

***Carbonea tephromelae* in the European Alps and selected distributional data for other *Carbonea* species**

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Abstract: Specimens previously determined as *Carbonea assimilis*, all lichenicolous on *Tephromela atra* and originating from the Eastern Alps (Austria and Italy), have been revised and found conspecific with the recently described *Carbonea tephromelae*. According to our observations *C. tephromelae* is a lichenized-lichenicolous species. Material of a number of additional *Carbonea* species has been used for comparison and the label data have been listed, resulting in notable range extensions for some lichenicolous species, namely *C. aggregantula* (first records for Slovenia and China), *C. herteliana* (first records for Germany, Italy, and Slovenia), *C. intrudens* (first records for Germany, Pakistan, and Canada), *C. supersparsa*, and *C. vitellinaria* (first records for Australia).

Key words: Ascomycota, Lecanorales, lichenicolous fungi, arctic-alpine distribution pattern.

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Introduction

The genus *Carbonea* (Hertel) Hertel was originally described on the level of subgenus (HERTEL 1967) and contained only two lichenized species, the actual *Carbonea atronivea* (Arnold) Hertel as type and *Carbonea vorticosa* (Flörke) Hertel. When later it was raised to genus level (HERTEL 1983) also two lichenicolous species have been recognized as congeneric and combined into the genus, namely *Carbonea supersparsa* (Nyl.) Hertel and *Carbonea vitellinaria* (Nyl.) Hertel. A full description of the genus has been provided for instance by CHAMBERS et al. (2009) or PIROGOV et al. (2014), whereas that by KNOPH et al. (2004) is still based on a mixture of *Carbonea* and *Scoliciosporum* characters.

The genus was scheduled for a monographic revision by scholars of Hannes HERTEL and announced for the series Bibliotheca Lichenologica (e.g. in RAMBOLD & TRIEBEL 1992). Apparently this book has never been published, probably because the designated senior author, Johannes KNOPH, died before the work could be completed (SIPMAN et al. 2019).

Currently *Carbonea* comprises some 20 accepted species (ANDREEV 2003, PIROGOV et al. 2014). The genus is present on all continents with a varying number of species. The majority of taxa grows on siliceous rocks or invades hosts colonizing this type of substrate. Several species develop an independent thallus (e.g., *Carbonea assentiens*, *C. atronivea*), but the genus *Carbonea* shows a clear evolutionary line towards secondary delichenization. In *Carbonea* lichenicolous growth ranges from lichenicolous lichens with well-developed thallus (e.g., *C. distans* on *Orphniospora mosigii*) to lichenicolous lichens with reduced thalli (e.g., *C. tephromelae* on *Tephromela atra*) and to lichenicolous fungi not forming lichenized thalli, although in these cases there may well exist a parasymbiotic relationship to a compatible host, forming 3-partite (2 fungi, 1 alga) systems (e.g., *Carbonea vitellinaria* on *Candelariella vitellina* agg.). Host specialisation on genus level appears to be the most common case, although normally only a restricted number of species are definitely infected (e.g., *Carbonea vitellinaria* on *Candelariella vitellina* agg., *Carbonea intrudens* on *Rhizocarpon* subgen. *Rhizocarpon*; see HAFELLNER 2006). Other *Carbonea* species show a high degree of specialisation (e.g., *C. superjecta* on *Lecanora (Diomedella) disjungenda* or *C. tephromelae* on *Tephromela atra*; see HERTEL 1984, TRIEBEL 1989, SVENSSON & WESTBERG 2021). For some species, relatively wide host spectra have been reported, e.g. for *Carbonea supersparsa*, which apart from compatible hosts of the *Lecanora polytropa* group has also been recorded not only from species of other *Lecanora* groups but also from *Acarospora*, *Rhizocarpon*, *Trapelia* (compare VOUAUX 1913, KEISSLER 1930). For *Carbonea assimilis*, on the other hand, both lichenized non-lichenicolous (e.g., KÖRBER 1861, SZCZEPAŃSKA 2020, SVENSSON & WESTBERG 2021) and lichenized lichenicolous populations (e.g., POELT 1958, HERTEL 1970) have been reported. This could be an indication for the existence of further so far not recognized and therefore undescribed species for which the story of *Carbonea tephromelae* is a good example.

Until recently, findings of a lichenicolous *Carbonea* species upon *Tephromela atra* have been named *C. assimilis* (e.g., POELT & TÜRK 1984, HAFELLNER et al. 2005, HAFELLNER 2006, 2007) and these data have also been included in standard checklists (e.g., NIMIS et al. 2018). However, SVENSSON & WESTBERG (2021) have demonstrated that there exists a highly specialized *Carbonea* on this host, which is distinguishable from *C. assimilis* on species level and was named *C. tephromelae*. Based on this insight the author restudied the relevant specimens preserved in GZU, and it turned out that all former records of presumed *Carbonea assimilis* on *Tephromela atra* had to be revised and transferred to the recently described species.

Material and methods

Dried herbarium specimens cited together with the treatments of the species have been examined. External morphology was studied with a dissecting microscope (WILD M3, 6.4–40×). Anatomical studies of the thallus and the ascomata were carried out under the light microscope (LEICA DMRE, 100–1000×). Sectioning was performed with a freezing microtome (LEITZ, sections of 12–15 µm) but squash preparations were also used, especially for ascus analysis. Preparations were mounted in distilled water. When necessary, contrasting was performed by a pretreatment with lactic acid-cotton blue (MERCK 13741). Amyloid reactions in hymenia were observed by the use of Lugol's reagent (I) (MERCK 9261). Sections and squash preparations were not pre-treated with diluted KOH (K) unless otherwise stated (K/I). Additionally, diluted HNO₃ (N) has been used as reagent for non-crystallized epihymenial pigments (MEYER & PRINTZEN 2000). Microscopical measurements refer to dimensions in distilled water.

Abbreviations for institutional herbaria follow HOLMGREN et al. (1990). Abbreviations of author names are those proposed by BRUMMITT & POWELL (1992). Geographic units are defined and named according to HOLLIS & BRUMMITT (1992) or BRUMMITT (2001).

For material studied for comparison see below!

Results

Carbonea tephromelae M.Svensson & M.Westb., *Phytotaxa* 522(3): 225 (2021).

Typus: Sweden, Lule Lappmark, Jokkmokk par., Padjelanta National Park, 11 km WNW of Staloluokta, S slope of Unna Duvgge (Unna Toki), c. 460 m NE of small cabin, 67.34787°N, 16.45453°E, elev. 703 m, S-exposed slope in bare mountain region, on rock, 5 August 2020, leg. M. Westberg PAD384 (UPS L-994014) n.v. Locality data from protologue.

Host of type: *Tephromela atra* (thallus)

Full description: SVENSSON & WESTBERG 2021: 225–226.

Icon.: SVENSSON & WESTBERG 2021: 225, Figure 2A (habit), 2B (section of apothecium), 2C–E (ascospores); this publication, Fig. 1A–C (habit of three different infections, all on the same specimen), 1C (close-up showing the dull-brown thallus and an apothecium).

Key characters for identification: Infections causing the formation of somewhat depressed areas on the host thallus, usually about 2–5–10 mm in diam. Thallus indistinct, consisting of very inconspicuous minute dull brownish areola-like ± flat particles containing cells of a coccal green alga, partly with black prothallus along the edges and attached to the margins of the white to cream-colored host areoles. Apothecia not agglomerated, in scattered groups of about 5–20(–40), along the edges of the *Tephromela*

atra areoles in contact with the brown thalline particles or the black prothallus, glossy black, about 0.2–0.4 mm in diam., with slightly protruding margin when young, later flat but hardly convex; in median longitudinal section with carbonized exciple, (sub)hyaline hypothecium (attention: extra-median sections may give the impression of a carbonized dark-brown hypothecium!), with hyaline non-inspersed hymenium verging into blue-green in the upper third; the blue-green pigment reacting N+ red, K-. Asci of *Lecanora*-type, 8-spored, 40–50 x 12–20 µm. Ascospores broadly ellipsoid to subglobose, hyaline, 7.5–10.5 x 6–8 µm, with l/w ratio 1–1.5.

