The lichen genus *Stereocaulon* in Poland I. *S. condensatum* and *S. incrustatum*

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Abstract: Oset, M. 2008. The lichen genus *Stereocaulon* in Poland I. *S. condensatum* and *S. incrustatum*. – Herzogia **21**: 51–59.

Notes on the morphology, chemistry, habitat requirements and distribution of *Stereocaulon condensatum* and *S. incrustatum* in Poland are provided. Species are found in both lowland and montane regions, but *S. condensatum* occurs only in the lower parts of the mountains, where it prefers open habitats. *S. condensatum* normally contains atranorin and lobaric acid, but three specimens contained only the latter. The majority of the specimens of *S. incrustatum* lacked lobaric acid (usually with atranorin and lobaric acid), which is contrary to previous reports.

Zusammenfassung: Oset, M. 2008. Die Flechtengattung *Stereocaulon* in Polen I. *S. condensatum* und *S. incrustatum*. – Herzogia **21**: 51–59.

Die Morphologie, Sekundärstoffchemie, Standortsansprüche und Verbreitung von *Stereocaulon condensatum* und *S. incrustatum* in Polen werden behandelt. Die beiden Arten kommen sowohl im Flachland als auch in den Gebirgen vor. *S. condensatum* findet man nur in den niederen Lagen der Gebirge, wo es exponierte und offene Standorte bevorzugt. *S. condensatum* enthält normalerweise Atranorin und Lobarsäure, aber drei Proben enthielten nur Lobarsäure. Der Mehrzahl der Proben von *S. incrustatum* fehlt Lobarsäure (normalerweise mit Atranorin und Lobarsäure), was im Gegensatz zu früheren Beobachtungen steht.

Key words: Lichenized Ascomycota, Stereocaulaceae, lichen chemistry, biodiversity.

Introduction

The genus *Stereocaulon* Hoffm. nom.cons. (see Lamb 1959) (Stereocaulaceae, Lecanorales, Ascomycota) includes species that possess a dimorphic thallus, being both crustose ('primary thallus') and shrubby ('secondary thallus' called pseudopodetium). The primary thallus in *Stereocaulon* is crustose and consists of basal granules, or can be areolate or squamulose. Although some species can produce soredia or phyllocladia (see below) on the persisting primary thallus, in most species the primary thallus disappears at a very early stage of development. The secondary thallus is built of stiff (when dry), corticate or non-corticate shrubby, erect and usually branched pseudopodetia. Pseudopodetia can show persistent phyllocladia (or phyllocladoid branchlets), apothecia, and in most species cephalodia, which contain cyanobacteria (*Nostoc* or *Stigonema*). Phyllocladia and phyllocladioid branchlets play an important role in the taxonomy and delimitation of *Stereocaulon* species. Their morphology can be very variable, and range from verrucose to granular, cylindrical, squamulose or even to foliose. The apothecia are terminal or lateral placed, with a pale (red-)brown to dark brown or blackish, usually convex disc, and lack a thalline margin. According to Motyka (1964), four types of apothecia are distinguished, the *Stereocaulon nanodes*-type, the *S. alpinum*-type, the *S. tomentosum*-type, and the *S. paschale*-type.

All members of *Stereocaulon* are unlikely to be confused with those of any other genera, except perhaps *Leprocaulon* Nyl., which has very fine decorticated branches and lacks ascomata (Ryan 2002, Saag et al. 2007).

As many *Stereocaulon* taxa are rather similar in morphology, the secondary chemistry plays an important role in the taxonomy of the genus. The substances found in the genus are depsides (with atranorin as the most common substance of the genus), depsidones, dibenzofuranes, and aliphatic acids (Motyka 1964, Culberson 1969, Lamb 1977, Purvis 1992, Motiejūnaitė 2002). Nevertheless, since many species are chemically identical (e.g. *S. paschale* (L.) Hoffm. and *S. taeniarum* (H.Magn) Kivistö, see Kivistö 1998), their determination has to be based on both morphological and chemical data.

Although there have been numerous taxonomic treatments of *Stereocaulon* (see Lamb 1951, Motyka 1964, Purvis 1992, Ryan 2002), a modern comprehensive global revision is lacking, and it is difficult to identify species. Magnusson (1926) revised the genus worldwide, but overestimated morphological characters and some taxa remain unclear. Lamb (1951, 1977) was the first to provide valuable data on the morphology, phylogeny, taxonomy and chemistry of the genus. A revision of the *Stereocaulon* species occurring in Russia by Dombrovskaya (1996) is another valuable contribution; it includes important data on the chemistry and morphology of each species, including a key, which can be used outside of Russia. Two recent papers are based on molecular data: Myllys et al. (2005) studied the phylogenetic relationships of all members of the Stereocaulaceae, and Högnabba (2006) tried to clarify phylogenetic relationships of several taxa within the genus (see below).

