL, 1891). Probably, a holartic species. In Poland reported from Kampinos Forest, Lower Silesia, Cracow-Wieluń Upland, Roztocze Plateau, West Beskidz Range, Tatra Mts. (STACH, 1964; KACZMAREK, 1963, 1973; SZEPTYCKI, 1967). Winter occurring species, encountered on snow. Immature forms occur during summer in mosses and lichens.

Several specimens on snow in *Fagetum carpaticum oxalidetosum* (Gródek).

* *Hypogastrura vernalis* (CARL, 1901). Species distributed throughout the whole Europe. Recorded also in southern Tuva (STEBAEVA, 1963) and southern Ural (BUJNOVA & all., 1963; STEBAEVA, 1976). In Poland found in Nowy Targ Basin, Wolin Is., Poznań and Ojców regions (STACH, 1964; KOBYLĄŃSKA, 1976; SZEPTYCKI, 1964, 1967). Most commonly occurs in dry habitats with alcale soils.

Very numerously in *Festucetum pallentis potentilletosum* (Zameczysko Crag), in *Festucetum pallentis* (Kotłowy Stream Valley, Hukowa Crag, Podskale), numerously in *Dendranthemo-Seslerietum* (Trzy Korony Peak, Sobczański Gully, Sokolica Peak, Białe Crags).

* *Hypogastrura viatica* (TULLBERG, 1872). A cosmopolitan species occurring on the sea coasts; inland found on river and lake shores, and in synanthropic habitats. In Poland reported from Baltic Coast, Lower Silesia, western Sudeten, West Beskidz Mts. (STACH, 1964), and also from Ojców region (SZEPTYCKI, 1967).

One specimen has been found in the moist detritus on the Dunajec riverside in Czorsztyn — probably imported from synanthropic stands placed upstreams.

Ceratophysella armata (NICOLET, 1841). Probably, a cosmopolitan species. In Poland reported from many sites (STACH, 1964; KACZMAREK, 1963, 1975; ŁOSIŃSKI, 1972; SZEPTYCKI, 1967); however, until recently this species was confused with *denticulata*, thus not all of the former records are reliable. Occurs in various habitats, often on mushrooms, in leaf litter (moist), in mosses, under rotten tree bark and in rodent's nests.

Singly in the soil samples of *Fagetum carpaticum typicum* (Pieniński Stream Valley) and from *Carici-Fagetum cephalantheretosum* (Trzy Korony Peak, Białe Crags). Also, on mushrooms from a beechwood in Pieniński Stream Valley and in Harczygrund Valley.

* *Ceratophysella engadinensis* GISIN, 1949. Species known from few stands in Western Europe (GAMA, 1964; GISIN, 1949; HAYBACH, 1972a; POINSOT, 1965, 1966; SELGA, 1971; TÖRNE, 1958), from Tatra Mts. (RUSEK, 1976b), South Carpathians (GRUIA & ZAMFIRESCO, 1973), Rodopians (ZONEV & JELEVA, 1977a), northern foothills of Vitosha Mts. (ZONEV & JELEVA, 1977b), and also from Peru (WINTER, 1962). So far, in Poland recorded only from Ojców region, where it has been found in soil on a pasture (association *Agrostis vulgaris*; SZEPTYCKI, 1967).

In the Pieniny Mts. one specimen in *Dendranthemo-Seslerietum* (Sobczański Gully).

Ceratophysella denticulata (BAGNALL, 1941). Species widely distributed in Europe. In Poland reported from Wolin Is. (SZEPTYCKI, 1964), from Ojców region (SZEPTYCKI, 1967), Poznań region (KOBYLAŃSKA, 1967) and from the Pieniny Mts. (WEINER, 1976). It seems to be much more common (cf. comment to *C. armata*). Occurs in forest litter, in mosses, under detached tree bark, in small mammals' nests and on mushrooms.

Singly in *Fagetum carpaticum typicum* (Ociemny Stream Valley, Pieniński Stream Valley), in *Fagetum carpaticum typicum* (oligothrophic variant) (Nowa Pezka, near Wyrobek Meadow), in *Carici-Fagetum cephalantheretosum* (Trzy Korony Peak, Rabsztyn Crag), in *Carici-Fagetum abietetosum* (Facimiech-Klejowa Peaks) and in *Myricarietalia* on Dunajec riverside in Czorsztyn, in detritus. Moreover several specimens have been found in moss growing on stones in spruce forest on Gola Peak.

Ceratophysella granulata STACH, 1949. Central European species, with single stands in Western Europe: at Rodan estuary (STACH, 1949a) and Hebrides Is. (GOTO, 1955). In Poland, recorded from Tatra Mts. (STACH, 1964), also found in Aksamitka-cave, on the Slovakian side of Pieniny Mts. (STACH, 1949a). Occurs in forest litter, in mosses on trees and rock, and in caves.

In the Pieniny Mts. numerously and very numerously in the caves of Sobczański Gully and of Ociemny.

Ceratophysella luteospina (STACH, 1920) Distributed mainly in montane areas of southern Europe. Northernmost stand of this species has been reported from Ojców area (SZEPTYCKI, 1967). In Poland recorded also in Cracow region, West Beskidy Mts., Pieniny Mts. and Tatra Mts. (STACH, 1964; WEINER, 1976).

Most commonly it was found on mushrooms, also in forest litter, under stones, in the nests of small mammals, etc.

In the Pieniny Mts. — singly in the soil samples from *Fagetum carpaticum typicum* in Ociemny and Huliński Stream Valleys (WEINER, 1976), also in *Carici-Fagetum cephalantheretosum* (Białe Crags), in *Origano-Brachypodietum laserpitietosum* (Trzy Korony Peak) and in *Dendranthemo-Seslerietum* (Sobczański Gully). Moreover, very commonly on mushrooms in forest and meadow habitats.

** *Ceratophysella meridionalis* (NOSEK & ČERVEK, 1967). This species was previously known from a single stand in Yugoslavia (NOSEK & ČERVEK, 1967).

In the Pieniny Mts. I have found one specimen in the soil sample of *Carici-Fagetum* on Czubata Crag.

* *Ceratophysella sigillata* (UZEL, 1891). Probably, a holarctic species. In Poland reported from East Sudeten, West Beskidy Range (STACH, 1964) and from Ojców region (SZEPTYCKI, 1967). Winter occurring species, encountered on snow and also in forest litter and soil.

In the Pieniny Mts. in soil samples (taken in November and early April exclusively), numerous in *Origano-Brachypodietum laserpitietosum* (Sobczański Gully) and singly in the soil samples taken from the bank of Pieniński Stream, in *Fagetum carpaticum typicum*.

Schoettella ununguiculata (TULLBERG, 1869). Species known from many localities in Europe, reported from North America, also from southern Ural (BUJNOVA & all., 1963; STEBAEVA, 1976) and from Novosibirsk region (STEBAEVA, 1976). In Poland widely distributed and presumably common (Stach, 1964; KOBYLAŃSKA, 1976; ŁOSIŃSKI, 1972; SZEPTYCKI, 1967; WEINER, 1976; WIŚNIEWSKI, 1967). Xerophilous.

In *Carici-Fagetum abietetosum* (WEINER, 1976). Very numerous in xerothermic habitats (*Dendranthemo-Seslerietum*, *Festucetum pallentis potentilletosum*, *Origano-Brachypodietum laserpitietosum* and in *Pinus silvestris-Carex alba* association); also in *Carici-Fagetum* or *Fagetum carpaticum typicum*, provided, that the habitats of these associations are overgrown with spruce. On the other hand, occurs numerous in *Phyllitido-Aceretum* (Trzy Korony Peak, Famiciech Peak).

In the Pieniny Mts. this species is associated with dry, saxicolous habitats (rocks, rubble) and with conifer litter.

Choreutinula inermis TULLBERG, 1871. (*Schoetella inermis*: STACH, 1964; KACZMAREK, 1973; SZEPTYCKI, 1967; WEINER, 1976; WIŚNIEWSKI, 1967). Presumably, a palearctic species. In Poland reported from Poznań region, Kampinos Forest, Cracow-Wieluń Upland, West Beskidy Range and Pieniny Mts. (STACH, 1964; BŁASZAK & all. 1973; KACZMAREK, 1973; SZEPTYCKI, 1967; WEINER, 1976; WIŚNIEWSKI, 1967). Occurs in moss, litter, rotten fir trunks, under the detached treebark of firs and pines, in anthills.

In *Carici-Fagetum abietetosum* (WEINER, 1976). Singly and not numerous in *Fagetum carpaticum typicum* (Pieniński Stream Valley), in oligotrophic

Fagetum carpaticum typicum (Macelak Peak), in *Carici-Fagetum* (Długa Grapa Crag), in *Dendranthemo-Seslerietum* (Trzy Korony Peak, Sokolica Peak), in *Festucetum pallentis potentilletosum* (Pulsztyn Crag) and in *Carici-Fagetum cephalantheretosum* (Pieniński Stream Valley, under Czerwone Crags); exceptionally, very numerous in a sample with mosses taken in winter from *Phyllitido-Aceretum* on Trzy Korony Peak.

* *Mesachorutes ojcoviensis* STACH, 1919. South-European troglobiotic species. In Poland reported from Nietoperzowa Cave near Ojców (STACH, 1964; SZEPTYCKI, 1967), the caves of Sokole Mts. in the northern part of Cracow-Wieluń Upland (SKALSKI & WÓJCIK, 1968), and from Mylna Cave in the Tatra Mts. (SKALSKI, 1969).

In the Pieniny Mts. I have found it in the litter, appr. 4 m deep from the entrance to the Cave of Ociemny — not numerous.

Xenylla acauda GISIN, 1947. So far, this species was known only from a few localities: from the Alps (GAMA, 1969; GISIN, 1947, 1957a; HAYBACH, 1972b; TÖRNE, 1958), Pieniny Mts. (WEINER, 1976, 1977b), Cordillera Central (Spain), Cantabrian Mts. (SELGA, 1971) and from mountain areas of California and Idaho in North America (GAMA, 1974). It occurs in dry environments: grasslands, mountain steppes and meadows, in dry and lucid forests. Furthermore, this species has been recorded on Skokholm Is. (Coast of Wales; GOUGH, 1971, 1972), in an alpine garden, probably introduced incidentally. There were also two lowland localities reported: in Leningrad region, where it was found in a squirrels' nest (VYSOCKAYA, 1958) and in Oslo Fiord — on the roots of plants growing on a beach (FJELLBERG, personal communication). However, quite distinct character of these last habitats suggests, that it might have been some other species.

In the Pieniny Mts. it occurs very numerous and numerous in the soil samples of *Dendranthemo-Seslerietum* (Sobczański Gully, Trzy Korony Peak, Sokolica Peak, Grabczycha Crag), *Festucetum pallentis potentilletosum* (Macelowa Peak) and of *Pinus silvestris-Calamagrostis varia* association (Czerwone Crags); singly in *Carici-Fagetum cephalantheretosum* (Trzy Korony Peak) and *Carici-Fagetum abietetosum* (Facimiech).

* *Xenylla borneri* AXELSON, 1906. Species distributed in almost the whole Europe, reported also from South-Eastern Altai (STEBAEVA, 1973; 1976; s. cf. *borneri*). In Poland, reported from Świętokrzyskie Mts., Nowy Targ Basin (STACH, 1964), Wolin Is. (SZEPTYCKI, 1964) and from Ojców region (SZEPTYCKI, 1967). It occurs under detached tree bark, in mosses and lichens, conifer litter and in the nests of small mammals.

Singly or not numerous in the soil samples of *Phyllitido-Aceretum* (Trzy Korony Peak), *Fagetum carpaticum typicum* (Pieniński Stream Valley) and in oligotrophic *Fagetum carpaticum typicum* (Harczygrund Valley). Furthermore, I have found it under tree bark of a dead fir in *Carici-Fagetum* (Głęboki Stream Valley) and in mosses growing on rocks in *Fagetum carpaticum oxalidetosum* (Gródek-Ociemne).

Xenylla brevicauda TULLBERG, 1869. Boreal-alpine species; besides of Europe reported from Tuva (STEBAEVA, 1963). In Poland it was found in Kraków-Wieluń Upland, in the Pieniny Mts. and in Nowy Targ Basin (STACH, 1964; SZEP-
TYCKI, 1967; WEINER, 1976). Occurs in forest litter, mosses and lichens.

Singly or not numerous in *Carici-Fagetum cephalantheretosum* (Trzy Korony Peak); *Fagetum carpaticum typicum* (Ociemny Stream Valley). Quite numerous in *Fagetum carpaticum typicum* (Przechodki Cape).

* *Xenylla brevissimilis* STACH, 1949. Species recorded in Central and Southern Europe. In Poland it was found in Nowy Targ Basin (STACH, 1964) and in Kampinos Forest (KACZMAREK, 1973). Occurs in mosses and lichens.

Singly in *Carici-Fagetum abietetosum* (Facimiech-Klejowa Peaks), *Carici-Fagetum* (Pieniński Stream Valley, Gojny Forest), *Fagetum carpaticum typicum* (Pieniński Stream Valley). Quite numerous in *Festucetum pallentis potentilletosum*, in a sample with ants (Pulsztyn Crag). Collected also from junipers in *Festucetum pallentis potentilletosum* (Flaki massif).

* *Xenylla corticalis* BÖRNER, 1901 (*Xenylla planipila*: STACH, 1949a, 1964; KOBYLAŃSKA, 1976). Known from many sites in almost the whole Europe. From Poland reported from the vicinity of Poznań, from Cracow-Wieluń Upland, from Nowy Targ Basin (STACH, 1964; KOBYLAŃSKA, 1976; WIŚNIEWSKI, 1967).

In the Pieniny Mts. I have collected several dozen of specimens from under the bark of fallen firs in *Carici-Fagetum abietetosum* on Facimiech-Klejowa Peaks and in *Fagetum carpaticum typicum* in Pieniński Stream Valley.

* *Xenylla maritima* TULLBERG, 1869. Probably, a cosmopolitan species. In Poland widely distributed (STACH, 1964; KOBYLAŃSKA, 1976; SZEP-
TYCKI, 1967; WIŚNIEWSKI, 1967). Occurs in various dry habitats: in forest litter, mosses, lichens, under stones, in the nests of small mammals.

In the Pieniny Mts. I have found two specimens: one under the piece of rock from a shadow face of Igła Jag, another in a soil sample containing dry lichens from rocks in *Carici-Fagetum cephalantheretosum* on Trzy Korony Peak.

* *Xenylla schillei* BÖRNER, 1903. Distributed in South-Western Europe, reported also from southern Tuva (STEBAEVA, 1963, 1976). In Poland, found in West Beskidy Range, Nowy Targ Basin, Tatra Mts. (STACH, 1964) and Kampinos Forest (KACZMAREK, 1973). Occurs in moist habitats, in conifer litter, mosses, and also in small mammals' nests.

In the soil samples: numerous in *Dendranthemo-Seslerietum* (Trzy Korony Peak — Ganek), and not numerous in an association with *Salvia verticillata* at the foot of Goła Peak. Furthermore, on junipers growing in *Festucetum pallentis potentilletosum* (Pulsztyn Crag).

* *Willemia anophthalma* BÖRNER, 1901. Widely distributed species. In Poland reported from many localities (STACH, 1964; KACZMAREK, 1973; KOBYLAŃSKA, 1976; SZEP-
TYCKI, 1967; WIŚNIEWSKI, 1967). Occurs in conifer litter, mosses, under detached tree bark, in rodents' nests and in anthills.

Very numerously occurred in a sample taken 4 m down from the entrance of

Ociemny Cave, quite numerous in samples from the association *Pinus silvestris*-*Carex alba* on the slopes of Macelowa Peak, not numerous in *Phyllitido-Aceretum* (Trzy Korony Peak). Singly in *Dendranthemo-Seslerietum* and *Origano-Brachypodietum laserpitietosum* on Trzy Korony Peak.

**Willemia aspinata* STACH, 1949. Species widely distributed in Europe. In Poland recorded only in Nowy Targ Basin and Tatra Mts. (STACH, 1949a, 1959), in Kampinos Forest (KACZMAREK, 1963, 1973) and Ojców region (SZEPTYCKI, 1967). Occurs in conifer litter, humus and in rodents' nests.

I have found it only in the soil samples from *Fagetum carpaticum typicum* (Pieniński Stream Valley, near Łączana Meadow), from *Phyllitido-Aceretum* (Trzy Korony Peak), *Carici-Fagetum* (Rabsztyn Crag), *Carici-Fagetum abietetosum* (Facimiech-Klejowa Peaks) and in *Dendranthemo-Seslerietum* near a single beech-tree (Trzy Korony Peak), singly in all these samples.

Willemia intermedia MILLS, 1934. A holarctic or amphi-atlantic species. In Europe known from a few localities (DALLAI, 1973; DUNGER, 1968a, 1971a; GAMA, 1964; HÜTHER, 1962; PETERSEN, 1965; WIŚNIEWSKI, 1967). Reported from North America (BELLINGER, 1954; MILLS, 1934; SNIDER, 1967; WRAY & all., 1963; WRAY & KNOWLTON, 1956b), and also from South America (HÜTHER, 1962).

I have found only two specimens: one in the soil sample from *Pinus silvestris*-*Calamagrostis varia* on Czerwone Crags, another — from the soil sample taken 4 m deep from the entrance of the Ociemny Cave.

Brachystomella parvula (SCHÄFFER, 1896). Probably, a cosmopolitan species. In Poland found in Lower Silesia, Kampinos Forest, Cracow-Wieluń Upland, Nowy Targ Basin, Pieniny and Tatra Mts. (STACH, 1964; KACZMAREK, 1973; SZEPTYCKI, 1967; WEINER, 1976), and also on Wolin Is. (SZEPTYCKI, unpubl.). Occurs in the soil moist of and wet meadows, encountered also in rodents' nests.

In the soil samples: in *Anthylli-Trifolietum* (Wyrobek Meadow, Szopka Pass) — quite numerous; not numerous in *Festucetum pallentis* under Hukowa Crag above the Dunajec River (within the zone of floodings). Moreover, a dozen of specimens in staled hay in Harczygrund and Mała Valleys.

**Microgastrura duodecimoculata* STACH, 1922. South-European species (Fig. 13). Reported from Albania — Scutari Lake vicinity (STACH, 1922), Dinara Mts. (CVIJOVIĆ & ŽIVADINOVIĆ, 1970), Trans-Danubian Highland, Northern Highland, and Mecsek Hills (DUNGER, 1975; LOKSA, 1966), Sudeten (DUNGER, 1977), Eastern Alps (GISIN, 1952, 1957a, TÖRNE, 1958), Apuane Alps, Abruzzese, Lipari Is. (DALLAI, 1970, 1971, 1973), Provence Alps (ROUGON & ROUGON, 1970), from Montaigne Noire (CASSAGNAU, 1965), Catalonia (SELGA, 1971) central Portugal (GAMA, 1961, 1954) and Atlas Mts. (LAWRENCE, 1963). In Poland previously found in Ojców region only (SZEPTYCKI, 1967). Occurs in the litter of warm and lucid forests and brushlands.

In the Pieniny Mts. in the soil samples, singly or not numerous in *Dendranthemo Seslerietum* (Trzy Korony Peak, Sobczański Gully), in *Festucetum pallentis* *potentilletosum* (Gorczyński Gully), in association with *Salvia verticillata* (foothills of Goła Peak) and in *Carici-Fagetum* (Czubata Crag).

Friesea albida STACH, 1949. Reported from the mountains of Southern and Central Europe. In Poland found in Tatra Mts. (STACH, 1949a, 1959), in the Pieniny Mts. (WEINER, 1976) and Bieszczady Mts. (SZEPTYCKI, unpubl.). Occurs under detached tree bark, in forest litter, in mosses and lichens, and in small mammals' nests.

In the Pieniny Mts. quite numerous in *Carici-Fagetum cephalantheretosum* (between Czerteż and Czertezik Peaks), singly in *Tilio-Carpinetum* (at the foot of Piecki Cliff) and in *Origano-Brachypodietum laserpitietosum* (Sobczański Gully).

***Friesea afurcata* DENIS, 1926. Reported from Southern and Central Europe and from Lebanon. Occurs on seashores, riverbanks and other coasts, and in swampy sites.

In the Pieniny Mts. in *Myricarietalia* (Dunajec riverside in Czorsztyn) — numerous.

Friesea claviseta AXELSON, 1900. Probably, a holarctic species. In Poland widely distributed (STACH, 1964; SZEPTYCKI, 1967; WEINER, 1976; WIŚNIEWSKI, 1967). Corticophilous, encountered also in the soil samples from forests and open habitats, as well as from rodents' nests and anthills.

In the soil samples from *Fagetum carpaticum typicum* (Pieniński Stream Valley), *Fagetum carpaticum oxalidetosum* (Facimiech Peak) *Carici-Fagetum* (Długa Grapa Crags), and in *Fagetum carpaticum typicum* (Ociemny Stream Valley) — singly or numerous. Furthermore, collected from under the bark of a fir in *Carici-Fagetum abietetosum* (Facimiech-Klejowa Peaks).

Friesea mirabilis (TULLBERG, 1871). Probably, a holarctic species. In Poland reported from many sites (STACH, 1964; KACZMAREK, 1963, 1973; SZEPTYCKI, 1964, 1967; WEINER, 1976; WIŚNIEWSKI, 1967). Species occurring in soil, also encountered under detached bark of rotten stumps, in rodents' nests and in anthills.

In *Fagetum carpaticum typicum* in Ociemny Stream Valley (WEINER, 1976), moreover in *Fagetum carpaticum typicum* (Pieniński Stream Valley, Ostry Peak), in *Phyllitido-Aceretum* (Trzy Korony Peak, a couloir between Niżni Łazek Glade and Dunajec River), and in *Carici-Fagetum* (Długa Grapa Crags) — singly. Quite numerous in oligotrophic *Fagetum carpaticum* on Nowa Peak. One specimen from staled hay (Harczygrund Valley).

Friesea truncata CASSAGNAU, 1958. Species reported from south-eastern France (CASSAGNAU, 1958), Ischia Is., Apuane Alps, Abruzzese (DALLAI, 1968; 1970, 1971), Skokholm Is. at the Coast of Wales (GOUGH, 1971) and from the Pieniny Mts. (WEINER, 1976). Moreover, reported as *Friesea mirabilis* var. *reducta* from Madeira (GAMA, 1959), from Faroër Is. (GISIN, 1961b), from Westmorland in the Great Britain (HALE, 1966), from the vicinity of Innsbruck (TÖRNE, 1958), from Vyhorlat Mts. (RUSEK, 1963b), Lower Tatra Mts. (NOSEK, 1969) and from south-eastern Altai and Siberia (STEBAEVA, 1973, 1976). No previous records from Poland; neither *truncata* nor *mirabilis* var. *reducta* have been reported in faunistic papers. Encountered in the forest litter and also in the soil of other habitats.

In the soil samples of *Fagetum carpaticum typicum*, *Carici-Fagetum cephalantheretosum*, *Alnetum incanae*, *Anthylli-Trifolietum* — not numerous, from *Tilio-Carpinetum* — quite numerous, from *Myricarietalia* and from *Pinus silvestris-Calamagrostis varia* association — singly. In *Dendranthemo-Seslerietum* not numerous to very numerous, depending on sample. Moreover, very numerous in *Valeriano-Caricetum flavae* (WEINER, 1976).

Odontella empodialis STACH, 1934 (Fig. 2 b-c). Species reported from South and Central Europe. Previous record of this species from the Pieniny Mts. (WEINER, 1976) should apply to *nana* (see below). Corticophilous species, occurring also in the forest litter.

In the Pieniny Mts. I have found 11 specimens in *Alnetum incanae* (Pieniński Stream Valley).

*****Odontella nana* CASSAGNAU, 1954 (*Odontella empodialis*: WEINER, 1976),** (Fig. 2 f-i). So far this species was reported from only three localities: Central Pyrenees (CASSAGNAU, 1954a), Montagne Noire (CASSAGNAU, 1965), and a separate subspecies from Central Crete Is. (ELLIS, 1976). Collected from mosses or soil.

In the Pieniny Mts. I have found a dozen of specimens in the soil samples of *Pinus silvestris-Carex alba* association (Macelowa Peak); numerous in *Dendranthemo-Seslerietum* (Trzy Korony Peak); singly in *Fagetum carpaticum typicum*, in mosses and liverworts growing on stones (Pieniński Stream Valley).

*****Odontella scabra* STACH, 1946 (Fig. 3).** Previously reported from Styria (STACH, 1946) and from Montagne Noire (CASSAGNAU, 1965), where it was found in very moist situations (forests on swamps, swamps), in the litter and humus.

In the Pieniny Mts. I have found two specimens in the soil samples from oligotrophic *Fagetum carpaticum typicum* (Nowa Peak) and from *Phyllitido-Aceretum* (Facimiech Peak).

****Xenyllodes armatus* AXELSON, 1903.** Probably, a holarectic species. In Europe mainly in mountains. From Poland known from the Tatra Mts. (STACH, 1964), Wolin Is. (SZEPTYCKI, 1964) and from Ojców region (SZEPTYCKI, 1967). Occurs in the forest litter, in humus, mosses, under stones and detached tree bark.

In the Pieniny Mts. it has occurred numerously in only one sample from *Fagetum carpaticum typicum* in Pieniński Stream Valley.

*****Xenyllodes caeca* (GISIN, 1952), (Fig. 4).** So far, reported only from Eastern Alps (GISIN, 1952) and Apuane Alps (DALLAI, 1970). Collected from thermophilous pine forests (*Pino-Caricetum humilis*).

In the Pieniny Mts. I have collected three specimens in *Dendranthemo-Seslerietum* in Trzy Korony massif.

Under the phase contrast microscope in two specimens the eyes were of 1+1 pattern, while in the third one it was 1+0.

Pseudachorutella assigillata (BÖRNER, 1901). Species distributed in Europe. In Poland reported from West Beskidy Range, Tatra Mts. (STACH, 1964), Ojców region (Szeptycki, 1967), Poznań region (KOBYLAŃSKA, 1976) and Pieniny Mts. (WEINER, 1976). Occurs under detached tree bark and in forest litter.

