

Monographiae Botanicae **104**

Magdalena Oset

The lichen genus *Stereocaulon*  
(Schreb.) Hoffm. in Poland  
– a taxonomic and ecological study

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## Abstract

The monograph includes the results of research of the taxonomy, chemistry, ecology and distribution of *Stereocaulon alpinum*, *S. botryosum*, *S. condensatum*, *S. dactylophyllum*, *S. evolutum*, *S. incrustatum*, *S. nanodes*, *S. paschale*, *S. pileatum*, *S. saxatile*, *S. subcoralloides*, *S. spathuliferum*, *S. taeniarum*, *S. tomentosum* and *S. vesuvianum* in Poland. 1823 specimens from Polish and some European herbaria were examined. The occurrence of *S. spathuliferum* has not been confirmed during this study, therefore its status in Poland remains unknown. During the study three lectotypes were designated. The lichenicolous fungi, *Cercidospora stereocaulorum* and *Roselliniella stereocaulorum* on *Stereocaulon* were also noted. A key to known *Stereocaulon* taxa in Poland, including *S. spathuliferum* is provided.

## Keywords

lichenized Ascomycota; Stereocaulaceae; taxonomy; lichen chemistry; diversity; Poland

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## Competing interests

No competing interests have been declared.

## 1. Introduction

The name *Stereocaulon* (Schreb.) Hoffm. is known since 1791, when Schreber [1] used it to distinguish section within the genus *Lichen* L. Unfortunately, the author did not cite any species belonging to this section. In the present, accepted sense *Stereocaulon* was proposed by Hoffmann [2], who included to this genus *S. condensatum* Hoffm. and *S. paschale* (L.) Hoffm., and some species belonging nowadays to other genera: *Leprocaulon* Nyl., *Sphaerophorus* Pers., *Pertusaria* DC., *Lichina* C. Agardh and *Parmeliella* Müll. Arg. However, for the first time, the name *Stereocaulon* in a generic rank was used by Schrader [3], who included it to the name *Lichen corallinus* L. [= *Pertusaria corallina* (L.) Arnold]. Therefore, according to Lamb [4], the name *Stereocaulon* should be used for species currently belonging to the genus *Pertusaria* DC., described in 1805, and the oldest generic name for *Stereocaulon* would be *Coralloides* Hoffm. To avoid a multiplication of the new nomenclatoric combinations, the name *Stereocaulon* sensu (Schreb.) Hoffm., as *nomen conservandum* was proposed [4]. The correct name citation is *Stereocaulon* (Schreb.) Hoffm. not *Stereocaulon* (Schreb.) Schrad. Meanwhile Dodge [5] designated as a generitype *S. pachale* – one of those species described by Hoffmann [2].

In the nineteenth century a significant contribution to the understanding of the lichen genus *Stereocaulon* was brought by Th. Fries and W. Nylander. The first published monographic treatment of the genus was written by Fries [6,7], who described many new representatives. After revision of the type specimens, eight of these taxa were accepted, while others were considered as synonyms of previously described species of *Stereocaulon*. The taxonomic position of some of them still remains unclear. Nylander [8–13] also described new taxa within *Stereocaulon*, eight of them [*S. apocalypticum* Nyl., *S. corticatulum* Nyl., *S. curtatum* Nyl., *S. exutum* Nyl., *S. foliolosum* Nyl., *S. pityrizans* Nyl., *S. subcoralloides* (Nyl.) Nyl. and *S. verruciferum* Nyl.] are actually accepted.

The first work devoted to the genus taxonomy in the twentieth century was published by Riddle [14], who reported nine species from North America and presented the key for their determination. In addition, this author, focused for the first time on phyllocladia as an important diagnostic character. The names that he proposed for the structures are in use till today.

In the following years, articles on the *Stereocaulon* species from Kamchatka [15] and Scandinavia [16] were published.

The first breakthrough work focused on the taxonomy of European *Stereocaulon* was the monograph by Magnusson [17], who reported 23 species from Northern Europe, including five species new to science. Three of them are currently accepted (*S. capitellatum* H. Magn., *S. rivulorum* H. Magn. and *S. saxatile* H. Magn.). In his next work [18], the author described two further species – *S. lavicola* H. Magn. and *S. supervestiens* H. Magn. In the twenties of the twentieth century, an elaboration relating to non-European species was also established [19]. C.W. Dodge based his work mostly on notes left by R.W. Riddle in various European herbaria during his studies on the monograph of the genus *Stereocaulon*, which unfortunately was never completed.

Some researchers complained that Dodge did not present detailed descriptions, but he only listed the tropical and neotropical species [4]. Nevertheless, his publication is one of the first works on lichens of the genus *Stereocaulon* occurring outside Europe.

An important systematic-taxonomic work is the publication by Motyka [20], which includes the characteristics of the genus, the key for European species and figures of selected taxa.

However, this work is based only on literature data, mainly by Fries [6,7] and Magnusson [17], because the author did not conduct detailed studies of the genus.

The years 1951–1977 should be considered as the most important period in the taxonomic studies on *Stereocaulon*. There were created three works of English lichenologist I.M. Lamb. The first one concerned the morphology, phylogeny and taxonomy of the genus [4]. Author described here two new subgenera, *Holostelidium* I.M. Lamb and *Enteropodium* I.M. Lamb, and distinguished new sections and subsections. In addition, he proposed new combinations at the specific level. In 1977 he released the world *Stereocaulon* monograph containing many nomenclatural innovations [21]. The author recognized 123 species (of which 19 were new to science), 47 varieties (of which 14 were new to science) and 40 forms (of which 11 were new to science). Additionally, 51 lectotypes and 1 neotype have been designated in that work. Lamb included also the list of 91 invalid, excluded and rejected taxa. In all, he described 19 species regarded today as distinct species (e.g. *S. austroindicum* I.M. Lamb, *S. papuanum* I.M. Lamb, *S. weberi* I.M. Lamb) [21]. In the next year, the determination key for all *Stereocaulon* taxa has been published [22].

In subsequent years, significantly less species were described, mainly from arctic and tropical regions of the world (e.g. [23–32]).

Apart of the classical taxonomy, studies of the chemistry and diversity of secondary metabolites of the lichen genus *Stereocaulon* were also conducted. The exact chemical composition of most of the known species and variability of their chemotypes determined by Tønsgberg [33].

At the beginning of the 21 century, results of molecular studies on the family Stereocaulaceae Chevall. and genus the *Stereocaulon* were published [34–36].

Stenroos et al. [34] analysed the phylogenetic relationships of selected genera. Results of their studies supported the recognition of the four families: Cladoniaceae Zenker, Stereocaulaceae, Icmadophilaceae Triebel and Baeomycetaceae Dumort. Within the Stereocaulaceae they classified *Stereocaulon* only, while membership *Muhria* P.M. Jørg. (with *M. urceolata* P.M. Jørg.) they considered as uncertain.

The combined analysis of partial  $\beta$ -tubulin, GAPDH and SSU rDNA sequences conducted by Myllys et al. [35] confirmed the monophyly of Stereocaulaceae comprising *Lepraria* Ach., *Stereocaulon* and *Muhria*. *Murhia* is nested in *Stereocaulon* and shows some affinity to the crustose *S. cumulatum* (Sommerf.) Timdal and *S. leucophaeopsis* (Nyl.) P. James & Purvis.

The results of subsequent studies conducted by Högnabba [36], based on DNA sequences from the ITS1–5.8 S–ITS2 rDNA gene cluster and from the protein-coding  $\beta$ -tubuline gene, provided evidence for the monophyly of the lichen genus *Stereocaulon*, and for close relationship between the monotypic *Muhria* and *Stereocaulon* suggesting, that the two genera should be treated as one, monophyletic group. The analyses included 101 specimens representing 49 taxa showed 8 separated phylogenetic groups. Some of the widespread and morphologically variable species, such as *S. alpinum* Laurer, *S. incrustatum* Flörke, *S. saxatile* H. Magn., *S. vesuvianum* Pers. seems to be polyphyletic. According to Högnabba [36] small number of analysed samples and applied markers may be insufficient to conclude the taxonomy of these species. However, the results could be a starting point for further research and discussion on this topic.

Representatives of the genus *Stereocaulon* are widespread in many regions of the Northern Hemisphere (especially in Western and Northern Europe, in the Arctic and North America). The genus was comprehensively revised in few areas only. Although the studies on the taxon are intensive, there is still a necessity of further monographic study, especially in poorly

analysed regions, especially Eastern European and non-European countries. It would increase the knowledge concerning *Stereocaulon* within the entire range of its distribution.

### 1.1. Lichenological researches on *Stereocaulon*

In the border of today Poland the first works including *Stereocaulon* taxa were published in the second half of 19 century by Flotow [37], Koerber [38], Ohlert [39,40], Warnstorf [41], Stein [42] and Eitner [43–45]. In those works, nine species were reported: *S. alpinum*, *S. condensatum*, *S. dactylophyllum* Flörke, *S. incrustatum*, *S. nanodes* Tuck., *S. paschale*, *S. pileatum* Ach., *S. tomentosum* Th. Fr., *S. vesuvianum*.

Further data concerning the genus were included in publications of Motyka [46], Szatala [47] and Krawiec [48,49]. The first determination key for species reported from Poland was published by Nowak and Tobolewski [50]. The work contains also detailed descriptions of the morphology, anatomy and habitat requirements of 13 species of the genus.

Although in the twentieth century were published many works on the species *Stereocaulon* from Poland ([51] and literature cited there, and [52–57]), that there is still much places for which those data are incomplete. So far, 13 taxa has been identified in the country: *S. alpinum*, *S. botryosum* Ach., *S. condensatum*, *S. dactylophyllum*, *S. evolutum* Graewe ex Th. Fr., *S. incrustatum*, *S. nanodes*, *S. paschale*, *S. pileatum*, *S. spathuliferum* Vain., *S. taeniarum* (H. Magn.) Kivistö, *S. tomentosum*, *S. vesuvianum* [51], but nearly all of them have not been confirmed by TLC investigations (except Opanowicz and Izydorek [58] who detected chemical compounds by TLC in *S. evolutum*). Taking into account, that the specimens were determined using morphological characters only, detailed TLC data are missing, chemical analyses have been mostly confined to spot test reaction(s), the data on the distribution and status of *Stereocaulon* species in Poland are still incomplete and uncertain.

Very important seems to be the fact that 11 of 13 Polish species of *Stereocaulon* are included in the “Red list of threatened lichens in Poland” [59], 6 of them are classified as endangered (category EN). Therefore, it is reasonable to conduct research on the lichen genus *Stereocaulon*, which will allow recognizing the risks of individual species, and perhaps help to plan their protection.

### 1.2. Aims of the study

Due to the insufficient level of knowledge concerning *Stereocaulon* in Poland, the monograph of the genus, containing full details of taxonomic, ecological and geographical characteristics, taking into account the contemporary recognition of species and revision based on thin layer chromatography (TLC) is required.

The aims of the work are:

- (i) revision of the *Stereocaulon* species in Poland based on their chemistry, morphology and anatomy.
- (ii) detailed morphological, anatomical and chemical characteristics elaboration for each species.
- (iii) constructing a determination key for *Stereocaulon* taxa in Poland.



- (iv) determination of the habitat requirements of individual species in Poland and the differences or similarities with other well-studied areas.
- (v) presentation of the current distribution of individual taxa in Poland.
- (vi) studies on the lichenicolous fungi inhabiting Polish *Stereocaulon* species.

## 2. Object of the study

### 2.1. General remarks on the genus *Stereocaulon* in Europe

The genus *Stereocaulon* includes species that possess a dimorphic thallus, being both crustose, areolate or squamulose “primary thallus” and shrubby (“secondary thallus” = pseudopodetium). Thallus of the genus *Stereocaulon* representatives are quite easy to recognize in the field, but many of the characteristics of their morphology is very difficult to interpret without using a stereomicroscope (e.g. shape of phyllocladia and cephalodia). Moreover, structure of the thallus may be modified, depending on the habitat conditions, what makes the determination of the taxa very difficult. An important diagnostic feature that helps to identify species of the genus are phyllocladia. However, in many cases their structure does not allow to distinguish particular species. In such cases lichen substances analysis is essential for species determination.

The data concerning habitat requirements are also useful and allow for the differentiation of certain taxonomic groups (group of *S. vesuvianum*) or even particular species. Although chemistry of many species in the world was examined, these tests were often not sufficiently accurate (based on spot test reaction mostly). Therefore, it seems, that analysed specimens, were not well determined. This is the reason, why the chemotaxonomic data of *Stereocaulon* are still incomplete, unreliable and sometimes contradictory (e.g. [20,21]).

Lichens belonging to the discussed genus are widespread throughout the world from the Arctic and Antarctic to the tropics in both hemispheres and can exist in various habitats. Species occur mostly on rocks 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 [60].

Currently, about 150 species of *Stereocaulon* have been reported worldwide. Many of them occur in several varieties and forms, such as *S. ramulosum* (Sw.) Räsch. f. *elegans* Th. Fr., f. *nudatum* (Müll. Arg.) I.M. Lamb, f. *cumcompressum* I.M. Lamb, f. *tomentosulum* I.M. Lamb, or var. *exalbidum* (Nyl.) I.M. Lamb, var. *perpumilum* I.M. Lamb, var. *submollescens* (Nyl.) I.M. Lamb, but they usually represent habitat modifications only and are not worthy of highlighting.

Many taxa distinguished within *Stereocaulon* are tropical, not noted anywhere outside this area, e.g. *S. crambidiocephalum* I.M. Lamb, *S. microcarpum* Müll. Arg. and *S. pachycephalum* Vain. [4,21,61]. That group includes both, taxa described many years ago [62], and recently, for example, *S. globisorum* Sipman [23] and *S. klondikense* T. Sprib. [63]. Considering available literature data it can be concluded that *Stereocaulon* is much better elaborated in the Northern Hemisphere than in the Southern one.

Forty one taxa of *Stereocaulon* have been found in Europe, of which 10 were recorded only on this continent (in the list below with an asterisk – “\*”). List of *Stereocaulon* species occurring in Europe include:

- Stereocaulon alpinum* Laurer
- Stereocaulon alpestre* (Flot.) Domb.
- Stereocaulon arcticum* Lynge
- Stereocaulon arenarium* (Savicz) I.M. Lamb
- Stereocaulon atlanticum* (I.M. Lamb) I.M. Lamb
- Stereocaulon azureum* (Schaer.) Nyl.
- Stereocaulon botryosum* Ach.
- Stereocaulon capitellatum* H. Magn.
- Stereocaulon condensatum* Hoffm.
- Stereocaulon coniophyllum* I.M. Lamb
- Stereocaulon cumulatum* (Sommerf.) Timdal\*
- Stereocaulon dactylophyllum* Flörke
- Stereocaulon delisei* Bory ex Duby
- Stereocaulon depressum* (Frey) I.M. Lamb
- Stereocaulon evolutum* Graewe ex Th. Fr.
- Stereocaulon glareosum* (Savicz) H. Magn.
- Stereocaulon grande* (H. Magn.) H. Magn.
- Stereocaulon groenlandicum* (E. Dahl) I.M. Lamb
- Stereocaulon incrustatum* Flörke
- Stereocaulon leucophaeopsis* (Nyl.) P. James & Purvis\*
- Stereocaulon macaronesicum* Purvis & P. James\*
- Stereocaulon nanodes* Tuck.
- Stereocaulon paschale* (L.) Hoffm.
- Stereocaulon pileatum* Ach.
- Stereocaulon plicatile* (Leight.) Fryday & Coppins\*
- Stereocaulon ramulosum* (Sw.) Räsusch.
- Stereocaulon rivulorum* H. Magn.
- Stereocaulon saxatile* H. Magn.
- Stereocaulon simplex* D. Hawksw.\*
- Stereocaulon spathuliferum* Vain.
- Stereocaulon sphaerophoroides* Tuck.\*
- Stereocaulon subcoralloides* (Nyl.) Nyl.
- Stereocaulon subdenudatum* Hav.\*
- Stereocaulon symphycheilum* I.M. Lamb
- Stereocaulon taeniarum* (H. Magn.) Kivistö
- Stereocaulon tomentosum* Th. Fr.
- Stereocaulon tornense* (H. Magn.) P. James & Purvis\*
- Stereocaulon uliginosum* I.M. Lamb\*
- Stereocaulon vanoyei* Duv.\*
- Stereocaulon vesuvianum* Pers.
- Stereocaulon vulcani* (Bory) Ach.

The above-mentioned list includes both, species widely distributed in the world, found on all continents and in different habitats, and species with bipolar distribution. Thirty one of these species are widely distributed outside the Europe. This group includes, among others, *S. alpinum*, *S. arcticum*, *S. condensatum*, *S. incrustatum* and *S. vesuvianum*. It should be noted that many taxa reported from various countries is known from single localities [20,21]. It is caused by low level of knowledge concerning lichen diversity of some areas, e.g. Africa or South America, and the difficulty in determining of many taxa.

## 2.2. Morphological features

These include: primary thallus, pseudopodetia, phyllocladia, cephalodia, apothecia, pycnidia and soredia.

**Primary thallus and pseudopodetia.** Members of the lichen genus *Stereocaulon* remind in habit some species of the genus *Cladonia* P. Browne. Like *Cladonia* species, they are characterized by the presence of the primary thallus and secondary thallus called podetium. However, podetia of *Cladonia* species, are not homologous with podetia occurring in *Stereocaulon*. In the first case podetia grow out vertically from the horizontal squamules, and in *Stereocaulon* they are produced through the upward growth of the basal granular squamules. Due to the differences in the development of the secondary thallus, Vainio [64] recommended to call them pseudopodetia, although quite commonly the abbreviated name podetia is used [4,17,20]. In this publication, the nomenclature proposed by Vainio [64] is adopted.

Primary thallus of *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 [60].

Pseudopodetia of *Stereocaulon* species can be stiff, corticate or non-corticate shrubby, erect and usually branched, firmly affixed to the rhizinae in many species, e.g. in *S. dactylophyllum*, *S. nanodes*, *S. saxatile* or directly to the soil in *S. condensatum*, *S. incrustatum* and *S. tomentosum*. Loosely attached to the substratum is thallus of e.g. *S. evolutum*. In *S. paschale* and *S. leprocephalum* Vain., primary thallus disappears, and pseudopodetia necrose at the base [4,17,60].

The height of pseudopodetia is variable and varies considerably within the species. In many taxa both high and low forms were observed. In some cases, pseudopodetia are either not developed or are rudimentary (see *S. condensatum*), or are shortened and adhered to the substrate e.g. in *S. evolutum* [21]. A useful diagnostic feature is a branch of pseudopodetia. In some species also this feature is variable, especially in *S. vesuvianum* and *S. botryosum*, since pseudopodetia of some forms are simple, and some others sparsely branched [17,21].

Pseudopodetia of *Stereocaulon* species are white, greyish-black (*S. wrightii* Tuck.), ochraceous or darkening at the base (*S. subcoralloides*), essentially solid, without central cavity and usually roundish, rarely broadly or narrowly ellipsoid in the section [4,20,60].

Presence or absence of the tomentose pseudopodetia is also an important taxonomical feature. In many species this character is constant, while in others it varies with the stages of development; sometimes tomentum is present on the upper parts of the thallus, and often disappears towards the base of pseudopodetium [17].

**Phyllocladia.** Phyllocladia of *Stereocaulon* are characteristic. By some authors were called *ramuli phyllocladoidei* [17]. Though each species has a typical form of its own phyllocladia, they may vary in shape, sometimes in one specimen e.g. foliaceous to squamuliform, digitate to coralloid phyllocladia can be observed. Most likely, such large morphological plasticity aims to increase of photosynthesis efficiency [4]. The size of phyllocladia in some species is also not a conservative feature, e.g. in *S. grande* [4].

Phyllocladia are characterized by greyish-white, sometimes pinkish or bluish colour. As with other lichenized fungi, also in *Stereocaulon* colour changes depending on the geographic region. In Western and partly in Central Europe phyllocladia (and the whole thallus) are grey, while on the north and at higher altitudes, the structures are paler, whitish, bluish or yellowish, what is mainly correlated with more intensive insolation [20].

The first classification of phyllocladia (based on morphology) was proposed by Riddle [14], who distinguished three types of the structures: palmate-digita, coralloid and umbilicate to granular. The next types distinguished Magnusson [17], increasing their number to eight. Then, Motyka [20] presented his comparison and classification, which is based on the previous work and gave seven types of phyllocladia, which names were used in this study (Tab. 1). Between different types of phyllocladia, there are also intermediate forms, e.g. flattened, coralloid phyllocladia in *S. evolutum*. In some species different types of phyllocladia can be observed in the same specimen, e.g. in *S. anomalum* I.M. Lamb [21].

**Tab. 1** Classification of *Stereocaulon*'s phyllocladia based on morphology according to Motyka [20].

Type of phyllocladia	Characteristic	Examples of species
Verrucose	quite regular, the middle of the slightly flattened, narrower at the ends, sometimes crimped or creased	<i>S. alpinum</i> , <i>S. alpestre</i> , <i>S. condensatum</i> , <i>S. glareosum</i> , <i>S. incrustatum</i>
Coralloid	elongated, cylindrical, similar to small branch	<i>S. dactylophyllum</i> , <i>S. ramulosum</i> , <i>S. subcoralloides</i>
Fan-shaped, flattened	flattened, wide as the surface of the leaf	<i>S. nanodes</i> , <i>S. leprocaulooides</i> , <i>S. tomentosum</i> , <i>S. wrightii</i>
Squamulose	flattened and irregular, often notched at the edges, form of blades	<i>S. delisei</i> , <i>S. dactylophyllum</i> var. <i>occidentale</i> , <i>S. d.</i> var. <i>flabellatum</i>
Dactyliform	indented deeper than scaly, peak episodes directed in different directions,	<i>S. grande</i> , <i>S. paschale</i> , <i>S. pomiferum</i> , <i>S. taeniarum</i>
Peltate (shield-like)	flattened, or even concave with dark olive-coloured center and paler margin	<i>S. arcticum</i> , <i>S. symphycheilum</i> , <i>S. vesuvianum</i>
Granular	small, irregular shape, often with soredia	<i>S. botryosum</i> , <i>S. spissum</i> , <i>S. weberi</i>

The distribution of phyllocladia on pseudopodetium is a characteristic feature, which can be partially modified by habitat conditions. Phyllocladia as the structures in which the photobiont is located, generally develop on those parts of the thallus, which are exposed to the sunlight. Therefore on the vertical pseudopodetia, forming loose cushions, the phyllocladia are arranged around the perimeter or in the upper parts of the pseudopodetium. Pseudopodetia lying on the substrate or growing laterally have their phyllocladia on the dorsal side only [17,20].

**Cephalodia.** Apart from the symbiosis with green algae, many species of lichenized Ascomycota enter into a symbiotic relationship with cyanobacteria, which are usually concentrated in special structures called cephalodia [20]. These are characteristic for most of *Stereocaulon* species, except *S. azureum*, *S. scutelligerum* Th. Fr. and *S. virgatum*. In *S. nanodes* and *S. pileatum* cephalodia appear on primary thallus and pseudopodetia, while in other species they can be observed on the pseudopodetia only. These structures differ in size, colour and shape depending on taxon, and they constitute an important taxonomic criterion in determining the boundaries between species and groups of species [4,21].

The most often, in cephalodia occur cyanobacteria of the genera *Nostoc* Vaucher ex Bornet & Flahault and *Stigonema* C. Agardh ex Bornet & Flahault [4,20,21]. Cephalodia containing *Nostoc* are usually small, whitish or grey-green with a surface covered with tomentum (e.g. in *S. alpinum*). Those that contain *Stigonema* are usually larger, with the granular surface, dark brown, brownish-violet, olive green or blackish in colour (e.g. in *S. paschale*) [4,20,21].

In the first half of the nineteenth century, nomenclature and taxonomic significance of cephalodia in *Stereocaulon* were unclear. Until Fries [6,7] distinguished two principal types: the brown-blackish, pulvinate cephalodia (e.g. in *S. paschale* and *S. vesuvianum*) and the podicellate, subglobose, foveolate-scribitulate cephalodia, more or less concolorous with the thallus (e.g. in *S. ramulosum*). Then Nylander [10] paid his attention to the taxonomic significance of the morphology of cephalodia. Besides, it was a time, when the first mentions concerning cyanobacteria present in cephalodia were published.

The next classification of cephalodia was based on their size and it was proposed by Johnson [65]. As a result of comparative and statistical studies, he explained that the gross morphology of the cephalodium is a good taxonomic character and that the cephalodia are organic and normal structures of the lichen, and has no pathological origin. Based on that research he distinguished three types of cephalodia:

- (i) sphaerical – sessile or nearly so, often inconspicuous, hemispherical or subspherical, small, seldom over 1 mm in diameter, the larger ones appearing in aggregates, grey to brown (e.g. *S. paschale*, *S. tomentosum*);
- (ii) botryose – stalked at maturity, similar in shape to branches of grapes, concolorous with the pseudopodetium, cinereous, usually rather large, 2–4 mm in diameter (e.g. *S. exutum*, *S. japonicum* Th. Fr.);
- (iii) scribitulate – usually stalked at maturity, spherical, or more or less clavate, wrinkled, concolorous with the pseudopodetium, whitish to ashy, often large, 1–7 mm in diameter (e.g. *S. ramulosum*).

According to Lamb [4,21,66], basing on the morphological features, cephalodia can be divided into four groups:

- (i) simple, primitive cephalodia without distinct botryose division, associated on verrucose, squamulose, squamulose-digitate or palmate true phyllocladia;
- (ii) botryose, associated with true phyllocladia on pseudopodetia of medullary origin or phyllocladioid branchlets on pseudopodetia derived by the elongation of all tissues of the primary thallus;
- (iii) sacculate constantly associated with phyllocladioid branchlets born on pseudopodetia derived by the elongation of all tissues of the primary thallus; anatomically loose-cored construction;
- (iv) protosacculate, anatomically solid-cored construction.

**Apothecia and pycnidia.** Most species of the genus *Stereocaulon* produce apothecia of lecideine type. Their shape, size, colour, internal structure and the number of spores are helpful in the classification of some species. However, in many species, they have limited taxonomic value because they form very rarely [4].

The apothecia of *Stereocaulon* may be either lateral on the pseudopodetia or pseudopodetial branches or terminal on their ends. They are a very diverse in size in different species, being commonly smaller when lateral and larger when terminal. Very small apothecia are usually characteristic of the *S. vesuvianum* group and *S. tomentosum*. The largest apothecia among *Stereocaulon* species were observed in *S. intermedium* and *S. ramulosum* [4].

It was considered for a long time, that in *Stereocaulon* apothecia of both lecideine and lecanorine type occur, and from this reason a division into two subgenera, *Lecideocaulon* Vain. and *Lecanocaulon* (Nyl.) Vain. [67,68] was proposed. However, it was later discovered, that the division was based on faulty observations. Further study showed, that in *Stereocaulon* apothecia of the lecideine, biatorine or sublecidine type occur, while occasionally observed photobiont cells are of secondary origin [4].

Apothecia in *Stereocaulon* are usually pale- to dark brown, with clearly brighter margin when young, and excluded in older specimens. Hypothecium is usually colourless, occasionally brown or yellow. Asci are 8-spored, clavate or cylindrical, *Porpidia*-like. Ascospores are usually colourless, 1- to 13-septate, smooth, thin-walled, ellipsoid [4,20,60].

**Pycnidia.** Pycnidia were observed in more than 40 species of the genus *Stereocaulon* [4]. They usually occur at or near the apices of the pseudopodetia, often directly below the apothecia. They are globose with a dark brown, rarely pale, more or less paraplectenchymatic wall and small ostium [4,20].

The pycnoconidia distinctly vary in shape and size, from shortly baciliform ( $4 \times 0.7\text{--}1.0 \mu\text{m}$ ) to filiform and more or less arcuate ( $8\text{--}12 \times 0.5 \mu\text{m}$ ) [4,20].

**Soredia.** Apart from spores, soredia are the only other type of diaspore found in *Stereocaulon*. They were observed in about 30 species, of which in Poland in *S. nanodes*, *S. pileatum*, *S. paschale*, *S. saxatile* f. *sorediatum* (H. Magn.) I.M. Lamb and *S. vesuvianum*. According to Lamb [4], the presence of soredia in *Stereocaulon* is not a good taxonomic feature on the species level, because in many taxa (e.g. *S. paschale*) they appear accidentally. However, in some taxa, soredia are always present and are treated as a diagnostic feature (e.g. in *S. leprocephalum*, *S. spathuliferum*) [4,20].

Many species produce soredia on flattened, leaflike or spathulate expansions (e.g. in *S. spathuliferum*). In some cases, the structures are the upright squamules of the primary thallus (e.g. in *S. nanodes*). Apical soredia in *Stereocaulon* usually occur on the ends of the pseudopodetia (e.g. *S. pileatum*), but occasionally are found on the ends of phyllocladioid branchlets (e.g. in *S. sorediiferum* Hue and *S. strictum* Th. Fr.). In that case they are very small [4,20,22].

The soredia are usually farinose, consisting of very small diaspore particles, but may be granulose, formed of comparatively coarse grain.

### 2.3. Chemistry

The chemical compounds present in *Stereocaulon* thalli are various and can be divided into five chemosyndromes: depsides, depsidones, dibenzofuranes, terpenoids and aliphatic acids (Tab. 2). Apart of usnic acid known in *S. melanopotamicum* I.M. Lamb and terpenoids occurring in *S. brassii* I.M. Lamb, all other chemosyndromes are present in *Stereocaulon* taxa found in Poland.

**Tab. 2** Discriminating characters of four morphologically similar species of *Stereocaulon* containing lobaric acid and atranorin according to Lamb [21] and Kivistö [30].

Character	<i>S. alpinum</i>	<i>S. paschale</i>	<i>S. taeniarum</i>	<i>S. saxatile</i>
Pseudopodetia	ca. 1–3 cm tall	(2–)3–5(–6) cm tall	3–6 cm tall	1–2 cm tall
Tomentum	distinctly pink	white to pinkish	white to pinkish	grey
Ccephalodia	hemispherical, bluish, tomentose	botryose, bluish-black	absent	rare, inconspicuous

Because of the small number of data on the chromatographic properties of lichen substances in Polish lichenological literature, characteristics of the metabolites, which were found in Polish species of the genus *Stereocaulon*, are presented below. For each of them, features necessary for their identification are listed. For most of the secondary metabolites, at least one lichen species from which the pattern substance can be easily obtained are also given.

**DEPSIDES. Atranorin.** Spots test reactions: K+ yellow, PD+ yellow. TLC: classes Rf A7, C7; pUV 254 (short wave UV): visible; sUV 366 (long wave UV) and daylight: shades of orange, the severity of the colour depends on the concentration; control species: *Cladonia symphylicarpa* (Ach.) Fr. [69]; present in all *Stereocaulon* species.

**DEPSIDONES. Stictic acid.** Spots test reactions: K+ yellow, PD+ orange. TLC: classes Rf A3, C3 (2–3); pUV 254 (short wave UV): visible; H; sUV 366 (long wave UV): orange; daylight: orange; control species: *Lepraria finkii* (B. de Lesd.) R.C. Harris (syn. *L. lobificans* auct.) [70]; present, among others, in *Stereocaulon dactylophyllum*, *S. glabrum* (Müll. Arg.) Vain., *S. pityrizans*, *S. subdenudatum*, *S. tomentosum*, *S. vesuvianum*. **Norstictic acid.** Spots test reactions: K+ red, PD+ orange. TLC: classes Rf A4, C3; pUV 254 (short wave UV): visible; H; sUV 366 (long wave UV): orange; daylight: orange; control species: *Cladonia symphylicarpa* [69]; present, among others, in *Stereocaulon antarcticum* Vain., *S. dactylophyllum*, *S. glabrum*, *S. myriocarpum* Th. Fr., *S. tomentosum*, *S. vesuvianum*. Stictic acid and norstictic acid are in the thallus of *Stereocaulon* substances of the highest concentration. Apart from them, together with stictic acid in the lower concentration constictic acid and cryptostictic acid may be present, and with norstictic acid also connorstictic acid (see [21]). **Lobaric acid.** Spots test reactions: K–, PD–. TLC: classes Rf A3, C4; pUV 254 (short wave UV): visible; H; sUV 366 (long wave UV): invisible; daylight: pale grey; control species: *Parmelia saxatilis* (L.) Ach. and *Protoparmelia badia* (Hoffm.) Hafellner [70]; present, among others, in *Stereocaulon condensatum*, *S. evolutum*, *S. paschale* and *S. saxatile*.

DIBENZOFURANES. **Porphyritic acid.** Spots test reactions: K–, C+ green, PD–. TLC: classes Rf A2, C1; pUV 254 (short wave UV): visible; sUV 366 (long wave UV): invisible; daylight: invisible; control species: *Haematomma ochroleucum* (Neck.) J.R. Laundon [70,71]; present, among others, in *S. arenarium*, *S. botryosum*, *S. strictum* and *S. togashii* I.M. Lamb.

FATTY ACIDS. Currently three fatty acids are present in *Stereocaulon* species [21]. **Bourgeanic acid.** Spots test reactions: K–, PD–. TLC: classes Rf A6, C5; pUV 254 (short wave UV): invisible; sUV 366 (long wave UV): invisible; daylight: invisible; control species: *Ramalina bourgeana* Mont. ex Nyl. [72] and *Cladonia innominata* Lendemer [syn. *C. conista* (Ach.) Robbins ex A.F. Allen] [73]; present, among others, in *S. alpinum* var. *erectum* Frey [54].

#### 2.4. Taxonomic position of the genus *Stereocaulon* and its intergeneric considerations

The genus *Stereocaulon* belongs to the class Lecanoromycetes O.E. Erikss. & Winka, subclass Lecanoromycetidae P.M. Kirk, P.F. Cannon, J.C. David & Stalpers ex Miadl., Lutzoni & Lumbsch, order Lecanorales Nannf. and family Stereocaulaceae Chevall. [74]. The first work on this family (Stereocaulaceae), was published by Chevallier (1826–1927) [75].

Apart of *Stereocaulon*, other genera *Herteliidea* Printzen & Kantvilas, *Lepraria* Ach., *Squamarina* Poelt and *Xyleborus* R.C. Harris & Ladd are classified within the family [74,76].

*Herteliidea* includes five species occurring mainly in Australia, and inhabiting mostly burned or decaying wood, soil or bryophytes. This genus is characterized by crustose thallus, sometimes with soredia, apothecia lecideine, often growing in clusters, asci *Micarea*-type and no septate ascospores [77].

*Lepraria* includes crustose lichens with leprose, ecorticate thallus, never producing apothecia. Recently, species with shrubby thallus, previously classified in the genus *Leprocaulon* were incorporated to the genus. Currently, over 70 species are classified within *Lepraria* [78–81].

*Squamarina* is characterized by squamulose, often pruinose thallus with lobed margins. Apothecia are concave or flat, with yellow-brown to red-brown disc. Asci are 8-spored, *Bacidia*-type. To those genus belong 20 species growing in dry regions of the northern hemisphere, occur mostly on soil and rocks [82].

*Xyleborus* is a monotypic genus represented by *Xyleborus sporodochifer* R.C. Harris & Ladd. described in 2007 from Ozarkas in USA. It is crustose lichen occurring mainly on rotten wood, characterized by *Micarea*-type asci [76].

Until recently, to Stereocaulaceae three other genera, i.e. *Argopsis* Th. Fr., *Compsocladium* I.M. Lamb and *Pilophorus* Th. Fr. were included (cf. [21] and references therein). However, on the basis of recent studies, the taxa were transferred to other taxonomic units [74].

#### 2.5. Infrageneric divisions

The lichen genus *Stereocaulon* is morphologically variable, therefore, many researchers have tried to establish some infrageneric taxa. Koerber [38] divided genus into two sections, *Cereolus* Körb., with persistent primary thallus (here he included *S. condensatum* and *S. pileatum*) and *Eustereocaulon* Körb., including the remaining species. Fries [6] divided section *Eustereocaulon* into two groups: *Saxifraga* Th. Fr. and *Terrestria* Th. Fr., basing on the type of implantation



pseudopodetia to the substrate (respectively, loose or firmly attached to the substrate). In addition, he proposed section *Chondrocaulon*, which included one species *S. quisquillare* (Leers) Hoffm. [= *Leprocaulon microscopicum* (Vill.) Gams ex D. Hawksw.].

Nylander [10] suggested that *S. colensoi* C. Bab. should be placed in a new genus *Corynophoron* Nyl. The same author has later classified two species: *S. quisquillare* and *S. arbuscula* Nyl. in a separate genus *Leprocaulon* Nyl. [4].

Another change in the systematics of the genus proposed Vainio [64], who divided genus into two subgenera: *Lecidocaulon* Vain., which included species having lecideine apothecia and *Lecanocaulon* (Nyl.) Vain., with species having lecanorine apothecia. However, this division was completely erroneous, because data concerning presence of the photobiont cells in apothecia of *Lecanocaulon* were not confirmed.

In another work Vainio [83] divided the genus into sections *Pheobasis* Vain. characterized by brown hypothecium, *Diplocheilon* Vain. with a pseudothalline or supposedly thalline margin on the outside of the excipulum and *Myleocarpon* Vain. characterized by a lax central cone having interstices between the hyphae.

In the twenties of 20th century Du Rietz [16] proposed a classification of the genus *Stereocaulon* based on a shape of phyllocladia and distinguished two subsections – *Macrocarpa* Du Rietz (terminal, big apothecia) and *Microcarpa* Du Rietz (lateral, small apothecia). Within *Macrocarpa* he divided two series, *Cylindrophylla* Du Rietz (cylindrical-coralloid phyllocladia) and *Squamophylla* Du Rietz (squamulose or verrucose phyllocladia).

In subsequent years, the proposals of *Stereocaulon* classification were also presented by Dodge [19], Clements and Shear [84], Satô [85] and Räsänen [86], but their systems were not accepted.

Currently acceptable division of the genus into subgenera was published by Lamb [4]. His classification was based on the phylogenetic concept, on morphological and anatomical features, and on ontogeny. The final concept was published in 1977 [21].

SUBGENERIC CLASSIFICATION OF *STEREOCAULON* (according to Lamb [21]):

**Subgenus I. *Stereocaulon*** – pseudopodetia produced by the basal medullary stratum only of the primary thallus; true phyllocladia present, similar to those forming the primary thallus. Type: *S. paschale* (L.) Hoffm.

Within the subgenus *Stereocaulon* the following sections are distinguished:

**Section 1. *Stereocaulon*** – primary thallus persistent or evanescent, composed of squamules or verrucose similar to the phyllocladia of the pseudopodetia; phyllocladia without darker centers; cephalodia simple to botryose, with poorly developed cortical layer. Type: *S. paschale*; other species: *S. alpinum*, *S. botryosum*, *S. condensatum*, *S. dactylophyllum*, *S. evolutum*, *S. grande*, *S. incrustatum*, *S. pileatum*, *S. saxatile*, *S. subcoralloides*, *S. tomentosum* et al.

**Section 2. *Stereocladium*** (Nyl.) C.W. Dodge – primary thallus persistent, of erect, flabellate-spathulate squamules; phyllocladia of pseudopodetia granulose to verrucose, without darker centers; cephalodia simple, scabrid-tuberculate, with poorly developed cortical layer. Type and the only species belonging to this section: *S. nanodes*.

**Section 3. *Denudata*** Jatta – primary thallus persistent or evanescent, of squamules similar to the phyllocladia of the pseudopodetia; phyllocladia squamulose, peltate, verrucose, dactylaeform to cylindric-coralloid, flabellate or flattened-foliose, usually with darker centers and paler margins; cephalodia simple to botryose, with poorly developed

cortical layer (in some species absent). Type: *S. vesuvianum*. In addition, within the subsection *Denudata* individuals of lower rank are distinguished:

**Subsection A. *Denudata*** – phyllocladia lateral, sessile, verrucose to peltate, coralloid, or foliose; apothecia lateral and small. Type: *S. vesuvianum*; other species: *S. arcticum*, *S. arenarium*, *S. symphycheilum*, *S. vanoyei*.

**Subsection B. *Phyllocaulon*** (Tuck.) I.M. Lamb – phyllocladia apical, flattened, spathulate; apothecia lateral. Typ: *S. wrightii*, other species: *S. apocalypticum*.

**Subsection C. *Botryoideum*** (G.T. Johns. emend. I.M. Lamb) I.M. Lamb – phyllocladia lateral, usually cylindric-coralloid and without darker spots or centers, rarely verrucose with darker spots or centers, never flattened-foliose; apothecia terminal. Type: *S. exutum*; other species: *S. etigoense* (Asah.) I.M. Lamb, *S. pendulum* Asah., *S. saviczii* Du Rietz.

**Section 4. *Lobophoron*** (P.A. Duvign.) I.M. Lamb – phyllocladia lateral, verrucose, coralloid, or foliose, or completely dissolved into soredia; cephalodia protosacculate (solid-cored, with well developed gelatinized cortical layer). Type: *S. foliolosum*; other species: *S. coniophyllum* I.M. Lamb, *S. himalayens* Asahina & I.M. Lamb, *S. humbertii* P.A. Duvign.

**Subgenus II. *Pilophoropsis*** (I.M. Lamb) I.M. Lamb – both phyllocladial branchlets (harmonic) and true phyllocladia (disharmonic) present, the latter derived from the pseudopodetial thallus-mantle, verrucose to digitate-coralloid; cephalodia botryose. Type and the only species belonging to this subgenus: *S. curtatum*.

**Subgenus III. *Holostelidium*** I.M. Lamb – pseudopodetia produced by all layers of the primary thallus; phyllocladial branchlets usually present; no true phyllocladia; cephalodia sacculate or protosacculate. Type: *S. sorrediferum* Hue.

