



Three new species of crustose Physciaceae from Guatemala, with notes on some additional species

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Abstract

Three crustose species of Physciaceae from Guatemala are reported as new to science, the saxicolous *Buellia rugosissima* and *Dimelaena subsquamulosa* and the corticolous *Sculptolumina conradiae*. Detailed descriptions of these species are presented together with notes on their chemistry, distribution, ecology and taxonomy. Additional information is given for a further ten species of Physciaceae, nine of which are new records for the country.

Key words: biodiversity, Central America, lichenized Ascomycota, Neotropics, taxonomy

Introduction

In a previous report on lichens from Guatemala (van den Boom *et al.* 2007), 184 taxa were recorded. The specimens were collected during a field trip through this country in 2004. However, species belonging to the crustose Physciaceae were not included but are treated in the present contribution. In recent time the descriptions of many new species as well as new keys have been published for the genus *Buellia* s. l. (Marbach 2000). This publication has greatly facilitated the study of the Neotropical representatives of this group. Only one of the species collected in the present work had been recorded previously for Guatemala, namely *Amandinea diorista* (Nyl.) Marbach var. *diorista* (Marbach 2000). Other *Buellia* s. l. species reported for Guatemala in Marbach (2000) included *Amandinea submontana* Marbach, *A. xylographella* (Nyl.) Marbach, *Baculifera entochlora* (J. Steiner) Marbach, *B. longispora* Marbach, *B. micromera* (Vain.) Marbach, *B. orosa* Marbach & Kalb, *Cratiria obscurior* (Stirt.) Marbach, *C. rutilans* Marbach & Kalb, *Gassicurtia catasema* (Tuck.) Marbach, *G. coccinea* Fée, *Hafellia pruinosa* Marbach & Kalb, *Orcularia insperata* (Nyl.) Kalb & Giralt (as *Amandinea insperata* (Nyl.) H. Mayrhofer & Ropin) and *Sculptolumina serotina* (Malme) Marbach.

The collections studied are from central and southern Guatemala, mainly from elevations between 870 and 3150 m. One coastal locality in the area of Monterrico (Pacific Ocean) was also studied (Fig. 1). Two saxicolous species, *Buellia rugosissima* and *Dimelaena subsquamulosa*, and the corticolous, *Sculptolumina conradiae*, are described as new, and nine additional taxa are reported from Guatemala for the first time (marked in the text with an asterisk).

Material and Methods

The study is based on corticolous and saxicolous material. The collections were examined by standard techniques using stereoscopic and compounds microscopes. Only free ascospores lying outside the asci were measured.

Measurements were made in material mounted in water. Mean value (M) and standard deviation (SD) were calculated for the three new species. The results are given as (minimum value observed)–M–SD–M+SD(–maximum value observed); M, SD and n (the total number of ascospores measured) are given in parentheses.

Chemical constituents were identified by standardized thin-layer chromatography (TLC) (Orange *et al.* 2001).

The specimens are kept in the herbarium of the collector (van den Boom), unless otherwise indicated. The holotype collections are deposited in the herbarium of the University of Graz, Austria (GZU).



FIGURE 1. Indication of the main collecting sites. A. Area of Quezaltenango. B. Guatemala city. C. Mixco Viejo. D. Area of Coban. E. Monterrico (mentioned in brackets after the country under specimens examined).

The new species

Buellia rugosissima Giralt, van den Boom & Elix *sp. nov.* (Fig. 2) MycoBank MB 807079

Thallus saxicolous, rimose-areolate, pale greyish-brown, containing atranorin. Prothallus present, dendritic, black. Medulla not amyloid, I-. Apothecia lecideine, remaining immersed, 0.1–0.4 mm diam. Proper exciple poorly differentiated, *aethalea*-type, brown-aeruginose like the epihymenium, N+ red-violet. Hymenium without oil droplets. Hypothecium hyaline. Ascospores *Buellia*-type, (15.0–)16.1–19.7(–21.0) × (8.0–)8.4–10.4(–11.5) μm; walls strongly rugulate (ornamentation visible at × 400). Conidia bacilliform, 5.0–6.0 × 1.0 μm.

Type:—GUATEMALA. (A) Quezaltenango: S of Quezaltenango, S of Llano del Pinal, N slope of Volcano Santa María, path among small agriculture fields with small forests, shrubs, trees and outcrops, 2500 m, 14°47.1'N, 91°32.9'W, 23 July 2004, P. & B. van den Boom 32921 (holotype GZU!, isotype hb. v.d. Boom!).

Thallus saxicolous, crustose, thin, ±continuous, epilithic, becoming rimose-areolate to areolate, matt, whitish-grey to pale greyish-brown to brownish. Medulla not amyloid, I-. Prothallus distinct, dendritic, also visible between the areoles, black. Photobiont trebouxoid; algal cells 7–15 µm diam. Apothecia lecideine, (0.1–)0.2–0.3(–0.4) mm diam., remaining immersed, predominantly in center of areoles. Proper margin usually indistinct, very rarely visible, black. Disc epruinose, plane, black. Proper exciple *aethalea*-type, poorly differentiated, outer part brown-aeruginose, 20–40 µm thick, N+ red-violet; inner part indistinct, colourless, up to 10 µm thick. Epithemium brown-aeruginose, N+ red-violet. Hymenium hyaline, not interspersed with oil droplets, 80–100 µm high. Hypothecium hyaline, 40–80 µm deep. Asci *Bacidia*-type, 8-spored. Apical cells of paraphyses 2.0–3.5 µm wide, brown capitate. Ascospores *Buellia*-type, of (15.0–)16.1–19.7(–21.0) × (8.0–)8.4–10.4(–11.5) µm (M= 17.9 × 9.4 µm; SD= 1.8 × 1 µm; n= 28), broadly ellipsoid, strongly rugulate (ornamentation visible at × 400), constricted at septum when mature. Conidia bacilliform, 5.0–6.0 × 1.0 µm.

