

Australian coralloid fungi IV – *Ramaria filicicola*

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Introduction

Ramaria gracilis (Pers. : Fr.) Quél. is a very widely distributed taxon in the northern hemisphere with a range extending from the United States (Petersen 1975; Exeter et al. 2006) across to Europe (Breitenbach & Kranzlin 1986; Hansen & Knudsen 1997) and thence into Russia (Petersen 1975). This coralloid fungus is characterised by whitish or cream-coloured fruiting bodies that become ochraceous with age, are tufted in habit, have a somewhat tough texture, are extensively branched with acute apices, usually have a distinct odour of aniseed when fresh and mostly appear on the litter of northern hemisphere species of conifer. Rhizomorphs can be expected to be present in any collection of *R. gracilis*, and usually they are abundantly produced.

Systematically, *R. gracilis* belongs to subgenus *Lentoramaria* Corner. This subgenus contains species of *Ramaria* (Fr.) Bonord. in which the walls of the hyphae become extensively thickened. Two distinct types of hyphae can be produced which are called skeletal hyphae and secondarily skeletalised hyphae (Petersen 1988). Skeletal hyphae are typically quite narrow in diameter (2–4 µm), have an extremely fine, hair-like lumen, are without branches, do not have clamps except at their commencement, and often have lengths of 100–200 µm or occasionally longer. Secondarily skeletalised hyphae can be visualised as normal hyphae in which the cell wall has become much thicker than normal. These hyphae can be branched and/or clamped and usually have a rather rough or uneven outline when compared with a normal generative hypha.

Ramaria gracilis belongs to a section of *Lentoramaria* in which skeletal hyphae are found abundantly in the rhizomorphs and additionally

Abstract

A large number of Australian collections that would routinely be assigned to *Ramaria gracilis* (Pers. : Fr.) Quél. have been examined together with authentic material of that species from both Sweden and the United Kingdom. This has confirmed that the European and Australian taxa are separate species and that *R. gracilis* as known in Europe does not occur in Australia. The type collection of *Ramaria filicicola* (S.G.M.Fawc.) Corner has been examined and all Australian collections previously identified as *R. gracilis* are now considered to be identical to *R. filicicola*. An updated description for *R. filicicola* is here provided together with a colour image of this Australian taxon. *Ramaria filicicola* is now considered to be a widespread Australian species which also occurs in New Zealand.

Key words: fungi, systematics, *gracilis*, Australia

penetrate upwards into the stipe and at least the lower branches. These tissues are therefore dimitic and they may also contain secondarily skeletalised hyphae. Corner (1970) erroneously stated that the skeletal hyphae in *R. gracilis* were restricted to the rhizomorphs, however Petersen (1975, 1988) found that skeletal hyphae are present in the fruiting body itself and this is also confirmed by Hansen and Knudsen (1997).

Most Australian records of a 'whitish to buff' coralloid taxon identify the species as *Ramaria gracilis*. At least some of these records have noted that the Australian species so identified differed in some ways from the European species, but these differences were apparently dismissed as minor because the whole 'raft of characteristics' seemed to fit *R. gracilis* much more closely than anything else. Fuhrer (2005) published an image and a short description of a coralloid fungus which he identified as *R. gracilis*, and the current situation seems to be that if the fungus is whitish, tufted, has acute apices and is on forest litter, then it must be *R. gracilis*.

Difficulties arise however, when another species, *Ramaria filicicola* (S.G.M.Fawc.) Corner (= *Clavaria filicicola* S.G.M.Fawc.), is considered. *Ramaria filicicola* is remarkably similar to *R. gracilis* and, as its name suggests, was found in association with tree-ferns and/or their associated litter. Australian material describing *R. filicicola* has rarely been published apart from the original type description of Fawcett (1940), and it seems to have been separated from *R. gracilis* largely on the basis of the preference for tree-fern debris (Fawcett 1940; Willis 1958). Species separation purely on the single criterion of substrate is, in the author's opinion, unsatisfactory. However, this situation has recently become even more untenable because Fuhrer (2005) indicated that what he considered to be *R. filicicola* is capable of exploiting both forest and tree-fern litter.

This paper therefore has two aims. First, to ascertain whether the Australian species designated as *R. gracilis* is actually identical to the European taxon. Second, and as a consequence, to compare collections of Australian material and determine if the separation of the two Australian taxa identified as *R. gracilis* and *R. filicicola* is supported, or whether they are in fact the same species.