Within the subgenus *Holostelidium* the following sections are distinguished:

**Section 1. *Holostelidium*** I.M.Lamb – pseudopodetia usually well branched and with numerous and well developed phyllocladioid branchlets; cephalodia sacculate or protosacculate. Type: *S. sorediiferum*. In addition, within the subsection *Holostelidium* distinguished lower taxonomic units, i.e.:

**Subsection A. *Holostelidium*** I.M.Lamb – Spores vermiform, (6–)8–30-septate; apothecia hypophysate in the young condition; cephalodia sacculate or protosacculate, smoothly globose to commonly indented-scrobiculate, with uniform cortex; hypothecium colorless. Type: *S. sorediiferum*; other species: *S. claviceps* Th. Fr., *S. macrocephalum* Müll. Arg., *S. massartianum* Hue, *S. pomiferum* P.A. Duvign.

**Subsection B. *Aciculisporae*** Du Rietz – spores fusiform-cylindric, 3–7-septate (rarely up to 16-septate); apothecia not hypophysate; cephalodia sacculate or protosacculate, smoothly globose to commonly indented scrobiculate or rarely cristate, with uniform or dimorphous cortex. Type: *S. ramulosum*; other species: *S. atlanticum*, *S. corticatulum*, *S. meyeri* Stein., *S. pachycephalum*.

**Subsection C. *Dactyloideum*** (I.M. Lamb) I.M. Lamb – spores vermiform, (7–)8–13-septate; apothecia not hypophysate; cephalodia protosacculate, finally digitately divided (dactylae form), with uniform cortex; hypothecium pigmented (dark brown). Type and only known species: *S. strictum* Th. Fr.

**Section 2. *Redingeria*** I.M. Lamb – pseudopodetia simple or sparingly branched; no phyllocladioid branchlets developed; cephalodia sacculate. Type: *S. caespitosulum* Red.; other species: *S. gregarium* Red., *S. loricatum* Red.

Dombrowskaya [87] did not fully agree with the classification of Lamb. However, her work relates only to one geographical area (former Soviet Union) and covers only half of the species included in the Lamb's work [21]. Despite the fact, that the system proposed by Dombrowskaya can not be omitted, currently classification of Lamb [21] is accepted.

In recent time, some changes in the above-described classification resulted from the inclusion of the five *Stereocaulon* species, which are characterized by a lack of secondary thallus. These are: *S. cumulatum*, *S. leucopheopsis*, *S. plicatile*, *S. nivale* and *S. tornense*. The inclusion of these taxa to the genus was based on anatomical features as well as morphological and chemical characteristics. These include: ascus *Porpidia*-type, nonamyloid hymenium, simple or sparsely branched paraphyses, colorless ascospores, the occurrence of cyanobacteria in their thallus and the presence of atranorin, lobaric acid and stictic acid [32,88–90]. As the result of the emergence of new species, Dombrowskaya [91] described a new subsection *Protodenudata* within section *Denudata*, which includes crustose species found in the former Soviet Union (*S. leucopheopsis* and *S. tornense*). However, phylogenetic research conducted by Höggna [36], demonstrated that molecular data do not indicate a relationship between these taxa and species belonging to section *Denudata*.

### 3. Material and methods

#### 3.1. Material

The study is based on examination of 1823 specimens deposited in the following herbaria GPN, KRA, KRAM, KRAP, KTC, LBL, LOD, POZ, SLTC, TRN, UGDA, WA, WRSL and at the University of Białystok (no herbarium acronym; abbreviations after Thiers [92]), and private collections provided by: Dr. Maria Kossowska (University of Wrocław) and Dr. Katarzyna Szczepańska (University of Natural Sciences, Wrocław), Dr. Magdalena Opanowicz (Great Britain), Dr. Michał Węgrzyn (Jagiellonian University, Kraków) and Monika Dimos-Zych, MSc (University of Wrocław).

For comparative purposes foreign collections of *Stereocaulon* specimens, from some major European herbaria: B, BILAS, BM, BP, H, LPB, UPS and private herbarium M.R.D. Seaward were also tested. Type specimens from the collections of Eric Acharius (H-ACH, BM-ACH), Theodor Fries (UPS), A.H. Magnusson (UPS) and William Nylander (H-NYL), B, BM, BP, H, UPS, WRSL isotypes, lectotypes, topotypes and other specimens of arctic, boreal and tropical species deposited in there were also examined. Moreover, data concerning the studied exsiccatae stored in the above-mentioned herbaria are included to the results; abbreviations of the exsiccatae were adopted from Index of Exsiccatae [93].

#### 3.2. Methods

**The study of morphology and anatomy.** Morphological and chemical characters were studied on the basis of herbarium specimens. The analysis and measurements of morphological

structures of all examined specimens were studied with a stereomicroscope (Nikon SMZ645). The following characters were examined only, and the shape and size of primary thallus; shape of phyllocladia; presence of tomentum and soredia; presence and type of phyllocladia; shape and colour of apothecia.

The classification of phyllocladia proposed by Motyka [20] was adopted, and the type of cephalodia followed the classification of Johnson [65] and Lamb [4,21].

The determination the actual cyanobacteria present in cephalodia, microscopic preparations in water were observed under a light microscope (Zeiss Axioskope 2). Cyanobacteria were determined to the genus level, which is of sufficient level of accuracy to enable the identification of certain *Stereocaulon* species. No detailed measurements of anatomical characteristics of all specimens were undertaken since size is of limited taxonomic value [21].

**The analysis of chemistry.** Chemical characters of all studied specimens were analyzed with thin layer chromatography (TLC; solvents A and C) according to the methods proposed by White and James [94] and by Orange et al. [70].

In order to identify pattern substances of *Stereocaulon*, specimens checked by experts (I.M. Lamb, T. Ahti, L. Kivistö) were used. Also the properties of individual metabolites given by Huneck and Yoshimura [95] were accepted and the chemicals program Wintabolites was employed in the analyses [72]. Comparative specimens from the foreign collection, which were already subjected to TLC, and identification of their metabolites was significantly presumable, were not analysed again.

Before the chromatography was performed, specimens of morphologically similar species were stained with spot-test reaction, i.e. 10–20% potassium hydroxide solution (K), 10% alcoholic solution of paraphenylenediamine (PD) and examined under a lamp UV; methods according to Orange et al. [70].

**Determination of habitat requirements and distribution in Poland.** In order to determine habitat requirements, the information recorded by the collector on the labels and the literature data were used. In addition, for each revised specimen from Poland the type of substrate was noted (e.g. soil, rock, granite, limestone, gravel, stones).

The labels of specimens originating from Poland and written in Polish were translated into English. In all other cases the labels are cited in original language present on the labels. All localities of the examined material of *Stereocaulon* spp. are mapped according to the ATPOL grid square system according to Zajac [96], modified by Cieśliński and Fałtynowicz [97]. Geographical coordinates were cited only if they were provided on the labels. The names of geographic mesoregiones proposed by Kondracki [98] were accepted.

The information concerning global distribution of examined taxa has been mainly based on specimens examined by the author. In addition, data of Lamb [4,21,22] and Kivistö [30] were also used. Other publications containing quotations of the *Stereocaulon* were used only when there was no data on the occurrence of species of this genus in the above-mentioned elaborations. Endangered species has been given according to Cieśliński et al. [59].

**Lichenicolous fungi occur on *Stereocaulon* thalli in Poland.** To identify lichenicolous fungi inhabiting *Stereocaulon* species, microscopic preparations were made in water or 20% potassium hydroxide (KOH).

**Nomenclature.** Nomenclature of *Stereocaulon* species names presented by Lamb [21] and Kivistö [30] was adopted. The nomenclature of species occurring outside Polish territory and

taxa with other genera were taken from the following works: Lamb [21], Purvis and James [88], Sipman [23], Weber [25], Dombrowskaya [26–28,87], Purvis et al. [99], Timdal [32], Gilbert et al. [60], Spribille et al. [63]. Names of lichenicolous fungi follow Zhurbenko et al. [100] and Zhurbenko [101]. The authors' names abbreviations are derived from elaboration of Brummit and Powell [102].

## 4. Results and discussion

### 4.1. General remarks

Fifteen species of the genus *Stereocaulon* occur in Poland. As a result of presented studies two species, *S. saxatile* H. Magn. and *S. subcoralloides* Nyl., one variety, *S. alpinum* var. *erectum* Frey and one form, *S. saxatile* f. *sorediatum* (H. Magn.) I.M. Lamb are given as new to Poland. The discoveries were published yet by Oset [54,55]. The presence of one earlier reported species from the country, *S. spathuliferum* Vain., is considered as questionable [51]. Moreover, two lichenicolous fungi on *Stereocaulon* taxa (*S. alpinum* and *S. condensatum*) in Poland, *Cercidospora stereocaulorum* (Arnold) Haffelner and *Roselliniella stereocaulorum* Zhurb., Kukwa & Oset, were noted during this study.

The study showed that some *Stereocaulon* taxa at the species level are chemically constant and do not show any qualitative differences in lichen secondary metabolites between individual specimens. The group includes among others *S. condensatum*, *S. paschale* and *S. vesuvianum* growing in Poland. The largest chemical intraspecific variation among Polish species reveals in *S. incrustatum* [53].

In specimens from Poland norstictic acid has performed always with stictic acid, and its presence (and the presence of constictic, cryptostictic and connorstictic acids) in this case has no diagnostic significance, therefore, all of these substances have been identified during the determination as a stictic acid complex. Whereas lobaric acid is the second most common, just after atranorin, substance in thallus of examined specimens of *Stereocaulon*. In total, it was found in 10 of the 14 species recorded in Poland.

### 4.2. Key to *Stereocaulon* species found in Poland

The following key contains one species of the genus *Stereocaulon* (*S. spathuliferum*), whose occurrence in the country remains unclear.

According to Nowak and Tobolewski [50], *S. alpestre* (Flot.) Dombr. [syn. *S. tomentosum* var. *alpestre* Flot., *S. tomentosum* f. *alpestre* (Flot.) Nyl.] [27] was noted from Sudety Mts, but that record was probably a misinterpretation [103]. *Stereocaulon tomentosum* var. *alpestre* was described by Flotow [100] from the Czech Republic, and not as reported Lamb [21] and Dombrowskaya [27] from the border of the Czech Republic and Poland. To date, no Polish specimens for this species have been located.

- 1 Stictic acid present, thallus PD+ orange.....2

1*	Stictic acid absent, thallus PD– or PD+ yellow.....	5
3	Phyllocladia peltate, with a well-defined darker grey-green zone in the centre .....	<i>S. vesuvianum</i> (15)
2*	Phyllocladia not peltate, without a darker centre.....	3
3	Phyllocladia with spatulate apical extensions, with soredia.....	<i>S. spathuliferum</i> (11)
3*	Phyllocladia without spatulate apical extensions, without soredia.....	4
4	Pseudopodetia mostly not tomentose; phyllocladia cylindrical, coralloid and elongate, similar to small branch.....	<i>S. dactylophyllum</i> (4)
4*	Pseudopodetia thickly cream-grey tomentose; phyllocladia mostly flattened and squamule- like.....	<i>S. tomentosum</i> (14)
5	Porphyrillic acid present; lobaric acid absent.....	<i>S. botryosum</i> (2)
5*	Porphyrillic acid absent; lobaric acid present.....	6
6	Primary thallus persistent, or if evanescent, its one surface sorediate and pseudopodetia short.....	7
6*	Primary thallus evanescent; pseudopodetia conspicuous, often ±richly branched.....	9
7	Phyllocladia verrucose; pseudopodetia grow out of the scales primary thallus, erect to 2 cm tall.....	<i>S. condensatum</i> (3)
7	Phyllocladia not verrucose.....	8
8	Phyllocladia ±fan-shaped with lower surface sorediate; pseudopodetia to 0.5 cm tall, without soralia at the tip.....	<i>S. nanodes</i> (7)
8*	Phyllocladia wart-like or cylindrical, rarely branched, not sorediate; pseudopodetium 2–5 mm tall; terminal soralia present on the pseudopodetia.....	<i>S. pileatum</i> (9)
9	Phyllocladia cylindrical, finger-like to coralloid, similar to small branch .....	<i>S. subcoralloides</i> (12)
9*	Another type of phyllocladia.....	10
10	Pseudopodetia covered thickly dark grey tomentum or tomentum absent; mostly on rocks.....	11
10*	Pseudopodetia covered pale tomentum; mostly on soil.....	12
11	Pseudopodetia without tomentum below; flattened, deeply divided into ±cylindrical ex- tensions.....	<i>S. evolutum</i> (5)
11*	Pseudopodetia distinctly tomentose below; tomentum ash-grey; phyllocladia flat to convex, scale-like to granular, soredia present (f. <i>sorediatum</i> ) or absent (f. <i>saxatile</i> ) .....	<i>S. saxatile</i> (10)
12	Phyllocladia dactyliform or grain-like.....	13
12*	Phyllocladia verrucose.....	14
13	Cephalodia numerous, irregular, shrubby, granular or warty, black.....	<i>S. paschale</i> (8)
13*	Cephalodia absent.....	<i>S. taeniarum</i> (13)
14	Pseudopodetia distinctly branched, not brittle; phyllocladia verrucose, tomentum creamy- pink; cephalodia greenish-bluish-grey containing <i>Nostoc</i> , bourgeanic acid present (var. <i>erectum</i> ) or absent (var. <i>alpinum</i> ).....	<i>S. alpinum</i> (1)
14*	Pseudopodetia simple or sparingly branched; phyllocladia verrucose, immersed in tomentum in a half part; cephalodia dark brown containing <i>Stigonema</i> .....	<i>S. incrustatum</i> (6)

### 4.3. Characteristics of the *Stereocaulon* species occurring in Poland

#### 4.3.1. *Stereocaulon alpinum* Laurer (Plate I–1,2)

in Funk, Cryptog. Gewächse 33: 6 (1827). = *Stereocaulon tomentosum* var. *alpinum* (Laurer) Th. Fr., De Stereoc. et Pilophor. Comment.: 30 (1857). = *Stereocaulon tomentosum* subsp. *alpinum* (Laurer) Th. Fr., Monogr. Stereoc. et Pilophor.: 357 (1858). = *Stereocaulon paschale* f. *alpinum* (Laurer) Mudd, Manual Brit. Lich.: 66 (1861). = *Stereocaulon paschale* var. *alpinum* (Laurer) Du Rietz, Svensk Bot. Tidskr. 20: 96 (1926).

**SYNTYPUS** (Lamb 1977:202): [Austria, Alps, Kärnten] “besonders schön am Pasterzen Gletscher, 1827, s.coll. (LE, Funck, Crypt. Gew. Bes. Fichtelgeb. Ed. II 684).

**Note.** According to Art. 9.2 and 9.11 ICBN [104] name requires lectotypification.

**Description.** Primary thallus disappearing. Pseudopodetia decumbent or erect, distinctly branched, forming low, flat cushions, firmly attached to the substrate, 1–4 cm tall; at the base simple or sparsely branched, blackish to pale brown and without phyllocladia, lighter in the upper part, with a growing number of branches and with more numerous phyllocladia. Pseudopodetia covered by creamy-pink tomentum. Phyllocladia single at the lower part, numerous at the top, verrucose or lobate, mostly grey with a blue tint (in older specimens with a yellowish tinge; Plate I–2). Cephalodia on lower side of branches, hemispherical, greenish-bluish-grey, up to 0.7 mm diameter, partly concealed in the tomentum, containing *Nostoc* (Plate I). Apothecia rare, not seen in Polish specimens, terminal, or grouped on the upper branches when young flat and marginate, later convex and immarginate, disk dark brown.

**Chemistry.** *Stereocaulon alpinum* produces atranorin, lobaric acid and in some specimens also bouergeanic acid (in *S. alpinum* var. *erectum*). Spot test reactions: K+ yellow, PD ±yellow [54].

**Notes.** *Stereocaulon alpinum* is characterized by its disappearing primary thallus, pseudopodetia with lower part and under surface covered with a distinct creamy-pink tomentum, whitish grey, verrucose or sometimes lobate greyish-blue phyllocladia, partially concealed in tomentum and cephalodia containing *Nostoc* [54].

The present study proved that *S. alpinum* in Poland is consistent in its morphology, but some specimens in addition to always-produced atranorin and lobaric acid contained also bouergeanic acid. The specimens with such chemistry belong to *S. alpinum* var. *erectum* Frey [51,54]. According to Kivistö [30] *S. alpinum* var. *erectum* has taller pseudopodetia (to 6 cm tall), than *S. alpinum* var. *alpinum* Laurer.

The most closely related taxon to *S. alpinum* is *S. saxatile* [36,60]. Both species are characterized by the same chemistry, and also their morphology is quite similar [21,87]. They differ mainly in the type of the tomentum and cyanobacteria in cephalodia. *S. saxatile* has grey tomentum, rarely produces cephalodia, but then with *Stigonema*, whereas *S. alpinum* is characterized by creamy-pink tomentum and numerous greenish-bluish-grey cephalodia containing *Nostoc* (Tab. 3) [4,21,54,60].

*Stereocaulon alpinum* is also quite similar to *S. paschale* and *S. taeniarum* (Tab. 2). They differ in the type of cephalodia. *S. alpinum* has bluish, often tomentose, hemispherical cephalodia with *Nostoc*, whereas in *S. paschale* cephalodia are dark, black, shrubby, granular or warty with poorly developed cortical layer and can contain *Nostoc* or *Stigonema*. In *S. taeniarum* cephalodia are not developed (cf. [21,30]).

Similar species and often confused with *S. alpinum* var. *erectum* is *S. grande* (H. Magn.) H. Magn., which is characterized by the presence of dactyliform phyllocladia, whereas phyllocladia of *S. alpinum* var. *erectum* are usually verrucose [21,30]. In addition cephalodia occurring in *S. grande* are larger, spherical and light brown, while in *S. alpinum* var. *erectum*

**Tab. 3** The lichen secondary metabolites of *Stereocaulon* species on the world according to Lamb [4,21,22], Culberson [172], Tønsberg [33], Sipman [23]; Spribille et al. [63].

Name of substance	Substance class	Occurring (selected taxa)	Suggest control species
anziaic acid	depsides	<i>S. crambidiocephalum</i>	<i>Anzia japonica</i>
atranorin	depsides	all species	<i>Cladonia symphyrcarpia</i>
bourgeanic acid	fatty acids	<i>S. alpinum</i> var. <i>erectum</i>	<i>Ramalina lacera</i> , <i>Cladonia innominata</i>
colensoinic acid	depsidones	<i>S. etiogoense</i>	<i>S. colensoi</i>
connorstictic acid	depsidones	<i>S. atlanticum</i> ,	<i>Pleurosticta acetabulum</i>
consalazinic acid	depsidones	<i>S. atlanticum</i>	<i>Parmotrema reticulatum</i>
constictic acid	depsidones	<i>S. subdenudatum</i>	<i>Xanthoparmelia conspersa</i>
didymic acid	dibenzofuranes	<i>S. didymicum</i>	<i>Cladonia incrassata</i>
fumarprotocetraric acid	depsides	<i>S. novogranates</i>	<i>Cladonia ciliata</i> , <i>C. pyxidata</i>
glomellic acid	depsides	<i>S. wadei</i>	<i>Xanthoparmelia loxodes</i> , <i>X. delisei</i>
glomelliferic acid	depsides	<i>S. myriocarpum</i> , <i>S. stenosperrum</i>	<i>Xanthoparmelia loxodes</i> , <i>X. delisei</i>
isousnic acid	dibenzofuranes	<i>S. salazinum</i> (Réunion)	<i>Lecanora saligna</i> , <i>Bunodophoron notatum</i>
lecanoric acid	depsides	<i>S. pachycephalum</i>	<i>Pertusaria hemisphaerica</i>
lobaric acid	depsidones	<i>S. cymosum</i> , <i>S. evolutum</i>	<i>Parmelia omphalodes</i> , <i>Protoparmelia badia</i>
miriquidic acid	depsides	<i>S. capitellatum</i> , <i>S. implexum</i> (II chemotype)	<i>Miriquidica leucophea</i>
norlobaric acid	depsidones	<i>S. weberi</i>	no data
norrangiformic acid	fatty acids	<i>S. corticatulum</i> , <i>S. delisei</i>	<i>Cladonia rangiformis</i>
norstictic acid	depsidones	<i>S. dactylophyllum</i> , <i>S. pityrizans</i>	<i>Pleurosticta acetabulum</i>
perlatolic acid	depsides	<i>S. meyeri</i>	<i>Cladonia portentosa</i>
porphyrylic acid	dibenzofuranes	<i>S. botryosum</i> , <i>S. arenarium</i>	<i>Haematomma ochroleucum</i>
protocetraric acid	depsides	<i>S. gregarium</i> , <i>S. novogranates</i>	<i>Flavoparmelia caperata</i>
rangiformic acid	fatty acids	<i>S. corticatulum</i>	<i>Cladonia rangiformis</i>
salazinic acid	depsidones	<i>S. vulcani</i>	<i>Parmelia sulcata</i>
stenosporic acid	depsides	<i>S. argus</i>	<i>Melanelia disjuncta</i>
stictic acid	depsidones	<i>S. tomentosum</i> , <i>S. dactylophyllum</i>	<i>Parmotrema perlatum</i>
sublimatic acid	no data	<i>S. pachycephalum</i> (Peru)	no data
ursolic acid	terpenoids	<i>S. brassii</i>	no data
usnic acid	dibenzofuranes	<i>S. salazinum</i> (Réunion)	<i>Flavoparmelia caperata</i>

are rare, small and greenish-grey coloured. According to Kivistö [30] the status of these two taxa is unclear, perhaps they represent one species with high morphological variability. This requires further investigation.

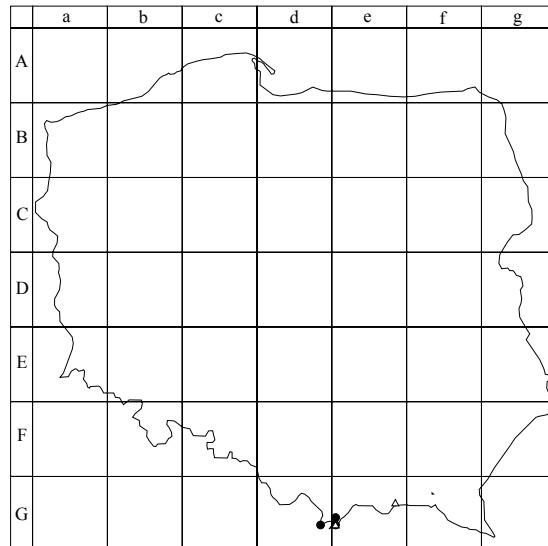


**Habitat requirements.** According to Fałtynowicz [51] *S. alpinum* is a terricolous lichen. Meanwhile, present studies have shown that in Poland grows both on the soil (7 specimens, i.e. 41%) and on rocks (10 specimens, i.e. 59%). Nevertheless, records of *S. alpinum* inhabiting rocks come from a small area of the Tatra Mountains, where the species grows on rocks covered with a layer of periodically wet humus, often in the vicinity of mosses [52]. Very similar habitat preferences for *S. alpinum* gives Motyka [20].

**World distribution.** *Stereocaulon alpinum* has been recorded so far all over the world, from temperate to alpine regions and the Arctic [4,21,60]. During this study the species was confirmed for several regions in Europe (Austria, Bulgaria, Estonia, Finland, France, Germany, Iceland, Norway, Romania, Slovakia, Switzerland, Sweden, Italy and the Faroe Islands), North America (Alaska, Greenland, Canada and the USA), South America (Argentina), Antarctica, China and Russia in Asia. In addition, this taxon was also given by Lamb [21] from Antarctica, the Czech Republic, Hungary, Mongolia, northern India, Korea and Chile.

Other literature records: South America – Ecuador [105], Peru [105]; Asia – China [106], Pakistan [107]; Europe – Andorra [108], Spain [109], Portugal [110], United Kingdom [111] and the Pacific Islands [112].

**Distribution in Poland.** The species was regarded to be quite rare in the country and characterized by a mountain type of distribution. It was recorded mainly from the Tatra Mts and the Sudety Mts [20,50–52,54]. Indeed, the revision focused on the chemistry of *S. alpinum* (see also [54]) confirmed its mountain distribution (Fig. 1) occurs in the Tatra and Sudetes at altitudes above 1600 m. It is a rare species, considered to be endangered in Poland (category EN) [59]. *Stereocaulon alpinum* var. *erectum* was reported yet from only three localities in Poland by Oset [54]. Number of examined specimens from Poland: 17 (14 specimens of *Stereocaulon alpinum* var. *alpinum*, 3 specimens of *S. alpinum* var. *erectum*).



**Fig. 1** Distribution of *Stereocaulon alpinum* in Poland given in ATPOL grid square system (circle – *S. alpinum* var. *alpinum*; triangles – *S. alpinum* var. *erectum*).

***Stereocaulon alpinum* var. *alpinum***

**Specimens examined:** **Gd-68** – Tatry Zachodnie Mts, Jarząbczy Wierch Mt., Dolina Jarząbcza valley, alt. ca. 1680 m, on soil, 12.09.1958, leg. Z. Tobolewski (POZ); Pass between Kończysty Wierch Mt. and Czubik Mt., alt. ca. 1825 m, on soil, 18.08.1956, leg. Z. Tobolewski (POZ). **Ge-50** – Tatry Wschodnie Mts, Dolina Stawów Gąsienicowych valley, under Czarny Staw pond, near Kościelec Mt., alt. ca. 1620 m, on soil, 07.09.1958, leg. Z. Tobolewski (POZ). **Ge-60** – Tatry Wschodnie Mts, Dolina Pięciu Stawów Polskich valley, near Kotłowy Staw pond, on soil, 12.08.1929, leg. J. Motyka (LBL); Szpiglasowa Przełęcz pass, alt. 2107 m, 49°11'53"N, 20°02'34"E, on the rocks boulders and moss, 15.07.2004, leg. A. Flakus 2408 (KRAM); leg. A. Flakus 2479 (KRAM); leg. A. Flakus 2480 (KRAM); Mieguszowiecka Przełęcz pod Chłopkiem pass, alt. 2307 m, 49°11'01"N, 20°03'56"E, on the rocks boulders, 21.07.2003, leg. A. Flakus 859 (KRAM); 22.08.2005, leg. A. Flakus 5498 (KRAM); 49°11'09"N, 20°03'55"E, on the rocks boulders, 16.07.2004, leg. A. Flakus 2542 (KRAM); alt. 2100 m, 49°11'20"N, 20°03'34"E, on the rocks boulders, 22.07.2004, leg. A. Flakus 2755 (KRAM); leg. A. Flakus 2756 (KRAM); Przełęczka pod Zadnim Mnichem pass, alt. 2135 m, 49°11'19"N, 20°03'06"E, on the rocks boulders rich in humus, 15.08.2004, leg. A. Flakus 3181 (KRAM); Hińczowy Żleb Mt., alt. 2200 m 49°11'10"N, 20°03'21"E, on the rocks boulders, 22.07.2004, leg. A. Flakus 2786 (KRAM).

***Stereocaulon alpinum* var. *erectum***

**Specimens examined:** **Ge-38** – Beskid Niski Mts, Przełęcz Beskid pass, 08.1925, on soil, leg. J. Motyka (LBL). **Ge-60** – East Tatra Mts, Dolina za Mnichem valley, alt. ca. 1800 m, on soil, 10.09.1954, leg. Z. Tobolewski (POZ); Białczańska Przełęcz pass, alt. 2085 m, 49°11'20"N, 20°05'13"E, on humus, 20.08.2005, leg. A. Flakus 5465 (KRAM).

**Exsiccatae examined:** Anonymus, Lich. Exs. Arizona State Univ. 26 (BM). Arnold, Lich. Exs. 1363a (UPS). Arnold, Lich. Exs. 1604 (H). Beck & Zahlbruckner, Krypt. Exs. 152 (BP 13425, 41325, 41327, H-three specimens). Borza, Fl. Roman. Exs. 1409 (UGDA). Cretzoiu, Lich. Roman. Exs. 1409 (H). Elenkin, Lich. Fl. Ross. 73a (BP 13421). Elenkin, Lich. Fl. Ross. 73b (BP 13421). Follmann, Lich. Exs. Sel. Cassel. 134 (H). Funck, Crypt. Gew. Fichtelgeb. Ed. II 684 (LE). Hansen, Lich. Groenl. Exs. 8 (H). Hansen, Lich. Groenl. Exs. 170 (H). Hansen, Lich. Groenl. Exs. 187 (H). Hansen, Lich. Groenl. Exs. 349 (H). Hansen, Lich. Groenl. Exs. 421 (H). Hansen, Lich. Groenl. Exs. 510 (BM, H). Hansen, Lich. Groenl. Exs. 531 (H). Hansen, Lich. Groenl. Exs. 601 (BM, H). Hansen, Lich. Groenl. Exs. 705 (H). Hansen, Lich. Groenl. Exs. 737 (H). Hansen, Lich. Groenl. Exs. 829 (BM, H). Hansen, Lich. Groenl. Exs. 888 (BM, H). Hansen, Lich. Groenl. Exs. 916 (H). Hansen, Lich. Groenl. Exs. 996 (H). Hansen, Lich. Groenl. Exs. 1012 (H). Hansen, Lich. Groenl. Exs. 1019 (H). Harmand, Lich. Gall. Rar. Exs. 25 (H). Kashiwadani, Lich. Minus Cogn. Exs. 45 (H). Kashiwadani, Lich. Minus Cogn. Exs. 46 (H). Kurokawa & Kashiwadani, Lich. Rar. Crit. Exs. 684 (BM, H). Magnusson, Lich. Sel. Scand. Exs. 210 (H, as *S. alpinum* var. *erectum*). Malmé, Lich. Suec. Exs. 652 (B 158702). Mattsson, Lich. Austroamer. Herb. Regnelliano 526 (H). Obermayer, Lichenoth. Graec. 298 (H). Passauer, Crypt. Exs. 4566 (H). Petrak, Crypt. Exs. 4237 (H). Poelt, Pl. Graec. Lich. 232 (BM). Savicz, Lichenoth. Ross. 74 (BP 6554, H). Schaerer, Lich. Helv. Exs. Ed. I (BP 13423). Thomson, Lich. Arct. 37 (H, LBL). Thøgersen, Lich. Norveg. Medit. Exs. 19 (H). Trevisan, Lichenoth. Ven. 144 (H). Vězda, Lich. Sel. Exs. 964 (BP 76067). Vězda, Lich. Sel. Exs. 964 (H). Vězda, Lich. Sel. Exs. 989 (BM, H, as *S. alpinum* var. *erectum*). Vězda, Lich. Sel. Exs. 1744 (H).

**Selected reference materials** (a total of 160 specimens of *Stereocaulon alpinum* var. *alpinum*): **Antarctica.** Galindez Islands: NW corner of island, in rock cracks, 10.12.1935, British Graham Land (Penola) Expedition, 1934–1937, 1309 (BM). **Argentina.** Tierra del Fuego, Sierra Alvear, the southern slope Las Cotorras, above 20 km ENE of Ushuaia, alt. ca. 600 m., in the alpine region, on the ground, 09.02.1940, leg. R. Santesson 775 (H). **Austria.** Tirol, Pitztal, Weg zur Braunschweiger Hütte, 16.10.1965, leg. W.U. Berthold (B 85164). **Bulgaria.** Cepelarska planina: in monte "Karlak dag" pr. Pasmakli, alt. ca. 1700–2100 m., supra tarram, 7–8.06.1929, leg. O. Szatal (BP 41320). **Canada.** Hood River, west bank of Hood, 10 km upstream from mouth, just below rapids, grassy areas and thickets of *Salix* sp., on bare ground, 03.08.1991, leg. William A. Gould 1943 (UGDA). **China.** Tybet, in muscis ad ripas flum, Go-czu (13 000), inter flumina Golubaja et Mekong (Tibet: regio Kam), leg. Ladygin (BP 13421). **Estonia.** Pärnu country, Kihnu island, Kiivaia boreal heath pine forest (58°08'00"N, 23°59'00"E), on sands, 27.07.1987, leg. T. Randlane 61 (herb. Seaward). **Faroe Islands.** Streymoy: along the road to Mt. Sornfelli slope and boggy pasture, rock outcrops, 10.08.1995, leg. S. Stenroos, L. Kivistö 33 (H). **Finland.** Lapponia kemensis Kittilensis (Lkk/KiL). Kittilä: in latere Keimiotunturi, 02.07.1867, leg. Norrlin (H). **France.** Savoie, Parc national de la Vanoise, alt. 2400 m s.m., ad terram macram, 08.1970, leg. J. Asta, G. Clauzade, Cl. Roux (H). Germany. Baden, Schwarzwald, auf Schwemmhöden bei Horbach, Wittenschwand beim alten Nickelbergwerk, 24.06.1954, leg. W. Krause (B 66463). **Greenland.** Narsarsuaq, on the slope of Mt. Suluraq, 61°10'N, 45°24'W, alt. 20–50 m, in a *Betula pubescens* scrub, 19.07.1982, leg. S. Svane 5271a (H). **Iceland.** IVE (Vestur-Island), Mýrasýsla, Brekkumúli mt by the pass Brattabrekka – 64.87°N, 21.52°W. alt. ca. 400 m, on soil, on mosses, 24.07.2009, leg. M. Oset (UGDA). **Italy.** in locis arenosis prope Sulden, leg. A. Zahlbruckner (BP 13425). **Norway.** Hedmark Follidal: Sanddalen, narrow valley (seepage channel in spring) in glacial-fluvial sediments E of state road No. 27, alt. 710 m, epigeic on sand, sparagmatic with high content of quartz, 23.09.1977, leg.

Per-Jan Thøgersen (H). **Romania**. Muntenia, distr. Dâmbovită, Inter Bolboci et Cheile Zănoage montium Bucegi, alt. ca. 1400 m, solo calc. arenoso., 15.08.1936, leg. P. Cretzoiu (UGDA). **Russia**. Caucasus Magnus, regio montis Elbrus: ad latera austro-occidentalia montis Ceget, supra convexum torrentis Baksan dicti, alt. 2000–2300 m s.m., ad terram, 20.06.1980, leg. A. Vězda (B 75593). **Slovakia**. Tatry Bielskie, w Siodle “Śirdze Pole”, pomiędzy Hlupym Vrelem a Zdziarską Vidľą, alt. ca. 1800 m, on soil, 19.07.1956, leg. Z. Tobolewski (POZ). **Sweden**. Jämtland, Storlien, in arena denudata, lapillis immixta; in regione betulina, 02.03.1917, leg. G.O.A. Malmé (B 158702). **Switzerland**. Graubünden, Albula-Tal, TK 25: 1217 Scalettapaß, Bergün, Weg von Chants nach Ravaisch, nahe der Kesch-Hütte, alt. 2500–2650 m, auf erde, 11.09.1989, leg. H. Mietzsch (KRAM-L 32052). **USA**. Alaska, of Flower slope along Nunivak Slough near Barrow, on soil, 24.07.1958, leg. R.E. Shanks, A.J. Sharp (LBL).

**Selected reference materials** (a total of 51 specimens of *Stereocaulon alpinum* var. *erectum*): **Argentina**. 54°39'S, 67°44'W, Periphery of *Sphagnum* bog near sawmill, 12 km NE of Hosteria Petrel, along Ruta Nac. No. 3, elev. 110 m., 22.11.1971, leg. H. Imshaug, K. Ohlsson (KRAM-L 19265). **Canada**. Hood river, Wilberforce Falls area, east side of canyon, below falls, 67°06'N, 108°47'W, elev. 123 m., tundra with thick carpet of mosses, 17.08.1990, leg. W.A. Gould 1614 (KRAM). **Finland**. Kuusamo (Ks). Salla: Värriötunturit, by Värriö Research Station, S-slope of Kotovaara, alt. 360, lichen woodland, 10.06.1980, leg. T. Ahti 38022 (H). **Iceland**. IVE (Vestur-Island), Mýrasýsla, Brekkumúli mt by the pass Brattabrekka – 64.87°N, 21.52°W. from 400 m a.s.l., on soil, 24.07.2009, leg. M. Oset (UGDA). **Norway**. Troms, Balsfjord sogn: S part, ca. 3 km S of mouth of Fjeldfrøskelven, alt. 140 m., pine lichen woodland, on rock outcrop, 15.08.1959, leg. R.L. Hämet (H). **Russia**. Kola Peninsula, south-western Khibiny, the Malaja Belaja river valley, ca. 6 km E of Khibiny village, alt. ca. 300 m., in mesic *Pinus*-dominated forest, on siliceous stone, 08.08.2000, leg. J. Motiejūnaitė (BILAS 5353). **Switzerland**. Graubünden, Engadin, Samaden, Kies – und Sandalluvionen des Inn nahe beim Bahnhof, 1725 m., 1931, leg. E. Frey 1636 (H). **USA**. Oregon, Linn County: in meridie a Sahalie Falls, Clear Lake Cutoff Highway, alt. 870 m s.m., in silva clara, as saxa erupta, 02.05.1970, leg. L.H. Pike 1349 (BM).

Additional reference material examined:

*Stereocaulon grande* (H. Magn.) H. Magn.

in Nills., Ark. f. Bot. 24A(3): 71 (1931). = *Stereocaulon paschale* var. *grande* H. Magn., Göteborgs Kungl. Vetensk. Samhälles Handl. ser. 4, 30 (7): 49 (1926).

LECTOTYPUS (Lamb 1977: 220): Sweden, Jämtland, par. Kall, Sundet., 1914, A.H. Magnusson (UPS-L 108395!).

**Exsiccatae examined:** Haukulinen, Lich. Fenn. Exs. 758 (H). Haukulinen, Lich. Fenn. Exs. 1080 (H). Huuskonen, Lichenoth. Fenn. 1034 (B 46443). Kurokawa & Kashiwadani, Lich. Rar. Crit. Exs. 684 (B 57220). Magnusson, Lich. Sel. Scand. Exs. 238 (B 92636). Räsänen, Lich. Fenn. Exs. 396 (H). Räsänen, Lich. Fenn. Exs. 757 (H). Vězda, Lich. Sel. Exs. 465 (BM, H, UPS).

**Selected specimens examined:** **Finland**, Tavastia australis. Lammi: Halila, Halilankallio reserve and Halila farm. GPS: 61°04'46"N, 25°03'23"E, alt. 110–130 m, on soil, 15.08.2007, leg. M. Oset (UGDA). **Norway**. Spitsbergen, Ariekammen, 77°00.598'N, 15°31.860'E, close to seashore, on plant and moss remains, 26.07.2005, leg. A. Zwolnicki (UGDA-L 13860). **Sweden**. Uplandia, Bergsbrunna prope Uppsala, ad terram lapidosam, 26.05.1929, leg. J. Motyka (LBL).

#### 4.3.2. *Stereocaulon botryosum* Ach. (Plate I–3–5)

Lichenogr. Univers.: 581. (1810). = *Stereocaulon alpinum* f. *botryosum* (Ach.) Laur., in Fries, Lichenogr. Europea Reform.: 204 (1831). = *Stereocaulon alpinum* var. *botryosum* (Ach.) Schaer., Lichenum Helveticorum Spicilegium, Pars prima, sect. VI: 277 (1833). = *Stereocaulon tomentosum* var. *botryosum* (Ach.) Nyl., Lich. Scand.: 64 (1861).

LECTOTYPUS (Lamb 1977: 207, first-step): [Switzerland] “ad montes Helvetiae”, leg. Schleicher (H-ACH 1768!). (Oset & Kukwa 2014, second-step): [Switzerland] “ad montes Helvetiae”, leg. Schleicher (H-ACH 1768A); ISOLECTOTYPE BM-ACH 773!, left-hand specimen).

= *Stereocaulon fastigiatum* Anzi, Catal. Lich. Sondr.: 11 (1860). = *Stereocaulon evolutum* var. *fastigiatum* (Anzi) Th. Fr., Lichenogr. Scandin. 1: 45 (1871).

LECTOTYPUS (*hoc loco designatus*): [Italy] Ad latera perpendicularia et umbrosa rupium graniticarum in alpebus editissimis Bormii et Vallis-Tellinae, Gavia et Zebù (UPS!, Anzi, Lich. Rar. Langob. Exs. 16).

**Description.** Primary thallus farinose, disappearing. Pseudopodetia firmly attached to the substrate, growing in dense tufts, in the central part up to 3 cm height, at the edge of tufts smaller, forming almost of crusty mass. Pseudopodetia usually grows out of one place, giving sapling look at section (Plate I–5), brownish-black at the base, whitish at the upper parts, tomentum greyish at the bottom, in the upper part often naked, branching from the base upwards, the tips fastigiated and forming cauliflower-like masses. Phyllocladia granular or verrucose,

very rarely flattened, glaucous or whitish-grey (Plate I–4). Cephalodia rare, not known in Polish material, concealed within the tomentum, dark blue, tuberculose, containing *Nostoc* (Plate I–3). Apothecia not known in Polish material (observed in the material from Finland and Sweden), 1.5–3 mm in diam., terminal, dark brown, flat at the beginning, older convex.

**Chemistry.** The species always produces atranorin and porphyryllic acid [21,113]. Spot test reactions: K+ yellow, PD–. The chemistry of only Polish specimen agrees with that reported earlier.