Species occur mostly on rocks and, in montane regions, also on metal-rich spoil heaps, on shingle, soil, and amongst terricolous mosses. Many species grow in dry, open habitats, but some prefer humid localities (Purvis 1992).

In general, the worldwide distribution is reasonably well investigated. Taxa are found from the Arctic and Antarctic to the tropics in both Hemispheres (Lamb 1951, Motyka 1964, Purvis 1992, Ryan 2002), but there are still substantial gaps in our knowledge of many taxa in various regions of the world. In many cases, published data should be treated with caution, since the determination of the taxa is often based mainly on morphological characters.

As there is no comprehensive study of the genus for the whole Polish territory, one can assume, that several taxa have been overlooked or misdetermined. Detailed TLC data are missing, chemical analyses having been mostly confined to spot test reaction. Thus, data on the distribution and threat of *Stereocaulon* species in Poland are still incomplete and uncertain. To date, 13 taxa have been reported from Poland (Fałtynowicz 2003), but nearly all of them have not been confirmed by TLC investigations. Some species are considered to be rather common (e.g. *S. condensatum* Hoffm., *S. tomentosum* Fr., *S. vesuvianum* Pers.), but others are known only from a few stands (e.g. *S. botryosum* Ach., *S. evolutum* Graewe ex Th.Fr., *S. spathuliferum* Vain.). Based on morphology and TLC-data, the present paper focuses on studies of the two commonest species in Poland, namely *S. condensatum* and *S. incrustatum*.

Molecular analyses performed by Högnabba (2006) showed that the genus *Stereocaulon* could be divided into eight groups, a result which did not reflect the hitherto generic classification. The author also demonstrated that some taxa, such as *S. saxatile* H.Magn. (see below) and *S. incrustatum*, are probably not monophyletic. One sample of *S. incrustatum* was placed in ‘group 5’ (together with *S. arcticum* Lynge, *S. azoreum* (Schaer.) Nyl., *S. verruciferum* Nyl. and *S. vesuvianum*), and a second sample was placed in ‘group 6’ [together with

S. dactylophyllum Flörke, *S. paschale*, *S. saxatile* (p.p.)], *S. subcoralloides* (Nyl.) Nyl. and *S. taeniarum*. *S. condensatum* was included in 'group 7a', together with *S. alpinum* Laurer, *S. grande* (H.Magn.) H.Magn. and two samples of *S. saxatile*. *S. condensatum* has never been regarded as closely related to any of these taxa, but it is considered to be most closely related to *S. glareosum* (Savicz) H.Magn. and *S. incrustatum* (HÖGNABBA 2006).

Nevertheless, even if *S. condensatum* and *S. incrustatum* are genetically not closely related, they are morphologically very similar and thus both are treated here. The present paper presents the results of studies on the morphology, chemistry, distribution and habitat requirements of *S. condensatum* and *S. incrustatum* in Poland, together with information on specimens from elsewhere. Further papers dealing with other *Stereocaulon* species from Poland are projected.

Material and methods

Polish material of *Stereocaulon* from the following herbaria was studied: B, GPN, KRAM, LBL, KTC, OLS, POZ, TRN, UGDA, WA and WRSL. For comparative studies, foreign collections from B, BILAS and H were also examined.

The morphological characters (i.e. thickness, morphology and colour of thallus; shape of phyllocladia; presence, shape and size of cephalodia) were studied using a stereomicroscope. Cyanobacteria from cephalodia were examined under a light microscope and determined to genus level. Chemical analyses were performed by thin-layer chromatography (TLC) in solvent C according to the methods of ORANGE et al. (2001).

All examined localities are mapped according to the ATPOL grid square system (ZAJĄC 1978; modified by CIEŚLIŃSKI & FAŁTYNOWICZ 1993; see also KUKWA et al. 2002), where, on the basis of geographical coordinates, the area of Poland is divided into 100 × 100 km squares (symbols from Ag to Gg), and each in turn is divided into subunits of 10 × 10 km, with numbers from 00 to 99 (starting from the left).

The species

Stereocaulon condensatum Hoffm.

Deutschland Flora oder Botanisches Taschenbuch, Zweyter Theil, Cryptogamie: 130 (1796).

Exsiccates examined: Fałtynowicz & Miądlikowska, Lich. Polon. Exs. 13 (LBL, UGDA). Krawiec, Lichenoth. Polon. 71 (LBL, TRN, WA). Nowak, Lich. Polon. Merid. Exs. 59 (LBL). Vězda, Lich. Sel. Exs. 2475 (B–97740). Zielińska, Pl. Varsav. Exs. 40 (WA).

