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## ORIGINAL RESEARCH PAPER

# New and interesting species of lichens from xerothermic habitats in NW Poland

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This paper presents data on the occurrence of lichens in xerothermic grasslands, representing a great mycological peculiarity of the NW part of Pomerania, Poland. The 12 examined specimens of six species originated from fieldwork carried out in 2011–2014 in the nature reserves Brodogóry, Stary Przylep, Bielinek, Wrzosowiska Cedyńskie, Prof. Adam Wodziczko Nature Reserve in the Wolin National Park, and an old chalk excavation site on Wolin Island. Within the study sites, four lichen species were recorded as a new to Western Pomerania: *Agonimia gelatinosa*, *Collema cristatum*, *Dermatocarpon luridum*, and *Leptogium subtile*. The other two species, *Collema auriforme* and *C. flaccidum*, are rarely observed in the studied region.

**Keywords**

biodiversity; lichens; nature reserves; NW Poland

**Introduction**

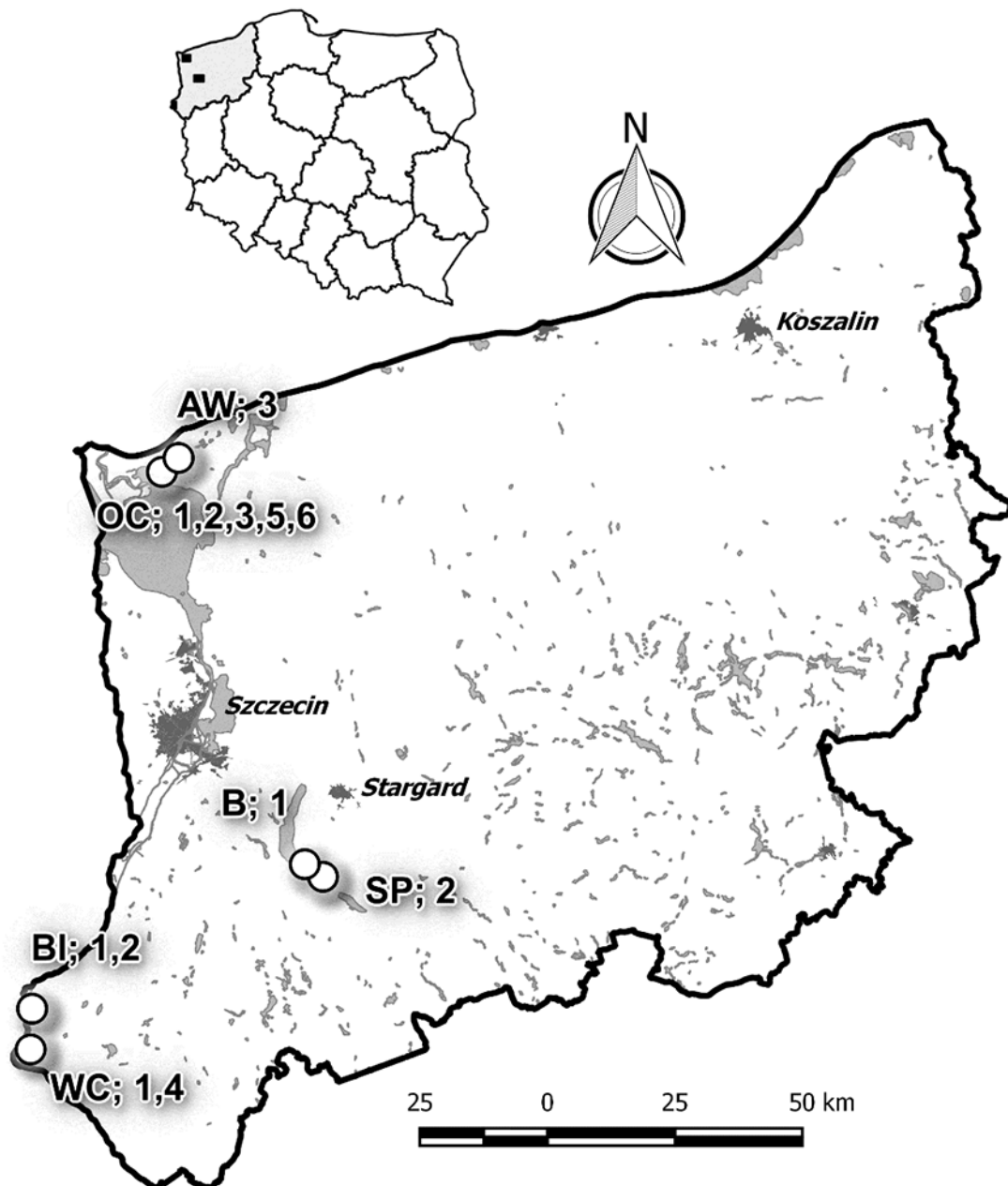
The great peculiarity of NW Pomerania are xerothermic grasslands. They develop in specific climatic conditions only, particularly in the areas where high soil and near-surface air layer temperatures occur periodically. Soils overgrown with xerothermic plants must be reasonably fertile and rich in calcium carbonate. Such conditions create favorable habitats for development of xerothermophilous and calciphilous lichens [1]. In Poland, calciphilous lichens usually occur in the mountains and uplands in limestone areas [2,3]. In lowlands, this group of lichens is rarely recorded in natural ranges of xerothermic grasslands of the Lower Vistula, Odra, and Warta rivers [4–7]. Xerothermic grasslands of NW Poland are found in morainic areas, characterized by varied relief. The vegetation is not dense, composed mostly of patches of the feather-grass community *Potentillo-Stipetum capillatae*. Because of its loose structure and specific soil conditions, the community also includes many plants typical of sandy grasslands of the class *Koelerio glaucae-Corynephoretea canescentis* as well as thermophilous and heliophilous species of the class *Festuco-Brometea* [8,9] (and also unpublished documentation by Dr Tadeusz Głazek from 1971 “Rezerwat florystyczno-dydaktyczny ‘Stary Przylep’”).