**Notes.** This species is characterized by branched from the base and becoming fastigiate and forming cauliflower-like masses pseudopodetia which forms dense tufts, mainly radiating from the centre and the production of porphyryllic acid. This is the only species occurring in Poland, which produces this substance. The original material of *S. botryosum* is deposited at the University of Helsinki (H-ACH) and the Natural History Museum in London (BM-ACH). The collection in H-ACH contains four specimens, under one label. Only one specimen corresponds with *S. botryosum* in the current taxonomic sense. Below this specimen the annotation “Helvetia” was found, which correlates with the information contained in the protolog: “Habitat ad montes Helvetiae. Schleicher” [114]. The BM-ACH collection contains three specimens, but only one (left specimen), belongs to *S. botryosum*. Unfortunately, the label has no data on the locality and the collector. Therefore the specimen from the University of Helsinki (H-ACH 930) has been designated as the lectotype for the name *S. botryosum* [115].

**Habitat requirements.** According to Fałtynowicz [51] *S. botryosum* is a terricolous lichen in Poland, but according to Thompson [113] it is a saxicolous lichen, what the comparative studies confirmed almost in their entirety. On soil 6 specimens were noted only (5 from Finland, 1 from Norway). Unfortunately, the label herbarium of the specimen found in Poland has no data on the habitat. Usually *S. botryosum* prefers humid, shaded places (see [20]).

**World distribution.** *Stereocaulon botryosum* is a boreal-arctic, circumpolar lichen, and according to Lamb [21], known only from the Northern Hemisphere, mainly from Europe. However, Calvelo and Liberatore [116] recently reported *S. botryosum* from Southern Hemisphere. As a result of this study the species has been confirmed from Greenland, and Austria, Finland, Norway, Switzerland, Sweden and Italy in Europe. Lamb [21] confirmed specimens of *S. botryosum* also from France and Iceland, as well as Canada and the USA. It has also been reported from Asia (China) [117], and the Czech Republic [118].

**Distribution in Poland.** The species was reported for the first time from Poland by Opanowicz in 2003 from the Sudety Mts [51], but detailed locality was never published. Probably the determination was incorrect, as the identity was not confirmed by TLC (Opanowicz 2008, personal communication). During this study only one specimen of *S. botryosum* was found in Polish materials. It was collected in the Tatra Mts, at altitudes of ca. 1333 m (Fig. 2). It seems that *S. botryosum* is really endangered lichen species in the country [59]. Number of examined specimens from Poland: 1.

**Specimens examined:** Gd-59 – Tatrzy Zachodnie Mts, Dolina Kondratowa valley, Łopata Mt., 08.1925, leg. J. Motyka (LBL).

**Exsiccatae examined:** Anzi, Lich. Rar. Langob. Exs. 16 (UPS, as *S. fastigiatum*). Arnold, Lich. Exs. 1575 (H, as *S. alpinum*). Hansen, Lich. Groenl. Exs. 208 (B 46358). Hansen, Lich. Groenl. Exs. 440 (B 90838, BM). Hansen, Lich. Groenl. Exs. 632 (B 116761). Hansen, Lich. Groenl. Exs. 792 (B 130962). Malme, Lich. Suec. Exs. 979A (B 158701,

as *S. fastigiatum* var. *dissolutum*). Malme, Lich. Suec. Exs. 979A (H, as *S. fastigiatum*). Petrak, Crypt. Exs. 3664 (H, as *S. fastigiatum* var. *dissolutum*).

**Selected reference materials** (a total of 49 specimens *Stereocaulon botryosum*): **Austria.** Tirol, Ötztal, Vent, near Breslauer Hütte, alt. ca. 2850 m, in vertical fissure in humid rockface, 01.09.1993, leg. H. Sipman 34638 (B). **Finland.** Lapponia enontekiensis: Guonjarvankka, in regione alpine, ad lapidem, 06.08.1947, leg. A.J. Huuskonen (H). **Greenland.** Fire Fingre Sø. 78°59'N, 67°10'W, on siliceous boulders 03.08.1999, E.S. Hansen (B 130692). **Italy.** Ad latera permendicularia et umbrosa rupium graniticarum in albus editissimis Bormii et Vallis-Tellinae, s.coll. (B 65456). **Norway.** Sör-Trøndelag, Dorefeld, Knutshö, alt. 1500 m, leg. I.M. Lamb 7042 (H). **Sweden.** Torne Lappmark, Comm. Kiruna, N-slope of mount Katternjunnji, S of Riksgränsen railway station, W of Abisko, alt. ca. 500 m, 68°25,1'N, 18°08'E, among moss on boulder, 24.08.1986, leg. H. Sipman 21240 (B).

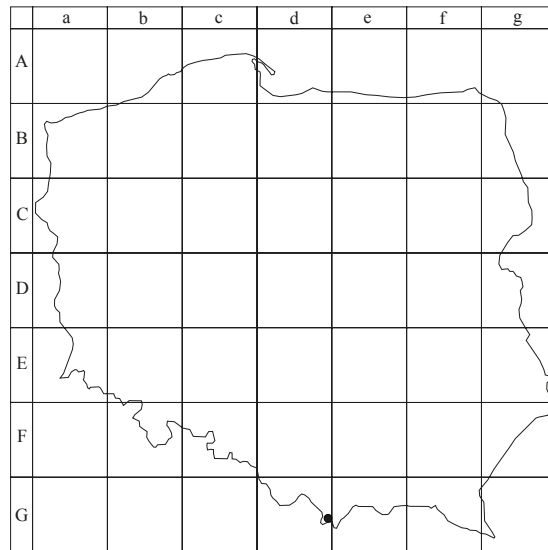


Fig. 2 Distribution of *Stereocaulon botryosum* in Poland.

#### 4.3.3. *Stereocaulon condensatum* Hoffm. (Plate I–6,7)

Deutschl. Fl., Zweiter Theil (Erlangen) (1796). = *Lichen condensatus* (Hoffm.) Ach., Lichenogr. Suec. Prodr.: 209 (1798). = *Stereocaulon paschale* var. *condensatum* (Hoffm.) Schaer., Lichenum Helveticorum Spicilegium, vol. 1, sect. VI: 273 (1833). = *Cereolus condensatus* (Hoffm.) Boistel, Nouv. Flore Lich., 2e. partie: 33 (1903).

**NEOTYPUS** (Oset & Kukwa 2014): [Germany, Saxony] Roßwein: auf Halden an der Silberwäsche bei Gersdorf im Tal der Freiburger Mulde., October 1931, leg. W. Flößner (B-600184305!, Schade, Stolle & Riehmer, Lich. Saxon. Exs. 496).

= *Stereocaulon condyloideum* Ach., Method. Lich., Suppl.: 51 (1803). = *Stereocaulon condensatum* subsp. *condyloideum* (Ach.) Nyl., Syn. Method. Lich. 1(2): 251 (1860). *Stereocaulon condensatum* var. *condyloideum* (Ach.) Nyl., Lich. Scandin.: 66 (1861). = *Stereocaulon condensatum* f. *condyloideum* (Ach.) H. Magn., Göteborgs K. Vetensk.-o. Vitterh.-Samh. Handl. Ser. 4, 30(7): 68 (1926).

**HOLOTYPUS** (Lamb 1977: 310): [Sweden] "ad terram glareosam", s.coll. (H-ACH 1754!).

= *Stereocaulon condensatum* f. *septentrionale* H. Magn., Göteborgs K. Vetensk.-o. Vitterh.-Samh. Handl. Ser. 4, 30(7): 67 (1926).

**LECTOTYPUS** (Lamb 1977: 310): [Sweden] Härjedalen: Linsån, 10.08.1917, leg. C. Stenholm (UPS-L 108390!).

**Description.** Primary thallus persistent as grey granules, initially isolated, later forming a crustose layer over the substrate. Pseudopodetia rarely present, 1–2 cm tall, simple or sparsely branched in the upper part, naked or covered with a thin tomentum. Phyllocladia verrucose or granular, lighter on the top, beigeish-brown (Plate I–7). Cephalodia abundant, between primary thallus granules or at the base of pseudopodetium, verrucose or granular, dark reddish black, containing *Stigonema* (Plate I–6). Apothecia, rare, terminal, dark brown, in young specimens with pale margin in older convex and emarginate.

**Chemistry.** According to Lamb [21] *S. condensatum* produces both atranorin and lobaric acid, very rarely only atranorin is detected. Similar results were also obtained for Polish collections. Over 96% specimens of *S. condensatum* produced both substances. Merely in one sample only atranorin was found, and in five only lobaric acid. Spot test reactions: K+ yellow, PD± yellow, which agrees with literature data (cf. Lamb [21] and literature cited therein; see also [53,60]).

**Notes.** *Stereocaulon condensatum* is characterized by the persistent, granular or verrucose primary thallus forming a crustose layer over the substrate, squamulose, verrucose, or sometimes scaly phyllocladia, cephalodia containing *Stigonema* and the presence of atranorin and often lobaric acid [4,21,50,53].

The most similar species is *S. glareosum*. Both taxa are characterized by the same chemistry and similar morphology, however, *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, most often in specimens from Fennoscandia; they are terminal or lateral, dark brown [21,60,87]. This species has not been recorded in Poland so far, but according to Motyka [20] is likely to occur in the Tatra Mts. However, *S. condensatum* has verrucose or granular, dark reddish black, with a rough surface which are frequently interspersed amongst phyllocladia (also on pseudopodetia) and containing *Stigonema*; apothecia are rare, produce on pseudopodetia or on basal phyllocladia.

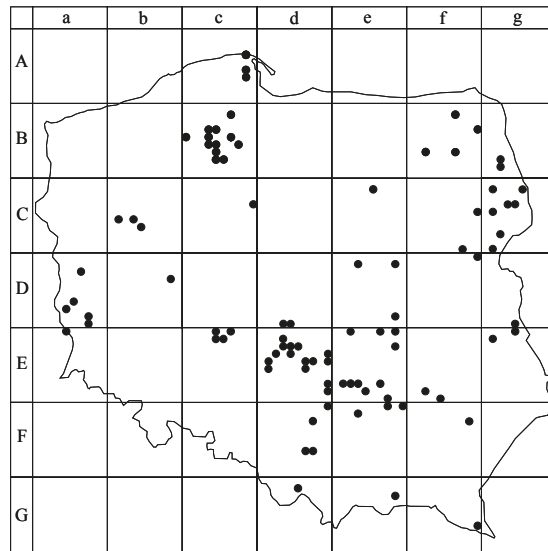
*Stereocaulon incrustatum* is similar to *S. condensatum*. Both species are characterized by similar morphology and chemistry (see notes in *S. incrustatum* [53]).

**Habitat requirements.** It is terricolous lichen, which occurs mostly on sandy soil (98%), often with *Cladonia* spp., rarely on rocks (3 specimens from Poland, i.e. 2%; 2 from Finland), sometimes noted on the rabbit droppings (Germany), or old clothes (Germany). It occurs mostly in dry pine forests, heath and inland sand dune vegetation and along railways.

**World distribution.** *Stereocaulon condensatum* is known mainly from the Northern Hemisphere. It is a temperate to boreal-arctic, amphiatlantic and possibly circumpolar lichen [21,53,60]. It seems that the species is common in the boreal zone of Europe and North America [4,20,21,50,60]. At present *S. condensatum* is known also from Asia and Oceania (but see below reports by Lamb [21]). The author of this study examined specimens from Asia (Japan, Russia), Europe (Belgium, the Czech Republic, Estonia, Finland, France, Germany, Lithuania, Norway, Sweden) and North America (Greenland). In addition Lamb [21] recorded *S. condensatum* from Canada, USA, Denmark, the Netherlands, United Kingdom in Europe, and Japan and Mongolia in Asia.

Other literature records: Asia – China [106], India [119]; Europe – Austria [120], Spain [109], Ireland [121], Iceland [122], Svalbard [123], Romania [124]; the Pacific Islands [112], Hawaii [112].

**Distribution in Poland.** *Stereocaulon condensatum* was reported for the first time from Poland in 1849 (see [37,51]). Later it was noted quite often, and in the second half of the twentieth century it was considered as a species commonly found in the country, except of mountains areas [20]. This revision confirmed that in Poland *S. condensatum* is the most common members of the genus (Fig. 3). It occurs throughout the county up to the lower parts of mountains. The localities cited below were partly cited by Oset [53], but several new data are added here as well. Number of examined specimens from Poland: 179.



**Fig. 3** Distribution of *Stereocaulon condensatum* in Poland.

**Specimens examined:** **Ac-38** – Wybrzeże Słowińskie coast, N of Bielawskie Błoto peatbog, on soil, 07.1958, leg. Z. Tobolewski (POZ). **Ac-58** – Wysoczyzna Żarnowiecka high plain, ca. 2 km SW of Mała Piasznica village, Wejherowo forest inspectorate, forest section No. 41, on soil, 21.04.1983, leg. A. Zalewska (UGDA-L 3454). **Ac-68** – Pradolina Łęby i Redy proto-valley, road from Ciechocino district to Śmiechowo district, on soil, 16.08.1930, leg. F. Krawiec (LBL). **Bc-16** – Pojezierze Kaszubskie lakeland, near Kościerzyna town, by Głębobczek lake, on soil, 06.1974, leg. W. Fałtynowicz (UGDA-L 779). **Bc-33** – Bory Tucholskie forests, Przymuszewo forest inspectorate, Widno forest division, forest section No. 48a, on soil, 04.04.1975, leg. W. Fałtynowicz (UGDA-L 988). **Bc-34** – Bory Tucholskie forests, Bór chrobotkowy nature reserve, forest section No. 328a, by the road, on soil, 12.08.2009, leg. M. Kukwa 7529 (UGDA); Przymuszewo forest inspectorate, forest section No. 327/328, rezerwat Bór Chrobotkowy im. Prof. Z. Tobolewskiego nature reserve, on soil, 19.05.1999, leg. U. Bielczyk (KRAM-L 44766). **Bc-40** – Równina Charzykowska plain, between Bytów and Człuchów towns, 2.5 km NW of Suszka village, on soil, 25.07.1989, leg. W. Fałtynowicz (UGDA-L 4184). **Bc-43** – Bory Tucholskie forests, Przymuszewo forest inspectorate, Popówka forest division, forest section No. 285b, on soil, 05.04.1977, leg. W. Fałtynowicz (UGDA-L 195); forest section No. 294d, on soil, 02.03.1975, leg. W. Fałtynowicz (UGDA-L 987); forest section No. 303b, on soil, 02.03.1975, leg. W. Fałtynowicz (UGDA-L 986). **Bc-46** – Bory Tucholskie forests, near Czersk town, on soil, 13.08.1968, leg. W. Sodkiewicz (POZ); 10.10.1969, leg. W. Sodkiewicz (POZ). **Bc-53** – Bory Tucholskie forests, Klosnowo village, 1986, leg. E. Lickiewicz (LBL). **Bc-54** – Bory Tucholskie forests, Ryteł forest inspectorate, near Mrowiniec village, on soil, 28.07.1973, leg. K. Czyżewska (LOD-L 3839). **Bc-57** – Bory Tucholskie forests, 20 km NE of Tuchola town, near Rosochatka village, on soil, 30.09.1988, leg. W. Fałtynowicz (B 13084, 146054, BM, H, LBL, LOD-L 10201, UGDA, UPS); 1 km N of Rosochatka

village near Czersk town, on soil, 30.09.1988, leg. W. Fałtynowicz (KRAM-L 22466, UGDA-L 4021). **Bc-64** – Kotlina Gorzowska basin, Międzyrzecze Warty i Noteci interfluvial zone, Puszcza Notecka forest, road between Mokrz and Rzecin villages, on soil, 27.09.1954, leg. Z. Tobolewski (POZ). **Bc-74** – Pojezierze Krajeńskie lakeland, Przymuszewo forest inspectorate, forest section No. 341, on soil, 17.09.1974, leg. K. Czyżewska (LOD-L 5126). **Bc-75** – Pojezierze Krajeńskie lakeland, 15 km of Tuchola town, on soil, 13.08.1968, leg. W. Sodkiewicz (POZ). **Bf-16** – Pobrzeże Kaszubskie seashore, by Dobrogaszcz lake, on soil, 25.06.1981, leg. W. Fałtynowicz (UGDA-L 1636). **Bf-39** – Równina Augustowska plain, near Lipowiec village, on soil, 04.08.1983, K. Czyżewska (LOD-L 8725). **Bf-62** – Pojezierze Elckie lakeland, Babrosty village, E of Pisz town, on soil, 26.08.1990, leg. S. Ciesliński (KTC). **Bf-66** – Pojezierze Elckie lakeland, Dolina Biebrzy valley, ca. 10–11 km SSE of Grajewo town, on soil, 25.09.1986, leg. S. Ciesliński (KTC). **Bg-72** – Wzgórze Sokółskie hills, on soil, 08.04.1969, leg. K. Czyżewska (LOD-L 210, 211). **Bg-82** – Wzgórze Sokółskie hills, Buchwałowo district, near Sokółka town, on soil, 05.08.1983, leg. K. Czyżewska (LOD-L 7622). **Cb-51** – Kotlina Gorzowska basin, Dolina Dolnej Noteci valley, Drezdenko town, on soil, 26.09.1975, leg. L. Lipnicki (TRN); Stare Bielice village, 08.08.1984, leg. K. Czyżewska (LOD-L 7614). **Cb-53** – Kotlina Gorzowska basin, Puszcza Notecka forest, Wronki forest inspectorate, Dębogóra forest division, forest section No. 273, on soil, 27.07.1954, leg. Z. Tobolewski (POZ); Potrzebowice forest inspectorate, Marylec forest division, forest section No. 225, on soil, 24.07.1954, leg. R. Tobolewska (POZ). **Cb-64** – Kotlina Gorzowska basin, Puszcza Notecka forest, road between Mokrzec and Rzecin villages, on soil, 27.09.1954, leg. Z. Tobolewski (POZ). **Cc-39** – Kotlina Toruńska basin, Toruń city, near Przysiecka road, on pebbles, 02.08.2005, leg. E. Adamska (TRN); between Nieszawka village and Toruń Kluczyki railway station, on soil, 04.08.1984, leg. K. Czyżewska (LOD-L 7639). **Ce-15** – Kotlina Warszawska basin, Puszcza Kampinoska forest near Warszawa city, Truskaw Pocięcha town, on soil, 27.08.1963, leg. Venseghy (BP 51827). **Cf-49** – Dolina Górnej Narwi valley, Pański – cemetery, on soil, 28.08.1991, leg. S. Ciesliński (KTC). **Cf-97** – Wysoczyzna Drohiczyńska high plain, ca. 1 km W of Wólka Zamkowa village, on soil, 19.08.1991, leg. S. Ciesliński (KTC). **Cg-11** – Wysoczyzna Białostocka high plain, ca. 1 km NNE of Grabówka village, on soil, 30.06.1991, leg. S. Ciesliński (KTC). **Cg-15** – Wysoczyzna Białostocka high plain, 3 km SSE of Kruszyniany village, on soil, 15.08.1992, leg. S. Ciesliński (KTC); 1 km W of Swisłoczany village, on soil, 15.08.1992, leg. S. Ciesliński (KTC). **Cg-33** – Dolina Górnej Narwi valley, Narew, on soil, 25.06.1987, leg. K. Czyżewska (LOD-L 7357). **Cg-34** – Dolina Górnej Narwi valley, 0.5 km NW of Tanica Górna valley, on soil, 15.08.1992, leg. S. Ciesliński (KTC-two specimens). **Cg-41** – Dolina Górnej Narwi valley, 2 km NE of Deniski village, on soil, 13.08.1992, leg. S. Ciesliński (KTC). **Cg-72** – Równina Bielska plain, 1.5 km SW of Jelonka nature reserve, Kleszczele village, alt. 160 m, 26.07.1981, leg. M.R.D. Seaward (herb. Seaward 103999); Jelonka nature reserve, position 34, on soil, 1980, leg. S. Ciesliński (KTC-two specimens); position 32, on soil, 1980, leg. S. Ciesliński (KTC); Jelonka nature reserve near Kleszczele village, on soil, 11.09.1991, leg. I. Piśút (LOD-L 8931); 05.11.1978, leg. S. Ciesliński (KTC); alt. 160 m, on soil, 15.09.1990, leg. S. Ciesliński, K. Czyżewska, A. Lackovičová and Piśút (B 97740, BM, H); between Kleszczele village and “Piaski” range, on soil, 26.06.1987, leg. K. Czyżewska (LOD-L 9004); Kleszczele village, 04.1994, leg. E. Lickiewicz (LBL); “Piaski” range near Jelonka nature reserve, W of Puszcza Białowieska forest, on soil, 12.10.2004, leg. S. Ciesliński (KTC); **Cg-91** – Wysoczyzna Drohicka high plain, Piszczatka village, on soil, 11.05.1987, leg. S. Ciesliński (KTC); 2 km NNE of Tymianka village, on soil, 12.08.1996, leg. S. Ciesliński (KTC). **Da-26** – Równina Torzymaska plain, road between Bytnica village and Krosno Odrzańskie town, 52°07'27"N, 15°08'05"E, on soil, 08.07.2005, leg. P. Czarnota 4651 (ex GPN). **Da-65** – Obniżenie Nowosolskie depression, ca. 2 km W of Lubsko, town, on soil, 27.08.1976, leg. B. Kupczyk (POZ). **Da-74** – Wzniesienia Żarskie high plain, Nowa Rola village, near Lubsko town, on soil, 05.07.1984, leg. K. Czyżewska (LOD-L 7468); Świbinki village, near Lubsko town, on soil, 05.07.1984, leg. K. Czyżewska (LOD-L 7261). **Da-87** – Bory Dolnośląskie forest, near Żagań town, on soil, 04.07.1984, leg. K. Czyżewska (LOD-L 7292, 7447). **Da-97** – Bory Dolnośląskie forest, Trzebów village near Rudawica village, on soil, 04.07.1984, leg. K. Czyżewska (LOD-L 7280). **Db-38** – Równina Szamotulska plain, near Poznań city, Ludwikowo village, on soil, 08.11.1929, leg. F. Krawiec (LBL). **Dd-93** – Wysoczyzna Łaska high plain, between Wiewiórczyn and Kolumna villages, on soil, 13.07.1984, leg. K. Czyżewska (LOD-L 7436). **Dd-94** – Wysoczyzna Łaska high plain, between Łask and Kolumna villages, on soil, 13.07.1984, leg. K. Czyżewska (LOD-L 7482). **De-13** – Kotlina Warszawska basin, Kampinoski National Park, Korfowe village, on soil, 15.07.1959, leg. J. Zielińska (WA 3288); 26.07.1961, leg. J. Zielińska (B 163210, BP 50589, H, LBL, LOD-L 191, UPS-L 48693, WA 3290, WRSL). **De-18** – Równina Wołomińska plain, traverse Rembertów near Wesoła village, 52°15'47,48"N, 21°14'34,64"E, on soil, 15.11.2009, leg. P. Zaniewski (UGDA); Szwalnicza village, 52°17'00,678"N, 21°12'03,252"E, on soil, 29.11.2009, leg. P. Zaniewski (UGDA-two specimens); “Gracholskie Piachy” dunes, on soil, leg. P. Zaniewski (UGDA). **De-88** – Równina Kozienicka plain, Dobieszyn forest inspectorate, forest section No. 46, on soil, 17.08.1974, leg. S. Ciesliński (KTC). **Df-09** – Wysoczyzna Drohicka high plain, Siemiatycze town, on soil, 10.05.1987, leg. S. Ciesliński (KTC); ca. 1 km NE of Wólka village by Bug river, on soil, 31.08.1991, leg. S. Ciesliński (KTC). **Dg-94** – Równina Łęczyńsko-Włodawska plain, Włodawa train station, on soil, 07.08.1986, leg. K. Czyżewska (LOD-L 8434). **Ea-04** – Bory Dolnośląskie forest, ca. 2 km NW of Przewóz village, 14.09.2000, leg. M.R.D. Seaward (herb. Seaward 113268). **Ec-04** – Wzgórze Ostrzeszowskie hills, Przedborów



forest inspectorate, forest section No. 29, on soil, 20.06.1975, leg. M. Tanaś, B. Paleska (LOD-L 4754). **Ec-06** – Wzgórza Ostrzeszowskie hills, Wanda forest inspectorate, Chlewo forest division, on soil, 27.07.1960, leg. Z. Tobolewski (POZ-two specimens). **Ec-14** – Wzgórza Ostrzeszowskie hills, Kobyla Góra village, on soil, 29.05.1975, leg. K. Czyżewska (LOD-L 5333); Przedborów forest inspectorate, Rybin forest division, forest section No. 151c, on soil, 20.06.1975, leg. B. Paleska, M. Tanaś (LOD-L 4748). **Ec-15** – Wysoczyzna Wieruszowska high plain, Parzynów village, on soil, 28.03.1933, leg. F. Krawiec (BM, LBL, LOD-L 8907, TRN, UGDA, WA 3291, WRSL). **Ed-13** – Kotlina Szczercowska basin, Lubiec I range, forest section No. 82, on soil, 15.04.1985, leg. K. Czyżewska (LOD-L 8561). **Ed-23** – Kotlina Szczercowska basin, Stanisławów I village, on soil, 26.05.1981, leg. K. Czyżewska (LOD-L 5758); Stanisławów II village, on soil, 26.05.1981, leg. K. Czyżewska (LOD-L 5764); near Brzeziny village, on soil, 26.07.1983, leg. K. Czyżewska (LOD-L 6892). **Ed-24** – Kotlina Szczercowska basin, Imielak village, near Szczerców village and Przerębiec bog, on soil, 06.07.1981, leg. K. Czyżewska (LOD-L 5706). **Ed-25** – Wysoczyzna Bełchatowska high plain, Rząsawa village, on Rakówka River, on soil, 27.07.1976, leg. K. Czyżewska (LOD-L 5585); near Rząsawa village, on soil, 28.07.1976, leg. K. Czyżewska (LOD-L 4598). **Ed-32** – Kotlina Szczercowska basin, Kule village near Węson village, on soil, 16.06.1964, leg. J. Nowak (KRAM-L 12558). **Ed-34** – Kotlina Szczercowska basin, Faustynów village, on soil, 25.08.1981, leg. K. Czyżewska (LOD-L 5622). **Ed-39** – Wzgórza Radomszczańskie hills, near Wielkopole village, on soil, 15.04.1970, leg. K. Czyżewska (LOD-L 2725); Stobnica village, on soil, 28.06.1972, leg. K. Czyżewska (LOD-L 2724). **Ed-41** – Wyżyna Wieluńska upland, Załęczański Landscape Park, near Ogroble village, on soil, 01.09.1981, leg. K. Czyżewska (LOD-L 4722); Ogroble village near Warta River, on soil, 23.06.1964, leg. J. Nowak (KRAM-L 12692); Jesiona village, on soil, 27.08.1979, leg. K. Czyżewska (LOD-L 4140); Góra Mogiła Mt., on soil, 03.07.1976, leg. G. Brzezicka (LOD-L-4144); between Kamion and Ogroble villages, on soil, 21.07.1976, leg. G. Brzezicka (LOD-L 5015). **Ed-46** – Wzgórza Radomszczańskie hills, Wójcik village, on soil, 31.07.1972, leg. K. Czyżewska (LOD-L 2726); near Wólka Pytowska village, on soil, 11.08.1970, leg. K. Czyżewska (LOD-L 2727). **Ed-47** – Wzgórza Radomszczańskie hills, between Kodrąb range and Lipowczyce village, on soil, 28.08.1972, leg. K. Czyżewska (LOD-L 2722). **Ed-49** – Wzgórza Radomszczańskie hills, Bąkowa Góra village, on soil, 03.08.1981, leg. P. Witosławski (LOD-L 5713). **Ed-51** – Wyżyna Wieluńska upland, Załęczański Landscape Park, Węże nature reserve, Góra Zelce Mt., on soil, 08.07.1974, leg. M. Stachurski (LOD-L 5014). **Ed-56** – Wzgórza Radomszczańskie hills, near Orzechówek village, on soil, 15.08.1972, leg. K. Czyżewska (LOD-L 2723). **Ed-79** – Niecka Włoszczowska basin, Kurzelów village, ca. 7 km NE of Włoszczowa town, on soil, 07.1987, leg. V. Rzedeczko, K. Toborowicz (KTC). **Ed-89** – Niecka Włoszczowska basin, Żeliszawiczki village, on soil, 20.06.1974, leg. K. Czyżewska (LOD-L 3382, 3416); **Ee-02** – Równina Radomska plain, between Odrzywół and Klwów villages, on soil, 17.06.1974, leg. K. Czyżewska (LOD-L 3417). **Ee-06** – Równina Radomska plain, near Przytyk village, on soil, 30.05.1976, leg. S. Cieśliński (KTC-two specimens). **Ee-08** – Równina Radomska plain, Lesiów village near Radom city, on soil, 18.08.1978, leg. S. Cieśliński (KTC- two specimens). **Ee-28** – Równina Radomska plain, Makowiec village, on soil, 02.09.1973, leg. S. Cieśliński (KTC-two specimens). **Ee-71** – Góry Świętokrzyskie Mts, Michała Góra village, on soil, 1977, leg. A. Moskwa, K. Toborowicz (KTC). **Ee-72** – Góry Świętokrzyskie Mts, Wesoła village by Wierna Rzeka River, on soil, 11.06.1975, leg. K. Toborowicz (KTC). 18.06.1975, leg. K. Toborowicz (KTC); 29.06.1975, leg. S. Cieśliński (KTC); Góra Miedzianka Mt., on soil, 06.09.1976, leg. K. Toborowicz (KTC); 24.08.1980, leg. M.R.D. Seaward, E.A. Bylińska 58921 (herb. Seaward 103882, WRSL). **Ee-73** – Góry Świętokrzyskie Mts, Słowik housing estate near Kielce city, forest section No. 9, on soil, 05.07.1972, leg. K. Toborowicz (KTC). **Ee-76** – Góry Świętokrzyskie Mts, S of Bieliny village, on soil, 03.06.1976, leg. S. Cieśliński (KTC). **Ee-84** – Góry Świętokrzyskie Mts, Chodcza forest division, forest section No. 135/140/141, on soil, 08.05.1975, leg. J. Nowak (KTC). **Ee-97** – Pogórze Szydłowskie foothills, Raków village near Kielce city, on soil, 06.07.1975, leg. S. Cieśliński (herb. Seaward 115428, KTC-two specimens); Chańcza forest division, forest section No. 90, ca. 2 km ES of Raków village, on soil, 07.1986, leg. A. Siwik (KTC). **Ef-82** – Góry Świętokrzyskie Mts, Łukawa village, on soil, 27.04.1976, leg. K. Toborowicz (KTC). **Ef-94** – Równina Biłgorajska plain, Lipa village, on soil, 21.07.1984, leg. K. Czyżewska (LOD-L 7380); between Lipa and Zaklików villages, on soil, 21.07.1984, leg. K. Czyżewska (LOD-L 7311). **Eg-04** – Równina Łęczysko-Włodawska plain, Lasy Sobiorskie forest near Włodawa town, 22.11.2002, leg. J. Bystrek (LBL). **Eg-11** – Zakłęśtość Sosnowicka hollow, Białka village near Sosnowica village, near road to Libiszowskie Lake, on soil, 1998, leg. J. Bystrek (LBL). **Fd-09** – Niecka Włoszczowska basin, Moskorzew forest inspectorate, forest section No. 279, on soil, 20.08.1975, leg. S. Cieśliński (KTC). **Fd-28** – Gorce Mts, S slope of Góra Czuba Mt., ca. alt. 800 m, on soil, 25.08.1965, leg. K. Glanc (KRAM-L 35984). **Fd-66** – Garb Tenczyński hummock, Zródła village by Wisła River near Okleśna village, on soil, 07.04.1955, leg. J. Nowak (KRAM-L 5338, 5348). **Fd-67** – Garb Tenczyński hummock, Zalas village near Krzeszowice town, alt. ca. 370 m, on soil, 04.1970, leg. J. Diak, J. Nowak (BM, BP 77474, H, LBL, LOD-L 15365). **Fe-07** – Pogórze Szydłowskie foothills, Zadoły village near Korytnica village, on soil, 1984, leg. G. Sikora (KTC-three specimens). **Fe-09** – Pogórze Szydłowskie foothills, ca. 4 km NW of Smerdyny village, on soil, 07.1984, leg. B. Zębik (KTC). **Fe-13** – Dolina Nidy valley, Pińczów town, on soil, 07.09.1977, leg. S. Cieśliński (KTC). **Ff-28** – Równina Biłgorajska plain, near Biłgoraj town, Biszcza village, on soil, 1982, leg. J. Bystrek (LBL). **Gd-15** – Beskid Żywiecki Mts, Góra Grapa-Żar Mt. near

Jeleśnia village, alt. ca. 500 m, on soil, 22.09.1964, J. Nowak (KRAM-L 15013, 16705, 16721); valley of Sopotnia Wielka stream, on stone, 25.09.1966, leg. J. Nowak (KRAM-L 16722). **Ge-28** – Beskid Niski Mts, Bordiów Wierch Mt., on stone, 23.07.1970, leg. M. Olech (KRA).

**Exsiccatae examined:** Anonymous, Reliqu. Suzaianae 65 (BM). Asahina, Lich. Japon. Exs. 293 (H). Cummings, Williams & Seymour, Lich. Bor.-Amer. 159 (H). Faltynowicz & Miądlkowska, Lich. Polon. Exs. 13 (B 146054, BM, H, LBL, LOD-L 10201, UGDA, UPS-L 56560). Fries, T., Lich. Scand.Rar. Critici. Exs. 64 (BM). Hansen, Lich. Groenl. Exs. 173 (H). Hansen, Lich. Groenl. Exs. 923 (BM). Harmand, Lich. Gall. Rar. Exs. 26 (H). Haukulinen, Lich. Fenn. Exs. 1082 (H). Krawiec, Lichenoth. Polon. 71 (BM, LBL, TRN, WA 3291, WRSL). Krzewicka, Lich. Sel. Exs. 23 (BM, H). Schaerer, Lich. Helvet. Exs. 828 (WA 3301). Magnusson, Lich. Sel. Scand. Exs. 155 (B 92553, BM, H, as *S. condensatum* var. *condyloideum*). Malme, Lich. Suec. Exs. 486 (H). Moberg, Lich. Sel. Exs. Upsal. 253 (BM, H). Norrlin, Herb. Lich. Fenn. 87 (H, as *S. condensatum* var. *condyloideum*). Nowak, Lich. Polon. Merid. Exs. 59 (BM, BP 77474, H, LBL, LOD-L 15365, UPS-L 48693). Suza, Lich. Bohemoslov. 65 (BM, H). Thøgersen, Lich. Norveg. Medit. Exs. 20 (H). Vězda, Lich. Sel. Exs. 143 (BP 50590, H). Vězda, Lich. Sel. Exs. 414 (BM, H). Vězda, Lich. Sel. Exs. 2475 (BM, H). Zielińska, Pl. Varsav. Exs. 40 (BP 50589, H, LOD-L 191, WA 3290, WRSL).

**Selected reference materials** (a total of 50 specimens of *Stereocaulon condensatum*): **Belgium**. Prov. Luxembourg (Arduenna): Bihain, in acervis lapidum ex lapicidinibus veteribus egestorum, alt. 560 m, inter lapides schistosos, ad terram, 22.08.1965, leg. J. Lambinon (BM, H). **The Czech Republic**. Moravia occident., Dačice: prope pagum Olšany, alt. 600 m, ad terram graniticam macram, 07.10.1961, leg. A. Vězda (BP 50590). **Estonia**. Pölvamaa, Värskä, on soil, 24.05.1988, leg. J. Motiejūnaitė (BILAS 4388). **Finland**. Juva: Kiiskilänniemi, road cutting, on rocks, 02.06.1989, leg. O. Vitikainen 12270 (H). **France**. Pouxieux (Vosges), près de la gare, leg. Hadot & Harmand (H). **Germany**. NRW, Eifel, Mechernich, Kallmuther Berg, MTB 5405, Bleiabbau, leg. G.B. Feige 5.1990 (KRAM). **Greenland**. Qeqertarsuaq, 69°49'N, 51°12'W, on clayey soil, 13.07.1992, leg. Eric Steen Hansen (WA 3274). **Japan**. Ūranbadai, Prov. Iwasiro, 01.10.1954, leg. Y. Asahina (H). **Lithuania**. Šalčininkai distr., Rūdninkai, on soil, 07.09.1994, leg. J. Motiejūnaitė (BILAS 1886). **Norway**. Hedmark Follidal: just N of Knutshovda aerial cableway near top, 945 m a.s.l., on sand, 24.07.1978, leg. P.J. Thøgersen 0.019a-1 (H). **Russia**. Republic of Karelia, province: Kon, Medvezhiegorskij District, Maslozero village, ca. 12 km NW, Pallosjarvi Lake, roadside, on sand, 20.07.2000 s.coll. (H). **Sweden**. Öland: Köping, in pineto cladinoso, on soil, 16.07.1914, leg. G.E. Du Rietz (B 158703).

Additional reference material examined:

*Stereocaulon glareosum* (Savicz) H. Magn.

Göteborgs Kungl. Vetensk. Samhälles Handl. Ser. 4, 30(7): 60 (1926).

HOLOTYPUS (Lamb 1977: 219): U.S.S.R., Kamtchatka, Sczapina River, 1909, leg. V.P. Savicz 6186 [115] (LE).

**Exsiccatae examined:** Beck & Zahlbruckner, Krypt. Exs. 152 (H). Haukulinen, Lich. Fenn. Exs. 963 (H). Hansen, Lich. Groenl. Exs. 129 (H). Hansen, Lich. Groenl. Exs. 985 (B 140894). Passauer, Crypt. Exs. 4735 (BP 84650). Passauer, Crypt. Exs. 4739 (H). Poelt, Pl. Graec. Lich. 235 (H). Räsänen, Lich. Fenn. Exs. 199 (H). Santesson, Lich. Austroamer. Herb. Regnelliano 528 (H).

**Selected specimens examined:** **Austria**. Tirol, Ötztaleralpen, beim Einfluß des Riffelbaches in den Riffelsee, SH, alt. ca. 2240 m Sandig, riesiger Boden (Silikat), 23.08.1961, leg. J. Poelt & M. Steiner (BP 84650); **Bolivia**. Erde, Steinen, in Nischen ob. Aldia Taguesi am Gmino d. Inca, alt. ca. 4500 m., 06.04.1987, leg. Stab (LPB). **Finland**. Satakunta, Pori, Yyterin sanntat, ad collem semigranulosum, in litore sabuloso maris, 20.08.1935, leg. M. Laurila (H). **Greenland**. Aappilattoq, 60°09'N, 44°17'W, on gravelly soil, 23.07.2004, leg. Eric Steen Hansen (B 140894). **Iceland**. IVE (Vestur-Island), Snæfellsnessýsla, Kolgrafarfjörður fjord – 64.91°N, 23.09°W. From sealevel., on soil, 23.07.2009, leg. M. Oset (UGDA). **Mongolia**. Bayan-Khongor pr., Baidarig sum, S slope of Khangai rigge of mountain, alt. 2400 m, on soil between rocks, 08.09.1973, leg. L.I. Biazrov 324 (MRDS). **Peru**. Dept. Pasco, Prov. Cerro de Pasco, ca. 3 km SE of Cerro de Pasco, alt. ca. 4300 m, 10°42'S, 76°15'W, 17.02.1981, leg. R. Santesson, R. Moberg P28:16 (H). **Russia**. near Chalgai, o. Ol'hon, 03.08.1997, leg. M.R.D. Seaward (MRDS 108916). **Sweden**. Jämtland: Forstvikén, by a foot-bridge over the torrent, Hällingsån, on the sandy bank, 03.08.1934, leg. A.H. Magnusson (UPS). **Switzerland**. Walliser Alpen, Wallis: Val d'Anniviers, Glazialallunion am Glacier du Zinal, 1900 m, geuchte Feinsandmulden, reichlich fruchtend, mit St. Farinaceum, 1959, leg. E. Frey (LBL).

#### 4.3.4. *Stereocaulon dactylophyllum* Flörke (Plate I–8, Plate II–9)

Deutsche Lich. 4: 13 (1819). = *Stereocaulon coralloides* var. *dactylophyllum* (Flörke) Th. Fr., De Stereoc. et Pilophor. Comment.: 16 (1857). = *Stereocaulon paschale* subsp. *dactylophyllum* (Flörke) Branth & Rostr., Bot. Tidsskr. 3: 162 (1869). = *Stereocaulon coralloides* f. *dactylophyllum* (Flörke) Th. Fr., Lichenogr. Scand. 1: 44 (1871). = *Stereocaulon coralloides* subvar. *dactylophyllum* (Flörke) Boistel, Nouvelle Flore des Lichenes, 2e. Partie: 36 (1903).

**SYNTYPUS** (Lamb 1977:212): [Germany] without locality (UPS, Flörke, Deutsche Lich. 78).

**Note.** According to Art. 9.2, 9.11 ICBN [104] name requires lectotypification.  
= *Stereocaulon coralloides* Fr., Schedulae Criticae de Lichenibus Exsiccatis Sueciae 3: 24 (1825). = *Stereocaulon paschale* subsp. *coralloides* (Fr.) Branth & Rostr., Bot. Tidsskr. 3: 162 (1869).

**SYNTYPUS** (Lamb 1977:310): [Sweden] without locality, data, s.coll. (M – Fries, Lich. Suec. Exs. 118).

**Note.** According to Art. 9.2, 9.11 ICBN [104] name requires lectotypification.  
= *Stereocaulon corallinum* auct. non (L.) Schrad. – name used by many researchers before Fries, but incorrectly; based on type *Lichen corallinus* L., which is a synonym of *Pertusaria corallina* (L.) Arn. (see [21]).

