

**Bryophytes of the Olkusz Ore-bearing Region
(southern Poland)**



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Abstract. In 2008–2014 bryological investigations were carried out in the Olkusz Ore-bearing Region. Considering literature data, 19 species and 1 variety of liverwort and 171 species and 2 varieties of moss are known from this area, which accounts for about 24.3% of the total muscoflora and 7.6% hepaticoflora of Poland. Over half this number constitute very rare (50.9%) or rare (18.3%) species, whereas common species contribute 6.5% of the total flora. The largest habitat group is represented by epigean taxa (70.0%), followed by epilithic (18.2%), epiphytic and paludicolous (both 17.6%), epixylic (16.5%), and aquatic (4.7%). In this paper the main features of the moss flora of the Olkusz Ore-bearing Region are given. Protected and threatened species are briefly discussed. Three species, namely *Philonotis arnellii* Husn., *Poblia lescuriana* (Sull.) Ochi and *Rhytidiadelphus subpinnatus* (Lindb.) T.J.Kop. are recorded for the first time in the Silesian Upland.

Key words. Bryophytes, mosses, liverworts, protected species, threatened species, Olkusz Ore-bearing region, Silesian Upland, Poland

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Introduction

The bryophyte floras of industrialised areas have been the subjects of investigations both in Poland (Jędrzejko, 1985, 1990; Stebel, 1997) and in other European countries, for example in the Czech Republic (Duda, 1989a, b) and Germany (Düll, 1980). Extensive human impact results in impoverishment of the bryofloras which become dominated by common hemerophilous species. Some less common mosses appear well adapted to such conditions and spread throughout industrialised areas. The best examples are species which frequently grow in degenerated forests surrounding urban-industrial complexes in Upper Silesia, for example *Orthodicranum tauricum* (Stebel *et al.*, 2012) and *Callicladium baldanianum* (Stebel, 2013).

Ore-bearing areas are an interesting field of study from the point of view of human impact on the moss flora. Zinc and lead ores have been dredged for centuries, since at least medieval times, leading to significant changes in the natural environment. In Poland, zinc and lead ores were mined in a few places in the Silesian-Cracow Highland. Most were exhausted or mining became unviable. Currently, the only mining site is an area called Olkusz Ore-bearing Region.

The bryofloras of ore-bearing areas remain poorly studied and only occasionally some rare species occurring in such places have been reported. The present treatment provides a summary of information concerning the bryophyte flora and its changes in the Olkusz

Ore-bearing Region which is situated in the easternmost part of the Silesian Upland in southern Poland.

This treatment is based on the field work carried out under the project PL0265 “Vegetation of calamine soils and its importance for biodiversity and landscape conservation in post-mining areas”. It gained a financial support by a grant from Iceland, Lichtenstein and Norway through the Financial Mechanism of the European Economic Area and, partly, through the statutory fund of the W. Szafer Institute of Botany of the Polish Academy of Sciences.

The scientific results of this project have been described in one monograph, 13 research papers and 15 popular articles. The participants of the project presented them on numerous scientific congresses, conferences and workshops and altogether no fewer than 41 abstracts devoted to various aspects of botanical research carried out within this project are available (Grodzińska & Godzik, 2015). Moreover, the scientific results have been recently summarised in a monograph dealing with natural and historical values of the Olkusz Ore-bearing Region (Godzik, 2015a). This extensive treatment presents a detailed characterisation of the Olkusz Ore-bearing Region, with particular reference to its landscape features related to mining and metalurgy (Godzik, 2015b; Woch, 2015) and history of mining (Godzik & Woch, 2015). It comprises also a detailed description of the vegetation

(Holeksa *et al.*, 2015) and main groups of organisms, including vascular plants (Nowak *et al.*, 2015), bryophytes (Ochyra & Godzik, 2015), lichens (Bielczyk, 2015) and macroscopic fungi (Mleczko & Beszczyńska, 2015). Moreover, some detailed topics have also been included in this monograph, including growth dynamics of Scots pine (Zielonka *et al.*, 2015), physiochemical and biological properties of soils in the dominant types of plant communities (Kapusta *et al.*, 2015) and impact of soil physicochemical properties and vegetation on soil microorganisms (Stefanowicz, 2015). In addition, another major work provides a survey of the vascular plants (Nowak *et al.*, 2011) and the present account is devoted to the bryophyte flora of this region.

We are grateful to Professor Rod D. Seppelt, Hobart, Tasmania and Mr Arthur

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Study area

The investigated area comprises the whole Olkusz Ore-bearing Region (OOR) and some coterminous areas located in southern Poland (Fig. 1). It is rectangular in outline (8×6 km), covering 48 sq. km at long. $19^{\circ}25' - 19^{\circ}32'E$ and lat. $50^{\circ}15' - 50^{\circ}19'N$ (Fig. 2). The central

part is where, since the Middle Ages, zinc and lead ores have been mined and processed. The eastern and southern parts of the area are occupied by sand quarries or overgrown by pine forest, whereas the western and northern margins are given over to agriculture.

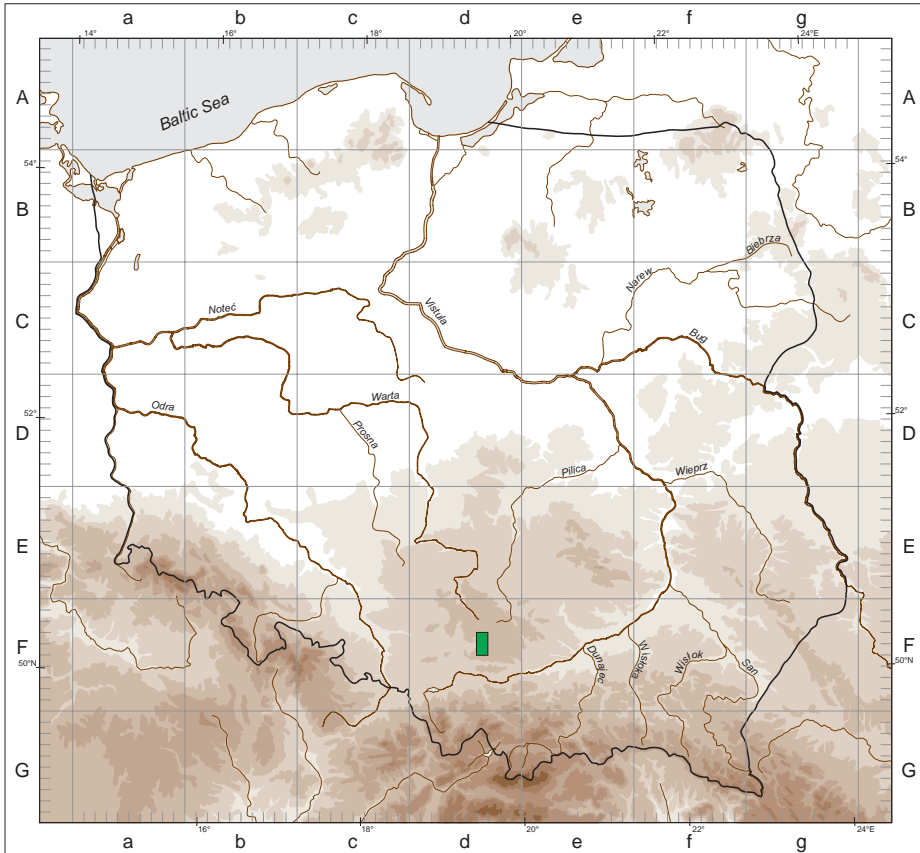


Fig. 1. Location of the Olkusz Ore-bearing Region in Poland in the Fd 36 and Fd 46 squares (marked with green) in the ATMOS grid square system.

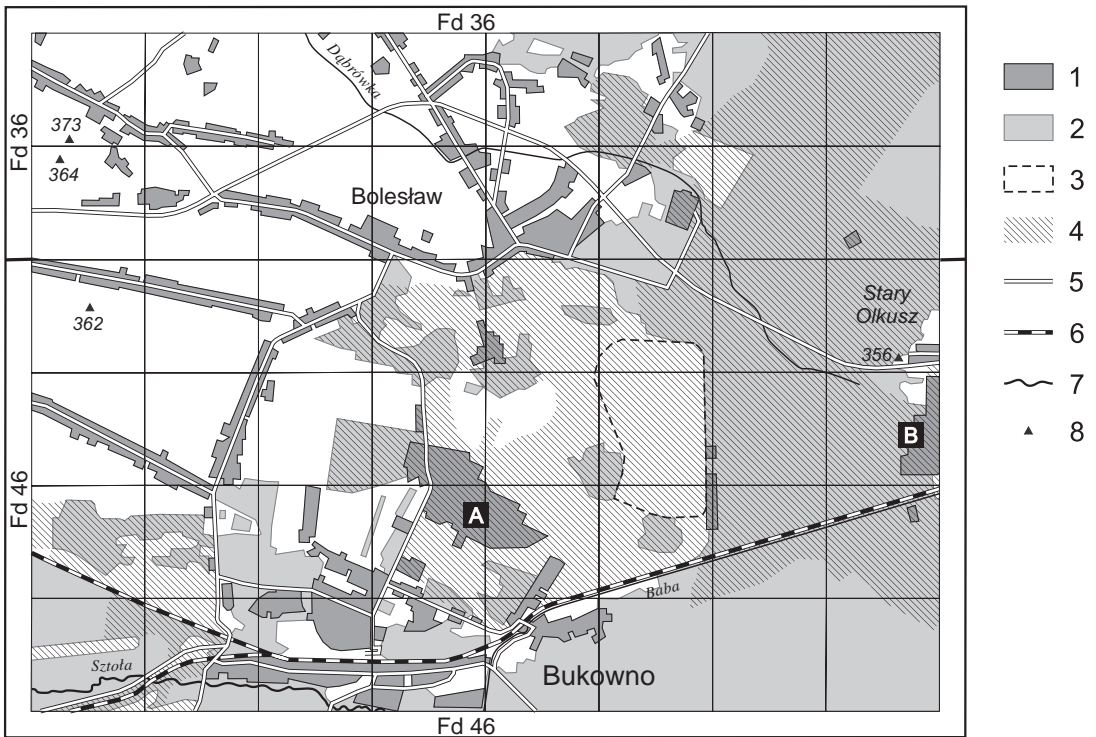


Fig. 2. Topography of the Olkusz Ore-bearing Region with marked 1 × 1 km grid square system. 1 – built-up areas; 2 – forest; 3 – tailing ponds; 4 – area transformed due to mining activity; 5 – roads; 6 – railway tracks; 7 – watercourses; 8 – highest elevations (m a.s.l.); A – the smelter of ZGH Bolesław; B – Zn-Pb processing plant. According to Nowak *et al.* (2011), modified.

The Olkusz Ore-bearing Region lies in the Silesian Upland macroregion in the eastern part of the Garb Tarnogórski mesoregion (Kondracki, 2009). Administratively, the OOR belongs to the Olkusz district of Małopolska Province. It covers almost all of the Bolesław commune, the northern part of the Bukowno town and the western edge of the Olkusz municipality, including the outskirts of Olkusz town (Fig. 3).

The climatic features of the OOR are typical for the Silesian-Cracow climatic region (Romer, 1949). The average annual temperature is 8°C and average annual precipitation 750 mm. Precipitation is highest in June, July and August, and lowest in February and March. The prevailing winds are westerly, light

to moderate. The growing season lasts 200–210 days (Starzewska-Sikorska, 2004).

Geologically, the OOR is dominated by Triassic ore-bearing dolomites, with concentrations of zinc and lead ore deposits. A considerable area is covered by younger Quaternary deposits of sand, loess, gravel and clay. Rendzina soils have developed on Triassic formations, and podzolic soils and rarely brown soils on postglacial deposits. The soils of post-mining areas are represented by initial rendzinas or degraded soils, or soil cover is absent (Książkiewicz *et al.*, 1965; Gilewska, 1972; Cabała, 2009).

The area shows a highly diversified relief, with numerous elevations, hummocks and mounds running parallel and rising to more

than 300 m a.s.l. The highest elevations are in the north-western and western parts of the area near Krzykawa (373 and 364 m a.s.l.) and Podlipie (362 m a.s.l.), and in the east near Stary Olkusz (356 m a.s.l.). In the north the terrain slopes gently down to the Biała river valley, and in the south to the Sztola river valley, with the characteristic geomorphology developed in the north-western part of the study area. As a result of erosion, the loess slopes are dissected by ravines, gullies and depressions.

The Olkusz Ore-bearing Region is part of the Vistula drainage basin. The most important river is the Sztola (Fig. 4), which drains the southern part of the region. The waters of the northern part drain into the Biała river. Smaller watercourses, mainly canals draining water from the mines, are artificial. The largest of them, the Dąbrówka Canal (Fig. 5) and Baba Canal, have concrete beds, but smaller ones such as the Sztolnia Canal are only partly regulated. The oldest channel is Sztolnia Ponikowska in the northern part. At present, all

that remains of it is a deep gully and small water bodies in the lowest parts of the former bed. Other water bodies have formed mainly in old mining pits (Fig. 6).

The Olkusz Ore-bearing Region has Poland's richest deposits of zinc and lead ores (Liszka & Świć, 2004). These are mostly of sulphide and carbonate, including galena (Pb ore), calamine and zinc blende (Zn ore), which were extracted by open-cast mining almost continuously from the 12th century to the end of the 20th (Blajda, 2010). Ores are now extracted only from an underground mine.

Many centuries of human activity have greatly altered the original landscape of the OOR, creating many different anthropogenic forms. Small holes surrounded by piled up mine waste (called *warpie* in Polish) are still to be found around Stary Olkusz; these are traces of the earliest mining activity. The intense mining activity of the nineteenth and twentieth centuries has left vast areas of excavations and spoil heaps near Bukowno and Bolesław.

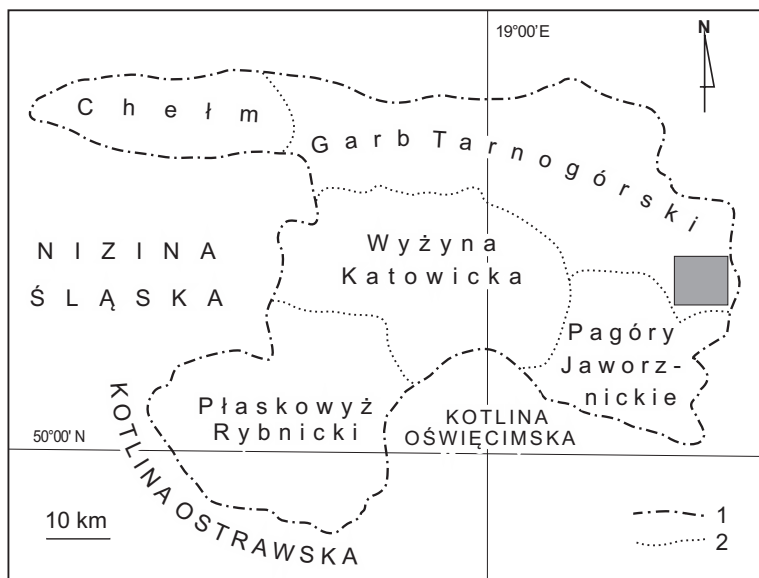


Fig. 3. Location of the study area (gray square) in the Silesian Upland. 1 – border of the Silesian Upland; 2 – border of mesoregions.



Fig. 4. The Sztola river in Bukowno with well developed fragments of the copse of willow and alder (photo Adam Stebel).



Fig. 5. The Dąbrówka Canal in the vicinity of the Pomorzany mine (photo Grażyna Szarek-Łukaszewska).



Fig. 6. A water body in an old sand pit near Bukowno overgrowing with the rush community dominated by *Phragmites australis* (Cav.) Steud. (photo Adam Stebel).



Fig. 7. Spontaneous succession on the sand pit. Photograph taken from the flotation tailings heap of Bolesław Mining and Metallurgical Plant (ZGH Bolesław) in Bukowno (photo Grażyna Szarek-Łukaszewska).



Fig. 8. Flotation tailing heap of Bolesław Mining and Metalurgical Plant in Bukowno (photo Adam Stebel).



Fig. 9. Bolesław Mining and Metalurgical Plant (ZGH Bolesław) in Bukowno (photo Grażyna Szarek-Lukaszewska).



Fig. 10. A sand quarry east of the flotation tailing heap of Bolesław Mining and Metalurgical Plant in Bukowno (photo Adam Stebel).



Fig. 11. A dolomite quarry in Cyzowizna (photo Adam Stebel).

Most excavations from ore extraction have been reclaimed, that is, filled and planted with trees (Fig. 7), except for the Bolesław open-cast mine which is still being reclaimed, and the Ujków Południe open-cast mine, used as a municipal landfill. Among them are mine spoil heaps of different shapes, forming higher and lower elevations (Fig. 8). Some have been afforested, while others are covered with spontaneous vegetation. Large areas of the OOR are occupied by infrastructure associated with the mines and zinc smelters (these areas were not covered by the present floristic work). On the northern edge of the OOR is the Pomorzany ore mine (a working mine), in the central part is the Bolesław Mining and Metallurgical Plant (ZGH Bolesław, the largest zinc mine in Poland) (Fig. 9), and in the eastern part the closed Olkusz ore mine, presently combined with the ore flotation plant of ZGH Bolesław. Between the zinc smelter and the ore flotation plant is a huge heap of flotation tailings (ZGH Bolesław tailing ponds), rising to 300 m a.s.l. and dominating the landscape. Next to it are working sand quarries (Fig. 10). In the OOR dolomite is also exploited (Fig. 11), but on a smaller scale. The largest dolomite

quarries are west of Stary Olkusz and south of Bukowno-Skotnica.

The northern part of the mining area is cut by the Kraków – Wrocław road (road No. 94) and the southern part by the Katowice – Kielce railway and a parallel broad gauge track for industry (metallurgy and sulphur).

The OOR soils show an extremely high concentration of heavy metals when compared with soils in other parts of Poland (Pasieczna & Lis, 2008) as a result of natural and anthropogenic factors. The natural source of metals is the weathering of shallow-dipping ore-bearing dolomite. Industrial activity, that is extraction and processing of metal ores, has produced huge amounts of metal-rich waste and vast quantities of metallic dusts emitted to the atmosphere, considerably increasing the heavy metal concentrations in the OOR soils and expanding the contaminated area. In the OOR the soils richest in zinc, lead and cadmium occur at ore extraction and processing sites, both historical and contemporary, around Bolesław, Bukowno, Ujków Stary, Krążek, Olkusz Stary, and close to the ZGH Bolesław and Pomorzany mines (Pasieczna & Lis, 2008).

Vegetation

Zinc and lead ore extraction and processing are among the most important factors shaping the landscape and affecting nature in the Olkusz Ore-bearing Region. This industry has developed since the Middle Ages. At first it caused only local though continuous degradation of the plant and soil cover. The technological progress that drove the mining industry during the past century enabled poor quality deposits to be exploited, considerably increasing the area of transformed landscape.

The degradation process accelerated with the coming of the first sand quarries in the latter part of the 20th century. The opening of successive sand quarries was associated with deforestation of large parts of the area and lowering of the water table (Pasiczna & Lis, 2008). As a consequence of industrial activity and the resulting pollution, arable fields around the mines and smelter were abandoned in the 1980s. Large-scale and ever more intense anthropogenic processes drastically affected the OOR vegetation. The present plant communities are of secondary origin or else represent impoverished forms of the typical plant associations that once occurred there.

At present a large area of the OOR is covered by forests of uneven age, planted recently in programmes to reclaim abandoned ore mine workings and sand quarries. They are mainly on a sandy substrate in the southern and eastern parts of the area. Among them suboceanic pine forest Leucobryo-Pinetum predominates. They represent mostly poorer aspect with *Vaccinium vitis-idaea* L. (Fig. 12) which

develops in very dry sites (Cabała, 1990). Tree stands are formed of *Pinus sylvestris* L. with an admixture of *Betula pendula* Roth and *Quercus robur* L. The undergrowth is composed mainly of young trees, *Juniperus communis* L. and members of the genus *Rubus* L. The herb layer is very poor, particularly in younger stands, and often comprises species typical of meadow and psammophilous grassland. Typical are vascular plants such as *Deschampsia flexuosa* (L.) Trin., *Vaccinium vitis-idaea*, *V. myrtillus* L., *Melampyrum pratense* L. and bryophytes, for example *Hypnum cupressiforme* Hedw., *Pleurozium schreberi* (Brid.) Mit., *Pseudoscleropodium purum* (Hedw.) Broth. and *Dicranum scoparium* Hedw. as well as some lichen species.

In the immediate neighbourhood of an industry complex the vegetation patches are severely damaged, whereas at greater distances their condition is slightly better, although throughout the whole area considerable changes in the appearance and species composition of forest stands are observed (Kaźmierczakowa, 1988). In wet places, for example near Cegielnia, boggy coniferous forest, mainly Molinio-Pinetum and strongly degenerated patches of Vaccinio uliginosi-Pinetum, occur. Here grow many locally rare species, for example *Cephalozia bicuspidata* (L.) Dumort. var. *bicuspidata*, *C. bicuspidata* var. *lammersiana* (Huebener) Breidl., *Lophozia ventricosa* (Dicks.) Dumort. (Fig. 13), *Sphagnum denticulatum* Brid., *S. fimbriatum* Wilson (Fig. 14), *S. inundatum* Russow, *S. palustre* L., *S. squarrosum* Crome,

Straminergon stramineum (Brid.) Hedenäs and *Warnstorfia fluitans* (Hedw.) Loeske.

Deciduous forest (Fig. 15) is practically absent from the OOR. Small patches of forest whose species composition is similar to that of oak-hornbeam forest *Tilio-Carpinetum* occur only in loess ravines in the north-western part of the area. In small areas, mainly in the Sztola river valley, the vicinity of Sztolnia Ponikowska and the Sztolnia canal, patches of riverside forest *Fraxino-Alnetum* occur, but with stands dominated by *Alnus glutinosa* (L.) Gaertn. On the ground within these forests the bryophyte layer is variously developed. Such species as *Atrichum undulatum* (Hedw.) P.Beauv. (Fig. 16), *Plagiomnium undulatum* (Hedw.) T.J.Kop. and *Polytrichastrum formosum* (Hedw.) G.L.Sm. dominate.

Some shrub communities contain many individuals of *Juniperus communis*. There are large patches of these communities in the former mining area near Stary Olkusz. Communities of the class *Rhamno-Prunetea* are found on dolomite elevations, balks, forest margins and abandoned metal-mining sites with a stony substrate. Damp and wet places, as well as the banks of watercourses and pools are dominated by shrub communities of the class *Salicetea purpureae*. The bryophyte layer in these wooded communities is poorly developed. Such species as *Brachythecium rutabulum* (Hedw.) Schimp. and *Oxyrrhynchium hians* (Hedw.) Loeske occur there.

Non-forest plant communities cover more than half the OOR area. The most important ones are meadows (Figs 17–19), xerothermic grasslands, saum vegetation (woodland margins), psammophilous grasslands, as well as ruderal and arable (Figs 20–21). weed communities. Meadow communities of the class *Molinio-Arrhenatheretea* are represented by the order *Arrhenatheretalia* (meadows occurring in mesic habitats, sometimes undersown with some grasses, for example *Dactylis glomerata* L.,

and the order *Molinietalia* (less intensively managed meadows of intermittently wet habitats at peaty meadows). The latter, which are remnants of former species-rich communities, are of particular botanical importance. Though their species composition has changed, many rare and protected vascular plant species exist there (e.g. *Silaum silaus* (L.) Schinz & Thell., *Iris sibirica* L., *Gladiolus imbricatus* L., *Serratula tinctoria* L. and *Colchicum autumnale* L.). However, these communities are poor in bryophytes, and only some common species, as a rule in small quantity, grow there, for example *Brachythecium rutabulum*, *Oxyrrhynchium hians* and *Plagiomnium undulatum*.

Despite the occurrence of suitable substrate, xerothermic grasslands of the class *Festuco-Brometea* are relatively rare in the OOR. Small patches persist on elevations near Stary Olkusz and Bukowno-Skotnica, on balks and on the margins of dolomite quarries. They are mostly impoverished forms of xerothermic grassland communities. In post-mining areas, xerothermic grassland species appear in specific plant communities. *Brachypodium pinnatum* (L.) P.Beauv., *Festuca ovina* L., *Melampyrum arvense* L. and *Phleum phleoides* (L.) H.Karst. are among the most typical species of these communities. The bryophyte layer is poorly developed, and such species as *Abietinella abietina* (Hedw.) M.Fleisch., *Brachythecium albicans* (Hedw.) Schimp. and *Thuidium assimile* (Mit.) A.Jaeger occur there.

Grassland patches are interspersed with patches of saum communities of the class *Trifolio-Geranietea sanguinei* (Fig. 22). The best-preserved patches of these communities are on an elevation west of Stary Olkusz. Some of the more interesting species are *Anthericum ramosum* L., *Libanotis pyrenaica* (L.) Bourg. and *Polygonatum odoratum* (Mill.) Druce. Traces of the occurrence of these communities – small patches with a single characteristic or distinguishing species such as *Geranium sanguineum* L.,



Fig. 12. Pine forest on sandy soil in the valley of the Sztola river (photo Adam Stebel).



Fig. 13. *Lophozia ventricosa*, an epigeal liverwort species, exceedingly rare in the Olkusz Ore-bearing Region (photo Vítězslav Plášek).



Fig. 14. *Sphagnum fimbriatum*, a very rare peat moss occurring in the boggy coniferous forest near Cegielnia (photo Adam Stebel).



Fig. 15. Deciduous forest dominated with *Quercus robur* and *Betula pendula* in the vicinity of Karna (photo Adam Stebel).



Fig. 16. *Atrichum undulatum*, an epigeal moss growing on the ground in deciduous forest, paths, waste land, meadows and in grasslands (photo Adam Stebel).



Fig. 17. Fallows and meadows near Krzykawa (photo Monika Jędrzejczyk-Korycińska).



Fig. 18. Fresh meadow of the Arrhenatheretalia order dominated by *Ranunculus acris* L. and *Rumex confertus* Willd. in the Krążek-Bolesław region (photo Monika Jędrzejczyk-Korycińska).



Fig. 19. Wet meadows in the vicinity of Krążek (photo Monika Jędrzejczyk-Korycińska).



Fig. 20. Arable fields and meadows in the south-western part of the OOR, near Bukowno-Skotnica (photo Monika Jędrzejczyk-Korycińska).



Fig. 21. Arable fields and meadows in south-western part of the OOR, near Bukowno-Skotnica (photo Monika Jędrzejczyk-Korycińska).



Fig. 22. Meadows dominated by *Geranium pratense* in the Krążek region (photo Paweł Kapusta).



Fig. 23. Psammophilous grassland dominated with *Corynephorus canescens* at Pustynia Starczynowska (photo Adam Stebel).



Fig. 24. *Niphotrichum canescens*, a moss typically growing in psammophilous grasslands (photo Adam Stebel).



Fig. 25. Xerothermic grasslands on the post-mining heaps to the left from the Saturn mine in Olkusz (photo Grażyna Szarek-Łukaszewska).



Fig. 26. Xerothermic grasslands on the post-mining heaps in Bolesław (photo Grażyna Szarek-Łukaszewska).



Fig. 27. A small patch of fen with *Eleocharis quinqueflora* in the vicinity of Cegielnia (photo Adam Stebel).



Fig. 28. *Pseudocalliergon lycopodioides*, a wetland moss considered as a glacial relict in Poland, associated with fens (photo Adam Stebel).



Fig. 29. *Torrentaria riparioides*, an aquatic moss floating in water in the Sztola river (photo Adam Stebel).

Vincetoxicum hirundinaria Medik. and *Peucedanum cervaria* (L.) Lapeyr. – can be found on spoil heaps originating from calamine extraction or on the margins of dolomite quarries. Bryophytes play a minor role in these communities.

Psammophilous grasslands (Fig. 23) are another characteristic community of the OOR. They occur mainly in the central, southern and south-eastern parts of the area. Their physiognomy is dominated by *Corynephorus canescens* (L.) P.Beauv. and *Koeleria glauca* (Spreng.) DC. In summer, *Thymus serpyllum* L., *Sedum acre* L. and *Gypsophila fastigiata* L. add colour to these grasslands. Among mosses, some species are confined to these phytocoenoses, for example *Brachythecium albicans* and *Niphotrichum canescens* (Hedw.) Bednarek-Ochyra & Ochyra (Fig. 24).

The most noteworthy feature of the OOR, found nowhere else in Poland (Wika & Szczypek, 1990, 1991; Matuszkiewicz, 2008; Grodzińska & Szarek-Łukaszewska, 2009; Szarek-Łukaszewska & Grodzińska, 2007, 2008), is calamine grasslands belonging to the *Armerietum maritimae* association (Figs 25–26). They are developed mainly on mine waste with ore-bearing dolomites, or on sandy soils contaminated with heavy metals, that is, calamine soils (Kapusta *et al.*, 2010). Their floristic composition and density depend on the age of the patches, which ranges from a few years to over a century. Among other plants, the most valuable elements are the montane species *Gentianella germanica* (Willd.) Börner and *Biscutella laevigata* L. and *Armeria maritima* (Mill.) Willd. subsp. *halleri* (Wallr.) Á.Löve & D.Löve, another plant characteristic of Western European calamine grasslands. The incidence of bryophytes varies with this layer composed mainly of such species as *Bryum pallescens* Schwägr., *Tortella tortuosa* (Hedw.) Limpr., *Weissia controversa* Hedw., *Campylophyllopsis calcarea* (Crundwell & Nyholm) Ochyra, *Plagiomnium cuspidatum*

(Hedw.) T.J.Kop. and *Pohlia nutans* (Hedw.) Lindb. (Grodzińska & Szarek-Łukaszewska, 2009; Grodzińska *et al.*, 2000). Some of them are under protection (Kowolik *et al.*, 2010), but they are generally vanishing from the OOR (Kapusta *et al.*, 2010).

Most valuable from the bryological point of view are the paludicolous communities. During these investigations only some patches from the alliance *Caricetalia davallianae* were found, mainly in the northern part of the area (Fig. 27). There grow rare and vanishing species such as *Calliergon giganteum* (Hedw.) Kindb., *Limprichtia cossonii* (Schimp.) L.E.Anderson, H.A.Crum & W.R.Buck, *Pseudocalliergon lycopodioides* (Brid.) Hedenäs (Fig. 28), *Sphagnum contortum* Schultz, *S. teres* (Schimp.) Ångstr. and *S. warnstorffii* Russow. These interesting bryophytes are associated with regionally rare vascular plants, for example *Drosera rotundifolia* L., *Eleocharis quinqueflora* (Hartm.) O.Schwarz and *Menyanthes trifoliata* L.

An aquatic bryoflora occurs in the Sztola river, canals and artificial water bodies dispersed throughout the whole investigated area. In the Baba canal and the Sztola river the moss *Torrentaria riparioides* (Hedw.) Ochyra occurs sometimes in large quantities (Fig. 29). It is a very rare species in the Silesian Upland. On the banks of water bodies and in shallow water some common hygro- and hydrophytic bryophytes grow, for example *Calliergonella cuspidata* (Hedw.) Loeske, *Drepanocladus aduncus* (Hedw.) Warnst. and *D. polycarpus* (Voit) Warnst. These mosses are accompanied by regionally rare vascular plants. For example, in Krażek settlement such species as *Myriophyllum spicatum* L. and *Nymphaea alba* L. were observed. It is worth noting, that in a pond in Krażek the aquarium plant *Cabomba caroliniana* A.Gray was observed for the first time, probably initiating its expansion in Poland (Krajewski, 2012a).

Materials and methods

The investigated area was divided into 1×1 km squares within the boundaries of a main square (10×10 km) of the ATMOS cartogram system (Ochyra & Szmajda, 1981). The whole area is situated within two main ATMOS grid squares: Fd-36 and Fd-46, with 16 and 32 small squares (1×1 sq. km), respectively (Figs 30–42). Field investigations were carried out

between 2008 and 2014 growing seasons. The geographical coordinates of particular bryophyte sites were obtained using a GPS receiver eTrex 30. Over 3000 voucher specimens were collected during this research and housed in the herbarium of the W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków (KRAM) and Herbarium of Department of

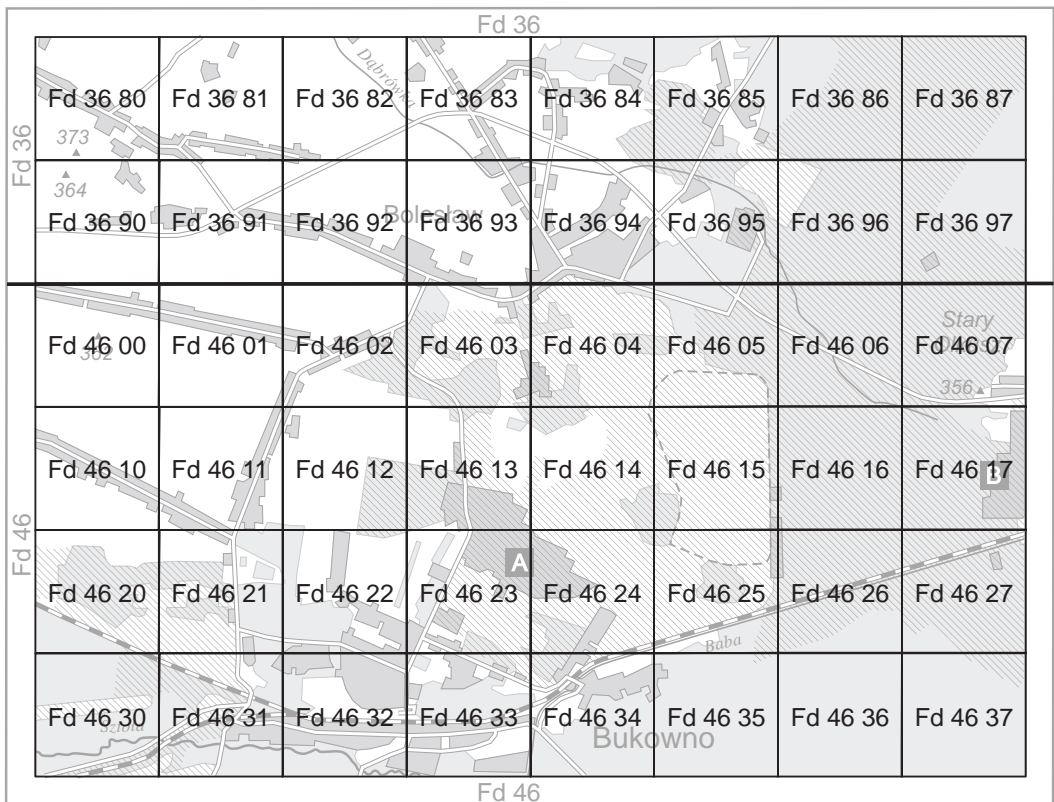


Fig. 30. Numbering of the 1×1 km squares of the Olkusz Ore-bearing Region in the ATMOS grid squares.

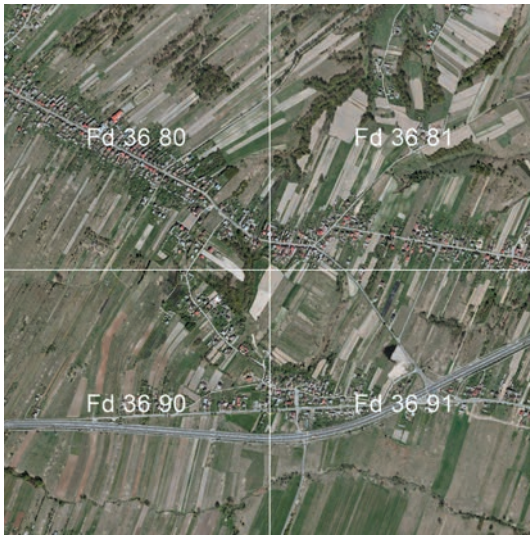


Fig. 31. Aerial photograph of the Fd 36/80, Fd 36/81, Fd 36/90 and Fd 36/91 squares (reproduced with permission, licence No. RO-IV.7522.464.2015_12_N).

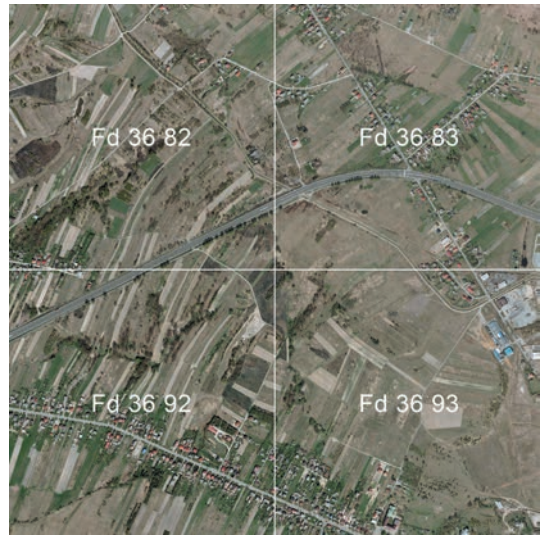


Fig. 32. Aerial photograph of the Fd 36/82, Fd 36/83, Fd 36/92 and Fd 36/93 squares (reproduced with permission, licence No. RO-IV.7522.464.2015_12_N).



Fig. 33. Aerial photograph of the Df 36/84, Df 36/85, Df 36/94 and Df 36/95 squares (reproduced with permission, licence No. RO-IV.7522.464.2015_12_N).

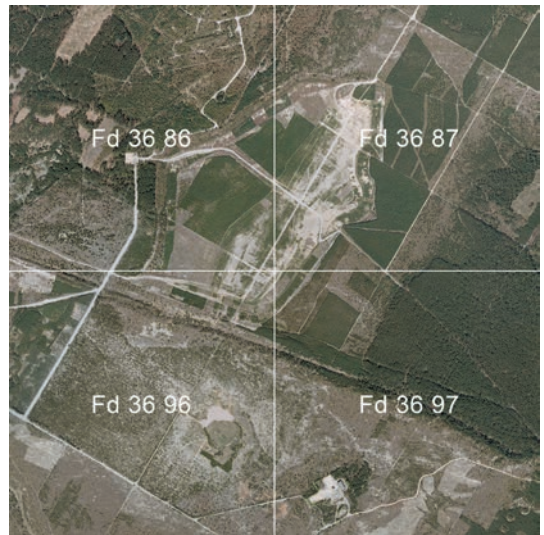


Fig. 34. Aerial photograph of the Df 36/86, Df 36/87, Df 36/96 and Df 36/97 squares (reproduced with permission, licence No. RO-IV.7522.464.2015_12_N).



Fig. 35. Aerial photograph of the Df 46/00, Df 46/01, Df 46/10 and Df 46/11 squares (reproduced with permission, licence No. RO-IV.7522.464.2015_12_N).



Fig. 36. Aerial photograph of the Df 46/02, Df 46/03, Df 46/12 and Df 46/13 squares (reproduced with permission, licence No. RO-IV.7522.464.2015_12_N).



Fig. 37. Aerial photograph of the Fd 46/04, Fd 46/05, Fd 46/14 and Fd 46/15 squares (reproduced with permission, licence No. RO-IV.7522.464.2015_12_N).



Fig. 38. Aerial photograph of the Fd 46/06, Fd 46/07, Fd 46/16 and Fd 46/17 squares (reproduced with permission, licence No. RO-IV.7522.464.2015_12_N).

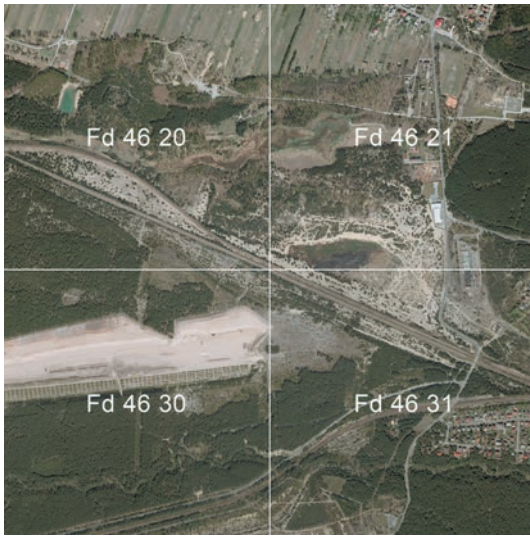


Fig. 39. Aerial photograph of the Fd 46/20, Fd 46/21, Fd 46/30 and Fd 46/31 squares (reproduced with permission, licence No. RO-IV.7522.464.2015_12_N).

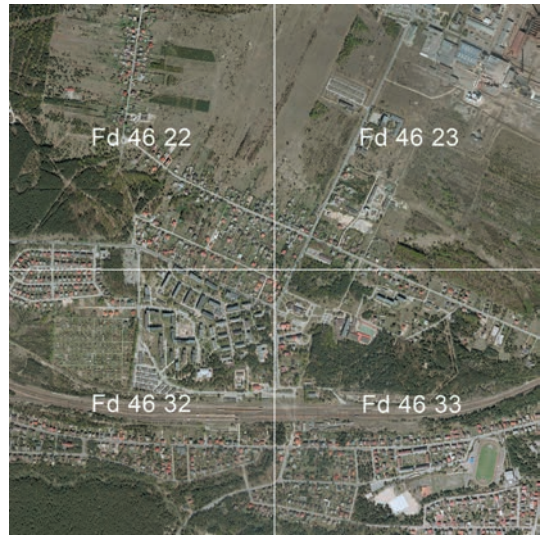


Fig. 40. Aerial photograph of the Fd 46/22, Fd 46/23, Fd 46/32 and Fd 46/33 squares (reproduced with permission, licence No. RO-IV.7522.464.2015_12_N).

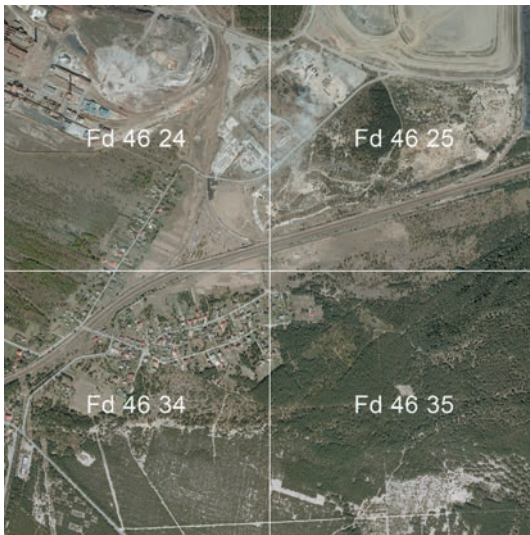


Fig. 41. Aerial photograph of the Fd 46/24, Fd 46/25, Fd 46/34 and Fd 46/35 squares (reproduced with permission, licence No. RO-IV.7522.464.2015_12_N).

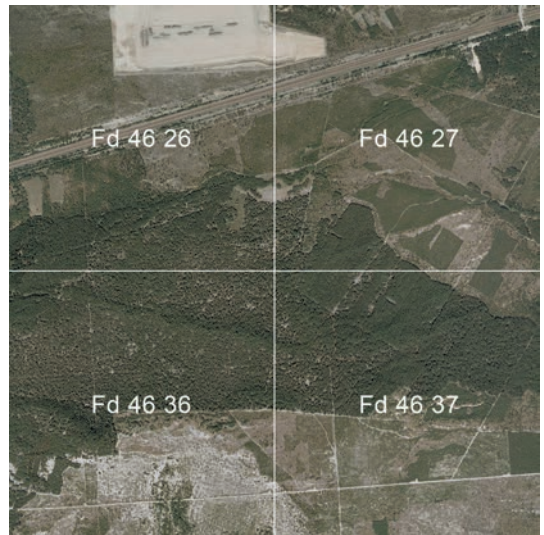


Fig. 42. Aerial photograph of the Fd 46/26, Fd 46/27, Fd 46/36 and Fd 46/37 squares (reproduced with permission, licence No. RO-IV.7522.464.2015_12_N).

Pharmaceutical Botany in the Medical University of Silesia in Katowice (SOSN). All available data from the literature and herbaria were revised and used.

The species are listed in systematic order of families. Within particular families species are listed alphabetically. For each species the following data are given:

1. Frequency according to the following scale: 1–4 squares – very rare taxa; 5–9 – rare; 10–18 – fairly frequent; 19–30 – frequent; 31–48 – common.

2. Habitat; for very rare taxa detailed descriptions are given, whereas for the others only general information is provided.

3. Number of localities.

4. List of localities (by numbered squares).

5. Literature and herbaria records (where they exist).

Liverwort names follow Klama (2006a), with mosses according to Ochyra *et al.* (2003) but considering subsequent taxonomic and nomenclatural novelties. Species protected by law in Poland were taken from 'Regulation of the Minister of Environment' (Anonymous, 2014), whereas threatened species are those identified as such by Klama (2006b) and Żarnowiec *et al.* (2004). Species threatened in Europe are accepted after Schumacker and Martiny (1995).

The distributions of particular species are shown on the cartograms. Due to the absence of precise localities, parts of the historical data were not considered.

Bryological research in the Olkusz Ore-bearing Region

That part of the Silesian-Cracow Upland between Olkusz, Bolesław and Bukowno with its calamine ore has been of interest to botanists for many years. Although investigations on the vascular plant flora of this area

have been carried out since the second half of the nineteenth century, the first information about bryophytes appeared much later. Wóycicki (1913) (Figs 43–44) reported (probably erroneously) a site of *Bryum algovicum*

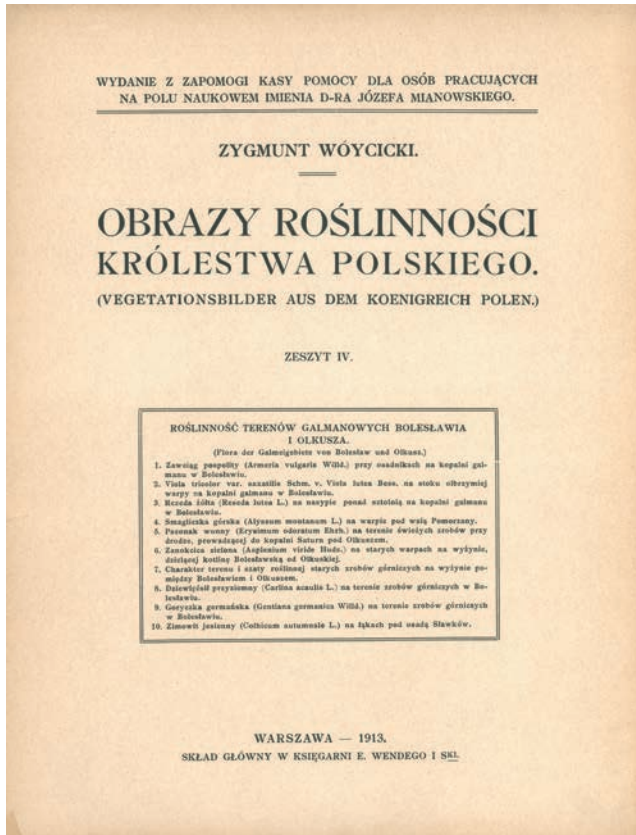


Fig. 43. Title page of Wóycicki's (1913) *Obrazy roślinności Królestwa Polskiego*, part 4 [=Vegetation pictures of the Kingdom of Poland] presenting the vegetation of the calamine areas in the Bolesław and Olkusz region.

Tablica VII.

Charakter terenu i szaty roślinnej starych zrobów górniczych
na wyżynie pomiędzy Bolesławiem i Olkusem.

(Według fotografii R. CHOLEWIŃSKIEGO, zdjętej w dniu 26 maja 1912 r.)