Notes: 1. *Carbonea tephromelae* has been thoroughly compared with *C. assimilis* by SVENSSON & WESTBERG (2021). Critically restudied specimens of *C. assimilis* were all found to be (finally) not lichenicolous, had ascospores with l/w ratios approaching 2 and were from sites in the temperate-montane to boreal ecozone.

2. SVENSSON & WESTBERG (2021) were able to get ITS and RPB2 sequences from *Carbonea tephromelae* and offered a phylogenetic tree including five *Carbonea* species. Unfortunately, these data have a flaw: the supposed closest relative, *Carbonea assimilis*, is not included in this analysis.

3. I think that the habit photograph published by SVENSSON & WESTBERG (2021) equally shows the reduced but recognizable thallus of the *Carbonea* but this was apparently overlooked by the authors. The presence of these dull brown thallus particles (badly developed areoles) was the main reason why I had previously named such specimens *C. assimilis*.

4. The specimens from the Alps fit perfectly the protologue based on material from northern Sweden and show the diagnostic character regarding the ascospore dimensions, which distinguishes *Carbonea tephromelae* from *C. assimilis* s. str. The photographs published together with the diagnosis could well have been taken from one of the Central European specimens.

5. Superficial black short branched hyphal strands occur regularly upon the areoles of *Tephromela atra* in the infected areas (compare Fig 1A in this publication and the photograph of the holotype!). It is unclear if these hyphae belong to the lichenicolous *Carbonea* or to a second so far unknown fungal species.

Hosts: The species is so far only known on *Tephromela atra*, of which it infects exclusively the thallus.

Known distribution and previous records: The species has so far been only reported from Sweden, where it has been found in the northern parts of the country at latitudes from about 66–67.5°N and at elevations ranging between 530 and 820 m s. m., thus in (sub)arctic environments. A revision of the specimens of supposed *Carbonea assimilis* upon *Tephromela atra* stored in GZU, some of them already published under this name (POELT & TÜRK 1984, HAFELLNER et al. 2005, HAFELLNER 2006, 2007), has shown that they all belong to *Carbonea tephromelae*. In the European Alps (at a latitude of about 47°N), *C. tephromelae* occurs in the lower alpine altitudinal belt. The so far observed altitudinal range is 2000–2500 m s. m.

Thus, with the additional data given below, the distribution pattern of the species is recognized to be arctic-alpine. So far, *C. tephromelae* is only known from Europe and apparently a rare species, especially in relation to the commonness of its host. But as the host species is widely distributed, there is a good chance that *C. tephromelae* will be reported also from other continents, namely from temperate to arctic Asia and Northern America. For instance, a report of supposed *Carbonea vitellinaria* upon *Tephromela atra* from Siberia in Russia (ZHURBENKO 2009) would be worth re-checking as it may well belong here.

Specimens seen (all on the thallus of *Tephromela atra*):

EUROPE: Austria: Kärnten, Hohe Tauern, Kreuzeck-Gruppe, SE Abhänge der Hochtristen, [46°47'40"N / 13°08'10"E], 2400–2500 m, GF 9244/2, auf niederen Schrofen, Grünschiefer, 14. VII. 1978, leg. J. Hafellner no. 3445 (herb. Hafellner). – Salzburg, Lungau, Niedere Tauern, Radstädter Tauern, Aufstieg vom Großeck zum Speiereck, W von Mauterndorf, ca. 2000 m, Kalkschiefer, 22. VII. 1982, leg. J. Hafellner no. 9947 (herb. Hafellner). – Salzburg, Lungau, [Niedere Tauern], Radstädter Tauern, Aufstieg vom Großeck zum Speiereck, W von Mauterndorf, über dem Großeck bei 2070–2120 m, Silikatsfelsen und Kalkschiefer, 22. VII. 1981, leg. J. Poelt, H. Mayrhofer & R. Türk (GZU). – Salzburg, Lungau, Niedere Tauern, Radstädter Tauern, Aufstieg vom Großeck zum Speiereck, W von Mauterndorf, am Nordgrat knapp unter dem Gipfel, 47°07'50"N / 13°37'35"E, c. 2380 m, Kalkschiefer, auf Neigungsflächen kleiner Schrofen, 22. VII. 1981, leg. J. Hafellner no. 41628 (herb. Hafellner). – Steiermark, Niedere Tauern, Wölzer Tauern, Rettkirchspitze NW von Oberwölz, im oberen Teil des NE-Grates SW ober der Neunkirchner Hütte, 47°15'45"N / 14°08'05"E, c. 2300 m, GF 8750/2, Gneisblockwerk und Fragmente alpiner Vegetation, auf Neigungsflächen von Blöcken, 24. VIII. 2002, leg. J. Hafellner no. 68105 & J. Miadlikowska (GZU). – Steiermark, Niedere Tauern, Wölzer Tauern, Greim c. 11 km NW von Oberwölz, im Gipfelbereich, 47°14'50"N / 14°09'05"E, c. 2470 m, GF 8750/4, Blockwerk und niedere Ausbisse aus Glimmerschiefer in alpinen Rasen und Fragmenten von Zwergstrauchheiden, auf Neigungsflächen von Blöcken und Felsausbissen, 30. VII. 2006, leg. J. Hafellner no. 67927 & L. Muggia (herb. Hafellner). – Steiermark, Gurktaler Alpen, N-Hänge des Stang Nock, knapp unter dem Gipfel, 46°56'10"N / 13°47'40"E, c. 2300 m, GF 9048/4, schrofendurchsetzte alpine Rasen, auf kleinen Silikatschrofen, 15. VIII. 1989, J. Hafellner no. 28984 & M. Magnes (GZU). – Steiermark, Zentrale Ostalpen, Seetaler Alpen, Zirbitzkogel Massiv W von Obdach, im Linderkar an den untersten E-Abhängen des Verbindungsgrates von Scharfes Eck und Oberer Schlaferkogel, NE unter dem Karsee „Lindersee“, 47°04'25"N / 14°34'18"E, ca. 2015 m alt., GF 8953/1, Blockwerk eines reliktschen Blockgletschers, nahe der Oberkante der mäßig steilen Stirnfront, Paragneis/Amphibolit, auf Neigungsflächen, 5. VII. 2020, leg. J. Hafellner no. 85328 (GZU). – **Italy:** Friuli-Venezia Giulia, Prov. Udine, Südalpen, Karnische Alpen, Monte Crostis N von Comeglians, am Grat W vom Gipfel, 46°34'20"N / 12°53'20"E, ca. 2240 m, alpine Matten und Silikatschrofen, auf niederen Silikatschrofen, 17. VIII. 1994, leg. J. Hafellner no. 84383 (GZU).

Extensive material of other *Carbonea* species stored in GZU has been studied for comparison, additionally to that cited previously in HAFELLNER (2006). The accumulated data lead to remarkable range extensions for some of the species, namely the lichenicolous *Carbonea aggregantula* (first records for Slovenia and China), *C. herteliana* (first records for Germany, Italy, and Slovenia), *C. intrudens* (first records for Germany, Pakistan, and Canada), *C. supersparsa*, and *C. vitellinaria* (first records for Australia). For summaries of the recorded overall distribution of most of the species, see BRACKEL (2014). Furthermore, information on relevant exsiccate numbers represented in GZU is included.

Carbonea aggregantula (Müll.Arg.) Diederich & Triebel

Hosts: *Lecanora polytropa* (1), *Lecanora alpigena* (2)

Exs.: Hafellner, Lichenicolous Biota. no. 202 (GZU).

