

Research Article

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Cladonia homosekikaica Nuno new to Sweden – a cup lichen found in the grey dunes of Gotland

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Abstract: While sampling the vegetation of the semi-natural grasslands with the EDGG standard methodology on the Swedish island of Gotland, the terricolous lichen species *Cladonia homosekikaica* Nuno from the *C. pyxidata-chlorophaea* complex was found in 2022. This is the first record of this species from Sweden. We provide here detailed information on its differentiation from similar *Cladonia* species, characterize its overall distribution and its site conditions on Gotland. The new locality is far away from the next occurrences, which are mainly in southern Europe, with isolated records in Iceland and Finland. The vegetation type was a nutrient-poor sandy grassland near the coast, belonging to the association *Festucetum polesicae* (alliance: *Koelerion glaucae*, order: *Sedo acris-Festucetalia*, class: *Koelerio-Coryneporetea canescentis*). The overall distribution of *Cladonia homosekikaica* indicates that the species is slightly xero-thermophilous and occurs in slightly acidic grasslands. It thus might be found in other sandy dry grasslands around the Baltic Sea.

Keywords: Chemotype; *Cladonia homosekikaica*; *Cladonia pyxidata-chlorophaea* complex; *Festucetum polesicae*; first record; Gotland; grey dune; *Koelerion glaucae*; sandy grassland; Sweden.

Nomenclature: Westberg et al. (2021) for lichens, except *Cladonia homosekikaica* according to Species Fungorum (www.speciesfungorum.org).

Abbreviations: EDGG = Eurasian Dry Grassland Group; TLC = Thin-layer chromatography.

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Introduction

Certain dry grassland types have a diverse flora of terricolous bryophytes and lichens (Dengler et al. 2020; Biurrun et al. 2021). Particularly rich are the alvar grasslands in the hemiboreal zone of Europe and some types of sandy dry grasslands, where the diversity of bryophytes and lichens often exceeds that of vascular plants (Löbel & Dengler 2008), but these two cryptogamic groups are often not or not thoroughly sampled by vegetation ecologists. The sampling methodology of the Eurasian Dry Grassland Group (EDGG; www.edgg.org) for vegetation plots aims at collecting high quality data of non-forest habitats of the Palaeartic biogeographic realm (Dengler et al. 2018), among others feeding the [GrassPlot Diversity Explorer](#) (see Biurrun et al. 2021). Particular aspects of the methodology are precisely delimited plots of a few standard grain sizes, careful sampling not only of the vascular plants, but also of the terricolous bryophytes and lichens, and the measurement of a range of relevant environmental variables. The careful

search for cryptogams repeatedly yielded records of very rare species, species new to a region or country or recently even a species new to science (Dengler & Boch 2007; Khodosovtsev et al. 2024). During sampling of semi-natural grasslands with the EDGG methodology on the Swedish island of Gotland (Dembicz & Dengler 2022), the cup lichen *Cladonia homosekikaica* was sampled in an alvar grassland and later determined with thin-layer chromatography (TLC). As this is the first record of this species from Sweden, we provide here a detailed overview on the determination of the species, its overall distribution and the characteristics of the locality on Gotland.

Methods

In June 2022, I. Dembicz and J. Dengler sampled semi-natural grasslands of different types (sandy, rocky, meso-xeric, mesic, wet) on the Swedish island of Gotland to contribute to filling the information gap in the GrassPlot database in Fennoscandia (see Dengler et al. 2018; Biurrun et al.

2019, 2021). In total they sampled 50 10-m² “normal” plots and five EDGG “biodiversity” plots (nested-plot series of 0.0001–100 m²) distributed across the occurring semi-natural grassland types across the entire island (Dembicz & Dengler 2022). Following the EDGG methodology (Dengler et al. 2016), not only vascular plants, but also all terricolous bryophytes and lichens were recorded.

