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Punctelia borreri a new corticolous lichen species from Hungary

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Punctelia borreri – egy új kéreglakó zuzmófaj Magyarországon

Összefoglalás – Dolgozatunkban a *Punctelia borreri* (Sm.) Krog magyarországi előkerüléséről adunk hírt. A faj a *Punctelia*-taxonokra irányuló terepi kutatásaink során került elő a Dunántúli-középhegységben. A faj első két megfigyelésére alapozva célirányos vizsgálatokat folytattunk Magyarország középhegységi tájain, amelynek eredményeképp a Bakonyból öt, a Balaton-felvidékről kettő és a Vértesből egy lelőhelyről sikerült igazolni jelenlétét. Telepeit különleges mikroklimatikus adottságokkal bíró mikroélőhelyeken találtuk meg (szurdokerdők lombkoronaszintje, szubmediterrán molyhos tölgyesek). A Nyugat-Európában - a faj számára optimálisabb éghajlati adottságú tájakon - terjedő *P. borreri* hazánkban ritka specialista. Erre alapozva feltételezzük, hogy ezek áreahatáron található szórványos előfordulások.

Kulcsszavak: areaperem, atlanti-mediterrán, mikroklímazug, Parmeliaceae, szurdokerdő

Summary – We report on the first records of *Punctelia borreri* (Sm.) Krog from Hungary. The species was found in the Transdanubian Mountains during field surveys targeting *Punctelia* taxa. Based on the first two localities, we conducted a systematic survey in the mid-mountain ranges of the country, which confirmed the species' presence at five sites in the Bakony Mountains, two in the Balaton Uplands, and one in the Vértes Mountains. The occurrences were found in microhabitats with unique microclimatic conditions (the canopy of ravine forests, sub-Mediterranean oak forests). While *P. borreri* is expanding its range in Western Europe under highly favourable oceanic climatic conditions, it remains a rare, specialist element in Hungary. Consequently, these occurrences are inferred to be near the margins of the species' distribution range.

Keywords: area margin, Atlantic–Mediterranean, microclimatic niche, Parmeliaceae, ravine forests

Introduction

The genus *Punctelia* belongs to the family *Parmeliaceae* and was segregated from the genus *Parmelia* (KROG 1982). It was named after the characteristic punctiform pseudocyphellae of the foliose thalli. Approximately 45 species of the genus are known worldwide, with a distribution primarily in the Neotropics and Africa (NIMIS & MARTELLOS 2020).

Until recently, the only species of the genus *Punctelia*, *Punctelia subrudecta* (Nyl.) Krog, had been reliably reported in Hungary (HAWKSWORTH *et al*. 2008, LŐKÖS & FARKAS 2009) out of the eight species documented in Europe (SZYMCZYK *et al*. 2015, LAJBLOVÁ & MALÍČEK 2024, GARRIDO-BENAVENT *et al*. 2025). The occurrence of *Punctelia stictica* (Duby) Krog, marked as

dubius in Hungary by HAWKSWORTH *et al*. (2008, 2011) and LŐKÖS & FARKAS (2009), refers to a record from Mátraszentimre (KISZELYNÉ 1983) that lacks a voucher specimen.

In 2022, we collected the first correctly identified specimens of *Punctelia jeckeri* (Roum.) Kalb from the Balaton Uplands. During systematic field surveys of this previously overlooked species (HÜVÖS-RÉCSI & BAUER 2026), we discovered a third species of the genus, *Punctelia borreri* (Sm.) Krog, in September 2025. In this paper, we summarize our current knowledge regarding the occurrence of this species in Hungary.

Punctelia borreri exhibits a temperate Atlantic–Mediterranean distribution (WIRTH *et al*. 2013). It occurs predominantly in Western and Central Europe. From among the neighbouring countries, the species has been reported from Austria, Croatia, Romania, Serbia, Slovakia, Slovenia, Ukraine (HAWKSWORTH *et al*. 2008, 2011, GBIF Secretariat 2023).

The European *Punctelia* species show low chemical variability (KUKWA & MOTIEJŪNAITĖ 2012), and morphological differences correlate well with genetic differences (LENDEMER & HODKINSON 2010). Although the species reported from Europe can be reliably distinguished based on thallus morphology and spot tests (HALE 1965), microcrystal tests ensure accurate identification. Microcrystal tests are particularly suitable for identifying gyrophoric acid and lecanoric acid, which are more difficult to distinguish by TLC (ORANGE *et al*. 2010).

Material and Methods

The identification of the species was based on the online keys published in ITALIC, the Information System of the Italian Lichens, version 8.0 (see NIMIS & MARTELLOS 2020), accessed between 28 September 2025 and 25 March 2026, as well as on WIRTH *et al*. (2013), WIRTH & KIRSCHBAUM (2023), LAJBLOVÁ & MALÍČEK (2024).