**Description.** Primary thallus disappearing. Pseudopodetia erect, up to 6 cm tall, often forming tufts, firmly attached to substrate, simple at the base and irregularly branched upwards with spreading long and short branches. Pseudopodetia usually without tomentum on lower part, very rarely slightly tomentose towards base of young branches, not dorsiventral. Phyllocladia cylindrical, branched becoming coralloid and elongate, not confluent, occasionally forming crust-like masses (Plate II–9). Cephalodia rare, partly concealed in the tomentum, verrucose or granular, brownish-grey, containing *Stigonema* (Plate I–8). Apothecia frequent, terminal on short, terminal branches, in young specimens with pale margin, in older convex and without margin.

**Chemistry.** *Stereocaulon dactylophyllum* produces atranorin and stictic, norstictic and cryptostictic acids. According to Lamb [21] norstictic acid occurs in this species rarely and in small amounts. Indeed, only two of sixteen examined Polish specimens contained trace of this substance. Spot test reactions: K+ yellow, PD+ orange.

**Notes.** *Stereocaulon dactylophyllum* is a very well known and rather readily recognizable lichen species, characterized by the coralloid (finger-like, elongate), much-branched phyllocladia, and the presence of stictic acid complex [20,60,113].

Within *S. dactylophyllum* several varieties and forms were distinguished, of which the latter probably reflect the influence of different environmental conditions. All specimens from the country belong to *S. dactylophyllum* s.str.

*Stereocaulon dactylophyllum* var. *occidentale* (H. Magn.) Grumm. was also noted from Poland, for example by Krawiec ([49]; as *S. spissum* Nyl.). This taxon differs from *S. dactylophyllum* s.str. by prostrate-decumbent, markedly dorsiventral pseudopodetia and shape of phyllocladia, which can be more flattened and digitate-squamulose [22]. Unfortunately, during this study any one Polish specimen annotated as *S. dactylophyllum* var. *occidentale* has not been found.

*Stereocaulon subcoralloides* is morphologically most similar species. However it produces atranorin and lobaric acid, its pseudopodetia are loosely attached to the substratum and they are only rarely branched in lower part but numerous towards the ends. Phyllocladia are coralloid and numerous at the top. Cephalodia also contain *Stigonema*, but they are numerous and olive-brown.

According to Gilbert et al. [60] *S. dactylophyllum* is also similar to *S. evolutum*. The feature that distinguishes the two taxa is a different composition of lichen secondary metabolites since *S. evolutum* produces atranorin and lobaric acid and its phyllocladia are first granular, later flattened, deeply divided into cylindrical extensions.

**Habitat requirements.** *Stereocaulon dactylophyllum* is a saxicolous species in Poland. It occurs mainly on granite (more than 90% of specimens) in pine forests and open habitats. According to Gilbert et al. [60] this taxon can occur on metal-enriched rocks. This information is also provided by Pyatt et al. [125], who examined the prevalence of *S. dactylophyllum*

on a substrate riched in various elements (such as Mg, Al, S, Mn, Pb, P) and the ability of the taxon to their accumulation.

**World distribution.** This species is a disjunct amphi-Atlantic boreal species, occurring in Europe, Greenland, eastern Canada and eastern and central USA. [21,113]. During this research localities in Europe (Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Lithuania, Norway, Romania, Sweden, United Kingdom and Italy) and North America (Canada, USA) have been confirmed. In addition Lamb [21] reported *S. dactylophyllum* from Greenland, Siberia, Estonia and Ukraine.

Other literature records: Asia – China [106], Mongolia [126]; Europe – Spain [109], the Netherlands [127], Ireland [121], Portugal (Azores) [128].

**Distribution in Poland.** *Stereocaulon dactylophyllum* was reported for the first time from Poland by Flotow in 1849 (cf. [51] and literature cited therein). It was recorded in Poland in many regions except cetral parts of the country. Current research shows, however, that these taxa occurs in north-west and south of Poland (Fig. 4). *Stereocaulon dactylophyllum* is an endangered lichen (category EN) [59]. Number of examined specimens from Poland: 16.

**Specimens examined:** **Ac-61** – Wysoczyzna Damnicka high plain, near Jałowców nature reserve, on rocks, 18.09.1982, leg. W. Fałtynowicz (UGDA-L 1747). **Ac-65** – Pojezierze Kaszubskie lakeland, Jeżewo village, SW of Strzebielino village, on rocks, 30.07.1985, leg. W. Fałtynowicz (UGDA-L 3017); Rozłazino village, on rocks, 04.04.1986, leg. W. Fałtynowicz, Z. Tobolewski (UGDA-L 2960). **Ac-66** – Pojezierze Kaszubskie lakeland, Paraszyno village, on rocks, 18.07.1985, leg. W. Fałtynowicz (UGDA); Porzecze village, S of Strzebielino village, on rocks, 11.07.1985, leg. W. Fałtynowicz (UGDA-L 3278). **Ac-88** – Pojezierze Kaszubskie lakeland, ca. 1 km S of Tuchomskie lake, 54°24'40"N, 18°21'40"E, on rocks, 11.06.2004, leg. M. Kukwa (UGDA-L 11765). **Ac-91** – Pradolina Łeby i Redy proto-valley, Wierzbnik village, Darżkowo 27 village, on stone, 11.09.2005, leg. I. Izydorek (SLTC). **Bb-12** – Równina Białogardzka plain, 2 km NE of Karlin village, near Białogard town, on rock, 19.10.1987, leg. W. Fałtynowicz, J. Miądlukowska (UGDA-L 3800). **Bb-19** – Pojezierze Bytowskie lakeland, Dretyń forest inspectorate, Trzcinnno forest division, forest section No. 168, on soil, 31.08.1978, leg. I. Izydorek (SLTC). **Bc-05** – Pojezierze Kaszubskie lakeland, Rozłazino village, on rock, 30.07.1985, leg. W. Fałtynowicz (UGDA-L 3439). **Fb-14** – Góry Stołowe Mts, S slope of Mały Szczeliniec

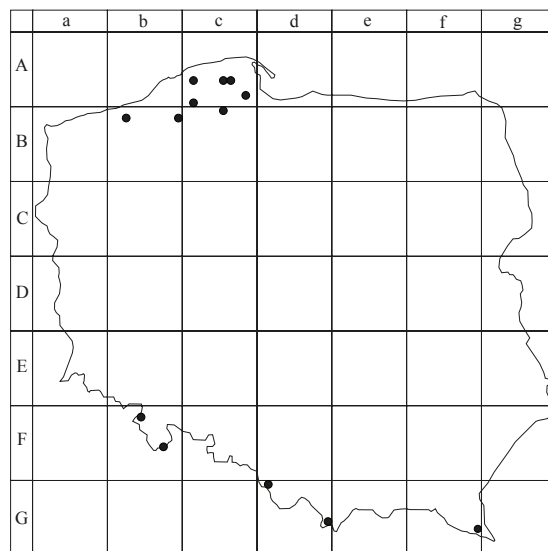


Fig. 4 Distribution of *Stereocaulon dactylophyllum* in Poland.

Mt., alt. ca. 820 m, on sandstone, 14.07.1951, leg. Z. Tobolewski (POZ). **Fb-57** – Masyw Śnieżnika Massif, Trójmorski Wierch Mt., alt. 1140 m, 23.06.2003, leg. K. Szczepańska (herb. Szczepańska 366). **Gd-01** – Beskid Śląski Mts, Krzywy Mt., alt. 630 m, on sands, 11.07.1963, leg. J. Kiszka (KRAP). **Gd-59** – Tatry Zachodnie Mts, Suche Czuby Mt., alt. ca. 1800 m, on a granite rock, 21.06.1998, leg. U. Bielczyk (KRAM-L 44455). **Gf-69** – Bieszczady Zachodnie Mts, SW slope of Połonina Caryńska Mt., alt. ca. 1150 m, on stone, 24.09.1958, leg. Z. Tobolewski (POZ); SE slope of Połonina Caryńska Mt., alt. 1100 m, on stone, 24.09.1968, leg. K. Glanc (KRAM-L 35895).

**Exsiccatae examined:** Arnold, Lich. Exs. 1483 (BM, H, as *S. coralloides*). Arnold, Lich. Exs. 1483 b (BM, H, as *S. coralloides*). Beck & Zahlbruckner, Crypt. Exs. 355 (BP 13488). Borza, Fl. Roman. Exs. 1409 (BM). Britzelmayer, Lich. Exs. Fl. Augsb. Suppl. II 524 (BM). Britzelmayer, Lich. Exs. 542 (H, as *S. coralloides*). Claudel, Claudel & Harmand, Lich. Gall. 107 (H). Passauer, Crypt. Exs. 4859 (BP 85636, as *S. dactylophyllum* var. *occidentale*). Desmazières, Pl. Crypt. N. France, Ed. 2. 46 (BM). Floerke, Deutsche Lich. 78 (UPS). Follmann, Lich. Exs. Sel. Cassel. 135 (H). Hansen & Christensen, Lich. Dan. Exs. 458 (H, UGDA). Havaas, Lich. Norveg. Occid. Exs. 103 (BP 13494). Hofmann, Pl. Crit. Saxon. 71 (BM, as *S. coralloides* var. *dactylophyllum*). Kerner von Marilaun, Fl. Exs. Austro-Hung. 1538 (BM-two specimens, H- two specimens). Kurokawa, Lich. Rar. Crit. Exs. 96 (BM, H). Leighton, Lich. Brit. Exs. 148 (H). Macoun, Canad. Lich. 133 (BM, as *S. paschale*). Malme, Lich. Suec. Exs. 559 (H, as *S. coralloides*). Petrak, Crypt. Exs. 355 (BP 13488, as *S. coralloides*). Räsänen, Lich. Fenn. Exs. 55 (BM, H- two specimens). Schade, Stolle & Rieher, Lich. Saxon. Exs. 363 (BP 65506, as *S. coralloides* f. *pumilum*). Stenhammar, Lich. Suec. Exs. 82 (BM). Suza, Lich. Bohemoslov. Exs. 66 (H). Trevisan, Lichenoth. Ven. 142 (H, as *S. corallinum*). Vězda, Lich. Sel. Exs. 44 (BM, H). Vězda, Lich. Sel. Exs. 866 (BM, H). Wartmann & Schenk, Schweiz. Krypt. 552 (BM). Zahlbruckner, Krypt. Exs. 155 (BM, as *S. coralloides*). Zahlbruckner, Krypt. Exs. 155 b (BM, as *S. coralloides*). Zwackh-Holzhausen, Lich. Exs. 997 (H-NYL 39878, as *S. dactylophyllum* var. *occidentale*).

**Selected reference materials** (a total of 110 specimens of *Stereocaulon dactylophyllum* s.str.): **Austria.** Vorarlberg. Verwall-Gruppe, S von Klösterle: Mittlerer Teil des Nanzigastales zwischen der Abzweigung zum Burtschakopf und der Nenzigastalpe sowie deren weiteren Umgebung, alt. 1320–1500 m, 26.07.1986, leg. A. Vězda (B 63744). **Belgium.** Prov. Luxembourg (Arduenna): Vielsalm, loco “Thier des Carrières” dictio, in acervis lapidum ex lapidibus veteris egestorum, alt. 450 m, ad lapides phylladeoes, 08.06.1967, leg. G. Clauzade, J. Lambinon (BM). **Canada.** Nova Scotia, Baddeck, Cape Breton Island, on rock and boulders, 22.07.1898, leg. J. Macoun (BM). **The Czech Republic.** Czeska Szwarzcaria, Studenec, 24.04.2003, leg. K. Szczepańska 239 (herb. Szczepańska). Denmark. Sjælland, Nivå, at railway track, on stones, 13.10.2005, leg. O.B. Lyshede, V. Alstrup (UGDA). **Finland.** Tavastia Australis (Ta/EH), Lammi: Evo, 1874, leg. J.P. Norrlin (H). **France.** Bretagne, Roc’h Trévezel, on rock, 19.07.1954, leg. Fr. Mattick (B 163177). **Germany.** Sachsen: Erzhalde “Kalter Muff” bei Ehrenfriedersdorf, 600 m ü. m., 27.07.1965, leg. S. Huneck (B 115830). **Great Britain.** Pembroke: S of Newport, by Bedd Morris, V. C. 45, Standing Stone, 31.07.1978, leg. P.W. James (BM). **Italy.** Syenitfelsen am Fusse der Margola bei Predazzo, 1884, leg. Lojka (BM). **Lithuania.** Ant silikatinio akmes ridulynė, Salantų RP, Skuodo raj., Šauklių geologinis draustinis, 11.09.2001, leg. J. Motiejūnaitė (BILAS 5961). **Norway.** Huglo pr. Bergen, on rocks, 19.07.1927, leg. J. Motyka (LBL). **Romania.** Muntenia, distr. Dâmbovița, inter Bolboci et Cheile Zănoagei, montium Bucegi, alt. 1400 m, solo calc. arenoso., 15.09.1936, leg. P. Cretzoiu (BM). **Scotland.** Sidlaw Hills, 05.1846, s.coll. (BM). **Sweden.** Östergötland, Österbymo, spruce forest, on rocks, 29.08.1987, leg. E. Koziol (KRAM-L 43399). **USA.** McDowell County: Near Mt. Mitchell, on roadside rock, 08.1958, leg. W.L. Culberson (B 132389).

#### 4.3.5. *Stereocaulon evolutum* Graewe ex Th. Fr. (Plate II–10,11)

Bot. Not.: 181 (1865). = *Stereocaulon evolutum* var. *typicum* Th. Fr., Lichenogr. Scand. 1: 45 (1871).

**HOLOTYPUS** (Lamb 1977: 217): [Sweden], Västergötland. Främmestad: Viste herad. Berget mid Baljefors 1864. No. 1. F. Graewe (UPS-L 108391!; ISOTYPUS: H!).

= *Stereocaulon evolutum* f. *planum* H. Magn., Göteborgs K. Vetensk.- o. Vitterh.-Samh. Handl. ser. 4, 30 (7): 70 (1926).

**LECTOTYPUS** (Lamb 1977: 311): [Sweden], Bohuslän, par. Naverstand, Klageröd, on rock, 24.07.1917, A.H. Magnusson (UPS-L 108389!).

= *Stereocaulon lusitanicum* H. Magn. ex Tav., Brotéria 16 (43): 147 (1947).

**HOLOTYPUS** (Lamb 1977: 311): [Portugal], Minho, Serra do Gerez, près Cabril, 1.07.1944, C. Tavares (No. 196) (UPS-L 82694!).

**Description.** Primary thallus disappearing. Pseudopodetia 1–3 cm tall, loosely attached to the substrate, usually forming compact cushions to 6 cm in diameter, grey, arched or prostrate at the apices, irregularly branched from the base, dorsiventral and decumbent. Grey tomentum only on apices of pseudopodetia or usually lack. Phyllocladia at first granular, later flattened,

deeply divided into cylindrical extensions, often overlapping and concealing pseudopodia; the lower surface glabrous, olive-grey (Plate II–11). Cephalodia rare, grain like, olive-brown, containing *Stigonema* (Plate II–10). Apothecia not present in Polish specimens. According to Lamb [21] and Dombrovskaya [87], this species forms terminal apothecia, 1 cm in diameter, flat at the beginning, older convex.

**Chemistry.** *Stereocaulon evolutum* produces atranorin and lobaric acid [21]. According to Ramaut [129] thallus contains atranorin, lobaric acid and norstictic acid, but during this study none of the analyzed specimens from the country and the world, did not contain norstictic acid. Probably norstictic acid reported by Ramaut [129] was some contamination from heterogenic sample. Some unidentified substances have been also detected in the present study in three specimens, from Sweden (1) and Finland (2). Spot test reaction: PD+ yellow.

**Notes.** *Stereocaulon evolutum* is characterized by dissapering primary thallus, grey tomentum present only on the apices of pseudopodium and grey, flattened, divided, often overlapping phyllocladia.

This species is morphologically and chemically similar to *S. saxatile*. Both produce atranorin and lobaric acid. *S. saxatile* has stout, prostrate, dorsiventral, richly branched in upper part pseudopodia, forming dense tufts. Its tomentum is grey, always present toward apices. Phyllocladia are quite different than *S. evolutum*. They are scale-like to granular, almost completely covering pseudopodia.

**Habitat requirements.** *Stereocaulon evolutum* is a saxicolous lichen (100% specimens) and occurs on erratic exposed boulders, especially on granite rocks. Sometimes it was found among mosses [20,50,60].

**World distribution.** This is a taxon with an Atlantic distribution occurring mainly along coastal regions of Western Europe from Scandinavia and the Faroe Islands to the north to Spain, Portugal, Madeira and Canary Islands [21]. The presence of this taxon in Canada, Denmark, Finland, France, Germany, Ireland, Norway, Sweden and the United Kingdom has been confirmed in this study. In addition Lamb [21] noted *S. evolutum* from Belgium. Other records are known also from Turkey [130] and the Czech Republic [131], Estonia [132], the Netherlands [127], Luxembourg [133] and Slovakia [134].

**Distribution in Poland.** *Stereocaulon evolutum* is very rare in Poland. So far it was known from only three localities, Kręgi Kamienne nature reserve, The Równina Polanowska plain, and The High Tatra Mts [51,52,58]. After the revision of Polish material this species was confirmed from the High Tatra Mts. The collections from Kręgi Kamienne reserve and Równina Polanowska plain have not been found. In this work *S. evolutum* is given for the first time from the Karkonosze Mts and the Góry Stołowe Mts (Fig. 5). According to Cieśliński et al. [59] it is a taxon vulnerable to extinction (category VU). Number of examined specimens from Poland: 6.

**Specimens examined:** **Eb-80** – Karkonosze Mts, Kopa Mt., near Karpacz town, alt. 1180 m, 26.08.1980, leg. M.R.D. Seaward, E.A. Bylińska (herb. Seaward 103506). **Fb-14** – Góry Stołowe Mts, Szczeliniec Wielki, alt. ca. 916 m, 50°29'07"N, 16°20'19"E, on rock, 16.06.2006, leg. M. Dimos-Zych (herb. Dimos-Zych). **Ge-60** – Tatry Wschodnie Mts, Szpiglasowa Przełęcz pass, alt. ca. 1200 m, on shale, 27.08.1956, leg. Z. Tobolewski (POZ). W slope of Hińczowa Przełęcz pass, alt. ca. 2323 m, 49°11'16"N, 20°03'19"E, the rock overhead, 01.08.2003, leg. A. Flakus 1111 (KRAM); Dolinka pod Kotłem valley in Dolina Pięciu Stawów Polskich valley, above Zadni Staw pond, alt. ca. 1950 m, 20.09.1955, leg. Z. Tobolewski (POZ-two specimens).

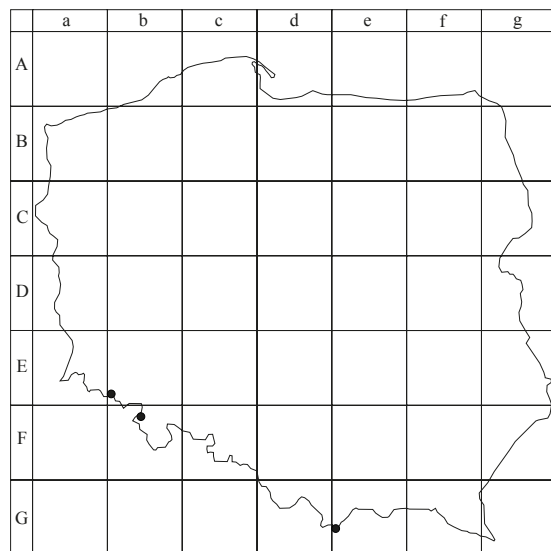


Fig. 5 Distribution of *Stereocaulon evolutum* in Poland.

**Exsiccatae examined:** Claudel, Claudel & Harmand, Lich. Gall. 479 (H). Hamberg, Krypt.-Herb. 50 (UPS). Hansen & Christensen, Lich. Dan. Exs. 146 (UGDA). Keissler, Krypt. Exs. 2065 (H). Magnusson, Lich. Sel. Scand. Exs. 237 (B 92635, BM, BP 13562, H, UPS-L 82694, as *S. evolutum* f. *planum*). Malme, Lich. Suec. Exs. 508 (B 158706, as *S. coralloides*). Malme, Lich. Suec. Exs. 677 (B 158699, H). Petrak, Crypt. Exs. 2065 (BP 13564). Räsänen, Lichenoth. Fenn. 103 (B 158708, 46477, as *S. squamescens*). Zahlbruckner, Crypt. Exs. 2065 (BP).

**Selected reference materials** (a total of 63 specimens of *Stereocaulon evolutum*): **Canada.** Sudbury, on rocks with *Cu*, 07.1974, S. Pączka (LOD-L 5077). **Denmark.** Bornholm, Paradisbakkerne, open area in forest together with *Leproloma membranaceum*, on granite rock, 30.06.1998, leg. E.S. Hansen (UGDA). **Finland.** Alandia (A1/A). Kumlinge: Torsholm, *Pinus sylvestris* clad, sloping rocks between the ferry berth and Tuggverka, 11.08.1991, leg. R. Skyén 5781 (H). **France.** La Salveteat (Hérault), supra rupes graniticas, leg. Fr. Marc (H). **Germany.** Sachsen-Anhalt: Harz, Höllenkuppe, Hohneklippen, auf Granit, alt. ca. 900 m, 27.08.1974, leg. S. Huneck (B 115832). **Great Britain.** Co. Devon, Dartmoor, E of Sourton, W of High Willhays, alt. ca. 400 m, at forest of Black Tor, on granite boulders, 05.09.1971, leg. H. Sipman 4762 (B). **Ireland.** Co. Donegal. VC. 34. Mt. Bulbin, S of Clonmany, alt. ca. 500 m, NW-facing shale cliffs in blanket bog, 18.07.1991, leg. H. Sipman 30820 (B). **Sweden.** Östergötland, Österbymo, spruce forest, the granite boulders, 08.1988, leg. E. Koziół (WRSL).

#### 4.3.6. *Stereocaulon incrustatum* Flörke (Plate II–12)

Deutsche Lich. 4: 12 (1819). = *Stereocaulon tomentosum* var. *incrustatum* (Flörke) Schaer., Lich. Helvet. Spicil., Sect. VI: 276 (1833). = *Stereocaulon tomentosum* subsp. *incrustatum* (Flörke) Nyl., Syn. Method. Lich. 1(2): 245 (1860).

**LECTOTYPUS** (Lamb 1977: 220): [Germany, Schmargendorf In Grunewald near Berlin.] In der Schonung gleich hinter Schmargendorf bei Berl. 1816 [H.G. Flörke] (ROST; ISOLECTOTYPUS: UPS-L 82693!). = *Stereocaulon incrustatum* var. *elatum* Oxner, J. Bot. Acad. Sci. RSS Ukraine 1(2): 314 (1940).

**LECTOTYPUS** (*hoc loco designatus*): Sibiria, Distr. Irkutsk, in ditone silvatica Baikalensi, in vicinitate st. Sljudianka, in promontorio jugi Chamar-Daban, 05.08.1927, A. Oxner (UPS-L 82701!).

**Description.** Primary thallus disappearing. Pseudopodetia erect or rising, ca. 1–3 cm tall, forming loose tufts, simple or sparingly branched, with thick, whitish-grey or ashy tomentum. Phyllocladia verrucose, whitish-grey, irregularly distributed along the pseudopodetia, with

basal parts immersed in tomentum (Plate II–12). Cephalodia usually where the phyllocladia are sparse, spherical, dark brown, containing *Stigonema*. Soredia rare. Apothecia rare, terminal, single or confluent, convex and without margin, blackish-brown (seen in one Polish specimen).

**Chemistry.** *Stereocaulon incrustatum* produces atranorin and rarely lobaric acid. 107 specimens (i.e. 88%) contained atranorin only, and in 15 cases lobaric acid was additionally detected. According to Lamb [21] the chemotype of *S. incrustatum* with only atranorin is extremely rare. Spot test reaction: K+ yellow, PD± pale yellow, KC–.

**Notes.** *Stereocaulon incrustatum* is easily recognizable due to erect, simple or sparingly branched pseudopodetia, to 3 cm tall, with thick, whitish-grey or ashy tomentum. Additionally very characteristic for these taxa are verrucose phyllocladia irregularly distributed along the pseudopodetia, with basal parts immersed in tomentum.

According to Lamb [21] *S. glareosum* is the most similar to *S. incrustatum*, but in my opinion, both species are significantly different, and *S. glareosum* more resembles *S. condensatum* (see notes under *S. condensatum*).

*Stereocaulon incrustatum* is chemically variable. According to the literature (e.g. [20,21,135]), this species produces atranorin and lobaric acid, and occasionally only atranorin. However, in Poland, only 12% of the analysed specimens contained both substances. It is worth mentioning that the isoelectotype deposited in UPS also contains only atranorin. According to research conducted by Högnabba [36], *S. incrustatum* is not a monophyletic species, so perhaps both chemotype can represent two different species. In order to verify this hypothesis, further molecular studies are required.

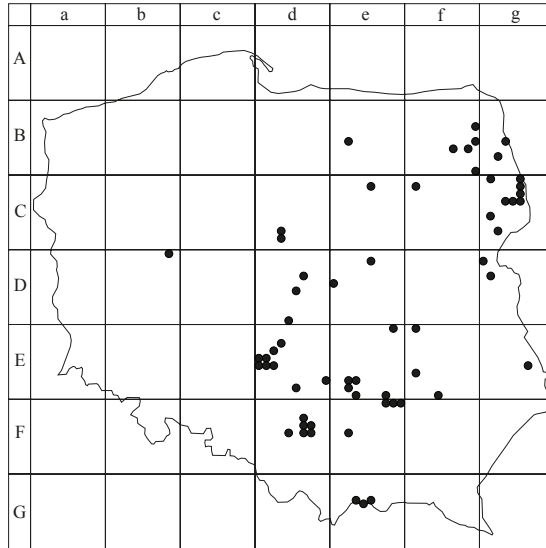
**Habitat requirements.** *Stereocaulon incrustatum* is terricolous, rarely saxicolous, lichen and occurs on sandy soil, siliceous boulders and small stones [51]. In Poland it is found mainly on soil (118 specimens; i.e. 97%), and very rarely on grit (1 specimen; i.e. 0.5%) and limestone (3 specimens; 2.5%). All examined specimens were found in well-lit and open habitats, such as dry pine forests and inland sand dune vegetation.

**World distribution.** *Stereocaulon incrustatum* is a hemiboreal to southern boreal species, which has never been reported from the Southern Hemisphere [21]. In Europe, it has a mainly continental distribution [21]. During this study the materials of *S. incrustatum* from Japan and Korea, as well as Austria, Belarus, Estonia, Finland, Lithuania, Germany, Norway, Russia, Slovakia, Sweden and Italy have been examined. In addition Lamb [21] confirmed its occurrence in Mongolia, USA (including Alaska) and Denmark, France, Romania and Hungary. It was also reported from Greenland [136].

**Distribution in Poland.** This taxon is distributed throughout Poland. Whereas the lack of data from the north and west parts of the country are most likely due to the lack of researches in these areas and the lack of corresponding herbarium material.

*Stereocaulon incrustatum* was found in Poland for the first time by Flotow ([37]; see also [51]). In the 60s of the twentieth century, it was considered as species known from numerous records in Pomerania, Silesia, the Sudety Mts, the Tatra Mts and other mountain ranges, and not collected in central and eastern Poland [20]. Current data do not support this distribution since more examined materials relate to eastern, central and southern parts of the country (Fig. 6). The localities cited below were partly cited by Oset [53], but several new data are added here as well. Number of examined specimens from Poland: 122.





**Fig. 6** Distribution of *Stereocaulon incrustatum* in Poland.

**Specimens examined:** **Be-52** – Pojezierze Olsztyńskie Lakeland, Olsztyn city, on soil, 20.05.1963, leg. J. Nowak (KRAM-L 8258). **Bf-39** – Równina Augustowska plain, near Lipowiec village, on soil, 04.08.1983, leg. K. Czyżewska (LOD-L 8178). **Bf-59** – Kotlina Biebrzańska basin, Grzędy nature reserve, on soil, 26.03.2001, leg. A. Czubała (Białystok 26). **Bf-66** – Kotlina Biebrzańska basin, Dolina Biebrzy valley, ca. 10–11 km SE of Grajewo town, on soil, 25.09.1986, leg. S. Ciesliński (KTC). **Bf-68** – Kotlina Biebrzańska basin, Dolina Biebrzy valley, Czerwone Bagno nature reserve, on soil, 24.09.1986, leg. S. Ciesliński (KTC). **Bf-99** – Wysoczyzna Białostocka high plain, Grądy village, 08.1976, leg. J. Bagińska (LBL); Jaskra village, 09.1976, leg. J. Bagińska (LBL). **Bg-53** – Wzgórza Sokólskie hills, Jagnity village above Biebrza River, on soil, 25.06.1981, leg. S. Ciesliński (KTC). **Bg-72** – Wzgórza Sokólskie hills, on soil, 08.04.1969, leg. K. Czyżewska (LOD-L 209). **Cd-73** – Kotlina Płocka basin, Warząchewka village, on soil, 30.07.1984, leg. K. Czyżewska (LOD-L 7538). **Cd-83** – Kotlina Płocka basin, near Włocławek city, on soil, 30.07.1984, leg. K. Czyżewska (LOD-L 7526). **Ce-15** – Kotlina Warszawska basin, Kampinos National Park, Truskaw village, on soil, 05.10.1960, leg. J. Zielińska (B 158707, BP 50583, H, LBL, LOD-L 193, WA 3297, WRSL). **Cf-11** – Dolina Dolnej Narwi valley, on soil, 13.05.1985, leg. K. Czyżewska (LOD-L 8920). **Cg-01** – Wysoczyzna Białostocka high plain, Puszcza Knyszyńska forest, Walify village, near Zubki village, on soil, 04.09.1991, leg. A. Karpowicz (Białystok 55, 56). **Cg-05** – Wysoczyzna Białostocka high plain, 3 km SSE of Kruszyniany village, on soil, 15.08.1992, leg. S. Ciesliński (KTC). **Cg-15** – Wysoczyzna Białostocka high plain, ca. 2.5 km W of Wierobie village, on soil, 29.06.1991, leg. S. Ciesliński (KTC). **Cg-25** – Dolina Górnej Narwi valley, ca. 2 km SW of Szymki village on soil, 13.05.1987, leg. S. Ciesliński, Z. Tobolewski (KTC). **Cg-33** – Dolina Górnej Narwi valley, Narew village, on soil, 25.06.1987, leg. K. Czyżewska (LOD-L 7358). **Cg-34** – Dolina Górnej Narwi valley, 0.5 km NW of Tanica Górna valley, on soil, 15.08.1992, leg. S. Ciesliński (KTC). **Cg-35** – Równina Bielska plain, near Zalew Siemianówka overflow and Tarnopol village, on soil, 02.05.1993, leg. B. Marszałik (Białystok 58, 59, 60, 61); Rybaki village, on soil, 23.05.1993, leg. B. Marszałik (Białystok 53). **Cg-51** – Kotlina Gorzowska basin, Stare Bielice village, on soil, 08.08.1984, leg. K. Czyżewska (LOD-L 7605). **Cg-72** – Równina Bielska plain, Jelonka nature reserve, on soil, 05.11.1978, leg. S. Ciesliński (KTC); W side of Puszcza Białowieska forest, on soil, 1979, leg. S. Ciesliński (KTC); 1.5 km SW of Jelonka nature reserve, Kleszczule village, alt. 180 m, 26.07.1981, leg. M.R.D. Seaward (herb. Seaward 103944); road from Kleszczule village to Jelonka village, 28.07.1975, leg. K.P. Günther (B 146063); Kleszczule village, 10.1993, leg. E. Lickiewicz (LBL); 04.1994, leg. H. Wójciak (LBL). **Db-08** – Pojezierze Poznańskie lakeland, Równina Poznańska plain, Poznań city, on soil, 04.1951, leg. T. Krotoska (POZ). **Dd-36** – Dolina Środkowej Wisły valley, vicinity of Puławy city, on soil, s.coll. (WA 3296, 3298). **Dd-55** – Wzniesienia Łódzkie heights, Rosanów village, Ciosny nature reserve, on soil,

25.06.1983, leg. K. Czyżewska (LOD-L 8421). **Dd-94** – Wysoczyzna Łaska high plain, between Łaska and Kolumna villages, on soil, 13.07.1984, leg. K. Czyżewska (LOD-L 7480). **De-15** – Kotlina Warszawska basin, Kampinos National Park, Pocięcha village, on soil, 15.08.1962, leg. J. Zielińska (WA 3293). **De-40** – Równina Łowicko-Błońska plain, near Krępy village, on soil, 30.06.1983, leg. K. Czyżewska (LOD-L 8443). **Dg-10** – Podlaski Przełom Bugu, Serpelice village, on soil, 1976, leg. E. Daniluk (LBL). **Dg-31** – Zakłęsłość Łomaska depression, Biała Podlaska city, on soil, 08.08.1986, leg. K. Czyżewska (LOD-L 4721). **Ed-23** – Kotlina Szczercowska basin, Stanisławów I village, on soil, 27.07.1976, leg. K. Czyżewska (LOD-L 5473). **Ed-32** – Kotlina Szczercowska basin, Kule village near Węson village, on soil, 16.06.1964, leg. J. Nowak (KRAM-L 12061). **Ed-40** – Wyżyna Wieluńska upland, Załęczański Landscape Park, near Madely, on soil, 28.06.1977, leg. K. Czyżewska (LOD-L 4202). **Ed-41** – Wyżyna Wieluńska upland, Załęczański Landscape Park, Sęśów village, on soil, 08.1979, leg. K. Czyżewska (LOD-L 4826, 4830); 07.07.1981, leg. K. Czyżewska (LOD-L 5587); Jesiona village, on grit, 27.08.1979, leg. K. Czyżewska (LOD-L 4141, 4205); Góra Mogiła Mt., near Kamion village, on soil, 21.07.1976, leg. G. Brzezicka (LOD-L 5010); SW slope of Góra Mogiła Mt., near Kamion village, on soil, 03.07.1976, leg. K. Czyżewska (LOD-L 4207); near Kamion village, on soil, 04.11.1976, leg. K. Czyżewska (LOD-L 4206); near Ogroble village, on soil, 20.07.1976, leg. K. Czyżewska (LOD-L 5005); 01.09.1981, leg. K. Czyżewska (LOD-L 5685); Bobrowniki village near Działoszyn town, on soil, 23.06.1964, leg. J. Nowak (KRAM-L 11979); Góra św. Genowefy Mt. near Bobrowniki village, on soil, 23.06.1964, leg. J. Nowak (KRAM-L 11957); Ogroble village by the Warta River, on soil, 23.06.1964, leg. J. Nowak (KRAM-L 12691). **Ed-50** – Wyżyna Wieluńska upland, Załęczański Landscape Park, Załęcze Wielkie village, on soil, 29.06.1977, leg. K. Czyżewska (LOD-L 4203); Wronia Woda sacred spot, forest section No. 20, on soil, 08.07.1978, leg. K. Czyżewska (LOD-L 4225). **Ed-51** – Wyżyna Wieluńska upland, Załęczański Landscape Park, Węże nature reserve, Góra Zelce Mt., on soil, 08.07.1971, leg. M. Stachurski (LOD-L 5013); Kuźnica village, near Góra Zelce Mt., on soil, 01.09.1981, leg. K. Czyżewska (LOD-L 5683). **Ed-52** – Wyżyna Wieluńska upland, between Węże and Zalesiaki villages, on soil, 30.05.1963, leg. J. Nowak (KRAM-L 12324); Bujeko town by Liswarta river, on soil, 04.06.1964, leg. J. Nowak (KRAM-L 12846, 13229, 13247). **Ed-79** – Niecka Włoszczowska basin, Kurzelów village, ca. 7 km NE of Włoszczowa town, on soil, 07.1987, leg. V. Rzedeczko, K. Toborowicz (KTC). **Ed-85** – Wyżyna Częstochowska upland, Bukowno village, on soil, 05.1956, leg. J. Nowak (KRAM-L 5336). **Ee-08** – Równina Radomska plain, Lesiów village near Radom city, on soil, 18.08.1978, leg. S. Cieśliński (KTC). **Ee-72** – Góry Świętokrzyskie Mts, Góra Miedzianka Mt. near Zajączkowo village, on soil, 06.09.1976, leg. Z. Tobolewski (POZ-two specimens); 24.08.1976, leg. S. Cieśliński (KTC); 24.08.1980, leg. M.R.D. Seaward, E.A. Bylińska (herb. Seaward 103731, WRS�); between Kozi Grzbiet Mt. and Góra Miedzianka Mt., on soil, 1976, leg. K. Toborowicz (KTC); Wesoła village by Wierna Rzeka River, on soil, 18.06.1976, leg. K. Toborowicz (KTC-two specimens); Rykoszyn village near Kielce city, on soil, 24.08.1976, leg. S. Cieśliński (KTC). **Ee-73** – Góry Świętokrzyskie Mts, Dolina Posłowicka valley, 2 km E of Słowik village, on soil, 1966, leg. S. Cieśliński (KTC). **Ee-82** – Góry Świętokrzyskie Mts, Bochenice village, by the Nida River, on soil, 1976, leg. C. Osuchowski (KTC). **Ee-93** – Płaskowyż Jędrzejowski plateau, Sobków village, on soil, 26.01.1975, leg. K. Toborowicz (KTC). **Ee-97** – Pogórze Szydłowskie foothills, Dębno near Raków villages, on soil, 11.06.1975, s.coll. (POZ); 14.06.1978, leg. S. Cieśliński (KTC); Raków village near Kielce city, on soil, 11.06.1975, S. Cieśliński (KTC); 29.06.1975, leg. S. Cieśliński (KTC); 1975, leg. K. Toborowicz (KTC); Chańcza forest division, forest section No. 90, ca. 2 km ES of Raków village, on soil, 07.1986, leg. A. Siwik (KTC). **Ef-01** – Dolina Środkowej Wisły valley, Bąkowiec village, ca. 2.5 km W of Bąkowiec station, on the way to Garbatka village, 30.06.1974, leg. S. Cieśliński (herb. Seaward 115430, KTC). **Ef-61** – Przedgórze Iłżeckie foothills, Karsy village near Ożarów village, on soil, 07.1978, leg. K. Toborowicz (KTC). **Ef-94** – Równina Biłgorajska plain, between Lipa and Zaklików villages, 21.07.1984, leg. K. Czyżewska (LOD-L 7461). **Eg-56** – Dolina Górnej Narwi valley, 0.5 km NW of Tanica Górna village, on soil, 15.08.1992, leg. S. Cieśliński (KTC). **Fd-26** – Garb Tarnogórski hummock, Podzamcze village near Ogrodzieniec town, on soil, 17.04.1958, leg. J. Nowak (KRAM-L 5243). **Fd-36** – Garb Tarnogórski hummock, Pustynia Błędownska near Olkusz town, on soil, 22.05.1974, leg. W. Fałtynowicz (UGDA-L 807); 05.05.1984, J. Kiszka (WA 3289); ca. 40 km NW of Kraków city, 05.05.1984, leg. E.A. Bylińska (herb. Seaward 104868); Klucze village near Olkusz town, S side of Pustynia Błędownska, on soil, 30.04.1955, leg. J. Nowak (KRAM-L 5337); N side of Pustynia Błędownska, on soil, 05.05.1984, leg. K. Czyżewska (LOD-L 15195); Bolesław village, on soil and pebbles, 15.10.2002, leg. J. Kiszka (KRAP). **Fd-37** – Wyżyna Olkuska upland, Skalskie village near Olkusz town, on soil, 06.04.1956, leg. J. Nowak (KRAM-L 5333). **Fd-44** – Wyżyna Katowicka upland, Jęzor settlement near Mysłowice town, on soil, 25.05.1977, leg. F. Celiński (POZ). **Fd-46** – Garb Tarnogórski hummock, Bukowno near Olkusz town, on soil, 28.06.2008, leg. U. Bielczyk (KRAP). **Fd-47** – Wyżyna Olkuska upland, Olkusz town, alt. 340 m, on soil, 17.07.1917, leg. G. Moesz (B 163179). **Fe-07** – Pogórze Szydłowskie foothills, Zadoły village near Korytnica village, on soil, 1984, leg. G. Sikora (KTC). **Fe-08** – Pogórze Szydłowskie foothills, Mostki forest division, forest section No. 140, by Kacanka river, 5 km SW of Bogoria village, on soil, 03.07.1986, leg. M. Chyba (KTC). **Fe-09** – Pogórze Szydłowskie foothills, Karolinów village, ca. 2 km W of Smerdyny village, on soil, 07.1984, leg. B. Zębik (KTC). **Fe-42** – Pagóry Jaworznickie, Kościelec village near Chrzanów village, alt. 300 m, on soil, 01.09.1968, leg. J. Nowak (KRAM-L 19305); 10.08.1970, leg. J.

Nowak (KRAM-L 21556). **Ge-33** – Pieniny Mts, ca. 1.5 km of Zawisy on the way to Hukowa Skała Mt., on soil, 14.09.1956, leg. Z. Tobolewski (POZ); ca. 0.5 km of Zawisy on the way to Hukowa Skała Mt., on gravel, 09.1956, leg. Z. Tobolewski (POZ); alt. 430 m, on soil, 10.09.1957, leg. Z. Tobolewski (B 158809, BP 13579); above Dunajec river between Zawisy and Hukowa Skała Mt., on soil, 10.09.1957, leg. K. Glanc (KRAM-L 35898, 35899). **Ge-35** – Beskid Sądecki Mts, Piwniczna Zdrój village, Kamieniec village by Poprad river, alt. 380 m, on soil, 23.08.1967, leg. M. Olech (KRA); Kamieniec pasture, alt. 380 m, on soil, 23.08.1967, M. Olech (KRA). **Ge-44** – Pieniny Mts, Małe Pieniny Mts, E of Wysokie Skalki Mt., alt. ca. 1000 m, on limestone rocks, 13.09.1956, leg. Z. Tobolewski (POZ-two specimens).

