New data on *Sculptolumina japonica* (Physciaceae)

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Abstract. *Sculptolumina japonica* (Tuck.) Marbach, a species growing on lignum, bark or decaying plants and hitherto known from subtropical and tropical areas and one locality in North America, is now reported from Europe (northern Portugal) and the Canary Islands (La Gomera). This species has been found to possess filiform conidia. As a consequence we propose to amend the genus *Sculptolumina* to accommodate species that have long filiform conidia in addition to hymenial oil droplets and ascospores with internal wall thickenings. New chemical data are reported for *S. japonica*, the world distribution of this species is mapped and illustrations of the ascospores and conidia are provided.

Keywords. *Sculptolumina*, *S. japonica*, morphology, distribution, taxonomy, Physciaceae, Portugal, Canary Islands.

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A peculiar and very distinctive species of *Buellia* s. lat. was discovered among Sampaio's collections in PO and among J. Etayo's collections from the Canary Islands. The specimens were labelled as *Buellia disciformis* and *Rinodina* sp., respectively. A detailed morphological and chemical study of the specimens as well as additional material (including the type) for comparison purposes, has confirmed that this represents *Sculptolumina japonica* (Tuck.) Marbach, a species found on lignum, bark or decaying plants, which is known to be widely distributed in subtropical and tropical areas of Africa, America, Asia and Australia (Marbach 2000) and a single locality in North America (Sheard et al. 2008).

Materials and Methods

This study was based on herbarium material from FH, PO and from the private herbaria of J. Etayo (Navarra, Spain) and K. Kalb (Neumarkt, Germany). Lichen morphology was examined by standard

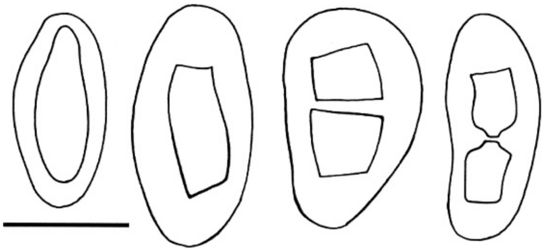

Figure 1. Ascospore ontogeny of type B of *Sculptolumina japonica* (holotype, FH). Scale = 10 μm.

techniques using stereo and compound microscopes. Current mycological terminology generally follows Kirk et al. (2001). Only free ascospores and conidia lying outside the asci and pycnidia have been measured. Measurements were made in water at 1000× magnification. The terminology used for the asci follows Rambold et al. (1994), while that of ascospore-type and ontogeny follows Giralt (2001) and Foucard et al. (2002). Chemical constituents were identified by high performance liquid chromatography (HPLC) (Elix et al. 2003; Feige et al. 1993).

The Species

Sculptolumina japonica (Tuck.) Marbach, Bibliotheca Lichenologica 74: 297. 2000; *Lecidea japonica* Tuck., Proc. Amer. Acad. Arts. 5: 421. 1862; *Buellia japonica* (Tuck.) Tuck., Lichens of California, Oregon and the Rocky Mountains 25. 1866. Type: Japan: U.S. Navy Pacif. Explor. Exped., *C. Wright* (holotype: FH!). **Figs. 1–3**

Further synonyms are given in Marbach (2000) and Sheard et al. (2008)

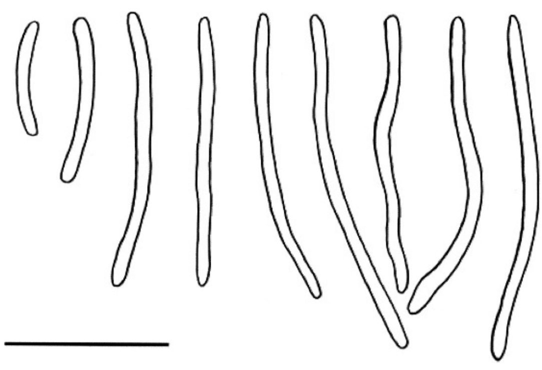

Figure 2. Filiform conidia of *Sculptolumina japonica* (holotype, FH). Scale = 10 μm.