Chemical spot tests and microcrystallization were performed according to standard protocols (ORANGE *et al*. 2010). Thalli were examined under a Nikon C-PS stereomicroscope, and microcrystallization test results were observed with a BTC BIM 516T LED compound microscope.

Taxonomic nomenclature follows Index Fungorum (2021), MycoBank (ROBERT *et al*. 2018).

Photographs documenting specimen features were taken with a Nikon D800 camera equipped with an AF-S Micro Nikkor 105 mm f/2.8G ED lens.

Geographic coordinates of sampling sites were recorded with a GPS device (Mobile Mapper 60 – Spectra Geospatial). Locality names correspond to those used in tourist maps and 1:10.000-scale topographic maps. The distribution map of Hungary was prepared using QGIS 2.18 (QGIS Development Team 2018), applying a 5 × 6 km grid system based on the Central European floristic mapping scheme (NIKLFELD 1971).

The enumeration of the data follows the regional classification system of Hungary proposed by DÖVÉNYI (2010). All collected material is deposited in the BP collection (Hungarian Natural History Museum, Budapest).

The field survey was designed based on the vegetation characteristics of the first two localities, taking into account the ecological requirements of the species (WIRTH 2010) and its European distribution pattern. We carried out targeted surveys in some of the middle mountainous ranges of the country, focused on similar habitats, at the following twenty sites (Appendix e1). During the field mapping of *P. jeckeri*, however, we visited numerous additional sites with suitable habitats in Transdanubia and the Northern Hungarian Mountains; therefore, the actual number of sampling sites was considerably higher than that reported here. We specifically surveyed the occurrence of *Punctelia* species over 77 CEU grid cells (Appendix e3), covering a wide range of habitat types. In each forest stand, we

examined tree trunks, fallen branches originating from the canopy, the crowns of windthrown trees, and log piles. The survey consisted of a 3–4 km transect within the study area, conducted primarily along forestry roads and hiking trails, complemented by a 2–3-hour targeted search for *Punctelia* species.

In addition to field data collection, we also examined specimens of the genus *Punctelia* collected in Hungary at the BP.

Punctelia borreri (Sm.) Krog
Nordic J. Bot. 2(3): 291 (1982)

Main morphological characteristics. Thallus foliose, 5-10 cm in diameter, rosette-forming. Lobes rounded, 5-10 mm wide, ascending on margins. Upper surface grey, with numerous punctiform white pseudocyphellae; lobes sometimes pruinose (Fig. e1). Soralia mainly laminal and white. Lower surface black, dark brown at the margins (Fig. e2). Apothecia rare, lecanorine type. Pycnidia black; conidia short-filiform, 5-7 × 1 µm. Upper cortex with atranorin, chloroatranorin; medulla: gyrophoric acid, fatty acids (WIRTH *et al*. 2013, WIRTH & KIRSCHBAUM 2023, NIMIS 2025, lichenportal.org).
Spot tests. Upper cortex: K+ yellow, C–, KC–, P– or P+ faintly yellow. Medulla and soralia: K–, C+ pink, KC+ red, P–, UV– (NIMIS 2025).
Habitat. A corticolous species, occurring mainly on deciduous trees.

A Hungarian-language identification key for the Punctelia species recorded in the country so far is provided in Appendix e2, adapted from European identification keys (LENDEMER & HODKINSON 2010, WIRTH *et al*. 2013, NIMIS & MARTELLOS 2020, WIRTH & KIRSCHBAUM 2023, LAJBLOVÁ & MALÍČEK 2024) and from our own experiences.

Results

In September 2025, we collected specimens of a *Punctelia* species new to Hungary, *P. borreri*, in the Bakony Mountains, near Hárskút, in the Esztergáli-völgy. Subsequently, in 2026, we found it at three additional sites within the Esztergáli-völgy and its side valleys (Fig. e3). We also recorded *P. borreri* in the Balaton Uplands, near the settlement of Hidegkút, in February 2026, followed by further occurrences in the Bakony (Isztimér: Burok-völgy), in the Vértes Mountains (Csákberény: Kőkapu-völgy), and a second site in the Balaton Uplands (Aszófő: Öreg-hegy) (Fig. 1). With these records, the number of collection sites increased to 8 (Table 1). The species occurred with low abundance at the Hungarian sites; in some cases, only small thalli of 1–1.5 cm in diameter were found. At the sites where *P. borreri* specimens were collected, individuals of two other *Punctelia* species (*P. subrudecta* and *P. jeckeri*) were also present almost without exception.

Punctelia borreri is macroscopically most similar to *P. subrudecta*. However, based on our observations, the black lower surface of the thallus and the pruinosity of the upper surface of the lobes clearly distinguish it from the latter. In *P. subrudecta*, the lower surface of the thallus ranges from light brown to darker brownish shades. All collected *P. borreri* specimens exhibited a pruinose thallus surface extending beyond the lobe margins, whereas *P. subrudecta* specimens never did. They also differ in their chemical composition, as *P. subrudecta* contains lecanoric acid, whereas *P. borreri* contains gyrophoric acid (HALE 1965). We confirmed the presence of gyrophoric acid in the collected *P. borreri* specimens from each locality using microcrystal tests with GE solvent (Fig. e4*a*, Fig. e4*b*).