Na pierwszym planie tablicy VII widać poryty dawnymi zrobami teren wyżynny, dzielący obie kotliny. Większe i drobniejsze złomy wapienia świecą jeszcze miejscami nagością swych płaszczyn na tle szaro-zielonej, to gęstszej, to przejrzystszej, szaty, na którą składają się: *Porosty* [przeważnie *Plucenia islandica kędzierzawa* (*Cetraria islandica* β *crispa* Ach.), *Chrobotek reniferowy* (*Cladonia rangiferina* L.) i *Chrobotek kubkowy* (*Cladonia pyxidata* L.)], *Mchy* [głównie wspomniany już powyżej *Prątnik* (*Bryum pendulum* Hornsch.)], dalej wonny a nader bujnie rozrastający się *Tymianek wązkolistny* (*Thymus Serpyllum* var. *angustifolius* Pers.), *Przytulia krzyżowa* (*Galium cruciatum* Sm.), *Przytulia północna* (*Galium boreale* L.), *Głowienka wielkokwiatowa* (*Brunella grandiflora* Jacq.), *Szarota biała* (*Gnaphalium dioicum* L.), *Gądział wosista* (*Ajuga genevensis* L.), *Jastrzębiec kosmaczek* (*Hieracium Pilosella* L.), *Faskier ostry* (*Ranunculus acer* L.), *Faskier bulwiasty* (*Ranunculus bulbosus* L.), tak rozpowszechniony wogóle w tej okolicy, i rzadszy *Faskier wielkokwiatowy* (*Ranunculus polyanthemus* L.). Obficie występuje w ich towarzystwie *Postonek pospolity* (*Helianthemum vulgare* Gaertn.), rozestany po ziemi *Potonicznik gładki* (*Herniaria glabra* L.), *Tasznik właściwy* (*Capsella Bursa pastoris* Moench), *Pięciornik szarawy* (*Potentilla arenaria* Borkh.)¹⁾ i *Potentilla cinerea* Chaix²⁾, purpurą kwiatów strojny *Goździk Kartuski* (*Dianthus Carthusianorum* L.), *Rogownice* [*Rogownica pięciopięciokowa* (*Cerastium semidecandrum* L.) i *Rogownica wielkokwiatowa* (*Cerastium arvense* L.)], *Zawciąg pospolity* (*Armeria vulgaris* Willd.) z domieszką *Gwiazdnika białawo-żółtego* (*Scabiosa ochroleuca* L.), *Komonicy pospolitej* (*Lotus corniculatus* L.), *Koniczyny łąkowej* (*Trifolium pratense* L.), *Dziewięciświat* [*Dziewięciświat przysiemnego* (*Carlina acaulis* L.) i *Dziewięciświat pospolitego* (*Carlina vulgaris* L.)] lub *Wilczomleczów szczupoliciświatowych* (*Euphorbia Cyparissias* L.), na których często bardzo pasorzytuje *Kanianka koniczynowa* (*Cuscuta Epithymum* L.). A dalej towarzyszy im *Turzyca kosmata* (*Carex hirta* L.) i rzadka tutaj *Carex contigua* Hoppe, *Kostrzewa owcza* (*Festuca ovina* L.), *Mietlica rozłogowa* (*Agrostis alba* L.), *Wyklina łąkowa* (*Poa pratensis* L.), *Len przyczyszczający* (*Linum catharticum* L.), *Krzyżownica pospolita* (*Polygala vulgaris* L.), *Przetacznik ożankowy* (*Veronica*

¹⁾ Jest to roślina szeroko u nas rozpowszechniona, podawana wszakże jako taka dość rzadko, gdyż, jak to wykazał A. Zalewski (=Rozbiór prac dotyczących flory polskiej, Kosmos, 1896), brano ją zawsze za *Potentilla verna* L., która w Polsce nie rośnie.

²⁾ A. Zalewski, l. c. p. 186.

Fig. 44. The first page of a legend to Table VII in Wóycicki's (1913) *Obrazy roślinności Królestwa Polskiego*, part 4 [=Vegetation pictures of the Kingdom of Poland].

(as *B. pendulum* Hornsch.). Much more data appeared in the second half of the twentieth century. A dozen or so moss species collected from slag heaps near Bolesław and Olkusz are mentioned in Dobrzańska's (1955) paper. One year later a monograph of the moss flora of the Silesian Upland was published (Kuc, 1956). Up to now it has been the most important source of knowledge of the moss flora of this region. Further data, mainly concerning rare

species, can be found in papers showing the distribution of moss species in Poland (Ochyra *et al.*, 1985, 1988a, b, c, d; Szmajda *et al.*, 1991). A few further data were published by Kaźmierczakowa (1988), Jędrzejko (1990), Ochyra and Bednarek-Ochyra (1990), Stebel (2002b) and Drobnik and Stebel (2003). Much information is contained in a paper by Ochyra and Godzik (2015).

General features of the bryophyte flora and its diversity in relation to the coterminous regions

The bryoflora of the Olkusz Ore-bearing Region consists of 190 species and three varieties, including 171 species and two varieties of moss and 19 species and one variety of liverwort. It accounts for about 24.3% of the total moss flora (Ochyra *et al.*, 2003) and 7.6% of the liverwort flora (Klama, 2006a) of Poland. Additionally, the present day occurrence of 24 species known from the literature, has not been confirmed.

Mosses of the Olkusz Ore-bearing Region belong to 42 families (Table 1). Of these, the richest are the Brachytheciaceae (20 species and 1 variety), Amblystegiaceae (18 species and 1 variety), Bryaceae (17 species) and Hypnaceae and Pottiaceae (16 species each). Liverworts are represented by 11 families, five of which include only a single species and four with two taxa each. The other two families, Geocalycaceae and Aneuraceae consist of four and three species, respectively.

Frequency analysis shows that the largest group is composed of very rare taxa (50.9%), followed by rare (18.3%), fairly frequent (15.4%), frequent (8.9%) and common (6.5%) (Fig. 45).

The Silesian Upland, whose north-eastern part comprises the Olkusz Ore-bearing Region, is bryologically one of the best known areas in Poland. The earliest information about its bryophyte flora dates from the middle of the nineteenth century (Kabath, 1846; Uechtritz, 1864; Rehmann 1865; Milde, 1868, 1869,

1870a, b; Limpricht, 1873, 1876a, b, 1890, 1895, 1904; Krupa 1882) and so far about 420 species have been recorded from this region. They have been considered in numerous local and general treatments (e.g. Jędrzejko, 1985, 1990; Stebel, 1997, 1998a; Fojcik & Stebel, 2001) which have shown that particular mesoregions of the Silesian Upland have a very rich bryoflora. For example, the bryophyte flora of the Płaskowyż Rybnicki consists of 47 species of liverwort and 223 species of moss, Wyżyna Katowicka – 45 and 226 species, Chełm – 34 and 216 species, Garb Tarnogórski – 34 and 234 species and Pagóry Jaworznickie – 45 and 220 species, respectively (Stebel, unpublished).

Considering the very small size, the relatively monotonous relief, the scarcity of habitats which are particularly suitable for bryophytes, especially rock outcrops, mires, old trees and stands of old forest, as well as the remarkable

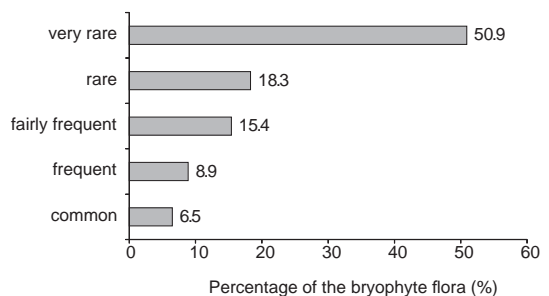


Fig. 45. Percentage of bryophyte species in each frequency class in the OOR flora.

Table 1. Families and genera represented in the bryoflora of the Olkusz Ore-bearing Region.

| Bryophyte families, number of taxa and percentage of the bryoflora of the Olkusz Ore-bearing Region (in brackets) | Bryophyte genera with number of taxa (in brackets) |
|---|--|
| 1 | 2 |
| Marchantiophyta | |
| Aneuraceae (3 species; 1.6%) | <i>Aneura</i> (1 species), <i>Riccardia</i> (2 species) |
| Calypogeiaceae (1 species; 0.5%) | <i>Calypogeia</i> (1 species) |
| Cephaloziaceae (1 species and 1 variety; 1.0%) | <i>Cephalozia</i> (1 species and 1 variety) |
| Cephaloziellaceae (2 species; 1.0%) | <i>Cephaloziella</i> (2 species) |
| Fossombroniaceae (1 species; 0.5%) | <i>Fossombronia</i> (1 species) |
| Geocalyceaceae (4 species; 2.1%) | <i>Chiloscyphus</i> (1 species), <i>Lophocolea</i> (3 species) |
| Lophoziaceae (2 species; 1.0%) | <i>Barbilophozia</i> (1 species), <i>Lophozia</i> (1 species) |
| Marchantiaceae (1 species; 0.5%) | <i>Marchantia</i> (1 species) |
| Pelliaceae (2 species; 1.0%) | <i>Pellia</i> (2 species) |
| Ptilidiaceae (1 species; 0.5%) | <i>Ptilidium</i> (1 species) |
| Ricciaceae (1 species; 0.5%) | <i>Riccia</i> (1 species) |
| Bryophyta | |
| Amblystegiaceae (18 species and 1 variety; 9.9%) | <i>Amblystegium</i> (3 species), <i>Calliergon</i> (2 species), <i>Campylophyllopsis</i> (1 species), <i>Campylium</i> (2 species and 1 variety), <i>Drepanocladus</i> (3 species), <i>Limprichtia</i> (1 species), <i>Leptodictyum</i> (1 species), <i>Pseudocalliergon</i> (2 species), <i>Sanionia</i> (1 species), <i>Straminergon</i> (1 species), <i>Warnstorfia</i> (1 species) |
| Aulacomniaceae (1 species; 0.5%) | <i>Aulacomnium</i> (1 species) |
| Bartramiaceae (1 species; 0.5%) | <i>Philonotis</i> (1 species) |
| Brachytheciaceae (20 species and 1 variety; 10.9%) | <i>Brachytheciastrum</i> (1 species), <i>Brachythecium</i> (6 species), <i>Cirriphyllum</i> (1 species), <i>Eurhynchiastrum</i> (1 species), <i>Eurhynchium</i> (1 species), <i>Homalothecium</i> (1 species), <i>Kindbergia</i> (1 species), <i>Oxyrrhynchium</i> (1 species and 1 variety), <i>Pseudoscleropodium</i> (1 species), <i>Rhynchostegium</i> (1 species), <i>Sciuro-hypnum</i> (4 species), <i>Torrentaria</i> (1 species) |
| Bryaceae (16 species; 8.3%) | <i>Bryum</i> (7 species), <i>Pohlia</i> (6 species), <i>Rhodobryum</i> (1 species), <i>Rosulabryum</i> (2 species) |
| Cinclidiaceae (2 species; 1.0%) | <i>Cinclidium</i> (1), <i>Rhizomnium</i> (1 species) |
| Climaciaceae (1 species; 0.5%) | <i>Climacium</i> (1 species) |
| Cratoneuraceae (1 species; 0.5%) | <i>Cratoneuron</i> (1 species) |
| Dicranaceae (10 species; 5.2%) | <i>Dicranella</i> (7 species), <i>Dicranum</i> (2 species), <i>Orthodicranum</i> (1 species) |
| Ditrichaceae (4 species; 2.1%) | <i>Ceratodon</i> (1 species), <i>Ditrichum</i> (3 species) |
| Encalyptaceae (2 species; 1.0%) | <i>Encalypta</i> (2 species) |
| Fissidentaceae (5 species; 2.6%) | <i>Fissidens</i> (5 species) |
| Funariaceae (1 species; 0.5%) | <i>Funaria</i> (1 species) |
| Grimmiaceae (5 species; 2.6%) | <i>Dryptodon</i> (1 species), <i>Niphotrichum</i> (1 species), <i>Schistidium</i> (3 species) |
| Helodiaceae (1 species; 0.5%) | <i>Helodium</i> (1 species) |

Table 1. Continued.

| Bryophyte families, number of taxa and percentage of the bryoflora of the Olkusz Ore-bearing Region (in brackets) | Bryophyte genera with number of taxa (in brackets) |
|---|--|
| 1 | 2 |
| Hylocomiaceae (5 species; 2.6%) | <i>Hylocomiadelphus</i> (1 species), <i>Hylocomium</i> (1 species), <i>Pleurozium</i> (1 species), <i>Rhytidiadelphus</i> (2 species) |
| Hypnaceae (16 species; 8.3%) | <i>Callicladium</i> (1 species), <i>Calliergonella</i> (1 species), <i>Ctenidium</i> (1 species), <i>Herzogiella</i> (1 species), <i>Hypnum</i> (2 species), <i>Platygyrium</i> (1 species), <i>Ptilium</i> (1 species), <i>Pylaisia</i> (1 species) |
| Leucobryaceae (1 species; 0.5%) | <i>Leucobryum</i> (1 species) |
| Leucodontaceae (1 species; 0.5%) | <i>Leucodon</i> (1 species) |
| Meesiaceae (3 species; 1.6%) | <i>Leptobryum</i> (1 species), <i>Meesia</i> (1 species), <i>Paludella</i> (1 species) |
| Mniaceae (2 species; 1.0%) | <i>Mnium</i> (2 species) |
| Orthotrichaceae (8 species; 4.2%) | <i>Orthotrichum</i> (7 species), <i>Ulota</i> (1 species) |
| Plagiomniaceae (6 species; 3.1%) | <i>Plagiomnium</i> (6 species) |
| Plagiotheciaceae (7 species; 3.6%) | <i>Plagiothecium</i> (7 species) |
| Polytrichaceae (7 species; 3.6%) | <i>Atrichum</i> (2 species), <i>Pogonatum</i> (1 species), <i>Polytrichastrum</i> (1 species), <i>Polytrichum</i> (3 species), |
| Pottiaceae (16 species; 8.3%) | <i>Aloina</i> (1 species), <i>Barbula</i> (2 species), <i>Bryoerythrophyllum</i> (1 species), <i>Didymodon</i> (3 species), <i>Protobryum</i> (1 species), <i>Pseudocrossidium</i> (1), <i>Syntrichia</i> (1 species), <i>Tortella</i> (1 species), <i>Tortula</i> (4 species), <i>Weissia</i> (1 species) |
| Seligeriaceae (1 species; 0.5%) | <i>Dicranoweisia</i> (1 species) |
| Sphagnaceae (12 species; 6.2%) | <i>Sphagnum</i> (12 species) |
| Splachnaceae (1 species; 0.5%) | <i>Splachnum</i> (1 species) |
| Tetraphidaceae (1 species; 0.5%) | <i>Tetraphis</i> (1 species) |
| Thuidiaceae (3 species; 1.6%) | <i>Abietinella</i> (1 species), <i>Thuidium</i> (2 species) |

devastation of the natural environment by the long-lasting human industrial and mining activity, the bryophyte flora of the Olkusz Ore-bearing Region is exceptionally rich. Nonetheless, the small stands of deciduous forest occurring on loess areas in the north-western part of the OOR and the fragments of wet alder forest and mires at the central-northern fringe of the study area yielded a number of interesting bryophyte species including three that are newly recorded in the Silesian Upland:

(1) *Philonotis arnellii* Husn. (Fig. 46) – its distribution in Poland is poorly known, although it predominantly occurs in the lowlands, especially in the western part of the

country, and at lower altitudes in the mountains. Recently, it was reported from single localities in Kotlina Raciborska basin (Stebel, 2005), the Beskidy Zachodnie mountains in the Western Carpathians (Stebel, 2006a) and the Bieszczady Zachodnie range in the Eastern Carpathians (Stebel & Żarnowiec, 2010).

(2) *Pohlia lescuriana* (Sull.) Ochi (Fig. 47) – a moss species very rarely reported from northern Poland (Szafran, 1957).

(3) *Rhytidiadelphus subpinnatus* (Lindb.) T.J.Kop. (Fig. 48) – a montane species occurring fairly often in the western part of the Carpathians (Stebel, 2006) and in the Sudetes (Szafran, 1961). Outside the mountains it is

very rare and recently in was reported from the Roztocze heights (Fudali *et al.*, 2015).

A long array of moss and liverwort species, which have been discovered in the Olkusz Ore-bearing Region during the present bryological survey of this area, proved to be very rare and occasional constituents of the bryoflora of the Silesian Upland. The following species are the best examples of this group:

(1) *Barbilophozia barbata* (Schreb.) Loeske (Fig. 49) – a liverwort occurring on the floor of coniferous forests, known only from the north-eastern part the region, namely from Dąbrowa Górnicza-Strzemieszyce, near the steel work “Huta Katowice” (Jędrzejko, 1985), “Diabla Góra” projected nature reserve near Bukowno (Jędrzejko *et al.*, 2000) and Bukowno-Polis (Stebel, 2002c) in the Garb Tarnogórski hump.

(2) *Cephaloziella rubella* (Nees) Warnst. (Fig. 50) – a liverwort growing mainly on mineral soil. It is a rare species, widely distributed but scattered and so far it is known from the following stations: Jaworzno-Byczyna and Jaworzno-Dąbrowa (Krupa, 1882); Park Śląski [= Silesian Park] in Chorzów (formerly Wojewódzki Park Kultury i Wypoczynku [= Park of Culture and Rest of Katowice Province]), Park Kultury i Wypoczynku in Gliwice [= Park of Culture and Rest of Gliwice] (formerly Park Gliwice-Zabrze) (Jędrzejko, 1975), near Jaworzno III Power Station in Jaworzno (Jędrzejko, 1985), Wodzisław Śląski-Marusze (Stebel, 1997) and Katowice-Brynów (Fojcik & Stebel, 2001).

(3) *Fossombronia wondraczekii* (Corda) Lindb. (Fig. 51) – a liverwort species growing on mineral soils and associated mainly with arable fields. In the Silesian Upland it is known from Mikołów-Mokre (Jędrzejko, 1985), Katowice-Zarzecze (Fojcik & Stebel, 2001) and Łaziska Górne-Brada (Stebel, 1997) in the Wyżyna Katowicka upland and Gorzycki, Rybnik-Gotartowice, Marklowice Górne,

Palowice, and Pszów-Doły in the Płaskowyż Rybnicki plateau (Stebel, 1997).

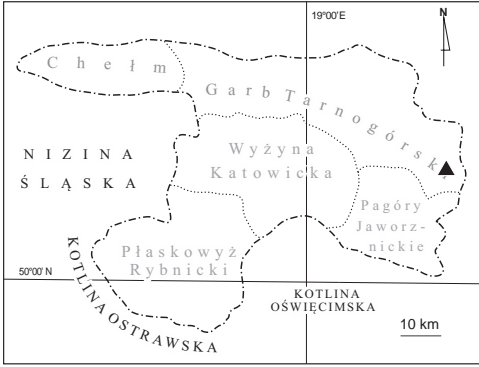
(4) *Lophocolea minor* Nees (Fig. 52) – a calciphile liverwort species, rarely recorded from the Silesian Upland in Czarnocin, Góra Świętej Anny (Limpricht, 1876b), Bobrowniki Śląskie, Dąbrowa Górnicza-Okradzionów and Świerklaniec (Jędrzejko, 1985), as well as Mysłowice-Krasowy (Stebel, 2006b).

(5) *Riccardia chamedryfolia* (With.) Grolle (Fig. 53) – a very rare paludicolous liverwort species, known only from a single station in the Silesian Upland, at Sosnowiec-Bory (Stebel & Smolińska, 2012).

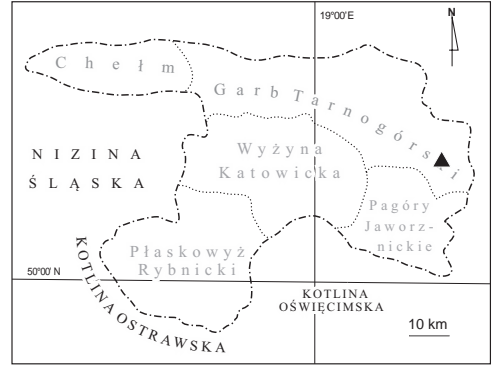
(6) *Riccardia palmata* (Hedw.) Carruth. (Fig. 54) – a montane liverwort species growing on rotten wood. So far, it has been recorded only from a single site in the Silesian Upland in Rybnik-Paruszowiec (Uechtritz, 1864).

(7) *Amblystegium radicale* (P.Beauv.) Schimp. (Fig. 55) – a hygrophilous species reported from several localities in the Silesian Upland, including Katowice-Giszowiec (Fojcik & Stebel, 1999), Katowice-Ochojec, Katowice-Murcki, las Murckowski, Katowice-Murcki, “Płone Bagno” projected nature reserve and Katowice-Murcki, “Dolinka Murckowska” rest centre in the Wyżyna Katowicka upland (Fojcik & Stebel, 2001), as well as Jastrzębie-Zdrój Bzie Zameckie and Żory-Kleszczówka in the Płaskowyż Rybnicki plateau (Stebel, 1997).

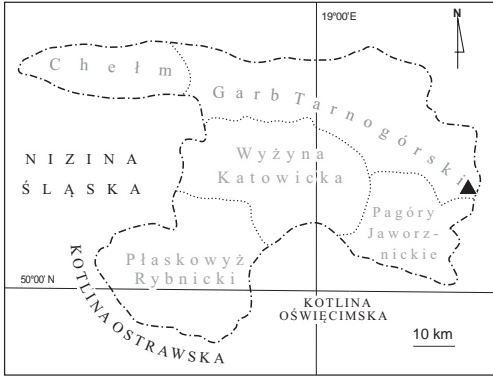
(8) *Atrichum angustatum* (Brid.) Bruch & Schimp. (Fig. 56) – a species associated with mineral soils. It is rare in the Silesian Upland and hitherto it has been recorded from Orzesze and Pszów (Uechtritz, 1864), Rybnik-Paruszowiec and Ruda-Młyn (Milde, 1869), Mikołów (Limpricht, 1876a), Zbroślawice (Kuc, 1956), Czernica, Łyski-Kamionki (Stebel, 1997), as well as in “Las Murckowski” Nature Reserve in Katowice (Stebel, 1998b) and in Katowice-Załęska Hałda (Fojcik & Stebel, 2001).



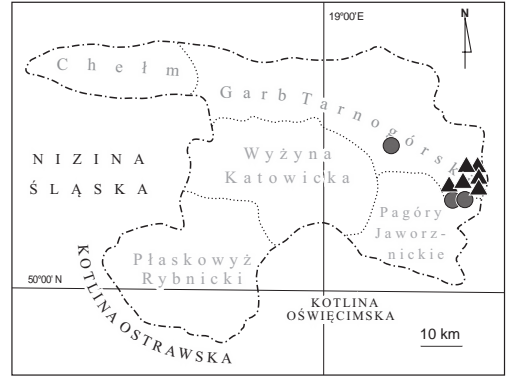
46. *Philonotis arnellii*



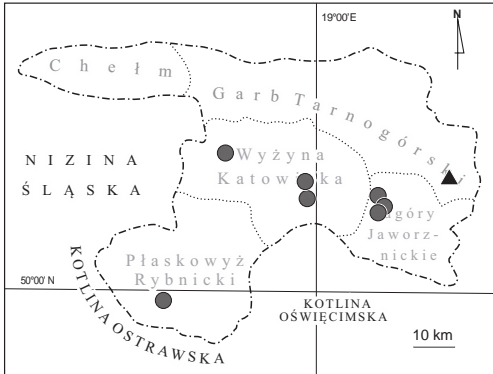
47. *Pohlia lescuriana*



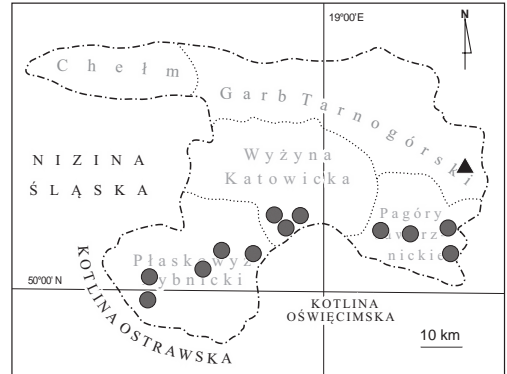
48. *Rhytidiadelphus subpinnatus*



49. *Barbilophozia barbata*

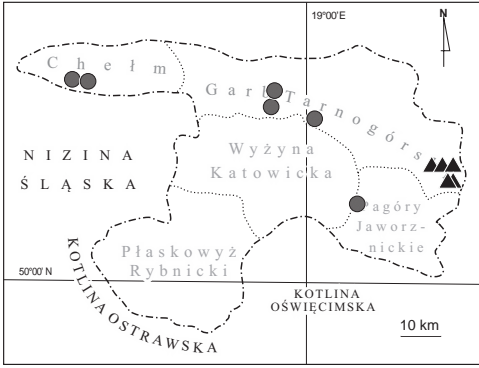


50. *Cephaloziella rubella*

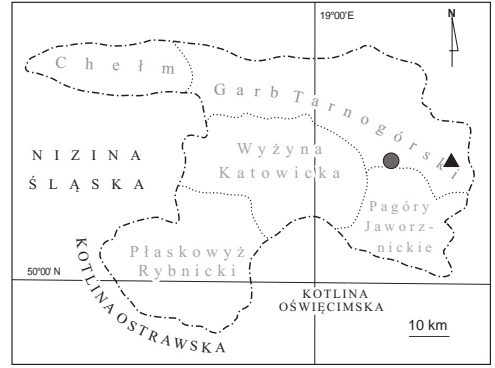


51. *Fossombronina wondraczekii*

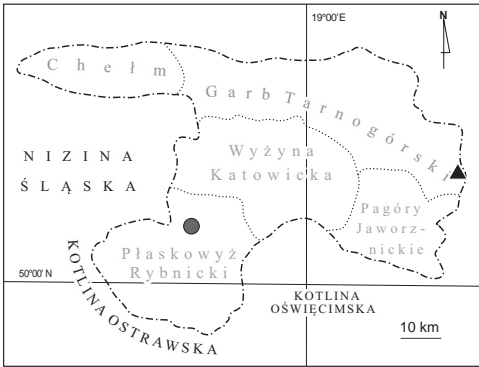
Figs 46–51. Distribution maps for *Philonotis arnellii* (46), *Pohlia lescuriana* (47), *Rhytidiadelphus subpinnatus* (48), *Barbilophozia barbata* (49), *Cephaloziella rubella* (50) and *Fossombronina wondraczekii* (51) in the Silesian Upland. Occurrence in the OOR marked with triangles.



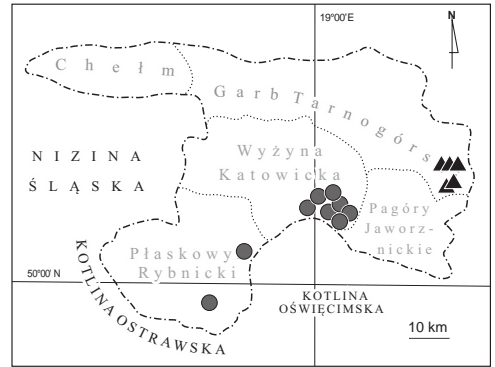
52. *Lophocolea minor*



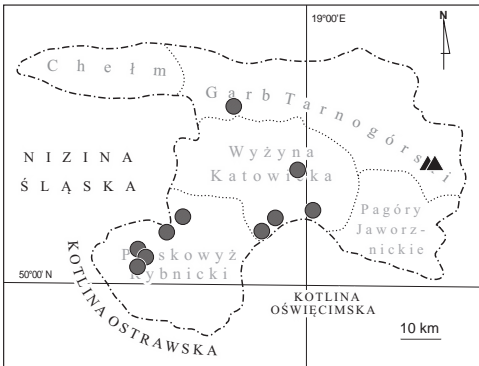
53. *Riccardia chamedryfolia*



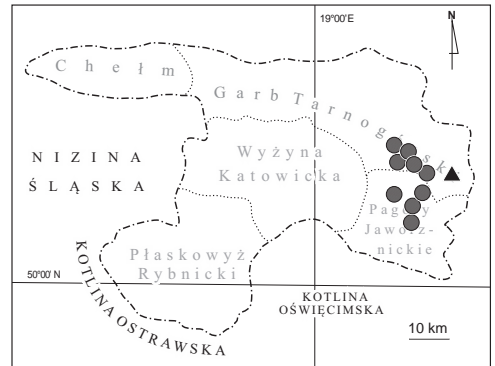
54. *Riccardia palmata*



55. *Amblystegium radicale*

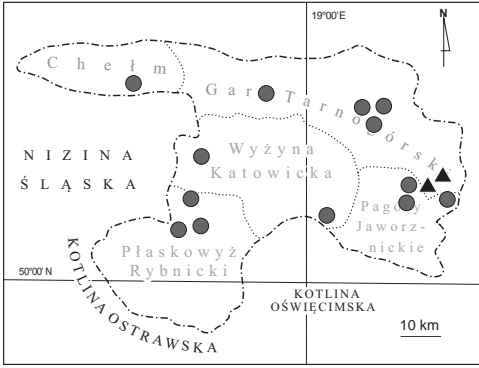


56. *Atrichum angustatum*

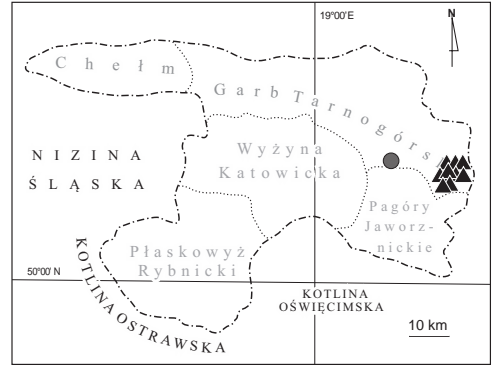


57. *Pseudocalliergon lycopodioides*

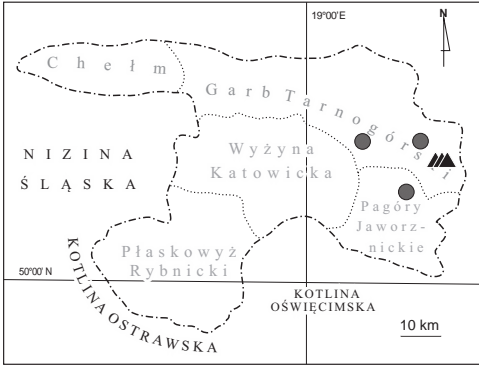
Fig. 52–57. Distribution maps for *Lophocolea minor* (52), *Riccardia chamedryfolia* (53), *R. palmata* (54), *Amblystegium radicale* (55), *Atrichum angustatum* (56) and *Pseudocalliergon lycopodioides* (57) in the Silesian Upland. Occurrence in the OOR marked with triangles.



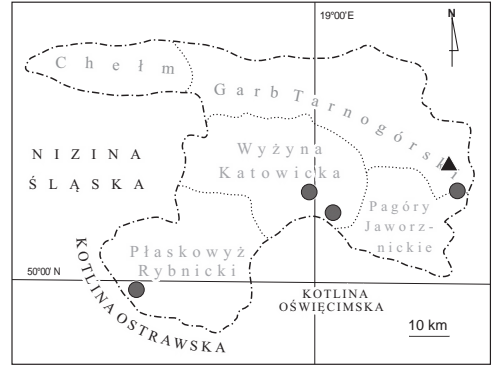
58. *Ptilium crista-castrensis*



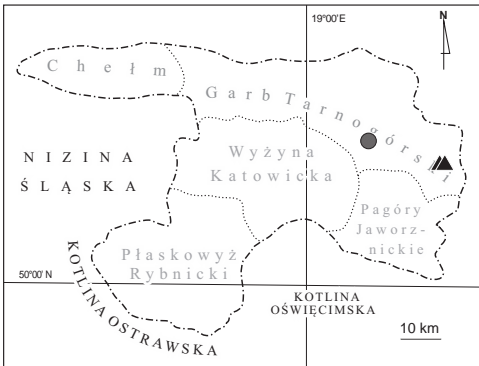
59. *Schistidium duprestii*



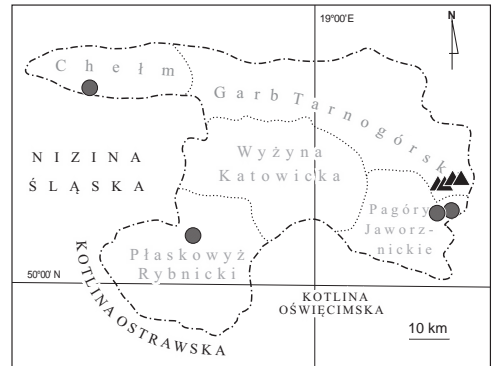
60. *Sphagnum contortum*



61. *Sphagnum russowii*



62. *Sphagnum warnstorffii*



63. *Torrentaria riparioides*

Figs 58–63. Distribution maps for *Ptilium crista-castrensis* (58), *Schistidium duprestii* (59), *Sphagnum contortum* (60), *S. russowii* (61), *S. warnstorffii* (62) and *Torrentaria riparioides* (63) in the Silesian Upland. Occurrence in the OOR marked with triangles.

(9) *Pseudocalliergon lycopodioides* (Brid.) Hedenäs (Fig. 57) – a paludicolous moss considered in Poland as a glacial relict (Bednarek-Ochyra, 1984). It was reported from several localities in the Silesian Upland, namely from Jaworzno-Jeziorki (Rehmann, 1865; Krupa, 1882; Jędrzejko *et al.*, 1984), Jaworzno-Byczyna (Krupa, 1882), between Jaworzno-Ciężkowice and Szczakowa (Kuc, 1956), Bór Biskupi, the Biała Przemsza river valley between Sławków and confluence with the Sztola river, Przymiarki, between Gołonóg and Wojkowice (Kuc, 1956) and Sarnów (Jędrzejko, 1990), but at most of these sites the species has not been recently rediscovered and it is apparently extinct. The records of this species from the mire in Dąbrowa Górnicza-Antoniów (Jędrzejko & Żarnowiec, 1984; Jędrzejko, 1990) are based upon misdeterminations and the voucher materials represent *Hamatocaulis vernicosus* (Mitt.) Hedenäs.

(10) *Prilium crista-castrensis* (Hedw.) De Not. (Fig. 58) – a rare moss occurring mainly in coniferous forests. It is known from scattered localities in the Silesian Upland, including Rybnik-Las Paruszowicki (Uechtritz, 1864), Jaworzno-Jeziorki (Rehmann, 1865); Rybnik and Gliwice (Milde, 1869); Proboszczowice, Słotwina near Łazy, Dąbrowa Górnicza-Trzebieszowice, upper course of the Jaworznik stream and upper course of the Sztola river (Kuc, 1956); Tarnowskie Góry and Dąbrowa Górnicza-Łosień (Jędrzejko, 1990), Knurów (Stebel 1997), as well Las Murckowski forest in Katowice-Murcki (Fojcik & Stebel, 2001).

(11) *Schistidium dupretii* (Thér.) W.A. Weber (Fig. 59) – because this species has long remained neglected (Blom, 1996), its distri-

bution in Poland is still inadequately known, although it is apparently widely distributed throughout the country. So far, it has been reported only once from the Silesian Upland, namely from Sosnowiec-Macзки (Stebel & Smolińska, 2012).

(12) *Sphagnum contortum* Schultz (Fig. 60) – a rare peatland moss, known from a few stations in the Silesian Upland, including, “Dolina Żabnika” Nature Reserve (Kuc, 1956; Żarnowiec *et al.*, 1995; Klama *et al.*, 1999), Dąbrowa Górnicza-Antoniów (Olesiński & Sendek, 1980; Jędrzejko & Żarnowiec 1982, 1984; Ochyra & Bednarek-Ochyra, 1987; Krzakowa & Melosik, 2000) and Dąbrowa Górnicza-Błęków (Malewski *et al.*, 1998).

(13) *Sphagnum russowii* Warnst. (Fig. 61) – a montane moss species, occasional in the Silesian Upland and hitherto known only from two sites in the Wyżyna Katowicka upland, namely in Katowice-Panewniki (Fojcik & Stebel, 1999) and Katowice-Murcki (Fojcik & Stebel, 2001), one site in Garb Tarnogórski hump (Stebel, 2002a) and a single locality in Wodzisław Śląski-Olszyny in the Płaskowyż Rybnicki plateau (Stebel, 1997).

(14) *Sphagnum warnstorffii* (Fig. 62) – a rare species which has hitherto been recorded only once in the Silesian Upland at Dąbrowa Górnicza-Antoniów (Olesiński & Sendek, 1980; Jędrzejko & Żarnowiec, 1984; Jędrzejko, 1983, 1990; Stebel & Fojcik, 2003).

(15) *Torrentaria riparioides* (Hedw.) Ochyra (Fig. 63) – a torrenticolous moss species, very rare in the Silesian Upland where it is known from scattered stations, namely Leśnica (Kuc, 1956), Trzebinia and Siersza (Jędrzejko, 1990) and Rybnik-Wielopole (Stebel, 1997).

Mountain species

Occurrence of mountain species in the flora of the southern uplands of Poland is relatively frequent (Kuc, 1964). However, in the Olkusz Ore-bearing Region, the number of mountain species is rather small. The main reasons are profound changes in the environment and the rather monotonous relief lacking larger rock outcrops. The mountain element comprises 10.7% of the present-day flora (11.9% if historical data are included). Mountain species occur in widely scattered sites, very frequently

occupying anthropogenic habitats (mainly old concrete walls), but there are no localities with higher concentrations of these species. They belong to the following groups:

(1) multizonal mountain species – *Campylium stellatum* (Hedw.) Lange & C.E.O.Jensen var. *protensum* (Brid.) Bryhn, *Ctenidium molluscum* (Hedw.) Mitt., *Ditrichum flexicaule* (Schwägr.) Hampe, *D. heteromallum* (Hedw.) E.Britton, *Encalypta streptocarpa* Hedw., *Pogonatum urnigerum* (Hedw.) P.Beauv., *Sanionia*

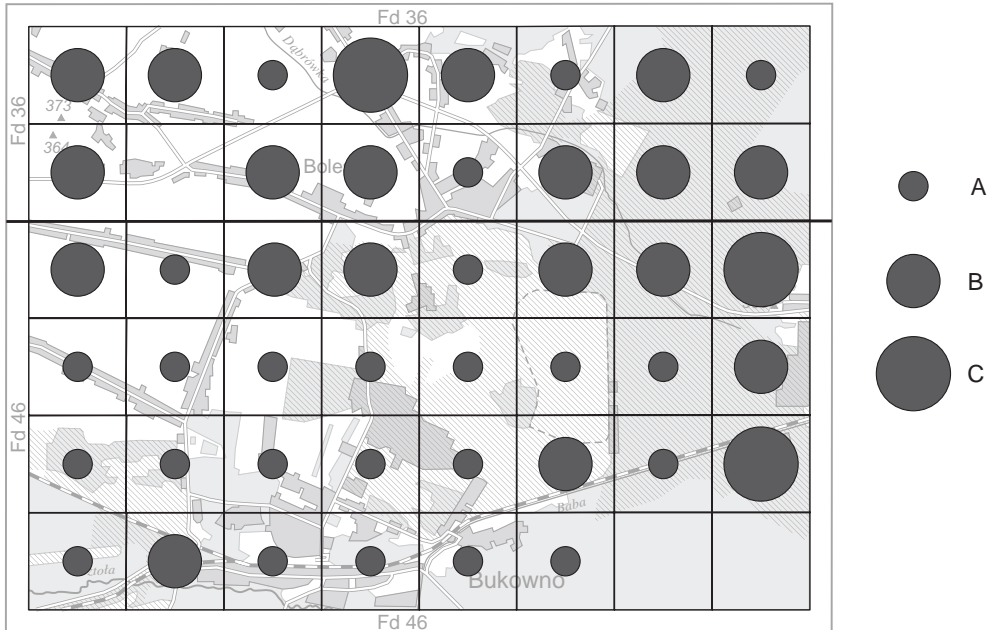


Fig. 64. Number of mountain species in individual grid squares in the Olkusz Ore-bearing Region. A – 1–2 species; B – 3–4 species; C – 5 and more species.

uncinata (Hedw.) Loeske, *Schistidium dupretii*,
Sciuro-hypnum populeum (Hedw.) Ignatov
& Huttunen, *Sphagnum girgensohnii* Russow
and *Tortella tortuosa* (Hedw.) Limpr.;

(2) forest belt species – *Fissidens dubius*
P.Beauv., *Mnium marginatum* (Dicks.) P.Beauv.,
Rhytidiadelphus subpinnatus, *Sciuro-hypnum*
plumosum (Hedw.) Ignatov & Huttunen,

S. reflexum (Brid.) Ignatov & Huttunen and
Sphagnum russowii;

(3) lower forest belt species – *Hypnum*
pallescens (Hedw.) P.Beauv.

Frequency of mountain species in indi-
vidual grid squares in the Olkusz Ore-bearing
Region is presented in Fig. 64.

Protected and threatened taxa

The Olkusz Ore-bearing Region contains many mosses which are protected by law (Anonymous, 2014) and/or are endangered in Poland (Żarnowiec *et al.*, 2004) and Europe (Schumacker & Martiny, 1995). There are seven species strictly protected (five not confirmed during present investigation), 37 species partly protected, three species threatened in Europe and 14 threatened in Poland (Table 2).

The greatest concentration of the protected and threatened species is in the northernmost

part of the OOR, where in one square more than 15 species occur, in four squares – 7–15 species, in two squares – 4–6 species, and only in one square (Fd 36/87) three threatened species have been recorded (Fig. 65). In the central and southern part of the study area the number of protected and threatened species markedly declines and only in three squares in the south-western corner and in the eastern part near Stary Olkusz 4–15 species are known to occur.

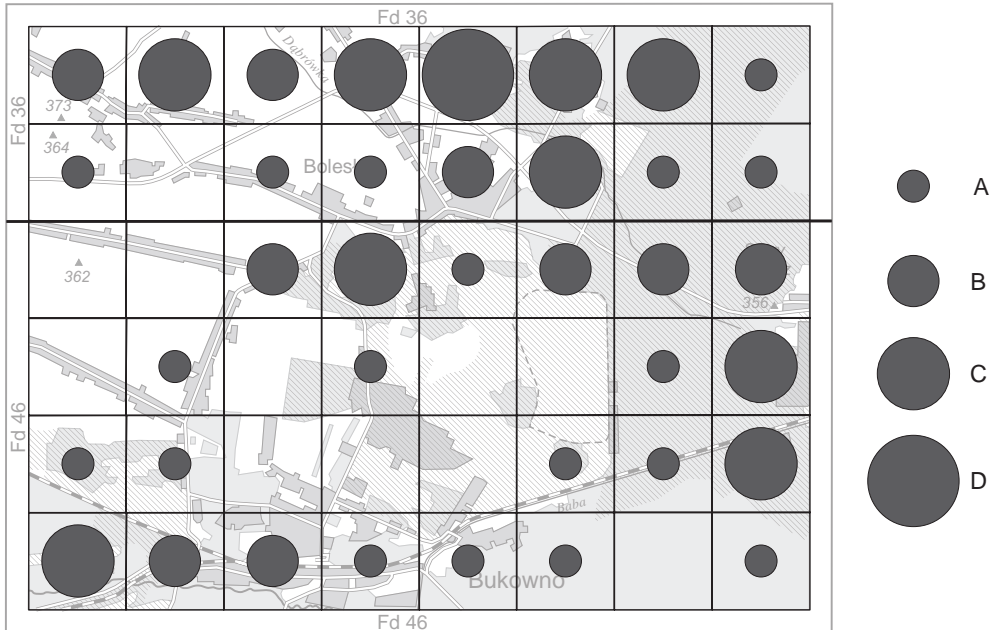


Fig. 65. Number of protected bryophyte species in individual grid squares in the Olkusz Ore-bearing Region. A – 1–3 species; B – 4–6 species; C – 7–15 species; D – 16 and more species.

Table 2. Protected and threatened bryophytes of the Olkusz Ore-bearing Region.

| Species name | Species protection in Poland | Threat category in Europe | Threat category in Poland |
|---------------------------------------|------------------------------|---------------------------|---------------------------|
| 1 | 2 | 3 | 4 |
| Liverworts Marchantiophyta | | | |
| <i>Fossombronia wondraczekii</i> | PP | – | E |
| <i>Riccardia chamedryfolia</i> | SP | – | E |
| Mosses Bryophyta | | | |
| <i>Abietinella abietina</i> | PP | – | – |
| <i>Amblystegium radicale</i> | PP | R | R |
| <i>Aulacomnium palustre</i> | PP | – | – |
| <i>Callicladium haldanianum</i> | – | RT | – |
| <i>Calliergonella cuspidata</i> | PP | – | – |
| † <i>Cinclidium stygium</i> | SP | – | E |
| <i>Climacium dendroides</i> | PP | – | – |
| † <i>Ctenidium molluscum</i> | PP | – | – |
| <i>Dicranum polysetum</i> | PP | – | – |
| <i>D. scoparium</i> | PP | – | – |
| † <i>Drepanocladus sendtneri</i> | PP | – | R |
| <i>Eurhynchium angustirete</i> | PP | – | – |
| † <i>Helodium blandowii</i> | SP | – | E |
| <i>Hylocomiadelphus triquetrus</i> | PP | – | – |
| <i>Hylocomium splendens</i> | PP | – | – |
| <i>Leucobryum glaucum</i> | PP | – | – |
| <i>Limprichtia cossonii</i> | PP | – | – |
| † <i>Meesia triquetra</i> | SP | – | V |
| <i>Orthotrichum stramineum</i> | – | – | V |
| † <i>Paludella squarrosa</i> | SP | – | E |
| <i>Philonotis arnellii</i> | PP | – | V |
| <i>Pleurozium schreberi</i> | PP | – | – |
| <i>Polytrichum commune</i> | PP | – | – |
| <i>Pseudocalliergon lycopodioides</i> | SP | RT | E |
| † <i>P. trifarium</i> | SP | – | E |
| <i>Pseudoscleropodium purum</i> | PP | – | – |
| <i>Ptilium crista-castrensis</i> | PP | – | – |
| <i>Rhytidiadelphus squarrosus</i> | PP | – | – |
| <i>Sphagnum contortum</i> | PP | – | – |
| <i>S. denticulatum</i> | PP | – | – |
| <i>S. fallax</i> | PP | – | – |
| <i>S. fimbriatum</i> | PP | – | – |
| <i>S. flexuosum</i> | PP | – | – |
| <i>S. girgensohnii</i> | PP | – | – |

Table 2. Continued.

| Species name | Species protection in Poland | Threat category in Europe | Threat category in Poland |
|--------------------------------|------------------------------|---------------------------|---------------------------|
| <i>Sphagnum inundatum</i> | PP | – | – |
| <i>S. palustre</i> | PP | – | – |
| <i>S. russowii</i> | PP | – | – |
| <i>S. squarrosum</i> | PP | – | – |
| <i>S. teres</i> | PP | – | – |
| <i>S. warnstorfi</i> | PP | – | – |
| † <i>Splachnum ampullaceum</i> | PP | – | V |
| <i>Thuidium assimile</i> | PP | – | – |
| <i>Th. delicatulum</i> | PP | – | – |
| <i>Ulota crispa</i> | PP | – | V |

Key: column 1: † – species not confirmed, probably extinct; column 2: SP – strictly protected species, PP – partially protected species; columns 3 and 4: E – Endangered, I – Indeterminate, R – Rare, RT – Regionally threatened species, V – Vulnerable.

Habitat analysis of the bryoflora

Epigean bryophytes

Epigean bryophytes form the richest group in the bryoflora of the Olkusz Ore-bearing Region, consisting of 118 species (69.8%) (Fig. 66). The most interesting are species occurring on bare soil (waysides, wasteland), for example *Ditrichum heteromallum* and *Pohlia lescuriana* (species new to the Silesian Upland), as well as *Atrichum angustatum* (Brid.) Bruch & Schimp., *Dicranella crista* (Hedw.) Schimp. and *Ditrichum pusillum* (Hedw.) Hampe. The commonest species on epigean habitats, such as *Ceratodon purpureus* (Hedw.) Brid. and *Bryum argenteum* Hedw., frequently form large patches.

Of special interest is *Bryum pallescens* Schwägr. This moss grows in great abundance especially on old slag heaps and wastelands and seems to be a species associated with soil rich in heavy metals.

Forest floors are inhabited by common bryophytes such as *Atrichum undulatum*,

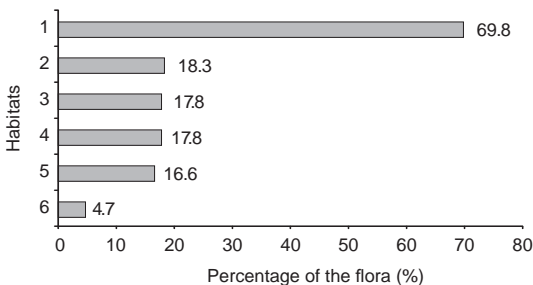


Fig. 66. Percentage of bryophytes in specific habitat types. 1 – epigean; 2 – epilithic; 3 – epiphytic; 4 – paludicolous; 5 – epixylic; 6 – aquatic.

Eurhynchium angustirete (Broth.) T.J.Kop. and *Mnium hornum* Hedw. (mainly in deciduous forests), as well as *Dicranum scoparium*, *Pleurozium schreberi*, *Hylocomium splendens* and *Pseudoscleropodium purum* (mainly in coniferous forests). Occasionally some species occur in scattered localities, for example *Rhytidiadelphus subpinnatus*, a species new to the Silesian Upland, and *Barbilophozia barbata*, which occurs only in the eastern part of the Silesian Upland.

Epilithic bryophytes

There are no larger rock outcrops in the Olkusz Ore-bearing Region and therefore all epilithic species occur on artificial rock-like habitats (walls, concrete posts and fences), as well as limestone rubble, mainly in abandoned quarries. However, the epilithic flora is relatively rich and is the second largest ecological group of bryophytes in the study area, comprising 31 species (18.3% of the total bryoflora). The bryoflora confined to epilithic habitats consists of common species, such as *Amblystegium serpens* (Hedw.) Schimp., *Bryum argenteum*, *Ceratodon purpureus*, *Didymodon rigidulus* Hedw., *Schistidium dupretii* and *S. crassipilum* H.H.Blom but no noteworthy species were observed here.

Epiphytic bryophytes

The epiphytic bryoflora is rather poor. Most obligatory epiphytes occur very rarely and in small quantities. The reason is primarily

the dramatic environmental transformation of the area, caused mainly by the excavation of zinc and lead ore, intensive forest management and the lack of larger stands of old trees. Air pollution caused by low emissions from local sources, fumes and pollutants from the Bolesław smelter plant work are also very important. Altogether 30 species (17.8% of the bryoflora) have been recorded on bark of trees and shrubs. The forest bryoflora is poor and only *Hypnum cupressiforme* occurs here relatively frequently.