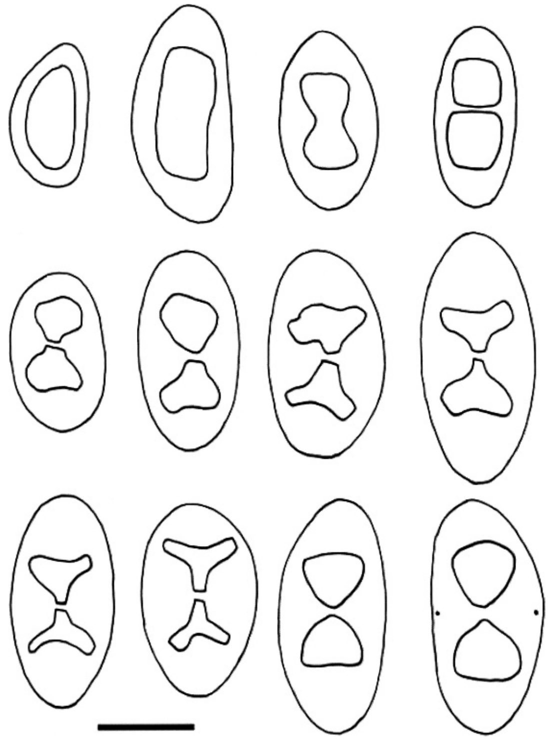

Figure 3. Ascospore ontogeny of type B and ascospore variability of *Sculptolumina japonica* (PO). Scale = 10 μm.

Description. Thallus crustose, continuous, indeterminate, inconspicuous to thin and smooth or thicker and leprose-granulose, gray to olive brown, minutely orange-spotted in places, under the microscope the cortical layer of these orange spots with an amorphous yellow-orange K+ purple pigment; medulla I-, totally interspersed with small yellowish to orange crystals (polarized light), dissolving in K and C, giving an intense yellow and red solution, respectively (microscope slide). Apothecia lecideine, black; excipulum poorly developed, 15–35 μm wide; hymenium to 140 μm high, inspersed with abundant oil droplets to 7 μm diam; hypothecium dark brown, to 120 μm deep; asci *Bacidia*-type, often containing less than 8 spores (see Marbach 2000: p. 28, Abb. 10C). Ascospores *Mischoblastia*-type, (18–)19–25(–31) × 9–13 μm; torus absent or poorly developed; spore-wall clearly ornamented; ontogeny of type B (**Figs. 1**, **3**). Conidia filiform, straight, slightly curved or irregularly curved, (7–)11–21 × 1 μm (type material) (**Fig. 2**).

Chemistry. Thallus K+ brownish or K+ purple, C+ pink to orange, P-, UV+ dark orange in part,

