

Biatora Fr.
(LECANORALES: BIATORACEAE)

After Printzen (1995), Coppins, 1992, and others

Rev. March 2, 1998

THALLUS crustose, effuse, sometimes membranous in part but mostly verrucose or granulose, not isidiate, creamy whitish to greenish, usually without defined cortical or medullary structures, sometimes consisting entirely of algae densely entangled by fungal hyphae; **prothallus** sometimes visible when granules are scattered, white, arachnoid; **soredia** present in some species; **photobiont** chlorococcoid, but different from that in Lecanora or Lecania, averaging 6-8 μm , maximum 12.5-4(-18) μm ; without haustoria within individual algal cells.

APOTHECIA sessile, biatorine, pale, **discs** whitish to red-brown or dark brown but never black, not pruinose, sometimes with a reddish brown pigment (especially in hymenium and upper exciple), but never with purplish, greenish, or very dark brown (carbonaceous) pigmentation, at first broadly adnate and plane to slightly convex, gradually becoming sessile and \pm constricted at the base and weakly to strongly convex or occasionally tuberculate; **apothecial sections** highly gelatinized; **true exciple** soon reflexed, well developed in sections, hyaline to brown inside, chondroid, composed of radiating hyphae 2-2.5 μm wide, with terminal cells sometimes to 4 μm wide, tightly bound in a gel-matrix that does not dissolve or markedly swell in K; outer edge sometimes covered by a narrow gel layer; hypothecium pale to brown, chondroid, of interwoven hyphae 1-2 μm wide in a dense gel-matrix; **subhymenium** distinct, somewhat opaque, often forming a straw- to brownish colored zone; **hymenium** to 60-80(-100) μm tall, without a well defined epithecium, with or without granules, I+ blue; **epihymenium** usually indistinct, but epipsamma present in some species; **paraphyses** strongly conglutinate even in K, embedded in a uniform hymenial gelatin or with gelatinous sheaths, 1.5-2 μm thick, rather thin-walled, simple or sometimes sparingly branched and anastomosing; tips slightly clavate (to 3 μm wide), not surmounted by distinct apical cap or hood, but sometimes with gelatinous caps; epihymenium sometimes brownish or yellowish. **Asci** 8-spored, cylindrical-clavate, lateral walls 0.7-1 μm wide, Biatora-type, with K/I+ blue apical dome penetrated from below by a narrow, K/I- apical cushion surrounded by a narrow, deeply K/I+ blue zone, the wall K/I- but surrounded by a K/I+ blue outer layer; ocular chamber poorly developed or not apparent. **Spores** colorless, ellipsoid or oblong, to oblong-fusiform, simple to rarely partly 1(-3)-septate, smooth, thin-walled (wall normally < 0.5 μm), without a distinct perispore.

PYCNIDIA rare or very inconspicuous, usually completely immersed; ostiole concolorous with apothecia; conidiophores type II of Vobis; **conidia** bacilliform.

CHEMISTRY: Containing gyrophoric acid, argopsin, less often lecanoric, usnic, isousnic, stictic, atranorin, norargopsin, unknown substances, or no substances detectable by TLC. On various substrates, usually on mossy rocks or the trunks of old trees (often overgrowing bryophytes or plant debris), on somewhat acidic substrata (not directly on rock), in relatively undisturbed habitats; the corticolous species are characteristic of ancient woodland.

A segregate from Lecidea, as usual based mainly on ascus structure. When fertile, the species can be recognized by their wide-spreading thalli with medium-sized to rather large, convex,

immarginate and pale apothecia [however, lots of species still in Lecidea also have these features!].

According to Printzen (1995), Biatora is characterized especially by the type of photobiont, conidiogenous hyphae, bacilliform pycnosporos, excipulum structure, and the mode of ascocarp ontogeny, as well as the ascus type. The apothecia are usually pale, but in some species can be deeply or darkly pigmented.

Coppins, 1992 cites Hafellner (including his 1989 Mycobilimbia treatment) as his source, and lists "Mycobilimbia" as a synonym without giving any justification; however, Coppins does not include the species that Hafellner considered to belong to that genus. Coppins states that "Bacidia sabuletorum" (treated by Hafellner under Mycobilimbia), as well as "Toninia lobulata", differ from Biatora in having thick-walled asci, broader paraphyses, ascospores with a warted perispore, and purplish and greenish pigments in the apothecia. He also states that the "Lecidea hypnorum group" (also treated by Hafellner under Mycobilimbia) differs from Biatora in having Porpidia-type asci. According to Printzen, Mycobilimbia should be reserved for species with mostly 1-3-septate spores; it differs from Biatora especially in that the apothecia are from the start sessile, strongly convex and immarginate, soon becoming globular and strongly constricted at the even when the disks have scarcely opened up (but asci have already developed when the disc has begun to open up).

I. Thallus sorediate or of minute, soredia-like granules in most parts.

[Soralia pale greenish to yellowish or pale buff]

Apothecia often absent.

Thallus not squamulose, not bright to vivid green when fresh

Note: sterile collections cannot be identified with this key.

1. Spores 1-3-septate. [see Mycobilimbia]

1. Spores simple, rarely some 1-septate intermixed. 2

2. Soralia C+ rose-red (gyrophoric acid).4

2. Soralia C-. [Thallus at least partly K+, KC+, or P+, with lichen substances. Spores 0-1-septate]. 5

3. Soralia thick. Apothecia to 1.1 mm diam. Spores 10.5-19.5 x (3-)3.5-6.5 μ m; mainly on corticolous (rarely saxicolous) mosses, more rarely directly on bark, mostly in humid, montane situations. Photobiont coccoid, 1-celled, without gelatinous cap, globose.

Minnesota. B. chrysantha (Zahlbr.) Printzen (syn. Lecidea gyrophorica)

3. Soralia thin and flat. Apothecia to 0.55 mm diam. Spores 9.5-14.5 x 3-4.5 μ m; mostly in alpine situations, on smooth, naked bark of shrubs. Photobiont 2-4 celled, to 20 μ m diam., with a common external gelatinous cap, globose to \pm cubic. Alaska to Washington. B. vacciniicola (Tonsb.) Printzen

4. Soralia P+ red. Apothecia 0.4-0.8(-1.0) mm diam. Spores (10-)12-17 x (4-)4.5-5(-6) μ m. With argopsin and norargopsin. Apothecia whitish or pale, without pigmentation in section. Spores 0(-1)-septate. Otherwise similar to B. epixanthoides,

and growing in similar habitats. B. efflorescens (Hedl.) Erichsen, nom. cons. prop. (syn. B. epixanthodiza)

4. Soralia P-. Apothecia 0.2-0.5 mm diam. Spores 7.5-13.5 x 2.5-3.5 um. With atranorin, usnic acid, isousnic acid, \pm stictic acid, \pm cryptostictic acid, \pm "flavopunctata-unknown." B. flavopunctata (Tonsb.) Hinteregger & Printzen

II. Thallus without soredia or soredia-like granules.

Apothecia usually present.

