*The Lichenologist* **37**(3): 191–197 (2005) 
doi:10.1017/S0024282905015203 *Printed in the United Kingdom*

# The first lichen-forming species of *Psammina*, *P. palmata* sp. nov., with notes on the status of *Cheiromycina* and *Pycnopsammina*

**Peter M. EARLAND-BENNETT and David L. HAWKSWORTH**

**Abstract:** The first lichen-forming species of *Psammina*, *P. palmata* sp. nov., is described from decorticate oak in West Suffolk (UK). It is distinguished from other species by the palmate and 2–3-order branched non-septate conidia flattened in a single plane. The conidia recall those of the lichen-forming hyphomycete genus *Cheiromycina* in some respects, but do not originate from the swollen subglobose cells characteristic of that genus. The generic concepts in this complex of algicolous, lichen-forming, lichenicolous, and saprobic fungi are discussed, and it is concluded that *Pycnopsammina* should be treated as a synonym of *Psammina* as the conidiogenesis resembles that of the type species of *Psammina*, which also has rather similar conidiomata; the combination *Psammina lobariae* comb. nov. (syn. *Pycnopsammina lobariae*) is therefore made. A key to the eight species now accepted in the genus is provided, which now includes algicolous, lichen-forming, lichenicolous, and plant saprobic species.

**Key words:** coelomycetes, conidial fungi, hyphomycetes, lichenicolous fungi, mitosporic fungi.

## Introduction

The conidial genus *Psammina* Sacc. & M. Rousseau[1] currently comprises six species with different biologies. The type species, *P. bommeriae* Sacc. & M. Rousseau, occurs on dead leaves of *Ammophila arenaria* and *Juncus effusus* in Europe. Two other species are known from plant material, *P. mariae-theresiae* Dias & R. S. S. Teixeira on dead twigs of *Smilax nigra* in Portugal (Dias & Teixeira 1963) and *P. elegiae* S. Lee & Crous on dead culms of *Elegia juncea* in South Africa (Lee & Crous 2003). The generic name *Psammina* was taken up by Hawksworth (1979) for a new lichenicolous species found growing on *Schismatomma decolorans* in Dorset (UK), and named *P. stipitata*. That species has subsequently been found on green coccoid algal crusts and a range of crustose and leprarioid lichens on both bark and rarely siliceous substrata in the UK, Denmark, The Netherlands, and Spain (Alstrup 1993; Earland-Bennett & Hawksworth 1999; Aptroot *et al.* 2004). Two futher algicolous and lichenicolous species have also now been described as

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[1]The author citations given for this generic name differ from publication to publication, and the date of valid publication has been variously stated to be 1891, 1892 and 1901. Saccardo and Rousseau used the name in the publication of Bommer & Rousseau (1891), but there it was attributed to them alone; under the current *Code* (Art. 46 Note 1), it must be attributed to them alone and not be cited as ''Sacc. & M. Rousseau ex E. Bommer & M. Rousseau'' as, for example, in Kirk et al. (2001). The issue of the journal in which the paper appeared related to society activities in 1890, and Bommer & Rousseau discuss collections made as late as October 1890 in their paper. Van Aerdschot (1921) gives the date as ''17-vii-90'' for both **29**(1) and **29**(2), but the ''90'' must be a *lapsus* as **29**(2) includes reports of meetings as late as 7 December 1890. Information van Aederschot presents on other issues around this time, including that for 1891, shows that they consistently came out one year after that on which they included reports of meetings and we have found no evidence that the issue for 1890 came out later than in 1891.