Description (mainly adopted from PURVIS 1992; for more details see LAMB 1951, 1977)**:** primary thallus as a basal crust of grey, sometimes bluish, warty or cylindrical phyllocladia, persistent; pseudopodetia c. 1–2 cm tall, absent or rare, simple or sparingly branched, ± tomentose and warted; phyllocladia warted, occasionally as incised squamules; cephalodia containing *Stigonema*, 0.5–1 mm in diam., subglobose, rough, brown to black, amongst phyllocladia and on pseudopodetia; apothecia 1–2 mm in diam., rather frequent, dark brown, on basal phyllocladia or on pseudopodetia (Fig. 1).

Chemistry of Polish specimens: Atranorin (absent in three specimens, tested twice) and lobaric acid (sometimes lacking). Spot test reaction: Pd± yellow, KC± violet.

Notes: *S. condensatum* is characterized by its basal crust of warty or cylindrical, grey, sometimes bluish, squamulose phyllocladia, by cephalodia containing *Stigonema*, and by the production of atranorin, mostly with lobaric acid (see LAMB 1951, 1977, PURVIS 1992).

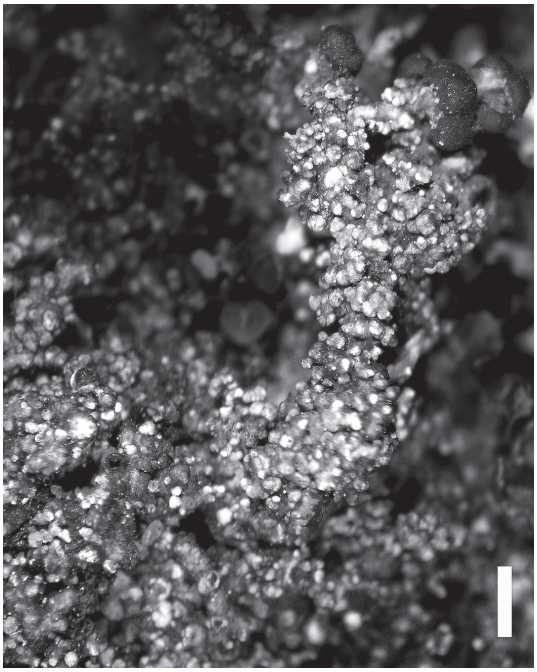

Fig. 1: Morphology of *Stereocaulon condensatum* (scale bar 1 mm).

The present research has proved that *S. condensatum* is consistent in chemistry and morphology. Only three specimens (of a total of 99) were wrongly filed under *S. incrustatum* and only three specimens were found to produce lobaric acid only.

S. glareosum is most closely related to *S. condensatum* (Lamb 1977): both species share the same chemistry (Lamb 1977, Dombrovskaya 1996), and also their morphology is quite similar. Nevertheless, *S. glareosum* has taller (up to 2.5 cm), conspicuous, sparingly branched and grey tomentose pseudopodetia. Its cephalodia are smooth, pale bluish-brown, brownish-violet or pinkish-white, and contain *Nostoc*. Apothecia are rarely developed. However, *S. condensatum* has hemispherical dark reddish-brown to black cephalodia with a rough surface which are frequently interspersed amongst phyllocladia (also on pseudopodetia) and contain *Stigonema*; apothecia are rather frequent and produced on pseudopodetia or on basal phyllocladia (Motyka 1964, Nowak & Tobolewski 1975, Purvis 1992). *S. glareosum* is a temperate to boreal-arctic, alpine-subalpine and obviously circumpolar lichen (Lamb 1977, Dombrovskaya 1996). It has never been recorded from Poland, but according to Motyka (1964), it might occur in the Tatra Mountains.

Habitat requirements: In Poland, *S. condensatum* occurs almost exclusively in exposed, open soil habitats, such as pine forests, heath and inland sand dune vegetation.

Distribution in Poland: *S. condensatum* was reported for the first time for Poland in 1849 (see Flotow 1849, Fałtynowicz 2003). Later it was recorded more and more frequently (see Fałtynowicz 2003), and in the second part of the 20th century, *S. condensatum* was considered to be a rather common species, at least outside of the mountain regions (Motyka 1964). The present study confirms Fałtynowicz (2003), that the taxon generally occurs in northern and southern Poland (Fig. 2), ranging from lowlands to lower altitudes of the mountains. The species has been reported in several published papers; several records from following papers have been confirmed in the present study: Krawiec (1935), Zielińska (1967), Nowak (1971), Fałtynowicz & Tobolewski (1989) and Cieśliński (2003).