1. Apothecia gray, gray-black, greenish gray, or olive; if pallid or red-brown, then apothecial sections C+ persistently orange. 2

1. Apothecia without grayish tinge, pallid, orange-brown, red-brown, dark brown, rarely in parts nearly black; apothecial sections never C+ persistently orange.

2. Spores 3-septate. (see Mycobilimbia and Lecania naegelii)

2. Spores mostly 0- to 1-septate (rarely a few 2-3-septate). 3

3. Exciple strongly reduced, of tangled, gelatinised hyphae, which entwine algae in the lower part; spores mostly 1-septate.. (Lecania cyrtella)

3. Exciple well developed, of parallel, strongly gelatinised hyphae, clearly delimited against thallus hyphae and algal layer; spores simple, rarely 1-septate. Apothecia and thallus in sections C-. Apothecia in sections with turquoise or olive-brown, N+ violet pigment; containing argopsin. B. ocelliformis (syn. Lecidea atroviridis)

4. On mosses, soil or (rarely) rotten wood. 5

4. On bark. 10

5. Thallus of minute, densely crowded squamules, fresh collections mostly vivid to dark green, old herbarium specimens mostly brownish. Thallus P- (no substances, or traces of gyrophoric acid due to contaminations). Spores (10-)12-19 x 3.5-5 um. On mossy tree trunks (especially oak), rarely on sheltered mossy rocks, in old woodlands. (uncommon form of?) B. vernalis (L.) Fr.

5. Thallus not of minute squamules, granular verrucose, warted or \pm rugose. On mosses or soil. 6

6. Spores at least partly 3-septate. (Mycobilimbia)

6. Spores simple or 1-septate. 7

7. Thallus P+ red, with argopsin. Thallus white or light gray (old herbarium specimens mostly light brown) warted to bullate, in parts subsquamulose, firm, with thick epinecral layer. On soil and detritus in arctic and subarctic regions. B. cuprea (Sommerf.) Fr.

7. Thallus P-. Thallus color and structure otherwise. On mosses and detritus. 8

8. Paraphyses (at least a few) apically strongly thickened (3-7 um); exciple of few diverging hyphae with nearly isodiametric cell lumina of up to 4 um. "Lecidea" meiocarpa Nyl. (not a Biatora according to Printzen)

8. Paraphyses apically not or only slightly thickened; exciple strongly developed, of hyphae with cylindrical cell lumina of up to 2.5 um. 9

9. Thallus greenish gray, relatively inconspicuous, mostly covering single moss branches; on bark often subsquamulose; exciple, hymenium and hypothecium unpigmented to

distinctly brownish yellow, without markedly contrasting pigmentation; spores 11.5-23 x 4-7 μm . On mosses in woodlands. B. vernalis

9. Thallus whitish gray, forming a rather firm, coherent crust; exciple colorless outside, yellowish or orange- to dark brown within or near hymenium; hymenium pale yellowish; hypothecium often (not always!) orange- to dark brown; spores 8-21 x 3-5.5 μm ; on mosses and detritus in alpine and subalpine situations. B. subduplex

10. Spores 3-septate. Apothecia 0.3-0.6 mm diam., epruinose. Exciple I_{Lugol} -; paraphyses and exciple hyphae atypically distinctly thickened. (Lecania naegelii)

10. Spores simple or 1-septate. 11

11. Exciple strongly reduced, of tangled, gelatinised hyphae, which entwine algae in the lower part. (Lecania cyrtella)

11. Exciple well developed, of parallel, strongly gelatinised hyphae, clearly delimited against thallus hyphae and algal layer. Asci 8-spored. 12

12. Apothecia in sections with conspicuous yellowish brown epipsamma granules dissolving in K. Apothecia 0.3-1 mm diam. Spores 10.5-18.5 x 3.5-5.5 μm . Exciple of tangled hyphae with narrow lumina. Asci Lecanora-type. (Lecanora symmicta agg.)

12. Apothecia without epipsamma, sometimes hymenium apically slightly darker than in the lower part. [spores . 3 μm wide]. 13

13. Apothecia in hand sections C+ fleetingly rose-red, reaction often inconspicuous; containing gyrophoric acid. Gelatinous sheaths of paraphyses and exciple hyphae surrounded by yellowish lines or minute irregular granules when viewed from above (oil immersion!). Mainly on Picea or Sorbus. B. helvola

13. Apothecia and thallus C-; without gyrophoric acid. Thallus P-. 14

14. Lumina of the excipular hyphae \pm cylindrical, up to 2.5 μm wide; paraphyses apically not or only slightly thickened. B. subduplex

14. Lumina of the excipular hyphae \pm isodiametric, to 4 μm ; paraphyses apically strongly (-7 μm) thickened (at least a few). "Lecidea" meiocarpa

Detailed descriptions:

B. chrysantha (Zahlbr.) Printzen

Thallus crustose to subsquamulose, granular-warty, non-sorediate parts endo- to episubstratal, forming a thin, wrinkled crust, indeterminate, forming rosettes or irregular patches to 15 cm or occasionally several dm diam., rarely areolate, areoles grayish green to dark green, discrete to contiguous, 0.1-0.25 mm diam., convex, often constricted at base, often with crenate edges, sometimes subsquamiform, bursting apically to form soredia; prothallus indistinct or absent; Soralia yellowish green to bright green (in shade), becoming straw colored in herbarium, irregular, rarely and only when young round, 0.25-0.7 mm diam., later with irregular outline and confluent, discrete at first but in older parts of thallus soon confluent forming a thick, rimose-areolate, leprose crust, \pm flat or cauliflower-like; soredia mostly fine, 15-40 μ m diam., often in consoredia to 50-70 μ m diam., with distinct wall, of few algae and fungal hyphae with \pm isodiametric cell lumina, very easily falling off the thallus; photobiont often aggregated, to 10(-17.5) μ m diam. Thallus section to 750 μ m thick, in non-sorediate parts with an indistinct cortex and irregular algal layer. Cortex c. 10 μ m thick. Algal layer \pm completely filling the non-sorediate parts; Photobiont coccoid, 1-celled, without gelatinous cap, globose; medulla not distinctly delimited from algal layer, a layer of \pm loose fungal hyphae without algae often lacking.