In the Pieniny Mts., besides the previously reported locality (WEINER, 1976),

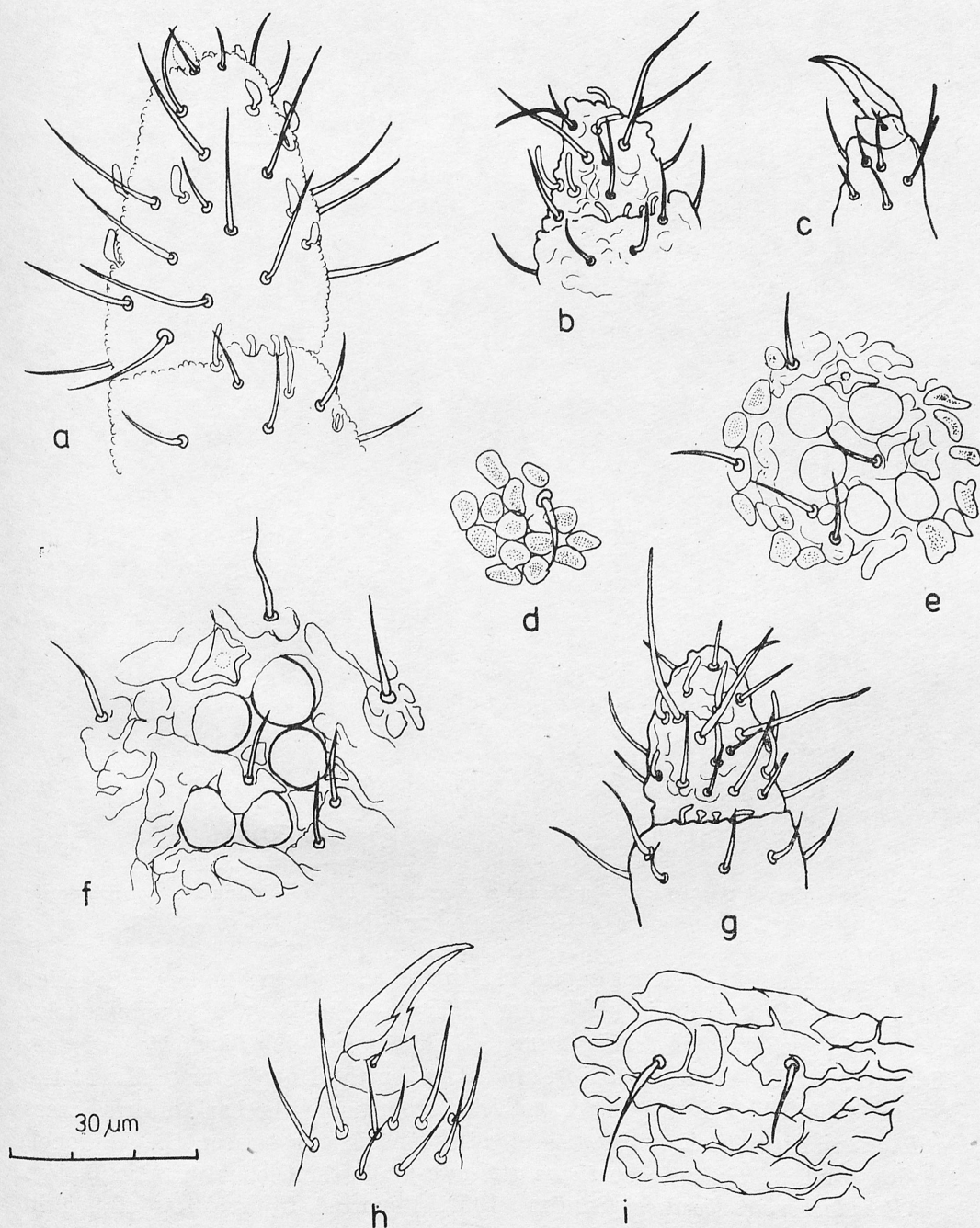


Fig. 2. *Hypogastrura crassaegranulata* ssp. *dobsinensis* STACH (a); *Odontella empodialis* STACH (b-e); *Odontella nana* CASSAGNAU (f-i); a, b, g — antennal segments III, IV; c, h — distal part of the 3rd leg; d, i — granulation of urotergite IV; e, f — postantennal organ and eyes

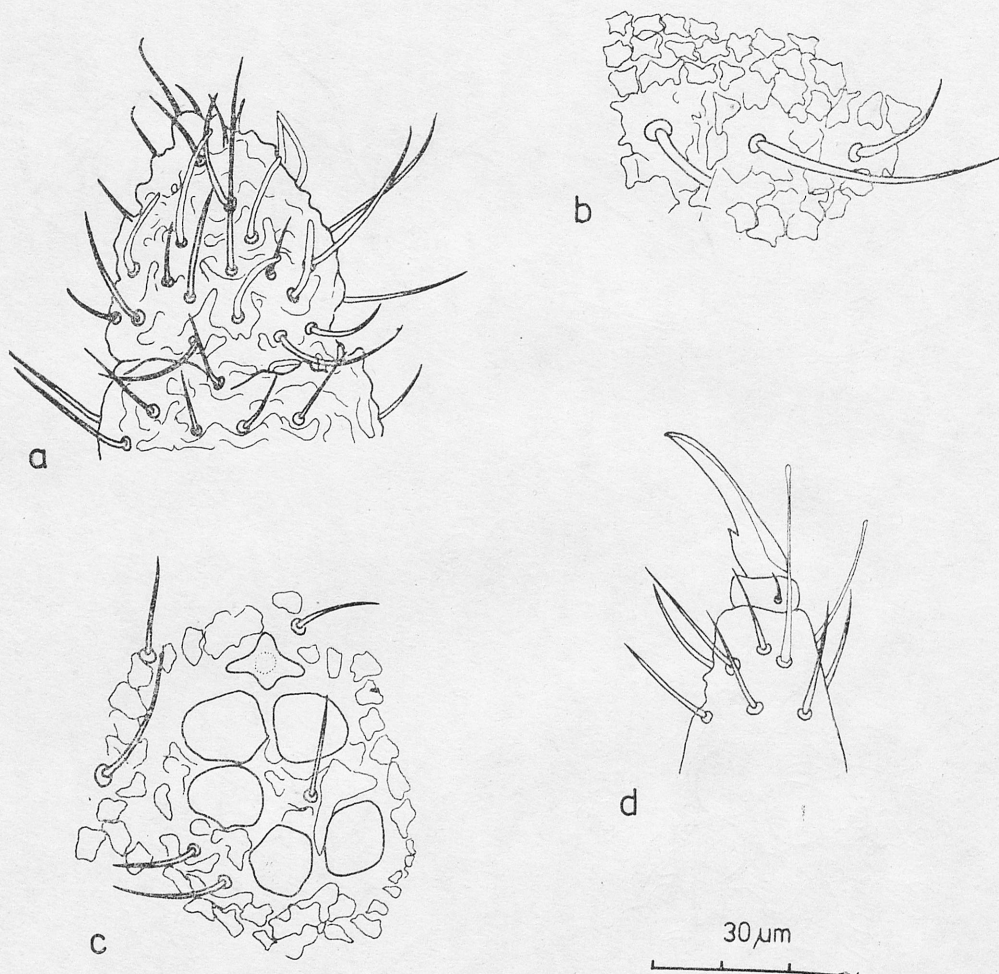


Fig. 3. *Odontella scabra* STACH: a — antennal segments III, IV, b — granulation of urotergite IV, c — postantennal organ and eyes, d — distal part of the 3rd leg

it has occurred in the soil samples of *Fagetum carpaticum typicum* (Sokolica Peak, Ostry Peak, Pieniński Stream Valley) — singly or not numerous; in *Carici-Fagetum cephalantheretosum* (Białe Crags), in *Phyllitido-Aceretum* (Trzy Korony Peak) and in *Tilio-Carpinetum* (on the Dunajec riverside, at the foot of Piecki Cliff). Furthermore, collected from under the bark of dried trees in *Fagetum carpaticum typicum* — oligotrophic variant — near the Wyrobek Meadow, and in *Fagetum carpaticum oxalidetosum* in the Głęboki Stream Valley.

**Pseudachorutes boernerii* SCHÖTT, 1902. Reported from a few stands in Europe and North America. In Poland recorded only in Nowy Targ Basin (STACH, 1964). Occurs under detached tree bark, between rotten leaves and under moist pieces of wood.

I have found only one specimen, outside of the main study area: in the city park of Szczawnica, in mosses growing on a sycamore.

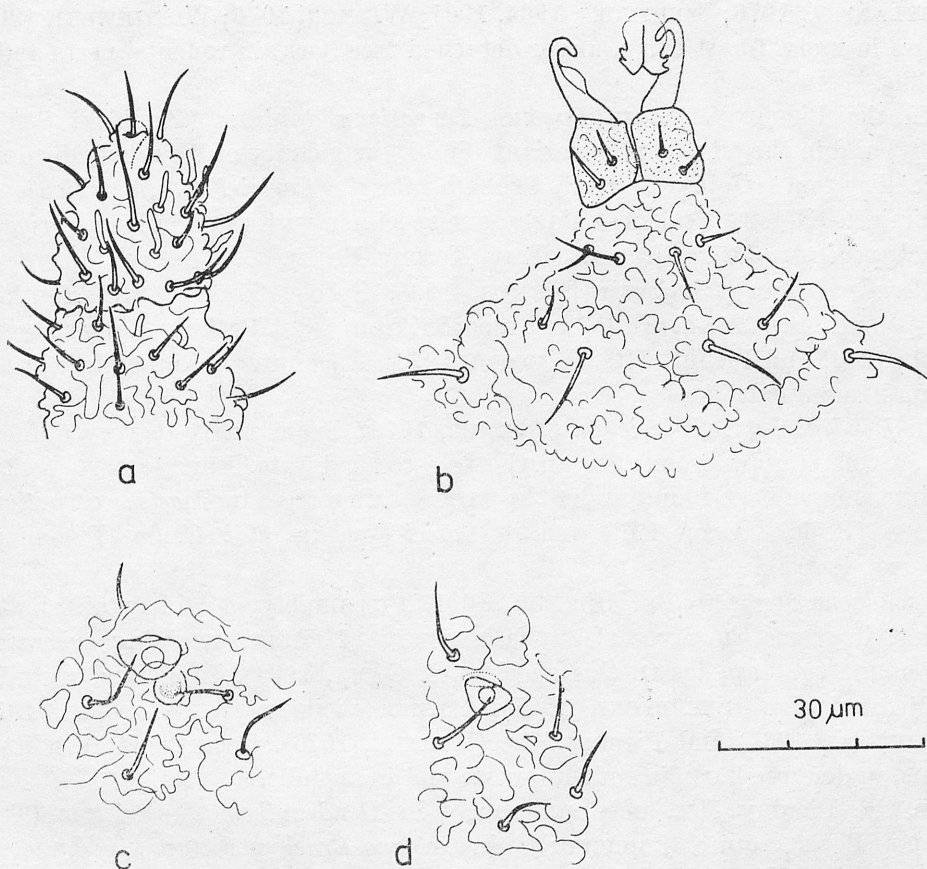


Fig. 4. *Xenyllodes caeca* (GISIN): a — antennal segments III, IV, b — furca and retinaculum, c — postantennal organ and eye, d — postantennal organ of partly eyeless specimen

Pseudachorutes corticicolus (SCHÄFFER, 1896). Species reported from Europe. SNIDER (1967) reported it also from North America. In Poland known from Cracow-Wieluń Upland, West Beskidy Range, Poznań region, Pieniny and Tatra Mts. (STACH, 1964; SZEPTYCKI, 1967; WEINER, 1976; WIŚNIEWSKI, 1967). Occurs under the tree bark, in humus, in rodents' nests and anthills.

Besides the previously reported locality (WEINER, 1976) I have found this species in soil samples, where it has occurred singly: in *Fagetum carpaticum typicum* (Pieniński Stream Valley), *Fagetum carpaticum oxalidetosum* (Facimiech Peak), *Carici-Fagetum cephalantheretosum* (Trzy Korony Peak), *Tilio-Carpinetum* (on the Dunajec riverside, at the foot of Piecki Cliff), in the association *Pinus silvestris-Carex alba* (Macelowa Peak), and under the bark of a dead spruce.

Pseudachorutes dubius KRAUSBAUER, 1898. Reported from almost the entire Europe, also from southern Ural (BUJNOVA & all., 1963), from south-eastern Altai (STEBAEVA, 1973, 1976) and from Siberia (STEBAEVA, 1976). In Poland known from many sites (STACH, 1964; KACZMAREK, 1963, 1973;

KOBYLAŃSKA, 1976; SZEPTYCKI, 1964, 1967; WEINER, 1976; WIŚNIEWSKI, 1967). Occurs in moist forest litter, under detached tree bark, in rodents' nests and in anthills.

In the Pieniny Mts.: in *Fagetum carpaticum typicum* (Pieniński Stream Valley) and in the oligotrophic variant (Flaki, the vicinity of Wyrobek Meadow), *Carici-Fagetum* (Gojny Forest, Czubata Crag), *Carici-Fagetum abietetosum* (Facimiech-Klejowa Peaks) — singly; one specimen with setae bulbs in *Origano-Brachypodietum laserpitietosum* (Trzy Korony Peak).

Pseudachorutes palmiensis BÖRNER, 1903. Species known from Southern Europe and Carpathians. In Poland reported from West Beskidy Range (STACH, 1949b, 1964) and Pieniny Mts. (WEINER, 1976). Encountered in forest litter and in small mammals' nests.

In *Dendranthemo-Seslerietum* (WEINER, 1976). From singly to very numerous in soil samples from near all the forested habitats. Furthermore, several specimens have been found under the bark of fallen trees in *Fagetum carpaticum typicum* (Bajków Groń Hill) and in *Carici-Fagetum abietetosum* (Facimiech-Klejowa Peaks).

Pseudachorutes parvulus BÖRNER, 1901. Presumably, a widely distributed species, it seems, however that the majority of data concerning *subcrassus* TULLBERG, 1871 applies to this species (cf. GAMA, 1964). In Poland recorded in Ojców region (SZEPTYCKI, 1967), Poznań vicinity (KOBYLAŃSKA, 1976; WIŚNIEWSKI, 1967) and Pieniny Mts. (WEINER, 1976). Occurs in forest litter, humus, under tree bark, in rodents' nests and in anthills.

In the Pieniny Mts. not numerous in *Dendranthemo-Seslerietum* (Trzy Korony Peak), quite numerous in *Origano-Brachypodietum stachyetosum* (Gorczyński Gully) and singly in *Carici-Fagetum* (Czubata Crag, Białe Crag).

**Anurida granulata* AGRELL, 1943. Probably, a Boreal-alpine species, reported also from Southern Tuva (STEBAEVA, 1963, 1976, s. cf. *granulata*). In Poland known from Kampinos Forest, Upper Silesia, Cracow-Wieluń Upland, West Beskidy Range, and Tatra Mts. (STACH, 1964; KACZMAREK, 1973; SZEPTYCKI, 1967). Occurs in forest litter, mosses, rotten wood and rodents' nests.

In the Pieniny Mts. I have found four specimens in oligotrophic *Fagetum carpaticum typicum* (Nowa Peak), *Carici-Fagetum cephalantheretosum* (Białe Crag) and in *Phyllitido-Aceretum* (Trzy Korony Peak). In the samples from *Dendranthemo-Seslerietum* (Trzy Korony Peak), *Carici-Fagetum abietetosum* (Facimiech-Klejowa Peaks) and from the cave in Ociemny specimens without eyes have been found (singly or not numerously). Presumably they are identical to the form mentioned (but not described) by NOSEK (1969) as *Anurida granulata* var. *coeca*.

Micranurida forsslundi GISIN, 1949 (*Micranurida anophthalmica*: STACH, 1949b, 1964; KACZMAREK, 1963, 1973; WEINER, 1976). Probably, an Euro-Siberian species. In Poland reported from Tatra Mts. (STACH, 1964), Kampinos Forest (KACZMAREK, 1963; 1973), and from Pieniny Mts. (WEINER, 1976). Occurs under tree bark and in humus.

One specimen from *Fagetum carpaticum typicum*, in Huliński Stream Valley (WEINER, 1976), two more from *Phyllitido-Aceretum* in a gully between the Niżni Łazek Glade and Dunajec River.

Micranurida pygmaea BÖRNER, 1901. Probably, a holarctic species. In Poland known from many stands (STACH, 1964; KACZMAREK, 1963, 1973; KOBYLAŃSKA, 1976; ŁOSIŃSKI, 1972; SZEPTYCKI, 1964, 1967; WEINER, 1976; WIŚNIEWSKI, 1967). Occurs in conifer litter, in the soil of meadows and forests, under tree bark and in anthills.

Singly in the soil samples: in *Fagetum carpaticum typicum* (Pieniński Stream Valley), oligotrophic *Fagetum carpaticum* (Nowa Peak, Flaki Ridge), *Carici-Fagetum abietetosum* (Facimiech-Klejowa Peaks), *Dendranthemo-Seslerietum* (Trzy Korony Peak), *Myricarietalia* (Dunajec riverside in Czorsztyn), *Valeriano-Caricetum flavae* (Krościenko) and in the cave of Ociemny.

Morulina verrucosa (BÖRNER, 1903). A Carpathian endemite. In Poland reported from West Beskidy Mts., Nowy Targ Basin, Pieniny and Tatra Mts. (STACH, 1964). Moreover, recorded in Bieszczady Mts., Low Beskidy Mts. and southern part of Dynów Uplands (SZEPTYCKI, WEINER — unpubl.). Occurs in rock crevices, under stones, under pieces of rotten wood, under tree bark and in forest litter.

Singly in the samples from *Fagetum carpaticum typicum* (Pieniński Stream Valley), *Tilio-Carpinetum* (Dunajec River bank at the foot of Piecki Cliff); quite numerous in *Valeriano-Caricetum flavae* (Krościenko). Also, in *Fagetum carpaticum oxalidetosum* (Ociemny Peak — Białe Crags), in *Carici-Fagetum* (Głęboki Stream Valley) and in the association with *Salvia verticillata* (Podłazce).

Thaumanura carolii (STACH, 1920). Distributed (Fig. 13, 14) in the Alps, Carpathians, Sudeten, Cracow-Wieluń Upland, Roztocze Plateau and in Balkan Mts. (CVIJOVIĆ & ŽIVADINOVIĆ, 1970; DALLAI, 1969b: fig. 3; DUNGER, 1970a, 1970b, 1972b, 1977; GRUIA, 1969; GRUIA & ZAMFIRESCO, 1973; MARTYNOVA, 1971b; NOSEK & VYSOCKAYA, 1973; ŽIVADINOVIĆ, 1973a; ŽIVADINOVIĆ, & RITTER-STUDNIČKA, 1970). The only one stand apart from the main in area of distribution, placed between Pregoła and Ława Rivers (HANDSCHIN, 1928), is uncertain. In Poland reported from West Beskidy Mts., Pieniny Mts. and Tatra Mts. (STACH, 1964), from Ojców region, Sudeten and Roztocze Plateau (SZEPTYCKI, 1967). Occurs particularly often under the detached tree bark and also on rotten wood, in mosses, under stones and in small mammals' nests.

In the Pieniny Mts. I found the specimens of this species under the detached, rotten bark of fallen firs in *Carici-Fagetum cephalantheretosum* (Trzy Korony Peak, Białe Crags), in *Carici-Fagetum* (Głęboki Stream Valley, Harczygrund Valley), in *Fagetum carpaticum typicum* (Przechodki Cape, Głęboki Stream Valley) and in *Fagetum carpaticum oxalidetosum* (Gródek). Furthermore, singly in the soil samples from these localities.

** *Neanura minuta* GISIN, 1963. The species has been known so far only from Bosnia and Herzegovina (BOGOJEVIĆ, 1968; GISIN, 1963a; ŽIVADINOVIĆ

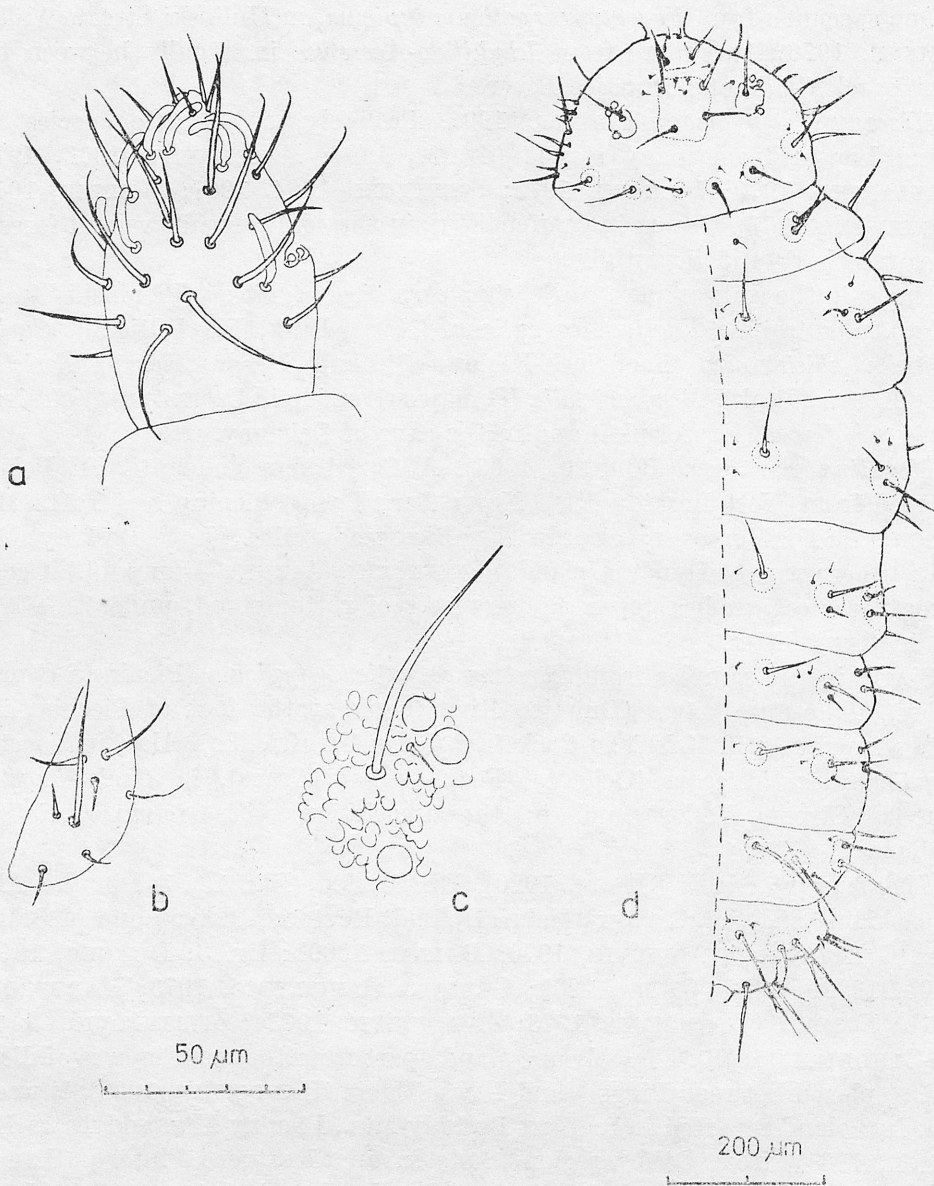


Fig. 5. *Neanura minuta* GISIN: a — antennal segment IV, b — labium, c — eyes, d — dorsal chaetotaxy

& CVIJOVIĆ, 1967; ŽIVADINOVIĆ & RITER-STUDNIČKA, 1970), where it occurs in pinewoods, thermophilous grasslands and oak-hornbeam forests (associations: *Sesleria serbica* and *Pinus silvestris nigrae*, *Seslerium rigidae*, and *Quercus-Carpinetum*).

In the Pieniny Mts. I have found 20 specimens from *Fagetum carpaticum typicum* (Ociemny Stream Valley, Głęboki Stream Valley and Flaki Ridge),

Carici-Fagetum cephalantheretosum (Białe Crags) and in *Carici-Fagetum abietetosum* (Facimiech-Klejowa Peaks). The specimens from the Pieniny Mts. differ from the description (GISIN, 1963a: fig. 3 and 4) only by minor details in chaetotaxy (Fig. 5).

Neanura muscorum (TEMPLETON, 1835). Probably, a holarctic species. In Poland reported from many stands (STACH, 1964; KACZMAREK, 1963, 1973; SZEP-
TYCKI, 1964, 1967; WIŚNIEWSKI, 1967). Occurs under the detached tree bark, in conifer and leaf litter, on rotten wood and in rodents' nests.

Singly in the soil samples from *Fagetum carpaticum typicum* (Pieniński Stream Valley), from oligotrophic *Fagetum carpaticum* (Nowa Peak) and from *Festucetum pallentis potentilletosum* (Zameczysko Crag). Furthermore, I have collected the specimens of this species in mosses taken from a swamp at the foot of Rabsztyn Crag and from a fallen tree in *Carici-Fagetum abietetosum* (Facimiech-Klejowa Peaks).

Neanura parva (STACH, 1951). Species known from Carpathians and South-eastern Alps. Reported also from southern Tuva (STEBAEVA, 1963, 1976) and southern Ural (BUJNOVA & all., 1963; STEBAEVA, 1976). In Poland known so far from Cracow-Wieluń Upland, Nowy Targ Basin, Pieniny Mts. and Tatra Mts. (STACH, 1964; SZEPTYCKI, 1967; WEINER, 1976). Occurs in forest litter, mosses, rotten stumps, under detached tree bark and in rodents' nests.

In *Fagetum carpaticum typicum* in Ociemny Stream Valley (WEINER, 1976) and in *Carici-Fagetum* (Głęboki Stream Valley, Harczygrund Valley) and on the border of *Valeriano-Caricetum flavae* and *Fagetum carpaticum typicum* (Krościenko). Furthermore, one specimen on a tree in *Fagetum carpaticum typicum* (Ociemny Peak, Białe Crags).

** *Neanura pseudoparva* RUSEK, 1963. So far, known only from Silesian-Moravian Beskidy Range (RUSEK, 1963a) and Vyhorlat Mts. (RUSEK, 1963b), where it was found in the litter of a beech-spruce forest.

In the Pieniny Mts. singly in oligotrophic *Fagetum carpaticum* (Nowa Peak, Harczygrund Valley), *Fagetum carpaticum oxalidetosum* (Czoło), *Carici-Fagetum abietetosum* (Facimiech-Klejowa Peaks), *Dendranthemo-Seslerietum* (Białe Crags), in *Pinus silvestris-Carex alba* association (Macelowa Peak), in *Valeriano-Caricetum flavae* (Krościenko). Furthermore, not numerous in lichens from a trunk in *Fagetum carpaticum typicum* bordering with *Alnetum incanae* at Przechodki Cape.

Lathriopyga conjuncta (STACH, 1926). Species known from the mountains of central and southern Europe. In Poland reported from Upper Silesia, Cracow-Wieluń Upland, Nowy Targ Basin, Pieniny and Tatra Mts. (STACH, 1964; SZEPTYCKI, 1967; WEINER, 1976). Occurs in rotten trees, under detached bark of stumps, in forest litter, in humus, under stones and in rodents' nests.

In *Fagetum carpaticum typicum* in Pieniński Stream Valley, in the association with *Laserpitium latifolium* (WEINER, 1976) and in *Carici-Fagetum cephalantheretosum* (Trzy Korony Peak, Białe Crags), *Carici-Fagetum* (Harczygrund Valley), *Fagetum carpaticum typicum* (Pieniński Stream Valley), moreover

from under the detached bark of fallen trees in the same stands and in *Anthylli-Trifolietum* (Szopka Pass).

Lathriopyga phlegrea (CAROLI, 1912)¹. South-European species, the northernmost localities are these in Ojców region (SZEPTYCKI, 1967) and in the Palatinate (HÜTHER, 1969). In Poland reported, among others, from the Pieniny Mts. (WEINER, 1976). The records of STACH (1964) are difficult to assess because they refer partly to *L. stachi* (GISIN, 1952). Occurs under the rotten bark, in forest litter, under the stones and in moss.

In thermophilous firwood on Facimiech-Klejowa Peaks and on the Pieniny meadow of Wyrobek (WEINER, 1976). Furthermore, singly in the soil samples and under detached tree bark in *Fagetum carpaticum typicum* (Pieniński Stream Valley, the slope under the Szopka Pass), *Fagetum carpaticum oxalidetosum* (Ociemny Peak, Białe Crags) and in the cave of Ociemny.

Lathriopyga plena STACH, 1951² (*Lathriopyga phlegrea* var. *plena* STACH, 1951, *Lathriopyga stachi* var. *plena*: STACH, 1964). Known from several stands in Central and Southern Europe (GAMA, 1964; BONET & all., 1976; SELGA, 1971; STOMP, 1974). In Poland reported from Pieniny and Tatra Mts. (STACH, 1951, 1964). Occurs under detached tree bark, in forest litter and under stones.

In the Pieniny Mts. three specimens have been found: in *Fagetum carpaticum typicum* (Pieniński Stream Valley), in *Carici-Fagetum abietetosum* (Facimiech-Klejowa Peaks) and in *Carici-Fagetum cephalantheretosum* (Trzy Korony Peak).

Neanurella szeptyckii WEINER, 1973. Known so far only from the Pieniny Mts. (WEINER, 1973, 1977b). A dozen more specimens of this species I have found in *Fagetum carpaticum typicum* (Pieniński Stream Valley) and in oligotrophic *Fagetum carpaticum typicum* on a stump (slopes under the Szopka Pass).

Tetrodontophora bielensis (WAGA, 1842). Circumpannonian species, often transported with larger rivers into the lowlands. In Poland known from many stands in southern part of the country, and along the Vistula and Odra rivers it reaches far up to the North (STACH, 1964; SZEPTYCKI, 1967; WEINER, 1976). Mainly in forests.

In the Pieniny Mts. very common in forests, less often in other habitats. In the late summer and in autumn occurs in great masses, even in meadows and ripicolous habitats, and particularly often on wet trunks and stumps.

Onychiurus (Oligaphorura) absoloni (BÖRNER, 1901). The species widely distributed in Europe, possibly a holarctic one. In Poland known from many localities (STACH, 1964; KACZMAREK, 1963, 1973; KOBYLAŃSKA, 1976; ŁOSIŃSKI, 1972; SZEPTYCKI, 1964, 1967; WEINER, 1976; WIŚNIEWSKI, 1967). Occurs in rotten wood, under the pieces of bark, and within the Alpine zone — in mosses and lichens.

In the soil samples: *Fagetum carpaticum typicum* (Pieniński Stream Valley,

¹ According to the recent unpublished studies by DEHARVENG the specimens included to this and to the next species belong to one species, *L. albella* (STACH, 1920), (L. DEHARVENG, personal communication).

² See footnote 1.

Ostry Peak) — not numerous; oligotrophic *Fagetum carpaticum* (Nowa Peak, slope under the Szopka Pass, Flaki Ridge) — singly; *Phyllitido-Aceretum* (Trzy Korony Peak) — not numerous; *Carici-Fagetum* (Białe Crag, Harczygrund Valley) — singly. One specimen under the bark of a fir growing on a meadow.

Onychiurus (Oligaphorura) serratotuberculatus STACH, 1933. Species known from a few localities in the West and East Carpathians (STACH, 1954; NOSEK, 1964; WEINER, 1976, 1977b), Neissetal (vicinity of Neisse River), (DUNGER, 1972a), Sudeten (STACH, 1933, 1954; DUNGER, 1977), Moravian Karst (RUSEK, 1968, 1972), from the mountains of Bosnia and Montenegro (CVIJOVIĆ & ŽIVADINOVIĆ, 1970; GISIN, 1963a; ŽIVADINOVIĆ, 1973a; ŽIVADINOVIĆ & all. 1967; ŽIVADINOVIĆ & RITER-STUDNIČKA, 1970); Eastern Alps (KSENNEMAN, 1938) and Rhodopians (ZONEV & JELEVA, 1977a), (Fig. 15). In Poland reported from Czarny Dunajec, Bystrzyca Kłodzka (STACH, 1964) and from Pieniny Mts. (WEINER, 1976, 1977b).