EUROPE: **Austria:** Kärnten, Zentralalpen, Saualpe W von Wolfsberg, sanfte SE-exponierte Hänge zwischen Ladinger Spitz und Speikkogel, NE unterhalb der Wolfsberger Hütte, 46°50'10"N / 14°39'50"E, ca. 1750 m, GF 9153/4, Zwergstrauchheiden im Waldgrenzökoton, auf kleinen, losen Glimmerschieferplatten, (1), 24. IX. 2010, leg. J. Hafellner no. 78513 (GZU). – Steiermark, Zentralalpen, Niedere Tauern, Seckauer Tauern, Berge N von Seckau, Verbindungsrücken zwischen Hämmerkogel und Schwaigerhöhe, 47°20'25"N / 14°45'25"E, ca. 2130 m, GF 8654/4, windausgesetzter Grat mit offener alpiner Vegetation, auf Lesesteinen aus Gneis, (1), 15. X. 2017, leg. J. Hafellner no. 83745 (GZU). – Vorarlberg, Zentralalpen, Verwall-Gruppe, Hochjoch Massiv E über Schruns, Grat zwischen Kreuzjoch und Hochjoch, 47°03'50"N / 09°59'10"E, ca. 2400 m, GF 8925/2, Gneisschrofen auf dem Grat, W-exponiert auf Neigungsflächen, (1), 28. VIII. 2008, leg. J. Hafellner no. 79301 (GZU). – Vorarlberg, Silvretta-Gruppe, Kl. Lobspitze SW über der Bielerhöhe, NE-Rücken über dem Silvretta-Stausee, 46°54'45"N / 10°05'25"E, ca. 2120 m alt., GF 9026/4, große Blöcke in Zwergstrauchheiden, Gneis, auf Neigungsflächen der Blöcke, (1), 26. VIII. 2008, leg. J. Hafellner no. 84109 (GZU). – **France:** Rhône-Alpes, Haute-Savoie, Western Alps, Mont Blanc group, slopes SE above Chamonix, SW of Refuge du Plan de l'Aiguille, 45°54'18"N / 6°52'56"E, elevation c. 2200 m, scree and scattered boulders of siliceous schist in dwarf shrub heath somewhat above the tree line, exp. NW, on inclined rock faces, (1), 18. VIII. 2011, leg. J. Hafellner no. 82809 (GZU). – **Italy:** Piemonte, prov. Torino, Western Alps, Alpi Cozie, mountains W of Pinerolo, northeastern slopes and ridges of the Punta Cialancia S above the village Perero, 44°53'00"N / 07°07'20"E, ca. 2350 m, boulders and cliffs of siliceous rocks, on boulders on the ridge, (1), 26. VII. 2001, leg. J. Hafellner no. 69379 (with P. L. Nimis & M. Tretiach) (GZU). – Trentino-Alto Adige, prov. Trento, Eastern Alps, Central Alps, Southern Rhaetian Alps, Ortler-group (Stelvio-group), c. 8 km N above Cógolo, La Cascata S above Lago Lungo, summit area, 46°25'30"N / 10°41'00"E, ca. 2575 m, boulders of micaschist in alpine vegetation, on inclined rock faces of boulders, (2), 27. VII. 2006, leg. J. Hafellner no. 69322 (with L. Muggia & M. Tretiach) (GZU). – Friuli-Venezia Giulia, prov. Udine, [Südalpen], Karnische Alpen, Monte Crostis N von Comeglians, am Grat W vom Gipfel, [46°34'20"N / 12°53'20"E], ca. 2240 m, alpine Matten und Schrofen, auf niederen Silikatschrofen, (1), 17. VIII. 1994, leg. J. Hafellner no. 36786 (GZU). – **Slovenia:** Southern Alps, Julian Alps, massif of Mangart NE of Bovec, slopes of large doline S of Mangartška koča (Mangart refuge), below Rdeča skala, 46°26'10"N / 13°38'45"E, c. 1880 m, alpine vegetation and rocks of bright (triassic) limestone / reddish (cretaceous) limestone, partly slightly siliciferous, on inclined rock faces on layers of chert, (1), 2. VIII. 2003, leg. J. Hafellner no. 78350 (GZU) [Note: with admixture of *Cercidospora epipolytropae*]. – **Spain:** Cataluña, Prov. Girona, Pyrenäen, Nuria N von Ribas de Freser, NE von der Bergstation der Zahnradbahn, Südhänge mit subalpinen Rasen und Kalkschieferschrofen, [42°24'05"N / 02°09'35"E], 2100–2200 m alt., auf Schieferblöcken, (1), 27. V. 1983, leg. J. Hafellner no. 17696 (GZU). – **Sweden:** Torne Lappmark, Umgebung von Abisko, Vassijaure gegen Kärkevage. in Überhängen eines Felsens, (1), 14. VII. 1967, leg. J. Poelt, det. J. Hafellner (GZU). – **Switzerland:** Kanton Bern, [Western Alps], Urner Alps, area of Steingletscher (Steingletscher) (below Sustenpass) c. 20 km NE of Meiringen, Chüöbärgli SW above Steisee, on slopes exposed to the N, 46°43'10"N / 08°25'45"E, elevation c. 2100 m, outcrops and boulders of siliceous rocks (granite, schist with low content of calcium) in alpine vegetation, on rock heads on a small ridge, (1), 26. VIII. 2006, leg. J. Hafellner no. 77411 (GZU). – Kanton Wallis, Aletschwald über Brig, 1900–2000 m alt., Gneisabbrüche, (1), 11. IX. 1968, leg. J. Poelt no. 6672a, det. J. Hafellner (GZU). – **ASIA:** **China:** Tibet, Himalaya, Langtang-Gruppe, Shisha Pangma, Nordabdachung, 5600–5800 m, auf Silikatgestein, (1), 12. IX. 1984, leg. G. Miehe, det. J. Hafellner (GZU). – **NORTHERN AMERICA:** **Canada:** British Columbia, Trophy Mountain Recreation Area, 51°46'N / 119°54'W, 1800–2200 m alt. alpine vegetation, on siliceous schist, (1), 24. VIII. 1994, leg. T. Goward & J. Poelt no. 95/262 (GZU). – **Greenland:** W-Grönland, Umanak,

Scheideck NE über Marmorilik, c. 850–970 m alt., Kalkkuppen, auf einem silikatischen Lesestein, (1), 8. VIII. 1983, leg. J. Poelt & H. Ullrich (GZU).

***Carbonea assentiens* (Nyl.) Hertel**

Exs.: Hertel, Lecideaceae exs. no. 102 (GZU). – Hertel, Lecideaceae exs. no. 362 (GZU).

***Carbonea assimilis* (Hampe ex Körb.) Hafellner & Hertel**

Exs.: Magnusson, Lich. Sel. Scand. exs. 64, sub *Lecidea a.* (GZU).

EUROPE: Austria: Steiermark, [Niedere Tauern], Schladminger Tauern, Vetterkar SE des Unteren Giglachsees, 2000–2200 m, GF 8747/2, Silikatblockwerk, auf Schieferblöcken, 19. VIII. 1991, leg. J. Poelt (GZU) [Note: not distinctly lichenicolous]. – **France:** Rhône-Alpes, Haute-Savoie, Western Alps, Mont Blanc group, Col de Tricot SE above of Bionnassay, SE above the saddle at the lowermost cliffs of W ridge of Pointe Inférieure de Tricot, 45°51'00"N / 6°46'15"E, elevation c. 2160 m, low cliffs of siliceous rocks with veins of calcareous schist exposed to NW, on inclined rock faces of siliceous rocks, 20. VIII. 2011, leg. J. Hafellner no. 84384 (herb. Hafellner). [Note: not distinctly lichenicolous]. – **Sweden:** Västergötland, par. Kållerød, Stretered, on sunny rocks in the heath, 1. IV. 1926, leg. A. H. Magnusson = Magnusson, Lich. Sel. Scand. exs. 64 (GZU) [Note: not distinctly lichenicolous]. – **United Kingdom:** Scotland, Westernness (V. C. 97), W of Glenborrodale Castle, woods at hillside, on rocks, 15. VI. 1992, leg. B. Coppins, P. W. James & J. Poelt no. Sc92/155 (GZU) [Note: not distinctly lichenicolous]. – **NORTHERN AMERICA: U.S.A.:** Wyoming, Park County, Yellowstone National Park, 4 miles W of Tower, 44°56'52"N / 110°28'34"W, c. 6800 ft., Douglas fir forest, boulders on talus on N facing slope, 22. VII. 1998, leg. C. M. Wetmore no. 81016a (GZU) [Note: Thallus growing adjacent to brown areoles of *Protoparmelia badia* but not distinctly lichenicolous].

***Carbonea atronivea* (Arnold) Hertel**

Exs.: Vězda, Lich. Sel. exs. no. 635, sub *Lecidea a.* (GZU).