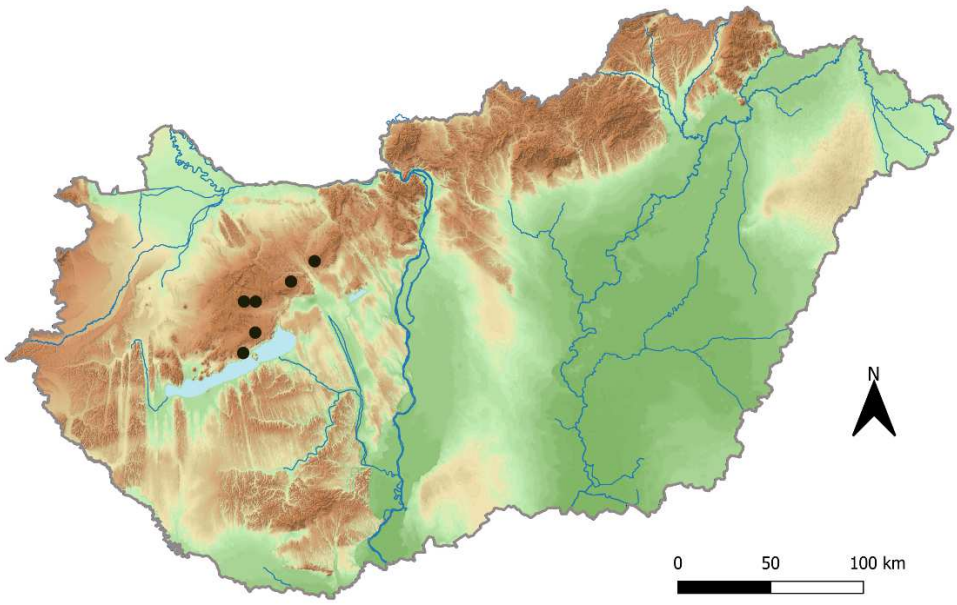

Fig. 1 Mapped occurrences of *Punctelia borreri* in Hungary.
1. ábra A *Punctelia borreri* magyarországi előfordulásainak térképe.

Table 1 *Punctelia borreri* material examined from Hungary
1. táblázat A Magyarországról vizsgált *Punctelia borreri* minták

Collector	**Date**	**Locality** (Settlement: locality)	**Subtrate**	**Specimen ID (BP)**	**CEU grid Nr.**
		Balaton Uplands			
A. Hüvös-Récsi, N. Bauer	21.02.2026	Hidegkút: Zsellér-hegy, Kálvária	*Quercus pubescens*	HNHM-LIC 006010	8774.2
A. Hüvös-Récsi	12.06.2026	Aszófő: Öreg-hegy	*Quercus pubescens*	HNHM-LIC 006067	9072.4
		Bakony Mts			
N. Bauer	04.04.2026	Isztimér: Burok-völgy	*Fagus sylvatica*	HNHM-LIC 006030	8774.2
N. Bauer	06.09.2025	Hárskút: Esztergáli-völgy	*Fraxinus excelsior*	HNHM-LIC 006014	8872.2
A. Hüvös-Récsi, N. Bauer	14.03.2026	Veszprém: Esztergáli-völgy	*Fraxinus excelsior*	HNHM-LIC 006015	8873.1
A. Hüvös-Récsi, N. Bauer	14.03.2026	Veszprém: Esztergáli-völgy, Esztergáli-kút alatt	*Fraxinus excelsior*	HNHM-LIC 006016	8873.1
A. Hüvös-Récsi, N. Bauer	14.03.2026	Veszprém: Sándor-árok	*Cerasus avium*	HNHM-LIC 006017	8872.2
		Vértes Mts			
N. Bauer	25.03.2026	Csákberény: Kőkapu-völgy	*Fraxinus excelsior*	HNHM-LIC 006066	8675.2