The better developed epiphytic flora is associated with free standing trees, mainly *Populus* spp. and *Salix* spp. Frequently occurring species in such habitats include *Amblystegium serpens*, *Ceratodon purpureus*, *Hypnum cupressiforme* and *Pylaisia polyantha* (Hedw.) Schimp. They are accompanied by such species as *Dicranoweisia cirrata* (Hedw.) Milde, *Orthotrichum affine* Brid., *O. diaphanum* Brid., *O. obtusifolium* Brid., *O. speciosum* Nees and *Ulota crispa* (Hedw.) Brid. These mosses, until recently very rare or absent in the Silesian Upland (Jędrzejko, 1990; Stebel, 1997), have markedly increased the number of their sites in recent years in many regions of Poland (Stebel, 2010).

Epixylic bryophytes

Bryophytes confined to rotten wood constitute a relatively large group of 28 species (16.6% of the bryoflora). These are mostly common species, also associated with other habitats, and include *Amblystegium serpens*, *Brachythecium salebrosum* (F.Weber & D.Mohr) Schimp., *Ceratodon purpureus*, *Dicranum scoparium* and *Hypnum cupressiforme*. One noteworthy species, *Riccardia palmata*, has been observed at only one locality, but its population was scanty. Some species associated mainly with epigeal habitats, for example *Leucobryum glaucum* and *Ptilium crista-castrensis*, in the Olkusz Ore-bearing

Region occur on stumps and logs. This phenomenon was observed also in the other parts of the Silesian Upland, mostly in areas with intensive forest management (Stebel, 1998c).

Paludicolous bryophytes

The bryoflora occurring in swampy habitats is fairly rich and consists of 30 species (17.8%). The most interesting species associated with eutrophic habitats include *Calliergon giganteum* (Hedw.) Kindb., *Limprichtia cossonii* (Schimp.) L.E.Anderson, H.A.Crum & W.R.Buck, *Sphagnum contortum*, *S. teres* and *S. warnstorffii* which occur in the northern periphery of the investigated area. Their habitats cover very small areas and are strongly threatened by the overgrowth of grass and shrub communities, and there is a strong likelihood that they may disappear in the short term. An interesting concentration of paludicolous bryophytes of oligotrophic habitats, such as *Sphagnum fallax* (Klinggr.) Klinggr., *Straminergon stramineum* and *Warnstorffia fluitans*, occurs in the vicinity of the settlement of Cegielnia in boggy thicket and coniferous forest habitats and at present seem not to be threatened. In many wet depressions, wastelands and ditches, few species, such as *Calliergonella cuspidata* (Hedw.) Loeske and *Drepanocladus polycarpos* (Voit) Warnst., are observed.

Aquatic bryophytes

Eight species (4.7%) of bryophytes were found growing in water in canals and ponds and in the Sztola river and constitute the smallest habitat group. The most frequent species are *Cratoneuron filicinum* (Hedw.) Spruce, *Leptodictyum riparium* (Hedw.) Warnst. and *Torrentaria ripariodes*. A noteworthy rare species occurrence is the mountain species *Sciurohypnum plumosum*.

Heavy metals in the environment and bryophytes

Assessment of the levels of environmental pollution can be carried out in two ways: using measuring devices or using organisms as indicators (Maschke, 1981; Markert *et al.*, 2003). The best indicators are those plants that have minimal uptake of nutrients from the substrate. This condition is met mainly by mosses. The purpose of biomonitoring using mosses is to determine the level of damage to the environment by gaseous and non-gaseous (dry and wet precipitation) air pollution. Mosses were used already in the 1960s and 1970s to assess the degree of the environment contamination (e.g. Rühling & Tyler, 1968; Tyler, 1970; Goodman & Roberts, 1971; Steinnes, 1987). In Poland, they were used for the first time to assess the degree of heavy metals contamination of the environment in national parks (Grodzińska, 1978).

Mosses are used to assess the current state of environment, as well as for the research at specified time intervals to track changes over the years (Rühling, 1994; Rühling *et al.*, 1997; Buse *et al.*, 2003; Harmens *et al.*, 2008, 2013). Using widely distributed species as indicators, large areas can be assessed, e.g. a whole continent (Harmens *et al.*, 2013), region (Suchar *et al.*, 2007a, b), selected countries (e.g., Poikolainen *et al.*, 2004; Grodzińska *et al.*, 1999; Cole *et al.*, 2014), as well as small areas such as national parks, nature reserves, forest complexes (e.g., Grodzińska *et al.*, 1990;

Godzik & Szarek, 1993; Grodzińska & Godzik, 1991; Szarek-Łukaszewska *et al.*, 2002). Most often mosses are used to record the impact of heavy metals on the environment, but they also have been shown to be good indicators of nitrogen levels in the environment (Kapusta *et al.* 2014b; Harmens *et al.*, 2015), organic pollutants such as PAHs (Gerdol *et al.*, 2002; Gałuszka, 2006; Godzik *et al.*, 2014), and radionuclides (Gerdol *et al.*, 2002).

Since 1990 most European countries have participated in five-yearly monitoring of heavy metal deposits in a few bioindicator moss species including *Pleurozium schreberi*, *Hylocomium splendens* (Hedw.) Schimp., *Hypnum cupressiforme* and *Pseudoscleropodium purum* (Rühling, 1994; Rühling *et al.*, 1997; Suchara *et al.*, 2007a, b; Harmens *et al.*, 2008, 2013).

Studies using mosses for the assessment of the level of heavy metal contamination within the Olkusz Ore-bearing Region, have been performed several times. Today, the main sources of metal contamination in the area are the emissions from the Boleslaw Mining and Metallurgical Plant in Bukowno (ZGH Boleslaw) and dusts from the slag heap, where the flotation tailings are deposited. The dust from this heap (height of 25–30 m, area of 109 ha), transported by wind, contributes to the contamination of the surrounding areas (Godzik, 2015).

More extensive research on heavy metal pollution in the vicinity of Olkusz has been made from the beginning of the 2000s with *Pleurozium schreberi* and the moss-bag method using *Sphagnum fallax* (Dmuchowski, 2005). Results were presented in the form of maps with the respective isoquants. The highest concentrations of elements associated with typical emissions for the region, i.e. zinc (Zn), lead (Pb), cadmium (Cd), iron (Fe) and arsenic (As) occurred in the area including the cities of Olkusz, Bolesław and Bukowno. Average concentrations of these metals significantly exceeded the values specified in the controls. *Sphagnum fallax* (the moss-bag method) accumulated lower concentrations of metals than *Pleurozium schreberi* collected directly in the field. The maximum concentrations in *P. schreberi* exceeded the control levels and were respectively: 1990 mg/kg Zn (42 mg/kg control), 1096 mg/kg Pb (3.1 mg/kg control), 17.7 mg/kg (0.16 mg/kg control), 5431 mg/kg Fe (243 mg/kg control), 19.0 mg/kg As (0.21 mg/kg control) (Dmuchowski, 2005).

The level of heavy metals, using mosses as bio-indicators, is regularly assessed in the region of Olkusz from several sites designated by the European program for monitoring the deposition of heavy metals. The heavy metals in mosses biomonitoring network was originally established in 1980 as a Swedish initiative and assays have since been repeated at five-yearly intervals. The first moss survey on a European scale was conducted in 1990 in the framework of ICP Vegetation Programme Coordination Centre (Working Group on Effects of the Convention on Long-range Transboundary Air Pollution). In the initial phase of this research the Silesian-Krakow region (including the vicinity of Olkusz) was found to be one of the most polluted in Europe (Rühling, 1994; Rühling *et al.*, 1997). During subsequent years there has been a definite decrease in the heavy metals deposition, but the Olkusz area still belongs to the most polluted with these elements (Buse *et al.*, 2003; Harmens *et al.*, 2008, 2013; Kapusta *et al.*, 2014a).

Changes in the bryoflora

The oldest records of the bryoflora are mostly fragmentary but date from the middle of the twentieth century when the Olkusz Ore-excavating Region was significantly altered as a result of centuries of human activity. For that reason a detailed comparison of changes in the flora is impossible. However, since that time there is little doubt that some interesting peatland moss species, such as *Helodium blandowii* (F.Weber & D.Mohr) Warnst., *Meesia triquetra* (Jolycl.) Ångstr., *Pseudocalliergon trifarium* (F.Weber & D.Mohr) Loeske and *Paludella squarrosa* (Hedw.) Brid., have become extinct. The most probable reason seems to be the fall off in the level of ground water caused by intense zinc and lead mining, as well as the abandonment of the traditional exploitation of meadows, pastures and fens, which caused their succession towards scrubland and forest congeries. A fairly large group of species which have not been rediscovered in the study area are mosses associated with grassland and early successional habitats, for example *Fissidens dubius*, *Homalothecium lutescens* (Hedw.) H.Rob. and *Protobryum bryooides* (Dicks.) J.Guerra & Cano. Xerothermic grasslands occupy only a small

part of the study area (Nowak *et al.*, 2011), partly due to habitat destruction through the construction of buildings and the abandonment of traditional farm management (grazing), which resulted in a successional shift towards shrublands and woodlands.

Numerous inoperative excavation sites of the mineral raw materials (dolomite, sand), which tend to be places rich in interesting species of bryophytes (Stebel, 2006b), were buried and reclaimed. Changes in the epiphytic flora seem interesting. Until recently, epiphytes constituted extremely rare elements of the bryoflora of the Silesian Upland (Jędrzejko, 1990). In recent years in many regions of Poland, for example in the Pieniny range (Stebel *et al.*, 2010) and in the Silesian Upland (Fojcik & Stebel, 2014), an increase in abundance of epiphytes has been observed. However, it mostly includes species of the family Orthotrichaceae. A similar situation occurs in the Olkusz Ore-bearing Region, where mosses such as *Orthotrichum stramineum* Brid. and *Ulotia crispa* were found. Until recently, they were believed to be endangered in Poland (Żarnowiec *et al.*, 2004).

List of collecting sites

For each collecting site the following data are given:

1. ATMOS grid square (in brackets), according to Ochyra & Szmajda (1981).

2. Topographical description, if necessary.

Identification of numbered localities in Figure 5 (Alphabetical)

Names of localities are typed in **bold** face.

Grid square **Fd 36/80**

Krzykawa, long. 19°25'51.47"E, lat.

50°18'31.82"N, north-eastern end of the village, alt. 349 m.

Krzykawa, Pokrzywdzie, long. 19°25'52.5"E, lat. 50°18'43.4"N, alt. 353 m.

Grid square **Fd 36/81**

Between **Pniaki** and **Krzykawa**, long. 19°26'08" – 19°26'20"E, lat. 50°18'20" – 50°18'40"N, east of the Krzykawa – Laski road, alt. 340–350 m.

Pniaki, long. 19°26'08" – 19°26'20"E, lat. 50°18'30" – 50°18'44"N, east of the Krzykawa – Laski road, alt. 340–350 m.

Grid square **Fd 36/82**

Zimny Dół in Nowy Ujków, long. 19°27'05" – 19°27'15"E, lat. 50°18'18" – 50°18'24"N, between Długa Street and the "Gierkówka" Road¹, alt. 335–340 m.

Between **Nowy Ujków** and **Kolonia Nowy Ujków Dół**, long. 19°27'25" – 19°27'35"E,

lat. 50°18'30" – 50°18'40"N, Dąbrówka Canal by Długa and Pleścińska Streets, alt. 307 m.

Kolonia Nowy Ujków, long. 19°27'18" – 19°27'23"E, lat. 50°18'47" – 50°18'48"N, Dąbrówka Canal near Laskowska Street, alt. 307 m.

Kolonia Nowy Ujków, long. 19°27'30" – 19°27'47"E, lat. 50°18'28" – 50°18'37"N, Dąbrówka Canal between Długa Street and the "Gierkówka" Road, alt. 310 m.

Grid square **Fd 36/83**

Kolonia Nowy Ujków 'Cicha Kolonia', long. 19°28'20" – 19°28'35"E, lat. 50°18'40" – 50°18'45"N, Cegielniana Street, alt. 310 m.

Kolonia Nowy Ujków, 'Cicha Kolonia', long. 19°28'30" – 19°28'35"E, lat. 50°18'45" – 50°18'47"N, Cegielniana Street, small peatland east of Poręba, alt. 310 m.

Kolonia Nowy Ujków, long. 19°28'00" – 19°28'10"E, lat. 50°18'40" – 50°18'46"N, at Bolesławska Street, north of Pleścińska Street, wetland on the right-hand side of the street, alt. 310 m.

Kolonia Nowy Ujków, long. 19°28'14" – 19°28'16"E, lat. 50°18'29" – 50°18'30"N, at the junction of Bolesławska and Poręba Streets with the "Gierkówka" Road, alt. 310 m.

Between **Kolonia Nowy Ujków** and **Busznice**, long. 19°27'50" – 19°28'10"E, lat. 50°18'20" – 50°18'25"N, Dąbrówka Canal, south of the "Gierkówka" Road, alt. 310 m.

¹ A popular name of the dual carriageway section of the national road No 94 from Katowice to Olkusz.

Grid square **Fd 36/84**

Sztolnia Ponikowska in Cegielnia, long. 19°29'20" – 19°29'29"E, lat. 50°18'35" – 50°18'45"N, midway between Hutki and Kolonia Nowy Ujków, alt. 310 m.

Sztolnia Ponikowska between Cegielnia and Poręba, long. 19°28'55" – 19°29'10"E, lat. 50°18'40" – 50°18'48"N, alt. 310 m.

Sztolnia Ponikowska in Poręba 800 m west of Cegielnia, long. 19°28'40" – 19°28'55"E, lat. 50°18'45" – 50°18'48"N, alt. 310 m.

Sztolnia Ponikowska in Cegielnia, long. 19°29'19"E, lat. 50°18'39"N, alt. 310 m.

Grid square **Fd 36/85**

Hutki, long. 19°30'10" – 19°30'19"E, lat. 50°18'40" – 50°18'48"N, 0.5 km north-east of the right-hand side of Królewska Street, south of Wisielok, alt. 315 m.

Sztolnia Ponikowska, between **Karna** and **Górka**, 0.5 km north-west of Hutki, long. 19°29'45" – 19°30'00"E, lat. 50°18'40" – 50°18'48"N, alt. 310 m.

Hutki, 250 m towards the west, long. 19°29'45"E, lat. 50°18'35"N, alt. 310 m.

Karna, near the road to Hutki, long. 19°29'54"E, lat. 50°18'47"N, alt. 313 m.

Grid square **Fd 36/86**

Hutki, 0.5 km E of the village, long. 19°30'20" – 19°31'09"E, lat. 50°18'18" – 50°18'48"N, pine forest and extensive sandpit, alt. 316 m.

Grid square **Fd 36/87**

Pomorzany, 2 km towards the west, long. 19°31'10" – 19°32'00"E, lat. 50°18'18" – 50°18'48"N, pine forest near the eastern part of extensive sandpit, alt. 315–325 m.

Grid square **Fd 36/90**

Małobądz, long. 19°25'55" – 19°26'00"E, lat. 50°18'10" – 50°18'15"N, Miła Street, alt. 340–345 m.

Małobądz Krze, Szamrak hill, long. 19°25'45" – 19°25'50"E, lat. 50°18'00" – 50°18'09"N, alt. 330–340 m.

Between **Podlipie** and **Małobądz Krze**, long. 19°25'30" – 19°26'05"E, lat. 50°17'48" – 50°17'50"N, stream south of the "Gierkówka" Road, alt. 330–340 m.

Grid square **Fd 36/91**

Nowy Ujków, long. 19°26'15" – 19°26'25"E, lat. 50°18'08" – 50°18'15"N, between Las-kowska Street and the "Gierkówka" Road, alt. 340–344 m.

Between **Podlipie** and **Małobądz**, long. 19°26'08" – 19°26'35"E, lat. 50°17'50" – 50°17'55"N, stream south of the "Gierkówka" Road, alt. 325 m.

Grid square **Fd 36/92**

Bolesław, long. 19°27'00" – 19°27'30"E, lat. 50°17'55" – 50°18'00"N, Główna Street, alt. 335 m.

Bolesław-Ćmielówka, long. 19°27'25" – 19°27'48"E, lat. 50°18'00" – 50°18'05"N, road east of Glinianki, alt. 335 m.

Grid square **Fd 36/93**

Bolesław, long. 19°28'10" – 19°28'20"E, lat. 50°17'55" – 50°18'05"N, Szkolna Street between Główna and Bolesławska Streets, alt. 330 m.

Bolesław, long. 19°28'15" – 19°28'30"E, lat. 50°18'15" – 50°18'18"N, Dąbrówka Canal at Pleścińska Street, alt. 305 m.

Bolesław, long. 19°27'46" – 19°27'48"E, lat. 50°18'11" – 50°18'13"N, loess ravine west of Pleściska, alt. 305 m.

Bolesław, long. 19°28'20" – 19°28'21"E, lat. 50°17'45" – 50°17'46"N, old cemetery north of the church, alt. 333 m.

Grid square **Fd 36/94**

Bolesław, long. 19°28'41" – 19°28'45"E, lat. 50°18'00" – 50°18'15"N, Wyzwolenia Street, alt. 312 m.

Bolesław, long. 19°28'50" – 19°29'10"E, lat. 50°17'55" – 50°18'00"N, Chmielna Street, alt. 315 m.

Bolesław, long. 19°29'10" – 19°29'18"E, lat. 50°18'15" – 50°18'18"N, Dąbrówka Canal east of the "Gierkówka" Road, alt. 310 m.

Bolesław, Kluczevska Street, Rozmus Forest, long. 19°29'15" – 19°29'28"E, lat. 50°17'45" – 50°17'50"N, alt. 313 m.

Grid square **Fd 36/95**

Dąbrówka, long. 19°29'29" – 19°29'40"E, lat. 50°17'45" – 50°17'52"N, Rozmus pine forest east of Kluczevska Street, alt. 313 m.

Dąbrówka, long. 19°29'35" – 19°29'42"E, lat. 50°18'10" – 50°18'15"N, Dąbrówka Canal near Kluczevska Street, alt. 313 m.

Bolesław, long. 19°30'10" – 19°19'13"E, lat. 50°18'00" – 50°18'05"N, Dąbrówka Canal 150 m near the "Pomorzany" mine and "Dąbrówka" shaft, alt. 313 m.

Grid square **Fd 36/96**

Sztolnia Ponikowska, long. 19°30'20" – 19°31'09"E, lat. 50°17'46" – 50°18'17"N, pine forest 200 m east of the "Dąbrówka" shaft of the "Pomorzany" mine with a new sandpit, alt. 317–325 m.

Grid square **Fd 36/97**

Stary Olkusz, long. 19°31'20" – 19°31'59"E, lat. 50°17'48" – 50°18'17"N, pine forest 3 km towards the north-west, near the "Mieszko" adit, alt. 320–325 m.

Grid square **Fd 46/00**

Podlipie-Sołtysie, area south of the settlement, long. 19°25'36"E, lat. 50°17'31"N, alt. 350 m.

Grid square **Fd 46/01**

Podlipie-Górka, place south of the Krążek-Podlipie road, long. 19°26'36"E, lat. 50°17'22"N, alt. 330 m.

Grid square **Fd 46/02**

Krążek, long. 19°27'04" – 19°27'12"E, lat. 50°17'22" – 50°17'28"N, ponds, alt. 322 m.

Krążek, long. 19°27'11" – 19°27'40"E, lat. 50°17'30" – 50°17'39"N, meadows between Podlipie and Polna Street, alt. 322 m.

Krążek, long. 19°27'18" – 19°27'34"E, lat. 50°17'30" – 50°17'39"N, near the traffic roundabout in the north-east part of the village by the main street, alt. 322 m.

Krążek, long. 19°27'25" – 19°27'46"E, lat. 50°17'20" – 50°17'30"N, 200 m from the traffic roundabout on the road to Tłukienka, deciduous forest, alt. 335 m.

Grid square **Fd 46/03**

Bolesław, long. 19°28'18" – 19°28'23"E, lat. 50°17'35" – 50°17'43"N, near the church and in the park, alt. 325 m.

Forest Joanna, long. 19°27'48" – 19°28'07"E, lat. 50°17'12" – 50°17'20"N, on the right-hand side of the road Krążek – Tłukienka, 800 m S of Bolesław, deciduous forest, alt. 335 m.

Between **Krążek** and **Tłukienka**, long. 19°28'05" – 19°28'20"E, lat. 50°17'12" – 50°17'25"N, deciduous forest on the left-hand side of the Krążek – Tłukienka road, 500 m south of Bolesław and 400 m west of Stara Wieś, alt. 340 m.

Bolesław, so-called Old Waste Dump, long. 19°28'15" – 19°28'30"E, lat. 50°17'25" – 50°17'32"N, alt. 340 m.

Bolesław, long. 19°28'35" – 19°28'38"E, lat. 50°17'26" – 50°17'28"N, 300 m south of the centre and 100 m south of the crossroads on Parkowa Street near Stara Wieś, on the abandoned orchard; alt. 318 m.

Bolesław, long. 19°28'37" – 19°28'38"E, lat. 50°17'30" – 50°17'31"N, 300 m south of the centre, at the crossroads on Parkowa Street near Stara Wieś, on wayside; alt. 319 m.

Bolesław, long. 19°27'50" – 19°28'00"E, lat. 50°17'36" – 50°17'43"N, cemetery by the road to Krążek, alt. 335 m.

Grid square **Fd 46/04**

Stara Wieś, long. 19°28'38" – 19°28'40"E, lat. 50°17'26" – 50°17'28"N, deciduous forest near a swampy area, alt. 315 m.

Stara Wieś, long. 19°28'42" – 19°28'47"E, lat. 50°17'25" – 50°17'28"N, pond and swamps on its western and southern margins, alt. 315 m.

Stara Wieś, long. 19°28'48" – 19°28'50"E, lat. 50°17'23" – 50°17'26"N, pond and swamps on its south-eastern margin, alt. 315 m.

Stara Wieś, long. 19°28'40" – 19°28'50"E, lat. 50°17'31" – 50°17'32"N, road running from the crossroads at Parkowa Street to the sports ground, wayside, alt. 319 m.

Bolesław, long. 19°29'00" – 19°29'25"E, lat. 50°17'30" – 50°17'35"N, sports ground, deciduous and pine forest towards the south-east in south of the road to the pump station north of the flotation tailings heap of the "Olkusz" mine, wayside, alt. 315 m.

Grid square **Fd 46/05**

Ujków Stary, long. 19°30'05" – 19°30'18"E, lat. 50°17'25" – 50°17'32"N, pine-birch forest north of the flotation tailings heap of the "Olkusz" mine at the sharp bend near the "Gierkówka" Road, alt. 318 m.

Ujków Stary, long. 19°29'50" – 19°30'05"E, lat. 50°17'19" – 50°17'22"N, northern slope of the flotation tailings heap of the "Olkusz" mine, alt. 320–340 m.

Ujków Stary, long. 19°29'50"E, lat. 50°17'25" – 50°17'28"N, channel at the pumping station on the northern side of the flotation tailings heap of the "Olkusz" mine, alt. 320 m.

Ujków Stary, long. 19°29'48" – 19°29'53"E, lat. 50°17'30" – 50°17'35"N, pine forest dominated by *Molinia coerulea* 200 m north of the pumping station on the northern side of the

flotation tailings heap of the "Olkusz" mine, alt. 320 m.

Dąbrówka, Rozmus, long. 19°29'30" – 19°29'55"E, lat. 50°17'38" – 50°17'43"N, 600 m to the west of the sharp bend and 500 m north of the pumping station on the northern side of the flotation tailings heap of the "Olkusz" mine, alt. 316 m.

Grid square **Fd 46/06**

Stary Olkusz, long. 19°30'35" – 19°31'10"E, lat. 50°17'25" – 50°17'40"N, pine forest 1 km towards the west on the right-hand side of the "Gierkówka" Road near the Roznos Canal, alt. 330 m.

Stary Olkusz, long. 19°30'30" – 19°30'40"E, lat. 50°17'27" – 50°17'35"N, pine forest 1 km towards the west on the right-hand side of the "Gierkówka" Road along the Roznos Canal, alt. 330 m.

Stary Olkusz, long. 19°30'19" – 19°30'25"E, lat. 50°17'30" – 50°17'35"N, pine forest 1 km towards the west on the right-hand side of the "Gierkówka" Road, deciduous forest on the left-hand side of the Roznos Canal, alt. 330 m.

"Grodzisko" (emplacement of a medieval castle) in Stary Olkusz, long. 19°30'55" – 19°31'00"E, lat. 50°17'14" – 50°17'18"N, pine forest towards the north-west and 200 m weuth-west of an old limestone quarry on the "Gierkówka" Road by the Roznos Canal, alt. 340 m.

"Grodzisko" (emplacement of a medieval castle) in Stary Olkusz, long. 19°31'01" – 19°31'05"E, lat. 50°17'14" – 50°17'15"N, pine forest towards the north-west and 200 m south-west of an old limestone quarry on the "Gierkówka" Road by the Roznos Canal, small old quarry closed down in the 1960s, alt. 340 m.

"Grodzisko" (emplacement of a medieval castle) in Stary Olkusz, long. 19°31'03" – 19°31'05"E, lat. 50°17'12" – 50°17'13"N, pine forest towards the north-west and 200 m south-west of an old limestone quarry on

the “Gierkówka” Road, south of a small old quarry closed down in the 1960s, deciduous forest by the pipe of the Roznos Canal, alt. 340 m.

Grid square **Fd 46/07**

Stary Olkusz, long. 19°31'30" – 19°31'50"E, lat. 50°17'12" – 50°17'30"N, Pomorska Street, pine forest with numerous dumps; alt. 335 m.

Stary Olkusz, old stonepit closed in 1995 in pine forest by the “Gierkówka” Road, long. 19°31'10" – 19°31'16"E, lat. 50°17'20" – 50°17'24"N, pine forest with numerous dumps, alt. 335 m.

Grid square **Fd 46/10**

Bukowno-Kleparz, area south of the settlement, long. 19°25'22"E, lat. 50°16'48"N, alt. 310 m.

Grid square **Fd 46/11**

Wodaça, long. 19°26'47" – 19°26'55"E, lat. 50°16'45" – 50°16'50"N, Sztolnia Canal 200 m north-east of the fire station, alt. 310 m.

Grid square **Fd 46/12**

Between **Tłukienka** and **Wygietza**, long. 19°27'50" – 19°28'00"E, lat. 50°16'43" – 50°16'46"N, deciduous forest, alt. 339 m.

Between **Tłukienka** and **Wygietza**, long. 19°27'15" – 19°27'25"E, lat. 50°16'45" – 50°16'50"N, fallow land, alt. 335 m.

Wodaça, 1.5 km north-west of Bukowno, long. 19°26'56" – 19°27'05"E, lat. 50°16'52" – 50°16'54"N, Sztolnia Canal, alt. 310 m.

Wodaça, 1.5 km north-west of Bukowno, long. 19°26'55" – 19°27'05"E, lat. 50°16'41" – 50°16'42"N, deciduous forest 150 m east of the Sztolnia Canal, alt. 320 m.

Grid square **Fd 46/13**

Ujków Stary, 500 m towards the west, long. 19°28'15" – 19°28'25"E, lat. 50°17'05"

– 50°17'12"N, pine and deciduous forest by the road to the refuse dump, alt. 335 m.

Between **Krażek** and **Tłukienka**, long. 19°28'00" – 19°28'05"E, lat. 50°17'05" – 50°17'10"N, grassland on the right-hand side of the Krążek – Tłukienka road, on the opposite side of the road to the refuse dump in Ujków Stary, alt. 335 m.

Tłukienka, long. 19°28'00" – 19°28'08"E, lat. 50°16'50" – 50°16'55"N, in an old church and adjacent deciduous forest, alt. 340 m.

Between **Tłukienka** and **Wygietza**, long. 19°27'50" – 19°28'00"E, lat. 50°16'43" – 50°16'46"N, old church and adjacent deciduous forest, alt. 345 m.

Grid square **Fd 46/14**

Ujków Stary, long. 19°29'15" – 19°29'23"E, lat. 50°16'55" – 50°17'00"N, refuse dump 400 m towards the south-east and 200 m west of the flotation tailings heap of the “Olkusz” mine, alt. 335 m.

Ujków Stary, long. 19°28'55" – 19°29'05"E, lat. 50°17'05" – 50°17'11"N, 1 km south-east of Bolesław, west of the road to the refuse dump, alt. 330 m.

Grid square **Fd 46/15**

Ujków Stary, long. 19°30'09" – 19°30'17"E, lat. 50°16'45" – 50°17'10"N, thin stands of *Betula pendula* and *Pinus sylvestris* by the road at the foot of the western side of the flotation tailings heap of the “Olkusz” mine, alt. 320 m.

Ujków Stary, long. 19°29'30" – 19°28'35"E, lat. 50°16'55" – 50°17'03"N, silt-covered land by the road to the refuse dump at the western side of the flotation tailings heap of the “Olkusz” mine, alt. 320 m.

Grid square **Fd 46/16**

“**Grodzisko**” (emplacement of a medieval castle) in Stary Olkusz, long. 19°31'00" – 19°31'05"E, lat. 50°17'08" – 50°17'10"N, pine forest 700 m towards the west and 300 m south-west

of an old limestone quarry on the “Gierkówka” Road south of the Roznos Canal, alt. 340 m.

Stary Olkusz, long. 19°30'20" – 19°30'30"E, lat. 50°16'50" – 50°16'52"N, pine forest by sandpit 300 m east of the flotation tailings heap of the “Olkusz” mine by the road towards the mine, alt. 325 m.

Grid square **Fd 46/17**

“**Grodzisko**” (emplacement of a medieval castle) in Stary Olkusz, long. 19°31'35" – 19°31'43"E, lat. 50°17'05" – 50°17'10"N, 400 m west of the “Olkusz” mine and “Chrobry” shaft, alt. 340 m.

“**Grodzisko**” (emplacement of a medieval castle) in Stary Olkusz, long. 19°31'20" – 19°31'25"E, lat. 50°17'03" – 50°17'08"N, 500–600 m west of the “Olkusz” mine and “Chrobry” shaft, at the beginning of the Roznos Canal, alt. 345 m.

“**Grodzisko**” (emplacement of a medieval castle) in Stary Olkusz, long. 19°31'09" – 19°31'20"E, lat. 50°17'05" – 50°17'10"N, 1 km west of the “Olkusz” mine and “Chrobry” shaft, by the upper course of the Roznos Canal, alt. 340 m.

Stary Olkusz, long. 19°31'20" – 19°31'35"E, lat. 50°16'40" – 50°16'54"N, thin stands of *Betula pendula* and *Pinus sylvestris* south of the road to the “Olkusz” mine and the sewage purification plant, alt. 335 m.

Stary Olkusz, long. 19°30'20" – 19°30'25"E, lat. 50°17'25" – 50°17'30"N, small pine-birch forest north-east of the office of the transport base at the north-eastern corner of the flotation tailings heap of the “Olkusz” mine on the left-hand side of the “Gierkówka” Road, alt. 330 m.

Grid square **Fd 46/20**

Jamna Góra in Bukowno, old quarry, long. 19°25'43"E, lat. 50°16'33"N, alt. 320 m.

Bukowno-Cyzowizna, near the Sztolnia Canal toward the west of Jamna Góra, long. 19°25'42"E, lat. 50°16'21"N, alt. 300 m.

Grid square **Fd 46/21**

Between **Wodąca** and **Skotnica**, long. 19°26'48" – 19°26'55"E, lat. 50°16'30" – 50°16'39"N, deciduous forest 200 m east of the fire station in Wodąca and near the cemetery, alt. 320 m.

Between **Wodąca** and **Skotnica**, long. 19°26'40" – 19°26'46"E, lat. 50°16'25" – 50°16'32"N, Sztolnia Canal near the cemetery, alt. 320 m.

Bukowno-Cyzowizna, eastern part, near the Sztolnia Canal, long. 19°26'15"E, lat. 50°16'26"N, alt. 300 m.

Grid square **Fd 46/22**

Between **Thukienka** and **Wygiełża**, long. 19°27'38" – 19°27'42"E, lat. 50°16'38" – 50°16'40"N, fallow land south of the road, alt. 335 m.

Wodąca, deciduous forest 400 m east of the fire station, 300 m west of Wygiełży and 200 m north-west of the cemetery, long. 19°26'56" – 19°27'05"E, lat. 50°16'30" – 50°16'45"N, alt. 320 m.

Bukowno-Skałka, western part, long. 19°27'24"E, lat. 50°16'19"N, alt. 325 m.

Grid square **Fd 46/23**

Bukowno, long. 19°28'00" – 19°28'08"E, lat. 50°16'30" – 50°16'38"N, north of the transformer station by Kolejowa Street, opposite the Bolesław smelting works, waste dumps, alt. 335 m.

Bukowno, long. 19°28'10" – 19°28'16"E, lat. 50°16'21" – 50°16'28"N, between the school and the Bolesław smelting works, alt. 350 m.

Bukowno, long. 19°28'10" – 19°28'30"E, lat. 50°16'08" – 50°16'15"N, deciduous forest north of Leśna Street, alt. 340 m.

Grid square **Fd 46/24**

Starczynów, long. 19°28'45" – 19°29'12"E, lat. 50°16'08" – 50°16'20"N, Poprzeczna Street, alt. 320–330 m.

Grid square **Fd 46/25**

Starczynów, long. 19°30'00" – 19°30'18"E, lat. 50°16'08" – 50°16'12"N, pine and spruce forest east of Sosnowa Street in the former Starczynowska Desert, between the Baba Canal and the Desert Trail, alt. 322 m.

Starczynów, long. 19°29'30" – 19°30'10"E, lat. 50°16'10" – 50°16'20"N, Baba Canal between the end of Bukowa Street and the bend in the road towards the flotation tailings heap of the "Olkusz" mine in the former Starczynowska Desert, alt. 322 m.

Grid square **Fd 46/26**

Pustynia Starczynowska, Baba Canal, long. 19°30'18" – 19°31'00"E, lat. 50°16'18" – 50°16'24"N, along the broad gauge railway east of the eastern side of the flotation tailings heap of the "Olkusz" mine, alt. 324 m.

Grid square **Fd 46/27**

Pustynia Starczynowska, long. 19°31'10" – 19°31'58"E, lat. 50°16'09" – 50°16'30"N, 1.5 km west of Olkusz along the Desert Trail, alt. 330–335 m.

Pustynia Starczynowska, long. 19°31'08" – 19°31'44"E, lat. 50°16'309" – 50°16'36"N, Baba Canal 700 m towards the south-west starting from the air-shaft of the "Olkusz" mine, alt. 325–331 m.

Grid square **Fd 46/30**

Bukowno, the Sztoła river valley, long. 19°26'01"E, lat. 50°15'46"N, alt. 298 m.

Grid square **Fd 46/31**

Bukowno, the Sztoła river valley, long. 19°26'33"E, lat. 50°15'42"N, alt. 300 m.

Grid square **Fd 46/32**

Bukowno, on the right bank of the Sztoła river between Pocztowa and Cicha Streets, long.

19°26'56" – 19°27'45"E, lat. 50°15'37" – 50°15'50"N, alt. 307–310 m.

Grid square **Fd 46/33**

Bukowno, long. 19°27'45" – 19°28'35"E, lat. 50°15'37" – 50°15'50"N, on the right bank of the Sztoła river between Pocztowa and Spacerowa Streets, alt. 307–310 m.

Grid square **Fd 46/34**

Between **Bukowno** and **Starczynów**, long. 19°28'35" – 19°29'00"E, lat. 50°15'45" – 50°16'00"N, Baba Canal along Młyńska Street, alt. 315 m.

Grid square **Fd 46/35**

Starczynów, long. 19°29'30" – 19°30'00"E, lat. 50°16'00" – 50°16'08"N, pine and spruce forest east of Sosnowa Street in the former Starczynowska Desert, along the Desert Trail, alt. 320 m.

Starczynów, long. 19°30'00" – 19°10'00"E, lat. 50°16'05" – 50°16'08"N, pine and spruce forest east of Sosnowa Street in the former Starczynowska Desert, along the Desert Trail, alt. 320–323 m.

Grid square **Fd 46/36**

Pustynia Starczynowska, 2 km south-east of Bukowno and 2 km south of Starczynów, long. 19°30'20" – 19°31'08"E, lat. 50°15'37" – 50°16'08"N, pine forest, alt. 323–340 m.

Grid square **Fd 46/37**

Pustynia Starczynowska, 2 km north-west of Żurada and 2 km south-east of Starczynów, long. 19°31'10" – 19°31'58"E, lat. 50°15'37" – 50°16'08"N, pine forest, alt. 332–340 m.

Systematic list of bryophytes

Altogether bryophytes in the Olkusz Ore-bearing Region were collected from 107 stations (see list of localities in the preceding chapter).

Key to abbreviations: *c. gem.* – with gemmae; *c. spor.* – with sporophytes; Lit. – literature records; stat. – station(s).

MARCHANTIOPHYTA — LIVERWORTS

Family **Marchantiaceae** Lindl.

1. *Marchantia polymorpha* L. subsp. *ruderalis* Bischl. & Boisselier – Rare (Fig. 67). In ruderal places, on disturbed waysides, canal banks and watercourses and ash deposits in patches of scorched ground. Commonly found with gemmae. Very frequent on the Silesian Upland where it thrives in similar habitats (Jędrzejko, 1985; Stebel, 1997; Fojcik & Stebel, 2001).

6 stat.: Fd 36/82 – east of Kolonia Nowy Ujków, the Dąbrówka Canal between Długa Street and Katowice-Olkusz road; Fd 46/03 – between Krążek and Tłukienka; Fd 46/07 – Stary Olkusz, Pomorska Street; 46/13 – Ujków Stary, wayside; Fd 46/20 – Bukowno-Cyzowizna, in a limestone kiln; Fd 46/27 – Pustynia Starczynowska, 1.5 km west of Olkusz along the Desert Trail, on spoil heap.

Family **Ricciaceae** Rchb.

2. *Riccia glauca* L. – Very rare (Fig. 68). Widely distributed but scattered in arable fields in the Silesian Upland (Jędrzejko, 1985; Stebel, 1997; Fojcik & Stebel, 2001).

1 stat.: Fd 36/80 – Krzykawa, on soil in dry and insolated situation in a wheat field, associated with *Pohlia melanodon*, *Leptobryum pyriforme* and *Dicranella staphylina*.

Family **Fossombroniaceae** Hazsl.

3. *Fossombronia wondraczekii* (Corda) Lindb. – Very rare (Fig. 69). Although this is the most frequent species of the genus *Fossombronia* Raddi in Poland, it is placed in the red list of Polish hepatics in the category E which comprises threatened species (Kłama, 2006b). An infrequent species in the Silesian Upland, known from some scattered localities (Jędrzejko, 1985; Stebel, 1997; Fojcik & Stebel, 2001).

1 stat.: Fd 36/84 – Sztolnia Ponikowska between Cegielnia and Poręba, on wet ground on wayside slope, *c. spor.*

Family **Pelliaceae** H.Klinggr.

4. *Pellia endiviifolia* (Dicks.) Dumort. – Rare (Fig. 70). On wet lime soil, banks of drainage ditches and in the spring area of streams. Relatively frequent in the Silesian

Upland, especially in the mesoregions of Garb Tarnogórski, Chełm and Pagóry Jaworznickie (Żarnowiec *et al.*, 1995; Stebel, 2000).

6 stat.: Fd 36/82 – Nowy Ujków, Zimny Dół; Fd 36/83 – ‘Cicha Kolonia’ at Cegielniana Street; Fd 36/84 – Sztolnia Ponikowska between Cegielnia and Poręba; Fd 46/02 – Krążek, meadows between Podlipie and Polna Street; Fd 46/04 – Stara Wieś; Fd 46/20 – Bukowno-Cyzowizna, in spring.

5. *P. epiphylla* (L.) Corda – Very rare (Fig. 71). On moist clayey soil in wayside. Very frequent in the Silesian Upland, especially in the mesoregions of Płaskowyż Rybnicki (Stebel, 1997) and Wyżyna Katowicka which generally lack limestone rocks (Jędrzejko, 1985; Fojcik & Stebel, 2001).

1 stat.: Fd 36/81 – between Pniaki and Krzykawa, on soil.

Family Aneuraceae H.Klinggr.

6. *Aneura pinguis* (L.) Dumort. – Very rare (Fig. 72). An epigeal species growing on soil in shaded deciduous forest. Widely distributed but scattered throughout the Silesian Upland (Jędrzejko, 1985; Stebel, 1997, 2006; Fojcik & Stebel, 2001).

2 stat.: Fd 36/95 – Dąbrówka, Rozmus Forest east of Kluczevska Street, on the ground on shady and slightly moist banks of the forest road; Fd 46/03 – between Krążek and Tłukienka, forest on the left-hand side of the Krążek – Tłukienka road, 500 m south of Bolesław and 400 m west of Stara Wieś, on bare soil on shaded and damp roadside bank.

7. *Riccardia chamedryfolia* (With.) Grolle – Very rare (Fig. 73). A species considered to be threatened in Poland (category E) (Klama, 2006b). It was found only recently at a single site in Sosnowiec-Bory in the Silesian Upland (Stebel & Smolińska, 2012) and in the coterminous northern part of the Kraków-Częstochowa

Upland it was recorded only in the nineteenth century and it has not been rediscovered since (Stebel, 2006c).

1 stat.: Fd 36/83 – at Bolesławska Street in Kolonia Nowy Ujków, wetland on the right-hand side of the street, on peat-bog densely overgrown by birch and pine thickets.

8. *R. palmata* (Hedw.) Carruth. – Very rare (Fig. 74). This is predominantly a montane species, known from the Carpathians and Sudetes in Poland (Szwejkowski & Koźlicka, 1980). Outside the mountains it is generally rare and most of its stations are in the northern lowlands of the country. It has so far been recorded only from a single locality near Rybnik in the Silesian Upland (Uechtritz, 1864), but it has not been rediscovered there since (Stebel, 1997). The present discovery is thus the only known existing locality of this species in this region.

1 stat.: Fd 46/07 – rotten stump in pine forest west of Stary Olkusz.

Lit.: Fd 46/07 (Ochyr & Godzik, 2015).

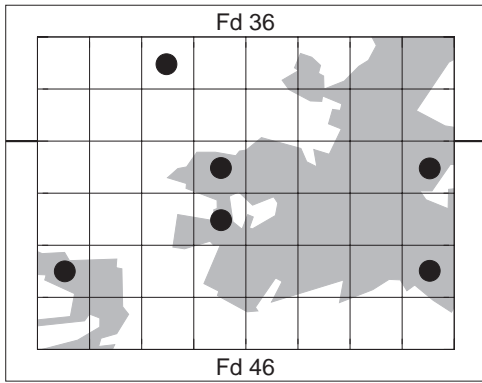
Family Ptilidiaceae H.Klinggr.

9. *Ptilidium pulcherrimum* (Weber) Vain. – Very rare (Fig. 75). On bark of deciduous trees and rotten logs. Frequent in the Silesian Upland (Stebel, 1997; Fojcik & Stebel, 2001).

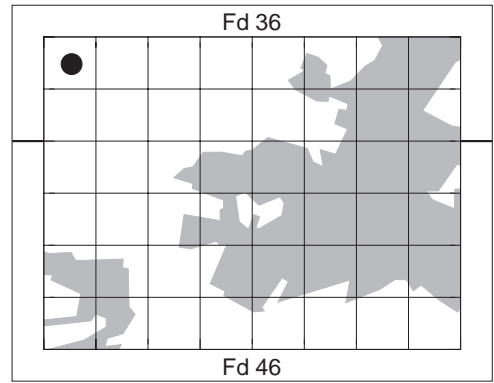
4 stat.: Fd 36/85 – Sztolnia Ponikowska between Karna and Górka; Fd 46/30 – Bukowno, Sztola river valley; Fd 46/31 – Bukowno, Sztola river valley; Fd 46/32 – Bukowno, Sztola river valley.

Family Geocalyceae H.Klinggr.

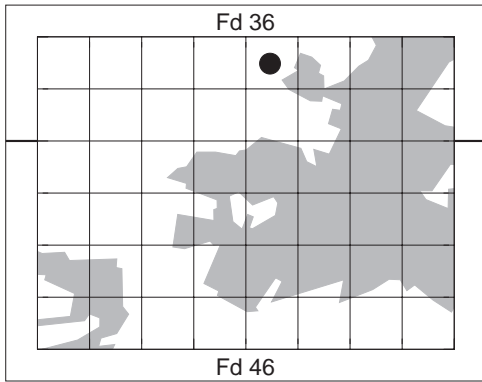
10. *Lophocolea bidentata* (L.) Dumort. – Rare (Fig. 76). Frequent on the Silesian Upland (Jędrzejko, 1985; Stebel, 1997; Fojcik & Stebel, 2001). It thrives on grassy slopes,



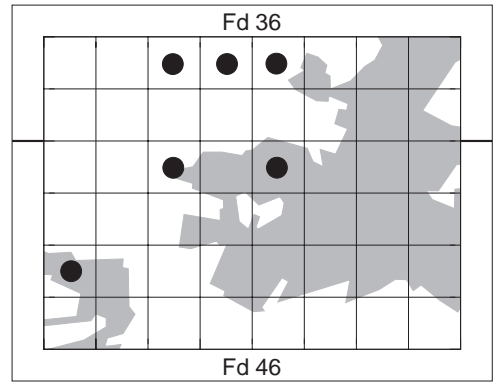
67. *Marchantia polymorpha* subsp. *ruderalis*



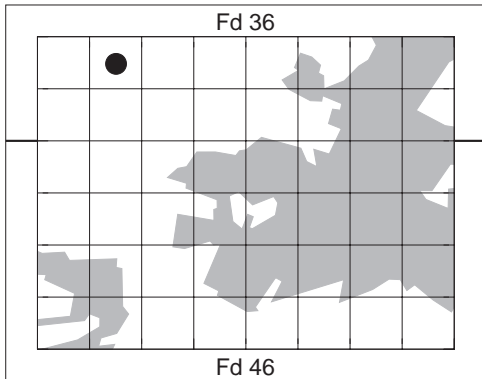
68. *Riccia glauca*



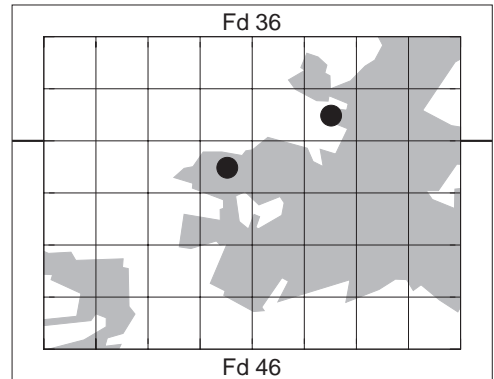
69. *Fossombronia wondraczekii*



70. *Pellia endiviifolia*



71. *Pellia epiphylla*



72. *Aneura pinguis*

Figs 67–72. Distribution maps for *Marchantia polymorpha* subsp. *ruderalis* (67), *Riccia glauca* (68), *Fossombronia wondraczekii* (69), *Pellia endiviifolia* (70), *P. epiphylla* (71) and *Aneura pinguis* (72) in the Olkusz Ore-bearing Region.

waysides, banks of drainage ditches, as well as in shaded thickets and deciduous forest.

8 stat.: Fd 36/80 – Krzykawa; Fd 36/82 – Nowy Ujków, Zimny Dół; Fd 36/90 – between Podlipie and Małobądz-Krże; Fd 36/91 – Nowy Ujków, between Laskowska Street and Katowice-Olkusz road; Fd 36/94 – Bolesław, Dąbrówka Canal east of the Katowice-Olkusz road; Fd 36/96 – Sztolnia Ponikowska; Fd 46/27 – Pustynia Starczynowska, 1.5 km west of Olkusz along the Desert Trail; Fd 46/30 – Bukowno, in the Sztoła river valley.

11. *L. heterophylla* (Schrad.) Dumort. – Frequent (Fig. 77). The most common liverwort in the study area, usually growing on rotten wood, bark of trees and mineral soil. Frequently found with sporophytes. Common throughout the Silesian Upland (Jędrzejko, 1985; Stebel, 1997; Stebel & Fojcik, 2001).

22 stat.: grid squares: Fd 36/80; Fd 36/81; Fd 36/83; Fd 36/84; Fd 36/85; Fd 36/86; Fd 36/90; Fd 36/91; Fd 36/93; Fd 36/94; Fd 36/95; Fd 36/96; Fd 46/03; Fd 46/07; Fd 46/11; Fd 46/12; Fd 46/17; Fd 46/21; Fd 46/30; Fd 46/31; Fd 46/32; Fd 46/37.

Lit.: Fd 46/07 (Ochyra & Godzik, 2015).

12. *L. minor* Nees – Rare (Fig. 78). On calcareous soil and always found with gemmae that are produced in profusion. The species is primarily associated with calcareous substrata and therefore it is rare on the Silesian Upland where it occurs only occasionally (Jędrzejko, 1985; Żarnowiec *et al.*, 1995; Stebel, 2006b).

6 stat.: Fd 36/90 – Małobądz, Miła Street; Fd 36/93 – Bolesław, Szkolna Street; Fd 36/95 – Dąbrówka, Rozmus forest; Fd 36/97 – Stary Olkusz, near the “Mieszko” adit; Fd 46/26 – Pustynia Starczynowska, along the broad gauge railway east of the eastern side of the flotation tailings heap of the “Olkusz” mine; Fd 46/27 – Pustynia Starczynowska, near the Baba Canal and 1.5 km west of Olkusz along the Desert Trail.

13. *Chiloscyphus pallescens* (Hoffm.) Dumort. – Rare (Fig. 79). On wet soil in depressions and hollows in forest. Scattered in the Cracow-Częstochowa Upland and fairly frequent in the Silesian Upland (Salachna, 2014).