Apothecia rather rare, often lacking, solitary or in groups of 2-3, 10-125 per square cm, sessile with constricted base, to partly somewhat stalked, 0.4-0.8(-1.1) mm diam., disc whitish, pale rose, or pale flesh colored or reddish brown, rarely ochre or gray-brown, matt to glazed-matt, epruinose, rarely flat or undulate, mostly moderately to strongly convex or tuberculate; margin mostly visible as a somewhat paler, more strongly glossy border, rarely somewhat prominent, then soon crowded back; excipulum hyaline to pale yellow-brown, laterally 50-95 μ m thick, basally 70-180 μ m, often not distinctly delimited from hymenium; hyphae with narrow-cylindrical, 1.5-2.5 μ m, apically 2-3 μ m wide lumina; hypothecium hyaline to pale yellow-brown, 85-300 μ m; subhymenium hyaline to pale yellow-brown, mostly somewhat darker than hymenium, in hand sections often gray from air bubbles; hymenium hyaline to pale yellow-brown, (40-)50-55 μ m; epihymenium not differentiated; paraphyses simple to sparingly branched, or furcate towards tips, conglutinate in water, with (1-)1.5-2 μ m, apically 2-3 μ m wide lumina, rarely apically with 5-6 μ m wide gelatinous sheath, mostly embedded in homogeneous hymenial gelatin. Asci Biatora type, 35-39 x 6-8 μ m, mostly sparse. Spores mostly only sparsely present, (10-)11.9-15.6(-19.5) x (3-)3.8.5-9(-7.5) μ m, broadly ellipsoid (to oblong-ellipsoid), simple, rarely 1-septate.

Soralia C+ pale and fleeting rose, K-, KC+ rose, P- (gyrophoric acid, with trace of lecanoric, \pm atranorin [contaminant?])

Usually on mosses over acidic bark of mature trunks of deciduous trees in the lowlands, or on subalpine Betula or Juniperus, mainly in continental sites, rarely on mossy rock. Minnesota, Michigan, Ontario.

B. cuprea (Sommerf.) Fr.

Thallus white or light gray (old herbarium specimens mostly ochre or light brown), matt, coarsely warted to areolate or bullate, in parts subsquamulose, forming a very firm crust over soil, to c. 10 cm diam.; areoles (0.1-)0.25-0.95 mm diam., convex, smooth, the larger ones marginally crenate, irregularly sprouting, the edges \pm lifted off the substrate, often overgrowing adjacent areoles; thallus sections 250-500 μ m thick; cortex 30-90 μ m, weakly delimited, with

thick epinecral layer; algal layer 90-200 μm , through mutual overlapping areoles often appearing several-layered, in part entirely filling the areoles between the cortex and medulla, in part interrupted by anticlinal, narrow hyphal bundles, with \pm isodiametric, 2-3.5 μm wide cell lumina; medulla weakly delimited above and below, herefore the height difficult to measure, of strongly gelatinized hyphae with \pm isodiametric, 2-2.5 μm wide lumina and partly with narrowly cylindrical, c. 1 μm wide lumina

Apothecia mostly several crowded together, rarely solitary, 60-145 per square cm, often also wide areas of the thallus \pm free of apothecia, when young mostly appressed, when old sessile with weakly constricted base, (0.3-)0.35-0.7(-1.3) mm diam., disc moderately to strongly convex to globose, often tuberculate and to 1.5 mm diam., red-brown or brownish black, rarely pale brown, matt to glazed-matt, epruinose; margin mostly absent from the start, rarely visible as a somewhat paler, non-prominent border; true exciple hyaline inside, rarely yellowish to pale brown or brown, outside mostly dark red-brown to black, K-, basally mostly darker than near the hymenium, especially intense where the excipulum meets the thallus or adjacent apothecia, laterally to 50-120 μm , basally to 90-240 μm wide, but mostly entirely excluded; excipular hyphae with narrowly cylindrical, (1-)1.5-2.5 μm , apically (1-)1.5-3 μm wide lumina; hypothecium hyaline to yellow-brown, partly with darker brown flecks, rarely in thick sections \pm completely brown, 120-360 μm , partly conical and extending into the thallus; subhymenium yellow-brown, rarely and then often spottily brown, in thin sections \pm hyaline, 50-100(-170) μm ; hymenium hyaline to yellow-brown, often streaked orange-brown to red-brown, 55-75 μm ; epihymenium not differentiated, or partly forming a 5-12 μm high, hyaline to yellow-brown gelatinous layer above the paraphyses tips; paraphyses basally mostly intergrading with the subhymenium, with 1-2.5 μm , apically 1.5-3 μm wide lumina, embedded in a homogenous hymenial gelatin. Asci 45-65 x 8.5-13 μm , mostly relatively sparse. Spores (10-)13-17.5(-20) x (3.5-)4.5-5.2(-6) μm , 0-(1-3)-septate, oblong ellipsoid to fusiform ellipsoid.

Pycnidia extremely inconspicuous, not visible from above, deeply immersed between areoles, unpigmented, \pm ovoid, c. 60 μm diam.; pycnosporos bacilliform, shorter ones even narrowly fusiform, 4.0-6.5 x 0.8 μm .

Thallus P+ red, with argopsin. K-, C-, KC-.

On soil and detritus in arctic and subarctic regions. Alaska.