Many lichens are adapted to adverse environmental conditions. They may colonize both natural and man-made substrata (such as concrete and bricks), and are often found in anthropogenic habitats, like wooden constructions, mechanically disturbed soils, worked stone surfaces and quarries. Xerothermic lichens in northern Poland are reported with increasing frequency in anthropogenic habitats, such as gravel pits, mine workings or quarries [10–12]. Such moderate anthropogenic pressure creates new habitats for lichens and may significantly increase their diversity.

This paper presents new localities of lichens that were recorded in xerothermic habitats in NW Poland, developed partly as a result of human activity.

## Material and methods

The presented list of records is derived from the material collected during fieldwork in 2011–2014. The study included the following study sites: Brodogóry Nature Reserve (B), Stary Przylep Nature Reserve (SP), Prof. Adam Wodziczko Nature Reserve (AW) in the Wolin National Park, an old chalk (OC) excavation site on Wolin Island, Bielinek Nature Reserve (BI), and Wrzosowiska Cedyńskie Nature Reserve (WC) (Fig. 1). In total, 12 specimens of six species were collected, now deposited in the Lichen Herbarium (SZUB-L) of the Department of Ecology and Environmental Protection at the University of Szczecin. Morphological and anatomical observations were made using standard microscopic techniques, under an inverted fluorescence microscope (Zeiss Axio Observer A1) and a light microscope (Zeiss Axio Scope A1).



**Fig. 1** Distribution map of the study sites, with numbers of the listed species found. AW – Prof. Adam Wodziczko Nature Reserve in the Wolin National Park; OC – old chalk excavation site on Wolin Island; B – Brodogóry Nature Reserve; SP – Stary Przylep Nature Reserve; WC – Wrzosowiska Cedyńskie Nature Reserve; BI – Bielinek Nature Reserve; 1 – *Agonima gelatinosa*; 2 – *Collema auriforme*; 3 – *C. cristatum*; 4 – *C. flacidium*; 5 – *Dermatocarpon luridum*; 6 – *Leptogium subtile*.

**Results: list of recorded species***Agonima gelatinosa* (Ach.) Brand & Diederich (Fig. 2a)

Terricolous (found on calcareous soil), muscicolous and also on plant debris. New to NW Poland. This rare species in Poland is known from the Gorce Mts [13,14], Kujawy region [7,15,16], Przemyśl town [17], Sudety Mts [18], and Tatry Mts [19].

