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A new species of small black disc fungi, *Smardaea australis* (Pezizales, Pyronemataceae), is described from Australia

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Abstract: A new species, *Smardaea australis* P.S.Catches. & D.E.A.Catches. (Ascomycota, Pezizales, Pyronemataceae) is described and illustrated. This is the first record of the genus in Australia. The phylogeny of *Smardaea* and *Marcelleina*, genera of violaceous-black discomycetes having similar morphological traits, is discussed.

Keywords: Fungi, discomycete, Pezizales, *Smardaea*, *Marcelleina*, Australia

Introduction

Small black discomycetes are often difficult or impossible to identify on macro-morphological characters alone. Microscopic examination of receptacle and hymenial tissues has, until the relatively recent use of molecular analysis, been the method of species and genus determination.

Between 2001 and 2014 five collections of a small black disc fungus with globose spores were made in South Australia. Initially the fungus was identified as *Marcelleina atroviolacea* Brumm., since it conformed in all respects with a fungus previously collected in 1964 from Anglesea, Victoria, by Gordon Beaton. This collection had been sent by Beaton to the Royal Botanic Gardens, Kew, and described by Rifai (1968) as *M. atroviolacea*.

No other species of *Marcelleina* Brumm., Korf & Rifai has been recorded in Australia, nor of other possibly confusing genera such as *Smardaea* Svrček and *Otidea* (Pers.) Bonord, although species of the latter genus have been found in New Zealand (Atlas of Living Australia, ALA). There are no records of any species of *Smardaea* in the ALA or Australia's Virtual Herbarium (AVH). Those in the ALA and AVH of *Marcelleina atroviolacea* are of the collections from South Australia covered in the present study and of Beaton's collection from Victoria. The ALA also records *M. atroviolacea* as being in New Zealand, but these collections had been misidentified and were *Pseudoplectania affinis* M.Carbone, Agnello & P.Alvarado (P. Johnston, pers. comm.; NZFungi2 2016). *Pseudoplectania* Fuckel also has dark coloured apothecia and globose ascospores, but differs morphologically from *Smardaea* in having dark hairs on the excipulum.

Marcelleina and *Smardaea*

Four genera of small black discomycetes with purple pigmentation, *Greletia* Donad., *Pulparia* P.Karst., *Marcelleina* and *Smardaea*, had been separated by characters in part based on distribution of this purple pigmentation, as well as on other microscopic characters. Their relationships have been much discussed (Donadini 1984; Pfister 1985; Moravec 1987; Haffner 1995; Perić 2001; Benkert 2005), but Korf & Zhuang (1991) followed Donadini (1979) in accepting two genera: *Marcelleina* (with *Pulparia* as a synonym) and *Smardaea* (with *Greletia* as a synonym).

The generic name *Marcelleina* was proposed by van Brummelen, Korf and Rifai in 1967 (Brummelen 1967; Rifai 1968; Moravec 1987) in honour of Mme Le Gal, an eminent French mycologist who specialised in discomycetes. The genus *Smardaea* was proposed by Svrček in 1969, named after František Šmarda, a Czech botanist.

Species in the genera *Marcelleina* and *Smardaea* have small, cupulate to saucer-like, sessile or subsessile, glabrous apothecia with violaceous-brown hymenium. The receptacle tissue of both is similar: ectal excipulum of globose or angular cells (*textura globulosa* or *textura angularis*) and medullary excipulum of interwoven septate hyphae (*textura intricata*). Asci are cylindrical and their apices do not turn blue in Melzer's reagent. Paraphyses are septate and contain purple granules.

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The two genera differ in that all *Marcelleina* species have globose spores, the paraphyses are usually unbranched and, though the sterile tissue and paraphysis contents have purple pigmentation, the asci and ascospores are not necessarily purple. The spores of *Smardaea* may be globose or ellipsoid, paraphyses are usually branched and there is purple pigment in asci, ascospores, paraphyses and excipula (Benkert & Moravec 1986; Moravec 1987; Hansen & Knudson 2000).

Nine species of *Smardaea* are presently recognised (Index Fungorum), four of which have globose spores. Of these only *S. planchonis* (Dun. ex Boudier) Korf & W.Y.Zhuang has smooth spores; *S. reticulosperma* (Donadini, Riousset & G. Riousset) Benkert has reticulate spores, those of *S. verrucispora* (Donadini & Monier) Benkert are warty and *S. marchica* (Benkert & J. Moravec) Benkert has subglobose, coarsely warted spores.

Eleven species of *Marcelleina* are listed in Index Fungorum. Seven of these have ornamented spores with ornamentations ranging from warty-tuberculate, ridged or partially to completely reticulate. Of the four smooth-spored species, *M. benkertii* J.Moravec, *M. chopraiana* (L.R.Batra) S.C.Kaushal, *M. parvispora* E.Rubio, Tabarés & M.A.Martinez and *M. atroviolacea*, only the latter has purple colour in all tissues and structures. The generic position of *M. parvispora* will be discussed later in this paper.