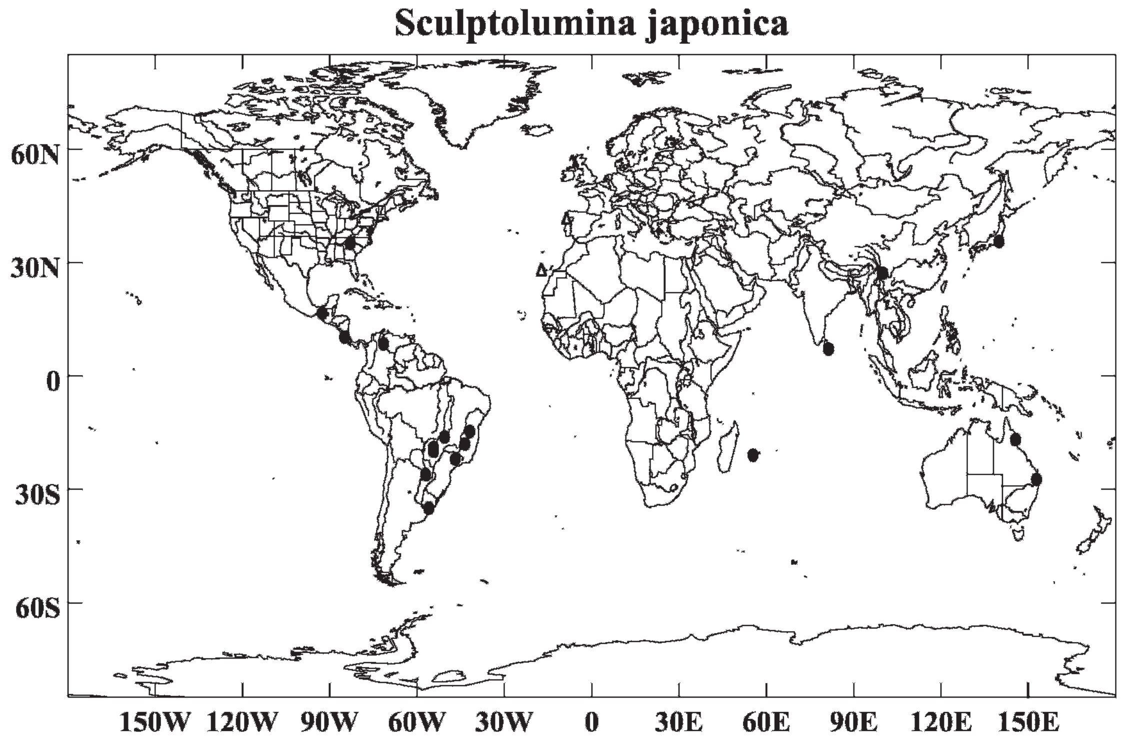

Figure 4. Distribution of *Sculptolumina japonica.* △ New records. ● Literature records.

medulla I-. Flavo-obscurin B1 [major], flavo-obscurin B2 [major], flavo-obscurin A [minor or trace], 7-chloroemodin [minor or trace], skyrin [trace or absent], two unknown anthraquinones [minor], one or two unknown flavo-obscurin derivatives [minor] by HPLC. The analyses were carried out on three specimens (FH-holotype, *Kalb 28556* and PO 1472) and supplements the chemical constituents identified by Kalb and Elix (1998) and Marbach (2000).

We wish to emphasize that the secondary chemistry of this species is unique and that, within the Physciaceae, the anthraquinones flavo-obscurin A, B1, B2 and 7-chloroemodin have only been detected in *Heterodermia obscurata* and several other species of *Heterodermia* (Cohen & Towers 1995; Yosioka et al. 1968a–c).

Distribution. *Sculptolumina japonica* is currently known from a single locality in Europe (northern Portugal) and one in the Canary Islands (La Gomera). These new records extend the distribution of this species from the tropics and subtropics north to the Macaronesian region and to the Eurosiberian region under oceanic influence (**Fig. 4**). Whereas this species was collected on the bark of an old oak tree at the European locality, in La Gomera it was found growing on decaying plants.

Characterization. This species is characterized by the crustose thallus, the minutely orange-spotted upper surface (anthraquinones), the lecideine apothecia with a poorly developed proper exciple, inspersed hymenium and brown hypothecium, the *Bacidia*-type asci, the large *Mischoblastia*-type ascospores with type-B ontogeny and the filiform conidia.

Observations. A detailed study of the holotype material led to the discovery of conidia in this specimen. The long, filiform conidia were straight or slightly curved, and (7–)11–21 × 1 µm. Thus additional distinctive features of *Sculptolumina japonica* reported here for the first time include the long, filiform conidia, the discontinuous, amorphous yellow-orange, K+ purple pigment located in some parts of the thalline cortex, the medullary crystals which give K+ intense yellow, and C+ red solutions and the type-B ascospore-ontogeny.

Presently the genus *Sculptolumina* includes only two species, the type species, *S. japonica*, and *S.*

serotina (Malme) Marbach. Both grow on bark, lignum or decaying plants in subtropical to tropical areas. *Sculptolumina serotina* differs from *S. japonica* in having *Pachysporaria*-type rather than *Mischoblastia*-type ascospores and in containing lobaric acid rather than anthraquinones (Kalb & Elix 1998; Marbach 2000).

