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Two new species, a new combination and four new records of saxicolous buellioid lichens (Ascomycota, Caliciaceae) from southern South America

John A. Elix, Helmut Mayrhofer & Juan Manuel Rodriguez

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John A. Elix
Research School of Chemistry, Building 137,
Australian National University, Canberra, A.C.T. 2601, Australia
e-mail: John.Elix@anu.edu.au

Helmut Mayrhofer
University of Graz, Institute of Biology, Division of Plant Sciences, NAWI Graz, Holteigasse 6, 8010 Graz, Austria
e-mail: helmut.mayrhofer@uni-graz.at

Juan Manuel Rodriguez
Centro de Ecologia y Recursos Naturales Renovables, Facultad de Ciencias Exactas, Físicas y Naturales, Universidad Nacional de Córdoba, Av. Vélez Sarsfield 1610, Córdoba, Argentina
e-mail: juan.rodriguez@unc.edu.ar

Abstract

Amandinea puertomonttensis Elix, H.Mayrhofer & J.M.Rodr. and *Tetramelas fuegiensis* Elix, H.Mayrhofer & J.M.Rodr. are described as new to science, and the new combination *Buellia pygmaea* (Räsänen) Elix, H.Mayrhofer & J.M.Rodr. is proposed for *B. protothallina* var. *pygmaea* Räsänen. *Amandinea fuscoatratula* (Zahlbr.) Elix, *A. subplicata* (Nyl.) Øvstedal, *Buellia ocellata* (Flot.) Körb. and *B. stellulata* var. *tasmanica* Elix & Kantvilas are reported for the first time from South America.

There have been no broad-based treatments of the saxicolous representatives of *Buellia sens. lat.* in South America since that of Magnusson (1955), although incidental new records have been reported, and lists of *Buellia* species have appeared in recent checklists (Galloway & Quilhot 1998; Calvelo & Liberatore 2002). Since the publication of those checklists, the following species have been recorded from southern South America: *Amandinea nitrophila* (Zahlbr.) Elix and *A. subcervina* (Nyl.) Elix for Argentina and Chile (Calvelo & Fryday 2006; Blaha *et al.* 2016; Elix 2017), and *Buellia subalbula* (Nyl.) Müll.Arg. from Chile (Bungartz *et al.* 2011). The following three species were known previously from the region but under later synonyms: *Buellia halonia* (Ach.) Tuck. from Chile (Bungartz *et al.* 2007), *B. mamillana* (Tuck.) W.A.Weber from Argentina, Brazil, Chile and Paraguay (Bungartz *et al.* 2007) and *Tetramelas thiopolizus* (Nyl.) Giralt & Clerc from Chile and Venezuela (Giralt & Clerc 2011).

In this paper, we describe new species of *Amandinea* and *Tetramelas*, and report four new records of saxicolous buellioid lichens from southern South America.

Methods

Observations and measurements of photobiont cells, thalline and apothecial anatomy, asci, ascospores, pycnidial anatomy and conidia were made on hand-cut sections mounted in water and treated with 10% potassium hydroxide (K) and 50% nitric acid (N). Calcium oxalate was detected by treatment of thalline and apothecial sections with a 10% aqueous solution of sulfuric acid; it forms colourless, needle-shaped crystals. Asci were also observed in Lugol's Iodine (I), with and without pretreatment in K. Chemical constituents were identified by thin-layer chromatography (Elix 2014) and comparison with authentic samples.

The new species

1. Amandinea puertomonttensis Elix, H.Mayrhofer & J.M.Rodr., sp. nov. Figs 1, 2
Mycobank No. **MB 826705**

Similar to *Amandinea nitrophila* (Zahlbr.) Elix, but differs in having a pustulate-sorediate upper surface and a non-inspersed subhymenium.

Type: Chile [Llanquihue Province, Los Lagos Region], Lake District, road along coast SW of Puerto Montt to Chinquinhue, *c.* 8 km behind Puerto Montt, sea level, on rock boulders at the beach, *M. Matzer & B. Pelzmann s.n.*, 27.xi.1994 (holotype – GZU).