Korf & Zhuang (1991) synonymised *Marcelleina atroviolacea* and *Smardaea planchonis* and erected the new combination *Smardaea planchonis*.

Distribution and habitat of *Smardaea planchonis*

Smardaea planchonis, albeit under its various synonyms, is widespread in the northern hemisphere (Rifai 1968; Perić 2001). The type locality is France and it has been found in a number of countries in central and southern Europe (Boudier 1887; Lagarde 1911; Donadini 1984; Moravec 1987; Marchetti & Franchi 1993; Haffner 1995; Perić 2001; Benkert 2005; Martin 2005; Cuesta & Ribes 2006; Lantieri *et al.* 2009), the U.S.A. (Pfister 1985), Bermuda (Seaver 1928) and has been reported in Argentina in the southern hemisphere (Gamundí 1960; Rifai 1968).

Smardaea planchonis is reported as growing in mostly sandy soil, often amongst moss and under Cupressaceae. For example, in Tuscany it has been found under *Cupressus sempervirens* L., *C. glabra* Sudw., *Juniperus oxycedrus* subsp. *macrocarpa* (Sibth. & Sm.) Ball and *J. phoenicea* L. (Marchetti & Franchi 1993). Benkert (2005), in his discussion on the distribution and ecology of *S. planchonis*, reported its presence under *Juniperus horizontalis* Moench., *J. chinensis* "plumosa aurea" and *Chamaecyparis obtusa* (Siebold & Zucc.) Endl. In the U.S.A. Pfister (1985) recorded it under *Yucca*. The Argentinian collections were from a park in the inland city of Mendoza, on moist soil in sandy groves.

Materials and methods

Habitat and associated plant communities were noted in the field. Collection locations were recorded by GPS, geodetic datum WGS84/GDA94 (Garmin GPS12) and *in situ* photographs taken (Nikon 4500). Macroscopic characters were described directly from fresh material. Colours are designated using the Royal Botanic Gardens Edinburgh Colour Chart (1969) and given as colour descriptor and number, e.g. "rust 13", and in general terms. Fresh material was dried in a food dehydrator at 35°C for 24 h (Hydraflo 1000FD).

Sections of fresh material and dried specimens were hand-cut and mounted in various media. For the amyloid reaction, fresh material was stained with Melzer's reagent and dried material was rehydrated in 5% NH_4OH before staining. Water mounts were used to determine colour of context, 5% KOH and 5% NH_4OH were used to determine reaction to alkali, and 5% H_2SO_4 to determine the acid reaction.

Measurements were made using an Olympus BH-2 microscope at ×400 or ×1000 with a calibrated ocular micrometer. Spore dimensions are given as: length range × width range (n = 40) and Q ratio (spore length/spore width). Dimensions of asci are given as length range × width range (n = 20). A Nikon 4500 camera was used to photograph microscopic characters.

Descriptions of *Smardaea australis* are based on the type collection, *P.S.Catcheside 4079* (AD-C 58765), with outlying measurements for other collections given in brackets. Photographs of fruit bodies and microscopic characters are from the type collection. All South Australian collections have been accessioned into the State Herbarium of South Australia (AD). AD numbers (AD-C nnnnn) are given in the Taxonomy section together with the Collector's number (*PSC nnnn*); in other sections only the Collector's number is used.

DNA Extraction, amplification and processing were as described in Catcheside *et al.* (2016). To place species of interest in the Pyronemataceae, sequences of the ribosomal RNA large subunit gene were aligned with those of representatives of each of the currently recognised families and lineages chosen from those used by Hansen *et al.* (2013). Sequences were manipulated with the Geneious 8.1.9 suite of programmes using Muscle for alignment and, for tree building, either neighbour joining (Fig. 8) or MrBayes (Fig. 9) using the HKY85 substitution model, 4 heated chains for 1,100,000 iterations including a burn-in of 100,000. Correlation between genetic and physical distance between collections was examined using the Pearson product-moment test in R.

Taxonomy

Smardaea australis* P.S.Catches. & D.E.A.Catches. *sp. nov.

Holotype: South Australia. Sleaford Bay, Coffin Bay National Park, on low sand dune, 34° 51' 12.8"S, 135° 44' 6.4"E, alt. c. 5 m, amongst moss with *Leucopogon parviflorus* (Andrews) Lindl., *Melaleuca* sp. and *Acacia longifolia* subsp. *sophorae* (Labill.) Court, 21 July 2014, *P.S. Catcheside PSC 4079 & D.E.A. Catcheside* (AD-C 58765).

Mycobank number: MB819607.