B. efflorescens (Hedl.) Rasanen

Thallus indeterminate, usually forming rounded to irregular patches to a few cm diam., rarely to 10 cm or more, thin to thick, rimose to rimose-areolate; non-sorediate parts epi- to endo-phloeodal. Prothallus rarely distinct, whitish. Areoles mostly marginal on the thallus, discrete or contiguous, white-gray to dark gray or grayish green, to 0.2 mm diam., flat or slightly convex, very irregularly and often incompletely delimited, rounded, entire to \pm incised, adnate, to \pm subsquamiform along a marginal zone. Soralia yellowish white, pale yellow, bright yellow-green, or bright green (in old herbarium specimens gray-white or ochre), paler than thallus, at first punctiform, flat, \pm uniformly distributed over the thallus, P+ immediately rust-red, bursting from apices or margins of areoles, or originating beneath substrate, diffuse, often efflorescent, variable in size, to 0.2-0.5(-0.7) mm diam., \pm circular or irregular, often only slightly raised, usually plane, discrete or later becoming confluent into a leprose crust which may become thick and crack into angular, variably sized portions. Soredia fine, 15-30(-40) μm diam., mostly in consoredia c. 50 μm diam., of few algae and hyphae with \pm isodiametrical cell lumina; wall distinct. Thallus sections 55-120(-240) μm thick. Cortex 10-35 μm , partly including the outer

bark layer. Algal layer \pm filling the rest of the thallus throughout. Photobiont often aggregated, to 7.5(-10) μ m diam. Medulla indistinct.

Apothecia infrequent (not yet known in N. American material), biatorine, mostly solitary, rarely several crowded, 15-100 per square cm, often wide areas of thallus free from apothecia, sessile with constricted base, often becoming immersed between soralia, 0.3-0.6(-0.95) mm diam., when tuberculate to 1.15 mm, orange brown to red brown or pale reddish brown, sometimes ochre to dirty brown, matt to matt-glossy, epruinose, plane to strongly convex, partly tuberculate; margin mostly slightly paler than disc, scarcely prominent, soon disappearing, rarely persistent, partly absent from the start. Excipulum hyaline, in thick sections also pale honey-yellow, inside and near the hymenium then often somewhat darker than outside, laterally 35-80(-110) μ m, basally 35-120(-145) μ m wide; hyphae with \pm narrowly cylindrical, (1-)1.5-2.5 μ m, apically 1.5-3 μ m wide lumina. Hypothecium hyaline, rarely pale yellow-brown, 20-120 μ m. Subhymenium hyaline to yellow-brown, in hand sections \pm gray from air bubbles, (25-)50-70 μ m; hymenium hyaline to pale honey yellow, (30-)40-50(-60) μ m; paraphyses often "angedeutet" monilliform, with 1-2 μ m, apically (1-)1.5-2.5 μ m wide lumina, embedded in homogenous hymenial layer. Asci 36-43 x 8-10 μ m. Spores narrowly ellipsoid, simple, rarely 1-septate, (9-)12.2-18.5(-22.5) x (3-)3.4-4.3(-5) μ m, often deformed or absent.

Pycnidia very rare or inconspicuous, immersed between soralia, ostiole orange brown. Pycnosporobacilliform, partly slightly bent, 6-8 x 0.7-1 μ m.

Thallus K-, C-, KC-, UV-, without atranorin, non-sorediate parts P-, soralia P+ brick red, with argopsin (major) and \pm norargopsin.

On Alnus, Populus and Salix, near sea level on the Pacific coast. Alaska.

B. flavopunctata (Tonsb.) Hinteregger & Printzen (syn. Lecanora flavopunctata)

Thallus mostly delimited, usually forming small rounded patches up to 1.5(-2.5) cm diam., confluent thalli to c. 10 cm long; typically rimose-areolate or verrucose "verunebnet" and rimose, partly verrucose-areolate, occasionally partly \pm continuous; non-sorediate parts rarely endophloeodal. Prothallus usually indistinct, whitish. Areoles mostly distinct, endo- to epi-substratal, whitish to greenish gray, grayish green, pale gray, dirty green-gray, often with yellow or ochre taint, sometimes pale yellow or yellowish gray, matt, discrete or becoming contiguous or rarely fused, sparse to numerous, \pm rounded to elongate, flat to convex, to 0.2-0.55 mm across, irregularly delimited; continuous parts weakly tuberculate, cracked. Soralia central or marginal on areoles or tubercles, gray-white, yellowish white, pale yellow to greenish yellow, at first delimited, \pm punctiform, discrete and round, flat to convex, (0.1-)0.2-0.35(-0.5) mm diam., later often somewhat diffuse but rarely coalescing, mostly flat, especially amongst endophloeodal thalli also convex, sometimes breaking through thallus cracks; soredia fine, 10-20(-25) μ m diam., very rarely in consoredia to 30-55 μ m diam., of few algae and hyphae with \pm isodiametric cell lumina; wall distinct. Thallus sections 25-60(-100) μ m high. Cortex 5-15 μ m, partly absent, partly enclosing outer bark layers. Algal layer filling the rest of the thallus in a \pm uniform layer, with yellow-brown granules. Photobiont 9-12(-18) μ m diam.

Apothecia often absent, sometimes present, solitary, rarely 2-4 grouped, very scattered, only in places 110-250 per square cm, sessile with not or only weakly constricted base, beige to pale ochre, pale brown to flesh colored, rarely orange-brown sometimes yellow tinged, matt, when wet sometimes appearing weakly whitish-pruinose, slightly convex, to 0.2-0.3(-0.7) mm diam. margin absent from the start, very rarely forming a dark, soon excluded border; excipulum in thin section hyaline, in hand sections hyaline to pale yellow-brown, outside partly with weaker

than the epihymenium granular deposits, laterally 25-35(-50) μm , basally 10-35(-50) μm wide; hyphae with narrowly cylindrical, rarely broadly ellipsoid, 1-2 μm , apically 1.5-2.5 μm wide luminae; hypothecium hyaline to yellow-brown, with \pm hyaline to pale yellow-brown crystals (not entirely soluble in K), which partly streak to the basal part of the hymenium, 0-50 μm thick, often weakly delimited from subhymenium; subhymenium hyaline to pale yellow-brown, 25-50 μm ; hymenium hyaline, rarely pale yellow-brown, 30-40 μm , epihymenium ochre, yellow-brown, granular, 3-10 μm high; paraphyses with 1-1.5 μm , apically 1.5-2.5 μm wide lumina, embedded in homogeneous hymenial gelatin; asci 22-31 x 7-8.5 μm ; spores simple to rarely 1-septate, mostly narrowly ellipsoid, sometimes oblong or somewhat curved, (7.5-)9.3-10.8(-13.5) x (2.5-)2.8-3.3(-4) μm , mostly only sparsely present.

Pycnidia rare or very inconspicuous, immersed, unpigmented, \pm globose, 30-55 μm . Pycnosores bacilliform, 5-7.5 x 0.7-1 μm .

Thallus and hypothecium C-, K+ yellowish, P-. Containing usnic acid, isousnic acid, and atranorin, plus accessory stictic and cryptostictic acids, an unidentified terpenoid, and other substances in trace amounts, without zeorin.

