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The lichen genera Lasallia and Umbilicaria in the Polish Tatra Mts

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THE LICHEN GENERA *LASALLIA* AND *UMBILICARIA* IN THE POLISH TATRA MTS

BEATA KRZEWICKA

Abstract: One species of *Lasallia* Mérat [*L. pustulata* (L.) Mérat] and 20 species of *Umbilicaria* were found in the Polish Tatra Mts. The *Umbilicaria* Hoffm. species were *U. aprina* Nyl., *U. cinerascens* (Arnold) Frey, *U. cinereorufescens* (Schaer.) Frey, *U. crustulosa* (Ach.) Frey, *U. cylindrica* (L.) Delise *ex* Duby, *U. decussata* (Vill.) Zahlbr., *U. deusta* (L.) Baumg., *U. grisea* Hoffm., *U. hirsuta* (Sw. *ex* Westr.) Hoffm., *U. hyperborea* (Ach.) Hoffm., *U. laevis* (Schaer.) Frey, *U. leiocarpa* DC., *U. microphylla* (Laurer) A. Massal., *U. nylanderiana* (Zahlbr.) H. Magn., *U. polyphylla* (L.) Baumg., *U. polyrrhiza* (L.) Ach., *U. proboscidea* (L.) Schrad., *U. subglabra* (Nyl.) Harm., *U. torrefacta* (Lightf.) Schrad. and *U. vellea* (L.) Hoffm. *Umbilicaria aprina* Nyl. was reported for the first from the Carpathians and *U. subglabra* (Nyl.) Harm. from the Polish Tatras. *Umbilicaria arctica* (Ach.) Nyl. was not confirmed from the Tatra Mts. A key to all taxa determination as well as detailed descriptions of their morphology and anatomy are supplied. The distribution and ecology of all species occurring in the Polish Tatra Mts are characterized by diagrams and maps.

Key words: Umbilicariaceae, *Lasallia, Umbilicaria*, key, taxonomy, ecology, distribution, maps, Polish Tatras, Western Carpathians

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INTRODUCTION

The extraordinary features of nature in the Tatra Mts are determined principally by the unique character of this massif. It is the only range in the Carpathians that has a subnival belt and the associated abundant occurrence of lichens.

The first records of lichens from the Tatra Mts date back to the 19th century (Lojka 1869, 1874; Hazslinsky 1870; Fritze & Ilse 1870), but they are very general and thus only of historical importance today. These early records include some fragmentary data on *Umbilicaria* Hoffm. species. Rehman in 1879 listed six species of the genus *Umbilicaria* found in the Tatras [*U. cylindrica* (L.) Delise *ex* Duby, *U. deusta* (L.) Baumg., *U. hirsuta* (Sw. *ex* Westr.) Hoffm, *U. polyphylla* (L.) Baumg., *U. proboscidea* (L.) Schrad., *U. vellea* (L.) Hoffm.]. In some later papers (Boberski 1889, 1892) the occurrence of these species was confirmed but the data did not provide further details such as locations. At twenties of the last century Suza (1926a, b, 1927, 1930) gave detailed descriptions of stations in his treatment of lichens

concerning mostly the Slovakian Tatra Mts. He provided an enormous body of knowledge of rare and new species in the area. For the Tatra Mts he listed 16 species of *Umbilicaria*, including the above species and *U. cinerascens* (Arnold) Frey, *U. crustulosa* (Ach.) Frey, *U. hyperborea* (Ach.) Hoffm., *U. laevis* (Schaer.) Frey, *U. leiocarpa* DC, *U. microphylla* (Laurer) A. Massal., *U. nylanderiana* (Zahlbr.) H. Magn., *U. subglabra* (Nyl.) Harm., *U. torrefacta* (Lightf.) Schrad. and, as we know now, the incorrectly reported *U. arctica* (Ach.) Nyl. (Lisická 1980; Krzewicka 2000b). Motyka (1924a, b, 1926, 1927) reported 11 taxa of *Umbilicaria* for the Polish part of the Tatras at the same time. They were: *U. cinerascens, U. crustulosa, U. cylindrica, U. deusta, U. hirsuta, U. hyperborea, U. leiocarpa, U. polyphylla, U. proboscidea*, *U. torrefacta*, and *U. vellea*. Later studies in the Tatras yielded information about many newly recorded species and their localities (Tobolewski 1955a, 1956a, 1957, 1959, 1960a, 1962a, 1965, 1969; Bystrek 1962). For example, *U. nylanderiana* was reported from the Polish Tatras for the first time in that period (Tobolewski 1954). At the end of 1950s, Matuszewska attempted to elaborate the distribution of *Umbilicaria* in the Polish Tatra Mts. The data were never published, but her research resulted in a huge *Umbilicaria* collection, which served as one of a valuable source of data for the present treatment. In the volume of *Flora Polska – Porosty* (*Lichenes*) devoted to the Umbilicariaceae family and prepared by Motyka (1964) the author reported as many as 20 species from the Tatra Mts area. Many data included in the monograph were based also on the Matuszewska collections (LBL). Later investigations in the Tatras provided only single but often interesting data on the lichen flora of this mountain range, including *Umbilicaria*. The studies were carried out mainly by Olech (1977, 1981, 1983, 1985), Alstrup and Olech (1988, 1990, 1992a) and Bielczyk (1997, 1999). The only available till now, comprehensive treatment of the *Umbilicaria* genus with special concern to the Slovakian Tatras is that provided by Lisická (1980). The monograph was the first source of summarized data with many new findings regarding the genus in the Tatras. The knowledge of the occurrence and distribution of *Umbilicaria* in the Polish part of mountains, however, remained patchy and fragmentary. Moreover, the information concerning particular species is often insufficient or lacking.

In 1998–2001 the genera *Lasallia* Mérat and *Umbilicaria* Hoffm. in the Polish Tatras were studied in detail, based on the field study and revision of herbaria material. The research brought much new and important information about those groups of lichens and their distribution in the Tatras (Krzewicka 1998, 2000b, 2002a, b, c; Krzewicka & Osyczka 2002a, b). The final result of the project is a local monograph of the two genera presented here.

THE MAIN SCOPE OF THE STUDY

Lichen species of the genera *Lasallia* and *Umbilicaria* occurring in the Polish Tatra Mts were the object of this study. Their taxonomy, distribution and ecology were investigated and described.

The research was intended to fill gaps in the knowledge of these lichens in the Tatra Mts: to determine the species composition of *Lasallia* and *Umbilicaria* genera within the Polish Tatras, to estimate the species' general and altitudinal distributions, to provide an ecological analysis of all taxa occurring there, to supply descriptions of the species and to offer an up-to-date guide to taxa identification.

CHARACTERISTICS OF THE STUDY AREA

LOCATION

The Tatra Mts are the highest mountain massif in the Carpathians (Fig. 1). They are located in the center of the Western Carpathians, and form natural the border between Poland and Slovakia. The foot part of the Polish Tatras is at alt. *ca* 900 m; the highest peak is the summit of Rysy Mt. (2499 m a.s.l.). The highest peak of the whole Tatras is the summit of Gerlachovský stit Mt. (2663 m a.s.l.) in the Slovakian territory. The Tatras cover a rela-

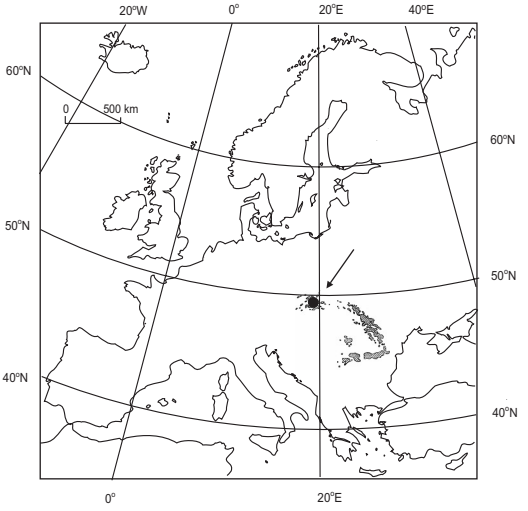


Fig. 1. Location of the Tatra Mts (black dot) on the map of Europe.

tively small area (750 km^2), of which only 21,164 hectares are within the borders of Poland. The Polish Tatras are 26.8 km long and 12.0 km wide. The Polish Tatras include only a part of the West and High Tatras, and their entire territory together with a small part of the adjacent flysch area have been a national park since 1954. In 1992 the park was proclaimed a biosphere reserve.

Though the Tatras are much lower than the Alps, they show all the features characteristic of the high mountains of the alpine system. The differentiation of climatic conditions along the altitudinal gradient, and the varied topography, geological substrates and soil composition are reflected in the great variety of habitats and the diversity of the flora and fauna there.

GEOLOGY

The Tatra Mts are built of magmatic and metamorphic rocks of the Carboniferous (granite, gneiss, mylonite, crystalline shale), and sedimentary rocks. Among the sedimentary rocks can be distinguished Permian sandstone and other rocks of the Mesozoic (limestone, dolomite, marl, clay slate, sandstone, breccia), and Tertiary (Eocene) rocks such as clay slate, sandstone, nummulite limestone and breccia. The West Tatras are built of both sedimentary and crystalline rocks. Crystalline rocks prevail in the High Tatras (Fig. 2) (Klimaszewski & Starkel 1972).

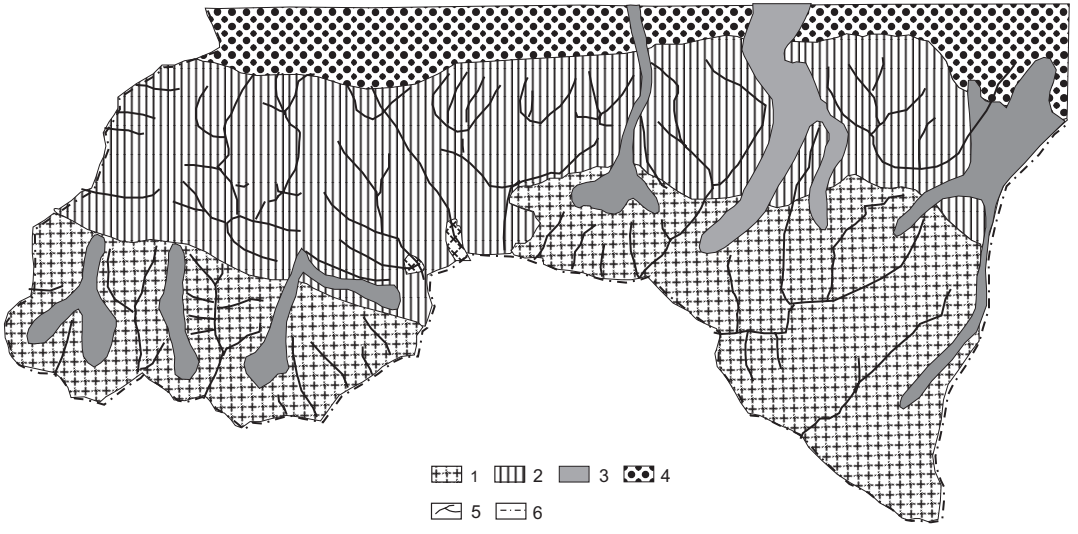


Fig. 2. Geological structure of the Polish Tatras (after Klimaszewski & Starkel 1972, modified and simplified). 1 – crystalline rocks, 2 – sedimentary (mainly calcareous) rocks, 3 – Quaternary sediments (mainly moraines), 4 – Podhale flysch, 5 – secondary lateral ridges, 6 – state boundary.

CLIMATE

The climate of the Tatra Mts is shaped by air masses from various places of origin, mainly polar marine (65% of annual incidents), polar continental to a lesser extent (19.7%), and Arctic (only 6%). Polar marine air comes from the Atlantic and contains large amounts of water vapor. Polar continental air arrives warm in the summer and cool in the winter. The climate is characterized by frequent and considerable changes of air pressure and a great variety of weather types. Extensive cloud cover and long-lasting precipitation in the Tatras are connected with warm fronts. Strong winds, rapid increases in cloud cover and shorter but more intensive precipitation and storms are typical of cool fronts (Hess 1996).

The average annual precipitation reaches 1138 mm in the town of Zakopane at alt. 844 m, and 1876 mm on Kasprowy Wierch Mt. at alt. 1991 m. The number of days with snow cover varies, depending on altitude, from 135 in Kuźnice village at alt. 1023 m to 230 on Kasprowy Wierch Mt. at alt. 1991 m (Orlicz 1962).

Regarding the differentiation of climatic conditions along the altitudinal gradient, five climatic belts have been distinguished in the Tatra Mts (Hess 1965). Their occurrence in the Polish Tatras is as follows:

– temperate cool (up to 1150 m a.s.l.) – mean annual temperature 4 to 6°C,

– cool (1150–1550 m a.s.l.) – mean annual temperature 2 to 4°C,

– very cool (1550–1850 m a.s.l.) – mean annual temperature 0 to 2°C,

– temperate cold (1850–2200 m a.s.l.) – mean annual temperature –2 to 0°C,

– cold (above 2200 m a.s.l.) – mean annual temperature –4 to –2°C.

VEGETATION BELTS

Five vegetation belts have developed in the Tatras: lower montane, upper montane, subalpine, alpine and subnival. The subnival belt does not occur in any other range of the Carpathians. The distribution of particular altitudinal belts and their share in the total surface area of the Polish Tatras are shown in Figure 3.

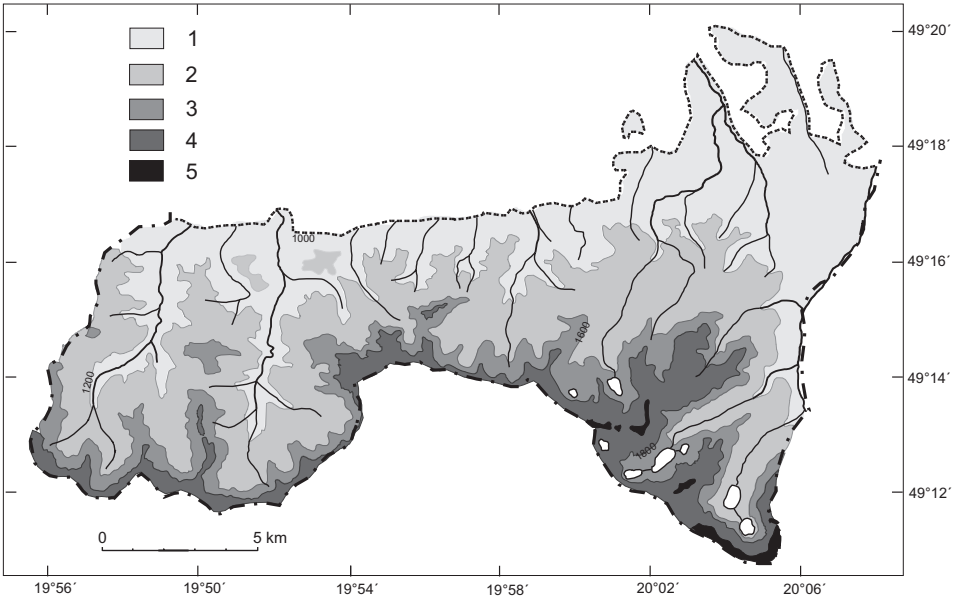


Fig. 3. Distribution of vegetation belts in the Polish Tatras (after Piękoś–Mirkowa *et al*. 1996). 1 – lower montane belt, 2 – upper montane belt, 3 – subalpine belt, 4 – alpine belt, 5 – subnival belt.

In the lower montane belt, which extends from the foot part of the Tatras to 1200(1250) m, the largest areas are occupied by Carpathian beech forest (association *Dentario glandulosae-Fagetum*). This community develops only on substrate rich in calcium carbonate, and thus is not present in some areas of the High Tatras covered with crystalline moraines. In such places, poor spruce forest (association *Plagiothecio-Piceetum tatricum*) thrives.

The upper montane belt (1200–1250 m to 1550 m) is occupied by spruce forest. The edaphic factor is responsible for its differentiation into two associations of the order *Vaccinio-Piceetalia*: *Polystricho-Piceetum* on calcareous rocks and *Plagiothecio-Piceetum* on siliceous rocks.

The subalpine belt develops above the timberline at 1550–1800 m. The *Pinetum mughi carpaticum* association occupies this belt. In the shrub layer the following species occur alongside *Pinus mugo* Turra, *Sorbus aucuparia* L. *emend*. Hedl. subsp. *glabrata* (Wimm. & Grab.) Cajander, *Ribes petraeum* Wulfen *in* Jacq., *Betula pubescens* Ehrh. subsp. *carpatica* (Willd.) Asch. & Graebn. and *Sorbus chamaemespilus* (L.) Crantz.

The alpine belt extends from 1800 m to 2250 m, where high-mountain grasslands become dominant. There occur the two most important, widely distributed grassland associations in the Tatras: *Oreochloo distichae-Juncetum trifidi* on crystalline rocks and *Festuco versicoloris-Seslerietum tatre* on limestone.

Above the alpine belt is the subnival belt, ranging from 2300 m to the highest Tatra peaks. It is characterized by bare rocks and very poor vegetation composed mainly of lichens. In this belt the climax association has developed as *Oreochloetum distichae subnivale*. It develops only on crystalline rocks in the High Tatras.

MATERIAL AND METHODS

The study is based on material collected during the author's fieldwork in the Polish Tatra Mts in 1998–2001. The collection is available in KRA and duplicates are deposited in KRAM, with smaller sets in BRA, KTC and MIN. In addition, a considerable amount of herbarium material was investigated. All material of *Lasallia* and *Umbilicaria* from BDPA, KRA, KRAM, KRAP, KTC, LBL, POZ, TRN, UGDA, WA and WRSL was studied (acronyms follow Holmgren *et al*. 1990 and Mirek *et al*. 1997). All specimens examined are listed in the paper.

Observations of specimens were made with a Nikon 600 microscope and a Nikon SMZ 645 stereomicroscope. For each species, the following features were noted: general morphology; structure of the lower and upper cortex; morphology of rhizines and shape, size, and distribution of thalloconidia. Thallus anatomy was investigated using handmade sections mounted in distilled water or lactophenol-cotton-blue for examination under the light microscope. Scanning electron microscopy was employed to study the conidia shape and size, ornamentation of the surface and to observe thalloconidia location. The structures were examined and photographed with a Joel JSM 5410 scanning electron microscope, mostly at 20 kV. Thin-layer chromatography was performed according to the standard methods of Culberson (1972) with later modifications (Culberson *et al*. 1981).

Habitat conditions were investigated at 798 localities in the whole area of the Polish Tatra Mts. The altitude, slope, aspect, and type of substrate at the localities were determined. For each locality, degree of insolation, humidity and shelter were described. The study results are presented in diagrams showing the frequency of occurrence of a given species at different altitudes above sea level, substrate properties, slopes, aspects and degree of insolation, humidity and shelter. Microsoft Excel 7.0 was used to make the graphs. Diagrams were made for 17 species. The number of sites in the analyses of particular species are as follows: *Umbilicaria aprina* – 3, *U. cinerascens* – 4, *U. cinereorufescens* – 9, *U. crustulosa* – 64, *U. cylindrica* – 242, *U. decussata* – 10, *U. deusta* – 178, *U. hirsuta* – 19, *U. hyperborea* – 27, *U. laevis* – 20, *U. leiocarpa* – 16, *U. nylanderiana* – 28, *U. polyphylla* – 91, *U. proboscidea* – 8, *U. subglabra* – 5, *U. torrefacta* – 47, and *U. vellea* – 27. For four species of all those occurring in the Polish Tatras (*Lasallia pustulata, Umbilicaria grisea, U. microphylla*, and *U. polyrrhiza*) the ecological requirements were not analyzed because not enough data were obtained from field studies. The four species were recorded from single localities or known mostly from herbarium data. A summary habitat preference diagram was produced on the basis of the results of analyses from all 798 sites.

In the presented publication genera and species are listed in alphabetical order. The main synonyms,

description, notes on habitat and distribution are given for each species. Characters peculiar to the species are discussed under each taxon. Descriptions and taxonomic discussions of species are based only on the material examined during the course of these studies.

The following information on the distribution of taxa is provided: occurrence in the Polish Tatra Mts, distribution in Poland with full bibliography, general distribution in Europe. The distribution of all species in the Polish Tatra Mts is presented in dot maps. The localities of the examined species are listed according to the modified ATPOL grid square system (Cieśliński & Fałtynowicz 1993). The distribution maps are based only on the examined materials.

The graphic presentation of each species includes:

– a cyclogram of the frequency of species on different substrates,

– diagrams of the frequency of species on different slopes and aspects,

– diagrams of the frequency of species in different degrees of insolation, humidity and shelter,

– a diagram of altitudinal distribution,

– a diagram of distribution in vegetation belts,

– a map of distribution in the Polish Tatra National Park.

EXPLANATIONS TO DIAGRAMS

Although all these species grow only on siliceous rocks they inhabit different types of rock–substrate. The "Rocks" diagrams show five types of substrate on which these species were found: scree, block of rock, rock wall, large boulder, and pebble.

The following scale was adopted to characterize slope:

0–15° – flat and sloping surfaces
15–30° – steep slopes
30–60° – very steep slopes
60–80° – precipitous slopes
80–90° – vertical surfaces

For the "Insolation" and "Shelter" diagrams a modified version of Barkman's scale was adopted (Barkman 1958).

Insolation was characterized as follows:

1 degree – very shaded (shaded all day)
2 degrees – shaded (shaded at midday)
3 degrees – moderately shaded / sunny (illuminated only half a day)
4 degrees – well illuminated (shaded only morning or evening)
5 degrees – very sunny (sunny all day)

Shelter was characterized as follows:

1 degree – very windy
2 degrees – windy
3 degrees – moderately windy / moderately sheltered
4 degrees – sheltered
5 degrees – very sheltered

Our own five-stage graduated scale was used to characterize humidity:

1 degree – very dry (without mosses, vascular plants sparse)
2 degrees – dry (only vascular plants, without mosses)
3 degrees – moderately dry / moist (numerous vascular plants, mosses sparse)
4 degrees – moist (humid, numerous mosses)
5 degrees – very moist (spray, near water seepage)

For the "Distribution in vegetation belts" diagram the following abbreviations were used:

Rd – lower montane belt, alt. 900–1200 m
Rg – upper montane belt, alt. 1201–1600 m
K – subalpine belt, alt. 1601–1800 m
H – alpine belt, alt. 1801–2200 m
T – subnival belt, alt. 2201–2449 m

TAXONOMIC TREATMENT OF THE SPECIES OCCURRING IN THE POLISH TATRA MTS

MORPHOLOGY

Lasallia is foliose lichen of brown, fragile thallus with central strand on the lower surface. The upper surface produces very characteristic pustules and branched isidia. The specimens of *Lasallia pustulata* occurring in the Polish Tatra Mts have small thalli reaching only 3–4 cm in diameter, with very damaged edges, fruitless, and with only tiny granulose isidia. Except for the small size and the lack of branched isidia, these individuals possess the anatomical and morphological structures typical for the species.

The species of the *Umbilicaria* have a dorsoventral organization with distinct upper and lower surfaces. These are fragile foliose thalli fixed to the substrate by a short central strand. The species studied in the Tatra Mts generally are characterized by dun-greyish coloration and variable size of thalli. The taxa occurring in this area include both very small representatives *ca* 0.5 cm in diameter (e.g., *U. microphylla*) and relatively large – reaching up to 8–10 cm in diameter. Thalli of Tatra specimens reaching 8–10 cm are very rare, and these are only very old individuals of

U. vellea and *U. hirsuta*. Most species occurring there currently, such as *U. cylindrica, U. crustulosa, U. decussata,* and *U. laevis*, reach only *ca* 3–4 cm. In general the thalli of *Umbilicaria* species in Tatra Mts are markedly smaller than the thalli of the same species occurring in polar regions (Filson 1987; Øvstedal & Lewis Smith 2001).

The species studied in the Tatra Mts occurred in several morphological forms: as single monophyllous specimens (*U. aprina*, *U. vellea*), as monophyllous thalli crowded closely together (*U. microphylla, U. cylindrica* var. *tornata*), and also as polyphyllous thalli with lobes of rather uniform length (*U. cinerascens* and *U. polyphylla*). Transitional forms of thalli between monophyllous and polyphyllous form are most common, however; in primarily monophyllous thalli, new lobes appeared in the central part, turning the thallus into a polyphyllous one (e.g., in *U. deusta* and *U. leiocarpa*).

The examined specimens were predominantly dark in color, from grey (*U. cylindrica*) and dun-greyish (*U. cinerascens*) through brown (*U. deusta*) and dark brown (*U. hyperborea*). There were also specimens with the upper side beige or greyish beige (*U. aprina, U. crustulosa*). There was some within-species variation in the color of the upper side of the thallus. Sometimes differences are noted between lobes of the same specimen. Lobes that are more shaded or more moistened may be differently colored. The color of the upper side of thallus is not a good diagnostic character. Some differences in the color of the upper side are noted also between specimens of the same species originating from different regions of the world. For example, the upper side of the thallus in *U. deusta* and *U. hyperborea* is brown or dark brown in Tatra Mts specimens, whereas in North American specimens it is much darker brown or nearly black (Llano 1950). The occurrence of white pruina in the central zone of the upper side of the thallus, caused by dead fungal cells, is a permanent species character. In *U. proboscidea* and *U. subglabra* this feature is particularly manifested. The color of the under side of the thallus is extremely variable and strongly affected by environmental conditions. In the same population, lobes growing under slightly different ecological conditions may differ in the color of the underside. Generally, under inferior light conditions the underside of the thallus remains paler for a longer time (Poelt & Nash III 1993).

Species of the genus *Umbilicaria* display considerable variation of the structure of the upper side and underside of the thallus: smooth, scabrous, even, wrinkled, rimose, rugose, vermiform-folded or ribbed. Within species, however, the variability of this feature is not significant, and the structure of the upper and lower cortex is a very good taxonomical feature for a given species. Thus, a smooth and vermiform-folded upper cortex is characteristic for *U. hyperborea* and *U. torrefacta*; a smooth and even upper cortex for *U. polyrrhiza* and *U. polyphylla*; a rimose but even upper cortex for *U. laevis* and *U. hirsuta*; and an uneven and distinctly areolate upper cortex for *U. leiocarpa*. Between specimens there may be minor differences in the intensity of a given character; for example, the degree of wrinkling varies in *U. hyperborea* – there are forms with nearly smooth upper cortex, only minutely vermiform wrinkled to distinctly vermiform-folded. Like the upper side of the thallus, the structure of the underside is species-specific. A smooth and even lower surface is a character for *U. nylanderiana* and *U. polyphylla*, a pitted lower surface for *U. deusta*, and an even lower surface, markedly areolate around the umbilicus, for *U. cinerascens*.

The underside of the thallus may also be bare or may form trabeculae, lamellae, papillae or rhizines of variable shapes and sizes: flattened or cylindrical, single or branched, short or long. Trabeculae are strap- or rib-shaped radiating structures from the umbilicus merging towards the mid-zone of the lower surface of the thallus. Lamellae are downwardly projecting, flattened strap- or plate-like structures from the under surface of the thallus. Papillae are small, wart-like protuberances.

A total lack of rhizines is an important taxonomic feature, but the presence of rhizines alone is a character of less taxonomic meaning. Among species of the same taxon having rhizines, there are specimens covered by dense rhizines as well as those with a few rhizines, or having a seemingly

bare thallus with a few rhizines hidden in depressions or folds of the thallus, often not visible at all. The rhizines in this group do not serve to fasten the thallus to the substrate, as this function is taken over by the umbilicus. They do, however, play an important role in the water management of these organisms as they provide an additional absorption surface. They may also be a source of asexual spores. In the Tatra Mts, eleven species do not develop rhizines, eight species have cylindrical rhizines, one species has flattened, shredded lamellae (*U. torrefacta*) and one species has papillae (*U. cinereorufescens*).

The lichens of the genus *Umbilicaria* reproduce by two ways: sexually by producing ascospores in apothecia, and asexually by producing soredia, isidia, conidia and thalloconidia. Based on the structure of the fructifications, these lichens can be divided into four groups having: apothecia with a smooth disc – leiodisc (e.g., *U. leiocarpa*), apothecia with a sterile, central column – omphalodisc (e.g., *U. crustulosa*), apothecia consisting of concentric gyri – gyrodisc (e.g., *U. cylindrica*) and apothecia consisting of radial gyri – actinodisc (e.g., *U. polyrrhiza*) (Llano 1950). In the Tatra Mts, both ana-teleomorphic and teleomorphic thalli are infrequent; only five of 20 species occurring there have normally developed apothecia with spores. Of these five species, only *U. torrefacta, U. hyperborea* and *U. cylindrica* almost always form apothecia. Specimens of *U. crustulosa* bearing fructifications were found as often as those without fructifications. In case of *U. proboscidea*, apothecia occurred on the thalli of only *ca* 30% of the examined specimens. In four other species (*U. deusta*, *U. leiocarpa*, *U. polyphylla*, *U. vellea*) greatly deformed fructifications were observed, and only on a few thalli. In *U. deusta*, fructifications were found on three specimens, that is, on *ca* 0.1% of the examined representatives. There was a similarly low frequency of specimens with fructifications in *U. polyphylla*; apothecia were found on two specimens. The specimens of *U. leiocarpa* and *U. vellea* had only deformed fructifications without spores.

Production of soredia and isidia is not very common in the species of the genus *Umbilicaria*. Among the Tatra species only *U. hirsuta* and *U. grisea* produce soredia, whereas isidia are created only by *U. deusta*. All the other taxa occurring in the Tatra Mts, whose thalli form neither massive numbers of fructifications nor soredia and isidia, have thalloconidia. Thalloconidia are often the only way of their reproduction noted in the area. In this genus the thalloconidia are formed principally from the lower cortex, and less frequently from the rhizines. There are 11 thalloconidia-forming species occurring in the Polish Tatra Mts. The presence and position as well as the size and shape of the thalloconidia are strictly species-specific. They occur on the whole of the underside of the thallus except for the marginal zone (*U. leiocarpa*) or except for the central zone (*U. cinerascens*), or except for both the marginal and central zones (*U. subglabra*). They can occur only on the underside of the thallus and be absent from the rhizines (*U. aprina*), or they can be produced on the rhizines exclusively (*U. vellea*). The sizes of thalloconidia range from 4.6 × 5.8 μm up to 21.9 × 31.4 μm; they may be unicellular (*U. leiocarpa*) or multicellular (*U. polyphylla*) (Table 1). The thalloconidia in *U. laevis* were discovered by Hasenhüttl & Poelt (1978). However they were characterized in detail for the first time during the course of this study. They are non-septate, usually spherical, and rarely oviform, delicately to moderately roughened, and dark brown colored. The size of the spores is 8.6 × 10.0 μm

Table 1. Average size of the thalloconidia in species of *Umbilicaria* in the Polish Tatra Mts.

Species	Average size	Type
U. leiocarpa	4.6 × 5.8 μm	non-septate
U. cinerascens	6.7 × 7.8 μm	non-septate
U. subglabra	7.1 × 7.4 μm	non-septate
U. decussata	7.3 × 8.6 μm	non-septate
U. aprina	7.6 × 8.8 μm	non-septate
U. laevis	8.6 × 10.0 μm	non-septate
U. nylanderiana	9.3 × 10.2 μm	non-septate
U. polyphylla	15.0 × 16.0 μm	multi-septate
U. polyrrhiza	18.7 × 19.5 μm	multi-septate
U. cinereorufescens	19.5 × 27.5 μm	multi-septate
U. vellea	21.9 × 31.4 μm	multi-septate

(Figs 31, 32). The thalloconidia are produced in small black patches on the underside of the thallus; occasionally, when the thalloconidia cover it completely the lower surface of the thallus is completely black, except for a marginal zone, which is always free of thalloconidia and light grey in color.

An additional way of the *Umbilicaria* species reproduction is conidia produced in uni- or multiloculate pycnidia. Pycnidia are immersed in upper cortex and are distributed in marginal zone of the thallus. They are mainly bottled-, pear-shape, with pale brown to brown wall and dark brown ostiole.

SPECIES REVIEW

List of species

On the basis of field studies and revision of herbarium materials, one species of the genus *Lasallia* [*Lasallia pustulata* (L.) Mérat] and 20 species of the genus *Umbilicaria* were found in the Polish part of the Tatra Mts: *Umbilicaria aprina* Nyl., *U. cinerascens* (Arnold) Frey, *U. cinereorufescens* (Schaer.) Frey, *U. crustulosa* (Ach.) Frey, *U. cylindrica* (L.) Delise *ex* Duby, *U. decussata* (Vill.) Zahlbr., *U. deusta* (L.) Baumg., *U. grisea* Hoffm., *U. hirsuta* (Sw. *ex* Westr.) Hoffm., *U. hyperborea* (Ach.) Hoffm., *U. laevis* (Schaer.) Frey, *U. leiocarpa* DC., *U. microphylla* (Laurer) A. Massal., *U. nylanderiana* (Zahlbr.) H. Magn., *U. polyphylla* (L.) Baumg., *U. polyrrhiza* (L.) Ach., *U. proboscidea* (L.) Schrad., *U. subglabra* (Nyl.) Harm., *U. torrefacta* (Lightf.) Schrad. and *U. vellea* (L.) Hoffm.

New records

During field studies carried out in the Polish Tatra Mts, three localities of *Umbilicaria aprina* were discovered. It was the first note of the taxon's occurrence in Poland and the Carpathians (Krzewicka & Osyczka 2002a). *Umbilicaria subglabra* is reported for the first time from the Polish Tatra Mts here.

Lichens reported from the Polish Tatra Mts, presently not found

The species not found during the course of recent field studies are *Lasallia pustulata, Umbilicaria microphylla* and *U. polyrrhiza*. These species were recorded from single locations in the Polish Tatra Mts almost 50 years ago.

Mistaken reports from the Tatra Mts

Umbilicaria arctica (Ach.) Nyl., a species previously reported from the Polish Tatra Mts (Motyka 1964; Alstrup & Olech 1992b) was not found in field studies during this project. Nor did revision of the herbarium material from this part of the Tatra confirm the occurrence of this species in these mountains. Motyka (1964) reported that a station of this species was discovered by Matuszewska in the 1950s on the summit of Mięguszowiecki Szczyt Mt., and contained several typical specimens. No specimens from this particular locality were found in the herbarium collections. The only specimens found in the herbarium material from the Tatra Mts and identified as *U. arctica* were collected by Motyka on Rysy summit were actually two other species: *U. cylindrica* and *U. crustulosa*. It might therefore be assumed that the specimens found by Matuszewska were not *U. arctica* as well. Most likely *U. arctica* has never occurred in the Tatra Mts, as the records of its presence in the area were proven incorrect by revision of the herbarium material. In the Slovakian Tatra Mts the occurrence of *U. arctica* was not confirmed either, and the specimens identified as *U. arctica* were actually *U. nylanderiana* (Lisická 1980; Pišút *et al*. 1996).

KEY TO THE SPECIES OF *LASALLIA* AND *UMBILICARIA* IN THE AREA STUDIED

1. Upper surface distinctly pustulate .... *L. pustulata*
1*. Upper surface not pustulate 2
2. Thallus with isidia; under surface brown, pitted, without rhizines ..... *U. deusta*
2*. Thallus without isidia; under surface differentiated 3
3. Upper surface sorediate or granulose towards the margins 4
3*. Upper surface not sorediate, and not granulose towards the margins 5
4. Under surface pale brown to brown, weakly areolate; with rhizines ..... *U. hirsuta*

4*. Under surface dark brown to black, strongly areolate; without or with sparse rhizines ... *U. grisea*

5. Thallus usually perforated; upper surface rugose, vermiform-folded; lower surface with lamellae ... . *U. torrefacta*

5*. Thallus not perforated; upper surface not rugose and not vermiform-folded; lower surface without lamellae 6

6. Upper surface brown to dark brown, wrinkled, rugose and/or with vermiform ridges 7

6*. Upper surface different in structure 10

7. Upper surface with vermiform ridges 8

7*. Upper surface wrinkled, rugose 9

8. Under surface black, smooth and even; with non-septate thalloconidia ..... *U. nylanderiana*

8*. Under surface brown, with wide and shallow depression; without thalloconidia .. *U. hyperborea*

9. Thalloconidia non-septate ..... *U. nylanderiana*

9*. Thalloconidia multi-septate ..... *U. polyphylla*

10. Upper surface shiny 11

10*. Upper surface dull 12

11. Thallus with rhizines ..... *U. polyrrhiza*

11*. Thallus without rhizines ..... *U. polyphylla*

12. Thalli crowded closely together 13

12*. Thalli not crowded closely together 14

13. Thallus with black, glossy, tumid margin; without cilia ..... *U. microphylla*

13*. Thallus margin not tumid; marginal cilia present ... . *U. cylindrica*

14. Under surface sooty black entirely or in patches 15

14*. Under surface not black, sometimes only umbilicus black 22

15. Thallus with rhizines 16

15*. Thallus without rhizines 18

16. Rhizines white to pale brown ..... *U. aprina*

16*. Rhizines dark brown or black 17

17. Under surface with two kinds of rhizines: brown, long and cylindrical, or black, short and ball-tipped ..... *U. vellea*

17*. Under surface with black, short rhizines .... *U. cinereorufescens*

18. Under surface verrucose-areolate around umbilicus ..... *U. cinerascens*

18*. Under surface not verrucose-areolate 19

19. Upper surface rimose and even, grey-beige .... *U. laevis*

19*. Upper surface wrinkled, not grey-beige 20

20. Upper surface with white, rugose, radial pattern in the center ..... *U. subglabra*

20*. Upper surface with white or yellowish, reticulate but not radial pattern in the center 21

21. Upper surface grey-yellowish, rough-ribbed, becoming less areolate toward the margins .... *U. leiocarpa*

21*. Upper surface grey with white reticulate pattern towards the margins ..... *U. decussata*

22. Thallus or at least young lobes with marginal cilia, or marginal rhizines looking like cilia .. .. *U. cylindrica*

22*. Thallus without marginal cilia 23

23. Upper surface smooth or radially wrinkled .... *U. crustulosa*

23*. Upper surface with white reticulate ridges in the center ..... *U. proboscidea*

CHARACTERISTICS OF TAXA

UMBILICARIACEAE Frey

Hedwigia **69**: 219. 1929.

Umbilicariaea Fée, Essai Cryptog. Ecorc. Officin.: 70. 1824.

Lasallia Mérat

Nouv. Flore Env. Paris ed. 2. **1**: 202. 1821.

Umbilicaria (Hoffm.) Schol. sect. *Lasallia* (Mérat) Schol., Nyt Mag. Naturvid. **75**: 22. 1934.

Thallus foliose, monophyllous, dorsoventral, attached by an umbilicus in the central part of the underside. Upper side pustulate, with raised, rounded or oval, convex pustules; the center paler with white necral layer. Isidia present and branched. Underside with broad, excavate depressions corresponding to pustules on the upper side, without rhizines. Photobiont green *Pseudotrebouxia*. Ascomata apothecia, sessile or ± stalked. Thalline exciple absent. Disc black, flat, smooth to roughened. Asci 1(–2) spored. Ascospores muriform, pale to dark brown. Pycnidia, immersed, with pale brown wall. Conidia bacilliform. Thalloconidia absent.

Lasallia pustulata (L.) Mérat (Fig. 4)

Nouv. Flore Env. Paris ed. 2. **1**: 202. 1821.

Lichen pustulatus L., Sp. Pl.: 1150. 1753. – *Umbilicaria pustulata* (L.) Hoffm., *in* Adumbrat., Plant. Lich. **2**: 13. 1794.

Thallus 3–4(6) cm diam., monophyllous, outstretched, ± adpressed to substrate, regular in outline, with numerous pustules radiating from the center, raised, with lacerated margins and sometimes perforated. Upper side pale brown to brown, dull, covered by a white, coarsely granular necral layer in the center. Medulla white. Underside brown, dark brown to black, roughened, with white pruina on veins, black around umbilicus, ± trabeculate in central parts. Rhizines absent. Isidia numerous, black, granular to cylindrical, densely branched. Apothecia rare, not seen in examined material. Pycnidia in marginal zone of the upper side, immersed, bottled-shape, with pale brown wall. Conidia bacilliform *ca* 4.0 × 1.0 µm. Thalloconidia absent.

CHEMISTRY. Gyrophoric and lecanoric acids.

NOTE. *Lasallia pustulata* is one of the most characteristic of epilithic macrolichens in Poland. Its large monophyllous thallus, with their numerous pustules and blackish semiglobular or granular isidia, clearly distinguish it from other foliose lichens. In Central Europe another species of the genus *Lasallia* is also reported – *L. rossica* Dombr. (Kondratyuk *et al.* 1996). It is known from mountains in the subalpine and alpine belts. This species is distinguished by its marginal and laminal isidia. *Lasallia rossica* has not been found in Poland so far.

HABITAT. This species occurs on siliceous rocks; in the Tatras it was found on large granite boulders on northern slopes.

DISTRIBUTION. It is a mountain species. In the Polish Tatras *L. pustulata* was found only once, by Matuszewska in 1959, on a slope of Mięguszowiecki Szczyt Mt. in the subnival belt (Fig. 4). So far it has not been located again.

In the Polish Carpathians it was reported from the Beskid Śląski Mts (Kiszka 1972; Nowak 1972), Pogórze Dynowskie foothills (Fałtynowicz & Bylińska 1999; Krzewicka 2000a) and Tatra Mts (Motyka 1964; Fałtynowicz & Bylińska 1999). Beyond the Carpathians it is known in the

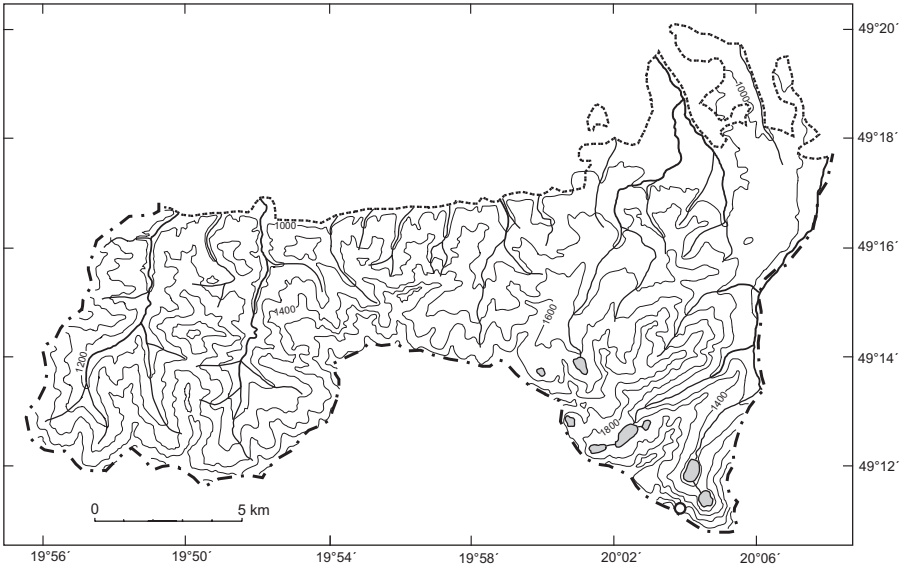


Fig. 4. Distribution map of *Lasallia pustulata* (L.) Mérat in the Polish Tatra Mts. o – locality to 1970.

Wyżyna Kielecka upland (Berdau 1876; Sepski 1984) and also in the Sudety Mts where is fairly frequent (Stein 1879, Eitner 1911; Tobolewski 1965; Nowak 1971, 1995; Seaward *et al*. 1981; Kozioł 1993; Bylińska & Kossowska 1996).

Lasallia pustulata has never been found in the Slovakian Tatras (Lisická 1980; Pišút *et al*. 1996).

EXSICCATI SEEN. *Flora Silesiaca Exs. No*. 1337 (LBL); Nowak, *Lich. Pol. Meridi. Exs. No. 80* (sub. *Umbilicaria p*.) (LBL); Nowak, *Lich. Pol. Meridi. Exs. No. 220* (LBL); Pišút, *Lich. Slovakiae Exs. No. 33* (KRAM, WA); Rabenhorst, *Lich. Eur. No. 838* (sub. *Umbilicaria p*.) (KRA); Savicz, *Lich. Rossica No. 1* (sub. *Umbilicaria p*.) (LBL); Suza, *Lich. Bohem. No. 227* (sub. *Umbilicaria p*.) (KRAM, POZ).

SPECIMENS EXAMINED. Grid square Ge-60 – HIGH TATRA MOUNTAINS: Mięguszowiecki Szczyt Mt., Aug. 1959, *leg. S. Matuszewska* (LBL).

Umbilicaria Hoffm.

in Linné Genera Plant., ed. 8.: 768. 1791.

Gyrophora Ach., Meth. Lich.: 100. 1803.

Thallus mono- or polyphyllous, dorsoventral, attached at a single point by a central or excentric strand called the umbilicus; soft, pliable and somewhat leathery when wet, brittle when dry. Upper surface pale grey-brown, dark brown to black, smooth to warted-areolate, sometimes folded or reticulate-ridged with a raised central area, margins sinuous, entire or incised, ciliate or not. Isidia and soredia occasionally present. Underside smooth or warted-areolate, sometimes pitted; rhizines, trabeculae, lamellae or papillae present or absent. Photobiont green (*Trebouxia*). Ascomata apothecia, ± irregular, immersed, sessile or stalked. Disc black, flat or convex, mostly gyrose, occasionally smooth with a central protruding button of sterile tissue. Thalline exciple absent. Asci 8-spored, elongate-clavate, thick-walled, apical dome I+ blue. Ascospores ellipsoid, simple and colorless or muriform becoming brown. Conidiomata pycnidia, uni- or multi-loculate. Conidia short, cylindrical. Thalloconidia present in non-isidiate, non-sorediate, rarely fruiting species, originating from lower cortex or on rhizines, non-septate or multi-septate.

Umbilicaria aprina Nyl. (Figs 5, 6, 7, 8)

Syn. Lich. **2**: 12. 1863.

Gyrophora aprina (Nyl.) Hue, Archiv. Mus. **3**: 36. 1891.

Thallus small up to 2 cm diam., monophyllous, rarely polyphyllous, thick, rigid, leathery. Upper side medium brown to olive-buff, dull, rimose, with a white necral layer in the central parts which fades peripherally, over the umbilicus undulating, vermiform-ridged and areolate. Medulla white.

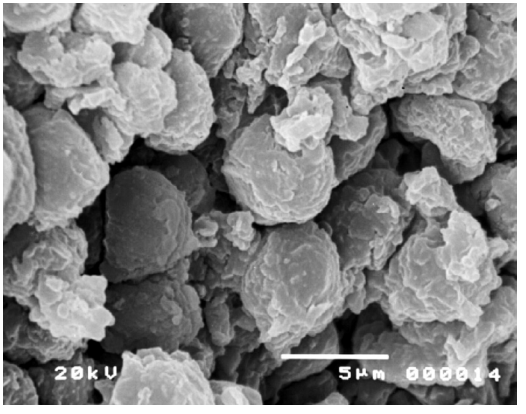


Fig. 5. *Umbilicaria aprina* Nyl. – non–septate conidia.

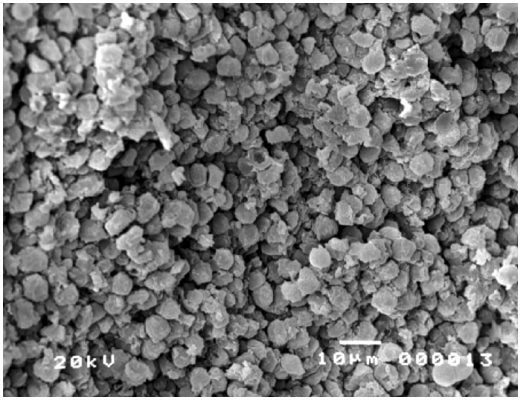


Fig. 6. *Umbilicaria aprina* Nyl. – thalloconidia on the underside of the thallus.