Chemistry:—Thallus K+ yellow; atranorin detected by TLC.

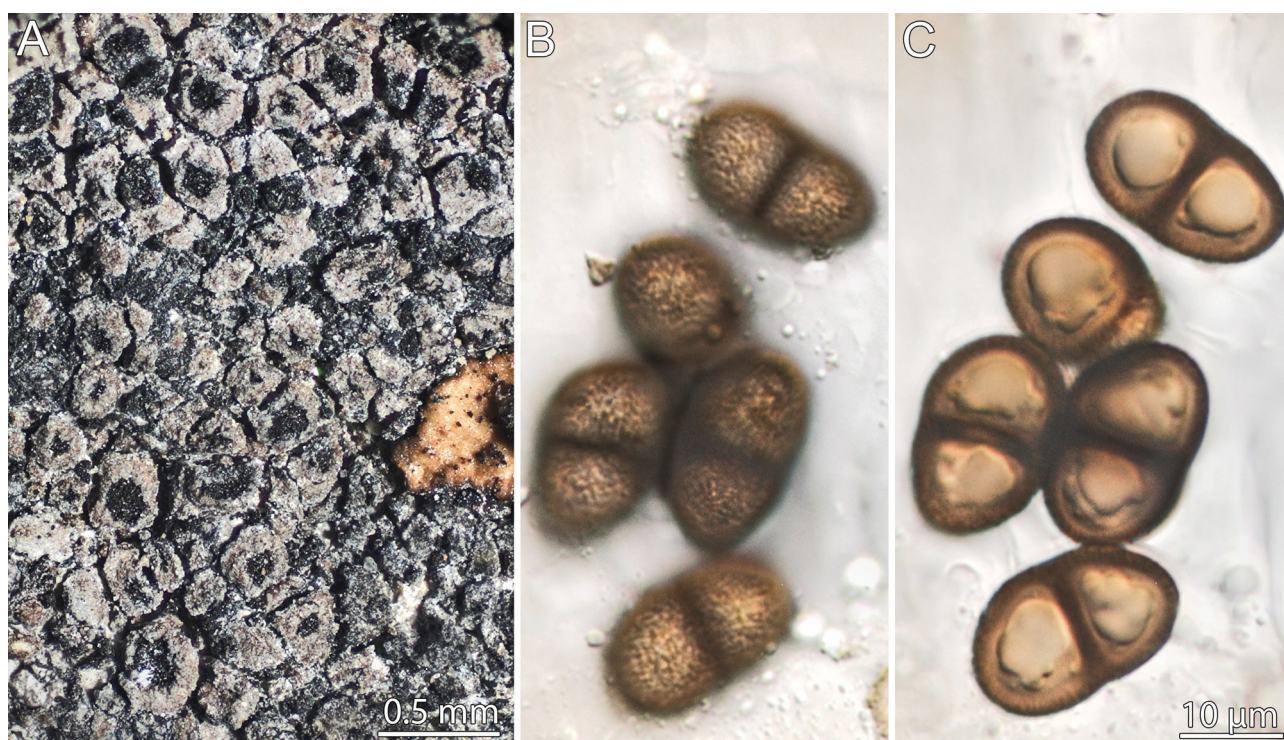


FIGURE 2. *Buellia rugosissima*, holotype. A. Habit. B. Ascospores showing a strongly rugulate ornamentation. C. *Buellia*-type ascospores.

Etymology:—The epithet refers to the strongly rugulate walls of the ascospores.

Ecology and distribution:—The known collections were found in a mountainous area at 2500 m elevation. The area has been influenced by human activity. At the type locality this species grows together with *Dimelaena subsquamulosa*, on a sloping, southerly exposed outcrop. Crustose lichens growing nearby included several brown *Acarospora* species, one of which has a C+ red thallus and could refer to *A. fuscata* (Nyl.) Arnold and several yellow *Acarospora* specimens which have not yet been identified. *Lepraria vouauxii* (Hue) R.C. Harris was collected from the vertical surface of the outcrop. Accompanying macrolichens on the same outcrop included *Phyrcia tribacia* (Ach.) Nyl., *Xanthoparmelia conspersa* (Ach.) Hale and *X. cumberlandia* (Gyeln.) Hale. The latter four species were reported in van den Boom *et al.* (2007).

Notes:—*Buellia rugosissima* is characterized by the rimose-areolate, greyish-brown thallus containing atranorin, the non-amyloid medulla and a very well delimited dendritic, black prothallus, the small, persistently immersed apothecia, the brown-aeruginose epithemium (N+ red-violet), the hyaline hypothecium and the large *Buellia*-type ascospores with a strongly rugulate ornamentation. These characters indicate that this new species belongs to the *B. aethalea*-group. However, it is clearly distinguished from other members of this group (*B. aethalea* (Ach.) Th. Fr., *B. spuria* (Schaer.) Anzi and *B. stellulata* (Taylor) Mudd) by its chemistry and larger and

strongly ornamented ascospores (cf. Bungartz & Nash 2004). *Buellia cranfieldii* Elix from Australia has identical chemistry and similar apothecial anatomy, but the ascospores are much smaller ($10\text{--}16 \times 5\text{--}8 \mu\text{m}$) and have non-ornamented walls (Elix 2010).