On bark (Alnus, Amelanchier, Oplopanax, Pachystima, Salix, Vaccinium), Pacific coast, 300-1390 m., Alaska to Washington.

B. helvola (Körber) Hellbom

Thallus thin, wrinkled, of mostly densely crowded verrucae, or rimose with \pm even upper surface, rarely partly endophloedal, to 2-8 cm diam., coalescing into larger colonies; verrucae whitish gray to dirty gray, often with greenish tinge, the color scarcely distinct from that of the substrate, in old herbarium specimens beige or brownish gray, matt, rarely matt-glossy, 0.1-0.3 mm diam., with irregular outline, weakly convex. Thallus sections 40-90(-120) μm thick. Cortex 5-15(-25) μm thick, in places absent. Algal layer \pm completely filling the thallus

Apothecia solitary or 2-4 grouped, 65-240 per square cm, sessile with weakly constricted base, 0.3-0.5(-0.8) mm wide, when tuberculate to 1.1 mm; orange brown, rarely red-brown or ivory colored to ochre and without reddish or orange tone, matt to matt-glossy, epruinose, plane to moderately or rarely strongly convex, to tuberculate, immarginate from the first, or rarely margin visible, somewhat paler or shinier than disc, scarcely prominent and soon excluded. Excipulum in thin section hyaline, in thick section honey-yellow, rarely entirely or externally hyaline, laterally 30-70(-85) μm , basally 30-56(-120) μm wide; with numerous hyphae with narrowly cylindrical, 1-1.5 μm , apically 1.5-2 μm wide luminae, with well visible gelatin layer 4-9 μm thick, interspersed with gyrophoric acid crystals. Hypothecium hyaline to honey yellow, 25-100 μm high; subhymenium in thin section hyaline, in thick section pale yellowish to honey yellow, 20-50(-65) μm high; hymenium in thin section hyaline, in thick section pale yellow to honey yellow, often streaked with yellow-brown gyrophoric acid crystals, 40-55(-60) μm high. Epihymenium hyaline to pale yellowish. Paraphyses coherent in K, lumina 1-1.5(-2) μm , apically (1-)1.5-2.5(-3) μm wide, gelatinous sheaths mostly bordered by gyrophoric acid crystals, but almost not distinctly delimited, 2.5-3.5 μm , apically 4.5-6.5(-10) μm wide; asci 31-46 x 7-12 μm . Spores (8.5-)10.2-14.2(-17.5) x (3-)3.4-4.5(-5) μm , oblong-ellipsoid, simple, rarely 1-septate.

Pycnidia very rare or inconspicuous, immersed, unpigmented, c. 40 μm diam.; pycnosores straight, short, 6.5-8 x 0.7-1 μm .

Thallus and apothecial sections K-, P-, C+ fleeting rose-red, with gyrophoric acid and \pm traces of lecanoric acid

On bark of conifers (especially spruce) and hardwoods.

B. ocelliformis (Nyl.) Arnold

Thallus to 3.5 cm across, rimose to rimose-areolate, partly endophylodal or very thin and weakly wrinkled; areoles 0.15-0.4 mm diam., very irregular in outline, plane, surface matt, pale gray to dirty greenish gray, in herbarium beige to ochre; hypothallus dark gray, mostly absent, sometimes visible as a narrow line at thallus periphery; thallus in section 25-70(-110) μ m thick; cortex 5-30(-45) μ m thick, sometimes entirely absent; algal layer \pm filling the thallus, with argopsin granules.

Apothecia single, rarely 2-5 grouped, 70-200(-350) per cm^2 , when young plane and appressed or sessile with scarcely narrowed base, 0.25-0.45(-0.85) mm, to 1.15 mm when tuberculate; disc dark gray to black, at least when wet with turquoise tone, rarely olive, matt to somewhat shiny, epruinose, flat to moderately or rarely strongly convex or tuberculate; margin white-gray to gray, in old specimens beige to orange-brown, sometimes olive, not or rarely very weakly raised, mostly only forming a paler zone, in flat apothecia \pm persistent, in convex apothecia crowded back or excluded; excipulum hyaline, inside or near the hymenium often turquoise to olive, laterally 30-85 μ m, basally 20-70(-120) μ m thick; hyphae with narrowly cylindrical, rarely broadly ellipsoid lumina 1-2(-2.5) μ m wide, apical ones (1-)1.5-2.5(-3) μ m wide; apical cells somewhat free, with 4-10 μ m wide gelatinous sheath; hypothecium hyaline, rarely flecked with turquoise or near hymenium turquoise or dirty olive, 10-60(-250) μ m high; subhymenium pale to intense turquoise or olive, sometimes spotty, 25-60(-90) μ m high; epihymenium not distinguishable from hymenium, very rarely apical parts of hymenium somewhat darker; hymenium pale to bright turquoise or olive, apically usually paler than basally, sometimes spotty, 30-40(-55) μ m high; paraphyses with lumina (0.5-)1-1.5 μ m wide, apically 1-2 μ m wide; asci 26-38 x 7.5-11.5 μ m; spores narrowly ellipsoid, simple, rarely 1-septate, (7.5-)9.7-14.2(-20) x (2.5-)2.8-4.2(-4.5) μ m.

Pycnidia very rare, or inconspicuous, immersed, unpigmented, \pm pyriform, c. 50 μ m diam.; pycnospores 9.5-13 x 0.7-1 μ m.

Thallus C-, K-, P+ red; outer part of excipulum rarely also spottily P+ red; hymenium and subhymenium N+ violet. With argopsin.

On bark.

B. subduplex (Nyl.) Printzen

Thallus smooth, rimose or warty areolate, in places also subsquamulose, to c. 5 cm diam., on mosses forming a relatively firm but often thin membranaceous or subgranular crust. Areoles mostly white to pale gray or beige to pale ochre, in very wet sites also dirty green or brown, matt, 0.15-0.55 mm across, the upper surface mostly irregularly uneven, marginally crenate, partly with edges lifted from the substrate; thallus sections 40-250(-350) μ m thick. Cortex 10-15(-95) μ m. Algal layer 25-100(-150) μ m, completely filling the thallus between cortex and medulla, or partly interrupted by anticlinal, narrow hyphal bundles, hyphae with \pm isodiametrical, 1-3.5 μ m wide lumina. Medulla 20-135 μ m, weakly delimited above and below, partly lacking, of relatively loose hyphae with narrowly cylindrical, c. 1 μ m wide lumina. Hypothallus brown-gray, very rare between the areoles.