In Portugal and the Canary Islands, *S. japonica* could only be mistaken for species of *Buellia* with oil droplets in the hymenium (i.e., *Hafellia* species, see Gams 2004) including, *Buellia disciformis* (Fr.) Mudd, *B. arnoldii* Servít, the corticolous form of *B. leptoclinoides* (Nyl.) Steiner, *B. sanguinolenta* Schauer, *Hafellia alisioae* Etayo & Marbach and *H. gomerana* Etayo & Marbach (recently described by Etayo & Marbach 2003). However, the *Callispora*-type ascospores clearly distinguish these species (see Etayo & Marbach 2003; Giralt et al. 2000).

European specimen examined. PORTUGAL. MINHO: Ponte de Lima, Santa Comba, carvalhos vellos, 11 Oct 1917, *Sampaio 1472L* (PO).

Macaronesian specimen examined. CANARY ISLANDS. LA GOMERA: Vallehermosos, crtra. Vallehermoso-Valle Gran Rey, afloramientos, 665 m, 5 Aug 1994, *Etayo* (HB. ETAYO)

Additional specimens examined for comparison (HB. KALB). AUSTRALIA. QUEENSLAND: Oberhalb von Lake Placid, wenige km südlich von Kuranda (etwa 20 km NW von Cairns), in einem tropischen Regenwald, 450 m, 16°50′S, 145°38′E, 27 Aug 1988, *Kalb 21321*; Mount Nebo Road, ca. 40 km W von Brisbane, Mt. Glorious in einem subtropischem Regenwald, 550 m, 27°23′S, 152°47′E, 29 Aug 1995, *Kalb 29640.* BRAZIL. BAHIA: Chapada Diamantina, Serra do Tombador; zwischen Mundo Novo und Morro do Chapeú, 1000 m, 18–20 Jul 1980, an *Vellozia*, *Kalb 13664*, an Holzzaun, *Kalb 13658.* MINAS GERAIS: Serra do Espinhaço, Serra do Caraça, Ungebung des Klosters Caraça (Hauptsammelgebiet von Vainio), an vertrockneter *Vellozia*, 1250 m, 8 Jul 1978, *Kalb 13665.* SÃO PAULO: Bezirk Rio Claro, etwa 2 km westlich von Rio Claro, 31 May 1980, *Kalb 28566*; etwa 25 km ostnordöstlich von São José do Rio Preto, an einem ungestürzten Laubbaum in einem Cerrado, 500 m, 14 Oct 1979, *Kalb 28571*; Serra de Mantiqueira, Campos do Jordão, 150 km nordöstlich von São Paulo in einem hellen, feuchten Urwald, 1700 m, 25 May 1978, *Kalb 28971*; Serra de Mantiqueira, Westanstieg zur Pedra do Bau, oberhalb von São Bento do Sapicaí, an einem Holzstumpf, 1400 m, 24 Feb 1980, *Kalb 10539*; Horto Forestal von São Paulo, 800 m, 16 Aug 1980, *Kalb 28570.* MASCARENE ISLANDS. REUNIÓN: Zwischen le Brûlé (S von St-Denis) und Plaine des Cnicots, Tropisher Regenwald mit *Nastus borbonicus*, *Acacia heterophylla*, *Cyathea borbonica*, *Philippia montana* etc., 1400–1600 m, 20°57′S, 55°27′E, 15 Aug 1991, *Kalb 26138*; Fahrstrasse zwischen le Vingt-Septième (Bourg Mourat) und dem Piton de la Furnaise, Kleiner Bestand aus *Sophora denudata* und *Philippia montana*, 2250 m, 21°13′S, 55°39′E, 29 Aug 1991, *Kalb 26310*, *26317.* MEXICO. CHIAPAS: bei Jitotol, an der Nationalstrasse 195, in einem lichten, trockenen Kiefernwald, 1600 m, 21 Jan 1979, *Kalb 28567.* PHILIPPINES. NORD LUZÓN: Prov. Baguio, in einem lichten Wald aus *Pinus* sp., 1400 m, 10 Aug 1983, *Kalb & Schrögl.* VENEZUELA. MÉRIDA: Distr. Sucre, oberhalb der Hacienda "Los Topes," San Juanito, wenige km ENE von Chiguara, 8°30′N, 71°30′W, 1500 m, 3 Aug 1989, *Kalb 24016.*