EUROPE: Austria: Kärnten, Nationalpark Hohe Tauern, Glockner-Gruppe, NW-Grat des Großen Magrötzen [Margrötzen] Kopfs W ober dem Hochtör, knapp SW unter dem Grat, [47°05'10"N / 12°50'05"E], ca. 2620 m, GF 8943/1, Kalkschiefer und Ca-haltiger Granatglimmerschiefer, auf SW-exponierten Schrofen und Blöcken, 30. VIII. 1996, leg. J. Hafellner no. 40055 (GZU). – Steiermark, [Zentralalpen], Gurktaler Alpen, N unter der Stang Scharte (zwischen Stang Nock und Gregerl Nock), 46°55'55"N / 13°48'10"E, ca. 2020 m, GF 9048/4, subalpine Zwergstrauchheiden mit einzelnen großen Felsblöcken, auf niederen Kalkschrofen, 15. VIII. 1989, leg. J. Hafellner no. 64019 (GZU). – Tirol, Nördliche Kalkalpen, Lechtaler Alpen, S-exponierte Schrofenhänge N und W der Augsburger Hütte über Grins, NW Landeck, [47°10'05"N / 10°29'30"E], ca. 2200–2400 m, GF 8828, Kalk und Mergelkalk, 9. VII. 1982, leg. J. Hafellner no. 9967 (GZU). – **Italy:** Trentino-Alto Adige, Südtirol, Südalpen, Dolomiten, Latemar-Gruppe, [SE über Welschnofen], Hänge unter der Latemar-Hütte, über der Zischgalm, [46°21'20"N / 11°33'20"E], ca. 2370 m alt., Kalkschrofen, 27. X. 1989, leg. J. Poelt (GZU). – **NORTHERN AMERICA: Greenland:** W-Grönland, Umanak, Hänge S über dem kleinen Sydsø, SE von Marmorilik, c. 480–550 m alt., Kalke und Fe-reiche Silikate, VIII. 1983, leg. J. Poelt & H. Ullrich (GZU).

***Carbonea distans* (Kremp.) Hafellner & Obermayer**

Host: *Orphniospora mosigii* (1)

Exs.: Cryptogamae exs. no. 4752, sub *Lecidea d.* (GZU). – Hafellner, Lichenicolous Biota. no. 222 (GZU). – Plantae Graecenses Lich. no. 151, sub *Lecidea d.* (GZU). – Poelt, Lichenes Alpium no. 98, sub *Lecidea d.* (GZU).

EUROPE: Austria: Kärnten, Zentralalpen, Saualpe, W von Wolfsberg, Kienberg, am Südrücken kurz SW vom Gipfel, Drei Öfen, 46°53'00"N / 14°38'55"E, ca. 2040 m, GF 9153/2, Felsburgen und Blockwerk aus Schiefergneis, umgeben von alpinen Rasen, auf W-exp. Steiflächen, (1), 7. IX. 2012, leg. J. Hafellner no. 80292 & A. Hafellner (GZU). –

Salzburg, Pinzgau, [Zentralalpen], Hohe Tauern, Glockner-Gruppe, N-Hänge des Kitzsteinhorns, ca. 0,5 km W vom Bundessportheim, [47°12'35"N / 12°41'10"E], ca. 2450 m, GF 8742/3, alpine Matten auf kalkhaltigem Grünschiefer, auf Steiflächen von Grünschieferschrofen, (1), 27. VIII. 1996, leg. J. Hafellner no. 47346 (GZU). – Steiermark, [Zentralalpen], Niedere Tauern, (Wölzer Tauern), Rottenmanner Tauern, Großer Bösenstein, im Gipfelbereich, 47°26'35"N / 14°24'15"E, ca. 2445 m, GF 8552/3, Gneis, auf Steiflächen niederer Schrofen und großer Blöcke, (1), 6. VIII. 2003, leg. J. Hafellner no. 68224 (GZU). – Tirol, Osttirol, [Südralpen], Karnische Alpen, Hegetkofel SW von Obertilliach, S-exponierte Hänge ober dem Hegetriegel, [46°40'20"N / 12°34'00"E], ca. 2300 m, GF 9341/1, alpine Matten und Schieferschrofen, auf teilweise Ca-hältigen Schieferschrofen, (1), 8. IX. 1989, leg. J. Hafellner no. 28708 & A. Hafellner (GZU). – Vorarlberg, Zentralalpen, Verwall-Gruppe, Hochjoch Massiv E über Schruns, Grat zwischen Kreuzjoch und Hochjoch, 47°03'50"N / 09°59'10"E, ca. 2400 m, GF 8925/2, Gneisschrofen auf dem Grat, W-exponiert auf Steiflächen, (1), 28. VIII. 2008, leg. J. Hafellner no. 79309 (GZU). – **France**: Rhône-Alpes, Haute-Savoie, Western Alps, Mont Blanc group, slopes SE above Chamonix, SW of Refuge du Plan de l'Aiguille, 45°54'18"N / 6°52'56"E, elevation c. 2200 m, scree and scattered boulders of siliceous schist in dwarf shrub heath somewhat above the tree line, exp. NW, on steep rock faces, (1), 18. VIII. 2011, leg. J. Hafellner no. 82820 (GZU). – **Italy**: Trentino-Alto Adige, prov. Trento, Eastern Alps, Central Alps, Southern Rhaetian Alps, Ortler-group (Stelvio-group), c. 8 km N above Cógolo, La Cascata S above Lago Lungo, summit area, 46°25'30"N / 10°41'00"E, ca. 2575 m, boulders of micaschist in alpine vegetation, on vertical rock faces of boulders, (1), 27. VII. 2006, leg. J. Hafellner no. 84387 (with L. Muggia & M. Tretiach). – **Switzerland**: Kanton Bern, Berner Alps, Grimselpass c. 20 km SE of Meiringen, W above the pass by the trail to Huseggihütte, 46°33'35"N / 08°19'40"E, elevation c. 2350 m, outcrops of siliceous rocks (granite, schist) in open alpine vegetation, on subvertical rock faces exposed to the N, (1), 24. VIII. 2006, leg. J. Hafellner no. 69312 (GZU). – Kanton Graubünden, [Western Alps], Urner Alps, Gotthard group, Oberalppass c. 6 km NE of Andermatt, S above the pass, 46°39'20"N / 08°40'15"E, elevation c. 2100 m, outcrops of siliceous schist in alpine vegetation on steep rock faces exposed to the S, (1), 23. VIII. 2006, leg. J. Hafellner no. 77332 (GZU). – Kanton Graubünden, [Eastern Alps, Western Rhaetian Alps], Albula group, Julierpass c. 9 km SW of St. Moritz, SW of the pass, 46°28'15"N / 09°43'35"E, elevation c. 2290 m, boulders of siliceous rocks in alpine vegetation, on subvertical rock faces exposed to the N, (1), 23. VIII. 2006, leg. J. Hafellner no. 77271 (GZU).

Carbonea herteliana Hafellner & Matzer

Host: *Rhizocarpon umbilicatum* (1)

Exs.: Hafellner, Lichenicolous Biota. no. 12 (GZU). – Santesson, Fungi Lichenicoli exs. no. 309 (GZU) Isotype!