Apothecia scattered to gregarious, sessile; (3–) 5–15 mm diameter, (1–) 3–8 mm high (Fig. 1). *Disc* more or less circular, concave to flat; margin initially slightly inrolled, later becoming plane, entire to crenate, often becoming eroded; fuscous-black 36, violaceous-black 38, blackish-purple; smooth, sometimes slightly pitted, waxy. *Receptacle* saucer- to cup-shaped; sessile; concolourous with disc; smooth to finely scurfy; attached to substrate by a small central soil pad (Fig. 2: Section through hymenium and excipulum; Fig. 3: Hymenium showing asci, ascospores and paraphyses). *Flesh* 1–1.5 mm thick; dark brown, purplish. *Ectal excipulum* 50–100 µm thick (Fig. 4). The outer layer composed of thick-walled globose, subglobose, sometimes polygonal cells (*textura globulosa*), cells 15–30 µm across; walls purple-brown; clumps of cells aggregated to give receptacle a slightly scurfy appearance. Inner layer of thinner-walled, cylindric-subglobose cells to 40 µm long, arranged with long axis at right angles to surface of receptacle; colour of cells ranging from colourless to purple to red-purple in NH_4OH, pale purple to deeper or red-purple in KOH, more strongly purple/red-purple in water, orange-red in H_2SO_4. *Medullary excipulum* of interwoven, septate, branched hyphae 4–10 µm diameter (*textura intricata*), with similar colour reactions as cells of the ectal excipulum. *Subhymenium* of more compacted hyphae. *Hymenium* 200–250 µm thick. *Asci* 8-spored; cylindrical-clavate, (160–) 170–225 × 8.5–12.5 µm (Fig. 5); amyloid; attenuating towards base; base forked, arising from croziers (Fig. 6). Immature asci with purple colouration in alkali and water, red in acid, no colour in fully mature asci. *Ascospores* globose (7.5–) 8.0–10.5 (–11.5) × (7.0–) 8.0–10.0 (–11.5) µm diameter; Q = 1–1.08 (–1.09); smooth; uniseriate; in upper portion of the ascus; hyaline, subhyaline; often with one large globule and several smaller ones. Immature ascospores with purple colouration in alkali and water, red in acid, no colour in fully mature spores. *Paraphyses* slender, filiform (Fig. 7); slightly longer than asci; straight or slightly curved; sparsely septate; tips slightly swollen 2–7 µm diameter; with granular contents which are more densely concentrated at tips; granular contents purple to purple-brown in water and alkali, becoming browner with age of apothecium; paraphyses branching especially near base; often nodulose.

Fig. 1. *Smardaea australis*. Apothecia *in situ*. Scale = 10 cm.

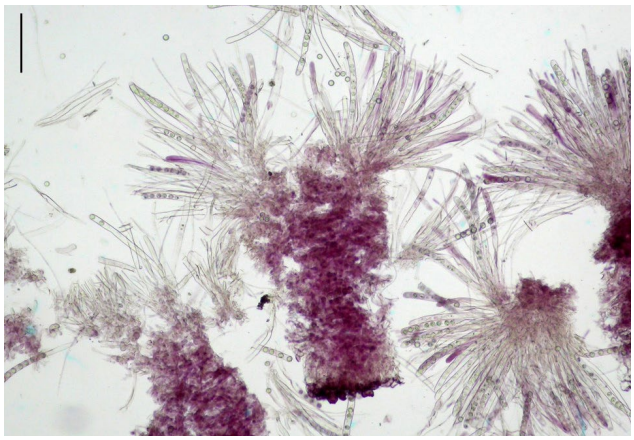

Fig. 2. *Smardaea australis*. Section through hymenium and excipulum. In water. Scale = 100 µm.

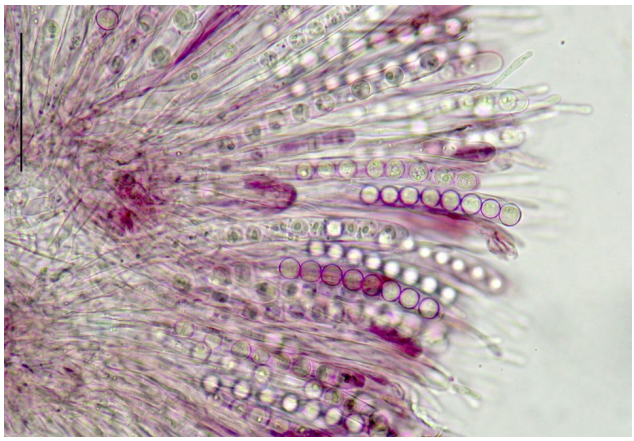

Fig. 3. *Smardaea australis*. Hymenium showing asci, ascospores, paraphyses. In water. Scale = 100 µm.

Additional specimens examined.