DISCUSSION

The genus *Sculptolumina* was segregated from *Buellia* by Marbach (2000). According to him, the genus was characterized by the following combination of characters: crustose thallus, lecideine apothecia with epruinose discs and an excipulum lacking secondary lichen substances, hymenium inspersed with oil droplets, paraphyses with long and weakly expanded apical cells and ascospores with small, funnel-shaped or rounded lumina (with thickened inner walls, of *Mischoblastia*- or *Pachysporaria*-types).

Within the family Physciaceae the form and length of the conidia is of great taxonomic value and has been used for delimiting genera for some time [e.g., *Physcia* and *Physciopsis* (= *Hyperphyscia*) (Choisy 1950; Hafellner et al. 1979); *Mobergia* (Mayrhofer et al. 1992); *Amandinea* and *Buellia* (Scheidegger 1993; *Australiaena* (Matzer et al. 1997)]. Thus, the long, filiform conidia found in the type of *Sculptolumina* represent an important diagnostic character for the genus. Thus *Sculptolumina* can be recircumscribed to include species that have long filiform conidia in addition to lecideine apothecia, brown hypothecia, inspersed hymenia and ascospores with thickened inner walls. In our opinion, this combination of characters better define the genus *Sculptolumina* and more readily distinguish it from other members of the Physciaceae, especially from those belonging to the very large crustose genera *Rinodina* and *Buellia* s. lat., including *Buellia* s. str. (= *Hafellia*, see Gams 2004), *Amandinea* or *Tetramelas*. Unfortunately, the conidia of the only other species assigned to *Sculptolumina* (*S. serotina*) are unknown at present.

According to Aptroot (2002) the genus *Sculptolumina* is indistinguishable from *Rinodina* in the current sense, and he regards them as being synonymous. Although the lecideine apothecia, brown hypothecia and *Bacidia*-type asci present in *Sculptolumina* distinguish it from most *Rinodina* species, the long filiform conidia totally exclude this synonymy. At present, the only species provisionally retained in *Rinodina* (Giralt 2000, 2001; Giralt & Matzer 1994) with lecideine apothecia, brown hypothecia and *Bacidia*-type asci are *R. ericina* (Nyl.) Giralt, *R. insularis* (Arnold) Hafellner and *R. kalbii* Giralt & Matzer (= *R. ericina*-group). Like all other *Rinodina* species, two of these species have short bacilliform conidia (unknown in *R. insularis*), to 8 µm long. If the presence of lecideine apothecia, brown hypothecia and *Bacidia*-type asci makes the generic position of the species of *R. insularis* group questionable (Giralt & Matzer 1994; Helms et al. 2003; Rambold et al. 1994), the inclusion of *Sculptolumina* within *Rinodina* is even more unlikely given that in addition to these features it has long filiform conidia, an important taxonomic character in the Physciaceae. Although molecular studies have yet to include either the *R. ericina*-group or *Sculptolumina*, these taxa clearly exhibit characters which distinguish them from *Buellia* and *Rinodina* (Helms et al. 2003).