Additional specimens examined:—GUATEMALA. (A) Quezaltenango: S of Quezaltenango, S of Llano del Pinal, N slope of volcano Santa Maria, path among small agriculture fields with small forests, shrubs, trees and outcrops along path, on outcrop, 2500m, $14^\circ 47.1' \text{N}$, $91^\circ 32.9' \text{W}$, 23 July 2004, P. & B. van den Boom 32928, 32935 (paratypes hb. v.d. Boom).

Dimelaena subsquamulosa Giralt, H. Mayrhofer, van den Boom & Elix *sp. nov.* (Fig. 3) MycoBank MB 807085

Thallus saxicolous, composed of subsquamulose areoles, discrete to continuous, loosely attached to substrate, pale orange-brown. Apothecia lecanorine, mostly subimmersed, $0.3\text{--}0.5\text{--}(0.8)$ mm diam. Hymenium not interspersed with oil droplets. Hypothecium hyaline. Ascospores *Buellia*-type, $(12.0\text{--})13.9\text{--}17.0\text{--}(19.0) \times (6.0\text{--})7.2\text{--}8.7\text{--}(10.0) \mu\text{m}$, ellipsoid with non-ornamented walls. Conidia bacilliform, $3.0\text{--}5.0 \times 1.0 \mu\text{m}$. Chemistry. Chemotype I: without secondary metabolites (holotype and isotype specimens); chemotype II: gyrophoric acid in the cortex (paratype, hb. v.d. Boom 33043).

Type:—GUATEMALA. (A) Quezaltenango: S of Quezaltenango, S of Llano del Pinal, N slope of Volcano Santa María, path among small agriculture fields with small forests, shrubs, trees and outcrops, 2500m, $14^\circ 47.1' \text{N}$, $91^\circ 32.9' \text{W}$, 23 July 2004, P. & B. van den Boom 32928 (holotype GZU!, isotype hb. v.d. Boom!).

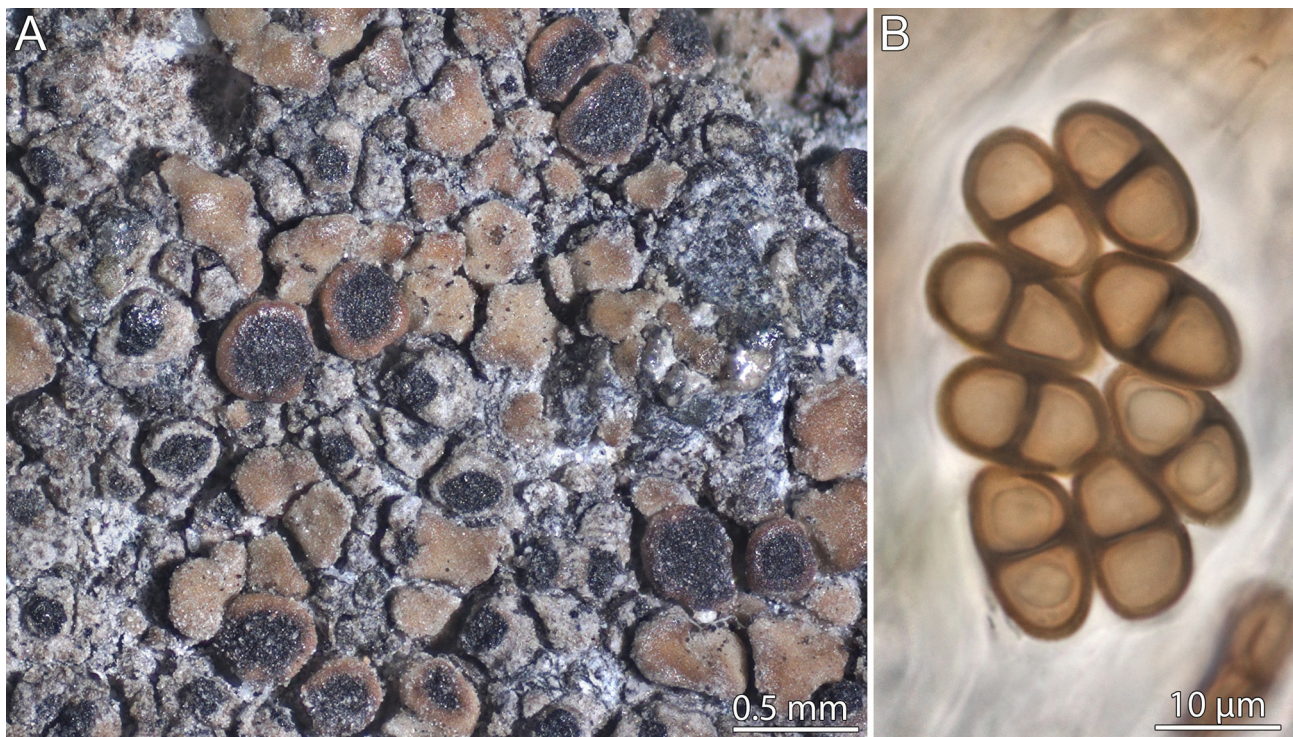


FIGURE 3. *Dimelaena subsquamulosa*, holotype. A. Habit growing associated with *Buellia rugosissima*. B. *Buellia*-type ascospores with walls not ornamented.