World distribution: *S. condensatum* is known only from the Northern Hemisphere, and according to Lamb (1977), it is a temperate to boreal-arctic, amphiatlantic and possibly circumpolar lichen. It appears to be common in the boreal zone of Europe and North America (Lamb 1951, 1977, Motyka 1964, Nowak & Tobolewski 1975, Purvis 1992), but there are only a few reports from Asia and Oceania. In Europe, Lamb (1977) confirmed its occurrence in Belgium, Czech Republic, Denmark, England, Finland, France, Germany, Netherlands, Norway, Scotland,

Slovakia and Sweden. It is also known from Estonia (Randlane & Saag 1999; see additional specimens examined) and Lithuania (Motiejūnaitė 2002; see additional specimens examined). In Asia, it is confirmed from Japan and Mongolia, and in North America from Canada (Québec, Labrador, Ontario, Manitoba, Saskatchewan, N.W. Territories), Greenland and the U.S.A. (Connecticut, Massachusetts, New Hampshire, Wisconsin, Alaska, Hawaii) (see Lamb 1977).

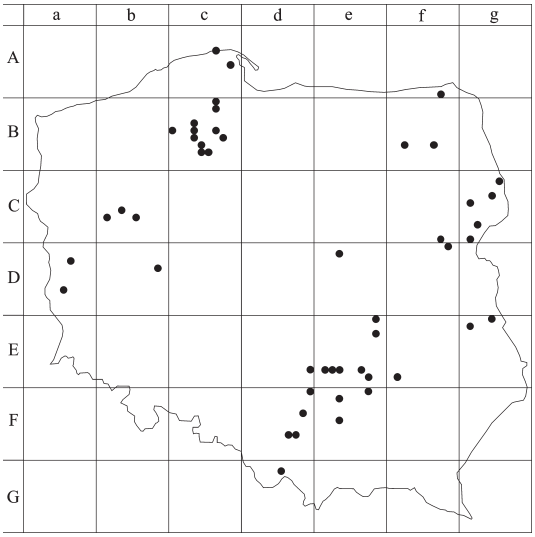

Fig. 2: Distribution of *Stereocaulon condensatum* in Poland.

Selected specimens examined containing atranorin and lobaric acid (96 specimens studied; all collected from soil)**: [Ac–36]** – N of Bielawskie Błoto peat bog, 07.1958, Z. Tobolewski (POZ); **[Ac–58]** – c. 2 km SW of Mała Piaśnica village, Wejherowo forest inspectorate, forest section no. 41, 21.04.1983, A. Zalewska (UGDA-L–3454); **[Af–97]** – Hańcza village, by Czarna Hańcza river, 06.07.1975, S. Cieśliński (KTC); **[Bc–06]** – By Dobrogoszcz lake, 25.06.1981, W. Fałtynowicz (UGDA-L–1636); **[Bc–16]** – by Głęboczek lake, 06.1974, W. Fałtynowicz (UGDA-L–779); **[Bc–33]** – Przymuszewo forest inspectorate, Widno forest division, forest section no. 48a, 04.04.1975, W. Fałtynowicz (UGDA-L–988); **[Bc–40]** – Between Bytów and Człuchów towns, 2,5 km NW of Suszka village, 25.07.1989, W. Fałtynowicz (UGDA-L–4184); **[Bc–43]** – Przymuszewo forest inspectorate, Popówka forest division, forest section no. 285b, 05.04.1977, W. Fałtynowicz (UGDA-L–195); forest section no. 294d, 02.03.1975, W. Fałtynowicz (UGDA-L–987); forest section no. 303b, 02.03.1975, W. Fałtynowicz (UGDA-L–986); **[Bc–46]** – near Czersk town, 10.10.1969, W. Sodkiewicz (POZ); near Czersk, W edge Trzebowierz range, 13.08.1968, W. Sodkiewicz (POZ); **[Bc–53]** – Klosnowo village, 1986, E. Lickiewicz (LBL); **[Bc–57]** – near Rosochatka village, 30.09.1988, W. Fałtynowicz (LBL); 1 km N of Rosochatka village near Czersk town, 30.09.1988, W. Fałtynowicz (UGDA-L–4021, KRAM-L–22466); **[Bc–64]** – road between Mokrz and Rzecin villages, 27.09.1954, Z. Tobolewski (POZ); **[Bc–74]** – forest inspectorate Przymuszewo, forest section no. 327/328, Bór Chrobotkowy im. Prof. Z. Tobolewskiego Nature Reserve, 19.05.1999, U. Bielczyk (KRAM-L–44766); **[Bc–75]** – 15 km of Tuchola town, 13.08.1968, W. Sodkiewicz (POZ); **[Bf–62]** – Babrosty village, E of Pisz town, 26.08.1990, S. Cieśliński (KTC); **[Bf–66]** – Dolina Biebrzy valley, c. 10–11 km SSE of Grajewo town, 25.09.1986, S. Cieśliński (KTC); **[Cb–51]** – Drezdenko town, 26.09.1975, L. Lipnicki (TRN); **[Cb–53]** – Notecka Forest, Marylec forest division, forest section no. 225, 24.07.1954, R. Tobolewska (POZ); **[Cb–65]** – Notecka Forest, forest division Dębogóra, forest section no. 273, 27.07.1954, Z. Tobolewski (POZ); **[Cf–97]** – c. 1 km W of Wólka Zamkowa village, 19.08.1991,S. Cieśliński (KTC); **[Cg–11]** – c. 1 km na NNE of Grabówka village, 30.06.1991, S. Cieśliński (KTC); **[Cg–15]** – 1 km W of Swisłoczany village, 15.08.1992, S. Cieśliński (KTC); 3 km SSE of Kruszyniany village, 15.08.1992, S. Cieśliński (KTC); **[Cg–34]** – Dolina Górnej Narwi valley, Tanica Górna, 0.5 km NW of village, 15.08.1992, leg. S. Cieśliński (KTC); **[Cg–72]** – 'Piaski' range near Jelonka Nature Reserve, 12.10.2004, S. Cieśliński (KTC); Jelonka Nature Reserve, 05.11.1978 & 1980, S. Cieśliński (KTC); Jelonka nature reserve, 15.09.1990, S. Cieśliński, K. Czyżewska, A. Lackovičová, I. Pišút, Vězda, Lich. Sel. Exs. 2475 (B–97740); Kleszczele, 04.1994, E. Lickiewicz (LBL); **[Cg–91]** – 2 km NNE of Tymianka village, 12.08.1996, S. Cieśliński (KTC); Piszczatka village, 11.05.1987, S. Cieśliński (KTC); **[Da–26]** – roadside between Bytnica village and Krosno Odrzańskie town, 52°07'27"N/15°08'05"E, on sandy soil, 08.07.2005, P. Czarnota (GPN 4651); **[Da–65]** – c. 2 km W of Lubsko town, 27.08.1976, B. Kupczyk (POZ); **[Db–38]** – Near Poznań city, Ludwikowo village, 08.11.1929, F. Krawiec (LBL); **[De–13]** – Kampinowski National Park, Korfowe village, 26.07.1961, J. Zielińska (LBL, WA); **[Df–09]** – c. 1 km NE of Wólka village by Bug river, 31.08.1991, S. Cieśliński (KTC); road from Sarnaki village to Siemiatycze town, 10.05.1987, S. Cieśliński (KTC); **[Ed–79]** – Kurzelów village, c. 7 km NE of Włoszczowa town, 07.1987, V. Rzodeczko, K. Toborowicz (KTC); **[Ee–08]** – Lesiów village near Radom city, 18.08.1978, S. Cieśliński (KTC); **[Ee–28]** – Makowiec village, 02.09.1973, S. Cieśliński (KTC); **[Ee–71]** – Świętokrzyskie Mts, Michała Góra, 1977, A. Moskwa, K. Toborowicz (KTC); **[Ee–72]** – Świętokrzyskie Mts, Wesoła village by Wierna Rzeka river, 11.06.1975, K. Toborowicz (KTC); 18.06.1975, K. Toborowicz (KTC); 29.06.1975, S. Cieśliński (KTC); Miedzianka