Some records of *Ramaria gracilis* in Australia

There do not seem to be any records indicating the presence of *Ramaria gracilis* in Australia prior to 1913. No mention of the species is to be found in the lists of Cooke (1892), McAlpine (1895) or Bailey (1913) and the first reliable description, with available herbarium records, appears to be that of Cleland (1935) who recorded a coralloid fungus he believed to be *Clavaria gracilis* Pers. : Fr. from South Australia, where he found it growing in tufts on *Pinus radiata* D. Don litter. Cleland noted that it had a pale buffy tint, acute apices, was extensively branched, and often had sheets of mycelium at the base. He also described its slightly tinted and irregular spores ($5.5 \times 3.5 \mu\text{m}$) but did not report any details of either the rhizomorphic or tramal structures. Cleland did not record any associated odour.

Fawcett (1939) recorded what she considered to be *C. gracilis* from the Brisbane Ranges in Victoria and provided an excellent description which included the presence of rhizomorphs and a slightly fragrant odour. Like Cleland (1935), Fawcett (1939) found the species in tufts amongst the litter of an exotic species of pine, in this case *Pinus insignis* Douglas ex Loudon. Willis (1958) gave a very brief description of what he considered was *Ramaria gracilis* which included the white or clay coloured to cinnamon tints of the fungus, together with the fact that it was found 'under pines'.

Griffiths (1985) described *R. gracilis* from the Darling Scarp of Western Australia where he recorded it as occurring 'in open mossy ground beneath Peppermints'. This record is uncertain because Griffiths also stated that the spores are 'squarish-oval with prominent pore'. The spores of *R. gracilis* do not have a 'prominent pore'. Hilton (1988) listed *R. gracilis* for Western Australia but, apart from a herbarium record, provided no other details.

Fuhrer and Robinson (1992) provide an excellent colour photograph and a short description of what they consider to be *R. gracilis* as found in Tasmania. They indicate that the species is found both in eucalypt forests and pine plantations. Despite the obvious 'buff tints', the overall 'whitish' colour is very marked in the photograph provided. Fuhrer (2005) contains a photograph of a large coralloid tuft identified as *R. gracilis* which is then described as white to clay-coloured and common in both eucalypt and pine forest. Fuhrer (2005) also noted

the habit of the species to form partial or complete 'growth rings several metres in diameter'.

Some records of *Ramaria filicicola* in Australia

Clavaria filicicola was first described from Victoria by Fawcett (1940) where it was found growing on the surface of tree-fern trunks (*Dicksonia antarctica* Labill.) just below the crown of leaves. Fawcett stated that it arose from a dense mycelium, that it was at first pure white and then became yellow to ochraceous buff when old, had sharply pointed apices and was without a distinct odour. The spores were described as yellowish in bulk, distinctly rough, oblong elliptical and $5.6\text{--}7 \times 3.6\text{--}3.9 \mu\text{m}$. Fawcett noted that *C. filicicola* closely resembles *C. gracilis*, but that the two species can be separated on the basis that *C. filicicola* has rougher spores, no odour and grows on tree ferns.

From the date of Fawcett's type description in 1940, there are very few published records for *Ramaria filicicola*. Corner (1950) transferred the species to *Ramaria* but simply quoted the description of Fawcett (1940). Corner considered that the species could be identical to *R. megalorhiza* (Berk. & Broome) Corner and he also noted that *R. filicicola* did not have the aniseed odour of *R. gracilis*. As well as the species *R. gracilis*, Willis (1958) also listed *R. filicicola* Corner and provided a description that emphasised the tree-fern trunk habitat as a method of identifying and separating the species from *R. gracilis*. Apart from the habitat separation, Willis's brief descriptions of both species are remarkably similar and would not serve to definitively separate the two taxa.

The last known published record for *R. filicicola* is that of Fuhrer (2005) where the photograph of the species shows it to be growing amongst forest litter with a fern component. Fuhrer indicated that the species was to be found amongst forest litter, but particularly decaying tree-fern debris.

Materials and methods

Forty-five collections were examined during the production of this paper and the material was sourced from the following herbaria: BRI, UNSW, MELU, MEL, HO, AD, PERTH, TENN and USO. A representative sample of 20 of those collections is presented under

'Selected specimens examined'. Specimen samples were examined under an Olympus CX40 research light microscope (with drawing tube) using both ammoniated congo red and cotton blue in lactic acid as the mountants. Congo red was the preferred initial stain for all tissues, while cotton blue (with the sample pre-heated for a few seconds in the mountant) was used to provide accurate observations of the spore wall and its structures. Q values are omitted for the basidia because, like most species of *Ramaria* so far encountered, the basidial lengths appear to vary considerably with both fruiting body maturity and even the sampling location on the fruiting body. The basidial mean should also be accepted with some caution. The distribution chart was developed using DMAP (Morton 2005). Colour chip references are not yet available for this taxon.