**Specimens examined.** Old chalk excavation site on Wolin Island (N 53°53'08.1" / E 14°27'11.7") on soil, leg. Anetta Wieczorek, Andrzej Łysko, SZUB-L 3008; Wrzosowiska Cedyńskie Nature Reserve (N 52°51'16.1" / E 14°10'27.3"), on soil, leg. Anetta Wieczorek, Andrzej Łysko, SZUB-L 3009; Bielek Nature Reserve (N 52°55'24.7" / E 14°10'18.1"), on soil, leg. Anetta Wieczorek, Andrzej Łysko, SZUB-L 3007; Brodogóry Nature Reserve (N 53°21'32.7" / E 14°93'08"), on soil, leg. Anetta Wieczorek, Andrzej Łysko, SZUB-L 3010.

*Collema auriforme* (With.) Coppins & J. R. Laundon (Fig. 2b)

In Pomerania recorded earlier at one site in Bory Tucholskie forest [20,21]. It is also reported from southern Poland, e.g., the Beskid Mały Mts [22], Beskid Sądecki Mts [23], Beskid Śląski Mts [24], Beskid Wyspowy Mts and Beskid Żywiecki Mts [25], Stołowe Mts [26], Kielce town [27], Kraków City [28], Pieniny Mts [29], Spiskie Foothills [30], Rożnowskie Foothills [31], Sudety Mts [32–34], Tatry Mts [35–38], Tarnów town [39], near Warsaw [40], and Kraków-Częstochowa Upland [41].

**Specimens examined.** Old chalk excavation site on Wolin Island (N 53°53'08.1" / E 14°27'11.7"), found on mosses, calcareous soil, in moist and shaded conditions, in anthropogenic habitats. It develops characteristic isidia in brownish-green lobes, leg. Anetta Wieczorek, Andrzej Łysko, SZUB-L 3006; Bielek Nature Reserve (N 52°55'24.7" / E 14°10'18.1"), on calcareous soil in natural habitats, leg. Anetta Wieczorek, Andrzej Łysko, SZUB-L 3004; Stary Przylep Nature Reserve (N 53°19'08" / E 14°99'41"), on calcareous soil, leg. Anetta Wieczorek, Andrzej Łysko, SZUB-L 2996.

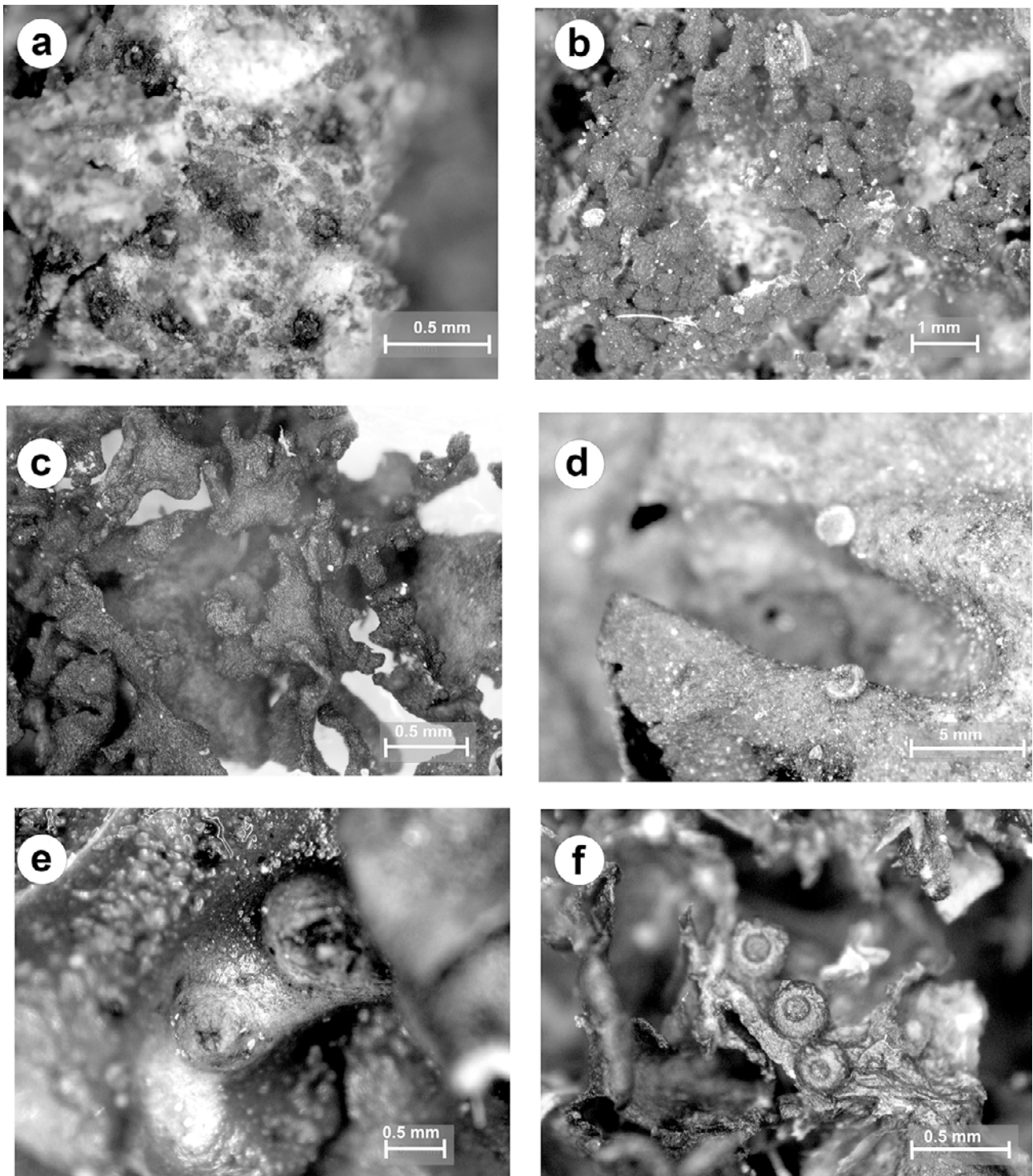
*Collema cristatum* (L.) Weber in F. H. Wigg. (Fig. 2c)