Apothecia mostly numerous and crowded, rarely solitary, 50-300 per square cm, sessile with distinctly, rarely weakly, constricted base, 0.2-0.7(-0.95) mm (rarely to 1.4 mm) diam., damaged apothecia often hyaline; discs orange-brown to dark red-brown, rarely dull brown, matt

to matt-glossy, epruinose, plane to strongly convex, sometimes tuberculate; margin mostly paler, rarely also darker than the disc, especially in moist apothecia often the outer part pale and the part next to the disc dark brown (two-colored rim), scarcely prominent, mostly crowded back when old, often absent from the start; excipulum externally hyaline, internally or near the hymenium yellow-brown to mahogany brown, rarely entirely hyaline, laterally 25-80(-100) μm , basally 35-165 μm wide; hyphae with \pm broadly cylindrical, 1-2.5 μm , apically 1.5-3 μm wide lumina; hypothecium yellow-brown to mahogany brown, partly brown spotted, rarely hyaline, 35-200(-300) μm ; subhymenium hyaline or yellow-brown to reddish brown, 20-80(-95) μm ; hymenium in thick section hyaline, in hand sections mostly pale yellow- or orange-brown, (35-)40-55(-60) μm ; paraphyses with 1-1.5 μm , apically 1.5-3(-4) μm wide lumina, mostly embedded in homogenous hymenial gelatin, rarely isolated gelatinous caps (2.5-)4-6.5 μm wide visible; asci 30-45 x 6-10 μm ; spores narrowly ellipsoid, simple, rarely 1-septate, (8-)9.7-15.2(-21) x (3-)3.5-5.0(-6) μm .

Pycnidia rares; pycnosporos 5-9 x 0.8-1 μm .

Thallus and apothecia C-, K-, P-, with no substances or an unknown substance (3-4A, 3BC, colorless, UV- before and after charring) (contaminant?)

On rotting branches and other vegetable matter. Alaska, Northwest Territories..

B. vacciniicola (Tonsb.) Printzen

Thallus crustose, endosubstratal in non-sorediate parts, very rarely of scattered episubstratal verrucae, indeterminate, at first often as small, rounded patches to ca. 1 cm diam., later becoming irregular and often confluent, forming patches to more than 10 cm long; endosubstratal parts staining the bark greenish gray; prothallus indistinct or absent. Areoles, if present, inconspicuous, often \pm covered by flakes of substrate, grayish to greenish, mostly discrete, \pm rounded, weakly convex to hemispherical, 0.1-0.15 mm diam. Soralia yellowish white to yellowish gray, pale green or pale yellowish green, protruding through substrate or bursting from areoles, sometimes delimited when young, punctiform, often irregular, mostly \pm flat and discrete, 0.1-0.35 mm diam., soon becoming confluent and diffuse, forming a relatively loose, often rimose crust. Soredia fine, (12-)15-25(-30) μm diam., of few algae and hyphae with \pm isodiametrical cell lumina, densely filled with granules. Thallus sections in endophloedal parts 30-60 μm , in epiphloedal parts 30-70 (sorediate parts -250) μm thick. Cortex consisting of outer bark layer or absent or weakly delimited and 5-10 μm thick. Algal layer \pm completely filling the thallus. Photobiont 2-4 celled, to 20 μm diam., with a common external gelatinous cap, globose to \pm cubic.

Apothecia usually absent, sometimes present, inconspicuous, solitary, very scattered, only in places 30-120 per square cm., sessile with not or only weakly constricted base, beige to ochre, grayish to pale brown, matt, epruinose, weakly convex, sometimes irregularly uneven, 0.15-0.2.5(-0.4.5) mm diam.; margin absent from the start, very rarely forming a somewhat paler border; excipulum hyaline, towards the outside with a deposit of yellow-brown granules, laterally 25-40(-50) μm , basally 10-65 μm wide, in very flat apothecia often only a narrow zone without asci next to the hymenium, hyphae with \pm cylindrical, 1-2 μm , apically 1.5-2.5 μm wide, lumina, mostly with well visible gelatinous layer 3.5-5 μm , apically 5-7 μm wide, interspersed with gyrophoric acid crystals, hypothecium hyaline, often with yellow-brown granules, 25-60 μm , often indistinctly delimited from subhymenium; subhymenium hyaline, with yellow-brown granules, 20-25 μm high; epihymenium yellow-brown, granular, mostly extending deep into hymenium, rarely relatively well delimited and 5-10 μm thick; hymenium hyaline, with yellow-

brown granules along the gelatinous sheaths of the paraphyses, 30-40 µm thick; paraphyses conglutinate, simple to sparingly branched, 1.0-2.5 µm wide with lumina 1-2 µm, apically 1.5-2.5 µm wide, mostly with distinctly visible, 2.5-5 µm, apically 4-8 µm wide gelatinous sheaths; asci 25-30 x 7-8 µm; spores simple or rarely 1-septate, narrowly ellipsoid, (7.5-)9.9-10.5(-14) x 92.5-)2.8-3.3(-4) µm, mostly only sparsely present or entirely absent.

Soralia and apothecial sections C+ rose-red, K-, P-, (gyrophoric acid, occasionally with trace of lecanoric).

On bark of Alnus, Pachystima myrsinites, Salix, and Vaccinium, 300-1390 m, Washington to Alaska.

B. vernalis (L.) Fr.

Thallus in fresh collections mostly vivid to dark green or grayish green (to greenish white according to British book), old herbarium specimens mostly gray to brownish gray; matt (according to Printzen; often with a varnish-like sheen according to the British book), rarely forming a ± smooth and membranous coating on mosses, usually granular-verrucose or with coherent or discrete (but never loose) granules 80-150 µm diam., or very irregularly uneven; areoles 0.1-0.25 mm diam., ± globose, rarely growing into lacerated to coralloid squamules and to 0.35 mm, on bark often ± scattered and weakly convex, rarely imbricated and forming several layers. Thallus sections 100-300(-600) µm thick. Cortex 5-30 µm thick, ± sharply delimited or absent. Algal layer completely filling the areoles or algae in 40-120 µm across groups. Medulla weakly delimited above and below, the height difficult to measure, of loose hyphae with narrowly cylindrical, c. 1 µm wide lumina.