**Exsiccatae examined:** Anzi, Lich. Rar. Langob. Exs. 14 (UPS). Arnold, Lich. Exs. 1565 (BM, H). Asahina, Lich. Japon. Exs. 295 (H, herb. Seaward 115429). Baglietto, Cesati & Notaris, Erb. Critt. Ital. Ser. II 349 (WRSL – two specimens). Flörke, Deutsche Lich. 77 (UPS-L 132036). Kashiwadani, Lich. Minus Cogn. Exs. 198 (H, herb. Seaward 110771). Kurosawa & Kashiwadani, Lich. Rar. Crit. Exs. 491 (BM, H). Magnusson, Lich. Sel. Scand. Exs. 156 (B 92554, BM, H). Magnusson, Lich. Sel. Scand. Exs. 287 (H, UPS). Pišút, Lich. Slovak. Exs. 264 (BM, BP 84932, UGDA, WA 3294). Rabenhorst, Lich. Europ. Exs. 455 (BM-two specimens). Schaerer & Hepp., Lich. Helvet. Exs. 829 (WA 3300). Tobolewski, Lichenoth. Polon. 184 (B 158809, BP 13579, UPS). Vězda, Lich. Sel. Exs. 1282 (H). Vězda, Lich. Sel. Exs. 1340 (H). Zielińska, Pl. Varsav. Exs. 39 (B 158707, H, LOD-L 193, WA 3297, WRSL).

**Selected reference materials** (a total of 42 specimens of *Stereocaulon incrustatum*): **Austria.** An Sonigen Abhängen, zwischen Porbyr Gerölle lei Botzen im Tirol Kansman s.coll. (WA 3300). **Belarus.** Puszczka Swisłocka, on soil, 1888, leg. F. Błoński (WA 3299). **Estonia.** Põlvamaa, Värskaa, on soil, 24.05.1988, leg. J. Motiejūnaitė (BILAS 4433). **Finland.** Suomi, Ab, Nauvo, Pensar, N - hiekkaranta, rantavyöhykkeen ja mäntymetsän rajalla hiekassa yksitellen, grid 27°E, on soil, 02.07.1940, leg. A.V. Auer (H). **Italy.** Sulla terra nei dintorni di Vercelli, Piemonte, 1858, leg. Cesati (WRSL). Japan. Hokkaido, Prov. Iburi: Kashiwabara, Tomakomai-city, elev. above 5 m, on sandy soil, 11.08.1980, leg. H. Kashiwadani 16039 (H). **Korea.** Prov. Hamkyongnam-do: Mt. Gap-san., 04.07.1934, leg. Y. Asahina 1303 (H). **Lithuania.** Dzikija National Park, Varina distr., in the pine forest, on soil, 04.07.1991, leg. J. Motiejūnaitė (BILAS 3854). **Norway.** Opland: Ringebu, alt. 200 m, open situation, 22.06.1928, leg. A. H. Magnusson (B 92554). **Russia.** Sibiria, Distr. Irkutsk, in ditone silvatica Baikalensi, in vicinitate st. Sljudianka, in promontorio jugi Chamar-Daban, 05.08.1927, leg. A. Oxner (UPS). **Slovakia.** Slovenské rudohorie: ad terram schistosam cuprum continentiam/strues fodinae lapidorum/ in decl. Inter opp. Gelenica et pag. Cechy, alt. 480 m, on soil, 26.10.1976, leg. A. Lackovičová, J. Liška et I. Pišút (WA 3294). **Sweden.** Blekinge: Kristianopol, north of the place, on snady soil, 07.1938, leg. B. Hedvall (H).

#### 4.3.7. *Stereocaulon nanodes* Tuck. (Plate II–13,14)

Amer. J. Sci. Arts, ser. 2, 28: 201 (1859).

**LECTOTYPUS** (Lamb 1977: 240): [USA, New Hampshire, White Mountaines] “in the gorge of the Ammonoosuck at the last ford”, 1848, s.coll. (FH-Tuck).

= *Stereocaulon tyroliense* Nyl., Flora 58: 302 (1875). = *Stereocaulon alpinum* var. *tyroliense* (Nyl.) Arn., Verh. K.K. Zool.-Bot. Ges. Wien, 27: 549, 566 (1877). = *Stereocaulon tyroliense* (Nyl.) Lettau, Hedwiga 60(3): 106 (1918). = *Stereocaulon nanodes* f. *tyroliense* (Nyl.) Lamb ex Maquiny, Lamb, Lambinon et Ramaut, Physiol. Pl. (Copenhagen) 14(2): 285 (1961).

**HOLOTYPUS** (Lamb 1977: 314): Austria, Tirol, Arnold, 1874 (H-NYL 40148!).

= *Stereocaulon tyroliense* var. *lapponicum* H. Magn., Goteborgs K. Vetensk.- o. Vitterh.- Samh. Handl. Ser. 4, 30(7): 74 (1926).

**LECTOTYPUS** (LAMB 1977: 314): [Sweden], Lycksele Lappmark: par. Tärna, Björkfors, Syterbäcken, 475 m, by a brook, 15.07.1924, A.H. Magnusson (8238) (UPS-L 108406!).

**Description.** Primary thallus persistent, of ascending to erect flattened phyllocladia, to 0.5 cm tall, grey, scattered or forming swards, at first widened at apices and appearing fan-shaped, later becoming irregularly branched in one plane; lower surface sorediate (Plate II–14). Pseudopodetia rather rare, up to 1 cm tall, wide, flat, sparsely branched, whitish-green, blackish at the base, covered with farinose soredia. Cephalodia on pseudopodetia, infrequent, bluish-grey, containing *Stigonema* (Plate II–13). Apothecia not seen in examined material (for more details on apothecia see [20,21,87]).

**Chemistry.** Thallus of *S. nanodes* contains atranorin and lobaric acid or sometimes atranorin only [21,60]. Atranorin and lobaric acid were detected in most of the Polish specimens, but

in four samples (also in 1 from the Czech Republic and 1 from Slovakia) only lobaric acid was found. This chemotype is reported here for the first time. Spot test reaction: PD± yellow.

**Notes.** *Stereocaulon nanodes* is easily recognizable due to the persistent, of ascending to erect fan-shaped phyllocladia, with soredia produced on lower surface [21].

*Stereocaulon pileatum* is similar to *S. nanodes*, but has wart-like basal phyllocladia and short pseudopodetia bearing terminal, globose soralia (for more details see under *S. pileatum*).

**Habitat requirements.** *Stereocaulon nanodes* is a saxicolous lichen (100% of Polish records). It grows mainly on boulders and rocks in open habitats, rubble rocks and heaths. It is confined also to rocks enriched in heavy metals (with lead and zinc; see [21,60]).

**World distribution.** The species is known from Europe, Asia and both Americas, but sometimes rarely recorded. In the frame of this revision *S. nanodes* was confirmed from Austria, Belgium, the Czech Republic, Denmark, Finland, Germany, Norway, Slovakia and Sweden. In addition Lamb [21] reported *S. nanodes* from Russia, Switzerland, United Kingdom and USA.

Other records are known also from the Netherlands [127], and Argentina [116].

**Distribution in Poland.** So far *S. nanodes* was recorded several times in Poland (see [51]). Now it is known much more frequent from northern and southern part of the country (Fig. 7). Vertical distribution of this taxon ranges from the sea level up to about 2300 m a.s.l. According to Cieśliński et al. [59], *S. nanodes* is an endangered lichen (category EN) in the country. Number of examined specimens from Poland: 61.

**Specimens examined:** **Bc-06** – Pojezierze Kaszubskie Lakeland, Kaliska village near Kościerzyna, on stone, 8.1981, leg. J. Szmeja (UGDA-L 3707); Węsiory village, on stone, 30.09.1986, leg. W. Fałtynowicz (UGDA-L 3000). **Bc-34** – Bory Tucholskie forests, Lubnia village, between Kościerzyna and Chojnice, on stone and soil, 23.04.1988, leg. W. Fałtynowicz (UGDA-L 3992). **Be-72** – Pojezierze Olsztyńskie lakeland, Nadrowo village, 2 km NNE of the railway station Waplewo, on a boulder, 23.06.1996, leg. S. Cieśliński (KTC). **Bf-74** – Wysoczyzna Kolneńska heigh plain,

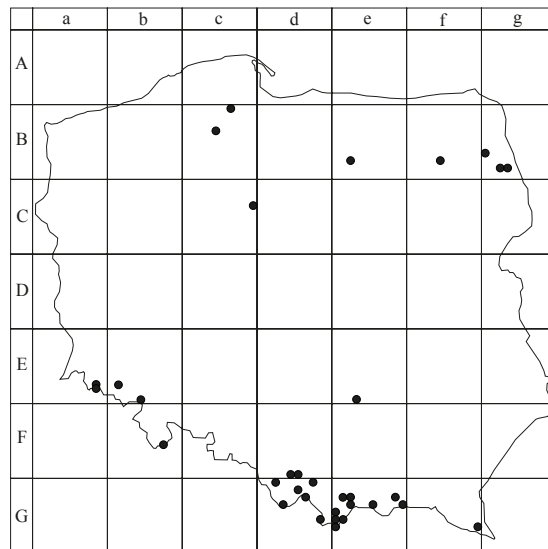


Fig. 7 Distribution of *Stereocaulon nanodes* in Poland.

ca. 1.5 km NW of Niedźwiadna village, on boulders, 24.08.1990, leg. S. Cieśliński (KTC). **Bg-60** – Wysoczyzna Białostocka high plain, 0.5 km N of Suchowola village, on boulders, 27.08.1990, leg. S. Cieśliński (KTC). **Bg-82** – Wzgórza Sokólskie hills, ca. 2.5 km W of Bogusze village, on boulders, 26.08.1991, leg. S. Cieśliński (KTC). **Bg-83** – Wzgórza Sokólskie hills, ca. 0.5 km NE of Horczaki Górne village, on boulders, 02.07.1991, leg. S. Cieśliński (KTC). **Cc-39** – Kotlina Toruńska basin, Toruń city, on the Przysiecka road, on stones, 02.08.2006, leg. E. Adamska (TRN). **Ea-78** – Karkonosze Mts, W of Śnieżne Kotły cirque, on granite rock, 27.07.2007, leg. K. Szczepańska 548 (herb. Szczepańska). **Ea-88** – Karkonosze Mts, Mały Śnieżny Kocioł cirque, on basalt veins, 08.2006, leg. M. Kossowska (herb. Kossowska). **Eb-71** – Rudawy Janowickie, Kolorowe Jeziora ponds, alt. 500 m, on soil with Fe, 13.10.2007, leg. K. Szczepańska (herb. Szczepańska). **Eb-94** – Masyw Śnieżnika Massif, Jaworek village, ca. 800 m, on silicate rock, 23.08.2003, leg. K. Szczepańska (herb. Szczepańska 486). **Ee-94** – Pogórze Szydłowskie foothills, Chałupki village near Dębska Wola, Góra Pasieczyska Mt., on stones, 23.10.1975, leg. K. Toborowicz (KTC). **Fb-57** – Masyw Śnieżnika Massif, Trójmorski Wierch Mt., on rock, 23.06.2003, leg. K. Szczepańska (WRSL 1896). **Fd-22** – Wyżyna Katowicka upland, Radzionków town, near Bytom city, 24.08.1986, leg. M.R.D. Seaward, E.A. Bylińska 105372 (herb. Seaward, WRSL). **Fd-94** – Beskid Mały Mts, Hrobacza Łąka Mt., alt. ca. 820 m, on sandstone rocks, 23.08.1960, leg. J. Nowak (KRAM-L 7419, 7423, 7424). **Fd-95** – Beskid Mały Mts, Kocierz Moszczanicka village, Góra Potrójna mt., alt. ca. 880 m, on sandstone rocks, 07.06.1996, leg. J. Nowak (KRAM-L 43439). **Gd-02** – Beskid Śląski Mts, Błatnia Mt., alt. 823 m, on stones, 06.08.1964, leg. J. Kiszka (KRAP); alt. 900 m, on stone, 06.09.1966, leg. J. Kiszka (KRAP); Brenna Mt, alt. 480 m, on stones, 10.09.1962, leg. J. Kiszka (KRAP). **Gd-07** – Beskid Zachodni Mts, Pasma Policy Mts, valley of Skawica Sołtysia stream, alt. ca. 550 m, on stones, 18.06.1965, s.coll. (KRAM-L 15979). **Gd-15** – Beskid Żywiecki Mts, Góra Grapa Mt., on stones, 28.09.1964, leg. J. Nowak (KRAM-L 16586). **Gd-26** – Pasma Babiogórskie Mts, Masyw Babiej Góry Massif, on rocks, 06.09.1967, leg. J. Nowak (KRAM-L 1348). **Gd-33** – Karpaty Zachodnie Mts, Beskid Żywiecki Mts, Góra Łysica Mt. above Rycerka Dolna village, alt. ca. 1630 m, on stones, 05.08.1964, leg. J. Nowak (KRAM-L 14477). **Gd-58** – Tatry Zachodnie Mts, Dolina Starorobociańska valley, above Polana Starorobociańska glade, alt. 1200 m, on granite rock, 15.08.1960, leg. Z. Tobolewski (POZ). **Ge-21** – Gorce Mts, Stare Wierchy glade, alt. ca. 810 m, on stones, 25.08.1968, K. Glanc (POZ); S slope of Waksmundzka Góra Mt., alt. ca. 1000 m, on stones, 26.07.1968, leg. K. Glanc (KRAM-L 35890). **Ge-22** – Gorce, SE slope of Lubań Mt., alt. 850 m, on stones, 04.08.1968, leg. K. Glanc (KRAM-L 35888); S slope of Lubań Mt., alt. 980 m, on stones, 10.08.1967, leg. K. Glanc (KRAM-L 35889). **Ge-28** – Beskid Niski Mts, Bordiów Wierch Mt., on pebbles, 23.07.1970, leg. M. Olech (KRA-two specimens). **Ge-32** – Gorce Mts, valley of Kluszkowianka stream, alt. 670 m, on stones, 09.08.1967, leg. K. Glanc (KRAM-L 35887). **Ge-35** – Beskid Sądecki Mts, Pasma Jaworzyny Krynickiej Mts, Hala Jaworzyny hall above of Parchowatka Mt., alt. 950 m, on stones, 24.09.1966, leg. M. Olech (KRA-two specimens); alt. 900 m, on stones, 03.07.1989, leg. L. Śliwa (KRA); S slope of Zadnie Góry Mt., alt. 920 m, on stones, 30.08.1967, leg. M. Olech (KRA); alt. 750 m, on stones, 30.08.1967, leg. M. Olech (KRA); alt. 950 m, on stones, 30.08.1967, leg. M. Olech (KRA); S slope of "wzgórza 552", between Żegiestów and Zubrzyk villages, alt. 520 m, on stones, 07.10.1967, leg. M. Olech (KRA); glade above of Zubrzyk Mt., alt. 740 m, on stones, 07.07.1989, leg. L. Śliwa (KRA); near Potok Jaworzyna stream, alt. 750 m, 30.08.1967, leg. M. Olech (KRA). **Ge-39** – Beskid Niski Mts, Przełęcz Regetowska pass, near Obcza Mt., alt. 720 m, 24.07.1971, leg. M. Olech (KRA). **Ge-40** – Rów Podtatrzański trench, Murzasichle village, alt. ca. 850 m, on granite rocks, 21.07.1971, leg. J. Nowak (KRAM-L 19237); 30.07.1971, leg. J. Nowak (H, KRAM-L 19304, LBL). **Ge-50** – Tatry Wschodnie Mts, Hala Gąsienicowa hall, on granite rock, 21.07.1961, leg. J. Nowak (KRAM-L 8684); Tatry Zachodnie Mts, Polana Kopieniec glade, alt. ca. 1250 m, on rocks, 12.07.1971, leg. J. Nowak (KRAM-L 19854). **Ge-51** – Pogórze Spisko-Gubałowskie Mts, Pasma Bukowiny Tatrzańskiej Mts, on Białka stream, alt. 700 m, sandstone rocks, 15.08.1967, leg. J. Kiszka (KRAP). **Ge-60** – Tatry Wschodnie Mts, Przełęczka pod Zadnim Mnichem pass, alt. 2135 m, 49°11'19"N, 20°03'06"E, on the rocks boulders, 24.08.2004, leg. A. Flakus 3513 (KRAM). **Ge-60** – Tatry Wschodnie Mts, Dolina Pięciu Stawów Polskich valley, Szpiglasowa Przełęcz pass, alt. ca. 1950 m, on stone, 27.08.1956, leg. Z. Tobolewski (POZ); Mieguszowiecka Przełęcz pod Chłopkiem pass; alt. 2307 m, 49°11'09"N, 20°03'55"E, on granite rock, 16.07.2004, leg. A. Flakus 2592,2 (KRAM); Niżnie Rysy Mt.; alt. 2430 m, 49°11'00"N, 20°05'17"E, on granite rock; 20.07.2004, leg. A. Flakus 2686 (KRAM); on granite rock, 15.07.2003, leg. A. Flakus 420 (KRAM); Żabi Szczyt Wyżni Mt., alt. 2259 m, 49°11'16"N, 20°05'21"E, on granite rock, 20.08.2005, leg. A. Flakus 5329 (KRAM). **Gf-69** – Bieszczady Zachodnie Mts, SW of Połonina Caryńska Mt., on rocks, 24.09.1958, leg. Z. Tobolewski (POZ-two specimens).

**Exsiccatae examined:** Anonymus, Reliqu. Suzaianae 68 (BM). Arnold, Lich. Exs. 1541 (B 81303, BM & H, as *S. nanodes* f. *tyroliense*). Follmann & Werner, Lich. Exs. Sel. Colon. 414 (H). Hansen & Christensen, Lich. Dan. Exs. 456 (H, UGDA). Magnusson, Lich. Sel. Scand. Exs. 6 (B 82404, H, as *S. tyroliense* var. *lapponicum*). Malme, Lich. Suec. Exs. 918 (H, as *S. pileatum*). Nowak, Lich. Polon. Merid. Exs. 175 (H, LBL). Stordeur, Lich. Sel. Exs. 20 (H). Verseghy, Lichenoth. Parva 85 (H, as *S. tyroliense* var. *lapponica*). Vězda, Lich. Sel. Exs. 416 (H). Vězda, Lich. Sel. Exs. 965 (BP 76069, H). Vězda, Lich. Sel. Exs. 1289 (H). Vězda, Lich. Sel. Exs. 1368 (BM).

**Selected reference materials** (a total of 29 specimens of *Stereocaulon nanodes*): **Austria**. Tirol, An Glimmerfelswänden in den oberen Theilen des Rendelthales oberhalb St. Anton am Arlberg, 26.08.1892, leg. Arnold (H). **Belgium**. Prov. Liège: Tihange, insula Soiron (in flumine Mosa), alt. 70 m, in rudibus calaminiariis copiosissime, 12.06.1965, leg. J. Lambinon (H). **The Czech Republic**. West Bohemia, NE of Františkovy Lázně, SOOS Nature Reserve, 50°08'55"N, 12°24'16"E, open place with mosses and some small pebbles, on pebbles, 19.04.2009, leg. M. Kukwa 7364 (UGDA). **Danmark**. Sjaelland, Nivå, at railway track with *S. dactylophyllum* and *S. vesuvianum*, on stone, 13.10.2005, leg. O.B. Lyschede, V. Alstrup (UGDA). **Finland**. Ostrobothnia borealis: Simo, Simonkylä, Pahnilankangas, ad saxa apicaria, 09.07.1936, leg. V. Räsänen (H). **Germany**. Mittlers Ahrtal, Bahntrasse am Bahnhof Altenhr, 170 m, 13.12.1994, leg. I. Gotzmann (B 6001162332). **Norway**. Nord Trøndelag, Stormyrfjellet, ca. 15 km ENE of Røyrvik, alt. ca. 960 m., 25.07.1982, leg. O.W. Purvis (BM). **Slovakia**. Tatra minor, Staré hory, 600–700 m., ad scorcias prope metalla cupri vestusta, 05.07.1976, leg. A. Vězda (KRAM-L 24772). **Sweden**. Härjedalen Prov., Tännäs par., Mt. Gruvvålen, (SW of Mt. Stora Mittåklappen), alt. 900 m, an old copper mine, 24.08.1973, leg. R. Santesson 24475 (UGDA).

#### 4.3.8. *Stereocaulon paschale* (L.) Hoffm. (Plate II–15)

Deutschl. Fl., Zweiter Theil (Erlangen) (1796). = *Lichen paschalis* L., Species Plantarum 2: 1153 (1753). = *Cladonia paschalis* (L.) Baumg., Flora Lipsiens.: 577 (1780). = *Coralloides paschale* (L.) Hoffm., Descriptio et Adumbratio Plantarum 1: 23 (1798). = *Verrucaria paschalis* (L.) Humb, Florae Fribergensis Specimen: 43 (1793). = *Baeomyces paschalis* (L.) Wahlenb., Flora Lapponica: 450 (1812). = *Patellaria paschalis* (L.) Wallr., Flora Cryptog. Germ., I: 441 (1831). = *Stereocaulomyces paschalis* (L.) Thomas, Beitr. Kryptogamenfl. Schweiz 9(1): 180 (1939) (nomen nudum).

**LECTOTYPUS** (Lamb 1977: 200): [probably Sweden] (LINN 1273–259, the lowest specimen).

= *Stereocaulon paschale* var. *vulgare* Th. Fr., De Stereoc. et Pilophor. Comment.: 33 (1857). = *Stereocaulon paschale* f. *vulgare* (Th. Fr.) Th. Fr., Lichenogr. Scand., Pars prima: 47 (1871).

**LECTOTYPUS** (Lamb 1977: 308): [Germany?] Flotow, Deutsch. Lich. Exs. 12A (UPS!).

= *Stereocaulon paschale* var. *serpens* Th. Fr., De Stereoc. et Pilophor. Comment.: 33 (1857). = *Stereocaulon paschale* f. *serpens* (Th. Fr.) Th. Fr., Lichenogr. Scand., Pars prima: 47 (1871).

**LECTOTYPUS** (*hoc loco designatus*): [Sweden, Uppland], Vaksala par., Vittulsberg [Witulfberg], 26.06.1852, Th. M. Fries (UPS-L 108397!).

**Description.** Primary thallus disappearing. Pseudopodetia up to 5 cm tall, loosely attached to the substrate, basally dying and blackish, growing in loose clusters, creeping to erect, with a distinct main branch sparingly branched at the base, richly branched towards the top, covered with greyish-white tomentum. Phyllocladia gathered in clusters, grain-like, granular or dactyliform, yellowish-grey, more numerous towards the pseudopodetial tips. Cephalodia numerous, irregular, shrubby, granular or warty, black, containing *Stigonema* (Plate II–15). Apothecia rare, terminal, when young flat marginate, older convex and immarginate, disk dark brown.

**Chemistry.** *Stereocaulon paschale* produces atranorin and lobaric acid (in all tested specimens). Spot test reaction: K+ yellow. The chemistry of Polish specimens agrees with those reported earlier [21,87,113].

**Notes.** *Stereocaulon paschale* is chemically identical with *S. alpinum* and *S. taeniarum*, but morphologically these species are fundamentally different. *S. paschale* is characterized by the pseudopodetia loosely attached to the substratum, granular to dactyliform phyllocladia covering the pseudopodetia all around. In addition the species has always numerous, conspicuous blackish cephalodia containing *Stigonema* (see [4,21,30]). Differences with *S. alpinum* are noted under that species (see Tab. 3). The shape of phyllocladia in *S. paschale* and *S. taeniarum* is essentially the same, but they differ in the presence of cephalodia and morphology of pseudopodetia. *Stereocaulon paschale* has usually abundant and conspicuous cephalodia, whereas in *S. taeniarum* they are absent. Moreover in *S. paschale* phyllocladia are more or less evenly distributed around the pseudopodetial axis, whereas *S. taeniarum* has “pine-like” pseudopodetia due to phyllocladia are clustered on the apices [30].

Kivistö [30] also showed a distribution of the two species as their distinguishing feature. According to her research conducted in Finland *S. taeniarum* occurs mostly on the southwest coast, and *S. paschale* was recorded throughout the country, with an upward trend in the north. In Poland, the situation is different. *Stereocaulon paschale* is widespread throughout the country, and *S. paschale* is probably the species occurring mainly in the northern Poland (Fig. 8).

**Habitat requirements.** It is a terricolous species. All examined Polish specimens were found on soil in open places. According to Thomson [113] *S. paschale* occurs on rocks and sometimes also on humus over rocks. Such preferences have been confirmed here based on comparative materials from Finland, Norway and Japan.

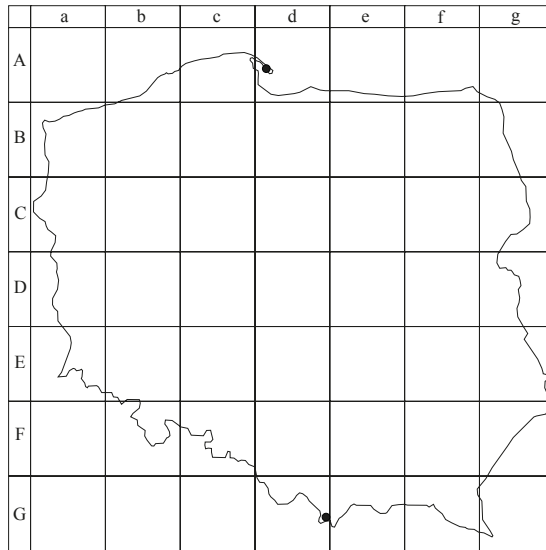
**World distribution.** *Stereocaulon paschale* is a widespread species known from all continents except Antarctica and Australia. It is in from the Mediterranean circumpolar zone. However, circumpolar, arctic, boreal mountain type of distribution suggested by Thomson [113] is incorrect, due to some specimens probably belonged to *S. taeniarum*.

During the revision conducted for this work, *S. paschale* was confirmed from Asia (Japan), Europe (Finland, France, Germany, Lithuania, Norway, Russia and Sweden) and North America (Canada, Greenland and USA). Lamb [21] reported this taxon also from Denmark, Estonia, the Netherlands, Iceland, Korea, Mongolia, Argentina and Chile. It was also reported from Madeira [137], China and India [106,119]. Moreover, in Europe, this species was also given from Azores [128], Spain [109], Luxembourg [133] and Romania [124].

**Distribution in Poland.** *Stereocaulon paschale* was considered as quite frequent lichen in northern Poland, but rather rare in the Carpathians and Sudety Mts (see [51] and literature cited therein). After the revision of all available material, many specimens appeared to belong to *S. taeniarum* (see also below), and at present *S. paschale* is considered to be very rare (2 localities) in the country (Fig. 8). Number of examined specimens from Poland: 3.

**Specimens examined:** Ad-51 – Mierzeja Helska split, near Hel town, on soil, 28.08.1930, leg. F. Krawiec (LBL). Gd-59 – Tatrzy Zachodnie Mts, Czerwone Wierchy Mt., near Kopa Kondracka Mt. and Małolączniak Mt., alt. ca. 1060 m, on soil, 11.09.1955, leg. Z. Tobolewski (BM, POZ).

**Exsiccatae examined:** Anonymus, Lich. Exs. Arizona State Univ. 26 (BM, H, as *S. alpinum*). Arnold, Lich. Exs. 1363 b (H, UPS-L 169958, as *S. alpinum*). Brockmüller, Mecklenb. Krypt. II 67 (B 99931). Brodo, Lich. Canad. Exs. 66 (BM). Brodo, Lich. Canad. Exs. 67 (BM). Flörke, Deutsche Lich. 199 A (UPS). Fries, T., Lich. Scand. Rar. Critic. Exs. 72 (BM-two specimens). Hale, Lich. Amer. Exs. 98 (BM, H, UPS, as *S. dactylophyllum*). Hansen, Lich. Groenl. Exs. 389 (H). Hansen, Lich. Groenl. Exs. 512 (BM). Hansen, Lich. Groenl. Exs. 530 (BM). Hansen, Lich. Groenl. Exs. 657 (BM, H). Hansen, Lich. Groenl. Exs. 695 (BM). Hansen, Lich. Groenl. Exs. 735 (BM). Hansen, Lich. Groenl. Exs. 935 (H, herb. Seaward 113552). Haukulinen, Lichenoth. Fenn. 1056 (H). Haukulinen, Lichenoth. Fenn. 1080 (B 46441, H-two specimens). Haukulinen, Lich. Fenn. Exs. 1230 (H). Haukulinen, Lich. Fenn. Exs. 1278 (H). Havaas, Lich. Norveg. Occid. Exs. 153 (BM, H). Huuskonen, Lichenoth. Fenn. 758 (B 46491). Huuskonen, Lichenoth. Fenn. 961 (B 46437). Kurokawa, Lich. Rar. Crit. Exs. 145 (H, as *S. sasakii*). Kurokawa & Kashiwadani, Lich. Rar. Crit. Exs. 441 (BM, H). Kurokawa & Kashiwadani, Lich. Rar. Crit. Exs. 442 (BM, H). Linkola & Wainio, Nyl. Norrl. Herb. Lich. Fenn. Cont. 501 (BM, BP 13626, H). Macoun, Canad. Lich. 44 (BM, as *S. tomentosum*). Magnusson, Lich. Sel. Scand. Exs. 157 (B 92555, BM). Malme, Lich. Suec. Exs. 509 (H). Migula, Krypt. Germ. Austr. Helv. Exs. 123 (BM). Petrak, Crypt. Exs. 3918 (B, BM, H). Rabenhorst, Lich. Europ. Exs. 134 (BM). Räsänen, Lich. Fenn. Exs. 57 (H). Räsänen, Lichenoth. Fenn. 103 (B158708, H, as *S. saxatile*). Räsänen, Lichenoth. Fenn. 171 (B 46438, 46440, BM, H). Räsänen, Lich. Fenn. Exs. 197 (H – two specimens). Räsänen, Lich. Fenn. Exs. 198 (BM, H). Räsänen, Lich. Fenn. Exs. 248 (BM, H – two specimens). Räsänen, Lichenoth. Fenn. 396 (BP 13680, as *S. squamescens*). Räsänen, Lich. Fenn. Exs. 760 (H). Räsänen, Lich. Fenn. Exs. 961 (BM). Räsänen, Lich. Fenn. Exs. 1056 (BM). Räsänen, Lich. Fenn. Exs. 1080 (BM). Räsänen, Lich. Fenn. Exs. 1081 (BM). Stenhammar, Lich. Suec. Exs. 80 (BM). Stenhammar,



**Fig. 8** Distribution of *Stereocaulon paschale* in Poland.

Lich. Suec. Exs. 81 (BM). Thøgersen, Lich. Norveg. Medit. Exs. 21 (H). Tobolewski, Lichenoth. Polon. 113 (BM). Vězda, Lich. Sel. Exs. 1211 (BM, H).

**Selected reference materials** (a total of 127 specimens of *Stereocaulon paschale*): **Canada.** Baffin Island, Rocky promontory at head of Kingnait Fiord, alt. 100 m, north facing slope of lake, 17.08.1974, leg. P.E. Jardine (BM). **Finland.** Enontekiö: Kilpisjärvi Siilasjärven laskujoen ja maantien välisen harjanteen laella, alt. 480 m. **Kangasmaalla.** Runsaasti, 21.09.1988, leg. M. Heino 450 (H). **France.** Voyageurs National Park, Point northwest of O’Leary Lake in eastern Namaken Lake, Forest of jack pines with some red pines and white pines, sec. 31, 07.06.1978, C.M. Wetmore 35094, leg. C.M. Wetmore (UGDA-L 4841). **Germany.** In lichten Waldungen und Heiden, selten: unweit der Lübecker Gränze, 11.1862, Häcker (B 99931). **Greenland.** Isortoq, 60°59’N, 47°32’W, 23.07.1998, leg. E.S. Hansen (BM). **Japan.** Hokkaido, Prov. Tokachi: Mt. Higashi-Nupukaushi, Kami-Shihoro-cho, Kato-gun, alt. 1000 m, on rocks, 17.09.1979, leg. H. Kashiwadani 15511 (BM). **Lithuania.** Skuodas distr., Saukliai geological preserve, in meadow with erratic, on siliceous stone, 11.09.2001, leg. J. Motiejūnaitė (BILAS 5921). **Norway.** Nordlandet, Kuánit núat, 64°24’N, 51°37’W, 13.08.1976, leg. V. Alstrup (herb. Seaward 115441); Svalbard, Hornsund, Ariekammen, elev. 200 m., 07.1985, leg. B. Godzik, K. Grodzińska (KRAM-L 33821). **Russia.** Murmansk Oblasta, Kola Peninsula, Khibiny Mts, vicinity of Perevalnye lakes, Kukisjok valley, on soil, 29.08.1974, leg. A.V. Dombrovskaya (UGDA-L 1114). **Sweden.** Jämtland, Undersåker, Hålland, 26.06.1949, leg. Gösta Kjellmert (LBL). **USA.** Voyageurs National Park, Point northwest of O’Leary in eastern Namakan Lake, Sec. 31, of jack pines with some red pines and white pines, 04.07.1978, leg. C.M. Wetmore 35094 (UGDA).

#### 4.3.9. *Stereocaulon pileatum* Ach. (Plate II–16)

Lichenogr. Univers.: 582 (1810). = *Stereocaulon paschale* var. *pileatum* (Ach.) Wahlenb., Flora Suecica 11: 855 (1826). = *Stereocaulon cereolinum* f. *pileatum* (Ach.) Th. Fr., De Stereoc. et Pilophor. Comment.: 19 (1857). = *Cereolus pileatus* (Ach.) Boistel, Nouvelle Flore des Lichens 2: 34 (1903).

**HOLOTYPE** (LAMB 1977: 226 [Switzerland] Helvetia, s.coll. (H-ACH 17551).

= *Stereocaulon condensatum* var. *sorediatum* Harm. ex Cruz., Bull. Acad. Int. Geogr. Bot. 22: 157 (1913).

**LECTOTYPUS** (DODGE 1929:111): [France], Hérault, La Salvetat, Fr. Marc (Claudel, Claudel & Harmand, Lich. Gall. Praecip. Exs. 474 – H!).



= *Stereocaulon pileatum* f. *macrum* H.Magn., Göteborgs K. Vetensk.- o. Vitterh.-Samh. Handl. ser. 4, 30 (7): 70 (1926).

**HOLOTYPE** (LAMB 1977: 312): [Sweden], Bohuslän, par Ljung, Kolbengtsered, A.H. Magnusson No. 9513, 13.08.1925 (UPS-L 85547; ISOTYPUS: FH).

= *Stereocaulon saxonicum* Bachm., Hedwigia 67: 109 (1927). = *Stereocaulon saxonicum* (Bachm.) Schade, Stolle & Riehm. Lich. Sax. EXS. Decas XXXIII, No. 330 (1927).

**TOPOTYPUS?** Germania (Saxonia): ad rupes basalticas in monte Giesing prope Altenberg, ca. 400 m s.m. leg. A. Zahlbruckner (H!, Zahlbruckner, Krypt. Exs. 2275).

**Note.** The original material of *E. Bachmann* has not been found so far, cited above specimen is probably topotype.

**Description.** Primary thallus crustose, greyish-white with white apices, composed of verruciform to more or less coralloid granules. Pseudopodetia short, up to 5 mm tall, firmly attached to the substratum, generally unbranched, with globose soralia at the top (Plate II–16). Phyllocladia scattered or abundant, greyish-white, mostly granular. Cephalodia small, flattened, verrucose, greyish-brown, amongst basal phyllocladia and on pseudopodetia, containing *Stigonema*. Apothecia not found in Polish specimens, but according to Gilbert et al. [60] they are pileate, with red-brown disc.

**Chemistry.** In Polish material *S. pileatum* always contains lobaric acid, but atranorin was absent in three specimens (tested twice). The results refer to the literature data (see, e.g. [21,60]). Spot test reaction: K+ yellow, PD–.

**Notes.** This taxon is easily recognizable and characterized by globose soralia at the top of short pseudopodetia, persistent primary thallus firmly attached to the substratum and the production of lobaric acid [22].

According to literature data *S. pileatum* is closely related to *S. nanodes*. This is probably due to both species occupied similar habitats and form small size of pseudopodetia. Although both taxa produce the same secondary lichen metabolites (atranorin, lobaric acid), morphology of *S. nanodes* is completely different as its soralia are not globose and perched on the top of pseudopodetia, but are formed at the lower surface of phyllocladia and small, flattened pseudopodetia [22].

**Habitat requirements.** *Stereocaulon pileatum* is saxicolous lichen and grows on sandstones and granite pebbles in open habitats. Sometimes it can grow in more or less shaded places [113]. According to Lamb [21] it is one of the few species that are resistant to environmental pollution, allowing this taxon to colonize urban areas.

**World distribution.** *Stereocaulon pileatum* is circumpolar, boreal lichen, widely distributed in the Northern Hemisphere [21]. Samples for this research were analysed from: the Czech Republic, Finland, France, Great Britain, Ireland, the Netherlands, Norway, Slovakia and Sweden, USA, Brazil and Japan. In addition Lamb [21] reported *S. pileatum* from Austria, Belgium, Luxembourg, Portugal, Switzerland, Ukraine, Italy and the Faroe Islands, as well as Canada and India. It was also reported from Bolivia [138], China [139], Japan [140] and Taiwan [141] as well as, Azores [128], Croatia, Spain [109], the Netherlands [127] in Europe, and the Pacific Islands [112], Hawaii [112], but some of those records may represent other taxa.

**Distribution in Poland.** *Stereocaulon pileatum* is very rare in Poland. This species occurs only in southern part of the country, where it was collected from a few localities only (Fig. 9). *Stereocaulon pileatum* vertical range varies from about 450 m in the Beskid Śląski Mts to 890 m above sea level in the Gorce Mts. In the past it was noted also in Sudety Mts and other mountain ranges in the Carpathians, but now many localities should be treated as historical

e.g. Góry Stołowe Mts. According to Cieśliński et al. [59], it is threatened in Poland. Number of examined specimens from Poland: 18.

**Specimens examined:** **Ea-78** – Góry Izerskie Mts, Szklarska Poręba town “Biała Dolina”, on stones, 10.1976, leg. J. Nowak (KRAM-L 21733). **Fd-94** – Beskid Mały Mts, Ponikiew village near Międzybuzie Białskie village, alt. ca. 435 m, on sandstone, 18.10.1966, leg. J. Nowak (KRAM-L 400). **Gd-01** – Beskid Śląski Mts, Czantoria Wielka Mt., alt. 660 m, on sandstone, 19.09.1966, leg. J. Kiszka (KRAP). **Gd-02** – Beskid Śląski Mts, Brenna village, Valley of Brennica stream, alt. 450 m, on stones, 10.09.1962, leg. J. Kiszka (KRAP). **Gd-03** – Beskid Śląski Mts, Valley of Biła stream, on stones, 20.08.1965, leg. J. Kiszka (KRAP). **Gd-07** – Beskid Zachodni Mts, Pasma Policy Mts, Valley of Rotnia stream, alt. ca. 500 m, on sandstone, 15.09.1970, leg. J. Nowak (BM, BP 77475, H, KRAM-L 20001, LBL, LOD-L 7350); 23.10.1965, leg. J. Nowak (KRAM-L 15926). **Gd-11** – Beskid Śląski Mts, W slope of Jawornik Mt., alt. 500 m, on stones, 12.07.1963, leg. J. Kiszka (KRAP). **Gd-12** – Beskid Śląski Mts, near Malinka stream, alt. 590 m, on stones, 08.09.1962, leg. J. Kiszka (KRAP). **Gd-15** – Beskid Żywiecki Mts, Grupa Piłska Mts, valley of Sopotnia Wielka stream, on stones, 25.09.1964, leg. J. Nowak (KRAM-L 16460); alt. ca. 750 m, valley of Sopotnia Wielka stream, on rock, 25.09.1964, leg. J. Nowak (KRAM-L 16311). **Ge-20** – Gorce Mts, N slope of Skalka Mt. near Obidowa Mt., alt. ca. 840 m, on stones, 03.07.1968, leg. K. Glanc (KRAM-L 35880); S slope of Skalka Mt., alt. 890 m, on stones, 03.08.1968, leg. K. Glanc (KRAM-L 35881).

**Exsiccatae examined:** Anonymus, Reliqu. Suzaianae 67 (BM, H). Anonymus, Reliqu. Suzaianae 68 (BM, H). Arnold, Lich. Exs. 916b (WRS�). Arnold, Lich. Exs. 916c (WRS�). Arnold, Lich. Exs. 1541 (H). Asahina, Lich. Japon. Exs. 298 (H). Claudel, Claudel & Harmand, Lich. Gall. 425 (H). Claudel, Claudel & Harmand, Lich. Gall. 474 (H, as *S. condensatum* var. *sorediatum*). Magnusson, Lich. Sel. Scand. Exs. 240 (B 92638, H, as *S. saxonicum*). Magnusson, Lich. Sel. Scand. Exs. 288 (B 92686, BM, H, UPS). Malmé, Lich. Suec. Exs. 918 (H). Nowak, Lich. Polon. Merid. Exs. 60 (BM, BP 77475, H, LBL, LOD-L 7350, UPS-L 48694). Tavares, Lich. Lusit. Sel. Exs. 190 (BM, H, as *S. pileatum* f. *sorediiferum*). Suza, Lich. Bohemislov. Exs. 42 (BM). Vězda, Lich. Sel. Exs. 16 (BM, BP 50591). Vězda, Lich. Sel. Exs. 417 (BP 52118, BM). Vězda, Lich. Sel. Exs. 1368 (BM, H). Vězda, Lich. Sel. Exs. 1685 (H). Zahlbruckner, Krypt. Exs. 2275 (H, as *S. alpinum* var. *tyroliense/saxonicum*).