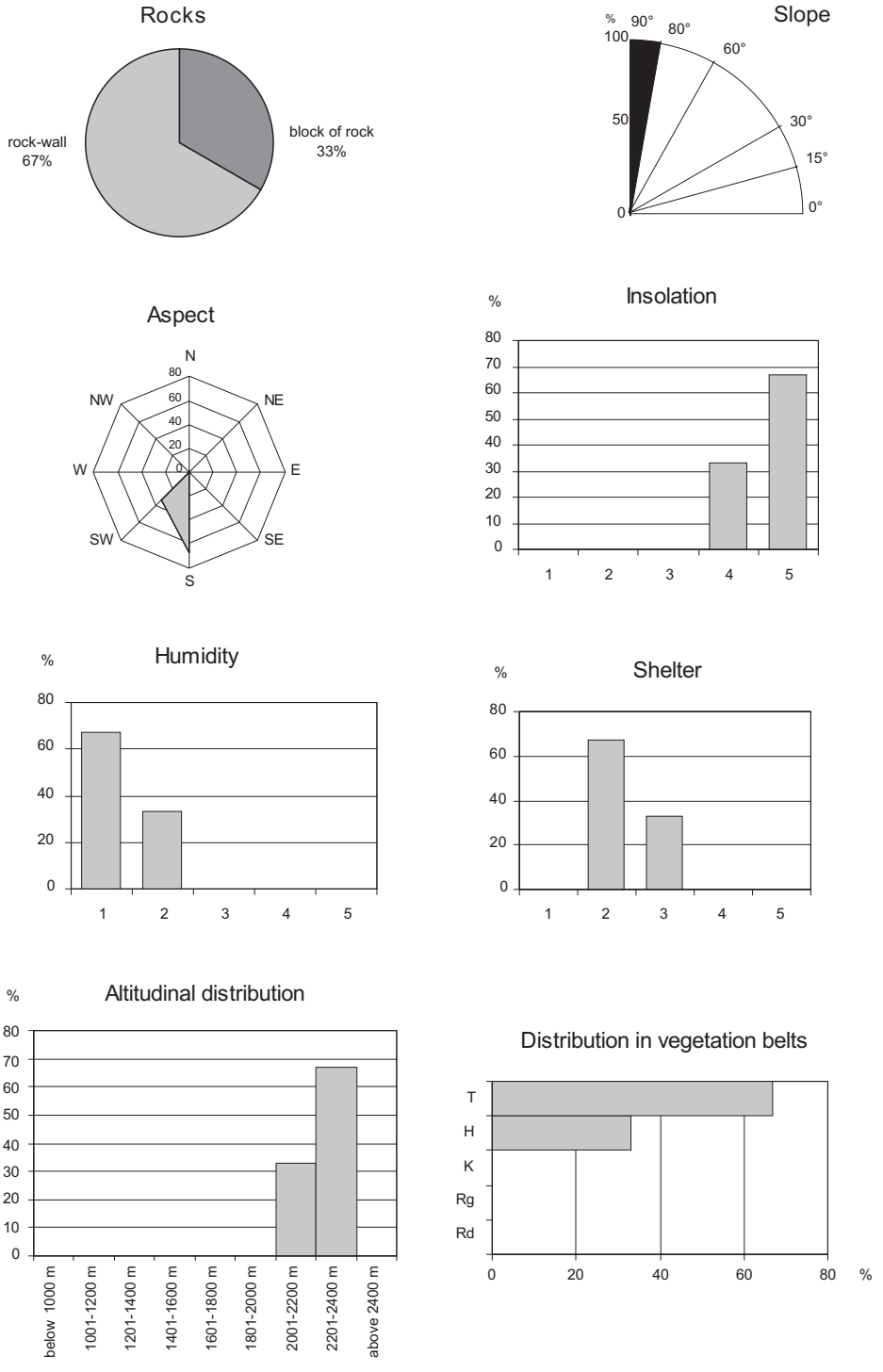


Fig. 7. Ecodiagram for *Umbilicaria aprina* Nyl. (explanations – see Material and methods).

Underside sooty black with paler brown patches, smooth, even. Rhizines numerous, mainly marginally distributed, cylindrical or flattened, simple to dichotomously branched, pale grey to white, darker towards margins, sometimes rhizines blackish in basal part, umbilicus small, light colored, compact. Thallus 200–230 μm; upper cortex 8–10 μm, palisadeplectenchymatous; algal layer continuous, *ca* 45 μm; medulla loose, *ca* 100 μm; lower cortex *ca* 30 μm, scleroplectenchymatous. Apothecia omphalodisc, rare, not seen in examined material. Pycnidia not observed. Thalloconidia non-septate, rarely 1-septate, or 2-septate, oviform to spherical, delicately to moderately roughened or rugged, brown to dark brown, 7.6 × 8.8 μm (Figs 5, 6). Thalloconidia usually cover the underside completely, but not on the rhizinomorphs, not on the grey 2 mm marginal zone, and not on pale patches.

CHEMISTRY. Gyrophoric and lecanoric acids.

HABITAT. This species occurs on siliceous rocks, inhabiting steep to vertical, smooth surfaces of granite blocks and rock walls, mostly in small colonies. It is found in south- and southwest-aspects where the snow cover does not last and where plants do not grow. This lichen grows in sunny and dry, moderately wind-exposed situations (Fig. 7).

DISTRIBUTION. High mountain (alpine) species. In Poland it grows exclusively in the Tatras, where recently it was found for the first time by Krzewicka (Krzewicka & Osyczka 2002a). In this area it is a rare species, having its main center of distribution in the alpine and subnival belts (Fig. 7). It is known only from a few scattered stations in the High Tatras. It was found in the Orla Perć range at alt. 2140 m, near the Przełęcz pod Chłopkiem pass at alt. 2320 m, and below the summit of Pośredni Mięguszowiecki Szczyt Mt. at alt. 2390 m (Fig. 8).

So far this species has not been reported from the Slovakian Tatras, but probably occurs there because localities bordering Slovakia have been found. In Europe *U. aprina* is also known from north Europe from Svalbard (Elvebakk & Hertel 1996), Scandinavia (Hasselrot 1943; Santesson 1993), and from hight mountains such as the Alps (Hasenhüttl & Poelt 1978; Nimis 1993), and the Pyrenees (Hestmark 2000).

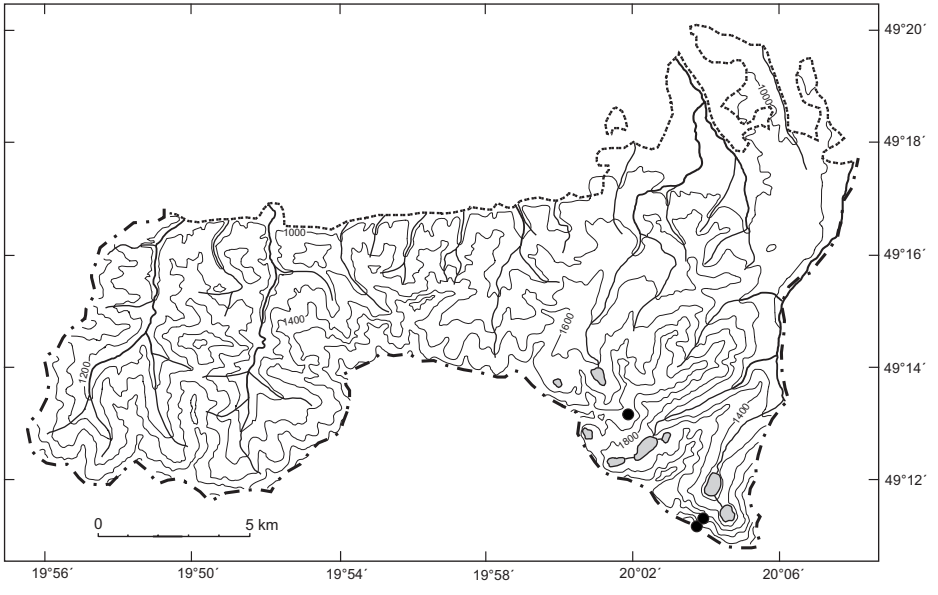


Fig. 8. Distribution map of *Umbilicaria aprina* Nyl. in the Polish Tatra Mts. ● – locality after 1970.

EXSICCATI SEEN. Steiner & Poelt, *Lichenoth. Afghanica No. 16* (W); *No. 25* (W); *No. 58* (W).

SPECIMENS EXAMINED. Grid square Ge-50 – HIGH TATRA MOUNTAINS: Orla Baszta Mt. near Granaty Mt., alt. 2140 m, 18 July 1999, *leg. B. Krzewicka* (KRA); Ge-60 – HIGH TATRA MOUNTAINS: Przełęcz Pod Chłopkiem pass, S slope, alt. 2320 m, 17 July 2000, *leg. B. Krzewicka* (KRA); Pośredni Mięguszowiecki Szczyt Mt., alt. 2390 m, 17 July 2000, *leg. B. Krzewicka* (KRA).

Umbilicaria cinerascens (Arnold) Frey (Figs 9, 10, 11, 12)

Hedwigia **71**: 115. 1931.

Gyrophora cinerascens Arnold, Verh. Zool.-Bot. Ges. Wien **25**: 438. 1875.

Thallus 3–4 cm diam., polyphyllous, rarely monophyllous, thick, rigid, lobes ascending in the center, and ± adpressed towards the margins, moderately incised, with undulating and oviform perforated margins; damaged margins without upper cortex white. Upper side mouse-grey to blotched with cinnamon brown, dull, even, slightly rimose, or smooth. Medulla white. Underside sooty black, sometimes with dark grey marginal zone, smooth, distinctly areolate only around umbilicus. Rhizines absent. Thallus 100–250 μm; upper cortex 10–15 μm, with discontinuous layer of necral cells; algal layer discontinuous or continuous, dark green, 35–45 μm thick; medulla 70–20 μm; lower cortex dark brown, 15–35 μm thick. Apothecia leiodisc, rare, not seen in examined material. Pycnidia not treated. Thalloconidia non-septate, dark brown, spherical, rarely oviform, roughened, 7.8 × 6.7 μm (Figs 9, 10). Thalloconidia usually cover the underside completely, except for areolate area around umbilicus.

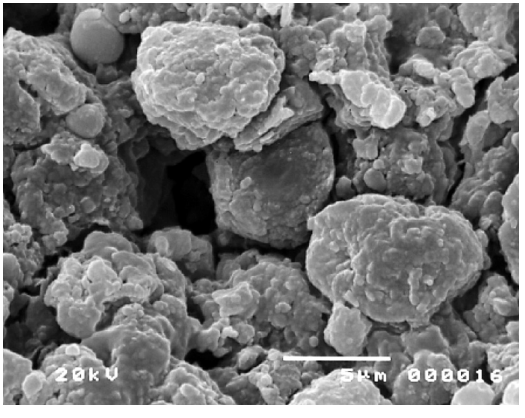


Fig. 9. *Umbilicaria cinerascens* (Arnold) Frey – non–septate conidia.

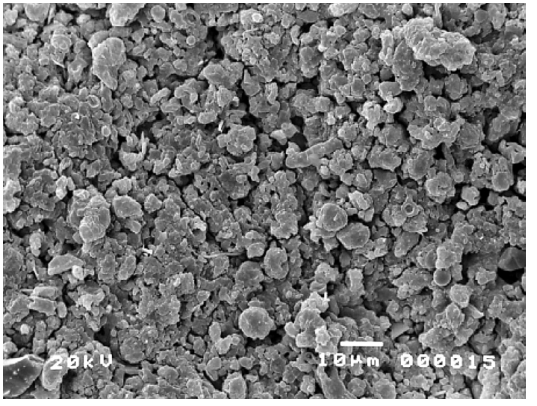


Fig. 10. *Umbilicaria cinerascens* (Arnold) Frey – thalloconidia on the underside of the thallus.

CHEMISTRY. Gyrophoric acid.

NOTE. In the area studied, *U. cinerascens* might be confused with *U. laevis* and less frequently with *U. cinereorufescens*. *Umbilicaria cinerascens* is distinguished by the underside, which is bared and distinctly areolate around the umbilicus. Whereas *U. cinereorufescens* has papillae and short rhizines on the underside, and *U. laevis* has smooth underside, without areolae and rizines.

HABITAT. This species occurs on siliceous rocks, on steep surfaces of large boulders and granite blocks of rock partly covered with mosses. It inhabits mainly west-facing slopes (60% of cases) and frequently north-facing slopes (30% of cases). It is found on somewhat shaded and somewhat sheltered or ± wind-exposed situations. It grows in moderately moist habitats (Fig. 11).

DISTRIBUTION. High mountain (alpine) species. In Poland it grows exclusively in the Tatras (Motyka 1926, 1927, 1964; Tobolewski 1965, 1996; Nowak & Tobolewski 1975; Alstrup & Olech

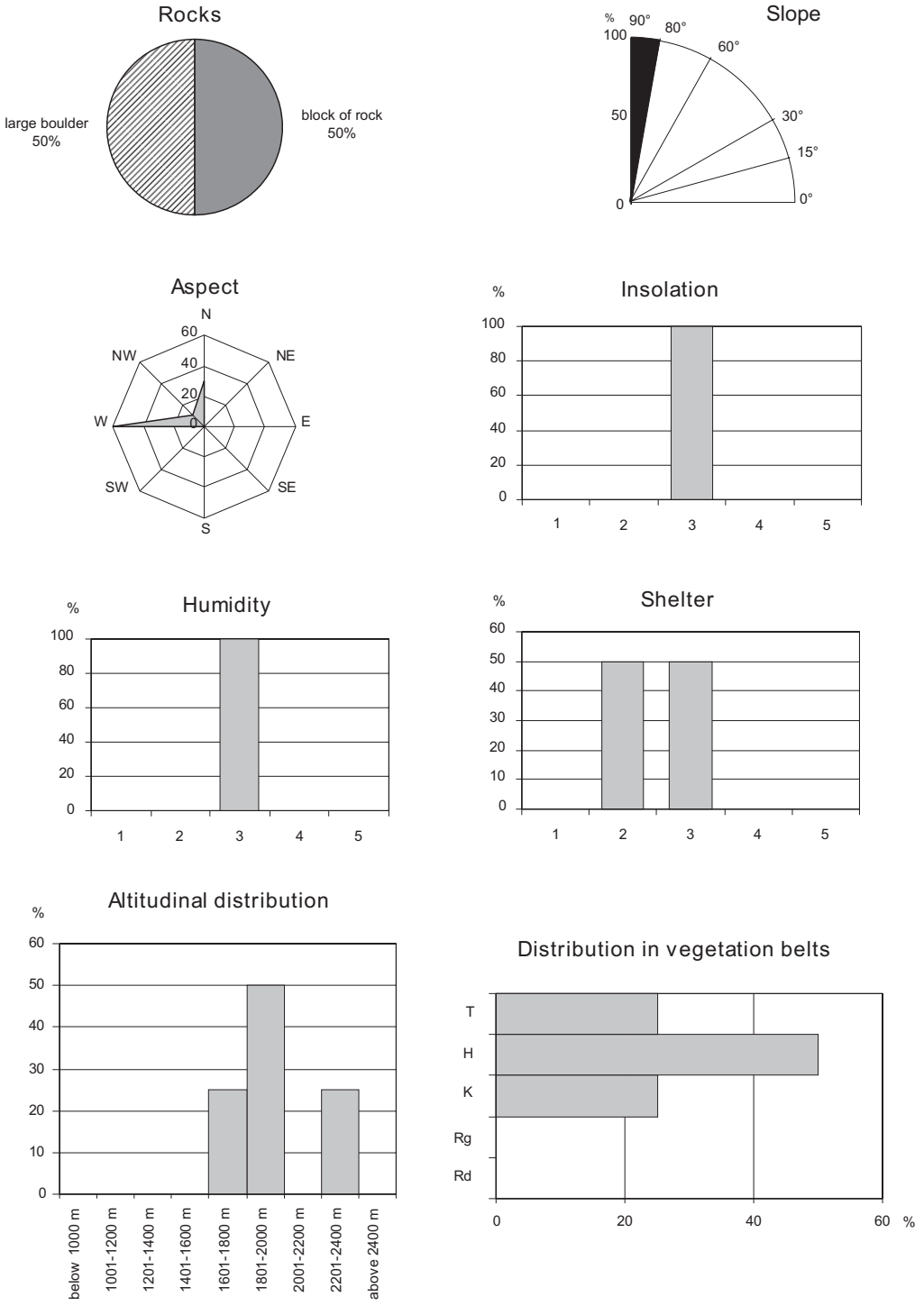


Fig. 11. Ecodiagram for *Umbilicaria cinerascens* (Arnold) Frey (explanations – see Material and methods).

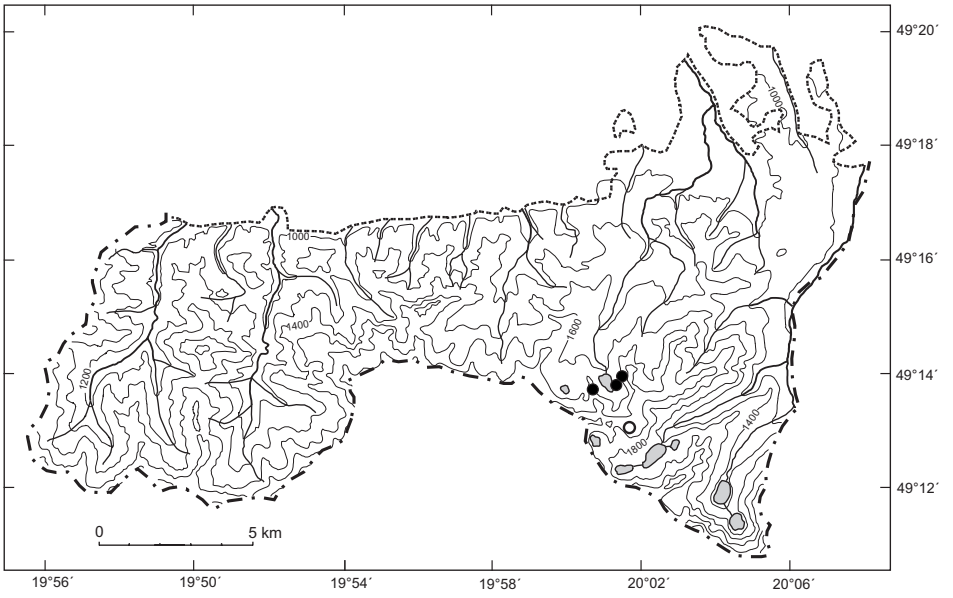


Fig. 12. Distribution map of *Umbilicaria cinerascens* (Arnold) Frey in the Polish Tatra Mts. ○ – locality to 1970, ● – locality after 1970.

1992b; Krzewicka 2000b, 2002c), where it is a very rare species. In Polish Tatra Mts it is known to occur in higher ranges, but so far has been recorded only from a small area in the region of Hala Gąsienicowa alpine meadow (Figs 11, 12). It seems that conditions are not favorable for growth of *U. cinerascens* in the Tatras, because only single scattered thalli have been found for about 70 years in this area. The lowest station is on the N slope of Mały Kościelec Mt. at alt. 1760 m; the highest locality is on Kozie Czuby Mt. at alt. 2260 m.

This species has not been reported recently in the Slovakian Tatras (Lisická 1980; Pišút *et al*. 1996), although Suza (1926a) found it there in 1923. It is known from the high mountains of Central and Southern Europe. Apart from the Tatra Mts, it is known from the Alps, Caucasus, and Iberian Peninsula (Golubkova *et al*. 1978; Nimis 1993; Llimona & Hladun 2001), and also from a few localities in Estonia, Eastern Europe (Randlane & Saag 1999).

EXSICCATI SEEN. *Krypt. Exs. Vindob. No. 4342* (POZ); Poelt, *Lich. Alpium No. 146* (KRAM, LBL, POZ).

SPECIMENS EXAMINED. Grid square Ge-50 – HIGH TATRA MOUNTAINS: Mały Kościelec Mt., N slope, alt. 1760 m, 08 July 1999, *leg. B. Krzewicka* (KRA); Żółta Turnia Mt., 28 Aug. 1927, *leg. J. Motyka* (LBL), alt. 1860 m, 09 July 1999, *leg. B. Krzewicka* (KRA); Kozie Czuby Mt., alt. 2260 m, 1959, *leg. J. Kowalczyk* (LBL).

Umbilicaria cinereorufescens (Schaer.) Frey (Figs 13, 14, 15)

Hedwigia **71**: 109. 1931.

Umbilicaria vellea γ – *spadochroa* ε – *cinereo-rufescens* Schaer., Enumer. Critic. Lich. Europ.: 25. 1850. *p.p.* – *Gyrophora cinereorufescens* (Frey) Schol., Nyt Mag. Naturvid. **75**: 28. 1934.

Thallus 3–4 cm diam., polyphyllous, rarely monophyllous, thick, rigid, irregular in shape; lobes in the middle shorter, the edges often curled under; lower margins wavy, lacerated and perforated; old specimens with black cracks resembling stitches. Upper side mouse-grey with red to cinnamon brown blotches, smooth, entire or irregularly cracked, ± covered with a thin pruina, minutely areolate in the central part. Medulla white. Underside jet black, strongly verrucose, trabeculate

around the umbilicus. Umbilicus black, short, thick, compact. Rhizines black, short, coarse and stubby called papillae or coralloid to cylindrical, simple or branched. Rhizines absent around umbilicus. Thallus 100–200 μm; upper cortex smooth, 20–30 μm, paraplectenchymatous; algal layer continuous, 50–80 μm; medulla *ca* 45 μm; lower cortex 40–100 μm; rhizinomorphs *ca* 200 μm wide, *ca* 400 μm long. Apothecia gyrodisc, rare, not seen in examined material. Pycnidia not treated. Thalloconidia multi-septate, 6–20-cellular, spherical to more elongated or irregular, dark brown, with roughened surface, 19.5 × 27.5 μm (Fig. 13). Thalloconidia in clusters on rhizinomorphs and rarely on the underside of thallus.

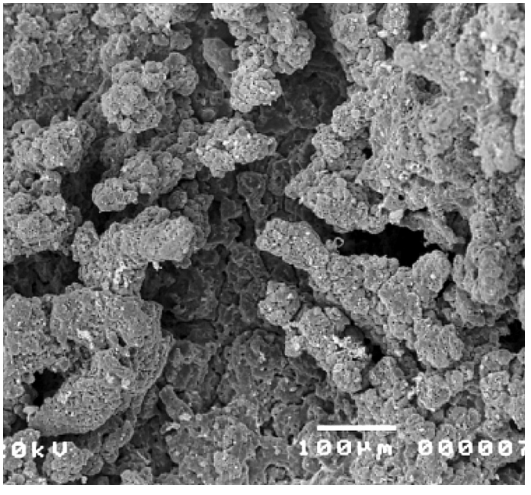


Fig. 13. *Umbilicaria cinereorufescens* (Schaer.) Frey – thalloconidia on the underside of the thallus.

CHEMISTRY. Small amounts of gyrophoric and lecanoric acids.

NOTE. This species is distinguished by the sparsely areolate underside, with numerous papillae and distinct trabeculae. Monophyllous specimens may be mistaken for *U. vellea*, and less frequently for polyphyllous specimens of *U. cinerascens*. In herbarium specimens, *U. vellea* with damaged brown cylindrical rhizines were also often determined as *U. cinereorufescens*.

HABITAT. This species occurs on siliceous rocks, on slightly to vertically inclined surfaces of rock walls (46% of cases), fairly frequently on blocks of rock (36% of cases), and on large granite boulders. It is found on south aspects (35% of cases) but is also frequent on north aspects (22%). It inhabits mainly sun-exposed and especially moderately moist situations, in moderately sheltered places (Fig. 14).

DISTRIBUTION. A rare species, occurring mainly in the subalpine belt. In Poland it grows exclusively in the Tatras (Motyka 1964; Nowak & Tobolewski 1975; Krzewicka 2000b, 2002c), where about 60% of the records are from the subalpine belt (Fig. 14). It occurs less frequently in the alpine belt and occasionally in the upper montane and subnival ones. It appears to grow only in the High Tatras, where it is known from three ± isolated areas: on Hala Gąsienicowa alpine meadow in the region of Żółta Turnia Mt., in the Dolina Pięciu Stawów Polskich valley, and the Morskie Oko valley in the region of Mnich Mt. (Fig. 15). The lowest locality is Wrota Chałubińskiego pass at alt. 1550 m, the highest Kozi Wierch Mt. at 2291 m.

In the Slovakian Tatras it is also known only from the High Tatras (Lisická 1980). Apart from those, in Europe the species is known from a few scattered situations in mountain areas such as from Scandinavia, south Swartzvald, the Alps, and mountains of the Iberian Peninsula (Nimis 1993; Santesson 1993; Wirth 1995; Llimona & Hladun 2001).

EXSICCATI SEEN. Hansen, *Lich. Groenl. Exs. No. 127* (WA); *No. 549* (WA); *Krypt. Exs. Vindob. No. 4240* (POZ); *No. 4455* (POZ); Pišút, *Lich. Slovakiae Exs. No. 161* (KRAM); Poelt, *Lich. Alpium No. 41* (KRAM, POZ); *No. 131* (KRAM, LBL, POZ).

SPECIMENS EXAMINED. Grid square Ge-50 – HIGH TATRA MOUNTAINS: Mały Kościelec Mt., N slope, alt. 1760 m, 08 July 1999, *leg. B. Krzewicka* (KRA); near Czarny Staw Gąsienicowy lake, 1949, *leg. J. Motyka* (LBL); Żółta Turnia Mt., NW slope, 28 Aug. 1927, *leg. J. Motyka* (LBL), SW slope, Aug. 1959, *leg. S. Matuszewska* (LBL), W slope, alt. 1770 m, 09 July 1999, *leg. B. Krzewicka* (KRA); Kozi Wierch Mt., alt. 2291 m,

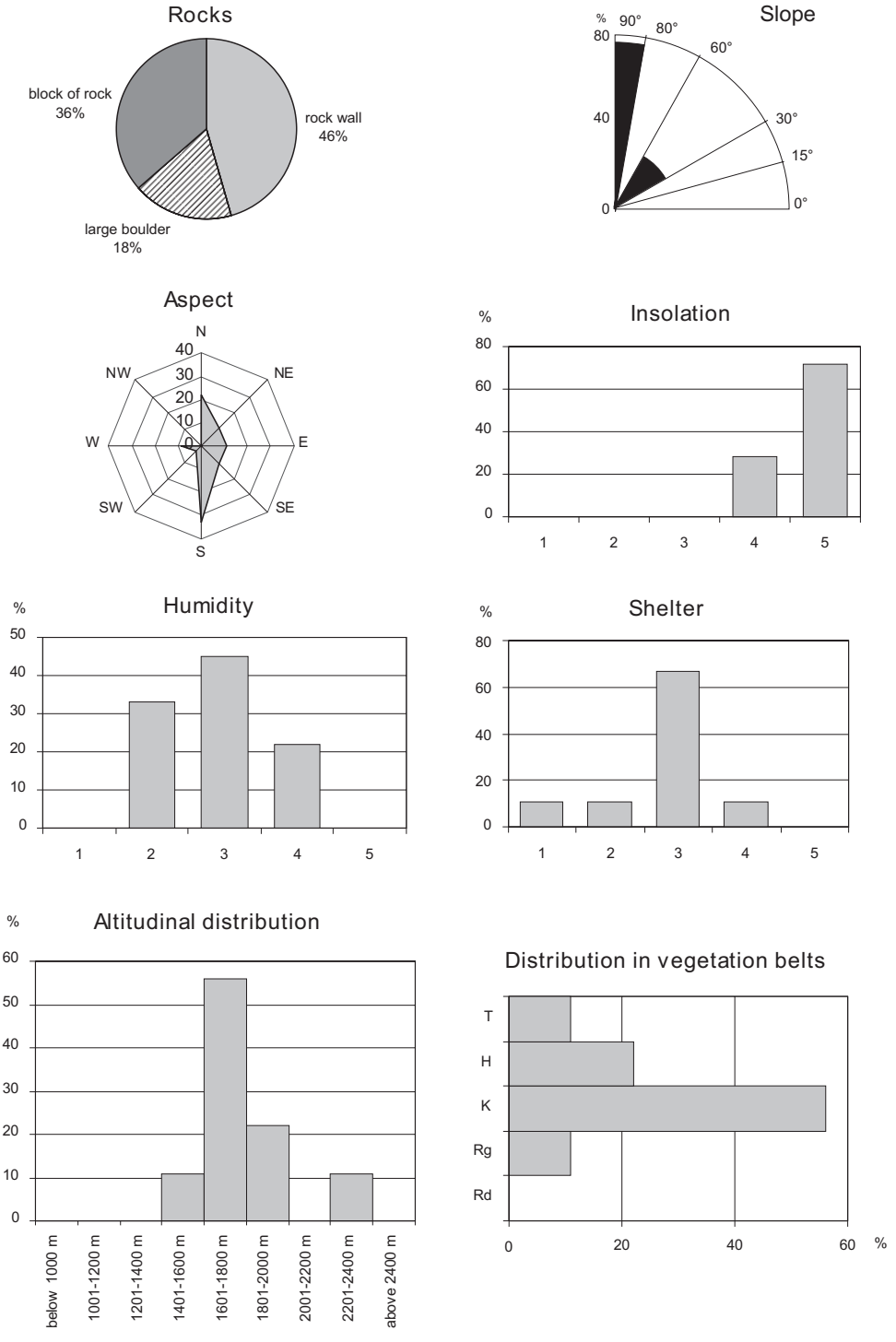


Fig. 14. Ecodiagram for *Umbilicaria cinereorufescens* (Schaer.) Frey (explanations – see Material and methods).

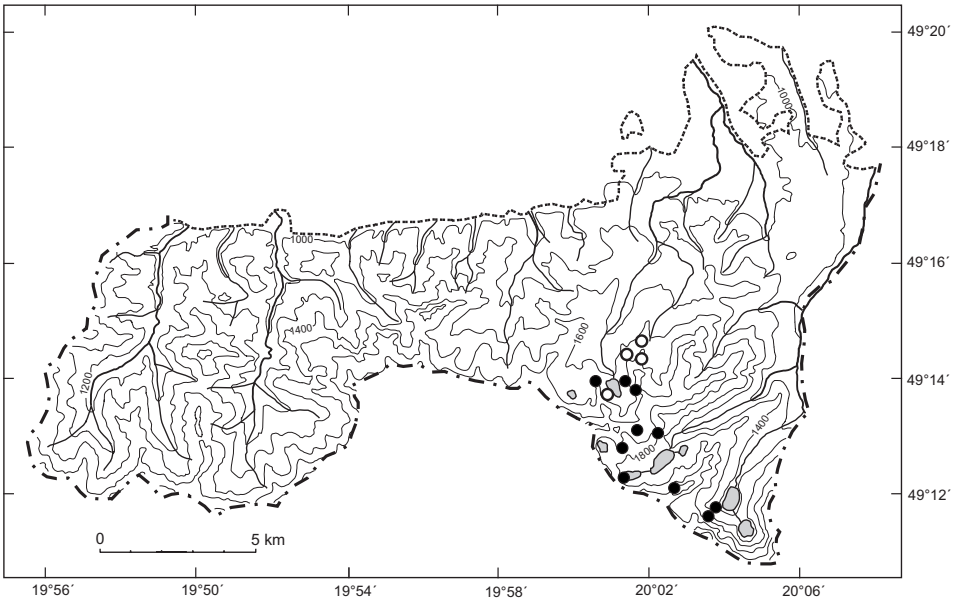


Fig. 15. Distribution map of *Umbilicaria cinereorufescens* (Schaer.) Frey in the Polish Tatra Mts. ○ – locality to 1970, ● – locality after 1970.

18 July 1999, *leg. B. Krzewicka* (KRA); Dolina Buczynowa valley, alt. 1770 m, 19 July 1999, *leg. B. Krzewicka* (KRA); Ge-60 – HIGH TATRA MOUNTAINS: Dolinka Pusta valley, alt. 1920 m, 22 July 1999, *leg. B. Krzewicka* (KRA); Szpiglasowe Kopki Mt., alt. 1920 m, 22 July 1999, *leg. B. Krzewicka* (KRA); Kotelnica Mt., E slope, alt. 1800 m, 19 July 1999, *leg. B. Krzewicka* (KRA); Mnich Mt., NE slope, alt. 1780 m, 16 Aug. 2000, *leg. B. Krzewicka* (KRA); Wrota Chałubińskiego pass, alt. 1550 m, 28 July 1999, *leg. B. Krzewicka* (KRA).

Umbilicaria crustulosa (Ach.) Frey

(Figs 16, 17)

Hedwigia **71**: 110. 1931.

Gyrophora crustulosa Ach., Lichenogr. Univers.: 673. 1810. – *Gyrophora depressa* (Ach.) Röhling, Deutschl. Fl. **3**(2): 48. 1813. – *Umbilicaria depressa* (Ach.) Duby, Bot. Gall. **2**: 596. 1830. – *Omphalodiscus crustulosus* (Ach.) Schol., Nyt Mag. Naturvid. **75**: 26. 1934.

Thallus 3–4(7) cm diam., monophyllous, sometimes deeply dissected and appearing polyphyllous; orbicular in outline, over the umbilicus moderately raised, with several folds fading peripherally, the edges often curled under, sometimes with deeply incised margins. Upper side pale brown to yellowish brown, darker towards the margins, dull, even or over the umbilicus slightly radially wrinkled, and distinctly areolate, towards the margins smooth, but marginal zone scabrous and rimose. Medulla white. Underside buff, smooth to slightly areolate towards the margins. Rhizines numerous, cylindrical, simple or dichotomical to irregular branched, concolorous with the lower cortex or darker mainly towards the margin. Area around the umbilicus without rhizines. Thallus 200–250(500) μm; upper cortex *ca* 30 μm; algal layer discontinuous, *ca* 70(100) μm; medulla 60–130 μm; lower cortex *ca* 40 μm; rhizinomorphs *ca* 450–3500 μm wide, *ca* 120 μm long. Apothecia omphalodisc, common, sessile to depressed, disc to 3 mm, black, smooth with central sterile button, occasionally appearing subgyrose, hypothecium brown, hymenium *ca* 80 μm, paraphyses septate, 8 simple, hyaline, ellipsoid spores 6.6–13.2 × 3.3–6.6 μm in ascus. Pycnidia numerous in marginal zone of the upper side, immersed, bottled-shape, with dark brown wall and

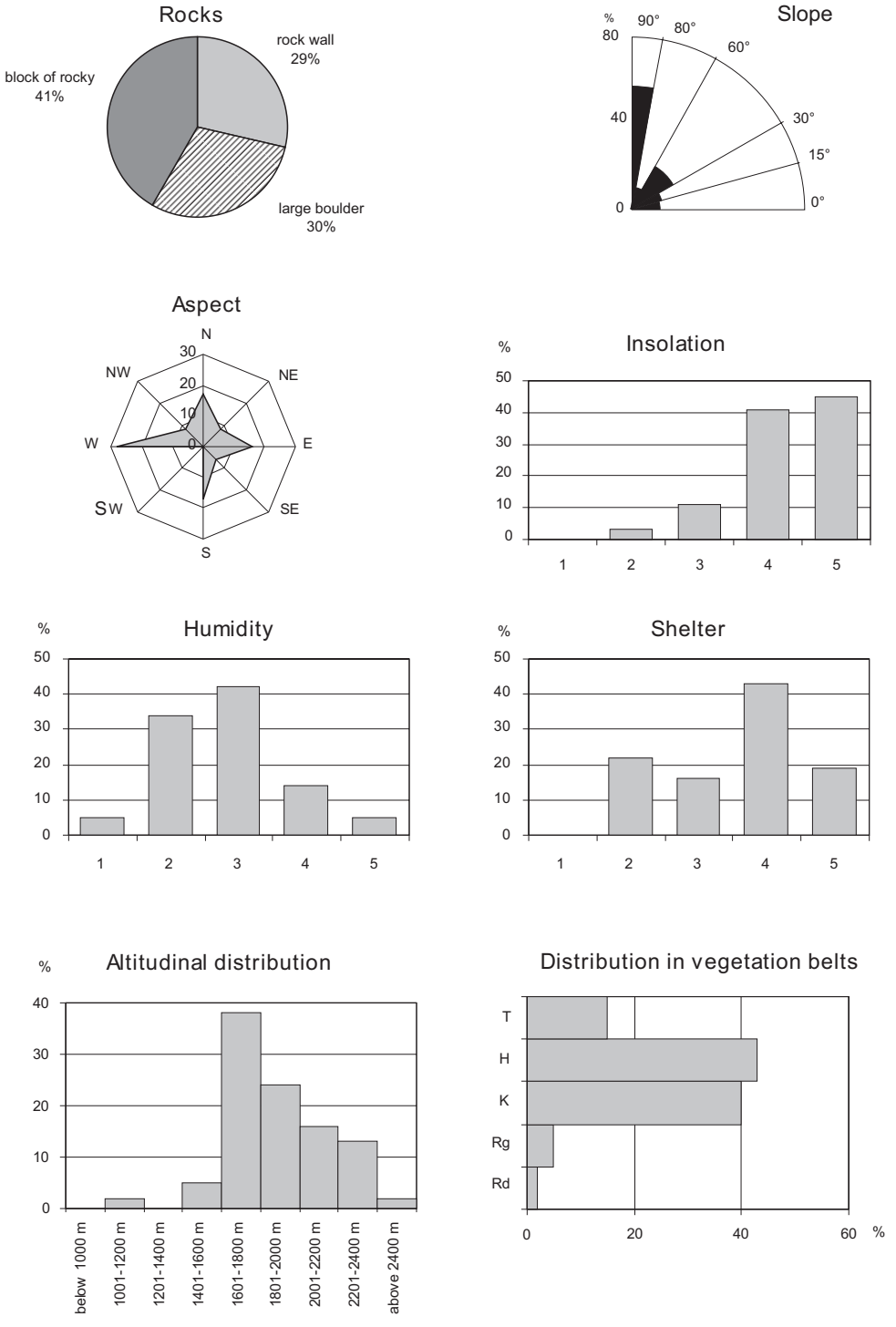


Fig. 16. Ecodiagram for *Umbilicaria crustulosa* (Ach.) Frey (explanations – see Material and methods).

black ostiole. Conidia bacilliform *ca* 3.0–4.0 × 0.8–1.0 μm. Thalloconidia absent.

CHEMISTRY. Gyrophoric acid, small amounts of lecanoric and hiascic acids.

HABITAT. This species occurs on siliceous rocks, most frequent on the top of vertical surfaces (60% of cases), granite blocks (41% of cases), large boulders and rock walls, sometimes on slightly inclined top sides of rocks. It occurs on various aspects but most often on west-facing slopes (28% of cases). It inhabits well-insolated localities, with a fairly wide amplitude of humidity and wind-exposure requirements (Fig. 16).

DISTRIBUTION. This is an alpine species. In the Polish Tatras it is a fairly frequent species. It extends from the lower montane belt up to the subnival belt, mostly in the subalpine and alpine belts (Fig. 16). As many as 80% of the examined stations were in these two zones, the center of its occurrence appearing to be at alt. 1600–1800 m (38% of cases). The lowest locality is Polana Chochołowska glade, alt. 1100 m, and the highest at Rysy Mt., 2499 m (the highest summit in the Polish Tatras). In the West Tatras this species occasionally occurs in isolated, scattered areas. *Umbilicaria crustulosa* is less frequent in the West Tatras nowadays; more than half of all localities recorded from the West Tatras are from before 1970. In the High Tatras it is a fairly frequent species, having its main center of distribution in the Dolina Pięciu Stawów Polskich valley, and is only somewhat less frequent in the Hala Gąsienicowa alpine meadow and the Morskie Oko valley (Fig. 17).

In the Polish Carpathians it is known only from the High and West Tatra Mts (Motyka 1924a, b, 1926, 1927, 1928; Tobolewski 1954, 1956b, 1962b, 1965; Nowak 1975; Nowak & Tobolewski 1975; Alstrup & Olech 1992b; Bielczyk 1997; Krzewicka 2002c). Apart from the Carpathians in Poland it has been recorded only from Sudety where it was found in the Karkonosze Mts (Stein 1879; Frey 1933) on Trzy Turnie Mt. at alt. 1200 m (Tobolewski 1954).

It is also a frequent species in the Slovakian High Tatras (Lisická 1980). It is widely distributed

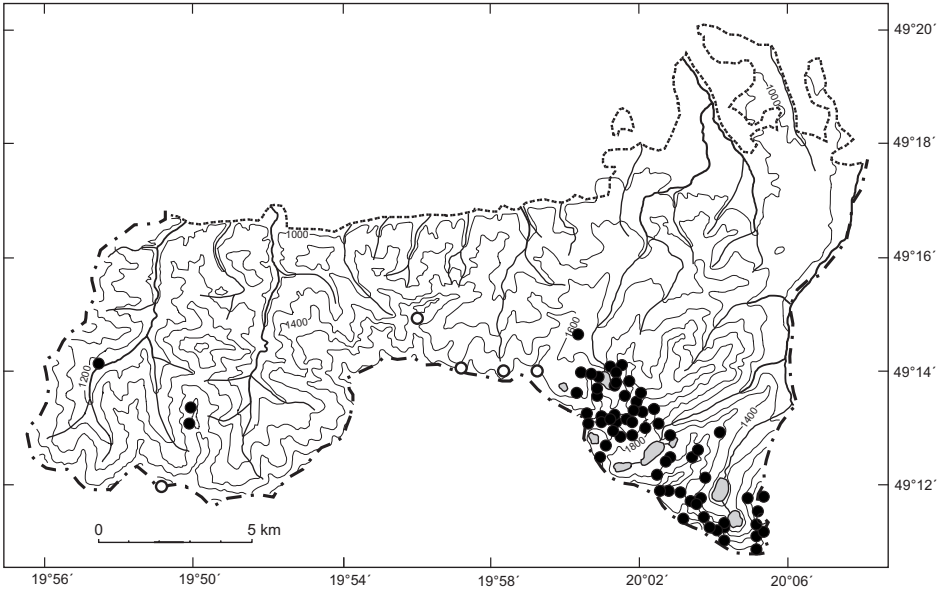


Fig. 17. Distribution map of *Umbilicaria crustulosa* (Ach.) Frey in the Polish Tatra Mts. ○ – locality to 1970, ● – locality after 1970.

in Europe, where it occurs on all high mountains of Southern and Central Europe, but in Northern Europe it is a rare species (e.g., Crespo & Sancho 1978; Golubkova *et al*. 1978; Lisická 1980; Murati 1992; Nimis 1993; Wirth 1995).

EXSICCATI SEEN. Havaas, *Lich. Norv. Occ. Exs. No. 206* (sub. *Gyrophora c.*) (KRAM); *Krypt. Exs. Vindob. No. 4241, No. 4456, No. 4457* (POZ); Nowak, *Lich. Pol. Meridi. Exs. No. 152* (LBL); Pišút, *Lich. Slovakiae Exs. No. 266* (KRAM, WA); Poelt, *Lich. Alpium No. 71* (KRAM, POZ); *No. 333* (KRAM); Rabenhorst, *Lich. Eur. No. 358* (sub. *Gyrophora vellea* var. *depressa*) (KRA); *No. 482*, (sub. *Gyrophora vellea*) (KRA); *No. 790* (sub. *Gyrophora vellea* var. *depressa*) (KRA); Tobolewski, *Lich. Polonica. No. 86* (LBL, KRAM, TRN, WA).