Mt., 06.09.1976, K. Toborowicz (KTC); **[Ee–73]** – Słowik housing estate near Kielce city, forest section no. 9, 05.07.1972, K. Toborowicz (KTC); **[Ee–76]** – Świętokrzyskie Mts, S of Bieliny village, 03.06.1976, S. Cieśliński (KTC); **[Ee–97]** –Chańcza forest division, forest section no. 90, c. 2 km ES of Raków village, 07.1986, A. Siwik (KTC); Raków village near Kielce city, 06.07.1975, S. Cieśliński (KTC); **[Ef–82]** – Świętokrzyskie Mts, Łukawa village, 27.04.1976, K. Toborowicz (KTC); **[Eg–04]** – Lasy Sobiborskie forest near Włodawa town, 22.11.2002, J. Bystrek (LBL); **[Eg–11]** – Białka village near Sosnowica village, near road to Libiszowskie lake, 1998, J. Bystrek (LBL); **[Fd–09]** – Moskorzew forest dsitrict, forest section no. 279, 20.08.1975, S. Cieśliński (KTC); **[Fd–38]** – near Wolbrom town, 09.1956, J. Nowak (KRAM-L–5341); **[Fd–66]** – Źródła village by Wisła river near Okleśna village, 07.04.1955, J. Nowak (KRAM-L–5348 & 5338); **[Fd–67]** – Zalas near Krzeszowice town, c. 370 m, 04.1970, J. Diak, J. Nowak (LBL); **[Fe–07]** – Zadoły near Korytnica villages, 1984, G. Sikora (KTC); **[Fe–13]** – Pińczów town, 07.09.1977, S. Cieśliński (KTC); **[Fe–43]** – road from Stary Młyn to Krzyszkowice, 04.09.1977, S. Cieśliński (KTC); **[Gd–15]** – Beskid Żywiecki Mts, Góra Grapa-Żar Mt. near Jeleśna village, alt. 500 m, 22.09.1964, J. Nowak (KRAM-L–16705), S. Cieśliński (KRAM-L–15013).