EUROPE: Austria: Kärnten, [Südralpen], Karnische Alpen, Gartnerkofel ca. 8 km SW von Hermagor, markante kurze Felsrippe im Südhang etwa halbwegs zwischen Südsattel und Gipfel, 46°34'15"N / 13°18'20"E, ca. 2100 m, GF 9445/2, Felsrippe aus Triaskalk in alpinen Rasen, auf Neigungsflächen, (1), 1. IX. 2007, leg. J. Hafellner no. 76884 (GZU). – Niederösterreich, Nordalpen (Nördliche Kalkalpen), Mürzsteger Alpen, Rax-Massiv, Bieskogel ca. 1,3 km E vom Habsburghaus, S-seitig an die sanfte Gipfelkuppe, 47°42'50"N / 15°42'55"E, ca. 1920 m, GF 8260/3, Ausbisse mesozoischer Kalke in Caricetum firmiae a) auf Neigungsflächen, (1), 2. IX. 2012, leg. J. Hafellner no. 81122 (GZU). – Steiermark, Nördliche Kalkalpen, Dachstein-Gruppe, Grimming W von Stainach, im Gipfelbereich, 47°31'15"N / 14°01'00"E, ca. 2350 m, GF 8450/3, alpine Matten und Kalkfelsen, auf niederen Kalkschrofen und -blöcken, (1), 10. VI. 2000, leg. J. Hafellner no. 51469 & A. Hafellner (GZU, herb. Hafellner). – Vorarlberg, Rätikon, Lünerkrinne E über dem Lünersee, ca. 12 km SSW von Bludenz, Felsköpfe entlang des Grates kurz SE über dem Steig über den Sattel, 47°03'30"N / 09°46'15"E, ca. 2150 m, GF 8924/2, Felsschrofen aus mergeligen Triaskalken in alpiner Vegetation, auf Neigungsflächen von Kalkschrofen, (1), 5. VIII. 2008, leg. J. Hafellner no. 72899 (GZU). – Vorarlberg, Rätikon, Hänge zwischen Lünersee und Gafalljoch, ca. 14 km SSW von

Bludenz, Geländerippe an den E-Abhängen der Kanzelköpfe, W gegenüber der Zollhütte, 47°02'35"N / 09°45'10"E, ca. 2150 m, GF 8924/4, kleine Kalkausbisse in zwergstrauchreichen Weiderasen, auf Neigungsflächen der Kalkausbisse, (1), 29. VIII. 2008, leg. J. Hafellner no. 73099 (GZU). – **France**: Rhône-Alpes, Haute-Savoie, Western Alps, Chablais Alps, les Grandes Platières, hilltop W above Col de Plate, 45°59'39"N / 6°43'40"E, elevation c. 2380 m, layered limestone and patches of alpine vegetation, on inclined rock faces, (1), 19. VIII. 2011, leg. J. Hafellner no. 82929 (GZU). – **Germany**: Bayern, Nordalpen, Chiemgauer Alpen, Kampenwand ca. 22 km SE von Rosenheim, S über der Steinlingalm, im Gratbereich W unter dem Gipfelkreuz, 47°45'20"N / 12°22'00"E, ca. 1640 m, am S-Fuß der Abbrüche des Gipfelaufbaus, Triaskalk, auf S-exponierten Neigungsflächen, (1), 28. VIII. 2009, leg. J. Hafellner no. 84389 (GZU). – **Italy**: Veneto, prov. Belluno, Southern Alps, Venetian Alps, Nevegal SE of Belluno, Col Faverghera, area of the Orto Botanico, 46°05'00"N / 12°18'00"E, ca. 1540 m, low limestone outcrops and boulders in subalpine meadows, on inclined rock faces exposed to the N, (1), 31. VIII. 2002, leg. J. Hafellner no. 61095 (GZU). – **Slovenia**: Southern Alps, Julian Alps, massif of Mangart NE of Bovec, slopes of large doline S of Mangartška koča (Mangart refuge), below Rdeča skala, 46°26'10"N / 13°38'45"E, c. 1880 m, alpine vegetation and rocks of bright (triassic) limestone / reddish (cretaceous) limestone, partly slightly siliciferous, on inclined rock faces, (1), 5. VII. 2003, bzw. 2. VIII. 2003, leg. J. Hafellner no. 78347 (GZU).

Carbonea intrudens (H.Magn.) Hafellner

Host: *Rhizocarpon geographicum* (1), *Rhizocarpon* (subgen. *Rhizocarpon*) spec. (2)

Exs.: Hafellner, Lichenicolous Biota. no. 13 (GZU).

EUROPE: **Austria**: Kärnten, Steirisches Randgebirge, Koralpe E von Wolfsberg, Großes Kar, auf der Höhe des obersten Karbodens am Fuß der NE-Hänge des Großen Speikkogel, N unterhalb der Radarstation, 46°47'30"N / 14°58'15"E, ca. 1980 m, GF 9255/2, ruhende Silikatblöcke zwischen *Pinus mugo*, an Neigungsflächen großer Gneisblöcke, (1), 22. VI. 2008, leg. J. Hafellner no. 71165, L. Muggia & A. Hafellner (GZU). – Steiermark, Niedere Tauern, Wölzer Tauern, Greim ca. 11 km NW von Oberwölz, im Gipfelbereich, 47°14'50"N / 14°09'05"E, ca. 2470 m, GF 8750/4, Blockwerk und niedere Ausbisse aus Glimmerschiefer in alpinen Rasen und Fragmenten von Zwergstrauchheiden, auf Neigungsflächen von Blöcken und Felsausbissen, (1), 30. VII. 2006, leg. J. Hafellner no. 67934 & L. Muggia (GZU). – Vorarlberg, Verwall-Gruppe, Hochjoch Massiv E über Schruns, beim Schwarzsee, N-exponierte Schrofen S über dem Südufer, 47°04'05"N / 09°58'55"E, ca. 2100 m, GF 8925/2, Amphibolit, auf Neigungsflächen, (1), 6. VIII. 2008, leg. J. Hafellner no. 78874 (GZU). – Vorarlberg, Verwall-Gruppe, Hochjoch Massiv E über Schruns, Grat zwischen Kreuzjoch und Hochjoch, 47°03'50"N / 09°59'10"E, ca. 2400 m, GF 8925/2, Gneisschrofen auf dem Grat, W-exponiert auf Neigungsflächen, (1), 28. VIII. 2008, leg. J. Hafellner no. 79302 (GZU). – Vorarlberg, Silvretta-Gruppe, Kl. Lobspitze SW über der Bielerhöhe, NE-Rücken über dem Silvretta-Stausee, 46°54'45"N / 10°05'30"E, ca. 2080 m, GF 9026/4, niedere Ausbisse aus Amphibolit zwischen Zwergstrauchheiden, auf langfristig bergfeuchten Neigungsflächen, (1), 26. VIII. 2008, leg. J. Hafellner no. 81274 (GZU). – **France**: Rhône-Alpes, Haute-Savoie, Western Alps, Mont Blanc group, slopes SE above Chamonix, SW of Refuge du Plan de l'Aiguille, 45°54'18"N / 6°52'56"E, elevation c. 2200 m, scree and scattered boulders of siliceous schist in dwarf shrub heath somewhat above the tree line, exp. NW, on inclined rock faces, (1), 18. VIII. 2011, leg. J. Hafellner no. 82810 (GZU). – **Germany**: Bayern, Nordalpen, Allgäuer Alpen, Grünten ca. 5 km NE von Sonthofen, am SW-Rücken kurz S über dem Grüntenhaus, 47°33'00"N / 10°18'55"E, ca. 1600 m alt., Lichtung im subalpinen Fichten-Wald, auf kleinen Blöcken aus Silikat-Sandstein neben dem Steig, (1), 7. IX. 2004, leg. J. Hafellner no. 84121 (GZU). – **Italy**: Piemonte, prov. Torino, Western Alps, Alpi Cozie, mountains W of Pinerolo, northeastern slopes and ridges of the Punta Cialancia S above the village Perero, 44°53'00"N / 07°07'20"E, ca. 2350 m, boulders and cliffs of siliceous rocks on boulders on the ridge, (2), 26. VII. 2001, leg. J. Hafellner no. 69380 (GZU). – Trentino-Alto Adige, prov. Trento, Eastern Alps, Central