5 stat.: Fd 36/81 – between Pniaki and Krzykawa, east of the Krzykawa – Laski road; Fd 36/97 – on soil on slope of a hollow in pine forest 3 km north-west of Stary Olkusz 300 m north of the “Mieszko” adit; Fd 46/03 – on exposed soil on slopes of a hollow in shaded deciduous forest 600 m west of Stara Wieś; Fd 46/06 – Stary Olkusz, pine forest 1 km towards the west near the Roznos Canal; Fd 46/07 – on patch of moist soil in pine forest 500 m west of Stary Olkusz.

Family Calypogeiaceae Arnell

14. *Calypogeia azurea* Stotler & Crotz – Very rare (Fig. 80). A montane species which is distributed throughout the Silesian Upland (Stebel, 1997; Fojcik & Stebel, 2001).

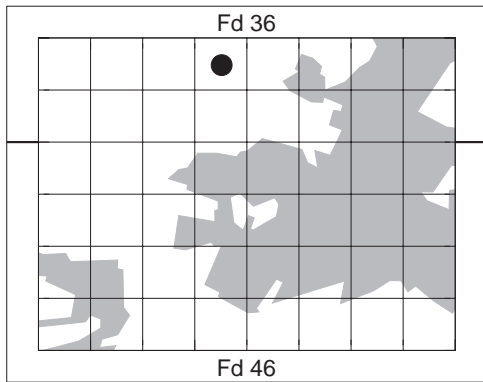
1 stat.: Fd 36/84 – Sztolnia Ponikowska in Połęba, on humus in wet mixed forest.

Family Cephaloziaceae Mig.

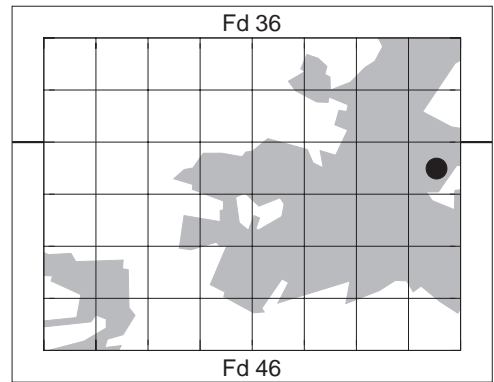
15. *Cephalozia bicuspidata* (L.) Dumort. var. *bicuspidata* – Very rare (Fig. 81). On humic soil and rotten wood. Frequent in the whole Silesian Upland (Jędrzejko, 1985, Stebel, 1997, Fojcik & Stebel, 2001).

2 stat.: Fd 36/84 – on humic soil in Sztolnia Ponikowska in Cegielnia; Fd 46/37 – pine forest in the former Pustynia Starczynowska, on rotten log.

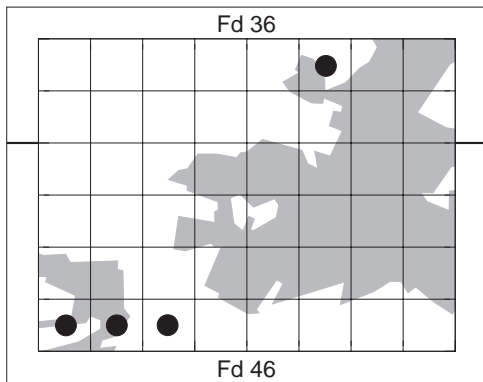
var. *lammersiana* (Huebener) Breidl. – Very rare (Fig. 82). This variety has been only recorded in the study area. In addition, known from a few localities in central and southern parts of the Silesian Upland (Żarnowiec *et al.*, 1995; Stebel, 1997; Fojcik & Stebel, 2001).



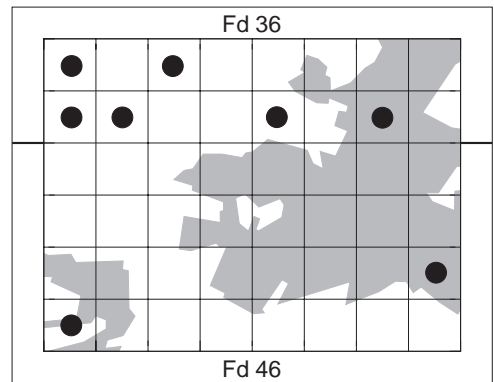
73. *Riccardia chamedryfolia*



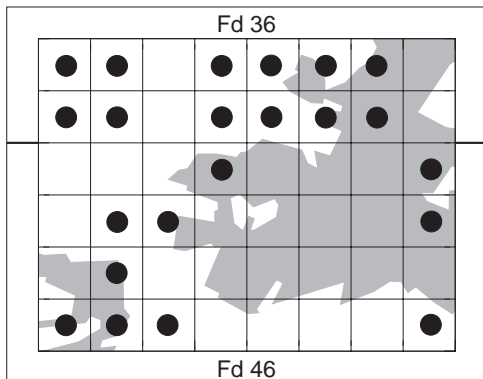
74. *Riccardia palmata*



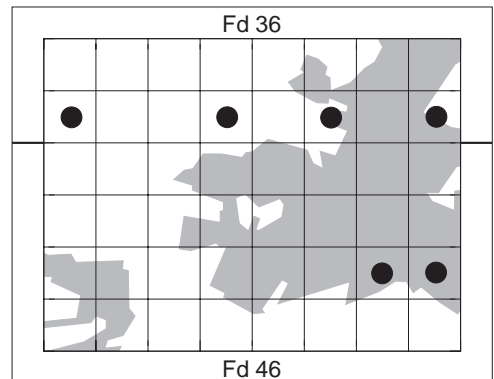
75. *Ptilidium pulcherrimum*



76. *Lophocolea bidentata*



77. *Lophocolea heterophylla*



78. *Lophocolea minor*

Figs 73–78. Distribution maps for *Riccardia chamedryfolia* (73), *R. palmata* (74), *Ptilidium pulcherrimum* (75), *Lophocolea bidentata* (76), *L. heterophylla* (77) and *L. minor* (78) in the Olkusz Ore-bearing Region.

1 stat.: Fd 36/84 – Sztolnia Ponikowska in Cegielnia, on damp humus in shaded sites in mixed forest.

Family *Cephaloziellaceae* Douin

16. *Cephaloziella divaricata* (Sm.) Schiffn. – Rare (Fig. 83). An epigeal species growing most often on sandy soil in pine forest, on the ground in grassland and on waysides. Known from scattered localities, distributed mainly in the central and southern parts of the Silesian Upland (Jędrzejko, 1985; Stebel, 1997; Fojcik & Stebel, 2001).

8 stat.: Fd 36/80 – Krzykawa; Fd 36/86 – 0.5 km east of Hutki; Fd 36/93 – Bolesław, Szkolna Street; Fd 36/97 – Stary Olkusz, near the “Mieszko” adit; Fd 46/17 – “Grodzisko” in Stary Olkusz; Fd 46/26 – Baba Canal, along the broad gauge railway east of the eastern side of the flotation tailings heap of the “Olkusz” mine; Fd 46/31 – Bukowno, in the Sztoła river valley; Fd 46/34 – Bukowno, near the Baba Canal.

Lit.: Fd 36/93 (Ochyra & Godzik, 2015).

17. *C. rubella* (Nees) Warnst. – Very rare (Fig. 84). In the Silesian Upland the species is rare and it is known only from scattered localities (Jędrzejko, 1985; Stebel, 1997; Fojcik & Stebel, 2001).

1 stat.: Fd 46/02 – on dry soil in tufts of mosses in pine forest east of Krążek.

Lit.: Fd 46/02 (Ochyra & Godzik, 2015).

Family *Lophoziaceae* Cavers

18. *Barbilophozia barbata* (Schreb.) Loeske – Rare (Fig. 85). Grows on soil and in mats of mosses on grassy slopes and on the ground in pine forest, usually in shaded habitats. In the Silesian Upland it occurs exclusively in the eastern part of the Garb Tarnogórski mesoregion (Jędrzejko, 1985; Jędrzejko *et al.*, 2000).

7 stat.: Fd 36/96 – Sztolnia Ponikowska, pine forest 200 m east of the “Dąbrówka” shaft of the “Pomorzany” mine with a new sandpit; Fd 36/97 – Stary Olkusz, near the “Mieszko” adit; Fd 46/07 – north-west of Stary Olkusz; Fd 46/17 – west of Stary Olkusz; Fd 46/23 – Bukowno, deciduous forest north of Leśna Street; Fd 46/27 – Pustynia Starczynowska, near the Baba Canal; Fd 46/31 – Bukowno, in the Sztoła river valley.

Lit.: Fd 46/07, Fd 46/17, Fd 46/23 (Ochyra & Godzik, 2015).

19. *Lophozia ventricosa* (Dicks.) Dumort. – Very rare (Fig. 86). In the Silesian Upland known only from two doubtful localities (Jędrzejko, 1985).

1 stat.: Fd 46/07 – on soil in a moss patch in pine forest about 900 m west of Stary Olkusz.

Lit.: Fd 46/07 (Ochyra & Godzik, 2015).

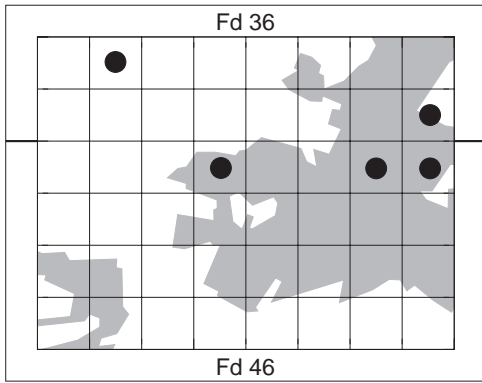
BRYOPHYTA – MOSSES

Family *Sphagnaceae* Dumort.

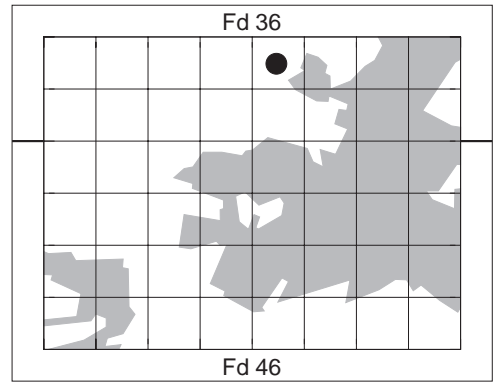
1. *Sphagnum contortum* Schultz – Very rare (Fig. 87). In peatlands. In the Silesian Upland known from scattered stations located in the eastern part (Stebel & Fojcik, 2003) and it is very rare in the Cracow-Częstochowa Upland

(Fojcik, 2011). According to the recent “Regulation of the Minister of the Environment of Poland” (Anonymous, 2014), all *Sphagnum* species mentioned below are partly protected by law.

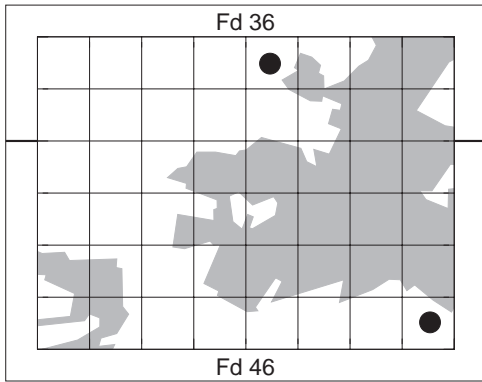
3 stat.: Fd 36/83 – Cegielniana Street, small peatland east of Poręba and Kolonia Nowy Ujków



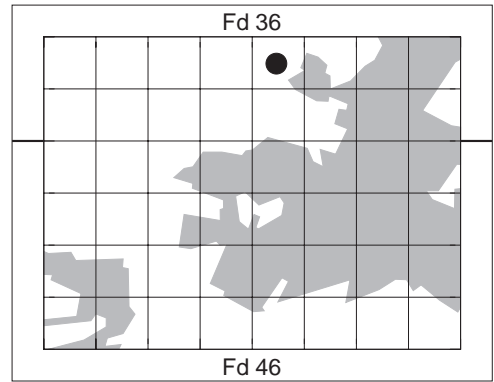
79. *Chiloscypus palleescens*



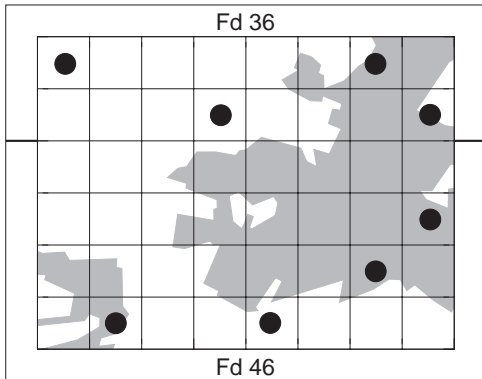
80. *Calypogeia azurea*



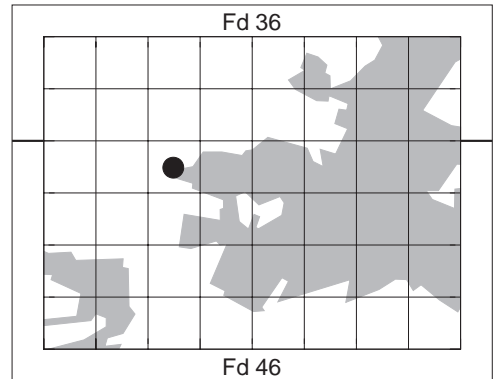
81. *Cephalozia bicuspidata* var. *bicuspidata*



82. *Cephalozia bicuspidata* var. *lammersiana*



83. *Cephaloziella divaricata*



84. *Cephaloziella rubella*

Figs 79–84. Distribution maps for *Chiloscypus palleescens* (79), *Calypogeia azurea* (80), *Cephalozia bicuspidata* var. *bicuspidata* (81), *C. bicuspidata* var. *lammersiana* (82), *Cephaloziella divaricata* (83) and *C. rubella* (84) in the Olkusz Ore-bearing Region.

and at Bolesławska Street; Fd 36/84 – Sztolnia Ponikowska between Cegielnia and Poręba; Fd 36/85 – Sztolnia Ponikowska between Karna and Górka.

2. *S. denticulatum* Brid. – Very rare (Fig. 88). In water in hollows in woodland. A species fairly frequent in the Silesian Upland (Stebel & Fojcik, 2003) and very rare in the Cracow-Częstochowa Upland (Fojcik, 2011).

1 stat.: Fd 36/84 – Sztolnia Ponikowska in Cegielnia, in water in wet woodland.

Lit.: Near Bolesław (Kuc, 1956 as *Sphagnum subsecundum* var. *rufescens*).

3. *S. fallax* (H.Klinggr.) H.Klinggr. – Very rare (Fig. 89). In minerotrophic fens and on wet peaty ground. Frequent in the Silesian Upland and Cracow-Częstochowa (Stebel & Fojcik, 2003; Fojcik, 2011) and one of the commonest species of peat moss in Poland.

2 stat.: Fd 36/84 – Sztolnia Ponikowska in Cegielnia; Fd 36/85 – Hutki, 0.5 km towards north-east on the right-hand side of Królewska Street, in a temporarily wet depression.

4. *S. fimbriatum* Wilson – Very rare (Fig. 90). On moist ground in thicket. One of the commonest species of *Sphagnum* in the Silesian Upland (Stebel & Fojcik, 2003) and fairly frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

1 stat.: Fd 36/84 – Sztolnia Ponikowska in Cegielnia, in wet thicket.

5. *S. flexuosum* Dozy & Molke. – Very rare (Fig. 91). On moist peaty ground in shaded sites. Infrequent in the Silesian Upland (Stebel & Fojcik, 2003). Very rare on the Cracow-Częstochowa Upland (Fojcik, 2011).

1 stat.: Fd 36/81 – between Pniaki and Krzykawa, on peaty ground in shaded woodland.

6. *S. girgensohnii* Russow – Very rare (Fig. 92). On moist peaty ground in shaded sites.

A montane species, known from scattered localities in the Silesian Upland (Stebel & Fojcik, 2003) and fairly frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

1 stat.: Fd 36/81 – between Pniaki and Krzykawa, on peaty ground in a shaded woodland.

7. *S. inundatum* Russow – Very rare (Fig. 93). On moist ground in thicket. In the Silesian Upland known from scattered localities (Stebel & Fojcik, 2003) and so far it has not been found in the Cracow-Częstochowa Upland (Fojcik, 2011).

1 stat.: Fd 36/84 – Sztolnia Ponikowska in Cegielnia, in wet thicket.

8. *S. palustre* L. – Very rare. (Fig. 94). On moist ground in shaded sites in thicket and woodland. One of the commonest species of *Sphagnum* in the Silesian Upland (Stebel & Fojcik, 2003) and it is also frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

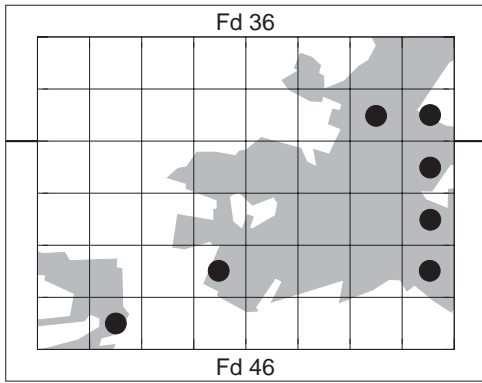
2 stat.: Fd 36/81 – between Pniaki and Krzykawa, on peaty ground in shaded woodland; Fd 36/84 – Sztolnia Ponikowska in Cegielnia and between Cegielnia and Poręba, peatland.

Lit.: between Stare Maczki and Olkusz (Kuc, 1956).

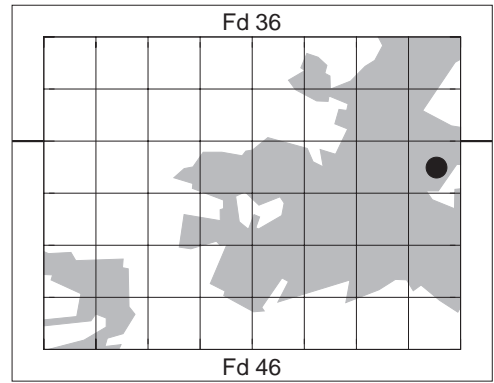
9. *S. russowii* Warnst. – Very rare (Fig. 95). On moist peaty ground in shaded sites. A montane species known from single localities on the Silesian Upland (Fojcik & Stebel, 1999, 2001) and the Cracow-Częstochowa Upland (Stebel & Fojcik, 2003; Stebel in Górski *et al.*, 2015).

1 stat.: Fd 36/81 – between Pniaki and Krzykawa, boggy place in forest.

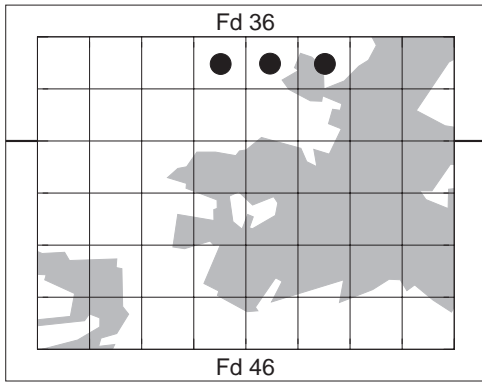
10. *S. squarrosus* Crome – Very rare (Fig. 96). On moist ground in shaded sites. Frequent in the Silesian Upland (Stebel & Fojcik, 2003)



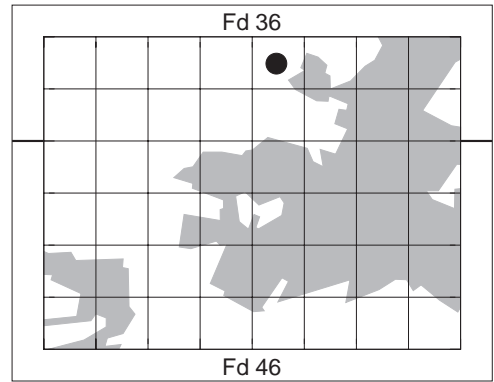
85. *Barbilophozia barbata*



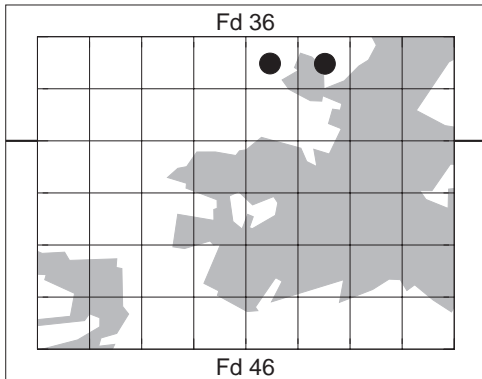
86. *Lophozia ventricosa*



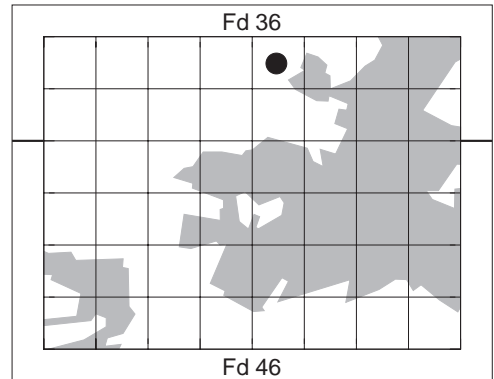
87. *Sphagnum contortum*



88. *Sphagnum denticulatum*

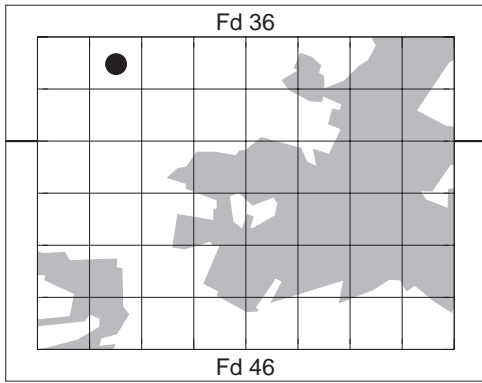


89. *Sphagnum fallax*

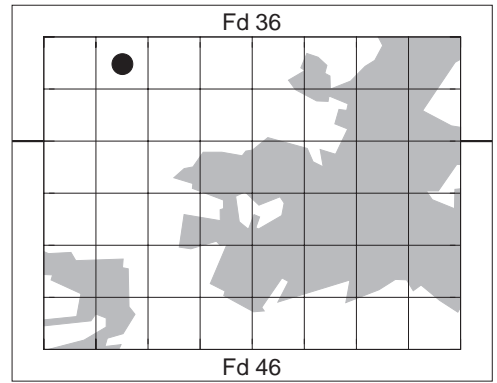


90. *Sphagnum fimbriatum*

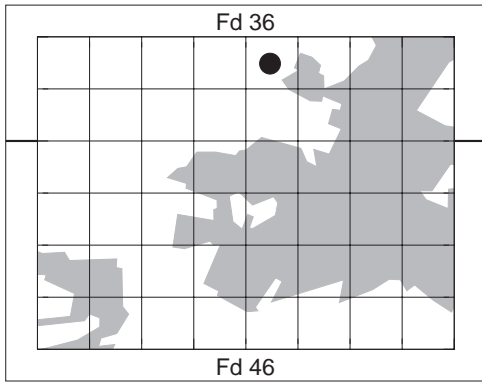
Figs 85–90. Distribution maps for *Barbilophozia barbata* (85), *Lophozia ventricosa* (86), *Sphagnum contortum* (87), *S. denticulatum* (88), *S. fallax* (89) and *S. fimbriatum* (90) in the Olkusz Ore-bearing Region.



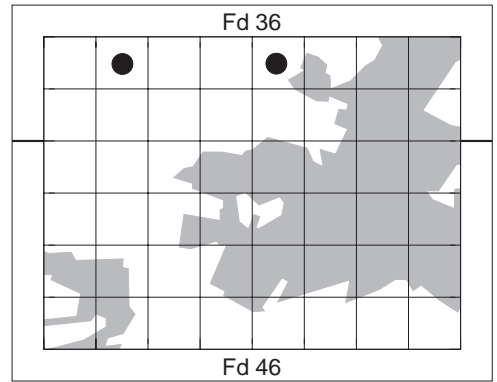
91. *Sphagnum flexuosum*



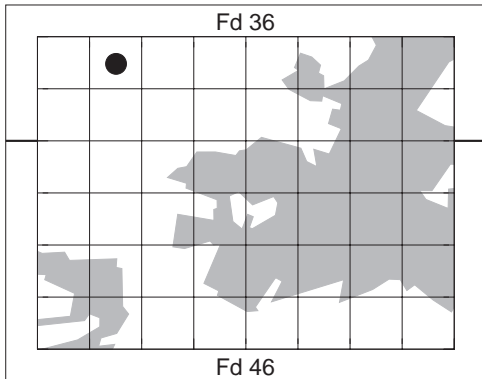
92. *Sphagnum girgensohnii*



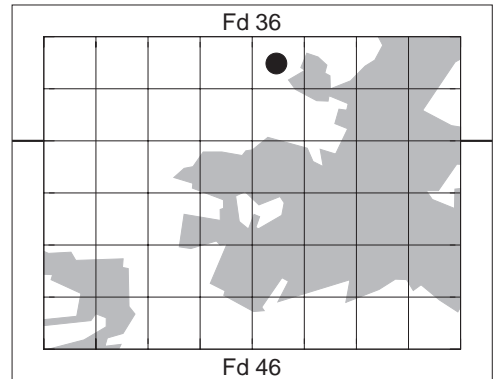
93. *Sphagnum inundatum*



94. *Sphagnum palustre*



95. *Sphagnum russowii*



96. *Sphagnum squarrosum*

Figs 91–96. Distribution maps for *Sphagnum flexuosum* (91), *S. girgensohnii* (92), *S. inundatum* (93), *S. palustre* (94), *S. russowii* (95) and *S. squarrosum* (96) in the Olkusz Ore-bearing Region.

and rare in the Cracow-Częstochowa Upland (Fojcik, 2011).

1 stat.: Fd 36/84 – Sztolnia Ponikowska in Cegielnia, in alder forest.

11. *S. teres* (Schimp.) Ångstr. – Very rare (Fig. 97). In peatland. Known from some scattered localities in the Silesian Upland, mainly in the eastern part of the region and rare elsewhere (Stebel & Fojcik, 2003). It is also rare in the Cracow-Częstochowa Upland (Fojcik, 2011).

1 stat.: Fd 36/84 – Sztolnia Ponikowska between Cegielnia and Poręba and Sztolnia Ponikowska in Poręba, in peatland.

12. *S. warnstorffii* Russow – Very rare (Fig. 98). In peatland. Known from single localities in the Silesian Upland (Stebel & Fojcik, 2003) and in the Cracow-Częstochowa Upland (Szafran, 1957; Stebel, 2002b, 2003).

2 stat.: Fd 36/83 – Kolonia Nowy Ujków, ‘Cicha Kolonia’, Cegielniana Street, peatland E of Poręba; Fd 36/84 – Sztolnia Ponikowska between Cegielnia and Poręba, in peatland.

Family Polytrichaceae Schwägr.

13. *Atrichum angustatum* (Brid.) Bruch & Schimp. – Very rare (Fig. 99). On clay and loess soils on waysides. Scattered in the Silesian Upland, mainly in its southern part (Kuc, 1956; Stebel, 1997, 1998a), and rare in the Cracow-Częstochowa Upland (Fojcik, 2011).

2 stat.: Fd 36/80 – Krzykawa, on clayey soil on road-cutting, shaded and slightly damp situation associated with *Ditrichum heteromallum* and *Poblia lescuriana*; Fd 36/81 – 1.5 km west of Pniaki, on loess soil in a shaded ravine.

14. *A. undulatum* (Hedw.) P.Beauv. – Fairly frequent (Fig. 100). On the ground in forest, paths, waste land, meadows and in

grassland. Rarely with sporophytes. Common in the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and Cracow-Częstochowa Upland (Fojcik, 2011).

12 stat.: grid squares: Fd 36/80; Fd 36/81; Fd 36/83; Fd 36/84; Fd 36/85; Fd 36/90; Fd 36/91; Fd 36/92; Fd 36/93; Fd 46/03; Fd 46/04; Fd 46/30.

Lit.: Bukowno (Kuc, 1956).

15. *Pogonatum urnigerum* (Hedw.) P. Beauv. – Not found during the present field studies. The locality of the species was provided unprecisely (Kuc, 1956) and it is likely that the moss was discovered outside the investigated area. The species is scattered in the Silesian Upland (Stebel, 1997, 1998a; Fojcik & Stebel, 2001) and frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

Lit.: between Bór Biskupi and Bukowno (Kuc, 1956).

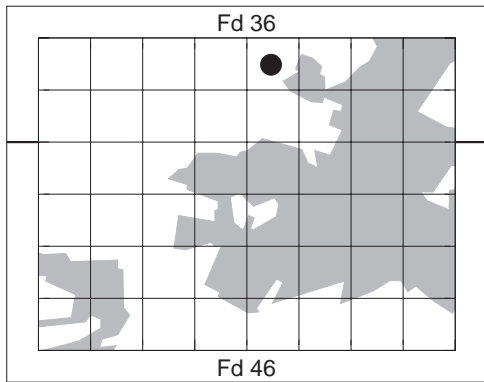
16. *Polytrichastrum formosum* (Hedw.) G.L.Sm. – Fairly frequent (Fig. 101). On the ground in forest. Rarely found with sporophytes. A species common in the the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and Cracow-Częstochowa Upland (Fojcik, 2011).

12 stat.: grid squares: Fd 36/80; Fd 36/81; Fd 36/83; Fd 36/84; Fd 36/85; Fd 36/86; Fd 36/92; Fd 36/95; Fd 36/97; Fd 46/20; Fd 46/30; Fd 46/36.

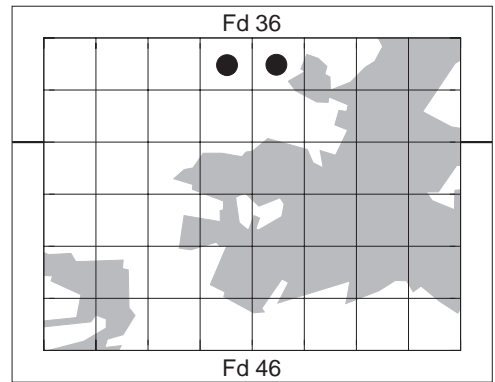
Lit.: Las Olkusz (Kuc, 1956).

17. *Polytrichum commune* Hedw. – Very rare (Fig. 102). A species partly protected by law in Poland (Anonymus, 2014). Frequent in the the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and Cracow-Częstochowa Upland (Fojcik, 2011).

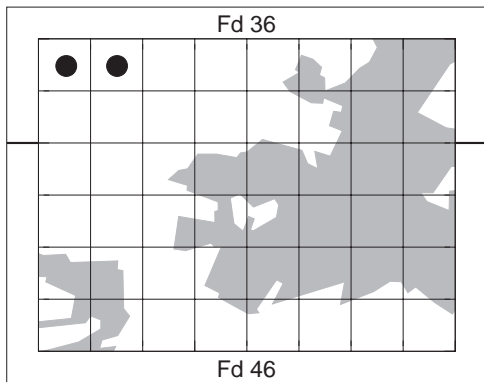
3 stat.: Fd 36/84 – Cegielnia, Sztolnia Ponikowska, peatland; Fd 36/86 – Hutki, drainage



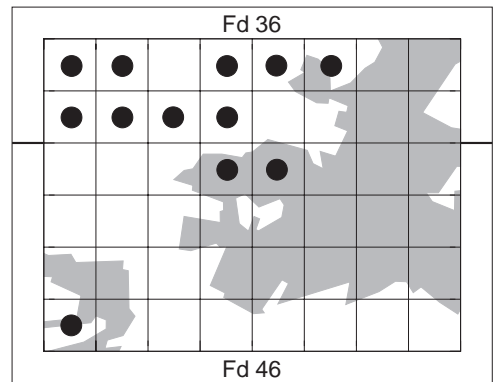
97. *Sphagnum teres*



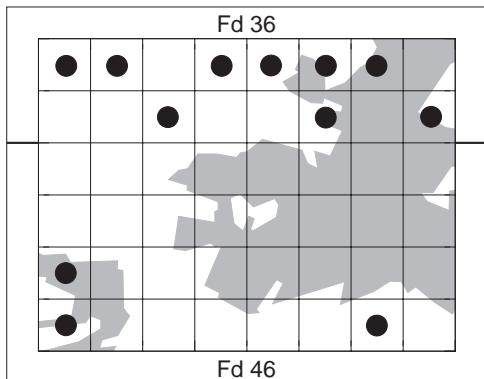
98. *Sphagnum warnstorffii*



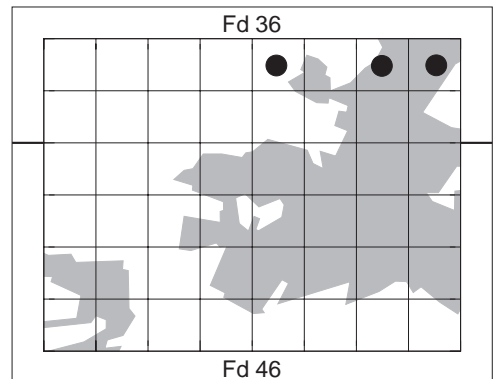
99. *Atrichum angustatum*



100. *Atrichum undulatum*



101. *Polytrichastrum formosum*



102. *Polytrichum commune*

Figs 97–102. Distribution maps for *Sphagnum teres* (97), *S. warnstorffii* (98), *Atrichum angustatum* (99), *A. undulatum* (100), *Polytrichastrum formosum* (101) and *Polytrichum commune* (102) in the Olkusz Ore-bearing Region.

ditch in *Pinus sylvestris* forest; Fd 36/87 – 2 km west of Pomorzany, on shaded roadside bank in *Pinus sylvestris* forest.

Lit.: Bukowno (Kuc, 1956).

18. *P. juniperinum* Hedw. – Fairly frequent (Fig. 103). On sandy soil in grassland and forest. Rarely with sporophytes. Frequent in the the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and Cracow-Częstochowa Upland (Fojcik, 2011).

12 stat.: grid squares: Fd 36/80; Fd 36/83; Fd 36/85; Fd 36/86; Fd 36/87; Fd 36/90; Fd 36/96; Fd 36/97; Fd 46/27; Fd 46/30; Fd 46/31; Fd 46/36.

Lit.: Bukowno (Kuc, 1956).

19. *P. piliferum* Hedw. – Rare (Fig. 104). On sandy soil in grassland in dry and open habitats. Rarely with sporophytes. Very common in the the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and Cracow-Częstochowa Upland (Fojcik, 2011).

9 stat.: Fd 36/81 – 1.5 km west of Pniaki; Fd 36/84 – Sztolnia Ponikowska in Cegielnia; Fd 36/87 – 2 km west of Pomorzany; Fd 36/97 – Stary Olkusz, near the “Mieszko” adit; Fd 46/30 – Bukowno, in the Sztola river valley; Fd 46/31 – Bukowno, in the Sztola river valley; Fd 46/34 – Bukowno, near the Baba Canal; Fd 46/36 – Pustynia Starczynowska, 2 km south-east of Bukowno and 2 km south of Starczynów; Fd 46/37 – Pustynia Starczynowska, 2 km north-west of Żurada and 2 km south-east of Starczynów.

Lit.: Bukowno, Stary Olkusz (Kuc, 1956).

Family Tetraphidaceae Schimp.

20. *Tetraphis pellucida* Hedw. – Very rare (Fig. 105). An epixylic moss growing on rotten wood. Commonly with gemmae. Frequent in the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and Cracow-Częstochowa Upland (Fojcik, 2011).

4 stat.: Fd 36/84 – Sztolnia Ponikowska in Cegielnia, rotten wood in mixed forest; Fd 36/85 – Hutki, 0.5 km towards the north-east on the right-hand side of Królewska Street, rotten log in mixed forest; Fd 46/30 – Bukowno, in the Sztola river valley, on rotten wood in mixed forest; Fd 46/37 – Pustynia Starczynowska, 2 km north-west of Żurada and 2 km south-east of Starczynów, on rotten log in pine forest.

Family Funariaceae Schwägr.

21. *Funaria hygrometrica* Hedw. – Fairly frequent (Fig. 106). In waste land, on waysides and on old concrete walls as well as on patches of scorched ground. Commonly found with sporophytes. Very frequent in the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and Cracow-Częstochowa Uplands (Fojcik, 2011).

11 stat.: grid squares: Fd 36/82; Fd 36/84; Fd 36/92; Fd 46/02; Fd 46/03; Fd 46/06; Fd 46/07; 46/13; Fd 46/17; Fd 46/20; Fd 46/31.

Lit.: Bolesław (Kuc, 1956); Bukowno (Jędrzejko, 1990).

Family Encalyptaceae Schimp.

22. *Encalypta streptocarpa* Hedw. – Frequent (Fig. 106). On limestone, dolomite, old concrete walls and occasionally on asphalt. Commonly found with gemmae, but generally sterile and only once collected with sporophytes. Fairly frequent in the Silesian Upland (Jędrzejko, 1990; Stebel, 1997, 1998a; Fojcik & Stebel, 2001) and very frequent and locally abundant in the Cracow-Częstochowa Upland (Fojcik, 2011).

17 stat.: grid squares: Fd 36/82; Fd 36/83; Fd 36/86; Fd 36/93; Fd 36/97; Fd 46/00; Fd 46/03; Fd 46/06; Fd 46/07; Fd 46/17; Fd 46/20; Fd 46/22; Fd 46/27; Fd 46/30; Fd 46/31; Fd 46/33; Fd 46/35.

Lit.: Bolesław (Kuc 1956); Stary Olkusz (Kuc 1956).

23. *E. vulgaris* Hedw. – Not found during the present field studies. Very rare in the Silesian Upland (Jędrzejko, 1990; Stebel, 1998a), but very frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

Lit.: near Bolesław and Olkusz (Dobrzańska, 1955); Bolesław (Kuc, 1956).

Family Fissidentaceae Schimp.

24. *Fissidens adianthoides* Hedw. – Very rare (Fig. 108). A swampy species rare in the Silesian Upland (Jędrzejko, 1990; Stebel 1997, 1998a) and frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

1 stat.: Fd 36/83 – Kolonia Nowy Ujków, 'Cicha Kolonia', Cegielniana Street, a small fen east of Poreba and Kolonia Nowy Ujków, at Bolesławska Street, wetland.

25. *F. bryoides* Hedw. – Not found during the present field studies. An epigeal species very frequent in the Silesian and Cracow-Częstochowa Uplands (Stebel, 1998a; Fojcik & Stebel, 2001; Fojcik, 2011).

Lit.: Bolesław (Kuc, 1956).

26. *F. dubius* P.Beauv. – Not found during the present field studies. A basiphilous species growing on limestone rocks. Rare in the Silesian Upland (Jędrzejko, 1990; Stebel, 1998a), but very frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

Lit.: near Bolesław and Olkusz (Dobrzańska, 1955).

27. *F. taxifolius* Hedw. – Very rare (Fig. 109). On mineral soil in forest. Very frequent in the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and Cracow-Częstochowa Upland (Fojcik, 2011).

2 stat.: Fd 36/92 – Bolesław-Ćmielówka, on wayside slope in woodland; Fd 46/04 – Stara Wieś, on mineral soil.

28. *F. viridulus* ([Sw.] ex anon.) Wahlenb. – Very rare (Fig. 110). An epigeal species known from some scattered localities from the Silesian Upland (Stebel, 1997, 1998a) and rare in the Cracow-Częstochowa Upland (Fojcik, 2011).

2 stat.: Fd 36/80 – Krzykawa, soil on roadside ditch; Fd 36/92 – Bolesław-Ćmielówka, wayside slope in thicket.

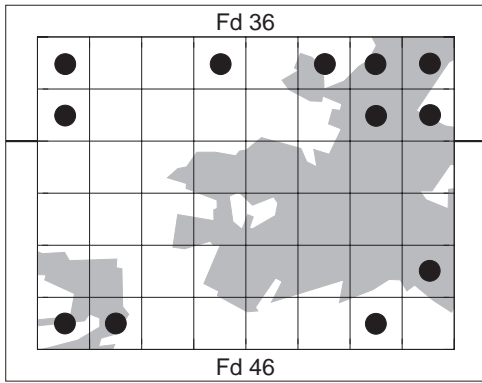
Family Ditrichaceae Limpr.

29. *Ceratodon purpureus* (Hedw.) Brid. – Common (Fig. 111). A ubiquitous moss species growing in a variety of habitats including soil, rocks, waste land, concrete walls, bark of trees and logs. Commonly with sporophytes. Common in the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and Cracow-Częstochowa Upland (Fojcik, 2011).

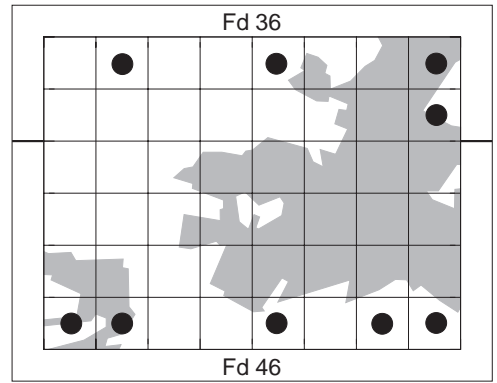
48 stat.: grid squares: Fd 36/80; Fd 36/81; Fd 36/82; Fd 36/83; Fd 36/84; Fd 36/85; Fd 36/86; Fd 36/87; Fd 36/90; Fd 36/91; Fd 36/92; Fd 36/93; Fd 36/94; Fd 36/95; Fd 36/96; Fd 36/97; Fd 46/00; Fd 46/01; Fd 46/02; Fd 46/03; Fd 46/04; Fd 46/05; Fd 46/06; Fd 46/07; Fd 46/10; Fd 46/11; Fd 46/12; Fd 46/13; Fd 46/14; Fd 46/15; Fd 46/16; Fd 46/17; Fd 46/20; Fd 46/21; Fd 46/22; Fd 46/23; Fd 46/24; Fd 46/25; Fd 46/26; Fd 46/27; Fd 46/30; Fd 46/31; Fd 46/32; Fd 46/33; Fd 46/34; Fd 46/35; Fd 46/36; Fd 46/37.

Lit.: near Bolesław and Olkusz (Dobrzańska, 1955); Bukowno (Kuc, 1956; Jędrzejko, 1990); Bukowno-Skotnica (Babczyńska-Sendek, 2005); Karna (Każmierczakowa, 1988); Fd 36/93, Fd 36/93, Fd 46/03, Fd 46/04, Fd 46/07, Fd 46/12, Fd 46/13, Fd 46/14, Fd 46/17, Fd 46/23, Fd 46/23 (Ochyra & Godzik, 2015).

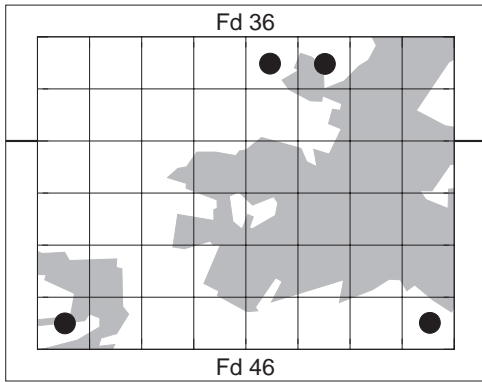
30. *Ditrichum flexicaule* (Schwägr.) Hampe – Not found during the present field studies.



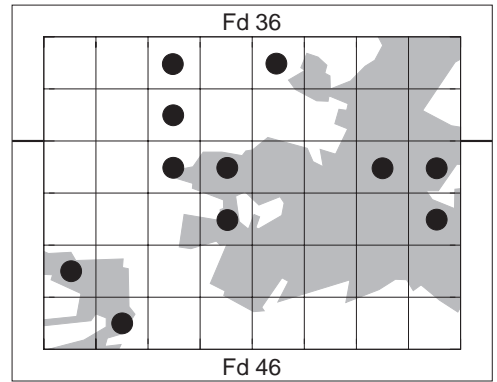
103. *Polytrichum juniperinum*



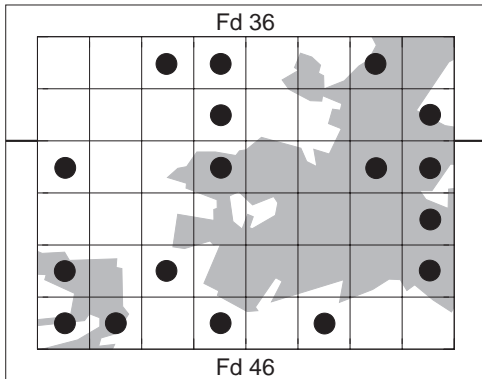
104. *Polytrichum piliferum*



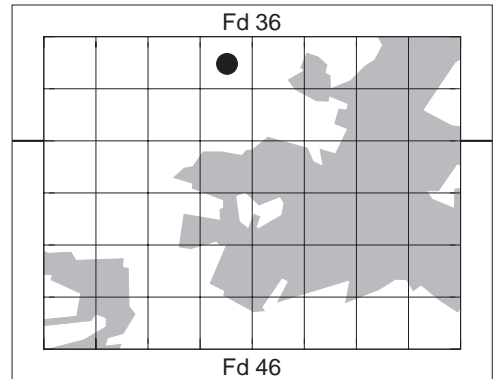
105. *Tetraxis pellucida*



106. *Funaria hygrometrica*



107. *Encalypta streptocarpa*



108. *Fissidens adiantoides*

Figs 103–108. Distribution maps for *Polytrichum juniperinum* (103), *P. piliferum* (104), *Tetraxis pellucida* (105), *Funaria hygrometrica* (106), *Encalypta streptocarpa* (107) and *Fissidens adiantoides* (108) in the Olkusz Ore-bearing Region.

A basiphilous saxicolous species rare in the Silesian Upland (Jędrzejko, 1990; Stebel, 2006b) and very frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

Lit.: near Bolesław and Olkusz (Dobrzańska, 1955).

31. *D. heteromallum* (Hedw.) E. Britton – Very rare (Fig. 112). On mineral soil. Recorded for the first time from the Silesian Upland. It is rare in the Cracow-Częstochowa Upland (Fojcik, 2011).

1 stat.: Fd 36/80 – Krzykawa, on clayey soil on road-cutting in shaded and slightly damp situation associated with *Atrichum angustatum* and *Pohlia lescuriana* and soil at base of *Fagus sylvatica* L.

32. *D. pusillum* (Hedw.) Hampe – Very rare (Fig. 113). On mineral soil. Known from the southern part of the Silesian Upland (Stebel, 2011) and very rare in the Cracow-Częstochowa Upland (Fojcik, 2011).

2 stat.: Fd 36/95 – Dąbrówka Canal in Bolesław, 150 m from the “Pomorzany” mine and “Dąbrówka” shaft, on sandy soil; Fd 46/05 – Dąbrówka, Rozmus, on the northern slope of the flotation tailings heap of the “Olkusz” mine, on sandy soil.

Family Dicranaceae Schimp.

33. *Dicranella cerviculata* (Hedw.) Schimp. – Very rare (Fig. 114). On peaty humus, found with abundant sporophytes. Fairly frequently recorded, although not abundant in the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and Cracow-Częstochowa Upland (Fojcik, 2011).

1 stat.: Fd 36/84 – Sztolnia Ponikowska in Cegielnia, on moist humus, *c. spor.*

34. *D. crispa* (Hedw.) Schimp. – Moss not found during the present investigation (Fig. 115). On loess soil. A species rare in the Silesian

Upland (Jędrzejko, 1990; Stebel, 1998a) and Cracow-Częstochowa Upland (Fojcik, 2011).

1 stat.: Fd 36/80 – between Krzykawka and Małobądz, on loess soil, *leg.* A. Stebel & J. Drobniak, 10 June 2002 (KRAM, SOSN).

35. *D. heteromalla* (Hedw.) Schimp. – Fairly frequent (Fig. 116). On soil, rotten wood and bark of deciduous trees, mainly *Betula pendula*. Fairly frequently found with sporophytes. Common in the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and Cracow-Częstochowa Upland (Fojcik, 2011).

16 stat.: grid squares: Fd 36/80; Fd 36/81; Fd 36/84; Fd 36/85; Fd 36/86; Fd 36/90; Fd 36/92; Fd 36/97; Fd 46/02; Fd 46/03; Fd 46/07; Fd 46/20; Fd 46/27; Fd 46/30; Fd 46/31; Fd 46/35.

Lit.: Las Olkusz (Kuc, 1956); Fd 46/07 (Ochyra & Godzik, 2015).

36. *D. rufescens* (Dicks.) Schimp. – Very rare (Fig. 117). An epigeal species rare in the Silesian Upland (Jędrzejko, 1990; Stebel, 1997, 1998a; Fojcik & Stebel, 2001) and Cracow-Częstochowa Upland (Fojcik, 2011).

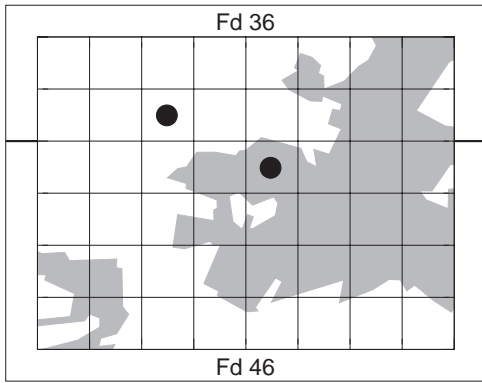
1 stat.: Fd 46/14 – Ujków Stary, refuse dump 400 m towards the south-east and 200 m west of the flotation tailings heap of the “Olkusz” mine, on dry to slightly moist soil and dolomite pebbles.