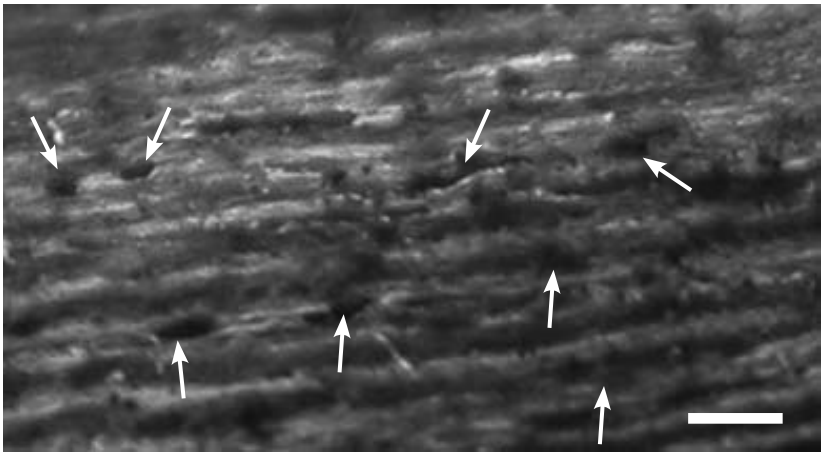

FIG. 1. *Psammina palmata* (holotype), habit on decorticate *Quercus* wood, showing the convex scattered thalli (arrows). Scale = 500 μm.

new from the UK, *P. inflata* Earl.-Benn. & D. Hawksw. and *P. simplex* Earl.-Benn. & D. Hawksw. (Earland-Bennett & Hawksworth 1999).

As a result of our continuing studies of lichens and lichenicolous fungi, we can now report the discovery of a lichen-forming species, which is congeneric with *P. stipitata* and the other algicolous and lichenicolous species of the genus. However, the characteristics of the conidiomata, conidia and the conidiogenous cells raise questions over generic concepts. Here we describe the new species as *P. palmata*, and consider the status of *Cheiromycina* and *Pycnopsammina*.

## Taxonomy

### Psammina palmata Earl.-Benn. & D. Hawksw. sp. nov.

MycoBank no. BM 500168.[2]

[2]The assigning of unique MycoBank database reference numbers to newly described fungi when they are first published is a practice initiated in 2004 with the publication of Crous *et al.* (2004*b*). For further information on the philosophy and procedures involved see Crous *et al.* (2004*a*). The securing of such numbers prior to publication is likely to be become a mandatory editorial requirement for the acceptance for papers including descriptions of new species in the leading mycological (including lichenological) journals over the next few years.

Differt a *Psamminis stipitatis* in conidiorum hyalinum, palmatum, cum (9–) 12–16 (–20) ramulis, non-septatum, e minioribus, usque (17–) 25–36 μm latibus e 20–30 μm altibus.

Typus: England, West Suffolk (V.C. 26), Mildenhall Parish, Beck Row, Aspal Close, 52/6977, on decorticate *Quercus* branch on the ground, 14 August 1996, *P. M. Earland-Bennett & C. J. B. Hitch* (K(M) 129111—holotypus).

(Figs 1–3)

*Thallus* superficial, strongly convex, rounded to elongate in surface view, from 100 μm diam. to 225 × 150 μm, dark green to greenish brown and gelatinous when moist, when dry not apparent and appearing as a diffuse brownish patch, arising singly and discrete, sometimes coalescing with other thalli to form more extensive nodular mats; outer surface of thalli brownish in section, composed of algal cells cemented by amorphous brownish polysaccharides and fungal hyphae; algal cells abundant, coccoid, 3–11 μm diam.; fungal hyphae brown, sparsely septate, with unevenly thickened walls, 3–4 μm thick.

*Conidiomata* arising from the convex thalli, sporodochial, comprising compacted masses of conidiogenous structures and conidia. *Conidiophores* semi-macronematous, erect, brown, smooth-walled, not clearly distinguished from the vegetative hyphae.