SPECIMENS EXAMINED. Grid square Gd-58 – WEST TATRA MOUNTAINS: Polana Chochołowska glade, alt. 1100 m, 07 May 1999, *leg. B. Krzewicka* (KRA); Gd-68 – WEST TATRA MOUNTAINS: Starobociański Wierch Mt., alt. 2100 m, 07 Aug. 1925, *leg. J. Motyka* (LBL); Gd-59 – WEST TATRA MOUNTAINS: Ornak Mt., 06 Aug. 1924, *leg. J. Motyka* (LBL), 07 July 1955, *leg. J. Nowak* (KRAM), E slope, alt. 1580 m, 07 Aug. 1999, *leg. B. Krzewicka* (KRA); Suchy Wierch Kondracki Mt., 26 July 1924, *leg. J. Motyka* (LBL); Kondracka Przełęcz pass, 13 Aug. 1928, *leg. J. Motyka* (LBL); Ge-50 – WEST TATRA MOUNTAINS: Pośredni Wierch Goryczkowy Mt., 28 Aug. 1927, *leg. J. Motyka* (LBL); Uhrocie Kasprowe Mt., 02 Sept. 1959, *leg. S. Matuszewska* (LBL); Ge-50 – HIGH TATRA MOUNTAINS: Las Gąsienicowy forest, alt. 1550 m, 09 July 1971, *leg. U. Bielczyk* (LBL); near Dwoisty Staw lake, Aug. 1925, *leg. J. Motyka* (LBL), Aug. 1926, *leg. J. Motyka* (LBL); near Zielony Staw lake, 16 Aug. 1925, *leg. J. Motyka* (KRAM); near Czarny Staw Gąsienicowy lake, alt. 1620 m, and 1680 m, 20 Aug. 1925, *leg. J. Motyka* (LBL), 16 Aug. 1926, *leg. J. Motyka* (LBL), 04 July 1929, *leg. J. Motyka* (LBL), 16 Sept. 1949, *leg. J. Motyka* (LBL), 09 July 1955, *leg. J. Nowak* (KRAM), 24 May 1959, *S. Matuszewska* (LBL); Mały Kościelec Mt., Aug. 1962, *leg. S. Matuszewska* (LBL); Mały Kościelec Mt., summit, alt. 1820 m, 06 June 1999, *leg. B. Krzewicka* (KRA), N slope, alt. 1760 m, W slope, alt. 1690 m, and 1760– 1750 m, 06 June 1999, *leg. B. Krzewicka* (KRA); Zadni Kościelec Mt., alt. 2100 m, 14 Aug. 1959, *leg. S. Matuszewska* (LBL); Kościelec Mt., alt. 2155 m, 06 July 1999, *leg. B. Krzewicka* (KRA), N slope, alt. 1870 m, 06 July 1999, *leg. B. Krzewicka* (KRA); Przełęcz Karb pass, alt. 1750 m, 09 July 1955, *leg. J. Nowak* (KRAM); Kościelcowa Przełęcz pass, Aug. 1959, *leg. S. Matuszewska* (LBL); Żółta Turnia Mt., Aug. 1929, *leg. J. Motyka* (LBL), Sept. 1955, *leg. I. Wojciechowski* (LBL), Aug. 1962, *leg. S. Matuszewska* (LBL), W slope, alt. 1770 m, 06 July 1999, *leg. B. Krzewicka* (KRA); Żółta Igła Mt., alt. 1730 m, 08 July 1999, *leg. B. Krzewicka* (KRA); Wierch pod Fajki Mt., 15 Aug. 1962, *leg. S. Matuszewska* (LBL); Świnica Mt., alt. 2301 m, 22 Aug. 1928, *leg. K. Wallisch* (LBL), Aug. 1959, *leg. J. Kowalczyk* (LBL), alt. 2301 m, 05 July 1999, *leg. B. Krzewicka* (KRA), S slope, alt. 2240 m, 05 July 1999, *leg. B. Krzewicka* (KRA); between Świnica Mt. and Zawrat pass, alt. 2180 m, 05 July 1999, *leg. B. Krzewicka* (KRA); Zawrat pass, alt. 2150 m, 05 July 1999, *leg. B. Krzewicka* (KRA); Zmarzłe Czuby Mt., N slope, alt. 2130 m, 22 July 1999, *leg. B. Krzewicka* (KRA); Mały Kozi Wierch Mt., alt. 2228 m, 22 July 1999, *leg. B. Krzewicka* (KRA); Zamarła Turnia Mt., Aug. 1959, *leg. J. Kowalczyk* (LBL); Kozie Czuby Mt., Aug. 1959, *leg. S. Matuszewska* (LBL), W slope, alt. 2070 m, 22 July 1999, *leg. B. Krzewicka* (KRA); Kozi Wierch Mt., alt. 2200 m, Sept. 1955, *leg. I. Wojciechowski* (LBL), SE slope, alt. 1700 m, 16 July 1999, *leg. B. Krzewicka* (KRA); Żleb Kulczyńskiego gully, Aug. 1959, *leg. S. Matuszewska* (LBL), Aug. 1962, *leg. S. Matuszewska* (LBL); Żleb Staniszewskiego gully, 19 Aug. 1959, *leg. J. Kowalczyk* (LBL); Skrajny Granat Mt., alt. 2215 m, 03 July 1999, *leg. B. Krzewicka* (KRA); Czarne Ściany Mt., alt. 2200 m, 18 July 1999, *leg. B. Krzewicka* (KRA); Orla Baszta Mt., alt. 2220 m, 18 July 1999, *leg. B. Krzewicka* (KRA); Dolina Buczynowa valley, alt. 1720 m, 1770 m, and 1830 m, 19 July 1999, *leg. B. Krzewicka* (KRA); Dolina Roztoki valley, Aug. 1962, *leg. S. Matuszewska* (LBL); Ge– 60 – near Zadni Staw lake, Aug. 1962, *leg. S. Matuszewska* (LBL); Zadni Piarg scree, alt. 1865 m, 17 July 1999, *leg. B. Krzewicka* (KRA); Dolinka Pod Kołem valley, alt. 1910 m, 17 July 1999, *leg. B. Krzewicka* (KRA); near Wole Oko lake, alt. 1890 m, 17 July 1999, *leg. B. Krzewicka* (KRA); Kołowa Czuba Mt., S slope, alt. 1790 m, 1840 m, and 1920 m, 17 July 1999, *leg. B. Krzewicka* (KRA); Dolinka Pusta valley, alt. 1920 m, 17 July 1999, *leg. B. Krzewicka* (KRA); Niżnie Rzędy gully, alt. 1770 m, 20 July 1999, *leg. B. Krzewicka* (KRA); near Wielki Staw lake, alt. 1720 m, 15 Sept. 1955, *leg. Z. Tobolewski* (POZ), Aug. 1962, *leg. S. Matuszewska* (LBL); Żółta Skała rock near Świstowa Czuba Mt., alt. 1720 m, 20 July 1999, *leg. B. Krzewicka* (KRA); Świstowa Czuba Mt., Aug. 1962, *leg. S. Matuszewska* (LBL); Niedźwiedź rock, alt. 1800 m, 21 July 1999, *leg. B. Krzewicka* (KRA); Miedziany Kostur Mt., N slope, alt. 1860 m, 21 July 1999, *leg. B. Krzewicka* (KRA); near Przedniego Stawu lake,

alt. 1685 m, and 1690 m, 20 July 1999, *leg. B. Krzewicka* (KRA); Szpiglasowe Kopki Mt., alt. 1920 m, 20 July 1999, *leg. B. Krzewicka* (KRA); above Szpiglasowa Przełęcz pass, alt. 2140 m, 20 July 1999, *leg. B. Krzewicka* (KRA); Szpiglasowy Wierch Mt., S slope, alt. 2170 m, 20 July 1999, *leg. B. Krzewicka* (KRA); Kirowy Upłaz Mt. near Szpiglasowa Przełęcz pass, alt. 1820 m, 20 July 1999, *leg. B. Krzewicka* (KRA); Zadni Mnich Mt., 07 Aug. 1959, *leg. J. Kowalczyk* (LBL); Dolina za Mnichem valley, 07 Aug. 1959, *leg. S. Matuszewska* (LBL); Mnich Mt., NE slope, alt. 1780 m, and 1830 m, 16 Aug. 2000, *leg. B. Krzewicka* (KRA), N slope, alt. 1820 m, W slope, alt. 1800 m, and 2000 m, 30 July 1999, *leg. B. Krzewicka* (KRA); on bank of Mnichowy Potok stream, alt. 1640 m, 30 July 1999, *leg. B. Krzewicka* (KRA); by Dwoista Siklawa stream, alt. 1550 m, 30 July 1999, *leg. B. Krzewicka* (KRA); Wrota Chałubińskiego pass, N slope, alt. 2000 m, 30 July 1999, *leg. B. Krzewicka* (KRA); near Czarny Staw pod Rysami lake, alt. 1590 m, Aug. 1962, *leg. S. Matuszewska* (LBL), alt. 1650 m, 17 Aug. 2000, *leg. B. Krzewicka* (KRA); Żabia Czuba Mt., alt. 2070 m, Aug. 1959, *leg. S. Matuszewska* (LBL); Żabi Niżni Szczyt Mt., alt. 2100 m, 19 Aug. 1955, *leg. K. Tatarkiewicz* (LBL); Apostoły Mts, alt. 1550 m, and 2050 m, 03 Aug. 1956, *leg. K. Tatarkiewicz* (LBL); Żabia Lalka Mt., S slope, alt. 1660 m, 18 Aug. 2000, *leg. B. Krzewicka* (KRA); Żabi Mnich Mt., alt. 2000 m, 2100 m, and 2150 m, 18 Aug. 1955, *leg. K. Tatarkiewicz* (LBL), W slope, alt. 1700 m, 29 July 1999, *leg. B. Krzewicka* (KRA); Kazalnica Mt., N slope, alt. 1730 m, 1999, and 2040 m, 17 Aug. 2000, *leg. B. Krzewicka* (KRA), E slope, alt. 1800 m, 27 July 1999, *leg. B. Krzewicka* (KRA); Czarnostawiańska Przełęcz pass, alt. 2300 m, 16 Aug. 1955, *leg. K. Tatarkiewicz* (LBL); Pośredni Mięguszowiecki Szczyt Mt., Aug. 1959, *leg. S. Matuszewska* (LBL), alt. 2390 m, 17 Aug. 2000, *leg. B. Krzewicka* (KRA); Mięguszowiecki Szczyt Mt., alt. 2300 m, 1927, *leg. K Wallish* (LBL), alt. 2350 m, Aug. 1954, *leg S. Matuszewska* (LBL), alt. 2400 m, 10 Aug. 1959, *leg. J. Kowalczyk* (LBL), alt. 2430 m, 22 Aug. 1955, *leg. K. Tatarkiewicz* (LBL); Cubryna Mt., 1927, *leg. K. Wallisch* (LBL); Bula Pod Rysami Mt., alt. 1740 m, 29 July 1999, *leg. B. Krzewicka* (KRA); N slope, alt. 1900 m, S slope, alt. 1760 m, 29 July 1999, *leg. B. Krzewicka* (KRA); Rysy Mt. summit, alt. 2449 m, 08 Aug. 1926, *leg. J. Motyka* (KRAM), 31 Aug. 1938, *leg Z. Tobolewski* (POZ), 25 Aug. 1955, *leg. K. Tatarkiewicz* (LBL), alt. 2449 m, 29 July 1999, *leg. B. Krzewicka* (KRA), below summit, alt. 2160 m, 2225 m, and 2350 m, 29 July 1999, *leg. B. Krzewicka* (KRA), NW slope, alt. 2400 m, and 2440 m, 08 Aug. 1926, *leg. J. Motyka* (LBL), alt. 2300 m, 02 Aug. 1929, *leg. J. Motyka* (LBL).

Umbilicaria cylindrica (L.) Delise *ex* Duby (Figs 18, 19)

Bot. Gall. **2**: 595. 1830.

Lichen cylindricus L., Sp. Pl.: 1144. 1753. – *Gyrophora cylindrica* (L.) Ach., Meth. Lich.: 107. 1803.

Thallus 3–4(7) cm diam., monophyllous or polyphyllous, lobes in the center ± ascending, cushion-shaped, with moderately incised margins having flat black cilia up to 2 mm long, cilia sparse or forming a dense fringe around the lobe margins. Upper side pale to dark grey, dull, smooth or scabrous, even or wrinkled, sometimes with a few folds and ridges present over the umbilicus, giving way to a reticulate pattern. Medulla white. Underside light brown or tan to pink, sometimes darker towards the umbilicus, sometimes with a grey pruinose marginal zone, even, smooth, area around the umbilicus without rhizines, umbilicus black. Rhizines numerous or sparsely, thin, long, cylindrical or flat, simple to irregular branched, concolorous with the lower cortex or darker mainly towards the margin. Thallus 190–340 μm; upper cortex 10–20 μm; algal layer continuous, 30–80 μm thick; medulla loose, 70–170 μm; lower cortex 10–20 μm, scleroplectenchymatous. Apothecia gyrodisc, common, markedly stipitate, disc to 2.5 mm, black, convex with few gyri, the gyri deep, hypothecium brown, hymenium *ca* 70 μm, paraphyses septate, 8 simple, hyaline, ellipsoid spores 8.0–15.0 × 3.0–9.0 μm in ascus. Pycnidia numerous, distributed in marginal zone or on all the upper surface, immersed, bottled-shape, with brown wall, and dark brown ostiole. Conidia *ca* 3.0–4.0 × 0.8 μm. Thalloconidia absent.

CHEMISTRY. Gyrophoric and lecanoric acids.

NOTE. *Umbilicaria cylindrica* is the most variable species in this genus. The variability appears mainly in the formation of rhizines, the occurrence of cilia, the folds and wrinkles of the upper side, the coloration of the underside, as well as the occurrence of mono- or polyphyllous thalli. Five

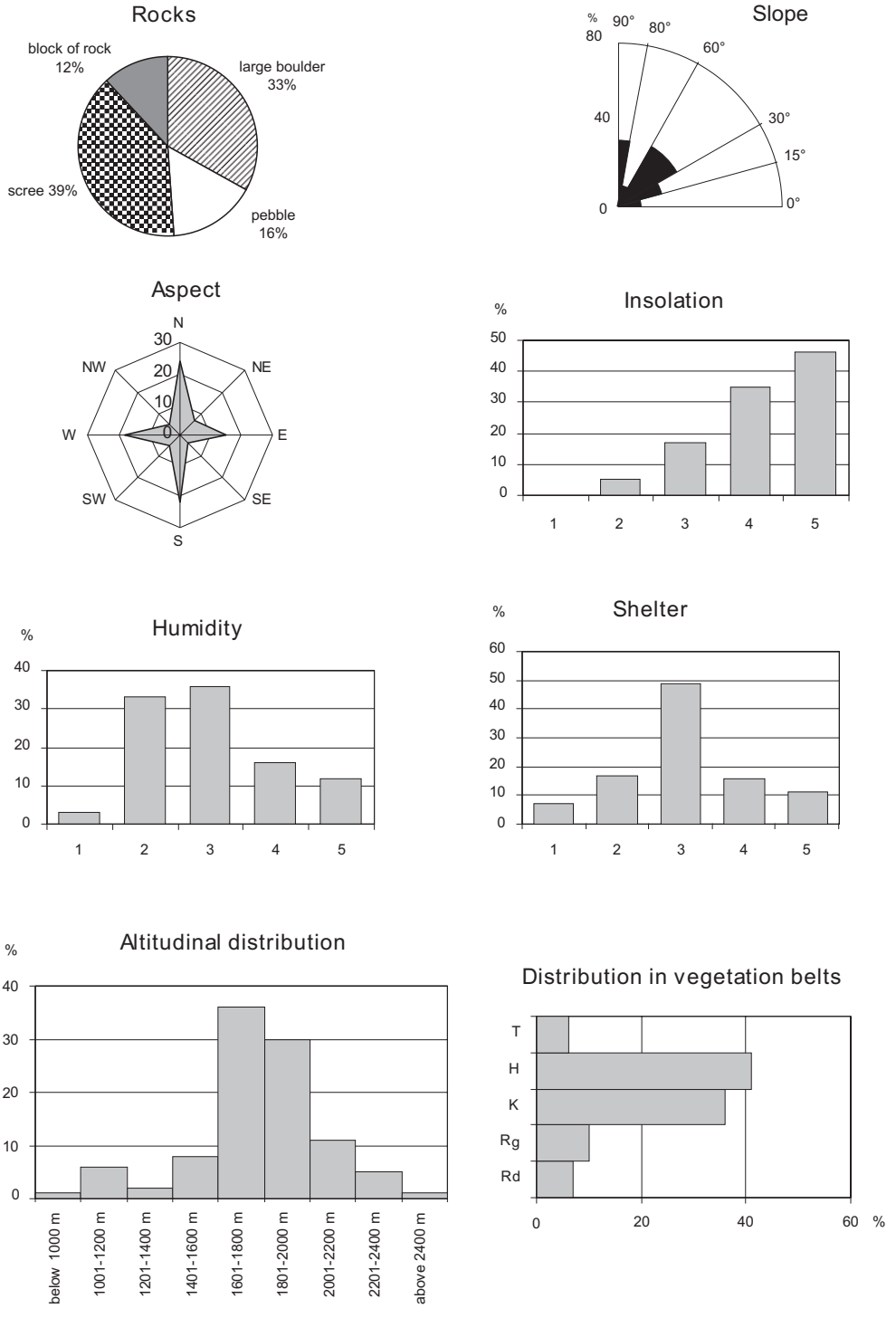


Fig. 18. Ecodiagram for *Umbilicaria cylindrica* (L.) Delise *ex* Duby (explanations – see Material and methods).

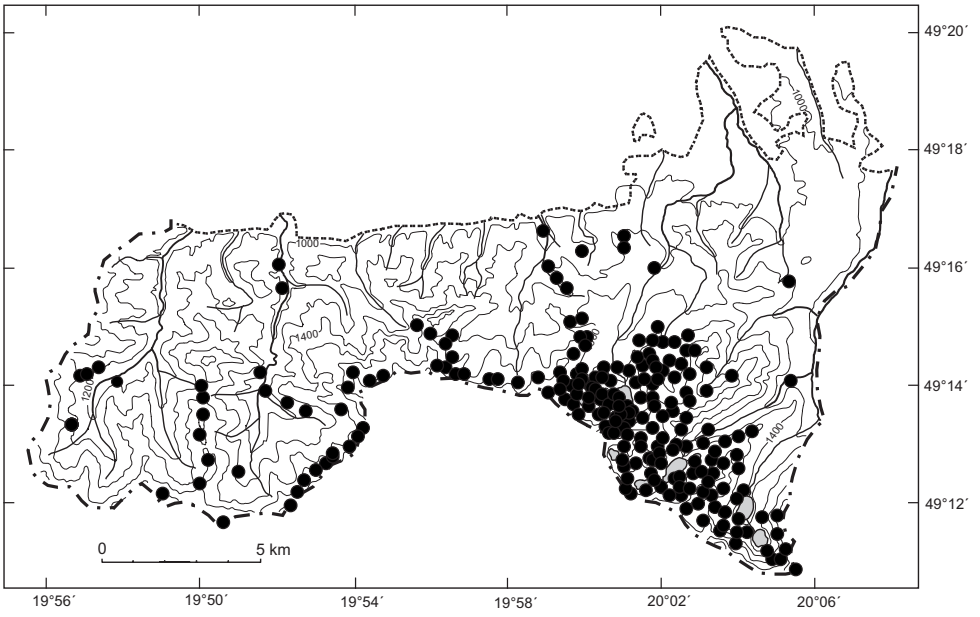


Fig. 19. Distribution map of *Umbilicaria cylindrica* (L.) Delise *ex* Duby in the Polish Tatra Mts. ● – locality.

distinctly different varieties of this species occure in the Tatra Mts.:

– var. *cylindrica*. Thallus monophyllous, upper side slightly wrinkled, reticulated, or almost even. Underside with fairly numerous, pale, cylindrical, mainly single rhizines. Numerous apothecia on distinct high stalks. Noticeable but not very numerous cilia on the edge of the thallus.

– var. *delisei* (Despr.) Nyl. Large thallus 6(10) cm diam., usually monophyllous, rigid, almost bare. Cilia only in some places on younger parts, ± flattened at the base, densely branched, blackish at peripheries. Underside of thallus pale, distinctly pink near umbilicus, greyish in peripheral part, with cylindrical, branched, moderately numerous rhizines.

– var. *fimbriata* (Ach.) Nyl. Medium-size thallus, usually *ca* 4 cm diam., monophyllous, with undulating edges, sometimes divided along the margin into many lobes or, less often, polyphyllous. Upper side even or folded, without ridges and wrinkles. Underside almost bare, a few rhizines in the peripheral part. Edge with very numerous, black, branched cilia up to 3(4) mm thick.

– var. *corrugatoides* Frey. Thallus variable in size, monophyllous, sometimes slightly incised, appearing to be polyphyllous, ± spread and adhering to substrate, over the umbilicus raised in the central part, with a network of ridges with thick white areoles. Fructifications not numerous. Cilia on the edge, thin, cylindrical, not very dense. Underside pale brown, covered with ± numerous rhizines.

– var. *tornata* (Ach.) Nyl. Thallus polyphyllous, usually small, sometimes only 2–3 mm diam., commonly *ca* 1 cm, densely concentrated, raised, with edges rounded or irregularly incised, often lacerated, usually with a few flattened cilia. Upper side usually brownish grey. Underside almost devoid of rhizines. Apothecia fairly numerous. Specimens occur in large sward-forming groups.

HABITAT. This species occurs on siliceous rocks, on horizontal and slightly inclined surfaces (50% of cases), fairly frequent on vertical surfaces (30% of cases), often on top of large granite boulders or blocks of rock (all together 45% of cases). It colonizes a wide variety of siliceous substrates, espe-

cially in open, exposed situations; it occurs on large boulders on scree where it is most frequent (39% of cases), and where it appears to be a pioneer species, and also on small isolated pebbles (16% of cases). It is not found on vertical rock walls. It is found with the same frequency on south, east, north, and west aspects. It grows on sun-exposed, moderately dry and windy sites, with a wide range of aspects. This species grows most often on anthropogenic substrate such as granite hiking trails (Fig. 18).

DISTRIBUTION. It is a mountain species. In the Polish Tatras *U. cylindrica* is a common and locally abundant species, extending from the lower montane belt to the subnival belt (Fig. 18). It appears to have its center of occurrence in the subalpine and alpine belts (75% of cases). In the subnival belt the species is rare (6% of cases) and occurs most often on anthropogenic substrate (hiking trails built of granite rocks). The lowest locality is the Wyżnia Miętusia Kira glade at alt. 940 m, and the highest at Rysy Mt., 2440 m. In the West Tatras this species occurs at scattered localities, mainly on granite hiking trails and outcrops of granite rocks. In the High Tatras it is common and widely distributed, occurring mainly in the Hala Gąsienicowa alpine meadow, the area of the Dolina Pięciu Stawów Polskich valley, and the Morskie Oko valley (Fig. 19).

In the Polish Carpathians it is known from many scattered stations in the Beskid Śląski Mts (Kiszka 1967b), Beskid Mały Mts (Nowak 1965), Beskid Makowski Mts (Nowak 1968), Beskid Wyspowy Mts (Nowak 1998), Beskid Żywiecki Mts (Tobolewski 1961a; Nowak 1967, 1998), Gorce Mts (Czarnota 2000), Beskid Sądecki Mts (Olech 1972, 1973; Śliwa 1998a, b), Pieniny Mts (Tobolewski 1955d, 1958; Kiszka 1997, 2000), Spisko-Gubałowskie foothills (Kiszka 1967a, 1985), High and West Tatra Mts (Boberski 1892; Motyka 1924a, b, 1926, 1927, 1928; Tobolewski 1955a, b, 1956a, 1962b, 1965, 1996; Alstrup & Olech 1992a; Bielczyk 1997, 1999) and Bieszczady Mts (Tobolewski & Glanc 1958; Glanc & Tobolewski 1960; Kiszka & Kościelniak 1998). Outside the Carpathians it has been recorded from a few localities in the Sudety Mts (Eitner 1911): from the Karkonosze Mts (Tobolewski 1954; Seaward *et al*. 1981, 1983; Kozioł 1993), Góry Stołowe Mts (Tobolewski 1955c) and Śnieżnik massif (Fabiszewski 1968). It was also known from the lowland in Poland, but only from a single locality in western Pomerania where was found more than 50 years ago (Krawiec 1933a, b, 1938; Fałtynowicz & Tobolewski 1989; Fałtynowicz 1992).

It is a frequent species also in the Slovakian High Tatras (Lisická 1980). *Umbilicaria cylindrica* is widely distributed especially in mountain regions of Europe. It is one of the most frequent species of the genus *Umbilicaria*. This species is reported from nearly all countries of Europe (e.g., Golubkova *et al*. 1978; Murati 1992; Nimis 1993; Wirth 1995; Llimona & Hladun 2001).

EXSICCATI SEEN. *Flora Silesiaca Exs. No. 1336* (LBL); Hansen, *Lich. Groenl. Exs. No. 66* var. *delisei* (WA); *No. 82* (WA); *No. 285* (WA); *No. 433* var. *delisei* (WA); *No. 603* (WA);Poelt, *Lich. Alpium No. 233* var. *tornata* (KRAM, LBL, POZ); Rabenhorst, *Lich. Eur. No. 356* (sub. *Gyrophora polymorpha a. cylindrica*) (KRA); *No. 791* (sub. *Gyrophora cylindrica*) (KRA); Tobolewski, *Lich. Polonica No. 87* (KRA, LBL, TRN, WA); *No. 212* (POZ); Vězda, *Lich. Bohem. Exs. No. 136* var. *denudata* (POZ); Weber, *Lich. Exs. Univ. Colorado Mus. No. 228* (KRAM).

SPECIMENS EXAMINED. Grid square Gd-58 – WEST TATRA MOUNTAINS: Polana Chochołowska glade, alt. 1100 m, Sept. 1959, *leg. J. Bystrek* (LBL), alt. 1115–1140 m, 07 May 1999, *leg. B. Krzewicka* (KRA); Wyżnia Dolina Chochołowska valley, alt. 1130 m, 07 May 1999, *leg. B. Krzewicka* (KRA); Dolina Chochołowska valley near Dolina Starobociańska valley, alt. 1050 m, 07 May 1999, *leg. B. Krzewicka* (KRA); Gd-59 – WEST TATRA MOUNTAINS: Wyżnia Miętusia Kira glade, alt. 940 m, 21 May 1999, *leg. B. Krzewicka* (KRA); Stare Kościeliska glade, alt. 1000 m, and 1055 m, 21 May 1999, *leg. B. Krzewicka* (KRA); Smytnia Polana glade, 1100 m, 21 May 1999, *leg. B. Krzewicka* (KRA); Ornak Mt., 15 Aug. 1962, *leg. S. Matuszewska* (LBL), E slope, alt. 1250 m, 07 July 1955, *leg. J. Nowak* (KRAM); Ornak Mt., alt. 1750 m, and 1850 m, E slope, alt. 1580 m, 07 Aug. 1999, *leg. B. Krzewicka* (KRA); Niżnia Tomanowa Polana glade, alt. 1325 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); Dolina Tomanowa valley, alt. 1160 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); Hala Tomanowa mountain

meadow, alt. 1100 m, 05 July 1955, *leg. J. Nowak* (KRAM); Twardy Upłaz Mt., 30 July 1924, *leg. J. Motyka* (LBL), alt. 2000 m, Sept. 1955, *leg. I. Wojciechowski* (LBL); Kamienisty Żleb gully, alt. 1630 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); Suchy Wierch Ornaczański Mt., alt. 1680 m, 07 Aug. 1999, *leg. B. Krzewicka* (KRA); Dolina Tomanowa valley, 26 Aug. 1951, *leg. J. Rydzak* (LBL); Tomanowa Przełęcz pass, alt. 1415 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); Ciemniak Mt., alt. 2090 m, 06 Aug. 1998, *leg. B. Krzewicka* (KRA); Krzesanica Mt., alt. 2122 m, 06 Aug. 1998, *leg. B. Krzewicka* (KRA); Kondracka Przełęcz pass, 28 Aug. 1924, *leg. J. Motyka* (LBL); Hala Kondratowa mountain meadow, alt. 1325 m, 17 July 1998, *leg. B. Krzewicka* (KRA); Długi Żleb gully in Dolina Kondratowa valley, alt. 1650 m, 17 July 1998, *leg. B. Krzewicka* (KRA); below Giewont, alt. 1850 m, 17 July 1998, *leg. B. Krzewicka* (KRA); Kopa Kondracka Mt., alt. 1980 m, 17 July 1998, *leg. B. Krzewicka* (KRA); Przełęcz Pod Kopą Kondracką pass, alt. 1863 m, 17 July 1998, *leg. B. Krzewicka* (KRA); Suche Czuby Mt., alt. 1790 m, 06 Aug. 1998, *leg. B. Krzewicka* (KRA); Gd-68 – WEST TATRA MOUNTAINS: Starobociański Wierch Mt., alt. 2176 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); Gd-69 – WEST TATRA MOUNTAINS: Hala Pyszna mountain meadow, 23 May 1959, *leg. S. Matuszewska* (LBL); Zadni Ornak Mt., alt. 1807 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); Kamienista Mt., alt. 2127 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); Hlińska Przełęcz pass, 1897 m, and 1930 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); Smereczyński Wierch Mt., 30 Aug. 1923, *leg. J. Motyka* (LBL), 22 May 1959, *leg. S. Matuszewska* (LBL), summit, alt. 2060 m, E slope, alt. 1900 m, and 2000 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); Smereczyńska Przełęcz pass, alt. 1800 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); below Smereczyńska Przełęcz pass, near Tomanowy Wierch Mt., alt. 1900 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); Tomanowy Wierch Mt., alt. 1960 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); Suchy Wierch Tomanowy Mt., alt. 1760 m, and 1860 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); Przełęcz Kondracka pass, alt. 1650 m, and 1770 m, 25 May 1986, *leg. V. Alstrup & M. Olech* (KRA); Ge-50 – HIGH TATRA MOUNTAINS: Kuźnice village, near Bystry Potok river, Aug. 1925, *leg. J. Motyka* (LBL); Polana Kopieniec glade, alt. 1240 m, 10 July 1999, *leg. B. Krzewicka* (KRA); Polana Olczyska glade, alt. 1050 m, 10 July 1999, *leg. B. Krzewicka* (KRA); Dolina Suchej Wody valley, alt. 1210 m, 10 July 1999, *leg. B. Krzewicka* (KRA); Dolina Jaworzynka valley, alt. 1110 m, 16 Oct. 1998, *leg. B. Krzewicka* (KRA); Kasprowy Wierch Mt., alt. 1950 m, 06 Aug. 1998, *leg. B. Krzewicka* (KRA); Mała Kopa Królowa Mt., alt. 1560 m, 01 July 1999, *leg. B. Krzewicka* (KRA); Wielka Kopa Królowa Mt., 1460 m, 01 July 1999, *leg. B. Krzewicka* (KRA); Pośredni Wierch Goryczkowy Mt., 26 Aug. 1927, *leg. J. Motyka* (LBL), alt. 1870 m, 17 July 1998, *leg. B. Krzewicka* (KRA); Uhrocie Kasprowe Mt., 02 Sept. 1959, *leg. S. Matuszewska* (LBL), alt. 1690 m, 04 July 1999, *leg. B. Krzewicka* (KRA); Beskid Mt. near Liliowe pass, alt. 1985 m, and 1907 m, 04 July 1999, *leg. B. Krzewicka* (KRA); Liliowe pass, N slope, alt. 1780 m, and 1805 m, 04 July 1999, *leg. B. Krzewicka* (KRA); Ge-50 – HIGH TATRA MOUNTAINS: Las Gąsienicowy forest, 1961, *leg. J. Nowak* (KRAM); Hala Gąsienicowa mountain meadow, Aug. 1925, *leg. J. Motyka* (LBL), Aug. 1927, *leg. J. Motyka* (LBL), 16 Aug. 1949, *leg. J. Motyka* (LBL), 03 June 1956, *leg. J. Motyka* (LBL), 16 Aug. 1959, *leg. J. Motyka* (LBL), 23 May 1959, *leg. S. Matuszewska* (LBL); near Murowaniec hut, alt. 1450 m, 01 July 1999, *leg. B. Krzewicka* (KRA); Pańszczycki Żleb gully, alt. 1580 m, 09 July 1999, *leg. B. Krzewicka* (KRA); near Czarny Staw Gąsienicowy lake, 16 Aug. 1959 *leg. S. Matuszewska* (LBL), on E bank, alt. 1570 m, and 1700 m, 02 July 1999, *leg. B. Krzewicka* (KRA); near Mokra Jama lake, alt. 1550 m, 02 July 1999, *leg. B. Krzewicka* (KRA); near Staw Samotniak lake, alt. 1620 m, 02 July 1999, *leg. B. Krzewicka* (KRA); below Litworowy Staw, alt. 1615 m, 02 July 1999, *leg. B. Krzewicka* (KRA); near Długi Staw lake, alt. 1870 m, 02 July 1999, *leg. B. Krzewicka* (KRA); near Zielony Staw lake, alt. 1690 m, and 1700–1750 m, 06 July 1999, *leg. B. Krzewicka* (KRA); near Dwoisty Staw lake, Aug. 1925, *leg. J. Motyka* (LBL); Skrajna Turnia Mt., alt. 1900 m, 16 June 1986, *leg. V. Alstrup & M. Olech* (KRA); near Kurtkowiec lake, alt. 1710 m, 06 July 1999, *leg. B. Krzewicka* (KRA); Przełęcz Karb pass, Aug. 1959, *leg. S. Matuszewska* (LBL), W slope, alt. 1715 m, 06 July 1999, *leg. B. Krzewicka* (KRA); Mały Kościelec Mt., 19 Aug. 1959, *leg. S. Matuszewska* (LBL), alt. 1800 m, and 1820 m, 17 June 1986, *leg. V. Alstrup & M. Olech* (KRA), N slope, alt. 1660 m, 1710 m, and 1760 m, W slope, alt. 1960 m, and 1730–1750 m, SW slope, alt. 1720 m, 06 July 1999, *leg. B. Krzewicka* (KRA); Kościelec Mt., Aug. 1963, *leg. S. Matuszewska* (LBL), 16 Aug. 1980, *leg. E. Budzba* (UGDA), summit, alt. 2155 m, N slope, alt. 1870 m, and 1960 m, 06 July 1999, *leg. B. Krzewicka* (KRA); Zadni Kościelec Mt., 12 Aug. 1959, *leg. S. Matuszewska* (LBL), Aug. 1959, *leg. J. Kowalczyk* (LBL); near Zmarzły Staw lake, alt. 1780 m, and 1970 m, 05 July 1999, *leg. B. Krzewicka* (KRA); Dolina Pańszczyca val-

ley, Zadni Upłaz Mt., N slope, alt. 1630 m, and 1660 m, 09 July 1999, *leg. B. Krzewicka* (KRA); near Czerwony Staw lake, July 1961, *leg. J. Bystrek* (LBL), alt. 1650 m, 05 July 1999, *leg. B. Krzewicka* (KRA); Pośrednia Turnia Mt., alt. 1710 m, and 1760 m, 05 July 1999, *leg. B. Krzewicka* (KRA); Przełęcz Świnicka pass, N slope, alt. 1950 m, 05 July 1999, *leg. B. Krzewicka* (KRA); Świnica Mt. summit, alt. 2250 m, 18 Aug. 1959, *leg. J. Kowalczyk* (LBL), below summit, alt. 2090 m, 05 July 1999, *leg. B. Krzewicka* (KRA), S slope, alt. 1910 m, 05 July 1999, *leg. B. Krzewicka* (KRA); between Świnica Mt. and Zawrat pass, alt. 2180 m, 05 July 1999, *leg. B. Krzewicka* (KRA); Zawrat pass, Aug. 1959, *leg. S. Matuszewska* (LBL), alt. 2150 m, 05 July 1999, *leg. B. Krzewicka* (KRA); near Czerwone Stawki lake, alt. 1800 m, 05 July 1999, *leg. B. Krzewicka* (KRA); near Długi Staw lake, alt. 1770 m, 02 July 1999, *leg. B. Krzewicka* (KRA); Żółta Turnia Mt., 16 Sept. 1949, *leg. J. Motyka* (LBL), Sept. 1955, *leg. I. Wojciechowski* (LBL), 25 May 1959, *leg. S. Matuszewska* (LBL), 08 Aug. 1963, *leg. S. Matuszewska* (LBL), alt. 1980 m, 12 Nov. 1960, *leg. J. Nowak* (KRAM); Żółta Turnia Mt., W slope, alt. 1600 m, 1770 m, and 1860 m, N slope, alt. 1495 m, 09 July 1999, *leg. B. Krzewicka* (KRA); Wierch pod Fajki Mt., alt. 1730 m, 15 Aug. 1959 *leg. S. Matuszewska* (LBL), alt. 1880 m, 1945 m, and 2120 m 03 July 1999, *leg. B. Krzewicka* (KRA); Zadni Granat Mt., alt. 2200 m, 03 July 1999, *leg. B. Krzewicka* (KRA); Skrajny Granat Mt., alt. 2015 m, and 2220 m, 03 July 1999, *leg. B. Krzewicka* (KRA); near Zmarzły Staw lake, Aug. 1959, *leg. S. Matuszewska* (LBL); Zmarzłe Czuby Mt., N slope, alt. 2130 m, 12 July 1999, *leg. B. Krzewicka* (KRA); Kozie Czuby Mt., alt. 2260 m, Aug. 1955, *leg. J. Kowalczyk* (LBL), 1959, *leg. S. Matuszewska* (LBL); Kozi Wierch Mt., alt. 2200 m, Aug. 1959, *leg. S. Matuszewska* (LBL), alt. 2228 m, and 2291 m, 18 July 1999, *leg. B. Krzewicka* (KRA); Orla Baszta Mt., alt. 2140 m, 18 July 1999, *leg. B. Krzewicka* (KRA); below Kozia Przełęcza pass, alt. 1820 m, 1900 m, 2010 m, and 2070 m, 22 July 1999, *leg. B. Krzewicka* (KRA); below Kozi Wierch Mt., alt. 1180 m, and 2200 m, 16 July 1999, *leg. B. Krzewicka* (KRA); Żleb Kulczyńskiego gully, 18 Aug. 1959, *leg S. Matuszewska* (LBL); Krzyżne Mt., SE slope, alt. 2020 m, 18 July 1999, *leg. B. Krzewicka* (KRA); Żleb pod Krzyżnem gully, alt. 2100 m, 18 July 1999, *leg. B. Krzewicka* (KRA); Dolina Buczynowa valley, alt. 1720 m, 1770 m, and 1830 m, 18 July 1999, *leg. B. Krzewicka* (KRA); Wyżnie Rzędy gully, alt. 1770 m, 18 July 1999, *leg. B. Krzewicka* (KRA); Potok Roztoka river, alt. 1490 m, 21 July 1999, *leg. B. Krzewicka* (KRA); Ge-51 – HIGH TATRA MOUNTAINS: Palenica Białczańska glade, alt. 1000 m, 25 Aug. 1999, *leg. B. Krzewicka* (KRA); Ge-60 – HIGH TATRA MOUNTAINS: near Zadni Staw lake, 16 Aug. 1962, *leg. S. Matuszewska* (LBL); Zadni Piarg scree, alt. 1865 m, 17 July 1999, *leg. B. Krzewicka* (KRA); Zawrat pass, S slope, alt. 1760 m, 05 July 1999, *leg. B. Krzewicka* (KRA); Dolina Pod Kołem valley, alt. 1670 m, 1890 m, 1910 m, and 1950 m, 16 July 1999, *leg. B. Krzewicka* (KRA); Kozi Wierch Mt., SE slope, alt. 1700 m, and 1770 m, 22 July 1999, *leg. B. Krzewicka* (KRA); Szeroki Żleb gully, alt. 1850 m, 1900 m, 1950 m, 2000 m, 2050 m, 2100 m, and 2150 m, 22 July 1999, *leg. B. Krzewicka* (KRA); Niedźwiedź rock, alt. 1800 m, 21 July 1999, *leg. B. Krzewicka* (KRA), N side, alt. 1720 m, and 1730 m, 21 July 1999, *leg. B. Krzewicka* (KRA); Świstowa Czuba Mt., alt. 1763 m, Aug. 1959, *leg. S. Matuszewska* (LBL), alt. 1685 m, and 1690 m, 20 July 1999, *leg. B. Krzewicka* (KRA); Kołowa Czuba Mt., alt. 1790 m, 1840 m and 1920 m, 16 July 1999, *leg. B. Krzewicka* (KRA); Dolinka Pusta valley, alt. 1920 m, 09 Apr. 1955, *leg. K. Tatarkiewicz* (LBL), Aug. 1959, *leg. S. Matuszewska* (LBL), alt. 1970 m, 16 July 1999, *leg. B. Krzewicka* (KRA); Czarny Staw Polski lake, on E bank, alt. 1730 m, 19 July 1999, *leg. B. Krzewicka* (KRA); Wodospad Siklawa waterfall, alt. 1525 m, and 1650 m, 19 July 1999, *leg. B. Krzewicka* (KRA); near Wielki Staw lake, alt. 1720 m, 20 Sept. 1955, *leg. Z. Tobolewski* (LBL, KRAM, POZ), alt. 1665 m, Aug. 1959, *leg. S. Matuszewska* (LBL), alt. 1730 m, 1840 m, and 1860 m, 19 July 1999, *leg. B. Krzewicka* (KRA); Miedziany Kostur Mt., W slope, alt. 1800 m, and 1840 m, 21 July 1999, *leg. B. Krzewicka* (KRA); Kotelnica Mt., E slope, alt. 1800 m, and 1810 m, 19 July 1999, *leg. B. Krzewicka* (KRA); Liptowski Kostur Wyżni Mt. on Czerwony Piarg scree, alt. 1980 m, 19 July 1999, *leg. B. Krzewicka* (KRA); Liptowski Kostur Niżni Mt., N slope, alt. 1800 m, 19 July 1999, *leg. B. Krzewicka* (KRA); Szpiglasowa Przełęcz pass, E slope, alt. 1740 m, 1820 m, 1880 m, 1920 m, 1980 m, 2140 m, and 2170 m, 20 July 1999, *leg. B. Krzewicka* (KRA); Opalony Wierch Mt., 05 Apr. 1955, *leg. K. Tatarkiewicz* (LBL); near Wyżni Mnichowy Stawek lake, alt. 1760 m, 1800 m, and 1880 m, 30 July 1999, *leg. B. Krzewicka* (KRA); near Mnichowe Stawki lakes, Aug. 1959, *leg. S. Matuszewska* (LBL); Mnich Mt., alt. 2000 m, 16 Sept. 1955, *leg. K. Tatarkiewicz* (LBL), 06 July 1958, *leg. K. Tatarkiewicz* (LBL), alt. 2060 m, Aug. 1959, *leg. S. Matuszewska* (LBL), W slope, alt. 2000 m, N slope, alt. 1920 m, 30 July 1999, *leg. B. Krzewicka* (KRA), NE slope, alt. 1780 m, 1830 m, and 1910 m, 16 Aug. 2000, *leg. B. Krzewicka* (KRA); Zadni Mnich Mt., alt. 2177 m, July 1959, *leg. J. Ko-*

walczyk (LBL); Dolina za Mnichem valley, alt. 1550 m, 1800 m, 1870 m, and 2000 m, 30 July 1999, *leg. B. Krzewicka* (KRA); Miedziane Kochy Mt., alt. 1720 m, and 1760 m, 21 July 1999, *leg. B. Krzewicka* (KRA); near Szeroki Żleb gully, alt. 1417 m, 04 Aug. 1998, *leg. B. Krzewicka* (KRA); near Morskie Oko hut, 20 Aug. 1926, *leg. J. Motyka* (LBL), 18 Aug. 1959, *leg. S. Matuszewska* (LBL), 1964, *leg. J. Bystrek* (LBL), 1410 m, and 1450 m, 17 July 1998, *leg. B. Krzewicka* (KRA); Owczy Żleb gully, 1740 m, 29 July 1999, *leg. B. Krzewicka* (KRA); near Czarny Staw pod Rysami lake, 1877, *leg. A. Rehmann* (KRAM), 18 Aug. 1926, *leg. J. Motyka* (LBL), Aug. 1959, *leg. S. Matuszewska* (LBL), 18 Aug. 1962, *leg. S. Matuszewska* (LBL), alt. 1590 m, 1600 m, 1610 m, 1650 m, 1670 m, 1700 m, and 1720 m, 29 July 1999, 18 Aug. 2000, *leg. B. Krzewicka* (KRA); Cubryna Mt., Aug. 1927, *leg. K. Wallisch* (LBL); Koleba pod Chłopkiem pass, alt. 1740 m, 17 Aug. 2000, *leg. B. Krzewicka* (KRA); Kazalnica Mt., N slope, alt. 2169 m, Aug. 1959, *leg. S. Matuszewska* (LBL), alt. 1730 m, 1980 m, 1990 m, and 2040 m, 17 Aug. 2000, *leg. B. Krzewicka* (KRA); Mięguszowiecka Przełęcz Pod Chłopkiem pass, alt. 2320 m, 27 July 1999, *leg. B. Krzewicka* (KRA), alt. 2200 m, and 2307 m, 17 Aug. 2000, *leg. B. Krzewicka* (KRA); Mięguszowiecki Szczyt Pośredni Mt., 1959, *leg. S. Matuszewska* (LBL), alt. 2390 m, 27 July 1999, *leg. B. Krzewicka* (KRA); Mięguszowiecki Szczyt Mt., alt. 2400 m, 22 Aug.1955, *leg. K. Tatarkiewicz* (LBL), 1959, *leg. S. Matuszewska* (LBL), 10 Aug. 1959, *leg. J. Kowalczyk* (LBL), alt. 2400 m, 27 July 1999, *leg. B. Krzewicka* (KRA); Mięguszowiecki Kocioł, alt. 1910 m, 27 July 1999, *leg. B. Krzewicka* (KRA); Czara Spadowa Kopa Mt., W slope, alt. 1650 m, 27 July 1999, *leg. B. Krzewicka* (KRA); Bula pod Rysami Mt., S slope, alt. 1740 m, 1760 m, and 1840 m, 29 July 1999, *leg. B. Krzewicka* (KRA), N slope, alt. 1900 m, 29 July 1999, *leg. B. Krzewicka* (KRA); Rysy Mt., Aug. 1925, *leg. J. Motyka* (LBL), July 1927, *leg. J. Motyka* (LBL), alt. 2449 m, 25 Aug. 1955, *leg. K. Tatarkiewicz* (LBL), NW slope, alt. 2000 m, 2100 m, 2160 m, 2200 m, 2300 m, 2350 m, and 2440 m, 29 July 1999, *leg. B. Krzewicka* (KRA); Mokra Wanta hut, alt. 1770 m, 18 Aug. 2000, *leg. B. Krzewicka* (KRA); Żabi Niżni Szczyt Mt., alt. 1900 m, 17 Aug. 1955, *leg. K. Tatarkiewicz* (LBL); Żabia Czuba Mt., alt. 1900 m, 18 Aug. 1955, *leg. K. Tatarkiewicz* (LBL), 08 Aug. 1959, *leg. S. Matuszewska* (LBL); Żabi Mnich Mt., W slope, alt. 1900 m, and 2100 m, 18 Aug. 1955, *leg. K. Tatarkiewicz* (LBL), W slope, alt. 1700 m, 1710 m, and 1900 m, 18 Aug. 2000, *leg. B. Krzewicka* (KRA); Żabia Lalka Mt., alt. 1660 m, 18 Aug. 2000, *leg. B. Krzewicka* (KRA).

Umbilicaria decussata (Vill.) Zahlbr.
(Figs 20, 21, 22, 23)

Cat. Lich. Univ. **8**: 490. 1942.

Lichen decussatus Vill., Hist. Pl. Dauphiné **3**: 964. 1789. – *Umbilicaria reticulata* (Schaer.) Carestia, Erbar. Crittogamol. **1**: 125. 1865. – *Gyrophora decussata* (Vill.) Zahlbr., Cat. Lich. Univ. **4**: 678. 1927. – *Omphalodiscus decussatus* (Vill.) Schol., Nyt Mag. Naturvid. **75**: 23. 1934.

Thallus 3–4 cm diam., monophyllous, rigid, thick, adpressed to substrate or undulating, with very wavy margins, the edges often curled. Upper side dark grey, coarsely granulose, with a white reticulate pattern, raised towards the center. Medulla white. Underside sooty black, dark brown only in places without thalloconidia, smooth, even or shallowly pitted, umbilicus very thick, short and compact. Rhizines absent. Thallus of various thicknesses, with ridges 300–500 μm, by ridges 150–230 μm; upper cortex dark brown, palisade-plectenchymatous, 25–30 μm; algal layer continuous, raised into ridges, 20–55 μm; medulla very loose under ridges, 60–110 μm; lower cortex 20–35 μm, scleroplectenchymatous. Apothecia omphalodisc, rare, not seen in examined material. Pycnidia not treated. Thalloconidia non-septate, spherical, smooth, dark brown, 7.3 × 8.6 μm

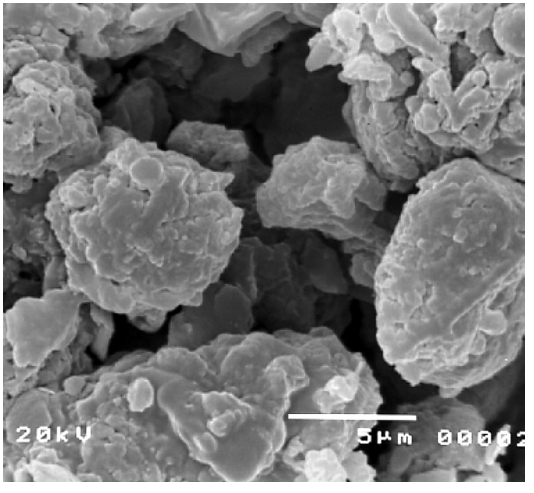


Fig. 20. *Umbilicaria decussata* (Vill.) Zahlbr. – non–septate conidia.

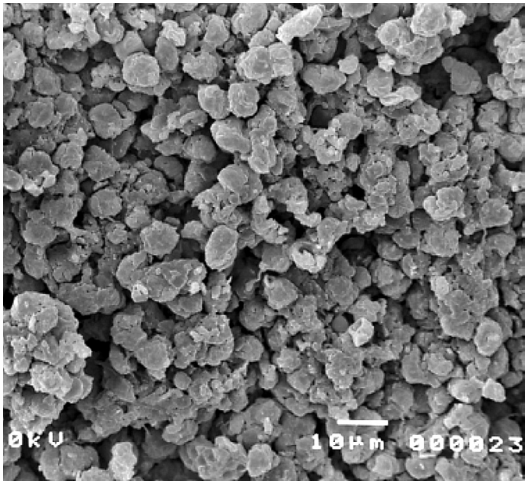


Fig. 21. *Umbilicaria decussata* (Vill.) Zahlbr. – thalloconidia on the underside of the thallus.

(Figs 20, 21). Thalloconidia entirely covered the underside.

CHEMISTRY. Gyrophoric acid and small amounts of lecanoric acid.

NOTE. Sometimes this species can be mistaken for *U. leiocarpa*, but the last species has a more yellowish upper side without a white reticulate pattern characteristic for *U. decussata*.

HABITAT. This species occurs on siliceous rocks. It appears to grow only on vertical and smooth surfaces (100% of cases) of large granite boulders, blocks of rock (together 80% of cases), and rock walls. It is also found on sunny, mainly south-exposed (36% of cases), ± wind-exposed, moderately moist to dry situations, and seems to be slightly nitrophilous (Fig. 22).