Lit.: Fd 46/14 (Ochyra & Godzik, 2015).

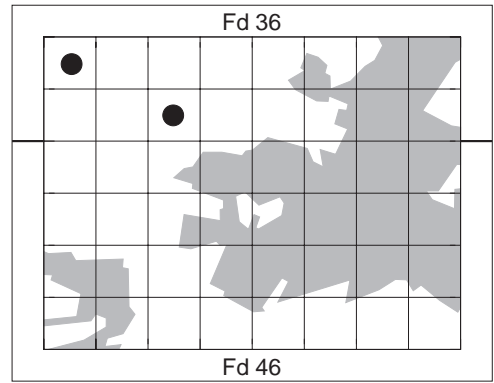
37. *D. schreberiana* (Hedw.) Dixon – Very rare (Fig. 118). An epigeal species fairly frequent in the Silesian Upland (Jędrzejko, 1990; Stebel, 1997, 1998a; Fojcik & Stebel, 2001) and frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

1 stat.: Fd 36/81 – Pniaki, on loess soil in a ravine in deciduous forest.

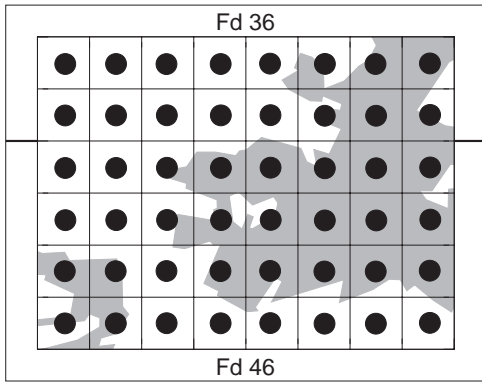
38. *D. staphylina* H. Whitehouse – Fairly frequent (Fig. 119). On waysides and in waste land on bare clayey soil. Commonly found



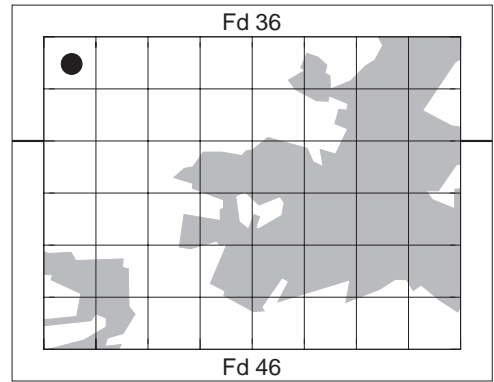
109. *Fissidens taxifolius*



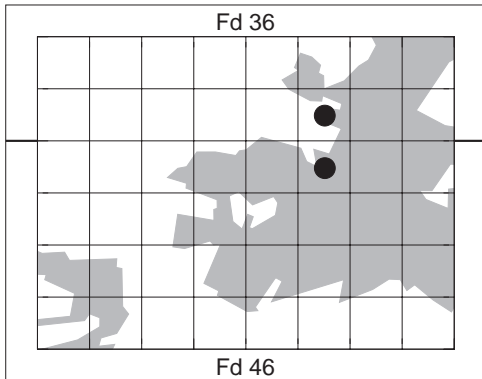
110. *Fissidens viridulus*



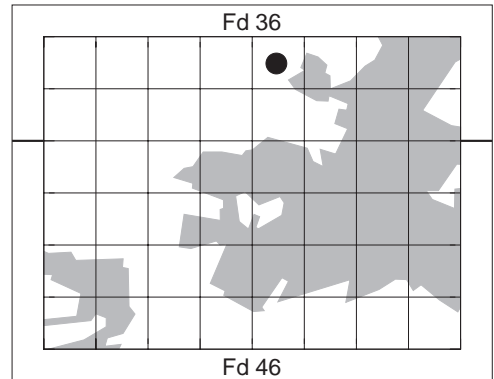
111. *Ceratodon purpureus*



112. *Ditrichum heteromallum*



113. *Ditrichum pusillum*



114. *Dicranella cerviculata*

Figs 109–114. Distribution maps for *Fissidens taxifolius* (109), *F. viridulus* (110), *Ceratodon purpureus* (111), *Ditrichum heteromallum* (112), *D. pusillum* (113) and *Dicranella cerviculata* (114) in the Olkusz Ore-bearing Region.

with rhizoidal gemmae. Frequent in the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and Cracow-Częstochowa Upland (Fojcik, 2011).

12 stat.: grid squares: Fd 36/80; Fd 36/81; Fd 36/84; Fd 36/92; Fd 36/93; Fd 36/96; Fd 46/03; Fd 46/04; Fd 46/06; Fd 46/07; Fd 46/13; Fd 46/14.

Lit.: Fd 46/03, Fd 46/04, Fd 46/13, Fd 46/14 (Ochyra & Godzik, 2015).

39. *D. varia* (Hedw.) Schimp. – Fairly frequent (Fig. 120). On bare soil in dry to moist waysides, in waste land and on banks of ditches and ponds. Rarely found with sporophytes. Frequent in the Silesian Upland (Jędrzejko, 1990; Stebel, 1998a; Fojcik & Stebel, 2001) and very frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

13 stat.: Fd 46/02; Fd 46/03; Fd 46/04; Fd 46/06; Fd 46/07; Fd 46/13; Fd 46/14; Fd 46/15; Fd 46/17; Fd 46/20; Fd 46/21; Fd 46/23; Fd 46/35.

Lit.: Fd 46/04 (Ochyra & Godzik, 2015).

40. *Dicranum polysetum* [Sw.] ex anon. – Very rare (Fig. 121). On sandy soil in pine forest. A species partly protected by law (Anonymus, 2014), fairly frequent in the Silesian Upland (Jędrzejko, 1990; Stebel, 1997, 1998a; Fojcik & Stebel, 2001) and very frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

1 stat.: Fd 36/86 – Hutki, in ditch in *Pinus sylvestris* forest in shaded and dry situation.

41. *D. scoparium* Hedw. – Fairly frequent (Fig. 122). On bark of deciduous trees, rotten wood and on the ground in forest. A species partly protected by law (Anonymus, 2014), common in the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and Cracow-Częstochowa (Fojcik, 2011).

11 stat.: grid squares: Fd 36/81; Fd 36/82; Fd 36/83; Fd 36/84; Fd 36/85; Fd 36/86; Fd 36/95; Fd 46/02; Fd 46/31; Fd 46/32; Fd 46/37.

42. *Orthodicranum montanum* (Hedw.) Loeske – Rare (Fig. 123). On bark of deciduous trees and rotten wood. A species very frequent in the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and Cracow-Częstochowa Upland (Fojcik, 2011).

8 stat.: Fd 36/80 – Krzykawa; Fd 36/84 – Sztolnia Ponikowska between Cegielnia and Połęba; Fd 36/85 – 0.5 km north-east of Hutki; Fd 36/86 – 0.5 km east of Hutki; Fd 36/95 – Dąbrówka, at Kluczevska Street near the Dąbrówka Canal; Fd 46/02 – Krążek; Fd 46/31 – Bukowno, in the Sztola river valley; Fd 46/32 – Bukowno, in the Sztola river valley.

Lit.: Bukowno (Kuc, 1956).

Family Leucobryaceae Schimp.

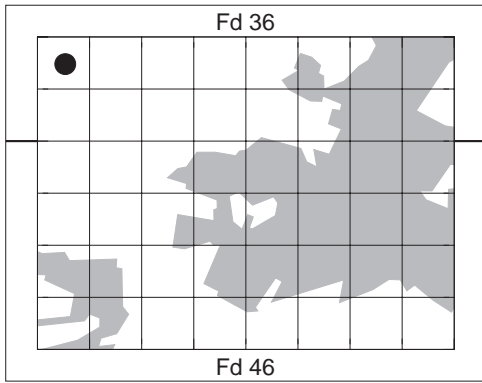
43. *Leucobryum glaucum* (Hedw.) Ångstr. – Very rare (Fig. 124). A species partly protected by law (Anonymus, 2014), rare in the Silesian Upland (Stebel, 1998a; Stebel & Fojcik, 2003) and frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

1 stat.: Fd 36/84 – Sztolnia Ponikowska in Cegielnia, rotten wood in moist mixed forest.

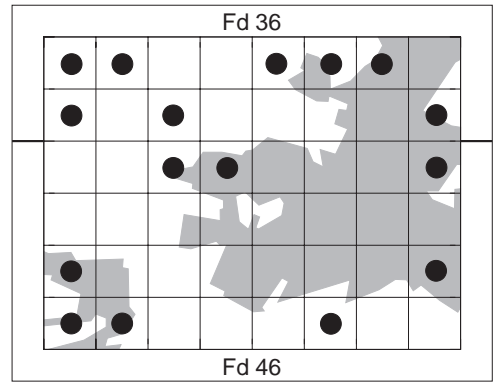
Lit.: near Bolesław and Olkusz, in *Pinus sylvestris* forest (Dobrzańska, 1955).

Family Seligieriaceae Schimp.

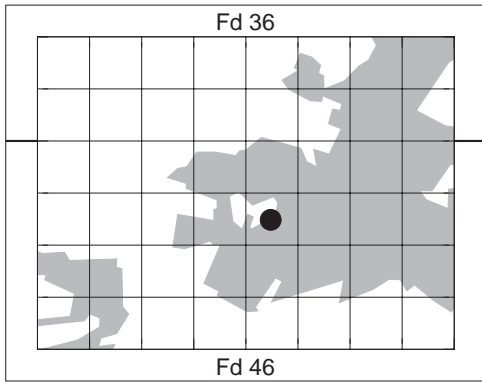
44. *Dicranoweisia cirrata* (Hedw.) Lindb. ex Milde – Very rare (Fig. 125). An epiphytic moss species rapidly expanding in Poland in recent years, frequent both in the Silesian Upland (Stebel, 1997, 1998a, 2008a; Stebel & Plášek, 2001; Fojcik & Stebel, 2001) and Cracow-Częstochowa Upland (Fojcik, 2011).



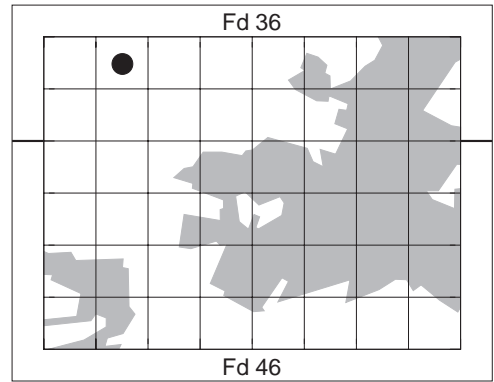
115. *Dicranella crispa*



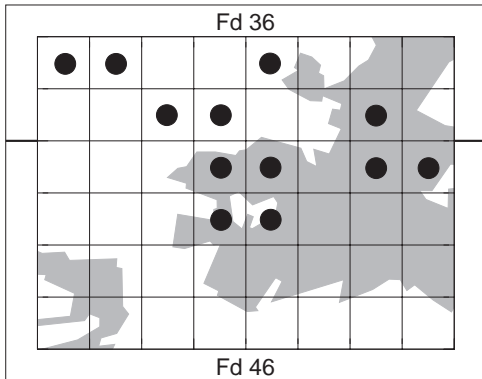
116. *Dicranella heteromalla*



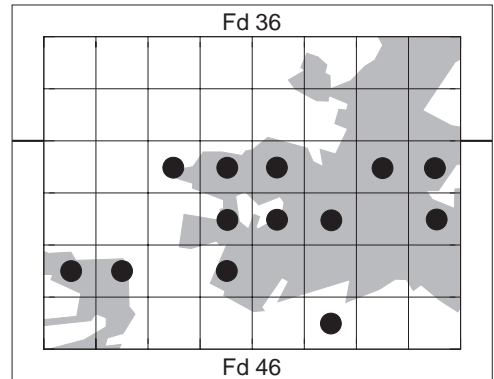
117. *Dicranella rufescens*



118. *Dicranella schreberiana*



119. *Dicranella staphylina*



120. *Dicranella varia*

Figs 115–120. Distribution maps for *Dicranella crispa* (115), *Dicranella heteromalla* (116), *D. rufescens* (117), *D. schreberiana* (118), *D. staphylina* (119) and *D. varia* (120) in the Olkusz Ore-bearing Region.

2 stat.: Fd 36/81 – between Pniaki and Krzykawa, on bark of *Betula pendula*, *c. spor.*; Fd 46/31 – Bukowno, in the Sztola river valley, on bark of *Quercus robur* on wayside of the Bukowno – Jarorzno road, *c. spor.* and *c. gem.*

Family Grimmiaceae Arn.

45. *Dryptodon pulvinatus* (Hedw.) Brid. – Rare (Fig. 126). On concrete walls, boulders and bridges. Fairly often producing sporophytes in profusion. A frequent species both in the Silesian Upland (Jędrzejko, 1990; Stebel, 1997, 1998a; Fojcik & Stebel, 2001) and Cracow-Częstochowa Upland (Fojcik, 2011).

9 stat.: Fd 36/80 – Krzykawa; Fd 36/82 – Nowy Ujków, Zimny Dół; Fd 36/83 – in the Dąbrówka Canal between Busznice and Kolonia Nowy Ujków; Fd 36/87 – 2 km west of Pomorzany; Fd 36/93 – Bolesław, in the Dąbrówka Canal at Pleścińska Street; Fd 36/94 – Bolesław, in the Dąbrówka Canal east of the Katowice – Olkusz road; Fd 46/05 – Ujków Stary, north of the flotation tailings heap of the “Olkusz” mine; Fd 46/10 – south of Bukowno-Kleparz; Fd 46/25 – Starczynów, near the Baba Canal.

46. *Niphotrichum canescens* (Hedw.) Bednarek-Ochyra & Ochyra – Fairly frequent (Fig. 127). On sandy soil in xerothermic grassland and waste land, old concrete walls and roadside banks, generally in dry and insolated habitats and only occasionally in shaded and somewhat damp sites. Frequent in the Silesian Upland (Bednarek-Ochyra, 1995; Stebel, 1997, 1998a; Fojcik & Stebel, 2001) and very frequent in the Cracow-Częstochowa Uplands (Fojcik, 2011).

14 stat.: grid squares: Fd 36/82; Fd 36/83; Fd 36/84; Fd 36/86; Fd 36/87; Fd 36/95; Fd 46/02; Fd 46/05; Fd 46/20; Fd 46/21; Fd 46/27; Fd 46/30; Fd 46/31; Fd 46/32.

Lit.: near Bolesław and Olkusz (Dobrzańska, 1955); Fd 46/02 (Ochyra & Godzik, 2015).

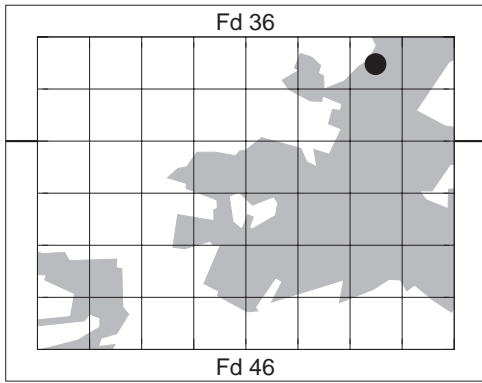
47. *Schistidium apocarpum* (Hedw.) Bruch & Schimp. – Very rare (Fig. 128). This species seems to be rare in the Silesian Upland and Cracow-Częstochowa Upland, but its distribution is still insufficiently known. In its traditional broad circumscription, *S. apocarpum* was an aggregate of a number of well defined and distinct species which are only distantly related to the core species of this complex (Blom, 1996). Accordingly, all collections of *S. apocarpum* deposited in Polish herbaria need a careful assessment which should result in better understanding of *S. apocarpum* s. str. and its segregates in Poland.

3 stat.: Fd 46/03 – in pine forest west of Krążek, stony soil; Fd 46/14 – Ujków Stary, on boulder; Fd 46/25 – Starczynów, in the Baba Canal, on wet concrete boulder near the water level.

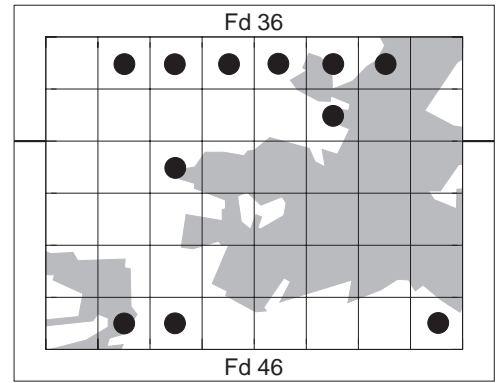
Lit.: (1) near Bolesław and Olkusz (Dobrzańska, 1955); Bukowno (Jędrzejko, 1990) – due to the lack of any voucher collections the real identity of these records is unknown. (2) Fd 46/03 – sampling plot No. 25 east of Krążek (Ochyra & Godzik, 2015).

48. *S. crassipilum* H.H.Blom – Common (Fig. 129). On insolated and exposed limestone and dolomite rocks, concrete walls, boulders, roof tiles, stony ruins and bridges. Commonly with sporophytes. This is the most common and abundant segregate of the *S. apocarpum* complex which is very frequent in the Cracow-Częstochowa Upland (Fojcik, 2011). Likewise, it seems to be the commonest species of genus in Silesian Upland and in the lowlands of Poland.

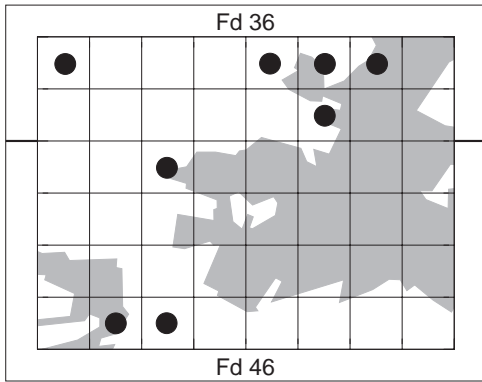
33 stat.: grid squares: Fd 36/82; Fd 36/83; Fd 36/84; Fd 36/85; Fd 36/92; Fd 36/93; Fd 36/94; Fd 36/95; Fd 36/97; Fd 46/00; Fd 46/01; Fd 46/02; Fd 46/03; Fd 46/04; Fd 46/05; Fd 46/06; Fd 46/10; Fd 46/11; Fd 46/12; Fd 46/13; Fd 46/14; Fd 46/15; Fd 46/17; Fd 46/20; Fd 46/21; Fd 46/22; Fd 46/24; Fd 46/25; Fd 46/26; Fd 46/27; Fd 46/31; Fd 46/33; Fd 46/34.



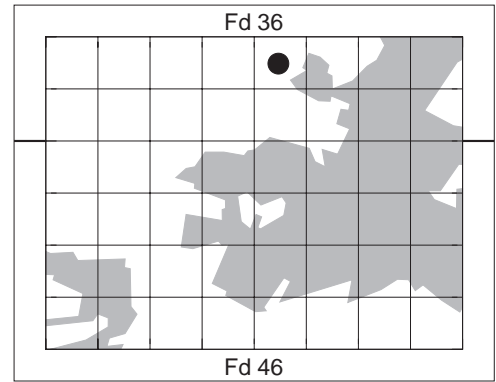
121. *Dicranum polysetum*



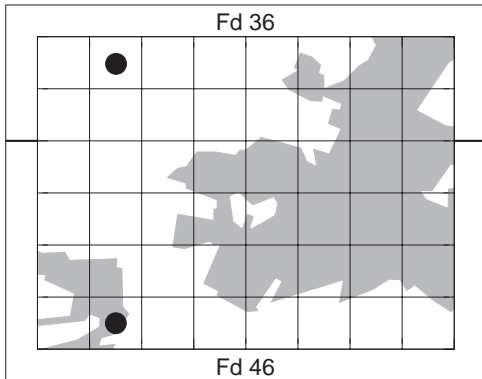
122. *Dicranum scoparium*



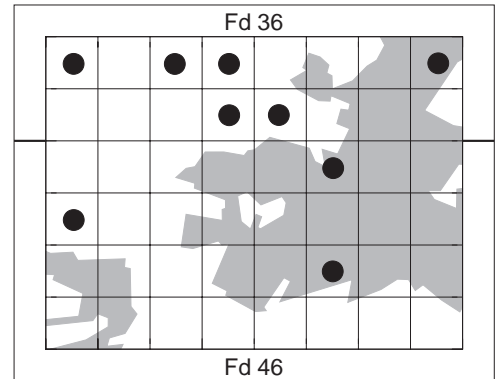
123. *Orthodicranum montanum*



124. *Leucobryum glaucum*



125. *Dicranowesia cirrata*



126. *Dryptodon pulvinatus*

Figs 121–126. Distribution maps for *Dicranum polysetum* (121), *D. scoparium* (122), *Orthodicranum montanum* (123), *Leucobryum glaucum* (124), *Dicranowesia cirrata* (125) and *Dryptodon pulvinatus* (126) in the Olkusz Ore-bearing Region.

Lit.: Fd 46/04, Fd 46/17 (Ochyra & Godzik, 2015).

49. *S. dupretii* (Thér.) W.A.Weber – Frequent (Fig. 130). On exposed and insolated limestone and dolomite rocks, concrete walls, bridges and roof tiles. Commonly found with sporophytes. The species was previously reported only once from the Silesian Upland (Stebel & Smolińska, 2012) and it is reported only from one locality (Dolina Kobylańska) in the Cracow-Częstochowa Upland (Blom, 1996). However, these data do not apparently reflect the real distribution of *S. dupretii* in these regions because, according to unpublished observations of the authors, *S. dupretii* occurs frequently in the mountains and uplands of Poland.

29 stat.: grid squares: Fd 36/83; Fd 36/84; Fd 36/86; Fd 36/87; Fd 36/92; Fd 36/93; Fd 36/94; Fd 36/95; Fd 36/96; Fd 36/97; Fd 46/00; Fd 46/01; Fd 46/02; Fd 46/03; Fd 46/04; Fd 46/05; Fd 46/06; Fd 46/10; Fd 46/12; Fd 46/13; Fd 46/14; Fd 46/15; Fd 46/17; Fd 46/21; Fd 46/24; Fd 46/25; Fd 46/26; Fd 46/27; Fd 46/34.

Lit.: Fd 36/93, Fd 46/03, Fd 46/04, Fd 46/13, Fd 46/14, Fd 46/17 (Ochyra & Godzik, 2015).

Family Pottiaceae Schimp.

50. *Aloina rigida* (Hedw.) Limpr. – Not found during the present field studies (Fig. 131). A xerothermic moss species, infrequently collected in the Silesian Upland (Stebel, 1998a, 2006b; Fojcik & Stebel, 2001) and Cracow-Częstochowa Upland (Fojcik, 2011).

1 stat.: Fd 46/20 – Bukowno, Jamna Góra, on dry in the *Teucrium botrys-Sedum acre* community, leg. B. Babczyńska-Sendek 67/93, 1 July 1993 (KRAM).

Lit.: Bukowno, Jamna Góra (Babczyńska-Sendek, 2005).

51. *Barbula convoluta* Hedw. – Fairly frequent (Fig. 132). On soil in disturbed sites in waste land, on waysides and railway embankment. A species frequent throughout the whole Silesian Upland and the Cracow-Częstochowa Upland (Jędrzejko, 1990; Stebel, 1997, 1998a; Fojcik & Stebel, 2001; Fojcik, 2011).

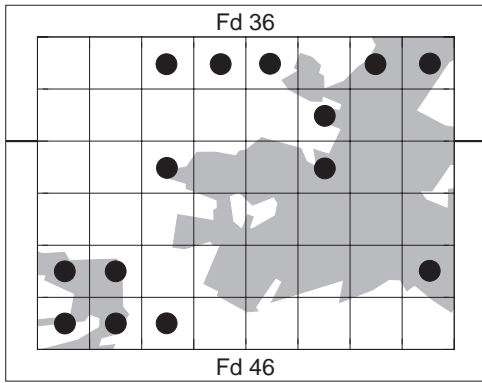
10 stat.: grid squares: Fd 36/87; Fd 36/90; Fd 36/95; Fd 36/96; Fd 46/00; Fd 46/06; Fd 46/07; Fd 46/20; Fd 46/21; Fd 46/31.

52. *B. unguiculata* Hedw. – Common (Fig. 133). On clayey and stony ground in waste land, on waysides, railway embankments, rarely on old concrete walls. Frequently found with sporophytes. Commonly distributed throughout the Silesian Upland and the Cracow-Częstochowa Upland (Jędrzejko, 1990; Stebel, 1997, 1998a; Fojcik & Stebel, 2001; Fojcik, 2011).

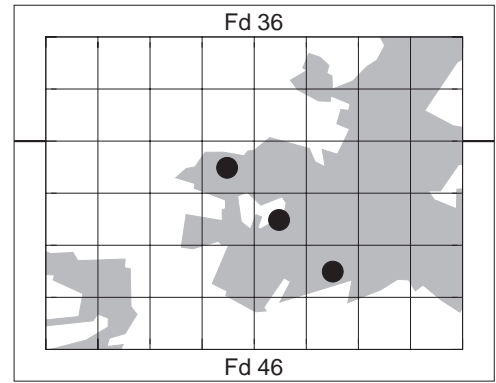
36 stat.: grid squares: Fd 36/80; Fd 36/82; Fd 36/83; Fd 36/84; Fd 36/85; Fd 36/87; Fd 36/90; Fd 36/91; Fd 36/92; Fd 36/93; Fd 36/94; Fd 36/95; Fd 36/96; Fd 36/97; Fd 46/02; Fd 46/03; Fd 46/04; Fd 46/05; Fd 46/06; Fd 46/07; Fd 46/12; Fd 46/13; Fd 46/14; Fd 46/15; Fd 46/16; Fd 46/17; Fd 46/20; Fd 46/21; Fd 46/23; Fd 46/24; Fd 46/25; Fd 46/26; Fd 46/27; Fd 46/30; Fd 46/33; Fd 46/34.

Lit.: near Bolesław and Olkusz (Dobrzańska, 1955); Bolesław (Kuc, 1956); Bukowno, Jamna Góra (Babczyńska-Sendek, 2005); Bukowno-Skotnica (Babczyńska-Sendek, 2005); Fd 46/02, Fd 46/03, Fd 46/04, Fd 46/12, Fd 46/13, Fd 46/14 (Ochyra & Godzik, 2015).

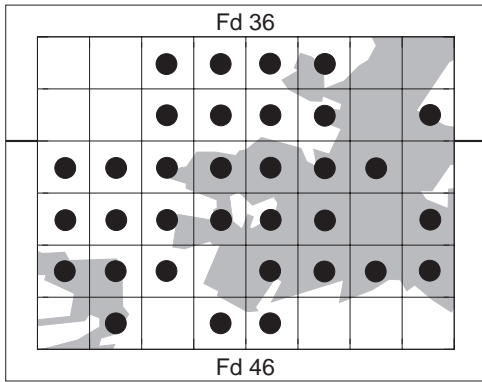
53. *Bryoerythrophyllum recurvirostrum* (Hedw.) P.C.Chen – Very rare (Fig. 134). On rocky ground. Scattered in the Silesian Upland (Jędrzejko, 1990; Stebel, 1997, 1998a; Fojcik & Stebel, 2001) and very frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).



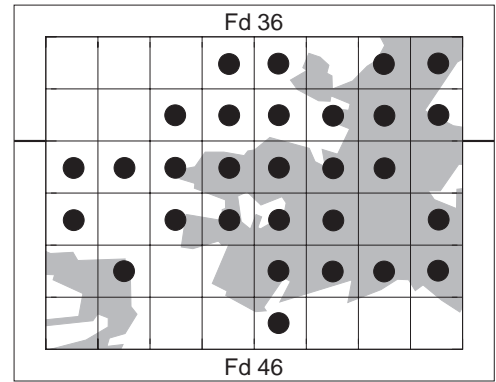
127. *Niphotrichum canescens*



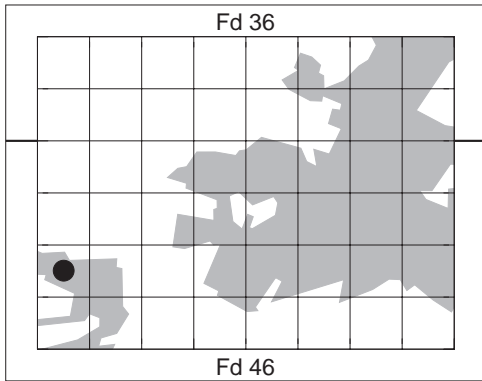
128. *Schistidium apocarpum*



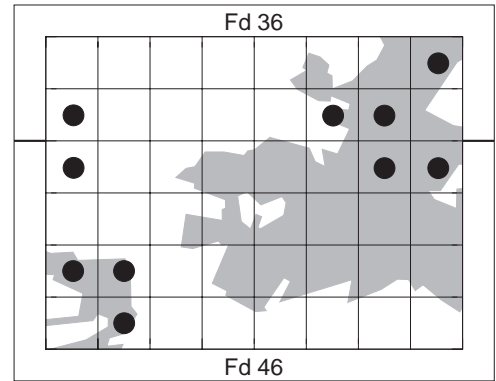
129. *Schistidium crassipilum*



130. *Schistidium dupretii*



131. *Aloina rigida*



132. *Barbula convoluta*

Figs 127–132. Distribution maps for *Niphotrichum canescens* (127), *Schistidium apocarpum* (128), *S. crassipilum* (129), *S. dupretii* (130), *Aloina rigida* (131) and *Barbula convoluta* (132) in the Olkusz Ore-bearing Region.

1 stat.: Fd 36/97 – Sary Olkusz, 300 m north of the “Mieszko” adit, on stony ground.

Lit.: Bolesław (Kuc, 1956); Bukowno (Jędrzejko, 1990).

54. *Didymodon fallax* (Hedw.) R.H.Zander – Frequent (Fig. 135). On soil in waste land, on waysides, railway embankments and in ditches in dry to damp sites. Fairly frequently producing sporophytes. Frequent in the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

21 stat.: grid squares: Fd 36/82; Fd 36/85; Fd 36/86; Fd 36/87; Fd 36/95; Fd 36/96; Fd 36/97; Fd 46/02; Fd 46/03; Fd 46/04; Fd 46/05; Fd 46/06; Fd 46/07; Fd 46/12; 46/13; Fd 46/14; Fd 46/15; Fd 46/20; Fd 46/27; Fd 46/30; Fd 46/31.

Lit.: near Bolesław and Olkusz (Dobrzańska, 1955); Bukowno (Jędrzejko, 1990); Fd 46/04 (Ochyra & Godzik, 2015).

55. *D. rigidulus* Hedw. – Frequent (Fig. 136). A saxicolous species growing on old concrete walls, bridges and limestone and dolomite rocks. Frequently found with gemmae, but only occasionally producing sporophytes. Very frequent in the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

19 stat.: grid squares: Fd 36/80; Fd 36/83; Fd 36/84; Fd 36/86; Fd 36/93; Fd 36/94; Fd 36/95; Fd 36/97; Fd 46/00; Fd 46/02; Fd 46/03; Fd 46/04; Fd 46/11; Fd 46/14; Fd 46/17; Fd 46/20; Fd 46/31; Fd 46/32; Fd 46/33.

Lit.: Fd 46/04; Fd 46/14 (Ochyra & Godzik, 2015).

56. *D. topfaceous* (Brid.) Lisa – Very rare (Fig. 137). On calcareous wet soil. Rare in the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and so far it has not been recorded from the Cracow-Częstochowa Upland (Fojcik, 2011). In Poland this is a rare

species, scattered in the Carpathians and in Lower Silesia and very rare in the lowlands.

2 stat.: Fd 36/94 – Bolesław, near Dąbrówka canal, wet soil; Fd 46/14 – Ujków Stary, on wet clayey soil (*leg.* J. Drobnik, 15 June 2002, KRAM, SOSN).

57. *Protobryum bryoides* (Dicks.) J.Guerra & Cano [syn. *Pottia bryoides* (Dicks.) Mitt.] – Not found during the present field studies. A xerothermic species rare in the Silesian Upland (Kuc, 1956; Jędrzejko, 1990; Stebel, 1998a) and quite frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

Lit.: Bolesław (Kuc, 1956 [*leg.* M. Kuc, 21 March 1955, KRAM]).

58. *Pseudocrossidium hornschi* (Schultz) R.H.Zander – Very rare (Fig. 138). On dry, clayey soil. Rare in the Silesian Upland (Stebel, 1997, 1998a; Fojcik & Stebel, 2001) and relatively frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

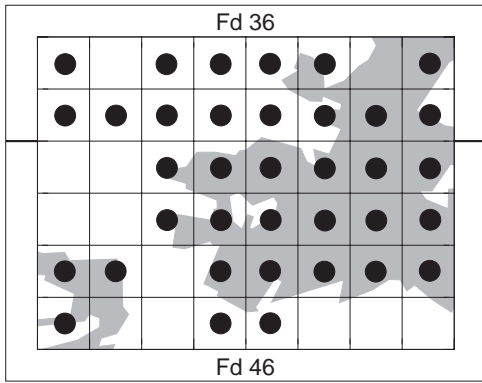
1 stat.: Fd 46/05 – Ujków Stary, northern slope of the sediment trap of the “Olkusz” mine, on soil.

59. *Syntrichia ruralis* (Hedw.) F.Weber & D.Mohr – Very rare (Fig. 139). Mostly on sandy soil and stony ground in open and dry habitats. Common in the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011) but surprisingly rare in the study area.

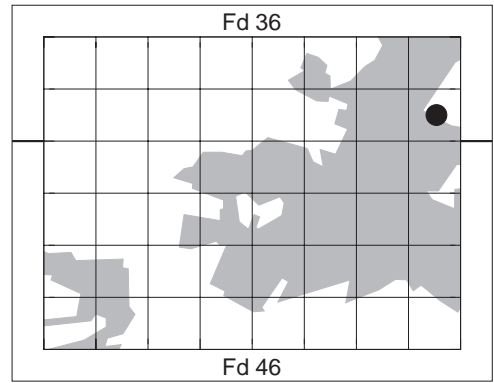
3 stat.: Fd 36/80 – Krzykawa, dry sandy soil on roadside ditch; Fd 46/27 – Pustynia Starczynowska, stony banks of the channel Baba; Fd 46/30 – Bukowno, Sztoła river valley, sandy insolated slope.

Lit.: Bolesław (Kuc, 1956); Bukowno (Kuc, 1956).

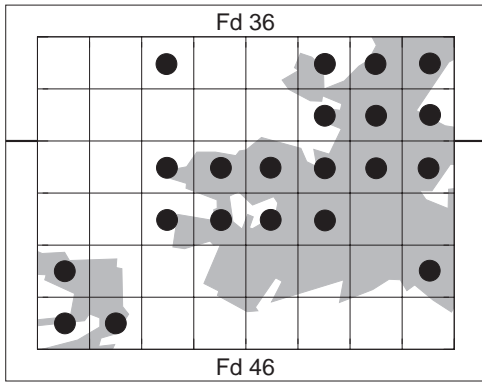
60. *Tortella tortuosa* (Hedw.) Limpr. – Frequent (Fig. 140). On calcareous soil, stony ground and limestone and dolomite rocks in dry habitats. Mostly sterile and very seldom



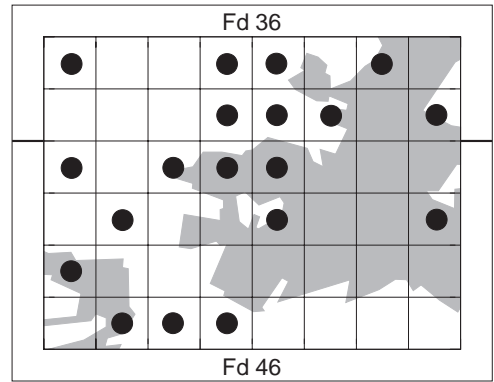
133. *Barbula unguiculata*



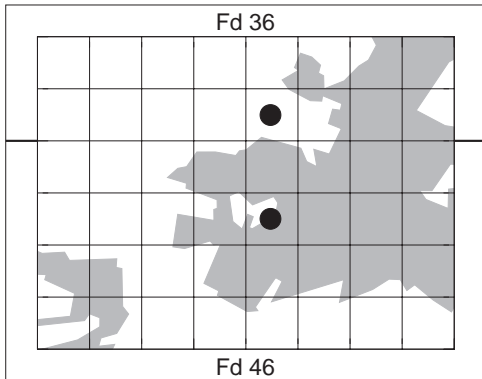
134. *Bryoerythrophyllum recurvirostrum*



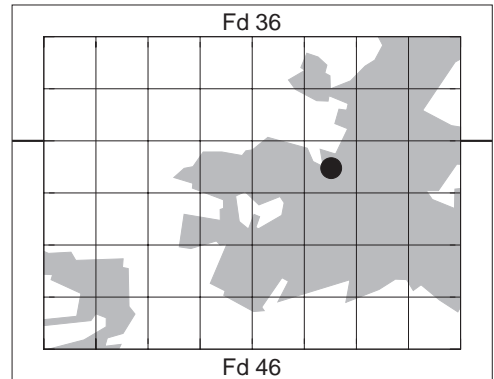
135. *Didymodon fallax*



136. *Didymodon rigidulus*



137. *Didymodon tophaceus*



138. *Pseudocrossidium hornschurchianum*

Figs 133–138. Distribution maps for *Barbula unguiculata* (133), *Bryoerythrophyllum recurvirostrum* (134), *Didymodon fallax* (135), *D. rigidulus* (136), *D. tophaceus* (137) and *Pseudocrossidium hornschurchianum* (138) in the Olkusz Ore-bearing Region.

found with sporophytes. Frequent in the Silesian Upland (except for Wyzyna Katowicka and Płaskowyż Rybnicki) (Stebel, 1998a; Fojcik & Stebel, 2001) and very frequent and abundant in some areas in the Cracow-Częstochowa Upland (Fojcik, 2011).

27 stat.: grid squares: Fd 36/84; Fd 36/86; Fd 36/92; Fd 36/93; Fd 36/95; Fd 36/96; Fd 36/97; Fd 46/02 – Krażek, *leg.* A. Stebel & J. Drobnik, 10 June 2002 (sosn); Fd 46/03; Fd 46/04; Fd 46/05; Fd 46/06; Fd 46/07; Fd 46/11; Fd 46/12; 46/13; Fd 46/14; Fd 46/15; Fd 46/16; Fd 46/17; Fd 46/21; Fd 46/23; Fd 46/24; Fd 46/25; Fd 46/27; Fd 46/33; Fd 46/34.

Lit.: near Bolesław and Olkusz (Dobrzańska, 1955); Bolesław (Kuc, 1956; Ochyra & Bednarek-Ochyra 1990 [*leg.* R. Ochyra, 3 August 1989, KRAM]); Bukowno (Jędrzejko, 1990); Stary Olkusz (Kaźmierczakowa, 1988); grid squares: Fd 46/02, Fd 46/03, Fd 46/04, Fd 46/13, Fd 46/14, Fd 46/17 (Ochyra & Godzik, 2015).

61. *Tortula acaulon* (With.) R.H.Zander [syn. *Phascum cuspidatum* Hedw.] – Not found during the present field studies. Scattered in the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and very frequent and locally abundant in the Cracow-Częstochowa Upland (Fojcik, 2011).

Lit.: Bolesław (Kuc, 1956).

62. *T. lanceola* R.H.Zander [syn. *Pottia lanceolata* (Hedw.) Müll.Hal.] – Not found during the present field studies. Rare in the Silesian Upland (Kuc, 1956; Stebel, 1998a) but frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

Lit.: Bolesław (Kuc, 1956 [*leg.* M. Kuc, 24 April 1952, KRAM]).

63. *T. modica* R.H.Zander [syn. *Pottia intermedia* (Turner) Fürnr.] – Very rare (Fig. 141). On dry clayey soil. Rare in the Silesian Upland (Kuc, 1956; Stebel, 1997, 1998a; Fojcik

& Stebel, 2001) and very frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

1 stat.: Fd 36/92 – Bolesław-Ćmielówka, clayey soil on wayside waste land, *c. spor.*

64. *T. muralis* Hedw. – Fairly frequent (Fig. 142). Mostly on old concrete walls, bridges, boulders and stones in dry and insolated habitats. Commonly producing sporophytes. Commonly occurring throughout the whole Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

17 stat.: grid squares: Fd 36/80; Fd 36/83; Fd 36/84; Fd 36/87; Fd 36/90; Fd 36/93; Fd 36/94; Fd 46/00; Fd 46/02; Fd 46/03; Fd 46/05; Fd 46/12; Fd 46/13; Fd 46/14; Fd 46/17; Fd 46/27; Fd 46/33.

Lit.: Bolesław (Kuc, 1956); Bukowno (Kuc, 1956); Fd 46/12 (Ochyra & Godzik, 2015).

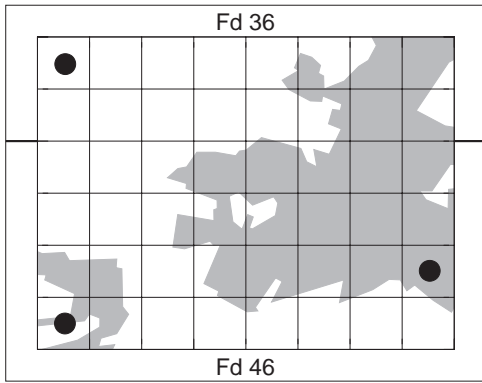
65. *Weissia controversa* Hedw. – Rare (Fig. 143). On soil in waste land in dry and open habitats. Rarely found with sporophytes. Scattered in the Silesian Upland (Kuc, 1956; Stebel, 1998a; Fojcik & Stebel, 2001) and relatively frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

6 stat.: Fd 36/93 – west of Kolonia Ujków Nowy; Fd 36/95 – Dąbrówka, the Rozmus forest; Fd 46/07 – Stary Olkusz, Pomorska Street; Fd 46/14 – south of Ujków Stary; Fd 46/23 – south of Huta Bolesław in Bukowno; Fd 46/24 – Starczyń, Poprzeczna Street.

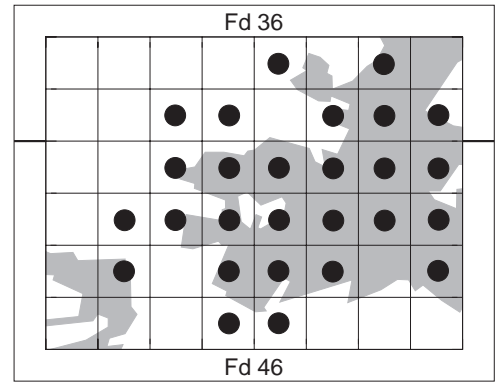
Lit.: Fd 36/93, Fd 46/14, Fd 46/23, Fd 46/24 (Ochyra & Godzik, 2015).

Family Orthotrichaceae Arn.

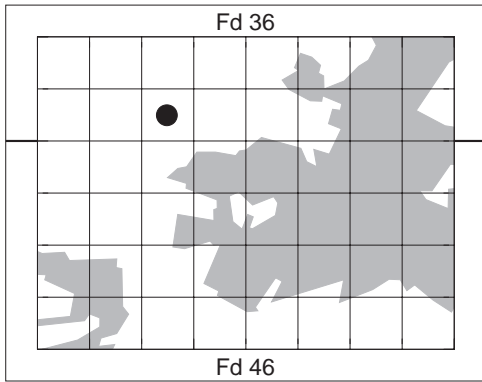
66. *Orthotrichum affine* Schrad. *ex* Brid. – Very rare (Fig. 144). On bark of deciduous trees. Always with sporophytes. Until recently the species was very rare in the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the



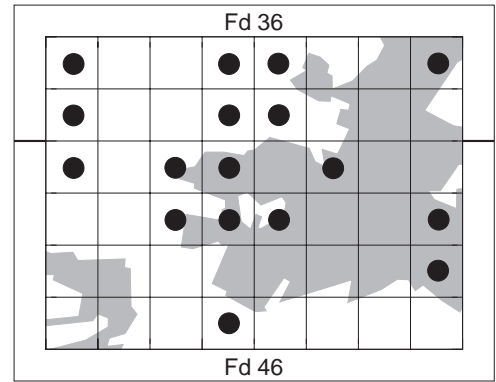
139. *Syntrichia ruralis*



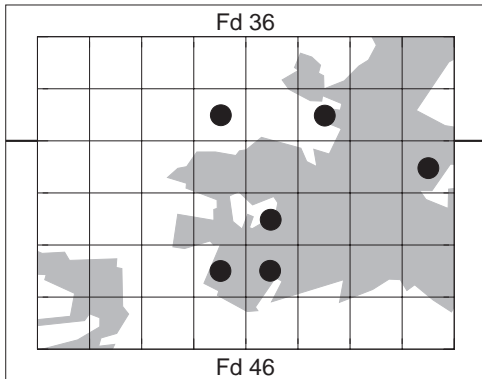
140. *Tortella tortuosa*



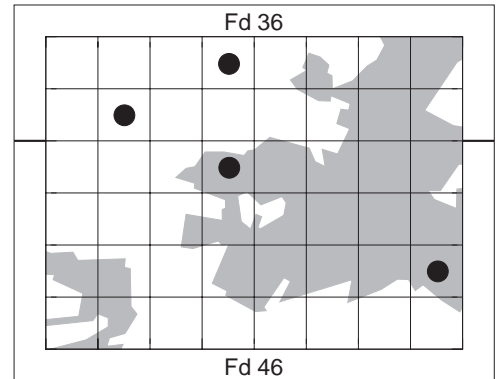
141. *Tortula modica*



142. *Tortula muralis*



143. *Weissia controversa*



144. *Orthotrichum affine*

Figs 139–144. Distribution maps for *Syntrichia ruralis* (139), *Tortella tortuosa* (140), *Tortula modica* (141), *T. muralis* (142), *Weissia controversa* (143) and *Orthotrichum affine* (144) in the Olkusz Ore-bearing Region.

Cracow-Częstochowa Upland but at present the number of its localities has markedly increased (Fojcik, 2011).

4 stat.: Fd 36/83 – Kolonia Nowy Ujków, ‘Cicha Kolonia’, Cegielniana Street; Fd 36/91 – between Podlipie and Małobądz; Fd 46/03 – Bolesław, park; Fd 46/27 – Pustynia Starczynowska, near the Baba Canal.

67. *O. anomalum* Hedw. – Rare (Fig. 145). On old concrete walls, bridges and limestone boulders. Always found with sporophytes. Fairly frequent in the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

6 stat.: Fd 36/80 – Krzykawa; Fd 36/82 – Nowy Ujków, Zimny Dół; Fd 36/83 – Kolonia Nowy Ujków, ‘Cicha Kolonia’ at Cegielniana Street; Fd 36/85 – Karna; Fd 36/94 – Bolesław, Wyzwolenia Street; Fd 46/02 – Krążek, meadows between Podlipie and Polna Street.

Lit.: Bukowno (Jędrzejko, 1990).

68. *O. diaphanum* Schrad. *ex* Brid. – Very rare (Fig. 146). On bark of deciduous trees. Always found with sporophytes. Frequent in the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

4 stat.: Fd 36/80 – Krzykawa-Pokrzywdzie; Fd 36/83 – Kolonia Nowy Ujków, ‘Cicha Kolonia’, Cegielniana Street; Fd 36/85 – Hutki and Karna; Fd 36/91 – between Podlipie and Małobądz.

69. *O. obtusifolium* Brid. – Very rare (Fig. 147). On bark of deciduous tree. Found with gemmae. Infrequently recorded in the Silesian Upland (Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

1 stat.: Fd 36/80 – Krzykawa-Pokrzywdzie, bark of *Populus* sp., *c. gem.*

70. *O. pumilum* [Sw.] *ex* anon. – Rare (Fig. 148). Bark of deciduous trees. Always with

sporophytes. Frequent in the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

8 stat.: Fd 36/80 – Krzykawa-Pokrzywdzie; Fd 36/81 – 1.5 km west of Pniaki; Fd 36/90 – between Podlipie and Małobądz-Krze; Fd 36/91 – between Małobądz and Podlipie; Fd 36/93 – Bolesław, loess ravine west of Pleścińska Street; Fd 46/32 – Bukowno, the Sztoła river valley; Fd 46/33 – Bukowno, between Pocztowa and Spacerowa Streets; Fd 46/34 – Bukowno, near the Baba Canal.

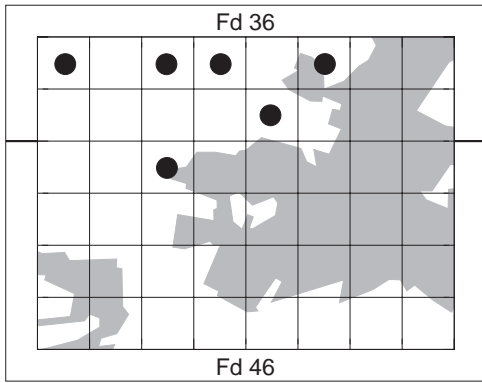
71. *O. speciosum* Nees – Fairly frequent (Fig. 149). On bark of deciduous trees. Always found with sporophytes. Frequently recorded in the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011) and it seems that its frequency has markedly increased in recent decades.