Discussion

Ramaria gracilis is defined as having both dimitic rhizomorphs and basidiomata: skeletal hyphae occur in the rhizomorphs, the stipe and usually in at least the lower branches of the fruiting body (Marr & Stuntz 1973; Petersen 1975; Hansen & Knudsen 1997; Franchi & Marchetti 2001). Whilst the Petersen neotype (L 910.262–1000, Petersen 1975) has not been seen (it can safely be assumed to conform precisely with Petersen's dimitic concepts), two collections of European material of *R. gracilis* from Norfolk, UK (USO 295806) and Drottningholm, Sweden (USO 333207) have been examined. Both of these collections (the first of which was collected by E.J.H. Corner himself) were identified by Corner as *R. gracilis* and each confirms the dimitic concepts presented by the above authors: skeletal hyphae were found to be present in the rhizomorphs and also running through the stipe trama and into the branch trama of the fruiting bodies. Corner (1970) erroneously indicated that skeletal hyphae were only to be found in the rhizomorphs/mycelium of *R. gracilis*, however the written and personal observational evidence provided above overwhelmingly shows that Corner was mistaken in his conclusions and that skeletal hyphae are to be found not only in the rhizomorphs of *R. gracilis* but also in the main parts of the fruiting body itself. This dimitic status of *R. gracilis* has also been confirmed by the examination of a relevant Canadian collection made by R.F. Cain (USO 295807).

Throughout this investigation, no collections of Australian material (originally assigned to either *R. gracilis* or *R. filicicola*) have demonstrated the presence of skeletal hyphae anywhere else other than in the rhizomorphs and thus both species as currently understood in Australia, are identical in this structural aspect. The presence or absence of secondarily skeletalised generative hyphae is rather more variable, but the overall circumstances are similar for Australian material that has been originally assigned to either species. Some collections assigned to either species have very few of these secondarily skeletalised hyphae which may be confined to the rhizomorphs only. In other collections, secondarily skeletalised generative hyphae may be found generally throughout the basidioma and this variable situation produced the comment by Petersen (1975) in which he indicated a Cleland collection totally lacked skeletalised generative hyphae. Petersen (1988) indicated that New Zealand material of *R. filicicola* consistently displayed skeletalised hyphae in the branch trama whereas in Australian material assigned to either *R. gracilis* or *R. filicicola*, the presence of skeletalised hyphae was less common.

No collection of either species, as found in Australia, is recorded as displaying a distinctive scent of aniseed. Cleland (1935) did not record any odour for *R. gracilis*, Fawcett (1939) indicated that *R. gracilis* had a slightly fragrant odour, and Fawcett (1940) indicated that *R. filicicola* was odourless. My own field observations indicate that there is only a slight 'medicinal' or 'fungousy' odour in any collection previously assigned to *R. gracilis* – there is never a strong aroma of aniseed. It is highly unlikely that other field workers would not have recognised such an aroma (if present) and recorded it, and on this basis it is confidently asserted that the aniseed odour is absent from Australian material that has been identified as either *R. gracilis* or *R. filicicola*.

Conclusions

There is no doubt that Australian collections assigned to *Ramaria gracilis* are very similar in macroscopic characters to the recognised European taxon, however the Australian collections differ in microstructure and almost certainly in some biochemical pathways as the absence of the aniseed odour demonstrates. For these reasons, the Australian species is no longer considered

to be *R. gracilis* but is a separate taxon. Petersen (1975) reached the same conclusion but was reluctant to make any changes because he had seen very little material. In a later publication, Petersen (1988) rejected the concept of *R. gracilis* for New Zealand material and placed all such collections under the name of *R. filicicola*.

The observations which form the basis of this present research also confirm that there are no discernible differences between the Australian material previously assigned to the European species *R. gracilis*, and material of the Australian species *R. filicicola*, apart from the normal macroscopic variations that can be expected under different habitat conditions. For all the above reasons, the name of *R. gracilis* is rejected for Australian material which is now identified as the single species *R. filicicola*.

Taxonomy

Ramaria filicicola (S.G.M.Fawc.) Corner, *Ann. Bot. Mem.* 1: 576 (1950)

Clavaria filicicola S.G.M.Fawc., *Proc. Roy. Soc. Victoria*, n.ser. 52: 155 (1940). *Type*: Victoria, Turtons Pass, May 1935, S.G.M.Fawcett s.n. (holo: MELU 7036F!)