In the Pieniny Mts. I have found one specimen on the Pieniny meadow (WEINER, 1976), and further three specimens in the soil sample from a stump in oligotrophic *Fagetum carpaticum* on the slope below the Szopka Pass.

Onychiurus (Kalaphorura) paradoxus (SCHÄFFER, 1900). So far, this species was known only from scarce stands in Alps (GISIN, 1964; NEUHERZ, 1975b) and Carpathians (DUNGER, 1975; GRUIA & ZAMFIRESCO, 1973; NOSEK & VYSOCKAYA, 1973; WEINER, 1976), but only recently it was correctly distinguished (GISIN, 1964). In Poland known from Pieniny Mts. (WEINER, 1976), however, it is possible, that the data of STACH (1964) concerning *burmeisteri* (LUBBOCK, 1873) also refer to this species. It seems appropriate to discuss here *O. carpenteri* STACH, 1920. The original description of this species is based upon one specimen only which is missing now. Relatively small body length, when compared with the other species of the subgenus *Kalaphorura* ABSOLON, 1901, chaetotaxy differing from the common pattern and the lack of data about the sex of this specimen (STACH, 1920, 1954) suggest, that the description was based on an immature individual. In my material I have found one very young specimen similar to *carpenteri*, without the medial setae on abdomen VI.

O. paradoxus occurs under the detached tree bark, in rotten wood, mosses and leaf litter. Encountered also in caves, on rubble and in the rodents' nests.

From singly to quite numerous in *Fagetum carpaticum typicum* (Pieniński Stream Valley, Ociemny Stream Valley), in the oligotrophic variant (Nowa Peak), *Carici-Fagetum cephalantheretosum* (Białe Crag, Trzy Korony Peak), in *Origano-Brachypodietum stachyetosum* (Gorczyński Gully), *Phyllitido-Aceretum* (between the Niżni Łazek Glade and Dunajec River), in *Pinus silvestris-Calamagrostis varia* association (Czerwone Crag), in the caves of Sobczyński Gully and of Ociemny.

Onychiurus (Protaphorura) armatus (TULLBERG, 1869). There is no consensus among collembologists in regard to this species (GISIN, 1952, 1956; BÖD-

VARSSON, 1959, 1970; HALE, 1964, 1968). Some authors consider it as a single, though highly variable species, others split it into several species.

Among the vast material from the Pieniny Mts. I have identified 5 of such forms. These are: *armatus* (TULLBERG, 1869) (sensu stricto); *latus* GISIN, 1956; *procampatus* GISIN, 1956; *fimatus* GISIN, 1952; and one form not described so far, similar to *armatus* sensu stricto. However, in the further discussion I use the term "*Onychiurus armatus* — group", because not all the morphological features applied by GISIN (1952, 1956) are taxonomically valid; this problem requires further studies.

Onychiurus (Protaphorura) januarii WEINER, 1977. Species known so far only from the Pieniny Mts. (WEINER, 1977a). Encountered only in the samples taken during winter or early spring.

In the Pieniny Mts. quite numerous in *Fagetum carpaticum typicum* (Ociemny Stream Valley), in oligotrophic *Fagetum carpaticum* (slope below the Szopka Pass, Wielkie Doliny Valley, Macelak Peak), not numerous or singly in *Anthylli-Trifolietum* (Wyrobek Meadow), *Carici-Fagetum cephalantheretosum* (Pieniński Stream Valley), on the border of *Carici-Fagetum cephalantheretosum* with *Dendranthemo-Seslerietum* (Trzy Korony Peak), in *Festucetum pallentis* (Kotłowy Stream Valley). Single specimens were collected from between fallen leaves in an oligotrophic *Fagetum carpaticum* near Wyrobek Meadow).

Onychiurus (Hymenaphorura) carpaticus STACH, 1934. East-Carpathian species, known from East Carpathians (STACH, 1954, 1964; NOSEK, 1958; RUSEK, 1963b), South Carpathians and Dobrogea (GRUIA, 1969, 1970). In Poland reported from the vicinity of Krynica (STACH, 1954, 1964) and Pieniny Mts. (WEINER, 1976, 1977b). Occurs in forest litter and on rotten wood.

From singly to numerous in *Fagetum carpaticum typicum* (Pieniński Stream Valley, Huliński Stream Valley), oligotrophic *Fagetum carpaticum* (Nowa Peak), *Phyllitido-Aceretum* (Pieniński Stream Valley), *Alnetum incanae* (Pieniński Stream Valley), *Carici-Fagetum abietetosum* (Facimiech-Klejowa Peaks), *Carici-Fagetum cephalantheretosum* (Trzy Korony Peak), *Origano-Brachypodietum laserpitietosum* (Sobczański Gully) and *Anthylli-Trifolietum* (Kosarzyska Meadow).

Onychiurus (Hymenaphorura) sibiricus (TULLBERG, 1876). Boreal-alpine species, reported from many stands in Europe and also in North America and Siberia. In Poland known from Cracow-Wieluń Upland, Małopolska Upland, East Sudeten, Nowy Targ Basin, Pieniny and Tatra Mts. (STACH, 1964; SZEP- TYCKI, 1967; WEINER, 1976). Occurs in connection with rotten wood. Encountered under the detached tree bark, in rotting stumps, forest litter, mosses and also in caves and rodents' nests.

From numerous to singly in *Fagetum carpaticum typicum*, *Fagetum carpaticum oxalidetosum*, in oligotrophic *Fagetum carpaticum*, *Phyllitido-Aceretum*, *Anthylli-Trifolietum*, *Carici-Fagetum cephalantheretosum* and in *Dendranthemo-Seslerietum*.

Onychiurus (Hymenaphorura) variotuberculatus STACH, 1934. South-Euro-

pean species, distributed from the Apuane Alps (DALLAI, 1970) to Caucasus (GRINSBERG, 1960). In Poland reported only from Pieniny Mts. (STACH, 1964; WEINER, 1976). Occurs in fresh forests and in caves.

In the association with *Laserpitium latifolium* (WEINER, 1976). From singly to numerous in *Fagetum carpaticum typicum*, in the oligotrophic variant, *Phyllitido-Aceretum*, *Carici-Fagetum cephalantheretosum* and *abietetosum*, *Origanum-Brachypodietum laserpitietosum*, in *Pinus silvestris-Carex alba* and *Pinus silvestris-Calamagrostis varia* associations.

* *Onychiurus (Paraonychiurus) granulatus* STACH, 1930. Known from Central Europe, from Central Poland on the North, to Yugoslavia and Bulgaria on the South. In Poland recorded in Upper Silesia, Małopolska Upland, Świętokrzyskie Mts., Cracow-Wieluń Upland, East Sudeten, and Tatra Mts. (STACH, 1964; SKALSKI & WÓJCIK, 1968; SZEPTYCKI, 1967). Occurs in rotten wood, under detached tree bark, in forest litter, in small mammals' nests and in caves.

In the Pieniny Mts. numerous in the soil samples from *Dendranthemo-Sclerietum* (Trzy Korony Peak), not numerous in *Fagetum carpaticum typicum*

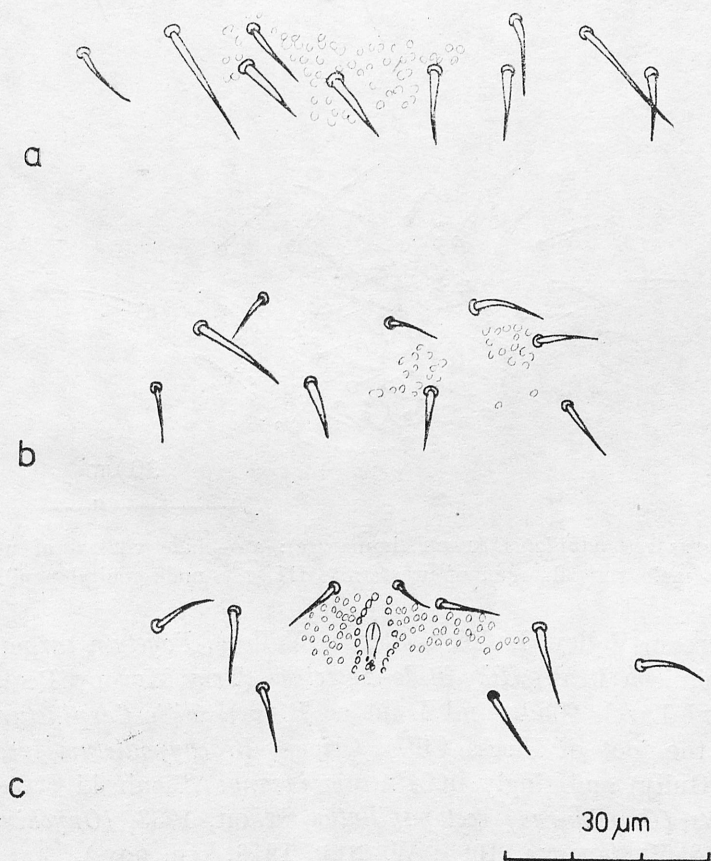


Fig. 6. *Onychiurus rectopapillatus* STACH (immature): a — male ventral organ urosternite II, b — male ventral organ of urosternite III, c — male genital papilla

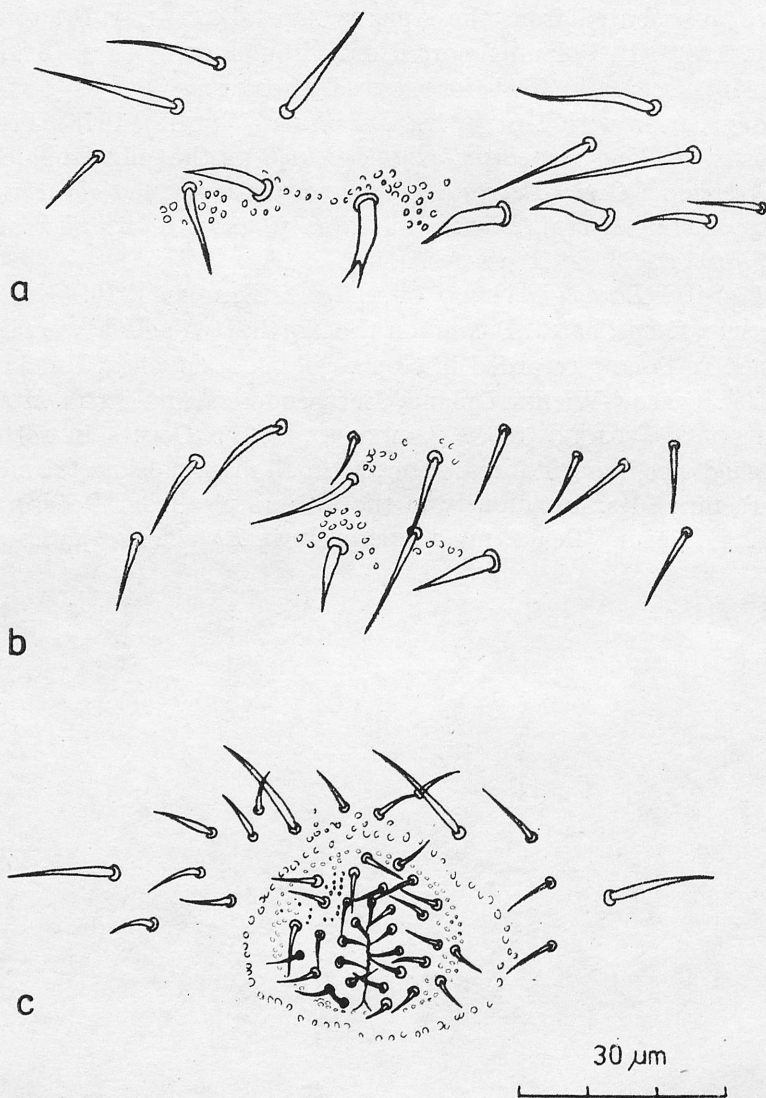


Fig. 7. *Onychiurus rectopapillatus* STACH (immature): a — male ventral of urosternite II, b — male ventral organ of urosternite III, c — male genital papilla

(Pieniński Stream Valley, Huliński Stream Valley), *Fagetum carpaticum oxalidetosum* (Facimiech Peak), *Phyllitido-Aceretum* (Trzy Korony Peak, a couloir between Nizni Łazek Glade and Dunajec River), *Tilio-Carpinetum* (Dunajec riverside at the foot of Piecki Cliff), *Origano-Brachypodietum laserpitietosum* (Sobczyński Gully) and singly in *Alnetum incanae* (Pieniński Stream Valley).

Onychiurus (*Onychiurus*) *rectopapillatus* STACH, 1933, (*Onychiurus pavlovskyi*: NOSEK & VYSOCKAYA, 1965; WEINER, 1976, syn. nov.).

O. pavlovskyi described from Transcarpathians by NOSEK & VYSOCKAYA (1965) differs from *rectopapillatus* only by the shape of setae on the male ven-

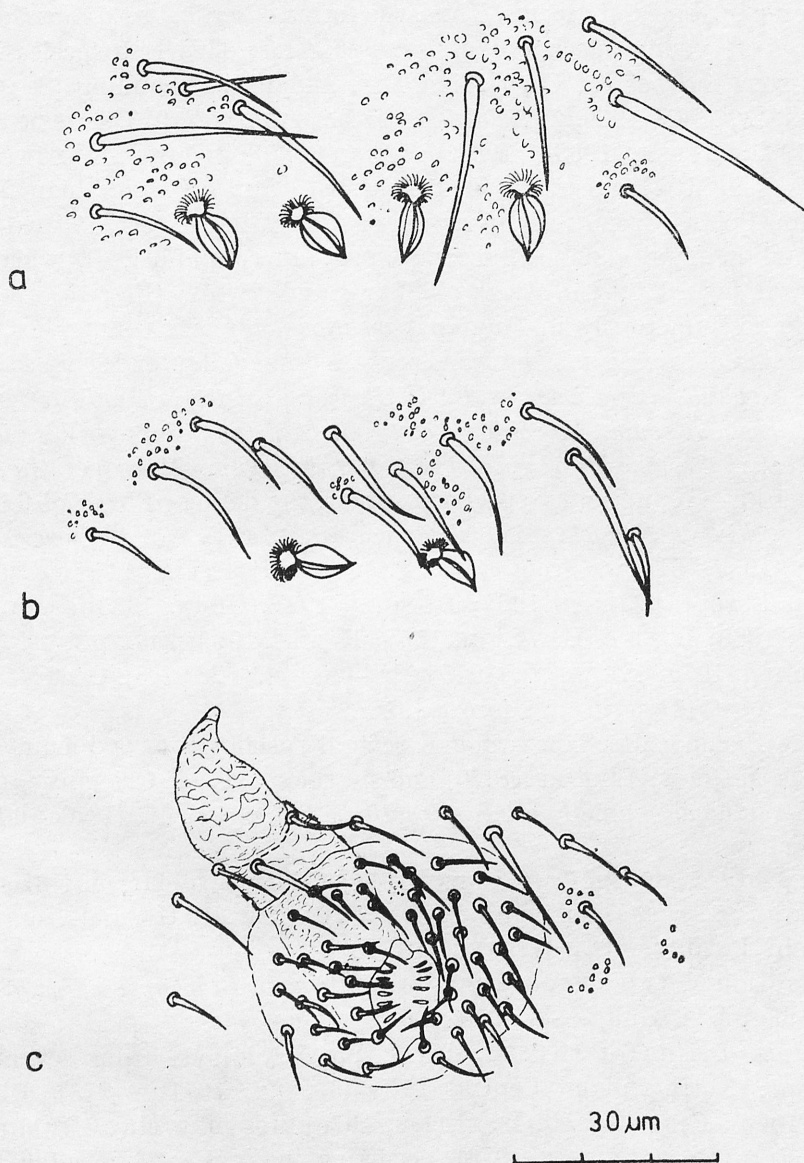


Fig. 8. *Onychiurus rectopapillatus* STACH (adult): a — male ventral organ of urosternite II, b — male ventral organ of urosternite III, c — male genital papilla with ductus ejaculatorius

tral organ. In my material the both forms occur often in one sample. All the males with the ventral organ, of "pavlovskiy" type (Fig. 6, 7) show incompletely developed genital papilla, while the ductus ejaculatorius is invisible. On the other hand, all males with the ventral organ of "rectopapillatus" type (Fig. 8) have well developed genital papilla and ductus ejaculatorius. There were also

found some intermediate forms. Thus, the forms described as *pavlovskyi* may be considered as young specimens of *rectopapillatus*. This last species is known mainly from the bow of Carpathian Mts. and its surrounding (STACH, 1954, 1964; GRUIA, 1965, 1969, 1970; GRUIA & ZAMFIRESCO, 1973; NOSEK & VYSOCKAYA, 1965; RUSEK, 1963b, 1964; WEINER 1976) and by DRĚNOWSKI (1937) from Vitosha Mts. (uncertain identification). Out of Carpathian Mts. it is known in Poland from Świętokrzyskie Mts. (STACH, 1934, 1954, 1964) and also found in Tyniec near Cracow (SZEPTYCKI, unpublished), where it was probably imported by the rivers of Skawa and Vistula (Fig. 15).

Singly to numerously in *Fagetum carpaticum typicum* (numerously — only in a sample containing mosses from rocks in the Valley of Pieniński Stream); *Fagetum carpaticum oxalidetosum*, *Carici-Fagetum abietetosum* and in *Carici-Fagetum cephalantheretosum*, *Phyllitido-Aceretum*, *Alnetum incanae*, *Valeriano-Caricetum flavae*, *Origano-Brachypodietum laserpitietosum*. Moreover, in the same habitats I have found many specimens under the detached bark of fallen trees.

** *Onychiurus (Onychiurus) silvarius* GISIN, 1952 (*Onychiurus variabilis*: WEINER, 1976). Known from a dozen of localities (Fig. 14) in Central and Southern Europe (DALLAI, 1967; DUNGER, 1975; GISIN, 1963b; GRUIA, 1969; HÜTHER, 1969; LOUB & HAYBACH, 1967; RUSEK, 1972; ŽIVADINOVIĆ & RITER-STUDNIČKA, 1970; NEUHERZ, 1975a, b — s. cf. *silvarius*). Occurs in moist habitats, most often in the forest litter.

In the Pieniny Mts. I have found several specimens on a Pieniny meadow (Wyrobek Meadow: WEINER, 1976) and in the cave of Ociemny and single specimens in oligotrophic *Fagetum carpaticum typicum* (Nowa Peak and Harczygrund Valley).

Mesaphorura hygrophila (RUSEK, 1971). Known so far only from rushes (*Glycerietum maximae*) in South Moravia (RUSEK, 1971b) and from *Alnetum incanae* in Pieniny Mts. (WEINER, 1976).

I have found two more specimens in *Origano-Brachypodietum laserpitietosum* (Sobczański Gully) — near the stream.

Mesaphorura italica (RUSEK, 1971). Species known from several stands in Europe: Northern and Central Italy (RUSEK, 1971b, 1973), Rhodos Is. (ELLIS, 1974), Central Crete Is. (ELLIS, 1976), Jeseniky Mts. (DUNGER, 1977) and Pieniny Mts. (WEINER, 1976), occurring in forest and meadow habitats.

In the association with *Laserpitium latifolium* below the Trzy Korony Peak, in the association with *Salvia verticillata* on Podłazce (WEINER, 1976), in *Fagetum carpaticum typicum* (Flaki Ridge, the edge of Łączana Meadow, near Wielkie Doliny Valley), and in *Anthylli-Trifolietum* (Wyrobek Meadow).

Mesaphorura krausbaueri BÖRNER, 1901. The species reported from almost the whole world and from numerous localities in Poland. However, until recently (RUSEK, 1971b) a number of different species was listed under the name *krausbaueri*. Therefore, previous data are no more valid. *M. krausbaueri* s. str. is known from a dozen of localities in Europe (DUNGER, 1975, 1977; ELLIS, 1976; KUBÍKOVÁ & RUSEK, 1976; NEUHERZ, 1975a; NOSEK, 1975; RUSEK, 1971). In Poland

it was found in the vicinity of Poznań (KOBYLAŃSKA, 1976) and in Pieniny Mts. (WEINER, 1976).

In *Alnetum incanae*, in the association with *Salvia verticillata*, in the association with *Laserpitium latifolium* (WEINER, 1976). From very numerous to singly in *Dendranthemo-Seslerietum* on Białe Crags, Grabczycha Crag, Ostra Crag, Sokolica Peak, in *Festucetum pallentis potentilletosum* (Rabsztyn, Pulsztyn, Gorczyński Gully), in *Anthylli-Trifolietum* (Ligarki Glade), *Carici-Fagetum* (Czubata Crag, Pieniński Stream Valley, Trzy Korony Peak) and *Phyllitido-Aceretum* (Trzy Korony Peak).

*****Mesaphorura macrochaeta* RUSEK, 1976 (*Mesaphorura krausbaueri*: WEINER, 1976 — partim).** Species known so far from only one stand (RUSEK, 1976a) — from a soil sample taken in the wood with *Pseudotsuga menziesii* in Canada (Vancouver Is.). According to the personal communication of RUSEK it does occur also in Europe.

The species has occurred on Pieniny meadow (Wyrobek Meadow), on xerophilous pasture (Podłazce) and in Carpathian alderwood (Czorsztyń). In further soil samples: not numerous in *Dendranthemo-Seslerietum* (Sobczański Gully), oligotrophic *Fagetum carpaticum* (Nowa Peak, the slope below the Szopka Pass), *Festucetum pallentis potentilletosum* (Macelowa Peak), and numerous in *Myricarietalia* (Dunajec riverside near Czorsztyń).

Mesaphorura sylvatica RUSEK, 1971. Species reported from Moravian Karst, Silesian-Moravian Beskidy Mts., Rila Mts., Prealpe Venete, Czech Karst (KUBÍKOVÁ & RUSEK, 1976; RUSEK, 1971b, 1973), Börzöny Mts., Jeseníky Mts. (DUNGER, 1975, 1977), Poznań vicinity (KOBYLAŃSKA, 1976), Pieniny Mts. (WEINER, 1976) and from Siberia (STEBAEVA, 1976). Occurs in soil in various habitats.

In *Dendranthemo-Seslerietum*, in some samples very numerous. In other unforested habitats — not numerous, and in forests singly or quite numerous.

Mesaphorura tenuisensillata RUSEK, 1974 (*Mesaphorura sensibilis*: WEINER, 1976). Species reported from a few localities: from thermophilous oakwoods and xerothermic grasslands in Czech Karst (KUBÍKOVÁ & RUSEK, 1976; RUSEK, 1974), from subalpine grasslands in Jeseníky Mts. (DUNGER, 1977) and from Carpathian beechwoods and alderwoods, Pieniny meadows, ripicolous grasslands in Pieniny Mts. (WEINER, 1976). Moreover, in the Pieniny Mts. singly in *Fagetum carpaticum oxalidetosum* (Czoło) and in oligotrophic *Fagetum carpaticum* (slopes below Szopka Pass).

Karlstejnina annae RUSEK, 1974. Species known from xerothermic grasslands in Czech Karst (KUBÍKOVÁ & RUSEK, 1976; RUSEK, 1974), beechwoods in Jeseníky Mts. (DUNGER, 1977) and from Carpathian beechwoods in Pieniny Mts. (WEINER, 1976). Next five specimens I have collected in the Pieniny Mts. in *Alnetum incanae* (Dunajec riverside in Czorsztyń).

*****Doutnacia xerophila* RUSEK, 1974.** So far, reported only from thermophilous ripicolous associations in xerothermic grasslands in Czech Karst (KUBÍKOVÁ & RUSEK, 1976; RUSEK, 1974).

In the Pieniny Mts. I have found several specimens in the soil samples from *Dendranthemo-Seslerietum* (Sokolica Peak), from *Pinus silvestris-Calamagrostis varia* association (Czerwone Crags) and from *Tilio-Carpinetum* (at the foot of Piecki Cliff, at the Dunajec River).

Jevania weinerae RUSEK, 1978 (*Karlstejnica* sp.: WEINER, 1976). Described from the Pieniny Mts. (RUSEK, 1978). Singly or not numerous in *Festucetum pallentis potentilletosum* (Pulsztyn and Rabsztyn Crags), *Alnetum incanae* (Czorsztyn) and *Myricarietalia* (Czorsztyn, at the Dunajec River).

Metaphorura affinis (BÖRNER, 1902) (*Metaphorura bipartita*: STACH, 1964; WEINER, 1976). Species widely distributed in Europe. Reported also from south Ural (BUJNOVA & all., 1963), south-eastern Altai, and from the vicinity of Tomsk and Novosibirsk (STEBAEVA, 1973, 1976). In Poland known from the Cracow-Wieluń Upland, Nowy Targ Basin, Tatra and Pieniny Mts. (STACH, 1964; SZEPTYCKI, 1967; WEINER, 1976). Occurs in plant detritus, under the stones, in rodents' nests — most often outside of the forests.

In the association with *Salvia verticillata* and in *Anthylli-Trifolietum* (WEINER, 1976). Quite numerous in *Festucetum pallentis potentilletosum* (Pulsztyn and Rabsztyn Crags, Gorczyński Gully), singly in *Origano-Brachypodietum laserpitietosum* (Sobczański Gully) and not numerous in *Dendranthemo-Seslerietum* (Trzy Korony Peak, Sobczyński Gully, Facimiech Peak, Białe Crags).

Stenaphorura quadrispina BÖRNER, 1901. Known from many stands in Europe, reported also from Lebanon and Australia. In Poland found in the Pomeranian Lake District, Cracow-Wieluń Upland, West Beskidy Mts., Nowy Targ Basin, Pieniny and Tatra Mts. (STACH, 1964; SZEPTYCKI, 1967; WEINER, 1976). Occurs on meadows and fields in humus and under stones.

Not numerous in Pieniny meadow, singly in saxicolous grasslands, xerothermic pastures and Carpathian alderwoods (WEINER, 1976). Not numerous in *Carici-Fagetum*, *Fagetum carpaticum typicum* and *Myricarietalia*.

Tetracanthella alpina sp. *carpatica* STACH, 1947 (*Tetracanthella carpatica*: STACH, 1957, partim, 1959, *Tetracanthella pilosa*: STACH, 1920). Species known from Tatra Mts. (STACH, 1947, 1959, 1964; CASSAGNAU, 1959), Small Carpathians (NOSEK, 1961, 1963) and Pieniny Mts. (WEINER, 1976). The specimens reported by STACH (1920) from Pieniny Mts. as *T. pilosa* SCHÖTT, 1891, also belong to this species. Occurs usually in moss growing on rocks.

Not numerous in *Fagetum carpaticum typicum* in Ociemny Stream Valley (WEINER, 1976).

**Tetracanthella arctica* CASSAGNAU, 1959 (*Tetracanthella wahlgreni*: STACH, 1947, partim; 1959). Boreal-alpine species, distributed in almost whole Arctics: North Canada, Greenland, Iceland, Faroer Is., Spitsbergen, Wrangel Is., Siberia (BÖDVARSSON, 1966; CASSAGNAU, 1959; GISIN, 1961b; MARTYNOVA 1971a, STEBAEVA, 1976), and also in the mountains of Central Europe. Reported from northern part of Carpathians (NOSEK & VYSOCKAYA, 1973; RUSEK, 1963a; STACH, 1964), Sudeten (CASSAGNAU, 1959; DUNGER, 1968b; 1970a, b, 1972b, 1977; STACH, 1964), and in Lusatia (DUNGER, 1968b, 1973). In Poland reported

from Silesian Beskid Range, Sudeten, Nowy Targ Basin, Tatra Mts., (STACH, 1964) and Ojców region (SZEPTYCKI, 1967). Occurs in mosses, lichens, under detached bark of conifers, in conifer litter and in rodents' nests.

Found only in the two samples: in moss growing on a stone — very numerous, and in *Dendranthemo-Seslerietum* transiting in to *Festucetum pallentis* — quite numerous. The both samples come from habitats flooded with water at higher levels of the Dunajec River.

Anurophorus cuspidatus STACH, 1920. Species distributed in the mountains of Southern Europe, reported also from Nepal (YOSHII, 1966, 1971). The Pieniny Mts. (STACH, 1920) constitute the northernmost stand of this species. Occurs in the mosses covering rocks and under the stones.

In the Pieniny Mts. numerous and very numerous in *Carici-Fagetum cephalantheretosum* (Trzy Korony Peak, Czerteż and Czertezik Peaks), not numerous in *Pinus silvestris-Carex alba* association (Macelowa Peak), singly in *Pinus silvestris-Calamagrostis varia* association (Czerwone Crags), in *Origano-Brachypodietum stachyetosum* (Gorczyński Gully) and in *Origano-Brachypodietum laserpitietosum* (Trzy Korony Peak).