Species that could not be determined in the field were collected for later identification in the lab. In the case of lichens, these identifications were conducted by S. Boch and C. Keller. Seven specimens that could not be identified morphologically with a binocular or a microscope and the commonly used simple chemical tests were prepared for further identification using thin-layer chromatography (TLC) according to Orange et al. (2001). By means of TLC, the occurrence of phenolic secondary lichen metabolites can be identified. This is important for the identification of particular species and in many species groups to be able to distinguish between different species, and is therefore commonly used for the identification of species of the genus *Cladonia*.

The vegetation was preliminarily classified phytosociologically (Dembicz et al. in prep.), mainly based on the similar vegetation types on the Baltic islands of Öland (Löbel & Dengler 2008) and Saaremaa (Boch & Dengler 2006).

Results

In total, we analysed five *Cladonia* specimens with TLC. Beside *Cladonia coccifera*, *C. pyxidata*, and *C. symphylicarpa*, one specimen of a cup lichen that resembled a small *C. chlorophaea* turned out being *Cladonia homosekikaica*, based on the identified secondary metabolites. We will deposit the specimen in the United Herbaria of Zürich (Z+ZT).

Cladonia homosekikaica was sampled in plot SEGR046 on 11 June 2022. This plot was located in Gammelnarn at the East coast of Gotland (57.38253° N, 18.82277° E). It grew in a grey dune, just 1 m a.s.l. (Fig. 1). According to the preliminary phytosociological classification, the stand belonged to *Festucetum polesicae* Regel 1928 (alliance: *Koelerion glaucae* Volk 1931, order: *Sedo acris-Festucetalia* Tx. 1951 nom. invers. propos., class: *Koelerio-Corynephoretea canescentis* Klika in Klika et Novák 1941). The herb layer covered 60% and the cryptogam layer 80%, and the total plant species richness in 10 m² was 34 (24 vascular plants, 3 bryophytes and 7 lichens). The most dominant species were *Pulsatilla pratensis* (20%), *Hieracium umbellatum* (15%) and *Avenella flexuosa* (12%) in the herb layer and *Dicranum scoparium* (60%), *Cladonia arbuscula* aggr. (10%) and *Hypnum cupressiforme* var. *lacunosum* (10%) in the cryptogam layer.

Review of the current knowledge on *Cladonia homosekikaica*

Morphology, chemistry and determination

Cladonia homosekikaica has been traditionally considered a chemotype of *C. chlorophaea*, but it has soredia varying in

size from farinose to granular, while those of *C. chlorophaea* are solely granulose. Therefore, it has been formally described as an independent species from Japan (Nuno 1975). The species has a persistent squamulose primary thallus composed of 1–1.5 mm × 1–1.5 mm wide squamules that are olive green on the upper side and white below, and show entire or slightly crenulate margins. The greyish green to dark greenish brown podetia have regular cups, mostly without proliferations and are 7–15 mm long × 3–5 mm wide. The podetial surface is corticate or ecorticate, with diffuse or scattered soralia and with frequent squamules at the base. The soredia vary in size from farinose to granular (20–80 µm). The dark brown apothecia are rarely developed at the margin of the cups, but pycnidia are frequent, and contain a hyaline slime (Burgaz et al. 2020a). Two chemotypes have been reported. One contains homosekikaic and sekikaic acids, and the other additionally contains substances of the fumarprotocetraric acid complex (Ahti & Stenroos 2013). Spot tests are K-, C-, KC-, P+ red or P-, UV+ white. In our specimen, we detected sekikaic, homosekikaic and fumarprotocetraric acids.

Cladonia homosekikaica can further be confused with *C. fimbriata* and *C. coniocraea*, but the latter two have more slender podetia with finer soredia and a cortex that is restricted to the very basal part. *Cladonia homosekikaica* further has a similar chemical composition as *C. novochlorophaea* and *C. rei*, but the podetia of the former are never sorediate, and podetia of the latter never have distinct cups. Illustrations can be found in Burgaz & Ahti (2009), Ahti & Stenroos (2013) and Burgaz et al. (2020a).