DISTRIBUTION. A high mountain (alpine) species. In the Polish High Tatras *U. decussata* grows at a few scattered stations. It extends from the subalpine belt up to the lower part of the subnival belt. In about 60% of cases this species has been found in the alpine belt, where it appears to have its main center of distribution (Fig. 22). The lowest locality is near Dwoisty Staw lake on the slope of Mały Kościelec Mt. at alt. 1690 m, the highest locality being the Przełęcz Pod Chłopkiem pass at 2320 m. In the High Tatras it occurs mainly in the area of the Morskie Oko valley (Fig. 23). As many as 65% of the examined stations are in this area.

In Poland it is very rare and grows exclusively in the High Tatras (Motyka 1964). In the literature the species *U. nylanderiana* was reported mistakenly by Nowak (1959, 1961; Tobolewski 1965) as *U. decussata* from the Wyżyna Krakowsko-Częstochowska upland (Krzewicka 2002b).

This species is slightly more frequent in the Slovakian part of the Tatras, reaching a maximum altitude of 2350 m there (Lisická 1980). In Northern Europe the species is reported from Svalbard where it is very common (Elvebakk & Hertel 1996), and from Scandinavia (Hakulinen 1962; Santesson 1993). In Central Europe it is known from the Alps (Nimis 1993) and the Tatra Mts (Lisická 1980), in Eastern Europe in the Urals (Golubkova *et al*. 1978), and in the south on high mountains of the Iberian Peninsula (Llimona & Hladun 2001) and the Balkans (Popnikolov & Zhelezova 1964).

EXSICCATI SEEN. Hansen, *Lich. Groenl. Exs. No. 103* (WA); *Exs. No. 354* (WA); *Krypt. Exs. Vindob. No. 4242* (POZ); Poelt, *Lich. Alpium No. 150* (LBL); Weber, *Lich. Exs. Univ. Colorado Mus. No. 230* (KRAM).

SPECIMENS EXAMINED. Grid square Ge-50 – HIGH TATRA MOUNTAINS: Mały Kościelec Mt., near Dwoisty Staw lake, alt. 1690 m, 06 July 1999, *leg. B. Krzewicka* (KRA); Żółta Turnia Mt., 08 Aug.1929, *leg. J. Motyka* (LBL); Orla Baszta Mt., alt. 2140 m, 18 July 1999, *leg. B. Krzewicka* (KRA); Ge-60 – HIGH TATRA MOUNTAINS: Cubryna Mt., N slope, Aug. 1927, *leg. J. Motyka* (LBL); Kotelnica Mt., E slope, alt. 1800 m, 19 July 1999, *leg. B. Krzewicka* (KRA); Szpiglasowa Przełęcz pass, alt. 1920 m, 20 July 1999, *leg. B. Krzewicka* (KRA); Szpiglasowy Wierch Mt., alt. 2170 m, 20 July 1999, *leg. B. Krzewicka* (KRA); Kazalnica Mt., alt. 2040 m, 17 Aug. 2000, *leg. B. Krzewicka* (KRA); Przełęcz Pod Chłopkiem pass, S slope, alt. 2320 m, 17 Aug. 2000, *leg. B. Krzewicka* (KRA); Mięguszowiecki Szczyt Mt., 28 Aug. 1959, *leg. S. Matuszewska* (LBL); Żabi Niżni Szczyt Mt., W slope, alt. 2180 m, 18 Aug. 1955, *leg. K. Tatarkiewicz* (LBL); Żabi Szczyt Mt., 08 Aug. 1959, *leg. S. Matuszewska* (LBL).

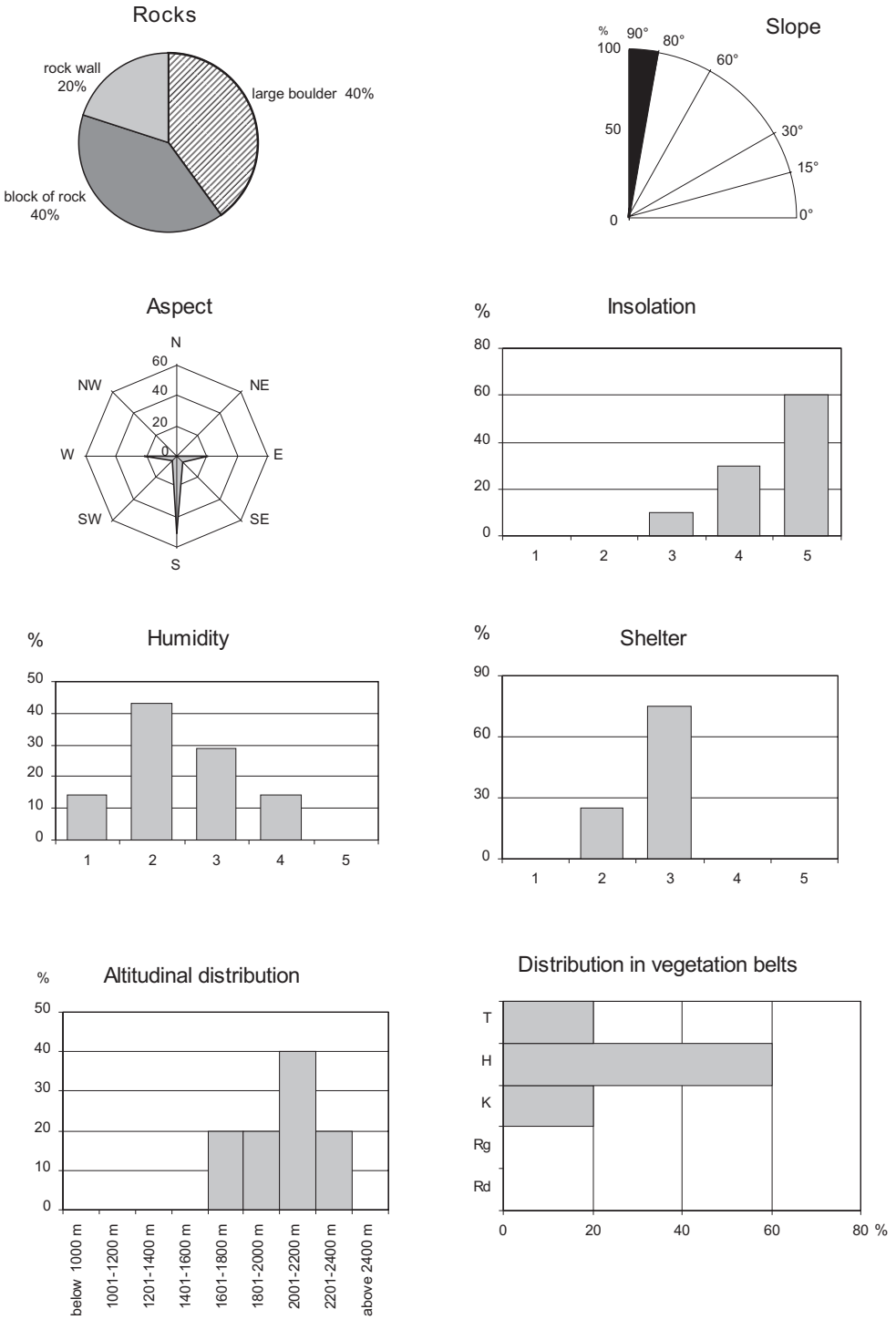


Fig. 22. Ecodiagram for *Umbilicaria decussata* (Vill.) Zahlbr. (explanations – see Material and methods).

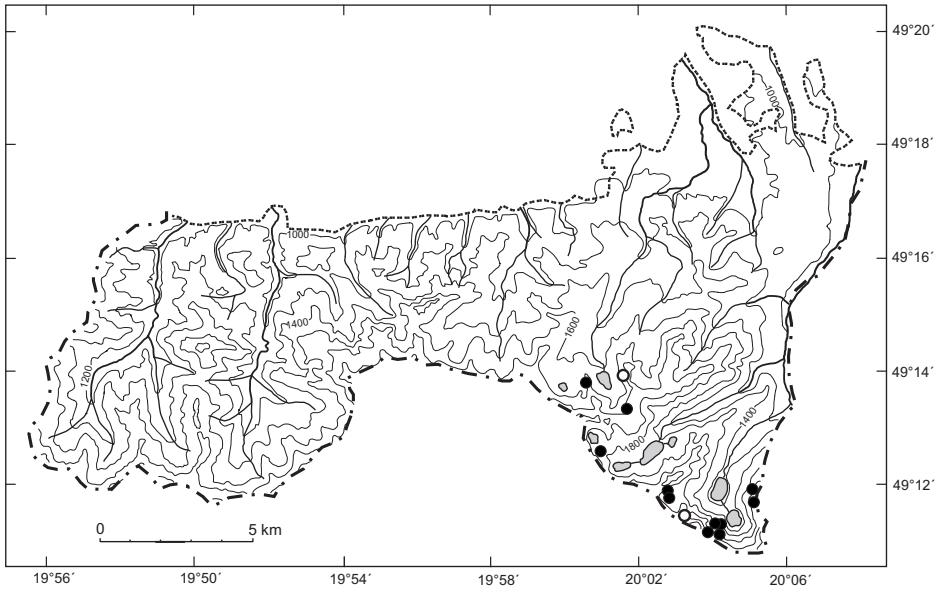


Fig. 23. Distribution map of *Umbilicaria decussata* (Vill.) Zahlbr. in the Polish Tatra Mts. ○ – locality to 1970, ● – locality after 1970.

Umbilicaria deusta (L.) Baumg. (Figs 24, 25)

Flora Lipsiensis: 571. 1790.

Lichen deustus L., Sp. Pl.: 1150. 1753. – *Gyrophora deusta* (L.) Ach., Meth. Lich.: 102. 1803.

Thallus 3–4(6) cm diam., monophyllous or polyphyllous, paper-thin and fragile when dry, somewhat gelatinous when moist, undulating, the edges often curled under, but with even margins when moist, color also becomes dark green. Young specimens (small up to 0.7 cm) monophyllous, orbicular in outline, shell-shape or ear-shape; old specimens polyphyllous, irregular in outline, lobes elongated, margins perforated, curled under or with ascending margins. Upper side dark brown to brownish black, dull or partly reflexed, smooth, even or slightly wrinkled, appearance like orange peel, usually with abundant isidia, punctiform or irregularly spreading along cracks and abrasions. Medulla white. Underside brown, sometimes black around umbilicus or, rarely, whole underside black, smooth to minutely areolate, pitted. Rhizines absent. Thallus 70–160 μm; upper cortex *ca* 10 μm; algal layer continuous, very thick but under isidia thin, 40–70 μm; medulla loose, 45–60 μm; lower cortex *ca* 20 μm, scleroplectenchymatous. Apothecia gyrodisc, very rare, found only on a few specimens in examined material, disc to 1.5 mm, gyrose, hypothecium light brown, hymenium 80–90 μm, paraphyses septate, 2.0–2.5 μm, spores irregular, 18.0–27.0 × 7.0–12.0 μm. Pycnidia not treated. Thalloconidia absent.

CHEMISTRY. Gyrophoric acid, small amounts of lecanoric acid.

NOTE. In the examined herbarium material this species was very often confused with *U. polyphylla*. The two species inhabit similar places and have similar morphology, but *U. deusta* can be distinguished by lack of thalloconidia, pitted brown underside, and upper side with isidia. *Umbilicaria polyphylla* can be distinguished by multicellular thalloconidia, smooth black underside, and by lack of isidia.

HABITAT. This species colonizes a wide variety of siliceous substrates, occurring on rock walls

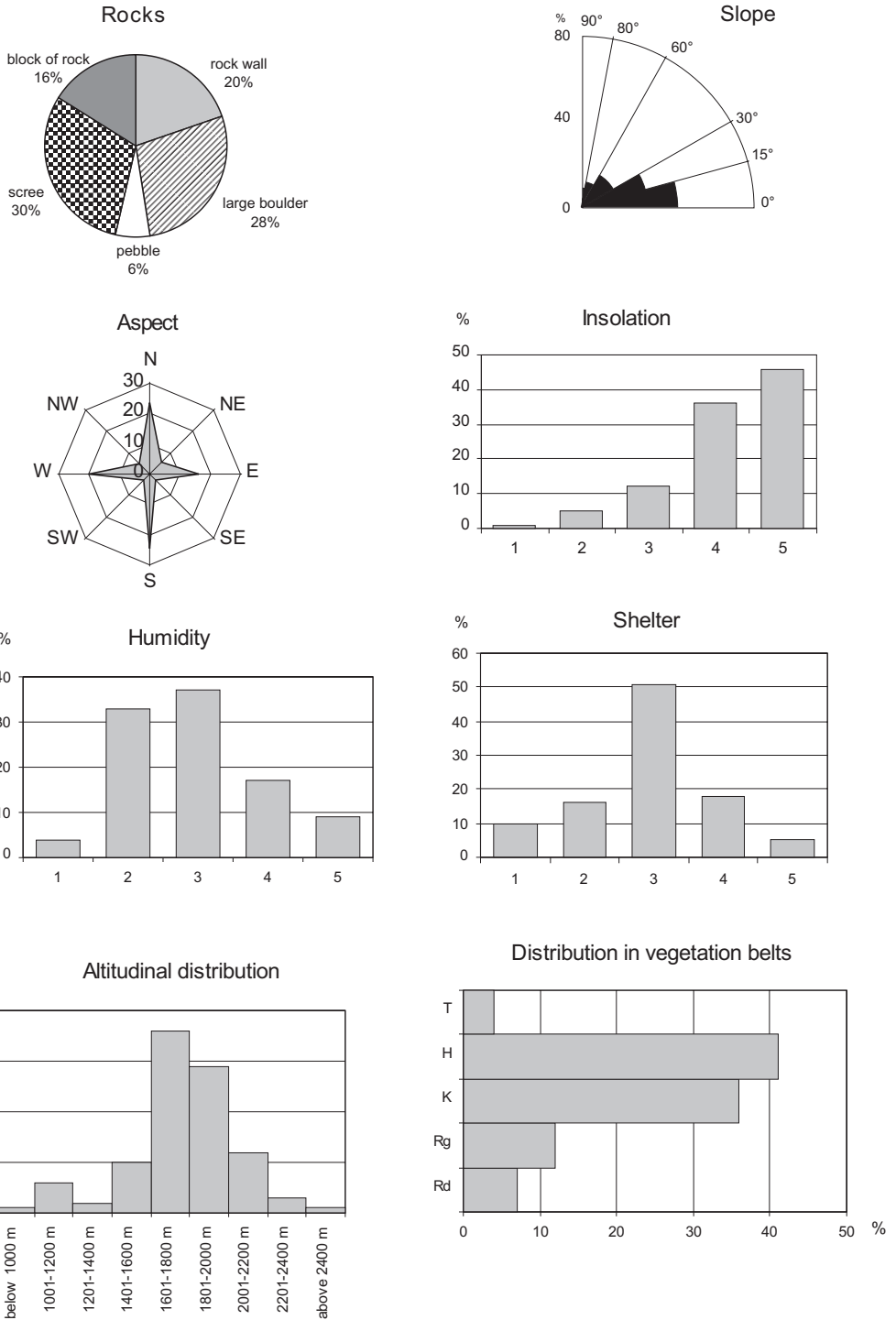


Fig. 24. Ecodiagram for *Umbilicaria deusta* (L.) Baumg. (explanations – see Material and methods).

(20% of cases), blocks (16%), boulders (28%), scree (30%) and pebbles (6%). It is most frequently found on horizontal or slightly inclined surfaces (70% of cases) (Fig. 24). It reaches its optimum development on tops of granite boulders and small meadow pebbles, on even, sunny surfaces, in moist places near soil surfaces that are covered by snow for a long time during winter and near herbal plants during summer, with a fairly wide range of aspects. Sometimes it forms almost monospecific stations, and the specimens can completely cover the upper surface of rocks.

DISTRIBUTION. In the Polish Tatras *U. deusta* is a common and locally very abundant species, extending from the foot of the mountains up to the subnival belt. It has its main center of distribution in the subalpine and alpine belts (77% of cases) (Fig. 24). In the subnival belt it occurs only occasionally (5% of cases) and almost exclusively on anthropogenic substrate, coming up to this zone on granite hiking trails. The lowest station is Wyżnia Miętusia Kira glade at alt. 940 m. The highest locality is Rysy Mt. at 2350 m. In the West and High Tatras *U. deusta* inhabits all siliceous rocks above the timber line, but below that it occurs only in well-insolated places such as glades. Thus in the West Tatras it is distributed similarly on granite hiking trails and outcrops of granite rocks. In the High Tatras it is common and widely distributed above the timber line in the areas of the Morskie Oko valley, Dolina Pięciu Stawów Polskich valley, and the Hala Gąsienicowa alpine meadow. In the upper and lower montane belts it is less frequent and occurs on open, exposed and sunny places (Fig. 25).

In Poland *U. deusta* is a fairly frequent mountain species, occasionally coming down into lowland where it is known from northwest Poland – western Pomerania (Lettau 1912; Krawiec 1933a, 1938; Koppe 1939; Fałtynowicz & Tobolewski 1989; Fałtynowicz 1992) and northeast Poland (Fałtynowicz 1981; Cieśliński & Tobolewski 1989). In the Polish Carpathians it is widespread throughout nearly all ranges. It was found in the Wiśnickie foothills (Śliwa *et al*. 2001), Beskid Śląski Mts (Kiszka 1967b; Nowak 1972), Beskid Mały Mts (Nowak 1965, 1971, 1972), Beskid Wyspowy Mts (Nowak 1998), Beskid Żywiecki Mts (Tobolewski 1961a; Nowak 1967, 1972, 1998), Gorce Mts (Nowak 1972; Czarnota 2000), Beskid Sądecki Mts (Boberski 1883; Olech 1973, Śliwa 1998a), Dynowskie foothills (Krzewicka & Śliwa 2000), Beskid Niski Mts (Sulma 1936; Olech 1974), Pieniny Mts (Tobolewski 1958; Kiszka 1997, 2000), Spisko-Gubałowskie foothills (Kiszka 1985), High and West Tatra Mts (Rehman 1879; Boberski 1892; Motyka 1924a, b, 1926, 1927, 1964; Tobolewski 1979, 1996; Alstrup & Olech 1992a, b; Bielczyk 1997) and Bieszczady Mts (Glanc & Tobolewski 1960; Kiszka & Kościelniak 1998). Outside the Carpathians it has been recorded from the Góry Świętokrzyskie Mts (Halicz & Kuziel 1966; Cieśliński 1975; 1991; Cieśliński & Halicz 1971; Cieśliński & Czyżewska 1992) and Sudety Mts (Stein 1879; Anders 1923; Tobolewski 1952, 1955c, 1960b, 1961b; Fabiszewski 1968; Seaward *et al*. 1981).

In the Slovakian Tatras it is also a common species, extending from the lower montane to the subnival belt (Lisická 1980). In Europe the species is reported from nearly all countries (e.g., Purvis *et al*. 1992; Fałtynowicz 1993; Nimis 1993; Kondratyuk *et al*. 1996; Randlane & Saag 1999; Scholz 2000; Llimona & Hladun 2001). It is one of the most frequent species of the genus *Umbilicaria*, occurring both in mountains and on lowlands.

EXSICCATI SEEN. Hansen, *Lich. Groenl. Exs. No. 106* (WA); *No. 119* (WA); *No. 553* (WA); *Krypt. Exs. Vindob. No. 4149* (POZ); Nowak, *Lich. Pol. Meridi. Exs. No. 79* (LBL); Pišút, *Lich. Slovakiae Exs. No. 34* (KRAM, WA); *No. 189* (KRAM); Rabenhorst, *Lich. Eur. No. 357* (sub. *Gyrophora polyphylla* var. *flocculosa*) (KRA); *No. 812* (sub. *Gyrophora polyphylla b. deusta*) (KRA); Tobolewski, *Lich. Polonica. No. 26* (KRA, LBL, WA); Weber, *Lich. Exs. Univ. Colorado Mus. No. 425* (KRAM).

SPECIMENS EXAMINED. Grid square Gd-58 – WEST TATRA MOUNTAINS: Wyżnia Dolina Chochołowska valley, alt. 1230 m, 07 May 1999, *leg. B. Krzewicka* (KRA); Polana Chochołowska glade, alt. 1100 m, Aug. 1962, *leg. S. Matuszewska* (LBL), 02 Dec.1995, *leg. J. Nowak* (KRAM), alt. 1115–1140 m, 07 May 1999, *leg. B. Krzewicka* (KRA); Dolina Jarząbcza valley, alt.

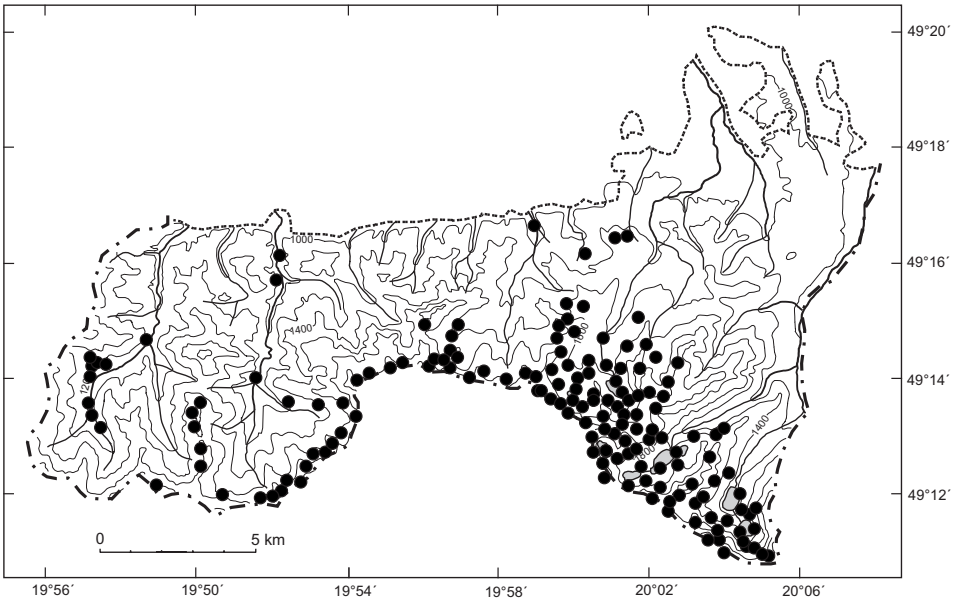


Fig. 25. Distribution map of *Umbilicaria deusta* (L.) Baumg. in the Polish Tatra Mts. ● – locality.

1360 m, 10 Nov. 1987, *leg. J. Nowak* (KRAM); Wyżnia Jarząbcza Polana glade, alt. 1126 m, 07 May 1999, *leg. B. Krzewicka* (KRA); Dolina Starobociańska valley, alt. 1050 m, 07 May 1999, *leg. B. Krzewicka* (KRA); Gd-59 – WEST TATRA MOUNTAINS: Wyżnia Miętusia Kira glade, alt. 940 m, 21 May 1999, *leg. B. Krzewicka* (KRA); Cudakowa Polana glade, 950 m, 21 May 1999, *leg. B. Krzewicka* (KRA); Smytnia Polana glade, alt. 1100 m, 21 May 1999, *leg. B. Krzewicka* (KRA); Ornak Mt., Aug. 1962, *leg. S. Matuszewska* (LBL), E slope, alt. 1580 m, 07 Aug. 1999, *leg. B. Krzewicka* (KRA); Dolina Tomanowa valley, 22 May 1959, *leg. S. Matuszewska* (LBL); Hala Tomanowa mountain meadow, alt. 1100 m, 05 July 1955, *leg. J. Nowak* (KRAM); Kamienisty Żleb gully, alt. 1630 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); Hala Kondratowa mountain meadow, alt. 1325 m, 04 Aug. 1998, *leg. B. Krzewicka* (KRA); Przełęcz Kondracka pass, alt. 1650 m, and 1770 m, 25 May 1986, *leg. V. Alstrup & M. Olech* (KRA); Ciemniak Mt., alt. 2090 m, 06 Aug. 1998, *leg. B. Krzewicka* (KRA); Krzesanica Mt., alt. 2118 m, 06 Aug. 1998, *leg. B. Krzewicka* (KRA); Kopa Kondracka Mt., alt. 1980 m, 06 Aug. 1998, *leg. B. Krzewicka* (KRA); Przełęcz Pod Kopą Kondracką pass, alt. 1863 m, 04 Aug. 1998, *leg. B. Krzewicka* (KRA); Długi Żleb gully, alt. 1650 m, 04 Aug. 1999, *leg. B. Krzewicka* (KRA); Suche Czuby Mt., alt. 1810 m, 18 June 1986, *leg. V. Alstrup & M. Olech* (KRA); Gd-68 – WEST TATRA MOUNTAINS: Starobociański Wierch Mt., alt. 2176 m, 07 Aug. 1999, *leg. B. Krzewicka* (KRA); Gd-69 – WEST TATRA MOUNTAINS: Hala Pyszna mountain meadow, May 1959, *leg. S. Matuszewska* (LBL); Kamienista Mt., alt. 2127 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); near Hlińska Przełęcz pass, alt. 1897 m, and 1930 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); Smereczyński Wierch Mt., May 1959, *leg. S. Matuszewska* (LBL), E slope, alt. 1900 m, 05 May 1999, *leg. B. Krzewicka* (KRA); hill near Smereczyński Wierch Mt., alt. 2000 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); Smereczyńska Przełęcz pass, alt. 1800 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); between Tomanowy Wierch Polski and Smereczyńska Przełęcz pass, alt. 1900 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); Tomanowy Wierch Polski Mt., alt. 1960 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); Suchy Wierch Tomanowy Mt., alt. 1760 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); Ge-50 – WEST TATRA MOUNTAINS: Kuźnice village, near Bystra stream, Aug. 1925, *leg. J. Motyka* (LBL, KRAM); Królowa Równień Mt., alt. 1560 m, and 1590 m, 01 July 1999, *leg. B. Krzewicka* (KRA); Wielki Kopieniec Mt., W slope, alt. 1240 m, 10 July 1999, *leg. B. Krzewicka* (KRA); Polana Kopieniec glade, alt. 1240 m, 10 July 1999, *leg. B. Krzewicka* (KRA); Polana Olczyska glade, alt. 1050 m, 10 July 1999, *leg. B. Krze-*

wicka (KRA); Rusinowa Polana glade, alt. 1250 m, 03 Aug. 1920, *leg. J. Nowak* (KRAM); Pośredni Wierch Goryczkowy, alt. 1800 m, 18 June 1986, *leg. V. Alstrup & M. Olech* (KRA); Uhrocie Kasprowe Mt., May 1959, *leg. S. Matuszewska* (LBL), alt. 1690 m, 04 July 1999, *leg. B. Krzewicka* (KRA); Kasprowy Wierch Mt., alt. 1950 m, 06 Aug. 1998, *leg. B. Krzewicka* (KRA); between Kasprowy Wierch Mt. and Liliowe pass, alt. 1907 m, and 1985 m, 04 July 1999, *leg. B. Krzewicka* (KRA); Liliowe pass, N slope, alt. 1780 m, and 1805 m, 04 July 1999, *leg. B. Krzewicka* (KRA); near Murowaniec hut, alt. 1450 m, 04 July 1999, *leg. B. Krzewicka* (KRA); Ge-50 – HIGH TATRA MOUNTAINS: Hala Gąsienicowa mountain meadow, 14 Sept. 1949, *leg. J. Motyka* (LBL), 1959, *leg. S. Matuszewska* (LBL), 21 July 1961, *leg. J. Nowak* (KRAM); Las Gąsienicowy forest, alt. 1490 m, 21 July 1961, *leg. J. Nowak* (KRAM); near Mokra Jama lake, alt. 1550 m, 02 July 1999, *leg. B. Krzewicka* (KRA); near Litworowy Staw lake, alt. 1615 m, 02 July 1999, *leg. B. Krzewicka* (KRA); near Zielony Staw lake, Aug. 1925, *leg. J. Motyka* (LBL), alt. 1690 m, and 1700–1750 m, 02 July 1999, *leg. B. Krzewicka* (KRA); near Kurtkowiec lake, alt. 1710 m, 06 July 1999, *leg. B. Krzewicka* (KRA); near Długi Staw lake, alt. 1770 m, and 1870 m, 02 July 1999, *leg. B. Krzewicka* (KRA); near Czerwone Stawki lakes, alt. 1800 m, 05 July 1999, *leg. B. Krzewicka* (KRA); Kościelec Mt., 14 Sept. 1949, *leg. J. Motyka* (LBL), 1959, *leg. S. Matuszewska*, (LBL), alt. 2155 m, N slope, alt. 1870 m, 08 Juny 1999, *leg. B. Krzewicka* (KRA); Karb pass, W slope, alt. 1715 m, 08 Juny 1999, *leg. B. Krzewicka* (KRA); Mały Kościelec Mt., 1959, *leg. S. Matuszewska* (LBL), W slope, alt. 1690 m, 1730–1750 m, and 1820 m, SW slope, alt. 1720 m, N slope, alt. 1660 m, and 1760 m, 08 Juny 1999, *leg. B. Krzewicka* (KRA); near Czarny Staw Gąsienicowy lake, alt. 1570 m, 1650 m, and 1700 m, 12 July 1999, *leg. B. Krzewicka* (KRA); near Zmarzły Staw lake, Aug. 1959, *leg. S. Matuszewska* (LBL), alt. 1780 m, and 1970 m, 05 July 1999, *leg. B. Krzewicka* (KRA); Zadni Upłaz Mt., N slope, alt. 1630 m, and 1660 m, 07 July 1999, *leg. B. Krzewicka* (KRA); Żółta Turnia Mt., alt. 1770 m, and 1860 m, N slope, alt. 1495 m, and 1980 m, W slope, alt. 1600 m, 09 July 1999, *leg. B. Krzewicka* (KRA); Żółta Igła Mt., 25 May 1959, *leg. S. Matuszewska* (LBL), alt. 1660 m, and 1700 m, 09 July 1999, *leg. B. Krzewicka* (KRA); Wierch pod Fajki Mt., Aug. 1959, *leg. S. Matuszewska* (LBL), W slope, alt. 1730 m, 03 July 1999, *leg. B. Krzewicka* (KRA); Wołoszyn Mt., alt. 2155 m, Sept. 1955, *leg. I. Wojciechowski* (LBL); Zadni Granat Mt., alt. 2200 m, 03 July 1999, *leg. B. Krzewicka* (KRA); Skrajny Granat Mt., summit alt. 2220 m, W slope, alt. 2015 m, 03 July 1999, *leg. B. Krzewicka* (KRA); Orla Baszta Mt., alt. 2140 m, 18 July 1999, *leg. B. Krzewicka* (KRA); Czarne Ściany Mt., alt. 2200 m, 18 July 1999, *leg. B. Krzewicka* (KRA); Kozia Przełęcz pass, W slope, alt. 1820 m, 1900 m, 2010 m, and 2070 m, 22 July 1999, *leg. B. Krzewicka* (KRA); Kozi Wierch Mt., alt. 2291 m, 31 July 1956, *leg. K. Tatarkiewicz* (LBL), alt. 2180 m, 18 July 1999, *leg. B. Krzewicka* 1999 (KRA); Zmarzłe Czuby Mt., N slope, alt. 2130 m, 22 July 1999, *leg. B. Krzewicka* (KRA); Zawratowa Turnia Mt., Aug. 1959, *leg. S. Matuszewska* (LBL), 1959, *leg. J. Kowalczyk* (LBL); Dolina Buczynowa valley, alt. 1720 m, 1770 m, and 1830 m, 19 July 1999, *leg. B. Krzewicka* (KRA); Pośrednia Turnia Mt., N slope, alt. 1710 m, and 1760 m, 05 July 1999, *leg. B. Krzewicka*, (KRA); Przełęcz Świnicka pass, N slope, alt. 1950 m, 05 July 1999, *leg. B. Krzewicka* (KRA); between Świnica Mt. and Przełęcz Świnicka pass, alt. 2090 m, 05 July 1999, *leg. B. Krzewicka* (KRA); Świnica Mt., alt. 2300 m, 19 June 1986, *leg. V. Alstrup & M. Olech* (KRA), alt. 2300 m, S slope, alt. 1910 m, and 2240 m, 05 July 1999, *leg. B. Krzewicka* (KRA); between Świnica Mt. and Zawrat pass, alt. 2180 m, 05 July 1999, *leg. B. Krzewicka* (KRA); Zawrat pass, alt. 2150 m, 05 July 1999, *leg. B. Krzewicka* (KRA); Skrajna Turnia Mt., alt. 1800 m, 1900 m, and 1960 m, 16 June 1986, *leg. V. Alstrup & M. Olech* (KRA); Ge-60 – HIGH TATRA MOUNTAINS: near Zadni Staw lake, alt. 1955 m, Aug. 1962, *leg. S. Matuszewska* (LBL), alt. 1950 m, 17 July 1999, *leg. B. Krzewicka* (KRA); Zadni Piarg scree, alt. 1865 m, 17 July 1999, *leg. B. Krzewicka* (KRA); Dolina Pod Kołem valley, alt. 1910 m, 16 July 1999, *leg. B. Krzewicka* (KRA); near Wole Oko lake, alt. 1670 m, and 1890 m, 17 July 1999, *leg. B. Krzewicka* (KRA); Kołowa Czuba Mt., S slope, alt. 1840 m, and 1920 m, SE slope, alt. 1790 m, 16 July 1999, *leg. B. Krzewicka* (KRA); Dolinka Pusta valley, alt. 1920 m, and 1970 m, 22 July 1999, *leg. B. Krzewicka* (KRA); Kozi Wierch Mt., S slope, alt. 1770 m, SE slope, alt. 1700 m, 18 July 1999, *leg. B. Krzewicka* (KRA); Szeroki Żleb gully near Kozi Wierch Mt., alt. 1950 m, 2000 m, 2150 m, and 2200 m, 18 July 1999, *leg. B. Krzewicka* (KRA); Wyżni Liptowski Kostur Mt., Czerwone Piargi scree, alt. 1980 m, 19 July 1999, *leg. B. Krzewicka* (KRA); Świstowa Czuba Mt., SW slope, alt. 1685 m, and 1720 m, 20 July 1999, *leg. B. Krzewicka* (KRA); Szpiglasowa Przełęcz pass, NW slope, alt. 1740 m, 1880 m, 1980 m, and 2140 m, SW slope, alt. 1730 m, 20 July 1999, *leg. B. Krzewicka* (KRA); Wodospad Siklawa waterfall, Aug. 1962, *leg. S. Matuszewska* (LBL), alt. 1525 m, and 1650 m, 16 July 1999, *leg. B. Krzewicka* (KRA); near Wielki Staw lake, Aug.

1962, *leg. S. Matuszewska* (LBL); Niedźwiedź rock, alt. 1800 m, 21 July 1999, *leg. B. Krzewicka* (KRA); Miedziane Kochy Mt., SW slope, alt. 1760 m, 28 July 1999, *leg. B. Krzewicka* (KRA); Miedziany Kostur Mt., Hruby Piarg scree, alt. 1800 m, 21 July 1999, *leg. B. Krzewicka* (KRA); Dolina Roztoki valley, alt. 1490 m, 16 July 1999, *leg. B. Krzewicka* (KRA); near Morskie Oko hut, alt. 1410 m, 29 July 1999, *leg. B. Krzewicka* (KRA); on S bank of Morskie Oka lake, alt. 1395 m, 22 June 1986, *leg. V. Alstrup & M. Olech* (KRA), alt. 1450 m, 29 July 1999, *leg. B. Krzewicka* (KRA); Wrota Chałubińskiego pass, alt. 1550 m, and 1800 m, 28 July 1999, *leg. B. Krzewicka* (KRA); Mnichowy Potok stream, alt. 1640 m, 28 July 1999, *leg. B. Krzewicka* (KRA); near Wyżnie Mnichowe Stawki lakes, alt. 1830 m, Aug. 1959, *leg. S. Matuszewska* (LBL), alt. 1760 m, 1800 m, and 1880 m, 28 July 1999, *leg. B. Krzewicka* (KRA); Mnich Mt., Aug. 1959, *leg. S. Matuszewska* (LBL), NE slope, alt. 1780 m, 1830 m, and 1910 m, W slope, alt. 2000 m, 16 Aug. 2000, *leg. B. Krzewicka* (KRA); Szeroki Żleb gully, alt. 1850 m, and 1900 m, 1999, *leg. B. Krzewicka* (KRA); Kazalnica Mt., N slope, alt. 1730 m, 1980 m, and 1990 m, 27 July 1999, *leg. B. Krzewicka* (KRA); Przełęcz Czarnostawiańska pass, alt. 2300 m, 19 Aug. 1955, *leg. K. Tatarkiewicz* (LBL); Przełęcz pod Chłopkiem pass, S slope, alt. 2320 m, 17 Aug. 2000, *leg. B. Krzewicka* (KRA); Koleba pod Chłopkiem pass, alt. 1740 m, 17 Aug. 2000, *leg. B. Krzewicka* (KRA); Mięguszowiecki Szczyt Mt. alt. 2300 m, 1959, *leg. S. Matuszewska* (LBL); near Czarny Staw lake, 1877, *leg. A. Rehmann* (KRAM), Aug. 1962, *leg. S. Matuszewska* (LBL), alt. 1590 m, 1600 m, and 1670 m, 27 July 1999, *leg. B. Krzewicka* (KRA); on NE bank of Czarny Staw lake, alt. 1650 m, 18 Aug. 2000 *leg. B. Krzewicka* (KRA); Owczy Żleb gully, S slope, alt. 1740 m, 18 Aug. 2000, *leg. B. Krzewicka* (KRA); Żabi Szczyt Niżni Mt., alt. 1900 m, 17 Aug. 1955, *leg. K. Tatarkiewicz* (LBL); Żabia Czuba Mt., alt. 1800 m, 18 Aug. 1955, *leg. K. Tatarkiewicz* (LBL); Żabi Mnich Mt., W slope, alt. 1700 m, 18 Aug. 2000, *leg. B. Krzewicka* (KRA); Bula pod Rysami Mt., alt. 1740 m, 1760 m, 1840 m, and 1900 m, 29 July 1999, *leg. B. Krzewicka* (KRA); Rysy Mt., alt. 2000 m, 2160 m, and 2350 m, 29 July 1999, *leg. B. Krzewicka* (KRA).

Umbilicaria grisea Hoffm. (Fig. 26)

Deutschl. Flora: 111. 1796.

Gyrophora murina Ach., Meth. Lich.: 110. 1803. – *Umbilicaria murina* (Ach.) DC. *in* Lam. & DC., Flore Franc. ed. 3. **2**: 412. 1805.

Thallus 1–2(6) cm diam., monophyllous, adpressed to substrate, even, only over the umbilicus slightly raised, margins moderately incised, and delicately folded, the edges slightly curled under. Upper side dark greyish brown, rimose, weakly areolate in central parts, and white pruinose, sorediate towards the margins. Medulla white. Underside dark brown to black, around umbilicus distinctly areolate, fading to the margins, without trabeculae, umbilicus single, short. Rhizines absent or, infrequently, single to weakly branched, concolorous with the lower cortex. Thallus *ca* 200 μm; upper cortex 10–18 μm; algal layer continuous, thick or thin, thickness varying greatly from *ca* 25 to 80 μm; medulla 20–100 μm; upper part loose, well differentiated from the lower scleroplectenchymatous part; lower cortex *ca* 20 μm, brown. Apothecia gyrodisc, rare, not seen in examined material. Soredia present. Pycnidia not treated. Thalloconidia absent.

CHEMISTRY. Gyrophoric acid, small amounts of lecanoric and umbilicaric acids.

NOTE. This species might sometimes be mistaken for *U. hirsuta*. *Umbilicaria grisea* is distinguished by its distinctly areolate underside, colored dark brown or black, and bare or sparse rhizines, whereas *U. hirsuta* is distinguished by sligtly areolate underside, colored pale brown, and with numerous rhizines.

HABITAT. This species occurs on siliceous rocks. It is found on steep surfaces of large boulders and granite blocks of rock, on slopes with west and east aspects; it seems to prefer situations with moderate light, ± moist, and partly sheltered.

DISTRIBUTION. *Umbilicaria grisea* is a rare species. From the Polish Tatra Mts this species is known from small area in the region of Hala Gąsienicowa alpine meadow. It was reported only from a few localities on *ca* at alt. 1650–1800 m.

In Poland it has been reported from a few localities in the Sudety Mts (Stein 1879; Seaward *et al*. 1981; Seaward 1992) and in the High Tatra Mts but only from three localities in the subalpine belt at alt. 1800 m, near Czarny Staw Gąsienicowy lake (Fig. 26) (Boberski 1892).

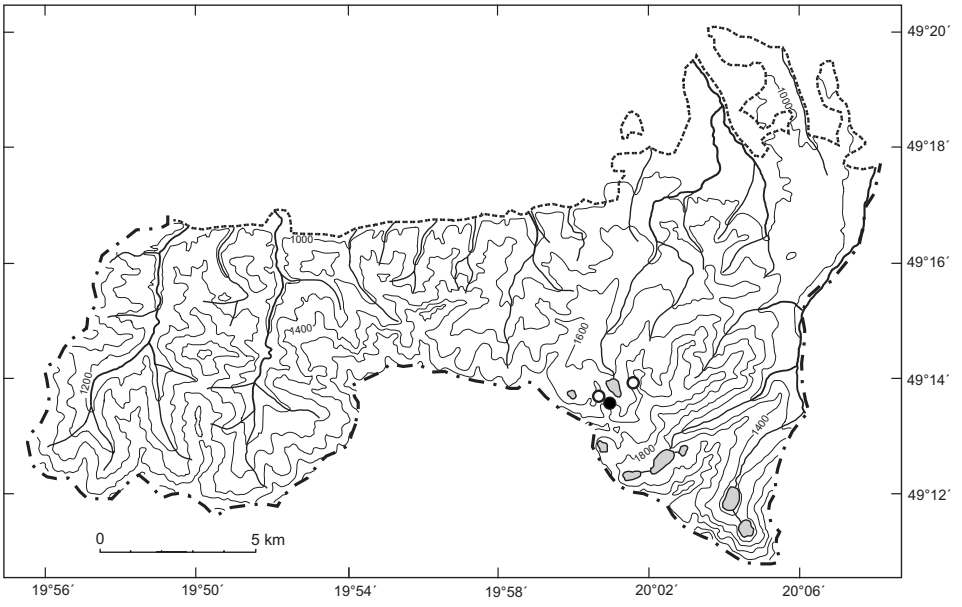


Fig. 26. Distribution map of *Umbilicaria grisea* Hoffm. in the Polish Tatra Mts. ○ – locality to 1970, ● – locality after 1970.

This species has a mainly western and temperate distribution in Europe; it is known from Scandinavia and Scotland to the Mediterranean mountains of France, Spain, Portugal, Italy and Greece (Frey 1936; Nimis 1993).

SPECIMENS EXAMINED. Grid square Ge-50 – HIGH TATRA MOUNTAINS: Żółta Turnia Mt., W slope, 1955, *leg. J. Wojciechowski* (LBL); Przełęcz Karb pass, NW slope, Aug. 1963, *leg. S. Matuszewska* (LBL); Kościelec Mt., E slope, alt. 1800 m, 19 July 1999, *leg. B. Krzewicka* (KRAM).

Umbilicaria hirsuta (Sw. *ex* Westr.) Hoffm.
(Figs 27, 28)

Deutschl. Flora: 112. 1795.

Lichen hirsutus Sw. *ex* Westr., Kgl. Vetensk. Acad. Nya Handl.: 47. 1793. – *Gyrophora hirsuta* (Sw.) Ach., Meth. Lich.: 109. 1803.

Thallus 5–6(10) cm diam., monophyllous, rarely polyphyllous, paper-thin, membranaceous, or thick and rigid, pale brown to brownish grey, with reddish spots, dull, rimose, scabrous, over the umbilicus covered with thin to thick white areoles, surrounded by smooth, rimose cortex which becomes more and more distinctly powdery sorediate towards the margins. Medulla white. Underside medium brown to buff, slightly areolate, old specimens darker around umbilicus, sometimes black, trabeculae radiating from the umbilicus, sometimes reaching the margins, darker than lower cortex. Rhizines simple, moderately to densely branched, cylindrical, strap-like, absent around the umbilicus, ± abundant distally, concolorous with the under side or slightly darker. Thallus of various thicknesses, 100–500 μm; upper cortex *ca* 25 μm, paraplectenchymatous; algal layer continuous, thick, 60–175 μm; medulla loose, 40–130 μm; lower cortex 20–60 μm, brown, scleroplectenchymatous. Apothecia gyrodisc, rare, not seen in examined material. Pycnidia not treated. Thalloconidia absent.

CHEMISTRY. Gyrophoric acid and small amounts of lecanoric acid.

NOTE. There are four sorediate taxa of *Umbilicaria* known in Europe: *U. freyi* Codogno, Poelt & Puntillo, *U. grisea, U. hirsuta* ssp. *hirsuta* and

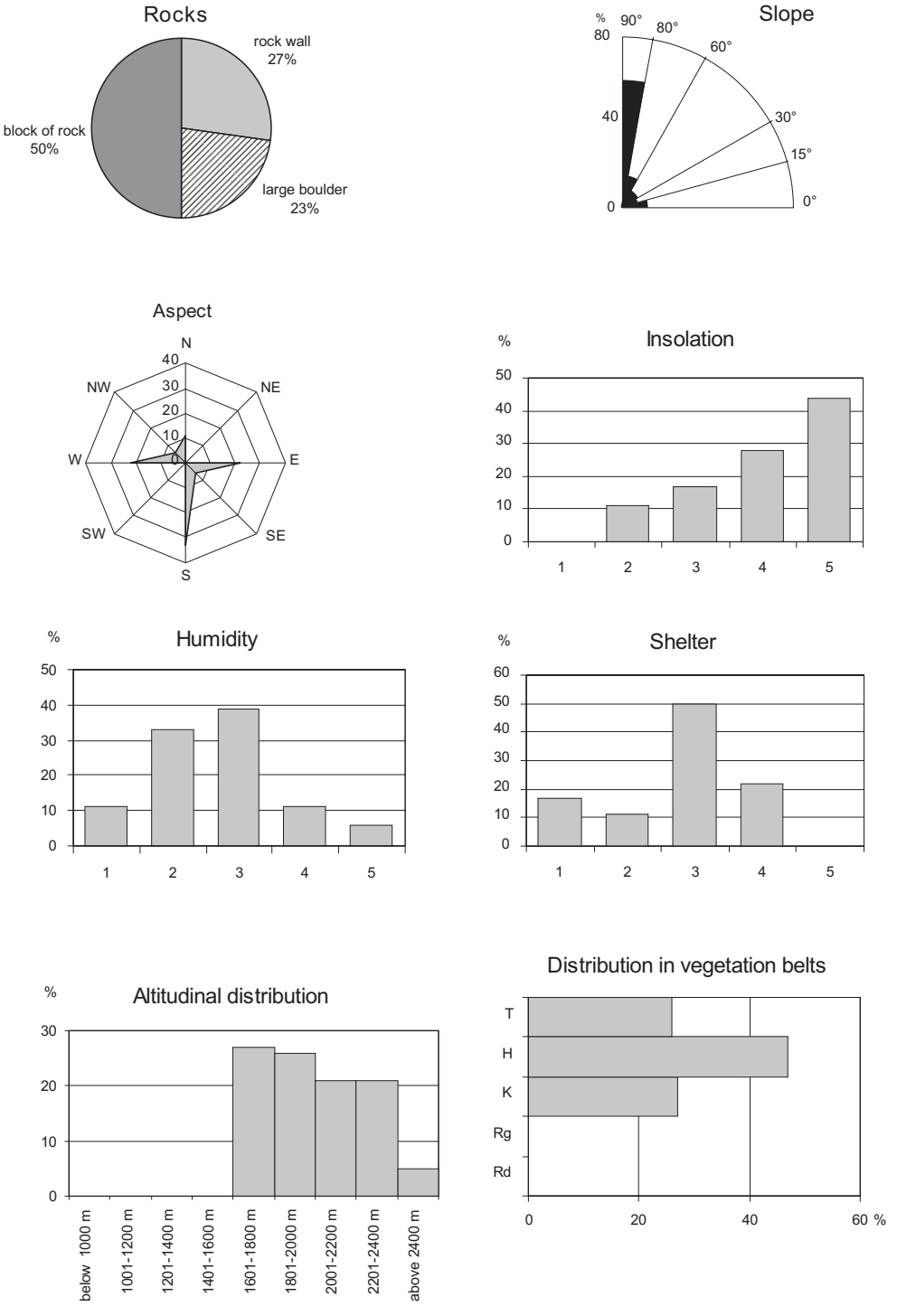


Fig. 27. Ecodiagram for *Umbilicaria hirsuta* (Sw. *ex* Westr.) Hoffm. (explanations – see Material and methods).