10 stat.: grid squares: Fd 36/80; Fd 36/81; Fd 36/83; Fd 36/85; Fd 36/93; Fd 46/02; Fd 46/03; Fd 46/11; Fd 46/32; Fd 46/34.

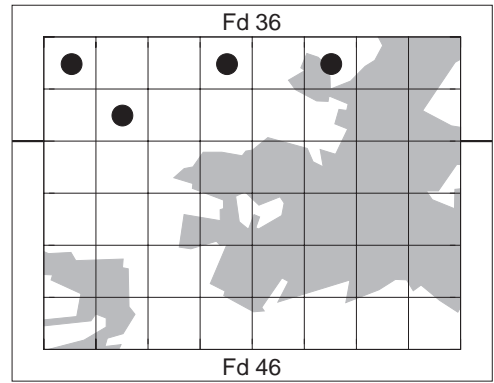
72. *O. stramineum* Hornsch. *ex* Brid. – Very rare (Fig. 150). An epiphytic moss on bark of deciduous trees. Always found with abundant sporophytes. Very rare in the Silesian Upland (Stebel, 1998a) and the Cracow-Częstochowa Upland (Fojcik, 2011). A species threatened in Poland (Żarnowiec *et al.*, 2004).

2 stat.: Fd 36/85 – Hutki, bark of wayside *Robinia pseudoacacia* near Bolesław-Klucze road, *c. spor.*; Fd 36/95 – Bolesław, near the Dąbrówka Canal near the “Pomorzany” mine and the “Dąbrówka” shaft, on bark of *Populus* sp., *c. spor.*

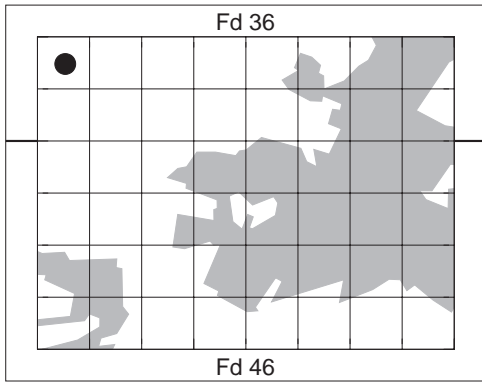
73. *Ulota crispa* (Hedw.) Brid. – Very rare (Fig. 151). An epiphytic moss on bark of deciduous trees. A species which clearly appears to increase its frequency in the Silesian Upland and Cracow-Częstochowa Upland in the last decade (Fojcik, 2011; Stebel, 2011 and unpublished data). A moss partly protected by



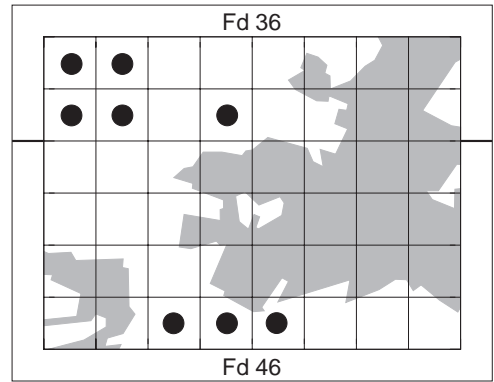
145. *Orthotrichum anomalum*



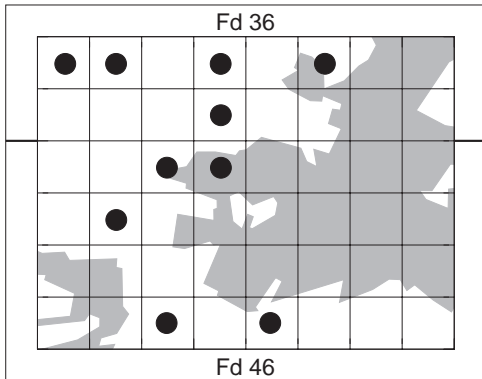
146. *Orthotrichum diaphanum*



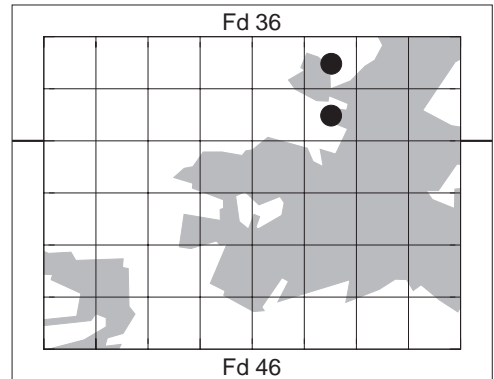
147. *Orthotrichum obtusifolium*



148. *Orthotrichum pumilum*



149. *Orthotrichum speciosum*



150. *Orthotrichum stramineum*

Figs 145–150. Distribution maps for *Orthotrichum anomalum* (145), *O. diaphanum* (146), *O. obtusifolium* (147), *O. pumilum* (148), *O. speciosum* (149) and *O. stramineum* (150) in the Olkusz Ore-bearing Region.

law in Poland (Anonymous, 2014) and threatened (category V, Żarnowiec *et al.*, 2004).

2 stat.: Fd 36/90 – between Podlipie and Małobądz-Krze, on bark of *Sambucus nigra* L.; Fd 36/95 – Bolesław, at the Dąbrówka Canal near the “Pomorzany” mine and the “Dąbrówka” shaft, bark of *Populus* sp.

Family Splachnaceae Grev. & Arn.

74. *Splachnum ampullaceum* Hedw. – Not found during the present field studies (Fig. 152). Very rare coprophilous moss which is scattered throughout the whole territory of Poland, especially in the lowlands, although extinct at many localities and not rediscovered since the nineteenth century (Szmajda *et al.*, 1991). In southern Poland the species has been recently found only in one site in the Kotlina Orawsko-Nowotarska basin (Pawlikowski *et al.*, 2013). A species partly protected by law in Poland (Anonymous, 2014) and threatened (category V, Żarnowiec *et al.*, 2004).

Lit.: Fd 36/85 – Hutki (Kuc 1956 [*leg.* M. Kuc, 19 September 1954, KRAM]); Sztola river near Bukowno (Szmajda *et al.*, 1991 [*leg.* M. Kuc, 20 August 1954, KRAM]).

Family Meesiaceae Schimp.

75. *Leptobryum pyriforme* (Hedw.) Wilson – Rare (Fig. 153). On soil in waste land and on waysides, quite often with rhizoidal gemmae. A species fairly frequent throughout the whole Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

8 stat.: Fd 36/80 – Krzykawa; Fd 36/83 – Kolonia Nowy Ujków at Bolesławska Street; Fd 36/84 – Sztolnia Ponikowska between Cegielnia and Poręba; Fd 36/92 – Bolesław-Ćmielówka; Fd 36/93 – Bolesław, szkolna Street; Fd 46/03 – Bolesław, so-called Old Waste-Dump; Fd 46/20

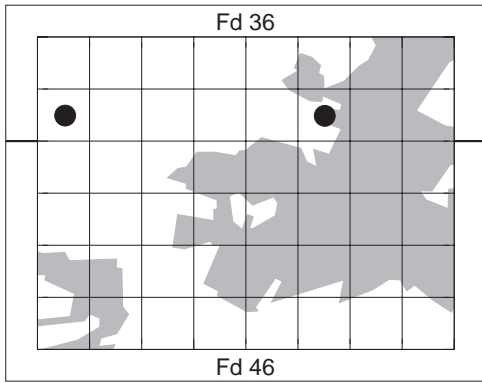
– Bukowno-Cyzowizna; Fd 46/27 – Pustynia Starczynowska, near the Baba Canal.

76. *Meesia triquetra* (Jolycl.) Ångstr. – Not found during the present field studies. The species is considered as a glacial relict in Poland (Ochyra *et al.*, 1988b). *Meesia triquetra* has quickly vanished from the southern part of the country where for the last time it was recorded in this region in the 1950s, including the Silesian Upland (Kuc, 1956, 1959a; Stebel, 1998). It has not been rediscovered since and it is apparently extinct in this region. In southern Poland the species has recently been found only once in the Tatra (Stebel & Perzanowska, 2011). A species strictly protected by law in Poland (Anonymous, 2014) as threatened (category V, Żarnowiec *et al.* 2004).

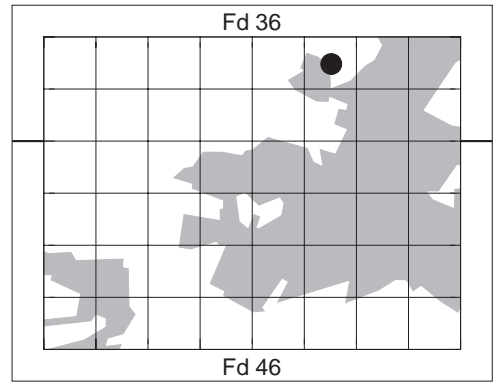
Lit.: Bolesław (Ochyra *et al.*, 1988b [*leg.* K. Zarzycki, 21 October 1956, KRAM]).

77. *Paludella squarrosa* (Hedw.) Brid. – Not found during the present field studies. A glacial relict which is very rare in southern Poland (Ochyra *et al.*, 1988a). It was recently recorded only from a few localities in the Silesian Upland, namely in Miasteczko Śląskie (Fojcik & Rostański, 1996), Balin (Fojcik & Gumiński, 1999) and in the Sztola river valley in Bukowno-Polis (Bacler & Stebel, 1997). The latter locality is situated in close proximity to the investigated area, but at present the state of its preservation is unknown. In the coterminous areas of the Cracow-Częstochowa Upland *P. squarrosa* was reported only once, namely from Bzów near Zawiercie (Kuc, 1956). A species strictly protected by law in Poland (Anonymous, 2014) and threatened (category E, Żarnowiec *et al.*, 2004).

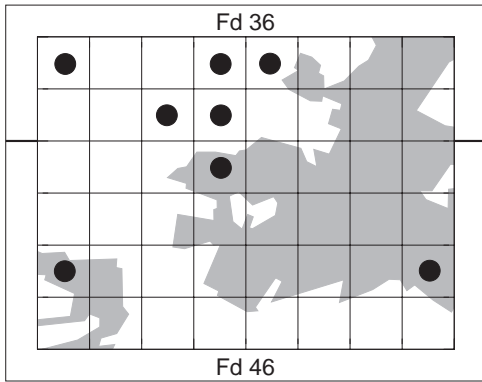
Lit.: Ujków, near railway line between Bukowno and Olkusz (Kuc, 1956; Ochyra *et al.*, 1988a [*leg.* M. Kuc, 11 October 1953, KRAM]).



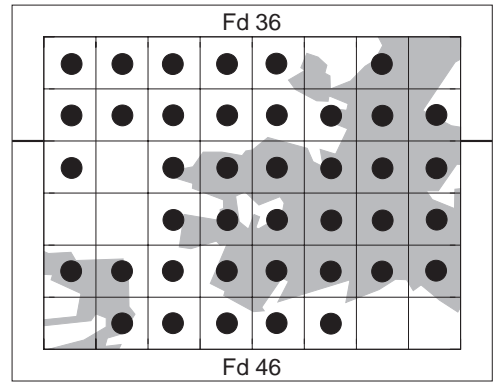
151. *Ulota crispa*



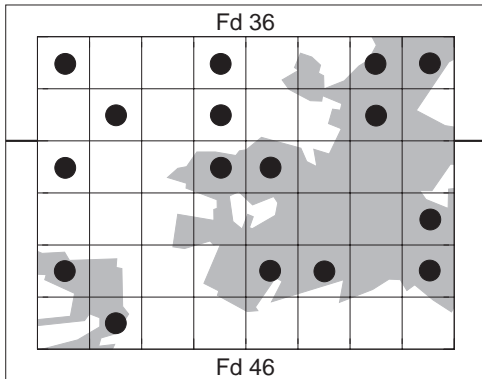
152. *Splachnum ampullaceum*



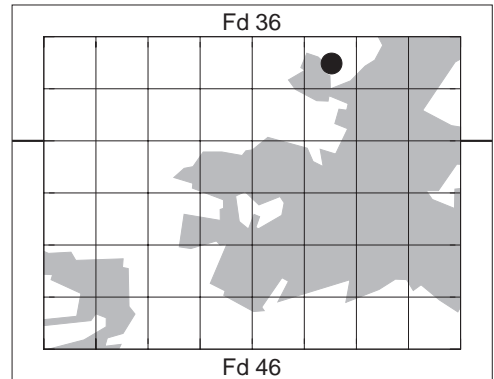
153. *Leptobryum pyriforme*



154. *Bryum argenteum*



155. *Bryum caespiticium*



156. *Bryum creberrimum*

Figs 151–156. Distribution maps for *Ulota crispa* (151), *Splachnum ampullaceum* (152), *Leptobryum pyriforme* (153), *Bryum argenteum* (154), *B. caespiticium* (155) and *B. creberrimum* (156) in the Olkusz Ore-bearing Region.

Family **Bryaceae** Schwägr.

78. ***Bryum argenteum*** Hedw. – The commonest species of the genus *Bryum* in the study area (Fig. 154). It occurs on all types of soil in anthropogenic sites, on stony ground, boulders in dry and exposed sites in waste land, on concrete walls and arable fields. Frequently found with sporophytes. A ubiquitous species common throughout the whole Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

40 stat.: grid squares: Fd 36/80; Fd 36/81; Fd 36/82; Fd 36/83; Fd 36/84; Fd 36/86; Fd 36/90; Fd 36/91; Fd 36/92; Fd 36/93; Fd 36/94; Fd 36/95; Fd 36/96; Fd 36/97; Fd 46/00; Fd 46/02; Fd 46/03; Fd 46/04; Fd 46/05; Fd 46/06; Fd 46/07; Fd 46/12; 46/13; Fd 46/14; Fd 46/15; Fd 46/16; Fd 46/17; Fd 46/20; Fd 46/21; Fd 46/22; Fd 46/23; Fd 46/24; Fd 46/25; Fd 46/26; Fd 46/27; Fd 46/31; Fd 46/32; Fd 46/33; Fd 46/34; Fd 46/35.

Lit.: Bukowno (Jędrzejko, 1990); Fd 46/12, Fd 46/13 (Ochyra & Godzik, 2015).

79. ***B. badium*** (Brid.) Schimp. – Not found during the present field studies. The literature records cannot be confirmed owing to the absence of voucher specimens. The distribution of this species in Poland is poorly known. It is very rare in the Silesian Upland (Stebel, 1998a) and in the coterminous Cracow-Częstochowa Upland (Fojcik, 2011).

Lit.: near Bolesław and Olkusz (Dobrzańska, 1955); Bolesław (Kuc, 1956).

80. ***B. caespiticium*** Hedw. – Fairly frequent (Fig. 155). On soil in dry and insolated places, usually in waste land, waysides, ruderal sites and on old concrete walls. Usually sterile and only occasionally found with sporophytes. A ubiquitous species common throughout the whole Silesian Upland (Stebel, 1998a; Fojcik

& Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

16 stat.: grid squares: Fd 36/80; Fd 36/83; Fd 36/86; Fd 36/87; Fd 36/91; Fd 36/93; Fd 36/96; Fd 46/00; Fd 46/03; Fd 46/04; Fd 46/17; Fd 46/20; Fd 46/24; Fd 46/25; Fd 46/27; Fd 46/31.

Lit.: near Bolesław and Olkusz (Dobrzańska, 1955); Bolesław (Kuc, 1956); Bukowno (Każmierczakowa, 1988; Jędrzejko, 1990); Bukowno-Skotnica (Babczyńska-Sendek, 2005); Stary Olkusz (Każmierczakowa, 1988); Fd 46/04 (Ochyra & Godzik, 2015).

81. ***B. creberrimum*** Taylor [syn. *B. affine* Lindb. & Arnell] – Very rare (Fig. 156). Not found during the present field studies. The distribution of this species in Poland is poorly known. It is rare and scattered in the Silesian Upland (Stebel, 1998a) and very rare in the coterminous Cracow-Częstochowa Upland (Fojcik, 2011) and. The record of this species from the study area is confirmed by the voucher specimen.

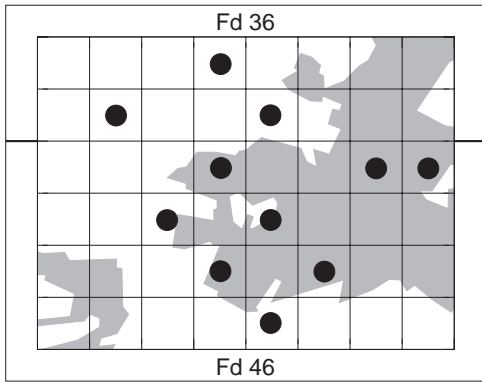
Lit.: Fd 36/85 – Hutki (Kuc, 1956 as *Bryum affine* [leg. M. Kuc, 12 September 1955, KRAM]).

82. ***B. dichotomum*** Hedw. [syn. *B. bicolor* Dicks.] – Fairly frequent (Fig. 157). On soil in dry habitats on waysides, in waste land and ruderal places. Commonly with axillary gemmae which are usually produced in great profusion. Scattered throughout the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

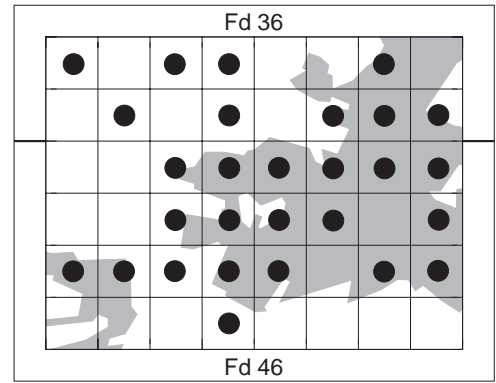
11 stat.: grid squares: Fd 36/83; Fd 36/91; Fd 36/94; Fd 46/03; Fd 46/06; Fd 46/07; Fd 46/12; Fd 46/14; Fd 46/23; Fd 46/25; Fd 46/34.

Lit.: Fd 46/12, Fd 46/14 (Ochyra & Godzik, 2015).

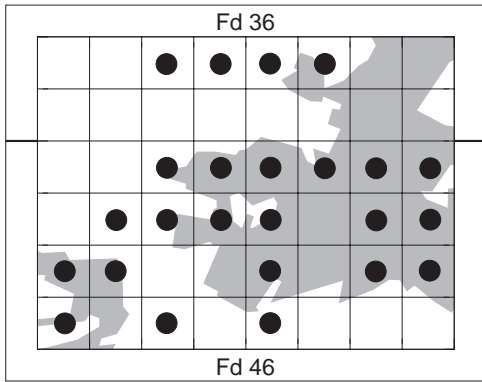
83. ***Bryum palleescens*** Schwägr. – Frequent. Along with *Bryum argenteum* and *B. pseudo-*



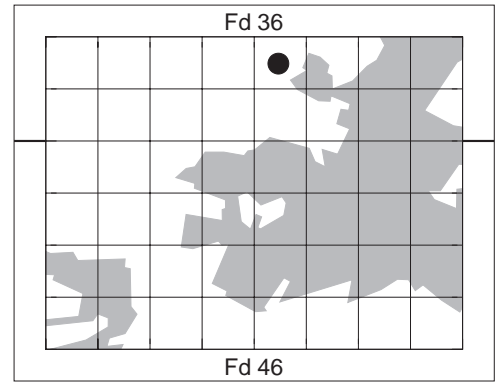
157. *Bryum dichotomum*



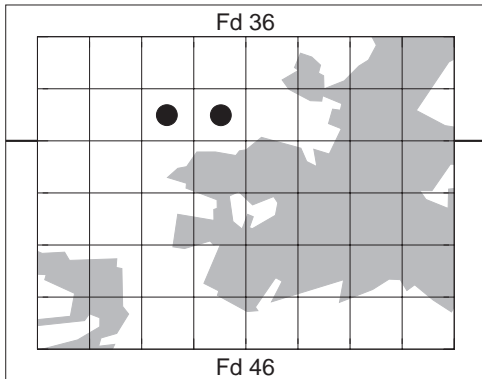
158. *Bryum pallescens*



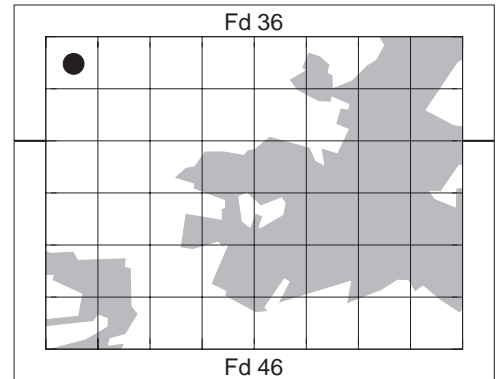
159. *Bryum pseudotriquetrum*



160. *Poblia bulbifera*



161. *Poblia cruda*



162. *Poblia lescuriana*

Figs 157–162. Distribution maps for *Bryum dichotomum* (157), *B. pallescens* (158), *B. pseudotriquetrum* (159), *Poblia bulbifera* (160), *P. cruda* (161) and *P. lescuriana* (162) in the Olkusz Ore-bearing Region.

triquetrum, it is one of the commonest species of the genus in the study area (Fig. 158). Occurs on stony basic ground, on soil with dolomite pebbles, on clay, sand and humus, concrete walls, in fissures of stones and boulders, often on heavy-metal mine waste in sites that alternate from drying out to being wet. Frequently with sporophytes. Interestingly, this species is rather infrequent in the Silesian Upland (Stebel, 1998a), but fairly frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

28 stat.: grid squares: Fd 36/80; Fd 36/82; Fd 36/83; Fd 36/86; Fd 36/91; Fd 36/93; Fd 36/95; Fd 36/96; Fd 36/97; Fd 46/02; Fd 46/03; Fd 46/04; Fd 46/05; Fd 46/06; Fd 46/07; Fd 46/12; Fd 46/13; Fd 46/14; Fd 46/15; Fd 46/17; Fd 46/20; Fd 46/21; Fd 46/22; Fd 46/23; Fd 46/24; Fd 46/26; Fd 46/27; Fd 46/33.

Lit.: Fd 46/02, Fd 46/03; Fd 46/04, Fd 46/12, Fd 46/13, Fd 46/14, Fd 46/22/23, Fd 46/23, Fd 46/24 (Ochyra & Godzik, 2015).

84. *Bryum pseudotriquetrum* (Hedw.) P.Gaertn., B.Mey. & Scherb. – Frequent (Fig. 159). On soil on banks of the Sztoła river, in drainage ditches, springs, wet waste land and mires, generally in moist to wet sites. Rarely with sporophytes. Frequent throughout the whole Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

24 stat.: grid squares: Fd 36/82; Fd 36/83; Fd 36/84; Fd 36/85; Fd 46/02; Fd 46/03; Fd 46/04; Fd 46/05; Fd 46/06; Fd 46/07; Fd 46/11; Fd 46/12; Fd 46/13; Fd 46/14; Fd 46/16; Fd 46/17; Fd 46/20; Fd 46/21; Fd 46/24; Fd 46/26; Fd 46/27; Fd 46/30; Fd 46/32; Fd 46/34.

85. *Poblia bulbifera* (Warnst.) Warnst. – Very rare (Fig. 160). On soil. Scattered in the Silesian Upland (Jędrzejko 1990; Stebel 1997, 1998a; Fojcik & Stebel, 2001). So far,

it has not been reported from the Cracow-Częstochowa Upland (Fojcik, 2011).

1 stat.: Fd 36/84 – Sztolnia Ponikowska between Cegielnia and Poręba, wet wayside, *c. gem.*

86. *P. cruda* (Hedw.) Lindb. – Very rare (Fig. 161). On loess and clayey soil on wayside slopes in woodland. Scattered in calcareous areas of the Silesian Upland (Kuc, 1956; Jędrzejko, 1990; Stebel, 1998a) but very frequent throughout the Cracow-Częstochowa Upland (Fojcik, 2011).

2 stat.: Fd 36/92 – Bolesław-Ćmielówka, wayside slope in thicket; Fd 36/93 – Bolesław, Szkolna Street between Główna and Bolesławska Streets, slope in thicket.

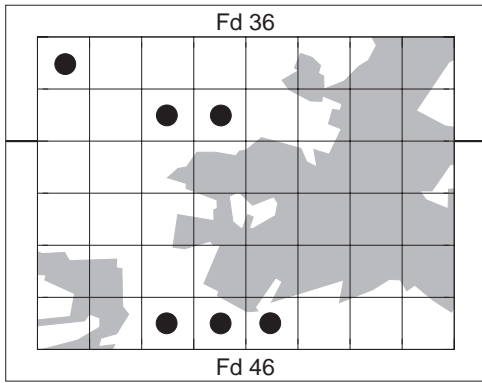
87. *P. lescuriana* (Sull.) Ochi – Very rare (Fig. 162). An epigeal species growing on loess soil. It is new to the Silesian Upland but its distribution in Poland is still poorly and inadequately known.

1 stat.: Fd 36/80 – Krzykawa, on clayey soil on road-cutting, shaded and slightly damp situation associated with *Ditrichum heteromallum* and *Atrichum angustatum*.

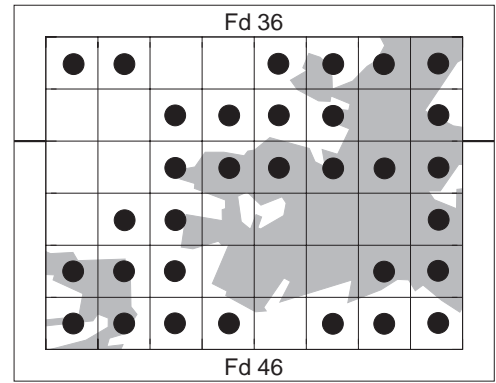
88. *P. melanodon* (Brid.) A.J.Shaw – Rare (Fig. 163). On mineral soil in open places, on spots of clay soil in meadows and arable fields in sites that alternate from drying out to being moist. Frequent in the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

6 stat.: Fd 36/80 – Krzykawa; Fd 36/92 – Bolesław-Ćmielówka; Fd 36/93 – Bolesław, Szkolna Street; Fd 46/32 – Bukowno, between Pocztowa and Cicha streets; Fd 46/33 – Bukowno, between Pocztowa and Spacerowa Streets; Fd 46/34 – Bukowno, near the Baba Canal.

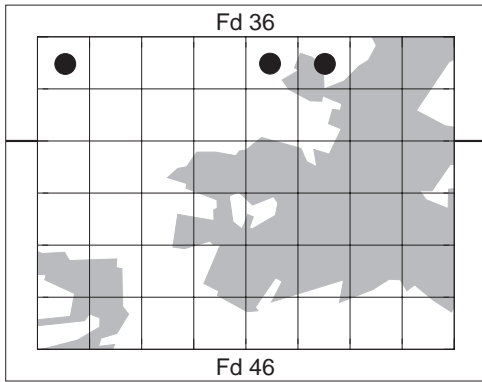
89. *P. nutans* (Hedw.) Lindb. – Common (Fig. 164). On soil and stony ground in forest



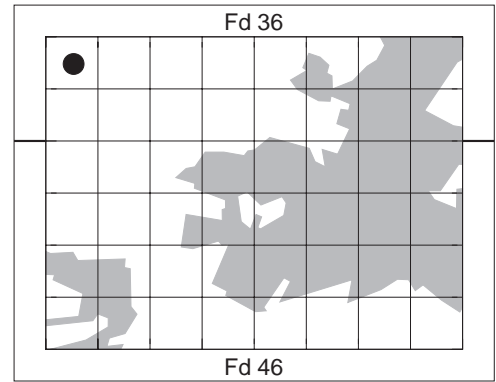
163. *Pohlia melanodon*



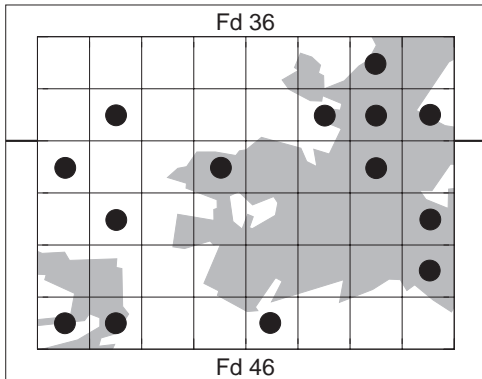
164. *Pohlia nutans*



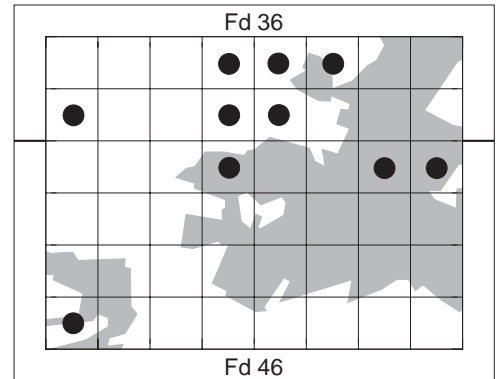
165. *Pohlia wahlenbergii*



166. *Rhodobryum roseum*



167. *Rosulabryum capillare*



168. *Rosulabryum moravicum*

Figs 163–168. Distribution maps for *Pohlia melanodon* (163), *P. nutans* (164), *P. wahlenbergii* (165), *Rhodobryum roseum* (166), *Rosulabryum capillare* (167) and *R. moravicum* (168) in the Olkusz Ore-bearing Region.

and woodland, on pine needles, bark of tree bases and rotten wood. Commonly with sporophytes. Common in the whole Silesian Upland and the Cracow-Częstochowa Upland (Jędrzejko, 1990; Stebel, 1997, 1998a; Fojcik & Stebel, 2001; Fojcik, 2011).

32 stat.: grid squares: Fd 36/80; Fd 36/81; Fd 36/84; Fd 36/85; Fd 36/86; Fd 36/87; Fd 36/92; Fd 36/93; Fd 36/94; Fd 36/95; Fd 36/97; Fd 46/02; Fd 46/03; Fd 46/04; Fd 46/05; Fd 46/06; Fd 46/07; Fd 46/11; Fd 46/12; Fd 46/17; Fd 46/20; Fd 46/21; Fd 46/22; Fd 46/26; Fd 46/27; Fd 46/30; Fd 46/31; Fd 46/32; Fd 46/33; Fd 46/35; Fd 46/36; Fd 46/37.

Lit.: Bukowno (Kaźmierczakowa, 1988; Jędrzejko, 1990); Las Olkusz (Kuc, 1956); Starczynów (Kaźmierczakowa, 1988); Fd 46/02, Fd 46/04, Fd 46/05, Fd 46/07, Fd 46/12, Fd 46/17, Fd 46/20, Fd 46/21 (Ochyra & Godzik, 2015).

90. *P. wahlenbergii* (F.Weber & D.Mohr) A.L.Andrews – Very rare (Fig. 165). On soil in shaded and moist sites. Frequently recorded in the Silesian Upland (Stebel, 1997, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

3 stat.: Fd 36/80 – Krzykawa, on soil in wayside thicket; Fd 36/84 – Sztolnia Ponikowska between Cegielnia and Poręba, on wet soil in wayside; Fd 36/85 – Hutki, 0.5 km towards the north-east of the right-hand side of Królewska Street, on wet soil at a forest road.

Lit.: Hutki (Kuc, 1956).

91. *Rhodobryum roseum* (Hedw.) Limpr. – Very rare (Fig. 166). On the ground on grassy slope in woodland. Known from scattered localities in Silesian Upland and the Cracow-Częstochowa Upland (Ochyra *et al.*, 1985; Jędrzejko, 1990; Stebel, 1997, 1998a; Fojcik & Stebel, 2001; Fojcik, 2011).

1 stat.: Fd 36/80 – Krzykawa-Pokrzywdzie, on grassy slope.

92. *Rosulabryum capillare* (Hedw.) J.R.Spence [syn. *Bryum capillare* Hedw.] – Fairly frequent (Fig. 167). On dry sandy soil and humus in pine forest, mainly in open and exposed places. Rarely with sporophytes. Frequent in the Silesian Upland and Cracow-Częstochowa Upland (Jędrzejko, 1990; Stebel, 1997, 1998a; Fojcik & Stebel, 2001; Fojcik, 2011).

14 stat.: Fd 36/86; Fd 36/91; Fd 36/95; Fd 36/96; Fd 36/97; Fd 46/00; Fd 46/03; Fd 46/06; Fd 46/11; Fd 46/17; Fd 46/27; Fd 46/30; Fd 46/31; Fd 46/34.

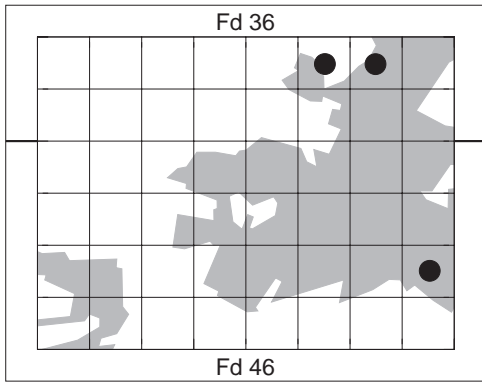
Lit.: near Bolesław and Olkusz (Dobrzańska, 1955); Karna (Kaźmierczakowa, 1988); Starczynów (Kaźmierczakowa, 1988); Fd 46/17 (Ochyra & Godzik, 2015).

93. *R. moravicum* (Podp.) Ochyra & Stebel [syn. *Bryum capillare* Hedw. var. *flaccidum* (Brid.) Bruch & Schimp.; *Rosulabryum laevifolium* (Syed) Ochyra] – Fairly frequent (Fig. 168). On bark of deciduous trees, on rotten wood, old stone walls, rarely on soil and boulders. Always with gemmae, very rarely with sporophytes. Very frequent throughout the whole Silesian Upland and the Cracow-Częstochowa Upland (Jędrzejko, 1990; Stebel, 1997, 1998a; Fojcik & Stebel, 2001; Fojcik, 2011).

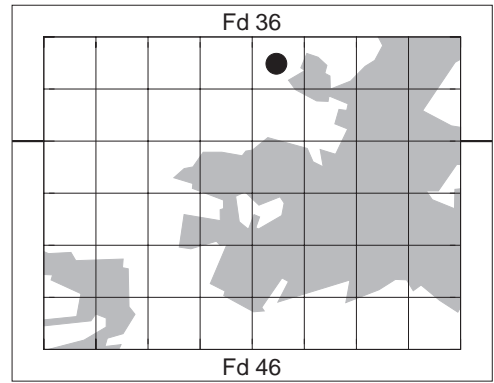
10 stat.: grid squares: Fd 36/83; Fd 36/84; Fd 36/85; Fd 36/90; Fd 36/93; Fd 36/94; Fd 46/03; Fd 46/06; Fd 46/07; Fd 46/30.

Family Aulacomniaceae Schimp.

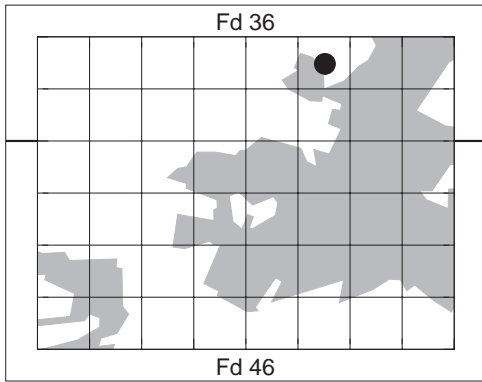
94. *Aulacomnium palustre* (Hedw.) Schwägr. – Very rare (Fig. 169). On the ground in wet mixed forest. A species partly protected by law in Poland (Anonymous, 2014). Frequent both in the Silesian Upland (Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).



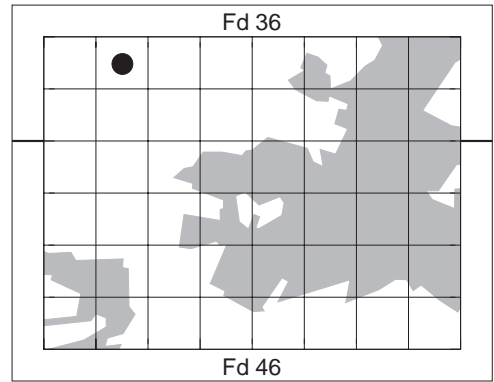
169. *Aulacomnium palustre*



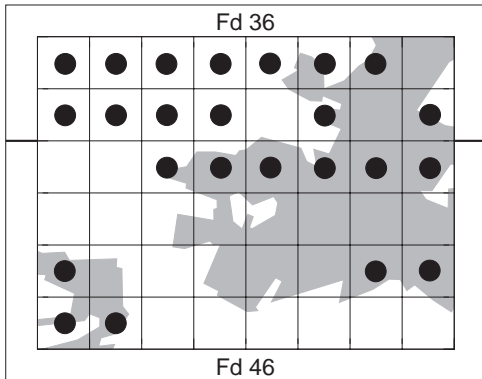
170. *Philonotis arnellii*



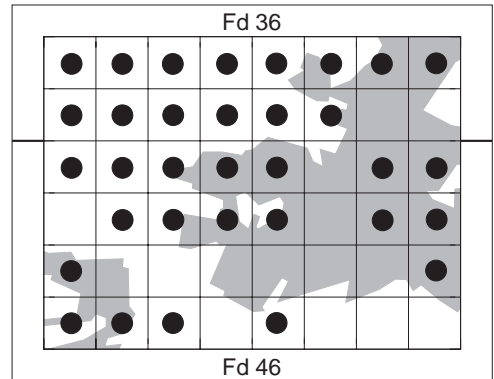
171. *Cinclidium stygium*



172. *Rhizomnium punctatum*



173. *Plagiomnium affine*



174. *Plagiomnium cuspidatum*

Figs 169–174. Distribution maps for *Aulacomnium palustre* (169), *Philonotis arnellii* (170), *Cinclidium stygium* (171), *Rhizomnium punctatum* (172), *Plagiomnium affine* (173) and *P. cuspidatum* (174) in the Olkusz Ore-bearing Region.

3 stat.: Fd 36/85 – Hutki, on the ground in wet mixed forest; Fd 36/86 – Hutki, in wet place in mixed forest; Fd 46/27 – Pustynia Starczynowska, in moist grassy pine forest.

Family Bartramiaceae Schwägr.

95. *Philonotis arnellii* Husn. – Very rare (Fig. 170). On wet soil. A species new to the Silesian Upland. It is unknown from the Cracow-Częstochowa Upland (Fojcik, 2011) and generally the geographical distribution of this species in Poland is insufficiently known. A species partly protected by law in Poland (Anonymous, 2014) and threatened (category V, Żarnowiec *et al.*, 2004).

1 stat.: Fd 36/84 – Sztolnia Ponikowska, between Cegielnia and Poręba, on a wet wayside slope.

Family Cinclidiaceae Kindb.

96. *Cinclidium stygium* Sw. – Not found during the present field studies (Fig. 171). A species considered as a glacial relict in Poland (Bednarek, 1984). Widely scattered in the northern lowlands and rare in the southern part of the country, including the Tatra Mountains (Lisowski, 1959 as *C. arcticum* Bruch & Schimp.; Mogensen, 1973). It was once recorded in the Silesian Upland (Kuc, 1956, 1959a), but the species is now apparently extinct at this locality (Jędrzejko, 1990). A species strictly protected by law in Poland (Anonymous, 2014) and threatened (category E, Żarnowiec *et al.*, 2004).

Lit.: Fd 36/85 – Hutki (Kuc, 1956 [*leg.* M. Kuc, 22 August 1954, KRAM]).

97. *Rhizomnium punctatum* (Hedw.) T.J.Kop. – Very rare (Fig. 172). On rotten wood in wet slope with seepage. Very frequent in the Silesian Upland and the Cracow-Częstochowa

Upland (Stebel, 1998a; Fojcik & Stebel, 2001; Fojcik, 2011).

1 stat.: Fd 36/81 – between Pniaki and Krzykawa, on wet soil on a wayside slope.

Family Plagiomniaceae T.J.Kop.

98. *Plagiomnium affine* (Blandow *ex* Funck) T.J.Kop. – Frequent (Fig. 173). On the ground in coniferous and mixed forest. Rarely with sporophytes. Common in the whole Silesian Upland and the Cracow-Częstochowa Upland (Stebel, 1998a; Fojcik & Stebel, 2001; Fojcik, 2011).

24 stat.: grid squares: Fd 36/80; Fd 36/81; Fd 36/82; Fd 36/83; Fd 36/84; Fd 36/85; Fd 36/86; Fd 36/90; Fd 36/91; Fd 36/92; Fd 36/93; Fd 36/95; Fd 36/97; Fd 46/02; Fd 46/03; Fd 46/04; Fd 46/05; Fd 46/06; Fd 46/07; Fd 46/20; Fd 46/26; Fd 46/27; Fd 46/30; Fd 46/31.

Lit.: Fd 46/02 (Ochyra & Godzik, 2015).

99. *P. cuspidatum* (Hedw.) T.J.Kop. – Common (Fig. 174). On sandy, clayey and stony soil in pine forest, in grassland and on fallow ground and on dolomite rocks, less often on bark of deciduous trees and logs and on limestone and concrete walls. Frequently with sporophytes. Very frequent throughout the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

33 stat.: grid squares: Fd 36/80; Fd 36/81; Fd 36/82; Fd 36/83; Fd 36/84; Fd 36/85; Fd 36/86; Fd 36/87; Fd 36/90; Fd 36/91; Fd 36/92; Fd 36/93; Fd 36/94; Fd 36/95; Fd 46/00; Fd 46/01; Fd 46/02; Fd 46/03; Fd 46/04; Fd 46/06; Fd 46/07; Fd 46/11; Fd 46/12; 46/13; Fd 46/14; Fd 46/16; Fd 46/17; Fd 46/20; Fd 46/27; Fd 46/30; Fd 46/31; Fd 46/32; Fd 46/34.

Lit.: Bolesław (Kuc, 1956); Fd 36/93, Fd 46/02, Fd 46/03, Fd 46/07, Fd 46/12, Fd 46/13, Fd 46/13/14; Fd 46/17 (Ochyra & Godzik, 2015).

100. *P. elatum* (Bruch & Schimp.) T.J.Kop. – Rare (Fig. 175). In mires on wet and peaty soil, in seepage and on wet places in forest. Frequent in the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and Cracow-Częstochowa Upland (Fojcik, 2011).

5 stat.: Fd 36/83 – ‘Cicha Kolonia’ at Cegielniana Street; Fd 36/84 – Sztolnia Ponikowska between Cegielnia and Poręba; Fd 46/02 – Krążek, meadows between Podlipie and Polna Street [leg. A. Stebel & J. Drobniak, 10 June 2002 (sosN); Fd 46/04 – Stara Wieś; Fd 46/33 – Bukowno, between Pocztowa and Spacerowa Streets.

101. *P. ellipticum* (Brid.) T.J.Kop. – Very rare (Fig. 176). On soil with seepage, in wet and shaded sites. Scattered in the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

2 stat.: Fd 36/80 – Krzykawa, among *Equisetum telmateia* Ehrh.; Fd 36/84 – Sztolnia Ponikowska between Cegielnia and Poręba, on wet slope with seepage.

102. *P. rostratum* (Schrad.) T.J.Kop. – Rare (Fig. 177). On calcareous soil, limestone and dolomite boulders and on basic stony and clayey soil in fallow fields, rarely in pine forest. A species associated with calcareous substrates and often misidentified with *P. affine*. Infrequent in the Silesian Upland, where it occurs mainly in Garb Tarnogórski, Chełm and Pagóry Jaworznickie mesoregions (Stebel, 1998a) and very frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

6 stat.: Fd 36/80 – Krzykawa; Fd 36/93 – Bukowno, between the school and the Bolesław smelting works; Fd 46/03 – Bolesław, cemetery; Fd 46/12 – Wodaça, east of the Sztolnia Canal; Fd 46/17 – “Grodzisko” in Stary Olkusz; Fd 46/27 in pine forest near the Baba Canal 150 m south of the “Olkusz” mine.

Lit.: Fd 36/93, 46/12, Fd 46/17 (Ochyra, Godzik 2015).

103. *P. undulatum* (Hedw.) T.J.Kop. – Fairly frequent (Fig. 178). In wet and shaded places in alder forest and carr, in shady grassland and in tall herb communities. Rarely with sporophytes. Common in the whole Silesian Upland and the Cracow-Częstochowa Upland (Stebel, 1998a; Fojcik & Stebel, 2001; Fojcik, 2011).

11 stat.: grid squares: Fd 36/80; Fd 36/81; Fd 36/83; Fd 36/84; Fd 36/90; Fd 36/93; Fd 36/94; Fd 36/95; Fd 46/27; Fd 46/30; Fd 46/32.

Family *Mniaceae* Schwägr.

104. *Mnium hornum* Hedw. – Very rare (Fig. 179). On loess soil and on humus in deciduous forest in wet, shady sites. Very frequent in the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

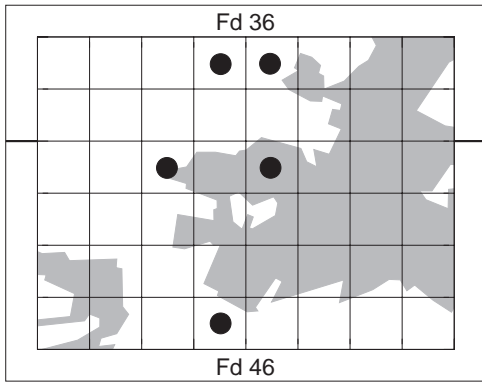
3 stat.: Fd 36/80 – Krzykawa, on soil in a small grove dominated with *Fagus sylvatica* and on soil in dry and shady situation in deciduous forest with *Fagus sylvatica* and *Carpinus betulus* L.; Fd 36/81 – Pniaki, on the ground in shaded sites in beech forest in a ravine; Fd 36/84 – Sztolnia Ponikowska in Poręba, on humus in wet mixed forest.

105. *M. marginatum* (Dicks.) P.Beauv. – Very rare (Fig. 180). On loess and clayey soil in dry and shaded situations. A species scattered in the central part of the Silesian Upland (Jędrzejko, 1990; Stebel, 1998a) and very frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

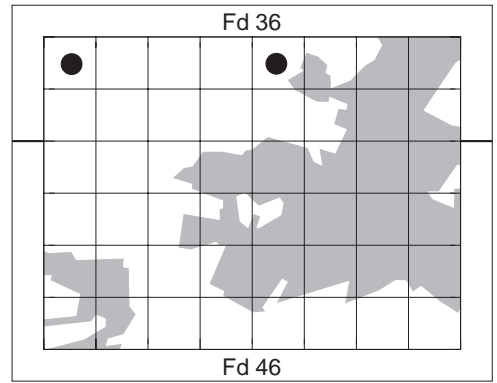
4 stat.: Fd 36/80 – Krzykawa, on clayey soil in a roadside ditch; Fd 36/90 – Małobądz, on loess soil in wayside; Fd 36/92 – Bolesław-Ćmielówka, on a wayside slope in woodland; Fd 36/93 – Bolesław, on loess soil in a ravine west of Pleściska.

Family *Climaciaceae* Kindb.

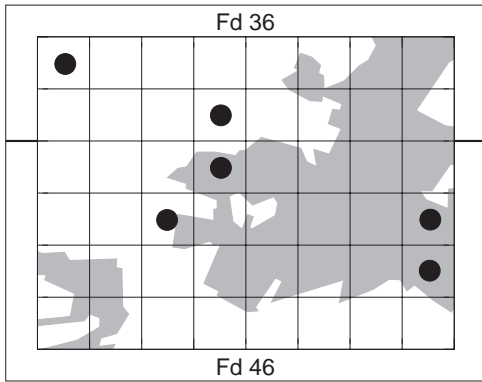
106. *Climacium dendroides* (Hedw.) F.Weber & D.Mohr – Fairly frequent (Fig. 181). On



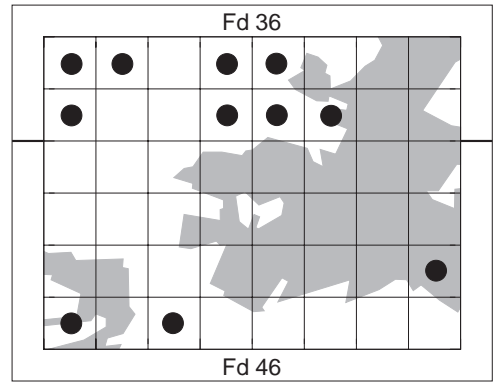
175. *Plagiomnium elatum*



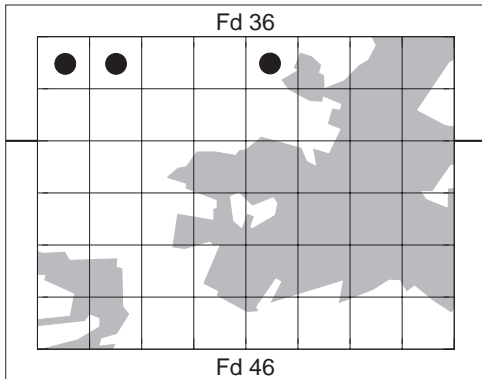
176. *Plagiomnium ellipticum*



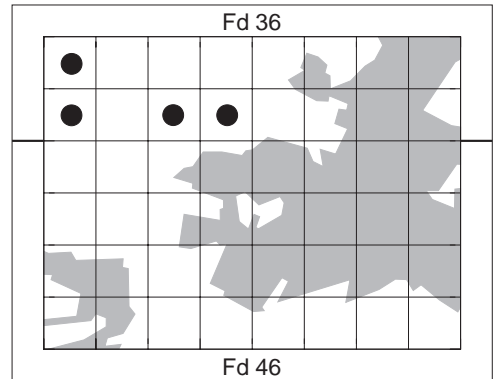
177. *Plagiomnium rostratum*



178. *Plagiomnium undulatum*



179. *Mnium hornum*



180. *Mnium marginatum*

Figs 175–180. Distribution maps for *Plagiomnium elatum* (175), *P. ellipticum* (176), *P. rostratum* (177), *P. undulatum* (178), *Mnium hornum* (179) and *M. marginatum* (180) in the Olkusz Ore-bearing Region.

the ground in mixed forest, waste land, waysides, mires and on wet meadows, in dry and moist situations. A species partly protected by law in Poland (Anonymous, 2014). Very frequent in the whole Silesian Upland and the Cracow-Częstochowa Upland (Stebel, 1998a; Fojcik & Stebel, 2001; Fojcik, 2011).