Thallus crustose, to *c.* 60 mm wide and 0.6 mm thick, continuous to cracked and areolate, with subeffigurate margins; individual areoles irregular, angular, 0.5–1 mm wide; upper surface pale brown to rusty brown, smooth to pustulate-sorediate in part, sorediate areas becoming pulvinate to 0.5 mm high, soredia granules 25–50 µm wide, shiny or matt; prothallus black, marginal or not apparent; medulla white, lacking calcium oxalate, (H_2SO_4–), I–; photobiont cells 10–16 µm wide. *Apothecia* 0.2–0.6 mm wide, lecideine, initially immersed, then becoming adnate or sessile, dispersed or rarely crowded; disc black, epruinose, weakly concave to plane or ultimately convex; proper exciple distinct, thick, prominent but excluded in convex apothecia, in section 50–75 µm thick, the outer zone brown-black, K–, paler brown within. *Epihymenium* 10–12 µm thick, brown to dark brown, K–, N–. *Hypothecium* 120–175 µm thick, brown to brown-black, K–, N–. *Hymenium* 70–80 µm thick, colourless, not inspersed; subhymenium 20–30 µm thick, pale brown, not inspersed with granules or oil droplets; paraphyses 1.5–1.7 µm wide, simple to sparsely branched, with apices 4–6 µm wide and brown caps. Asci of the *Bacidia*-type, 8-spored. *Ascospores* initially of the *Physconia*-type, of the *Buellia*-type when mature, 1-septate, brown, ellipsoid, 14–[*15.6*]–20 × 7–[*8.3*]–10 µm, not constricted at the septum; outer spore-wall finely ornamented (microrugulate). *Pycnidia* common, pyriform, immersed, brown to black; conidia filiform, curved, 12–27 × 0.7–1 µm.
Chemistry: Thallus K–, C–, P–, UV–; no lichen substances detected.

Etymology: This species is named for the occurrence of the type specimen near Puerto Montt, Chile.

Remarks
This species is characterized by the crustose, pale brown to rusty brown, continuous to rimose-areolate thallus with subeffigurate margins, a pustulate-sorediate upper surface, lecideine, immersed then sessile apothecia, a non-amyloid medulla, 1-septate, *Physconia*- then *Buellia*-type ascospores, 14–20 × 7–10 µm, curved, filiform conidia, 12–27 µm long, and the absence of lichen substances. *Amandinea nitrophila* from New Zealand, Kerguelen, Chile and Argentina has ascospores of similar size and ontogeny (Blaha *et al.* 2016), but the thallus of that species differs in lacking subeffigurate margins and a sorediate upper surface, and in having an inspersed subhymenium and ascospores that are often dilated at the septum. *Amandinea rangitatensis* Elix & H.Mayrhofer, from New Zealand, has a sorediate upper surface, but differs in forming irregular, crateriform soralia, in having larger apothecia (to 1 mm wide) that are initially lecanorine, then biatorine and ultimately lecideine with grey-white-pruinose discs, and well as in containing atranorin (Elix & Mayrhofer 2017).

At present, the new species is known from only the type locality. Associated species include *Amandinea subplicata* (Nyl.) Øvstedal, *Carbonea phaeostoma* (Nyl.) Hertel, *Rhizocarpon reductum* Th.Fr. and *Tetramelas anisomerus* (Nyl.) Elix.

2. Tetramelas fuegiensis Elix, H.Mayrhofer & J.M.Rodr., sp. nov. Figs 3, 4
MycoBank No. **MB 826706**

Similar to *Tetramelas nelsonii* (Darb.) Elix, but differs in having larger ascospores and in containing arthothelin.

Type: Argentina, Tierra del Fuego, Dept. Ushuaia, steep slope north of Passo Garibaldi, opposite Lago Escodido, [54°41'S, 67°52'W], 400–500 m alt., wet grass, *Nothofagus* forest with large silicate rocks, on rock, *J. Poelt s.n.*, 10.i.1989 (holotype – GZU).