**Selected reference materials** (a total of 45 specimens of *Stereocaulon pileatum*): **Brazil.** Beira Alta, Abrunhosa-a-Velha: Casal de S. Sebastião, cric. 430 m s.m., ad rupes graniticas decompositas, 05.09.1963, leg. C.N. Tavares (BM). **The Czech Republic.** Branná, inter Přemyslov et Nové Losiny, alt. ca. 800 m., in margine silvae, ad lapides schistosos, 12.07.1970, leg. A. Vězda (BM). **Finland.** U. Sibbo: Kitö, on rock, 28.08.1995, leg. L. Kivistö 51 (H). **France.** An Granit von Nicachat bei St. André d’Ornay, Vendée, 07.02.1884, leg. Richard 916b (WRS�). **Germany.** Forest Düppel, S.W. Berlin, railway ballast, 04.11.1984, leg. M.R.D. Seaward, H Sipman & C. Huneck (herb. Seaward 104932). **Great**

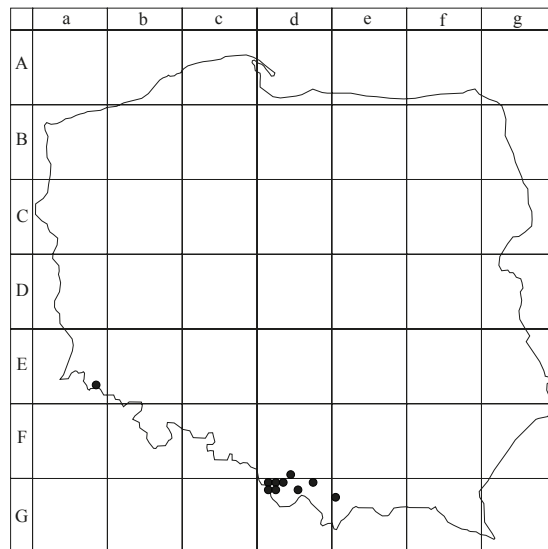


Fig. 9 Distribution of *Stereocaulon pileatum* in Poland.

**Britan.** London, Camden, Golders Hill Park, West Heath Road, wall of No. 229, on brick garden, 07.09.1969, leg. A.R. Vickery 117 (BM 662086). **Ireland.** Glen Inagh, Connemara, on wet rocks (BM). **Japan.** Mt. Kuzyû, Prov. Bungo, Kyûsûyû, 29.08.1958, leg. Y. Asahina, M. Togashi (H). **Norway.** Troms, Municipality: Storfjord, between road and Gustavsvingen, alt. 110–200 m, geo: 69°10.5′–69°28.7′N, 20°28.7′–20°29.7′E, on small stones along riverbed, 07.08.2003, leg. J. Motiejûnaitë (BILAS 6146). **Slovakia.** Carpati, montes Detvanská Polana: prope pagum Zolná, alt. 400 m, ad saxa conglomerata eruptiva, leg. A. Vëzda (BP 50591). **Sweden.** Västergötland, Älleberg, Saleby, alt. 325 m, on stone fence in shade, 22.08.1936, leg. A.H. Magnusson (B 92638). **USA.** North Carolina, near summit of Mount Mitchell (6684 ft.) Yancey Co., in conifer forest (mostly *Abies fraseri*), on rock ledges, 09.08.1967, leg. S. Tucker 6968 (BM).

#### 4.3.10. *Stereocaulon saxatile* H. Magn. (Plate III–17,18)

Göteborgs K. Vetensk.-o. Vitterh.-Samh. Handl. Ser. 4, 30(7): 41 (1926). = *Stereocaulon evolutoides* var. *saxatile* (H. Magn.) I.M. Lamb, Canad. J. Bot. 29: 581 (1951) (nom. illegit.).

**LECTOTYPUS** (LAMB 1977: 230): [Sweden], Medelpad, Alnö par., Gubben, “på toppen av vittrad sten I mindre sänka”, 4.07.1926, E. Eriksson (UPS-L 108401!).

= *Stereocaulon paschale* var. *evolutoides* H. Magn., Göteborgs K. Vetensk.- o. Vitterh.-Samh. Handl. ser. 4,30 (7): 50 (1926). = *Stereocaulon evolutoides* (H. Magn.) Frey, Rabenhorsts Krypt.-Fl. 9, Abt. IV, Hälfte: 145 (1932).

**LECTOTYPUS** (Lamb 1977: 313): [Sweden] Värmland, Sillerud, Noretjärn, 22.07.1912, H. Magnusson (UPS-L 108393!).

= *Stereocaulon paschale* subsp. *evolutoides* f. *laxum* I.M. Lamb, Ann. Rept. Nat. Mus. Canada, 1952–53, Bull. No. 132: 257 (1954).

**LECTOTYPUS** (Lamb 1977: 313, as HOLOTYPE; see [104], Art. 9.11): [Sweden] Värmland, Sillerud par., Järnsjön, 8.07.1912, H. Magnusson (UPS-L 108392!).

= *Stereocaulon tomentosum* var. *graphiticola* Räsänen, Lichenoth. Fenn. No. 247 (1947).

**HOLOTYPE** (Lamb 1977: 313): [Finland,] Savonia borealis: Kuopio, insula Lavio, supra saxa schistosa graphitica juxta fodinam. 15.XII.1946. Veli Räsänen et A.S. Leppälä (H! – Räsänen, Lichenoth. Fenn. 247; ISOTYPI: BM!, H!).

**Description.** Primary thallus disappearing. Pseudopodetia up to 1.5 cm tall, densely branched, with ash-grey tomentum towards apices, at the base glabrous, firmly attached to the substrate, stout, dorsiventral, forming dense, prostrate tufts. Phyllocladia abundant, greyish-white, flat to convex, scale-like to granular, almost completely covering pseudopodetia (Plate III–18). Soredia rounded, farinose, usually restricted to certain localized areas of the thallus. Cephalodia rare, granular, containing *Stigonema* (Plate III–17). Apothecia terminal or lateral, dark brown, observed in specimens from Finland and USA only.

**Chemistry.** The species produces atranorin and lobaric acid. Chemistry of the Polish examined specimens agrees with literature data [21,87]. Thallus reacts K<sup>+</sup> yellow, PD<sup>+</sup> pale yellow.

**Notes.** *Stereocaulon saxatile* is a taxon characterized by distinct morphology, the dorsiventral pseudopodetia covered with a ash-grey tomentum, the flat to convex, scale-like to granular phyllocladia and the production of lobaric acid and atranorin [21,22].

Lamb [21,22] distinguished three forms, *S. saxatile* f. *saxatile*, *S. saxatile* f. *sorediatum* I.M. Lamb and *S. saxatile* f. *paschaleoides* I.M. Lamb. *S. saxatile* f. *sorediatum* differs from the typical form in the presence of rounded soralia with, farinose soredia, whereas *S. saxatile* f. *paschaleoides* has the whitish-cream colored tomentum.

Magnusson [17] and Lamb [21] considered *S. saxatile* as a species similar to *S. paschale*. These two taxa are indeed morphologically and chemically very similar, but both have different types of cephalodia. In *S. saxatile* cephalodia are rare, brown, granular, containing *Stigonema*, while, in *S. paschale* they are numerous, irregular, shrubby, granular or warty, black.

*Stereocaulon saxatile* can be confused with *S. tomentosum*, which also develops grey tomentum, but contains stictic and norstictic acids instead of lobaric acid [21].

**Habitat requirements.** *Stereocaulon saxatile* is saxicolous lichen. It occurs on stones and rocks in pine forests. According to Gilbert et al. [60] it can also occurs on gravelly soil.

**World distribution.** This species has northern suboceanic type of distribution [21]. According to Ahti [142] it is middle boreal to hemiboreal, amphiatlantic taxon. Until now, it was not noted in the Arctic regions and the Southern Hemisphere. Materials from Finland, Germany, Norway, Russia, Slovakia, Sweden, USA have been examined during this study. In addition Lamb [21] reported *S. saxatile* from Belgium, Denmark, Great Britain, the Netherlands and Canada. It was also reported from China [117], Mongolia [143], Estonia [132], Ireland [121] and Spain [109].

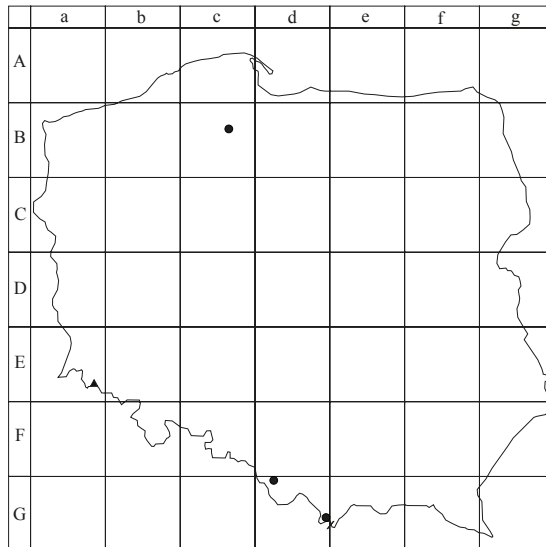
**Distribution in Poland.** *Stereocaulon saxatile* was rarely reported from northern and southern part of Poland (Fig. 10), however materials quoted to the first its Polish record by Krawiec [144] have not been found anywhere and data by Fałtynowicz [51] are incorrect. Just for the first time this species has been confirmed in the country by Oset [55]. Number of examined specimens from Poland: 10 (9 specimens of *S. saxatile* f. *saxatile*, 1 specimens of *S. saxatile* f. *sorediatum*).

*Stereocaulon saxatile* f. *saxatile*

**Specimens examined:** Bc-36 – Bory Tucholskie forests, Kręgi Kamienne nature reserve, near Odry village, on rock, 07.07.1985, s.coll. (LBL). Gd-02 – Wysoczyzna Polanowska high plain, Leśny Dwór forest inspectorate, Gałęźnia forest division, on stone, 01.08.1981, leg. I. Izydorek (LBL, SLTC). Gd-59 – West Tatra Mts, Czerwone Wierchy Mt., E slope of Małolączniak Mt., alt. ca. 1950 m, on rock, 11.09.1955, leg. Z. Tobolewski (BM, BP 13600, H, LBL, POZ, UPS).

*Stereocaulon saxatile* f. *sorediatum*

**Specimen examined:** Ea-78 – Góry Stołowe Mts, for Szrenica Mt. toward the Wielki Szyszak Mt., on rock, 14.06.1992, leg. M. Kosowska (UGDA-L 5172).



**Fig. 10** Distribution of *Stereocaulon saxatile* in Poland (circles – *S. saxatile* f. *saxatile*; triangles – *S. saxatile* f. *sorediatum*).

**Exsiccatae examined:** Follmann, Lich. Exs. Sel. Cassel. 158 (BM). Haukulinen, Lichenoth. Fenn. 1153 (B 46470). Howe, Lich. Nov. Angl. 22 (H, as *S. paschale*). Magnusson, Lich. Sel. Scand. Exs. 158 (B 92556, UPS-L 154345). Merrill, Lich. Exs. Ser. I 40 (H, as *S. paschale*). Pišút, Lich. Slovak. Exs. 142 (herb. Seaward 115443, BP 72206). Pišút, Lich. Slovak. Exs. 245 (BM, BP 84916, herb. Seaward 108433). Räsänen, Lichenoth. Fenn. 247 (BM, H – two specimens, as *S. tomentosum* f. *graphicola*). Räsänen, Tobolewski, Lichenoth. Polon. 113 (BP 13600, H, LBL, UPS, as *S. paschale*). Vězda, Lich. Sel. Exs. 312 (BP 51744, H, as *S. evolutoides*). Vězda, Lich. Sel. Exs. 1290 (BM, H).

**Selected reference materials** (a total of 40 specimens of *Stereocaulon saxatile*): **Finland.** Alandia (Al./A). Brändö: Åva, Åvaby, E exposed rock, in dry *Pinus silvestris-Juniperus communis-Cladonia* woods, on horizontal rock surface, 16.08.1992, leg. R. Skytén 6031 (H). **Germany.** Mitteldeutschland, Bez. Osthessen: polsterebilden an glatten, halbschattigen Felsbruchgläichen und in geschützten Gesteinsspalten im *Pertusarietum corallinae* Frey, 800 m, SO, pH 6.3, Basaltblockstrom im Naturschutzgebiet Schafstein unweit Wüstensachsen im Naturpark Hochrhön, 10.1973, leg. G. Follmann (BM). **Norway.** Hordaland, Ved Skålsaete i granvin, alt. Supra m. circit. 560 m., leg. J.J. Havaas (BM). **Russia.** Leningrad Region, Karelia australis (Ka/Rsj), Vyborg District: Bërezovje Islands Reserve, Bol'shoj, Bërezovyy Island, Polešë (Formerly Finland, Koivisto mlk.: Koivusaari, Saarenpää, Putronhiekkä), 60°16'N, 28°36'E, alt. 0–5 m, open to forested sand dunes along seaside, 12.08.2008, leg. T. Ahti 68368 (H). **Slovakia.** Nízke Tatry: ad terram schistosam cuprum continentiam /strues fodinae lapidorum/ supra viculum Richtárová in proximitate p. Staré Hory, alt. 600 m s.m., 23.08.1972, leg. I. Pišút (BP 84916). **Sweden.** Uppland, Löstabruk, on stone, 12.05.1996, leg. T. Ahti (BILAS 1732). **USA.** Acadia National Park, Mt. Desert Isl. On NW slope of Sauveur Mt. (2.5 miles N of Southwest Harbor), on hull and ridge with pines and few scattered maple and Thuja, 19.06.1983, leg. C.M. Wetman 45975 (UGDA-L 4842).

#### 4.3.11. *Stereocaulon spathuliferum* Vain. (Plate III–19,20)

Ark. Bot. 8 (4): 36 (1909). = *Stereocaulon fastigiatum* f. *spathuliferum* (Vain.) H. Magn., Goteborgs K. Vetensk.- o. Vitterh.-Samh. Handl. ser. 4, 30 (7): 37 (1926). = *Stereocaulon botryosum* f. *spathuliferum* (Vain.) Frey., Rabenhorsts Krypt.-Fl. 9, Abt. IV, Hälfte: 125 (1932). = *Stereocaulon botryosum* var. *spathuliferum* (Vain.) I.M. Lamb, Canad. J. Bot. 29: 581 (1951).

**HOLOTYPUS** (Lamb 1977): Norway, Granvin, Hardanger, Neisheimshorgen, altit. 980 m s.m., on rock, J.J. Havaas, 1900 (TUR-VAIN 3926).

**Description.** Primary thallus disappearing. Pseudopodetia up to 4 cm tall, dorsiventral, irregularly branched, terete or more or less flattened, white tomentose. Phyllocladia verrucose, with spatulate apical extensions, the upper side bluish-grey, the underside commonly soresiate (Plate III–20). Cephalodia mostly distinct, granular, bluish-grey, containing *Nostoc* (Plate III–19). Apothecia terminal (for more details see [21,28,60]). The description based on examined specimens found outside of Poland.

**Chemistry.** The species produces atranorin, stictic and norstictic acids. Spot test reaction: K+ red, PD+ orange. The chemistry of examined specimens agrees with that reported earlier [21,87].

**Notes.** This taxon is characterized by phyllocladia with spatulate apical extensions, which are often coarsely granular soresiate in the lower surface and the production of atranorin and stictic acid complex. According to Lamb [21] *S. spathuliferum* has some morphological affinity to *S. coniophyllum* Lamb and *S. nanodes* (probably due to soresidia), but differs in its chemistry producing atranorin, stictic and norstictic acids while both species produce atranorin and lobaric acid. *Stereocaulon delisei* Bory ex Duby, not yet known from Poland, is also very similar to *S. spathuliferum*, but develops conspicuous, globular, terminal soresiate mass on lateral branches. The two species can be distinguished by the composition of secondary metabolites since *S. delisei* produces rangiformic acid and norrangiformic acid [21,60].

Within the species three forms have been distinguished: of *S. spathuliferum* f. *dissolutum* (H. Magn.) I.M. Lamb, *S. spathuliferum* f. *globuliferum* (H. Mag) I.M. Lamb, *S. spathuliferum*

f. *pygmeum* (H. Mag) I.M. Lamb. All these taxa differ in the location of soralia and different distribution (see [21,22]); its taxonomic status needs clarification.

**Habitat requirements.** *Stereocaulon spathuliferum* is saxicolous lichen and occurs in well-insolated, open habitats. According to Gilbert et al. [60] *S. spathuliferum* grows on damp rocks in the vicinity of waterfalls or snow patches.

**World distribution.** *Stereocaulon spathuliferum* is classified by Lamb [4,21] as boreal-arctic, amphi-Atlantic bicentric or possibly circumpolar lichen and is reported by him from Europe (Scotland, Russia) and North America (Greenland, Canada, USA). In this work its occurrence is confirmed in Iceland, Finland, Norway and Sweden.

**Distribution in Poland.** *Stereocaulon spathuliferum* was noted from Poland only from Tatra Mts by Alstrup and Olech [145,146] and Olech [147]. The material is probably deposited in KRA, however for this study was unavailable to examine. Concerning its known world distribution it is probable, that the species does not occur in Poland at all. Number of examined specimens from Poland: 0.

**Exsiccatae examined:** Havaas, Lich. Norveg. Occid. Exs. 154 (H). Magnusson, Lich. Sel. Scand. Exs. 392 (B 92790,163209, H, as *S. botryosum* var. *dissolutum*). Malme, Lich. Suec. Exs. 979B (H, as *S. fastigiatum* var. *dissolutum*).

**Selected reference materials** (a total of 12 specimens of *Stereocaulon spathuliferum*): **Finland.** Lps, Petsamo: Pääksy-spahta, kalkkikivellä, 22.07.1927, leg. V. Kujala (H). **Iceland.** IVe (Vestur-Island), Mýrasýsla, Brekkumúli Mt by the pass Brattabrekka – 64.87°N, 21.52°W, alt. 400 m, on rock, 24.07.2009, leg. M. Oset (UGDA). **Norway.** Hordaland: in montibus inter Nesheimshorgen et Smøreggen par. Granvinensis, alt. 550–700 m, in rupibus nudis praeurptis in locis septentrionem spectantibus, in saxis subumbrosis et humidis, 1937, leg. J.J. Havaas (H). **Sweden.** Lappmark: Tärna, Björkfors, in ripa rivi Syterbäcken, alt. 475 m, 18.07.1924, leg. A.H. Magnusson (H); Lycksele Lappmark: Tärna par., Björkfors, Syterbäcken, alt. 450 m, on rocks, 18.07.1924, A.H. Magnusson 8236 (UPS, as *S. spathuliferum* f. *globuliferum*); Lycksele Lappmark: Tärna par., Blackfjället, alt. 600 m, on irrigated rock, 10.07.1924, A.H. Magnusson 8084 (UPS, as *S. spathuliferum* f. *pygmaeum*).

Additional reference material:

*Stereocaulon conioophyllum* I.M. Lamb, Bot. Not, 114(3): 267 (1961).

**HOLOTYPUS** (Lamb 1977: 268): Norway, Hordaland, Eidfjord, Hardanger, Vøringfoss, reg. subalpine, altit. 450–630 m s.m., 1899, J. Havaas (FH; ISOTYPUS: BG).

**Specimens examined:** **Norway.** Nordland, Narvik: ca. 0.3 km E of the railway-station, on rock outcrop, on a moist cliff, very abundant, 13.07.1960, leg. T. Ahti 12519 (B, H).

#### 4.3.12. *Stereocaulon subcoralloides* (Nyl.) Nyl. (Plate III–21)

Flora 57: 6, footnote (1874). = *Stereocaulon paschale* f. *subcoralloides* Nyl., Lich. Scandin.: 64 (1861).

**LECTOTYPUS** (selected by U. LAINE in Oset [55]): Finland, Ostrobothnia ouluensis. Kiiminki, E. Nylander (H-NYL 39994!)

**Description.** Primary thallus disappearing. Pseudopodetia erect, simple at the base, branched in the upper part, up to 3 cm tall, forming caespitose or dense tufts, weakly tomentose, tomentum white in the upper part, darkening at the base. Phyllocladia few in lower part of pseudopodetia, cylindrical, in the upper part very abundant, from finger-like to coralloid, grey, darker at the base, but pale towards the pseudopodetial tips (Plate III–21). Cephalodia numerous, tuberculate, olive-brown, containing *Stigonema*. Apothecia terminal, disc brown with pale margin, not seen in Polish material, but found in specimens from Finland, Norway and Sweden.

**Chemistry.** The species always produces atranorin and lobaric acid. The chemistry of Polish specimens agrees with that reported earlier (see [21,148]). Spot test reaction: K+ yellow and PD+ faintly yellow.

**Notes.** *Stereocaulon subcoralloides* is characterized by coralloid-elongate phyllocladia and the presence of atranorin and lobaric acid in thallus.

*Stereocaulon subcoralloides* resembles *S. dactylophyllum*, and all Polish specimens of *S. subcoralloides* were found under this name. Both taxa are similar in morphology, but differ in chemistry as *S. dactylophyllum* produces atranorin, stictic and norstictic acids. In addition, the two taxa have different shape of apothecia, the type of pseudopodetial branching and frequency of cephalodia [20,60,113].

According to Lamb [21] *S. subcoralloides* is very similar to *S. sibiricum* Lamb and *S. tennesseense* H. Magn. *S. sibiricum* has a tendency for some phyllocladia to become flattened-squamulose, and is chemically different (stictic acid instead of lobaric acid), whereas *S. tennesseense* has the same chemistry, but its phyllocladia are more flattened.

**Habitat requirements.** In Poland *S. subcoralloides* was found only on rocks in open habitats. According to Magnusson [17] and Motyka [20] this taxon prefers siliceous rocks in wooded areas.

**World distribution.** *Stereocaulon subcoralloides* is circumpolar, boreal lichen. The species is known from the Northern Hemisphere only. It has been confirmed here from Finland, Germany, Norway, European part of Russia and Sweden. In addition Lamb [21] reported from Canada and USA. It was also reported from the Czech Republic [118] and Estonia [149].

**Distribution in Poland.** It is a very rare species in the country what showed yet recent work by Oset [55]. Until now, only two sites were discovered (Fig. 11). Its records are from the 50's and 80's of the twentieth century, suggesting that *S. subcoralloides* can be critically vulnerable for extinction in Poland. Number of examined specimens from Poland: 3.

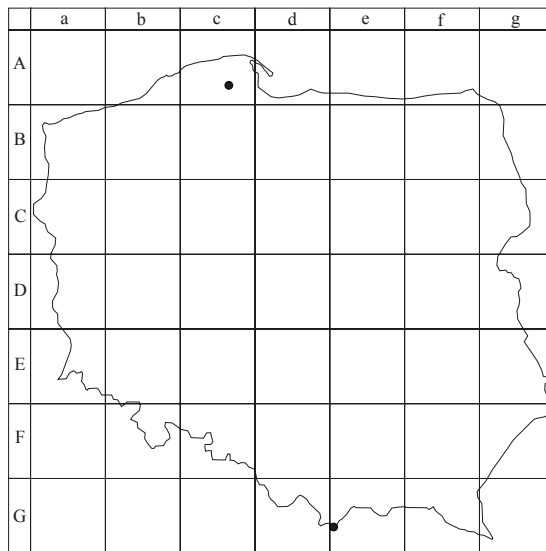


Fig. 11 Distribution of *Stereocaulon subcoralloides* in Poland.

**Specimens examined:** **Ac-76** – Pobrzeże Kaszubskie seashore, Osiek village, S of Strzebielino village, on rock, 23.07.1985, leg. W. Fałtynowicz (UGDA-L 2951). **Ge-60** – Tatry Wschodnie Mts, Dolina za Mnichem valley, above Cubryna Mt., alt. ca. 2080 m, 27.08.1956, leg. Z. Tobolewski (POZ); Szpiglasowa Przełęcz pass, alt. ca. 2100 m, on rock, 27.08.1956, leg. Z. Tobolewski (POZ).

**Exsiccatae examined:** Haukulinen, Lich. Fenn. Exs. 618 (H). Malme, Lich. Suec. Exs. 508 (H, as *S. coralloides*). Norrlin, Herb. Lich. Fenn. 85 (H). Räsänen, Lich. Fenn. Exs. 56 (H). Räsänen, Lich. Fenn. Exs. 104 (H). Räsänen, Lichenoth. Fenn. 618 (B 46484). Zahlbruckner, Krypt. Exs. 2066 (BM, H).

**Selected reference materials** (a total of 32 specimens of *Stereocaulon subcoralloides*): **Finland.** Tavastia australis. Lammi: Evo, Kotinen nature reserve, lake Valkea-Kotinen to hill Lapinkallio. GPS: 61°14'36"N, 25°04'05"E, alt. 155–175 m, on rock, 13.08.2007, leg. M. Oset (UGDA). **Germany.** Auf dem Ziegeldache der vaerfallenen Ziegelei in Edeweicht bei Zwischenahn in Oldenburg, 03.1887, leg. H. Sandstede (B 158811). **Norway.** Hordaland, insula Stord, 21.08.1927, leg. J. Motyka (LBL). **Russia.** Kola Peninsula, Khibiny Mts., 3 km E of Khibiny village Malaya Belaya er valley, alt. 300 m, on ground, 08.08.2000, leg. M. Kukwa (UGDA-L 8806). **Sweden.** Bohuslän, prope Göteborg, ad terram lapidosam, 07.1929, leg. J. Motyka (LBL).

#### 4.3.13. *Stereocaulon taeniarum* (H. Magn.) Kivistö (Plate III–22,23)

Sauteria 9: 26 (1998). = *Stereocaulon paschale* f. *taeniarum* H. Magn., Göteborgs K. Vetensk.-o. Vitterh.-Samh. Handl. Ser. 4, 30 (7): 48 (1926).

**LECTOTYPUS** (LAMB 1977: 313): [Sweden], Bohuslän, Öckerö par., Björkö, 9.08.1916, A.H. Magnusson (UPS-L 108396!).

**Description.** Primary thallus disappearing. Pseudopodetia loosely attached to the substratum, up to 5 cm tall, erect or creeping, always with one main branch at the base covered with a white to rose, tomentum thin at the base base and thicker above (Plate III–22). Phyllocladia dactyliform or grain-like sometimes verrucose or scaly, covering pseudopodetia around, more numerous at the top (Plate III–23). Cephalodia absent. Apothecia rare, terminal, dark brown (for more details see [30]), not observed in Polish specimens.

**Chemistry.** All examined specimens of *S. taeniarum* produced atranorin and lobaric acid. Spot test reaction: K+ yellow, PD+ yellow (see [30]).

**Notes.** *Stereocaulon taeniarum* was treated formerly as only a form of *S. paschale*, but recently its status at the species level has been established by Kivistö [30]. The differences between both species and also characters discriminating it from *S. alpinum* are presented in Tab. 3. According to Lamb [21] *S. paschale* f. *taeniarum* should be regarded as a form of *S. saxatile*, while Gunnar Carlin recognized this taxon as a variety of *S. grande* (see [30]). Now, it is believed that *S. taeniarum* is most morphologically and chemically similar to *S. paschale*. Recently, *S. taeniarum* has been considered as a rarer species in Poland than *S. paschale* [54].

**Habitat requirements.** *Stereocaulon taeniarum* is usually terricolous lichen in Poland (25 specimens), but in five cases rocks were noted as its substrate. The examination of those collections led to the conclusion that actually the specimens were growing on soil over rocks. It prefers dry pine forests, or other well-lit habitats such as high mountains. Similar habitat requirements reported also Kivistö [30].

**World distribution.** *Stereocaulon taeniarum* is a hemiboreal or south-boreal lichen [30] confirmed here from Finland, Lithuania, Russia, Slovakia and Sweden. Kivistö [30] reported this taxon from North America (Canada). This species has been only recently recognized in the world, so its detailed distribution may be still incomplete and requires further investigation.

**Distribution in Poland.** This species was noted for the first time in Poland only from a few localities by Kivistö [30], including the material published in exsiccatae of Fałtynowicz and



Miądlikowska [150], and later on by Kukwa and Fałtynowicz [151] (see also [51]). At present the species is known mainly from Western Pomerania, with scattered localities elsewhere (Fig. 12; see also [54]). Although the lichen now seems to be more common than thought reported, it still belongs to the endangered species in the country.

The localities cited below were partly cited by Oset [54], but several new data are added here as well. Number of examined specimens from Poland: 30.

**Specimens examined:** **Ac-66** – Pojezierze Kaszubskie Lakeland, 1.5 km S of Porzecznio village, on rock, 18.07.1985, leg. W. Fałtynowicz (UGDA-L 3359). **Af-97** – Pojezierze Wschodniosuwalskie Lakeland, Suwalski Landscape Park, “Głazowisko Bachanowo nad Czarną Hańczą” nature reserve, S of Bachanowo village, on rock, 13.09.1984, leg. K. Czyżewska, Z. Tobolewski (LOD-L 7791); 03.07.1999, leg. W. Fałtynowicz, M. Kukwa (UGDA-L 8482); S of Hańcza Lake, on rock, 22.09.1982, leg. W. Fałtynowicz (UGDA-L 3422); Błaskowizna village and Głazowisko Bachanowo nature reserve, 22.09.1982, leg. W. Fałtynowicz (KTC). **Bc-05** – Pojezierze Kaszubskie Lakeland, Rozłazino village, on rock, 26.07.1985, leg. W. Fałtynowicz (UGDA-L 3327). **Bc-10** – Wysoczyzna Polanowska high plain, ca. 1 km W of Trzcina village near Dretyń village, ca. 300 m W of lake, on stone, 28.06.1984, leg. I. Izydorek (SLTC). **Bc-24** – Bory Tucholskie forests, Przymuszewo forest inspectorate, Lubnia forest division, forest section No. 331/332, on soil, 05.03.1978, leg. W. Fałtynowicz (UGDA-L 1024). **Bc-34** – Bory Tucholskie forests, Lubnia village, between Kościerzyna and Chojnice towns, on soil, 23.04.1988, leg. M. Opanowicz (KRAM-L 22451); 24.04.1988, leg. W. Fałtynowicz (herb. Seaward 115438); E of Lubnia village, on soil, 20.10.2005, leg. E. Stefańska (WRSL 4806); rezerwat Bór Chrobotkowy im. Prof. Z. Tobolewskiego nature reserve, forest section No. 327, on soil, 12.08.2009, leg. M. Kukwa 7576 (UGDA); Przymuszewo forest inspectorate, between Lubnia and Wiele villages, forest section No. 327/328, rezerwat Bór Chrobotkowy im. Prof. Z. Tobolewskiego nature reserve, on soil, 19.05.1999, leg. M. Opanowicz (KRAM-L 44768); 27.09.2001, leg. M. Opanowicz (herb. Opanowicz 61); forest section No. 316/317, on soil, 26.06.2001, leg. M. Opanowicz (herb. Opanowicz 60); 27.09.2001, leg. M. Kukwa (GPN 2622). **Bc-35** – Bory Tucholskie forests, 30 km NE of Chojnice town, near Wiele village, on soil, 01.05.1990, leg. W. Fałtynowicz, J. Miądlikowska (B 140965, 146079, BM, H, LBL, LOD-L 10213, UPS). **Bc-43** – Bory Tucholskie forests, Przymuszewo forest inspectorate, Popówka forest division, forest section No. 292 b, on soil, 05.04.1977, leg. W. Fałtynowicz (UGDA-L 126). **Bc-44** – Bory Tucholskie forests, Przymuszewo forest inspectorate, Popówka forest division, forest section No. 317 bE, on soil, 01.04.1977, leg. W. Fałtynowicz (KRAM-L 21854, UGDA-L 102); forest section No. 317d, on soil, 01.04.1977, leg. W. Fałtynowicz (UGDA-L 125). **Cf-97** – Wysoczyzna Drohiczyńska high plain, ca. 1 km W of Wólka Zamkowa village, 19.08.1991, leg. S. Cieśliński (KTC); Wólka Zamkowa village, on soil, 19.08.1991, leg.

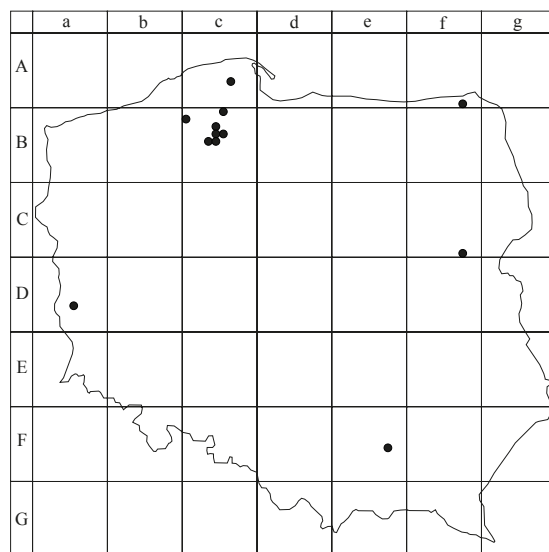


Fig. 12 Distribution of *Stereocaulon taeniarum* in Poland.

S. Cieśliński (KTC). **Da-65** – Obniżenie Nowosolskie depression, near Lubsko village, 23.07.2002, s.coll. (KTC). **Fe-57** – Kobierzyn village, leg. M. Opanowicz (KRAM-L 3820).

**Exsiccatae examined:** Fałtynowicz & Miądlukowska, Lich. Polon. Exs. 14 (B 140965, BM, H, LBL, LOD-L 10213, UGDA, UPS, as *S. paschale*). Moberg, Lich. Sel. Exs. Upsal. 73 (H). Tobolewski, Lichenoth. Polon. 113 (BP 13600, LBL).

**Selected reference materials** (a total of 22 specimens of *Stereocaulon taeniarum*): **Finland.** Uusimaa [=Nylandia] Sibbo: Träskby, hill Braskarberget, alt. 20–30 m, granitic rock outcrops with scattered *Pinus* trees on low hilltop, 15.06.1997, leg. H. Sipman, T. Ahti (B 116888). **Lithuania.** Aukštaitijos NP, Ignalinos raj., Vaišniūnų, ant silikationio akmens pamiškėje, 15.05.2001, leg. J. Motiejūnaitė (BILAS 5960). **Russia.** km 147 Obskaya-Paijuta railway, Yamal Peninsula, exposed heath, 02.08.1993, leg. B. Forbes (herb. Seaward 107043). **Slovakia.** Tatry Bielskie, w Siodle “Śirdze Pole”, between Hlupym Vrelem and Zdziarska Vidla, alt. ca. 1800 m, 19.07.1956, leg. Z. Tobolewski (POZ). **Sweden.** Sweden, Al. Jomala, Kungsö, Dalsberg, På Dalsbergs SE-brant vid Kungsöfjärdens, SW-hörn, 28.08.1976, leg. R. Skytén (H).

#### 4.3.14. *Stereocaulon tomentosum* Fr. (Plate III–24, IV–25)

Sched. Crit. Lich. Exs. 3: 20 (1825). = *Stereocaulon paschale* var. *tomentosum* (Fr.) Duby, Aug. Pyrami de Candolle Botanicon Gallicum, ed. 2, 2: 618 (1830). = *Stereocaulon paschale* subsp. *tomentosum* (Fr.) Branth & Rostr., Bot. Tidsskr. 3: 162 (1869).

**TYPUS:** not designated.

= *Stereocaulon tomentosum* subsp. *magellanicum* Th. Fr., De Stereoc. et. Pilophor. Comment.: 31 (1857).

**LECTOTYPUS** (Lamb 1977: 314): [Chile], Fretum Magellanicum, 1852, N.J. Andersson (UPS!).

= *Stereocaulon cupriniforme* Nyl., Flora 48: 211 (1865). = *Stereocaulon tomentosum* f. *cupriniforme* (Nyl.) Vain., Meddeland. Soc. Fauna Fl. Fenn. 6: 100 (1865). = *Stereocaulon tomentosum* var. *cupriniforme* (Nyl.) Oliv., Mém. Soc. Sci. Nat. Cherbourg 36: 162 (1906–1907).

**LECTOTYPUS** (Lamb 1977: 314): [Finland, Tavastia australis,] Asikkala, [1863, J.P. Norrlin] 162 (H-NYL. 39921!).

**Description.** Primary thallus disappearing. Pseudopodetia loosely attached to the substratum, up to 5 cm tall, prostrate or erect, in the upper part with many recurved short branches with cream-grey tomentum densely covering the whole length of pseudopodetium. Phyllocladia flattened and squamulose, overlapping and thickly covering pseudopodetia (Plate III–24). Cephalodia inconspicuous, concealed in the tomentum on the lower surface of pseudopodetium containing *Nostoc* (Plate IV–25). Apothecia frequent, lateral, usually abundant toward the end of branches, dark brown.

**Chemistry.** This species produces atranorin, stictic and norstictic acids. In some specimens norstictic acid may be present in very low concentrations, and sometimes it is almost invisible on the chromatogram. Two other secondary metabolites are always recorded in a very high concentration, which agrees with literature data ([21] and literature cited therein; see also [60]). Spot test reaction: K+ yellow, PD+ orange.

**Notes.** *Stereocaulon tomentosum* is characterized by loosely attached to the substratum pseudopodetia, the upper part with many recurved short branches, often forming cushions, dense cream-grey tomentum covering the whole length of pseudopodetia and numerous apothecia, usually abundant toward the end of the branches [21,60].

Chemically and morphologically *S. tomentosum* resembles *S. alpestre* (Flot.). *S. alpestre* contains the same secondary lichen metabolites, but it differs in shorter pseudopodetia with verrucose to thickly crenate-squamulose phyllocladia present in the lower part, which in middle of pseudopodetium disintegrate into densely arranged single grains.

Morphologically *S. tomentosum* also resembles *S. alpinum*, which differs in the presence of lobaric acid (see notes under *S. alpinum*).

According to Magnusson [17] *S. tomentosum* and *S. paschale* (L.) Hoffm. were often mistaken, especially in their sterile stage. Despite the resemblance in their morphology these

two species are quite easy to recognize on the basis of their chemistry as *S. paschale* produces atranorin and lobaric acid. In Polish material only two specimen were mistaken for *S. paschale*.

**Habitat requirements.** *Stereocaulon tomentosum* grows in Poland on sandy soil (32 specimens), and rarely on siliceous stones (6 specimens), in pine forests, grasslands, on railway embankments and open habitats [20,50].

**World distribution.** This taxon is characterized by circumpolar boreal-mountain type of distribution. During the revision it has been confirmed for Asia (China and Mongolia), Europe (Austria, Belarus, the Czech Republic, Finland, France, Iceland, Lithuania, Norway, Russia, Slovakia, Sweden and Hungary), North America (Canada, USA) and South America (Bolivia, Chile). In addition Lamb [21] noted *S. tomentosum* from Ecuador, Peru, Venezuela, Japan, Korea, Belgium, Denmark, Estonia, Spain, Switzerland, the United Kingdom and the Faroe Islands and Greenland. Other records are known also from Costa Rica in Central America [152], Colombia [105], India [119], Tajikistan [153], Tibet [106], and Luxembourg [133].

**Distribution in Poland.** *Stereocaulon tomentosum* is widespread in Poland (Fig. 13). Vertical distribution of this taxon varies from almost sea level to alt. ca. 1100 m in mountains.

For the first time *S. tomentosum* was reported from Poland by Flotow [37]. Later was recorded several times from many regions of the country (see [51] and literature cited therein). At present it is considered to be endangered lichen (category EN) [59]. Number of examined specimens from Poland: 31.