The species was recorded in the canopy of closed deciduous ravine forests, whereas in the more open oak forests characterized by higher light availability, it occurred as an epiphyte on bark. We collected *P. borreri* from *Fraxinus excelsior* L., *Fagus sylvatica* L., *Prunus avium* (L.) L., and *Quercus pubescens* Willd. The observed associated foliose and fruticose lichens included the following species (for species with fewer occurrence records, we also provide the locality): *Candellaria concolor* (Dicks.) Stein, *Flavoparmelia caperata* (L.) Hale, *Hypogymnia physodes* (L.) Nyl., *Hypogymnia tubulosa* (Schaer.) Hav., *Melanohalea exasperulata* (Nyl.) O. Blanco, A. Crespo, Divakar, Essl., D. Hawksw. & Lumbsch, *Melanohalea subaurifera* (Nyl.) O. Blanco, A. Crespo, Divakar, Essl., D. Hawksw. & Lumbsch, *Parmelia tiliacea* (Hoffm.) Hale, *Parmelia sulcata* Taylor, *Parmotrema perlatum* (Huds.) M. Choisy, *Phaeophyscia hirsuta* (Mereschk.) Essl. [Veszprém: Sándor-árok], *Phaeophyscia orbicularis* (Neck.) Moberg, *Physconia detersa* (Nyl.) Poelt, *Physconia entheroxantha* (Nyl.) Poelt [Hárskút: Esztergáli-völgy], *Physconia grisea* (Lam.) Poelt subsp. *grisea*, *Physconia perisidiosa* (Erichsen) Moberg [Isztimér: Burok-völgy], *Physcia adscendens* H. Olivier, *Physcia tenella* (Scop.) DC, *Punctelia jeckeri*, *Punctelia subrudecta*, *Ramalina* cf. *farinacea* (L.) Ach., *Ramalina* cf. *fastigiata* (Pers.) Ach.

A thorough revision of the BP Herbarium confirmed that no historical specimens of this species had been previously collected from Hungary.

Discussion

Based on our field observations and targeted surveys of *Punctelia* species, *Punctelia borreri* appears to represent a considerably rarer taxon in Hungary than both *P. subrudecta* and *P. jeckeri*. The latter was discovered only a few years ago and was recently mapped (HÜVÖS-RÉCSI & BAUER 2026). The rarity of the species presented here is inferred from the results of our systematic sampling focusing on *Punctelia* species, conducted across more than one hundred forest stands in Hungary. Within the surveyed plots, *P. subrudecta* and *P. jeckeri* proved to be substantially more frequent (Appendix e1).

Until now, relatively little is known about the habitat preferences of *P. borreri* in Hungary. A noteworthy advance in our knowledge of the species was achieved through a focused field survey initiated following the discovery of the first two records, which led to the identification of three additional localities. The majority of the confirmed occurrences of *P. borreri* have been recorded from ravine forests in the Transdanubian Mountains, accounting for six of the eight observations currently known. Although this pattern might suggest a methodological bias associated with the sampling effort, this explanation appears unlikely, as targeted surveys of *Punctelia* species conducted over the past four years in more than one hundred forest stands, representing a wide range of forest types from xerothermic open oak woodlands to montane beech forests, failed to detect *P. borreri*.

Among the recorded occurrences of *P. borreri*, we have two records originating from microhabitats of pubescent oak forest, where the colonies were accessible within the mid-stem zone (Hidegkút and Aszófő localities). All other records were collected from higher strata of the trees, specifically from the canopy layer, sampled from fallen branches and trees. This pattern may be associated with the species' light requirements, as ravine forest habitats on rocky valley bottoms represent closed, light-limited environments within the forest interior (PÓCS 1981). In such closed mesophilous forests, adequate light availability for the establishment of light-demanding foliose lichens may occur predominantly within the canopy layer.

Out of the 20 investigated valleys, the three sampling sites that yielded positive records (Esztergáli-völgy, Burok-völgy, and Kőkapu-völgy) exhibit considerable similarity in terms of

geological and geomorphological characteristics. All three valleys are situated in the central part of the Transdanubian Mountains, are predominantly underlain by Triassic dolomite bedrock, and display a NW–SE valley orientation. These shared features are also reflected in the present-day vegetation patterns of the valleys, suggesting potential similarities in their vegetation history. Particularly noteworthy is the fact that *P. borreri* was recorded in the upper third of all three ravines, in valley sections where the otherwise steep, rock-walled dolomite ravines are less deeply incised, and where canopy light conditions are presumably more favourable. We do not propose that the occurrence of a corticolous foliose lichen species is directly determined by the bedrock composition or geomorphological characteristics of its habitat. At the same time, these factors, which play a fundamental role in shaping landscape development and vegetation structure, undoubtedly influence the ecological properties and microhabitat conditions of a given area. It appears to us that, for the Atlantic–Mediterranean *P. borreri*, the canopy level of the ravine forests in the Transdanubian Mountains is one of the species' suitable habitats, where light and humidity conditions may be appropriate. The other two reported occurrences (Aszófő, Hidegkút) were found in pubescent oak forests of the Balaton Uplands, which have strong sub-Mediterranean characteristics. It seems that the species is also able to find suitable niches for colonisation in the well-lit forests around Lake Balaton. The unique mesoclimatic conditions of this region are also reflected in the distribution patterns of numerous sub-Mediterranean species of vascular flora (FEKETE 1964).