Anurophorus laricis NICOLET, 1842 (*Anurophorus laricis clavipilus*: STACH, 1947). Species reported from the whole Holarctic and from many localities in Poland as well. It appears, however (FJELLBERG, 1974; PALISSA, 1966), that it was often confused with other related species. It seems, that the form *clavipilus* described by STACH (1947) refer to *laricis* s. str. It is, however, uncertain, to which species refers the form *principalis*. *A. laricis* s. str. is an extremely xerophilous species, occurring in dry mosses, lichens, under tree bark and under stones (FJELLBERG, 1974).

The specimens from the Pieniny Mts. enlisted by STACH (1920) belong to this species. In my material it has not been found.

***Anurophorus septentrionalis* PALISSA, 1966. (*Anurophorus laricis*: SZEPTYCKI, 1967 — partim); (Fig. 9). Species reported from Finland (PALISSA, 1966), Swedish Lapland, South and East Norway (FJELLBERG, 1974, 1976) and from several stands on the East-European Lowland and Chukotka (MARTYNOVA, 1971); probably, more widely distributed, but until recently it was confused with *laricis*. In contrast to the last species, *septentrionalis* is a mesophilous species, occurring in forest litter.

Three specimens in fir woods planted in the habitat of *Carici-Fagetum* in Harezygrund Valley.

Pseudanurophorus binoculatus KSENEMAN, 1934. Boreal-alpine species (Fig. 17). Its distribution was described by MARCUZZI (1963; fig. 4). Additional, European localities are given by BÖDVARSSON, 1973; DUNGER, 1970a, b, 1972b, 1977; FJELLBERG, 1976; MURPHY, 1960; NOSEK, 1961, 1969; RUSEK, 1963a, 1968, 1973; SELGA, 1971. Also reported from North America (BELLINGER, 1954; WRAY, 1958). In Poland reported only from the vicinity of Ojców (SZEPTYCKI, 1967), Tatra Mts. (STACH, 1947, 1959, 1964) and from Pieniny Mts. (WEINER, 1976). Occurs in humus, mosses and lichens.

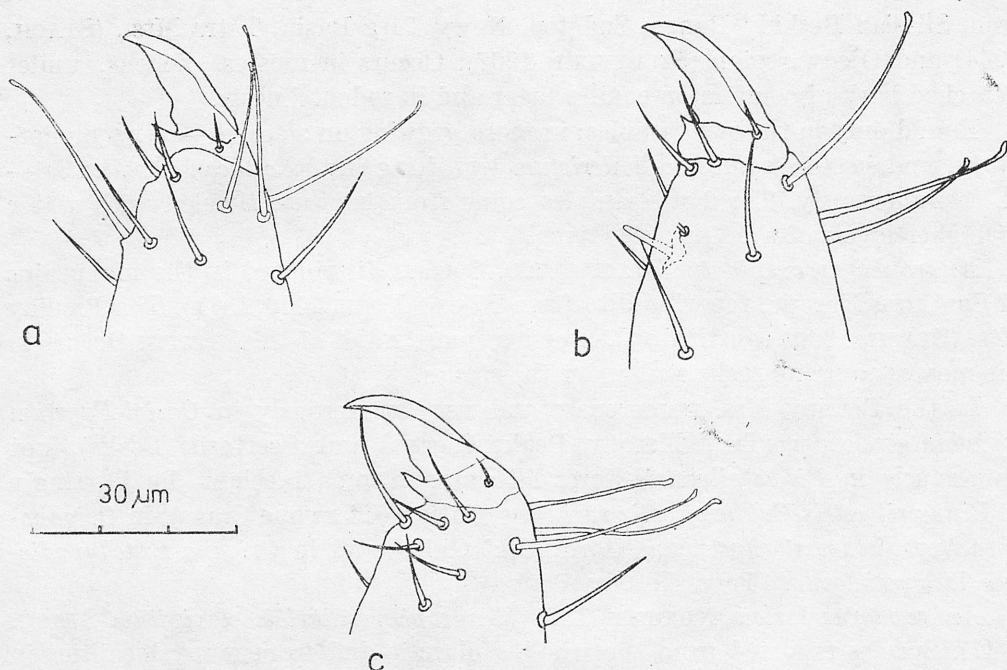


Fig. 9. *Anurophorus septentrionalis* PALISSA: a — distal part of the 2nd leg (adult male), b — distal part of the 3rd leg (adult male), c — end of the 3rd leg (adult female)

In *Anthylli-Trifolietum* (Wyrobek Meadow), and *Fagetum carpaticum typicum* (Pieniński Stream Valley) (WEINER, 1976). Also in *Phyllitido-Aceretum* on Facimiech Peak.

**Folsomides angularis* (AXELSON, 1905). Distributed in Europe, reported also from North America, South Ural (BUJNOVA & all., 1973; STEBAEVA, 1976), from Nepal (YOSIL, 1966) and from Argentina (IZARRA, 1965). In Poland known from East Sudeten (STACH, 1964) and Ojców vicinity (SZEPTYCKI, 1967). Occurs in mosses, saxicolous grasslands, less often in moist litter.

Singly or not numerous in *Dendranthemo-Seslerietum* (Białe Crags, Grabczycha Crag, Ostra Crag) and in *Pinus silvestris-Calamagrostis varia* association (Czerwone Crags).

**Folsomides marchicus* (FRENZEL, 1941). Species known from a few xerothermic localities (Fig. 16) in Southern Europe (BOCKEMÜHL, 1956; CASSAGNAU, 1954b, 1962; DALLAI, 1967, 1969a, 1970, 1973; DELAMARE, 1948; ELLIS, 1976; GAMA, 1964; GISIN, 1943; NOSEK, 1961, 1963; PALISSA, 1955; SELGA, 1971). In Poland reported only from Bielinek at Oder River (FRENZEL, 1941). Most often found in mosses.

Two specimens in *Dendranthemo-Seslerietum* on Trzy Korony Peak, Podskale and one in *Myricarietalia* (Dunajec riverside, Czorsztyn).

**Folsomides parvulus* STACH, 1922. Probably, a holarectic species. In Poland reported from Pieprzowe Mts., (STACH, 1964), Kampinos Forest (KACZMAREK,

1973), Ojców vicinity (SZEPTYCKI, 1967) and Kujawy District (ŁOSIŃSKI, 1974). Occurs in xerothermal habitats.

In *Festucetum pallentis* (Podskale), *Festucetum pallentis potentilletosum* (Rabsztyn Peak) — singly; Cisowiec Crag — numerous; *Dendranthemo-Seslerietum* (Sobezkański Gully, Trzy Korony Peak, Sokolica Peak) — not numerous.

Isotomodes productus (AXELSON, 1906). Probably a cosmopolitan species. In Poland known from many localities in the whole country (STACH, 1964; ŁOSIŃSKI, 1972, 1974; SZEPTYCKI, 1964, 1967; WEINER, 1976). Encountered under stones, in the vicinity of farm buildings and cultivated fields.

In *Dendranthemo-Seslerietum* (Trzy Korony Peak, Ostra Crag), *Carici-Fagetum abietetosum* (a gully near Hukowa Crag) — not numerous, in *Myricarictalia* (Dunajec River in Czorsztyn) — quite numerous.

**Isotomodes sexsetosus* GAMA, 1963. Species known from several stands in Central and South Europe (DUNGER, 1975; GAMA, 1963; LOUB & HAYBACH, 1967; KUBÍKOVÁ & RUSEK, 1976; ZONEV & JELEVA, 1977a, b); separate subspecies occurs in Southern France (POINSOT, 1965, 1966, 1972; ROUGON & ROUGON, 1970). In Poland reported only from the vicinity of Ojców (SZEPTYCKI, 1967). Occurs in the soil of grasslands, thermophilous shrublands and also in maple and beech forests.

6 specimens from the soil sample of *Dendranthemo-Seslerietum* (Facimiech Peak).

Folsomia candida WILLEM, 1902. Species widely distributed in Europe and adjoining areas, known also from China (RUSEK, 1971a). In Poland known from many stands (STACH, 1964; SZEPTYCKI, 1967; WEINER, 1976). Particularly common in synanthropic habitats, also in caves and small mammals' nests.

In Carpathian alderwood (WEINER, 1976), also in *Origano-Brachypodietum laserpitietosum* (Sobezkański Gully), *Fagetum carpaticum typicum* (Łączana Meadow) and under the stone in a thermophilous pasture — association with *Salvia verticillata* (Podlaźce) — singly.

Folsomia fimetaria (LINNAEUS 1758). Probably a holarctic species. In Poland known from many localities (STACH, 1964; KACZMAREK, 1973; KOBYLAŃSKA, 1976; ŁOSIŃSKI, 1972, 1974; SZEPTYCKI, 1964, 1967; WEINER, 1976; WIŚNIEWSKI, 1967). Occurs in forest litter, in mosses and lichens, under stones and in rodents' nests.

Singly in *Alnetum incanae* (Rówienka), *Fagetum carpaticum oxalidetosum* — Facimiech Peak, *Fagetum carpaticum typicum* (Pieniński Stream Valley) and litter taken 4 m deep from the entrance into the Ociemny Cave.

Folsomia inoculata STACH, 1947. Reported mainly from the mountains of Central Europe, also from Caucasus (STACH, 1947), Siberia (STEBAEVA, 1973, 1976) and South Sweden (BÖDVARSSON, 1961, 1963). In Poland found in Tatra Mts. (STACH, 1964) and Pieniny Mts. (WEINER, 1976). Often occurs under the detached tree bark and in rodents' nests.

Several specimens in *Fagetum carpaticum typicum* (Pieniński Stream Valley, Ociemny Stream Valley, Przechodki Cape) and *Carici-Fagetum* (Gojny Forest).

Moreover, in *Carici-Fagetum abietetosum* — not numerous (WEINER, 1976).

Folsomia penicula BAGNALL, 1939 (*Folsomia multiseta*: STACH, 1964; SZEPTYCKI, 1967; WEINER, 1976). Distributed in Central and Southern Europe, particularly in the alpine and subalpine areas. Reported also from Lebanon, Syria (CHRISTIANSEN, 1958) and Morocco (LAWRENCE, 1963). In Poland known from the Ojców vicinity, West Beskidy Range, Nowy Targ Basin, Pieniny Mts. and Tatra Mts. (STACH, 1964; SZEPTYCKI, 1967; WEINER, 1976). Occurs in forest litter, soil, under tree bark and small mammals' nests.

In the Pieniny Mts. very common, occurring very numerously and numerously in the majority of habitats. I did not find it only in *Caltho-Alnetum* and *Valeriano-Caricetum flavae*.

Folsomia quadrioculata (TULLBERG, 1871). Probably a holarctic species. In Poland known from many stands (STACH, 1964; KACZMAREK, 1963, 1973; KOBYLAŃSKA, 1976; ŁOSIŃSKI, 1972; 1974; SKALSKI & WÓJCIK, 1968; SZEPTYCKI, 1967; WEINER, 1976; WIŚNIEWSKI, 1967). Eurytopic species, occurring in soil, rodents' nests and anthills.

Very numerously and numerously in almost all habitats, except in *Pinus silvestris-Carex alba* association (in contrast to *penicula*); singly in the association *Valeriano-Caricetum flavae*, *Origano-Brachypodietum stachyetosum* and *Myricarietalia*.

*****Proisotoma clavipila*** (AXELSON, 1903). Reported from Finland (AXELSON, 1903) and Norway (FJELLBERG, 1973), but probably more widely distributed: until recently it was confused with *minuta*. It is possible, that the data of KOBYLAŃSKA (1976) concerning cf. *minuta* also refer to this species. Probably corticophilous species, in contrast to the soil-dwelling *minuta*.

In the Pieniny Mts. I have found a dozen of specimens in *Fagetum carpaticum typicum* (Gojny Forest), under the bark of fallen fir.

Proisotoma minima (ABSOLON, 1901). Probably, a holarctic species. In Poland widely distributed (STACH, 1964; KACZMAREK, 1963, 1973; SZEPTYCKI, 1964, 1967; WIŚNIEWSKI, 1967). Occurs under the detached tree bark, also in rodents' nests and anthills.

In the Pieniny Mts. two specimens from a soil sample taken from under the freshly fallen stump in deteriorated *Fagetum carpaticum typicum* (below the Szopka Pass). The sample contained roots.

Proisotoma minuta (TULLBERG, 1871), Probably a cosmopolitan species. In Poland known from many localities (STACH, 1964; ŁOSIŃSKI, 1972; SZEPTYCKI, 1964; WEINER, 1976; WIŚNIEWSKI, 1967). Occurs in humus, compost, rodents' nests and anthills.

In the soil samples from *Anthylli-Trifolietum* (Wyrobek Meadow) (WEINER, 1976), also *Myricarietalia* (Dunajec riverside near Czorsztyn) — singly. Very commonly occurring under the flower-pots in farmhouses (Harczygrund).

****Proisotoma recta*** STACH, 1930. Species reported from a few localities in Europe (Fig. 15): Tatra Mts. (STACH, 1929, 1959, 1964), Innsbruck (TÖRNE, 1958), Provence Alps (POINSOT, 1972), Galicia (Spain; SELGA, 1971). Besides the

Tatra Mts. not reported from Poland. Occurs in mosses growing on moist rocks or stones in mountain streams.

In the Pieniny Mts. common on wet rocks on the Southern slopes of Okraglica Crag (Trzy Korony Peak), on the walls of a rock shelter in Sobczański Gully and in a sample containing moist mosses from rocks in *Phyllitido-Aceretum* in Pieniński Stream Valley.

**Hydroisotoma schaefferi* (KRAUSBAUER, 1898). Known from the mountains of western Europe, Caucasus and North America. In Poland known so far from Tatra Mts. (STACH, 1964), Ojców vicinity (SZEPTYCKI, 1967) and Dukla Pass (SZEPTYCKI, unpubl.). Occurs under the stones partly submerged in water, in mountain stream beds and in wells.

I have collected the specimens of this species in spring and autumnal periods in streams. Moreover, one specimens I have found on snow in *Carici-Fagetum cephalantheretosum* (Trzy Korony Peak).

Cryptopygus bipunctatus (AXELSON, 1903), (*Isotomina bipunctata*: STACH, 1964; KACZMAREK, 1973; KOBYLAŃSKA, 1976; SZEPTYCKI, 1967; WEINER, 1976; WIŚNIEWSKI, 1967). Possibly, a palearctic species. In Poland reported from Kampinos Forest, Poznań vicinity, Cracow-Wieluń Upland and Pieniny Mts. (STACH, 1964; KACZMAREK, 1973; KOBYLAŃSKA, 1976; SZEPTYCKI, 1967; WEINER, 1976; WIŚNIEWSKI, 1967). Occurs in humus, under pieces of wood and under the stones.

In *Alnetum incanae* (WEINER, 1976), in *Dendranthemo-Seslerietum* (Grabczycha Crag). *Origano-Brachypodietum laserpitietosum* (Sobczański Gully) — not numerous. Moreover, several specimens have been found under the flower-pots in a farmhouse (Harczygrund Valley).

Cryptopygus thermophilus (AXELSON, 1900) (*Isotomina thermophila*: STACH, 1964; KOBYLAŃSKA, 1976; SZEPTYCKI, 1964, 1967; WEINER, 1976). Probably, a cosmopolitan species. In Poland reported from Cracow, Wolin Is., Ojców and Poznań vicinity, and also from Pieniny Mts. (STACH, 1964; KOBYLAŃSKA, 1976; SZEPTYCKI, 1964, 1967; WEINER, 1976). Occurs in humus, in flower-pots, in rodents' nests.

In *Valeriano-Caricetum flavae* in Krościenko, in the association with *Salvia verticillata* (WEINER, 1976), in *Festucetum pallentis potentilletosum* (Pulsztyn) — very numerous, and two specimens from under the splitted-off pieces of rocks in the same habitat on Cisowiec.

Isotomiella minor (SCHÄFFER, 1896). A cosmopolitan species. In Poland known from many stands (STACH, 1964; KACZMAREK, 1963, 1973; SZEPTYCKI, 1967; WEINER, 1976; WIŚNIEWSKI, 1967). Occurs in moist habitats: in soil, forest litter, under detached tree bark, in compost, rodents' nests and anthills.

Occurred in the soil samples of almost all habitats, except *Origano-Brachypodietum*. In forest habitats numerous, in the remaining ones not numerous or quite numerous.

Pseudisotoma monochaeta (KOS, 1942). Species recorded in many mountain localities of Southern Europe. Also reported from Tatra Mts., Montenegro

(STACH, 1964) and Pieniny Mts. (WEINER, 1976). The only lowland stands is in Denmark (PETERSEN, 1965). Occurs in mosses on rocks, in soil and tufts of grass.

In the Pieniny Mts. numerously or quite numerously in *Dendranthemo-Seslerietum*, *Carici-Fagetum cephalantheretosum*, *Phyllitido-Aceretum* and *Tilio-Carpinetum*. Singly in *Origano-Brachypodietum laserpitietosum* and in oligotrophic *Fagetum carpaticum*. Each of these samples contained moss. Further specimens I have found in mosses from *Phyllitido-Aceretum*.

Pseudisotoma sensibilis (TULLBERG, 1876). Probably a holarctic species. In Poland reported from many stands (STACH, 1964; SZEPTYCKI, 1967). Corticophilous species, encountered also in mosses, under stones and in rodents' nests.

Occurs in the soil samples containing moss, numerously and very numerously in extremely different habitats (*Phyllitido-Aceretum* or *Dendranthemo-Seslerietum*) A dozen of specimens from under the bark of fallen trees and from mosses covering rocks in *Fagetum carpaticum typicum*, *Carici-Fagetum cephalantheretosum*, and *Phyllitido-Aceretum*.

**Vertagopus arborea* (LINNAEUS, 1758). Distributed in Europe. Reported also from Lebanon, Western Syria and North America. In Poland known from Lower Silesia, West Beskidy Range, Tatra Mts., Wolin Is. and Ojców vicinity (STACH, 1964; SZEPTYCKI, 1964, 1967). Most commonly found under the detached tree bark, also reported from rodents' nests.

Several dozen of specimens from under the bark and from mosses in *Phyllitido-Aceretum* (Trzy Korony Peak).

Vertagopus cinerea (NICOLETT, 1841). Probably a holarctic species. In Poland reported from many stands (STACH, 1964; KACZMAREK, 1973; SZEPTYCKI, 1967; WEINER, 1976). Corticophilous, but also found in litter and rodents' nests.

In *Fagetum carpaticum typicum* (Pieniński Stream Valley), oligotrophic *Fagetum carpaticum typicum* (Pieniński Stream Valley), oligotrophic *Fagetum carpaticum* (below Szopka Pass) — singly. Moreover, under the bark of fallen trees in *Carici-Fagetum* (Głęboki Stream Valley, Harezygrund Valley, Gojny Forest), *Carici-Fagetum cephalantheretosum* (Trzy Korony Peak), *Carici-Fagetum abietetosum* (Facimiech-Klejowa Peaks).

**Vertagopus westerlundi* (REUTER, 1897). Boreal-alpine species, distributed in Europe. Reported also from South Ural (BUJNOVA & all., 1963; STEBAEVA, 1976), and Krasnoyarski District (MARTYNOVA, 1975). In Poland found in Lower Silesia, West and East Sudeten, Nowy Targ Basin, Tatra Mts. (STACH, 1964). Occurs in mosses, conifer litter, under detached tree bark and in rodents' nests; also on snow.

Singly in *Carici-Fagetum abietetosum* (Facimiech-Klejowa Peaks), *Fagetum carpaticum oxalidetosum* (Czoło), *Fagetum carpaticum typicum* (Pieniński Stream Valley) and *Festucetum pallentis* (at the foot of Hukowa Crag). Several further specimens under the bark of fallen trees (*Fagetum carpaticum typicum* — Sokolica

sticks deposited by water (Dunajec River bank at Wylizana Crag) and one specimen on snow (Trzy Korony Peak).

Isotoma nivea SCHÄFFER, 1896, (*Isotoma albella*: STACH, 1964; SZEPTYCKI, 1967). Until recently *I. nivea* was confused with the American *albella* PACKARD, 1873 (FJELLBERG, 1979). The European records of *albella* probably refer to the former species. Probably widely distributed in Poland (STACH, 1964; SZEPTYCKI, 1967). Found under the detached tree bark.

In the Pieniny Mts. I have found some two hundreds of specimens, from under the bark of fallen firs in *Fagetum carpaticum typicum* (Pieniński Stream Valley, Gojny Forest) and in *Carici-Fagetum abietetosum* (Facimiech-Klejowa Peaks).

* *Isotoma fennica* REUTER, 1895. Possibly, a palearctic species. In Poland recorded in Cracow vicinity, West Beskidy Range, Nowy Targ Basin, Tatra Mts. (STACH, 1964). Occurs in moist mosses near cold water, but also reported from rodents' nests (MARTYNOVA & all., 1971).

Quite numerous in *Fagetum carpaticum typicum* (Ociemny Stream Valley), and singly in *Anthylli-Trifolietum* (Wyrobek Meadow). One specimen under the stone on a plown field (near Cisowiec).

Isotoma hiemalis SCHÖTT, 1893. Species reported from Central and Northern Europe. Southernmost localities were found in Slovenia and Serbia (BOGOJEVIĆ, 1968). Reported from many stands in Poland (STACH, 1964; SZEPTYCKI, 1967; WEINER, 1976; WIŚNIEWSKI, 1967), also from Pieniny Mts. During winter encountered on snow, in under the stones and in the litter.

In the Pieniny Mts. very common on snow, mainly in forest habitats, but also in open areas. Singly in soil samples taken during and summer in *Carici-Fagetum cephalantheretosum* (Trzy Korony Peak, Białe Crag).

Isotoma notabilis SCHÄFFER, 1896. Cosmopolitan. In Poland reported from many stands (STACH, 1964; KACZMAREK, 1963, 1973; KOBYLAŃSKA, 1976; SKALSKI & WÓJCIK, 1968; SZEPTYCKI, 1964, 1967; ŁOSIŃSKI, 1972; WEINER, 1976; WIŚNIEWSKI, 1967). Occurs in litter and humus, in mosses, under stones and pieces of wood, under detached bark of stumps, on mushrooms, in small mammals' nests and in anthills.

In the Pieniny Mts. in the soil samples from all habitats, numerous. Only in caves not numerous.

** *Isotoma tigrina* TULLBERG, 1871 (*Isotoma olivacea*: WEINER, 1976). Species often confused with *I. olivacea* TULLBERG, 1871 (FJELLBERG, 1979).

In *Carici-Fagetum cephalantheretosum* — very numerous, *Fagetum carpaticum typicum* — not numerous or singly, in *Origano-Brachypodietum* — numerous, in *Caltho-Alnetum*, *Alnetum incanae* — quite numerous, in *Valeariano-Caricetum flavae*, *Anthylli-Trifolietum* — not numerous, and in *Myricarietalia*, *Fagetum carpaticum oxalidetosum* and *Phyllitido-Aceretum* — singly.

Isotoma viridis BOURLET, 1895. Probably a holarectic species. In Poland reported from many stands (STACH, 1964; KACZMAREK, 1963, 1973; KOBY-

LAŃSKA, 1976; ŁOSIŃSKI, 1972, 1974; SZEPTYCKI, 1964, 1967; WEINER, 1976; Peak, Wylizana Crag), under the splitted-off piece of rock (Igła Jag), on the WIŚNIEWSKI, 1967). Hygrophilous species, seemingly related to open habitats. During winter occurs on snow. Found also in small mammals' nests and in anthills.

In the Pieniny Mts. several hundreds of specimens were found mainly on fields and meadows, on snow and from under the stones in stream or near streams. Moreover, singly or quite numerous in the soil samples from all habitats.

Isotomurus palustris (MÜLLER, 1776). Probably a cosmopolitan species. In Poland known from many stands (STACH, 1964; KACZMAREK, 1973; SZEPTYCKI, 1967; WIŚNIEWSKI, 1967). Occurs in very moist habitats, particularly often near the banks of various waters and on swamps. Encountered also in anthills and in rodents' nests.

Very numerous in *Myricarietalia* (Czorsztyń, at the Dunajec River), singly in *Fagetum carpaticum typicum* at Pieniński Stream. Moreover, under the stones in stream beds or in their vicinity, independently on the surrounding plant associations.

* *Isotomurus plumosus* BAGNALL, 1940 (*Isotomurus palustroides subciliatus*: STACH, 1964; KACZMAREK, 1973). Species distributed in Europe. In Poland known from Kampinos Forest (KACZMAREK, 1973), Nowy Targ Basin (STACH, 1964), Wolin Is. and Wielkopolska District (SZEPTYCKI, unpubl.). Occurs in very moist habitats, in mosses, between fallen leaves, under stones.

Very numerous in *Caltho-Alnetum* (wells of Pieniński Stream) and one specimen in *Valeriano-Caricetum flavae* (Krościenko).

Oncopodura crassicornis SCHOEBOOTHAM, 1911. Species distributed in Europe, especially in its southern part. In Poland reported from Ojców vicinity, West Beskidy Range, Pieniny and Tatra Mts. (STACH, 1964; SZEPTYCKI, 1967; WEINER, 1976). Most often occurring in forest litter. Encountered in caves and rodents' nests.

Not numerous or singly in *Fagetum carpaticum typicum* in Pieniński Stream Valley, oligotrophic *Fagetum carpaticum* (below Szopka Pass), *Carici-Fagetum cephalantheretosum* (Białe Crags, Rabsztyn Peak, Trzy Korony Peak), *Carici-Fagetum* (Białe Crags), *Dendranthemo-Seslerietum* (Trzy Korony Peak), *Tilio-Carpinetum* (Dunajec River bank, at the foot of Piecki Cliff), *Anthylli-Trifolietum* (Ligarki Meadow) and in the cave of Ociemny.

Tomocerus minutus (TULLBERG, 1876). Species distributed in the Palearctic. In Poland reported from the Baltic coast, Masurian Lake District, Kampinos Forest, Lower Silesia, Cracow-Wieluń Upland, West Beskidy Range, Ojców vicinity, Nowy Targ Basin, Pieniny and Tatra Mts. (STACH, 1964; KACZMAREK, 1973; SZEPTYCKI, 1967; WEINER, 1976). However, it seems possible, that these data may partly refer to other species (cf. p. 456: *Plutomurus carpaticus*). Occurs in moist habitats: in moss, under stones, under the pieces of wood, under detached bark of rotten stumps and in rodents' nests.

Not numerous or singly in *Carici-Fagetum cephalantheretosum* (Białe

Crags), *Carici-Fagetum* (Gojny Forest), in *Fagetum carpaticum oxalidetosum* (Facimiech Peak). Collected also from under the stones in oligotrophic *Fagetum carpaticum* (below Wylizana Crag, Głęboki Stream Valley), on Pieniny meadow (foot of Flaki Ridge), in *Phyllitido-Aceretum* (slopes of Facimiech Peak) and from under the detached bark of a stump in *Carici-Fagetum* (Gojny Forest).

Tomocerus minor (LUBBOCK, 1862). Probably a holarctic species. In Poland reported from Pomerania Lake District, Lower Silesia, Świętokrzyskie Mts., East Sudeten, West Beskidy Range, Nowy Targ Basin, Pieniny and Tatra Mts. (STACH, 1964; SZEPTYCKI, 1967; WEINER, 1976). Occurs in moist habitats: in forest litter, mosses under stones, under the pieces of wood and in small mammals' nests.

Commonly but not numerous or singly in the soil samples from all habitats. Moreover, under the stones and pieces of wood, under the bark, of rotten trunks in forest habitats.

Tomocerus vulgaris (TULLBERG, 1871). Probably holarctic species. In Poland reported from Pomerania Lake District, Wolin Is., Wielkopolska District, Białowieża Forest, Kampinos Forest, Upper and Lower Silesia, Cracow-Wieluń Upland, Małopolska Upland, Roztocze Plateau, West Beskidy Range, Nowy Targ Basin, Pieniny and Tatra Mts. (STACH, 1964; KACZMAREK, 1963, 1973; SZEPTYCKI, 1964, 1967; WIŚNIEWSKI, 1967). Occurs in humus, under the stones and pieces of wood, in moss and in anthills.

In the Pieniny Mts. most commonly occurs under the stones near streams. Also collected from plants of forest bottom in *Fagetum carpaticum typicum* (Sokolica Peak), *Alnetum incanae* (Czorsztyn at Dunajec River), in staled hay on a Pieniny Meadow (Szopka Pass) and in the deposited twigs on Dunajec River bank (Czorsztyn).

Pogonognathellus flavescens (TULLBERG, 1871). Species widely distributed in Europe. Outside of Europe found in Siberia (MARTYNOVA, 1969; STEBAEVA, 1976), North America (CHRISTIANSEN, 1964; HAMMER, 1953; SNIDER, 1967). Hitherto existing data from Japan are considered as erroneous ones (YOSHII, 1977). In Poland reported from many stands (STACH, 1964; KACZMAREK, 1973; KOBYLAŃSKA, 1976; SKALSKI & WÓJCIK, 1968; SZEPTYCKI, 1964, 1967; WEINER, 1976; WIŚNIEWSKI, 1967). Occurs in most habitats, under stones, pieces of wood, on rotten stumps, in anthills and in small mammals' nests.

Singly in the soil samples from all habitats. Common under the stones, under the detached bark of rotting stumps and under pieces of sticks in all habitats except saxicolous grasslands.