Distribution and ecology

According to available knowledge, the species is scattered throughout the Northern Hemisphere, with evidence from Europe, Asia, North America but it has also been reported from Australia (Archer 1992; Ahti & Stenroos 2013; Burgaz et al. 2020s; GBIF Secretariat 2023). In Europe *C. homosekikaica* has been found in several countries such as Andorra, Belarus, Croatia, France, Greece, Lithuania, Montenegro, Portugal and Spain (Motiejūnaitė 2002; Burgaz & Ahti 2009; Ahti & Stenroos 2013; Burgaz et al. 2017, 2019, 2020a, 2020b; GBIF Secretariat 2023). It seems to be relatively widespread in Southern Europe, south of 45° latitude (GBIF Secretariat 2023). North of that latitude in Europe, there are only very few known occurrences, namely in Belarus, Lithuania (Motiejūnaitė 2002), Russia (Muchnik & Konoreva 2017), Finland (lichenportal.org) and Iceland (Ahti & Stenroos 2013; GBIF Secretariat 2023).

The species has been mainly reported growing on bare soil in exposed areas, with preference for acid substrates (Burgaz et al. 2020a) but has also been reported from wood (Tsurukau & Golubkov 2015; Muchnik & Konoreva 2017). This largely matches the ecology of the new site based on the species composition, albeit the soil samples have not been analyzed yet.

Discussion and outlook

The complicated taxonomy of the *Cladonia pyxidata-chlorophaea* complex and the need to use TLC for the identification of many of the member species, makes it likely that *C. homosekikaica* is more widely distributed than the current map suggests (GBIF Secretariat 2023). The overall distribution of *Cladonia homosekikaica* indicates that the species is slightly xero-thermophilous and occurs in slightly acidic grasslands. It thus might be found in other sandy dry grasslands around the Baltic Sea. It might also be worth analyzing herbarium specimens of the *Cladonia pyxidata-chlorophaea* complex to get a better overview of the global distribution of *Cladonia homosekikaica*.

Author contributions

I.D. and J.D. conducted the field sampling, while S.B. and C.K. identified the lichen samples in the lab. The article was planned and drafted by S.B. and J.D. while I.D. and C.K. checked, improved and approved it.

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References

- Ahti, T. & Stenroos, S. 2013. Cladoniaceae. *Nordic Lichen Flora* 5: 7–117.
- Archer, A.W. 1992. *Cladonia*. *Flora of Australia* 54: 111–143.
- Biurrun, I., Burrascano, S., Dembicz, I., Guarino, R., Kapfer, J., Pielech, R., Garcia-Mijangos, I., Wagner, V., Palpurina, S., (...) & Dengler, J. 2019. GrassPlot v. 2.00 – first update on the database of multi-scale plant diversity in Palaeartic grasslands. *Palaeartic Grasslands* 44: 26–47.
- Biurrun, I., Pielech, R., Dembicz, I., Gillet, F., Kozub, Ł., Marcenò, C., Reitalu, T., Van Meerbeek, K., Guarino, R., (...) & Dengler, J. 2021. Benchmarking plant diversity of Palaeartic grasslands and other open habitats. *Journal of Vegetation Science* 32: e13050.
- Boch, S. & Dengler, J. 2006. Floristische und ökologische Charakterisierung sowie Phytodiversität der Trockenrasen auf der



Figure 1. Grey dune community in Gammelgarn at the East coast of Gotland in which *Cladonia homosekikaica* was found. Photo: J. Dengler.