**Specimens examined:** **Ac-98** – Pojezierze Kaszubskie Lakeland, between Skrzyszów and Glinicz villages, on rock boulders, 22.08.1930, leg. F. Krawiec (LBL). **Bb-21** – Równina Białogardzka plain, W of Rarwino village near Białogard town, on rock, 19.10.1987, leg. W. Fałtynowicz, J. Miądlifikowska (UGDA-L 3762). **Bc-31** – Równina Chażykowska plain, Lipczynek village near Przechlewo village, on stone, 11.07.1987, leg. W. Fałtynowicz (UGDA-L 3918). **Bc-48** – Pojezierze Starogardzkie Lakeland, near Ocypl railway station, on rocks, 24.07.1984, leg. W. Fałtynowicz (UGDA-L 2518). **Be-51** – Pojezierze Olsztyńskie Lakeland, near Olsztyn city, 07.1954, leg. K. Glanc (POZ). **Bf-99** – Wysoczyzna Białostocka high plain, Grądy village, 09.1976, leg. J. Bagińska (LBL). **Bg-42** – Kotlina Biebrzańska basin, Rogożyn Stary village by Biebrza River, on soil, 04.07.1991, leg. S. Cieśliński (KTC). **Cc-39** – Kotlina Toruńska basin, Toruń city, near Przysiecka road, on stones, 02.08.2006, leg. E. Adamska (TRN). **Cf-16** – Wysoczyzna Wysokomazowiecka high plain, 3 km SW of Chlebnotki Nowe village, on soil, 30.08.1990, leg. S. Cieśliński (KTC). **Cg-25** – Dolina Gónej Narwi valley, ca. 2 km SW of Szymki village, on soil, 13.05.1987, leg. S. Cieśliński, Z. Tobolewski (KTC). **Cg-35** – Dolina Górnej Narwi valley, SE of Rybaki village, on soil, 13.05.1987, leg. S. Cieśliński, Z. Tobolewski (KTC). **Cg-42** – Równina Bielska plain, W of Klejniki village, on soil, 29.08.1991, leg. S. Cieśliński (KTC). **Cg-72** – Równina Bielska plain, Białowieża National Park, 1 km SW of Jelonka village, on soil, 1979, leg. S. Cieśliński (KTC); 2 km SSW of village, on soil, 1979, leg. S. Cieśliński (KTC); 1980, leg. S. Cieśliński (KTC–four specimens); 1.5 km SW of Jelonka village, alt. 180 m, 26.07.1981, leg. M.R.D. Seaward (herb. Seaward 103942); Kleszczewo village, 04.1994, leg. E. Lickiewicz (LBL). **Da-07** – Pojezierze Łagowskie Lakeland, Łągów forest inspectorate, 23.07.1949, leg. Z. Tobolewski (POZ). **Eb-28** – Wzgórze Trzebnickie hills, Oborniki Śląskie town near Zgorzelec city, 1860–1890, leg. A. Busch (B 116898). **Fb-14** – Góry Stołowe Mts, Skalniak near Karłowa, alt. ca. 800 m, on humus, 19.07.1951, leg. Z. Tobolewski (POZ). **Fe-07** – Pogórze Szydłowskie foothills, Zadoły village near Korytnica village, on soil, 1984, leg. G. Sikora (KTC). **Ge-34** – Beskid Sądecki Mts, Krościenko forest inspectorate, Szczawnica forest division, trail from Szlachtowa Mt. to Prehyba Mt., on soil, 23.08.1962, leg. J. Bystrek (LBL). **Ge-35** – Beskid Sądecki Mts, Pasma Jaworzyny range, SE slope Parchowatka Mt., alt. 920 m, on rocky ground, 24.09.1966, leg. M. Olech (KRA). **Gf-58** – Bieszczady Zachodnie Mts, Przełęcz Wetlińska pass, alt. ca. 850 m, on soil, 19.08.1958, leg. Z. Tobolewski (POZ); alt. ca. 1100 m, 19.08.1958, leg. K. Glanc (KRAM-L 35883); by Wetlinka river, the route to Smerek Mt., on soil, 21.08.1957, leg. Z. Tobolewski (POZ). **Gf-69** – Bieszczady Zachodnie Mts, NE slope of Połonina Caryńska Mt., alt. ca. 900 m, on soil, 24.09.1958, leg. Z. Tobolewski (POZ); alt. ca. 1100 m, 24.09.1958, leg. K. Glanc (KRAM-L 35884).

**Exsiccatae examined:** Anonymous, Fl. Hung. Exs. 16 (H). Claudel, Claudel & Harmand, Lich. Gall. 423 (B–93294, BM, H). Huuskonen, Lich. Fenn. 758 (B 46491). Haukulinen, Lich. Fenn. 935 (B 46492). Haukulinen, Lich. Fenn. 962 (B 46494, H). Haukulinen, Lich. Fenn. 963 (B 46493). Haukulinen, Lich. Fenn. Exs. 1140 (H). Kalb, Lich. Neotrop. 444 (H). Kavina & Hiltzer, Crypt. Česchoslov. Exs. 273 (BP 65517). Kerner von Marilaun, Fl. Exs. Austro-Hung.

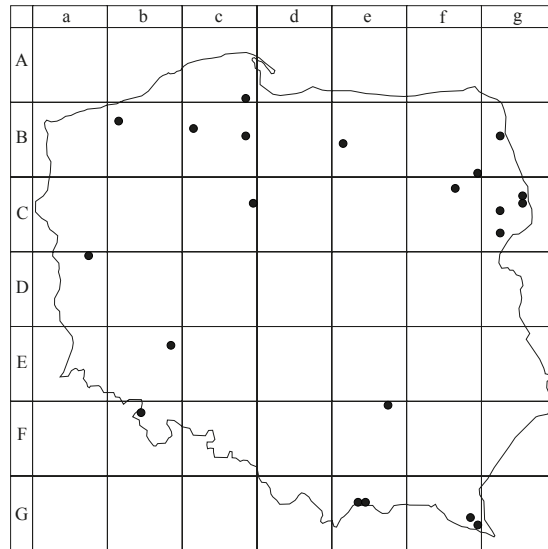


Fig. 13 Distribution of *Stereocaulon tomentosum* in Poland.

1539 (BP 86683, H). Lamy de la Chapelle, Fl.Gall. Germ. Exs. 1194 (B 66443). Lojka, Lichenoth. Reg. Hung. Exs. 12 (BP 13690). Malme, Lich. Suec. Exs. 651 (H). Martianoff, Pl. Minusien. Exs. (WRS�, as *S. coralloides*). Petrak, Crypt. Exs. 4145 (BM). Pišút, Lich. Slovak. Exs. 265 (BP 84931, as *S. tomentosum* var. *compactum*). Pišút, Lich. Slovak. Exs. 284 (BP 85646, as *S. tomentosum* var. *compactum*). Räsänen, Lich. Fenn. Exs. 736 (H). Räsänen, Lich. Fenn. Exs. 758 (H). Räsänen, Lichenoth. Fenn. 1140 (B 46495). Savicz, Lichenoth. Ross. 136 (H). Sched. Crit. Lich. Exs. Suec. 423 (B 66430). Suza, Lich. Bohemislov. 135 (BM). Verseghy, Lichenth. Parva 84 (BP 75691, as *S. tomentosum* var. *hercynum*). Vězda, Lich. Bohemoslov. Exs. 265 (UGDA, as *S. tomentosum* var. *compactum*). Vězda, Lich. Sel. Exs. 1283 (H, as *S. tomentosum* var. *compactum*). Zahlbruckner, Krypt. Exs. 1655 (BP 41389, BM, H). Zahlbruckner, Krypt. Exs. 1855 (B 66428, H).

**Selected reference materials** (a total of 97 specimens of *Stereocaulon tomentosum*): **Austria**. prope urbem Gmünd, 540 m s.m., leg. Eggerth (BP 86683). **Belarus**. Mialka, bank of the lake Drisviaty, 11.09.1989, leg. J. Motiejūnaitė (BILAS 873). **Bolivia**. La Paz, Prov. Murillo Zongo valley, along the road near Laguna Visachani, alt. 3750 m, 20.04.1982, leg. J.L.D. Meeuks, J. Ybert (LPB). **Canada**. Alberta: Eastern end of Lesser Slave Lake, on Hwy. 67, 7.1 km N of junction with Hwy. 2., on sand, 25.04.1983, leg. D.G. Horton (KRAM-L 21155). **Chile**. X Region, Chiloé, Parque Nacional de Chiloé, El Tepual, 74°12'E, 42°35'S, alt. 10–20 m, on lowland coastal forest and scrub: Tepualia, Nothofagus, 06.12.1986, leg. B.J. Coppins, D.J. Galloway, G. Guzmán, P.W. James 4943 (BM). **China**. Yünna: Pass Lenago zwischen Mekong u. Yangtse, 27°43'N, alt. 4000 m, 06.1914, leg. A.K. Gebauer (WRS�). **The Czech Republic**. ad terram glareosam prope Javoří Pila, Šumava, 1030 m s.m., 14.07.1935, leg. A. Hilitzer (BP 65517). **Ecuador**. Zwischen Pujili und Zumbahua, westlich von Latacunga, an freisthenden Granitfelswänden, 3800 m, 13.08.1987, leg. K. & A. Kalb (H). **Finland**. V. Karjaan mlk., Meltolasta SW, maantieylikäytävistä SW, rämeen kohdalla 4 m korkean ratavallin SE-rinne, 17.06.1964, leg. J. Suominen (H). France. Arlane, Puy-de Dime, 10.1963, leg. L. Brevière (B 66442). **Hungary**. prope Iglófüred, ad terram, leg. F. Filarszky (H). **Iceland**. IVE (Vestur-Island), Snæfellsnessýsla, Kolgrafararfjörður fjord – 64.91°N, 23.09°W. from seal level, on mosses, 23.07.2009, leg. M. Oset (UGDA). **Lithuania**. Vilnius district, Avižieniai environs, at forest edge, on stone, 17.09.1986, leg. J. Motiejūnaitė (BILAS 337). **Mongolia**. s.coll. (KRAM-L 225338). **Norway**. Rörås, Skaarnammerdalen, 28.09.1919, leg. H. Magnusson (BM). **Russia**. R. Burduguz, 30 km Se of Irkutsk, alt. 460 m, leg. M.R.D. Seaward (herb. Seaward 108932). **Slovakia**. Slovenské rudohorie: ad lapides schist. Prope metalla ferri vetusta non procul a Smolnícka Huta, 500 m s.m., 21.07.1974, leg. A. Vězda (UGDA). **Sweden**. Jämtland, Undersåker, Hälland, 29.06.1949, leg. Gösta Kjellmert (LBL). **USA**. Shaded rocks at the base of rockslide, Mision Valley, Lake County, Montana, 28.04.1938, leg. F.A. Barkley (BM).

Additional reference material:

*Stereocaulon alpestre* (FLOT.) DOMBR., Bot. Zhurn. 77(7): 98 (1992).

**TYPUS:** destroyed during World War II (LAMB 1977).

**Exsiccatae examined:** Hansen, Lich. Groenl. Exs. 854 (H, as *S. alpinum*). Thomson, Lich. Arct. 43 (H, LBL). Thomson, Lich. Arct. 46 (H, LBL).

**Selected specimens examined:** **Bolivia.** Dept. La Paz, Prov. Inquisivi: Boca de Rio Santiago, along the Rio Santiago 300 m., from its mouth, 1 km NE of Planta Hidroelectrica de Carabuco, 67°20'W, 16°49'S, alt. ca. 3090 m., scrubby area along the banks of the river, open, moss covered slope, 10.07.1986, leg. Marko Lewis 86-309 (LPB). **Finland.** Petsamo, regio alpina, 03.07.1928, leg. E. Häyrén (H). **Greenland.** Bådskæret, Wendel Pynt, 76°45'N, 18°50'W, 21.07.1982, leg. B. Lauritzen (KRAM-L 43862; as *S. alpinum*). **Iceland.** IVE (Vestur-Island), Snæfellsnessysla, Enni by Ólafsvík – 64.90°N, 23.76°W alt. 10–20 m, on mosses, 22.07.2009, leg. M. Oset (UGDA). **Norway.** Spitsbergen, Svalbard, Hornsund, Ariekammen, elev. 40 m, 07.1985, leg. B. Godzik, K. Grodzińska (KRAM-L 33797, as *S. alpinum*). **Russia.** N of central Syberia (Krasnoyarsk Territory), Severnaya Zemly Archipelago, N extremity of Bol'shevik Is., W cost of Mikoyan Bay at 200 m from the bay coast, 79:18N, 101:55E, alt. 10 m, on mosses, 21.07.1996, leg. M. Zhurbenko 96201 (H).

#### 4.3.15. *Stereocaulon vesuvianum* Pers. (Plate IV–26)

Ann. Wetter. Gesellsch. Ges. Naturk. 2: 19 (1810). = *Stereocaulon botryosum* subsp. *vesuvianum* (Pers.) Ach., Synopsis Methodichodica Lichenium: 285 (1814). = *Stereocaulon alpinum* var. *vesuvianum* (Pers.) Link, Grudriss der Kräuterkunde, vol. III: 168: (1833). = *Stereocaulon denudatum* var. *vesuvianum* (Pers.) Laur. in Hepp, Flechten Europas, Band I, Heft 1, No. 2 (1853). = *Stereocaulon denudatum* subsp. *vesuvianum* (Pers.) Th. Fr., De Stereoc. et Pilophor. Comment.: 28 (1857).

**HOLOTYPUS** (LAMB 1977: 242): Italy, Vesuvi crater, s.coll. (L-PERS; ISOTYPUS: H-ACH 1761!).

**Description.** Primary thallus disappearing. Pseudopodetia 1–4 cm tall, firmly attached to the substratum, more or less caespitose, erected, lacking tomentum, whitish or greyish, dark at the base, branched in upper part. Phyllocladia in most cases almost entirely covering the pseudopodetia, small often verrucose, but larger, usually peltate, flattened or concave with dark olive-coloured center part and paler margin (Plate IV–26), sometimes occasionally breaking into granular soredia. Cephalodia rare, verruculose, dark olive brown, containing *Stigonema*. Apothecia observed only one in Polish samples, 0.5–1 mm diam., rare, on lateral branches.

**Chemistry.** *Stereocaulon vesuvianum* can produce atranorin, stictic and norstictic acids [21]. In Polish material these lichen metabolites were present in the following combinations: atranorin and norstictic acid (1 specimen); atranorin, stictic acid and norstictic acid (50 specimens); atranorin, stictic acid and norstictic acid (trace; 80 specimens); atranorin and stictic acid (19 specimens); stictic acid (2 specimens).

Despite the clear differences in the composition of secondary metabolites between examined specimens, morphological variability has not been observed. Additionally, since diagnostic substances (stictic and norstictic acids) are biogenetically related, the chemical have not been given taxonomic status.

According to Bolognese et al. [154] characterized substance for *S. vesuvianum* is 4,6-dihydroxy-2-methoxy-3-methylacetophenone, but it has not been detected during this studies. Spot test reaction: K+ yellow, PD+ orange.

**Notes.** Diagnostic features of *S. vesuvianum* are the wart-like to peltate phyllocladia with characteristic dark olive-coloured center and paler margins. It is a very variable species several varieties [*S. v.* var. *symphycheileoides* I.M. Lamb; *S. v.* var. *efflorescens* (Räsänen) I.M. Lamb; *S. v.* var. *thyrsoides* I.M. Lamb; *S. v.* var. *nodulosum* (Wallr.) I.M. Lamb; *S. v.* var. *obscurum* (Müll. Arg.) I.M. Lamb; *S. v.* var. *kilimandscharoense* B. Stein.) and forms (*S. v. vesuvianum* f.

*santorinense* I.M. Lamb and five form within *S. vesuvianum* var. *nodulosum*: *S. f. umbonatum* (Wallr.) I.M. Lamb, *S. f. depressum* (H. Magn.) I.M. Lamb, *S. f. sessile* (H. Magn.) I.M. Lamb, *S. f. umbricolum* (Frey) I.M. Lamb, *S. f. verrucosum* I.M. Lamb) were distinguished]. Many of the above-mentioned taxa are only results of adaptations to different environmental conditions and have no taxonomic importance (see [61]).

According to Gilbert et al. [60] sorediate *S. vesuvianum* var. *nodulosum* resembles *S. delisei*, which differs by the lack of dark olive-coloured center and lack of stictic and norstictic acids. On the other hand, *S. vesuvianum* var. *syphycheileoides* is similar to *S. symphycheilum*, but differs in its chemistry as *S. symphycheilum* produces atranorin and lobaric acid while *S. vesuvianum* contains atranorin and stictic acid complex. *S. vesuvianum* var. *syphycheileoides* was described by Lamb [155] from Slovakia. This study did not confirm the occurrence of this taxon in Poland.

*Stereocaulon vesuvianum* can be mistaken for *S. arcticum*, which prefers another habitat (*S. vesuvianum* occurs mainly on rocks, while *S. arcticum* occurs on soil) and has pseudopodetia emorient below. According to Dahl [156] and Lyngø [157] distinguishing features for both taxa are different types of cyanobacteria in cephalodia: in *S. vesuvianum* it is *Stigonema*, and in *S. arcticum* it is *Nostoc*. However, later studies have shown that in both representatives of both types of cyanobacteria can live in the same specimen [21]. Considering the huge variety, many researchers have different concepts of *S. arcticum* and *S. vesuvianum*. According to Lamb [21] both taxa should be treated as two different species, meanwhile Kivistö [31] concluded that it is only one species. Molecular studies conducted by Högnabba [36] did not provide a clear answer to the question whether the two taxa belong to the same species. The researches should be repeated using larger number of samples.

**Habitat requirements.** *Stereocaulon vesuvianum* is saxicolous lichen, growing on granite and sandstone rocks. Very often it occurs also on humus and mosses over rocks. According to Gilbert et al. [60], in the United Kingdom *S. vesuvianum* growing on rock and stone containing heavy metal. *Stereocaulon vesuvianum* colonizes also lava flows [113].

**World distribution.** *Stereocaulon vesuvianum* is cosmopolitan and circumpolar. Based on many collections this species has been confirmed here to be widespread in the world. In Europe it was found in Austria, the Czech Republic, Denmark, Finland, France, Germany, Great Britain, Hungary, Iceland, Ireland, Italy, Norway, Slovakia and Ukraine. From Africa, specimens collected in Kenya, Tanganyika, Tanzania and Zaire were examined and moreover specimens from, Asia (Japan), North America (Greenland), South America (Bolivia) and Hawaii. In addition Lamb [21] noted *S. vesuvianum* from Australia and New Zealand, Madeira, Réunion, the Canary Islands, Argentina, Chile, Colombia, the Azores, Portugal, Russia and Switzerland. Other reports from Congo Republic [158] and Uganda [159], Peru [105], Venezuela [160], Costa Rica [152], Antarctica [161], China [106], and Estonia [149], the Netherlands [127], Romania [124], the Pacific Islands [112].

**Distribution in Poland.** In Poland *S. vesuvianum* occurs mainly in the southern part of the country, where it was collected from several mountain ranges (Fig. 14). Sometimes it is probably locally frequent there as suggest many its records in the Tatra Mts and the Karkonosze Mts throughout the last century. The vertical range varies from about 500 m a.s.l. on the Równina Sławieńska plain to approximately 2400 m a.s.l. in the Eastern Tatra Mts. According to Cieśliński et al. [59] *S. vesuvianum* is vulnerable lichen (category VU) in Poland.

Number of examined specimens from Poland: 152.

**Specimens examined:** **Ab-69** – Równina Sławieńska plain, Słupsk town, road to Strzelino town, on stone, 10.05.1984, leg. I. Izydorek (SLTC). **Ea-78** – Karkonosze Mts, W of Śnieżne Kotły cirque, on granite rock, 27.07.2007, leg. K. Szczepańska (herb. Szczepańska). **Ea-79** – Karkonosze Mts, Szrenica Mt., on granite rock, 14.08.2001, leg. K. Szczepańska 186, 197 (herb. Szczepańska); NE slope, on rock, 07.10.2007, leg. M. Kossowska (herb. Kossowska-two specimens); **Ea-88** – Karkonosze Mts, Mały Śnieżny Kocioł cirque., basalt vein, 08.2006, leg. M. Kossowska, W. Fałtynowicz (herb. Kossowska – two specimens). **Ea-89** – Karkonosze Mts, Kocioł Łomniczki cirque, alt. 1138 m, 50°44'40"N, 15°44'02"E, on stone, 01.05.2007, M. Oset (UGDA – ten specimens); S slope, on granite rock, 02.05.2007, s.coll. (WRSL); Śnieżka Mt., leg. Flotow (WRSL-two specimens); N slope of Śnieżka Mt., alt. 1450 m, on humus, 13.06.1954, leg. Z. Tobolewski (BP 192, BP 13502, LBL, TRN, UPS); NE slope of Śnieżka Mt., alt. 1443 m, 50°44'14,2"N, 15°44'06"E, on stone, 02.05.2007, leg. M. Oset (UGDA – six specimens); 50°44'13,5"N, 15°43'58,2"E, on stone, 02.05.2007, leg. M. Oset (UGDA); alt. 1435 m, 50°44'14"N, 15°44'02"E, on stone, 02.05.2007, leg. M. Oset (UGDA); Śnieżka Mt., on rock, 2004, leg. M. Kossowska (herb. Kossowska); leg. Th. Bail (WRSL). **Eb-71** – Rudawy Janowickie, Kolorowe Jeziorka ponds, alt. 500 m, on soil, 13.10.2007, leg. K. Szczepańska (herb. Szczepańska). **Eb-80** – Karkonosze Mts, NE slope of Śnieżka Mt., alt. 1510 m, 50°44'19"N, 15°44'38"E, on stone, 02.05.2007, leg. M. Oset (UGDA – three specimens); Kopa Mts, near Karpacz town, alt. 1180 m., 26.08.1980, leg. M.R.D. Seaward, E.A. Bylińska (herb. Seaward 103505); Czarny Grzbiet Mt., on humus and stones, 07.09.2001, leg. M. Kukwa (herb. Kukwa); E slope, Czarny Grzbiet Mt., 03.05.2002, M. Kukwa (herb. Kukwa); 24.07.2006, leg. M. Kossowska (herb. Kossowska). **Fb-47** – Masyw Śnieżnika Massif, Czarna Droga, on rock, 10.07.2003, leg. K. Szczepańska (WRSL 1276); Goworek Mt., on rock, 09.07.2003, leg. K. Szczepańska (WRSL 681); Śnieżnik Kłodzki Mt., on rock, 24.06.2003, leg. K. Szczepańska (WRSL 1725). **Fb-57** – Masyw Śnieżnika Massif, Trójmorski Wierch Mt., on rock, 23.06.2003, leg. K. Szczepańska (WRSL 1919). **Gd-26** – Pasma Babiogórskie range, Babia Góra Mt., on soil, 10.10.1957, leg. J. Nowak (KRAM-L 2526); 22.06.1961, leg. J. Nowak (KRAM-L 8791); alt. 1700 m, 18.08.1965, leg. J. Nowak (KRAM-L 2950); 1967, leg. J. Nowak (KRAM-L 1374); Diablak Mt., alt. 1700 m, on moss, 14.07.2001, leg. M. Węgrzyn (KRA); under Diablak Mt., on rock, 29.06.1954, s.coll. (LBL); near Diablak Mt., on soil, 20.09.1969, leg. K. Glanc (LOD-L 332). **Gd-59** – Tatry Zachodnie Mts, Twardy Uplaz Mt., alt. ca. 2020 m, on granite, 08.09.1955, leg. Z. Tobolewski (POZ); Suche Czuby Mt., alt. ca. 1800 m, on granite rock, 21.06.1998, leg. U. Bielczyk (KRAM-L 44475). **Ge-11** – Polana Górna glade under Kielbaśnie pass in valley of Zapalac stream, alt. 820 m, S slope, on sandstones, 23.10.1997, leg. P. Czarnota, J. Kiszka (GPN 1725/94). **Ge-50** – Tatry Zachodnie Mts, Dolina Pięciu Stawów Polskich valley, S slope of Mały Kozi Wierch Mt., in Dolina Pusta, alt. ca. 2040 m, on granite rock, 26.08.1956, leg. Z. Tobolewski (POZ); cirque under Pośredni Goryczkowy Mt., 26.08.1927, leg. J. Motyka (LBL); Tatry Wschodnie Mts, Dolina Pańszczyzy valley, on

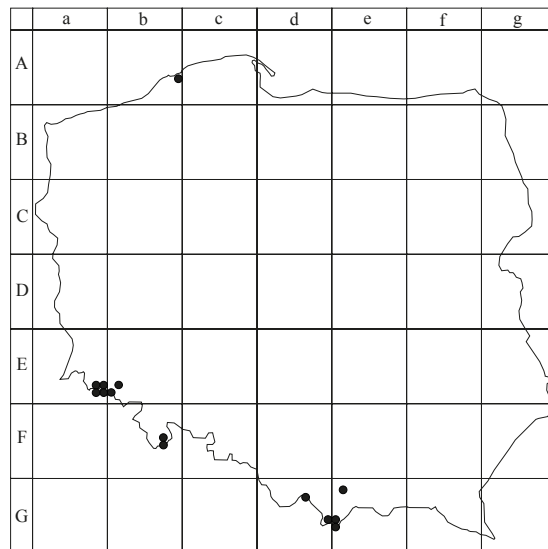


Fig. 14 Distribution of *Stereocaulon vesuvianum* in Poland.

granite rock, 21.06.1975, leg. J. Nowak (LOD-L 5992); Czerwony Stawek pond, on rocks, 07.1963, leg. J. Bystrek (LBL-ten specimens); above Czerwony Staw pond, the granite boulders, 22.06.1972, leg. K. Waydowska (KRAM-L 21166, 21168); Czarny Staw pond, 1877, leg. A. Rehmann (KRAM-L 20979); 30.08.1957, s.coll. (LBL); Czarny Staw pond near Hala Gąsienicowa hall, 30.07.1951, leg. Zimny (LBL); alt. 1600 m, 03.09.1980, leg. M.R.D. Seaward, E.A. Bylińska (herb. Seaward 103730); near Czarny Staw Gąsienicowy pond, 11.09.1946, leg. B. Krankowska (LBL); above Czarny Staw Gąsienicowy pond, 1877, leg. A. Rehmann (KRAM-L 3864); Czarny Staw Gąsienicowy pond near Kościelec, alt. ca. 1620 m, 07.09.1958, leg. Z. Tobolewski (POZ); under Czarny Staw Gąsienicowy pond, 24.05.1963, leg. J. Nowak (KRAM-L 4537); Dolina Pańszczyzy valley near Czerwony Wierchu Mt., 07.1963, leg. J. Bystrek (LBL); under Karb Mt., 30.08.1957, leg. J. Rydzak (LBL); Przełęcz Karb pass under Kościelec Mt., alt. 1852 m, on granite rock, 09.07.1955, leg. J. Nowak (KRAM-L 4680); under Kościelec Mt., on rocks, 22.08.1923, leg. Z. Tobolewski (KRAM-L 787); Mały Kościelec Mt., on soil, 1958, K. Glanc (KRAM-L 35891); on rocks, 05.1959, J. Bystrek (LBL); Żółta Turnia Mt., on soil, 12.10.1960, leg. J. Nowak (KRAM-L 6189, 6190, 6191); alt. ca. 1540 m, on granite rock, 13.07.1970, leg. J. Nowak (LBL); 30.07.1970, leg. J. Nowak (BP 77476, LOD-L7349); 13.07.1970, leg. J. Nowak (H); alt. ca. 1650 m, 03.04.1964, leg. K. Tatarkiewicz (LBL); W side of Żółta Turnia Mt., alt. ca. 1700 m, on sandstone, 27.07.1963, leg. K. Tatarkiewicz (LBL-two specimens); side of Żółta Turnia Mt. near Hala Gąsienicowa, 12.07.1955, leg. J. Nowak (KRAM-L 2527); under Żółta Turnia Mt., on granite and quartz rocks, 16.09.1929, leg. J. Motyka (LBL-three specimens); 10.09.1949, leg. J. Motyka (LBL); under Żółta Turnia Mt., road to Dolina Pańszczyzy valley, 20.07.1963, leg. J. Bystrek (LBL); under Dwoisty Staw pond, alt. ca. 1800 m, the erratic boulders, 09.07.1955, J. Nowak (KRAM-L 1210); Wołoszyńskie Szczyty Mt., 12.07.1951, leg. J. Motyka (LBL); Wołoszyn Mt., alt. 2000 m, 08.08.1960, leg. K. Tatarkiewicz (LBL); Wołoszyn Mt., above Dziad Mt., alt. 1780 m, 49°14'28"N, 20°04'29"E, on granite rock, 15.06.2003, leg. M. Węgrzyn 1246 (KRA); under Krzyżne pass, on stones, 09.1956, leg. I. Wojciechowski (LBL); Hala Gąsienicowa hall, 21.07.1961, J. Nowak (KRAM-L 8690); Dolina Gąsienicowa valley, Czerwone Stawki ponds, alt. 1660 m, 49°13'39"N, 20°00'13"E, on granite rock, 07.06.2003, leg. M. Węgrzyn 1123 (KRA); Beskid Mt., alt. 1920 m, 49°13'46"N, 19°59'18"E, on granite rock, 07.06.2003, leg. M. Węgrzyn 1051, 1068 (KRA); Zielony Staw pond, alt. 1670 m, 49°13'45"N, 19°59'50"E, on granite rock, 07.06.2003, leg. M. Węgrzyn 1100 (KRA); 49°13'49"N, 20°01'16"E, on granite rock, 29.06.2003, leg. M. Węgrzyn 1386 (KRA); Liliowe pass, 1952 m, on rock, 10.08.2009, leg. B. Oset (UGDA); road from Świnica Mt. to Hala Gąsienicowa hall, on rock, 10.08.2009, leg. M. Oset (UGDA). **Ge-60** -Tatry Wschodnie Mts, Dolina Pięciu Stawów Polskich valley, Szpiglasowa Perci Mt., alt. ca. 1900 m, 06.10.1964, leg. Z. Tobolewski (POZ); on Road to Dolina Pięciu Stawów valley, on rock, 28.08.1952, leg. J. Rydzak (LBL); Kocioł Czarnego Stawu cirque above Morskie Oko lake, near Mięgoszowiecka Przełęcz pass, on granite rock, 16.09.1966, leg. Z. Tobolewski (POZ); alt. ca. 1630 m, on granite rock, 14.09.1966, leg. Z. Tobolewski (POZ); Dolinka pod Kotłem valley in w Dolinia Pięciu Stawów Polskich valley, alt. ca. 1960 m, on granite rock, 20.09.1955, leg. Z. Tobolewski (POZ); Morskie Oko lake, alt. ca. 1400 m, on granite stone, 17.08.1955, leg. K. Tatarkiewicz (LBL); between Morskie Oko lake and Czarny Staw pond, on rock, 17.09.1969, leg. K. Czyżewska (LOD-L 5913); Krzyżne Mt., alt. 2130 m, on rock, 10.07.1955, leg. J. Nowak (KRAM-L 4345); Świstówka Mt. from Morskie Oko lake, 08.1925, s.coll. (KRAM-L 776); Żabia Czuba Mt., alt. ca. 1900 m, on stone 17.08.1955, leg. K. Tatarkiewicz (LBL); alt. ca. 2000 m, on erratic boulders, 17.08.1955, leg. K. Tatarkiewicz (LBL); W side, alt. ca. 1900 m, on stone, 22.08.1955, leg. K. Tatarkiewicz (LBL); N side Żabia Grań Mt., near Pl-Sk, alt. 1570 m, on granite rock, 09.07.2002, leg. P. Czarnota (GPN 2920); Rysy Mt., alt. ca. 2100 m, 07.1927, leg. J. Motyka (LBL); Mnich Mt., 06.07.1958, leg. K. Tatarkiewicz (LBL); alt. ca. 1900 m, "Kant", on rocks, 16.09.1955, leg. K. Tatarkiewicz (LBL); NE side, slope 0°, alt. 2430 m, 49°11'00"N, 20°05'17"E, on granite rock, 15.07.2003, leg. A. Flakus 440 (KRAM); leg. A. Flakus 435 (KRAM); on granite rock, 20.07.2004, leg. A. Flakus 2695 (KRAM); between Rysy Mt. and Przełęcz pod Rysami pass, alt. 2400 m, NE side, slope 5°, 49°10'51"N, 20°05'18"E, on granite rock, 08.08.2033, leg. A. Flakus 1432 (KRAM); Mięgoszowiecki Szczyt Mt., SE side, slope 80°, alt. 2438 m, 49°11'13"N, 20°03'34"E, on granite rock, 17.08.2003, leg. A. Flakus 1922 (KRAM); N side, slope 0°, 49°11'13"N, 20° 03'34"E, on granite rock; 17.08.2003, leg. A. Flakus 1923 (KRAM); slope 15°, 49°11'13"N, 20°03'34"E, on granite rock, 17.08.2003, leg. A. Flakus 1951 (KRAM); leg. A. Flakus 1929 (KRAM); leg. A. Flakus 1472 (KRAM); on erratic boulders, 09.08.2003, leg. A. Flakus 1465 (KRAM); leg. A. Flakus 1474 (KRAM); leg. A. Flakus 1466 (KRAM); Cubryna Mt., N side, slope 0°, alt. 2375 m, 49°11'16"N, 20°03'13"E, on granite and humus, 14.08.2004, leg. A. Flakus 3072 (KRAM); 23.08.2003, leg. A. Flakus 2098 (KRAM); leg. A. Flakus 2081 (KRAM); leg. A. Flakus 2079 (KRAM); leg. A. Flakus 2093 (KRAM); A. Flakus 2104 (KRAM); leg. A. Flakus 2100 (KRAM); Żabi Szczyt Wyżni Mt., alt. 2259 m, N side, slope 5°, 49°11'16"N, 20°05'21"E, on granite rock and humus, 20.08.2005, leg. A. Flakus 5356 (KRAM); Tatry Zachodnie Mts, Dolinka pod Kotłem valley in Dolinia Pięciu Stawów Polskich valley, alt. ca. 1950 m, 20.09.1955, leg. Z. Tobolewski (POZ); Kasprowy Wierch Mt., N slope, alt. 1780 m, on granite rock, 25.10.1986, leg. T. Ahti, M. Olech 46067 (H).

**Exsiccatae examined:** Arnold, Lich. Exs. 1576 (H, as *S. denudatum*). Asahina, Lich. Japon. Exs. 96 (H, as *S. vesuvianum* f. *nabewariense*). Baglietto, Cesati & Notaris, Erb. Critt. Ital. Ser. II 20 (BM). Flörke, Deutsche Lich. 79 (UPS-L 132038,



as *S. denudatum*). Follmann, Lich. Exs. Sel. Cassel. 159 (B 157419, 46501, BM, as *S. vesuvianum* var. *nodulosum*). Hansen & Christensen, Lich. Dan. Exs. 457 (UGDA). Harmand, Lich. Gall. Rar. Exs. 65 (H). Haukulinen, Lich. Fenn. Exs. 1154 (H, as *S. vesuvianum* var. *nodulosum* f. *umbonatum*). Huuskonen, Lichenoth. Fenn. 471 (B 46381, as *S. denudatum*). Larbaestier's Lichen Herbarium exsiccatum britannicum 7 (H, as *S. vesuvianum* var. *nodulosum*). Moberg, Lich. Sel. Exs. Upsal. 74 (H). Nowak, Lich. Polon. Merid. Exs. 61 (BP 77476, H, LBL, LOD-L 7349). Obermayer, Lichenoth. Graec. 298 (H). Petrak, Crypt. Exs. 4337 (H, as *S. denudatum* var. *vesuvianum*). Pišút, Lich. Slov. Exs. 63 (BP 51629). Pišút, Lich. Slov. Exs. 286 (BP 85648, UGDA, as *S. vesuvianum* var. *symphycheiloides*). Poelt, Pl. Graec. Lich. 246 (BM, H, as *S. vesuvianum* f. *verrucosum*). Räsänen, Lich. Fenn. Exs. 104 (H, as *S. vesuvianum* var. *nodulosum*). Räsänen, Lich. Fenn. Exs. 200 (H, as *S. vesuvianum* var. *nodulosum*). Räsänen, Lich. Fenn. Exs. 398 (H). Schade & Stolle, Hepat. Saxon. 259 (H, as *S. spissum*). Stenhammar, Lich. Suec. Exs. 83 (BM, as *S. vesuvianum* var. *nodulosum*). Tobolewski, Lichenoth. Polon. 85 (TRN, LBL, BP 192, 13502, as *S. denudatum*). Vězda, Lich. Rar. Exs. 368 (BM). Vězda, Lich. Rar. Exs. 467 (BM, H). Vězda, Lich. Sel. Exs. 731 (H). Vězda, Lich. Sel. Exs. 1070 (H). Vězda, Lich. Sel. Exs. 1281 (H, as *S. vesuvianum* var. *symphychoiloides*). Vězda, Lich. Sel. Exs. 1284 (BM, as *S. vesuvianum* var. *nodulosum*). Vězda, Lich. Sel. Exs. 1373 (H, as *S. vesuvianum* var. *kilimandscharoense*). Vězda, Lich. Sel. Exs. 1775 (BM, H, as *S. vesuvianum* var. *nodulosum*).

**Selected specimens examined for comparison** (a total of 131 specimens of *S. vesuvianum* s.str. tested including 1 specimen of *S. vesuvianum* var. *depressum*, 4 specimens of *S. vesuvianum* var. *kilimandscharoense*, 11 of *S. vesuvianum* var. *nodulosum*, 3 of *S. vesuvianum* var. *symphycheiloides* and 1 specimen of *S. vesuvianum* f. *depressum*, which are considered here as morphotypes of *S. vesuvianum*): **Austria**. An der Nordseite eines grossen Glimmerfelsens im Fichtengehölze des Verwallthales bei St. Anton am Arlberg, 19.08.1893, leg. Arnold (H, as *S. vesuvianum* var. *nodulosum*). **Bolivia**. Dept. Cochabamba, Prov. Carrasco, PN Carrasco, Monte Punku village, 17°35'01"S, 65°18'03"W, alt. 2800 m, open place, on soil, 2008, leg. Kukwa 6151 (LPB, UGDA). **The Czech Republic**. West Bohemia, NE of Františkovy Lázně, SOOS Nature Reserve, slovkovský les Mts., former village Litrbachy (= Čistá), 50°06'16"N, 12°43'55"E, the bottom of old heap covered in upper part with forest, on rock, 18.04.2009, leg. M. Kukwa 7354 (UGDA). **Denmark**. Sjælland, Nivå, at railway track, on stones, 13.10.2005, leg. O.B. Lyshede, V. Alstrup (UGDA). **Finland**. Karelia ladogensis: Impilahti, Pullinvuori, in silva, ad rupem, 18.06.1936, leg. A. J. Huuskonen (H, as *S. vesuvianum* var. *nodulosum*); **Finland**. Lapponia ontekiensis: N-Ridni, 1100 m s.m., ad rupem, 12.08.1958, leg. A.J. Huuskonen (H, as *S. vesuvianum* f. *depressum*). **France**. Bretagne, Roc'h Trévezel, on rock, 19.07.1954, leg. V.J. Grummann (B 163176). **Germany**. Eifel, Nerother Kopf westl. Von Daun, NW – exp. Auf Basaltblöcken, 05.1984, leg. G. Follmann (B 157421). **Great Britain**. Anglia, below Mickle Fell (65), alt. 500 m., 19.08.2000, leg. M.R.D. Seaward (herb. Seaward 109613); Kew Gardens Station (17), on station platform asphalt, 08.01.1989, leg. C.J.B. Hitch et al. (herb. Seaward 114182, as *S. vesuvianum* var. *symphycheiloides*). **Greenland**. Coast between Mosselbuhte and Verlegenhuken, 24.08.1936, s.coll. (LBL). **Hungary**. Magas Tara, Széplak, 08.1932, V. Greschik (BP 41316). **Hawaii**. Near Ainahou Ranch Road, Puna, alt. 3000 ft., in dry region, on exposed cinders & pahoehoe, 04.05.1966, leg. Otto & Isa Degener 3053 (herb. Seaward). **Iceland**. IVE (Vestur-Island), Snæfellsnessýsla, Kolgrafarfjörður fjord – 64.91°N, 23.09°W. From sealevel, on rock, 23.07.2009, leg. M. Oset (UGDA). **Ireland**. South side of Kylemore Lake, Connemara, on wet rocks, s.coll. (H, as *S. vesuvianum* var. *nodulosum*). **Japan**. Oniwa, Mt. Fugi, alt. 2300 m, 06.10.1987, leg. M.R.D. Seaward (herb. Seaward 105605). **Kenya**. Nyeri, Aberdare Mountains east of Lesatima, 0–20 S, 36–38 E, alt. 3600 m, in high moorland, on stone, 02.1977, leg. T.D.V. Swinscow (BM). **Norway**. Sør Trøndelag, Røros (11°23'E, 62°35'N), Storvartsgruva Copper mine (disused), spoil heaps, ca. 9 km NE of Røros, alt. ca. 840 m., 07.07.1982, leg. O.W. Purvis (BM). Svalbard, Spitsbergen, regio Arctica, 1934, leg. T. Wiśniowski (LBL). **Russia**. Kola Peninsula, Khibiny Mts., SE slope of Lovchor Mt., 4.5 km SE of Kirovsk, alt. 750 m, on rocks, 09.08.2000, leg. M. Kukwa (UGDA-L 8821). **Slovakia**. Slovenské rudhorie; ad scorias vetustas in valle rivi Smolník prope Smolnícka Píla, alt. 500 m, 27.05.1980, leg. E. Lisická, J. Liška, I. Pišút et A. Vězda (BP-85648, topotype of *S. vesuvianum* var. *symphycheiloides*). **Spain**. Isla Canarias, El Hierro, uppermost slopes of El Golfo, 1 km W below the turnoff to Santuario Virgen de los Reyes, by the road to Frontera, 27°44'00"N, 18°00'10"W, alt. 1280 m, N-exposed road-slope, on slidified lava, 04.02.1995, leg. J. Hafellner 33744 (H). **Scotland**. Meal Grom, West Ross-Shire, 29.07.1946, leg. R.W.G. Denis (LBL). **Sweden**. Uppland: Värmdön, Hasseludden, in rupibus gneissaeis, lente declivibus, saepe irrigatis, 15.05.1930, leg. Gust. O. A:n Malmé (B 158704). **Tanganyika**. Mt Meru, western slope above Olkakola estate, in the lowest part of the alpine region, alt. 3500 m, on stone, 1948, leg. O. Hedberg 2343 (BM). **Tanzania**. Arusha National Park, Meru Crater, Kititi Camous, alt. 2480–2600 m, in vegetatione subalpina cum Erica, ad laviam, 16–18.12.1988, leg. T. Pócs 88301 (BM). **Ukraine**. Karpaty Wschodnie, Czarnohora, 1934, leg. J. Motyka (LBL). **USA**. Alaska, Aleuten, Attu, alt. 300 m, 1949, leg. G.A. Llano 1463 (BM, as *S. vesuvianum* f. *verrucosum*). **Zaire**. Prov. Kivu, montes Birunga, in pede montis ignivomi Nyamuragira prope Sake secundum via ad Goma, alt. 1500 m, ad lapides vulcanicos anno 1948 eruptos, 08.02.1972, leg. J. Lambinon 72/543 (H, as *S. vesuvianum* var. *kilimandscharoense*).