Thallus crustose, discontinuous, areolate, to 90 mm wide and 0.4 mm thick; areoles irregular, angular, 0.2–1 mm wide, separate, scattered or rarely crowded and contiguous; upper surface pale yellow to yellow-green or yellow-brown, dull, verrucose-roughened, epruinose; prothallus black, marginal and between areoles; medulla white, lacking calcium oxalate, (H_2SO_4–), I+ weak purple-blue; photobiont cells 8–21 µm wide. *Apothecia* 0.4–1.1 mm wide, lecideine, separate and ± round, broadly adnate to sessile; disc black, epruinose, plane to markedly convex with age; proper exciple distinct but excluded in older, convex apothecia, in section 40–55 µm thick, outer part aeruginose-black, K−, N+ reddish purple to purple-brown, dark brown within. *Hypothecium* 200−250 µm thick, dark brown to brown-black. *Epihymenium* 12–15 µm thick, dark olive-brown to aeruginose-black, K−, N+ reddish purple to purple-brown. *Hymenium* 75–110 µm thick, colourless, ± with scattered oil droplets; subhymenium 40−60 µm thick, pale to mid-brown; paraphyses 1–2 µm wide, simple to sparsely branched, with apices 4–5 µm wide and dark aeruginose caps. *Asci* of the *Bacidia*-type, 8-spored. *Ascospores* initially of the *Callispora*- or *Physconia*-types, then of the *Buellia*-type, 1-septate, brown, ellipsoid to broadly fusiform, 17–[*22.1*]–30 × 8–[*10.8*]–15 µm, becoming constricted at the septum, often curved, rarely 2- or 3-septate; outer spore-wall finely ornamented (microrugulate). *Pycnidia* immersed, punctiform; conidia bacilliform to elongate-ellipsoid, 3.5–6.5 × 1–1.2 µm.
Chemistry: Thallus K+ yellow, C+ orange, KC+ deep orange, P–, UV+ orange; containing arthothelin (major), ± atranorin (minor), 4,5-dichloronorlichexanthone (trace).

Etymology: This species is named for the occurrence of the type specimen in Tierra del Fuego.

Remarks
Phylogenetic studies have confirmed that the genus *Tetramelas* Norman constitutes a well-founded segregate of *Buellia sens. lat.* (Helms *et al.* 2003; Nordin & Tibell 2005). Diagnostic characters include the presence of xanthones (arthothelin or 6-*O*-methylarthothelin) and commonly curved, 1–3-septate ascospores with pointed apices and *Callispora*-type thickenings in early ontogeny. *Tetramelas fuegiensis* exhibits all of those characteristics. In many respects, it resembles *T. nelsonii*, from the South Shetland Islands and continental Antarctica (Lamb 1968; Øvstedal & Lewis Smith 2001; Elix 2018). Both lichens are characterized by the presence of an aeruginose, N+ purple epihymenium and similar ascospores (which can become 2- or 3-septate), conidia and apothecial anatomy including similar reactions of the hypothecium and epihymenium. *Tetramelas nelsonii* differs from *T. fuegiensis* in containing 6-*O*-methylarthothelin (major or minor) and 4,5,dichloro-6-*O*-methylnorlichexanthone (minor or trace) and rarely accessory atranorin.

At present, the new species is known from only Tierra del Fuego. Associated species include *Acarospora* sp., *Amandinea subplicata* (Nyl.) Øvstedal, *Lecidella* sp. and *Rhizocarpon geographicum* (L.) DC.

SPECIMEN EXAMINED
Argentina: ● Tierra del Fuego, Dept. Río Grande, N-margin of the Andes, Cerro Chenen, E of Hacienda Chenen, rocky NE-facing hillside (above abandoned cabana), 200–230 m alt., on rock, *J. Poelt s.n.*, 8.i.1989 (GZU).