Thallus thick, areolate, margin not lobate. Areoles subsquamulose, $0.3\text{--}1.5\text{--}(3.0)$ mm wide, scattered or usually continuous, regularly rounded to sublobate or elongated, plane to slightly subconvex, loosely attached to substrate mainly by the central part with slightly ascending margins, creamy to pale orange-brown, margins often covered by a whitish pruina. Upper cortex $30\text{--}60 \mu\text{m}$ thick, composed of small isodiametric cells, $2.0\text{--}3.5 \mu\text{m}$ in diam., colourless except the uppermost cells which are pigmented orange-brown. Epinecral layer $5\text{--}10\text{--}(15) \mu\text{m}$ thick. Algal layer $50\text{--}90 \mu\text{m}$ thick with large trebouxioid algal cells, $10\text{--}15\text{--}(18) \mu\text{m}$ diam. Medulla with upper part below algal layer, hyaline, lower part \pm imbedded in reddish-brown substrate, not amyloid, I-. Lower cortex absent. Prothallus absent. Apothecia lecanorine, $0.3\text{--}0.5\text{--}(0.8)$ mm diam., immersed, subimmersed to adnate. Thalline margin concolorous or darker than thallus, usually persistent. Disc flat, epruinose, dark reddish brown. Thalline

exciple 30–50 µm thick, composed of small isodiametric cells 2–3 µm diam., like the thalline cortex. Epihymenium orange-brown, N-. Hymenium hyaline, not interspersed with oil droplets, 50–70(–100) µm high. Hypothecium hyaline, 80–100 µm deep. Asci *Bacidia*-type, 8-spored. Apical cells of paraphyses weakly enlarged, 2.0–3.0 µm in diam., colourless or with pale brown caps. Ascospores *Buellia*-type, (12.0–)13.9–17.0(–19.0) × (6.0–)7.2–8.7(–10.0) µm (M= 15.4 × 7.9 µm; SD= 1.5 × 0.8 µm; n= 111), ellipsoid, straight or sometimes slightly curved, constricted at septum; walls not ornamented. Conidia bacilliform, 3.0–5.0 × 1.0 µm.

Chemistry:—Chemotype I: all spot tests negative; no lichen substances detected by TLC; chemotype II: C+ rose; gyrophoric acid by TLC.

Etymology:—The epithet refers to the subsquamulose thallus of this species.

Ecology and distribution:—The two known collections were found in mountainous areas between 2500 and 3150 m elevation. Both areas have been influenced by human activity. In the type locality this species was growing on top of a volcanic outcrop in an open area along a trail, and was associated with *Buellia rugosissima* and close to several brownish and yellowish *Acarospora* species. The accompanying macrolichens were the same as mentioned under *B. rugosissima*. In the second locality, situated on the same mountain slope but at 3150 m elevation, crustose lichens growing nearby included *Buellia aethalea*, *B. eganii* Bungartz, *Candelariella rosulans* (Müll. Arg.) Zahlbr. and *Trapelia coarctata* (Sm. & Sow.) M. Choisy. Accompanying macrolichens included *Physcia dubia* (Hoffm.) Lettau, *Punctelia borreri* (Sm.) Krog., *Stereocaulon pachycephalum* Vain., *Umbilicaria leprosa* (Zahlbr.) Frey and *Xanthoparmelia cumberlandia* (Gyeln.) Hale. The latter taxa were reported in van den Boom *et al.* (2007).

Notes:—*Dimelaena subsquamulosa* is characterized by the creamy to pale orange-brown thallus composed of thick, subsquamulose areoles, the lecanorine apothecia, the hyaline hypothecium, the *Buellia*-type ascospores and the bacilliform conidia. Among the Physciaceae with a crustose thalli or thalli of an intermediate growth form (i.e. placodioid, subsquamulose to squamulose), only the genus *Phaeorrhiza* H. Mayrhofer & Poelt and some species of *Dimelaena* Norman show the same combination of diagnostic characters than *D. subsquamulosa*.

The thalline and apothecial characters of this new species are macro- and microscopically very close to *Phaeorrhiza nimbose* (Fr.) H. Mayrhofer & Poelt but it differs in having much smaller squamules, apothecia and ascospores. However, the inclusion of *D. subsquamulosa* in *Phaeorrhiza* does not seem appropriate since it lacks the typical brown rhizoidal hyphae, the main diagnostic character of this genus (Mayrhofer & Poelt 1978). Further, the ascus of *Phaeorrhiza* is of the *Lecanora*- rather than *Bacidia*-type (Rambold *et al.* 1994).

As a consequence, the new species is better included in the genus *Dimelaena*. Although this genus is generally characterized by placodioid thalli which are areolate in the center and have radiate-plicate marginal lobes, it includes two species, *D. californica* (H. Magn.) Sheard and *D. lichenicola* K. Knudsen, Sheard, Kokourcová & H. Mayrhofer which, probably do to their lichenicolous behaviour, show reduced thalli lacking well-developed plicate margins (Knudsen *et al.* 2013). Furthermore, the genus *Dimelaena* exhibits variable apothecial characters, as it includes species with lecanorine or lecideine apothecia and with hyaline or brown hypothecia. Among the ten species currently included in *Dimelaena*, *D. australiensis* H. Mayrhofer & Sheard, *D. oreina* (Ach.) Norman, *D. tenuis* (Müll. Arg.) H. Mayrhofer & Wippel, *D. thysanota* (Tuck.) Hale & W.L. Culb. and *D. weberi* Sheard have a colourless hypothecium. The new species clearly differs from all of these taxa in having much larger ascospores. Concerning the chemistry, among the *Dimelaena* taxa mentioned above, only *D. tenuis* and *D. thysanota* as *D. subsquamulosa* also contain gyrophoric acid, however in *D. tenuis* this secondary metabolite is usually accompanied or substituted by 5-*O*-methylhiassic acid (Elix 2011) and in *D. thysanota* by sphaerophorin and subsphaeric acid (Mayrhofer & Sheard 2004).