Alps, Southern Rhaetian Alps, Ortler-group (Stelvio-group), c. 8 km N above Cógolo, La Cascata S above Lago Lungo, summit area, 46°25'30"N / 10°41'00"E, ca. 2575 m, boulders of micaschist in alpine vegetation, on inclined rock faces of boulders, (1), 27. VII. 2006, leg. J. Hafellner no. 69338 (with L. Muggia & M. Tretiach) (GZU). – **Switzerland**: Kanton Bern, [Western Alps], Urner Alps, area of Steigletscher (Steingletscher) (below Sustenpass) c. 20 km NE of Meiringen, SW of Steisee, 46°43'20"N / 08°25'45"E, elevation c. 2000 m, moraine on gentle slope, on boulders of granite, (2), 26. VIII. 2006, leg. J. Hafellner no. 77445 (GZU). – Kanton Bern, [Western Alps], Berner Alpen [Bernese Alps], Grimselpass c. 20 km SE of Meiringen, W above the pass by the trail to Husegghütte, 46°33'35"N / 08°19'40"E, elevation c. 2350 m, outcrops of siliceous rocks (granite, schist) in open alpine vegetation, on inclined rock faces, (1), 24. VIII. 2006, leg. J. Hafellner no. 69300 (GZU). – Kanton Graubünden, [Western Alps], Urner Alps, Gotthard group, Oberalppass c. 6 km NE of Andermatt, S above the pass, 46°39'20"N / 08°40'15"E, elevation c. 2100 m, outcrops of siliceous schist in alpine vegetation, on inclined rock faces exposed to the N, (1), 23. VIII. 2006, leg. J. Hafellner no. 77324 (GZU). – Kanton Graubünden, [Eastern Alps, Western Rhaetian Alps], Albula group, Julierpass c. 9 km SW of St. Moritz, SW of the pass, 46°28'15"N / 09°43'35"E, elevation c. 2290 m, boulders of siliceous rocks in alpine vegetation, on inclined rock faces, (1), 23. VIII. 2006, leg. J. Hafellner no. 77251 (GZU). – **ASIA: Pakistan**: Karakorum, Upper Kaghan Valley, around the lake Saiphul (Saiful) Muluk, 34°50'N / 73°40'E, 4050 m alt., exposed hill, on granite, (2), 16. VII. 1990, leg. G. Miehe no. 364a & S. Miehe, det. J. Hafellner (GZU). – **NORTHERN AMERICA: Canada**: "Northwest Territories, Franklin District," [Nunavut, Qikiqtaaluk Region], Igloodik Island, 69°24'N / 81°49'W, in siliceous rocks, (1), 24. VII. 1985, leg. R. Warren (GZU). – **Greenland**: W. Grönland, Disko, Diskofjord, unweit des Ortes, (2), 4. VIII. 1982, leg. J. Poelt & H. Ullrich (GZU). – **U.S.A.**: Alaska, Kenai Peninsula Borough, N of Seward, along Lost Lake Trail, 3 km S of Lost Lake, 60°14'20"N / 149°25'40"W, alt. c. 650 m s. m., low outcrops of siliceous schist (flysch) in subalpine vegetation, on low outcrops, (1), 28. VIII. 2010, leg. J. Hafellner no. 79986 (together with T. Spribille, L. Muggia and C. Hampton-Miller) (GZU). – Alaska, Kenai Peninsula Borough, W of Seward Highway (Alaska Hwy 1), along Devil's Creek Trail, lowermost, S-exposed slopes of Gilpatrick Mountain, 60°35'20"N / 149°42'10"W, alt. c. 620 m s. m., boulder scree of siliceous schist (flysch), on rock, (2), 29. VIII. 2010, leg. J. Hafellner no. 80035 (together with L. Muggia) (GZU).

Carbonea superjecta (Nyl.) Hertel

Host: *Lecanora disjungenda* (syn. *Diomedella disjungenda*)

Exs.: Hertel, Lecideaceae exs. no. 123 (GZU).

Carbonea supersparsa (Nyl.) Hertel

Hosts: *Lecanora polytropa* (1), *Lecanora* spec. (2)

Exs.: Hafellner, Lichenicolous Biota. no. 352 (GZU).

EUROPE: Austria: Kärnten, [Südalpen], Karnische Alpen, Hochwipfel ca. 15 km WSW von Hermagor, am N-Grat hinab zum Kirchbacher Wipfel, kurz unterhalb vom Gipfel, 46°35'47"N / 13°10'40"E, ca. 2160 m, GF 9445/1, Ausbisse eines paläozoischen, silikatischen Schiefers in alpinen Rasen und lückigen Zwergstrauchbeständen, auf langfristig trockenen Neigungsflächen, (1), 2. IX. 2007, leg. J. Hafellner no. 76094 & W. Obermayer (GZU). – Salzburg, Nationalpark Hohe Tauern, Glockner Gruppe, NW-Grat des Großen Magrötzen [Margrötzen] Kopfs W ober dem Hocht, knapp NE unter dem Grat, [47°05'10"N / 12°50'10"E], ca. 2620 m, GF 8943/1, Granatglimmerschiefer, auf NE-exponierten Schrofen und Blöcken, (1), 30. VIII. 1996, leg. J. Hafellner no. 40085 (GZU). – Steiermark, Niedere Tauern, Wölzer Tauern, Großer Rotbühel S über der Planneralpe, im Gipfelbereich, 47°23'35"N / 14°12'30"E, ca. 2000 m, GF 8651/1, Blöcke aus Glimmerschiefer und lückigen Rasen zwischen lockeren *Pinus mugo*-Beständen, auf Neigungsflächen, (1), 8. VII. 2012, leg. J. Hafellner no. 80080 & L. Muggia (GZU). – **France**: Rhône-Alpes, Haute-Savoie, Western Alps, Mont Blanc group, slopes SE above Chamonix, SW of Refuge du Plan de l'Aiguille, 45°54'18"N / 6°52'56"E, elevation c. 2200 m, scree and scattered boulders of siliceous schist in dwarf shrub heath somewhat

above the tree line, exp. NW, on inclined rock faces, (1), 18. VIII. 2011, leg. J. Hafellner no. 82811 (GZU). – **Italy**: Friuli-Venezia Giulia, prov. Udine, Südalpen, Karnische Alpen, Monte Crostis Massiv N von Comeglians, S-Hänge des Monte Neval, 46°33'50"N / 12°53'30"E, ca. 2000 m, alpinen Matten mit zerstreuten Silikatblöcken, auf eutrophierten Horizontalfächen von Silikatblöcken, (1), 17. VIII. 1994, leg. J. Hafellner no. 84388 (GZU). – Trentino-Alto Adige, prov. Trento, Southern Alps, Dolomiti, Passo di Rolle N of San Martino di Castrozza, northern slopes of the mountain Tognazza, 46°17'20–25"N / 11°47'05–15"E, ca. 2100 m, low outcrops of siliceous rocks in subalpine pastures, on inclined rock faces exposed to the N, (2), 1. IX. 2002, leg. J. Hafellner no. 84378 (together with J. Nascimbene) (GZU). – **Switzerland**: Kanton Graubünden, [Western Alps], Uner Alps, Gotthard group, Oberalp pass c. 6 km NE of Andermatt, S above the pass, 46°39'20"N / 08°40'15"E, elevation c. 2100 m, outcrops of siliceous schist in alpine vegetation, on inclined rock faces exposed to the N, (1), 23. VIII. 2006, leg. J. Hafellner no. 77325 (GZU). – Kanton Graubünden, [Eastern Alps, Western Rhaetian Alps], Albula group, Julierpass c. 9 km SW of St. Moritz, SW of the pass, 46°28'15"N / 09°43'35"E, elevation c. 2290 m, boulders of siliceous rocks in alpine vegetation, on inclined rock faces, (1), 23. VIII. 2006, leg. J. Hafellner no. 77252 (GZU).

Carbonea vitellinaria (Nyl.) Hertel

Hosts: *Candelariella vitellina* (1), *Candelariella* spec. (2)

Exs.: Hafellner, Lichenicolous Biota no. 71, 111, 211 (all GZU). – Hertel, Lecideaceae exs. no. 164 (GZU). – Poelt, Lichenes Alpium no. 31, sub *Lecidea* v. (GZU). – Santesson, Fungi Lichenicoli exs. no. 8, 80, 129 (all GZU).