New combination

Buellia pygmaea (Räsänen) Elix, H.Mayrhofer & J.M.Rodr., comb. nov. Fig. 5
MycoBank number: **MB 826707**
Buellia protothallina var. *pygmaea* Räsänen, *Annales Botanici Societatis Zoologicae Botanicae Fennicae "Vanamo"* **2** (1), 31 (1932)
Type: Chile, Fuegia media, Lago Deseado, [54°23'S, 68°41'W], *H. Roivainen 704*, 5.i.1929 (H – holotype, not seen).

Thallus crustose, to 50 mm wide and 0.1 mm thick, continuous, areolate, the areoles aggregated or dispersed and delimited by a black prothallus; individual areoles irregular, angular, 0.1–0.4 mm wide; upper surface whitish or yellow-white, smooth; prothallus black, prominent, marginal and between areoles; medulla white, lacking calcium oxalate (H_2SO_4–), I+ purple-blue; photobiont cells 7–17 µm diam. *Apothecia* 0.1–0.3 mm wide, lecideine, immersed in the thallus or between the areoles, isolated or crowded, round or distorted by mutual pressure; disc black, epruinose, weakly concave then plane, initially with a necrotic thalline veil; proper exciple thin, persistent, slightly raised above disc, in section 25–40 µm thick; outer zone brown-black to greenish black, K–, N+ purple-brown; inner zone brown. *Epihymenium* 8–12 µm thick, aeruginose to greenish black, K+ blue-green, N+ purple. *Hypothecium* 100–125 µm thick, with deep red-brown to brown-black, K+ yellow then red crystals, N+ orange-brown. *Hymenium* 50–60 µm thick, colourless, not inspersed; subhymenium 15–25 µm thick, pale brown, inspersed with oil droplets; paraphyses 1.7–2 µm wide, moderately branched, capitate, with apices 3–4 µm wide; caps aeruginose. *Asci* of the *Bacidia*-type, with 8 or fewer spores. *Ascospores* 1-septate, brown, ellipsoid to subspherical, 8–[*10.5*]–12 × 5–[*7.2*]–8 µm, not constricted at the septum; outer spore-wall microrugulate to rugulate. *Pycnidia* common, pyriform, immersed, brown to black; conidia bacilliform, 4.5–6.5 × 0.7–1.2 µm.
Chemistry: Thallus K+ yellow then red, C–, PD+ orange-red, UV–; containing norstictic acid (major), connorstictic acid (minor), atranorin (trace or absent).

Remarks
This species closely resembles *B. aethalea* (Ach.) Th.Fr., which is also present in southern South America (Calvelo & Liberatore 2002). Both contain norstictic acid, have immersed to weakly adnate, lecideine apothecia with epruinose discs, aeruginose, N+ purple epihymenia, 1-septate, *Buellia*-type ascospores and bacilliform conidia. However, *B. aethalea* lacks an inspersed subhymenium and has larger ascospores 11–[*15.5*]–21 × 7–[*9.2*]–12 µm, which become constricted at the septum with age, and more elongate, bacilliform conidia, 5.5–8.5 µm long (Elix 2011).

SPECIMENS EXAMINED
Argentina: ● Tierra del Fuego, Dept. Ushuaia, Montes Martial near Ushuaia [54°46'S, 68°29'W], above Acrosilla, 700–1000 m alt., on silica rock among alpine heath, moor and stunted woodland, *J. Poelt s.n.*, 17.i.1989 (GZU) [two specimens].

New records for South America

1. Amandinea fuscoatratula (Zahlbr.) Elix, *Australas. Lichenol.* **77**, 39 (2015)
This species was previously known from New Zealand and Tasmania (Blaha *et al.* 2016). It is characterized by the crustose, rimose-areolate, pale to dark grey or grey-brown thallus, the initially immersed then broadly adnate to sessile apothecia, the non-amyloid medulla, non-inspersed subhymenium, 1-septate, *Physconia*- then *Buellia*-type ascospores, 11–16 × 5–10 µm, curved, filiform conidia, 15–25 µm long, and the absence of lichen substances. A detailed description and illustrations are given in Blaha *et al.* (2016).