Specimens examined containing lobaric acid only (3 specimens studied; all on soil)**: [Cb–53] –** Notecka Forest, Marylec forest division, forest section no. 225, 24.07.1954, leg. R. Tobolewska (POZ); **[Cg–41]** – Dolina Górnej Narwi valley, 2 km NE of Deniski village, 13.08.1992, S. Cieśliński (KTC). Poorly localized record: Pomerania, road between Czekocin and Śmiechowo villages, 16.08.1930, leg. F. Krawiec (LBL).

Additional specimens examined: Estonia. Põlvamaa, Värska, on soil, 24.05.1988, J. Motiejūnaitė (BILAS–4388). **Finland**. Juva: Kiiskilänniemi, road cutting, on rocks, 02.06.1989, O. Vitikainen (H). Etalä – Savo, Luumäki: Huopainen, 5 km N of Taavetti, road banks on esker in pine forest. alt. 80 m, 29.06.1994, T. Ahti, F. J. Daniëls, H. Bültmann (H). **Germany**. NRW, Eifel, Mechernich, Kallmuther Berg, MTB 5405, Bleiabbau, on soil, no date, G. B. Feige (KRAM-L–32065). **Lithuania**. Neringa, Juodkrantė, on soil, 23.08.1988, J. Motiejūnaitė (BILAS–484). Šalčininkai distr., Rūdninkai, on soil, 07.09.1994, J. Motiejūnaitė (BILAS–1886).

Stereocaulon incrustatum Flörke

Deutsche Lichenen, Lief. **4**: 12 (1819).

Exsiccates examined: Zielińska, Pl. Varsav. Exs. 39 (B–158707, WA–3297). Magnusson, Lich. Sel. Scand. Exs. 156 (B–92554). Pišút, Lich. Slovak. Exs. 264 (WA–3294). Schaerer, Lich. Helv. Exs. Ed. I 829 (WA–3300). Tobolewski, Lichenoth. Polon. 184 (B–158809).

Short description (for more details see Lamb 1951, 1977)**:** primary thallus disappearing; pseudopodetia rare or absent, c. 1–3 cm tall, simple or sparingly branched; phyllocladia squamulose; cephalodia containing *Nostoc*, frequent, up to 0.6 mm in diam., smooth, brown to black, frequently interspersed amongst phyllocladia; apothecia 1–2 mm in diam., rather frequent, terminal on pseudopodetia or on basal phyllocladia (Fig. 3).

Chemistry of Polish specimens: Atranorin and lobaric acid (the latter often lacking). While Lamb (1977) regarded the chemotype without lobaric acid as quite rare, in Poland this chemical race is much more frequent (73 specimens). Only 8 samples contained both, atranorin and lobaric acid. Spot test reaction: K+ yellow, P± pale yellow, KC– (see Motiejūnaitė 2002).

Notes: *S. incrustatum* is uniform in morphology, but consists of two chemical strains. According to the literature (Motyka 1964, Lamb 1977, Motiejūnaitė 2002), the thallus produces both atranorin and lobaric acid, or sometimes atranorin only. In Poland, however, only 12 specimens contained those two secondary metabolites, but 70 produced atranorin only. It should also be noted that the type collection of *S. incrustatum* contains only atranorin (fide Lamb 1977). As already stated by Högnabba (2006), the species is not monophyletic and perhaps both cited chemotypes belong to two different clades, but further studies are necessary to clarify this.

Pasich (1973) reported the occurrence of soralia in several Polish specimens of *S. incrustatum*, their exceptional occurrence being due to the influence of external conditions, probably atmospheric pollution by dust. Unfortunately, the specimens cited by Pasich (1973) have not, as yet, been found in herbaria. Nevertheless, in the course of the present study no sorediate material was found.

Habitat requirements: *S. incrustatum* is a terricolous, rarely saxicolous, lichen; it occurs on sandy soil, siliceous boulders and small stones. It prefers exposed places and open habitats, such as dry pine forests and inland sand dune vegetation (MOTYKA 1964, NOWAK & TOBOLEWSKI 1975). In Poland, it is found mainly on soil (78 specimens), and very rarely on grit (1 specimen) and on limestone (2 specimens).

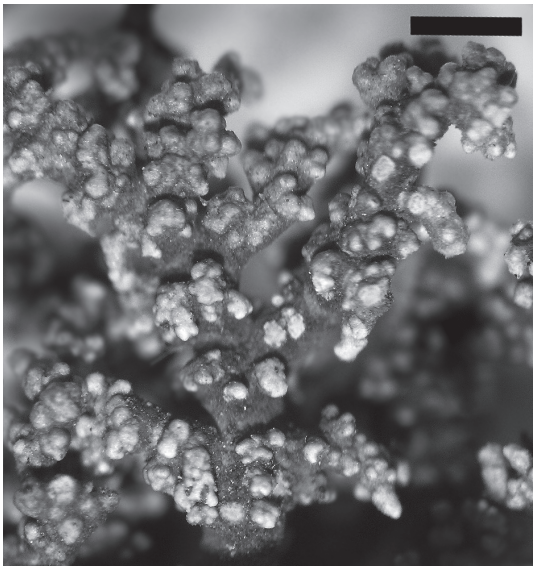

Fig. 3: Morphology of *Stereocaulon incrustatum* (scale bar 1 mm).