In order to achieve a broader, supraregional understanding of the distribution of *P. borreri* in Hungary, our investigations were extended to several ravines with comparable vegetation characteristics situated within the limestone and dolomite regions of the North Hungarian Mountains. Thus far, *P. borreri* has not been detected in these areas. Nevertheless, one of the most unexpected outcomes of the field surveys was that, within the investigated parts of the Bükk Mountains and the Aggtelek Karst, the other two corticolous *Punctelia* species also proved to be substantially rarer than in the Transdanubian Mountains. During the few hours allocated to the examination of a given locality, markedly fewer thalli were encountered than at the Transdanubian sampling sites. A similar decline in the frequency of *Punctelia* species can already be observed in the eastern part of the Transdanubian Mountains, particularly in the Pilis Mountains. We assume that climatic factors may underlie this pattern, as the gradual increase in continentality toward the eastern regions of the Hungarian middle mountain ranges is a well-established phenomenon (BIHARI *et al*. 2009, BORHIDI 2009), supported by phytogeographical evidence (ZÓLYOMI 1964, ZÓLYOMI & FEKETE 1994) and reflected in the distribution patterns of numerous plant species (ZÓLYOMI & FEKETE 1994, FEKETE *et al*. 2014). The same process is likely responsible for the eastward decline of several Atlantic and Atlantic–Mediterranean floristic elements at the national scale (PÓCS 1981, BORHIDI *et al*. 2012), a pattern that is likewise apparent in the Hungarian distribution of *P. jeckeri*.

At the current stage of knowledge, *P. borreri* can be considered a genuinely rare species in Hungary. The discovery of a lichen species previously unrecorded from a country may suggest recent range expansion, potentially associated with climate change or shifts in atmospheric pollution levels. Such processes have been documented for *P. borreri* in Atlantic-influenced regions of Europe (Kaplan Z. 2017). Furthermore, studies conducted in Germany have demonstrated that the frequency of Atlantic–Mediterranean species, including *Punctelia* species, increased continuously within the investigated area over a 13-year period, a pattern considered to be at least partly related to climate change (STAPPER & JOHN 2015). Comparable trends have also been reported from the Netherlands (VAN HERK *et al*. 2002). In addition, an increase in the number of known localities has been observed in Germany, particularly in climatically warmer regions (STORDEUR *et al*. 2015).

However, it should be noted that *P. borreri* likely occurs at the margin of its distribution range in Hungary. A similar pattern has recently been documented for *P. jeckeri*, which has been recorded from approximately a hundred localities (HÜVÖS-RÉCSI & BAUER 2026). We believe that the distributions of both species may be limited by increasing continentality. As a consequence, their occurrence is expected to remain infrequent in regions characterized by unfavourable macroclimatic conditions, where suitable habitats may be confined to isolated microclimatic refugia.

At present, it is not possible to determine whether either of the newly recorded *Punctelia* species is currently expanding its range in Hungary, as historical information on their occurrence within the country is insufficient. This lack of data is illustrated by the holdings of the BP Herbarium, which contain only eight *Punctelia* specimens collected between 1970 and the recent collections made by the present authors.

The discovery of *Punctelia* species newly recorded from Hungary and the documentation of their occurrences underscore the importance of systematically designed field surveys. To further elucidate the distribution patterns of these species in Hungary, additional studies have been planned.

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Elektronikus melléklet / Electronic appendix

Fig. e1 Part of the thallus of *Punctelia borreri* specimen (Veszprém: Esztergáli-völgy) HNHM-LIC 006015. Photo: N. Bauer

e1. ábra *Punctelia borreri* példány (HNHM-LIC 006015) teleprészlete (Veszprém: Esztergáli-völgy). Fotó: Bauer N.

Fig. e2 Lower surface of a *Punctelia borreri* thallus (detail). (Veszprém: Esztergáli-völgy) HNHM-LIC 006015. Photo: N. Bauer
e2. ábra *Punctelia borreri* példány (HNHM-LIC 006015) teleprészletének fonáka (Veszprém: Esztergáli-völgy). Fotó: Bauer N.
Fig. e3 The bluish grey thallus of *Punctelia borreri* (right) and the yellowish green thallus of *Flavoparmelia caperata* (top left) on the branch of *Fraxinus excelsior*, in the Esztergáli-völgy (14.03.2026.). Photo: N. Bauer
e3. ábra A *Punctelia borreri* kékesszürke telepe (jobbra) és a *Flavoparmelia caperata* sárgászöld telepe (balra, fent) az Esztergáli-völgyben magas kőris ágon (2026.03.14.). Fotó: Bauer N.
Fig. e4*a* Gyrophoric acid crystals from a *Punctelia borreri* specimen in GE solvent (Csákberény: Kőkapu-völgy). Photo: A. Hüvös-Récsi
e4.*a* ábra Giroforasav kristályok GE oldószerben, *Punctelia borreri* példányból (Csákberény: Kőkapu-völgy). Fotó: Hüvös-Récsi A.
Fig. e4*b* Lecanoric acid crystals from a *Punctelia subrudecta* specimen in GE solvent (Farkasgyepű: Köves-patak völgye). Photo: A. Hüvös-Récsi
e4.*b* ábra: Lekanorasav kristályok GE oldószerben, *Punctelia subrudecta* példányból (Farkasgyepű: Köves-patak völgye). Fotó: Hüvös-Récsi A.
Appendix e1 Investigated localities and recorded occurrences of *Punctelia* taxa during the mapping of *Punctelia borreri*.
e1. függelék A *Punctelia borreri* térképezése során vizsgált lelőhelyek és a kimutatott *Punctelia*-taxonok előfordulásai.
Appendix e2 Identification key to the *Punctelia* species recorded so far in Hungary.
e2. függelék Határozókulcs a Magyarországon eddig kimutatott *Punctelia*-fajokhoz.
Appendix e3 CEU grid cells surveyed and localities visited during the mapping of *Punctelia* species, between 2022 and June 2026.
e3. függelék 2022 és 2026 június között *Punctelia*-fajok térképezése során felkeresett CEU kvadrátok és a vizsgált lelőhelyek.