SPECIMENS EXAMINED
Argentina: ● Tierra del Fuego, Dept. Ushuaia, Estancia Moat, *c.* 4 km W of Pampa de los Indios, 0–30 m alt., *Nothofagus betuloides* forest, on coastal rock, *J. Poelt s.n.*, 12.i.1989 (GZU).
Chile: ● Chiloé, E coast, Chadmo, N of Quellón, beach area of village, sea level, on coastal rocks, *M. Matzer & B. Pelzmann*, 24.xi.1994 (GZU) [two collections].

2. Amandinea subplicata (Nyl.) Øvstedal, *in* D.O. Øvstedal & R.I. Lewis-Smith, *Lichens of Antarctica and South Georgia. A guide to their identification and ecology*: 87 (2001) Figs 6, 7
Lecidea subplicata Nyl., *in* Crombie, *J. Bot. (London)* **15**, 190 (1877).
Buellia subplicata (Nyl.) Müll.Arg., *Bot. Jahrb. Syst.* **5**, 138 (1884).

Type: Îles Kerguelen, Swain's Bay, on coastal rock, *A.E. Eaton* [Venus Transit Expedition] (BM 000671130! – lectotype here designated, selected from three syntypes present in BM with identical locality information).

Thallus crustose, forming patches to *c.* 30 mm wide, endolithic and not apparent, or epilithic, discontinuous, thin, membranaceous to rimose-areolate, white or pale grey; prothallus black, marginal or absent; medulla white, lacking calcium oxalate (H_2SO_4–), I–; photobiont cells 7–17 µm wide. *Apothecia* 0.3–0.7 mm wide, lecideine, broadly adnate to sessile, scattered or crowded, rounded or distorted through mutual pressure; disc black, epruinose, weakly concave to gyrose-distorted; proper exciple distinct, thin, persistent, raised above the disc, in section 40–360 µm thick, with the outer zone dark brown to black-brown, K–, brown within. *Epihymenium* 12–15 µm thick, dark brown, K–, N–. *Hypothecium* 170–250 µm thick, dark brown to black-brown, K–, N–. *Hymenium* 60–90 µm thick, colourless, not inspersed with oil droplets; subhymenium 15–20 µm thick, pale brown, not inspersed with granules or oil droplets; paraphyses 1.2–2 µm wide, simple to moderately branched; apices 4–6 µm wide and with dark brown caps. *Asci* of the *Bacidia*-type, 8-spored. *Ascospores* of the *Physconia*- then *Buellia*-type, 1-septate, brown, ellipsoid, 13–[*16.1*]–20 × 7–[*8.7*]–10 µm, sometimes curved, older spores rarely constricted at septum; outer spore wall microrugulate to rugulate. *Pycnidia* immersed, black; conidia filiform, curved, 15–22 × 0.7–1 µm.
Chemistry: Thallus K–, P–, C–, UV–; no lichen substances detected by TLC.

This species was previously known from the Kerguelen Islands, Prince Edward Island, Marion Island and South Georgia (Øvstedal & Lewis Smith 2001). It is characterized by an endolithic or inconspicuous, off-white to pale grey, crustose thallus lacking lichen substances, a non-amyloid medulla that lacks calcium oxalate, adnate to sessile, lecideine apothecia, 0.3–0.7 mm wide, often with gyrose-distorted discs, a brown, N– epihymenium, broad, ellipsoid *Physconia*-then *Buellia*-type ascospores, 13–20 × 7–10 µm, which are rarely constricted at the septum, having a rugulate to microrugulate outer wall, and curved, filiform conidia, 15–22 µm long.

SPECIMENS EXAMINED
Australia: *Macquarie Island*: ● Gadgets Gully, *c.* 2.4 km S of ANARE Station, 54°30'S, 158°55'E, 60 m alt., on rock with E aspect, *R.B. Filson 6358C & P. Atkinson*, 18.iii.1964 (MEL).
Chile: ● [Llanquihue Province, Los Lagos Region], Lake District, road along coast SW of Puerto Montt to Chinquinhue, *c.* 8 km behind Puerto Montt, sea level, on rock boulders at the beach, *M. Matzer & B. Pelzmann s.n.*, 27.xi.1994 (GZU) [2 specimens].