Within Poland reported previously only from the southern part of the country, e.g., the Beskidy Zachodnie Mts [42], Beskid Sądecki Mts [23], Vistula valley [43], Świętokrzyskie Mts [44], Kielce town [27], Kraków City [28], Chęciny region [45], Pieniny Mts [3,29], Śląsk Opolski town [46], Tatry Mts [37,47,48], Kraków-Częstochowa Upland [41], and Wieluńska Upland [49].

**Specimens examined.** Prof. Adam Wodciczko Nature Reserve in the Wolin National Park (N 53°51'50.0" / E 14°27'06.0"), on calcareous soil on sun-exposed sites in natural habitats, leg. Anetta Wieczorek, Andrzej Łysko, SZUB-L 3003; old chalk excavation site on Wolin Island (N 53°53'08.1" / E 14°27'11.7"), on calcareous soil, in exposed conditions, in artificial (excavation) habitats, leg. Anetta Wieczorek, Andrzej Łysko, SZUB-L 3002.

*Collema flaccidum* (Ach.) Ach. (Fig. 2d)

In Poland earlier known from several localities in the north of the country and several in the south [50]. Reported in the north of Kaszubskie Coastland [20,51,52], Suwałki Landscape Park [53], and near Białowieża National Park [54]. In the south of the country reported from the Bieszczady Mts [55,56], Beskid Niski Mts [57], Beskid Mały Mts [22], Beskid Sądecki Mts [23,58,59], Beskid Średni Mts [60], Beskid Wyspowy Mts and Beskid Żywiecki Mts [61], Gorce Mts [62], Stołowe Mts [26], Sudety Mts [63], and Tatry Mts [35,37,64,65].



**Fig. 2** Thalli of xerothermic lichens. 1 – *Agonima gelatinosa*; 2 – *Collema auriforme*; 3 – *C. cristatum*; 4 – *C. flacidium*; 5 – *Dermatocarpon luridum*; 6 – *Leptogium subtile*.

**Specimens examined.** Wrzosowiska Cedyńskie Nature Reserve (N 52°51'16.1" / E 14°10'27.3"), on damp rock, among mosses in open habitats, on the edge of the reserve, leg. Anetta Wieczorek, Andrzej Łysko, SZUB-L 3001.

*Dermatocarpon luridum* (With.) J. R. Laundon (Fig. 2e)

The record from the old chalk excavation site is the first record from northern Poland. Previously reported from only five localities in southern Poland, e.g., the Bieszczady Mts [55,56], Beskid Wyspowy Mts and Beskid Żywiecki Mts [61], Lower Silesia [66], Sudety Mts [63], and Tatry Mts [37,38,65,67–70].

**Specimens examined.** Old chalk excavation site on Wolin Island (N 53°53'08.1" / E 14°27'11.7"), grows on exposed calcareous soil around the margins of water bodies, leg. Anetta Wieczorek, Andrzej Łysko, SZUB-L 3011.