VICTORIA. Two miles West of Anglesea, terrestrial between road and dunes, 38° 25' 48.44"S, 144° 8' 40.14"E, 5 July 1964, as *Marcelleina atroviolacea* Brumm., *G.W. Beaton* (MELU F 121706a).
SOUTH AUSTRALIA. Flinders Ranges National Park below Bunyeroo Gorge car park, on surface of mostly bare clay soil amongst stones, 31° 25' 00"S, 138° 33' 29"E, alt. c. 300 m, on the bank of creek bed colonised by moss protonema, near *Callitris glaucophylla* Joy Thomps. & L.S.A. Johnson and *Eucalyptus camaldulensis* Dehnh., 10 Aug. 2001, *P.S. Catcheside PSC 1020 & D.E.A. Catcheside* (AD-C 51219); Mambray Creek, Mount Remarkable National Park, in soil amongst moss, 32° 49' 17"S, 138° 03' 37"E, alt. c. 200 m, in dry woodland near *C. glaucophylla*, *E. camaldulensis*, *Leucopogon* sp. and *Acacia* sp., 9 Aug. 2011, *P.S. Catcheside PSC 3637 & D.E.A. Catcheside* (AD-C 57291); Wilpena Pound, Flinders Ranges National Park, on surface of mostly bare clay soil, 31° 33' 03"S, 138° 35' 22"E, alt. c. 540 m, amongst *C. glaucophylla*, 16 July 2014, *P.S. Catcheside PSC 4043 & D.E.A. Catcheside* (AD-C 58766); Lincoln National Park, Eyre Peninsula, in soil and amongst moss, 34° 52' 12"S, 135° 52' 38"E, alt. c. 40 m, on raised bank at side of road, sandy dune heath, *L. parviflorus*, *Melaleuca* sp. and *A. longifolia* subsp. *sophorae*, 22 July 2014, *P.S. Catcheside PSC 4080 & D.E.A. Catcheside* (AD-C 58767).

Etymology. From the Latin *australis*, meaning southern. Referring to the geographic distribution of the species in the southern hemisphere.

Note. The nuclear ribosomal sequences of each of the five collections, *PSC 1020* (GenBank KY067461), *PSC 3637* (GenBank KY067462), *PSC 4043* (GenBank KY067463), *PSC 4079* (GenBank KY067464) and *PSC 4080* (GenBank KY067465), differ (Fig. 8), with *PSC 1020* and *PSC 4043* being heterozygous at single nucleotide positions in ITS2 and ITS1, respectively. There are ten variable sites in ITS1 (5.7%), eight in ITS2 (4.1%) and a further six in the ~960bp of the ribosomal RNA large subunit gene that was sequenced. This degree of intraspecific divergence in ITS sequence is high for ascomycetes (Nilsson *et al.* 2008). However, there is no significant correlation of sequence divergence and distance between collection sites (Pearson product-moment t = 1.38, df = 19, p = 0.18) and no obvious grouping with respect to substrate or plant association. Accordingly we consider each to be strains of *Smardaea australis*.

Notwithstanding the morphological similarity of *Smardaea* and *Marcelleina* species, comparison of ribosomal RNA large subunit sequences shows they are only distantly related members of the Pyronemataceae placed in the *Otidea* lineage and Pezizaceae respectively (Fig. 9).

Discussion

With the relatively few morphological characters to distinguish between them, identification of small black discomycetes is problematic. Spore characters, ascus amyloidity, pigmentation of tissues have been and are used to help identification to genus and species levels. Since the development of molecular sequencing and phylogenetic analyses, it has become clear that macro- and micromorphological characters alone are insufficient to determine taxonomic identity and phylogenetic relationships.

Taxonomy, morphology and purple pigmentation of *Marcelleina* and *Smardaea*

The similarities of the smooth, globose-spored species of *Marcelleina* and *Smardaea* make separation on morphological characters of the two genera difficult, if not impossible. As currently understood, all species of *Marcelleina* have inamyloid asci, globose spores and partial purple pigmentation of tissues. *Marcelleina atroviolacea* was alone amongst the marcelleinas in having purple pigment in all tissues, a character that suggests it be put in the genus *Smardaea*. Svrček's concept of the genus *Smardaea* was of species having inamyloid asci, oblong-ellipsoid, verrucose spores and all tissues with violaceous colouration. When Korf & Zhuang (1991) synonymised *M. atroviolacea* and *S. planchonis*, a synonymy that the present authors accept, they extended

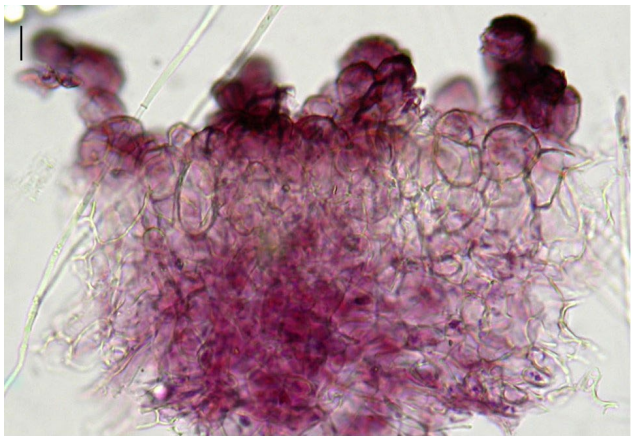

Fig. 4. *Smardaea australis*. Ectal exipulum. In water. Scale = 10 µm.