3. Buellia ocellata (Flot.) Körb., *Syst. Lich. Germ.* 224 (1855)
This species is known from Europe, North America, Macaronesia, Asia and Africa (Coppins *et al.* 2009), south-eastern Australia (McCarthy 2018) and New Zealand (Elix *et al.* 2015). It is characterized by an areolate to subsquamulose, yellowish to grey thallus, the areoles typically aggregated into small patches 1–2 cm wide, the presence of arthothelin (C+ orange), immersed apothecia occurring singly in each areole, an aeruginose, N+ red-violet epihymenium, a greenish lower hymenium, *Buellia*-type ascospores, 12–22 × 6.5–12 µm, and bacilliform conidia, 4–6 × 0.8–1 µm. A detailed description is given in Coppins *et al.* (2009).

SPECIMENS EXAMINED
Argentina: ● Tierra del Fuego, Dept. Río Grande, disturbed, grazed fuegian steppe N of Río Grande, 5–10 m alt., on rock, *J. Poelt s.n.*, 3.i.1989 (GZU); ● Tierra del Fuego, Dept. Río Grande, old *Nothofagus antarctica* forest, *c.* 7 km SE of Estancia Río Apen, 100–150 m alt., on rock, *J. Poelt s.n.*, 7.i.1989 (GZU).
Ecuador: ● Andes, [Cordillera Occidental], Chimborazo, below the refuge, 4800 m alt., on rock, *H. Huss s.n.*, 27.viii.1980 (GZU).

4. Buellia stellulata var. **tasmanica** Elix & Kantvilas, *Australas. Lichenol.* **73**, 32 (2013)
This taxon was previously known from Australia and New Zealand (Elix & Kantvilas 2013; Elix *et al.* 2017). Morphologically, it is identical to *Buellia stellulata* (Taylor) Mudd var. *stellulata*, but it can be readily distinguished chemically because the latter contains additional 2'-*O*-methylperlatolic acid (major) and confluentic acid (minor). A detailed description is given in Elix & Kantvilas (2013).

SPECIMEN EXAMINED
Chile: ● Prov. de Concepción, Cerro el Pompon, rockfalls on the coast at the mouth of the Río Bio-Bio, on rock, *O. Matthei & J. Poelt s.n.*, 26.vii.1979 (GZU).

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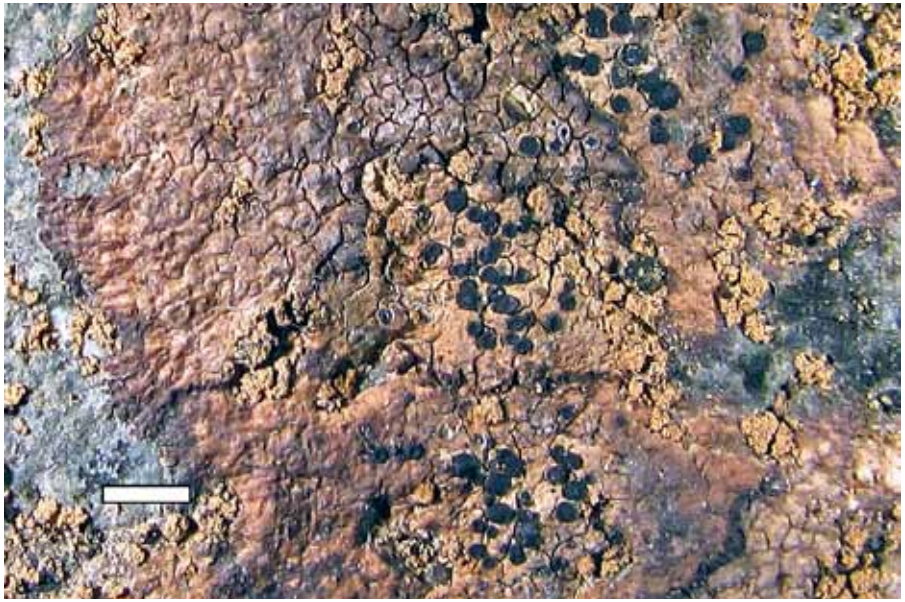

Fig, 1. *Amandinea puertomonttensis* (holotype in GZU). Scale = 2 mm.