12 stat.: grid squares: Fd 36/80; Fd 36/81; Fd 36/82; Fd 36/83; Fd 36/84; Fd 36/85; Fd 36/90; Fd 36/95; Fd 46/02 – Krażek, *leg.* A. Stebel & J. Drobnik, 10 June 2002 (sosn); Fd 46/17; Fd 46/27; Fd 46/32.

Lit.: near Bolesław and Olkusz (Dobrzańska, 1955).

Family Leucodontaceae Schimp.

107. *Leucodon sciuroides* (Hedw.) Schwägr. – Not found during the present field studies. It was reported from the Silesian Upland from several sites (Kuc, 1956; Berdowski, 1979) and one collection was made in Bukowno in the study area. However, in recent decades it has not been rediscovered in this region but it is frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

Lit.: Bukowno, on bark of *Salix* sp. (Kuc, 1956 [*leg.* M. Kuc, 2 November 1953, KRAM]).

Family Thuidiaceae Schimp.

108. *Abietinella abietina* (Hedw.) M.Fleisch. – Very rare (Fig. 182). On dry soil in insolated and open sites in grassland and pine forest on mining waste. A species partly protected by law in Poland (Anonymous, 2014). Rare in the Silesian Upland (Stebel, 1998a; Stebel & Fojcik, 2003), but it is very frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

4 stat.: Fd 36/82 – at the Dąbrówka Canal between Długa Street and Katowice–Olkusz road east of Kolonia Nowy Ujków; Fd 46/07 – Stary

Olkusz, Pomorska Street; Fd 46/17 – “Grodzisko” in Stary Olkusz, at the beginning of the Roznos Canal; Fd 46/27 – Pustynia Starczynowka, near the Baba Canal.

Lit.: near Bolesław and Olkusz (Dobrzańska, 1955); Bolesław (Kuc, 1956); Bukowno, near the foundry (Jędrzejko, 1990 [*leg.* K. Jędrzejko, 24 August 1989, sosn]); Fd 46/07 (Ochyra & Godzik, 2015).

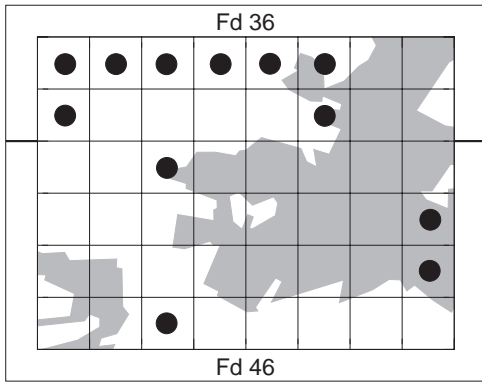
109. *Thuidium assimile* (Mitt.) A.Jaeger – Frequent (Fig. 183). On the ground in dry to moist, shaded sites in grasslands, mixed and deciduous forest and on old heaps and grassy slopes in waysides. A species partly protected by law in Poland (Anonymous, 2014). Frequent in the Silesian Upland (Stebel, 1998a; Stebel & Fojcik, 2001) and very frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

21 stat.: grid squares: Fd 36/80; Fd 36/81; Fd 36/82; Fd 36/83; Fd 36/85; Fd 36/86; Fd 36/93; Fd 36/94; Fd 36/95; Fd 36/97; Fd 46/02; Fd 46/03; Fd 46/04; Fd 46/05; Fd 46/06; Fd 46/11; Fd 46/17; Fd 46/27; Fd 46/30; Fd 46/31; Fd 46/32.

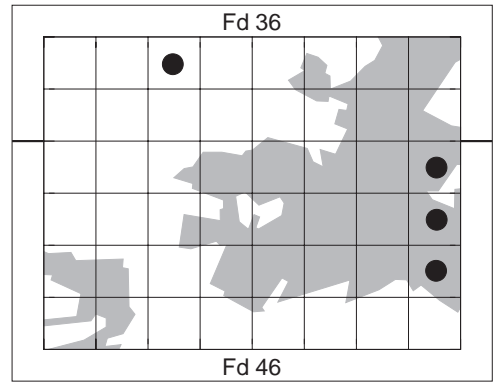
110. *Th. delicatulum* (Hedw.) Schimp. – Very rare (Fig. 184). On dry soil, usually in shady sites in coniferous, mixed and deciduous forest and woodland, on mining waste and on grassy slopes in waysides. A species partly protected by law in Poland (Anonymous, 2014). Rare in the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) but fairly frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

4 stat.: Fd 46/03 – west of Stara Wieś, on the ground in pine forest; Fd 46/07 – west of Stary Olkusz at Pomorska Street, in pine forest on mining waste; Fd 46/17 – west of the “Olkusz” mine, on sandy ground in pine forest; Fd 46/30 – Bukowno, in the Sztola river valley, on a grassy slope.

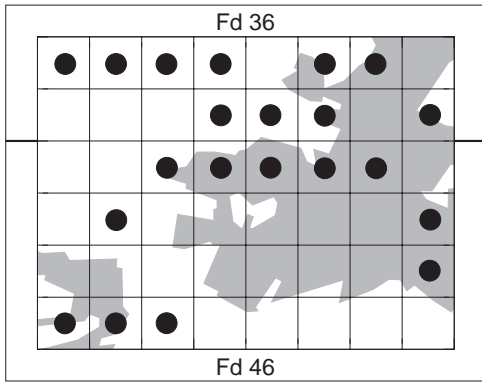
Lit.: near Bolesław and Olkusz (Dobrzańska, 1955); Fd 46/03, Fd 46/07, Fd 46/17 (Ochyra & Godzik, 2015).



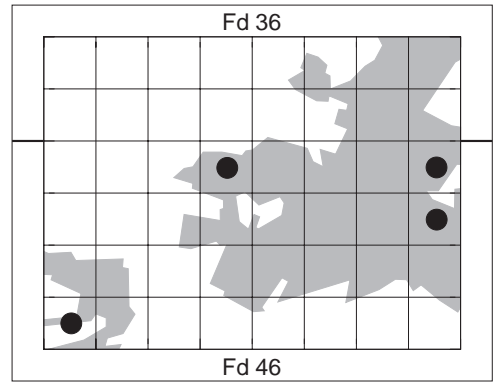
181. *Climacium dendroides*



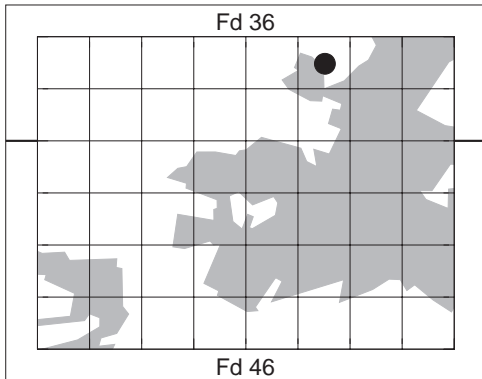
182. *Abietinella abietina*



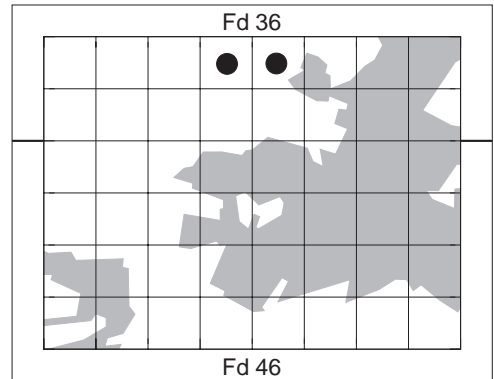
183. *Thuidium assimile*



184. *Thuidium delicatulum*



185. *Helodium blandowii*



186. *Hylocomiadelphus triquetrus*

Figs 181–186. Distribution maps for *Climacium dendroides* (181), *Abietinella abietina* (182), *Thuidium assimile* (183), *Th. delicatulum* (184), *Helodium blandowii* (185) and *Hylocomiadelphus triquetrus* (186) in the Olkusz Ore-bearing Region.

Family **Helodiaceae** Ochyra

111. *Helodium blandowii* (F.Weber & D.Mohr) Warnst. – Not found during the present field studies (Fig. 185). A species considered as a glacial relict in the moss flora of Poland (Bednarek, 1984). A very rare and vanishing moss species in the Silesian Upland (Ochyra *et al.*, 1988c; Stebel, 1998a) and the Cracow-Częstochowa Upland (Fojcik, 2011). In the Silesian Upland it was recently found only at a few sites, including Wodzisław Śląski-Olszyny (Stebel, 1997), Poręba Stawki (Fojcik, 1992), Katowice-Ochojec (Fojcik & Stebel, 2001) and Rogoźnik-Siemonia (Stebel, 2011). A species strictly protected by law in Poland (Anonymous, 2014) and threatened (category E, Żarnowiec *et al.*, 2004).

Lit.: Fd 36/85 – Hutki (Kuc, 1956; Ochyra *et al.*, 1988c [leg. M. Kuc, 14 September 1954, KRAM]).

Family **Hylocomiaceae** M.Fleisch.

112. *Hylocomiadelphus triquetrus* (Hedw.) Ochyra & Stebel [syn. *Rhytidiadelphus triquetrus* (Hedw.) Warnst.] – Very rare (Fig. 186). On the ground in shady site in deciduous forest and woodland. A species partly protected by law in Poland (Anonymous, 2014). Rare in the Silesian Upland (Stebel, 1998a; Stebel & Fojcik, 2003) but very frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

2 stat.: Fd 36/83 – Kolonia Nowy Ujków, 'Cicha Kolonia', Cegielniana Street, on the ground in woodland; Fd 36/84 – Cegielnia, in wayside in mixed forest.

Lit.: near Bolesław and Olkusz (Dobrzańska, 1955).

113. *Hylocomium splendens* (Hedw.) Schimp. – Fairly frequent (Fig. 187). On the ground on the floor of coniferous forest, rarely on rotten

wood. A species partly protected by law in Poland (Anonymous, 2014). Fairly frequent in the Silesian Upland (Stebel, 1998a; Stebel & Fojcik, 2003) but very frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

11 stat.: grid squares: Fd 36/81; Fd 36/84; Fd 36/85; Fd 36/86; Fd 36/94; Fd 36/95; Fd 36/96; Fd 46/02 – Krążek, leg. A. Stebel & J. Drobniak, 10 June 2002 (sosn); Fd 46/06; Fd 46/17; Fd 46/27.

Lit.: Las Olkusz (Kuc, 1956); Karna (Kaźmierczakowa, 1988).

114. *Pleurozium schreberi* ([Willd.] ex Brid.) Mitt. – Frequent (Fig. 188). On soil on the floor of coniferous and mixed forest, occasionally on rotten wood, in grassland at forest margins and in heathland. A species partly protected by law in Poland (Anonymous, 2014). Common in the whole Silesian Upland (Ochyra *et al.*, 1988c; Stebel, 1998a) and the Cracow-Częstochowa Upland (Fojcik, 2011).

29 stat.: grid squares: Fd 36/80; Fd 36/81; Fd 36/83; Fd 36/84; Fd 36/85; Fd 36/86; Fd 36/87; Fd 36/94; Fd 36/95; Fd 36/96; Fd 36/97; Fd 46/02; Fd 46/03; Fd 46/05; Fd 46/06; Fd 46/07; 46/13; Fd 46/16; Fd 46/17; Fd 46/20; Fd 46/21; Fd 46/25; Fd 46/26; Fd 46/27; Fd 46/30; Fd 46/31; Fd 46/32; Fd 46/35; Fd 46/37.

Lit.: near Bolesław and Olkusz (Dobrzańska, 1955); Las Olkusz (Kuc, 1956); Karna (Kaźmierczakowa, 1988); Sary Olkusz (Kaźmierczakowa, 1988); Fd 46/02, Fd 46/03, Fd 46/05, Fd 46/07, Fd 46/17 (Ochyra & Godzik, 2015).

115. *Rhytidiadelphus squarrosus* (Hedw.) Warnst. – Rare (Fig. 189). On grassy slopes and waysides, in mixed and deciduous forest, in dry and shaded habitats. A species partly protected by law in Poland (Anonymous, 2014). Common throughout the whole Silesian Upland (Stebel, 1998a) and the Cracow-Częstochowa Upland (Fojcik, 2011).

9 stat.: Fd 36/80 – Krzykawa; Fd 36/81 – between Pniaki and Krzykawa; Fd 36/83 – ‘Cicha Kolonia’ at Cegielniana Street; Fd 36/84 – Sztolnia Ponikowska in Cegielnia; Fd 36/85 – Sztolnia Ponikowska between Karna and Górka; Fd 36/94 – Bolesław, the Rozmus forest near Kluczewska Street; Fd 46/03 – Bolesław, park; Fd 46/05 – Dąbrówka, Rozmus; Fd 46/30 – Bukowno, the Sztola river valley.

116. *Rb. subpinnatus* (Lindb.) T.J.Kop. – Very rare (Fig. 190). On grassy ground in moist pine forest. A montane species, widely distributed in many ranges in the Western Carpathians (Stebel, 2006a; Stebel & Vončina, 2014). This is the first record of this species in the Silesian Upland. In the Cracow-Częstochowa Upland it was reported only from Puszcza Dulowska (Kuc, 1964).

1 stat.: Fd 46/27 – Pustynia Starczynowska, in moist grassy pine forest.

Family Cratoneuraceae Mönk.

117. *Cratoneuron filicinum* (Hedw.) Spruce – Fairly frequent (Fig. 191). On wet banks of the Sztola river, in canals, drainage ditches, in wet places in waste land, on soil, concrete walls, on boulders, often floating in water. Frequent in the Silesian Upland (except Wyżyna Katowicka and Płaskowyż Rybnicki) (Stebel, 1998a; Fojcik & Stebel, 2001) and very frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

17 stat.: grid squares: Fd 36/82; Fd 36/83; Fd 36/84; Fd 36/85; Fd 36/90; Fd 36/94; Fd 36/95; Fd 46/02 – Krążek, *leg.* A. Stebel & J. Drobnik, 10 June 2002 (sosn); Fd 46/20; Fd 46/21; Fd 46/24; Fd 46/25; Fd 46/26; Fd 46/27; Fd 46/30; Fd 46/32; Fd 46/33.

Family Brachytheciaceae Schimp.

118. *Brachythecium velutinum* (Hedw.) Ignatov & Huttunen – Common (Fig. 192).

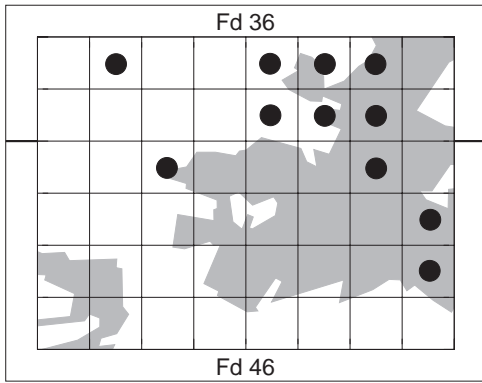
One of the commonest species in the study area growing on soil, pine needles, humus, at tree bases and on stumps and rotten wood in coniferous, mixed and deciduous forest, woodland, as well as on stony ground and concrete walls, in dry and exposed or shaded habitats. Commonly with sporophytes. Common both in the Silesian Upland (Stebel, 1998a) and the Cracow-Częstochowa Upland (Fojcik, 2011).

48 stat.: grid squares: Fd 36/80; Fd 36/81; Fd 36/82; Fd 36/83; Fd 36/84; Fd 36/85; Fd 36/86; Fd 36/87; Fd 36/90; Fd 36/91; Fd 36/92; Fd 36/93; Fd 36/94; Fd 36/95; Fd 36/96; Fd 36/97; Fd 46/00; Fd 46/01; Fd 46/02; Fd 46/03; Fd 46/04; Fd 46/05; Fd 46/06; Fd 46/07; Fd 46/10; Fd 46/11; Fd 46/12; Fd 46/13; Fd 46/14; Fd 46/15; Fd 46/16; Fd 46/17; Fd 46/20; Fd 46/21; Fd 46/22; Fd 46/23; Fd 46/24; Fd 46/25; Fd 46/26; Fd 46/27; Fd 46/30; Fd 46/31; Fd 46/32; Fd 46/33; Fd 46/34; Fd 46/35; Fd 46/36; Fd 46/37.

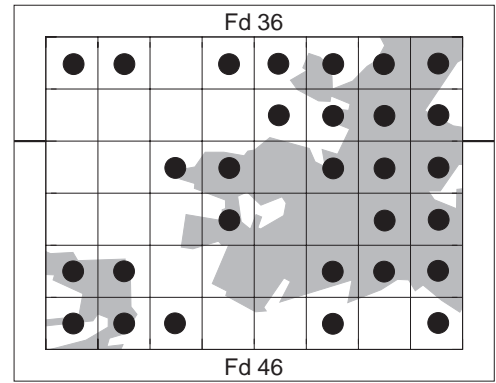
Lit.: near Bolesław and Olkusz (Dobrzańska, 1955); Bukowno (Kaźmierczakowa, 1988; Jędrzejko, 1990); Las Olkusz (Kuc, 1956); Starczynów (Kaźmierczakowa, 1988); Stary Olkusz (Kaźmierczakowa, 1988); Fd 46/02, Fd 46/03, Fd 46/04, Fd 46/05, Fd 46/07, Fd 46/13, Fd 46/17, Fd 46/20, Fd 46/21 (Ochyra & Godzik, 2015).

119. *Brachythecium albicans* (Hedw.) Schimp. – Common (Fig. 193). On sandy and clay soil and humus in grassland, waste land, waysides, railway embankment, rarely on old concrete walls. Frequently with sporophytes. Common in the whole Silesian Upland (Stebel, 1998a) and the Cracow-Częstochowa Upland (Fojcik, 2011).

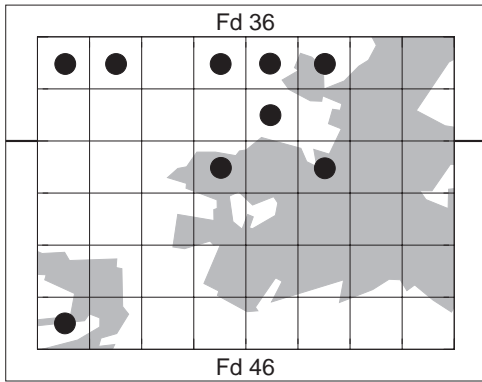
37 stat.: grid squares: Fd 36/80; Fd 36/81; Fd 36/82; Fd 36/83; Fd 36/85; Fd 36/86; Fd 36/87; Fd 36/90; Fd 36/91; Fd 36/92; Fd 36/93; Fd 36/94; Fd 36/95; Fd 46/00; Fd 46/01; Fd 46/02; Fd 46/03; Fd 46/05; Fd 46/06; Fd 46/07; Fd 46/10; Fd 46/11; Fd 46/12; Fd 46/13; Fd 46/14; Fd 46/17; Fd 46/20; Fd 46/21; Fd 46/22;



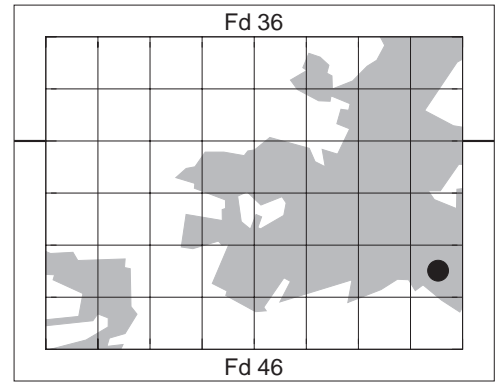
187. *Hylocomium splendens*



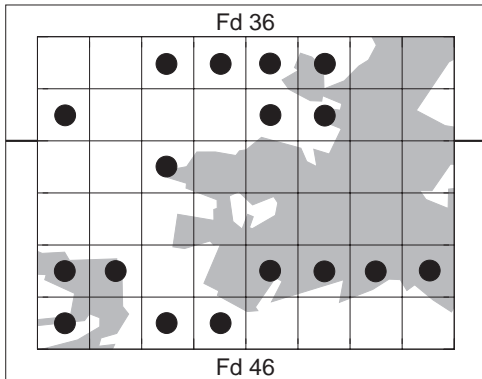
188. *Pleurozium schreberi*



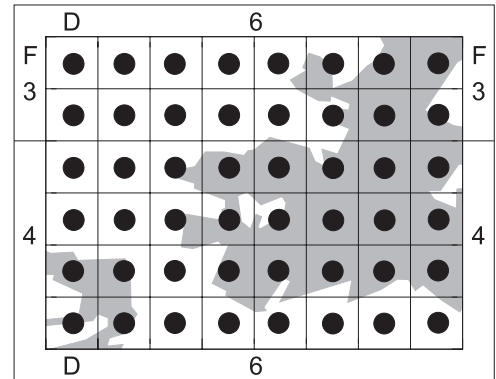
189. *Rhytidiadelphus squarrosus*



190. *Rhytidiadelphus subpinnatus*



191. *Cratoneuron filicinum*



192. *Brachytheciastrum velutinum*

Figs 187–192. Distribution maps for *Hylocomium splendens* (187), *Pleurozium schreberi* (188), *Rhytidiadelphus squarrosus* (189), *Rb. subpinnatus* (190), *Cratoneuron filicinum* (191) and *Brachytheciastrum velutinum* (192) in the Olkusz Ore-bearing Region.

Fd 46/26; Fd 46/27; Fd 46/30; Fd 46/31; Fd 46/32; Fd 46/33; Fd 46/34; Fd 46/35.

Lit.: near Bolesław and Olkusz (Dobrzańska, 1955); Fd 36/93, Fd 46/03, Fd 46/14 (Ochyra & Godzik, 2015).

120. *B. campestre* (Müll.Hal.) Schimp. – Very rare (Fig. 194). On soil in a young forest stand. Widely scattered and infrequent in the Silesian Upland (Stebel, 1998a) and Cracow-Częstochowa Upland (Fojcik, 2011). Its distribution in Poland is still insufficiently known.

1 stat.: Fd 36/94 – Bolesław, Wyzwolenia Street, on ground in young forest.

121. *B. glareosum* (Bruch ex Spruce) Schimp. – Very rare (Fig. 195). On stony ground with limestone rocks in pine forest. Scattered in the Silesian Upland (Stebel, 1998a) and very frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

1 stat.: Fd 36/95 – Dąbrówka, Las Rozmus forest, on limestone protruding from the ground in pine forest.

122. *B. mildeanum* (Schimp.) Schimp. – Very rare (Fig. 196). On fairly moist soil in pine forest on mining waste and on soil in fallow fields. Scattered and infrequent both in the Silesian Upland (Stebel, 1998a) and Cracow-Częstochowa Upland (Fojcik, 2011).

2 stat.: Fd 36/93 – in pine forest east of Krążek, on mining waste; Fd 46/03 – west of Kolonia Nowy Ujków, on the fallow ground.

Lit.: Fd 36/93, Fd 46/03 (Ochyra & Godzik, 2015).

123. *B. rutabulum* (Hedw.) Schimp. – Common (Fig. 197). On the ground in pine forest and fallow fields, on soil in woodland, on meadow, waste land, rotten wood, concrete walls, bridges and on bark of deciduous trees. Frequently with sporophytes. Common

throughout the whole Silesian Upland (Stebel, 1998a) and Cracow-Częstochowa Upland (Fojcik, 2011).

39 stat.: grid squares: Fd 36/80; Fd 36/81; Fd 36/82; Fd 36/83; Fd 36/84; Fd 36/85; Fd 36/86; Fd 36/87; Fd 36/90; Fd 36/91; Fd 36/92; Fd 36/93; Fd 36/94; Fd 36/95; Fd 36/97; Fd 46/00; Fd 46/02; Fd 46/03; Fd 46/04; Fd 46/05; Fd 46/06; Fd 46/07; Fd 46/10; Fd 46/11; Fd 46/12; 46/13; Fd 46/14; Fd 46/16; Fd 46/17; Fd 46/20; Fd 46/21; Fd 46/23; Fd 46/26; Fd 46/27; Fd 46/31; Fd 46/32; Fd 46/33; Fd 46/35; Fd 46/37.

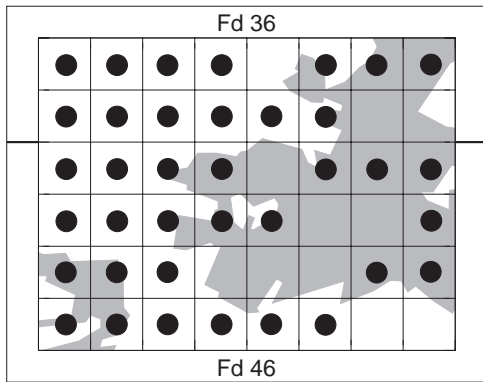
Lit.: Karna (Kaźmierczakowa, 1988); Fd 36/93, Fd 46/02, Fd 46/03, Fd 46/04, Fd 46/07, Fd 46/12, Fd 46/13, Fd 46/17, Fd 46/20 (Ochyra & Godzik, 2015).

124. *B. salebrosum* ([Hoffm.] ex F.Weber & D.Mohr) Schimp. – Common (Fig. 198). On soil, pine needles, stumps, fallen tree branches, exposed roots and stony ground in waste land, concrete walls and on bark of deciduous trees. Frequently with sporophytes. Common both in the Silesian Upland (Stebel, 1998a) and Cracow-Częstochowa Upland (Fojcik, 2011).

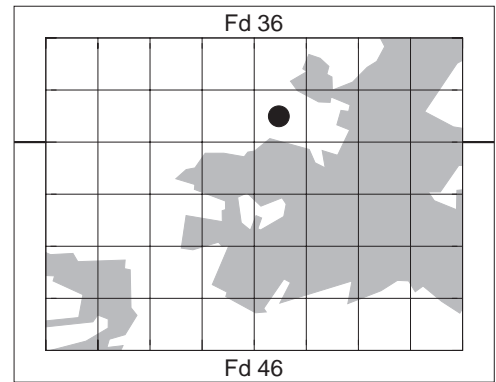
38 stat.: grid squares: Fd 36/80; Fd 36/81; Fd 36/82; Fd 36/83; Fd 36/84; Fd 36/85; Fd 36/86; Fd 36/87; Fd 36/90; Fd 36/91; Fd 36/92; Fd 36/93; Fd 36/94; Fd 36/95; Fd 36/96; Fd 36/97; Fd 46/00; Fd 46/01; Fd 46/02; Fd 46/03; Fd 46/04; Fd 46/06; Fd 46/07; Fd 46/11; Fd 46/12; 46/13; Fd 46/17; Fd 46/20; Fd 46/21; Fd 46/26; Fd 46/27; Fd 46/30; Fd 46/31; Fd 46/32; Fd 46/33; Fd 46/34; Fd 46/35; Fd 46/37.

Lit.: near Bolesław and Olkusz (Dobrzańska, 1955); Bolesław (Kuc, 1956); Karna (Kaźmierczakowa, 1988); Fd 46/02, Fd 46/03, Fd 46/07, Fd 46/13, Fd 46/17, Fd 46/20 (Ochyra & Godzik, 2015).

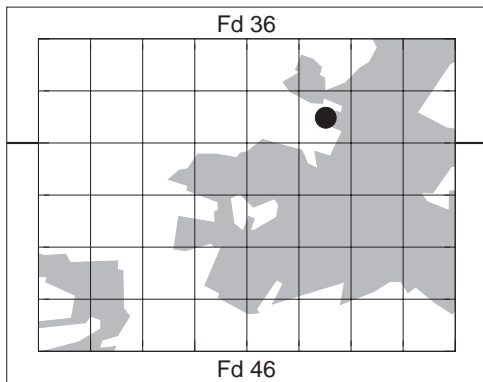
125. *Cirriphyllum piliferum* (Hedw.) Grout – Very rare (Fig. 199). On the ground on a grassy slope in a loess ravine. Scattered in the Silesian



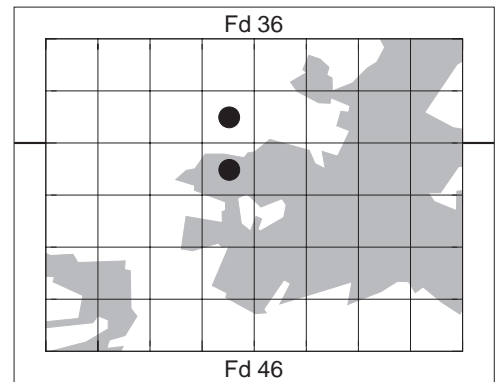
193. *Brachythecium albicans*



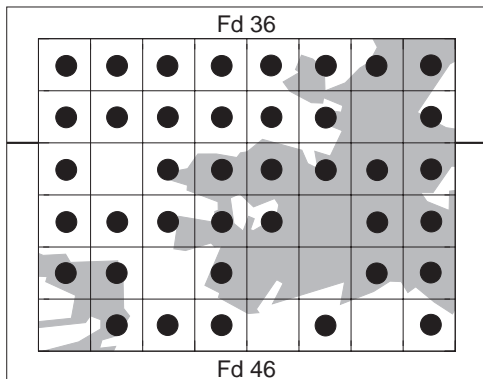
194. *Brachythecium campestre*



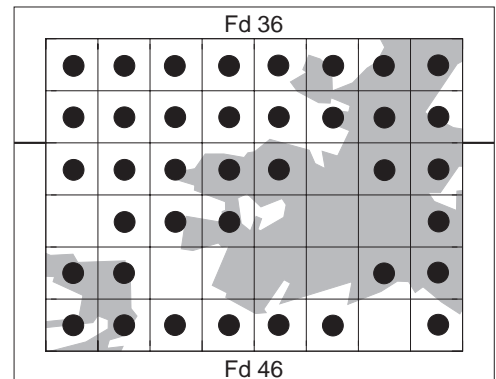
195. *Brachythecium glareosum*



196. *Brachythecium mildeanum*



197. *Brachythecium rutabulum*



198. *Brachythecium salebrosum*

Figs 193–198. Distribution maps for *Brachythecium albicans* (193), *B. campestre* (194), *B. glareosum* (195), *B. mildeanum* (196), *B. rutabulum* (197) and *B. salebrosum* (198) in the Olkusz Ore-bearing Region.

Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and very frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

1 stat.: Fd 36/81 – between Pniaki and Krzykawa, on loess soil on a grassy slope in a ravine.

126. *Eurhynchiastrum pulbellum* (Hedw.) Ignatov & Huttunen – Rare (Fig. 200). On limestone and dolomite stony ground, calcareous soil in forest and xerothermic grassland. Scattered in the Silesian Upland (except Wyżyna Katowicka and Płaskowyż Rybnicki) (Stebel, 1998a) and very frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

6 stat.: Fd 36/92 – Bolesław-Ćmielówka; Fd 46/03 – west of Stara Wieś, pine forest on mining waste; Fd 46/06 – pine forest 1 km towards the west on the right-hand side of the “Gierkówka” Road along the Roznos Canal; Fd 46/13 – south-west of Stara Wieś, pine forest on mining waste; Fd 46/17 – “Grodzisko” in Stary Olkusz; Fd 46/20 – south-west of Cyzowizna, pine forest on sand.

Lit.: Fd 46/03, Fd 46/13, Fd 46/20 (Ochyra & Godzik, 2015).

127. *Eurhynchium angustirete* (Broth.) T.J.Kop. – Rare (Fig. 201). On the ground and rotten wood in deciduous forest in shaded habitats. A species partly protected by law in Poland (Anonymous, 2014). Frequent throughout the whole Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

5 stat.: Fd 36/81 – between Pniaki and Krzykawa; Fd 36/82 – Kolonia Nowy Ujków, the Dąbrówka canal near Laskowska street; Fd 36/84 – Sztolnia Ponikowska in Cegielnia; Fd 36/85 0.5 km north-east of Hutki; Fd 46/03 – Stara Wieś.

128. *Homalothecium lutescens* (Hedw.) H.Rob. – Not found during the present field studies. A species scattered in the Silesian Upland (except Wyżyna Katowicka and

Płaskowyż Rybnicki) (Stebel, 1998a) and very frequent on the Cracow-Częstochowa Upland (Fojcik, 2011).

Lit.: near Bolesław and Olkusz (Dobrzańska, 1955); Bolesław (Kuc, 1956).

129. *Kindbergia praelonga* (Hedw.) Ochyra – Very rare (Fig. 202). On soil on the floor of pine forest. Fairly frequent throughout the whole Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

1 stat.: Fd 46/07 – Olkusz Stary, Pomorska Street, pine forest with numerous dumps, on the ground.

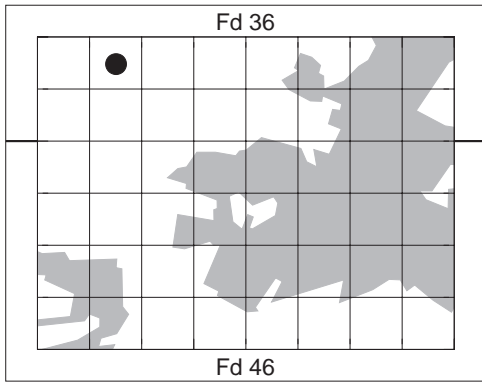
Lit.: Fd 46/07 (Ochyra & Godzik, 2015).

130. *Oxyrrhynchium hians* (Hedw.) Loeske var. *hians* – Fairly frequent (Fig. 203). On soil in fallow fields and grassland, on the ground in deciduous and mixed forest, in woodland, on meadows and waste land. Common in the whole Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

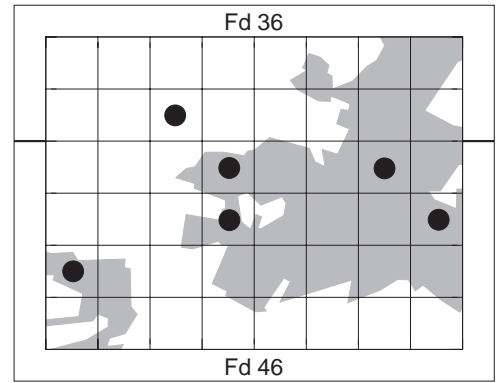
14 stat.: grid squares: Fd 36/80; Fd 36/81; Fd 36/83; Fd 36/84; Fd 36/85; Fd 36/91; Fd 36/92; Fd 36/93; Fd 46/03; Fd 46/06; Fd 46/12; Fd 46/13; Fd 46/17; Fd 46/27.

Lit.: Fd 36/93, Fd 46/12, Fd 46/13 (Ochyra & Godzik, 2015).

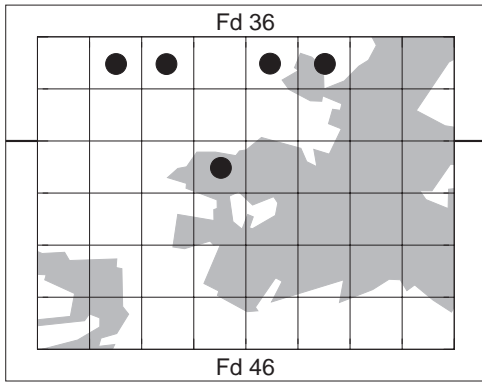
var. *rigidum* (Boulay) Ochyra & Żarnowiec – Rare (Fig. 204). On calcareous soil, on dolomite rocks in woodland and mixed forest, in dry and shady habitats. This variety is not universally recognised, hence its distribution is not well known. It is distinguished by its crowded, non-complanate leaves. Known from the Kotlina Żywiecka (Stebel, 2008b) and the Pieniny range (Stebel *et al.*, 2010) in the Western Carpathians.



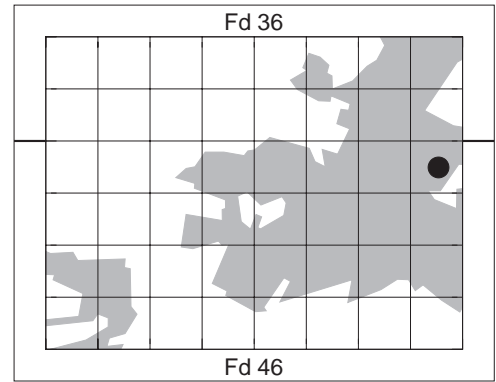
199. *Cirriphyllum piliferum*



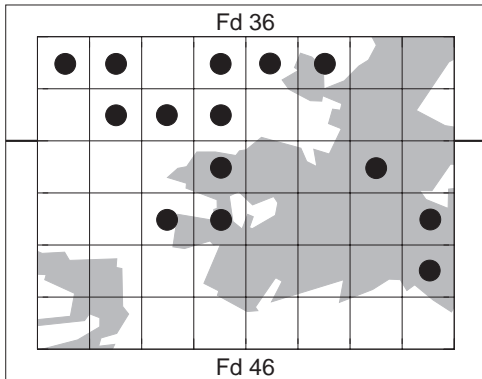
200. *Eurhynchiastrum pulchellum*



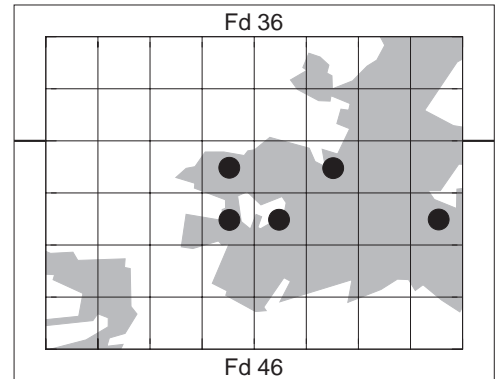
201. *Eurhynchium angustirete*



202. *Kindbergia praelonga*



203. *Oxyrrhynchium hians* var. *hians*



204. *Oxyrrhynchium hians* var. *rigidum*

Figs 199–204. Distribution maps for *Cirriphyllum piliferum* (199), *Eurhynchiastrum pulchellum* (200), *Eurhynchium angustirete* (201), *Kindbergia praelonga* (202), *Oxyrrhynchium hians* var. *hians* (203) and *O. hians* var. *rigidum* (204) in the Olkusz Ore-bearing Region.

5 stat.: Fd 46/03 – Bolesław, so-called Old Waste-Dump, on soil; Fd 46/05 – Ujków Stary, north of the sediment trap of the “Olkusz” mine; 46/13 – Ujków Stary, on soil; Fd 46/14 – Ujków Stary, on soil; Fd 46/17 – “Grodzisko” in Stary Olkusz, on slope.

131. *Pseudoscleropodium purum* (Hedw.) M.Fleisch. *ex* Broth. – Fairly frequent (Fig. 205). On the ground in coniferous and mixed forest and in woodland, on grassy waysides and in grassland. A species partly protected by law in Poland (Anonymous, 2014). Common in the whole Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

13 stat.: grid squares: Fd 36/81; Fd 36/83; Fd 36/85; Fd 36/86; Fd 36/87; Fd 36/95; Fd 36/96; Fd 46/03; Fd 46/05; Fd 46/30; Fd 46/31; Fd 46/32; Fd 46/34.

Lit.: Las Olkusz (Kuc, 1956).

132. *Rhynchostegium murale* (Hedw.) Schimp. – Frequent (Fig. 206). On limestone and dolomite stones and boulders, concrete walls, road asphalt and calcareous soil in sites that alternate from drying out to being wet. Occasionally with sporophytes. Common throughout the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

23 stat.: grid squares: Fd 36/83; Fd 36/84; Fd 36/86; Fd 36/93; Fd 36/94; Fd 36/95; Fd 36/96; Fd 36/97; Fd 46/02; Fd 46/03; Fd 46/04; Fd 46/06; Fd 46/07; Fd 46/12; 46/13; Fd 46/17; Fd 46/21; Fd 46/22; Fd 46/26; Fd 46/27; Fd 46/31; Fd 46/33; Fd 46/34.

Lit.: Fd 46/12 (Ochyra & Godzik, 2015).

133. *Sciuro-hypnum oedipodium* (Mitt.) Ignatov & Huttunen – Fairly frequent (Fig. 207). On the ground and rotten wood in coniferous and mixed forest and woodland. Fairly

frequently with sporophytes. Frequent in the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and Cracow-Częstochowa Upland (Fojcik, 2011). Its frequency and the number of localities seem to have increased in the recent years.

15 stat.: grid squares: Fd 36/81; Fd 36/86; Fd 36/95; Fd 46/02; Fd 46/03; Fd 46/04; Fd 46/05; Fd 46/06; Fd 46/07; Fd 46/17; Fd 46/20; Fd 46/26; Fd 46/27; Fd 46/30; Fd 46/37.

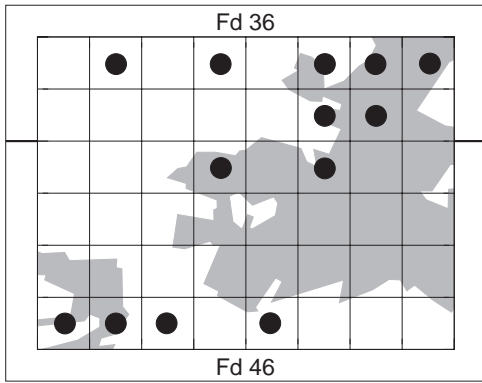
Lit.: Fd 46/02, Fd 46/03, Fd 46/04, Fd 46/05, Fd 46/07, Fd 46/17 (Ochyra & Godzik, 2015).

134. *S. plumosum* (Hedw.) Ignatov & Huttunen – Very rare (Fig. 208). On concrete plate in water. This montane species is known from solitary stations in the Silesian Upland, including Rybnik (Milde, 1869), Katowice-Muchowiec and Katowice-Podlesie (Fojcik & Stebel, 2001) and Katowice-Ochojec (Stebel, 2009). Likewise, it is very rare in the coterminous Cracow-Częstochowa Upland where it is known from Dubie (Krupa, 1882), Wąwóz Bolechowicki gorge (Amirowicz, 1981a, b), Alwernia (Stebel in Górski *et al.*, 2015) and Grodzisko (“Gąszczyk”) (Hereźniak *et al.*, 1973). According to Fojcik (2011) the latter locality is doubtful.

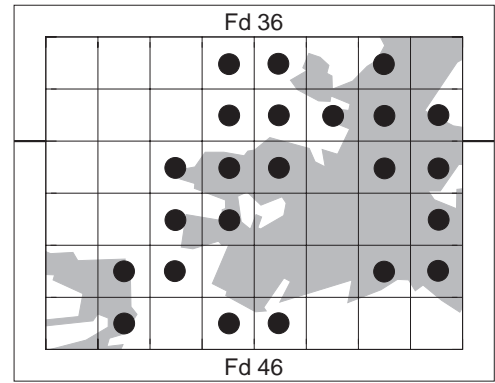
1 stat.: Fd 46/25 – Starczynów, Baba Canal between the end of Bukowa Street and the bend in the road towards the flotation tailings heap of the “Olkusz” mine.

135. *S. populeum* (Hedw.) Ignatov & Huttunen – Rare (Fig. 209). On limestone and concrete walls. Occasionally with sporophytes. Frequent in the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and Cracow-Częstochowa Upland (Fojcik, 2011).

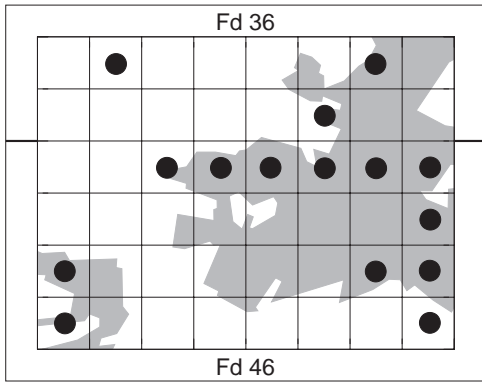
6 stat.: Fd 36/83 – Kolonia Nowy Ujków at Bolesławska Street; Fd 36/90 – Małobądz, Miła Street; Fd 36/94 – Bolesław, in the Dąbrówka Canal east of the Katowice-Olkusz road; Fd 46/00 – in



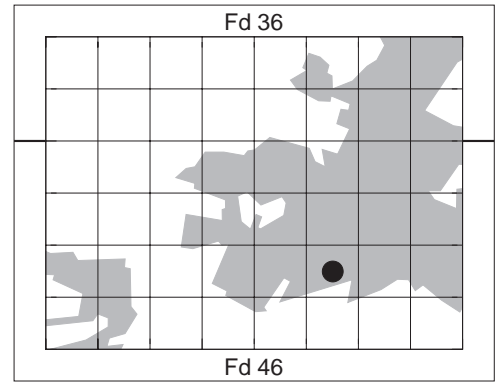
205. *Pseudoscleropodium purum*



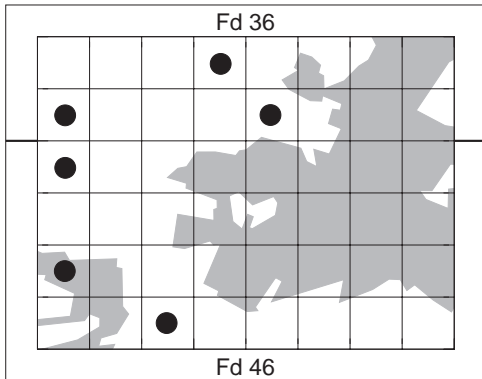
206. *Rhynchostegium murale*



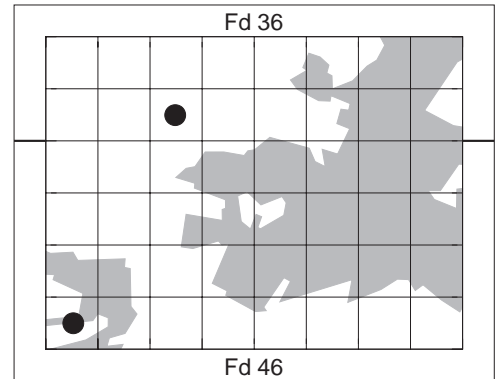
207. *Sciuro-hypnum oedipodium*



208. *Sciuro-hypnum plumosum*



209. *Sciuro-hypnum populeum*



210. *Sciuro-hypnum reflexum*

Figs 205–210. Distribution maps for *Pseudoscleropodium purum* (205), *Rhynchostegium murale* (206), *Sciuro-hypnum oedipodium* (207), *S. plumosum* (208), *S. populeum* (209) and *Sciuro-hypnum reflexum* (210) in the Olkusz Ore-bearing Region.

the southern part of Podlipie-Sołtysie; Fd 46/20 – Bukowno, Jamna Góra; Fd 46/32 – Bukowno, in the Sztola river valley.

136. *S. reflexum* (Starke) Ignatov & Huttunen – Very rare (Fig. 210). On rotten wood and concrete boulders. Infrequent in the Silesian Upland (Stebel, 1998a, 2009; Fojcik & Stebel, 2001) and fairly frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

2 stat.: Fd 36/92 – Bolesław, Główna Street, on concrete; Fd 46/30 – Bukowno, in the Sztola river valley, on bark of fallen log of *Alnus glutinosa*.

137. *Torrentaria riparioides* (Hedw.) Ochyra [syn. *Platyhypnidium riparioides* (Hedw.) Dixon] – Rare (Fig. 211). Floating in water in the Sztola river and Baba Canal or growing on wet soil on banks of the canal in places temporarily inundated. Very rare in the Silesian Upland, known from Leśnica (Kuc, 1956), Trzebinia and Siersza (Jędrzejko, 1990) and Rybnik-Wielopole (Stebel, 1997) but frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

9 stat.: Fd 46/24 – Starczynów, Poprzeczna Street; Fd 46/25 – Starczynów, Baba Canal between the end of Bukowa Street and the bend in the road towards the flotation tailings heap of the “Olkusz” mine; Fd 46/26 – Pustynia Starczynowska, in the Baba Canal along the broad gauge railway east of the eastern side of the flotation tailings heap of the “Olkusz” mine; Fd 46/27 – Pustynia Starczynowska, in the Baba Canal near the air-shaft of the “Olkusz” mine; Fd 46/30 – Bukowno, in the Sztola river; Fd 46/31 – Bukowno, in the Sztola river; Fd 46/32 – Bukowno, in the Sztola river; Fd 46/33 – Bukowno, in the Sztola river; Fd 46/34 – between Bukowno and Starczynów, in the Baba Canal along Młyńska Street.

Family *Plagiotheciaceae* M.Fleisch.

138. *Plagiothecium cavifolium* (Brid.) Z.Iwats. – Very rare (Fig. 212). On loess soil in

a ravine. Frequent throughout the whole Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

1 stat.: Fd 36/80 – Krzykawa, on soil in dry and shady habitat in a ravine with deciduous forest dominated by *Fagus sylvatica* and *Carpinus betulus*, associated with *Mnium hornum*.