Apothecia solitary to many and crowded, (25-)100-200(-280) per square cm, sessile with distinctly or rarely weakly constricted base, 0.35-0.6(1.2) mm diam. (rarely to 1.45 mm), at first top-shaped, later convex-adpressed to subglobose, pale to testaceous, orange-brown to red-brown, sometimes without reddish tone and ochre to dull brown, matt to matt-glossy, epruinose, weakly to strongly convex, rarely ± plane, margin paer and mostly somewhat more strongly shiny than disc, not or scarcely prominent and soon excluded, rarely persistent or absent from the beginning; apothecia without distinct pigmentation in section, except for a pale straw (K+ yellowish) hypothecium. Excipulum hyaline, in thic sections, especially inside and near hymenium, sometimes yellow-brown to orange brown, laterally 50-100(-150) µm, basally 60-300 µm wide; hyphae with narrowly cylindrical, 1-2(-3) µm, apically 1.5-3(-4.5) µm wide lumina. Hypothecium hyaline, in thick section partly pale yellow, 95-300 µm; subhymenium in thin section hyaline, in thick section yellow-brown to orange-brown, often grayish from air bubbles, 40-70(-120) µm; hymenium hyaline to pale yellow-brown, rarely orange-brown, pigmentation then often irregular, in long streaks or basally or apically stronger, (45-)50-65(-95) µm; paraphyses with (0.5-)1-2 µm, apically 1-3(-4) µm wide lumina, embedded in homogenous hymenial gelatin. Asci 35-53 x 6.5-11 µm. Spores (10-)12.6-19.4(-25.5) x (3.5-)4.3-5.8(-7) µm, narrowly ellipsoid, simple, rarely 1- or 3-septate.

Thallus and apothecia P- (no substances, or traces of atranorin or gyrophoric acid, probably due to contaminations). K-, C-, KC-.

On mossy tree trunks (especially oak), rarely on sheltered mossy rocks, in old woodlands. Minnesota, Michigan, New England, Ontario, Newfoundland; Labrador (?)

Excluded Species

Spores 2-3 um wide. Spores simple; pycnidia unpigmented, semi-immersed, with conspicuous white "cap" of protruding pycnospores; pycnospores 25-50 x 1.5-2 um. "Lecidea." albohyalina

Thallus K-, C-, KC-, P-, without lichen substances. Spores 0-3(-5)-septate. Thallus pale, gray green or gray, immersed or thinly granular-verrucose, with irregular, often confluent; soredia 20-60 um diam. Apothecia 0.4-1.2 mm diam., sessile and \pm turbinate, later hemispherical to subglobose, gray brown to red-brown; upper hymenium and upper true exciple pale brown; hypothecium hyaline; subhymenium hyaline to red-brown. Spores 17-25(-30) x 4.5-7 um, fusiform. Thallus P-, K- (no substances). Over bryophytes or on bark of mossy trunks of old deciduous trees in ancient woodlands, rarely on mossy rocks in wooded ravines. "B." epixanthoides (Nyl.) Diedrich (belongs in Mycobilimbia according to Printzen)

"Bacidia"/"Catillaria" sphaeroides

Spores (0-)1(-3)-septate. Thallus gray-green, finely to mealy granular; granules 25-70 um diam. Apothecia 0.4-0.8(-1.1) mm diam., at first hemispherical, later becoming \pm globose, pale to dull orange-pink, or sometimes (especially when old) pale reddish brown, in section without pigmentation. Spores (9.5-)11-17 x 3.5-5 um, fusiform-ellipsoid. On sheltered, mature deciduous tree trunks (especially Fraxinus and Quercus), often around their bases, in old woodlands, more rarely on mossy rocks in wooded ravines or sheltered gullies.

Belongs in Mycobilimbia according to Printzen

"Lecidea". albohyalina

Thallus thin, composed of minute white verrucules, or obsolete; soredia absent; hypothallus indistinct.

Apothecia 0.2-0.3 mm diam., dense to rarely partly subdispersed, simple or a few subconfluent, often strongly constricted at base; disk depressed-convex or becoming strongly convex, pale yellowish or pinkish (rarely dark gray), \pm matt, often thinly subpruinose; margin subconcolorous, thin, often scarcely prominent, becoming excluded. Exciple well developed, ca. 40 um thick, hyaline, I-; hyphae \pm radiating, rather thick-walled (walls turgid in K), conglomerate, sparingly branched and anastomosing (seen in K or sulfuric acid); cells oblong to ellipsoid and rounded. Hypothecium hyaline or pale, I- (to blue in "f. prosequens Vainio"); hyphae irregularly interwoven, conglomerate, rather thin-walled in upper part, thick-walled below; cells subglobose or ellipsoid; lumina 2(-3) um wide. Hymenium 40-50 um, hyaline, without granules, I+ persistently blue. Paraphyses simple, rather strongly coherent but not distinctly gelatinous, the apices partly clavate but scarcely swollen. Spores 8 per ascus, simple to partly 1-septate, oblong, 9-13 x 2-2.5(-3) um.

Pycnospores \pm curved, 12-14 x 1 um. Algae protococcoid, ca. 5 um diam. Thallus K-, C-. On bark, especially Salix or Sorbus. Michigan.

(belongs in a new genus along with L. meiocarpa, according to Printzen)

"Lecidea". meiocarpa

Thallus crustose, effuse, of small, thin, scattered verrucae, or continuous, of thin convex areolae, grayish white to greenish gray, K-, C-, KC-, P-.

Apothecia abundant, sometimes several aggregated, usually brownish orange to orange-brown, or sometimes brownish yellow, yellowish brown or red-brown, often with a mixture of colors in the same specimen; biatorine, when young plane with a distinct proper margin, soon becoming convex, (0.17-)0.18-0.31-0.48(-0.63) mm diam. Proper exciple thin, later becoming suppressed, with a pale tinge of the external color of the apothecium, composed of rather few, dichotomizing and anastomosing hyphae with \pm ellipsoid or rectangular lumina (6-10 x 2-4 μ m) and heavily gelatinized walls. Hypothecium pale below, in upper part of same color as proper exciple and hymenium, or sometimes darker (to pale orange or brownish). Hymenium (33-)34-43-51(-52) μ m high; epihymenium not distinct. Paraphyses branched only in upper part, 1.6-2.4 μ m wide in mid-hymenium, with scarce gelatinous matrix (easily separated in K0, tips distinctly thickened, (2.5-)3.6-4.3-5.2(-7.4) μ m wide, with or without thin gelatinous cap. Asci 8-spored; tholus with wide and blunt ocular chamber and a conical axial body surrounded by a narrow, heavily amyloid zone; less amyloid outside this zone. Spores mostly 1-celled, some 2-celled, (8.7-)9.6-12.1-14.8(-19.2) x (2.5-)3.3-3.7-4.2(-5.0) μ m. Pycnidia ca. 100 μ m diam., pale orange-brown, immersed in thallus; conidia \pm curved, euseptate, 19-35 x 1-1.8 μ m. No substances, or 1-2 unidentified triterpenoids. On smooth bark of deciduous trees and shrubs, especially Salix or Sorbus, or sometimes on wood or detritus. Reports from Alaska and probably from California are incorrect. Often confused with B. helvola, but differs in having different hymenium height and apothecium width; paraphyses easily separated in K, the tips often wider, with gelatinous cap thin or lacking; excipulum with few hyphae and short lumina; thallus C-, without gyrophoric acid; conidia \pm curved and much longer; on hardwoods, not mainly conifers.