An additional genus of Physciaceae with subsquamulose thallus is *Monerolechia* (Fr.) Kalb, recently resurrected by Kalb (2004) but not yet fully accepted. However, this monotypic genus clearly differs from *D. subsquamulosa* by having lecideine apothecia, a brown hypothecium and *Physcia tenella*-type asci (= *Lecanora*-type) (cf. Marbach 2000, abb 10: 28 and Kalb 2004).

Additional specimens examined:—GUATEMALA. (A) Quezaltenango: S of Quezaltenango, S of Llano del Pinal, N slope of Volcano Santa María, path among small agriculture fields with small forests, shrubs, trees and outcrops, 2500m, 14°47.1'N, 91°32.9'W, 23 July 2004, P. & B. van den Boom 32921, 32941 (paratypes, hb. v.d. Boom); (A) NW of Quezaltenango, NNW of San Marcos, along trail from San Sebastian to top of volcano Tajumulco, on ENE slope, above the small village El Rodeo, shrubs and outcrops in open field, 3150 m, 15° 2.9' N, 91° 51.3' W, 25 July 2004, P. & B. van den Boom 33043 (paratype, hb. v.d. Boom).

Sculptolumina conradiae H. Mayrhofer, Giralt, van den Boom & Elix *sp. nov.* (Fig. 4) MycoBank MB 807086

Similar to *Sculptolumina japonica* (Tuck.) Marbach but differs in lacking secondary metabolites, by the presence of only a few hymenial oil droplets and in having 1–3-septate ascospores $(19.0\text{--}21.0\text{--}27.2\text{--}(29.0) \times (8.0\text{--}9.4\text{--}12.7\text{--}(15.0)) \mu\text{m}$ with four \pm -rounded lumina at maturity and smooth walls. Pycnidia and conidia unknown.

Type:—GUATEMALA. (A) Quezaltenango: WSW of Quezaltenango, San Martín, SE of village, along path to Laguna Chicabal, mixed forest on NW slope, scattered outcrops along path and at open places, on trunk of mature *Alnus arguta*, 2700 m, 14° 48.2' N, 91°38.8'W, 22 July 2004, P. & B. van den Boom 32863 (holotype GZU!, isotype hb. v.d.Boom!).

Thallus indeterminate, discontinuous, composed of scattered to contiguous granules, bullate (ca. 0.05 mm diam.) to minutely squamulose and sublobate (ca. 0.2 mm diam.), pale to dark brown. Prothallus absent. Medulla not amyloid, I-. Photobiont trebouxoid; algal cells up to 10 μm diam. Apothecia lecideine, 0.2–0.4(–0.7) mm diam., adnate to sessile, black. Proper margin rather thick and prominent in young apothecia, becoming thinner, usually persistent, black. Disc concave to plane, rarely becoming subconvex, epruinose, black. Proper exciple, *aethalea*-type, 30(–50) μm wide, composed of rounded cells 5.0–7.0 μm diam., outer part dark brown, inner part hyaline. Epithemium brown, N-. Hymenium hyaline, without or with a few oil droplets, 90–110 μm high. Hypothecium up to 70 μm deep, dark brownish-black, upper part black-olivaceous, N-, \pm inspersed with oil droplets. Asci *Bacidia*-type, 8-spored but often with only 4–6 well-developed ascospores. Paraphyses with apical cells 3.0–4.0 μm wide, with brown caps. Ascospores 1–3-septate, $(19.0\text{--}21.0\text{--}27.2\text{--}(29.0) \times (8.0\text{--}9.4\text{--}12.7\text{--}(15.0)) \mu\text{m}$ ($M=21.1 \times 11.1 \mu\text{m}$; $SD=3.1 \times 1.7 \mu\text{m}$; $n=23$), ellipsoid, with four lumina, similar to the *Conradia*-type; septal or central lumina \pm rhomboid to rounded, apical lumina \pm hemispherical to rounded; lateral walls thick; torus absent or poorly developed at central septum; walls not ornamented. At first lumina only septal, later with two additional apical lumina connected to the septal lumina by a short to indistinct canal (isthmus) which may be interrupted or not (rarely) by the insertion of an additional septum. Ontogeny type-A (the septum is inserted before apical inner wall thickenings become distinct). Pycnidia and conidia not seen.

Chemistry:—All spot tests negative; no lichen substances detected by TLC.

Etymology:—The epithet refers to the similarity of its ascospores to the *Conradia*-type of *Rinodina conradii* Körb. It is the first known species in the genus *Sculptolumina* Marbach with 3-septate ascospores.

Ecology and distribution:—This species is known from two localities, both situated at an elevation of 2700 m. All collections were from the trunks of *Alnus arguta*. In the mixed forest at the type locality, *S. conradiae* was very abundant on several rather small trees. Adjacent lichens included *Chrysothrix xanthina* (Vain.) Kalb, *Flavoparmelia caperata* (L.) Hale, *Hypotrachyna rockii* (Zahlbr.) Hale, *Japewiella tavaresiana* (H. Magn.) Printzen, *Parmotrema soreddiferum* Hale, *Physcia alba* (Fée) Müll. Arg., *P. poncinsii* Hue, *Punctelia perreticulata* (Räsänen) G. Wilh. & Ladd, *P. subrudecta* (Nyl.) Krog and *Thelenella modesta* (Nyl.) Nyl. All of these species were recorded previously in van den Boom *et al.* (2007).