EUROPE: Austria: Kärnten, Hohe Tauern, Hafner-Gruppe, Faschauner Eck N von Malta, auf dem Gipfel, [47°00'23"N / 13°30'02"E], 2612 m, GF 8947/3, Silikatfels, (1), 17. IV. 1987, leg. K. Cernic, ex herb. Hafellner no. 16152 (GZU). – Steiermark, Steirisches Randgebirge, Grazer Bergland, Steinkogel S über Gasen, ca. 10 km W von Birkfeld, kleine Kuppe (Kote 1356) auf dem sanft nach SE abfallenden Geländerücken, 47°21'05"N / 15°34'15"E, ca. 1350 m, GF 8659/1, subalpine Weide knapp über der Waldgrenze, auf Blöcken aus Grünschiefer, (1), 13. XI. 2010, leg. J. Hafellner no. 76539 & L. Muggia (GZU). – Tirol, [Zentralalpen], Tuxer Alpen, Geier S ober der Wattener Lizum, Ostgrat, kurz unter dem Gipfel, [47°08'25"N / 11°38'10"E], ca. 2780 m, GF 8835/4, lückige alpine Matten, SE-exponiert auf Serpentinitschrofen, (1), 7. VII. 1992, leg. Hafellner no. 23433 & M. Magnes (GZU). – Tirol, Osttirol, [Zentralalpen], Lasör-linggruppe, Defereggental, St. Jakob, Unterrotte, am Ufer des Trojer Almbaches, 46°55'15"N / 12°20'05"E, ca. 1450 m, GF 9039/4, auf Silikatblöcken, (1), 10. IX. 2008, leg. E. Schöpflin, herb. Hafellner no. 74908 (GZU). – **France:** Dept. Cantal, Auvergne, Orgues SE von Chadecol, E ober Blesle, ca. 680 m; SW-exponierte Basaltabbrüche, auf Erde in Felsspalten, (2), 1. VIII. 1980, leg. A. Bellemère & J. Hafellner no. 9592 (GZU). – Rhône-Alpes, Haute-Savoie, Western Alps, Mont Blanc group, slopes SE above Chamonix, SW of Refuge du Plan de l'Aiguille, 45°54'18"N / 6°52'56"E, elevation c. 2200 m, scree and scattered boulders of siliceous schist in dwarf shrub heath somewhat above the tree line, exp. NW, on inclined rock faces, (1), 18. VIII. 2011, leg. J. Hafellner no. 82812 (GZU). – **Italy:** Trentino-Alto Adige, prov. Trento, Eastern Alps, Central Alps, Southern Rhaetian Alps, Ortler-group (Stelvio-group), c. 8 km N above Cógolo, La Cascata S above Lago Lungo, summit area, 46°25'30"N / 10°41'00"E, ca. 2575 m, boulders of micascist in alpine vegetation, on inclined rock faces of boulders, (2), 27. VII. 2006, leg. J. Hafellner no. 69337 (with L. Muggia & M. Tretiach) (GZU). – Piemonte, prov. Torino, Western Alps, Alpi Cozie, mountains W of Pinerolo, northeastern slopes and ridges of the Punta Cialánzia S above the village Perero, 44°53'00"N / 07°07'20"E, ca. 2350 m, boulders and cliffs of siliceous rocks, on boulders on the ridge, (1), 26. VII. 2001, leg. J. Hafellner no. 69381 (with P. L. Nimis & M. Tretiach) (GZU). – **Spain:** Prov. Avila, Parameras de Avila, bei Mengamuñoz, ca. 1300–1350 m, Silikatblöcke in einer Garrigue, (1), 10. IX. 1980, leg. J. Hafellner no. 10652 (GZU). – **Svalbard [to Norway]:** Spitzbergen, Woodfjorden, Bockfjorden, Sverrefjellet, Klippenrippe auf der NE-Seite, 79°16'N / 13°20'E, ca. 420 m alt., Lavafelsen, (1), 22. VII. 1979, leg. J. Hafellner no. 5106, 5109 (GZU). – **Switzerland:** Kanton Bern, Berner Alps, Große Scheidegg c. 10 km

SW above Meiringen, small ridge in short distance SE above the saddle, 46°39'20"N / 08°06'10"E, elevation c. 1980 m, outcrops of siliceous (partly slightly calcareous) schist in a subalpine pasture, on slope exposed to NW, (1), 25. VIII. 2006, leg. J. Hafellner no. 75453 (GZU). – Canton Ticino (Tessin), Western Alps, Lepontine Alps, Adula Alps, c. 6 km NE of the village Olivone, W slopes of Torno above the Lago di Luzzzone, above Alpe Garzott, 46°34'20"N / 08°59'25"E, elevation c. 1640 m, large boulders of mafic metamorphite in a pasture, on inclined rock faces, (1), 22. VIII. 2012, leg. J. Hafellner no. 81762 & L. Muggia (GZU). – Kanton Graubünden, [Eastern Alps, Western Rhaetian Alps], Albula group, Julierpass c. 9 km SW of St. Moritz, SW of the pass, 46°28'15"N / 09°43'35"E, elevation c. 2290 m, boulders of siliceous rocks in alpine vegetation, on inclined rock faces, (1), 23. VIII. 2006, leg. J. Hafellner no. 77253 (GZU). – **ASIA: India:** [Western] Himalaya, Kashmir, Gipfel über dem Zojibal Pass gegenüber dem Haramugh, ca. 4300 m, (1), VII. 1975, leg. E. Albertshofer (GZU). – **Nepal:** Central Himalaya, Langtang, Surdscha Kunda, alt. 4760 m s. m., offener Erdstrom, (2), 12. VIII. 1986, leg. G. Miehe & S. Miehe no. 8772, det. J. Hafellner (GZU). – **Pakistan:** Northern Areas, Northwestern Himalaya, Baltistan, eastern Deosai plateau, 35°05'N / 75°34'E, 3950–4000 m alt., rocky slope, on siliceous rock, (2), 13. VII. 1991, leg. J. Poelt no. K91-347 (GZU). – **AFRICA: Canary Islands [to Spain]:** Tenerife, Las Cañadas, schwach geneigte Hänge der Montaña de las Arenas Negras SE oberhalb von El Portillo, [28°17'30"N/16°33'15"W], ca. 2160 m, auf niederen Lavablöcken, (1), 20. II. 1989, leg. J. Hafellner no. 36360 & A. Hafellner (GZU). – **AUSTRALASIA: Australia:** New South Wales, Mount Kosciusko National Park, Perisher Creek between Smiggin Holes and Guhega, 36°22'S / 148°24'E, 1620–1680 m, granite, (2), 3. III. 1985, leg. H. Mayrhofer no. 15422, H. Hertel & R. Filson (GZU). – Victoria, Bogong Hills Plains, Mt. Cope, 36°56'S / 147°17'E, 1800–1837 m, granite, (2), 25. II. 1985, leg. H. Mayrhofer no. 15391, H. Hertel & R. Filson (GZU). – **NORTHERN AMERICA: U.S.A.:** Arizona, Coconino Co., San Francisco Peaks N of Flagstaff, Humphries Peak, on the ridge S below the summit, 35°20'30"N / 111°40'45"W, ca. 3600 m alt., volcanic boulders and small cliffs on the ridge, on protected rock faces exposed to the N, (1), 7. VII. 1994, leg. J. Hafellner no. 36800 (GZU). – Arizona, Apache Co., Apache National Forest, Mt. Baldy Wilderness, along Hall Creek (the first drainage W of the Little Colorado River Valley), 33°57'30"N / 109°32'W, ca. 2750 m, open *Picea engelmannii-Abies lasiocarpa* forest, on volcanic conglomerate in a pasture, (1), 2. VII. 1994, leg. J. Hafellner no. 36593 (GZU).

Carbonea vorticosa (Flörke) Hertel

Exs.: Arnold, Lich. exs. no. 719a, sub *Lecidea* v. (GZU). – Hertel, Lecideaceae exs. no. 363 (GZU). – Obermayer, Dupla Graecensia no. 598, 1038 (both GZU).