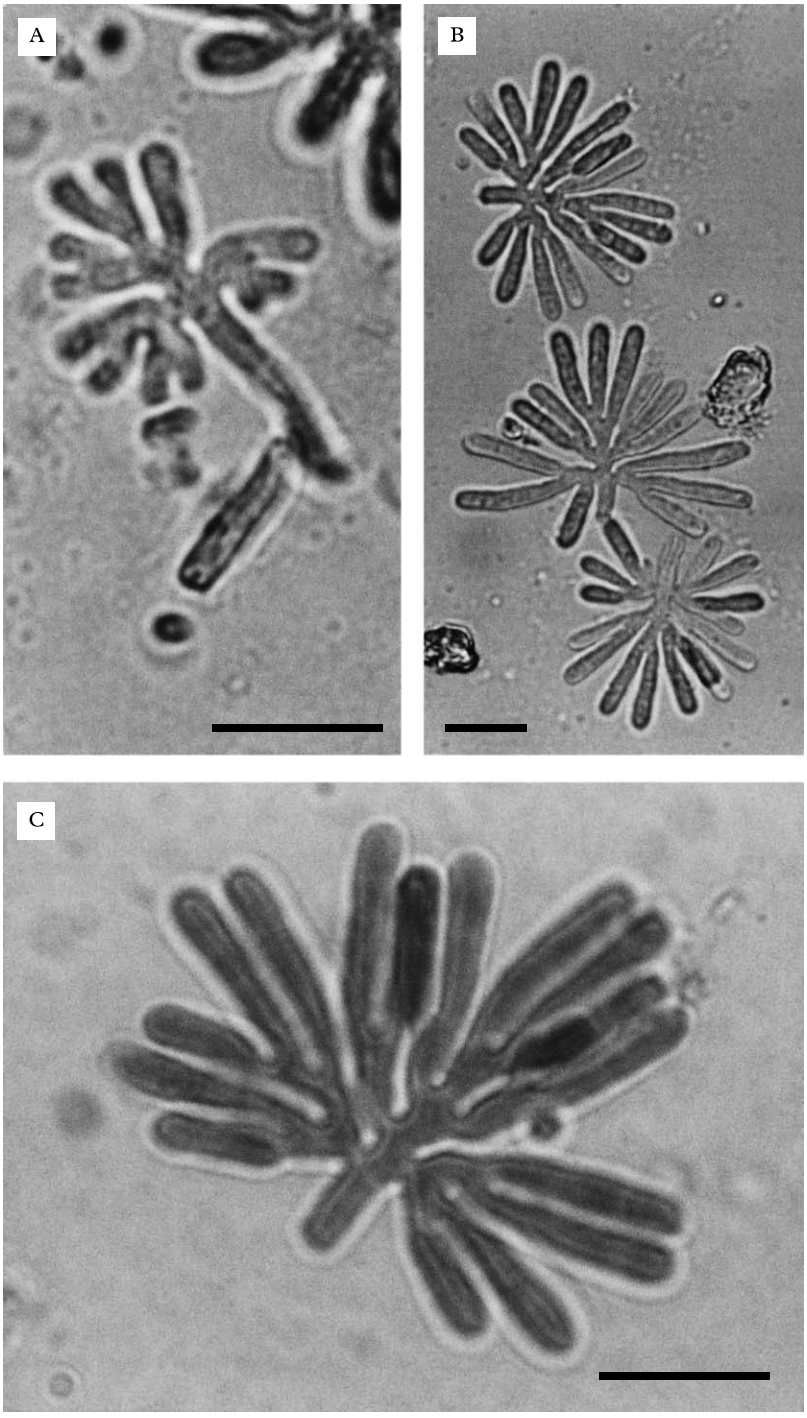


FIG. 2. *Psammina palmata* (holotype). A, developing conidium attached to a hypha-like conidiogenous cell; B, mature conidia; C, detail of a mature conidium. All stained in lactofuschin and observed by differential interference contrast microscopy. Scales = 10 μm.

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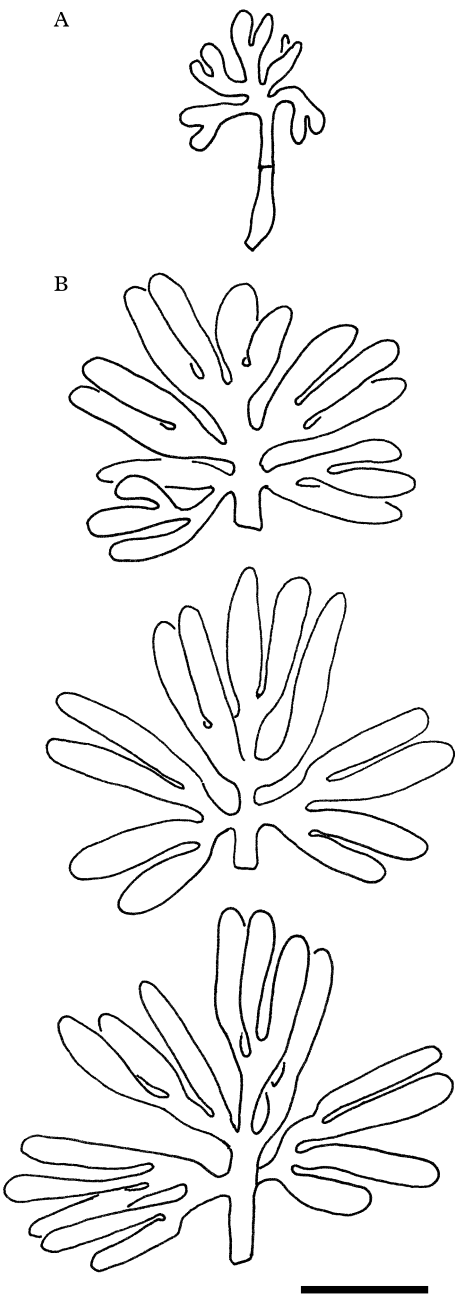