Fig. 5. *Smardaea australis*. Asci. In water. Scale = 10 µm.

the generic concept of *Smardaea* to include species with globose, smooth spores. Benkert (2005) commented that *S. planchonis* is the only species of *Smardaea* with such spores. *S. australis* becomes the second species in the genus with that combination of spore characters.

When Beaton identified his Victorian collection of a discomycete as *Marcelleina atroviolacea* he was following Rifai's concept of *M. atroviolacea*. Rifai documented the Australian Pezizales that had been sent to the Royal Botanic Gardens at Kew, a work that was published in 1968. The genus *Smardaea* was not erected until the following year (Svrček 1969) so Rifai's concept of *M. atroviolacea* would now place that taxon in the genus *Smardaea*. Beaton's collection of *M. atroviolacea* (MELU F 121706a) was examined and found to be similar in all respects to the South Australian collections, now named *S. australis*, based on comparison of spore and ascus measurements (Table 1), hymenial tissue, their inamyloid asci, smooth, globose spores and branched paraphyses with purple pigment.

The purple pigmentation in tissues is obviously an important character in determining genus and species, but its variability presents difficulties in interpretation. The asci and ascospores of all *Smardaea* species contain purple pigment while those of *Marcelleina* species are not necessarily purple; the paraphysis contents of both genera contain purple pigment.

In all Australian collections of *Smardaea australis* the cells and colouration of excipular tissue were similar: ectal excipulum of thick-walled, purplish-brown, globose to subglobose cells, medullary tissue of densely interwoven, purple hyphae. However, the intensity of the purple pigmentation in hymenial tissues varied in the different collections and was seemingly age-dependent. Asci, ascospores and paraphyses of collection *PSC 4043* had the most intense pigmentation, those in *PSC 4080* the least. The apothecia of *PSC 4080* were more mature than those of the other collections with almost all asci having mature ascospores. The distribution of pigmentation also varied in all collections: immature asci had distinct purple colouration as did their ascospores. The purple granular material in the paraphysis tips was variable, some paraphyses had strongly pigmented contents while the contents of others were clear. From our observations it appears that the pigmentation fades with maturity and thus is age-dependent. All pigmented tissues became a slightly darker, duller purple in KOH and NH_4OH and red-orange in acid. The purple colour was brightest in water which was found to be the most useful medium when determining intensity and distribution of the pigmentation.

While morphologically the Australian material has some characteristics of *Marcelleina* species, the extent of purple pigmentation and sometimes branched paraphyses fit better with *Smardaea*. Morphologically our new species, *Smardaea australis*, most closely resembles the northern hemisphere *S. planchonis*, however, it differs from *S. planchonis* in having shorter asci (Table 1): the ascus length of *S. australis* ranges from 155–225 µm, while that of *S. planchonis* is from 190–240 µm, if the measurements of Boudier (1887) are discounted. The size of the ascospores of both species is similar. Unfortunately there are currently no molecular data for *S. planchonis*, so the two taxa cannot be compared on a molecular basis.

Phylogenetic relationships of *Marcelleina* and *Smardaea*

Recent phylogenetic studies confirm the placement of *Marcelleina* in the Pezizaceae (Hansen *et al.* 2001; Hansen *et al.* 2005; Hansen & Pfister 2006; Perry *et al.* 2007; Tedersoo *et al.* 2010; Hansen *et al.* 2013). The position of the genus *Smardaea* in the Pyronemataceae is rather more complex. Perry *et al.* (2007) placed two species, *S. reticulosperma* (Donadini, Riousset & G.Riousset) Benkert and *S. amethystina* (W.Phillips) Svrček in the *Pyropyxis* clade and several species of *Otidea* in the adjacent *Otidea* clade. Tedersoo *et al.* (2013) show similar placements. Hansen *et al.* (2013) separated the *Pyropyxis* and *Otidea* lineages, while Frey *et al.* in *Engler's Syllabus of Plant Families* (2016) treat the large family Pyrenomycetaceae *s.l.* by dividing it into several groups,

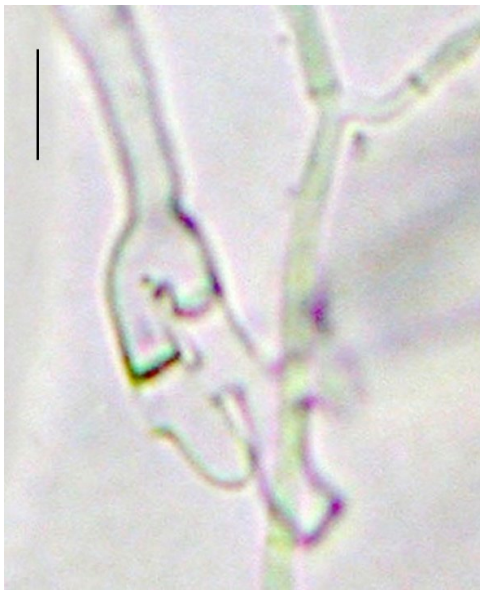

Fig. 6. *Smardaea australis*. Croziers. In water. Scale = 10 µm.