EUROPE: Austria: Kärnten, Zentralalpen, Saualpe W von Wolfsberg, Forstalpe, NW-Hänge, „Steinerne Hochzeit“, 46°54'05"N / 14°39'35"E, ca. 1950 m, GF 9053/4, Felsburgen aus Gneis und Glimmerschiefer umgeben von Zwergstrauchheiden, an Neigungsflächen, 4. IX. 2011, leg. J. Hafellner no. 78604 (GZU). – Steiermark, Niedere Tauern, Schladminger Tauern, Deneck S über St. Nikolai im Sölketal, am S-Grat knapp unterhalb vom Gipfel, 47°17'15"N / 14°03'05"E, ca. 2420 m, GF 8750/1, W-exp. Glimmerschieferschrofen und Rasenbänder, an Neigungsflächen der Schrofen, 12. IX. 2009, leg. J. Hafellner no. 74321 (GZU). – Steiermark, [Zentralalpen], Steirisches Randgebirge, Grazer Bergland, Steinkogel S über Gasen, ca. 10 km W von Birkfeld, kleine Kuppe (Kote 1356) auf dem sanft nach SE abfallenden Geländerücken, 47°21'05"N / 15°34'15"E, ca. 1350 m, GF 8659/1, subalpine Weide knapp über der Waldgrenze, auf Blöcken aus Grünschiefer, 20. XI. 2011, leg. J. Hafellner no. 79017 (GZU). – Tirol, Osttirol, [Zentrale Ostalpen], Defereggengebirge, Hirschbichl ca. 4,5 km WSW von St. Jakob-in-Defereggeng, E Abhänge, kurz über der Lappachalm, 46°54'25"N / 12°16'30"E, ca. 1930 m, GF 9039/4, subalpine Weidefläche, auf kleinen Gneisblöcken, 11. IX. 2006, leg. E. Schöpflin in herb. Hafellner no. 67455 (GZU). – **France:** Rhône-Alpes, Haute-Savoie, Western Alps, Mont Blanc group, slopes SE above Chamonix, SW of Refuge du Plan de l'Aiguille, 45°54'18"N / 6°52'56"E, elevation c. 2200 m, scree and scattered boulders of siliceous schist in dwarf shrub heath somewhat above the tree line, exp. NW, on inclined rock faces, 18. VIII. 2011, leg. J. Hafellner no. 82784 (GZU). – Rhône-Alpes, Haute-Savoie, Western Alps, Mont Blanc group, Col de Tricot SE above of Bionnassay,

SE above the saddle at the lowermost cliffs of W ridge of Pointe Inférieure de Tricot, 45°51'00"N / 6°46'15"E, elevation c. 2160 m, low cliffs of siliceous rocks with veins of calcareous schist exposed to NW, on inclined rock faces of siliceous rocks, 20. VIII. 2011, leg. J. Hafellner no. 82949 (GZU). – **Italy**: Trentino-Alto Adige, prov. Trento, Eastern Alps, Central Alps, Southern Rhaetian Alps, Ortler-group (Stelvio-group), c. 8 km N above Cógolo, La Cascata S above Lago Lungo, summit area, 46°25'30"N / 10°41'00"E, ca. 2575 m, boulders of micaschist in alpine vegetation, on inclined rock faces of boulders, (2), 27. VII. 2006, leg. J. Hafellner no. 69333 (with L. Muggia & M. Tretiach) (GZU). – **Switzerland**: Kanton Bern, [Western Alps], Berner Alpen [Bernese Alps], Grimselpass c. 20 km SE of Meiringen, W above the pass by the trail to Husegghütte, 46°33'35"N / 08°19'40"E, elevation c. 2350 m, outcrops of siliceous rocks (granite, schist) in open alpine vegetation, on inclined rock faces, 24. VIII. 2006, leg. J. Hafellner no. 69295 (GZU). – **NORTHERN AMERICA: Greenland**: W-Grönland, Umanak, Scheideck NE über Marmorilik, c. 850–970 m alt., Kalkkuppen, auf silikatischem Schiefer, 8. VIII. 1983, leg. J. Poelt & H. Ullrich, det. G. Rambold (GZU). – **U.S.A.**: Alaska, North Slope Borough, Brooks Range, Endicott Mountains, S below Atigun Pass, N of Chandalar Station, E-exposed slopes W above the James Dalton Highway (Alaska Hwy 11), 68°06'30"N / 149°32'15"W, alt. c. 1120 m s. m., dwarf shrub tundra with low outcrops of siliceous schist, on loose pebbles, 19. VIII. 2010, leg. J. Hafellner no. 79883 (together with T. Spribille, L. Muggia and C. Hampton-Miller) (GZU).

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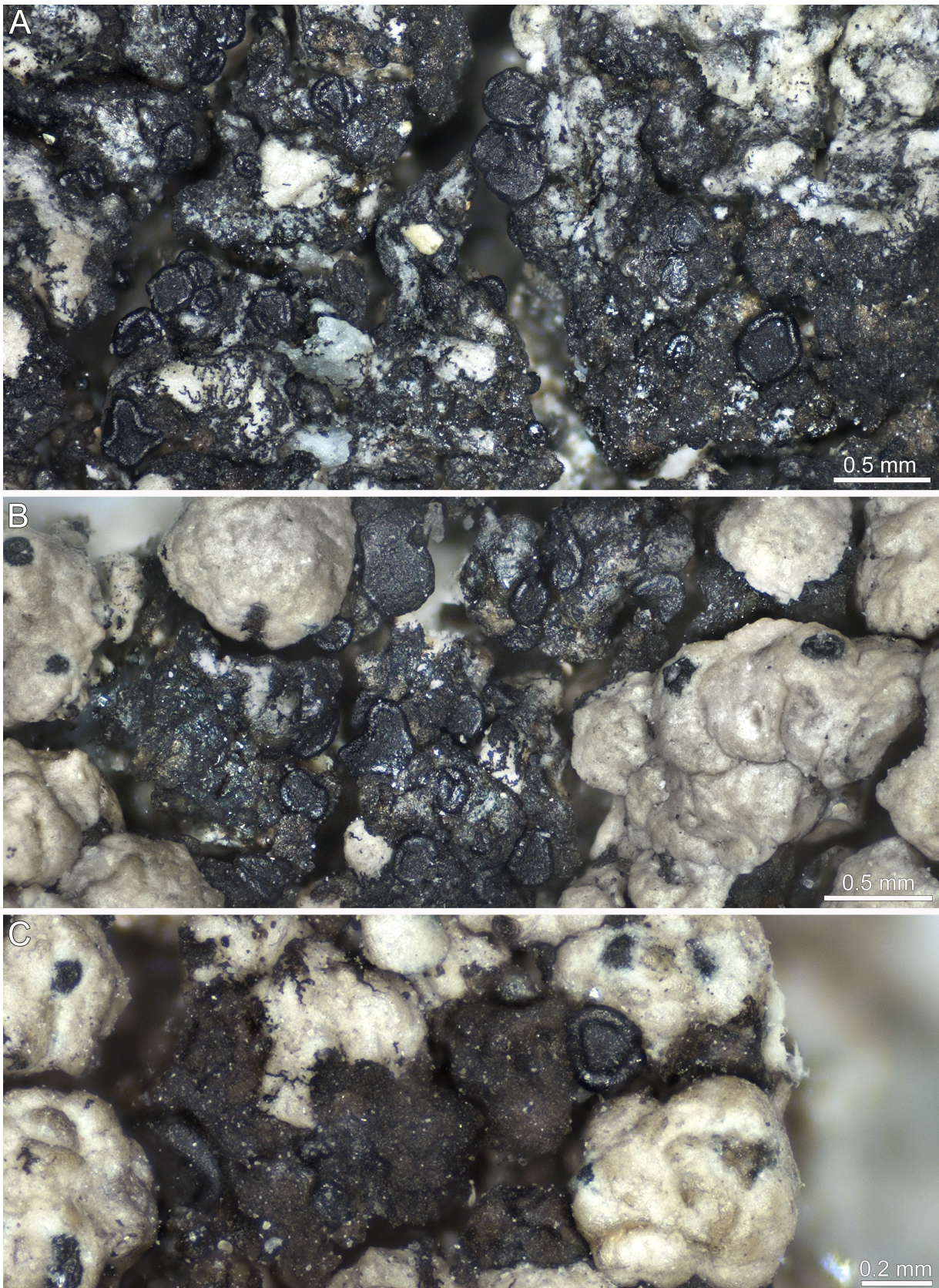


Fig. 1: *Carbonea tephromelae* on *Tephromela atra*: three different infections, all from the same specimen (leg. J. Poelt et al., 22.VII.1981). – **A–B**) Infected areas with thallus and apothecia of *Carbonea tephromelae*. – **C**) Close-up of young infection showing the dull brown thallus and one apothecium of *Carbonea tephromelae*. The black roundish patches on the whitish *Tephromela* areoles are ostiolar regions of host pycnidia (Fig. 1B, C). [photos: Walter OBERMAYER; pdf-version in color]