Notes:—*Sculptolumina conradiae* is characterized by the brownish, granulose to minutely squamulose thallus which lacked secondary metabolites, the lecideine apothecia, ± 0.5 mm diam. with black, epruinose discs, the poorly developed, carbonaceous proper exciple, the hymenium lacking or including only a few oil droplets, the dark brown hypothecium, the *Bacidia*-type asci and the large, smooth walled, 1–3-septate ascospores with markedly thickened lateral and septal inner walls, resulting in 4 \pm -rounded lumina (similar to the *Conradia*-type). Despite the ascospores of *S. conradiae* are similar to those of *R. conradii*, the additional diagnostic characters of the new species clearly preclude its inclusion in the genus *Rinodina* (Ach.) Gray, characterized by lecanorine apothecia, colourless hypothecium and *Lecanora*-type asci.

The new species is far better included in the genus *Sculptolumina* for the following reasons: 1) the thalline and apothecial characters are consistent with those of *Sculptolumina japonica*; 2) among the genera of *Physciaceae* segregated from *Buellia* s. lat. by Marbach (2000), only *Sculptolumina* has ascospores with very pronounced inner wall thickenings at all stages of ontogeny (rinodinoid-ascospores). The genus is also characterized by hymenia inspersed with oil droplets. Although the new species lacks or has only a few oil droplets in the hymenium, this character has proved to be variable in other genera of *Physciaceae* (e.g. *Buellia* s. str., *Chromofulvea* Marbach, *Cratiria* Marbach, *Endohyalina* Marbach emend. Giralt, van den Boom & Elix, *Rinodina* and *Stigmatochroma* Marbach). Filiform conidia are a further diagnostic feature of *Sculptolumina* (Giralt *et al.* 2009) but, unfortunately, they have not been observed in *S. conradiae*.

Presently, the genus *Sculptolumina* includes only two taxa, the type species, *S. japonica* and *S. serotina*. They differ from *S. conradiae* in both their chemistry and ascospores. *S. japonica* contains anthraquinones and has *Mischoblastia*-type ascospores whereas *S. serotina* contains the lobaric acid chemosyndrome and has ascospores similar to those of *S. conradiae* but 1-septate, with only two rounded lumina (\pm *Pachysporaria*-type) instead of 3-septate, with four rounded lumina. Both grow on bark, lignum or decaying plants, mainly in subtropical to tropical regions and are also present in Guatemala.



FIGURE 4. *Sculptolumina conradiae*, holotype. A. Immature ascospores with a single lumen. B. Young 1–2-septate ascospores. C–D. Mature 3-septate ascospores with four \pm rounded lumina (similar to the *Conradia*-type) and walls not ornamented. D–E. Habit.

The 3-septate ascospores of *S. conradiae* somewhat resemble the tetralocular but 1-septate ascospores of *Orcularia placodimorpha* (Vain.) Kalb & Giralt and *O. placodimorphoides* (Imshaug) Kalb & Giralt (Kalb & Giralt 2011). However, the sequence for the differentiation of the lumina and the canals (isthmus) are clearly different. In the new species immature ascospores are 1-septate with two lumina divided by a septum and not connected by a canal (or isthmus). Later during the ontogeny, with spore maturation, each one of the two lumina differentiates an apical lumen; the apical and central lumina of each cell are connected by a short canal. Finally, a new septum is inserted in this short canal and the ascospores become 3-septate.

This ontogeny contrast with species of *Orcularia* (Malme) Kalb & Giralt, where at one stage of its spore ontogeny each ascospore cell has an apical lumen and both lumina are connected by a long canal. During the ontogeny, this canal differentiates by swelling a central lumen per cell. No septa are inserted between the apical and central lumina of each cell, thus the ascospores remain 1-septate. The immature, colourless, non-septate ascospores of *Orcularia* are also different and characteristic of this genus. They have one single lumen \pm bone-shaped as the consequence of strong lateral inner wall thickenings which appear before the septum is inserted (Kalb & Giralt 2011). This contrasts with *Sculptolumina* where the septum is formed early on.

The 3-septate ascospores of *Rinodina conradii* are also superficially similar but their development follows a type-B ontogeny (the septum is inserted after the apical thickenings become distinct). Consequently, simple, non-septate ascospores and 1-septate ascospores always show apical thickenings (cf. Mayrhofer *et al.* 2001).

Finally, the *Callispora*-type ascospores with very strong subapical, inner wall thickenings (1-septate with four locules or 3-septate) of some species of *Buellia* s. str (= *Hafellia* Kalb, H. Mayrhofer & Scheid. in Kalb), e.g. *B. fraudans* (Starbäck) Elix, *B. gomerana* (Etayo & Marbach) Giralt & van den Boom, *B. pseudotetrapla* (Pusswald) Elix and *B. tetrapla* (Nyl.) Müll. Arg. (cf. Etayo & Marbach 2003) also resemble the ascospores of *Sculptolumina conradiae*.