Pogonognathellus longicornis (MÜLLER, 1776). Reported from the whole Europe outside of the Arctic regions, also from Siberia (STEBAEVA, 1976) and Caucasus (RUSEK, 1961). In Poland known from many stands (STACH, 1964; KACZMAREK, 1973; SZEPTYCKI, 1964, 1967). Occurs under the pieces of wet wood in forests and meadows, under stones and in rodents' nests.

In the Pieniny Mts. I have collected several specimens: on a Pieniny Meadow

from under a log (Szopka Pass) and on plants (below Białe Crags) and under the stone at the stream in *Carici-Fagetum* (near Ostra Crag).

Plutomurus carpathicus RUSEK & WEINER, 1978 (*Tomocerus minutus*: SZEPTYCKI, 1967 — partim). Known hitherto from the Pieniny Mts., Vyhorlat Mts., Lower Tatra Mts. and Silesian-Moravian Beskidy Range (RUSEK & WEINER, 1978) (Fig. 16), and from Ojców.

In the Pieniny Mts. common in forest habitats: *Fagetum carpathicum typicum*, *Fagetum carpathicum oxalidetosum*, oligotrophic *Fagetum abietetosum*, *Phyllitido-Aceretum* — not numerous or quite numerous in the soil samples. Also found under stones and pieces of wood, under the tree bark. Quite numerous in samples from *Valeriano-Caricetum flavae* and singly on a Pieniny meadow (in mosses near wells). It is the third most common species of *Tomoceride*, after *Tomocerus minor* and *Pogonognathellus flavescens*.

* *Orchesella alticola* UZEL, 1891. Reported from the mountains of Central Europe, and also from Pyreneen (CASSAGNAU, 1964; SELGA, 1971). In Poland known from Lower Silesia, East Sudeten, Cracow-Wieluń Upland, Tatra Mts. (STACH, 1964; SZEPTYCKI, 1963, 1967). Species quite eurytopic in montane situations, and preferring cold habitats in lower localities (cave entrances, shadowed fragments of rock faces).

In the Pieniny Mts. a dozen of specimens on rocks or under stones in *Dendranthemo-Seslerietum* in Sobczański Gully and on Trzy Korony Peak.

Orchesella bifasciata (BOURLET, 1839). Species widely distributed in Europe. In Poland reported from many stands (STACH, 1964; KACZMAREK, 1963, 1973; SZEPTYCKI, 1964; 1967; WEINER, 1976). Occurs in not too moist habitats.

In the Pieniny Mts. it occurs in mosses and in the soil in *Carici-Fagetum cephalantheretosum*, *Dendranthemo-Seslerietum*, *Origano-Brachypodietum stachyetosum*, *Festucetum pallentis potentilletosum* and *Phyllitido-Aceretum*. Furthermore, common under the tree bark and in mosses on rocks.

* *Orchesella cincta* (LINNAEUS, 1758). Distributed in the whole Europe, also reported from North America (SNIDER, 1967; WRAY & KNOWLTON, 1956a) and from Siberia (STEBAEVA, 1976). In Poland known from many stands (STACH, 1964; KACZMAREK, 1963, 1973; KOBYLAŃSKA, 1976; SZEPTYCKI, 1964). In Western Poland common in natural biotopes, while in Southern Poland almost limited to synanthropic habitats.

I have collected four specimens outside of the study area: Szczawnica, in a house garden, from under the bark of a pine and of a larch.

Orchesella flavescens (BOURLET, 1839). Probably, a holarctic species. In Poland reported from many localities (STACH, 1964; KACZMAREK, 1963, 1973; SZEPTYCKI, 1964, 1967; WIŚNIEWSKI, 1967). Occurs on herbs, mushrooms, stumps, under stones, in rodents' nests and in the anthills.

In the Pieniny Mts. it occurs very commonly on herbs, under the stones, in rotten wood in all habitats except *Dendranthemo-Seslerietum* and *Festucetum pallentis potentilletosum*.

Orchesella spectabilis TULLBERG, 1871. Distributed in Central and South-

-Eastern Europe and in southern part of Scandinavian Peninsula. In Poland known from many localities (STACH, 1964; KACZMAREK, 1973; SZEPTYCKI, 1967; WIŚNIEWSKI, 1967). Occurs in dry and sunny habitats, in open areas. Encountered on herbs, under stones, in rodents' nests and in anthills.

In the Pieniny Mts. I have collected the specimens of this species from under stones and on mushrooms on a Pieniny meadow, on herbs at the edge of Carpathian alderwood, on a trunk of fallen fir in an oligotrophic beechwood and on the snow on a field. One specimen from the soil sample of *Festucetum pallentis potentilletosum* (Flaki).

* *Orchesella xerothermica* STACH, 1960. Species reported from a few localities in Central-Eastern Europe (Fig. 17): Cracow, Pieprzowe Mts., Western Ukraina: Podole and Wołyń (STACH, 1960), Ojców vicinity (SZEPTYCKI, 1967), Kampinos Forest (KACZMAREK, 1973), Vojvodina (BOGOJEVIĆ, 1968), South Carpathians and Dobrogea (GRUIA, 1970). Most often occurs under stones in xerothermic habitats (pastures, xerothermic grasslands).

In the Pieniny Mts. I have found a dozen of specimens under stones and on junipers in *Anthylli-Trifolietum* (Mała Valley), association with *Salvia veritcillata* (Podłazce, between Cisowiec and Długa Grapa Crag), lucid *Alnetum incanae* (Krościenko) and in raspberry bushes in *Carici-Fagetum* (Zameczysko Crag).

Heteromurus nitidus (TEMPLETON, 1835). Species very widely distributed in Europe, except Northern Scandinavia. In Poland probably widely distributed, particularly in synanthropic habitats (STACH, 1964; SZEPTYCKI, 1967). Occurs under the flower-pots, under pieces of wood, in rodents' nests and in caves.

In the Pieniny Mts. from under the flower-pots in a farmhouse (Harczygrund Valley), under stones in stream beds (commonly) and one specimen in the litter of *Carici-Fagetum cephalantheretosum* (Białe Crag).

Entomobrya arborea (TULLBERG, 1871). Species widely distributed in Europe. In Poland reported from Mazovian Lowland, Pieprzowe Mts., Roztocze Plateau, Sandomierz Lowland, Ojców vicinity, West Beskidy Range, Nowy Targ Basin, Pieniny and Tatra Mts. (STACH, 1964; KACZMAREK, 1973; SZEPTYCKI, 1967). Most often found in tree bark chinks, also under the lichens growing on trees. The species is rare and therefore the detailed data on its occurrence are lacking.

I have collected one specimen on the bark of fallen fir at the Dunajec River bank, and two others in moss growing on a maple tree in Szczawnica city park.

Entomobrya corticalis (NICOLET, 1841). Species known from Northern and Central Europe. In Poland reported from many localities (STACH, 1964; KACZMAREK, 1963, 1973; KOBYLAŃSKA, 1976; SZEPTYCKI, 1964, 1967; WIŚNIEWSKI, 1967). Corticophilous, sometimes encountered in mosses and lichens on trees and in anthills.

In the Pieniny Mts. found under the bark of trees and stumps, always very numerously. Found in all forest types, and even under the bark of a fir growing on a Pieniny meadow.

Entomobrya dumitrescuae GRUIA, 1967. Hitherto, known from a few stands in South Carpathians (Hunedoara, Brasov), Dobrogea (GRUIA, 1967), Rhodos Is. (ELLIS, 1974) and Pieniny Mts., where I have found it on a rock in *Dendranthemo-Seslerietum* (Białe Skály Crags) and on a polypore growing on a fallen fir in *Fagetum carpaticum typicum* (WEINER, 1977b).

* *Entomobrya lanuginosa* (NICOLET, 1841). Probably a holarctic species. In Poland reported from Pomerania Lake District, Cracow, West Beskidy Range, Nowy Targ Basin, Tatra Mts. (STACH, 1964) and Ojców vicinity (SZEPTYCKI, 1967). Occurs in meadows and grasslands, on mushrooms, under detached tree bark, under stones and in rodents' nests.

In the Pieniny Mts. singly under stones and in staled hay, on junipers growing on thermophilous pasture, and also in dry lichens and on cutted stamps in *Carici-Fagetum cephalantheretosum*.

Entomobrya marginata (TULLBERG, 1871). West-palearctic species. Data from outside of this area seem to refer to some other species. In Poland known from Pomerania Lake District, Poznań region, Mazovian Lowland, Lower Silesia, Cracow-Wieluń Upland, West Beskidy Range, Nowy Targ Basin, Pieniny and Tatra Mts. (STACH, 1964; KACZMAREK, 1973; KOBYLAŃSKA, 1976; SZEPTYCKI, 1967; WEINER, 1976; WIŚNIEWSKI, 1967). Occurs in arid habitats: under tree bark, in mosses, under stones, in conifer litter, in anthills and rodents' nests.

Quite numerous and numerous in *Festucetum pallentis potentilletosum* (Gorczyński Gully, Macelowa Peak), *Festucetum pallentis* (Grabczycha Crag, Białe Crags). Also collected from under the tree bark in *Carici-Fagetum cephalantheretosum*.

* *Entomobrya multifasciata* TULLBERG, 1871. Probably, a cosmopolitan species. In Poland reported from many stands (STACH, 1964; KACZMAREK, 1973; KOBYLAŃSKA, 1976; SZEPTYCKI, 1964, 1967; WIŚNIEWSKI, 1967). Thermophilous species. Occurs in xerothermic habitats, under detached tree bark, under stones and also in the nests of small mammals and in anthills.

In *Dendranthemo-Seslerietum* on Sokolica Peak, Facimiech Peak, Zamkowa Peak, Grabczycha Crag — quite numerous, on Trzy Korony Peak, Głowa Cukru Jag — numerous; in *Festucetum pallentis potentilletosum* (Gorczyński Gully) — numerous, and in the association with *Salvia verticillata* (at the foot of Goła Peak) — singly.

Entomobrya nivalis (LINNAEUS, 1758). Distributed probably in the whole Holarctic, known also from South America (IZARRA, 1972b, RAPOPORT, 1970), to where it may had been introduced. In Poland reported from many localities (STACH, 1964; SZEPTYCKI, 1967; WIŚNIEWSKI, 1967). Occurs on various herbs and bushes, in moss, under tree bark, under stones, in small mammals' nests and in anthills, preferring arid habitats.

Singly in *Origano-Brachypodietum stachyetosum* (Gorczyński Gully) and *Origano-Brachypodietum laserpitietosum* (Sobczański Gully). Very common on

junipers and small pines in various unforested habitats; also under the bark of fallen trees.

Entomobrya puncteola UZEL, 1891. Central-European species, known from Eastern Alps up to the East Carpathians, and from Pomerania down to the Karst Upland in Yugoslavia. In Poland reported from Chełmno, Łomża, Krasnobród, Ropczyce, West Beskidy Range, Pieniny Mts. (STACH, 1964) and Ojców vicinity (SZEPTYCKI, 1967). Also found in the vicinity of Dukla and Krosno (SZEPTYCKI, unpubl.). Encountered on trees and bushes, also in rodents' nests.

Only one specimen from Pieniny Mts., collected in Krościenko in *Valeriano-Caricetum flavae* bordering with *Fagetum carpaticum typicum*.

Entomobryides myrmecophila (REUTER, 1886). Species distributed in Europe. In Poland reported from Pomerania Lake District, Mazovian Lowland, Poznań region, Lower Silesia, Cracow-Wieluń Upland, Sandomierz Lowland, Nowy Targ Basin and Pieniny Mts. (STACH, 1964; KACZMAREK, 1973; SZEPTYCKI 1967; WIŚNIEWSKI, 1967). Myrmecophilous, sometimes encountered under detached tree bark.

In the Pieniny Mts. I have collected the specimens of this species on a Pieniny meadow (at the foot of Długa Grapa Crag) and on a dry pasture (between Cisowiec and Zameczysko Crag) from anthills covered by stones. Single specimens in the soil samples from *Fagetum carpaticum typicum* (Pieniński Stream Valley) and *Carici-Fagetum cephalantheretosum* (Pieniński Stream Valley).

Willowsia buski (LUBBOCK, 1870). Probably a holarctic species. In Poland known from many stands (STACH, 1964; KACZMAREK, 1973; KOBYLAŃSKA, 1976; SZEPTYCKI, 1964, 1967; WIŚNIEWSKI, 1967). Xero- and corticophilous species, found also in the anthills and in rodents' nests.

Very numerous in *Dendranthemo-Seslerietum* (Trzy Korony Peak — under the shelter of Ganek Cliff), quite numerous in *Festucetum pallentis potentilletosum* (Pulsztyn Crag, Gorczyński Gully), singly in *Dendranthemo-Seslerietum* (Trzy Korony Peak) and in *Myricarietalia* (Dunajec River near Czorsztyn). Furthermore, singly in various forest biotopes under tree bark and in *Festucetum pallentis potentilletosum* (Cisowiec Crag) — under the splitted-off pieces of rocks.

**Willowsia nigromaculata* (LUBBOCK, 1873). Known from many stands in Europe, particularly in its central part. In Poland reported from Białowieża Forest, Nowy Targ Basin, Tatra Mts., Wolin Is., Ojców region, Kampinos Forest and Poznań vicinity (STACH, 1964; BŁASZAK & all., 1975; SZEPTYCKI, 1964, 1967; WIŚNIEWSKI, 1967). Xerophilous species, occurring also in rodents' nest and anthills.

In the Pieniny Mts. I have found two specimens in the soil samples from *Festucetum pallentis potentilletosum* (Flaki Ridge) and from *Carici-Fagetum abietetosum* (Facimiech-Klejowa Peaks).

Lepidocyrtus ruber SCHÖTT, 1902. Distributed in Europe. In Poland reported from Pomerania Lake District, Poznań vicinity, Kampinos Forest, Ojców

vicinity, West Beskidy Range and Pieniny Mts. (STACH, 1964; KACZMAREK, 1973; KOBYLAŃSKA, 1976; SZEPTYCKI, 1967; WEINER, 1976). Occurs on wet meadows.

On herb in *Valeriano-Caricetum flavae* and in *Anthylli-Trifolietum*.

Pseudosinella alba (PACKARD, 1873). Species known from the entire Europe (except the Arctic), and also from North America. In Poland widely distributed (STACH, 1964; KOBYLAŃSKA, 1976; SZEPTYCKI, 1967; WIŚNIEWSKI, 1967). Occurs under detached tree bark, in humus, in rodents' nests and in anthills.

In the Pieniny Mts. I have found one specimen under the piece of a stick in *Fagetum carpaticum oxalidetosum* (Gródek).

**Pseudosinella octopunctata* (BÖRNER, 1901). Species occurring in Central and Southern Europe, known also from North America, North Africa, Asia Minor and South America (presumably introduced). In Poland found only in Ojców region (SZEPTYCKI, 1967). Occurs mainly in unforested habitats, under stones, in rock crevices, under pieces of wood and in rodents' nests.

In *Festucetum pallentis potentilletosum* on Macelowa Peak, and Pulsztyn Peak — numerous, Rabsztyn Crag — very numerous, in *Dendranthemo-Seslerietum* on Sokolica Peak — numerous, on Facimiech Peak — not numerous. Very numerous in a sample taken from gravel at the Dunajec River in Czorsztyn (the sample contained mainly detritus and litter deposited by water). Moreover, single specimens were collected from under the pieces of rocks in *Festucetum pallentis potentilletosum* (Cisowiec Crag, Zameczysko Crag) and in *Dendranthemo-Seslerietum* (Sobczański Gully).

Pseudosinella zygophora (SCHILLE, 1912) (*Pseudosinella wahlgreni*: STACH, 1964; SZEPTYCKI, 1967; WIŚNIEWSKI, 1967). Species quite recently distinguished (STOMP, 1971), but it seems, that the majority of Central-European data concerning *wahlgreni* (BÖRNER, 1907) refer actually to this species. In Poland reported from several localities (STACH, 1964; SZEPTYCKI, 1964, 1967; WEINER, 1976; WIŚNIEWSKI, 1967). Occurs in the forest litter, in humus, under stones, in rodents' nests and in anthills.

Numerously in *Carici-Fagetum abietetosum* (Facimiech-Klejowa Peaks), and in all the remaining habitats quite numerous or singly. Furthermore, some specimens were collected from under the stones and from mushrooms.

Cyphoderus albinus NICOLET, 1842. Species widely distributed in Europe. Reported from all continents, but it is not certain whether it was always properly distinguished. In Poland known from Wolin Is., Wielkopolska District, Mazowsze District, Lower Silesia, Cracow-Wieluń Upland, Sandomierz Lowland, Pieprzowe Mts., West Beskidy Range, Pieniny Mts. (STACH, 1964; SZEPTYCKI, 1964, 1967; WIŚNIEWSKI, 1967). Myrmecophilous. Occurs also in rodents' nests.

In the Pieniny Mts. a dozen of specimens from the samples from *Festucetum pallentis potentilletosum* (Pulsztyn Crag) and *Dendranthemo-Seslerietum* (Ganek Cliff — Trzy Korony Peak) and from the splitted-of pieces of rocks in *Festucetum pallentis potentilletosum* (Cisowiec and Rabsztyn Crag).

Neelus minutus FOLSOM, 1901. Species occurring probably in the whole

Holarctics. In Poland reported from Ojców region (SZEPTYCKI, 1967) and Pieniny Mts. (WEINER, 1976). Prefers moist habitats.

Numerously in the soil samples from *Carici-Fagetum cephalantheretosum* (Białe Crags), quite numerous in *Carici-Fagetum* (Głęboki Stream Valley, Harczygrund Valley), not numerous in *Fagetum carpaticum typicum* (Pieśniński Stream Valley) and in *Valeriano-Caricetum flavae* (Krościenko).

**Neelus murinus* FOLSOM, 1896. Species reported from Europe, America and Australia. In Poland found in East Sudeten, Kampinos Forest, and Beskid Sądecki Range (STACH, 1964; KACZMAREK, 1973; SZEPTYCKI, unpubl.). Occurs in moist habitats, in mosses and in caves. Encountered also in rodents' nests.

In the Pieniny Mts. two specimens from the soil samples from *Carici-Fagetum cephalantheretosum* on Trzy Korony Peak and from a cave in Sobczański Gully.

**Megalothorax incertus* BÖRNER, 1903. Species known from Southern Europe, reported also from North America and Australia. In Poland found in Ojców vicinity (SZEPTYCKI, 1967) and in the caves of Sokole Range (SKALSKI & WÓJCIK, 1968). Occurs in moist habitats, and particularly in the moss on rocks.

Several specimens were collected from the soil samples in *Fagetum carpaticum typicum* (Pieśniński Stream Valley), *Valeriano-Caricetum flavae* (Krościenko), from the cave of Ociemny, and also in *Dendranthemo-Seslerietum* (Sobczański Gully, Białe Crags).

Megalothorax minimus WILLEM, 1900. Species widely distributed, presumably cosmopolitan. In Poland reported from Pomerania Lake District, Wielkopolska District, Kampinos Forest, Cracow-Wieluń Upland, Małopolska Upland, Pieniny and Tatra Mts. (STACH, 1964; KACZMAREK, 1963; 1973; SZEPTYCKI, 1963; 1973; SZEPTYCKI, 1967; WEINER, 1976). Occurs in the variety of biotopes.

In the Pieniny Mts. found in the soil samples of all habitats: singly, not numerous or quite numerous. Only in a sample taken from under the freshly fallen tree in an oligotrophic beechwood (the slope below Szopka Pass) — numerous.

**Sminthurides aquaticus* (BOURLET, 1943). Probably a cosmopolitan species. In Poland known from Mazovian Lowland, Lower Silesia, East Sudeten and Tatra Mts. (STACH, 1964; KACZMAREK, 1973), and also from Wolin Is. (SZEPTYCKI, unpubl.). Occurs usually on the water surface or on the vegetation near the water.

In the Pieniny Mts. — on the water surface of a small pad made up by a stream, at the foot of Długa Grapa Crag.

**Sminthurides malmgreni* (TULLBERG, 1876). Probably cosmopolitan. In Poland recorded in Kampinos Forest, Cracow-Wieluń Upland, West Beskidy Range, Nowy Targ Basin (STACH, 1964; KACZMAREK, 1973; SZEPTYCKI, 1967) and on Wolin Is. (SZEPTYCKI, unpubl.). Related to the very wet biotopes: occurs on the water surface of small reservoirs, on wet meadows and swamps.

In the Pieniny Mts. only three specimens: from the water surface of a small pad at the foot of Długa Grapa Crag, under the stone in a stream bed (between

the Crags of Zameczysko and Cisowiec), and from the soil sample from *Caltho-Alnetum* (wells of Pieniński Stream).

**Sminthurides schoetti* AXELSON, 1903 (Fig. 10). Possibly, an Euro-Siberian species. In Poland found in Nowy Targ Basin, Tatra Mts., Kampinos Forest and in the Ojców region (STACH, 1964; KACZMAREK, 1973; SZEPTYCKI, 1967). Occurs in mosses soaked with water, on permanently wet meadows, less often on the surface of small water reservoirs.

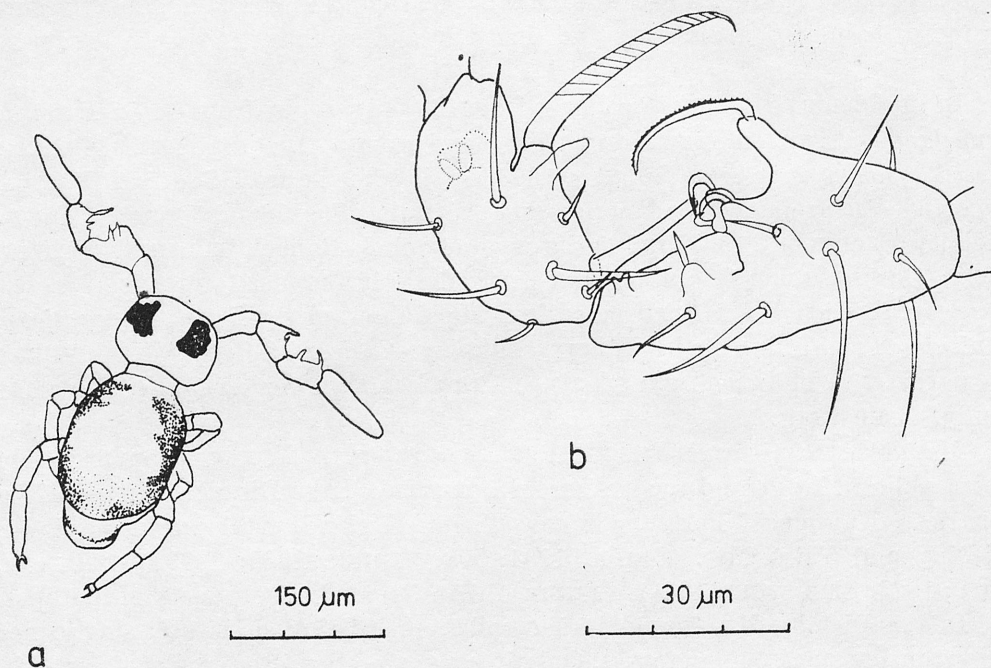


Fig. 10. *Sminthurides schoetti* AXELSON: a — habitus, b — antennal segments III, IV

Quite numerous in *Valeriano-Caricetum flavae* (Krościenko), not numerous in moss near the well on a Pieniny meadow (Szopka Pass), singly in the moss from the wall of a small rock shelter in Sobczański Gully.

**Sphaeridia pumilis* (KRAUSBAUER, 1898). Cosmopolitan species. In Poland reported from Pomeranian and Masurian Lake Districts, from Wielkopolska — Kujawy Lowland, Kampinos Forest, Cracow-Wieluń Upland, West Beskidy Range, Nowy Targ Basin and Tatra Mts. (STACH, 1964; KACZMAREK, 1973; KOBYLAŃSKA, 1976; SZEPTYCKI, 1964, 1967; WIŚNIEWSKI, 1967). Species related to moist habitats.

Not numerous or quite numerous in *Anthylli-Trifolietum*, *Valeriano-Caricetum flavae*, *Festucetum pallentis potentilletosum*, *Tilio-carpinetum*, *Carici-Fagetum* and also very numerous in one sample from *Dendranthemo-Seslerietum*. Furthermore, one specimen was found under the stone in a stream bed near Ostra Crag.

Stencidia violacea (REUTER, 1878). Probably cosmopolitan. In Poland reported from Lower Silesia, Cracow-Wieluń Upland, Nowy Targ Basin, Pieniny Mts. (STACH, 1964) and from Kampinos Forest (KACZMAREK, 1973). Occurs on the vegetation of wet meadows, on the banks of small water reservoirs and in soil.

The specimens reported by STACH (1920, 1956) were collected on a wet meadow. Not found in my materials.

Arrhopalites coecus (TULLBERG, 1871). Probably holarctic species. In Poland reported from West Beskidy Range, Cracow region, Nowy Targ Basin, Tatra Mts., Ojców vicinity, Pieniny Mts. (STACH, 1964; SZEPTYCKI, 1967; WEINER, 1976). Often encountered under the flower-pots and in caves.

Only four specimens collected in the Pieniny Mts. (dry pasture, Podłaźce).

**Arrhopalites pygmaeus* (WANKEL, 1861). Possibly, a holarctic species. In Poland reported from Lower Silesia, East Sudeten, Tatra Mts., Kampinos Forest, from the caves of Sokole Range, Ojców region (STACH, 1956, 1964; KACZMAREK, 1973; SKALSKI & WÓJCIK, 1968; SZEPTYCKI, 1967). Most often found in caves, also in the soil.

Two specimens were found in the cave of Ociemny, one in *Fagetum carpaticum typicum* near Pieniński Stream.

***Arrhopalites secundarius* GISIN, 1958 (Fig. 11a, b). Hitherto species known only from the Swiss Jura (GISIN, 1958), Palatinate (HÜTHER, 1961), Krupińska Upland (RUSEK, 1956b), Abruzzese (DALLAI, 1971) and Siberia regions of Novosibirsk and Tomsk (STEBAEVA, 1976). Collected in moist deciduous forests, swamps, in the soil of vineyards, in plain taiga and forested steppe.

In the Pieniny Mts. one specimen in moss growing on a fallen stump, near the anthill (*Phyllitido-Aceretum* on Trzy Korony Peak).

**Arrhopalites sericus* GISIN, 1947 (Fig. 11 c, d). Reported from Western and Central Europe and from Central Volga Region (ALEJNIKOVA & MARTYNOVA, 1966). In Poland known from the Ojców region (SZEPTYCKI, 1967). Occurs in moss, also found in caves.

Only one specimen in the litter of *Fagetum carpaticum typicum* near Pieniński Stream.

***Arrhopalites spinosus* RUSEK, 1967 (Fig. 11e, f). Species known so far from Lower Tatra Mts. (RUSEK, 1967), where it was collected in a thermophilous beech-hornbeam forest (*Acereto-Carpinetum*).

In the Pieniny Mts. I have found two specimens in the moss from wet rocks in *Carici-Fagetum cephalantheretosum* below the Białe Crags, and in the litter from *Carici-Fagetum abietetosum* on Facimiech — Klejowa Peaks.

**Sminthurinus alpinus* GISIN, 1953, (Fig. 11g). Known from the Alps (GISIN, 1953; 1963c), Rila Mts. (RUSEK, 1965b), Lower Tatra Mts. (NOSEK, 1969), and a separate subspecies from the islands of Rhodos and Crete (ELLIS, 1974, 1976). Reported also from India (CHOUDHURI & ROY, 1972; after: ELLIS, 1976). Occurs under the detached tree bark and on rotten stumps.

