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Physalacria corticola, *P. stilboidea*, and *Stilbum vulgare*, three sphaeropedunculate Basidiomycota new to Taiwan, with notes on *Stilbum erythrinae*

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ABSTRACT

Three saprotrophic species of Basidiomycota forming sphaeropedunculate basidiomata, *Physalacria corticola*, hitherto only known from Singapore, *Physalacria stilboidea* known from New Zealand and United Kingdom, and *Stilbum vulgare*, hitherto not recorded for Asia, were found on dead branches and leaves in Taiwan. These species are described and illustrated in detail. Based on type study of *Stilbum erythrinae* Hansf., this species is tentatively transferred to *Chionosphaera*.

Keywords: Agaricomycotina, Chionosphaeraceae, clavarioid basidiomata, *Physalacriaceae*, Pucciniomycotina, *Stilbum*.

Introduction

Basidiomycota forming clavarioid fruitbodies are particularly attractive to mycologists because of the unusual shape of fruiting structures which is strikingly different from the usual mushroom. The taxonomical value of this type of fruiting is, however, restricted, because it developed convergently several times in Ascomycota and Basidiomycota. In Basidiomycota, clavarioid basidiomata are formed in the "homobasidiomycetous lineage" (Agaricomycotina) as well as in the "rust-related heterobasidiomycetous lineage" (Pucciniomycotina). Species of the first lineage were treated by Corner (1950, 1970), and of the second by Oberwinkler and Bandoni (1982). In Taiwan we collected and identified species belonging to the genera *Physalacria* (Agaricomycotina) and *Stilbum* (Pucciniomycotina) on leaf and twig litter on the ground. Both genera have hitherto not been recorded for Taiwan. Since the taxonomy of some *Stilbum* species is unclear, the type specimen of *S. erythrinae* was re-examined.

Materials and methods

Microscopic measurements and drawings of the fungal structures were based on freshly collected and dried specimens stained with 1% aqueous phloxine and mounted in 5–10% KOH. Numbers in brackets indicate extreme values of

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20 measurements with mean value plus/minus standard deviation. Measurements presented without numbers in brackets are based on randomly searching very small and very large structures. Specimens are deposited at the herbarium of National Museum of Natural Science, Taichung, R.O.C. (TNM).

Taxonomy

Physalacria corticola Corner, Ann. Bot. Mem. 1: 463. 1950. (Figs. 1 & 2)

(Description mainly based on fresh material of R. Kirschner 517). Basidiomata 640–1170 µm high, solitary or in pairs, white. Stipe cylindrical, 340–560 × 60–110 µm, composed of parallel, clamped, thin-walled, approx. 5 µm wide hyphae, with few lateral nipple- or hyphal outgrowths, approx. 2–10 × 2–3 µm, and scattered, hyaline, conoid caulocystidia with or without short shouldered apical nipple capped with amorphic, refractive material (conspicuous in fresh material, rapidly dissolved in KOH, disappearing in dried material), protruding to approx. 10–18 µm above the stipe surface, approx. 7 µm wide at the base. Head subglobose, hollow, collabent, smaller heads 270–370 µm diam., larger ones slightly shorter than wide, 525–800 µm long and 600–960 µm wide, without vesicle-like swollen cells, without isodiametric crystals, completely covered with hymenium composed of cystidia, fusiform basidioles, and basidia. Cystidia arising from the clamped subhymenium, ventricose with shouldered apical nipple capped with refractive material, (15–)29–55(–70) × (8–)9–13(–17) µm. Basidia fusoid when young (= basidioles), clavate with four 3 µm long sterigmata when mature, mature basidia (12–)13–15.5(–17) µm long, 2–3 µm wide at the base, 4.5–5 µm wide at the broadest part. Basidiospores hyaline, smooth, thin-walled, long-ellipsoidal or slightly navicular, 5.5–6(–6.5) × 2–3 µm.

Material examined. Taiwan, Taipei City, National Taiwan University, campus, on dead woody stem, May 3, 1999, R. Kirschner 496, same locality, on fallen branch, June 1, 1999, R. Kirschner 517 (TNM), Taipei County, Wen-

Fig. 1. *Physalacria corticola*, two dried basidiomata (R. Kirschner 517). Scale bar = 500 µm.