Additional reference material:

***Stereocaulon arcticum*** Lyngb, Skr. norske Vidensk.-Akad. Mat.-Naturvid. Klasse 1936, 6: 69 (1938).

**HOLOTYPE** (Lamb 1977: 249): Jan Mayen, Hageruphytta, 1930, J. Lid (O).

**Exsiccatae examined:** Hansen, Lich. Groenl. Exs. 292 (BP 89429, H). Hansen, Lich. Groenl. Exs. 355 (H). Hansen, Lich. Groenl. Exs. 811 (H, as *S. arenarium*). Hansen, Lich. Groenl. Exs. 850 (B 130837). Poelt, Pl. Graec. Lich. 337 (B 48030). Räsänen, Lich. Fenn. Exs. 397 (H-two specimens).

**Selected specimens examined:** **Finland.** Nw-Le, Porojärvet, Ridni, Gipfelplateau, Schiefergeröll, 1300 m., 24.07.1955, leg. A. Henssen 724 (H). **Iceland.** IVe (Vestur-Island), Hnappadalssýsla, Eldborgarhraun lava field – 64.79°N, 22.31°W. alt. 20–40 m, on soil, 21.07.2009, leg. M. Oset (UGDA-L 16571). **Norway.** Spitsbergen. Hawa, Rotjesfjellet, on soil, 13.08.1958, leg. M. Kuc (KRAM-L 3164).

***Stereocaulon symphycheilum*** I.M. Lamb, Bot. Notiser 114: 271 (1961).

**HOLOTYPE:** Sweden, Lycksele Lappmark, par. Tärna, Hemavan, Syterbäcken, 1959, V. Ahmandijan 26 (FH; ISOTYPUS: UPS!).

**Selected specimens examined:** **Finland.** Kuusamo (Ks). Salla: Väriötunturit, Syväkuru, alt. ca. 330–380 m, rocky gorge, grid 27°E: 7516:610, UTM: PR2, on large boulders, 10.06.1980, leg. T. Ahti 38054 (H). **Great Britain.** Westmorland, Lake District, Coniston, Littlehow Crags above Levers Water, alt. 600 m, on rocks bearing malachite/azurite (copper minerals) on spoil heaps, 29.04.1984, leg. O. W. Purvis (BM). **Iceland.** IVe (Vestur-Island), Snæfellsnessýsla, Fróðárheiði pass, between Miðfell and Knarrarfjall mountains – 64.85°N, 23.48°W, alt. ca. 360 m, on rock, 22.07.2009, leg. M. Oset (UGDA). **Russia.** Kolapeninsula, southern Khibiny, NE slope of Lovchorr mountain, ca. 7 km E of Kirovsk city, alt. ca. 600 m, in montane tundra, on soil and gravel, 09.08.2000, leg. J. Motiejūnaitė (BILAS 5308). **Sweden.** Västerbotten, Skellefteå, Kågnäset, Långhällan, in crevenses of rock near the sea, on rock, 08.07.1997, leg. Lars-Erik Muhr (BM).

**Type material of *Stereocaulon vesuvianum* f. *depressum* examined:** Sweden, Lycksele Lappmark, par. Tärna, Brandsfjället, 1924, A.H. Magnusson 8962 (UPS, holotypus).

**Type material of *Stereocaulon vesuvianum* var. *kilimandscharoense* examined:** [Africa], Senecio Bach, 3000, M. Meyer (WRSL, lectotypus).

**Type material of *Stereocaulon denudatum* examined:** Germany, Flörke, Flörke, Deutsche Lich. 79 (UPS-L 132038, lectotypus).

**Type material of *Stereocaulon vesuvianum* var. *symphycheileoides* examined:** Czechoslovakia, Slovakia, Carpathians, Slovenské Rudohorie Mts., Mníšek in valley of Smolník River near Smolnická pila, altit. 500 m s.m., on old volcanic rocks, 1974, A. Kiszely and A. Vězda, Vězda, Lich. Sel. Exs. 1281 (H, isotypus).

**Type material of *Stereocaulon vesuvianum* var. *verrucosum* examined:** USA, Alaska, Aleutian, Attu, 300 m., 1949, G.A. Llano 1463, Poelt, Pl. Graec. Lich. 246 (UPS-L 47414, isotypus).

#### 4.4. Lichenicolous fungi inhabiting on *Stereocaulon* in Poland

Until 2000 only 9 taxa of lichenicolous fungi inhibiting representatives of the genus *Stereocaulon* were reported [162]. Currently, the occurrence of 30 species of lichenicolous fungi (Tab. 4) and 8 lichenicolous lichens on *Stereocaulon* are known. 18 of them are host specific and restricted to this genus [101,163]. The relatively small number of these parasities may be due to the fact that the lichen genus *Stereocaulon* as a host for lichenicolous fungi has never been a special interest for investigation.

Czyżewska and Kukwa [164] stated, that four lichenicolous fungi can be observed on the thallus of *Stereocaulon* species occurring in Poland (*Arthonia stereocaulina*, *Cercidospora stereocaulorum*, *Endococcus nanellus*, *Roselliniella stereocaulorum*). However, the taxonomic revision allowed confirming only two of them:

##### 4.4.1. *Cercidospora stereocaulorum* (Arnold) Haffelner

Herzogia 7(3–4): 362 (1987). = *Leptosphaeria stereocaulorum* Arnold, Flora 57: 175 (1874). = *Metasphaeria stereocaulorum* (Arnold) Sacc., Syll. Fung. 2: 183 (1883).

**Syntypus:** [Austria] Parasit auf Stereoc. Gneissboden der Berghöhe ober dem Griesberger Thale. 8000! Brenner in Tirol. 8/82. [F.C.G. Arnold] (M-0041204).

**Notes.** Specimen annotated by J. Hafellner as "Typus von *Leptosphaeria stereocaulorum*" and D. Triebel. Data from Botanische Staatssammlung München (<http://www.botanischestaatssammlung.de>).

**Morphology.** Ascomata perithecioid, 0.1–0.2(–0.3) mm in diam., with distinctly visible ostiolum, smooth, black, shiny, sessile on the hosts thallus. Peridium blue-green in upper part, hyaline in lower part. Asci subcylindrical, 4-spored. Ascospores narrowly ellipsoidal, with 3 transverse septa, 13–26.5 × 4.5–7.5 μm; wall smooth (for detailed description see [101]).

**Hosts.** *Stereocaulon alpinum*, *S. dactylophyllum*, *S. vesuvianum* (occurs on phyllocladia, rare on pseudopodetia, cephalodia and old apothecia).

**Notes.** *Cercidospora stereocaulorum* is characterized by 3-septate ascospores. Ascospores of Polish collections reach 18.5–25.5 × 5–7 μm and differ a little bit in the dimensions known from the literature (see [101]). Another *Cercidospora* species growing on *Stereocaulon*, *C. alpina* Ihlen & Wedin, has 8-spored asci, 18–43 × 4–7 μm, with perispore, only on crustose terricolous *S. cumulatum* (see [101] and literature cited therein). According to Zhurbenko [101] the number of ascospores (as well as the number of septa in spores) is unstable and requires further study.

*Cercidospora punctillata* (Nyl.) R. Sant. and *C. decolorella* (Nyl.) O.E. Erikss. & J.Z. Yue are very similar to *C. stereocaulorum*. Those taxa do not grow on *Stereocaulon* and are characterized by different number of ascospores and their septation (see [101] and literature cited therein).

**General distribution.** This lichenicolous fungus is known only from the Northern Hemisphere in North America (Alaska, Canada, Greenland), Europe (Austria, Norway, Poland, Sweden, United Kingdom) and many regions of the European and Asian parts of Russia [101,165–167].

**Distribution in Poland.** In Poland it is reported from only one locality (see also [167]). Number of specimen examined: 1.

**Specimen examined:** Ge-60 – Tatry Wschodnie Mts, Mięguszwiecka Przełęcz pod Chłopkiem pass, 49°11'09"N, 20°03'55"E, alt. 2307 m, on *Stereocaulon alpinum* growing on soil, 16.07.2004, leg. A. Flakus 2551/1 (KRAM).

#### 4.4.2. *Roselliniella stereocaulorum* Zhurb., Kukwa & Oset

Mycotaxon 109: 323 (2009).

**HOLOTYPE:** USA, Alaska, Great Kobuk Sand Dunes, Ahnewetut Creek, 67°02'N, 158°50'W, alt. 50 m, open lichen heath among sparse *Picea glauca* forest, on *Stereocaulon alpestre* (stems, phyllocladia), 1.VIII.2000, M. Zhurbenko 0045 (LE 210332).

**Morphology.** Vegetative hyphae immersed in the substrate, abundant, flexuose, scarcely branched, brown. Ascomata perithecioid, dispersed, usually pyriform or ovate, rarely subglobose or narrowly ovate, black, rarely with a brown tint, matt, rough, 0.2–0.4 × 0.3–0.5 mm, ¾ immersed in host thallus to sessile, with or without hairs. Hairs more or less straight, unbranched, smooth-walled, brown, septate. Peridium mostly brown, but paler towards the centre, 20–30 μm thick. Hymenium hyaline I–, K–. Interascal filaments long, scarcely septate and branched. Asci unitunicate, always 4-spored when mature, but young sometimes with 8 immature ascospores. Ascospores uniseriate, non-septate, ellipsoidal, occasionally broadly or narrowly ellipsoidal, rarely rounded, lemon-shaped or narrowly ovate, at first colorless, then medium brown and K+ olive, (14–)20–23–26.5(–35) × (10–)11.5–13–14.5(–18.5) μm, I–,

**Tab. 4** Lichenicolous fungi on *Stereocaulon* species on the world (according to Diederich and Sérusiaux [133], Kocourková [173], Zhurbenko and Triebel [163], Zhurbenko et al. [100], Zhurbenko [101]).

Species	Host	Notes
<i>Abrothallus stereocaulorum</i> Etayo & Diederich	<i>Stereocaulon</i> sp.	parasite, occurs on phyllocladia and pseudopodetia
<i>Arthonia stereocaulina</i> (Ohlert) R. Sant.	<i>S. alpinum</i> , <i>S. arcticum</i> , <i>S. botryosum</i> , <i>S. condensatus</i> , <i>S. capitellatum</i> , <i>S. depressum</i> , <i>S. glareosum</i> , <i>S. groenlandicum</i> , <i>S. intermedium</i> , <i>S. myriocarpum</i> , <i>S. paschale</i> , <i>S. rivulorum</i> , <i>S. saxatile</i> , <i>S. tomentosum</i>	mainly commensals, occurs on phyllocladia, rare on pseudopodetia
<i>Catillaria stereocaulorum</i> (Th. Fr.) H. Oliver	<i>S. alpestre</i> , <i>S. alpinum</i> , <i>S. botryosum</i> , <i>S. depressum</i> , <i>S. groenlandicum</i> , <i>S. grande</i> , <i>S. intermedium</i> , <i>S. paschale</i> , <i>S. rivulorum</i> , <i>S. saxatile</i> , <i>S. subcoralloides</i> , <i>S. tomentosum</i>	commensals, occurs on phyllocladia, rare on pseudopodetia and soralia
<i>Cercidospora alpina</i> Ihlen & Wedin	<i>S. cumulatum</i>	commensals
<i>Cercidospora stereocaulorum</i> (Arnold) Hafellner	<i>S. alpinum</i> , <i>S. botryosum</i> , <i>S. dactylophyllum</i> , <i>S. depressum</i> , <i>S. groenlandicum</i> , <i>S. intermedium</i> , <i>S. paschale</i> , <i>S. rivulorum</i> , <i>S. saxatile</i> , <i>S. subcoralloides</i> , <i>S. symphycheilum</i> , <i>S. vesuvianum</i>	commensals, sometimes creates spherical galls, occurs on phyllocladia, rare on pseudopodetia, cephalodia and old apothecia
<i>Dactylospora deminuta</i> (Th. Fr.) Triebel	<i>S. depressum</i>	commensals, noted also on <i>Lecanora epibryon</i> , <i>Pertusaria octomela</i> occurs on pseudopodetia
<i>Endococcus nanellus</i> Ohlert	<i>S. alpestre</i> , <i>S. alpinum</i> , <i>S. botryosum</i> , <i>S. glareosum</i> , <i>S. grande</i> , <i>S. myriocarpum</i> , <i>S. paschale</i> , <i>S. tomentosum</i>	parasymbiont, occurs on phyllocladia, rare on pseudopodetia and apothecia
<i>Endococcus rugulosus</i> Nyl. s.l.	<i>S. spicatile</i>	commensals, species widely distributed, growing on crustose lichens, eg <i>Rhizocarpon</i> sp., <i>Aspicilia</i> sp.
<i>Intralichen christiansenii</i> (D. Hawksw.) D. Hawksw. & M.S. Cole	<i>S. condensatum</i>	parasite, noted on apothecia e.g. on <i>Candelariella aurella</i> , <i>Lecanora dispersa</i> , <i>Peltula obscurans</i> and <i>Psorotichia schaeferi</i>
<i>Lasiosphaeriopsis stereocaulicola</i> (Linds.) O.E. Erikss. & R. Sant.	<i>S. alpinum</i> , <i>S. arcticum</i> , <i>S. arenarium</i> , <i>S. botryosum</i> , <i>S. depressum</i> , <i>S. glareosum</i> , <i>S. groenlandicum</i> , <i>S. intermedium</i> , <i>S. paschale</i> , <i>S. rivulorum</i>	commensals, sometimes creates spherical galls, occurs on phyllocladia, rare on pseudopodetia and cephalodia
<i>Leucogyrophana lichenicola</i> Thorn, Malloch & Ginns	<i>S. paschale</i> , <i>S. saxatile</i> , <i>S. tomentosum</i>	noted also on <i>Cladonia</i> spp.
<i>Lichenopeltella stereocaulorum</i> Zhurb.	<i>S. alpinum</i> , <i>S. botryosum</i> , <i>S. groenlandicum</i> , <i>S. paschale</i> , <i>S. rivulorum</i>	commensals, occurs on phyllocladia, rare on pseudopodetia and cephalodia
<i>Lichenosticta dombrovskae</i> Zhurb.	<i>S. alpinum</i> , <i>S. glareosum</i> , <i>S. groenlandicum</i> , <i>S. rivulorum</i>	commensals, occurs mainly on phyllocladia, rare on pseudopodetia
<i>Meritismatium decolorans</i> (Arnold) Triebel	<i>S. alpinum</i> , <i>S. glareosum</i>	commensals, occurs on pseudopodetia, rare on phyllocladia and cephalodia, growing on another lichens

Tab. 4 (continued)

Species	Host	Notes
<i>Merismatium</i> aff. <i>nigritellum</i> (Nyl.) Vouaux	No data (see [101])	commensals, growing on another lichenes
<i>Niesslia peltigericola</i> (D. Hawksw.) Etayo	<i>S. depressum</i> , <i>S. rivulorum</i>	commensals, previously recorded only on <i>Peltigera</i> species, occurs based on pseudopodetia and phyllocladia
<i>Odototrema stereocaulicola</i> Zhurb.	<i>S. saxatile</i> , <i>S. vesuvianum</i>	commensals, occurs on phyllocladia
<i>Operographa stereocaulicola</i> Alstrup & D.Hawksw.	<i>S. alpinum</i> , <i>S. arcticum</i> , <i>S. botryosum</i> , <i>S. capitellatum</i> , <i>S. depressum</i> , <i>S. groenlandicum</i> , <i>S. paschale</i> , <i>S. rivulorum</i> , <i>S. subcoralloides</i> , <i>S. tomentosum</i>	commensals, occurs on pseudopodetia and phyllocladia
<i>Paranectria</i> cf. <i>alstrupii</i> Zhurb.	No data (see [101])	<i>Psoroma hypnorum</i> (Vahl) Gray
<i>Phaeosporobolus alpinus</i> R. Sant., Alstrup & D. Hawksw.	<i>S. depressum</i> , <i>S. paschale</i> , <i>S. saxatile</i>	Noted also on <i>Pertusaria</i> and <i>Ochrolechia</i> species, occurs on pseudopodetia and phyllocladia
<i>Polycoccus trypteloides</i> (Th. Fr.) R. Sant.	<i>S. alpestre</i> , <i>S. alpinum</i> , <i>S. condensatum</i> , <i>S. depressum</i> , <i>S. glareosum</i> , <i>S. grande</i> , <i>S. groenlandicum</i> , <i>S. intermedium</i> , <i>S. myriocarapum</i> , <i>S. paschale</i> , <i>S. rivulorum</i>	sometimes creates galls, occurs on pseudopodetia, rare on phyllocladia
<i>Protothenella spherinoidella</i> (Nyl.) H. Mayerhofer & Poelt	<i>S. saxatile</i>	rare species, noted also on <i>Cladonia</i> and <i>Peltigera</i> species
<i>Pyrenomycete</i> 1 (cf. [101])	<i>S. myriocarapum</i> , <i>S. paschale</i>	commensals, occurs on pseudopodetia and phyllocladia
<i>Pyrenomycete</i> 2 (cf. [101])	<i>S. glareosum</i> , <i>S. rivulorum</i>	commensals, occurs on tomentose pseudopodetia
<i>Rhymbocarpus stereocaulorum</i> (Alstrup & D. Hawksw.) Etayo & Diederich	<i>S. alpinum</i> , <i>S. depressum</i> , <i>S. glareosum</i> , <i>S. groenlandicum</i> , <i>S. incrustatum</i> , <i>S. rivulorum</i>	commensals, occurs on pseudopodetia, rare on phyllocladia
<i>Roselliniella stereocaulorum</i> Zhurb., Kukwa & Oset	<i>S. alpestre</i> , <i>S. alpinum</i> , <i>S. condensatum</i> , <i>S. glareosum</i> , <i>S. rivulorum</i>	commensals occurs on phyllocladia
<i>Sphaerellothecium araneosum</i> (Arnold) Zopf s.l.	<i>S. rivulorum</i> , <i>S. vesuvianum</i>	noted also on <i>Ochrolechia</i> spp., commensals, occurs on phyllocladia
<i>Sphaerellothecium stereocaulorum</i> Zhurb. & Triebel	<i>S. depressum</i> , <i>S. glareosum</i> <i>S. groenlandicum</i> , <i>S. rivulorum</i>	likely to be mild parasite occurs on pseudopodetia, caphalodia, rare on phyllocladia
<i>Stigmidium berigicum</i> Zhurb. & Triebel	<i>S. alpinum</i> , <i>S. tomentosum</i> , <i>S. rivulorum</i>	parasymbiont. occurs on phyllocladia, rare on pseudopodetia
<i>Stigmidium stereocaulorum</i> Zhurb. & Triebel	<i>S. depressum</i> , <i>S. groenlandicum</i> , <i>S. rivulorum</i>	mild parasite
<i>Taeniolella christiansenii</i> Alstrup & D. Hawksw.	<i>S. alpestre</i> , <i>S. alpinum</i> , <i>S. botryosum</i> , <i>S. depressum</i> , <i>S. glareosum</i> , <i>S. groenlandicum</i> , <i>S. intermedium</i> , <i>S. rivulorum</i> , <i>S. symphycheilum</i>	parasite, occurs on phyllocladia, pseudopodetia and soredia

K/I–. Wall smooth, ascospore apices rounded or sometimes acute (the description adopted from Zhurbenko et al. [100]).

**Hosts.** *Stereocaulon alpestre*, *S. alpinum*, *S. condensatum*, *S. glareosum*, *S. rivulorum* (occurs on phyllocladia).

**Notes.** Amongst the so far known *Roselliniella* species, *R. stereocaulorum* is most similar to *R. cladoniae* (Anzi) Matzer & Hafellner, which grows on *Cladonia* species. The latter species differs in larger (0.15–0.7 mm wide, 0.2–0.7 mm high) perithecia, (1–)2–8-spored asci and ascospores with often microguttulate surface, which can reach 52 µm in length and are occasionally septate [168].

**General distribution.** So far it has been recorded in 6 localities in Europe (Poland), Asian part of Russia (Baikal Siberia and Yakutiya) and North America (Alaska) [100,169].

**Distribution in Poland.** In Poland, it was found at two localities only [100,169]. Number of specimens examined: 2.

**Specimens examined:** Bf-66 – Kotlina Biebrzańska Basin, Dolina Biebrzy Valley, ca. 10–11 km SSE of Grajewo town, near railway station Grajewo-Białystok, pinery, on *Stereocaulon condensatum* growing on soil, 25.09.1986, leg. S. Cieśliński (KTC, UGDA, paratypi). Cf-97 – Wysoczyzna Drohicka high plain, ca. 1 km W of Wólka Zamkowa village, 52°24'37"N, 22°35'43"E, on *Stereocaulon condensatum* growing on soil, 19.08.1991, leg. S. Cieśliński (KTC, sub *Stereocaulon condensatum*).

Two lichenicolous fungi were reported in Poland to be growing on *Stereocaulon*, *Arthonia stereocaulina* (Ohlert) R. Sant. and *Endococcus nanellus* Ohlert. Both are known only from their historical records [164].

*Arthonia stereocaulina* is characterized by its bright hypothecium, colourless ascospores measuring 11.5–14 × 4.5–6 µm and grows only on *Stereocaulon* species [101,164,170]. This species was described from Poland by Ohlert [40] as the parasite of *Stereocaulon condensatum* [164], and was never reported again from this country. The type has not been located so far and it is probably lost.

Currently *A. stereocaulina* is known from North America (Canada, USA), Europe (Norway, Poland, United Kingdom) and the Asian part of Russia (including Siberia and Baikal) [40,101,164,170].

*Endococcus nanellus* is characterized by perithecia of ca. 100 µm in diam. and narrow 1-septate ascospores with rounded apices 9–12 × 3–4 µm. It inhabits only *Stereocaulon* species (*S. alpestre*, *S. alpinum*, *S. botryosum*, *S. glareosum*, *S. grande*, *S. myriocarpum*, *S. paschal*, *S. tomentosum*) [101,164]. In Poland, this lichenicolous fungus is known only from historical records, including the type locality [40,171]. Unfortunately, the type material has not been located so far.

*Endococcus nanellus* is reported only from the Northern Hemisphere from Canada, the United States (Alaska), Greenland, Kazakhstan, and many regions of the Asian and European parts of Russia [40,101].

## 5. Summary of results and conclusions

- (i) 1823 specimens from Poland were examined from Polish herbaria (GPN, KRA, KRAM, KRAP, KTC, LBL, LOD, POZ, SLTC, TRN, UGDA, WA i WRSL) and some private collections.
- (ii) In order to better understand variability of the *Stereocaulon* species, their distribution and habitat requirements were studied based on materials deposited in European herbaria B, BILAS, BM, BP, H, LPB, UPS and the private herbarium M.R.D. Seaward.
- (iii) Type specimens of *S. botryosum*, *S. condensatum* f. *septentrionale*, *S. condensatum* var. *sorediatum*, *S. condyloideum*, *S. cupriniforme*, *S. dactylophyllum*, *S. evolutum*, *S. evolutum* f. *planum*, *S. fastigiatum*, *S. grande*, *S. incrustatum*, *S. incrustatum* var. *elatum*, *S. lusitanicum*, *S. paschale* subsp. *evolutoides* f. *laxum*, *S. paschale* var. *evolutoides*, *S. paschale* var. *vulgare*, *S. paschale* var. *serpens*, *S. pileatum*, *S. pileatum* f. *macrum*, *S. saxatile*, *S. saxonicum*, *S. spathuliferum* f. *globuliferum*, *S. spathuliferum* f. *pygmaeum*, *S. subcoralloides*, *S. symphycheilum*, *S. taeniarum*, *S. tomentosum* subsp. *magellanicum*, *S. tomentosum* var. *graphiticola*, *S. tyroliense*, *S. tyroliense* var. *lapponicum*, *S. vesuvianum*, *S. vesuvianum* f. *depressum*, *S. vesuvianum* var. *kilimandscharoense* deposited in H, H-NYL, UPS, WRLS were also examined.
- (iv) Based on Art. 9.2 and 9.11 ICBN, lectotypes of *S. fastigiatum*, *S. incrustatum* var. *elatum*, *S. paschale* var. *serpens* are selected. Lectotypes of *S. alpinum*, *S. dactylophyllum*, *S. coralloides*, and neotype of *S. tomentosum*, and probably neotypes of *S. alpestre*, *S. vesuvianum* var. *nodulosum* should be designated.
- (v) The first key for determination of Polish *Stereocaulon* species based on morphological and chemical characters has been presented.
- (vi) 14 species of the genus *Stereocaulon* occur in Poland; one with two varieties and one with two form.
- (vii) During the study four taxa, *S. alpinum* var. *erectum*, *S. saxatile*, *S. saxatile* f. *sorediatum* and *S. subcoralloides*, have only recently been reported for Poland [54,55].
- (viii) The presence of one earlier reported species (*S. spathuliferum*) is considered to be questionable.
- (ix) The morphology and the chemistry of Polish *Stereocaulon* taxa almost not differ from the earlier literature data. Exceptions are *S. incrustatum*, where chemotype with atranorin only have been discovered, and *S. vesuvianum*, with 6 chemotypes.
- (x) *Stereocaulon alpinum*, *S. evolutum* and *S. vesuvianum* occur in natural habitats, while *S. condensatum*, *S. incrustatum* and *S. taeniarum* prefer anthropogenic habitats. No taxon is associated with wood or bark of trees.
- (xi) Epilithic *Stereocaulon* species grow mainly in the north and south of the country, representing a mountain type of distribution (*S. botryosum*, *S. dactylophyllum*, *S. evolutum*, *S. pileatum*, *S. saxatile*, *S. subcoralloides*, *S. vesuvianum*). Epigeits occur in whole Polish territory (*S. condensatum*, *S. incrustatum*, *S. taeniarum*, *S. tomentosum*).
- (xii) In the light of this study, *S. paschale*, formerly considered to be common in Poland, is a rare taxon while *S. taeniarum*, known to be rare, is reported from many localities.
- (xiii) Most species of the lichen genus *Stereocaulon* are endangered in Poland; they are often known from only a few localities (*S. botryosum*, *S. evolutum*, *S. paschale*, *S. subcoralloides*, *S. saxatile*).

- (xiv) Two lichenicolous fungi *Cercidospora stereocaulorum* and *Roselliniella stereocaulorum*, have been currently found on Polish specimens of *Stereocaulon*. Two other species have only historic data in Poland.

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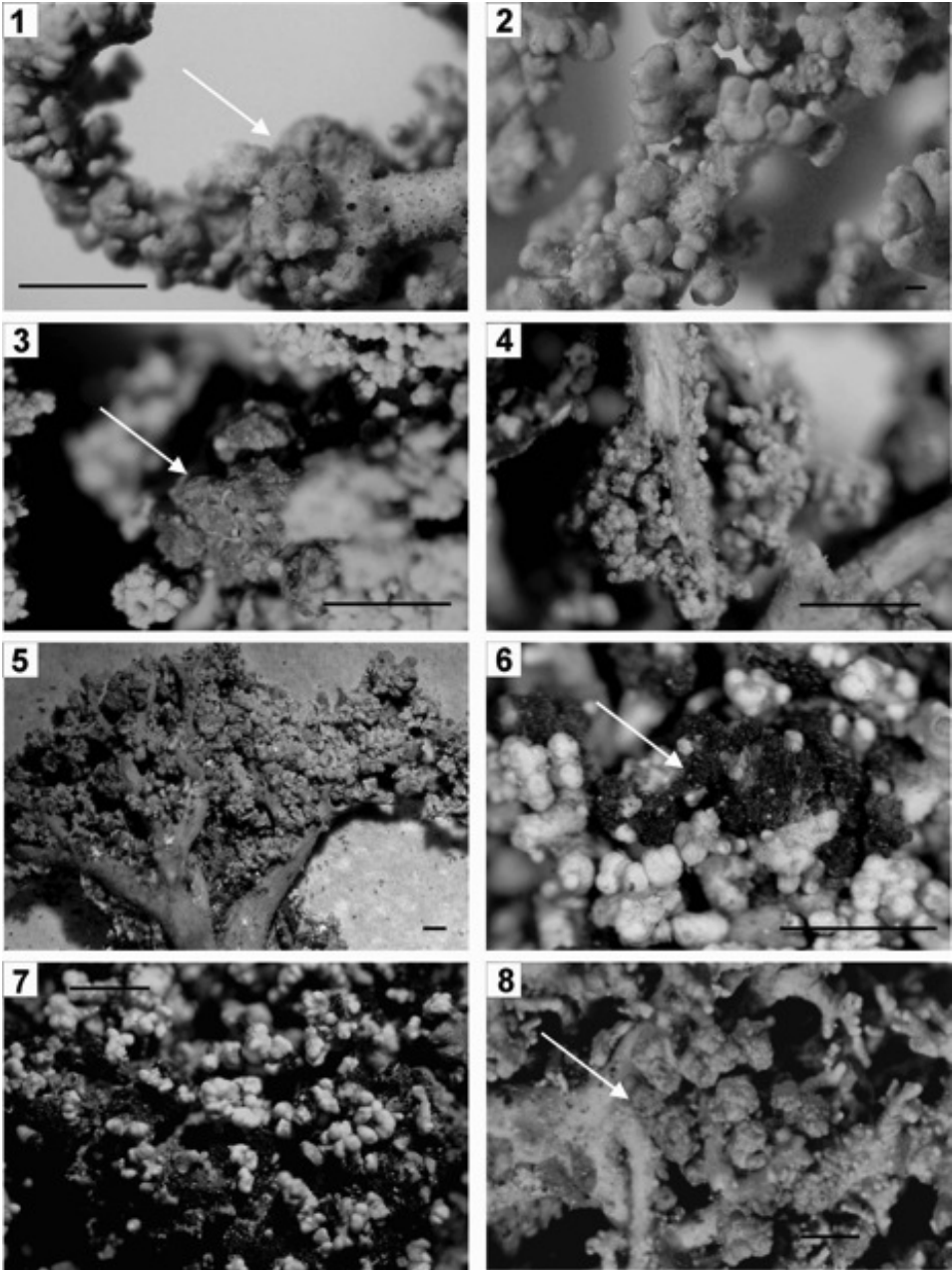
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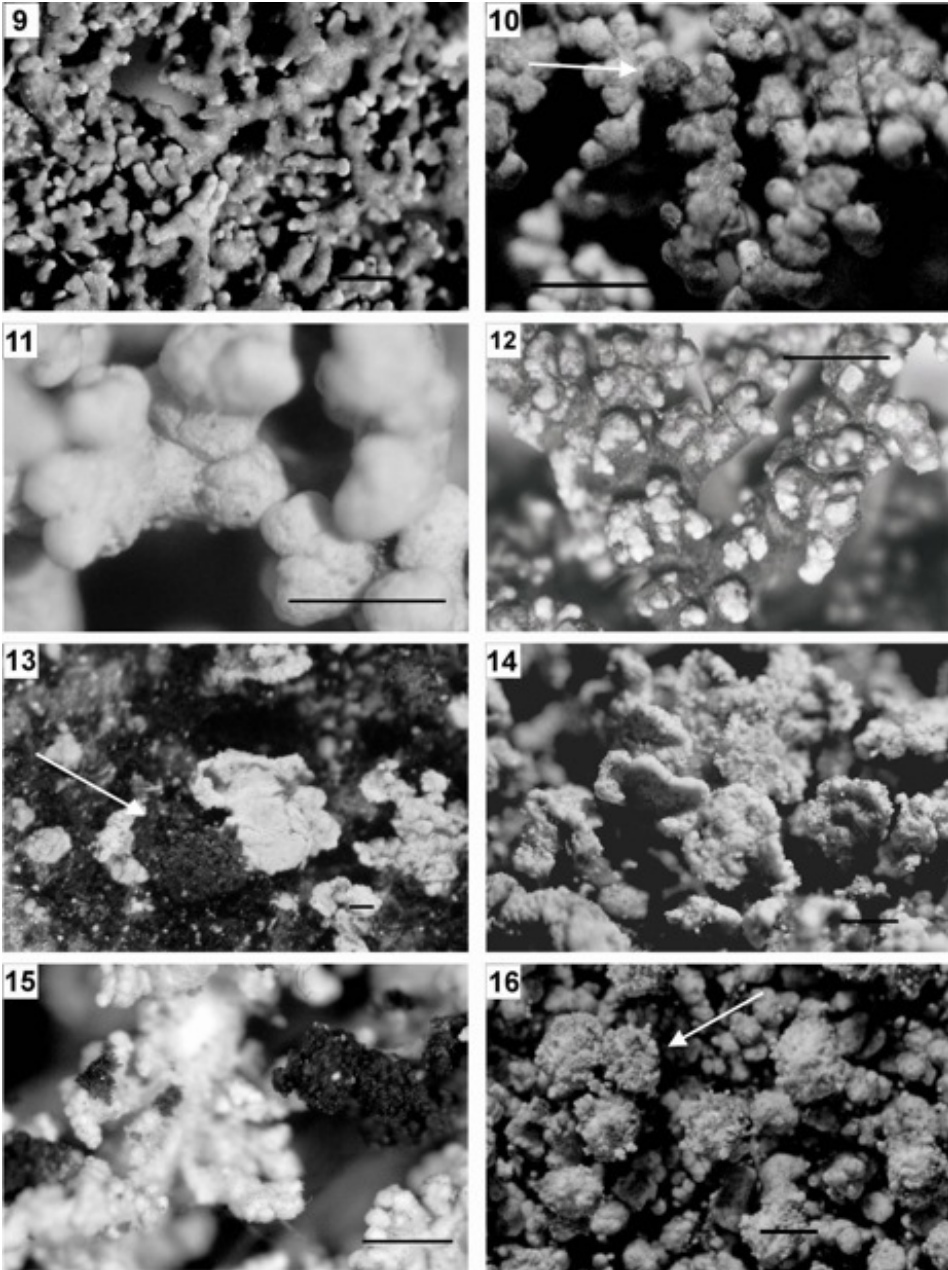
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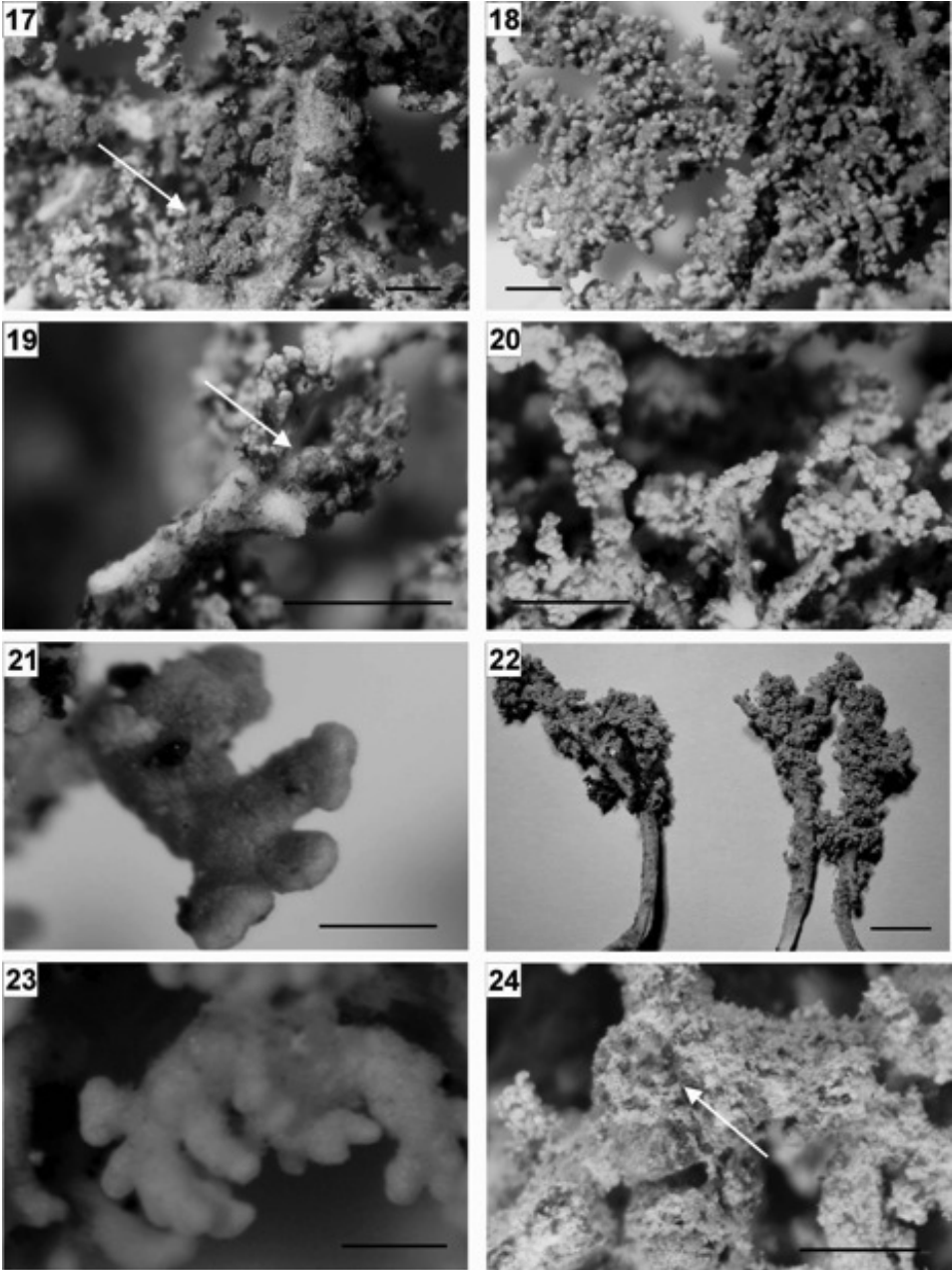


**Plate I** Morphology of *Stereocaulon*. 1 *S. alpinum* – cephalodium (leg. A. Flakus 2479, KRAM). 2 *S. alpinum* – phyllocladia verrucose (leg. A. Flakus 2479, KRAM). 3 *S. botryosum* – cephalodium (s.coll., BM 500798). 4 *S. botryosum* – phyllocladia granular [s.coll., BM 500798]. 5 *S. botryosum* – sapling look at section (s.coll., BM 500798). 6 *S. condensatum* – cephalodium (Fałtynowicz & Miądlukowska, Lich. Polon. Exs. 13, H). 7 *S. condensatum* – phyllocladia verrucose (Fałtynowicz & Miądlukowska, Lich. Polon. Exs. 13, H). 8 *S. dactylophyllum* – cephalodium (leg. W. Fałtynowicz, UGDA-L 3278). Scale bar: 1 mm.

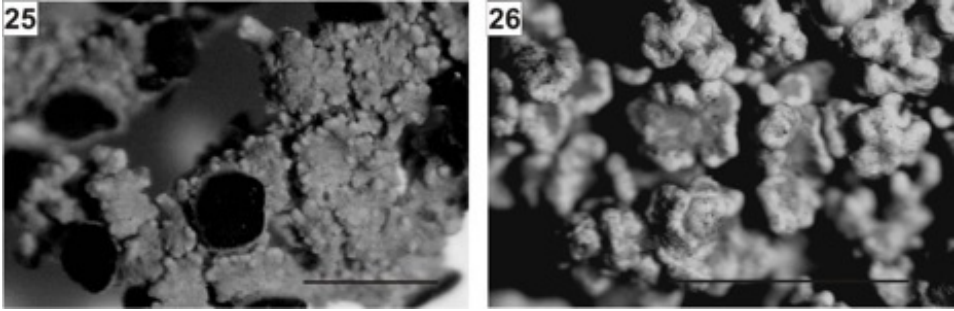


**Plate II** Morphology of *Stereocaulon*. **9** *S. dactylophyllum* – phyllocladia coralloid (leg. W. Fattyłowicz, UGDA-L 3278). **10** *S. evolutum* – cephalodium (leg. A. Flakus 1111, KRAM). **11** *S. evolutum* – phyllocladia deeply divided into cylindrical (leg. A. Flakus 1111, KRAM). **12** *S. inrustatum* – phyllocladia verrucose (Tobolewski, Lichenoth. Polon. 184, B 158809). **13** *S. nanodes* – cephalodium (leg. V. Räsänen, H). **14** *S. nanodes* – fan-shaped, flattened phyllocladia (leg. V. Räsänen, H). **15** *S. paschale* – cephalodium (Räsänen, Lich. Fenn. Exs. 198, H). **16** *S. pileatum* – soralium (Nowak, Lich. Polon. Merid. Exs. 60, LBL). Scale bar: 1 mm (9–15); 1 cm (16).





**Plate III** Morphology of *Stereocaulon*. **17** *S. saxatile* – cephalodium (leg. T. Ahti 54609, H). **18** *S. saxatile* – phyllocladia scale-like (leg. T. Ahti 54609, H). **19** *S. spathuliferum* – cephalodium (leg. M. Oset, UGDA-L 16578). **20** *S. spathuliferum* – phyllocladia verrucose, with spatulate apical expansion (leg. M. Oset, UGDA-L 16578). **21** *S. sucoralloides* – phyllocladia corallaloid (leg. W. Fałtynowicz, UGDA-L 2951). **22** *S. taeniarum* – general view (leg. L. Kivistö 103, H). **23** *S. taeniarum* – phyllocladia dactyliform (leg. L. Kivistö 103, H). **24** *S. tomentosum* – cephalodia (leg. W. Fałtynowicz, UGDA-L 2518). Scale bars: 1 mm (17–21, 23–24); 1 cm (22).



**Plate IV** Morphology of *Stereocaulon*. **25** *S. tomentosum* – phyllocladia flattened (leg. W. Fałtynowicz, UGDA-L 2518). **26** *S. vesuvianum* – phyllocladia peltate (leg. A. Flakus 2098, KRAM). Scale bar: 1 mm.

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