Clavaria gracilis sensu Cleland, *Toadstools and Mushrooms and Other Larger Fungi of South Australia* part 2: 266 (1935) and *sensu* Fawcett, *Proc. Roy. Soc. Victoria*, n. ser. 51: 17 (1939) *non* Pers.: Fr.

Ramaria gracilis *Victorian Naturalist* 74: 131 (1958) and *sensu* Fuhrer, *A field guide to Australian fungi*: 211 (2005) *non* (Pers.: Fr.) Quéf.

Clavaria crispula sensu Fawcett, *Proc. Roy. Soc. Victoria*, n. ser. 51: 16 (1939) *non* Fr.: Fr.

Ramaria crispula sensu J.H.Willis, *Victorian Naturalist* 74: 131 (1958) *non* (Fr.: Fr.) Quéf.

Clavaria stricta sensu Fawcett, *Proc. Roy. Soc. Victoria*, n. ser. 51: 17 (1939) *non* Pers.: Fr.

Basidiomata –6 cm diam. and –10 cm high; overall shape oboconical; *apices* dull white, tapered and awl-shaped, often dichotomous, dry; *branches* whitish to pale pinkish buff and then becoming buff-brown and more brownish as patches of basidiospores mature, cylindrical although sometimes flattened and usually very distinctly flattened near the axils, smooth but with scattered rough patches, vertically oriented; *axils* usually round but there may be

occasional acute axils present; *stipe* 1–2 cm long and up to 0.5 cm diam., single, pale buff, smooth but with scattered rough patches, aborted branches absent. *Flesh* white, colour changes absent. *Odour* slightly fragrant to medicinal or absent; *taste* not recorded. *Rhizomorphs* present and usually abundant. *Basidiospores* (5.0–)5.8–7.2 × 3.2–4.3 μm, mean 6.3 × 3.8 μm, Q: 1.5–2.0, mean Q: 1.67, ellipsoid, occasionally uniguttulate but mostly granular, hilar appendage prominent and truncate, ornamentation of scattered warts and small ridges, spore wall and warts strongly cyanophilic in cotton blue; *basidia* 32–47 × 5.4–7.8 μm, mean 38.9 × 6.7 μm, 4-spored, clamped; *sterigmata* up to 8 μm long, distinctly long-conical, straight; *branch trama* monomitic, composed of thin-walled, clamped, sometimes inflated hyphae 3.5–14 μm diam., with or without scattered to abundant secondarily skeletalised generative hyphae 3–8 μm diam. which commence or end in a clamp connection or sometimes an ampulliform swelling,

ampulliform septa present and common, skeletal and gloeoplerous hyphae absent; *stipe trama* monomitic and similar to branch trama except that ampulliform septa are abundant; skeletal hyphae are sometimes invasively present in the stipe trama immediately adjacent to the mycelium, but they do not penetrate any distance up the stipe; *ampulliform septa*, ~16 μm diam., often with delicate stalactitic ornamentation present; *rhizomorphic trama* dimitic, generative hyphae similar to stipe trama but with abundant skeletal hyphae 1.5–2.5 μm diam. and often with secondarily skeletalised generative hyphae. (Figs 1, 2)

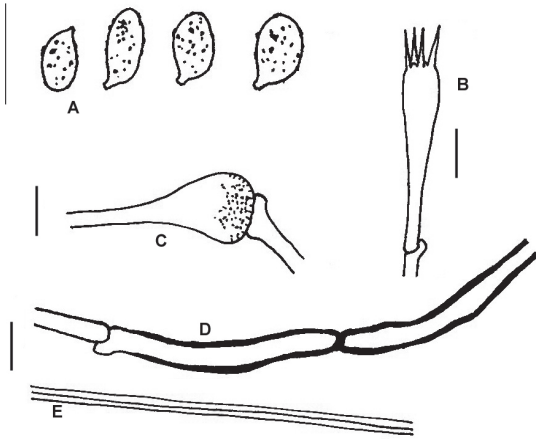
Macrochemical reactions: Not yet known for Australian material however Petersen (1988) states that New Zealand material becomes a deep slate-green when tested with a 10% aqueous solution of ferric chloride.