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HÜVÖS-RÉCSI Annamária & BAUER Norbert (2026):

Punctelia borreri a new corticolous lichen species from Hungary

***Punctelia borreri* – egy új kéreglakó zuzmófaj Magyarországon**

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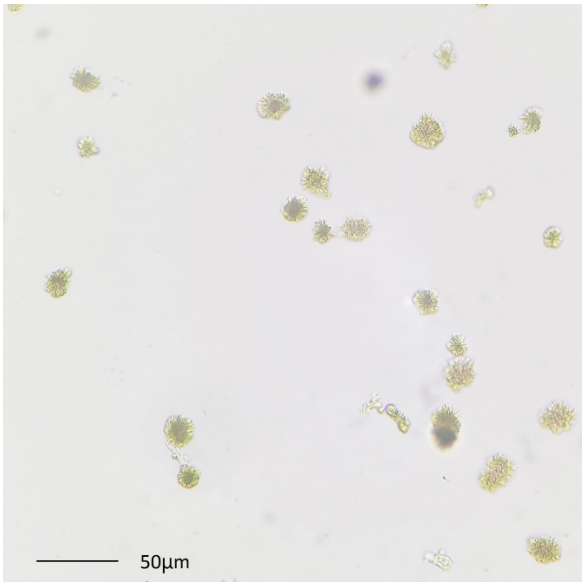

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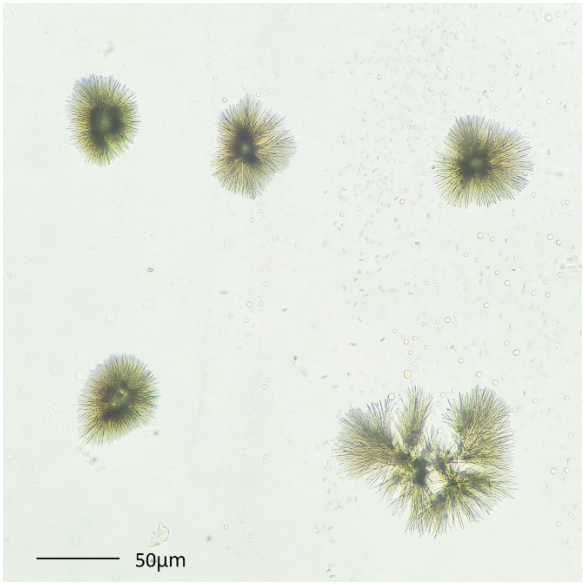
e4.*a* ábra Giroforasav kristályok GE oldószerben, *Punctelia borreri* példányból (Csákberény: Kőkapu-völgy). Fotó: Hüvös-Récsi A.



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e4.*b* ábra: Lekanorasav kristályok GE oldószerben, *Punctelia subrudecta* példányból (Farkasgyepű: Köves-patak völgye). Fotó: Hüvös-Récsi A.

Appendix e1 Investigated localities and recorded occurrences of *Punctelia* taxa during the mapping of *Punctelia borreri*
e1. függelék A *Punctelia borreri* térképezése során vizsgált lelőhelyek és a kimutatott *Punctelia*-taxonok előfordulásai