U. hirsuta ssp. *papyria* (Ach.) Crespo & Sancho. So far only two of them – *U. grisea* and *U. hirsuta* ssp. *hirsuta* – have been found in Poland.

HABITAT. This species occurs on siliceous rocks, mainly on vertical surfaces (60% of cases) of granite blocks of rock (50% of cases) and rock walls, and less frequently on slightly inclined surfaces of large boulders, never occurring on scree and pebbles. It is found on different aspects, but most frequently southern ones (35% of cases), generally in sunny, moderately sheltered and moist situations, but it can also grow on moderately moist and dry situations (Fig. 27).

DISTRIBUTION. This is a mountain species. In the Polish Tatras *U. hirsuta* extends from the subalpine to subnival belts, mostly in the alpine belt (*ca* 50% of cases) (Fig. 27). The lowest stations are the Dolina Buczynowa valley at alt. 1720 m, and on the E slope of Miedziane Kochy Mt. at alt. 1720 m. The highest locality is Rysy Mt. at alt. 2440 m. In the High Tatras it is fairly frequent and occurs mainly on slopes of Kościelec Mt., in the Orla Perć range, and on the slopes of mountains surrounding Morskie Oko lake (Fig. 28). In the West Tatras it has been recorded only from four scattered stations. Its low frequency there is probably associated with the scarcity of granite blocks.

In the Polish Carpathians it is comparatively common only in the Tatra Mts (Rehman 1879; Boberski 1889, 1892; Motyka 1926, 1927; Tobolewski 1960a, 1965; Bielczyk 1999; Śliwa & Krzewicka 2002). Outside the Tatras it is a relatively uncommon species. It was reported from scattered, isolated localities in the Wiśnickie foothills (Śliwa *et al*. 2001), Beskid Mały Mts (Nowak 1965, 1972), Ciężkowice foothills (Kozik 1970, 1976, 1977; Czwórnog & Śliwa 1995), Przemyśl foothills (Kiszka & Piórecki 1991), Beskid Niski (Sulma 1936) and Pieniny Mts (Kiszka 1997, 2000). Outside the Carpathians it has been recorded in the Sudety Mts (Stein 1879; Kozioł 1993; Bylińska & Kossowska 1996), Góry Izerskie Mts (Nowak 1995), Karkonosze Mts (Glanc & Tobolewski 1969; Seaward *et al*. 1981, 1983), Góry Stołowe Mts (Tobolewski 1952, 1955c, 1960b, 1961b), and in central Poland from the Kielecko-Sandomierska upland at alt. 473 m (Cieśliński & Toborowicz 1989).

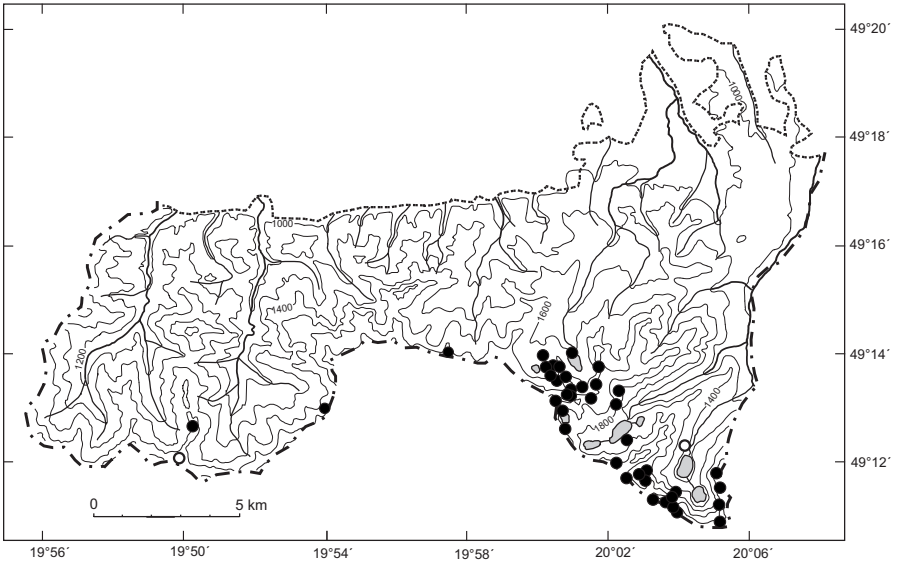


Fig. 28. Distribution map of *Umbilicaria hirsuta* (Sw. *ex* Westr.) Hoffm. in the Polish Tatra Mts. ○ – locality to 1970, ● – locality after 1970.

In Europe it is fairly widely distributed (Frey 1936). According to Wirth (1995), *U. hirsuta* extends from the lowland up to the subalpine belt, and occasionally reaches the alpine belt.

EXSICCATI SEEN. *Flora Silesiaca Exs. No. 1335* (LBL); *Krypt. Exs. Vindob. No. 4243* (POZ); *No. 4343* (POZ); Nowak, *Lich. Pol. Meridi. Exs. No. 243* (LBL); Pišút, *Lich. Slovakiae Exs. No. 64* (WA); Rabenhorst, *Lich. Eur. No. 813* (sub. *Gyrophora hirsut*) (KRA); Tobolewski, *Lich. Polonica. No. 23* (KRA, LBL, KRAM, POZ, WA); Weber, *Lich. Exs. Univ. Colorado Mus. No. 69* (KRAM).

SPECIMENS EXAMINED. Grid square Gd-69 – WEST TATRA MOUNTAINS: Ornak Zadni Mt., alt. 1807 m, 07 Aug. 1999, *leg. B. Krzewicka* (KRA); Siwe Turnie Mt., alt. 1860 m, Sept. 1959, *leg. J. Szweykowski* (POZ); Tomanowy Wierch Mt., alt. 1960 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); Suche Czuby Mt., alt. 1800 m, 1998, *leg. U. Bielczyk* (KRAM); Ge-50 – HIGH TATRA MOUNTAINS: near Czarny Staw Gąsienicowy lake, 17 Sept. 1949, *leg. J. Motyka* (LBL); Mały Kościelec Mt., 13 Aug. 1959, *leg. S. Matuszewska* (LBL); Kościelec Mt., alt. 2100 m, 10 Aug. 1958, *leg. K. Tatarkiewicz* (LBL); 16 Aug. 1980, *leg. E. Budzba* (UGDA); Kościelec Mt., NW slope, 07 Aug. 1963, *leg. S. Matuszewska* (LBL); Kościelec Mt., E slope, 13 Aug. 1959, *leg. S. Matuszewska* (LBL); Zadni Kościelec Mt., 13 Aug. 1959, *leg. J. Kowalczyk*, 14 Aug. 1959, *leg. S. Matuszewska* (LBL); Żółta Turnia Mt., 25 Aug. 1925, *leg. J. Motyka* (LBL), 16 Sept. 1949, *leg. J. Motyka* (LBL), 08 Aug. 1963, *leg. S. Matuszewska* (LBL); Świnica Mt., alt. 2300 m, 19 June 1986, *leg. V. Alstrup & M. Olech* (KRA); Kozi Wierch Mt., alt. 2291 m, 18 July 1999, *leg. B. Krzewicka* (KRA); Kozie Czuby Mt., 18 Aug. 1959, *leg. K. Tatarkiewicz* (LBL); Orla Baszta Mt., alt. 2140 m, 18 July 1999, *leg. B. Krzewicka* (KRA); between Kozi Wierch Mt. and Granaty Mt., alt. 2150 m, and 2200 m, 18 July 1999, *leg. B. Krzewicka* (KRA); Żleb Kulczyńskiego gully, 18 Aug. 1959, *leg. S. Matuszewska* (LBL); Niżnie Rzędy gully near Dolina Buczynowa valley, alt. 1730 m, 19 July 1999, *leg. B. Krzewicka* (KRA); Dolina Buczynowa valley, alt. 1720 m, 19 July 1999, *leg. B. Krzewicka* (KRA); Ge-60 – HIGH TATRA MOUNTAINS: Zadni Piarg scree, alt. 1865 m, 17 July 1999, *leg. B. Krzewicka* (KRA); near Zadni Staw lake, Aug. 1962, *leg. S. Matuszewska* (LBL); Niedźwiedź rock near Wielki Staw lake, alt. 1800 m, 21 July 1999, *leg. B. Krzewicka* (KRA); Szpiglasowy Wierch Mt., S slope, alt. 2170 m, 20 July 1999, *leg. B. Krzewicka* (KRA); Wrota Chałubińskiego pass, alt. 1800 m, 28 July 1999, *leg. B. Krzewicka* (KRA); Miedziane Kochy Mt., E slope, alt. 1720 m, 28 July 1999, *leg. B. Krzewicka* (KRA); Mnich Mt., alt. 2000 m, 16 Sept. 1955, *leg. K. Tatarkiewicz* (LBL), 07 Aug. 1959, *leg. J. Kowalczyk* (LBL); Mnich Mt., W slope, alt. 2000 m, 30 July 1999, *leg. B. Krzewicka* (KRA), N slope, alt. 2100 m, 16 Sept. 1955, *leg. K. Tatarkiewicz*, 07 Aug. 1959, *leg. J. Kowalczyk* (LBL); Mniszek Mt., N slope, alt. 2040 m, 16 Sept. 1955, *leg. K. Tatarkiewicz* (LBL); Rybi Potok stream near Morskie Oko lake, 26 Aug. 1959, *leg. S. Matuszewska* (LBL); Żabia Czuba Mt., alt. 2000 m, 26 Aug. 1955, *leg. K. Tatarkiewicz* (LBL); Żabi Mnich Mt., alt. 2150 m, 18 Aug. 1955, *leg. K. Tatarkiewicz* (LBL); Cubryna Mt., N slope, Aug. 1927, *leg. K. Wallisch* (LBL); Kazalnica Mt., N slope, alt. 1980 m, 17 Aug. 2000, *leg. B. Krzewicka* (KRA); Przełęcz Pod Chłopkiem pass, S slope, alt. 2320 m, 17 Aug. 2000, *leg. B. Krzewicka* (KRA); Pośredni Mięguszowiecki Szczyt Mt., alt. 2390 m, 17 Aug. 2000, *leg. B. Krzewicka* (KRA); Mięguszowiecki Szczyt Mt., 28 Aug. 1927, *leg. K. Wallisch* (LBL), Aug. 1959, *leg. S. Matuszewska* (LBL); Rysy Niżne Mt., alt. 1950 m, 17 Sept. 1955, *leg. K. Tatarkiewicz* (LBL); Rysy Mt., N slope, alt. 2440 m, 23 Aug. 1955, *leg. K. Tatarkiewicz* (LBL); Rysy Mt., alt. 2350 m, 29 July 1999, *leg. B. Krzewicka* (KRA).

Umbilicaria hyperborea (Ach.) Hoffm.

(Figs 29, 30)

Deutschl. Flora: 110. 1796.

Lichen hyperboreus Ach., Kgl. Vetensk. Acad. Nya Handl. **15**: 89. 1794. – *Gyrophora hyperborea* (Ach.) Ach., Math. Lich.: 104. 1803.

Thallus 5–6(10) cm diam., monophyllous, thick, rigid, irregular in outline, lobes usually deeply dissected, the edges curled under, margins very fragile, lacerated and oval-shaped perforated. Upper side uniformly dark brown, at times paler towards the centre, smooth, glossy, uneven, covered with narrow, irregular, vermiform ridges extending to margins, not forming a network, over the umbilicus raised, sometimes with lobed excrescences over it. Underside pale to medium brown, darker around umbilicus, towards the margins whitish, appears rimy, smooth, shallow dimpled. Rhizines absent. Thallus of various thicknesses, with ridges 200–500(800) μm, by ridges 160–240 μm; upper cortex dark brown, 6–15 μm; algal layer continuous, raised into ridges, 35–115

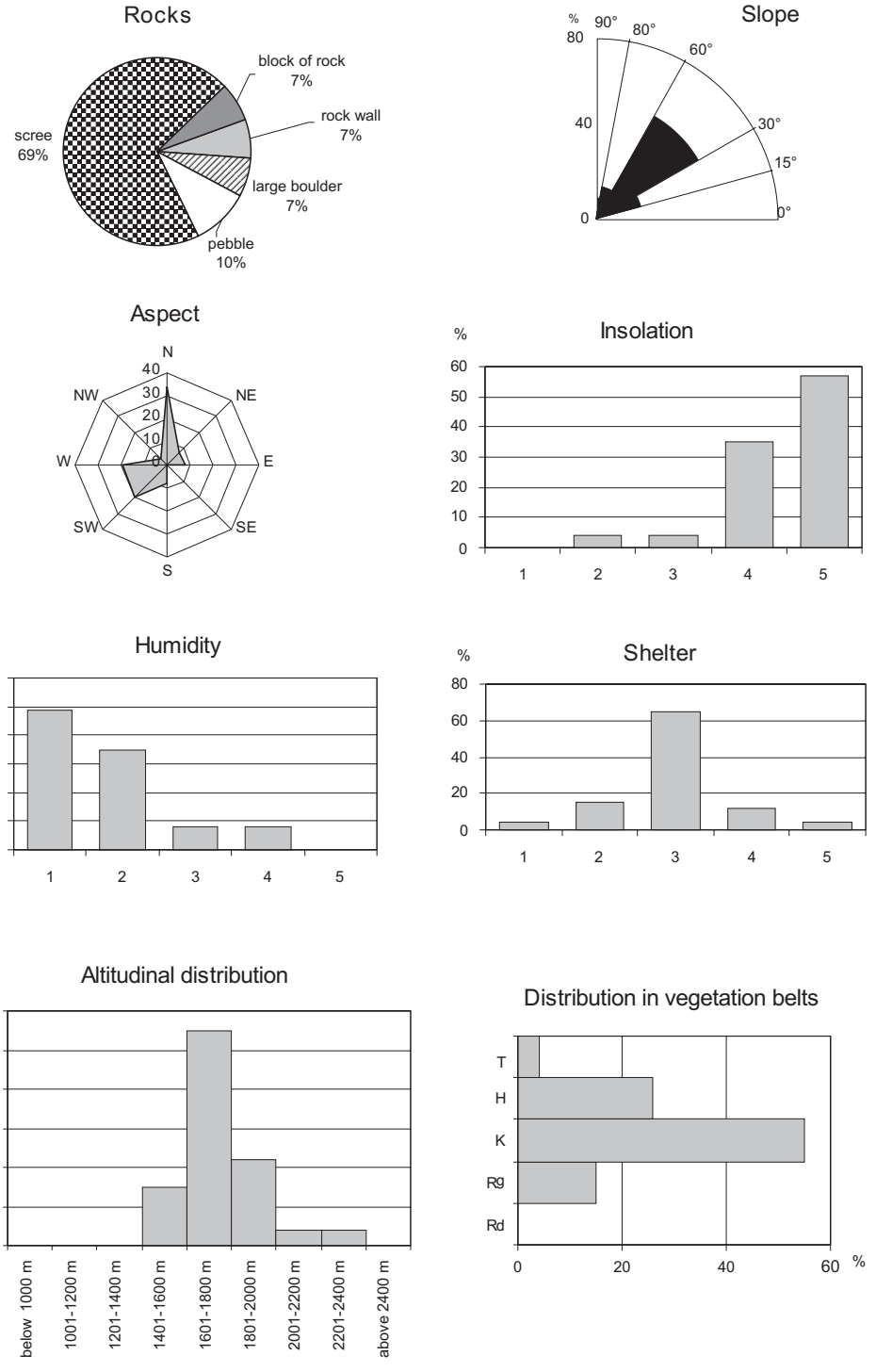


Fig. 29. Ecodiagram for *Umbilicaria hyperborea* (Ach.) Hoffm. (explanations – see Material and methods).

μm; medulla very loose under ridges with air spaces, 70–300 μm; lower cortex 15–25 μm, scleroplectenchymatous. Apothecia gyrodisc, common, covering the upper surface except over the the umbilicus, 1–1.5 mm diam., sessile, usually between the ridges, young irregular in shape, old circular, disc black, gyrose, the gyri irregular to regularly dichotomous, ascus 60.0–80.0 × 15.0–18.0 μm, asci with 8 simple spores 13.0–16.0 × 8.0 μm. Pycnidia not treated. Thalloconidia absent.

CHEMISTRY. Gyrophoric and umbilicaric acids, and small amounts of lecanoric acid.

NOTE. In the material studied, several specimens varied from the typical form of the species. These specimens had a very dark, almost black, rimose and distinctly areolate underside of the thallus. In some places the underside was almost even, not dimpled. The upper side was somewhat less vermiform than usualy. The specimens orginated from on rock rubble near Żółta Turnia Mt. In the examined material were also found few specimens with sparse, simple, short, cylindrical rhizins were also found in the examined material.

HABITAT. This species occurs on siliceous rocks, almost exclusively on huge old granite screes on small boulders (69% of cases). It prefers good illumination, but is most frequently found on a north aspect (35% of records); in the Polish Tatras, there is good insolation on most screes on gentle north slopes. It prefers slightly inclined (55% of cases), sunny and moderately wind-exposed surfaces of rocks, dry in summer and with long-lasting snow cover in winter, and almost without herbal plants (Fig. 29).

DISTRIBUTION. This is a rare mountain species. In the Polish Tatras *U. hyperborea* extends from the upper part of the upper montane belt to the lower part of the subnival belt, and reaches optimum development in the subalpine belt at alt. 1600 m to 1800 m (55% of cases) (Fig. 29). In other zones it occurs at single, scattered localities. The lowest locality is the S slope of Kopa Magury Mt. at alt. 1450 m. The highest locality is Pośredni Mięguszowiecki Szczyt Mt. at alt. 2390 m. In the High Tatras it is fairly frequent only in the area of Żółta Turnia Mt. on huge screes (Fig. 30). Beyond this area it grows less frequently and in the West Tatras it is known from less than ten localities.

In Poland it is known from only a few regions. In the Polish Carpathians it occurs in the Tatra Mts where it is a fairly frequent species (Motyka 1926, 1927; Tobolewski 1955b, 1956a, 1957, 1965, 1969; Bielczyk 1997; Krzewicka 2002a). Outside the Carpathians it has been recorded in the Sudety Mts from only one locality in the Góry Stołowe Mts at alt. 910 m (Tobolewski 1952, 1955c, 1961b). From lower situations it is known from the Gory Świętokrzyskie Mts at alt. 600 m (Kobendza & Motyka 1928, 1929; Motyka 1934; Cieśliński & Halicz 1971; Cieśliński 1975; Cieśliński & Czyżewska 1992) and was also reported from northern Poland at one locality in western Pomerania (Koppe 1932).

This species occurs in mountains of Central and Southern Europe (e.g., Lisická 1980; Wirth 1995; Llimona & Hladun 2001), and also in mountains and lower parts of Northern Europe where it is very common (Hakulinen 1962; Santesson 1993), inhabiting both acidic-rocks and wooden substrates (original inf. Krzewicka).

EXSICCATI SEEN. Hansen, *Lich. Groenl. Exs. No. 95* (WA); *No. 519* (WA); *No. 590* (WA); *Krypt. Exs. Vindob. No. 4344* (POZ); Rabenhorst, *Lich. Eur. No. 884* (sub. *Gyrophora hyperborea*) (KRA); Tobolewski, *Lich. Polonica No. 24* (KRA, LBL, WA); Vězda, *Lich. Bohem. Exs. No. 139* (POZ).

SPECIMENS EXAMINED. Grid square Gd-59 – WEST TATRA MOUNTAINS: Ornak Mt., S slope, 27 June 1923, *leg. J. Motyka* (LBL), alt. 1750 m, and 1850 m, 07 Aug. 1999, *leg. B. Krzewicka* (KRA); Giewont Mt., S slope, alt. 1760 m, 25 May 1986, *leg. V. Alstrup & M. Olech* (KRA); Gd-69 – WEST TATRA MOUNTAINS: Zadni Ornak Mt., alt. 1860 m, 07 Aug. 1999, *leg. B. Krzewicka* (KRA); Suchy Wierch Tomanowy Mt., alt. 1760 m, and 1860 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); Ge-50 – WEST TATRA MOUNTAINS: Kasprowy Wierch Mt., alt. 1950 m, 06 Aug. 1998, *leg. B. Krzewicka* (KRA); Kopa Magury Mt., S slope, alt. 1450 m, 01 July 1999, *leg. B. Krzewicka* (KRA); Ge-50 – HIGH TATRA MOUNTAINS: Dolina Gąsienicowa valley, Zielony Staw lake, alt. 1670 m, 15 Sept. 1956, *leg. Tobolewski* (POZ), alt. 1690 m, 02 July 1999, *leg. B. Krze-*

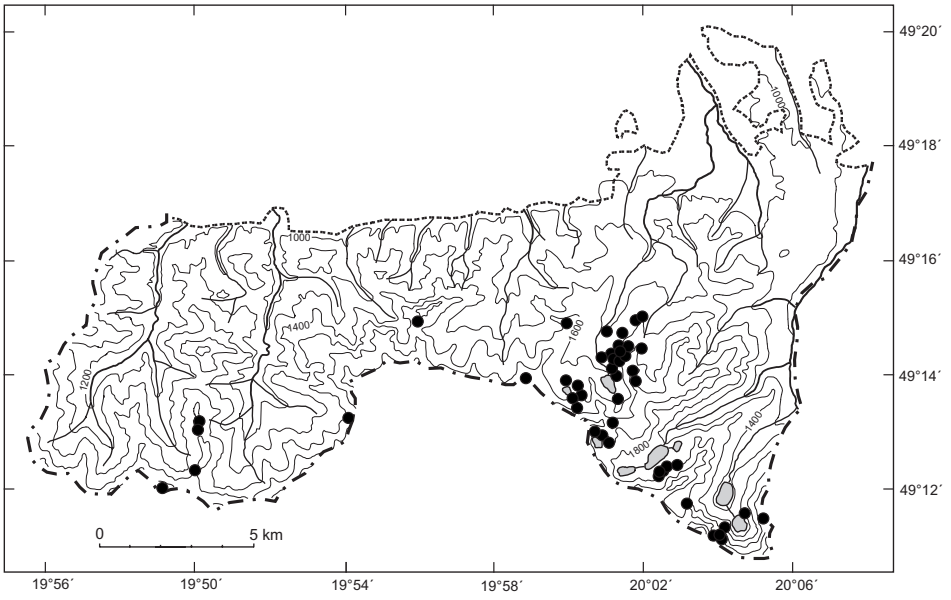


Fig. 30. Distribution map of *Umbilicaria hyperborea* (Ach.) Hoffm. in the Polish Tatra Mts. ● – locality.

wicka (KRA); Mały Kościelec Mt., 1959, *leg. S. Matuszewska* (LBL), alt. 1730 m, and 1750 m, 06 July 1999, *leg. B. Krzewicka* (KRA); Kościelec Mt., W slope, near Długi Staw lake, alt. 1770 m, 02 July 1999, *leg. B. Krzewicka* (KRA); Przełęcz Karb pass, NW slope, alt. 1715 m, 06 July 1999, *leg. B. Krzewicka* (KRA); Dolina Gąsienicowa valley, near Dwoisty Staw lake, alt. 1690 m, 06 July 1999, *leg. B. Krzewicka* (KRA); Dolina Gąsienicowa valley near Czarny Staw lake, alt. 1570 m, 02 July 1999, *leg. B. Krzewicka* (KRA); Żółta Igła Mt. below Żółta Turnia, alt. 1660 m, and 1700 m, 02 July 1999, *leg. B. Krzewicka* (KRA); Żółta Turnia Mt., 16 Sept. 1949, *leg. J. Motyka* (LBL), alt. 1500 m, 26 June 1954, *leg. Tobolewski* (POZ), 25 May 1959, *leg. S. Matuszewska* (LBL), N slope, alt. 1495 m, 07 July 1999, *leg. B. Krzewicka* (KRA), W slope, alt. 1500 m, and 1600 m, 07 July 1999, *leg. B. Krzewicka* (KRA), Dolina Pańszczyca valley, near Czerwony Staw lake, Aug. 1959, *leg. S. Matuszewska* (LBL), 12 July 1961, *leg. J. Bystrek* (LBL), alt. 1630 m, and 1660 m, 07 July 1999, *leg. B. Krzewicka* (KRA); Mały Kozi Wierch Mt., alt. 2228 m, 22 July 1999, *leg. B. Krzewicka* (KRA); Ge-60 – HIGH TATRA MOUNTAINS: Dolina Pięciu Stawów Polskich valley, Zadni Piarg scree near Zadni Staw lake, alt. 1865 m, 17 July 1999, *leg. B. Krzewicka* (KRA); Dolinka pod Kołem valley near Zadni Staw lake, alt. 1900 m, 28 Aug. 1956, *leg. Z. Tobolewski* (POZ); Niedźwiedź rock, N side, alt. 1720 m, 20 July 1999, *leg. B. Krzewicka* (KRA); Hruby Piarg scree, W slope, Miedziany Kostur Mt., alt. 1800 m, 21 July 1999, *leg. B. Krzewicka* (KRA); Brzuchaty Piarg scree, W slope, alt. 1840 m, 21 July 1999, *leg. B. Krzewicka* (KRA); Żabia Grań Mt. 03 Aug. 1929, *leg. J. Motyka* (LBL); Czarny Staw lake, NE slope, alt. 1630 m, 14 Sept. 1966, *leg. Z. Tobolewski* (POZ); Kazalnica Mt., N slope, alt. 1980 m, 17 Aug. 2000, *leg. B. Krzewicka* (KRA); Przełęcz Pod Chłopkiem pass, S slope, alt. 2320 m, 17 Aug. 2000, *leg. B. Krzewicka* (KRA); Pośredni Mięguszowiecki Szczyt Mt., alt. 2390 m, 17 Aug. 2000, *leg. B. Krzewicka* (KRA); Mnich Mt., NE slope, alt. 1780 m, and 1830 m, 16 Aug. 2000, *leg. B. Krzewicka* (KRA).

Umbilicaria laevis (Schaer.) Frey

(Figs 31, 32, 33, 34)

Hedwigia **71**: 117. 1931.

Gyrophora atropruinosa α *laevis* Schaer., Naturwiss. Anzeiger Allgem. Schweiz. Ges. Naturwiss. **1**: 8. 1818. – *Gyrophora laevis* (Schaer.) Du Rietz, Arkiv f. Bot. **19**(12): 6. 1925.

Thallus 3–4 cm diam., polyphyllous, regular in outline, lower lobes ± adpressed to substrate,

lobes in the center shorter and ascending, cushion-shaped, margins of young lobes black, glossy, not tumid, lace-like, old lobes lacerated, deeply incised, sometimes also lace-like, the edges curled, undulating. Upper side greyish beige, darker towards the margins, smooth, irregularly cracked, only over the umbilicus scabrous, white areolate. Medulla white. Underside smooth, even, black around umbilicus, brown with black patches towards margins, sometimes all black, marginal zone 2–3 mm wide, grey, rime-like. Rhizines absent. Thallus 120–200 μm thick; upper cortex 8–24 μm, palisadeplectenchymatous; algal layer continuous, 40–80 μm; medulla 45–80 μm, upper part loose, lower part scleroplectenchymatous; lower cortex 12–23 μm. Apothecia leiodisc, rare, not seen in examined material. Pycnidia pear-shaped, with dark brown ostiole. Conidia *ca* 3.0–4.0 × 0.8–1.0 μm. Thalloconidia: first description for this species, non-septate, usually spherical, rarely oviform, delicately to moderately roughened, dark brown, 8.6 × 10.0 μm. Thalloconidia are produced in small black patches, occasionally when the underside is wholly black the thalloconidia cover the underside completely except for a marginal zone which is always free of thalloconidia and light grey in color.

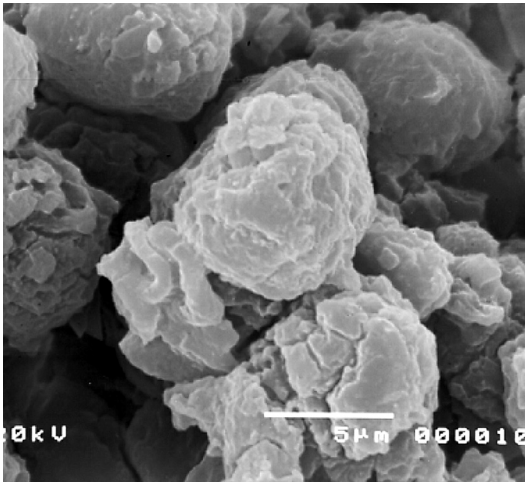


Fig. 31. *Umbilicaria laevis* (Schaer.) Frey – non–septate conidia.

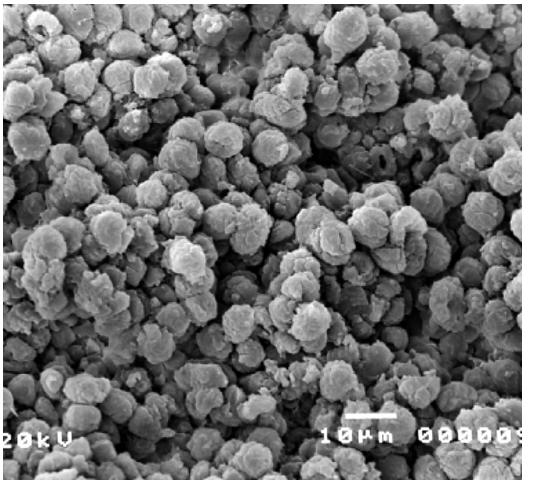
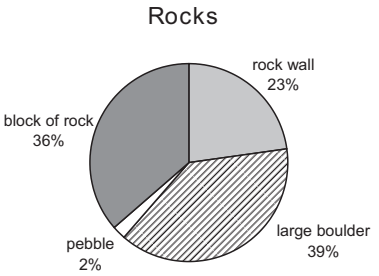


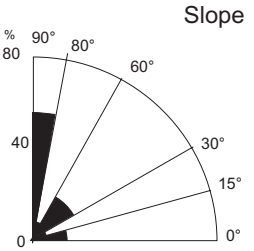
Fig. 32. *Umbilicaria laevis* (Schaer.) Frey – thalloconidia on the underside of the thallus.

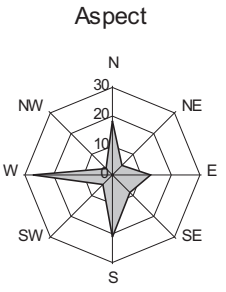
CHEMISTRY. Gyrophoric acid.

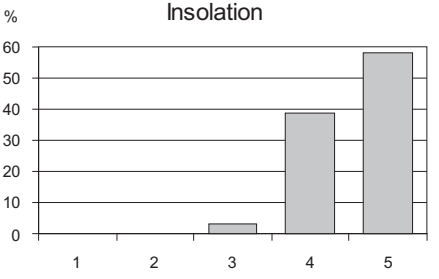
NOTE. The thalloconidia in *U. laevis* for the first time were discovered by Hasenhüttl & Poelt (1978). However the authors examined only two specimens: one with thalloconidia and one without. In later examinations the thalloconidia were not reported as occurring in *U. laevis* (Hestmark 1990). The observations in his report, however, were based on five specimens only in case of this taxon. Thalloconidia were found in *U. laevis* during the course of present study. They can be produced in massive numbers or sporadically on the underside of the thallus. If only a few of them are produced, the places of their formation are very inconspicios (visible as small, *ca* 1.5 mm diam. spots), and thus easily overlooked.

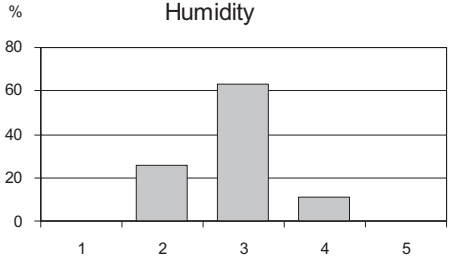
HABITAT. This species occurs on siliceous rocks, on large granite boulders (39% of cases), blocks of rock (36%), and rock walls (23%). It grows on slightly inclined to horizontal top surfaces of rocks and also on slopes of various inclinations, but mainly on vertical surfaces of the upper part of rocks (50% of cases). It seems to prefer sunny, moderately moist and not very sheltered situations, with a fairly wide range of aspects, though

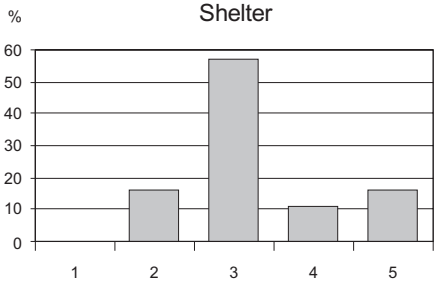


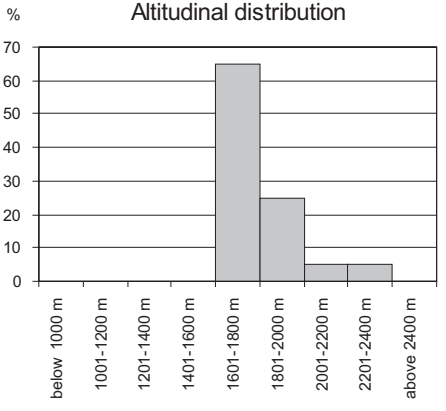












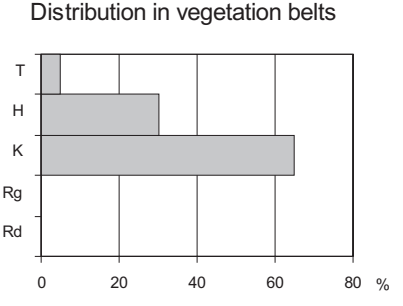


Fig. 33. Ecodiagram for *Umbilicaria laevis* (Schaer.) Frey (explanations – see Material and methods).

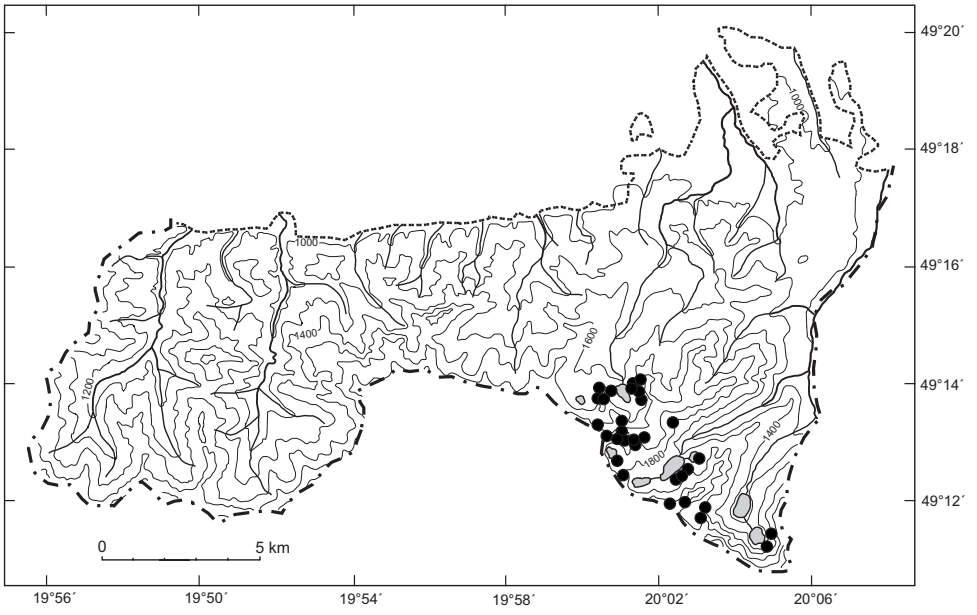


Fig. 34. Distribution map of *Umbilicaria laevis* (Schaer.) Frey in the Polish Tatra Mts. ● – locality.

more frequent on west-facing slopes (*ca* 28% of cases) (Fig. 33).

DISTRIBUTION. High mountain (alpine) species. In Poland it grows exclusively in the High Tatras (Motyka 1964; Alstrup & Olech 1992a; Tobolewski 1996). *U. laevis* extends from the subalpine belt to the lower part of the subnival belt, and reaches its optimum development in the subalpine belt, alt. 1600 m to 1800 m (65% of cases) (Fig. 33). In other zones it is less frequent and occurs at single, scattered localities: 30% of cases were recorded in the alpine belt and only 5% of cases in the subnival belt. The lowest localities are the N slope of Mały Kościelec Mt. at alt. 1660 m, Żółta Igła Mt. at 1660 m, and Żabia Lalka Mt. at 1660 m. The highest locality is Mały Kozi Wierch Mt. at 2228 m. It appears to grow only in the High Tatras where it is known from three ± isolated areas: on Hala Gąsienicowa alpine meadow in the region of Żółta Turnia Mt. and Kościelec Mt., in the Dolina Pięciu Stawów Polskich valley, and the Morskie Oko valley in the region of Mnich Mt. and Żabia Lalka Mt. (Fig. 34).

In the Slovakian Tatras it seems less frequent, but was also found in the West Tatras in one locality, and in one locality in the Belanské Tatra Mts (Lisická 1980). *U. laevis* is reported from mountains of central and Southern Europe in the subalpine and alpine belts. It occurs in the Alps, Carpathians and Pyrenees (Lisická1980; Nimis 1993; Llimona & Hladun 2001).

EXSICCATI SEEN. Poelt, *Lich. Alpium No. 319* (KRAM); *No. 320* (KRAM); Suza, *Lich. Bohem. Exs. No. 79* (sub. *Gyrophora subglabra*) (KRAM, POZ).

SPECIMENS EXAMINED. Grid square Ge-50 – HIGH TATRA MOUNTAINS: Mały Kościelec Mt., alt. 1800 m, 17 June 1986, *leg. V. Alstrup & M. Olech* (KRA), alt. 1820 m, 08 July 1999, *leg. B. Krzewicka*, (KRA), N slope, alt. 1660 m, and 1760 m, 08 July 1999, *leg. B. Krzewicka* (KRA), W slope, alt. 1960 m, and 1730–1750 m, 06 July 1999, *leg. B. Krzewicka* (KRA); Kościelec Mt., alt. 2155 m, 08 July 1999, *leg. B. Krzewicka* (KRA); Żółta Turnia Mt. 1927, *leg. J. Motyka* (LBL), W slope, alt. 1770 m, and 1860 m, 09 July 1999, *leg. B. Krzewicka* (KRA); Żółta Igła Mt., alt. 1660 m, 1700 m, and 1730 m, 09 July 1999, *leg. B. Krzewicka* (KRA); Wierch pod Fajki Mt., W slope, alt. 1730 m, 03

July 1999, *leg. B. Krzewicka* (KRA); Dolina Buczynowa valley, alt. 1720 m, 1770 m, and 1830 m, 19 July 1999, *leg. B. Krzewicka* (KRA); Kozi Wierch Mt., alt. 2291 m, 18 July 1999, *leg. B. Krzewicka* (KRA); Mały Kozi Wierch Mt., alt. 2228 m, 18 July 1999, *leg. B. Krzewicka* (KRA); Świnica Mt., S slope, alt. 2000 m, 05 July 1999, *leg. B. Krzewicka* (KRA); Ge-60 – HIGH TATRA MOUNTAINS: Dolina pod Kołem valley near Zadni Staw lake, alt. 1910 m, 17 July 1999, *leg. B. Krzewicka* (KRA); Zadni Piarg scree, alt. 1865 m, 17 July 1999, *leg. B. Krzewicka* (KRA); Wole Oko lake, alt. 1890 m, 17 July 1999, *leg. B. Krzewicka* (KRA); Kołowa Czuba Mt., S slope, alt. 1840 m, and 1920 m, 20 July 1999, *leg. B. Krzewicka* (KRA); Dolinka Pusta valley, alt. 1820 m, and 1920 m, 22 July 1999, *leg. B. Krzewicka* (KRA); Kotelnica Mt., S slope, alt. 1800 m, 19 July 1999, *leg. B. Krzewicka* (KRA); Niedźwiedź rock near Wielki Staw lake, alt. 1800 m, 20 July 1999, *leg. B. Krzewicka* (KRA), N side, alt. 1720 m, 20 July 1999, *leg. B. Krzewicka* (KRA); Miedziany Kostur Mt., N slope, alt. 1860 m, 21 July 1999, *leg. B. Krzewicka* (KRA); Przedni Staw lake on E bank, alt. 1685 m, and 1690 m, 21 July 1999, *leg. B. Krzewicka* (KRA); Szpiglasowy Wierch Mt., S slope, alt. 2170 m, 20 July 1999, *leg. B. Krzewicka* (KRA); Szpiglasowa Przełęcz pass, E slope, alt. 1920 m, and 2140 m, 20 July 1999, *leg. B. Krzewicka* (KRA); Wyżnie Mnichowe Stawki lakes, alt. 1800 m, 30 July 1999, *leg. B. Krzewicka* (KRA); Mnich Mt., N slope, alt. 1920 m, 30 July 1999, *leg. B. Krzewicka* (KRA); Czarny Staw pod Rysami lake, NE bank, alt. 1650 m, 18 Aug. 2000, *leg. B. Krzewicka* (KRA); Żabia Lalka Mt., alt. 1660 m, 18 Aug. 2000, *leg. B. Krzewicka* (KRA).

Umbilicaria leiocarpa DC. (Figs 35, 36, 37, 38)

in Lam. & DC., Flore Franc. ed. 3. **2**: 410. 1805.

Gyrophora leiocarpa Du Rietz, Arkiv f. Bot. **19**(12): 7. 1925. – *Agyrophora leiocarpa* (DC.) Gyeln., Ann. Mycol. **30**: 444. 1932.

Thallus up to 10(15) cm diam., thick, rigid, monophyllous, usually deeply dissected, often appearing polyphyllous, orbicular in outline, with irregular, fragile and oval-shaped perforated margins, the edges cracked, white, curled upward. Old specimens with juvenile thalli in the center. Upper side greyish yellow, dull, rimose, dirty-white, thickly areolate around center, with irregular, sharp ridges over the umbilicus, ridges sometimes up to 1 cm high and 1.0–1.5 mm wide, peripheral parts smooth, even, reticulately cracked, with whitish yellow reticulate pattern caused by small patches of cortex separated by darker cracks, marginal zone darker, greyish brown. Medulla white. Underside smooth, slightly undulating, black, only marginal zone 2–3 mm wide greyish brown, rime-like, underside sometimes mottled black. Rhizines absent. Thallus of various thicknesses, with ridges 215–400 μm, by ridges 150–250 μm; upper cortex *ca* 32 μm, scleroplectenchymatous;

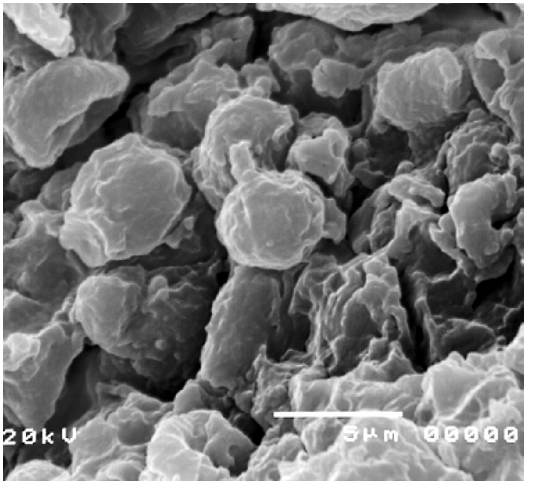


Fig. 35. *Umbilicaria leiocarpa* DC. – non–septate conidia.

medulla above algal layer 16–32 μm; algal layer continuous but of various thicknesses, 46–128 μm; medulla 55–110 μm; lower cortex 18–48 μm, scleroplectenchymatous. Apothecia leiodisc, rare, on only a few specimens in examined material, misshapen, stipitate, to 1 mm broad, disc scabrous, black, without spores. Pycnidia in marginal zone of the upper side, immersed, bottled-shape, with dark brown wall and ostiole. Conidia bacilliform *ca* 2.4–4.7 × 1.0–2.0 μm. Thalloconidia: non-septate, rarely 1-septate, spherical, smooth, dark brown, 4.6 × 5.8 μm (Fig. 35). Thalloconidia sometimes cover the underside completely, but more often a 2–4 mm wide peripheral brownish zone is free of thalloconidia, places with thalloconidia are sooty black (Fig. 36).

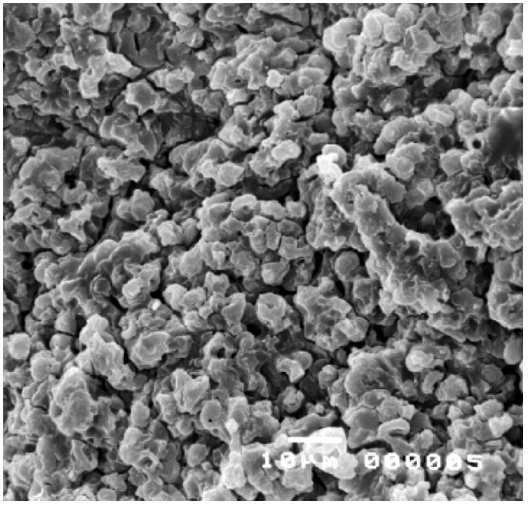


Fig. 36. *Umbilicaria leiocarpa* DC. – thalloconidia on the underside of the thallus.

CHEMISTRY. Small amounts of gyrophoric and lecanoric acids.

NOTE. *Umbilicaria leiocarpa* is similar to *U. rigida* (Du Rietz) Frey which occurs in Scandinavia. Both species are similarly colored on the upper side and have a paler center, thickly covered by large areolas, and both have apothecia with a smooth disc. *Umbilicaria rigida* produce apothecia frequently, while *U. leiocarpa* very rarely. The species are easily distinguished by the underside: in *U. rigida* it is areolate and without thalloconidia, and in *U. leiocarpa* it is smooth and with thalloconidia.

HABITAT. The species occurs on siliceous rocks, on smooth, mainly steep to vertical surfaces (58% of cases) of large granite boulders, blocks of rock and rock walls. As many as 40% of examined stations were situated on north-facing slopes, and it is also fairly frequent on west-facing ones (27% of cases). It is found especially on exposed, windy, open and moderately moist or dry situations (Fig. 37).

DISTRIBUTION. High mountain (alpine) species. In Poland it grows exclusively in the Tatras (Motyka 1926, 1927, 1928, 1934, 1964; Tobolewski 1956b, 1957, 1965; Olech 1981; Bielczyk 1997; Krzewicka 2002c). There it occurs from the subalpine to the subnival belt (Fig. 37). It appears to have its center of occurrence in the subalpine belt from alt. 1600 m to 1800 m (43% of cases). The lowest locality is the N slope of Mały Kościelec Mt., alt. 1660 m. The highest locality is Mięguszowiecki Szczyt Pośredni Mt. at 2340 m. It appears to grow only in the High Tatras where is known in the Polish Tatras from the Orla Perć range and from mountains surrounding Morskie Oko lake (Fig. 38). In the West Tatras it is known from only two localities. Motyka reported one locality in 1929 on Ornak Mt. at alt. 1800 m, and the second locality was recorded in 1977 from the Slovakian West Tatras at alt. 1900 m by Dúbrovcová (Lisická 1980).

