

A new record of *Rogersiomyces okefenokeensis* (Basidiomycota) from beetle galleries in pines in Taiwan

Roland Kirschner^{1,*} & Chee-Jen Chen^{2,**}

¹ Botanisches Institut, Universität Frankfurt, Senckenberganlage 31-33,
D-60054 Frankfurt, Germany

² Department of Biotechnology, Southern Taiwan University of Technology,
1 Nantai Street, Yung Kang City, 71043 Tainan, Taiwan, Republic of China

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Rogersiomyces okefenokeensis, characterised by fasciculate holobasidia with reduced sterigmata and ellipsoidal basidiospores, was hitherto only known from its type locality from an aquatic habitat in North America and its systematic position remained unclear. It was found again in beetle galleries in the bark of pines in Taiwan. The specimens are described and illustrated. The ultrastructure of the septal pore indicates an affiliation to the Homobasidiomycetes.

Keywords: apobasidia, Filobasidiales, Homobasidiomycetes, *Hyphobasidifera*, insect dispersal.

Rogersiomyces okefenokeensis Crane & Schoknecht was first found on submerged decaying leaves collected in Georgia, USA (Crane & Schoknecht, 1978). The basidiocarps were described as being composed of fasciculate, aseptate apobasidia and the spores as germinating directly with hyphae (Crane & Schoknecht, 1978). The term “apobasidium” refers to a basidium with spores borne symmetrically on the sterigmata and not forcibly discharged (Hawksworth & al., 1995: 49). The apobasidia of *R. okefenokeensis* and some other basidiomycetes are considered as an adaptation to the aquatic habitat, where these fungi have been found (Crane and Schoknecht, 1978). Because of similar basidial morphologies, Crane & Schoknecht (1978) suggested a close relationship between *R. okefenokeensis* and species of *Filobasidium* Olive, *Filobasidiella* Kwon-Chung, and *Chionosphaera* Cox. This affiliation was questioned by Oberwinkler & al. (1983), but at that time conclusive data were not available to clarify this question. *R. okefenokeensis* was not found again after its discovery in North America, and the genus remained

* Fax: +49 69 798 24822; e-mail: kirschner@em.uni-frankfurt.de

** e-mail: c5200999@mail.stut.edu.tw

monotypic. A specimen similar to *R. okefenokeensis* was isolated from the bark of a broad-leaved tree in Malaysia by Matsushima & Matsushima (1996), who erected a new species in a new genus, *Hyphobasidiofera malaysiana* K. Matsushima & T. Matsushima.

Galleries within the bark of trees are mainly excavated by bark beetles (Coleoptera: Scolytidae) and are a habitat for minute fungi that are adapted to insect dispersal (Dowding, 1984). In most Ascomycota and Basidiomycota, the spores are forcibly discharged into the air and distributed by air currents. The spores of most fungi specifically occurring in the insect tunnels within the bark, however, are passively released and dispersed by insect vectors (Dowding, 1984). Most of these specialised fungi belong to the Ascomycota, while reports of Basidiomycota are scarce (Whitney & al., 1987).

Material and methods

Material was collected in Peitou, Taipei, Taiwan [10th July 1999 (R. Kirschner 535) and 20th April 2001 (R. Kirschner 811)]. Dried specimens were deposited in TNM. Bark samples containing old insect tunnels (probably of bark beetles, Scolytidae, or weevils, Curculionidae) were peeled off from dead, standing trees of *Pinus* sp., taken to the laboratory, and the inner side of the bark was investigated under a dissecting microscope. Fungi growing within the insect tunnels were mounted in 5% KOH and investigated using light microscopy. For measurements, drawings and the description of morphological characteristics, material growing *in situ* in the tunnels was used. The dimensions of 20 basidia and 20 basidiospores were measured. Cultures were obtained by transferring spores from the tips of basidial clusters to Petri dishes containing autoclaved pieces of conifer twigs embedded in 1.5% water agar. Transmission electron microscopy (TEM) was carried out using culture material as described in Kirschner & al. (1999).