*Leptogium subtile* (Schrad.) Torss. (Fig. 2f)

New to northern Poland. Previously reported from only two localities in southern Poland: Bielska Plain [71] and the Gorce Mts [62].

**Specimens examined.** Old chalk excavation site on Wolin Island (N 53°53'08.1" / E 14°27'11.7"), on debarked wood and mosses in humid places, leg. Anetta Wieczorek, Andrzej Łysko, SZUB-L 2998.

## Discussion

In the studied localities, xerothermic epigeic lichens were found on calcareous soil, humus, and decaying remains of plants as well as on rock-waste. Calciphilous lichens were not homogeneous with respect to specific habitat requirements. Here, a common factor was only the chemical nature of substratum (calcium carbonate). Other factors differed, e.g., the degree of sun exposure or substratum moisture [72].

In total, six new species of lichenized fungi were observed: one in the Prof. Adam Wodziczko Nature Reserve in the Wolin National Park, five in the old chalk excavation site on Wolin Island, one in the Brodogóry Nature Reserve, one in the Stary Przylep Nature Reserve, two in the Wrzosowiska Cedyńskie Nature Reserve, and two in the Bielinek Nature Reserve (Fig. 1). The species are either new or rare in Western Pomerania. All the collected lichens were found in isolated localities, in small populations. Their thalli were healthy, with well-developed reproductive organs, and did not show any symptoms of decline. Four of the recorded lichens were new to NW Pomerania: *Agonimia gelatinosa*, *Collema cristatum*, *Dermatocarpon luridum*, and *Leptogium subtile* (Fig. 2). They were found together in the old chalk excavation site located in the buffer zone of the Wolin National Park.

Lichens of xerothermic habitats are usually inconspicuous and rarely observed. They are described chiefly during specialized lichenological explorations. Currently, their distribution in Europe is well-studied. They are recorded in several climatic zones, from the boreal to the Mediterranean zone [73], but most frequently in SE and S parts of Europe with a continental climate. In other parts of the continent, with a more humid climate, isolated patches of steppe vegetation are found on particularly warm and dry sites [74]. The patches occupy calcium-rich, steep riverbanks, ravines, or calcareous rocks. In Central Europe, xerothermic lichens are rare or very rare, particularly in the lowlands [75–78] (Tab. 1). The small size of the patches and the increasing eutrophication of adjacent areas are important threats to those populations. The presented records are some of the northernmost localities of xerothermic lichens, which are particularly important for the dynamics of those taxa.

**Tab. 1** Other European records of the lichen species reported in this study.

Species	Countries
<i>Agonima gelatinosa</i> (Ach.) M. Brand & Diederich	Estonia [79], Netherlands [78], Poland [80]
<i>Collema auriforme</i> (With.) Coppins & J. R. Laundon	Albania [81], Austria [82], Bosnia and Herzegovina [83], Bulgaria [84], Croatia [85], France [86], Germany [87], Greece [88,89], Iceland [90], Macedonia [91], Netherlands [78], Poland [80], Slovakia [92], Slovenia [93,94], Spain [95,96], Switzerland [97–101], Turkey [102–106]
<i>Collema cristatum</i> (L.) F. H. Wigg.	Austria [82], Bosnia and Herzegovina [83], Bulgaria [84], Croatia [85], Estonia [79], Germany [87], Italy [107,108], Ireland [109], Lithuania [110], Poland [80], Russia [111], Slovenia [94,107], Spain [96,112], Switzerland [101,113,114], Turkey [115–123]
<i>Collema flaccidum</i> (Ach.) Ach.	Austria [82,124,125], Bosnia and Herzegovina [83], Bulgaria [84], France [126], Germany [88,127], Greece [89], Latvia [128], Macedonia [91], Poland [80], Romania [129], Serbia [130], Switzerland [98,101]
<i>Dermatocarpon luridum</i> (With.) J. R. Laundon	Bosnia and Herzegovina [83], Bulgaria [84], Lithuania [131], Estonia [132], Germany [87], Greece [89], Poland [80], Portugal [133], Spain [134], Switzerland [135], Turkey [104,136]
<i>Leptogium subtile</i> (Schrad.) Torss.	Austria [137], Bosnia and Herzegovina [83], Bulgaria [84], Czech Republic [138,139], France [126], Germany [87,140], Netherlands [78], Poland [80], Russia [141–144], Spain [145,146], Sweden [147], Switzerland [100,113,148], Turkey [123,149], Ukraine [150]

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