Date	**Studied site** [Locality (Settlement)]	**CEU grid Nr.**	*P. borreri*	*P. jeckeri*	*P. subrudecta*
		Balaton Uplands			
21.02.2026	Zsellér-hegy, Kálvária (Hidegkút)	8973.3	*1*	*1*	*1*
20.03.2026	Koloska-völgy (Balatonfüred)	9073.1	*0*	*1*	*1*
12.06.2026	Aszófő: Öreg-hegy	9072.4	*1*	*0*	*1*
		Bakony Mts			
06.09.2025	Esztergáli-völgy (Hárskút)	8873.1	*1*	*0*	*1*
14.03.2026	Esztergáli-völgy (Hárskút, Márkó, Veszprém)	8873.1	*1*	*1*	*1*
14.03.2026	Esztergáli-völgy (Veszprém)	8872.2		*1*	*1*
28.03.2026	Köves-árok, Holló-kút-völgye (Ajka)	8971.2	*0*	*1*	*1*
23.04.2026	Mina-völgy (Nagyvázsony)	8972.3	*0*	*0*	*1*
19.04.2026	Cuha-völgy (Bakonyszentlászó)	8672.2	*0*	*1*	*1*
10.04.2026	Malom-völgy (Eplény, Hajmáskér)	8773.4	*0*	*1*	*1*
21.03.2026	Köves-patak völgye (Farkasgyepű)	8871.2	*0*	*1*	*1*
27.03.2026	Séd-völgy (Veszprém)	8873.3	*0*	*0*	*1*
04.04.2026	Burok-völgy (Isztimér)	8774.2	*1*	*1*	*1*
21.03.2026	Csalános-völgy (Kislőd)	8871.4	*0*	*1*	*1*
14.04.2026	Gella-völgy (Szentgál)	8772.3	*0*	*1*	*1*
23.04.2026	Vár-völgy (Várpalota)	8774.4	*0*	*1*	*1*
		Keszthely Mts			
11.04.2026	Büdöskúti-völgy (Vállus)	9270.1	*0*	*1*	*1*
		Vértes Mts			
25.03.2026	Kőkapu-völgy, Meszes-völgy (Csákberény)	8675.2	*1*	*1*	*1*
31.30.2026	Fáni-völgy (Gánt-Vérteskozma)	8576.2	*0*	*1*	*1*
		Pilis Mts			
25.03.2026	Vaskapu-völgy (Pilisszentkereszt)	8279.3	*0*	*1*	*0*
		Mecsek Mts			
02.04.2026	Bodzás-völgy, Püspökszentlászlói-völgy (Pécsvárad)	9876.1	*0*	*1*	*1*
03.04.2026	Boldogasszony-völgy (Cserkút)	9974.2	*0*	*1*	*1*
		Aggtelek Mts			
07.03.2026	Baradla-völgy (Aggtelek)	7588.2	*0*	*1*	*1*
		Bükk Mts			
01.05.2026	Pazsag-völgy, Hór-völgy, Csúnya-völgy (Bükkzsérc, Répáshuta)	7989.3	*0*	*1*	*1*
02.05.2026	Ablakoskő-völgy (Nagyvisnyó)	7988.2	*0*	*0*	*0*

Appendix e2 Identification key to the *Punctelia* species recorded so far in Hungary
e2. függelék Határozókulcs a Magyarországon eddig kimutatott *Punctelia*-fajokhoz

1.a A telep fonáka krémszínűtől sötétebb barnáig; bélréteg C+ vörös (lekanorasav tartalmú) 2

1.b. A telep fonáka a széleken sötétbarna, középen fekete; bélréteg C+ rózsaszín (giroforasav tartalmú) 3

2.a A telep szürke árnyalatú, a lebenyek széle fényes, nem pruinózus; a szorédiumok főleg a lebenyek felszínén helyezkednek el; konídium: horog alakú (unciform), 4-5 x c. 1 µm; főként fakérgen *Punctelia subrudecta* (Nyl.) Krog

2.b A telep zöldes árnyalatú, a lebenyek széle legalább néhol pruinózus; a szorédiumok főleg a lebenyek szélén helyezkednek el; konídium: horog alakú (unciform), rövid fonalas (filiform), 3-5 x c. 1 µm; lombhullató fák kérgén *Punctelia jeckeri* (Roum.) Kalb

3. A telep szürke, szürkéskék árnyalatú, a lebenyek gyakran nagyobb felületen pruinózusak; a szorédiumok a telep felületén számosak; konídium: rövid fonalas (filiform), 5-7 x 1 µm; lombhullató fák kérgén *Punctelia borreri* (Sm.) Krog

Appendix e3 CEU grid cells surveyed and localities visited during the mapping of *Punctelia* species, between 2022 and June 2026
e3. függelék 2022 és 2026 június között *Punctelia*-fajok térképezése során felkeresett CEU kvadrátok és a vizsgált lelőhelyek