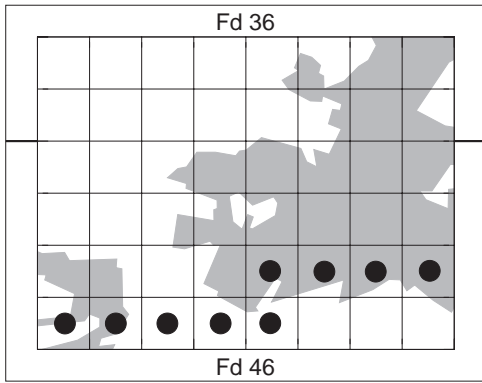
139. *P. curvifolium* Schlieph. ex Limpr. – Fairly frequent (Fig. 213). On bark at bases of trees and shrubs, rotten wood and on the ground in coniferous forest. Frequently with sporopytes. Common throughout the whole Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

17 stat.: grid squares: Fd 36/81; Fd 36/83; Fd 36/84; Fd 36/85; Fd 36/86; Fd 36/90; Fd 36/92; Fd 36/95; Fd 36/97; Fd 46/06; Fd 46/07; Fd 46/22; Fd 46/26; Fd 46/30; Fd 46/31; Fd 46/35; Fd 46/37.

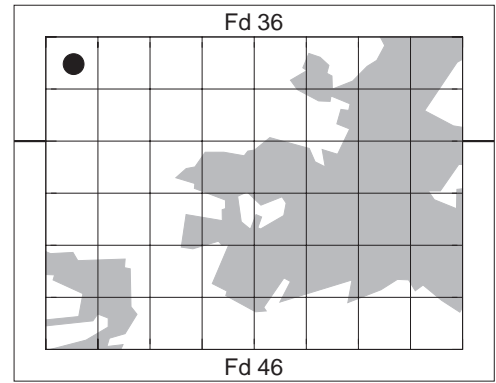
140. *P. denticulatum* (Hedw.) Schimp. – Rare (Fig. 214). Bark of trees, logs and stumps, rarely mineral soil. Rarely with sporophytes. Frequent throughout the whole Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

9 stat.: Fd 36/81 – 1.5 km west of Pniaki; Fd 36/83 – Kolonia Nowy Ujków at Bolesławska Street; Fd 36/85 – 0.5 km north-east of Hutki; Fd 36/95 – Bolesław-Dąbrówka at Kluczevska Street, near the Dąbrówka Canal; Fd 46/03 – Bolesław, near church and park; Fd 46/04 – Stara Wieś; Fd 46/07 – west of Stary Olkusz at Pomorska Street; Fd 46/17 – Stary Olkusz, thin stands of *Betula pendula* and *Pinus sylvestris* south of the road to the “Olkusz” mine and the sewage purification plant; Fd 46/31 – Bukowno, in the Sztola river valley.

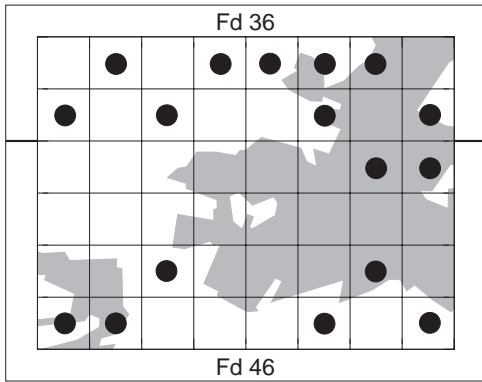
Lit.: Las Olkusz (Kuc, 1956); Fd 46/04, Fd 46/07, Fd 46/17 (Ochyra & Godzik, 2015).



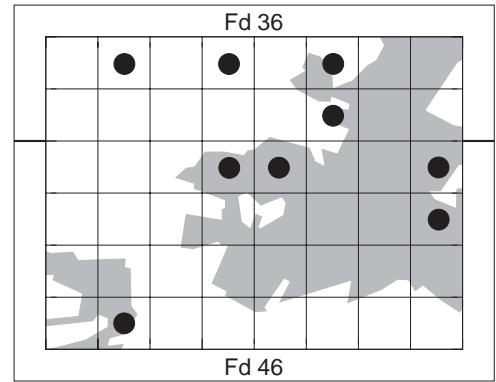
211. *Torrentaria riparioides*



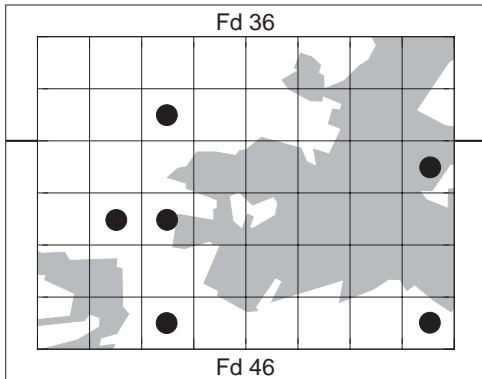
212. *Plagiothecium cavifolium*



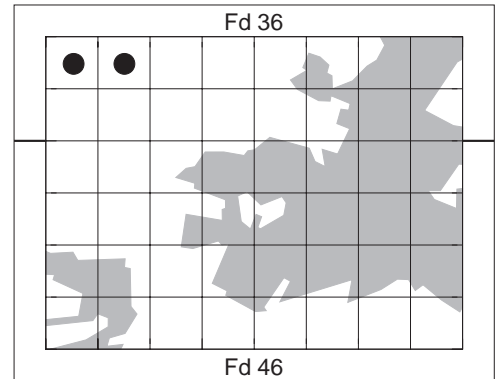
213. *Plagiothecium curvifolium*



214. *Plagiothecium denticulatum*



215. *Plagiothecium laetum*



216. *Plagiothecium nemorale*

Figs 211–216. Distribution maps for *Torrentaria riparioides* (211), *Plagiothecium cavifolium* (212), *P. curvifolium* (213), *P. denticulatum* (214), *P. laetum* (215) and *P. nemorale* (216) in the Olkusz Ore-bearing Region.

141. *P. laetum* Schimp. – Rare (Fig. 215). On bark at bases of trees and on exposed roots, rotten logs and stumps and rarely on mineral soil. Occasionally with sporophytes. Common throughout the whole Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

6 stat.: Fd 36/92 – Bolesław-Ćmielówka; Fd 46/07 – west of Stry Olkusz at Pomorska Street; Fd 46/11 – Wodaça, near the Sztolnia Canal; Fd 46/12 – between Tłukienka and Wygieźła; Fd 46/32 – Bukowno, the Sztola river valley; Fd 46/37 – Pustynia Starczynowska.

Lit.: Fd 46/07 (Ochyra & Godzik, 2015).

142. *P. nemorale* (Mitt.) A.Jaeger – Very rare (Fig. 216). On bark at base of the trunk of hornbeam and on loess soil in woodland. Frequent throughout the whole Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

2 stat.: Fd 36/80 – Krzykawa, on bark at base of trunk of *Carpinus betulus*; Fd 36/81 – Pniaki, on loess soil in woodland.

143. *P. ruthei* Limpr. – Very rare (Fig. 217). In moist places in mixed forest and on slopes of old heaps. Fairly frequent throughout the whole Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

3 stat.: Fd 36/97 – on soil on slope of a hollow in pine forest 3 km north-west of Stry Olkusz 300 m north of the “Mieszko” adit; Fd 46/25 – Starczynów, near the Baba Canal, on the ground in mixed forest; Fd 46/26 – south of the Baba Canal, along the broad-gauge railway east of the eastern side of the flotation tailings heap of the “Olkusz” mine, on the ground in mixed forest.

144. *P. succulentum* (Wilson) Lindb. – Not found during the present field studies. Known from scattered sites in the Silesian Upland

(Stebel, 1998a), but so far it has not been recorded in the Cracow-Częstochowa Upland (Fojcik, 2011). The distribution of this species is still poorly and insufficiently known in Poland. No voucher specimen is available, so this literature record of *P. succulentum* cannot be confirmed

Lit.: Las Olkusz (Kuc, 1956).

Family *Amblystegiaceae* Kindb.

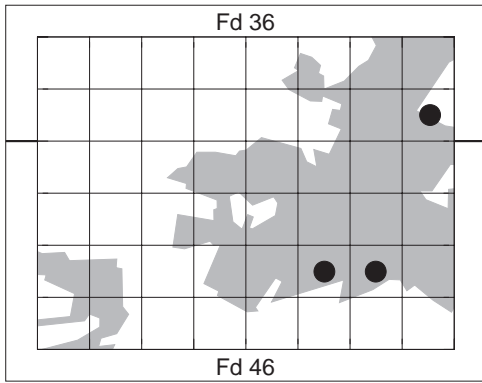
145. *Amblystegium juratzkanum* Schimp. – Rare (Fig. 218). On soil on banks of drainage ditches, in wet depressions in woodland and on fallow fields, in moist habitats. Usually with sporophytes. Frequent throughout the whole Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

5 stat.: Fd 36/83 – ‘Cicha Kolonia’ at Cegielniana Street; Fd 36/84 – Sztolnia Ponikowska at Cegielnia; Fd 36/85 – Sztolnia Ponikowska between Karna and Górka; Fd 46/02 – Krążek, on the meadow between Podlipie and Polna Street; fallow fields south of Krążek; Fd 46/33 – Bukowno, between Pocztowa and Spacerowa Streets.

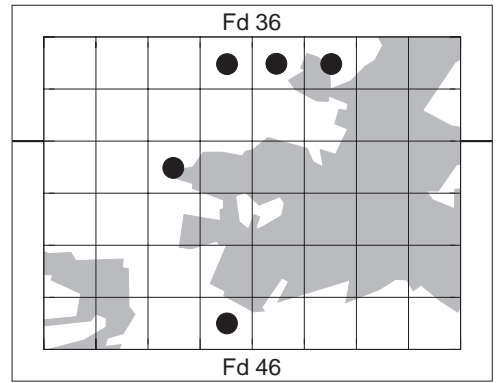
Lit.: Bukowno (Kuc, 1956); Fd 46/02 (Ochyra & Godzik, 2015).

146. *A. radiale* (P.Beauv.) Schimp. – Rare (Fig. 219). In wet depressions on soil in shady sites in woodland. Scattered in the Silesian Upland (Stebel 1997, 1998a; Fojcik & Stebel 2001) and very rare in the Cracow-Częstochowa Upland (Fojcik, 2011).

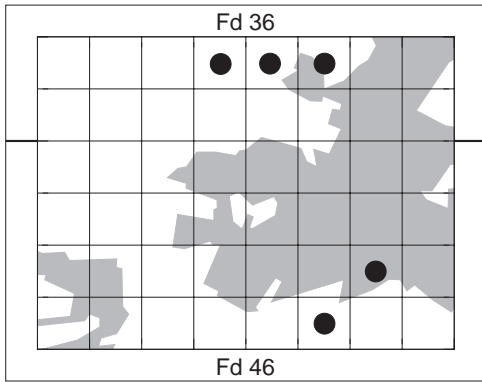
5 stat.: Fd 36/83 – ‘Cicha Kolonia’ at Cegielniana Street and Kolonia Nowy Ujków at Bolesławska Street; Fd 36/84 – Sztolnia Ponikowska in Cegielnia; Fd 36/85 – Sztolnia Ponikowska between Karna and Górka; Fd 46/26 – at the Baba Canal east of the flotation tailings heap of the “Olkusz” mine; Fd 46/35 – Starczynów, east of Sosnowa Street.



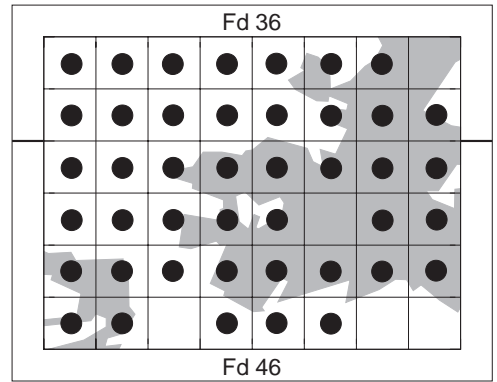
217. *Plagiothecium ruthei*



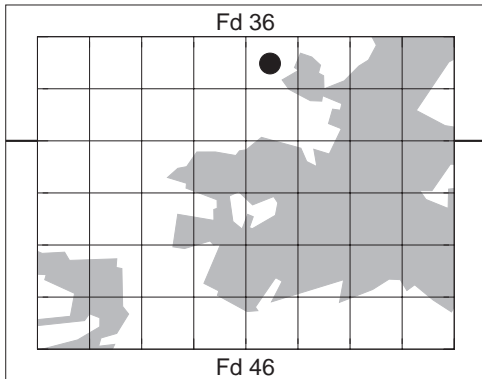
218. *Amblystegium juratzkanum*



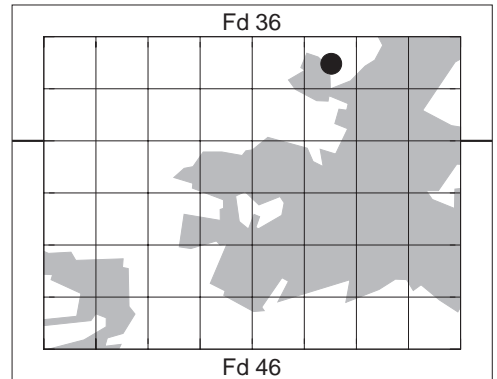
219. *Amblystegium radicale*



220. *Amblystegium serpens*



221. *Calliergon cordifolium*



222. *Calliergon giganteum*

Figs 217–222. Distribution maps for *Plagiothecium ruthei* (217), *Amblystegium juratzkanum* (218), *A. radicale* (219), *A. serpens* (220), *Calliergon cordifolium* (221) and *C. giganteum* (222) in the Olkusz Ore-bearing Region.

147. *A. serpens* (Hedw.) Schimp. – Common (Fig. 220). On dry or somewhat moist soil in open or sheltered sites in ruderal places, on old concrete walls, foundations and bridges, bark of deciduous trees and logs. Commonly with sporophytes. A ubiquitous species, common in the whole Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

43 stat.: grid squares: Fd 36/80; Fd 36/81; Fd 36/82; Fd 36/83; Fd 36/84; Fd 36/85; Fd 36/86; Fd 36/90; Fd 36/91; Fd 36/92; Fd 36/93; Fd 36/94; Fd 36/95; Fd 36/96; Fd 36/97; Fd 46/00; Fd 46/01; Fd 46/02; Fd 46/03; Fd 46/04; Fd 46/05; Fd 46/06; Fd 46/07; Fd 46/10; Fd 46/11; Fd 46/12; Fd 46/13; Fd 46/14; Fd 46/16; Fd 46/17; Fd 46/20; Fd 46/21; Fd 46/22; Fd 46/23; Fd 46/24; Fd 46/25; Fd 46/26; Fd 46/27; Fd 46/30; Fd 46/31; Fd 46/33; Fd 46/34; Fd 46/35.

Lit.: Bukowno (Kuc, 1956); Fd 36/93, Fd 36/93, Fd 46/03, Fd 46/04, Fd 46/12, Fd 46/13, Fd 46/14 (Ochyra & Godzik, 2015).

148. *Calliergon cordifolium* (Hedw.) Kindb. – Very rare (Fig. 221). On the ground in a wet depression. Frequent throughout the whole Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

1 stat.: Fd 36/84 – Sztolnia Ponikowska in Cegielnia, wet depression in woodland.

149. *C. giganteum* (Schimp.) Kindb. – Very rare (Fig. 222). In mire. Very rare in the Silesian Upland (Stebel, 1998a) and fairly frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

1 stat.: Fd 36/85 – Sztolnia Ponikowska between Karna and Górka, peatland.

150. *Campylium polygamum* (Schimp.) Lange & C.E.O. Jensen – Very rare (Fig. 223). On wet soil in a ditch. Scattered in the Silesian

Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and very rare in the Cracow-Częstochowa Upland (Fojcik, 2011).

1 stat.: Fd 36/83 – Kolonia Nowy Ujków, at Bolesławska Street, on wet soil in a ditch.

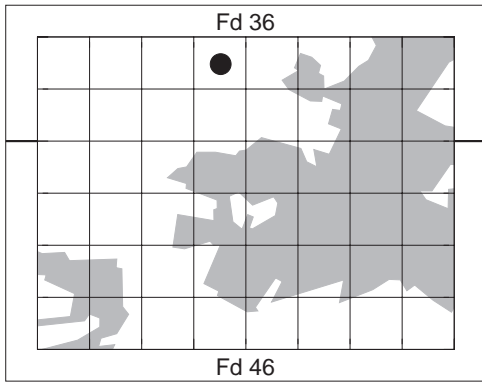
151. *C. stellatum* (Hedw.) Lange & C.E.O. Jensen var. *stellatum* – Not found during the present study (Fig. 224). On wet meadow. Rare in the Silesian Upland (Stebel, 1998a) and relatively frequent in the Cracow-Częstochowa Upland (Fojcik, 2011).

1 stat.: Fd 46/02 – Krążek, leg. A. Stebel & J. Drobnik, 10 June 2002 (KRAM, SOSN).

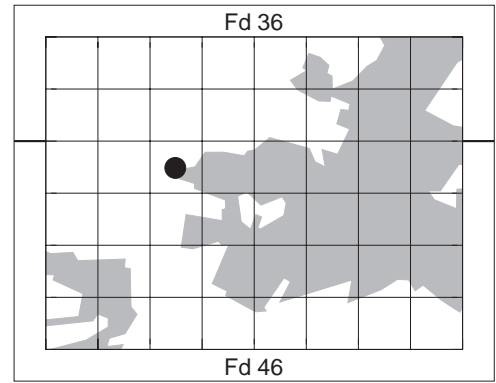
var. *protensum* (Brid.) Bryhn – Rare (Fig. 225). On wet soil in drainage ditches, in mires and hollows in deciduous forest. This variety (sometimes also considered as a species in its own right) is not universally recognised and its distribution in Poland is still insufficiently known.

6 stat.: Fd 36/83 – Kolonia Nowy Ujków, ‘Cicha Kolonia’ at Cegielniana Street; Fd 36/84 – Sztolnia Ponikowska between Cegielnia and Poręba and Sztolnia Ponikowska in Poręba; Fd 36/90 – Małobądz-Krze, Szamrak Hill; Fd 36/95 – Dąbrówka, Dąbrówka Canal near Kluczeńska Street; Fd 46/02 – Krążek, meadows between Podlipie and Polna Street; Fd 46/05 – Dąbrówka, Rozmus.

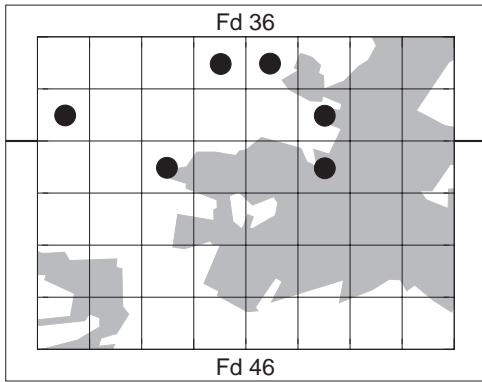
152. *Campylophyllopsis calcarea* (Crundwell & Nyholm) Ochyra [syn. *Campylidium calcareum* (Crundwell & Nyholm) Ochyra] – Fairly frequent (Fig. 226). On calcareous soil, limestone and dolomite boulders and stones, on rich basic mining waste (dolomite) and old concrete. Frequently with sporophytes. Frequent in the Silesian Upland (except Wyzyna Katowicka and Płaskowyż Rybnicki) (Stebel, 1998a) and in the Cracow-Częstochowa Upland (Fojcik, 2011).



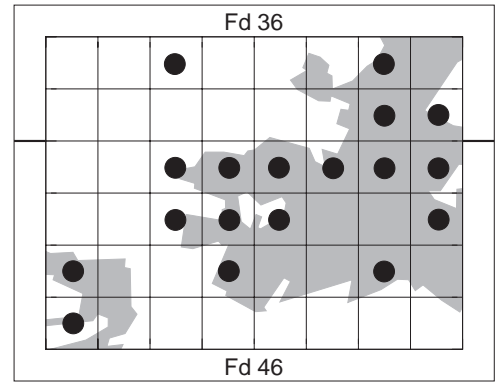
223. *Campylium polygamum*



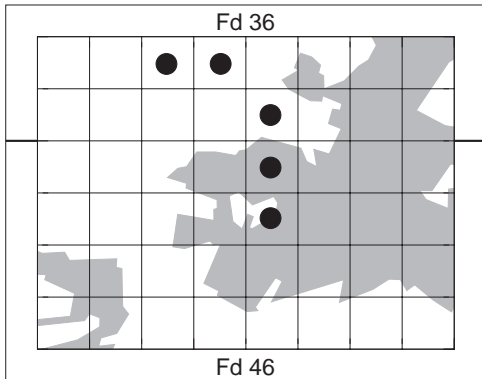
224. *Campylium stellatum* var. *stellatum*



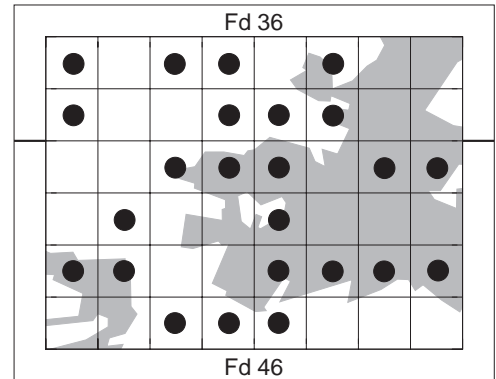
225. *Campylium stellatum* var. *protensum*



226. *Campylophyllopsis calcarea*



227. *Drepanocladus aduncus*



228. *Drepanocladus polycarpus*

Figs 223–228. Distribution maps for *Campylium polygamum* (223), *C. stellatum* var. *stellatum* (224), *C. stellatum* var. *protensum* (225), *Campylophyllopsis calcarea* (226), *Drepanocladus aduncus* (227) and *D. polycarpus* (228) in the Olkusz Ore-bearing Region.

18 stat.: grid squares: Fd 36/82; Fd 36/86; Fd 36/96; Fd 36/97; Fd 46/02; Fd 46/03; Fd 46/04; Fd 46/05; Fd 46/06; Fd 46/07; Fd 46/12; Fd 46/13; Fd 46/14; Fd 46/17; Fd 46/20; Fd 46/23; Fd 46/26; Fd 46/30.

Lit.: Fd 46/02, Fd 46/03, Fd 46/04, 46/13, Fd 46/14 (Ochyra & Godzik, 2015).

153. *Drepanocladus aduncus* (Hedw.) Warnst. – Rare (Fig. 227). In stagnant water in ponds and small water bodies, in wet ditches and hollows in fields, sometimes floating in flowing water in canals. Very frequent throughout the whole Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

5 stat.: Fd 36/82 – Nowy Ujków, Zimny Dół, in wet ditch; Fd 36/83 – Kolonia Nowy Ujków, at the meeting point of Bolesławska and Poręba Streets with the “Gierkówka” Road, on banks of a small water body; Fd 36/94 – Bolesław, in the Dąbrówka Canal, floating in water; Fd 46/04 – Stara Wieś, in pond; Fd 46/14 – Ujków Stary, *leg.* J. Drobnik, 15 June 2002 (sosn).

154. *D. polycarpus* (Blandow *ex* Voit) Warnst. – Frequent (Fig. 228). On wet mineral soil on waste land and meadows, in drainage ditches, on banks of canals and the Sztoła river, in wet depressions in forest and in mires in sites that alternate from drying out to being wet. Frequent in the whole Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011). The distribution in Poland is not adequately known because in the past this species was often merged with *D. aduncus* (Żarnowiec, 2001).

24 stat.: grid squares: Fd 36/80; Fd 36/82; Fd 36/83; Fd 36/85; Fd 36/90; Fd 36/93; Fd 36/94; Fd 36/95; Fd 46/02 – Krążek, *leg.* A. Stebel & J. Drobnik, 10 June 2002 (sosn); Fd 46/03; Fd 46/04; Fd 46/06; Fd 46/07; Fd 46/11; Fd 46/14 – Ujków Stary, *leg.* J. Drobnik, 15 June 2002 (sosn);

Fd 46/20; Fd 46/21; Fd 46/24; Fd 46/25; Fd 46/26; Fd 46/27; Fd 46/32; Fd 46/33; Fd 46/34.

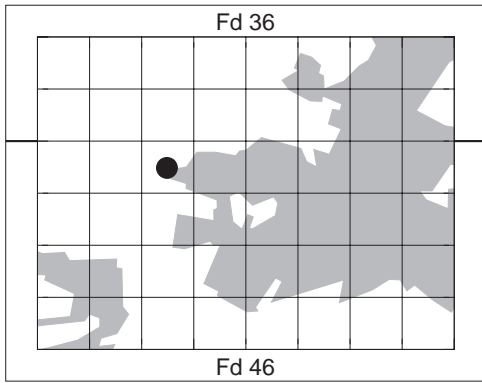
155. *D. sendtneri* (Schimp.) Warnst. – Not found during the present field studies, but it was collected in the village of Krążek a decade ago (Fig. 229). Unfortunately, this locality is now altered owing to the drainage of fens. Reported from several localities in the Silesian Upland (Kuc, 1956, 1959a) and Cracow-Częstochowa Upland (Szafran, 1955; Kuc, 1959b) but for many years it has not been observed in these regions. A species partly protected by law in Poland (Anonymous, 2014) and threatened (category R, Żarnowiec *et al.* 2004).

Lit.: Fd 46/02 – Krążek (Stebel, 2002b; Drobnik & Stebel, 2003 [*leg.* A. Stebel & J. Drobnik, 10 June 2002 (sosn)]).

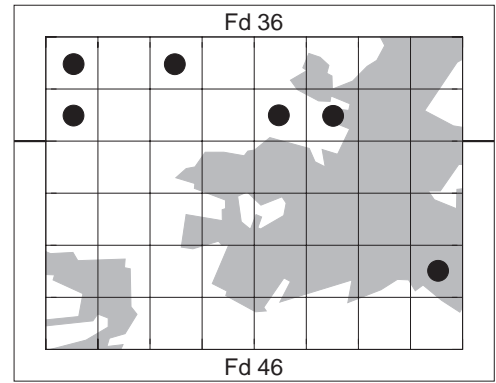
156. *Leptodictyum riparium* (Hedw.) Warnst. – Rare (Fig. 230). In water, usually submerged in canals and ponds. A hydrophytic species frequent throughout the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

6 stat.: Fd 36/80 – Krzykawa-Pokrzywdzie; Fd 36/82 – Kolonia Nowy Ujków, in the Dąbrówka Canal at Laskowska Street; Fd 36/90 – between Podlipie and Małobądz-Krze; Fd 36/94 – Bolesław, in the Dąbrówka Canal east of the Katowice-Olkusz road; Fd 36/95 – Bolesław-Dąbrówka, in the Dąbrówka Canal at Kluczevska Street; Fd 46/27 – Pustynia Starczynowska, in the Baba Canal near the air-shaft of the “Olkusz” mine.

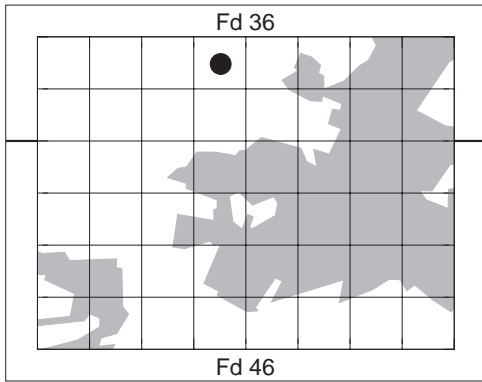
157. *Limprichtia cossonii* (Schimp.) L.E.Anderson, H.A.Crum & W.R.Buck – Very rare (Fig. 231). In wet site in mire with *Eleocharis quinqueflora*. In the last decade this species was observed only at a few localities in the Silesian Upland, including Poręba, Dąbrowa Górnicza-Pogoria and Jaworzno-Jeziorki (Stebel & Fojcik, 2003), Dąbrowa Górnicza-Antoniów (Stebel, unpublished) and Sosnowiec-Maczki (Stebel



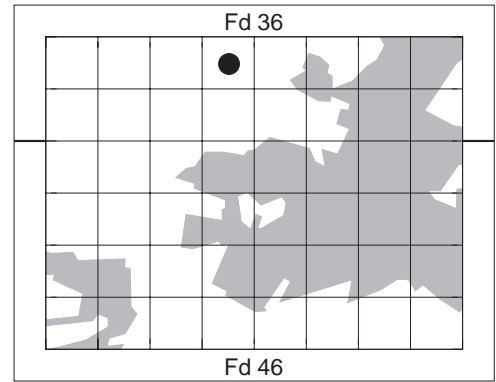
229. *Drepanocladus sendtneri*



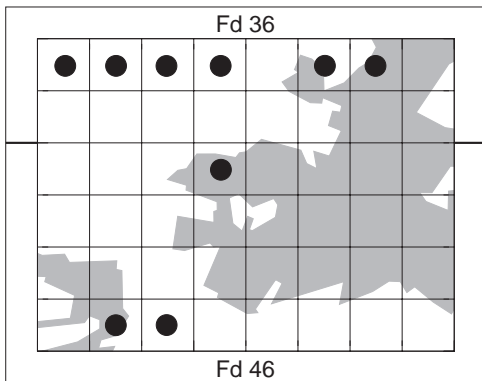
230. *Leptodictyum riparium*



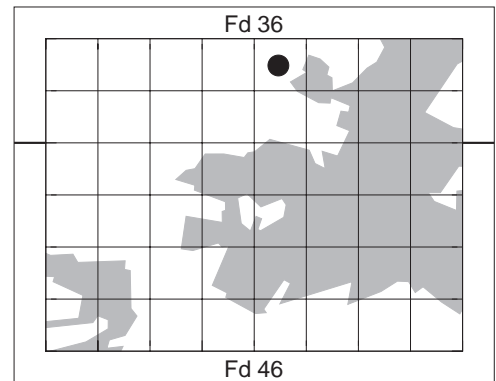
231. *Limprichtia cossonii*



232. *Pseudocalliergon lycopodioides*



233. *Sanionia uncinata*



234. *Straminergon stramineum*

Figs 229–234. Distribution maps for *Drepanocladus sendtneri* (229), *Leptodictyum riparium* (230), *Limprichtia cossonii* (231), *Pseudocalliergon lycopodioides* (232), *Sanionia uncinata* (233) and *Straminergon stramineum* (234) in the Olkusz Ore-bearing Region.

& Smolińska, 2011). In contrast, the species is relatively frequent in the Cracow-Częstochowa Upland (Fojcik, 2011). A species partly protected by law in Poland (Anonymous, 2014).

1 stat.: Fd 36/83 – Cegielniana Street, small peatland towards the east of Poręba.

158. *Pseudocalliergon lycopodioides* (Brid.) Hedenäs – Very rare (Fig. 232). In wet site on peaty ground. This species belongs to the group of glacial relicts in Poland (Bednarek, 1984). In the Silesian Upland it is known from several localities in its eastern part (Kuc, 1956; Jędrzejko, 1990) and recently it has been observed only in Sosnowiec-Bory (Stebel & Smolińska, 2011) and Sławków (Krajewski, 2012b). So far, the species has not been recorded in the Cracow-Częstochowa Upland (Fojcik, 2011).

1 stat.: Fd 36/83 – Kolonia Nowy Ujków, at Bolesławska Street, on peaty soil in a hollow on peat bog densely overgrown with shrubs.

159. *P. trifarium* (F.Weber & D.Mohr) Loeske – Not found during the present field studies. A glacial relict (Bednarek, 1984), vanishing in southern Poland. At present it is still extant only on the peat-bog Antoniów in Dąbrowa Górnicza (Stebel, unpublished). A small population of this species was reported by Fojcik (1992) from the village of Łaski immediately to the north of the study area, but its current situation is unknown. *Pseudocalliergon trifarium* has been recorded at several sites in the Cracow-Częstochowa Upland (Kuc, 1956, 1959a; Jasnowski, 1957; Ochyra *et al.*, 1988d; Babczyńska-Sendek, 1998) but has not been rediscovered (Fojcik, 2011).

Lit.: Bolesław (Ochyra *et al.*, 1988d [*leg.* K. Zarzycki, 21 October 1956 (KRAM)]).

160. *Sanionia uncinata* (Hedw.) Loeske – Rare (Fig. 233). On bark of deciduous trees,

stumps and on mineral soil in woodland and deciduous and mixed forest. Rarely with sporophytes. Frequent throughout the whole Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

9 stat.: Fd 36/80 – Krzykawa; Fd 36/81 – between Pniaki and Krzykawa; Fd 36/82 – Nowy Ujków, Zimny Dół; Fd 36/83 – ‘Cicha Kolonia’ at Cegielniana Street; Fd 36/85 – Sztolnia Ponikowska between Karna and Górka; Fd 36/86 – 0.5 km east of Hutki; Fd 46/03 – between Krążek and Tłukienka; Fd 46/31 – Bukowno, in the Sztola river valley; Fd 46/32 – Bukowno, in the Sztola river valley.

161. *Straminergon stramineum* (Dicks. *ex* Brid.) Hedenäs – Very rare (Fig. 234). On wet ground in woodland. Fairly frequent in the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

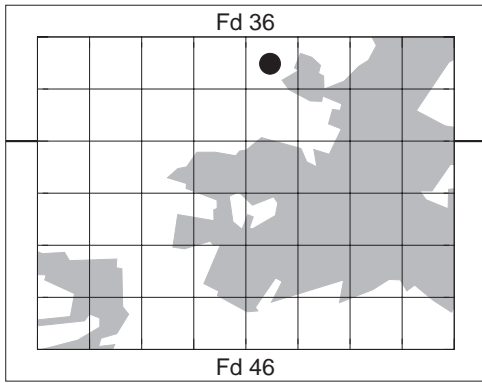
1 stat.: Fd 36/84 – Sztolnia Ponikowska in Cegielnia, in wet places in woodland.

162. *Warnstorfia fluitans* (Hedw.) Loeske – Very rare (Fig. 235). On wet ground in woodland. Relatively frequent throughout the whole Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

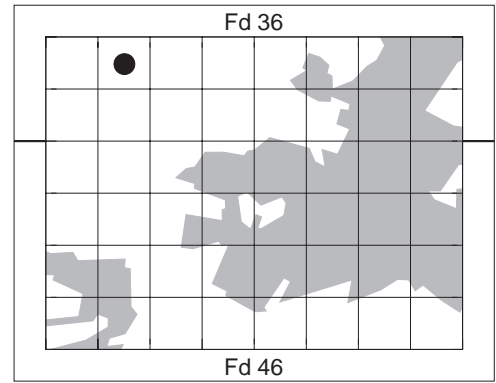
1 stat.: Fd 36/84 – Sztolnia Ponikowska in Cegielnia, in wet place in woodland.

Family Hypnaceae Schimp.

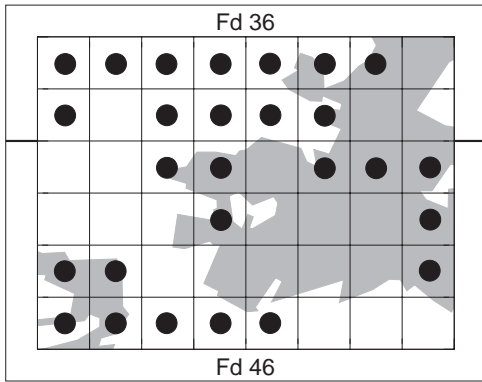
163. *Callicladium baldanianum* (Grev.) H.A.Crum – Very rare (Fig. 236). On bark of *Acer pseudoplatanus* L. A species threatened in Europe (category RT, Schumacker & Martiny, 1995). Frequent in the Silesian Upland (Stebel, 1998a, 2013) and the Cracow-Częstochowa Upland (Fojcik, 2011).



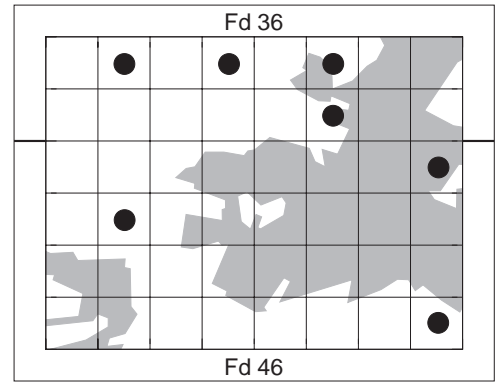
235. *Warnstorfia fluitans*



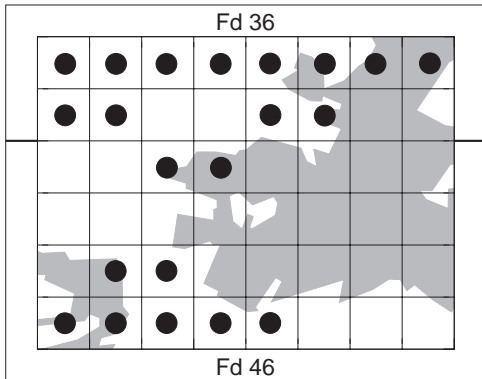
236. *Callicladium haldanianum*



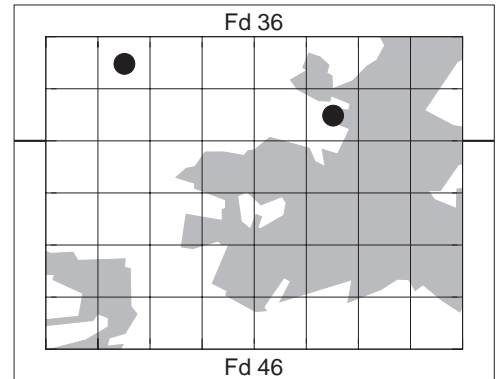
237. *Calliergonella cuspidata*



238. *Herzogiella seligeri*



239. *Hypnum cupressiforme*



240. *Hypnum pallescens*

Figs 235–240. Distribution maps for *Warnstorfia fluitans* (235), *Callicladium haldanianum* (236), *Calliergonella cuspidata* (237), *Herzogiella seligeri* (238), *Hypnum cupressiforme* (239) and *H. pallescens* (240) in the Olkusz Ore-bearing Region.

1 stat.: Fd 36/81 – between Pniaki and Krzykawa, on bark of *Acer pseudoplatanus* in beech forest in a ravine.

164. *Calliergonella cuspidata* (Hedw.) Loeske – Frequent (Fig. 237). On wet mineral soil in meadows and in waste land, in drainage ditches, on wet banks of canals and the Sztoła river, in wet depressions in forest and in mires, on humus and slightly moist stony ground in pine forest on mining waste. A species partly protected by law in Poland (Anonymous, 2014). Common throughout the whole Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

27 stat.: grid squares: Fd 36/80; Fd 36/81; Fd 36/82; Fd 36/83; Fd 36/84; Fd 36/85; Fd 36/86; Fd 36/90; Fd 36/92; Fd 36/93; Fd 36/94; Fd 36/95; Fd 46/02 – Krażek, *leg.* A. Stebel & J. Drobnik, 10 June 2002 (sosn); Fd 46/03; Fd 46/05; Fd 46/06; Fd 46/07; Fd 46/13; Fd 46/17; Fd 46/20; Fd 46/21; Fd 46/27; Fd 46/30; Fd 46/31; Fd 46/32; Fd 46/33; Fd 46/34.

Lit.: Fd 46/03 (Ochyra & Godzik, 2015).

165. *Ctenidium molluscum* (Hedw.) Mitt. – Not found during the present field studies. Very rare in the Silesian Upland, recently recorded only in Mysłowice (Stebel, 2006) and Radzionków (Stebel, 2011). Frequent in the Cracow-Częstochowa Upland (Ochyra *et al.*, 1985; Fojcik, 2011).

Lit.: Bolesław (Ochyra *et al.*, 1985 [*leg.* K. Zarzycki, 21 October 1956 (KRAM)]).

166. *Herzogiella seligeri* (Brid.) Z.Iwats. – Rare (Fig. 238). An epixylic species growing on decaying wood. Fairly frequently with sporophytes. Common throughout the whole Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

7 stat.: Fd 36/81 – between Pniaki and Krzykawa; Fd 36/83 – ‘Cicha Kolonia’ at Cegielniana Street; Fd 36/85 – Sztolnia Ponikowska between Karna and Górka; Fd 36/95 – Bolesław-Dąbrówka at Kluczevska Street near the Dąbrówka Canal; Fd 46/07 – Stary Olkusz, Pomorska Street; Fd 46/11 – Wodąca, near the Sztolnia Canal; Fd 46/37 – Pustynia Starczynowska.

Lit.: Fd 46/07 (Ochyra & Godzik, 2015).

167. *Hypnum cupressiforme* Hedw. – Frequent (Fig. 239). On bark of deciduous trees, logs, stumps and soil. Fairly frequently with sporophytes. Common in the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

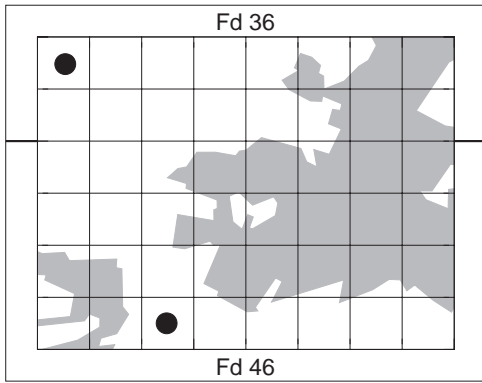
21 stat.: grid squares: Fd 36/80; Fd 36/81; Fd 36/82; Fd 36/83; Fd 36/84; Fd 36/85; Fd 36/86; Fd 36/87; Fd 36/90; Fd 36/91; Fd 36/94; Fd 36/95; Fd 46/02; Fd 46/03; Fd 46/21; Fd 46/22; Fd 46/30; Fd 46/31; Fd 46/32; Fd 46/33; Fd 46/34.

168. *H. pallescens* (Hedw.) P.Beauv. – Very rare (Fig. 240). On bark of deciduous trees in forest. Scattered throughout the Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

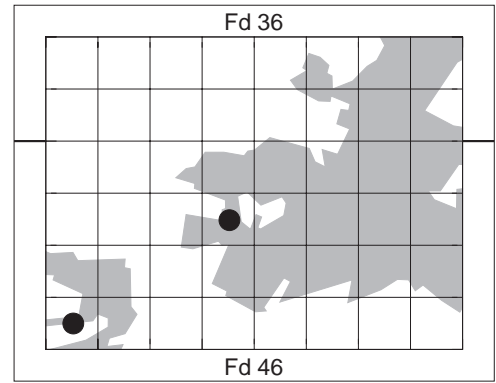
2 stat.: Fd 36/81 – between Pniaki and Krzykawa, on bark of *Quercus robur*; Fd 36/95 – Bolesław-Dąbrówka, near the Dąbrówka Canal at Kluczevska Street, on bark of *Alnus glutinosa*.

169. *Platygyrium repens* (Brid.) Schimp. – Very rare (Fig. 241). An epiphytic moss growing on bark of deciduous trees. Frequent in the whole Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

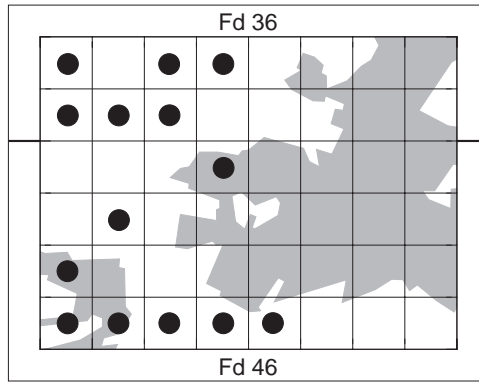
2 stat.: Fd 36/80 – Krzykawa, on bark of an apple-tree in an abandoned orchard, *c. gem.*; Fd 46/32 – Bukowno, the Sztoła river valley, on bark of *Alnus glutinosa* near the Sztoła river.



241. *Platygyrium repens*



242. *Ptilium crista-castrensis*



243. *Pylaisia polyantha*

Figs 241–243. Distribution maps for *Platygyrium repens* (241), *Ptilium crista-castrensis* (242) and *Pylaisia polyantha* (243) in the Olkusz Ore-bearing Region.

170. *Ptilium crista-castrensis* (Hedw.) De Not. – Very rare (Fig. 242). On sandy soil and on logs in pine forest in dry habitats. At present this species is very rare in the Silesian Upland, known from widely scattered localities (Stebel & Fojcik, 2003) and it is more frequent in the Cracow-Częstochowa Upland (Fojcik, 2011). A species partly protected by law in Poland (Anonymous, 2014).

2 stat.: 46/13 – Ujków Stary, 0.5 km towards the west, on sandy soil; Fd 46/30 – Bukowno, in the Sztola river valley, a few steams on log in pine forest.

171. *Pylaisia polyantha* (Hedw.) Schimp. – Fairly frequent (Fig. 243). On bark of solitary deciduous trees in dry and exposed sites. Frequently with sporophytes. Very frequent throughout the whole Silesian Upland (Stebel, 1998a; Fojcik & Stebel, 2001) and the Cracow-Częstochowa Upland (Fojcik, 2011).

14 stat.: grid squares: Fd 36/80; Fd 36/82; Fd 36/83; Fd 36/90; Fd 36/91; Fd 36/92; Fd 46/03; Fd 46/11; Fd 46/20; Fd 46/30; Fd 46/31; Fd 46/32; Fd 46/33; Fd 46/34.

Doubtful and excluded species

Bryum algovicum Sendtn. ex Mull.Hal. – Wóycicki (1913: p. 23, 25) reported this species as *Bryum pendulum* (Hornsch.) Schimp. in the tables VI and VII from “an upland separating the Bolesław and Olkusz basins, on the right-hand side of the road towards Bolesław, covered with many old heaps and shallow depressions being the remnants of the numerous buried pit-shafts” growing on calcareous rubble and leavings of calamine ore. He considered it to be the most frequent moss species in this area. Unfortunately, no voucher collections are available. This report is most probably based upon misdetermination because *B. algovicum* is actually a very rare species in the southern uplands of Poland (Kuc, 1964). This is contrary to the statement of Szafran (1957) who described *B. algovicum* as a common moss in the Polish lowlands. *Bryum algovicum* has not been observed in the study area, including the site described by Wóycicki (1913). However, the externally similar species *B. pallescens* grows commonly in such habitats and actually it is the most widespread and abundant species of the genus in the Olkusz Ore-bearing Region. Accordingly, *B. algovicum* is excluded from the bryophyte flora of the study area.

Aulacomnium androgynum (Hedw.) Schwägr. – In KRAM there is a single specimen bearing the following label data: “Hutki near Bolesław, Pustynia Błędowska. Swamps in forest. On decaying log and soil, 22 August 1954, leg. M. Kuc”. It is difficult to state with full certainty whether this specimen was

collected in the study area because M. Kuc gave “Pustynia Błędowska desert” on the label. This could suggest that the material came from the area towards the north of the village of Hutki from the edge of Pustynia Błędowska which is situated outside the study area.

Rhynchostegium megapolitanum (Blandow ex F.Weber & D.Mohr) Schimp. – This species was reported by Dobrzańska (1955) from the vicinity of Bolesław and Olkusz and Kuc (1956) from the forest between Kozi Bród and Pustynia Błędowska desert. The latter locality is very general and possibly is situated outside the study area but Kuc (1964) stated that this record is erroneous (unfortunately, no voucher specimens have been located in KRAM). The occurrence of *Rh. megapolitanum* in this area is doubtful and according to Melosik (1993) all reports of this species from the Polish lowlands situated to the east of the Warta River and the lower Vistula are based upon misdeterminations. The nearest locality of *Rh. megapolitanum* is in the Wyżyna Wieluńska upland (Fojcik, 1999).

Scorpidium scorpioides (Hedw.) Limpr. – In KRAM there is a single specimen bearing the following label data: “Laski k. Bolesławia, zagłębienia wśród wydm (staw), 11.X.1957 M. Kuc [=Laski near Bolesław, depressions amongst dunes (pond), 11 October 1957 leg. M. Kuc]”. This specimen was collected apparently outside the study area, most probably to the north of the village of Laski at the edge of the Pustynia Błędowska desert and

such interpretation is strongly supported by using the term “wydma [=dune]” where the moss was discovered.

Campylophyllopsis sommerfeltii (Myrin) Ochyra – This species was reported by Kuc (1956) as *Chrysophyllum sommerfeltii* (Myrin) Roth from “Bolesław-Strzemieszyce”. This locality is interpreted as an area situated between the town of Bolesław and Dąbrowa Górnicza-Strzemieszyce which is situated towards the north-west of the study area. The voucher specimens deposited in KRAM (“Bolesław-Strzemieszyce, suche zbocza, 10.VII.1953 M. Kuc [=Bolesław-Strzemieszyce, dry slopes, 10 July 1953, leg. M. Kuc]” clearly refers to *Campylophyllopsis calcarea*. Actually, all records of *C. sommerfeltii* cited by Kuc (1956, 1964) belong to

this species. Additionally, it is likely that the specimen in question was collected outside the study area. Jędrzejko (1990) reported this species from Bukowno and although no voucher collection is available to study, it is very probable that this record also refers to *C. calcarea*, the only species of the genus which is widespread in the study area. *Campylophyllopsis sommerfeltii* is an exceedingly rare species known only from the easternmost part of Poland, including Puszcza Augustowska Primeval Forest, Roztocze heights and Bieszczady Zachodnie range in the Eastern Carpathians (Fudali *et al.*, 2015). All reports of this species from other parts of the country are based upon misdeterminations and the relevant collections actually represent *C. calcarea*.

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