Distribution in Poland: *S. incrustatum* was found in Poland for the first time by FLOTOW (1849, see also FAŁTYNOWICZ 2003). In the 1960s, it was considered to be rare in the eastern part of the country (MOTYKA 1964), but more recently it was reported as generally occurring in northern and southern Poland (FAŁTYNOWICZ 2003), which is confirmed by the present study (see Fig. 4). There are several literature records from Poland (see FAŁTYNOWICZ 2003 and literature cited therein); the studied specimens have been correlated with records published by CIEŚLIŃSKI (2003).

World distribution: *S. incrustatum* is a hemiboreal to southern boreal species which has never been reported from the Southern Hemisphere (fide LAMB 1977). In Europe, it has a mainly continental distribution; LAMB (1977) confirmed its occurrence in Austria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Italy, Norway, Rumania, Slovakia, Sweden, Switzerland and Ukraine. MOTIEJŪNAITĖ (2002) also found it in Lithuania (see also additional specimens examined). Additionally it is reported here from Belarus. In Asia it is known from Japan, Korea and Mongolia, and in North America from U.S.A. (Colorado, Alaska) (see LAMB 1977).

Selected specimens examined containing atranorin (70 specimens studied; unless otherwise stated, specimens were collected from soil)**: [Be–52]** – Olsztyn city, 20.05.1963, J. Nowak (KRAM-L–8258); **[Bf–66]** – Dolina Biebrzy valley, c. 10–11 km SSE of Grajewo town, 25.09.1986, S. Cieśliński (KTC); **[Bf–68]** – Dolina Biebrzy valley, Czerwone Bagno nature reserve, 24.09.1986, S. Cieślinski (KTC); **[Bf–99]** – Jaskra village, 09.1976, J. Bagińska (LBL); **[Ce–15]** – Kampinowski National Park, Truskaw village, 05.10.1960, J. Zielińska (LBL); (B 158707); (WA–3297); **[Cg–05]** – 3 km SSE of Kruszyniany village, 15.08.1992, S. Cieśliński (KTC); **[Cg–15]** – c. 2,5 km W of Wierobie village, 29.06.1991, S. Cieśliński (KTC); **[Cg–25]** – Dolina Górnej Narwi, c. 2 km SW of Szymki village, 13.05.1987, S. Cieśliński, Z. Tobolewski (KTC); **[Cg–72]** – Road from Kleszczele town to Jelonka village, 28.07.1975, K. P. Günther (B–146063); Kleszczele town, 04.1994, H. Wójciak (LBL); Jelonka Nature Reserve, 05.11.1978, S. Cieśliński (KTC); 1979, S. Cieśliński (KTC); **[Db–08]** – Poznań city, 04.1951, K. Krotoska (POZ); **[Dd–36]** – vicinity of Puławy city, s.dat., s.coll. (WA–3296 & 3298); **[De–15]** – Kampinowski National Park, Pociecha village, 15.08.1962, J. Zielińska (WA–3293); **[Dg–10]** – Serpelice village, 1976, E. Daniluk (LBL); **[Ed–41]** – Góra św. Genowefy Mt., near Bobrowniki village, 23.06.1964, J. Nowak (KRAM-L–11957); **[Ed–52]** – Between Węże anad Zalesiaki villages, 30.05.1963, J. Nowak (KRAM-L–12324); **[Ed–79]** – Kurzelów village, c. 7 km NE of Włoszczowa town, 07.1987, V. Rzodeczko, K. Toborowicz (KTC); **[Ee–08]** – Lesiów village near Radom city, 18.08.1978, S. Cieśliński (KTC); **[Ee–72]** – Świętokrzyskie Mts, Miedzianka Mt., 24.08.1976, S. Cieśliński (KTC); near Zajączkowo village, 06.09.1976, Z. Tobolewski (POZ); Wesoła by Wierna river, 18.06.1976, K. Toborowicz (KTC); 29.06.1975, S. Cieśliński (KTC); between Kozi Grzbiet Mt. and Miedzianka Mt., 1976, K. Toborowicz (KTC); Rykoszyn village near Kielce city, 24.08.1976,