FIG. 3. *Psammina palmata* (holotype). A, developing conidium attached to a hypha-like elongate-ampulliform conidiogenous cell; B, mature conidia (the lower with a single septum at the base of the right-hand group of arms. Scale = 10 μm.

*Conidiogenous cells* monoblastic, integrated, terminal, elongate-cyclindrical, brown, smooth-walled, often markedly swollen below and somewhat eccentrically ampulliform, 6–10 × 1·5–2·5 μm. *Conidia* arising singly, dry, acrogenous, non-septate or exceptionally with 1–2 basal septa at branching points, hyaline, palmately branched in a single plane, overall (17–) 25–36 μm wide and 20–30 μm tall, mainly 2–3 dichotomously branched, finally with (9–)12–16(–20) arms; stem 1·5–2·5 μm wide; individual arms somewhat to clearly constricted at the base, (1·5–)2–2·5 (–3) μm wide, (4·5–) 8–12 (–15) μm in length.

*Etymology*. From *palmatus* (Lat.), arranged in the manner of an outspread hand, after the form of the conidia.

*Ecology*. On dead decorticate *Quercus* wood on the ground in an ancient park. Evidently lichenized; the thalli do not recall the thallus of any other lichen and the fungal tissues are intimately and consistently arranged with green coccoid algal cells. The algae are healthy and do not appear to be discoloured or damaged by the fungus.

*Distribution*. British Isles (England). Known only from the holotype collection.

*Observations*. This new species recalls *Psammina stipitata* in the form of the conidia, but in that species the mature conidia each have about 50 arms arranged in a ball and not flattened in a single plane; the conidia of *P. stipitata* measure 50–80 μm diam overall (lightly squashed), and the arms are generally 3–7-septate, although in one collection we recently studied they were 0–2-septate but otherwise agreed with *P. stipitata*.[3] The conidia of *P. simplex* also have the arms arranged as in a ball, but have fewer septa than *P. stipitata*, about 20–30 arms, and measure 17–57 μm diam overall (lightly squashed). The conidial arms of *P. inflata* are curved and clavate, becoming 3·5–6

[3]**Great Britain:** *England*: V.C. 26, West Suffolk: Milden, Mildenhall, Long Wood (nat. grid ref. 52/944451, on *Lepraria incana* on *Fraxinus excelsior*, 7 June 2003, *P. M. Earland-Bennett & C. J. B. Hitch* (hb. Earland-Bennett).

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(–6·5) µm at the tips. Only in *P. palmata* do the conidia have 2–3 orders of branching. In addition, the conidia in this species are entirely or almost entirely non-septate and remain completely hyaline with no evidence of any brownish tinge in microscopic preparations. Where septa develop, they are in the basal parts and not in the conidial arms.

The palmate arrangement of the conidial arms in a single plane recalls that seen in some species of the lichenized conidial genus *Cheiromycina*, but the conidia in that genus arise from characteristic globose cells that have been interpreted as their conidiogenous cells (see below).