In the Pieniny Mts. I have collected this species from the surface and from

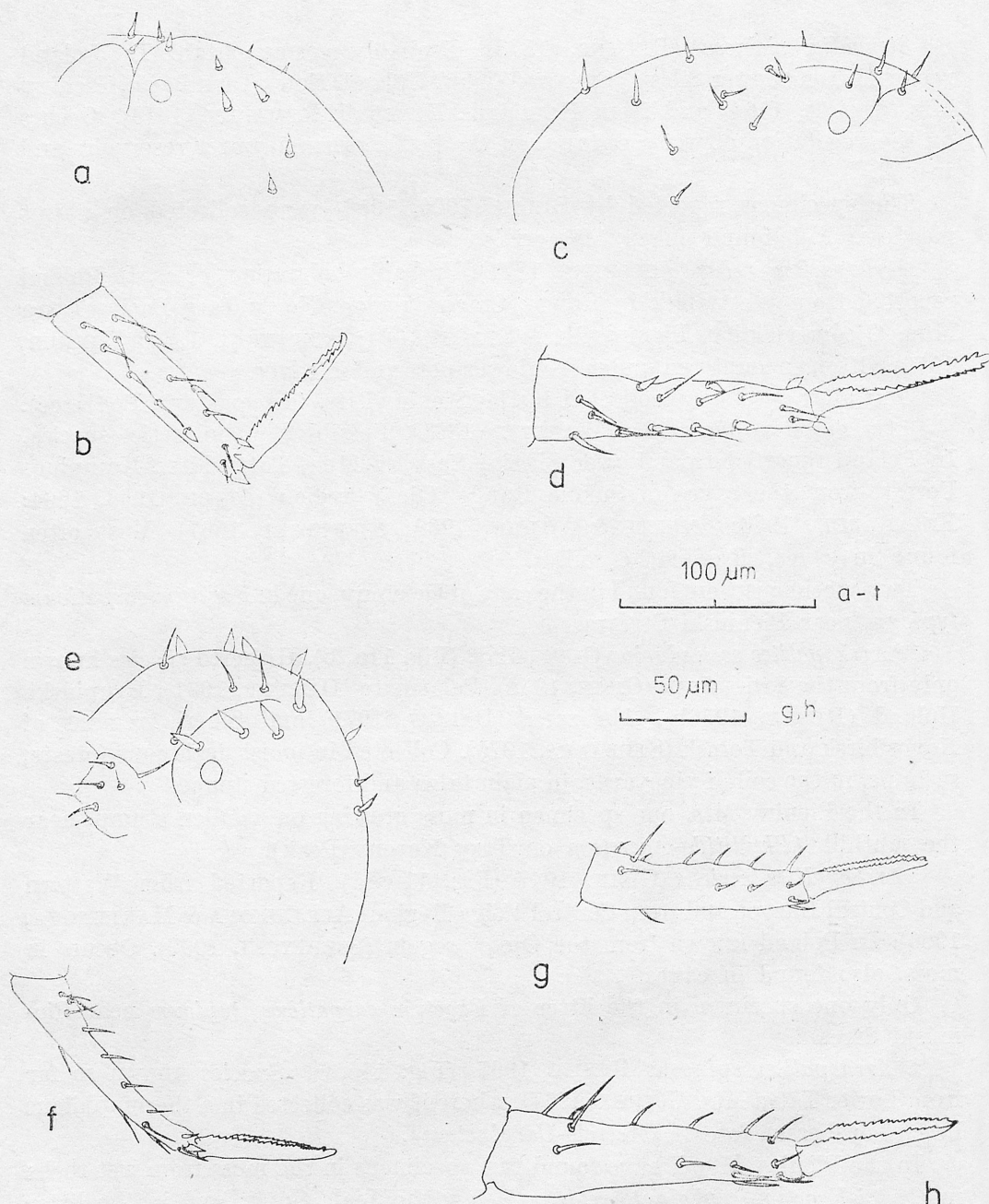


Fig. 11. *Arrhopalites secundarius* GISIN (a-b); *Arrhopalites sericus* GISIN (c, d); *Arrhopalites spinosus* RUSEK (e, f); *Sminthurinus alpinus* GISIN (g); *Sminthurinus gisini* GAMA (h); a, c, e — upper part of the head; b, d, f, g, h — dens and mucro

under the tree bark, and from fallen trees in *Carici-Fagetum* (Harczygrund Valley, Czubata Crag), in *Carici-Fagetum cephalantheretosum* (Facimiech-Klejo-wa Peaks) and in *Pinus silvestris-Carex alba* association (the slopes of Macelowa Peak).

Sminthurinus aureus (LUBBOCK, 1862). Species probably cosmopolitan, provided that it does not consist a group of different species. In Poland widely distributed (STACH, 1964; KACZMAREK, 1973; SZEPTYCKI, 1964, 1967). Occurs in moss growing on the ground, under detached tree bark, and also on herbs.

In the Pieniny Mts. occurred rarely; quite numerous in *Alnetum incanae* (Rówienka), not numerous in *Festucetum pallentis* (Ganek — Trzy Korony Peak), *Dendranthemo-Seslerietum* (Sobczański Gully), *Fagetum carpaticum typicum* (Sokolica Peak), singly in *Carici-Fagetum* (Zameczysko Crag), *Carici-Fagetum abietetosum* (Facimiech-Klejowa Peaks), *Phyllitido-Aceretum* (Facimiech Peak). Moreover, one specimen under the stone near stream in *Carici-Fagetum* (the vicinity of Ostra Crag; var. *ochropus* REUTER, 1890), second one (black form) — on a Pieniny meadow in staled hay (Harczygrund Valley).

***Sminthurinus gisini* GAMA, 1965, (Fig. 11h) (*Sminthurinus niger*: SZEPTYCKI, 1967 — partim). Hitherto reported from two localities in Portugal (GAMA, 1965), from Sudeten (DUNGER, 1970a, b, 1977) and Lower Tatra Mts. (RUSEK, 1966b, s. *Sm. carpaticus* RUSEK, 1966). Corticophilous.

In the Pieniny Mts. collected from the bark of various trees in *Fagetum carpaticum typicum* (Pieniński Stream Valley, Bajków Groń, Gojny Forest), in oligotrophic *Fagetum carpaticum* (Nowa Peak), *Carici-Fagetum abietetosum* (Facimiech-Klejowa Peaks, a gully between Hukowa Cliff and Sokolica Peak), and in *Phyllitido-Aceretum* (Czertezik Peak). Furthermore, some specimens were found on *polypora* growing on willows near farms on Palenica slope.

* *Gisinianus flammeolus* (GISIN, 1957), (*Sminthurinus flammeolus*: SZEPTYCKI, 1967). Species reported from many stands in Europe (BOGOJEVIĆ, 1968; BRETFELD, 1975; CASSAGNAU, 1965; DUNGER, 1973; GISIN, 1957b, 1961a; HÜTHER, 1969; NOSEK, 1969; RUSEK, 1966a, 1968;). In Poland known only from the Ojców vicinity (SZEPTYCKI, 1967). Occurs between fallen leaves, on small herbs.

Singly in the soil samples from *Fagetum carpaticum typicum* (Pieniński Stream Valley), *Caltho-Alnetum* (wells of Pieniński Stream), in the association with *Salvia verticillata*, between pines and junipers (at the foot of Goła Peak). Also in *Anthylli-Trifolietum* in a drainage ditch (Mała Valley) and under the rotten bark of a fallen fir in *Fagetum carpaticum typicum* (Pieniński Stream Valley).

* *Bouretiella arvalis* (FITCH, 1863). Presumably, a cosmopolitan species. In Poland reported from Pomerania Lake District, Mazovian Lowland, Lower Silesia, Cracow-Wieluń Upland, West Range, Nowy Targ Basin, Tatra Mts. (STACH, 1964; SZEPTYCKI, 1967). Occurs in open areas, mainly in meadows and cultivated fields.

Several specimens from the Pieniny Mts. were collected from herbs in *Myricarietalia* at the Dunajec riverside in Czorsztyn.

Bourietiella hortensis (FITCH, 1863). Probably cosmopolitan. In Poland reported from the Mazovian Lowland, and Upper Silesia, Cracow-Wieluń

Upland, East Sudeten, West Beskidy Range, Pieniny and Tatra Mts. (STACH, 1964). Occurs in insolated habitats.

In the Pieniny Mts. found in *Myricarietalia* at the Dunajec River, between the cities of Szczawnica and Krościenko.

Bourletiella viridescens STACH, 1920. Reported from a dozen stands in almost the whole Europe. In Poland known from Pieniny the Mts. and Nowy Targ Basin (STACH, 1964). Occurs in xeric and barren meadows.

Two specimens on herbs in *Myricarietalia* (Dunajec riverside, Czorsztyń).

Deutherosminthurus bicinctus (KOCH, 1840). Probably palearctic species. In Poland reported from Upper Silesia, Cracow-Wieluń Upland, East Sudeten, West Beskidy Range, Nowy Targ Basin, Pieniny Mts., Tatra Mts. (STACH, 1964; SZEPTYCKI, 1967). Occurs in the places with exuberant vegetation.

Commonly in grasslands overgrown with forests: *Anthylli-Trifolietum*, *Origano-Brachypodietum laserpitietosum*, *Origano-Brachypodietum stachyetosum*, *Festucetum pallentis*, in the association with *Veratrum lobelianum* and *Laserpitium latifolium*. Collected also from herbs in *Carici-Fagetum* and *Carici-Fagetum abietetosum*.

Deutherosminthurus repandus (ÅGREN, 1903). Presumably cosmopolitan. In Poland reported from many localities (STACH, 1964; KACZMAREK, 1973; SZEPTYCKI, 1967). Encountered on dry, insolated meadows and fields, less often in moist habitats.

In the Pieniny Mts. occurs commonly on plants in the unforested biotopes.

* *Heterosminthurus insignis* (REUTER, 1876). Presumably a holarctic species. Found in many stands in Poland (STACH, 1964). Numerous encountered in moist meadows, swamps and near the water reservoirs.

Common in wet meadows in West Pieniny Mts. and on the plant growing along the streams; three specimens collected from under the stones in Sobczański stream bed.

Heterosminthurus linnaniemii (STACH, 1920). Quite rare central-European species, reported also from Southern Tuva and South-Eastern Altai (STEBEVA, 1963, 1973, 1976). In Poland known from the Mazovian Lowland, Kampinos Forest, Cracow-Wieluń Upland, West Beskidy Range, Nowy Targ Basin, Tatra and Pieniny Mts. (STACH, 1964; KACZMAREK, 1973; SZEPTYCKI, 1967) and from Roztocze Plateau (SZEPTYCKI, unpubl.). Occurs on herbs in moister open habitats.

In the Pieniny Mts. several dozens of specimens captured on herbs in Pieniny meadows and tall herbs meadows, particularly in moister patches of these associations.

* *Lipothrix lubbocki* (TULLBERG, 1872), (*Sphyrotheca lubbocki*: STACH, 1964; KACZMAREK, 1973; KOBYLAŃSKA, 1976; SZEPTYCKI, 1964, 1967; WIŚNIEWSKI, 1967). Widely distributed in Europe. Reported also from North Africa. In Poland known from many stands (STACH, 1964; KACZMAREK, 1973; KOBYLAŃSKA, 1976; SZEPTYCKI, 1964, 1967; WIŚNIEWSKI, 1967). Occurs under stones,

in forest litter, under the detached tree bark of stumps and in small mammals' nests.

Not numerous or quite numerous in the soil samples of all biotopes. Commonly on stumps, fallen trees, under stones, and on rock walls in almost all habitats except *Dendranthemo-Seslerietum*.

Allacma fusca (LINNAEUS, 1758). Probably a holarctic species. Occurs on the lowland, in mountains reaches the timberline. In Poland reported from many stands (STACH, 1964; KACZMAREK, 1973; KOBYLAŃSKA, 1976; SZEPTYCKI, 1964, 1967). Common on the tree trunks, stumps, stones, also in rodents' nests.

In the Pieniny Mts. found in all forest habitats, where it was very common on stumps, on pieces of wood and under the stones, also on herbs. Immature forms in the soil samples.

Sminthurus guthriei STACH, 1920. Species known from a few stands in the Carpathian Mts. (GRUIA, 1966, 1970; GRUIA & ZAMFIRESCO, 1973; NOSEK, 1962;), from Tuva and Novosibirsk region (STEBAEVA, 1973, 1976). In Poland known only from the Pieniny Mts. (STACH, 1920; WEINER, 1977b). Occurs in dry and isolated habitats.

In the Pieniny Mts. 9 specimens on herbs in *Anthylli-Trifolietum* (near Białe Crags and Nowa Peak) and in *Festucetum pallentis potentilletosum* (Flaki).

* *Sminthurus flaviceps* TULLBERG, 1871. Species distributed in Europe. In Poland reported from the Mazovian Lowland, Lower and Upper Silesia, Cracow-Wieluń Upland, West Beskidy Range (STACH, 1964; KACZMAREK, 1973; SZEPTYCKI, 1967). Most often found on fresh meadows and in forest litter.

In the Pieniny Mts. several specimens taken from mushrooms, and herbs growing on a Pieniny meadow (Harczygrund Valley) and under stones at Limbargowy Stream.

Sminthurus maculatus TÖMÖSVÁRY, 1883. Species reported from Central and Southern Europe. In Poland known from the Cracow-Wieluń Upland and Pieniny Mts. (STACH, 1964; SZEPTYCKI, 1967). Occurs on herbs in xerothermic habitats.

In the Pieniny Mts. common in *Festucetum pallentis potentilletosum* (Cisowiec and Zameczysko Crags, Macelowa Peak, Pulsztyn Crag), in *Origano-Brachypodietum laserpitietosum* (Facimiech Peak, Grabczycha Crag), in *Anthylli-Trifolietum* (near Białe Crags, Szopka Pass) and in *Pinus silvestris-Carex alba* association (slopes of the Macelowa Peak).

** *Sminthurus nigromaculatus* TULLBERG, 1872. A Central-Western European species, reaches 60° lat. N, and does not occur in the Mediterranean region (WALLACE, 1973). Hitherto not reported from Poland, however WALLACE (1973) claims, that some specimens from the Ojców region, reported by SZEPTYCKI (1967) do belong to this species. Occurs in open habitats.

Very commonly on plants in all open habitats. Most numerous in *Dendranthemo-Seslerietum*.

Sminthurus viridis (LINNAEUS, 1758). Widely distributed species, probably a cosmopolitan one. Reaches the latitude of 63° N (WALLACE, 1973). In Poland reported from many stands (STACH, 1964; KACZMAREK, 1973; SZEPTYCKI, 1964, 1967). Common on fields and meadows.

In the Pieniny Mts. collected from herbs on a Pieniny meadow below Białe Crags and on Stolarzówka Meadow.

Sminthurus wahlgreni STACH, 1920. Species known from the Carpathian Mts. (GRUIA, 1966, 1970; NOSEK, 1962, 1963), the Mecsek Hills in Hungary (LOKSA, 1966), Dobrogea in Roumania (GRUIA, 1970), Kopaonik Mts. in Yugoslavia (STEVANOVIĆ, 1956), the foot of Provence Alps (ROUGON & ROUGON, 1970), the Vienna Forest (LOUB & HAYBACH, 1967, s. cf. *wahlgreni*) and from Southern Ural (BUJNOVA & all., 1963, s. *wahlgreni*?). In Poland known only from the Pieniny Mts. (STACH, 1920; WEINER, 1977b). Most often occurring during autumn, winter and spring, in bushes and on snow.

Common in autumn on junipers growing in dry pasture (near Kotłowy Stream, at the foot of Gola Peak, between the Cisowiec and Zameczysko Crags), and several specimens were found on snow in *Carici-Fagetum cephalantheretosum* (Trzy Korony Peak) and on the border of *Fagetum carpaticum oxalidetosum* (Gródek).

Capraínea marginata (SCHÖTT, 1893) (*Sminthurus marginatus*: STACH, 1964; KACZMAREK, 1973; SZEPTYCKI, 1964; 1967). Species widely distributed in Europe. In Poland reported from Wolin Is., Białowieża Forest, West Beskidy Range, Nowy Targ Basin, Kampinos Forest, Cracow-Wieluń Upland, and Pieniny Mts. (STACH, 1964; KACZMAREK, 1973; SZEPTYCKI, 1964, 1967). Occurs in forest in moss and on herbs, under the pieces of wood and in forest litter.

In the Pieniny Mts. relatively common on trunks, under pieces of wood, in moss, under stones in *Carici-Fagetum*, *Fagetum carpaticum oxalidetosum* and in *Anthylli-Trifolietum* bordering with *Carici-Fagetum*.

Dicyrtomina minuta (LINNAEUS, 1767). Probably a west-palearctic species. In Poland reported Wolin Is., Kampinos Forest, Lower Silesia, Cracow-Wieluń Upland, Małopolska Upland, East Sudeten, Pieniny and Tatra Mts. (STACH, 1964; KACZMAREK, 1973; SZEPTYCKI, 1964, 1967). Occurs in forests on stumps, on stones, and under the pieces of wood.

In the Pieniny Mts. two specimens of the typical form collected from herbs in *Alnetum incanae* in Czorsztyn, and a dozen of specimens of var. *flavosignata* on sticks in *Carici-Fagetum* (Harczygrund Valley), and on plants in *Anthylli-Trifolietum* near Białe Crags.

Dicyrtomina ornata (NICOLET, 1842). Species reported from almost the whole Europe. In Poland known from Baltic Coast, Upper Silesia, Cracow-Wieluń Upland, Świętokrzyskie Mts., West Beskidy Range, Pieniny and Tatra Mts. (STACH, 1964; SZEPTYCKI, 1967). Occurs on various herbs, under the pieces of wood and on stumps in fresh forests and bushes.

Commonly in *Fagetum carpaticum typicum*, *Carici-Fagetum*, *Carici-Fagetum*

abietetosum and under stones near the streams. The typical form occurs along with var. *signata*.

Dicyrtoma fusca (LUCAS, 1849). Probably a palearctic species. In Poland reported from Kampinos Forest, Poznań region, Lower Silesia, West and East Sudeten, Cracow-Wieluń Upland, West Beskidy Range, Pieniny and Tatra Mts. (STACH, 1964; KACZMAREK, 1973; SZEPTYCKI, 1967; WIŚNIEWSKI, 1967). Occurs in moist habitats, under the pieces of wood, under stones, on herbs, mushrooms and stumps.

Commonly under stones and sticks in *Fagetum carpaticum typicum*, *Carici-Fagetum cephalantheretosum*, and under the stones near streams.

* *Ptenothrix ciliata* STACH, 1957. Species known only from a few stands: Podolia, Kiev region, Pieniny Mts. (STACH, 1957), Ojców vicinity (SZEPTYCKI, 1967), Bieszczady Range (SZEPTYCKI, unpubl.) and Jeseniky range within the Sudeten Mts. (DUNGER, 1970a, 1977). Found under stones and fallen leaves.

In the Pieniny Mts. three specimens on the bark of a fallen fir laying at the Dunajec River bank near Przechodki Cape.

* *Ptenothrix leucostrigata* STACH, 1957. Species known from several stands in Poland (STACH, 1964; KACZMAREK, 1973; SZEPTYCKI, 1967) and also in Byelorussia (STACH, 1957) and from Börzsöny Range in Carpathians (DUNGER, 1975 s. sf. *leucostrigata*). Occurs in moss, under the pieces of wood, under stones.

I have collected several specimens in *Carici-Fagetum* (from under the stones) and two specimens from under the pieces of wood in *Carici-Fagetum abietetosum* on Facimiech Peak.

Ptenothrix setosa (KRAUSBAUER, 1898). Species known from Central Europe. In Poland reported from the Upper Silesia, West Beskidy Range, Pieniny Mts. (STACH, 1964) and from Ojców vicinity (SZEPTYCKI, 1967). Occurs in moist habitats: under the stones and pieces of wood in forests.

One specimen of this species found together with *ciliata*.

V. FAUNISTIC CHARACTERISTICS OF HABITATS

1. Introductory remarks

The aim of this study was to present possibly complete list of species of *Collembola* from the study area, and therefore the material was collected using a variety of sometimes uncomparable methods. The most extensive material was obtained by the TULLGREN's method (with some modifications — see Material and Methods), from the samples of litter, soil, moss and sod. This collection was complemented by the specimens captured in the same habitats from under stones, pieces of rotten wood, etc. A separate group of samples consists of springtails collected with sampler from herbs, bushes and trees, as well as of those collected in such habitats, for which TULLGREN's methods

were not applicable, e. g. from under the tree bark, from the banks of water reservoirs and from synanthropic habitats. These last biotopes were examined only roughly.

The faunistic characteristics presented below includes a detailed classification, and description of the soil samples and epigeon, while the corticophilous, ripicolous and synanthropic fauna is characterized only superficially.

2. Soil fauna

It is extremely difficult to characterize the fauna of soil *Collembola* in regard to the phytosociological classification of habitats in Pieniny Mts. It results from the two reasons: first, some of the plant associations occur in small, partly mixed up and atypical patches (especially on southern slopes). Secondly, almost all the phytosociological units include a set of microhabitats (as far as small invertebrates are concerned), replicating in various associations.

Therefore, I accepted the individual samples as the main units for classification. Since the samples were not collected in a quantitative manner, the only feature compared was the species composition of particular samples. A numerical method was used for classification, similar to those applied in taxonomy and phytosociology (DZWONKO, 1977).

The similarity ($S_{i,j}$) between the samples or groups of samples (i, j) was calculated according to the JACCARD'S formula (the ratio between the number of the common species to the number of all the species occurring in the groups i, j).

After the matrix of similarities was established, the most similar groups were successively merged by pairs, using the unweighted pair-group method with arithmetic averages (UGPMA; SNEATH & SOKAL, 1973; DZWONKO, 1977):

$$S_{k,ij} = \frac{n_i S_{ik} + n_j S_{jk}}{n_i + n_j}$$

where: $S_{k,ij}$ is similarity of a sample or group of samples k to the group ij , composed of samples i and j ; n_i and n_j are the actual numbers of objects in each group at the current step of clustering.

The JACCARD'S formula as well as the above described clustering method UGPMA are most commonly used in numerical taxonomy due to their relatively clear interpretation and satisfactory results which they yield in many biological applications.

Altogether, 135 samples were subject to classification. The calculations were made on a CYBER-72 computer using FORTRAN programs in the "Cyfronet" Environmental Computing Center.

The results of the classification in the form of a dendrogram (Fig. 12) were subsequently compared with the phytosociological classification of the habitats studies.

The groups of samples distinguished on the diagram reflect microhabitat

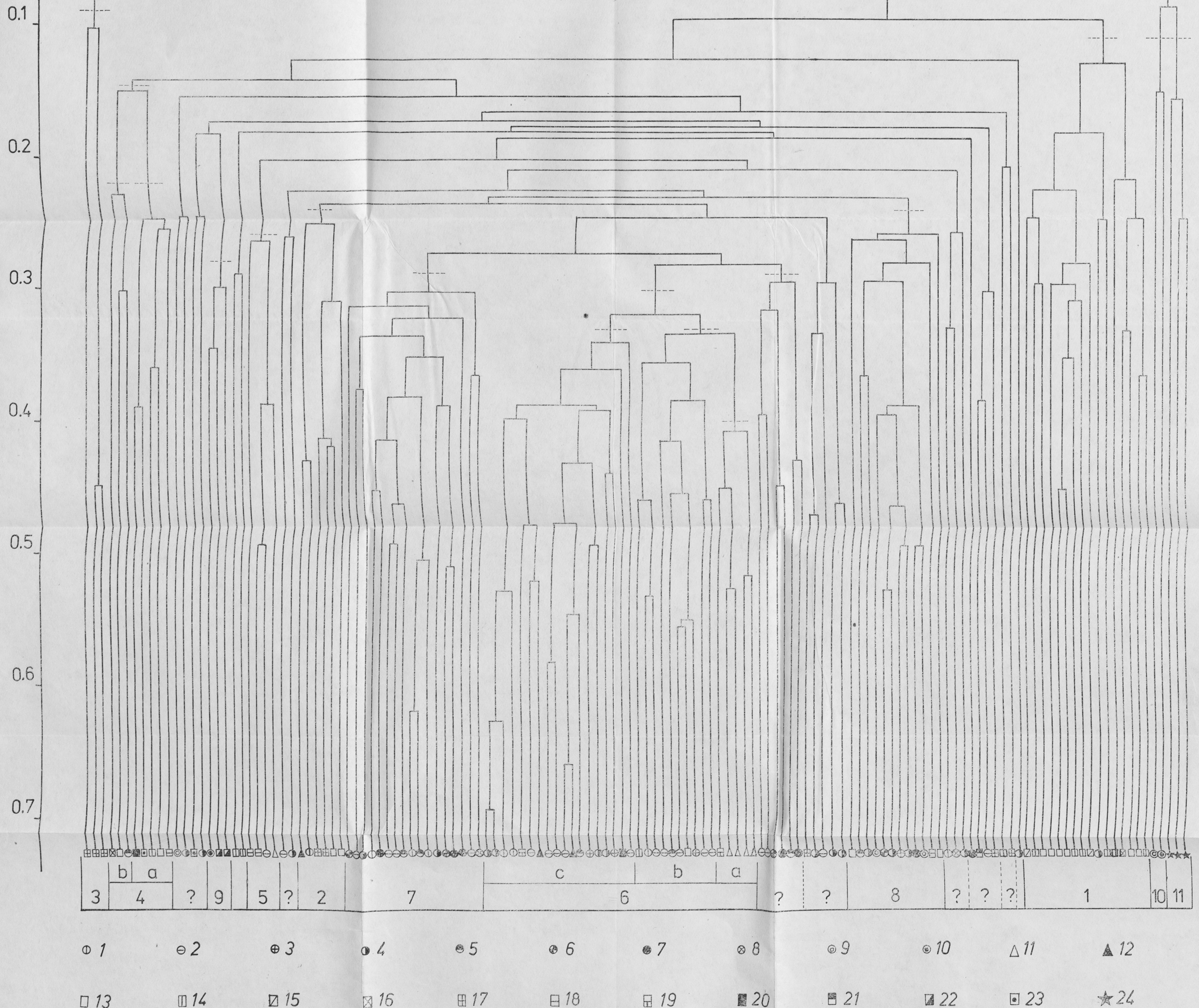


Fig. 12. The dendrogram of similarities between the Collembolan species composition of soil samples taken from various plant associations: 1 — Carici-Fagetum, 2 — Carici-Fagetum cephalantheretosum, 3 — Carici-Fagetum abietetosum, 4 — Fagetum carpaticum typicum, 5 — Fagetum carpaticum — oligotrophic variant, 6 — Fagetum carpaticum ozalidetosum, 7 — Phyllitido-Aceretum, 8 — Tilio-Carpinetum, 9 — Alnetum incanae, 10 — Caltho-Alnetum, 11 — Pinus silvestris-Carex alba association, 12 — Pinus silvestris — Calamagrostis varia, 13 — Dendranthemo-Seslerietum, 14 — Dendranthemo-Seslerietum transiting in Festucetum pallentis, 15 — Dendranthemo-Seslerietum transiting in the association with Alyssum arduini, 16 — Festucetum pallentis, 17 — Festucetum pallentis potentilletosum, 18 — Origano-Brachypodietum laserpitietosum, 19 — Origano-Brachypodietum stachyetosum, 20 — Anthylli-Trifolietum, 21 — association with Salvia verticillata, 22 — Valeriano-Caricetum flavae, 23 — caves, 24 — Myricarietalia. Vertical axis shows the similarity index, according to JACCARD's formula; clustering made with the use of unweighted pair-group method. See text for the discussion of the groups distinguished.

relations within the particular plant associations. Therefore, only in some cases the numerical classification remains in accordance with the classification based on plant associations; otherwise, such factors as humidity or exposition constituted the ordinal criterion.

The fauna of montane saxicolous grasslands *Dendranthemo-Seslerietum*, was very distinctly distinguished (1). The species composition was relatively stable throughout the period of taking samples from this habitat (from spring to late autumn) and it emphasizes the xerothermic and alpine character of this biotope. Most numerous and most commonly the following species occur here: *Xenylla acauda*, *Onychiurus armatus*-group, *Entomobrya multifasciata*, *Isotoma viridis*, *Pseudisotoma sensibilis*, *E. marginata*, *Mesaphorura krausbaurei*, *silvatica*, *Orchesella bifasciata* and *Hypogastrura vernalis*. Thus, the alpine species (such as *X. acauda* or, less often, *Xenyllodes caeca* and *H. crassae-granulata* (*dobsinensis*)), occur here along with xerophilous forms: *Entomobrya multifasciata*, *marginata*, *Pseudisotoma sensibilis*, and less often *Folsomides marchicus*, *angularis* and *parvulus*. At higher elevations in *Dendranthemo-Seslerietum*, in rock crevasses *E. multifasciata*, *Orchesella bifasciata* and *alticola* also occur. This last species appears also on rocks in shadowed situations.

The 1st group does not include all the samples taken in *Dendranthemo-Seslerietum*. These of the saxicolous grasslands (*Dendranthemo-Seslerietum* and *Festucetum pallentis*) on which the conifer litter falls (2), are represented by a different fauna, comprised of *Folsomia penicula*, *Isotoma notabilis*, *Onychiurus armatus*-group, *Isotomiella minor*, *Orchesella bifasciata*, *Mesaphorura krausbaueri*, *Pseudosinella zygophora*, *Entomobrya marginata*. Some species typical for *Dendranthemo-Seslerietum* also occur here e. g. *Xenylla acauda*, *Folsomides marchicus*, *E. multifasciata*, *Hypogastrura vernalis*, as well as the species of thermophilous brushwoods and thermophilous forests: *Anurophorus cuspidatus* and *Microgastrura duodecimoculata*.

Quite different configuration of species occurred in the soil samples from degenerated grasslands — *Festucetum pallentis potentilletosum* from West Pieniny Mts. (3). Common species are: *Schoettella ununguiculata*, *Cryptopygus thermophilus*, *Pseudosinella octopunctata*, *Willowsia buski*, *Xenylla brevissimilis*. Similarly as in the previous group, but less common, *Hypogastrura vernalis* and *Mesaphorura krausbaueri* occur here. Due to the great number of anthills, one can find also *Cyphoderus albinus*.