In Europe this species is reported from the Alps (Nimis 1993), Swartzvald (Wirth 1995), mountains of the Iberian Peninsula (Llimona & Hladun 2001), Balkans (Murati 1992), and also Scandinavia (Hakulinen 1962).

EXSICCATI SEEN. Pišút, *Lich. Slovakiae Exs. No. 247* (KRAM, WA); Poelt, *Lich. Alpium No. 150* (sub. *U. decussata*) (KRAM, LBL, POZ); *No. 271* (KRAM, POZ); Suza, *Lich. Bohem. No. 78* (KRAM, POZ); Tobolewski, *Lich. Polonica. No. 137* (POZ).

SPECIMENS EXAMINED. Grid square Gd-59 – WEST TATRA MOUNTAINS: Ornak Mt., E slope, 06 Aug. 1929, *leg. J. Motyka*, (LBL); Ge-50 – HIGH TATRA MOUNTAINS: Dolina Gąsienicowa valley near Dwoisty Staw lake, Aug. 1925, *leg. J. Motyka* (LBL), alt. 1690 m, 06 July 1999, *leg. B. Krzewicka* (KRA); Mały Kościelec Mt. 19 Aug. 1959, *leg. S. Matuszewska* (LBL), W slope, alt. 1750 m, 06 July 1999, *leg. B. Krzewicka* (KRA), N slope, alt. 1720 m, and 1660 m, 08 July 1999, *leg. B. Krzewicka* (KRA); Przełęcz Karb pass, E slope, alt. 1850 m, 09 July 1955, *leg. J. Nowak* (KRAM), 19 Aug. 1959, *leg. S. Matuszewska* (LBL); Kościelec Mt., alt. 1790 m, 09 Aug. 1954, *leg. K. Tatarkiewicz* (LBL), 18 Sept. 1955 *leg. Z. Tobolewski* (POZ), 14 Aug. 1959, *leg. S. Matuszewska* (LBL), 16 Aug. 1980, *leg. E. Budzba* (UGDA), 17 June 1986, *leg. V. Alstrup & M. Olech* (KRA), W slope, alt. 1700 m, and 1800 m, 07 Aug. 1963, *leg. S. Matuszewska* (LBL); Zadni Kościelec Mt. 14 Aug. 1959, *leg. S. Matuszewska* (LBL), 1961, *leg. J. Bystrek* (LBL); Żółta Turnia Mt., 08 Aug. 1929, *leg.*

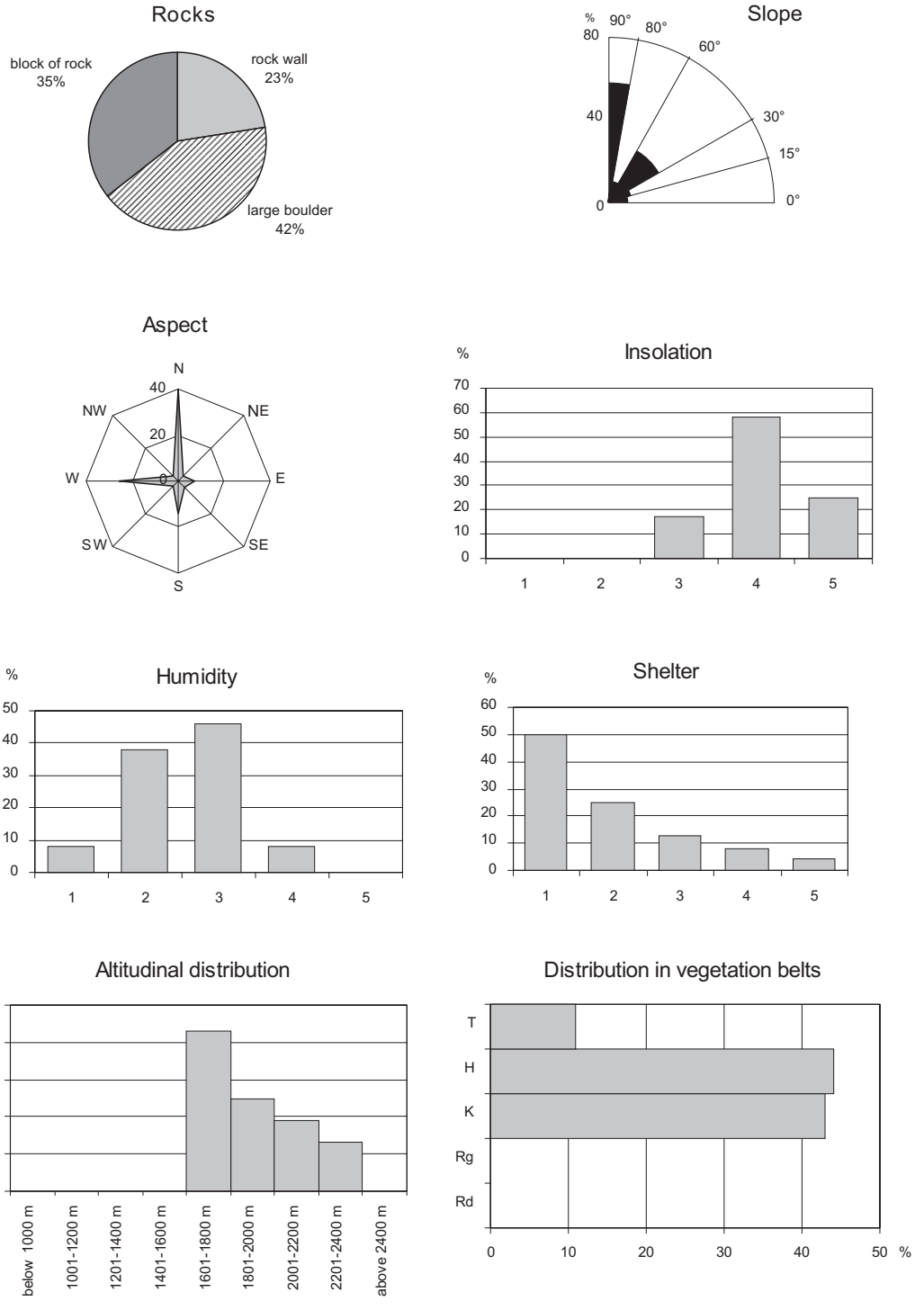


Fig. 37. Ecodiagram for *Umbilicaria leiocarpa* DC. (explanations – see Material and methods).

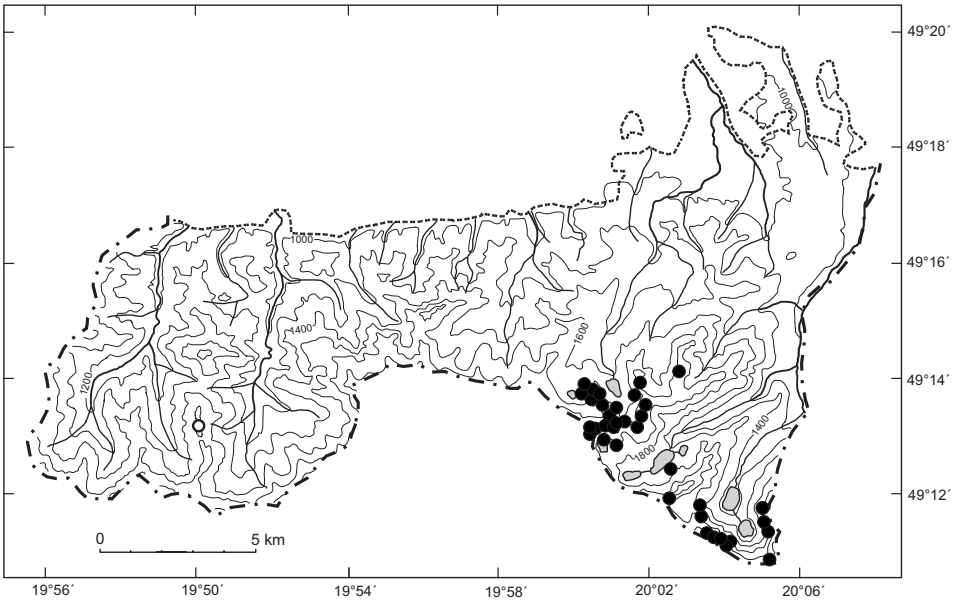


Fig. 38. Distribution map of *Umbilicaria leiocarpa* DC. in the Polish Tatra Mts. ○ – locality to 1970, ● – locality after 1970.

J. Motyka (LBL), Sept. 1955, *leg I. Wojciechoski* (LBL), N slope, alt. 1980 m, 09 July 1999, *leg. B. Krzewicka* (KRA); Żółta Igła Mt. near Żółta Turnia Mt., Sept. 1959, *leg. J. Kowalczyk* (LBL), alt. 1770 m, 09 July 1999, *leg. B. Krzewicka* (KRA); Wołoszyn Mt., alt. 2000 m, 08 Aug. 1958, *leg. K. Tatarkiewicz* (LBL); Świnica Mt. alt. 2200 m, 15 Aug. 1959, *leg. J. Kowalczyk* (LBL), 2300 m, 19 June 1986, *leg. V. Alstrup, M. Olech* (KRA); Zawrat pass, N slope near Zmarzły Staw lake, Aug. 1959, *leg. S. Matuszewska* (LBL); Mały Kozi Wierch Mt., S slope, alt. 2050 m, 26 Aug. 1956, *leg. Z. Tobolewski* (POZ); Kozia Przełęcz pass, alt. 2010 m, 18 Aug. 1959, *leg. S. Matuszewska* (LBL), 22 July 1999, *leg. B. Krzewicka* (KRA); Kozie Czuby Mt. Aug. 1955, *leg. J. Kowalczyk* (LBL); Granaty Mt. Aug. 1959, *leg. S. Matuszewska* (LBL); Ge-60 – HIGH TATRA MOUNTAINS: Dolina pod Kołem valley near Zadni Staw lake, alt. 1910 m, 1999, *leg. B. Krzewicka* (KRA); Kołowa Czuba Mt., alt. 1960 m, 19 June 1986, *leg. V. Alstrup & M. Olech* (KRA); Miedziany Kostur Mt., N slope near Wielki Staw lake, alt. 1860 m, 21 July 1999, *leg. B. Krzewicka* (KRA); Szpiglasowy Wierch Mt., S slope, alt. 2170 m, 20 July 1999, *leg. B. Krzewicka* (KRA); Mnich Mt., alt. 2000 m, 16 Oct. 1955, *leg. K. Tatarkiewicz* (LBL), 07 Aug. 1959, *leg. S. Matuszewska* (LBL), alt. 2000 m, 30 July 1999, *leg. B. Krzewicka* (KRA), N slope, alt. 2040 m, 03 Apr. 1955, *leg. K. Tatarkiewicz* (LBL); Mniszek Mt., slope, alt. 2000 m, 03 Apr. 1955, *leg. K. Tatarkiewicz* (LBL); Cubryna Mt., N slope, Aug. 1927, *leg. J. Motyka* (LBL), Aug. 1927, *leg. K Wallisch* (LBL); Koleba Pod Chłopkiem pass, alt. 1740 m, 17 Aug. 2000, *leg. B. Krzewicka* (KRA), S slope, alt. 2320 m,17 Aug. 2000, *leg. B. Krzewicka* (KRA); Czarny Mięguszowiecki Szczyt Mt., alt. 2400 m, 28 Aug. 1959, *leg. S. Matuszewska* (LBL); Pośredni Mięguszowiecki Szczyt, alt. 2340 m, 28 Aug. 1959, *leg. S. Matuszewska* (LBL), 17 Aug. 2000, *leg. B. Krzewicka* (KRA); Kazalnica Mt., NE slope, 25 Aug. 1959, *leg. J. Kowalczyk* (LBL), alt. 2040 m, 17 Aug. 2000, *leg. B. Krzewicka* (KRA); Apostoły Mts., alt. 2050 m, 03 May 1956, *leg. K. Tatarkiewicz* (LBL); Żabia Czuba Mt., alt. 1190 m, and 2200 m, 19 Aug. 1955, *leg. K. Tatarkiewicz* (LBL), 08 Aug. 1959, *leg. J. Kowalczyk* (LBL), alt. 2200 m, 08 Aug. 1959, *leg. S. Matuszewska* (LBL).

Umbilicaria microphylla (Laurer) A. Massal. (Fig. 39)

Ricerche Auton. Lich. Crost.: 62. 1852.

Umbilicaria atropruinosa var. *microphylla* Laurer *in* Sturm., Deutschl. Flora **2**(24): 13. 1832. – *Gyrophora microphylla* (Laurer) Arnold, Verhandl. Zool-Bot. Ges. Wien. **28**: 385. 1878.

Thallus small, to 0.5 cm diam., monophyllous, thalli grow close together, giving the appearance of being polyphyllous, with ascending and undulating margins; margins with black, glossy, tumid edges. Upper side mouse-grey, dull, rimose, lighter towards the center. Medulla white. Underside dark brown to brown-black, smooth, scabrous only around umbilicus. Umbilicus black, thick. Rhizines absent. Thallus 150–200 μm; upper cortex 10–20 μm, palisadoplectenchymatous; algal layer continuous, 40–60 μm; medulla both loose, plectenchymatous, and compact, scleroplectenchymatous, 40–70 μm; lower cortex brown, *ca* 20 μm, paraplectenchymatous. Apothecia leiodisc, not seen in examined material. Pycnidia not observed. Thalloconidia absent.

CHEMISTRY. Gyrophoric acid.

NOTE. The thalli of this species, like those of *U. cylindrica* var. *tornata*, grow in groups forming compact grey swards. These taxa can be easily confused in the field, because of the similarity of form and color of their thalli. They should be distinguished by the presence of at least a few cilia at the margin of the thallus in case of *U. cylindrica* and by a swollen shiny black margin in case of *U. microphylla*.

HABITAT. This species occurs on siliceous rocks, was found on a large granite boulder in a moist and north-exposed place.

DISTRIBUTION. High mountain (alpine) species. In Poland it has been reported exclusively in the High Tatras (Motyka 1964; Bielczyk 1997) where it was found at only one locality in the Dolina Pięciu Stawów Polskich valley near Wielki Staw lake at alt. 1665 m. This species has not been found recently; *U. microphylla* was last reported in the Polish Tatras by Matuszewska in 1959 (Motyka 1964) (Fig. 39).

This species is much more frequent on the Slovakian part of the Tatras and extends from alt. 1900 m to 2200 m (Lisická 1980). In Europe it is known only from the mountains of Central and Southern Europe. Outside the Tatra Mts it occurs in the Alps (Nimis 1993), mountains of the Iberian Peninsula (Llimona & Hladun 2001) and the Balkan Peninsula (Popnikolov & Zhelezova 1964; Murati 1992).

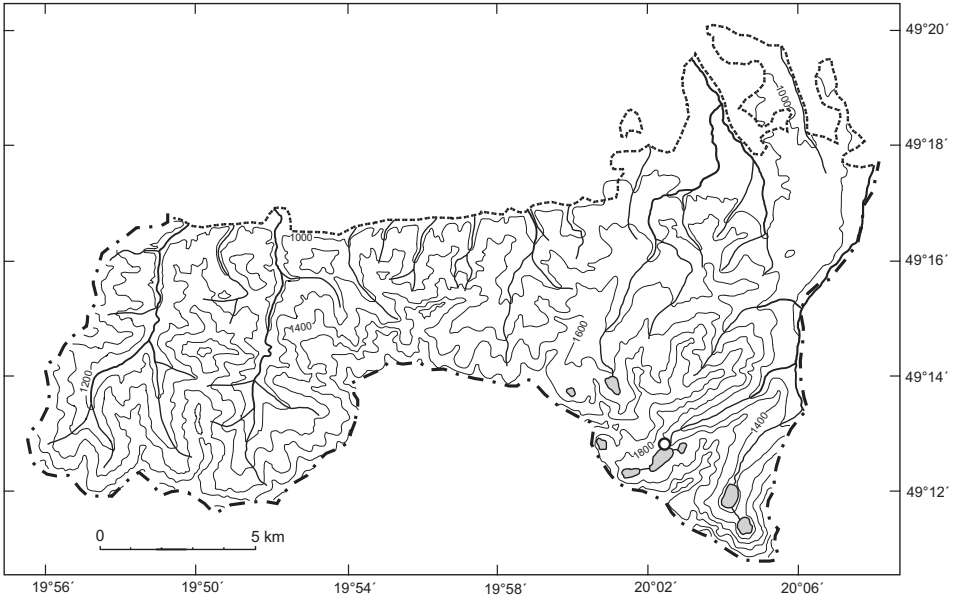


Fig. 39. Distribution map of *Umbilicaria microphylla* (Laurer) A. Massal. in the Polish Tatra Mts. o – locality to 1970.

EXSICCATI SEEN. Pišút, *Lich. Slovakiae Exs. No. 88* (KRAM, WA); Poelt, *Lich. Alpium No. 170* (KRAM, LBL, POZ); Rabenhorst, *Lich. Eur. No. 355* (sub. *Gyrophora anthracina* b. *microphylla*) (KRA).

SPECIMENS EXAMINED. Grid square Ge-60 – HIGH TATRA MOUNTAINS: Dolina Pięciu Stawów Polskich valley, N side of large block of rock, 1929, *leg. J. Motyka* (ZAUM), alt. 1665 m, 20 Aug. 1959, *leg. S. Matuszewska* (LBL).

Umbilicaria nylanderiana (Zahlbr.) H. Magn. (Figs 40, 41, 42, 43)

Magnusson, Lich. Sel. Scandinavici Exs. No. 252. 1937. *Umbilicaria corrugata* (DC.) Nyl., Lichenogr. Scandin.: 119. 1861. – *Gyrophora corrugata* (DC.) Arnold, Verhandl. Zool.-Bot. Ges. Wien **25**: 438. 1875. – *Gyrophora nylanderiana* Zahlbr., Cat. Lich. Univ. **4**: 720. 1927.

Thallus 2–3(5) cm diam., monophyllous, deeply dissected and appearing polyphyllous, margins often lacerated and perforated, ascending and undulating, new cracks in thallus white. Upper side dark brown, sometimes with a thin white necrotic layer over the umbilicus, rugose with vermiform ridges, towards the margins ± even, smooth when young, later rugose, especially in the center. Medulla white. Underside sooty black with lighter margins, smooth, even or dimpled, umbilicus black, thick. Rhizines absent. Thallus of various thicknesses, with ridges 110–310 μm, by ridges 100–200 μm; upper cortex dark brown, 10–20 μm; algal layer continuous, raised into ridges, 30–70 μm; medulla 50–150 μm; lower cortex 10–20 μm. Apothecia gyrodisc, not seen in examined material. Pycnidia in marginal zone of the upper side, immersed, spherical-shaped, with dark brown ostiole. Conidia bacilliform *ca* 2.3 × 3.1 μm. Thalloconidia: non-septate, rarely 1-septate, spherical, delicately roughened, dark brown, 9.3 × 10.2 μm (Figs 40, 41). Thalloconidia cover the underside completely, or margin free of them.

CHEMISTRY. Gyrophoric, lecanoric and umbilicaric acids.

NOTE. Young thalli of *U. nylanderiana* with slightly wrinkled upper side might be confused with *U. polyphylla* (L.) Baumg. In this instance

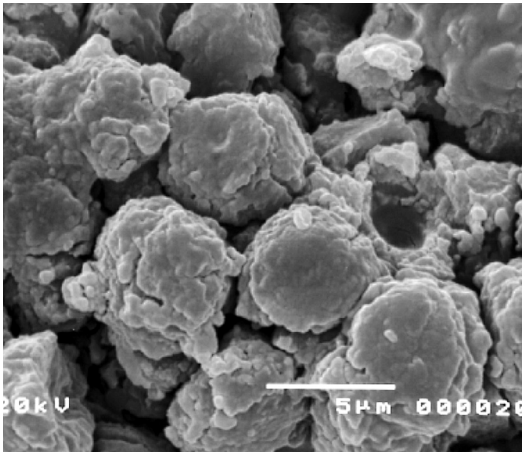


Fig. 40. *Umbilicaria nylanderiana* (Zahlbr.) H. Magn. – non–septate conidia.

a good diagnostic character distinguishing these two species is the construction of the thalloconia. *Umbilicaria nylanderiana* has simple or bicellular thalloconidia, while *U. polyphylla* has multicellular ones which are three or four time larger than those of *U. nylanderiana.*

HABITAT. This species occurs on siliceous rocks, on large isolated granite boulders and blocks, and

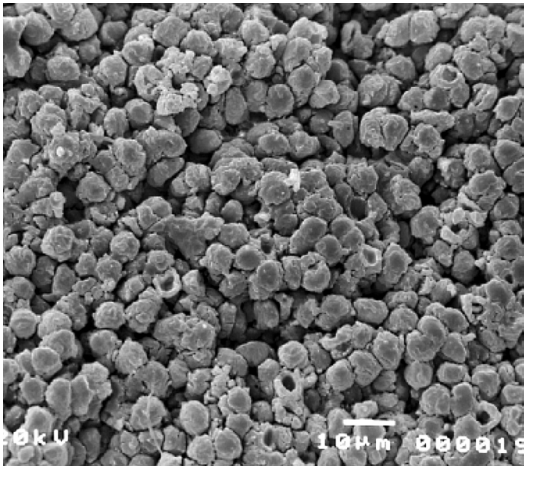
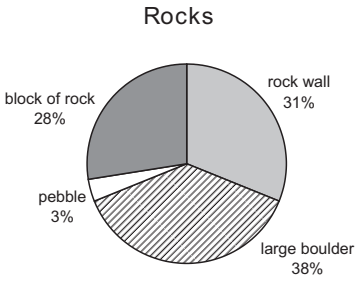
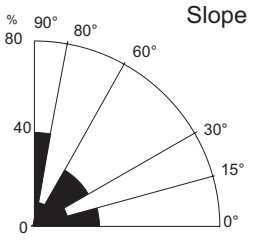
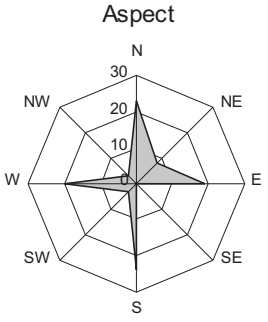
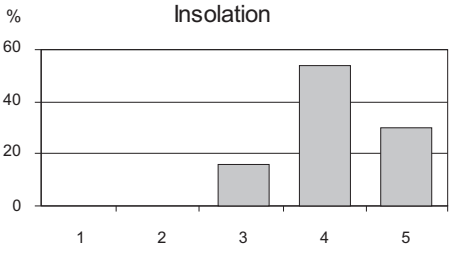


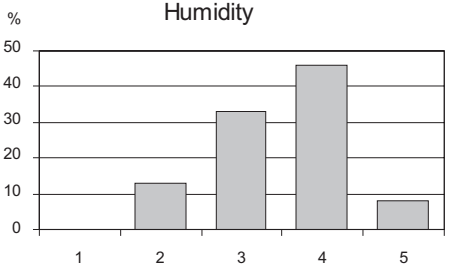
Fig. 41. *Umbilicaria nylanderiana* (Zahlbr.) H. Magn. – thalloconidia on the underside of the thallus.

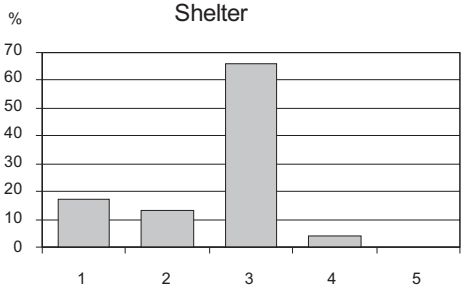


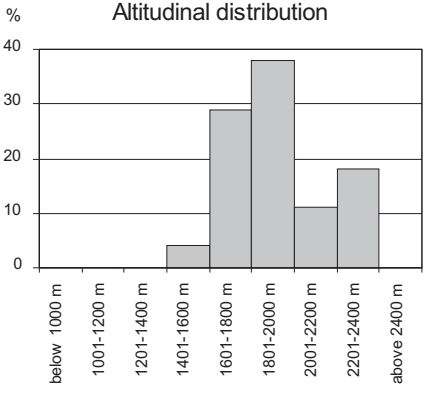












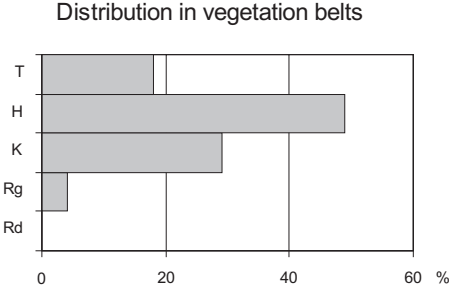


Fig. 42. Ecodiagram for *Umbilicaria nylanderiana* (Zahlbr.) H. Magn. (explanations – see Material and methods).

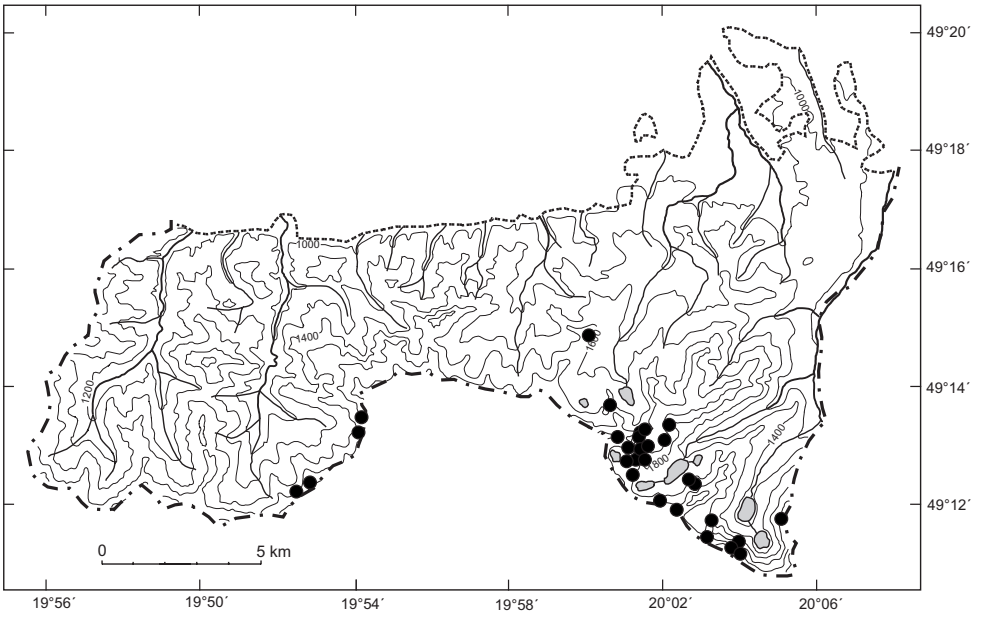


Fig. 43. Distribution map of *Umbilicaria nylanderiana* (Zahlbr.) H. Magn. in the Polish Tatra Mts. ● – locality after 1970.

also on not very high rock walls. It appears to grow on slopes of different inclinations, usually on vertical surfaces of the upper part of rocks (40% of cases), and is also fairly frequent on slightly inclined to horizontal tops of rocks (altogether 70% of cases). It seems to prefer sites in the vicinity of bryophytes and herbal plants growing on humus on rock surfaces in fairly moist, partly shaded and sheltered situations, with a moderately wide range of aspects (Fig. 42).

DISTRIBUTION. This is a rare mountain species. In the Polish Tatras it extends from the upper montane belt to the lower part of the subnival belt, primarily in the alpine belt (Fig. 42). As many as 50% of the examined stations were situated in the alpine zone, with the center of its occurrence apparently from 1800 m to 2000 m (38% of cases). The lowest locality is Kopa Królowa Mt. at 1560 m, and the highest is Czarny Mięguszowiecki Szczyt Mt. at alt. 2400 m. In the West Tatras this species occasionally occurs at isolated, scattered localities. In the High Tatras, however, it is a fairly frequent species, having its main center of distribution in the Dolina Pięciu Stawów Polskich valley (Fig. 43).

In Poland it is known from one locality in the Beskid Mały Mts at alt. 830 m (Nowak 1965, 1972), one locality in the Wyżyna Krakowsko-Częstochowska upland at 370 m (where it was reported as *U. decussata*) (Nowak 1959, 1961), and a few localities in the Sudety and Karkonosze Mts (Frey 1933; Tobolewski 1954); it is more frequent only in the Tatra Mts (Tobolewski 1956a, 1965, 1996; Krzewicka 2002b, c).

In the Slovakian Tatras this species is rare. In Europe it is reported from the Iberian Peninsula, the Aspromonte Massif in southern Calabria, the Balkans, the mountains of Germany and France, the Alps, the Carpathians, the Caucasus and Scandinavia (e.g., Hakulinen 1962; Clauzade & Roux 1985; Nimis 1993; Scholz 2000; Llimona & Hladun 2001).

EXSICCATI SEEN. *Krypt. Exs. Vindob. No. 4345* (POZ); Poelt, *Lich. Alpium No. 42* (POZ); Tobolewski, *Lich. Polonica No. 88* (sub. *U. corrugata*) (KRA, KRAM, LBL, TRN, WA).

SPECIMENS EXAMINED. Grid square Gd-69 – WEST TATRA MOUNTAINS: Hlińska Przełęcz pass, alt. 1895 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); Suchy Wierch Tomanowy Mt., E slope, alt. 1760 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); Tomanowy Wierch Polski Mt., alt. 1960 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); Smereczyński Wierch Mt., SW slope, alt. 2000 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); Ge-50 – WEST TATRA MOUNTAINS: Hala Jaworzynka mountain meadow, Kopa Królowa Mała Mt., alt. 1560 m, 01 July 1999, *leg. B. Krzewicka* (KRA); Ge-50 – HIGH TATRA MOUNTAINS: Mały Kościelec Mt., W slope near Dwoisty Staw lake, alt. 1690 m, 06 July 1999, *leg. B. Krzewicka* (KRA); Dolina Pańszczyca valley, above Czerwone Stawki lake, alt. 1800 m, 05 July 1999, *leg. B. Krzewicka* (KRA); Świnica Mt., S slope, alt. 1910 m, 17 July 1999, *leg. B. Krzewicka* (KRA); Kozi Wierch Mt., alt. 2291 m, 18 July 1999, *leg. B. Krzewicka* (KRA); Mały Kozi Wierch Mt., alt. 2228 m, 22 July 1999, *leg. B. Krzewicka* (KRA); Krzyżne Mt., SE slope, alt. 2220 m, 18 July 1999, *leg. B. Krzewicka* (KRA); Dolinka Buczynowa valley, alt. 1720 m, 19 July 1999, *leg. B. Krzewicka* (KRA); Ge-60 – HIGH TATRA MOUNTAINS: Kołowa Czuba Mt., above Dolinka Pusta valley, S slope, alt. 1840 m, 16 July 1999, *leg. B. Krzewicka* (KRA); Dolinka Pusta valley, alt. 1920 m, 22 July 1999, *leg. B. Krzewicka* (KRA); Dolinka pod Kołem valley near Zadni Staw lake, alt. 1950 m, Aug. 1962, *leg. S. Matuszewska* (LBL); Zadni Staw lake on W bank, alt. 1950 m, 22 July 1999, *leg. B. Krzewicka* (KRA); Wole Oko lake, N bank, alt. 1890 m, 17 July 1999, *leg. B. Krzewicka* (KRA); Opalony Wierch Mt., S slope, alt. 1685 m, 19 July 1999, *leg. B. Krzewicka* (KRA); Kotelnica Mt., E slope, alt. 1800 m, 19 July 1999, *leg. B. Krzewicka* (KRA); Szpiglasowa Przełęcz pass, alt. 2140 m, 20 July 1999, *leg. B. Krzewicka* (KRA); Mnich Mt., W slope, alt. 2000 m, 30 July 1999, *leg. B. Krzewicka* (KRA); NE slope, alt. 1780 m, 16 Aug. 2000, *leg. B. Krzewicka* (KRA); Przełęcz Pod Chłopkiem pass, S slope, alt. 2320 m, 17 Aug. 2000, *leg. B. Krzewicka* (KRA); Pośredni Mięguszowiecki Szczyt Mt., alt. 2320 m, Aug. 1960, *leg. S. Matuszewska* (LBL), alt. 2390 m, 17 Aug. 2000, *leg. B. Krzewicka* (KRA); Czarny Mięguszowiecki Szczyt Mt., alt. 2400 m, Aug. 1959, *leg. S. Matuszewska*, (LBL).

Umbilicaria polyphylla (L.) Baumg.

(Figs 44, 45, 46, 47)

Flora Lipsiensis: 571. 1790.

Lichen polyphyllus L., Sp. Pl.: 1150. 1753. – *Gyrophora polyphylla* (L.) Funck, Crypt. Gewächse **4**: 4. 1804.

Thallus to 2(4) cm diam., polyphyllous, cushion-shaped, rarely monophyllous, paper-thin and fragile when dry, irregular in outline, margins lacerated, undulating and deeply dissected, or entire, the edges strongly curled upward or rarely under, the umbo slightly folded. Upper side dark brown, rarely grey-brown, smooth, slightly glossy, even or with slightly reticulate wrinkles. Medulla white. Underside smooth, even, and sooty black, sometimes brown around umbilicus. Rhizines absent. Thallus 150–200(300) μm thick; upper cortex 10–20 μm, palisadeplectenchymatous; algal layer continuous, thick, 40–70 μm; medulla loose with air spaces, 50–100 μm; lower cortex 10–20 μm, sclereplectenchymatous. Apothecia gyrodisc, very rare, found on only two specimens in examined material, disc 0.5–4.0 mm, gyrose, hypothecium dark brown to black, hymenium 60–70 μm, paraphyses septate, 1.7–2.0 μm, spores irregular, 39.0–58.0 × 13.0–16.0 μm. Pycnidia in marginal zone of the upper side, immersed, spherical-shaped, with dark brown ostiole. Conidia *ca* 4.0–5.5 × 0.6 μm. Thalloconidia: multi-septate, usually 6– to 10-cellular, spherical to ellipsoid, smooth, brown to dark brown, 15.0(20.0) × 16.0(26.0) μm (Figs 44, 45). Thalloconidia covered the underside completely except for brown area around umbilicus, places with thalloconidia sooty black.

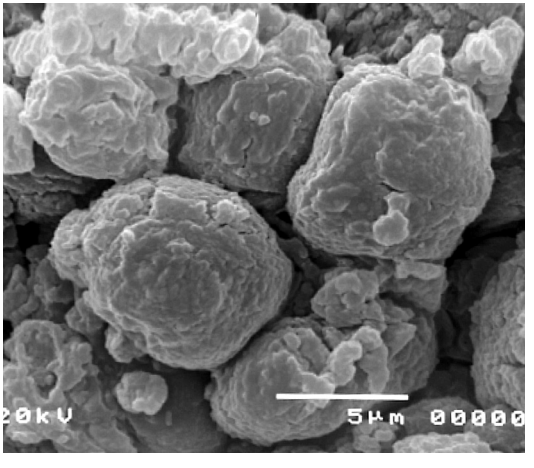


Fig. 44. *Umbilicaria polyphylla* (L.) Baumg. – multi–septate conidia.

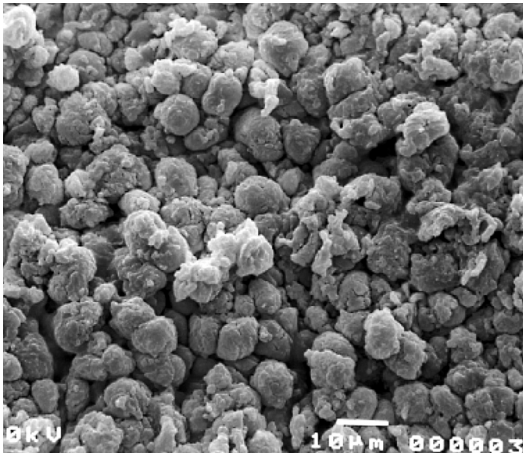


Fig. 45. *Umbilicaria polyphylla* (L.) Baumg. – thalloconidia on the underside of the thallus.

CHEMISTRY. Gyrophoric and umbilicaric acids.

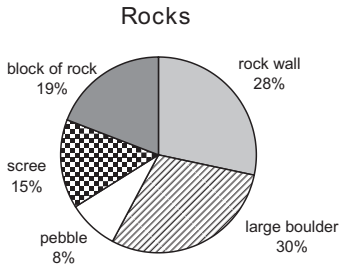
NOTE. Occasionally this species has irregular, tubercular formations on the upper side of the thallus. They are necral cells of fungi often inhabited by free green algae. The formations sometimes look like isidia and in this case the specis might be confused with isidiose *U. deusta*. A good differentiating character between those two species is the presence of thalloconidia in *U. polyphylla* and the lack of them in *U. deusta*.

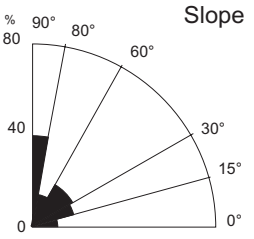
HABITAT. This species colonizes a wide variety of siliceous substrates, occurring on granite rock walls (28% of cases), blocks (19%), boulders (30%), scree (15%), and pebbles (8%). It is most frequently found on vertical surfaces (40% of cases), and also frequently on horizontal or slightly inclined surfaces (altogether 45% of cases). It is found on sun-exposed (85% of cases) and moderately sheltered situations (58% of cases), with a rather wide range of humidity and aspects (Fig. 46).

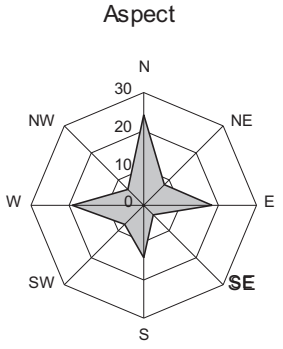
DISTRIBUTION. This is a mountain species. In the Polish Tatras it is a fairly frequent species, having its main center of distribution in the subalpine (42% of cases) and alpine (42%) belts. It occurs less frequently in the upper montane belt (10%) and occasionally comes up into the subnival belt (4%) and down into the lower montane belt (2%). As many as 75% of the examined stations were situated from alt. 1600 m to 2000 m (Fig. 46). The lowest locality is Wyżnia Miętusia Kira glade at 940 m. The highest locality is Rysy Mt. at 2400 m. In the High Tatras it is a common and widely distributed species, above the timber line in the areas of the Morskie Oko valley, Dolina Pięciu Stawów Polskich valley and Hala Gąsienicowa alpine meadow. In the West Tatras it is less frequent and occurs at scattered localities (Fig. 47).

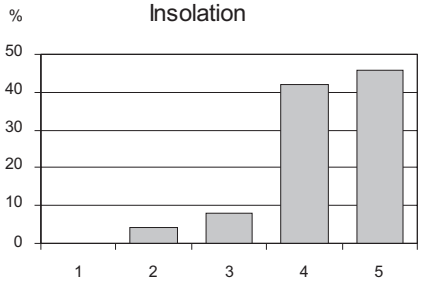
In the Polish Carpathians it is scattered over some ranges. It is known from the Beskid Śląski Mts (Kiszka 1967b), Beskid Mały Mts (Nowak 1965, 1972), Beskid Makowski Mts (Nowak 1972), Beskid Wyspowy Mts (Nowak 1972, 1998), Beskid Żywiecki Mts (Nowak 1972, 1998), Gorce Mts (Nowak 1972; Tobolewski & Kubczyk 1976), Dynowskie foothills (Krzewicka & Śliwa 2000), Pieniny Mts (Boberski 1886; Tobolewski 1958; Kiszka 1997, 2000), Tatra Mts (Rehman 1879; Motyka 1924a, b, 1926, 1927, 1934, 1964; Alstrup & Olech 1992a) and Bieszczady Mts (Glanc & Tobolewski 1960; Kiszka & Kościelniak 1998). Beyond the Carpathians it occurs in the Sudety Mts in the Góry Izerskie Mts (Anders 1923), Karkonosze Mts (Stein 1879; Seaward *et al*. 1983), Góry Stołowe Mts (Tobolewski 1952, 1955c, 1961b), and the Śnieżnik Massif (Fabiszewski 1968). In Poland it is also known from the Góry Świętokrzyskie Mts (Berdau 1876; Błoński 1890; Kobendza & Motyka 1928, 1929; Motyka 1934; Cieśliński & Halicz 1971; Cieśliński 1975, 1991; Cieśliński & Czyżewska 1992), western Pomerania (Krawiec 1933a; 1938; Koppe 1939; Tobolewski & Kubczyk 1976; Fałtynowicz & Tobolewski 1989, Fałtynowicz & Miądlikowska 1990; Fałtynowicz 1992; Kiszka & Lipnicki 1994) and northeast Poland (Fałtynowicz 1981; Cieśliński & Tobolewski 1989) where it is uncommon.

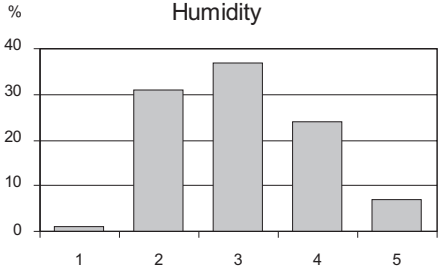
In the Slovakian Tatras this species is also fairly frequent in the High Tatras and less frequent in the West and Belanské Tatras (Lisická 1980). In Europe it is known from both mountains and lowlands. The species is reported from nearly all countries in Europe (e.g., Hakulinen 1962; Clau-

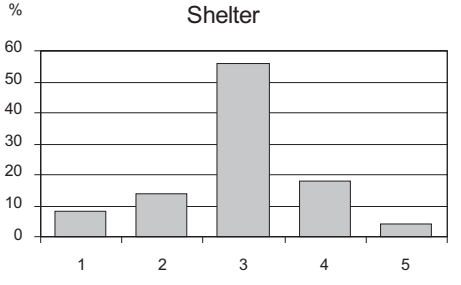


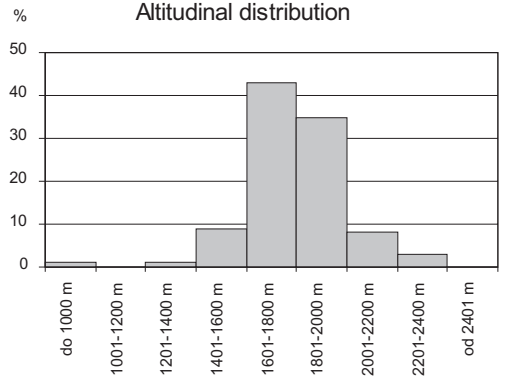












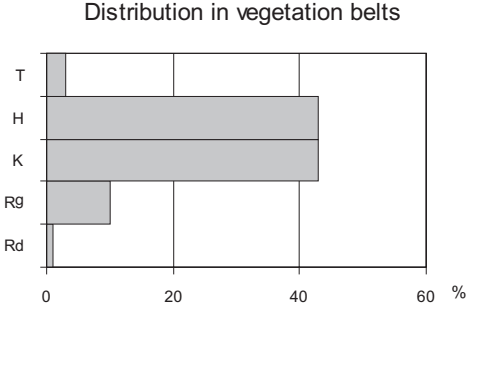


Fig. 46. Ecodiagram for *Umbilicaria polyphylla* (L.) Baumg. (explanations – see Material and methods).

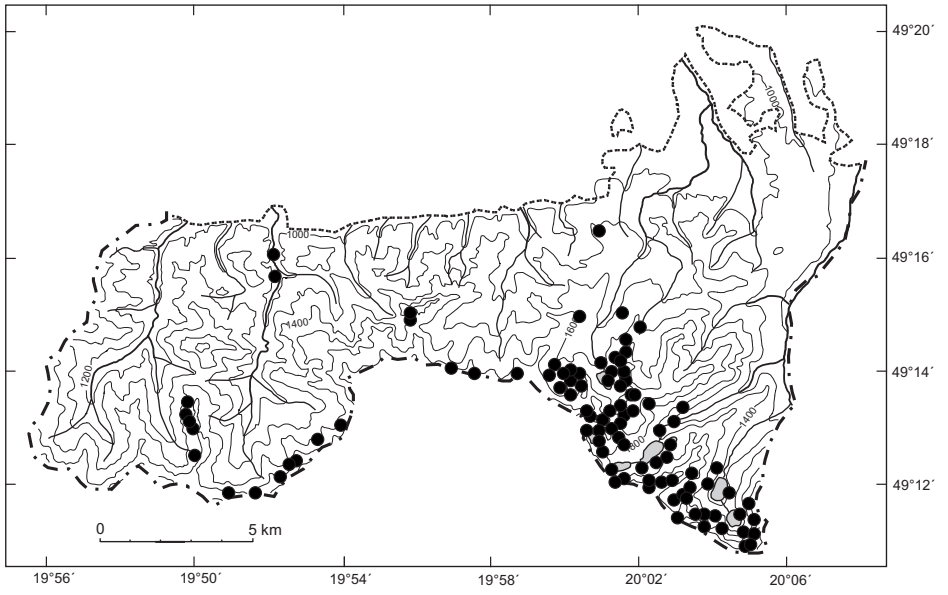


Fig. 47. Distribution map of *Umbilicaria polyphylla* (L.) Baumg. in the Polish Tatra Mts. ● – locality.

zade & Roux 1985; Nimis 1993; Verseghy 1994; Scholz 2000; Llimona & Hladun 2001), but is much less common in the mountains of Northern Europe (Elvebakk & Hertel 1996).

EXSICCATI SEEN. Pišút, *Lich. Slovakiae Exs. No. 89* (KRAM, WA); Poelt, *Lich. Alpium No. 197* (KRAM, LBL, POZ); Tobolewski, *Lich. Polonica No. 25* (LBL, POZ, WA).