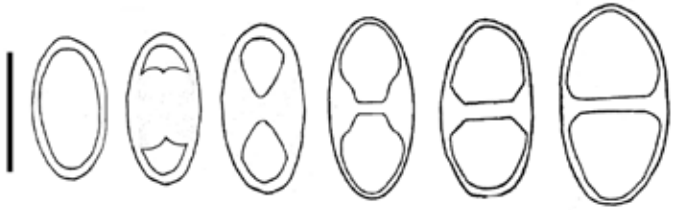

Fig. 2. Ascospore ontogeny of *A. puertomonttensis*. Scale = 10 µm.

Fig. 3. *Tetramelas fuegiensis* (holotype in GZU). Scale = 1 mm.

Fig. 4. Ascospore ontogeny of *T. fuegiensis*. Scale = 10 µm.

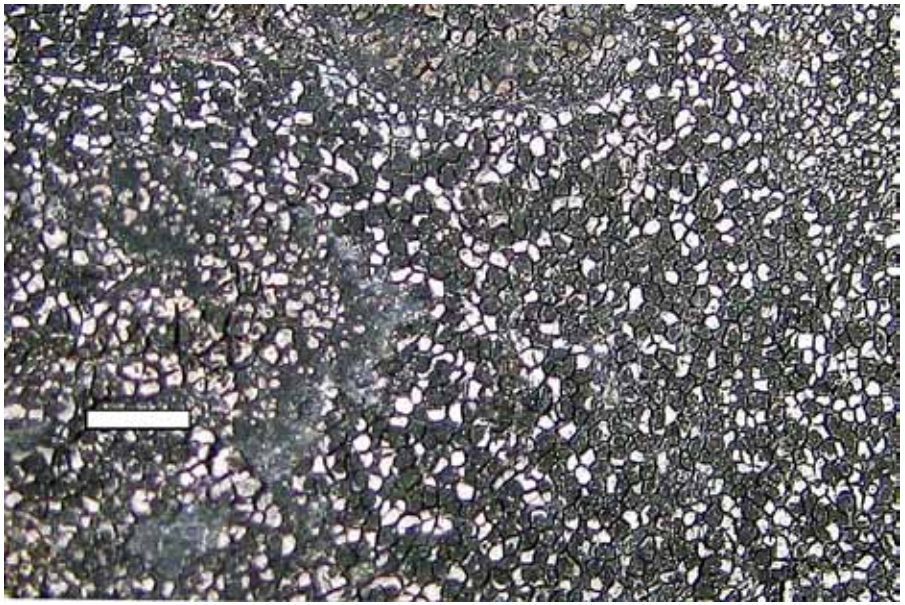

Fig. 5. *Buellia pygmaea* (*J. Poelt s.n.*, 17.i.1989 in GZU). Scale = 1 mm.

Fig. 6. *Amandinea subplicata* (*M. Matzer & B. Pelzmann*, 27.xi.1994 in GZU). Scale = 1 mm.

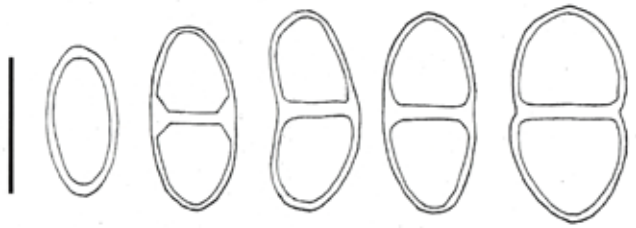

Fig. 7. Ascospore ontogeny of *A. subplicata*. Scale = 10 µm.