- Insel Saaremaa (Estland). *Arbeiten aus dem Institut für Landschaftsökologie Münster* 15: 55–71.
- Burgaz, A.R. & Ahti, T. 2009. Cladoniaceae. *Flora Liquenológica Ibérica* 4: 1–111.
- Burgaz, A.R., Fontecha-Galán, A., Gutiérrez-Larruga, B. & Rodríguez-Arribas, C. 2017. The Cladoniaceae and three additional noteworthy lichens from Croatia. *Herzogia* 30: 138–151.
- Burgaz, A.R., Gutiérrez, B. & Pino-Bodas, R. 2019. Cladoniaceae of Montenegro. *Botanica Complutensis* 43: 109–139.
- Burgaz, A.R., Ahti, T. & Pino-Bodas, R. 2020a. Mediterranean Cladoniaceae. Spanish Lichen Society (SEL), Madrid, ES.
- Burgaz, A.R., Gutiérrez, B., Rodríguez-Arribas, C. & Pino-Bodas, R. 2020b. The genus *Cladonia* from Greece. *Herzogia* 33: 340–376.
- Dembicz, I. & Dengler, J. 2022. Gotland – a grassland paradise in the middle of the Baltic Sea. *Palaeartic Grasslands* 54–55: 48–58.
- Dengler, J., Boch, S. 2007. Taxonomy, ecology, and distribution of six remarkable plant taxa (Spermatophyta, Bryophyta, and Lichenes) of the Estonian dry grassland flora. *Phyton* 47: 47–71.
- Dengler, J., Boch, S., Filibeck, G., Chiarucci, A., Dembicz, I., Guarino, R., Henneberg, B., Janišová, M., Marcenò, C., (...) & Biurrun, I. 2016. Assessing plant diversity and composition in grasslands across spatial scales: the standardised EDGG sampling methodology. *Bulletin of the Eurasian Dry Grassland Group* 32: 13–30.
- Dengler, J., Wagner, V., Dembicz, I., García-Mijangos, I., Naqinezhad, A., Boch, S., Chiarucci, A., Conradi, T., Filibeck, G., (...) & Biurrun, I. 2018. GrassPlot – a database of multi-scale plant diversity in Palaeartic grasslands. *Phytocoenologia* 48: 331–347.
- Dengler, J., Biurrun, I., Boch, S., Dembicz, I. & Török, P. 2020. Grasslands of the Palaeartic Biogeographic Realm. In: Goldstein, M.I., DellaSala, D.A. & DiPaolo, D.A. (eds.) *Encyclopedia of the world's biomes. Volume 3: Forests – trees of life. Grasslands and shrublands – sea of plants*. pp. 617–637. Elsevier, Amsterdam, NL.
- GBIF Secretariat 2023. *Cladonia homosekikaica* Nuno. URL: <https://doi.org/10.15468/39omej> [accessed 19 May 2024].
- Khodosovtsev, A., Darmostuk, V., Dembicz, I., Dengler, J., Moysiyanenko, I. & Kuzemko, A. 2024. *Circinaria ucrainica* sp. nova, a new species from sand dunes of the Lower Dnipro valley (Ukraine). *The Lichenologist* (in press).
- Löbel, S. & Dengler, J. 2008 [“2007”]. Dry grassland communities on southern Öland: phytosociology, ecology, and diversity. *Acta Phytogeographica Suecica* 88: 13–32.
- Motiejūnaitė, J. 2002. Lapiškos ir krūmiškos kerpės [Foliose and fruticose lichens]. *Lietuvos Grybai* 13: 1–311.
- Muchnik, E. & Konoreva, L. 2017. New and noteworthy records of lichens and allied fungi from central European Russia. *Herzogia* 30: 509–514.
- Nuno, M. 1975. Four new species of *Cladonia* from Asia. *Journal of Japanese Botany* 50: 289–296.
- Orange, A., James, P.W. & White, F.J. 2001. *Micro-chemical methods for the identification of lichens*. British Lichen Society, London, UK.
- Tsurykau, A. & Golubkov, V. 2015. The lichens of the *Cladonia pyxidata-chlorophaea* complex in Belarus. *Folia Cryptogamica Estonica* 52: 63–71.
- Westberg, M., Moberg, R., Myrdal, M., Nordin, A. & Ekman, S. 2021. *Santesson's checklist of Fennoscandian lichen-forming and lichenicolous fungi*. Museum of Evolution, Uppsala University, Uppsala, SE.