SPECIMENS EXAMINED. Grid square Gd-58 – WEST TATRA MOUNTAINS: Polana Chochołowska, alt. 1100 m, 07 May 1999, *leg. B. Krzewicka* (KRA); Gd-59 – WEST TATRA MOUNTAINS: Wyżnia Miętusia Kira glade, alt. 940 m, 21 May 1999, *leg. B. Krzewicka* (KRA); Cudakowa Polana glade, 950 m, 21 May 1999, *leg. B. Krzewicka* (KRA); Przełęcz Kondracka pass, 28 Aug. 1926, *leg. J. Motyka* (LBL), alt. 1725 m, 06 Aug. 1998, *leg. B. Krzewicka* (KRA); Ornak Mt., 06 Aug. 1924, *leg. J. Motyka*, Aug. 1962, *leg. S. Matuszewska* (LBL), alt. 1700 m, 1750 m, and 1850 m, 07 Aug. 1999, *leg. B. Krzewicka* (KRA); Suche Czuby Mt., alt. 1790 m, 06 Aug. 1998, *leg. B. Krzewicka* (KRA); Gd-69 – WEST TATRA MOUNTAINS: Zadni Ornak Mt., alt. 1807 m, 07 Aug. 1999, *leg. B. Krzewicka* (KRA); Hlińska Przełęcz pass, alt. 1897 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); Smereczyński Wierch Mt., alt. 2060 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); below Smereczyńskim Wierchem Mt., alt. 2000 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); Smereczyńska Przełęcz pass, alt. 1800 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); between Tomanowy Wierch Mt. and Smereczyńska Przełęcz pass, alt. 1900 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); Tomanowy Wierch Mt., alt. 1960 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); Suchy Wierch Tomanowy Mt., alt. 1860 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); Ge-50 – WEST TATRA MOUNTAINS: Polana Kopieniec glade, alt. 1240 m, 10 July 1999, *leg. B. Krzewicka* (KRA); Pośredni Wierch Goryczkowy Mt., alt. 1870 m, 06 Aug. 1998, *leg. B. Krzewicka* (KRA); Kasprowy Wierch Mt., alt. 1950 m, 06 Aug. 1998, *leg. B. Krzewicka* (KRA); Ge-50 – HIGH TATRA MOUNTAINS: Hala Gąsienicowa mountain meadow, 06 Aug. 1925, *leg. J. Motyka* (LBL); near Murowaniec hut, alt. 1450 m, 01 July 1999, *leg. B. Krzewicka* (KRA); Zielony Staw lake, alt. 1690 m, 1700, and 1750 m, 02 July 1999, *leg. B. Krzewicka* (KRA); near Mokra Jama lake, alt. 1550 m, 02 July 1999, *leg. B. Krzewicka* (KRA); near Dwoisty Staw lake, alt. 1690 m, 06 July 1999, *leg. B. Krzewicka* (KRA); near Długi Staw lake, alt. 1770 m, 02 July 1999, *leg. B. Krzewicka* (KRA); Mały Kościelec Mt., alt. 1820 m, N slope, alt. 1660 m, and 1760 m, 08 July 1999, *leg. B. Krzewicka* (KRA); Kościelec Mt. Aug. 1959, *leg.*

S. Matuszewska (LBL), alt. 2155 m, N slope, alt. 1870 m, and 1960 m, 08 July 1999, *leg. B. Krzewicka* (KRA); near Czarny Staw Gąsienicowy lake, alt. 1700 m, 12 July 1999, *leg. B. Krzewicka* (KRA); Żółta Turnia Mt. 19 Sept. 1949, *leg. J. Motyka* (LBL), 17 Aug. 1959, *leg. S. Matuszewska* (LBL), 07 Aug. 1963, *leg. S. Matuszewska* (LBL), W slope, alt. 1770 m, N slope, alt. 1495 m, 09 July 1999, *leg. B. Krzewicka* (KRA); Żółta Igła Mt., alt. 1660 m, and 1700 m, 09 July 1999, *leg. B. Krzewicka* (KRA); Zadni Upłaz Mt., N slope, alt. 1630 m, 07 July 1999, *leg. B. Krzewicka* (KRA); Dolina Pańszczyca valley, 17 Aug. 1959, *leg. S. Matuszewska* (LBL), 08 Aug. 1963, *leg. S. Matuszewska* (LBL); Wierch pod Fajki Mt., W slope, alt. 1730 m, 03 July 1999, *leg. B. Krzewicka* (KRA); Skrajny Granat Mt., alt. 2220 m, 03 July 1999, *leg. B. Krzewicka* (KRA); Dolina Buczynowa valley, alt. 1730 m, 1770 m, and 1830 m, 19 July 1999, *leg. B. Krzewicka* (KRA); Czarne Ściany Mt., alt. 2220 m, 18 July 1999, *leg. B. Krzewicka* (KRA); Mały Kozi Wierch Mt., alt. 2228 m, 22 July 1999, *leg. B. Krzewicka* (KRA); near Zmarzły Staw lake, alt. 1970 m, 05 July 1999, *leg. B. Krzewicka* (KRA); Zmarzłe Czuby Mt., N slope, alt. 2130 m, 05 July 1999, *leg. B. Krzewicka* (KRA); between Świnica Mt., and Zawrat pass, alt. 2180 m, 05 July 1999, *leg. B. Krzewicka* (KRA); Ge-60 – HIGH TATRA MOUNTAINS: near Zadni Staw lake, Aug. 1962, *leg. S. Matuszewska* (LBL); Zadni Piarg scree, alt. 1865 m, 17 July 1999, *leg. B. Krzewicka* (KRA); Dolina pod Kołem, alt. 1910 m, 17 July 1999, *leg. B. Krzewicka* (KRA); near Wole Oko lake, alt. 1870 m, and 1890 m, 17 July 1999, *leg. B. Krzewicka* (KRA); Kołowa Czuba Mt., alt. 1840 m, and 1920 m, SE slope, alt. 1790 m, 16 July 1999, *leg. B. Krzewicka* (KRA); Dolinka Pusta valley, alt. 1800 m, 09 Apr. 1955, *leg. K. Tatarkiewicz* (LBL), alt. 1820 m, 16 July 1999, *leg. B. Krzewicka* (KRA); Kozi Wierch Mt., SW slope, alt. 1900 m, 22 July 1999, *leg. B. Krzewicka* (KRA); E slope Kotelnicy Mt., alt. 1800 m, and 1810 m, 19 July 1999, *leg. B. Krzewicka* (KRA); Wodospad Siklawa waterfall, alt. 1525 m, and 1650 m, 16 July 1999, *leg. B. Krzewicka* (KRA); Niedźwiedź rock near Wielki Staw lake, alt. 1720 m, and 1800 m, 20 July 1999, *leg. B. Krzewicka* (KRA); Miedziany Kostur Mt., N slope, alt. 1840 m, and 1860 m, W slope, alt. 1700 m, 21 July 1999, *leg. B. Krzewicka* (KRA); near Przedni Staw lake, alt. 1685 m, and 1690 m, 21 July 1999, *leg. B. Krzewicka* (KRA); Dolina Roztoki valley, alt. 1490 m, 16 July 1999, *leg. B. Krzewicka* (KRA); Niżni Liptowski Kostur Mt., alt. 1820 m, 20 July 1999, *leg. B. Krzewicka* (KRA); Czerwony Piarg scree, alt. 1880 m, 20 July 1999, *leg. B. Krzewicka* (KRA); Szpiglasowa Przełęcz pass, E slope, alt. 1920 m, and 2140 m, 20 July 1999, *leg. B. Krzewicka* (KRA); Szpiglasowy Wierch Mt., S slope, alt. 2170 m, 20 July 1999, *leg. B. Krzewicka* (KRA); near Morskie Oko hut, 1959, *leg. S. Matuszewska* (LBL); by Mnichowy Potok stream, alt. 1640 m, 28 July 1999, *leg. B. Krzewicka* (KRA); Wyżnie Mnichowe Stawki lakes, alt. 1800 m, 30 July 1999, *leg. B. Krzewicka* (KRA); Mnich Mt., NE slope, alt. 1780 m, and 1830 m, W slope, alt. 2000 m, N slope, alt. 1920 m, 30 July 1999, *leg. B. Krzewicka* (KRA); Wrota Chałubińskiego pass, alt. 1550 m, 1800 m, and 1870 m, 28 July 1999, *leg. B. Krzewicka* (KRA); near Czarny Staw pod Rysami lake, NE bank, alt. 1590 m, 1600 m, and 1650 m, 29 July 1999, *leg. B. Krzewicka* (KRA); Białczańska Przełęcz pass, W slope, alt. 1720 m, 18 Aug. 2000, *leg. B. Krzewicka* (KRA); Żabia Lalka Mt., S slope, alt. 1660 m, 18 Aug. 2000, *leg. B. Krzewicka* (KRA); Koleba pod Chłopkiem pass, alt. 1740 m, 17 Aug. 2000, *leg. B. Krzewicka* (KRA); Kazalnica Mt., N slope, alt. 1730 m, and 2040 m, 17 Aug. 2000, *leg. B. Krzewicka* (KRA); Bula pod Rysami Mt., S slope, alt. 1760 m, 29 July 1999, *leg. B. Krzewicka* (KRA); Rysy Mt., 07 Aug. 1926, *leg. J. Motyka* (LBL), alt. 2480 m, 08 Aug. 1961, *leg. J. Motyka* (KRAM), alt. 2400 m, 29 July 1999, *leg. B. Krzewicka* (KRA).

Umbilicaria polyrrhiza (L.) Ach.

(Figs 48, 49, 50)

Kgl. Vetensk. Akad. Nya Handl. **15**: 92. 1794.

Lichen polyrrhizos L., Sp. Pl.: 1151. 1753. – *Gyrophora polyrrhiza* (L.) Körb., Parerg. Lich.: 41. 1859. – *Actinogyra polyrrhiza* (L.) Schol., Nyt Mag. Naturvid. **75**: 28. 1934.

Thallus 4–5 cm diam., monophyllous, outstretched, ± adpressed to substrate, slightly undulating, the edges slightly curled upward, margins with black oval-shaped patches. Upper side uniformly coppery brown, smooth and glossy, new cracks white, older black. Medulla white. Underside black, warted, distinctly areolate towards umbilicus, sometimes trabeculate around umbilicus. Rhizines present, margin densely covered by black rhizines, which divide irregularly or with many divisions from one point, often terminally dissolving into clumps of thalloconidia. Thallus 130–175 μm thick; upper cortex 3–6 μm; algal layer 40–55 μm; medulla 60–70 μm; lower cortex 20–50 μm. Apothecia actinodisc, not seen in

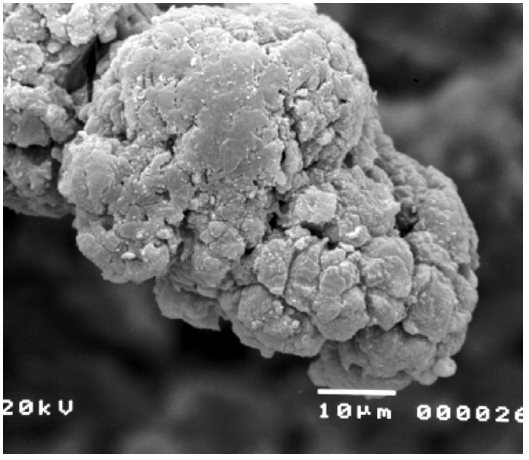


Fig. 48. *Umbilicaria polyrrhiza* (L.) Ach. – multi–septate conidia.

examined material. Picnidia not observed. Thalloconidia: multi-septate, 100 to 400-cellular, sometimes ± irregular in shape, roughened, dark brown, 19.5 × 18.7 µm (Figs 48, 49). Thalloconidia on the rhizines, mainly terminally distributed.

CHEMISTRY. Gyrophoric and umbilicaric acids.

NOTE. The field studies did not yield any current findings of *U. polyrrhiza*. It is known that there were four specimens of the taxon at its sole station (two of them are in the herbarium). The lack of any new records of this taxon is alarming; it can be assumed that the station was completely destroyed

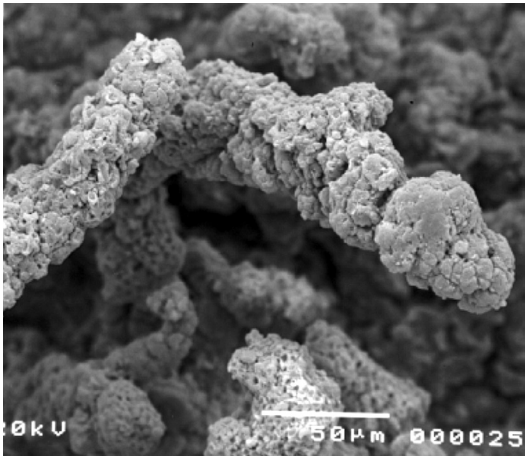


Fig. 49. *Umbilicaria polyrrhiza* (L.) Ach. – thalloconidia on the underside of the thallus.

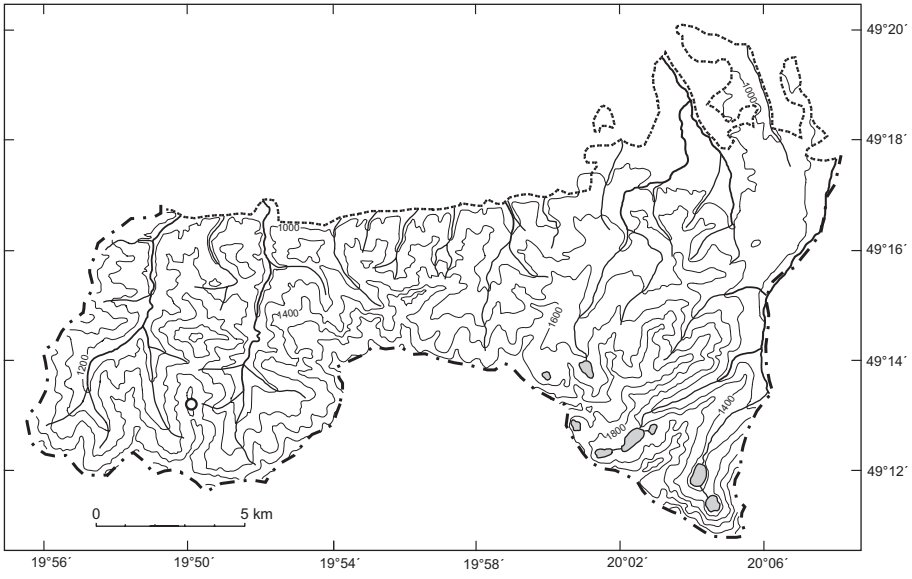


Fig. 50. Distribution map of *Umbilicaria polyrrhiza* (L.) Ach. in the Polish Tatra Mts. o – locality to 1970.

in the last four decades. This species should probably be regarded as nearing extinction in Poland.

HABITAT. This species occurs on siliceous rocks; it was found on large granite boulders, in the vicinity of bryophytes, on moist, moderately sheltered, northwest-exposed sites.

DISTRIBUTION. Only Matuszewska (herbarium LBL) reported this species in Poland, from one locality in the West Tatra Mts in 1962 (Fig. 50), on the slope of Ornak Mt. in the subalpine belt (Motyka 1964). So far it has not been found in the Slovakian Tatras (Lisická 1980; Pisut *et al*. 1996).

In Europe it occurs mainly in Western Europe, confined to areas with a rather humid climate, such as the Iberian Peninsula, the Alps, and Mediterranean mountains (Nimis 1993; Llimona & Hladun 2001).

EXSICCATI SEEN. Rabenhorst, *Lich. Eur. No. 811* (sub. *Gyrophora polyrrhizos*) (KRA, WRSL).

SPECIMENS EXAMINED. Grid square Gd-59 – WEST TATRA MOUNTAINS: Ornak Mt., NE slope, 15 Aug. 1962, *leg. S. Matuszewska* (LBL).

Umbilicaria proboscidea (L.) Schrad.

(Figs 51, 52)

Spicil. Florae Germ. **1**: 103. 1794.

Lichen proboscideus L., Sp. Pl.: 1150. 1753. – *Gyrophora proboscidea* (L.) Ach., Meth. Lich.: 105. 1803.

Thallus 3–4(6) cm diam., monophyllous, thin, adhering to substrate, orbicular or oval in outline, margins lacerated, shallowly incised, the edges slightly curled upward, the umbo raised. Upper side dark brown to black, with white coarsely granulose center, dull, with a reticulate pattern of ridges, over the umbilicus, fading to vermiform ridges towards the margins. Medulla white. Underside pale brown, darker towards margins, margins grey, appearing rimy, smooth, ± even, or with shallow depression around umbilicus. Rhizines usually absent, when present simple or sparsely branched, peripheral, concolorous with the underside or slightly darker. Thallus with ridges 110–160 μm thick, by ridges 120–280 μm thick; upper cortex 8–16 μm; algal layer continuous, of different thicknesses, 36–56 μm; medulla loose, 43–136 μm; lower cortex 14–24 μm, paraplectenchymatous. Apothecia gyrodisc, not very common, sessile, disc black, to 1.5 mm, gyrose, the gyri regularly dichotomous, spores simple, ovoid, 12.0–15.0 × 5.0–7.5 μm. Pycnidia not treated. Thalloconidia absent.

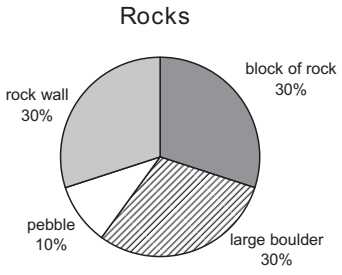
CHEMISTRY. Gyrophoric and lecanoric acids.

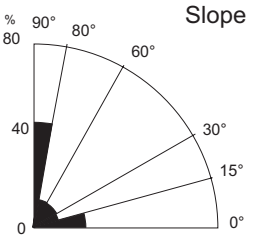
NOTE. Specimens with a pale grey-brown upper side are very similar to specimens of *U. cylindrica* var. *corrugatoides*. This variety also has a white, reticulately ridged center. The two taxa are distinguished by the cilia; *U. cylindrica* has cilia on the margins of the lobes, especially on young, small lobes; *U. proboscidea* never has cilia.

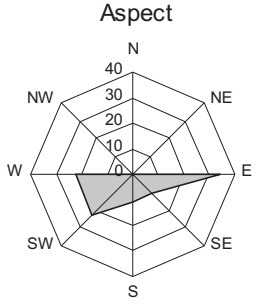
HABITAT. This species occurs on siliceous rocks, on steeply inclined surfaces of rock walls, large boulders (60%) and granite blocks (30%). It inhabits east– (35% of cases) and less frequently west– (23%) and south-facing (10%), It is found in sun-exposed situations (77% of cases) but can also tolerate moderate shade (20%). It seems to prefer rather sheltered, dry (43% of cases), and moderately moist situations (32%) (Fig. 51).

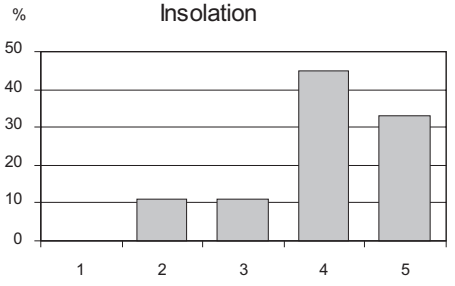
DISTRIBUTION. This is a mountain species. In the Polish Tatras it extends from the subalpine to the alpine belts exclusively, from 1600 m to 2200 m, although primarily in the alpine belt (62% of cases) (Fig. 51). The lowest locality is the slope of Żółta Turnia Mt. at 1600 m. The highest locality is Kościelec Mt. at alt. 2155 m. In the High Tatras it occurs at a few scattered localities such as the Orla Perć range and the slopes of Kościelec Mt. and Świnica Mt. In the West Tatras it is known to occur at four stations: Ornak Mt., Zadni Ornak Mt., Twardy Upłaz Mt., and Przełęcz Pod Kopą Kondracką pass (Fig. 52).

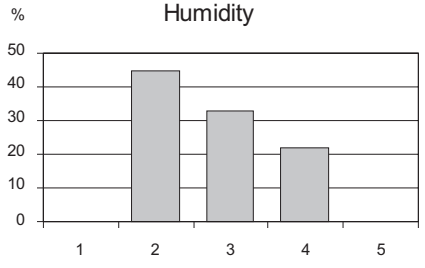
In Poland it is very rare species, occurring in the Tatra Mts (Motyka 1924b, 1926, 1927, 1928, 1964; Tobolewski 1956a) and in the Sudety Mts, where it has been found at a few localities in the Karkonosze Mts at alt. *ca* 1200 m (Eitner 1901; Frey 1933; Tobolewski 1965) and in the Góry Stołowe Mts at *ca* 900 m (Eitner 1901; Tobolewski 1955c).

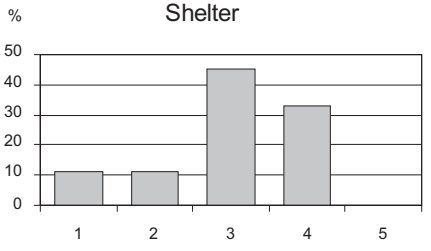


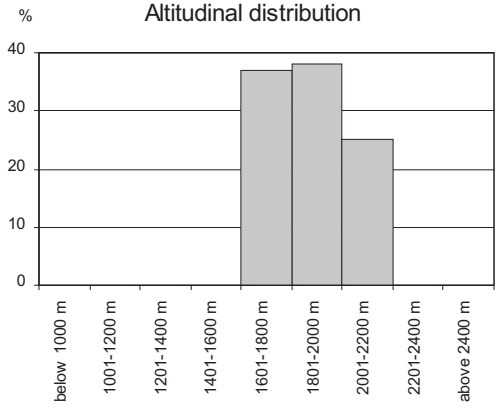












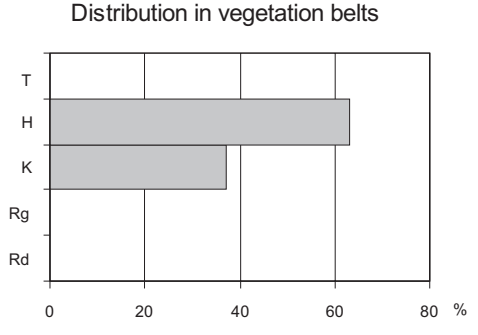


Fig. 51. Ecodiagram for *Umbilicaria proboscidea* (L.) Schrad. (explanations – see Material and methods).

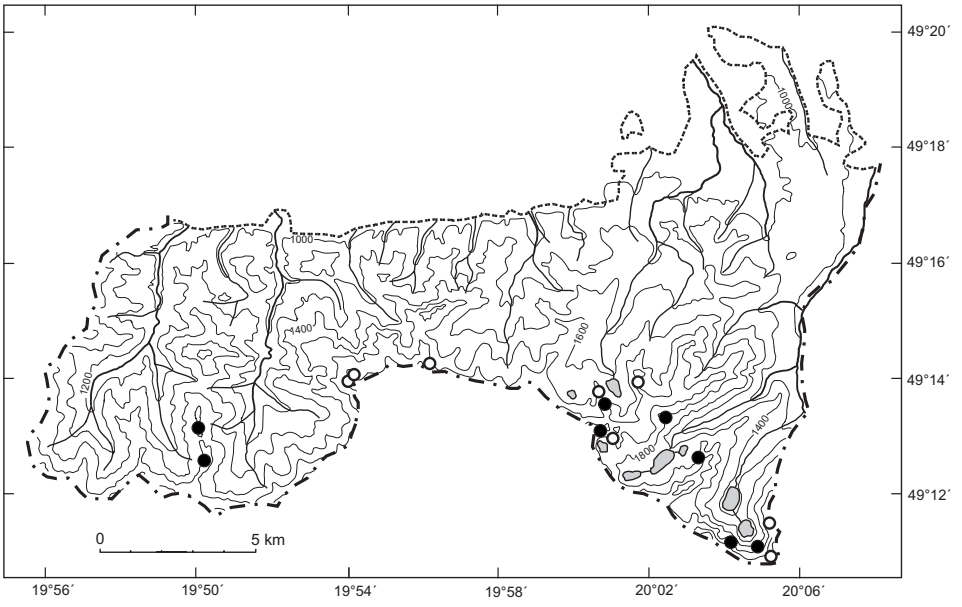


Fig. 52. Distribution map of *Umbilicaria proboscidea* (L.) Schrad. in the Polish Tatra Mts. ○ – locality to 1970, ● – locality after 1970.

In the Slovakian Tatras it is also a very rare species, apparently occurring at one locality in the West Tatras and six sites in the High Tatras (Lisická 1980). In Northern Europe it is a very common species (e.g., Popnikolov & Zhelezova 1964; Santesson 1993; Elvebakk & Hertel 1996; Randlane & Saag 1999), while in Southern and Central Europe it is less frequent (Frey 1936; Lisická 1980; Nimis 1993).

EXSICCATI SEEN. Hansen, *Lich. Groenl. Exs. No. 90* (WA); *No. 266* (WA); *No. 283* (WA); *No. 288* (WA); *No. 300* (WA); *No. 314* (WA); Havaas, *Lich. Norv. Occ. Exs. No. 205* (sub. *Gyrophora proboscidea*) (KRAM).

SPECIMENS EXAMINED. Grid square Gd-59 – WEST TATRA MOUNTAINS: Przełęcz pod Kopą Kondracką pass, 30 Aug. 1923, *leg. J. Motyka* (LBL); Twardy Upłaz Mt., 30 July 1924, *leg. J. Motyka* (LBL), 29 July 1927, *leg. J. Motyka* (LBL); Ornak Mt., Aug. 1962, *leg. S. Matuszewska* (LBL), alt. 1750 m, and 1850 m, 07 Aug. 1999, *leg. B. Krzewicka* (KRA); Gd-69 – WEST TATRA MOUNTAINS: Zadni Ornak Mt., alt. 1807 m, 07 Aug. 1999, *leg. B. Krzewicka* (KRA); Ge-50 – HIGH TATRA MOUNTAINS: Mały Kościelec Mt., 19 Sept. 1959, *leg. S. Matuszewska* (LBL); Kościelec Mt., 26 Aug. 1959, *leg. S. Matuszewska* (LBL), alt. 2155 m, 08 July 1999, *leg. B. Krzewicka* (KRA); Żółta Turnia Mt., 1926, *leg. J. Motyka* (LBL), alt. 1600 m, 16 Sept. 1955, *leg. Z. Tobolewski* (POZ); slope of Świnica Mt., alt. 1910 m, 17 July 1999, *leg. B. Krzewicka* (KRA); Dolina Buczynowa valley, alt. 1720 m, 19 July 1999, *leg. B. Krzewicka* (KRA); Ge-60 – HIGH TATRA MOUNTAINS: near Zadni Staw lake, Aug. 1962, *leg. S. Matuszewska* (LBL); near Przedni Staw lake, alt. 1685 m, 20 July 1999, *leg. B. Krzewicka* (KRA); Przełęcz pod Chłopkiem pass, alt. 2040 m, 17 Aug. 2000, *leg. B. Krzewicka* (KRA); Żabi Mnich Mt., alt. 2100 m, 16 Aug. 1955, *leg. K. Tatarkiewicz* (LBL); Bula pod Rysami Mt., alt. 1760 m, 29 July 1999, *leg. B. Krzewicka* (KRA); Rysy Mt., alt. 1800 m, 25 Aug. 1924, *leg. J. Motyka* (LBL).

Umbilicaria subglabra (Nyl.) Harm.

(Figs 53, 54, 55, 56)

Lich. France **4**: 707. 1909.

Gyrophora subglabra Nyl., Lich. Environs de Paris: 135. 1896.

Thallus 3–4 cm diam., monophyllous, deeply dissected appearing polyphyllous, irregular in outline, rigid and fragile, with a lacerated and

perforated marginal zone, rarely peripheral lobes distinctly dissected, with blackish, glossy, tumid, and lace-like the edges. Upper side rimose, pale to dark grey, with a white necral layer in central parts; distinctly granular-pruinose, towards the margins smoother; over the umbilicus slightly raised, radially ridged, and undulating. Medulla white. Underside smooth, even, usually wholly sooty black or with paler brown patches and brown marginal zone. Umbilicus short and thick. Rhizines absent. Thallus 120–180 μm thick; upper cortex 10–20 μm; algal layer discontinuous, thick, 40–65 μm; medulla 45–80 μm, well differentiated from the lower cortex; lower cortex 14–24 μm, scleroplectenchymatous. Apothecia leiodisc, rare, not seen in examined material. Pycnidia not observed. Thalloconidia: non-septate, rarely 1-septate, spherical, delicately roughened, dark brown, 7.1 × 7.4 μm (Figs 53, 54). Thalloconidia sometimes cover the underside completely, but more often a 2–4 mm wide brownish peripheral zone is free of thalloconidia.

CHEMISTRY. Gyrophoric acid, small amounts of lecanoric and umbilicaric acids.

NOTE. Within this species, var. *pallens* (Nyl.) Frey was distinguished and later upgraded to a species as *U. pallens* Poelt. The upper side of the thalli of *U. subglabra* and *U. pallens* are very similar, and the species are distinguished by the underside. *Umbilicaria subglabra* has a black underside with thalloconidia, while *U. pallens* has a pale underside without thalloconidia. So far *U. pallens* has not been found in the Tatra Mts and is known only from the Western Alps and Pyrenees, where it occurs in the montane belt. Probably it is more frequent in the mountains of Europe, and further study should resulted in new localities for this species.

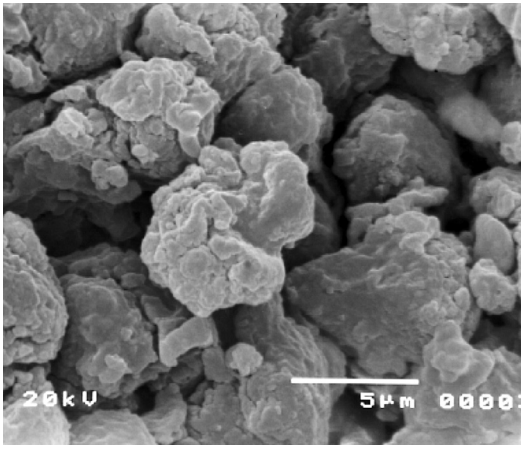


Fig. 53. *Umbilicaria subglabra* (Nyl.) Harm. – non–septate conidia.

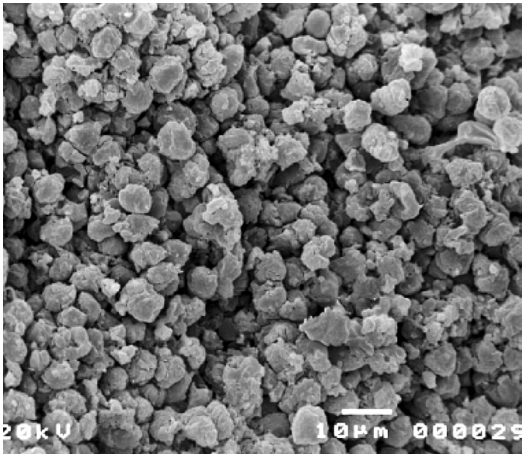


Fig. 54. *Umbilicaria subglabra* (Nyl.) Harm. – thalloconidia on the underside of the thallus.

HABITAT. This species occurs on siliceous rocks, and is found on more inclined (40% of cases) to vertical (40%) surfaces of isolated granite blocks (60%) and small rock walls (40%), where it often forms almost monospecific stations. It grows only in south-facing (70% of cases), sunny, very exposed, moderately sheltered situations (100%). It prefers moist places (80% of cases) in the vicinity of herbal plants surrounding isolated boulders and seems slightly nitrophilous (Fig. 55).

DISTRIBUTION. A high mountain (alpine) species. In Poland it grows exclusively in the High Tatras where it is a very rare species. It is locally abundant, however: one station can have 30–40 specimens. It has been found at three localities in the subalpine belt, and two localities in the lower part

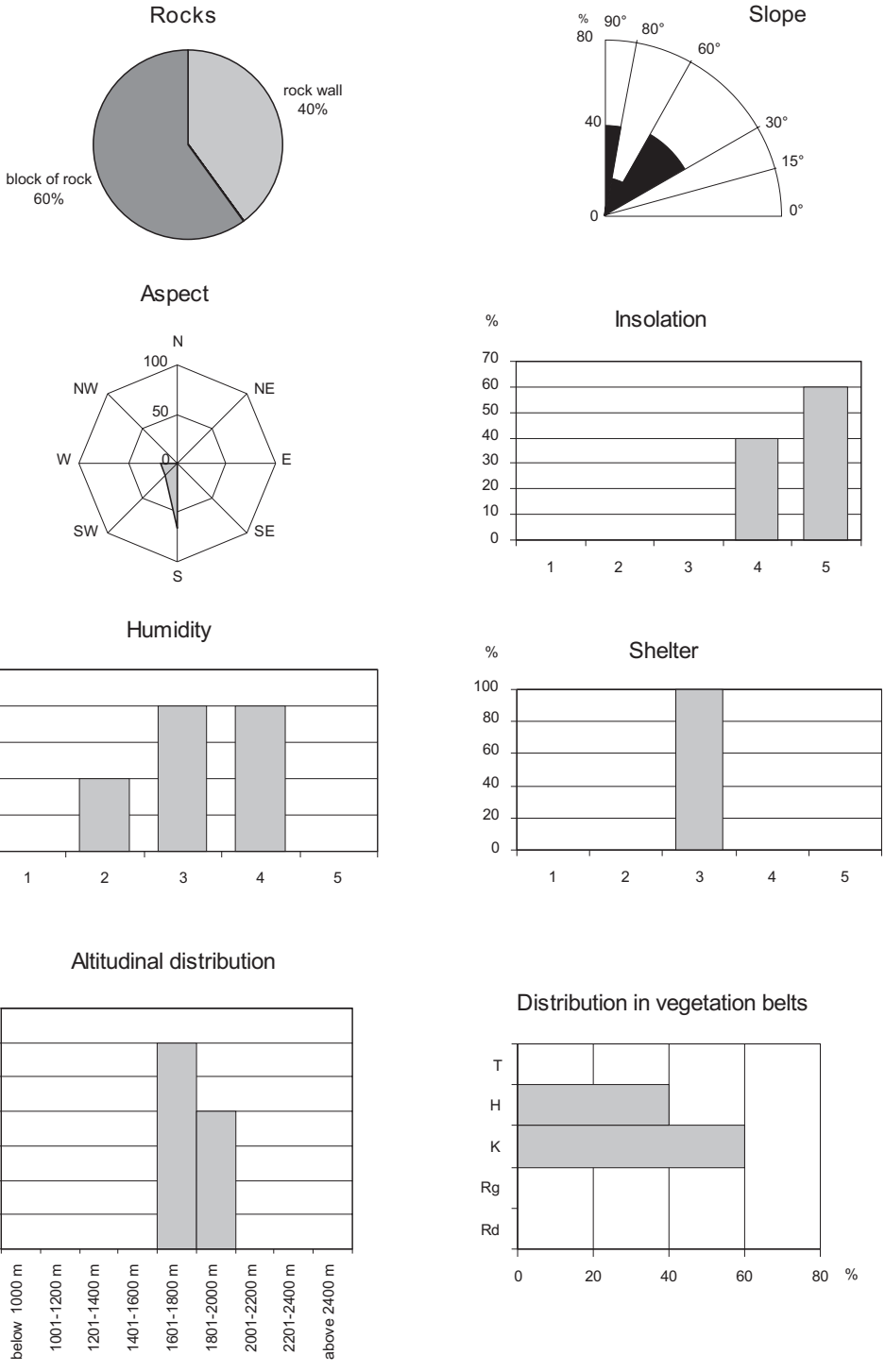


Fig. 55. Ecodiagram for *Umbilicaria subglabra* (Nyl.) Harm. (explanations – see Material and methods).

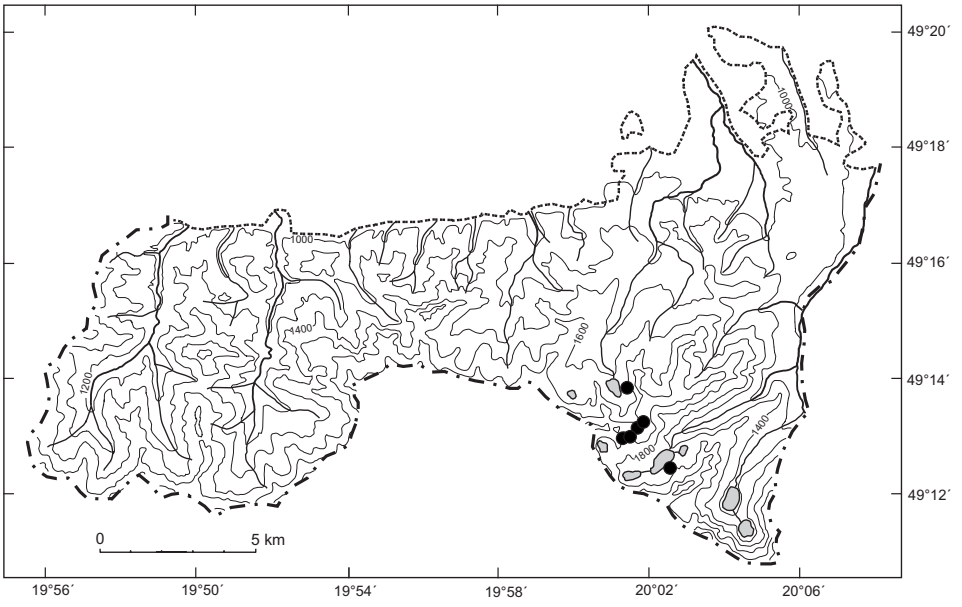


Fig. 56. Distribution map of *Umbilicaria subglabra* (Nyl.) Harm. in the Polish Tatra Mts. ● – locality after 1970.

of the alpine belt (Fig. 55). The lowest locality is Miedziane Kochy Mt. at alt. 1720 m. The highest locality is the Dolinka Pusta valley at 1920 m. It appears to be limited almost entirely to the Dolina Pięciu Stawów Polskich valley, where four of the five localities were found (Fig. 56).

Umbilicaria subglabra occurs in the mountains of Central and Southern Europe (Lisická 1980; Llimona & Hladun 2001) and also in Northern Europe where it is known only from diabase rocks in Sweden (Santesson 1993).

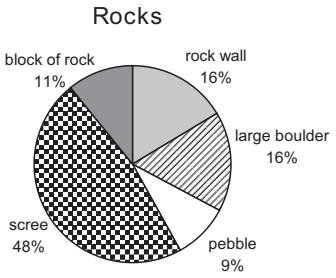
EXSICCATI SEEN. *Krypt. Exs. Vindob. No. 4346* (POZ); Pišút, *Lich. Slovakiae Exs. No. 248* (KRAM, WA); Poelt, *Lich. Alpium No. 43* (POZ); *No. 232* (KRAM, LBL, POZ).

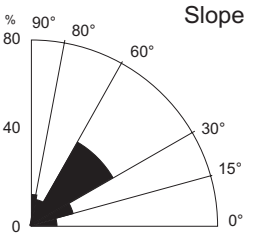
SPECIMENS EXAMINED. Grid square Ge-50 – HIGH TATRA MOUNTAINS: Żółta Igła Mt., alt. 1730 m, 09 July 1999, *leg. B. Krzewicka* (KRA); Ge-60 – HIGH TATRA MOUNTAINS: Dolinka Pusta valley, alt. 1920 m, 22 July 1999, *leg. B. Krzewicka* (KRA); Kozi Wierch Mt., S slope, alt. 1800 m, and 1820 m, 22 July 1999, *leg. B. Krzewicka* (KRA); Miedziane Kochy Mt., alt. 1720 m, 28 July 1999, *leg. B. Krzewicka* (KRA).

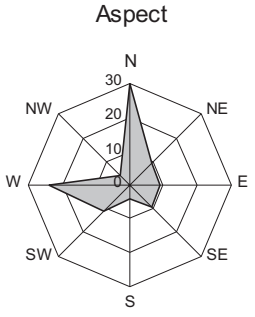
Umbilicaria torrefacta (Lightf.) Schrad.
(Figs 57, 58)

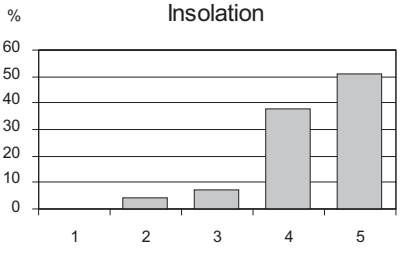
Spicil. Florae Germ. **1**: 104. 1794.
Lichen torrefactus Lightf., Fl. Scotica **2**: 862. 1777. – *Umbilicari erosa* (Weber) Ach., Kgl. Vetensk. Akad. Nya Handl. **15**: 87. 1794. – *Gyrophora torrefacta* Cromb., Monogr. Lich. Brit. **1**: 329. 1894.

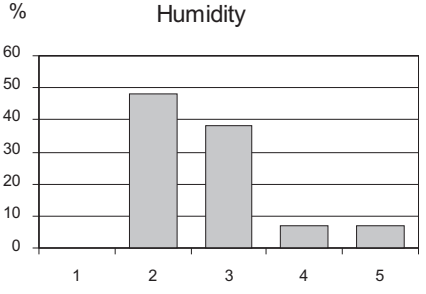
Thallus 6–7(12) cm diam., monophyllous, thick, rigid, irregular in outline, outstretched, ± adhering to substrate, deeply incised, with lacerated and distinctly perforated margins, undulating, the edges often curled under or upward. Upper side uniformly dark brown to coppery-brown, smooth, the umbo slightly raised, with lobed excrescences over it, and with a few radial folds, more even or slightly vermiform-folded towards margins. Medulla white. Underside pale brown to brown, smooth to scabrous, well-developed trabeculae radiating from the umbilicus over the entire underside or becoming ± fimbriate, with sparse or numerous lamellae. Rhizines sparse, simple, cylindrical. Thallus 160–250(320) μm thick; upper cortex 13–20 μm; algal layer con-

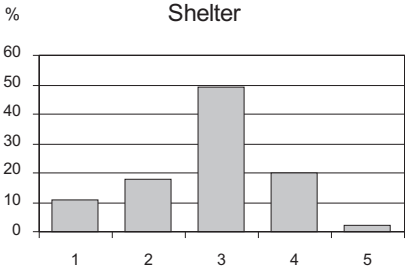


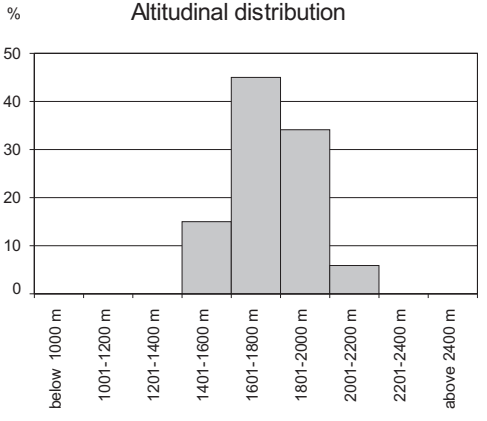












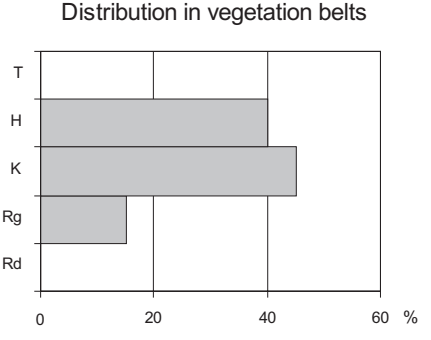


Fig. 57. Ecodiagram for *Umbilicaria torrefacta* (Lightf.) Schrad. (explanations – see Material and methods).

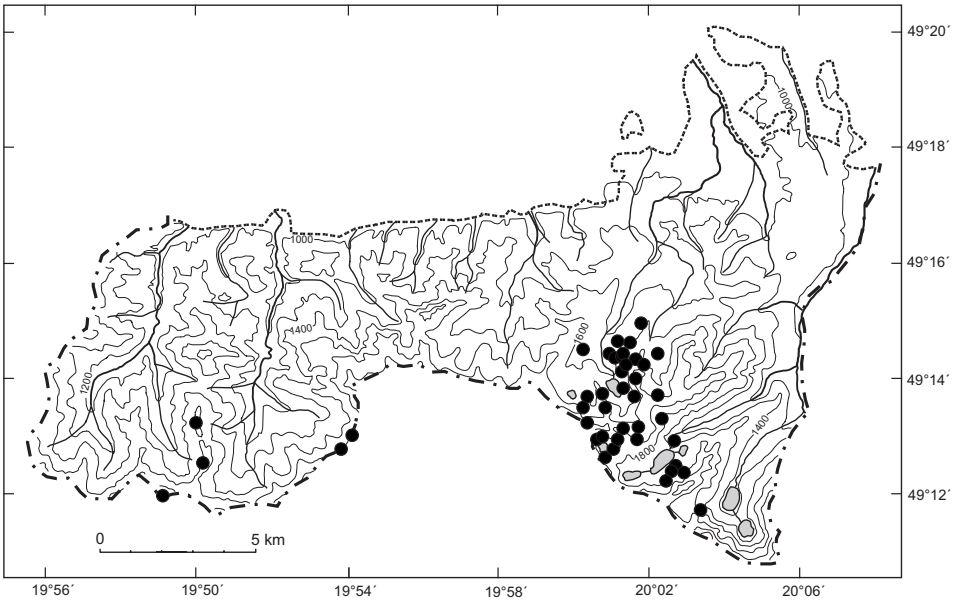


Fig. 58. Distribution map of *Umbilicaria torrefacta* (Lightf.) Schrad. in the Polish Tatra Mts. ● – locality.

tinuous, thick, 50–80 μm; medulla 60–140 μm; lower cortex 30–46 μm, scleroplectenchymatous. Apothecia gyrodisc, common, upper surface except umbo covered, to 3 mm diam., sessile, usually between the ridges, often growing together, round or irregular, star-shaped, disc black, gyrose, the gyri irregular, ascus 45 × 13 μm, asci with 8 simple spores 8–11 × 5–6 μm. Thalloconidia absent.

CHEMISTRY. Gyrophoric and umbilicaric acids.

NOTE. The upper side of the thalli of *U. torrefacta* might be very similar to *U. hyperborea* – dark brown with vermiform ridges. However, these species can be easily distinguished by the underside. *Umbilicaria torrefacta* has numerous pale brown lamellae and trabeculae, while *U. hyperborea* has a bare underside.

HABITAT. This species occurs on siliceous rocks, mainly on huge old granite screes (48% of cases), boulders (16%) and other kinds of substrate such as rock walls (16%) and blocks (11%). It is most frequently found on north (30% of cases) and west (25%) aspects. It prefers sunny (88%), dry (47% of cases), and ± sheltered situations. In the Polish Tatras, most screes occur on slightly inclined north slopes where there is good insolation (Fig. 57).

DISTRIBUTION. This is a mountain (alpine) species. In the Polish Tatras it extends from the higher part of the upper montane belt up to the alpine belt, and appears to have its center of occurrence in the subalpine belt (44% of cases). It is fairly frequent in the lower part of the alpine belt (34% of cases), much less frequent in the upper montane belt (14%), and occasionally (5%) grows in the upper part of the alpine belt (alt. 2000 m to 2200 m) (Fig. 57). The lowest locality is near the Murowaniec hut at 1450 m. The highest localities are on the slope of Mały Kozi Wierch Mt. at 2200 m and Kozi Wierch Mt. at 2200 m. In the High Tatras it is frequent in the area of Żółta Turnia Mt. and the Dolina Pod Kołem valley on huge screes. In the West Tatras it is less frequent and is known from about ten localities (Fig. 58).

In Poland it is known except for the Tatra Mts (Motyka 1924b, 1926, 1927; Tobolewski 1955b,

1957; Bielczyk 1997) from the Sudety Mts where it grows in the Karkonosze Mts (Frey 1933; Tobolewski 1954).

In the Slovakian Tatras it occurs mainly in the High Tatras (Lisická 1980). *Umbilicaria torrefacta* is uncommon both in the Tatras and in other mountains of Central and Southern Europe. Only in Northern Europe it is a very common, such as on Scandinavia and Svalbard (Santesson 1993; Llimona & Hladun 2001). It is known from the mountains of the Iberian Peninsula, France, Germany, the Alps, southern Calabria, the Balkans, the Sudety Mts, and the Carpathians (e.g., Popnikolov & Zhelezova 1964; Lisická 1980; Clauzade & Roux 1985; Murati 1992; Nimis 1993; Scholz 2000; Krzewicka 2002c).

EXSICCATI SEEN. Hansen, *Lich. Groenl. Exs. No. 160* (WA); *No. 240* (WA); *No. 267* (WA); *No. 410* (WA); *No. 444* (WA); Tobolewski, *Lich. Polonica No. 89* (sub. *U. erosa* var. *torrefacta*) (KRA, KRAM, LBL, TRN, WA); Vězda, *Lich. Bohem. Exs. No. 137* (sub. *U. erosa*) (POZ); *No. 138* (sub. *U. erosa* var. *torrefacta*) (POZ).