CEU grid Nr.	Studied sites
7588.2	Aggtelek: Baradla-völgy
7988.2	Nagyvisnyó: Ablakoskő-völgy
7989.3	Bükkzsérc, Répáshuta: Pazsag-völgy, Hór-völgy, Csúnya-völgy
8092.3	Tiszaújváros: Tiszasziget
8265.4	Fertőrákos: Kecske-hegy; Sopron: Tómalmi-domb
8274.3	Ács: Duna-part, Szőlőhegy
8277.2	Lovasberény: Meleg-hegy
8279.3	Pilisszentkereszt: Nagy-Bodzás, Nagy-Szoplák, Vaskapu-völgy
8378.2	Piliscsaba: Tinnye-hegy, Nagy-Kopasz
8379.3	Piliscsaba: Borókás-árok
8380.2	Göd: Gödi-sziget
8471.1	Felpéc: Sisek-domb
8476.4	Tatabánya: Csákányospuszta
8479.1	Nagykovácsi: Nagy-Szénás
8576.1	Gánt: Malom-út; Oroszlány: Új-legelő, Községi-legelő; Várgesztes: Gadóz, Hideghely
8576.2	Gánt-Vérteskozma: Boglári-oldal, Fáni-völgy, Macskagödör
8576.4	Csákvár: Vásár-hegy
8577.3	Alcsútdoboz: Csaplári-erdő
8664.4	Bozsok: Kalapos-kő, Végh-erdő
8665.1	Cák: Gesztenyés-oldal
8672.2	Bakonyszentlászló: Cuha-völgy
8673.3	Bakonyszentkirály: Cuha-völgy
8675.2	Csákberény: Kőkapu-völgy, Meszes-völgy
8676.1	Gánt: Horog-völgy, Kápolnapuszta
8772.1	Bakonybél: Gerence-völgy, Száraz-Gerence-völgy; Bakonyszücs: Cser-börc, Parajos-tető, Tönkölös-hegy; Ugod: Vörös János-séd völgy
8772.3	Bakonybél: Hegyes-kő; Hárskút: Fehérkő-árok; Szentgál: Gella-völgy
8773.4	Eplény: Malom-völgy
8774.2	Isztimér: Burok-völgy
8774.4	Várpalota: Vár-völgy
8782.1	Csévharaszt: Csévharaszti borókás
8871.2	Farkasgyepű: Köves-patak völgye, Peres-erdő
8871.4	Kislőd: Csalános-völgy

CEU grid Nr.	Studied sites
8872.1	Szentgál: Hermán, Középső-Hajag
8872.2	Veszprém: Esztergáli-völgy
8873.1	Veszprém, Márkó: Esztergáli-völgy
8873.3	Veszprém: Séd-völgy
8966.4	Vasvár: Nagy-erdő
8970.3	Káptalanfa: Nagytárkány-puszta
8971.2	Ajka: Kab-hegy, Köves-árok, Holló-kút-völgye, Szerencse fel-forrás; Úrkút: Kab-hegy, Peres
8972.3	Nagyvázsony: Mina-völgy
8973.3	Hidegkút: Kálvária, Recsek-hegy, Zsellér-hegy
8973.4	Alsóörs: Csere-hegy
8974.4	Balatonkenese: Márkó-hegy
8975.2	Polgárdi: Kőszár-hegy, Hármas-völgy
8984.1	Nagykőrös: Nagy-erdő
9069.3	Zalaszántó: Kovácsi-erdő
9070.1	Nyirád: Alsó-Nyirádi-erdő; Zalahaláp: Alsó-Nyirádi-erdő
9070.3	Zalahaláp: Deáki-erdő, Viszló-völgy
9070.4	Zalahaláp: Herceg-tag
9072.4	Aszófő: Öreg-hegy
9073.1	Balatonfüred: Koloska -völgy; Csopak: Öreg-hegy
9073.3	Tihany: Apáti-tető, Apáti-hegy
9162.2	Felsőszölnök: Hármashatár
9163.2	Szentgotthárd: Huszászi-patak völgye
9167.4	Nagykapornak: Remete-kert
9169.1	Rezi: Rezi-tető
9169.2	Várvölgy: Láz-tető
9170.4	Hegymagas: Szent György-hegy
9171.1	Szentbékkálla: Veléte
9172.1	Balatonakali: Magyal
9173.2	Szántód: Csikászó-erdő
9173.4	Balatonendréd: Gyugyi-erdő
9174.3	Ságvár: Malom-hegy
9268.1	Nagykapornak: Kapornaki-erdő
9270.1	Balatongyörök: Virágos-hegy; Vállus: Büdöskúti-völgy; Zalahaláp: Ódörögd-puszta
9272.2	Balatonszemes: Bagó-hegy
9272.3	Balatonlelle: Várszó-erdő
9273.1	Kereki: Erzsébet-völgy
9471.3	Libickozma: Kopárpuszta, Vadaskerti-erdő
9567.1	Rigyác: Szuloki-erdő
9571.1	Mesztegnyő: Vad-kert
9669.2	Böhönye: Csöpröndi-erdő
9670.2	Böhönye: Balogdi-erdő; Kutas: Gyótai-erdő; Nagybajom: Ötöshárs-víztározó körül
9677.4	Szekszárd: Sötét-völgyi erdő
9876.1	Pécsvárad: Zengő, Bodzás-völgy, Püspökszentlászlói-völgy
9974.2	Cserkút: Boldogasszony-völgy; Kővágószőlős: Jakab-hegy
0175.2	Siklós: Tenkes