Fig. 7. *Smardaea australis*. Paraphyses. In water. Scale = 100 µm.

among them the family Otideaceae Eckblad, in which *Smardaea*, *Pyropyxis* and *Otidea* are included.

Ribosomal 28S sequences confirm that the Australian collections are within the genus *Smardaea* (Fig. 9) with the closest sister species being *S. reticulosperma* and *S. amethystina*. *Smardaea reticulosperma*, like *S. australis*, has globose spores but these have reticulate ornamentation. *Smardaea amethystina* has ellipsoid, warty spores. In the same clade are taxa lacking purple pigment, thus separating them from *Smardaea*: *Pyropyxis rubra* (Peck) Egger and two species of *Jafnea*, *J. fusicarpa* (W.R. Gerard) Korf and *J. semitosta* (Berk. & M.A.Curtis) Korf. *Pyropyxis rubra* has ellipsoid, smooth spores, but differs from *Smardaea* species in containing orange pigment. *Jafnea* species have ellipsoid spores, and the apothecia are brown and have hairs, another character that separates them from *Smardaea* whose apothecia are glabrous. *Otidea* species lie within the same clade. They are characterised by having apothecia which are split down one side, are yellow, brown or ochre, and have smooth, ellipsoid spores.

Thus there seems no particular morphological character that typifies members of the Otideaceae. Amyloidity of asci has been used to separate taxa such as the family Pezizaceae from the Pyronemataceae (Rifai 1968). The Pyronemataceae, which now include the Otideaceae, have inamyloid asci; the amyloid reaction of the ascus is a character associated with the Pezizaceae. Hansen *et al.* (2001) consider that amyloidity has been lost in some lineages, such as *Marcelleina*.

Marcelleina is in a lineage which is some distance from the Otideacae (Fig. 9). The phylogenetic data of Hansen *et al.* (2013) show *Marcelleina* and *Peziza gerardii* Cooke in the *Marcelleina/P. gerardii* lineage in the Pezizaceae as opposed to the Pyrenomycetaceae *s.l.* in which the Otideaceae lie. They also pointed out that Schumacher & Jenssen (1992) had noted the morphological similarities between *P. gerardii* and *Marcelleina* and *Smardaea*. *Peziza gerardii* is a violaceous-brown discomycete with amyloid asci and fusoid, ribbed ascospores (Beug *et al.* 2014), thus differing from *Marcelleina* with its inamyloid asci and

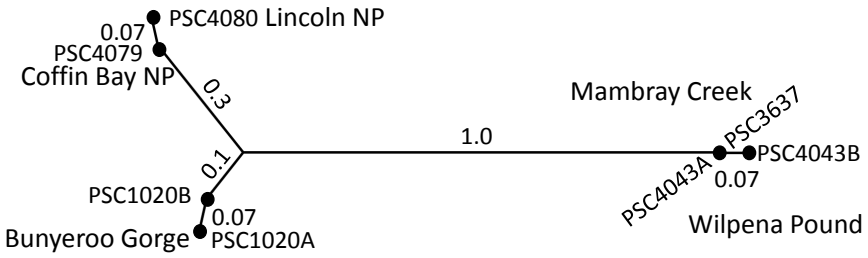

Fig. 8. *Smardaea australis* is genetically diverse. Neighbour joining tree of the sequences from five collections (~960 bp comprising 18S partial, ITS1, 5.8S, ITS2, 28S partial ribosomal RNA genes). Figures show the % divergence between sequences, names are the places of collection and A and B after the collection number refer to genotype differences between dikaryon components.