Additional specimens examined:—GUATEMALA. (A) Quezaltenango: WSW of Quezaltenango, San Martin, SE of village, along path to Laguna Chicabal, mixed forest on NW slope, scattered outcrops at open places, 2700 m, 14° 48.2' N, 91° 38.8' W, 22 July 2004, P. & B. van den Boom 32875 (paratype hb. v.d.Boom). (A) S of Quezaltenango, S of Llano del Pinal, N slope of volcano Santa Maria, path among small agriculture fields with small forests, shrubs, trees and outcrops, 2700 m, 14° 46.6' N, 91° 33.3' W, 23 July 2004, P. & B. van den Boom 32980 (hb. v.d. Boom).

Additional species

Amandinea diorista (Nyl.) Marbach **var. diorista** Marbach (2000: 58).

Characterized by a greyish thallus containing 4,5-dichlorolichexanthone (nr. 33558), the small apothecia, up to 0.3 mm in diam., the *Buellia*-type ascospores of 9.0–15.0 \times 4.5–6.0 μ m with rugulate walls when mature and the filiform conidia. A tropical species typically growing on coastal mangroves, known from Guatemala, India and the Fijian Islands (Marbach 2000).

Material examined:—GUATEMALA. (E) Monterrico: E of village, nature reserve 'Biotopo Monterrico-Hawaii', coastal mangrove swamps, on *Rhizophora mangle*, 1 m, 13° 54.2' N, 90° 28.3' W, 5 July 2004, P. & B. van den Boom 33558, 33567 (hb. v.d. Boom); (E) at Monterrico village, near Tortugario Monterrico, little museum in a small park with mixed trees, on branches of trees, 13° 54.3' N, 90° 29.0' W, 20 m, 5 August 2004, P. & B. van den Boom 33573 (hb. v.d. Boom).

**Buellia aethalea* (Ach.) Th. Fr. (1874: 604).

Characterized by the areolate, whitish to greyish thallus reacting K⁺ yellow then red (norstictic acid), the amyloid medulla (I+ violet), the cryptolecanorine apothecia, with an olivaceous to aeruginose (N + red-violet) proper exciple and epihymenium and a pale brown hypothecium and the *Buellia*-type ascospores, 10.0–18.0 \times 7.0–11.0 μ m, constricted at septum and rugulate. A silicicolous species widely distributed around the world (Elix 2011).

Material examined:—GUATEMALA. (A) Quezaltenango: NW of Quezaltenango, NNW of San Marcos, along trail from San Sebastian to top of volcano Tajumulco, on ENE slope, above the small village El Rodeo, shrubs and outcrops in open field, sloping rock, 3150 m, 15° 2.9' N, 91° 51.3' W, 25 July 2004, P. & B. van den Boom 33079a (hb. v.d. Boom).

**Buellia eganii* Bungartz, in Bungartz & Nash (2004: 445).

Characterized by the thick, areolate to rimose-areolate, pale greyish thallus containing lecanoric acid (C+ red), the non-amyloid medulla (I-), the immersed apothecia with a brown (N-) proper exciple and epihymenium and a hyaline hypothecium and the *Buellia*-type ascospores, 11.0–17.0 × 7.0–8.0(–9.0) µm with microrugulate spore walls (visible at × 1000). This silicolous species occurs in subalpine to alpine habitats and was hitherto known only from Arizona and New Mexico (Bungartz & Nash 2004).

Material examined:—GUATEMALA. (A) Quezaltenango: NW of Quezaltenango, NNW of San Marcos, along trail from San Sebastian to top of volcano Tajumulco, on ENE slope, above the small village El Rodeo, shrubs and outcrops in open field, on sloping volcanic rock, 3150 m, 15° 2.9' N, 91° 51.3' W, 25 July 2004, *P. & B. van den Boom* 33043, 33049, 33079 (hb. v.d. Boom).

**Buellia jugorum* (Arnold) Arnold (1884: 588).

Characterized by the thick yellowish, thallus reacting C+ orange (arthothelin chemosyndrome) with a non-amyloid medulla (I-), immersed apothecia with an *aethalea*-type proper exciple, the aeruginose epihymenium and/or proper exciple (N+ red-violet) and the *Buellia*-type ascospores, 12.0–15.0 × 7.5–9.0 µm, with rugulate walls. This silicolous species was previously known from montane Europe (Foucard *et al.* 2002) and from North America [Colorado, New Mexico] (Anderson 1974).

Material examined:—GUATEMALA. (A) Quezaltenango: S of Quezaltenango, S of Llano del Pinal, N slope of volcano Santa Maria, path among small agriculture fields with small forests, shrubs, trees and outcrops along path, on rock outcrop, 2500 m, 14° 47.1' N, 91° 32.9' W, 23 July 2004, *P. & B. van den Boom* 32935, 32941 (hb. v.d. Boom).

**Buellia* aff. *pallidomarginata* A. Nordin (2000: 79).

Characterized by the whitish thallus reacting K+ deep yellow, the apothecia with a proper margin paler than the disc and the 3-septate ascospores, 13.0–19.0 × 5.5–7.0 µm, with weak septal wall thickenings and smooth to microrugulate spore walls. It differs from *B. pallidomarginata* s. str. by its smaller ascospores. The material is too damaged to confirm its identity with certainty. *Buellia pallidomarginata* is a corticolous, tropical species only known from Central India (Nordin 2000) and recently collected in Thailand (own data).

Material examined:—GUATEMALA. (E) Monterrico: E of village, nature reserve 'Biotopo Monterrico-Hawaii', coastal mangrove swamps, on *Rhizophora mangle*, 1 m, 13° 54.2' N, 90° 28.3' W, 5 July 2004, *P. & B. van den Boom* 33560 (hb. v.d. Boom).