Atproot (2002) further suggested that the genus *Sculptolumina* is closely related to the *Rinodina oxydata*-group which has identical *Mischoblastia*-type ascospores. Aspects of this view are defended by Sheard et al. (2008). Although this recent study emphasizes the significant interest of *Buellia japonica* because it shares typical characters of *Rinodina* (*Mischoblastia* ascospores) and *Buellia* (lecideine apothecia and brown hypothecia), it gives four reasons for not recognizing *Sculptolumina* and for maintaining *S. japonica* within *Buellia*. Like Aptroot (2002), Sheard et al. (2008) referred to the possibility that given its *Mischoblastia*-type ascospores, *B. japonica* could be closely related to the species of the *R. oxydata*-group, and advocated the possible inclusion of *B. japonica* and *R. oxydata* group within *Mischoblastia* Massal. (Massalongo 1852; Rambold et al. 1994), dependent upon further studies. Rambold et al. (1994) were tempted to reëstablish the genus *Mischoblastia* to include the species of the *R. oxydata*-group based mainly on the fact that the "asci were intermediate between the *Lecanora* and the *Bacidia*-types." Further correlating characters mentioned by these authors were the presence of *Bagliettoana*-green pigment and the tendency of the lecanorine apothecia to become pseudolecanorine (see also Matzer & Mayrhofer 1996: 22). These three characters, together with the colorless hypothecia, the hymenia lacking oil droplets and the presence of atranorin and bacilliform conidia (present in the species of *R. oxydata*-group or *Mischoblastia*, if accepted) are all absent in *Sculptolumina*. Thus we are confident that *S. japonica* is unrelated to the *R. oxydata*-group because they only share one key character, the presence of *Mischoblastia*-type ascospores. Moreover, in contrast to *R. oxydata*-group, where the *Mischoblastia*-type ascospores develop with type-A ontogeny, the ascospores of *S. japonica* develop with type-B ontogeny.

Although Aptroot (2002) did not consider the second species of *Sculptolumina* (*S. serotina*), with *Pachysporaria* type ascospores (Marbach 2000), Sheard et al. (2008) used the fact that the two species assigned to the genus have alternative types of spores as a further argument for rejecting the genus *Sculptolumina*. However, within the Physciaceae, genera often include species which exhibit different ascospore-types [e.g., *Amandinea* and *Buellia* (*Buellia*- and *Physconia*-types); *Hyperphyscia*, *Phaeophyscia* and *Physcia* (*Physcia*- and *Pachysporaria*-types); *Rinodina* (many different ascospore-types)] whereas different genera often exhibit the same ascospore-types [e.g., *Buellia*-type (*Amandinea*, *Buellia*, *Phaeorryza*); *Dirinaria*-type

(*Australiaena*, *Diploicia*, *Pyxine*, *Rinodina*, etc.); *Physcia*-type (*Mobergia*, *Rinodina*, etc.); *Physconia*-type (*Anaptychia*, *Tornabea*, etc.)].

According to Helms et al. (2003), most species of *Rinodina*, including those of the *R. oxydata*-group, would be included in the family Physciaceae, whereas the species of *Sculptolumina* and those of the *R. ericina*-group, would belong to the Caliciaceae or Buelliaceae. Indeed, ascospores with inner wall thickenings are not exclusive to the Physciaceae since all genera in the Buelliaceae with *Callispora*, *Dirinaria* and *Physconia*-type ascospores possess the same feature (e.g., *Hafellia*, *Pyxine*, *Buellia*). Not unexpectedly, the Physciaceae include at least one species ("*Buellia*" *parvula*) and one genus (*Phaeorriza*) with *Buellia*-type ascopores which lack internal wall thickenings.

Sheard et al. (2008) maintained *S. japonica* within *Buellia* s.l. However, when it is well known that *Buellia* is polyphylethic and when genera previously segregated or excluded from it are widely accepted [e.g., the genera *Hafellia* (= *Buellia* s. str., see Gams 2004), *Tetramelas*, *Australiaena*], it seems inconsistent not to accommodate *B. japonica* within the well-circumscribed genus *Sculptolumina*.

In our opinion, the joint occurrence of filiform conidia, inspersed hymenium and ascospores with inner wall thickenings clearly delimit the genus *Sculptolumina* and distinguishes it, not only from *Rinodina* (including the *R. oxydata*- and *R. ericina*-groups), *Amandinea*, *Buellia*, *Hafellia* and *Tetramelas* but also from all genera hitherto described in the Physciaceae (including the Buelliaceae).

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