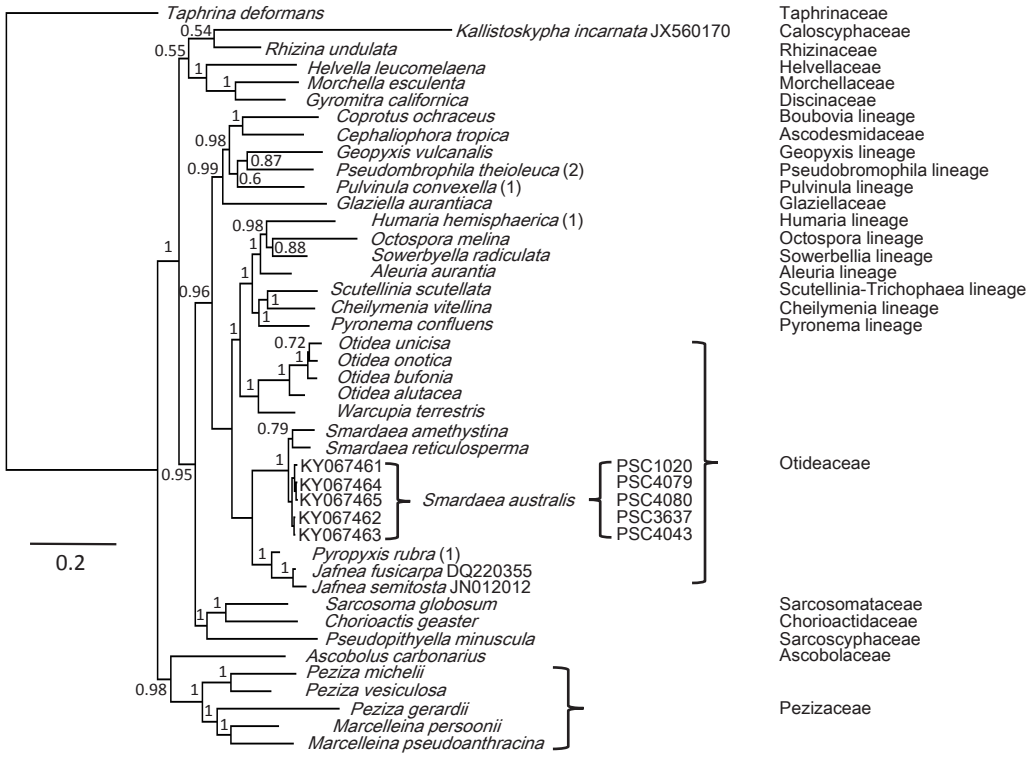

Fig. 9. Phylogeny of Pyrenomycetes showing the *Smardaea* and *Marcelleina* clades are distantly related. Sequences of the ribosomal RNA large subunit gene were aligned with those of representatives of each of the currently recognised families and lineages chosen from those used by Hansen *et al.* (2013). Tree construction used MrBayes. Figures show the posterior probability of branches (note that the support for some is less secure than those based on the combined RPB1, RPB2, EF-Icx and LSU sequences used by Hansen). GenBank accession numbers for the sequences used follow each species name.

globose spores. Although *Peziza gerardii* and species of *Marcelleina* have purple pigments they do not have these in all tissues whereas all species of *Smardaea* have purple pigments in all tissues.

The difficulties in species identification and placement within phylogenetic relationships of some of the small disc fungi is exemplified by a species described as a *Marcelleina*, *Marcelleina parvispora* E. Rubio, Tabarés & M.A.Martínez. However much earlier, in 1917, this taxon had been described as a species of *Caloscypha* Boudier: *C. incarnata* Duverney & Maine. It has a whitish to pinkish-violaceous hymenium, is found in association with *Eucalyptus* species and occurs in various parts of the world. After morphological examination and phylogenetic studies, Pfister *et al.* (2013) transferred the taxon into a new genus *Kallistoskypha* Pfister, Agnello, Lantieri & LoBuglio in the Caloscyphaceae, a family adjacent to Pezizaceae. Previously, *Caloscypha* had been included in the Pyrenomycetaceae (Pfister *et al.* 2013).

Habitat and trophic mode

Collections of *Smardaea australis* from the lower Eyre Peninsula, Port Lincoln and Coffin Bay, South Australia, and near Anglesea, Victoria, were on sandy dunes in coastal heath. Those specimens from the more northern localities in South Australia, i.e. Wilpena Pound and Bunyeroo Gorge, Flinders Ranges, and Mambray Creek, Mount Remarkable National Park, were on clay soil with river red gum, *E. camaldulensis* (Myrtaceae), and native pine, *C. glaucophylla* (Cupressaceae). Soil and vegetation types were thus different for these similar South Australian collections. The morphologically similar *Smardaea planchonis* is reported as growing mostly in sandy soils, as did coastal collections of *S. australis* but unlike those to the north on heavier soils. The five South Australian specimens of *S. australis* were collected from sites up to 460 km apart and, although they do have divergent ITS sequences, the diversity appears consistent with a single species. Molecular sequencing of the Victorian collection was not attempted due to its age.

Healy *et al.* (2013) investigated the trophic status of a high diversity of Pezizales. Within the Otideaceae, which includes the genera *Pyropyxis*, *Jafnea*, *Otidea* and *Smardaea*, they consider that *Otidea leporina* (Batsch) Fuckel is ectomycorrhizal. Hansen *et al.* (2013) consider *S. amethystina* and *S. reticulosperma* to be saprobic and comment that this is surprising since *P. rubra* is parasitic and differs morphologically by containing orange, not purple, pigments. A species of *Jafnea*, *J. semitosta* is considered saprobic (Antonín & Moravec 2010; Kuo 2012). There are therefore ectomycorrhizal, saprobic and parasitic species within the one family of Otideaceae. The trophic mode of *Smardaea* species is still uncertain. Tedersoo *et al.* (2006) and Tedersoo *et al.* (2010) did not include *Smardaea* in their study of fungal ectomycorrhizal lifestyles, but determined *Marcelleina* to be mycorrhizal.