Habit: Basidiomata emerging from mycelial mats (in or under litter on soil or in tree-fern debris) which are

Figure 1. *Ramaria filicicola* from Queensland showing rhizomorphs, © A.M.Young



Figure 2. *Ramaria filicicola*. **a.** basidiospores; **b.** basidium; **c.** ampulliform septum; **d.** secondarily skeletalised hypha; **e.** skeletal hypha. Scale bars = 10 µm



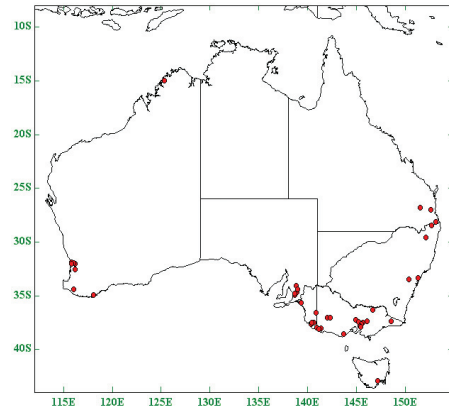
particularly noticeable when occurring in forests of *Pinus* spp., gregarious and may form 'fairy rings'.

Habitat: May occur in tree-fern areas (especially *Dicksonia antarctica*), but mostly found in forest or woodland; frequent in forests of *Pinus* spp. and also in mixed forest or woodland containing *Eucalyptus* and/or *Acacia* spp.

Notes: Fawcett (1940) described the type habitat of *Ramaria filicicola* as the 'trunks of *Dicksonia antarctica*, usually immediately below the crown of leaves'. Unfortunately, her description thus led to the situation in which the species was considered to be more or less restricted to tree-fern material. Herbarium records indicate that Fawcett's tree-fern substrate appears to be more 'unusual than normal' when it is compared with the remainder of the recorded substrates frequented by *R. filicicola*. Collection notes available to this study suggest that the species is almost always found on ground litter (with or without a tree-fern component) and that the litter may be derived from either native or exotic trees.

Ramaria filicicola is now known to be widespread across southern Australia with its range extending into south-east Queensland, and there is a single collection from the Kimberley region of Western Australia (Fig. 3). It also occurs in New Zealand. The wide range of this taxon and its presence in native eucalypt forests indicate that

Figure 3. *Ramaria filicicola*. Map showing currently known Australian distribution



the species is indigenous to the Australian region and was not introduced accidentally with species of *Pinus* or other exotics. Records indicate that 'fairy rings' can be formed in both native eucalypt/acacia forests and exotic pine forests.

Selected specimens examined: QUEENSLAND. Lamington National Park, 11.iii.1997, A.M.Young 1921, (BRI, AQ603862); Mount Mee, 26.v.2005, A.M. Young & N.A. Fechner s.n., (BRI). **NEW SOUTH WALES.** Gibraltar Range National Park, 22.vi.2006, N.A. Fechner & A.M. Young s.n., (BRI); Richmond Range State Forest, 10.iii.1983, J.J. Bruhl s.n., (UNSW 83/168); Mount Tomah, 12.iv.1975, A.M. Young 312, (BRI, BRIP24912). **VICTORIA.** Brisbane Ranges, 14.vi.1936, S.G.M. Fawcett s.n., (MELU 7109F); Narbethong, 29.vi.1976, H.A. Morrison s.n., (MEL 269111, BRI). **TASMANIA.** North West Bay River, 21.iv.2005, G. Gates & D. Ratkowsky GGDR30/2005, (HO). **SOUTH AUSTRALIA.** Bangham, J.B. Cleland s.n., (ADC 000469); Mt. Burr, ix.1965, J.A. Simpson s.n., (ADC 000 470); Marsh's Swamp, 2.viii.1969, L.D. Williams 3377, (ADC 28710). **WESTERN AUSTRALIA.** Pemberton, 4.viii.1981, R.N. Hilton s.n., (PERTH 00947806); Cameron Forest Block, 22.vi.2004, R.M. Robinson & R.H. Smith FC690, (PERTH 06641202); Juniperina Creek, 14.v.1992, K. Syme & M. Hart KS471/92, (PERTH 05439698). **NEW ZEALAND.** Nelson, 20.iv.1983, R.H. Petersen s.n., (TENN 43829).

Specimens examined of Ramaria gracilis: CANADA. Cedar Mills, Peel Co. Ontario, 30.ix.1956, R.F. Cain s.n., (USO 295807). **SWEDEN.** Drottningholm, 1905, C.G. Lloyd 19125, (USO 333207). **UNITED KINGDOM.** Brandon, Norfolk, 4.x.1946, E.J.H. Corner 449, (USO 295806).

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