Two groups of samples (4a, 4b) originating from different but always moist unforested habitats (4) differ considerably from the previously described, distinctly xerophilous fauna of saxicolous grasslands. The great humidity of the samples is connected with the timing of collecting the samples from *Dendranthemo-Seslerietum* and *Festucetum pallentis* (early spring or late summer), with the position close to a well (on a Pieniny meadow) or in a rock shelter. The common feature of all the samples of the group 4a was the abundance of mosses. There are a few species common for all these samples: *Isotoma notabilis*, *Megalothorax minimus*, *Sminthurides schoetti*, *Folsomia penicula*, *I. viridis*. In the samples

occurred also the species characteristic for particular associations: *Brachystomella parvula* in Pieniny meadows, *Xenylla acauda* in *Dendranthemo-Seslerietum* and *Proisotoma recta* in a rock shelter. This last species occurs also in masses on the moist rocks in *Dendranthemo-Seslerietum*, usually in autumn. The most characteristic species for the group 4b were *Onychiurus januarii*, *Pseudoisotoma sensibilis* and *Orchesella bifasciata*.

The samples taken in the both sub-associations of *Origano-Brachypodietum* have not formed a homogenous group, but instead they contributed to the different groups of southern slopes. The habitats intermediate between *Origano-Brachypodietum laserpitietosum* and *Carici-Fagetum cephalantheretosum*, as well as some of the samples from *Pinus silvestris* — *Carex alba* association (thermophilous and moist), have constituted a common group (5). This group is comprised of: *Onychiurus armatus*-group, *Folsomia quadrioculata*, *Tetrodontophora bielensis*, *Isotoma notabilis*, *Isotomiella minor*, *Anurophorus cuspidatus*, *F. penicula*, *Schoetella ununguiculata*, *Liphotrix lubbocki*, and also species typical for forests: *I. pseudomaritima* and *O. variotuberculatus*. Some species related to a thick layer of litter are dominating here.

The samples taken from thermophilous forests, mainly from southern slopes, and containing conifer litter, have constituted a distinctly distinguished and very numerous group (6). Within this broad group, three smaller and strongly integrated habitat complexes are distinguished. The first one (6a) contains the samples from *Pinus silvestris* — *Carex alba* association, together with the samples from *Origano-Brachypodietum stachyetosum*. These associations occur at lower elevations, near to each other. This group is characterised by the following species: *Folsomia penicula*, *Liphotrix lubbocki*, *Onychiurus armatus*-group, *Isotoma notabilis*, *Anurophorus cuspidatus*, *Orchesella bifasciata*, *Pseudosinella zygophora*, and also the species related to forest habitats, and rarely occurring here: *Willemia anophthalma*, *Tomocerus minor*, *O. variotuberculatus*.

The next sub-group (6b) consists of the samples taken from fixed debris in thermophilous beechwoods or from rocky ridges covered with thermophilous firwoods. Apparently, the typically thermophilous species are absent here. Very characteristic is the common occurrence of *Folsomia penicula* (found in all samples). The configuration of species is as follows: *Folsomia penicula*, *Onychiurus armatus*-group, *F. quadrioculata*, *Liphotrix lubbocki*, *Isotomiella minor*, *Isotoma notabilis*, *Orchesella bifasciata*, *O. variotuberculatus*, *Pseudosinella zygophora*, and also *Lathriopyga conjuncta*, *Ceratophysella denticulata* and *Tetrodontophora bielensis*.

The third complex within the same group (6c) is composed of some atypical patches of thermophilous beechwoods with fragments of beech and fir woods, and of these patches of oligotrophic Carpathian beechwood, which are not exposed to the North or North-East. Moreover, the samples from *Pinus silvestris-Calamagrostis varia* association, *Dendranthemo-Seslerietum* occurring under pines on cliffs, and *Origano-Brachypodietum stachyetosum* (variant with bushes) also belong here. The following species make up the fauna of this group: *Isotoma*

notabilis, *Folsomia penicula*, *Onychiurus armatus*-group, *Isotomiella minor*, *Pseudosinella zygophora*, *F. quadrioculata*, *Tomocerus minor*, *Megalothorax minimus*, *Schoettella ununguiculata*, *Mesaphorura sylvatica*, *O. variotuberculatus*, *Tetrodontophora bielanensis*, and also *Choreutinula inermis*, *O. pardoxus*, *Willemia aspinata*. In the samples collected in winter or early spring *O. januarii* occurs.

A separate large complex is made up of mesophilous forests, regardless to their exposition (7). This group consists of the samples from *Fagetum carpaticum typicum*, *oxalidetosum* and oligotrophic variant, *Phyllitido-Aceretum*, *Carici-Fagetum cephalantheretosum* and *abietetosum*, and *Tilio-Carpinetum*. All these samples contain great amount of leaf litter. This group includes the samples collected in the richest habitats. The highest number of species (83) occurs in this group. The following configuration of species is characteristic here: *Folsomia quadrioculata*, *Isotoma notabilis*, *Isotomiella minor*, *Pseudosinella zygophora*, *Onychiurus armatus*-group, *Megalothorax minimus*, *Pogonognathellus flavescens*, *O. rectopapillatus*, *F. penicula*, *Plutomurus carpaticus*, *O. variotuberculatus*, *Tomocerus minor*, *I. pseudomaritima*, *Neelus minutus*, *Ceratophysella denticulata*, *Tetrodontophora bielanensis*. In many samples *Oncopodura crassicornis* and *Pseudachorutes palmiensis* also occurred.

From among the forest habitats, a group of samples (8) has differentiated, related to the coldest, moist habitats of *Alnetum incanae*, *Phyllitido-Aceretum*, *Fagetum carpaticum typicum*, and *oxalidetosum*, *Carici-Fagetum abietetosum*, and even *Origano-Brachypodietum* and *Dendranthemo-Seslerietum*, if the samples were taken in early spring or late autumn at clusters of fallen beech leaves. The species composition is not specific: *Folsomia quadrioculata*, *Onychiurus armatus*-group, *Isotomiella minor*, *O. carpaticus*, *Tetrodontophora bielanensis*, *O. rectopapillatus*, *Friesea truncata*. Moreover, singly occurred: *Pseudanurophorus binoculatus*, *Pseudachorutes dubius*, and *Proisitoma recta*. The lack of the most common species of *Tomoceridae*: *Tomocerus minor* or *Plutomurus carpaticus*, is striking.

Another distinct group is comprised of the samples from the biotopes connected with the leakage of water (9): swamps, swamps bordering with Carpathian beechwoods, Carpathian beechwood bordering with alderwoods on marshes. The species characteristic for moist or even wet habitats occur here: *Sminthurus schoetti*, *Isotomurus palustris*. The most common species are: *Isotoma notabilis*, *Megalothorax minimus*, *Pogonognathellus flavescens*, *Plutomurus carpaticus*, *Micranurida pygmaea*, *Neanura pseudoparva*, *Sphaeridia pumilis*, *Isotoma tigrina*, *Isotomiella minor*, *Friesea truncata*.

The soil samples from *Caltho-Alnetum* (10) differ in their species composition from all other samples. Seven species occurred in this group, with the dominating *Isotomurus plumosus*, and *Sminthurides malmgreni* occurring commonly on water surface.

Poorly integrated, but independent group consist of the samples collected on riverside gravels (11). The species composition is very specific, with commonly

occurring *Isotomurus palustris*, *Hypogastrura assimilis*, *Friezea afurcata*, *Jevania weinerae*, *Isotomodes productus*, *Proisotoma minuta* and *Isotoma tigrina*.

Some groups distinguished in the dendrogram (Tab. 1) are difficult to interpret in regard to the recorded habitat characteristics (they are indicated with question marks on the dendrogram). On the other hand, the samples from some well defined biotopes (Pieniny meadow, caves) have not appeared on the dendrogram.

The samples taken from Pieniny meadow do not constitute any separate group. They are usually not numerous, and the species composition resembles this of the neighbouring forests. The fauna is represented by very common species, such as *Folsomia quadrioculata*, *Isotomiella minor*, *Isotoma notabilis*, *Onychiurus armatus*-group, *Proisotoma minuta*. Less common are *Sphaeridia pumilis*, *Isotoma viridis*, and *tigrina*, and a species typical for meadows *Brachystomella parvula*. In the samples collected in the vicinity of beechwoods, such species as *Pseudosinella zygophora*, *Oncopodura crassicornis*, *Tomocerus minor* and *Onychiurus sibiricus* occur. During winter *O. januarii* also appears.

The fauna of caves resembles very much the fauna of surrounding habitats (*Fagetum carpaticum* typical and oligotrophic variants). Two species were found only in the caves. They were *Mesachorutes ojcoviensis* and *Ceratophysella granulata*. The first one has always been collected only in caves and it seems to be a true troglobiont. It is of interest, that in the Pieniny Mts. I have not found *Ceratophysella granulata* outside of the caves, albeit in other areas this species occurs also in other habitats. Some species occur very rarely outside of the caves in the Pieniny Mts. and they may be considered as typical troglophilous forms: *Arrhopalites pygmaeus*, *Onychiurus silvarius*, *Willemia anophthalma*, *Anurida granulata* and *Willemia intermedia*.

Besides of the numerical classification of the samples, I have conducted a direct comparison of the Collembolan fauna of the main phytosociological units, merging the samples collected in each plant association, and comparing them by the use of diagrams (Tab. I).

The most distinct associations in regard to the Collembolan fauna are *Myricarietalia*, because the majority of common species has not occurred here.

The fauna of saxicolous and xerothermic grasslands has many common features with those of relict pinewoods (*Pinus silvestris*-*Carex alba*, *Pinus silvestris*-*Calamagrostis varia*). Some of the species common for these thermophilous, unforested habitats, occur also in forests growing on the same slopes. On the other hand, all the forest associations have very rich fauna of *Collembola*, with a similar species composition.

Also the faunas of Pieniny meadows, *Tilio-Carpinetum* and *Alnetum incanae* demonstrate many common characteristics with these of other forests, being, however, much less abundant in species.

On the other hand, the fauna of such associations as *Caltho-Alnetum*, or caves, is relatively well distinguished, due to the occurrence of species very characteristic for these biotopes.

The two methods of analysis of the soil fauna composition brings about a conclusion, that an accurate distinction of the springtail associations according to the plant associations is not possible for the following reasons:

1. The numbers of samples taken in various associations were unequal (with the majority of samples taken in beechwoods and in *Dendranthemo-Seslerietum*).
2. The occurrence of numerous microhabitats within a single habitat, as defined by a phytosociological unit.
3. The samples were collected in various seasons. For the above reasons, in one plant association many species of extremely different requirements may occur.

3. Epigeon

On the herbs growing in open habitats (Pieniny meadows, tall herbs meadows, saxicolous grasslands, xerothermic grasslands, dry pastures) the following species occur: *Deuterosminthurus repandus*, *bicinctus* (not collected in *Dendranthemo-Seslerietum*), *Sminthurus nigromaculatus*, *Orchesella flavescens*. In *Dendranthemo-Seslerietum* the plants are penetrated by *Entomobrya multifasciata*, while in *Festucetum pallentis potentilletosum* — by *E. nivalis*. The occurrence of the species listed above depends to a great extent on the season of the year and the current state of the habitats' dessication. On the Pieniny meadow, some species demanding higher humidity also occur, e. g.: *Sminthurus guthriei* and *Heterosminthurus linnaniemii*. This last species may also be found in a tall grass meadow. On swampy meadows and on the plants growing in swamps I have collected the specimens belonging to the three species: *Lepidocyrtus ruber*, *Heterosminthurus linnaniemii* and *insignis*. This last species often occurs on plants growing near the small water reservoirs, and on the water surface as well, though rarely. Other species related to the water plants and water surface (*Sminthurides aquaticus* and *malmgreni*) also occur in the same habitats.

Quite interesting is the fauna of *Collembola* occurring on junipers, small spruces and pine trees growing on meadows, pastures and grasslands. The species encountered here since spring through autumn is *Entomobrya nivalis*. Sporadically occur: *Orchesella xerothermica*, *Sminthurus nigromaculatus*, *maculatus*, and *Deuterosminthurus repandus*. On the junipers in *Festucetum pallentis potentilletosum* I have found two more species: *Xenylla schillei* and *brevissimilis* (occurring singly). These two last species, along with *Entomobrya nivalis*, occur also in the soil samples from these habitats. During autumn, *Sminthurus wahlgre-ni* (commonly) and *Entomobrya lanuginosa* (singly) occur in dry pastures.

In the forest habitats, on the plants of herb layer one can find *Orchesella flavescens*, and also *Allacma fusca*, *Tetrodontophora bielanensis*, *Dicyrtomina minuta*, *ornata*, and in less humid patches — *Orchesella bifasciata*. In the herb layer, in insolated patches or at the border with open habitats, *Orchesella xerothermica*, *spectabilis*, *Entomobrya puncteola* and *Deuterosminthurus bicinctus* singly occur.

4. Corticophilous fauna, fauna of rotten stumps

The corticophilous fauna is represented here by the following species: *Entomobrya corticalis*, *Isotoma albella*, *Xenylla corticalis*, *Friesia claviseta*, *E. nivalis*. Other species encountered on the bark may occur also elsewhere, often in some more moist habitats, e. g.: *Vertagopus cinerea*, *Sminthurinus alpinus*, *gisini*, *Pseudachorutella assigillata*, *Pseudachorutes palmiensis*, *Xenylla boernerii*, *Entomobrya marginata*, *Willowsia buski*, *Orchesella bifasciata*, *V. westerlundii*. Under the moist, rotting bark of various fallen trees, e. g.: *Onychiurus granulatus*, *rectopapillatus*, *armatus*-group, *absoloni*, *Pogonognathellus flavescens*, *Plutomurus carpaticus*, *Tomocerus minor*, *minutus*, *Lathriopyga conjuncta*, *plena*, *phlegrea*, *Hypogastrura aequipilosa*, *Neanura parva*, *Pseudosinella zygophora*, *Lipothrix lubbocki*, *Entomobrya lanuginosa*, *Caprainea marginata*, *Gisinianus flammeolus*, *N. minuta*, *Ptenothrix setosa*.

On the rotting trunks, stumps or under the pieces of wood appear *Tetrodontophora bielensis*, *Allacma fusca*, *Dicyrtomina minuta*, *Dicyrtoma fusca*, *Ptenothrix leucostrigata*, *atra*, *Pogonognathellus flavescens* and *Tomocerus minor*, without regard to the forest type.

5. Ripicolous fauna

In gravel at the Dunajec River banks several species of *Collembola* occur, which were never found in other situations. *Bourletiella arvalis* and *viridiscens* were collected from plants growing on gravel heaps in Czorsztyn, while on the stones and plants below the Pieniny Gorge of the Dunajec River (Szczawnica-Krościenko) only *B. hortensis* was found. Unfortunately, the material from this habitat is scanty and one cannot determine the reasons for such a distribution. Other species found on gravel were: *Orchesella flavescens* and *Isotomurus palustris*.

Quite dissimilar is the fauna found under the stones partly submerged in mountain streams, and in the closest vicinity of streams. In the periods of late autumn, late winter and early spring a hydropetric species characteristic for the cold mountain streams occurs: *Hydroisotoma schaefferi*. I was not able to find the specimens of this species during summer, while *Isotomurus palustris* occurred in masses, accompanied by *Sminthurus malmgreni* and *Isotoma viridis*. This last species occurs also during spring and autumn. Under the stones in small streams running through the forests the same species occur, which are also found on rotten stumps. These species would gather under the stones in the summer time, when the surrounding habitats are subjected to partial dessication. These are *Dicyrtoma fusca*, *Dicyrtomina ornata*, *Caprainea marginata*, *Ptenothrix leucostrigata*, *Orchesella flavescens*, *Pogonognathellus flavescens*, and also *Sminthurinus aureus* and *Spaeridia pumilis*.

6. The fauna of other habitats

The mushrooms constitute the habitat numerously occupied by the spring-tails. The species found on mushrooms do occur also in other habitats, but in the

presence of mushrooms the springtails gather on them very numerously. E. g., *Ceratophysella luteospina* encountered usually in soil, occurs in masses on mushrooms growing on meadows and in woodlands near meadows. Another species, *C. armata*, was collected on mushrooms growing in the forests of Carpathian beechwood type. Only once I have found *C. denticulata* on a parasol mushroom growing in *Carici-Fagetum abietetosum*. On mushrooms growing in fertile meadows at lower elevations I have found the following species: *Ptenothrix atra*, *Sminthurus nigromaculatus*, *flaviceps*, *Allacma fusca*, *Pogonognathellus flavescens*, *Tomocerus minor*, *Pseudosinella zygophora*, *Orchesella spectabilis*, *Entomobrya nivalis*, *Isotoma tigrina*. On polypores: *Hypogastrura aequipilosa*, *O. bifasciata*, *P. flavescens*, *Dicyrtoma fusca* and once — *E. dumitrescuae*.

During winter there occur the snow-dwelling species. The most numerous is *Isotoma hiemalis*, which occur as well on the snow inside of the forests, as on meadows. In forests, one can also encounter *Hypogastrura socialis*, *Orchesella flavescens*, *Sminthurus wahlgreni*, *Hydroisotoma schaefferi*, *Pogonognathellus flavescens*. In fields and meadows in lower situations *I. viridis* and *O. spectabilis* occur. I have found also one specimen of *Vertagopus westerlundii*.

Two species have occurred synanthropically, near the farmhouses: *Orchesella cincta* and *Hypogastrura purpurescens*. This last species has been found on a polypore growing on a willow near a house. In the moss covering maple tree trunk in the city park of Szczawnica I found *Pseudochorutes boernerii* and *Entomobrya arborea*. Inside of the farmhouse I have collected from under the flower-pots *Proisotoma minuta*, *Cryptopygus bipunctatus*, *Onychiurus armatus*-group (= *fimatus*), *Isotomiella minor*, *Mesaphorura macrochaeta*, *Heteromurus nitidus*.

VI. ZOOGEOGRAPHICAL PROBLEMS

1. Introduction

The fauna of springtails of the Pieniny Mts. is very rich. No one of the surrounding terrains studied before presents such a great number of species. In the Tatra Mts. only 134 species have been listed (STACH, 1959, 1964), in the West Beskidy Range (including Nowy Targ Basin) — 151 species (STACH, 1964). Only in Lower Tatra Mts., covering much larger area than the Pieniny Mts., 202 species and 7 forms have been found (NOSEK, 1969). This relatively great number of Collembolan species in the Pieniny Mts. has resulted from the two reasons.

On the one hand, the recent several years have bring about a substantial progress in the systematics of *Collembola*, which has led to the identification of larger number of species. And thus, for example, the former "*Mesaphorura krausbaueri*" includes at present some genera and 11 species. On the other hand, however, the richness of the fauna of the Pieniny Mts. is caused by the physio-

graphical conditions: great variety of land sculpture, geological forms, and also the diversity of microclimates and habitats.

Another important fact was, that during the Pleistocene Pieniny Mts. were placed relatively far away from the head of the continental glacier and were not covered with local glaciations.

2. Zoogeographical analysis

The most numerous group of the fauna consists of widely distributed species. This phenomenon may be related to the following facts: First, for the *Collembola* as a whole, at least for the European species, large geographical ranges are typical (with some rare exceptions). It results from the susceptibility of *Collembola* for accidental introductions and due to the occurrence of similar microhabitats within many different habitats. The Pieniny Mts. are relatively low and therefore the lowland species, usually widely distributed, may find here the appropriate habitats.

Several chronological elements also contribute to the group of widely distributed species: these are cosmopolitan, holarctic, palaearctic, west-palaearctic and central-european species. However, for the sake of the zoogeographical characteristics of the study area, the detailed distinction of these elements seems inessential.

The other group, important from the zoogeographical point of view comprise the montane species. Also within this group some chorological elements may be distinguished. The first one consists of species known from various mountain ranges of Central and Western Europe, and sometimes more widely distributed in the mountains of central and southern Palearctic or even Holarctic. I count the following species into this group:

Hypogastrura crassaegranulata (Fig. 13) — occurs in Carpathians, on Cracow-Wieluń Upland, in Alps, Bavaria, Burgogne, Dinara Mts., Pyreneen Cantabrian Mts., and Caucasus.

Ceratophysella luteospina — known from Carpathians, Cracow-Wieluń Upland, Sudeten, North Alps, Yugoslavia, Italy and Pyreneen.

Friesea albida — occurs in the mountains of South and Central Europe.

Xenylla acauda — reported hitherto from Alps, Pieniny Mts., Cordillera Central (Spain), Cantabrian Mts., montane areas of California and Idaho (North America).

Thaumanura carolii (Fig. 10) — known from the Alps, Carpathians, Sudeten, Cracow-Wieluń Upland, Roztocze Plateau, mountains of the Balkan Peninsula and from a single lowland stand at Pregola River.

Lathriopyga conjuncta — species widely distributes in the mountains of Central and South Europe.

Neanura parva — occurring in Sudeten, Cracow-Wieluń Upland, Carpathians, Alps, southern Tuva and southern Ural.

Onychiurus paradoxus — reported from Alps and Carpathians, and presumably

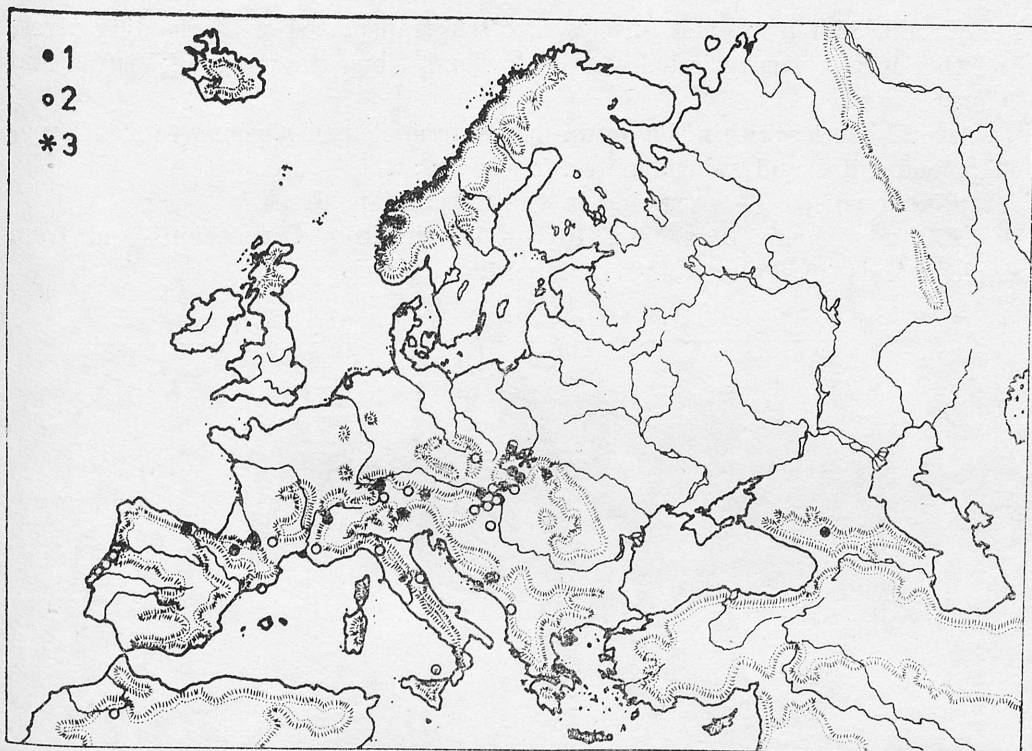


Fig. 13. Distribution of *Microgastrura duodecimoculata* STACH — 1 and *Hypogastrura crassae-granulata* (STACH) — 2, Pieniny — 3

even more widely distributed (often confused with the closely related *O. burmersteri*).

Isotomodes sexsetosus — species reported from the montane areas of South, and Central Europe.

Proisotoma recta (Fig. 15) — known from Tatra Mts., Alps, Provence Alps and Galicia (Spain).

Hydroisotoma schaefferi — occurs in the mountains of Europe, in Caucasus and in North America.

Isotoma pseudomaritima — species occurring in the mountains of Central Europe, in Slovenia and southern Ural.

Orchesella alticola — reported from the mountains of Central Europe and Pyrenees.

Sminthurinus alpinus — known from the Alps, Lower Tatra Mts., and a separate subspecies from Rhodos and Crete Islands.

The second element within the group of montane species consists of Circum-pannonian species, distributed in Carpathians, Sudeten, East Alps, and in northern part of Balkan Peninsula. Here belongs:

Tetrodontophora bielensis — known from Carpathians, Sudeten, Cracow-Wieluń Upland, Transylvanian Alps, Julian Alps, Dinara Mts. and Balkan

Penninsula. Moreover, this species is often transported with flooding rivers and therefore it was recorded also on lowland, along the rivers of Vistula and Oder.

Several species within the group of montane elements belong to the Carpathian endemites and subendemites. These are:

Morulina verrucosa — occurring in the Carpathian Mts.

Onychiurus rectopapillatus (Fig. 15) — known from Carpathians and from single stands in Polesie and Małopolska Upland.

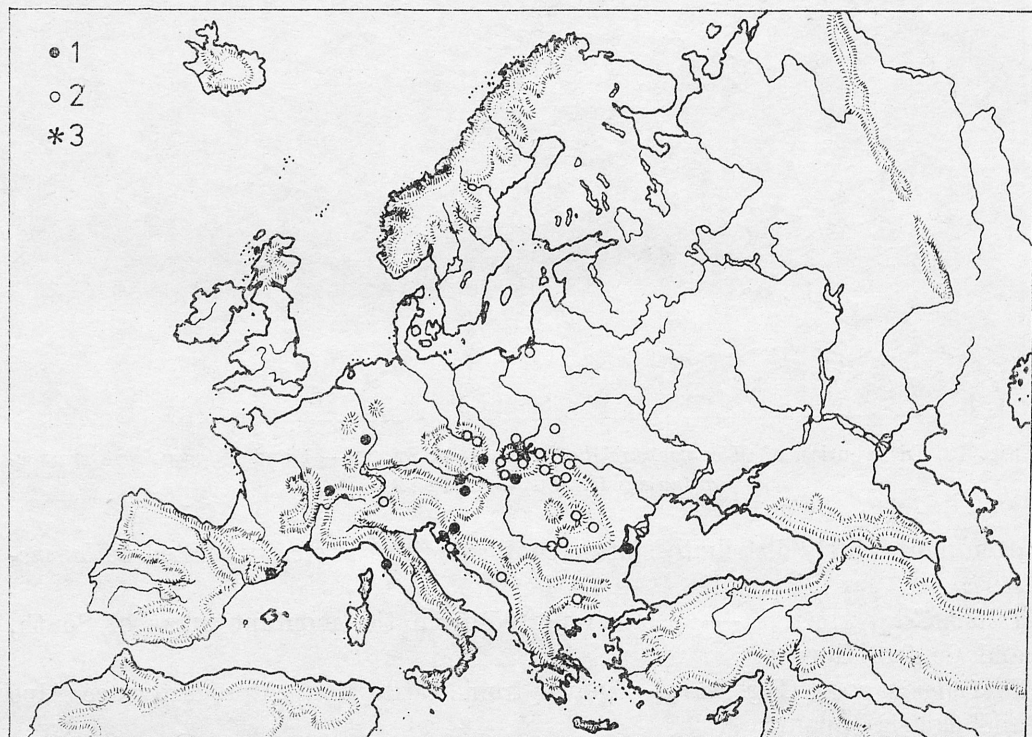


Fig. 14. Distribution of *Onychiurus silvarius* GISIN — 1 and *Thaumanaura carolii* (STACH) — 2, Pieniny — 3

Plutomurus carpathicus (Fig. 16) — known from the northern part of Carpathians, and also from the Ojców region.

The East- and West-Carpathian elements contribute only slightly to the fauna of the Pieniny Mts. At an East-Carpathian element *Onychiurus carpathicus* may be considered, the species known from East Carpathians, West Beskidy Range, Pieniny Mts., South Carpathians and Dobrogea.

The species of the West-Carpathian origin is *Tetracanthella alpina carpatica* — reported from Tatra Mts., Small Carpathians, and Pieniny Mts.

The important group in the fauna of the area studied comprises of the Boreal-alpine species. These species are widely distributed in northern areas

of Palearctic and even Holarctic, at the lower latitudes they occur only in mountains. I include the following species into this group:

Anurida granulata — reported from the northern part of Europe, from the mountains of Central Europe and from southern Tuva.

Onychiurus sibiricus — known from South Europe, Asia and America, and also from the mountains of Central Europe and Asia (Southern Ural).

Xenylla brevicauda — known from Carpathians, Cracow-Wieluń Upland, Alps, Pyreneen, Volga Upland, Scandinavia and Scotland.