"Hypocenomyce" anthracophila

Apothecia rare, strongly convex, brown, immarginate, marginal or attached to the underside of the squamules; squamules ascending, geotropically oriented, normally sorediate, shiny. Mature spores narrowly ellipsoid to fusiform; paraphyses apical cells slightly thickened to capitate, with dark brown, sharply delimited pigmented area in upper part of cell; hypothecium hyaline. Underside pale brown; soralia farinose, gray. Medulla and soralia KC+ purple, UV+ bluish white, containing anthracophila unknowns 1,2,3 and 4; thallus K-, C-. Squamules (at least the cortex) P+ red (fumarprotocetraric and protocetraric acids), rarely proliferating; margins white to pale brown, usually entire, somewhat upturned; young squamules more or less concave; upper side greenish brown to medium brown, often darker towards base. Squamules to 0.8(-1.3) mm diam., later weakly to strongly convex. Apothecia to 0.8(-1.3) mm diam., simple or more rarely compound, when young sometimes plane and with indistinct margin, then convex, reddish brown. Spores simple or more rarely 1-septate, 7-9.9-13 x 1.5-2.1-2.5 μ m. Pycnidia uncommon. On wood (usually burnt) or rarely bark. Massachusetts, Michigan, Minnesota, New York, S. Dakota, Ontario, British Columbia. (Timdal describes this species as having brown squamules; a common form in California appears similar but is green.

"Lecidea" porphyrospoda

Close to L. leprosula according to Printzen

"Lecidea". pullata = L. amaurospoda (Anzi) Vainio

Soralia gray to gray-brown. Thallus effuse, rather thickly granular-sorediate, gray to gray-brown; soredia 30-80 μ m diam., at first arising from convex areoles (0.1-0.2 mm diam.) which

soon become hidden or completely dissolved; external hyphae often brown-walled. Photobiont cells 5-10 μm diam. Apothecia (0.15-)0.2-0.3(-0.4) mm diam.; disc \pm flat, arranged in dense botryose clusters, constricted below and often \pm stipitate, dark reddish brown to black; true exciple very thin, whitish then brown, pale brownish within; edge and epithecium brown or yellowish brown, K-; hymenium 30-55 μm tall, colorless to yellowish brown; hypothecium dark brown. Paraphyses 1.5-2 μm wide, the apices often with a dark brown cap, to 4 μm wide. Asci 35-45 x 9-11 μm , Biatora-type. Spores 7-12(-13) x (2.5-)3-4 μm , 0(-1)-septate. Thallus P-, K-, C-, KC-, UV+ white (perlatolic acid). On wood and exposed old bark of pines. Boreal. [Coppins treats this species under Lecidea; Printzen says it's of uncertain position]. "B. botryosa

"Lecidea" turgidula

Epihymenium hyaline to brown-black or blue-green, K- or K+ green intensifying, Spores oblong to oblong-ellipsoid, 7-13 x 3-5 μm . Asci Bacidia-type. Discs sometimes thinly white pruinose, with bluish bloom when wet. Spores sometimes 1-septate. Discs pale olive to brown or black. Thallus whitish to olivaceous, K-, P-, C-, KC-, poorly developed, membranous to minutely granular or verrucose, or absent. Apothecia 0.2-0.5(-0.6) mm diam., sessile or (on wood) partly immersed; margin often disappearing. Hypothecium hyaline to pale brownish. Hymenium 30-40(-45) μm , streaked violaceous (K+ green) or brownish to greenish (K+ intensifying). Epihymenium also with minute pale granules that dissolve in K. Exciple usually of coherent (in K) radiating hyphae, hyaline to dark greenish or brownish, I \pm pale violet. Paraphyses 1.3-2 μm wide, sparingly branched and anastomosed, the tips scarcely swollen but sometimes with a dark brownish hood to 5 μm wide. Pycnidia ca. 100 μm diam., black, \pm immersed in substratum, the wall green-brown, K+ green intensifying; conidiogenous cells catenate, subcylindrical; conidia arising laterally and terminally, 3-3.5 x 1.5-1.8 μm , bacilliform. Thallus containing placodiolic acid. On wood or less often bark, usually on conifers. Widespread.

Systematic position unclear according to Printzen

"B." carnealbida

Spores mostly 3-septate. Apothecia ivory white, without internal pigmentation. Spores (12-)13-22 x 4-7 μm . On mosses on rock. Canada. (Esslinger treats this under Bacidia; belongs in Mycobilimbia according to Printzen)

Literature

Coppins, B. J. 1992. Biatora. In: Purvis, et al., Lichen Flora of Great Britain and Ireland.

Ekman, S. 1994. Biatora meiocarpa (Nyl.) Arnold, a misunderstood species. Lichenologist 26(1): 31-37.

Printzen, C. 1995a. Some notes on the delimitation of the genus Biatora Fr. (Lecanorales, lichenized ascomycetes). Crypt. Bot. 5: 105-110.

Printzen, C. 1995b. Die Flechtengattung Biatora in Europa. Bibl. Lichenolog. 60.

Purvis, O. W. & P. J. James. Hypocenomyce. In: Purvis, et al., Lichen Flora of Great Britain and Ireland.

Timdal, E. 1984. The genus Hypocenomyce (Lecanorales, Lecideaceae) with special emphasis on the Norwegian and Swedish species. Nord. J. Bot. 4: 83-108.

Vainio, E. 19_. Lichenographia Fennoscandia.