### Key to the accepted species of *Psammina*

1 Conidial arms 0–15-septate, at least some arms in each conidium with a septum . . . . . 2
Conidial arms never septate, or if septa present confined to basal branching points, (4·5–)8–12(–15) × (1·5–)2–2·5(–3) µm; lichen-forming, UK . . . . **palmata**

2(1) Conidial arms 0–2(–3)-septate . . . . . 3
Conidial arms 3–7-septate . . . . . 4

3(2) Conidial arms 0–1(–2)[4]-septate, (7–)15–25(–29) × (1·5–)2–4 µm; on *Lecania cyrtella*, *Lecanora expallens*, *Placynthiella dasaea*, and green coccoid algae, UK and The Netherlands . . . . . **simplex**
Conidial arms 1–2(–3)-septate, (8–)10–15(–17) × 3·5–6(–6·5) µm; on *Lepraria incana* and green coccoid algae, UK . . . . . **inflata**

4(2) Conidia with 20 or more arms when mature . . . . . 5
Conidia with 5–10 arms, arms 3–4-septate, 21–27 × 2·5–3·5 µm; on *Lobaria pulmonaria*, France, Spain and the UK . . . . . **lobariae**

5(4) Conidia more than 50 µm diam. when mature . . . . . 6
Conidia to 45 µm diam., arms 3–6-septate, 12–25 × 2–2·5 µm; on *Ammophila arenaria* and *Juncus effusus*, Belgium and UK . . . . . **bommeriae**

6(5) Conidial arms 3–7-septate, more than 2 µm wide . . . . . 7
Conidial arms (2–)3(–4)-septate, 19–35 × 2 µm; on *Elegia juncea*, South Africa . . . . . **elegiae**

7(6) Conidial arms *c.* 50 per conidium, arms 25–50 × 3–3·5(–4·5) µm, 3–7-septate; on *Anisomeridium polypori*, *Lecanora conizaeoides*, *L. expallens*, *Lepraria incana*, *L. lobificans*, *Psilolechia lucida*, *Schismatomma decolorans*, an unidentified lichen, and green coccoid algae, Denmark, The Netherlands, Spain and UK . . **stipitata**
Conidial arms 45–80 per conidium, arms 27·5–45 × 2·5–3 µm, 3–6-septate; on dead branches of *Smilax nigra*, Portugal . . . . . **mariae-theresiae**

## Discussion

In the new species *Psammina palmata*, the conidia arise from discrete elongate vertical conidiogenous cells, as they do in the algicolous and lichenicolous species. However, in the type species of the genus, *P. bommeriae*, they arise as short lateral branches from the conidiophores. Further, the conidial

[4]While this paper was in press, a specimen with the same-sized conidia as *P. simplex* but with 3-5-septate arms was discovered (**Great Britain:** *England*: **V.C. 25**, East Suffolk: Framlingham, (nat. grid ref. 62/285629), on green algae on *Salix* trunk, 8 iii 2005, *P. M. Earland-Bennett & C. J. B. Hitch* (hb. Earland-Bennett). As in the case of *P. stipitata*, the number of septa (see above) would appear to be a less stable character than the numbers and sizes of arms.

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arms arise from a number of short cells and do not branch again (Sutton 1980). *Psammina bommeriae* was originally considered acervulate, while *P. elegiae* was described as "acervuloid to indeterminate" and figured as having elongated conidiogenous cells (Lee & Crous 2003). It is intriguing that the details of the conidiogenous cells in the conidium initials of the monotypic genus *Pycnopsammina lobariae* Diedrich & Etayo, which is lichenicolous on *Lobaria pulmonaria* (Etayo & Diederich 1995), appear from the original drawings to be identical to those of *P. bommeriae*, while those of *Psammina elegiae* appear identical to those of the previously described lichenicolous species, and also *P. palmata*. Interestingly, while *Pycnopsammina* is described as having immersed ostiolate conidiomata, the published illustration suggests that these might be better interpreted as an acervulus. In introducing the new generic name, Etayo & Diederich (1995) stressed the filiform conidiophores of *Psammina* as a critical character; however, such distinctive conidiophores are known in the algicolous and lichenicolous species (and *P. elegiae*) but not in *P. bommeriae*. We therefore see no reason to retain *Pycnopsammina lobariae* in a separate genus and make the necessary new combination here.[5]