**Rinodina colobinoides* (Nyl.) Zahlbr. (1931: 499).

Characterized by the thalline and apothecial tissues containing a yellow pigment which reacts K+ purple, the entirely leprose thallus (blastidiate) and the *Pachysporaria*-type ascospores developing with type A ontogeny. It is an oceanic species with a tropical and subtropical distribution, known from tropical South America, the Caribbean and India (Giralt *et al.* 1995). This species also occurs in Europe [Portugal (Giralt 2010) and the British Isles (Hitch 1995)], Macaronesia [Azores (Rodrigues & Aptroot 2005) and Cape Verde Islands (Giralt *et al.* 2008)] and North America [coastal plains of the Gulf of Mexico (Sheard 2010, Tucker 1979)].

Material examined:—GUATEMALA. (C) Guatemala ciudad: NNW of Guatemala ciudad, Mixco Viejo, scattered mixed trees (mainly Mimosaceae) and a few stones among Maya monuments, on *Acacia*, 870 m, 14° 52.4' N, 90° 39.7' W, 28 July 2004, *P. & B. van den Boom* 33174, 33175 (hb. v.d. Boom).

**Rinodina flavosoralifera* Tønsberg (1992: 288).

Characterized by a thallus composed of yellowish, sorediate areoles reacting C+ orange (arthothelin chemosyndrome) and the large *Pachysporaria*-type ascospores (up to 35.0 × 18.0 µm) which develop sporoblastidia (*Polyblastidium*-type) (Giralt *et al.* 2010). The species is known in Europe from Norway, Scotland, England and the Pyrenees (France), in North America from Alaska and California and in Africa from the Canary Islands (Giralt *et al.* 2010, Sheard 2010). The Guatemalan specimens possess better developed apothecia and ascospores than the previously recorded southernmost specimens from the Canary Islands and California.

Material examined:—GUATEMALA. (A) Quezaltenango: WSW of Quezaltenango, San Martin, SE of village, along path to Laguna Chicabal, mixed forest on NW slope, scattered outcrops along path and at open

places, on *Alnus*, 2700 m, 14° 48.2' N, 91° 38.8' W, 22 July 2004, P. & B. van den Boom 32838 (hb v.d. Boom); (A) S of Quezaltenango, S of Llano del Pinal, N slope of volcano Santa Maria, path among small agriculture fields with small forests, shrubs, trees and outcrops along path, on *Baccharis vaccinioides*, 2700 m, 14° 46.6' N, 91° 33.3' W, 23 July 2004, P. & B. van den Boom 32975 (hb. v.d. Boom).

****Rinodina griseosoralifera*** Coppins (1989: 169).

Characterized by a thallus composed of discrete whitish areoles which become soresiate and react K⁺ yellow (atranorin) and the large *Pachysporaria*-type ascospores up to 29.0 × 14.0 μm. The species was previously known from Europe [Norway, British Isles, Austria (Mayrhofer & Moberg 2002) and the Iberian Peninsula (Giralt 2010)] and along the west coast of North America from Alaska to California (Sheard 2010). As with *R. flavosoralifera*, the present specimens possess well-developed apothecia and ascospores.

Material examined:—GUATEMALA. (A) Quezaltenango: S of Quezaltenango, S of Llano del Pinal, N slope of volcano Santa Maria, path among small agriculture fields with small forests, shrubs, trees and outcrops along path, on *Sambucus*, 2700 m, 14° 46.6' N, 91° 33.3' W, 23 July 2004, P. & B. van den Boom 32965, 32970 (hb. v.d. Boom).

****Rinodina maculans*** Müll. Arg. (1889: 66).

Characterized by the lack of secondary substances and the narrow *Pachysporaria*-type ascospores (up to 20.0 × 8.0 μm) developing with type B ontogeny. A corticolous species widely distributed in Central and South America (Sheard 2010, Malme 1902: sub *R. intrusa* (Nyl.) Malme) and also present in China (Aptroot *et al.* 2007: sub *R. neglecta* Aptroot) and the eastern coastal plains of North America (Sheard 2010).

Material examined:—GUATEMALA. (B) Guatemala ciudad: garden around University San Carlos, scattered mixed trees, on *Jacaranda mimositifolia*, 1730 m, 14° 37.2' N, 91° 33.3' W, 27 July 2004, P. & B. van den Boom 33150 (hb. v.d. Boom).

****Sculptolumina japonica*** (Tuck.) Marbach (2000: 297).

Characterized by the brownish, inconspicuous to leprose-granulose thallus containing orange pigments which react K⁺ purple (anthraquinones), the lecideine apothecia, the brown hypothecium, the interspersed hymenium and the large, microrugulate *Mischoblastia*-type ascospores (up to 30.0 × 13.0 μm). Another interesting distinguishing feature of this species are the large filiform conidia (up to 30 μm), first described in Giralt *et al.* (2009) and observed for the second time in the specimen cited below. A corticolous/lignicolous species whose distribution extends from the tropics and subtropics north to the Macaronesian region and to the Eurosiberian region under oceanic influence (Giralt *et al.* op. cit.). Reported once from North America (North Carolina, Sheard *et al.* 2008).

Material examined:—GUATEMALA. (D) Coban: E of Coban, San Pedro Carcha, Balneario Las Islas, hill along and above cascades, *Acer*, *Pinus* and *Quercus* trees and some outcrops, 1325 m, 15° 28.0' N, 90° 18.5' W, 31 July 2004, P. & B. van den Boom 33263 (hb. v.d. Boom).

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