SPECIMENS EXAMINED. Grid square Gd-59 – WEST TATRA MOUNTAINS: Przełęcz pod Kopą Kondracką pass, 08 Aug. 1926, *leg. J. Motyka* (LBL); Ornak Mt., Aug. 1962, *leg. S. Matuszewska* (LBL), alt. 1700 m, 1750 m, and 1850 m, E slope, alt. 1580 m, 07 Aug. 1999, *leg. B. Krzewicka* (KRA); Gd-68 – WEST TATRA MOUNTAINS: Starobociański Wierch Mt., alt. 2176 m, 07 Aug. 1999, *leg. B. Krzewicka* (KRA); Gd-69 – WEST TATRA MOUNTAINS: Zadni Ornak Mt., alt. 1807 m, 07 Aug. 1999, *leg. B. Krzewicka* (KRA); Suchy Wierch Tomanowy Mt., alt. 1760m, and 1860 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); between Tomanowy Wierch Mt. and Smereczyńska Przełęcz pass, alt. 1900 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); Ge-50 – HIGH TATRA MOUNTAINS: near Murowaniec hut, alt. 1450 m, 01 July 1999, *leg. B. Krzewicka* (KRA); Dolina Pańszczyca valley, alt. 1500 m, 16 Sept. 1955, *leg. Z. Tobolewski* (POZ), Aug. 1962, *leg. S. Matuszewska* (LBL); Mały Kościelec Mt., 19 Aug. 1959, *leg. S. Matuszewska* (LBL), alt. 1820 m, W slope, alt. 1690 m, 1730 m, and 1750 m, 06 July 1999, *leg. B. Krzewicka* (KRA); Kościelec Mt., 07 Aug. 1963, *leg. S. Matuszewska* (LBL), N slope, alt. 1870 m, and 1960 m, 06 July 1999, *leg. B. Krzewicka* (KRA); near Długi Staw lake, alt. 1770 m, 02 July 1999, *leg. B. Krzewicka* (KRA); Żółty Potok stream, alt. 1580 m, 07 July 1999, *leg. B. Krzewicka* (KRA); Żółta Turnia Mt., 10 Aug. 1925, *leg. J. Motyka* (LBL), 13 Aug. 1929, *leg. J. Motyka* (LBL), 16 Sept. 1949, *leg. J. Motyka* (LBL), Sept. 1955, *leg. I. Wojciechowski* (LBL), alt. 1500 m, 16 Sept. 1955, *leg. Z. Tobolewski* (POZ), 25 May 1959, *leg. S. Matuszewska* (LBL), 08 Aug. 1963, *leg. S. Matuszewska* (LBL), N slope, alt. 1980 m, 09 July 1999, *leg. B. Krzewicka* (KRA); Zadni Upłaz Mt., 19 July 1926, *leg. J. Motyka* (KRAM), alt. 1700 m, 12 Oct.1960, *leg. J. Nowak* (KRAM), alt. 1660 m, 07 Aug. 1999, *leg. B. Krzewicka* (KRA); Żółta Igła Mt., alt. 1660 m, and 1700 m, 09 July 1999, *leg. B. Krzewicka* (KRA); near Czarny Staw Gąsienicowy lake, alt. 1570 m, 1650 m, and 1700 m, 12 July 1999, *leg. B. Krzewicka* (KRA); between Świnica and Świnicka Przełęcz pass, alt. 2090 m, 05 July 1999, *leg. B. Krzewicka* (KRA); Mały Kozi Wierch Mt. alt. 2200 m, 22 July 1999, *leg. B. Krzewicka* (KRA); Kozi Wierch Mt., alt. 2200 m, 18 July 1999, *leg. B. Krzewicka* (KRA); Dolina Buczynowa valley, alt. 1770 m, and 1830 m, 19 July 1999, *leg. B. Krzewicka* (KRA); Krzyżne Mt., alt. 1495 m, and 1600 m, 19 July 1999, *leg. B. Krzewicka* (KRA); Ge-60 – WEST TATRA MOUNTAINS: Zadni Piarg scree, alt. 1850 m, 17 July 1999, *leg. B. Krzewicka* (KRA); near Zadni Staw lake, Aug. 1962, *leg. S. Matuszewska* (LBL), alt. 1950 m, 17 July 1999, *leg. B. Krzewicka* (KRA); near Wole Oko lake, alt. 1890 m, 17 July 1999, *leg. B. Krzewicka* (KRA); Dolina Pod Kołem valley, alt. 1900 m, 28 Aug. 1956, *leg. Z. Tobolewski* (POZ); Kołowa Czuba Mt., alt. 1790 m, and 1840 m, 17 July 1999, *leg. B. Krzewicka* (KRA); near Wodospad Siklawa waterfall, alt. 1525 m, and 1650 m, 16 July 1999, *leg. B. Krzewicka* (KRA); near Wielki Staw lake, alt. 1800 m, 21 July 1999, *leg. B. Krzewicka* (KRA); Brzuchaty Piarg scree, alt. 1840 m, 21 July 1999, *leg. B. Krzewicka* (KRA); Miedziany Kostur Mt., N side, alt. 1840 m, 21 July 1999, *leg. B. Krzewicka* (KRA); Hruby Piarg scree, alt. 1800 m, 21 July 1999, *leg. B. Krzewicka* (KRA); Świstowa Czuba Mt., alt. 1685 m, 1690 m, and 1720 m, 20 July 1999, *leg. B. Krzewicka* (KRA); Mnich Mt., alt. 1920 m, 05 Aug. 1999, *leg. B. Krzewicka* (KRA); near Czarny Staw pod Rysami lake, alt. 1650 m, 18 Aug. 2000, *leg. B. Krzewicka* (KRA).

Umbilicaria vellea (L.) Hoffm. (Figs 59, 60, 61)

in Adumbrat. Plant. Lich. **2**: 9.1794.

Lichen velleus L., Sp. Pl.: 1150. 1753. – *Umbilicaria vellea* (L.) Ach., Kgl. Vetensk. Akad. Nya Handl. **15**: 101. 1794. – *Gyrophora vellea* (L.) Ach., Meth. Lich.: 109. 1803.

Thallus 4–5(20) cm diam., mainly monophyllous, rigid, over the umbilicus slightly raised with a few folds, margins entire to incised, edges slightly curled under or upward. Upper side pale brown to greyish violet, dull, smooth to scabrous, distinctly rimose, with dark cracks or bands. Medulla white. Underside black, scabrous, ± trabeculate around umbilicus, with a dense felt of rhizines, absent around the umbilicus, and marginal zone. Rhizines of two length classes: predominantly black short, stout, ball-tipped, and others pale brown to brown, cylindrical, single to bran-

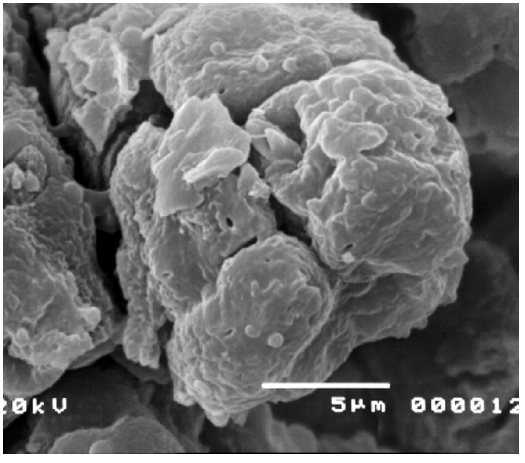


Fig. 59. *Umbilicaria vellea* (L.) Hoffm. – multi–septate conidia.

ched. Umbilicus black and thick. Thallus 200–300(400) µm thick; upper cortex 11–30 µm, palisadeplectenchymatous; algal layer continuous, thick, 50–140 µm; medulla dense, 45–130 µm; lower cortex brown, thick, 20–60 µm, scleroplectenchymatous. Apothecia gyrodisc, rare, not seen in examined material. Pycnidia on the upper side in marginal zone, not numerous. Thalloconidia: multi–septate, 50- to 300-cellular, rarely spherical, smooth, dark brown to black, delicately roughened, 21.9(40.0) × 31.4(60.0) µm (Fig. 59). Thalloconidia on lower cortex and in clusters on rhizines.

CHEMISTRY. Gyrophoric, lecanoric, and umbilicaric acids.

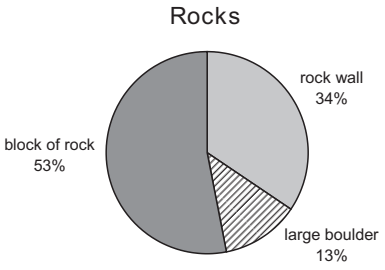
NOTE. This species is distinguished by the presence of two length kinds of rhizines on the underside: brown, long and cylindrical, up to 3–4 mm; and black, short and ball-tipped, up tu 0.5 mm. Damaged herbarium specimens of *U. vellea*, mainly with damaged long rhizines, might be confused with *U. cinereorufescens*.

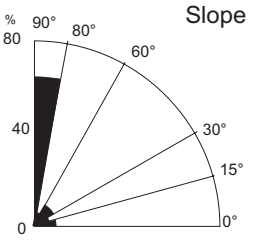
HABITAT. This species occurs on siliceous rocks, on steeply inclined to overhanging surfaces of blocks (53% of cases), and rock walls (34% of cases) with water seepage. It seems to prefer good light (78% of cases), moist to very moist (65% of cases) and sheltered situations (65% of cases), on east (22% of cases), south (18% of cases) and west (25% of cases) aspects (Fig. 60).

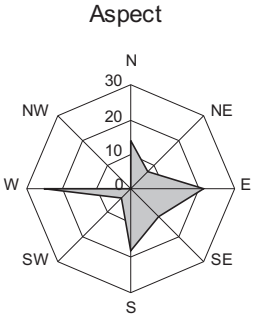
DISTRIBUTION. It is a rare mountain (alpine) species. In the Polish Tatras it extends from the subalpine to the subnival belt. In those areas it is a fairly frequent species, having its main center of distribution (68% of cases) from the lower part of the alpine belt up to the subnival belt (alt. 1600 m to 2000 m) (Fig. 60). The lowest localities are the Niżnie rzędy gully near Krzyżne Mt. at alt. 1730 m, and Żółta Igła Mt. at 1730 m. The highest locality is Mięguszowiecki Szczyt Mt. at 2350 m. It is less frequent in the West Tatras where it occurs at a few scattered localities, and much more frequent in the High Tatras where it is known to occur in the Orla Perć range, Dolina Pięciu Stawów Polskich valley, and Morskie Oko valley (Fig. 61).

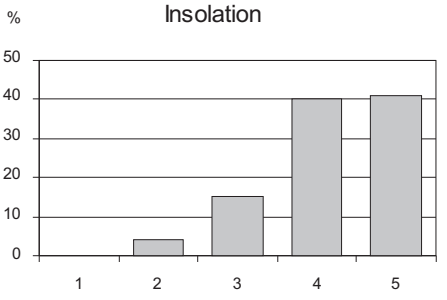
In Poland has been recorded in the Tatra Mts (Rehman 1879; Motyka 1926 1927, 1934; Tobolewski 1955b, 1960a, 1996; Nowak 1975; Bielczyk 1997; Krzewicka & Osyczka 2002b) and the Sudety Mts (Stein 1879; Frey 1933; Krzewicka & Osyczka 2002b) where occurs on a few localities.

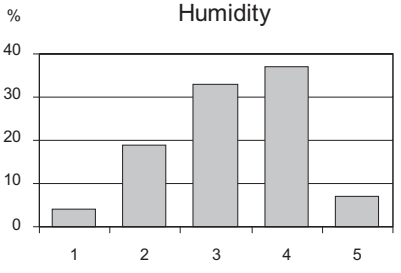
In the Slovakian Tatras it is fairly frequent in the High Tatras and less frequent in the West and Belanské Tatras (Lisická 1980). *Umbilicaria vellea* occurs in the higher mountains of Europe, mainly in the alpine zone. Where it is also known from the mountains of the Iberian Peninsula (Llimona & Hladun 2001), the Alps (Nimis 1993), the mountains of Germany (Scholz 2000) and France

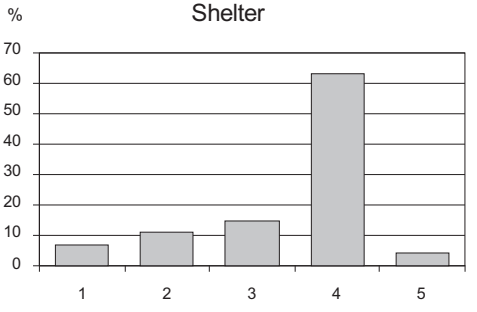


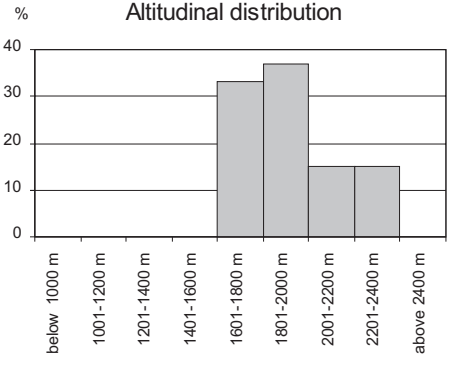












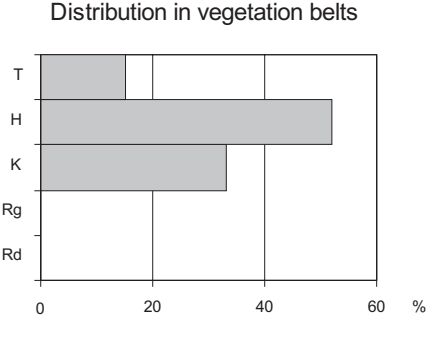


Fig. 60. Ecodiagram for *Umbilicaria vellea* (L.) Hoffm. (explanations – see Material and methods).

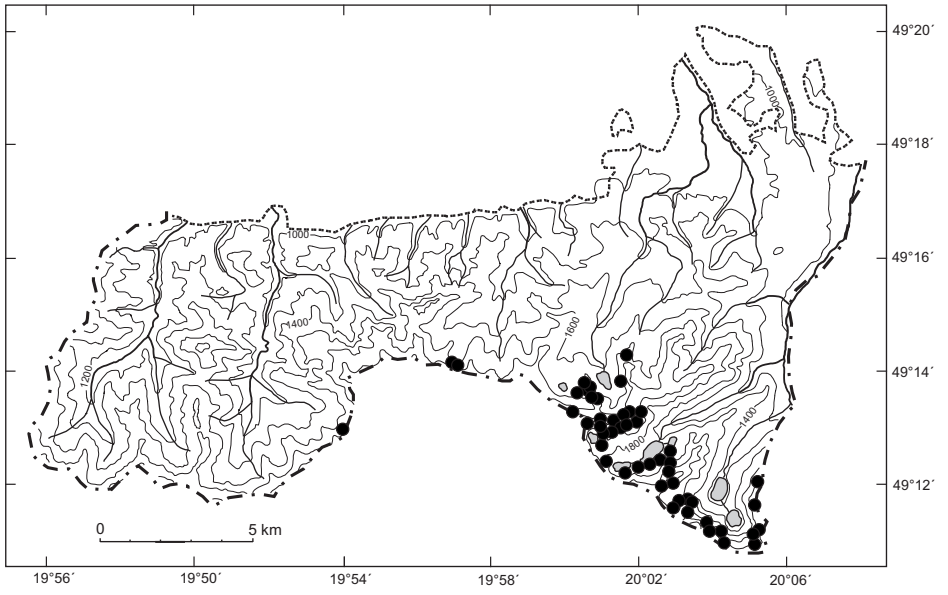


Fig. 61. Distribution map of *Umbilicaria vellea* (L.) Hoffm. in the Polish Tatra Mts. ● – locality.

(Clauzade & Roux 1985), the high Mediterranean mountains of Calabria (Nimis 1993), the Balkans (Popnikolov & Zhelezova 1964; Murati 1992), and also from lower part of Scandinavia and Svalbard (Santesson 1993; Elvebakk & Hertel 1996), the Caucasus and Ural Mts (Golubkova *et al*. 1978).

EXSICCATI SEEN. Hansen, *Lich. Groenl. Exs. No. 14* (WA); *No. 229* (WA); *No. 515* (WA); *Krypt. Exs. Vindob. No. 4244* (POZ); Nowak, *Lich. Pol. Meridi. Exs. No. 151* (LBL); Pišút, *Lich. Slovakiae Exs. No. 90* (WA); Rabenhorst, *Lich. Eur. No. 861* (sub. *Gyrophora vellea*) (KRA); Savicz, *Lich. Rossica No. 61* (sub. *Gyrophora vellea*) (KRAM).

SPECIMENS EXAMINED. Gird square Gd-59 – WEST TATRA MOUNTAINS: Suchy Konracki Wierch Mt., alt. 1800 m, 26 Aug. 1926, *leg. J. Motyka* (LBL); Suche Czuby Mt., 18 June 1986, *leg. V. Alstrup & M. Olech* (KRA); Gd-69 – WEST TATRA MOUNTAINS: Tomanowy Wierch Mt., alt. 1960 m, 5 Aug. 1999, *leg. B. Krzewicka* (KRA); Ge-50 – HIGH TATRA MOUNTAINS: near Czarny Staw Gąsienicowy lake, 16 Sept. 1949, *leg. J. Motyka* (LBL); Mały Kościelec Mt., Aug. 1962, *leg. S. Matuszewska* (LBL); Krab pass, 07 Aug. 1963, *leg. S. Matuszewska* (LBL); Kościelec Mt., 23 Aug. 1926, *leg. J. Motyka* (LBL), alt. 1750 m, 24 June 1954, *leg. Z. Tobolewski* (POZ); Żółta Turnia Mt., 22 Aug. 1929, *leg. J. Motyka* (LBL), 17 Sept. 1949, *leg. J. Motyka* (LBL), Sept. 1955, *leg. I. Wojciechowski* (LBL), Aug. 1959, *leg. S. Matuszewska* (LBL), W slope alt. 1770 m, S slope, alt. 1860 m, 09 July 1999, *leg. B. Krzewicka* (KRA); Dolina Pańszczyca valley, N slope Żółta Turnia, 18 Aug. 1926, *leg. J. Motyka* (KRAM), 10 July 1955, *leg. J. Nowak* (KRAM), 25 May 1963, *leg. J. Nowak* (KRAM); Żółta Igła Mt. alt. 1730 m, 09 July 1999, *leg. B. Krzewicka* (KRA); Zamarła Turnia Mt., S slope,18 Aug. 1928, *leg. K. Wallisch* (LBL); Mały Kozi Wierch Mt., alt. 2228 m, 18 July 1999, *leg. B. Krzewicka* (KRA); Kozia Przełęcz Mt., alt. 2010 m, 18 July 1999, *leg. B. Krzewicka* (KRA); Kozi Wierch Mt., alt. 2200 m, and 2291 m, 18 July 1999, *leg. B. Krzewicka* (KRA); Skrajna Turnia Mt., alt. 1850 m, 16 June 1986, *leg. V. Alstrup & M. Olech* (KRA); Granaty Mt. 03 Aug. 1956, *leg. K. Tatarkiewicz* (LBL), 19 Aug. 1959, *leg. J. Kowalczyk* (LBL); Zmarzłe Czuby Mt., N slope, alt. 2130 m, 16 July 1999, *leg. B. Krzewicka* (KRA); Orla Baszta Mt. near Granaty Mt., alt. 2140 m, 18 July 1999, *leg. B. Krzewicka* (KRA); Dolina Buczynowa valley, alt. 1770 m, 19 July 1999, *leg. B. Krzewicka* (KRA); Niżnie Rzędy gully near Krzyżne Mt., alt. 1730 m, 19 July 1999, *leg. B. Krzewicka* (KRA); Ge-60 – HIGH TATRA MOUNTAINS: Dolina pod Kołem valley, near Zadni Staw lake, Aug. 1962, *leg. S. Matu-*

szewska (LBL); Kołowa Czuba Mt., alt. 1840 m, 16 July 1999, *leg. B. Krzewicka* (KRA); Dolinka Pusta valley, alt. 1920 m, 18 July 1999, *leg. B. Krzewicka* (KRA); Miedziane Mt., SE slope, alt. 2100 m, 06 Aug. 1955, *leg. K. Tatarkiewicz* (LBL); Niedźwiedź rock near Czarney Staw Polski lake, SE slope, alt. 1800 m, 21 July 1999, *leg. B. Krzewicka* (KRA); Niżni Liptowski Kostur Mt. near Czarny Staw Polski lake, NW slope, alt. 1820 m, 21 July 1999, *leg. B. Krzewicka* (KRA); Kotelnica Mt. E slope, alt. 1800 m, 19 July 1999, *leg. B. Krzewicka* (KRA); Szpiglasowa Przełęcz pass, alt. 1920 m, 20 July 1999, *leg. B. Krzewicka* (KRA); Wrota Chałubińskiego pass, NE slope, alt. 1800 m, and 1870 m, 28 July 1999, *leg. B. Krzewicka* (KRA); Mnich Mt., alt. 2000 m, 16 Sept. 1955, *leg. K. Tatarkiewicz* (LBL), NE slope, alt. 1780 m, and 1830 m, 16 Aug. 2000, *leg. B. Krzewicka* (KRA); Mniszek Mt. near Mnich Mt., alt. 2040 m, 26 July 1956, *leg. K. Tatarkiewicz* (LBL); Cubryna Mt., 1926, *leg. K. Wallisch* (LBL); Przełęcz Pod Chłopkiem pass, alt. 2320 m, 17 Aug. 2000, *leg. B. Krzewicka* (KRA); Kazalnica Mt., N slope, alt. 1980 m, 17 Aug. 2000, *leg. B. Krzewicka* (KRA); Pośredni Mięguszowiecki Szczyt Mt., alt. 2390 m, 17 Aug. 2000, *leg. B. Krzewicka* (KRA); Mięguszowiecki Szczyt Mt., Aug. 1927, *leg. K. Wallisch* (LBL), alt. 2350 m, 22 Aug. 1955, *leg. K. Tatarkiewicz* (LBL), Aug. 1959, *leg. S. Matuszewska* (LBL); Żabi Mnich Mt., alt. 2000 m, and 2100 m, 18 Aug. 1955, *leg. K. Tatarkiewicz* (LBL); Niżni Żabi Szczyt Mt., alt. 2000 m, 19 Aug. 1955, *leg. K. Tatarkiewicz* (LBL); Żabia Czuba Mt., alt. 2000 m, 18 Aug. 1955, *leg. K. Tatarkiewicz* (LBL); Bula pod Rysami Mt., alt. 1760 m, 29 July 1999, *leg. B. Krzewicka* (KRA); Rysy Mt., alt. 2100 m, 06 Aug. 1927, *leg. J. Motyka* (LBL).

ECOLOGY

The studied lichens of the genera *Umbilicaria* and *Lasallia* occur exclusively on crystalline substrate (100% of cases). The absence of acidic substrates, such as granite, quartzite, is one of the most important factors limiting the occurrence of these organisms in the Polish Tatra Mts.

The second most important factor is an insolation. These lichens are photophilous, preferring sites with moderate or intense insolation (80% of all cases) (Fig. 62, Insolation). They do not occur in forested and shaded sites despite the presence of granite substrates.

Another important factor limiting the occurrence of *Umbilicaria* species is the slope of the substrate (Fig. 62, Slope). Certain preferences for sites of different steepness can be observed. The following categories of species can be distinguished:

1) occurring principally on vertical or at least partly vertical surfaces (90–60°) – *U. aprina, U. cinerascens, U. cinereorufescens, U. crustulosa, U. decussata, U. hirsuta, U. laevis, U. leiocarpa, U. proboscidea* and *U. vellea*;

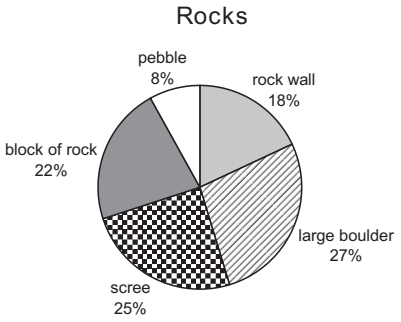
2) occurring on moderately steep surfaces (60–15°) – *U. hyperborea, U. torrefacta*;

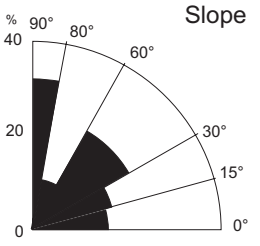
3) occurring on horizontal surfaces (15–0°) – *U. deusta*;

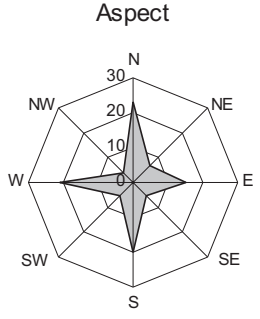
4) without special preferences, occurring on surfaces of varying steepness – *U. cylindrica, U. nylanderiana, U. subglabra, U. polyphylla*.

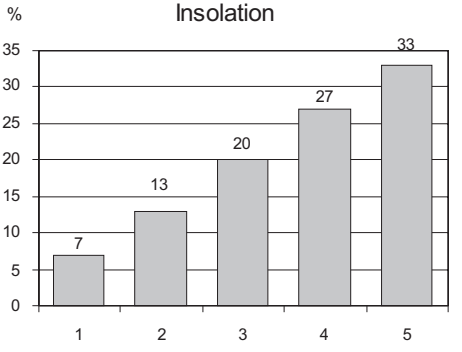
The highest number of taxa (10 species) belongs to the first group occurring on vertical surfaces. It might be expected, that the highest number of stations be recorded on this category of surface (33% of stations on 90–80° slopes and 10% of stations on 80–60° slopes – in total – 43% of all stations). The second group, including species that grow on moderately steep slopes (60–30° and 30–15° ranges), covers as many as 37% of the stations and two species were classified there. It is worthy to being mentioned here, that the taxa belonging to the second group are considerately common compare to the species of the previous group. Only one species was observed as preferring horizontal surfaces (16% of stations on 0–15° slopes).

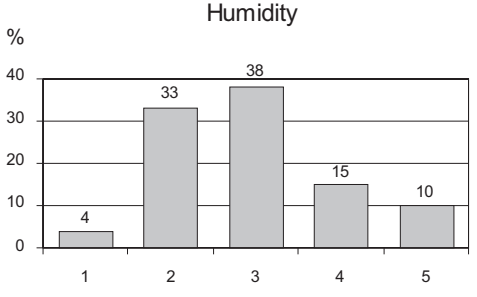
Another analyzed factor was the form of substrate, that is, whether there was any preference for colonizing boulders, rock blocks, vertical rock walls, screes and pebbles. It was found that the studied lichens most often grew on large rock boulders (27% of all cases), and only less frequently on screes (25% of all cases) and block of rocks (22% of all cases) (Fig. 62, Rocks). While the least frequent locations were on stones of mountain meadows – pebbles (8% all of cases). Most of the *Umbilicaria* species in this study are associated with one or two types of substrate forms. For example, *U. aprina, U. cinereorufescens,*

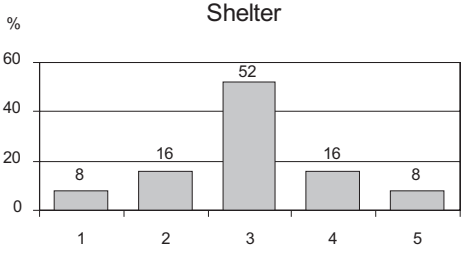


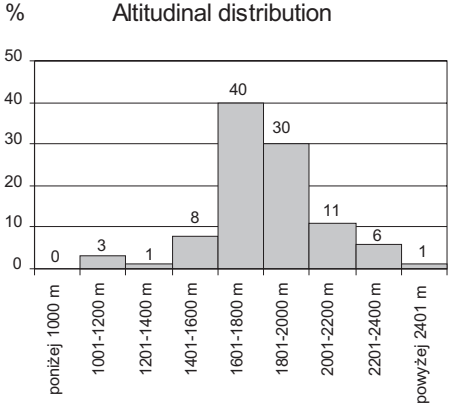












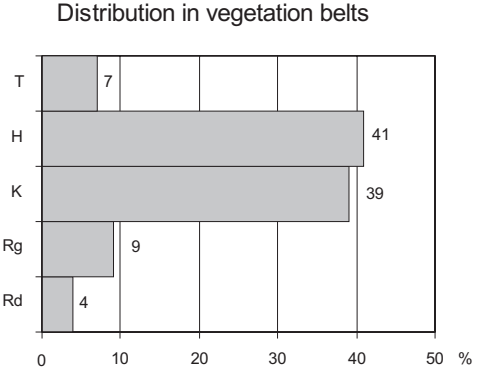


Fig. 62. Comprehensive ecodiagram for *Umbilicaria* ssp. (explanations – see Material and methods).

U. hirsuta, U. subglabra and *U. vellea* occurred mainly on rock walls (18% of cases of the species) and rock blocks (22% of cases of the species). *Umbilicaria cinerascens, U. crustulosa, U. decussata, U. laevis* and *U. leiocarpa* occurred frequently on rock blocks (22% of cases of the species) and large boulders (27% of cases of the species) (Fig. 62). Species occurring mostly on screes are *U. hyperborea* (69% of cases the species) (Fig. 29) and *U. torrefacta* (48% of cases the species) (Fig. 57). Apart from these two species, *U. cylindrica* (39% of cases the species), *U. deusta* (30% of cases the species) and *U. polyphylla* (15% of cases the species) also occurred on screes but not so frequently. Only *U. deusta* and *U. polyphylla* occurred on all five types of substrate in the study area (Figs 24, 46).

The aspect of the slopes is of secondary importance concerning occurrence of particular species (Fig. 62, Aspect). In the Tatras on moderately steep slopes facing north, insolation is still sufficient, thus most of the *Umbilicaria* species were recorded there with similar frequencies compare to the other aspects. For example, on north aspect as many as 25% of all cases were recorded, on south aspect 20%, and on west aspect 22%. Some species, such as *U. decussata* (56% of cases the species) and *U. subglabra* (72% of cases the species) prefer one kind of aspect – south (Figs 22, 55). Another example is *U. leiocarpa* prefers north slopes facing (40%) and west slopes facing (28% of cases the species) (Fig. 37).

Another habitat preferences of these lichens were humidity. The *Umbilicaria* species were recorded in places with various degree of humidity; on dry and very dry places (37% of cases), moderately moist (38%) and moist places (15%), lichens associated with very moist places were infrequent (10%) (Fig. 62, Humidity). The examples of species occurring in dry and very dry places are *U. hyperborea* (*ca* 85% of cases of the species) and *U. torrefacta* (ca 50% of cases of the species); *U. vellea* (*ca* 45% of cases of the species) is an example of the taxon occurring in moist places (Figs 29, 57, 60).

The *Umbilicaria* species were found mainly in places moderately sheltered from wind (3 degree) (52% of all cases) (Fig. 62, Shelter). However, some species preferred different degrees of shelter. For example, *U. leiocarpa* is associated with windy and very windy habitats (75% of cases of the species) (Fig. 37), and *U. vellea* is connected with shelter and very shelter habitats (65% of cases of the species) (Fig. 60).

DISTRIBUTION

GENERAL DISTRIBUTION

21 species of *Lasallia* and *Umbilicaria* occur in the whole Polish Tatra Mts. In the High Tatras, 20 taxa were found (one species of *Lasallia* and 19 species of *Umbilicaria*); in the West Tatras, 11 species of the genus *Umbilicaria* were found (Fig. 63). *Umbilicaria polyrrhiza* is the only species recorded from the West Tatras but not occurring in the High Tatras.

In the horizontal distribution of the studied lichens there is a notable concentration of stations in the High Tatra Mts (85% of cases) (Fig. 64). This is associated with the distribution of rocks of crystalline origin. In this part of the Tatra Mts, crystalline rocks form many granite ridges, vertical walls, boulders and rock debris, providing a diversity of habitat sites for these lichens. The list of species occurring solely in this part of the Tatra Mts includes *L. pustulata*, *U. aprina*,

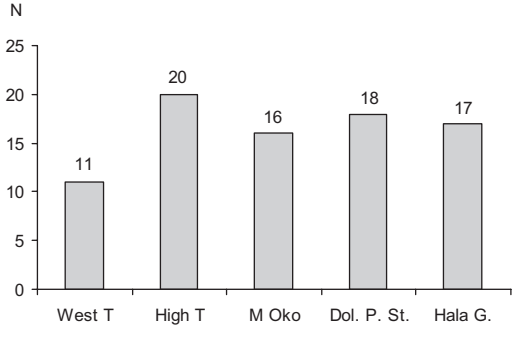


Fig. 63. Diversity of *Umbilicaria* species in different parts of the Polish Tatra Mts. West T – West Tatras, High T – High Tatras, M Oko – Morskie Oko valley, Dol. P. St. – Dolina Pięciu Stawów Polskich valley, Hala G. – Hala Gąsienicowa, N – number of taxa.

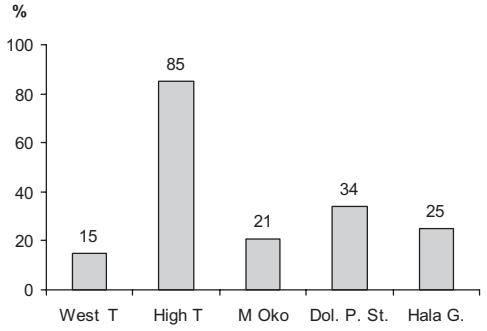


Fig. 64. Percental share of localities of lichens of the genus *Umbilicaria* in the Polish Tatra Mts: West T – West Tatras, High T – High Tatras, M Oko – Morskie Oko valley, Dol. P. St. – Dolina Pięciu Stawów Polskich valley, Hala G. – Hala Gąsienicowa.

U. cinerascens, *U. cinereorufescens*, *U. decussata*, *U. grisea*, *U. laevis*, *U. leiocarpa*, *U. microphylla* and *U. subglabra.* The stations of the species under study in the High Tatra Mts are concentrated around the high ranges in three naturally distinct regions: the Morskie Oko valley (16 species), the Dolina Pięciu Stawów valley (18 species) and the area of the Hala Gąsienicowa alpine meadow (17 species) (Fig. 63). Thus the various parts of the High Tatra support similar numbers of species. However, when the number of stations of lichens in the Tatra Mts is considered instead of the number of taxa, the percentage shares vary between the different regions. Lichens of the genus *Umbilicaria* occur most often in the Dolina Pięciu Stawów valley, where *ca* 34% of the total number of stations were found; only 25% of the stations were in the area of the Gąsienicowa Hala alpine meadow, and only *ca* 21% in the Morskie Oko valley (Fig. 64).

Despite the significant number of species in the West Tatra Mts (as many as 11 taxa), the frequency of their stations is not high – only some 15% of the total number of recorded stations (Fig. 64). This is due mainly to the dearth of crystalline rock substrate in the West Tatra Mts. In this part of the Tatras, acidic rock substrate occurs on only a few outcrops of granite rocks, on hiking trails, and as granite stones and boulders in meadows and glades. In the West Tatra Mts, lichens of the genus *Umbilicaria* occur mostly on the ridge along the national border where they grow on natural granite outcrops and on anthropogenic substrates of granite-paved hiking trails. They are also fairly often found on Ornak Mt. on huge granite boulders. Less commonly these lichens colonize stones and boulders in forest glades. Such species as *U. cylindrica*, *U. deusta* and *U. polphylla* can also be found on large granite stones in riverbeds.

ALTITUDINAL DISTRIBUTION

Among the treated species, high-mountain species predominate, having their centers of distribution in the subalpine and alpine zones. Of the 21 taxa studied, as many as 19 were found in the subalpine zone and 18 in the alpine zone (Fig. 65). A high mountain species occurring solely in the highest parts of the Tatra Mts is *U. aprina*. It does not descend below the alpine zone and its center of distribution is in the subnival zone. The general mountain species are *U. cylindrica, U. crustulosa, U. deusta* and *U. polyphylla*. These lichens were recorded in all the altitudinal vegetation zones. The low frequency of their stations in the higher and lower montane zones is probably due to the low number of suitable habitats. The vertical distribution of species and particularly of *U. cylindrica* and *U. deusta* largely corresponds with the occurrence of open and well- insolated spaces such as forest glades. The shade of dense forest canopy

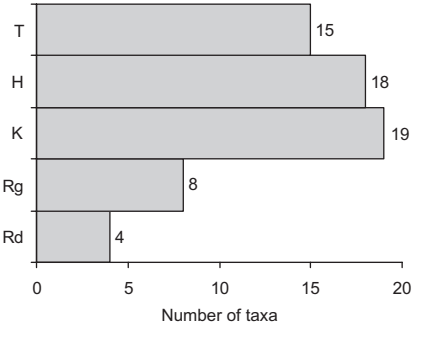


Fig. 65. Numbers of *Umbilicaria* species occurring in particular vegetation belts in the Polish Tatra Mts. Rd – lower montane belt, Rg – upper montane belt, K – subalpine belt, H – alpine belt, T – subnival belt.

in the upper and lower montane zones precludes the occurrence of these lichens altogether. Of the remaining four species occurring also in the upper montane forest zone, only *U. nylanderiana* seems to occur sporadically, while such species as *U. cinereorufescens, U. hyperborea* and *U. torrefacta* occur there more frequently (*ca* 15% of their stations were recorded in this zone).

Of the total number of all the stations with lichens of the genus *Umbilicaria* recorded during the field study, the largest number of stations was recorded in the alpine zone (*ca* 41%) and only somewhat fewer in the subalpine zone (39%) (Fig. 66). In all, 80% of the stations were found in these two zones. In the lower montane zone only 4% of the stations were recorded, in the upper montane zone 9%, and in the subnival zone 7%. The low number of stations in the subnival zone contrasts with the rich species composition (15 taxa) in this small zone (this zone covers only *ca* 0.3% of the total area of the Polish Tatra Mts).

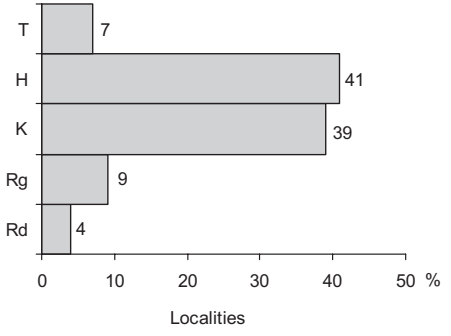


Fig. 66. Percental share of localities of lichens of the genus *Umbilicaria* occurring in particular vegetation belts in the Polish Tatra Mts. Rd – lower montane belt, Rg – upper montane belt, K – subalpine belt, H – alpine belt, T – subnival belt.

FREQUENCY

Among the lichens treated in this study, only *Umbilicaria cylindrica* and *U. deusta* can be termed a very common species in the Polish Tatra Mts (Figs 19, 25). These lichens grow in all available habitats from the foot of the mountains up to the highest summits. These species were found on more than one hundred localities in the area studied. *Umbilicaria cylindrica* and *U. deusta* are also the only species of the genus *Umbilicaria* found on both natural and anthropogenic substrates (rocks on hiking trails). Slightly less frequent but also relatively common are species such as *U. crustulosa* and *U. polyphylla* (Figs 17, 47). The taxa, which occurred on more than 50 but less than 100 localities, were classified to this group. The next category of frequency is the species recorded at 30–50 localities. There is only one species – *U. torrefacta* belonging to this group. The species is only locally frequent. It occurs in large number on a small area in the High Tatras from alt. 1600 m to 2000 m (Figs 57, 58). The most numerous group includes species of scattered distribution (33% of cases; six taxa) (Fig. 67). The species were recorded at 11 to 29 stations and these are: *U. hirsuta, U. hyperborea, U. laevis, U. leiocarpa*, *U. nylanderiana* and *U. vellea*. The number of rare and very rare species is also relatively high (28% and 11% sub consequently). Those groups include *U. aprina, U. cinerascens, U. cinereorufescens, U. grisea, U. proboscidea* and *U. subglabra*. They were found at only a few stations in the Polish Tatra Mts.

The studied lichens occur mainly in the higher part of the mountains, where they grow at many scattered stations, most often as small populations.

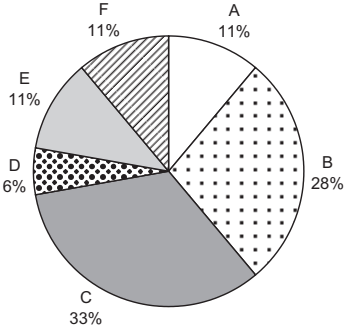


Fig. 67. Frequency of occurrence of *Umbilicaria* species in the Polish Tatra Mts. A – very rare species (1–3 localities), B – rare species (4–10 localities), C – species scattered of distribution (11–29 localities), D – frequent species (30–50 localities), E – common species (51–100 localities), F – very common species (more than 100 localities).

The *Umbilicaria* species in the Polish Tatra Mts are mostly very rare, rare or scattered. To those three categories of frequency belong as many as 12 species – 72% of all species found during field studies (Fig. 67). The frequency of species which were not found during the last fieldwork (*Lasallia pustulata, U. microphylla*, and *U. polyrrhiza*) was not analyzed.

Dynamics

The dynamics of the lichen distribution in the study area could be tracked thanks to historical materials, most of all the collections of Matuszewska (LBL herbarium). Matuszewska carried out fieldwork on the distribution of the genus *Umbilicaria* in the Tatra Mts in 1959–1963. Although the studies were not accomplished they resulted in the significant collection from almost the whole Polish Tatra Mts. The richness of herbarium materials gathered by Matuszewska testifies to the comprehensiveness of her fieldwork. Due to this fact the historical data could be compare with current ones in order to track the change in the distribution ranges of particular *Umbilicaria* species in the Polish Tatra Mts.

Species nearly extinct from the area and disappearing species

The species that could not be found in the area of the Polish Tatra Mts in spite of recent detailed field studies are *Lasallia pustulata, Umbilicaria microphylla* and *U. polyrrhiza*. Each of them was originally reported from the area from only a single station almost 50 years ago. These are likely to be declared extinct from the area and they are regarded as nearly extinct in this treatment. The species with significantly decreased numbers of sites include *U. cinerascens, U. grisea* and *U. proboscidea*. These lichens have been reported from a few stations before, and ever fewer in recent times. These species are considered as disappearing taxa. The distribution pattern of species that are nearly extinct or disappearing in the Polish Tatra Mts are illustrated on the maps, incorporating both historical (to 1970) and current (mainly from 1998–2001) data on their occurrence (Figs 4, 12, 26, 39, 50, 52).

Locally spreading up species

The locally expanding species include lichens reported currently from a higher number of stations than during previous investigations. The species, which number of stations increased significantly in the study area is *U. torrefacta* (Fig. 58). It was annotated in herbarium material as very rare, but recently a large population of this species has been found in the Hala Gąsienicowa area. These are well-developed thalli without any symptoms of degeneration, in various stages of development. This may signify recent growth of population and local expansion. *Umbilicaria cylindrica* and *U. deusta* possibly have increased their distribution ranges as well (Figs 19, 25). Among the studied lichen species, *U. cylindrica* has the widest distribution in the Polish Tatra Mts. It occurs at many stations in the High Tatras and at scattered stations in the West Tatras. This lichen occupies practically every place available to this species, on silicate substrates in open and insolated places. Only somewhat less common is *U. deusta*, which is found at slightly fewer stations in the High Tatras and occurs with the same frequency as *U. cylindrica* in the West Tatras. These lichens are also the only ones to occur on the anthropogenic substrates of granite-paved hiking trails. The historical material does not contain any data on findings of these species on this kind of substrate. Probably this occurrence was not as common then as it is now. By colonizing anthropogenic substrate, these species have extended their distribution ranges, particularly in the West Tatra Mts, which is very short of natural sites for this group of lichens.

Neutral species

Lichens not significantly impacted by changes of the conditions of the surrounding environment are considered neutral species. Thus, both number of stations occupied by these species and their populations' size should not fluctuate much with time. Based on known historical localities of *Umbilicaria* species, it may be presumed that all other *Umbilicaria* species occurring in the Tatras and not

discussed above should belong to this category of species. Their number of stations remained stable during the last decades, although certain stations become extinct while new ones emerge. However, because of the overall low number of stations of these species it is difficult to establish whether their populations will maintain stable in future. In case of rare species even minor changes of environment conditions can entail dramatic consequences. For this reason only two the most frequent species (*U. crustulosa* and *U. polyphylla*) can be deemed neutral and, with due reservations, all the other species might be considered rather as disappearing lichens.

CONCLUSIONS

Lichens belonging to the genera *Lasallia* and *Umbilicaria* are rare and very rare species in Poland, because they are mainly arctic-alpine species, growing primarily at the highest mountain locations. In Poland the main center of their occurrence is the Tatra Mts. All species of *Umbilicaria* found in Poland occur in the Polish Tatras, except for the taxon *U. dendrophora* (Poelt) Hestmark, which occurs exclusively in the Karkonosze Mts, and was found at only one locality there – at Zakręt Śmierci (Seaward *et al*. 1981; Topham *et al*. 1982).

This research on *Lasallia* and *Umbilicaria* in the Polish Tatra Mts provided an opportunity to summarize the knowledge about those organisms for that area. The field studies and revision of the herbarium material yielded many new findings and important facts. The project resulted in the comprehensive treatment of the group of taxa for the Polish Tatra Mts.

In the Tatra Mts the presence of one species of the genus *Lasallia* and 20 species of the genus *Umbilicaria* were reported. Detailed site surveys led to the discovery of a new species for the Carpathians, *U. aprina* (Fig. 8). The first localities of *U. subglabra* in the Polish Tatra Mts were recorded (Fig. 56). Previously this species was known from the Slovakian Tatra Mts. Revision of herbarium materials indicated that *U. arctica* was mistakenly reported from the Polish Tatras. Motyka (1964) reported the taxon as discovered by Matuszewska on the summit of Mięguszowiecki Szczyt Mt., but specimens from this particular locality were not found in the herbarium collections. The only specimens of the herbarium material from the Tatra Mts and identified as *U. arctica*, actually were recognized as two other species: *U. cylindrica* and *U. crustulosa*. Three taxa previously collected from the area (*Lasallia pustulata*, *Umbilicaria microphylla*, *U. polyrrhiza*) were not confirmed as occurring presently.

The study in Polish Tatra Mts made it possible: to evaluate species diversity within the genera studied, to compile distribution patterns for all taxa, to assess the habitat preferences of particular species, and to indicate degrees of threat. It also allowed a better understanding of their morphology. As a result an up-to-date key for taxa determination based on the most significant and distinct characters is offered. Some newly discovered diagnostic characters, such as thalloconidia in *U. laevis*, were used to compile detailed, current descriptions of taxa.

The research showed that the presence of these lichens is associated with the distribution of rocks of crystalline origin. In their horizontal distribution there is a notable concentration of stations in the High Tatra Mts (85% of cases) (Fig. 64). These lichens were recorded in all the altitudinal vegetation zones, but the largest number of stations was recorded in the alpine zone (*ca* 41%) and only somewhat fewer in the subalpine zone (39%) (Fig. 66). There were as many as 19 species recorded in the subalpine and 18 species in alpine belts (Fig. 65). The high number of species was also recorded in subnival belt (15 species) but they covered only 7% of all localities. The center of distribution for *Umbilicaria* species in the Tatras (and in Poland) is in the High Tatras in the subalpine and alpine belts (Fig. 62).

Although *Umbilicaria* are relatively frequent lichens in the Tatra Mts, only two species can be ranked as very common in the area (*U. cylindrica, U. deusta*) (Figs 19, 25), and two other are common species (*U. crustulosa, U. polyphylla*) (Figs 17, 47). All other taxa were found to be much less

frequent to rare and very rare, occurring in a few or simple scattered localities (Fig. 67).

Because *Lasallia* and *Umbilicaria* are very rare taxa on the national scale and often grow in the Tatra Mts at a few localities only, they deserve special conservation. In spite of this the lichens are not legally protected in Poland. They are indirectly protected by their occurrence in a national park, but this form of protection seems insufficient in the case of some species. For example, three *Umbilicaria* species previously known from the region were not found (*L. pustulata U. microphylla* and *U. polyrrhiza*) (Figs 4, 39, 50); they probably have become extinct in this area. Another example is *U. proboscidea*, recorded at numerous localities along marked hiking trails 50 years ago but nowadays found at only a few localities, in places difficult to reach and far away from trails (Fig. 52).

To protect the natural resources of *Umbilicaria* spp. diversity in the Tatra National Park, one of the most interesting places in Poland in terms of natural values, long-term monitoring of endangered taxa localities is recommended, especially in areas most at risk.

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