However, there is then the issue as to whether the *Psammina* species with more elongated conidiophores and conidiogenous cells should be kept in that genus. An additional complication is the essentially lichen-forming genus *Cheiromycina* B. Sutton, in which the type species *C. flabelliformis* B. Sutton and *C. petri* D. Hawksw. & Poelt (Sutton & Muhr 1986; Hawksworth & Poelt 1986, 1990) both have compacted sporodochia and produce palmate conidia which are flattened in a single plane. However, in those two species the conidia are multiseptate and arise from subglobose strongly inflated conidiogenous cells, which can arise in chains of similar cells, as illustrated by Sutton & Muhr (1986). Subsequently, Aptroot & Schiefelbein (2003) described two additional new sporodochial lichen-forming species in *Cheiromycina*, neither of which formed palmate conidia, but both of which were reported as having conidia formed from the characteristic subglobose cells seen in the two species with palmate conidia.

At first we were inclined to include our new species in *Cheiromycina*, especially because of its lichenized nature, but A. Aptroot (*in litt.*) did not consider that it should be accommodated in that genus. As the details of conidiogenesis are of major systematic importance in the conidial fungi, we concur with that view. However, in describing the new species in *Psammina*, we were particularly influenced by the observation that the very young conidia of *P. palmata*, when the first branches are starting to form (Fig. 2A), are almost indistinguishable from those at the same stage in *P. stipitata*, as illustrated in Hawksworth (1979: 245, fig. 30B).

The traditional interpretation of complex conidia in fungi, as structures produced from specialized conidiogenous cells, has been challenged by Kendrick (2003) who draws particular attention to *Psammina*, evidently basing his views on the drawings of *P. stipitata* published by Hawksworth (*loc. cit.*), two of which are reproduced twice (Kendrick 2003: 86, fig. 8H, 98, fig. 17A). He states (p. 85) that the structures have:

> "the appearance of a conidiophore that branches repeatedly at the apex, dichotomously or trichotomously. Yet eventually a single multi-armed propagule (a staurospore) is released. It may be pushing the envelope to describe this as a conidium, although one of the principal features of these asexual spores is that they are liberated from the cells that produce them. Here the line between conidiophores and reproductive unit has become blurred . . ."

Further, Kendrick (p. 99) proceeds to argue that the structures are analogous to colony development and that they can "be regarded as modified branching hyphal systems". If Kendrick's interpretation is correct, the application of computer modelling systems of hyphal growth developed by Meskauskas *et al.* (2004*a*, *b*) to cases like *P. stipitata*, *P. palmata*, and the other

[5]**Psammina lobariae (Diederich & Etayo) Earl.-Benn. & D. Hawksw. comb. nov.** Basionym: *Pycnopsammina lobariae* Diederich & Etayo, *in* Etayo & Diederich, *in* Daniels *et al.*, *Flechten Follmann*: 215 (1995).

algicolous, lichenicolous and plant saprobic species now placed in the genus, could show that the substantial differences observed in the final conidium types are due to different regulatory scenarios of hyphal growth.

The differences in the details of conidial development between the type species of *Psammina* (and of *Pycnopsammina*) and the other species could be used to justify the introduction of a new generic name for *P. stipitata* and similar species, including *P. palmata*. However, we refrain from introducing a new genus now as we feel this would be premature. In the absence of molecular data, which would be the ideal way to resolve this issue, that step should only be taken after critical studies have been carried out on the details of development of the 'conidia' in all the species in the complex, ideally using both the new computer modelling systems, and further transmission electron microscopy to ascertain if there are specialized structures involved in spore secession that are not visible by light microscopy.

We are grateful to André Aptroot (Centraalbureau voor Schimmelcultures, Utrecht) for his opinion on the generic placement of the new species described in this paper. This study was completed while D. L. H. was supported by the Programa Ramón y Cajal of the Ministerio de Ciencia y Tecnología of Spain held in the Facultad de Farmacia of the Universidad Complutense de Madrid. Bibliographical work on this note was completed at The Royal Botanic Gardens Kew while D.L.H. was in receipt of SYNTHEYS award GB-TAF-238 from the Consortium of European Taxonomic Facilities (CETAF).

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*Accepted for publication* 10 *March* 2005