Results

Rogersiomyces okefenokeensis Crane & Schoknecht. Amer. J. Bot. 65: 902, 1978. – Figs. 1–2.

Basidia in irregular clusters (Fig. 1A) visible as scattered white spots with the naked eye, not forming continuous basidiocarps. – Hyphidia and cystidia absent. – Hyphae hyaline, thin-walled, smooth, with simple clamps at the septa, 1.5–3 µm diam. – Basidia aseptate, with basal clamps, obclavate, thin-walled, 38–65 µm long, 5–6 µm wide at the base, 2 µm wide at the apex, with four 1–2 µm long sterigmata, which in some cases appear refractive as seen by

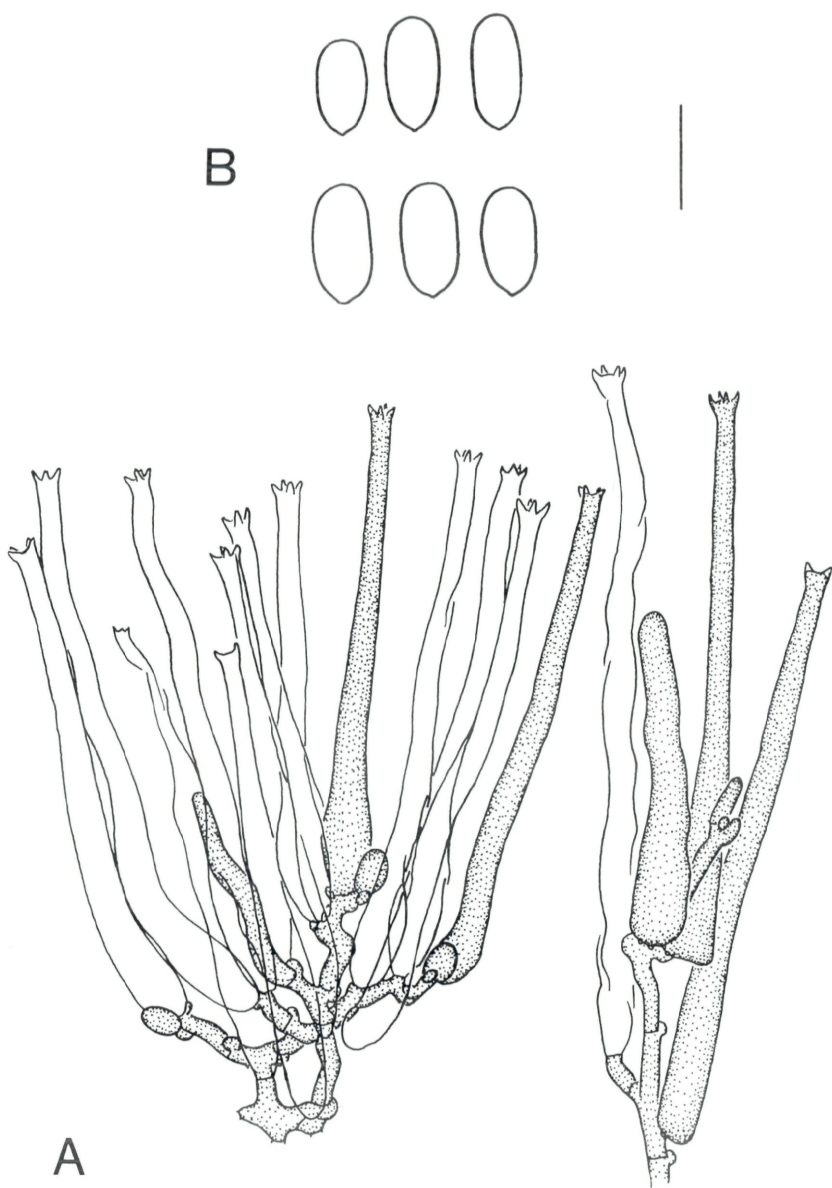


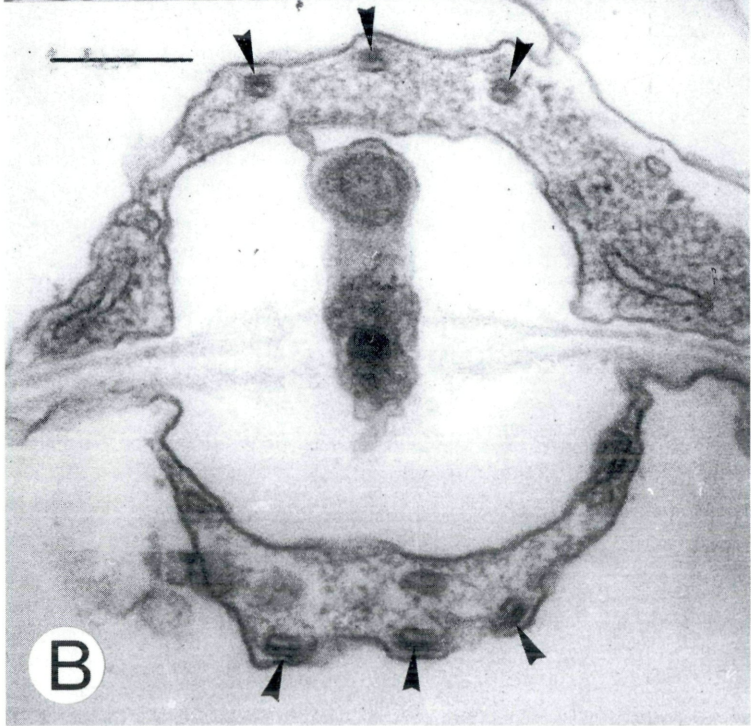
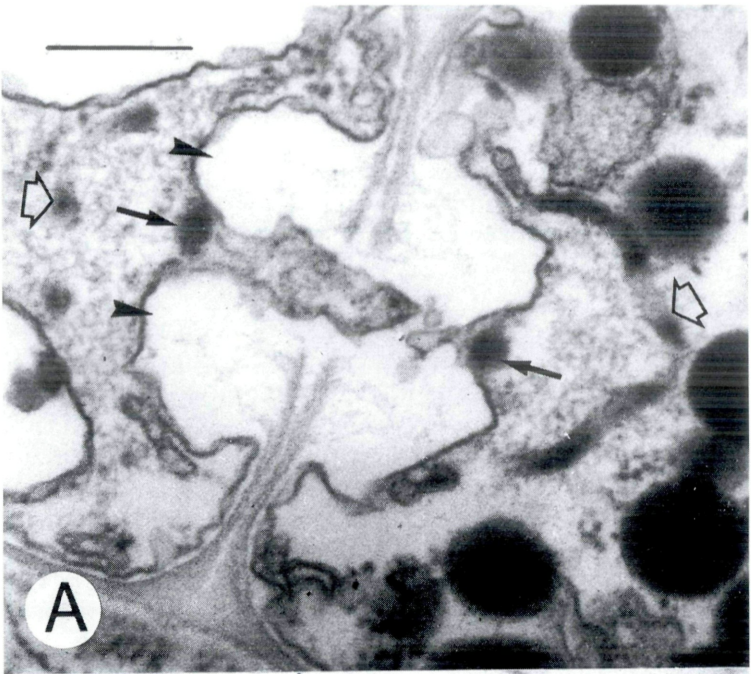
Fig. 1. – *Rogersiomyces okefenokeensis*, R. Kirschner 535. – A. Two clusters of basidia, presence of cytoplasm indicated with dots. Empty, in some cases collapsed basidia without dots. – B. Basidiospores. – Scale bar = 10 μ m.

light microscopy. – Basidiospores hyaline, thin-walled, smooth, ellipsoidal, inamyloid, $8\text{--}11.5 \times 4.5\text{--}7\ \mu\text{m}$, inconspicuously apiculate (Fig. 1B). – Anamorph absent. – Structures and dimensions of basidia and basidiospores in fresh cultures on conifer twigs embedded in water agar identical to those found *in situ*. As seen by TEM, septa with dolipores with a channel occluded by plugs and associated with perforated parentheses (Fig. 2).