Table 1. Measurements of asci and spores and locality in collections of *Smardaea australis* from Australia and *S. planchonis* worldwide. n.d. = no data

Collection/ Reference	Asci Range (µm)	Mean Asci (µm)	Spore Range (µm)	Mean Spore (µm)	Spore Q Range	Mean Spore Q	Locality
			***Smardaea australis* in South Australia**				
PSC 4079 (holotype)	170–225 × 8.5–12.5	194.75 × 10.32	8.0–10.5 × 8.0–10.0	9.2 × 9.05	1–1.08	1.0175	Eyre Peninsula
PSC 1020	190–225 × 10–12.5(–14)	208.4 × 11.6	8.0–11.5 × 8.0–11.5	10.1 × 9.87	1–1.05(1.09)	1.023	Flinders Ranges
PSC 3637	160–190(–210) × 9.5–12	177.25 × 10.8	8.0–10.5 × 7.5–10.5	9.03 × 8.87	1–1.07(1.09)	1.018	Mambray Creek
PSC 4080	160–200 × (8.5–)9–12.5	176.8 × 10.32	7.5–9.5 × 7.0–9.5	8.62 × 8.43	1–1.1	1.02	Eyre Peninsula
PSC 4043	155–195 × 9.5–12	173.45 × 10.37	8.0–1102 × 8.0–11.0	9.74 × 9.55	1–1.08	1.02	Flinders Ranges
			***Smardaea australis* in Victoria**				
MELU F 121706a	(160–)185–210 × 10–12	192.6 × 11	9.0–10.5 × 9.0–10.5	9.55 × 9.44	1–1.04	1.025	Anglesea
			***Smardaea planchonis* worldwide**				
Boudier 1887	135–150 × 10–12	n.d.	10 – 11(–12) (diam.)	n.d.	n.d.	n.d.	France
Cuesta & Ribes 2006	193.5–234 × 8.5–12.4	213.7 ×10.5	9.7–11.4 × 9.4–11.2	10.5× 10.3	1–1.1	1.02	Spain
Marchetti & Franchi 1993	190–230 × 11–12(–15)	n.d.	9–11(–12) (diam.)	n.d.	n.d.	n.d.	Tuscany
Haffner 1995	195–240 × 9.7–12	n.d.	7.9–11.3 (diam.)	n.d.	n.d.	n.d.	Austria
Benkert 2005	200–235 × 11–13(–16)	n.d.	10–12 (diam.)	n.d.	n.d.	n.d.	Germany
Perić 2001	198–228(–230) × 12–13(–15)	n.d.	8.5–11.5 (diam.)	n.d.	n.d.	n.d.	Montenegro
Pfister 1985	215–225 × 11–12	n.d.	8–10 (diam.)	n.d.	n.d.	n.d.	U.S.A.
Gamundí 1960	191–222 × 10.7–14.5	n.d.	None given	n.d.	n.d.	n.d.	Argentina

Lantieri *et al.* (2009) suggested that *S. planchonis* is mycorrhizal. Collections were mostly recorded under Cupressaceae or Pinaceae, perhaps suggesting that this species is mycorrhizal with trees of those families. *Smardaea australis* cannot be mycorrhizal with conifers since there were no *Callitris* species in the Eyre Peninsula localities. The trophic status of *Smardaea* remains unresolved.

In summary

The similarities in morphology and pigmentation of the *Smardaea* and *Marcelleina* species are striking given the ancient phylogenetic divergence implied by the 28S rDNA sequences (Fig. 9) and other analyses that infer two distinct lineages (Hansen *et al.* 2001; Hansen *et al.* 2005; Hansen & Pfister 2006; Perry *et al.* 2007; Tedersoo *et al.* 2010; Hansen *et al.* 2013). These data suggest cases of convergent evolution, perhaps driven by exposure to high levels of insolation, where the intense purple pigmentation would have provided protection from ionising radiation.

In the absence of molecular data on northern hemisphere collections of *Smardaea planchonis*, it is not possible to determine for certain, whether the Australian collections are synonymous with those from the northern hemisphere or Argentina. However, the shorter asci, variability and relative paleness of the violaceous pigmentation, absence of probably associated plant species and the distance from northern hemisphere and South American collections are consistent with the Australian collections being a new species.

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CORRIGENDUM to: A new species of small black disc fungi, *Smardaea australis* (Pezizales, Pyronemataceae), is described from Australia

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The description of the new species *Smardaea australis* P.S.Catches. & D.E.A.Catches. (Catcheside *et al.* 2017) contained one error. Inadvertently, the asci were described as "amyloid". This is not correct, the species has inamyloid asci, as do other species of the genus.

We thank Dr Mario Filippa for alerting us to the mistake.

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