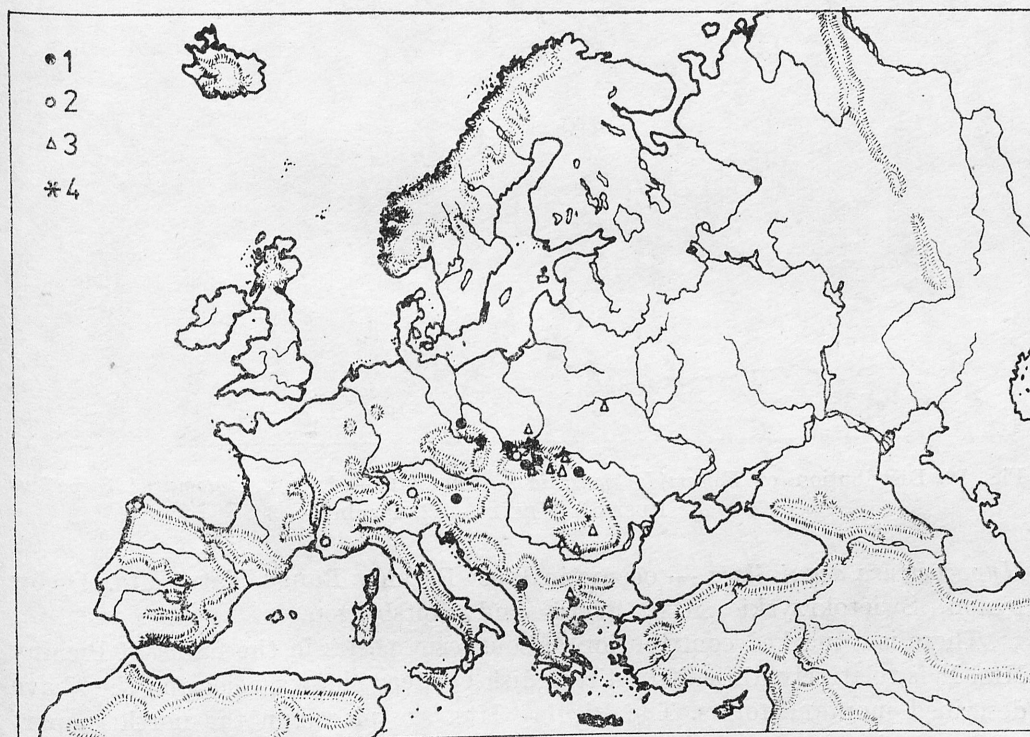


Fig. 15. Distribution of *Onychiurus serratotuberculatus* STACH — 1, *Proisotoma recta* STACH — and *Onychiurus rectopapillatus* STACH — 3, Pieniny — 4

Tetracanthella arctica — occurring on Spitsbergen, Iceland, South Canada, Wrangel It., Sudeten, Ojców region, Moravian Karst, Carpathians, and a separate ssp. in Pyreneen.

Pseudanurophorus binocularis (Fig. 17) — known from northern Europe and also from Sudeten, Cracow-Wieluń Upland, Moravian Karst, Carpathians, Alps, Prealpe Venete, Cordillera Central, also from Tennessee and Connecticut in North America.

Vertagopus westerlundii — reported from northern Europe, Carpathians, Sudeten, Alps, Pyreneen, Krasnoyarsk District and South Ural.

Folsomia inoculata — reported from the mountains of southern Europe, and also from Caucasus, Siberia and Southern Sweden.

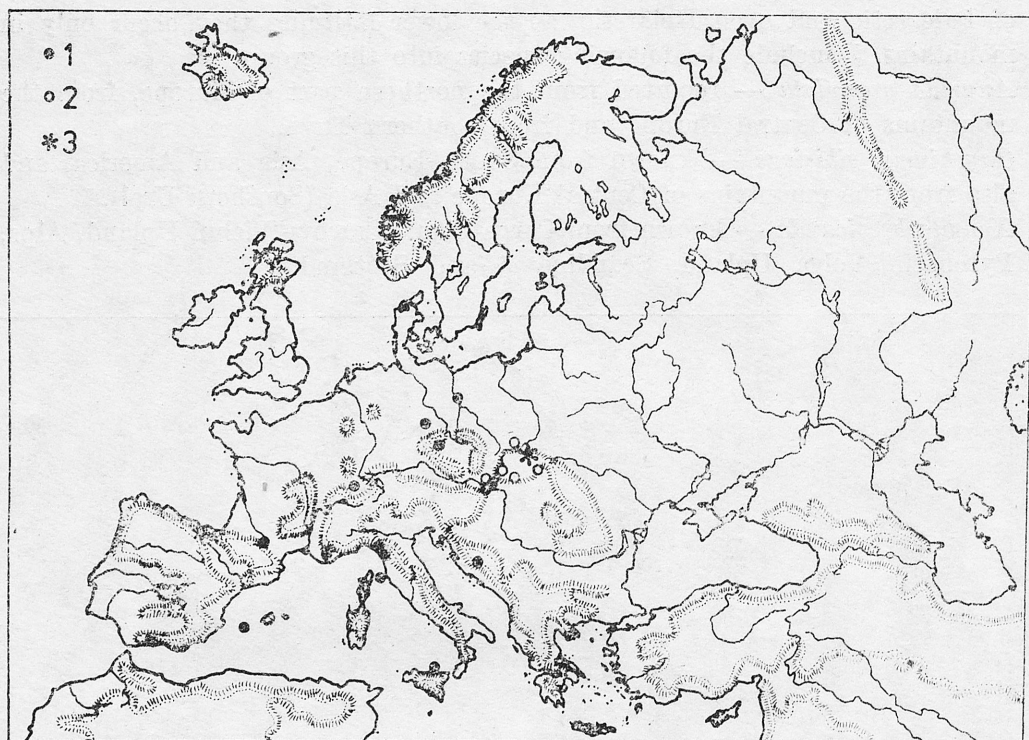


Fig. 16. Distribution of *Folsomides marchicus* (FRENZEL) — 1 and *Plutomurus carpaticus* RUSEK & WEINER — 2, Pieniny — 3

Hypogastrura aequipilosa — occurs in West Beskidy Range, Tatra Mts., Ojców region, Świętokrzyskie Mts., Styria and Spitsbergen.

There is a marked contribution of southern species in the fauna of Pieniny Mts. It is relatively difficult to distinguish between these species and the above described montane forms. The Pieniny Mts. are placed in the northern part of Carpathian bow and they reach the northern boundaries of the ranges of several montane species as well. These forms which occur also in the lowland of Southern Europe, the forms related to xerothermic habitats and these of the montane forms which occur mainly in the mountains of Southern Europe I include to the group of southern species. Accordingly, the following species belong to this group:

Mesachorutes ojcoviensis, the species is widely distributed in the caves of Southern Europe. The northernmost locality of this species was found in the caves of Cracow-Wieluń Upland.

Microgastrura duodecimoculata (Fig. 13) — species reported from Albania, Dinara Mts., Transdanubian and Northern Highlands, Mecsek Hills, Sudeten, Ojców region, East Alps, Apuane Alps, Lipari Is., Montagne Noire, foothills of Provence Alps, Catalonia, central Portugal and Atlas Range.

Pseudochorutes palmiensis — occurs in Southern Europe, especially in moun-

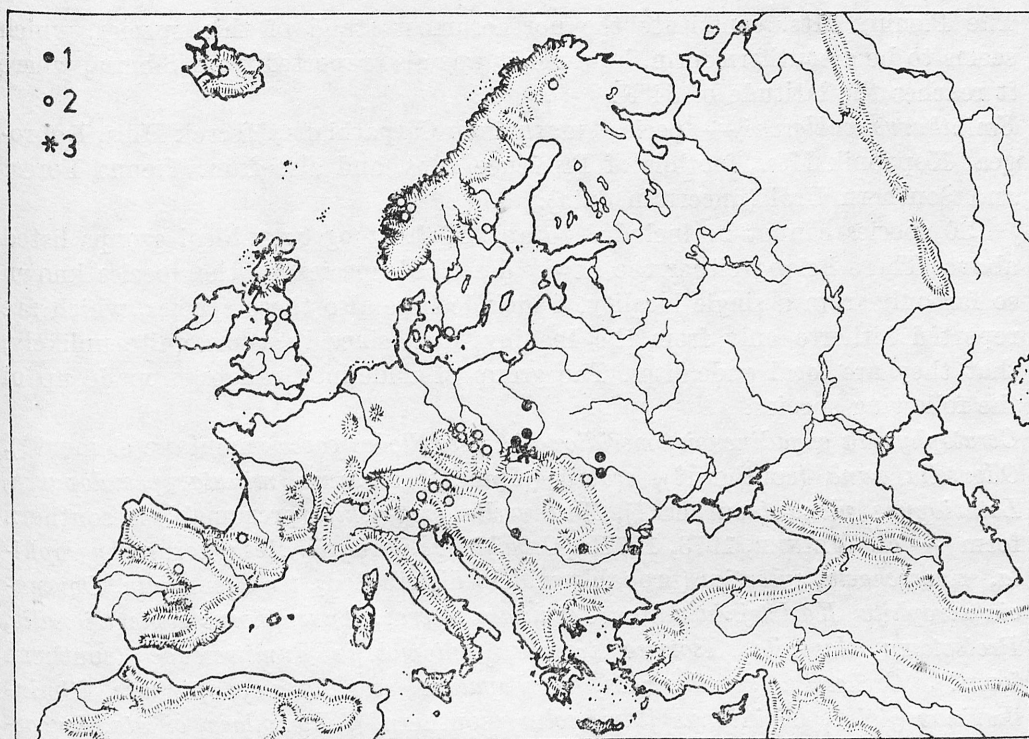


Fig. 17. Distribution of *Orchesella xerothermica* STACH — 1 and *Pseudanurophorus binoculatus* KSENEMAN (European localities only) — 2, Pieniny — 3

tains. Pieniny Mts., Krynica and Truskawiec constitute the northernmost localities.

Lathriopyga phlegrea — the majority of stands is known from Southern Europe. The vicinity of Ojców and Zwierzyniec (Poland) constitute the northern limit of distribution.

Onychiurus variotuberculatus — species occurring from Apuane Alps to Caucasus. Pieniny Mts. constitute the northernmost stand of the species.

Onychiurus serratotuberculatus (Fig. 15) — known from Carpathians, Yugoslavia, Moravy, East Alps. Its northern boundary determine the stands in Bystrzyca Kłodzka, Izerian Plateau and in the Pieniny Mts.

Anurophorus cuspidatus — species distributed in the mountains of Southern Europe, reported also from Nepal. The Pieniny Mts. constitute the northernmost stand of this species.

Folsomides marchicus (Fig. 16) — species occurring in South and Central Europe, in xerothermic habitats. The northernmost stand was found in Bielinek at Oder River.

Oncopodura crassicornis — the majority of stands of this species was reported from South Europe.

Sminthurus guthriei — species known from Caucasus, Carpathians, Transylvania.

The Pieniny Mts. constitute the northernmost stand of this species, which seems to be a southern form, however it was also reported from Siberia, where it reaches the latitude of 54°N.

Sminthurus wahlgreni — species known from Carpathians, Mecsek Hills, Dobrogea, Kopaonik Mts., foothills of Provence Alps, and also from Vienna Forest and Southern Ural (uncertain data).

30 species cannot be included to any of the zoogeographical groups listed above. There belong either the newly described species, or the species known so far only from a single locality. I include here also these species, which are reported hitherto only from the Pieniny Mts., since it seems quite unlikely, that they are local endemites. The group of undefined ranges is made up of the following species:

Ceratophysella engadinensis, *meridionalis*, *Xenyllodes caeca* (montane element?), *Odontella nana* (southern?), *scabra* (alpine?), *Neanura minuta*, *pseudoparva*, *Lathriopyga plena* (southern?), *Neanurella szeptyckii* (presumably a southern form — cf. WEINER, 1973, 1977b), *Onychiurus januarii*, *Mesaphorura hygrophila*, *macrochaeta*, *sylvatica* (probably widely distributed), *tenuisensillata*, *Doutnacia xerophila*, *Karlstejnia annae*, *Jevania weinerae*, *Anurophorus septentrionalis*, *Proisotoma clavipila*, *Isotoma tigrina*, *Entomobrya dimitrescuae* (southern form?), *Orchesella xerothermica*, *Arrhopalites secundarius*, *spinus*, *Sminthurinus gisini*, *Gisinianus flammeolus* (southern?), *Ptenothrix ciliata*, *leucostrigata*.

The share of the particular zoogeographical groups in the whole Collembolan fauna of the Pieniny Mts. may be presented as follow:

widely distributed species	123	64.4%
montane species	19	9.9%
Boreal-alpine species	8	4.2%
southern species	11	5.8%
the species of uncertain distribution	30	15.7%

According to the zoogeographical elements distinguished, the fauna of springtails of the Pieniny Mts. shows a composition intermediate between the fauna of Tatra Mts. (STACH, 1959) and Ojców region (SZEPTYCKI, 1967). The fauna of Tatra Mts. is reach in Boreal-alpine and montane forms. On the other hand, STACH (1959) did not distinguish any southern elements. However, a more detailed study of the limestone West Tatra Mts. could enrich the list of southern species in this area. On the other hand, Pieniny Mts. differ from the Ojców area by the higher number of montane elements, and by a slightly greater number of southern species.

3. Remarks on the history of fauna

KUNTZE (1934) and URBAŃSKI (1939) have claimed, that the fauna of Pieniny Mts. is of the postglacial origin. In the light of the present data, as well of paleographic as of biogeographic ones, this concept should be considered

as too extremal one. Only STACH (1954) guessed, that the fauna of *Collembola* of the Pieniny Mts. was of pre-glacial origin (cf. STACH, 1954; comment on *Onychiurus carpenteri*, p. 122), basing, however, on false assumptions. Obviously the climatic changes at the decline of Pleistocene and during Holocene have finally brought the physiographic and faunistic relations into the present form. However, it seems, that the contemporary fauna is composed as well of the species which have colized this area during Holocene, as of the older forms. These were the forms, which immigrated during the Pleistocene climatic coolings, as well as the species which survived in situ since Tertiary. Such reasoning may be supported with some floristic data (KORNAŚ, 1958; ZARZYCKI, 1976), and faunistic findings (PAWŁOWSKI, 1975), concerning not only the Pieniny Mts., but also the adjacent areas of the Carpathian Mts.

Some paleographic data also support the thesis concerning the possibility of survival of the Tertiary forms. The main features of land sculpture were formed during Tertiary (BIRKENMAJER, 1958; KLIMASZEWSKI, 1948), so that the existence of stands having favourable microclimate, much warmer than in the surrounding (e. g.: protected southern slopes of rocks), was possible in spite of the transition of climate from warm and humid one during Pliocene to the climate of Arctic-Alpine tundra during the Cracovian glaciation (SZAFER, 1954).

Obviously, one should look for the oldest elements of the fauna among the Carpathian endemites and among the species, the range of which does not exceed the limits of Pleistocene glaciation. Usually, however, due to the insufficient knowledge of the species distribution, it is not possible to determine, whether they have survived from Pleistocene in situ, or they have immigrated from the neighbouring forest refuges. Especially, the soil dwelling species have had the chance to survive the glaciation in this area. The conditions in soil do not change so drastically as these on the surface. Moreover, during the glaciations, on the southern slopes of mountains in Europe there were conditions appropriate for the occurrence of woodland and bush clusters (cf. PAWŁOWSKI, 1975). Thus, one can assume, that such species as *Onychiurus carpathicus* and *Oncopodura crassicornis* are the Tertiary element in the fauna of Pieniny Mts., even though at the present they are related to forest habitats. *O. carpathicus* is a East-Carpathian endemite, which support the thesis about its survival in the Pieniny Mts., while in the Tatra Mts. (covered by local glaciation) it is absent. A similar phenomenon occurs in the case of *Machilidae* (*Thysanura*) (STACH, 1925). *O. crassicornis*, due to its eozogacial distribution, may also constitute a preglacial element in the fauna of Pieniny Mts. (cf. STACH, 1934, 1936). This species occurs also in the Ojców vicinity (SZEPTYCKI, 1967), one can assume, however, that it has survived there due to the concave nunatak of Jura (cf. PAWŁOWSKI, 1975; particularly the data on *Trechus pulchellus* PUTZEYS, 1846, p. 176).

Doubtlessly, *Morulina verrucosa* is a very old element in the Carpathian fauna. STACH (1959), basing on the contemporary knowledge of the distribution

of the genus (from which only two species were known at that time), considered this element as relatively young, glacial form. This concept was accepted by other authors (NOSEK, 1969). At present, 9 species and one subspecies are known within the genus *Morulina* BÖRNER, 1906, occurring mainly in the mountains of temperate zone of Holarctics and in Arctics, except the arctic Scandinavia. The arctic stands only slightly enter the area of the pleistocene continental glacier. These data allow for a hypothesis, that only some part of the arctic stands may be related to the Holocene fauna migrations, while the stands at lower latitudes within Holarctics are much older, presumably related to the northern coast of Tetyda Ocean.

Another old element of the fauna of Pieniny Mts. constitutes *Tetracanthella alpina carpatica*. This is a subspecies of a more widely species, distributed in Alps, and belonging to a group limited in its occurrence to Alps, Transylvanian Alps and Carpathians (CASSAGNAU, 1959).

An equally old element may constitute *Plutomurus carpaticus*. All the species belonging to the genus *Plutomurus* YOSII, 1956, are distributed in the areas never covered by glaciations, moreover, the majority of species occur in caves. Only the stands of *P. carpaticus* from the Ojców region are placed within the limits of Cracovian glaciation, but this phenomenon may be explained the same way as in the case of *Oncopodura crassicornis*, by the presence of a nunatak. One can also assume, that the center of dispersion of the genus *Plutomurus* was placed in the Far East. Majority of species (9) of this genus occur in this area (Japan, Korea), and only a few have been reported from the western states of the U.S.A. (3 species). Next three species were reported from Southern Ural (1 species), Caucasus (2 species), and only one species from Europe (Carpathians, Cracow-Wieluń Upland).

It is not unlikely that in the Pieniny Mts. during Tertiary there existed cold mountain streams and wet and chilly rock faces. I believe, however, that the species like *Hydroisotoma schaefferi* and *Prosisotoma recta* (ripicolous species connected with very cold mountain streams) have immigrated into the area of the Pieniny Mts. during the period of a distinct cool of one of the glaciations.

One can also hypothetize, that the high-mountain species: *Xenylla acauda* and *Xenyllodes caecus* also originate from the glacial periods. This may be supported by the occurrence of the clusters of plants typical for glacial relict colonies (KORNAŚ, 1958).

The Boreal-alpine species occurring in the Pieniny Mts. also originate probably from one of the periods of climatic cool.

On the other hand, one can assume, that during interglacial (particularly during Mazovian) the forest species arrived to the area. These species may be considered as the southern elements in the fauna of Pieniny Mts. And thus, e. g. *Onychiurus variotuberculatus*, species very similar to *carpaticus*, has immigrated probably from the neighbouring forest during the Mazovian interglacial period, as suggests the absence of this species in the fauna of Tatra Mts., Sudeten and Ojców Region.

One cannot, however, determine whether the more widely distributed forest species, these occurring also in Tatra Mts., Sudeten and Świętokrzyskie Mts., have survived glaciations in the Pieniny Mts. and then proceeded further dispersal, or they immigrated here in post-glacial period.

An Euro-siberian species, *Tomocerus minutus*, demonstrating a Boreal-alpine disjunction in Europe, is probably a Siberian forest species, in regard to its origin. Analogous distribution demonstrates a snail, *Discus rudieratus* (FERUSSAC, 1821) which occurred in northern Asia already during the upper Tertiary, and in Central Europe it is known as a fossil form low lower Pleistocene (interglacial G/M), (RIEDEL & WIKTOR, 1974). Taking into account the overlapping distributions, one can assume, that also *T. minutus* reached the area of Poland in the same period. One cannot determine, however, whether this species has survived glaciations in the Pieniny Mts., or it has entered the area several times.

Of a special interest in this discussion is *Tetrodontophora bielanensis*, a circumpannonian species. This is doubtlessly an old element in the fauna of Pieniny Mts. and in adjacent areas, because it constitutes also a systematical relict. It belongs to a monotypic genus from a subfamily represented by three species of three genera. Two of them occur in Far East, and one in Central Europe. Most probably, it occurred in the Pieniny Mts. before the glacial period. It is not known, however, if this species did not retreat to the near forest refuges, in spite of its specific biology of reproduction (JURA, 1965).

Synanthropic species, such as *Orchesella cincta* and *Hypogastrura purpurascens*, could have occurred in the Pieniny Mts. not before the sedentary man. In the Pieniny Mts. the first traces of man date from Neolithic age (cf. SMÓLSKI, 1960) and it is likely, that the synanthropic species arrived at that time to the Pieniny valleys.

In connection to the particular distribution of the Boreal-alpine *Tetracanthella arctica* in the Pieniny Mts., one can guess, that this species immigrates contemporarily from Tatra Mts., similarly as some plants (*Arabis alpina*, *Cerastium tatrae*, *Rumex scutatus*) (ZARZYCKI, 1976), along the alluvia of Dunajec River.

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STRESZCZENIE

W latach 1971—1973 i 1975—1977 prowadzono badania fauny skoczogonków Pienińskiego Parku Narodowego. Autorka znalazła 204 gatunki oraz 12—16 form, które prawdopodobnie stanowią gatunki nowe dla wiedzy. Stwierdzono 18 gatunków nowych dla Polski, a 4 zostały opisane na podstawie materiału zebranego w czasie prowadzonych badań.

Praca niniejsza zawiera listę gatunków z uwzględnieniem ich rozmieszczenia na świecie i występowania w poszczególnych środowiskach w Pieninach. Charakterystyka faunistyczna obejmuje szczegółowe omówienie prób glebowych. Klasyfikację prób glebowych przeprowadzono metodą numeryczną, obliczając podobieństwo według JACCARDA i grupując próby parami metodą średnich nieważonych (UGPMA). Grupy wyróżnione na dendrogramie (Fig. 12) odzwierciedlają stosunki mikrosiedliskowe, istniejące w poszczególnych zbiorowiskach roślinnych. Omówiony został także epigeon oraz fauna kortikofilna, ripikolna i synantropijna.

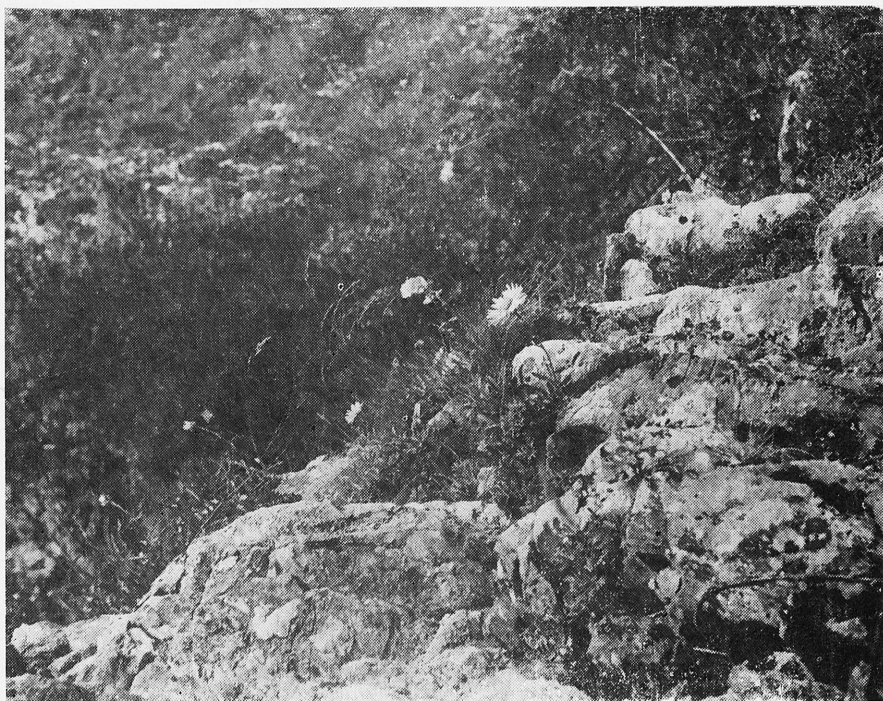
Pod względem zoogeograficznym autorka wyodrębniła 4 zasadnicze grupy. Są to: gatunki szeroko rozmieszczone (kosmopolityczne, holarktyczne, palearktyczne czy europejskie), gatunki górskie, borealno-górskie i południowe. Stwierdzono silny związek fauny Pienin z fauną całego łuku Karpat. Charakterystyczne jest występowanie w tym niezbyt wysokim paśmie górskim gatunków wysokogórskich, a także stosunkowo wysoki udział elementów południowych.

Na podstawie analizy warunków paleograficznych i biogeograficznych autorka dokonała próby wyróżnienia relikтів z poszczególnych okresów. Wydaje się, że najstarsze elementy w faunie Pienin pochodzą z trzeciorzędu. Można także wyróżnić elementy glacialne, interglacialne czy postglacialne, a także gatunki migrujące współcześnie z innych regionów (np. z Tatr).

Redaktor pracy: doc. dr A. Szeptycki

Plate XIX

- 1 — saxicolous mountain grassland — *Dendranthemo-Seslerietum* — in Sobczański Gully
- 2 — relict saxicolous pine wood — *Pinus silvestris-Calamagrostis varia* association — on Czerwone Crags



Phot. 1

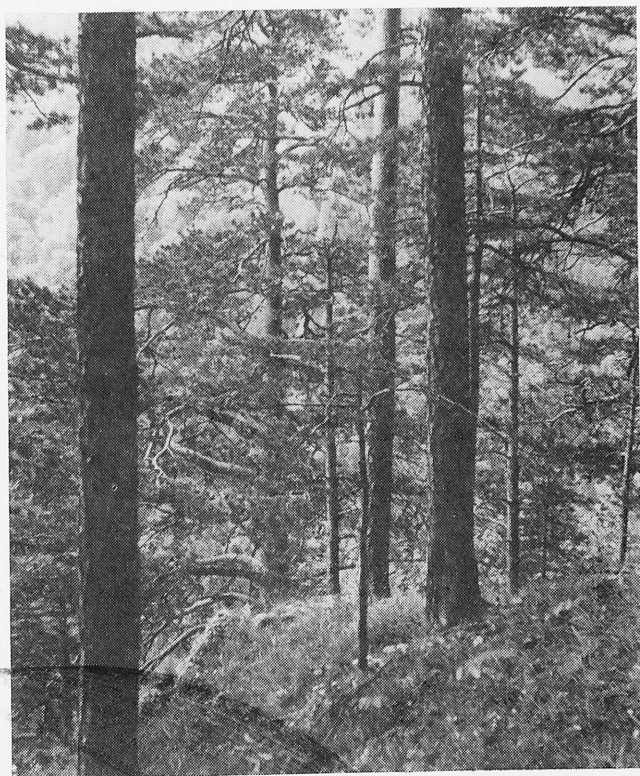
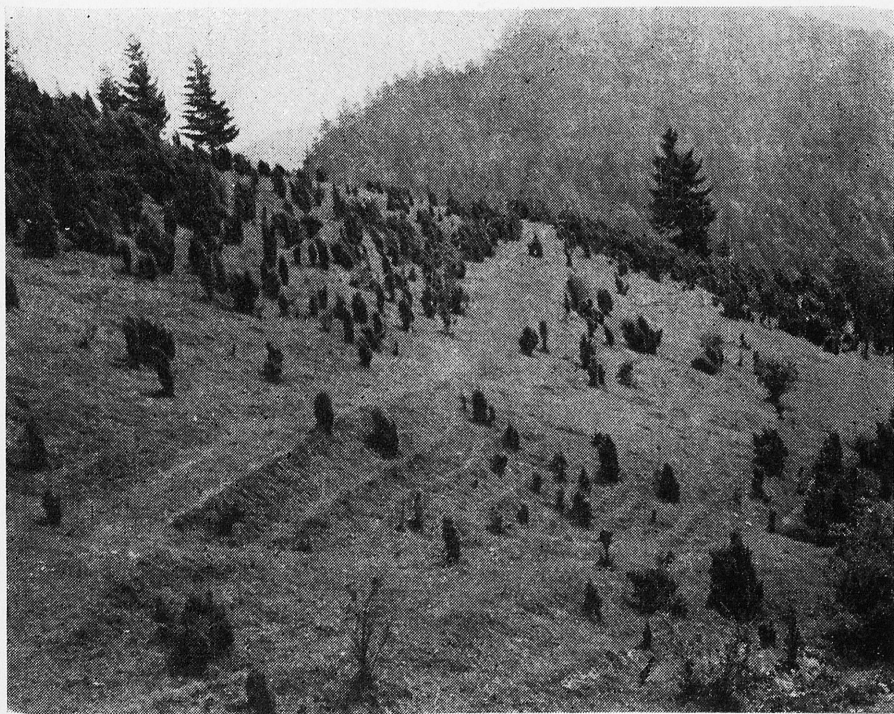


Plate XX

- 1 — xerothermal grassland — *Origano-Brachypodietum laserpiliotosum* — in Sobezański Gully
2 — dry pasture — association with *Salvia verticillata* — Podlażce



Phot. 1



Phot. 2

Plate XXI

- 1 — carpathian beechwood — *Fagetum carpaticum typicum* — near Wielka Valley
- 2 — sycamore wood — *Phyllitido-Aceretum* — on the slopes of Trzy Korony Peak



Phot. 1



Phot. 2

Plate XXII

- 1 — "Pieniny meadow" — *Anthylli-Trifolietum* — Wyrobek Meadow
- 2 — tall herbs meadow — association with *Veratrum lobelianum* and *Laserpitium latifolium* —
below Trzy Korony Peak



Phot. 1



Phot. 2