Discussion

The morphological details of spores and basidia described above agree with those given in the description of *Rogersiomyces okefenokeensis* by Crane & Schoknecht (1978). Although we have not investigated material of *Hyphobasidiofera malaysiana* K. Matsushima & T. Matsushima, the informative illustrations and description by Matsushima & Matsushima (1996) allow us adequate comparisons with *R. okefenokeensis* which appears to be nearly identical to *H. malaysiana*. *Hyphobasidiofera malaysiana* differs from *R. okefenokeensis* only by the larger basidiospores in the former species ($11\text{--}15 \times 8\text{--}10\ \mu\text{m}$, Matsushima & Matsushima, 1996). From the morphological point of view, these two species appear to be closely related and should not be separated into two monotypic genera. We do not, however, propose a formal synonymy here, because other additional characteristics and molecular analyses are not yet available.

The ultrastructure of the septal pore of *R. okefenokeensis* collected in Taiwan shows the presence of perforated parentheses. This supports the assumption of Oberwinkler: *R. okefenokeensis* should not be included in the Filobasidiaceae, as proposed by Crane & Schoknecht (1978), because in species of *Filobasidium* the dolipore is not associated with perforated parentheses (Moore & Kreger-van Rij, 1972). The septal pore in species of another heterobasidiomycetous genus, *Chionosphaera* Cox (Chionosphaeraceae), is not a dolipore, but a simple pore not associated with any kind of parentheses (Kirschner & al., 2001; Oberwinkler & Bandoni, 1982). Dolipores with perforated parentheses indicate an affiliation to the Homobasidiomycetes (Khan & Kimbrough, 1982). Moreover, members of the Filobasidiaceae and Chionosphaeraceae exhibit a dimorphic life-cycle including an anamorphic yeast stage and a teleomorphic hyphal stage, and are, therefore, affiliated to the heterobasidiomycetous fungi (Oberwinkler & Bandoni, 1982; Oberwinkler & al., 1983). In *R. okefenokeensis* and *H. malaysiana*, however, basidiospores germinate with hyphae (Crane & Schoknecht, 1978; Matsushima & Matsushima, 1996), which also supports the placement of these species within the Homobasidiomycetes. In our cultures, no yeast stage was found.



Crane & Schoknecht (1978) discussed the passive spore release from the apobasidia of *R. okefenokeensis* with respect to an aquatic habitat. *H. malaysiana* was, however, isolated from dead bark of a broad-leaved tree (Matsushima & Matsushima, 1996). The specimens of *R. okefenokeensis* from Taiwan were found in insect tunnels beneath the bark of standing trees. In this case, dispersal by water is less probable than that by the insects that had excavated the galleries. As the insects had left the galleries before sampling and the fungus could, therefore, not be isolated directly from the insects, insect dispersal could not be documented and the possible insect vectors were not identified. The pattern of the galleries in the bark, however, indicated that they had been produced by bark beetles or weevils. There are some further examples of basidiomycetes in which the spores are produced on apobasidia and transported by insects living in the bark, e. g. *Atractocolax pulvinatus* R. Kirschner, R. Bauer & Oberw. (Kirschner & al., 1999), *Chionosphaera cuniculicola* R. Kirschner, D. Begerow & Oberw. (Kirschner & al., 2001), and *Entomocorticium dendroctoni* Whitney (Whitney & al., 1987). Apobasidia, therefore, might have evolved not only in connection with water dispersal, but also with dispersal by insects.

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Fig. 2. – *Rogersiomyces okefenokeensis*, transmission electron micrographs of septal pores (dolipores), R. Kirschner 811. – A. Pore channel between the septal pore swellings (arrowheads) occluded by electron-dense pore plugs (black arrows), associated with perforated parenthesomes (hollow arrows). – B. Perforated parenthesomes (arrowheads) appearing fragmented in the section. – Scale bars = 0.2 µm.

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Autor(en)/Author(s): Kirschner Roland, Chen Chee-Jen

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