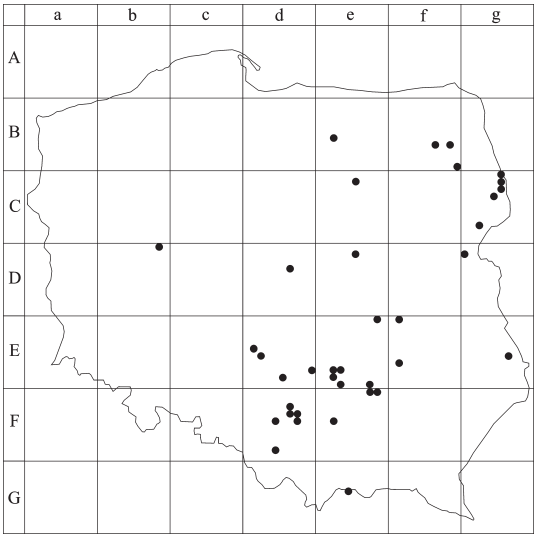

Fig. 4: Distribution of *Stereocaulon incrustatum* in Poland.

S. Cieśliński (KTC); **[Ee–82]** – Świętokrzyskie Mts, Bocheniec village, by Nida river, 1976, C. Osuchowski (KTC); **[Ee–93]** – Sobków village, 26.01.1975, K. Toborowicz (KTC); **[Ee–97]** – Świętokrzyskie Mts, Raków village near Kielce city, 11.06.1975, S. Cieśliński (KTC); 1975, K. Toborowicz (KTC); Dębno near Raków villages, 11.06.1975, s.coll. (POZ) & 14.06.1978 , S. Cieśliński (KTC); **[Ef–01]** – Bąkowiec village, c. 2,5 km of Bąkowiec station, on the way to Garbatka village, 30.06.1974, S. Cieśliński (KTC); **[Ef–61]** – Karsy village near Ożarów village, 07.1978, K. Toborowicz (KTC); **[Eg–56]** – Dolina Górnej Narwi valley, 0,5 km NW of Tanica Górna village, 15.08.1992, S. Cieśliński (KTC); **[Fd–26]** – Podzamcze village near Ogrodzieniec town, 17.04.1958 , J. Nowak (KRAM-L–5243); **[Fd–36]** – Klucze village near Olkusz town, 30.04.1955, J. Nowak (KRAM-L–5337); Pustynia Błędowska, 05.05.1984, J. Kiszka (WA–3289); **[Fd–37]** – Skalskie village near Olkusz town, 06.04.1956, J. Nowak (KRAM-L–5333); **[Fd–44]** – Jęzor settlement near Mysłowice town, 25.05.1977, F. Celiński (POZ); **[Fd–84]** – Kęty village near Ryczówki village, 11.09.1957, J. Nowak (KRAM-L– 4477); **[Fe–07]** – Zadoły village near Korytnica village, 1984, G. Sikora (KTC); **[Fe–08]** – Mostki forest division, forest section no. 140, by Kacanka river, 5 km WS of Bogoria village, 03.07.1986, M. Chyba (KTC); **[Ge–44]** – Małe Pieniny Mts, E of Wysokie Skałki Mt., alt. 1000 m, 13.09.1956, Z. Tobolewski (POZ).

Selected specimens examined containing atranorin and lobaric acid (12 specimens; all on soil)**: [Cg–34]** – Dolina Górnej Narwi, 0.5 km NW of Tanica Górna village, 15.08.1992, S. Cieśliński (KTC); **[Cg–72]** – Kleszczele town, 10.1993, E. Lickiewicz (LBL); **[Ed–41]** – Bobrowniki village near Działoszyn village, 23.06.1964, J. Nowak (KRAM-L–11979); **[Ed–85]** – Bukowno village, 05.1956, J. Nowak (KRAM-L–5336); **[Ee–73]** –Świętokrzyskie Mts, Dolina Posłowicka valley, 2 km E of Słowik housing estate, 1966, S. Cieśliński (KTC); **[Fd–36]** – Pustynia Błędowska near Olkusz town, 22.05.1974, W. Fałtynowicz (UGDA-L–807); **[Fd–47]** – Olkusz town, c. 340 m, 17.07.1917, G. Moesz (B–163179); **[Fe–42]** – Kościelec village near Chrzanów village, alt. 300 m, 01.09.1968, J. Nowak (KRAM-L–19305) & 10.08.1970, J. Nowak (KRAM-L–21556);

Additional specimens examined: Belarus. Swisłocka Forest, details of the locality lacking, on soil, 1888, F. Błoński (WA–3292 & 3299). **Estonia**. Põlvamaa, Värska, on soil, 24.05.1988, J. Motiejūnaitė (BILAS–4433). **Finland**. Ab, Nauvo, Pensar, N-hiekkaranta, rantavyöhykkeen ja mäntymetsän rajalla hiekassa yksitellen, on soil, 02.07.1940, A. V. Auer (H). **Lithuania**. Varinos raj., Puvočiai, on soil, 16.07.1998, J. Motiejūnaitė (BILAS–3705).

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