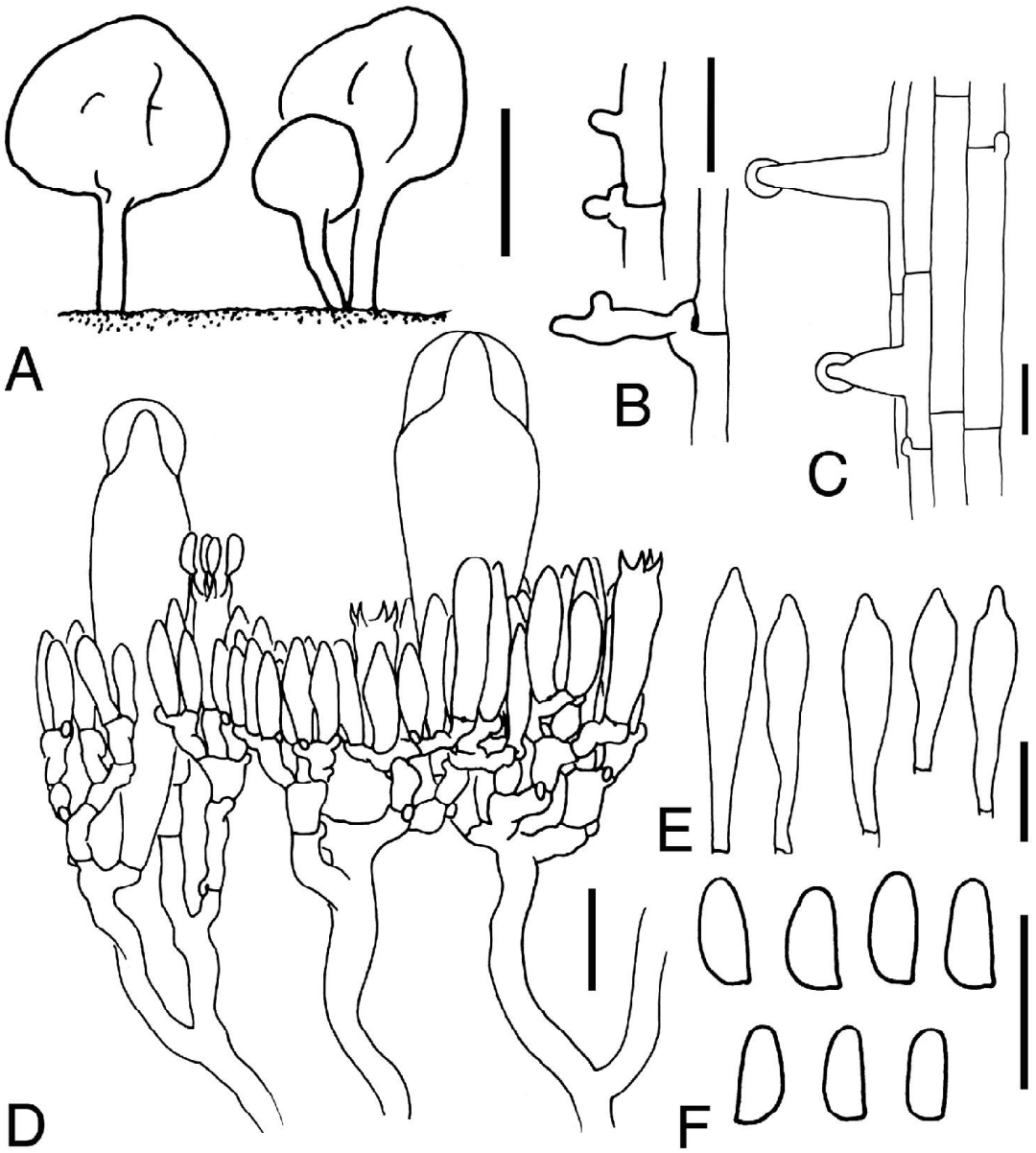

Fig. 2. *Physalacria corticola* (fresh material from R. Kirschner 517, except for B: R. Kirschner 667). A. Basidiomata. Scale bar = 500 µm. B. Detail from Stipe with nipple- and hyphal-like outgrowths. Scale bar = 10 µm. C. Two caulocystidia from stipe. Scale bar = 10 µm. D. Detail from hymenium and subhymenium showing cystidia, basidia, and basidioles. Scale bar = 10 µm. E. Hymenial cystidia (apical cap formed of refractive material dissolved). Scale bar = 20 µm. F. Basidiospores. Scale bar = 10 µm.

shan, Chih Nan Temple, on fallen branch, May 27, 2000, R. Kirschner 667 (TNM), Chia Yi County, Chung Pu, on fallen branch, May 4, 2001, R. Kirschner and C.-J. Chen 841 (TNM), Kaohsiung County, near Hulugu ("Gourd Gorge"), 100–200 m, on rotting bamboo culm, September 11, 2002, R. Kirschner and C.-J. Chen 1535 (TNM).

Known distribution. Singapore (Corner, 1950; Dentinger and McLaughlin, 2006), Taiwan (new record).

Notes. The specimen from Taiwan was identified mainly due to the small, narrow basidiospores and small basidiomata according to Corner (1950) and subglobose heads, shape of cystidia, structures of stipe hyphae, absence of

vesiculate cells at the base of the head, and overall presence of clamps according to Berthier (1985). Some cystidia were, however, larger than given in previous descriptions. The species is similar to *P. bambusae* Höhn., a variable species according to Berthier (1985), differing from *P. corticola* mainly by the lack of lateral hyphal outgrowths of the stipe which were few in the specimens from Taiwan, presence of swollen cells forming a sterile base of the head, and by slightly larger spores. The specimen on bamboo had the same characteristics (particularly absence of a sterile zone of swollen cells in the head) as the other specimens of *P. corticola* on fallen branches, but was, however, poorly developed. *Physalacria corticola*, therefore, appears to prefer woody substrates, but independent from whether they are formed by trees or bamboos. The amount and quality of the individual specimens are very heterogeneous; presently specimen R. Kirschner 667 contains the highest amount of well preserved basidiomata.

In molecular analyses, the species appears closely related to the type species of the genus, *P. inflata* (Schwein.: Fr.) Peck, thus representing a "true" *Physalacria* species (Dentinger and McLaughlin, 2006). A "Physalacriaceae Clade" including species of *Physalacria* as well as of genera with agaricoid and corticioid basidiomata was also revealed by other molecular analyses (e.g. Wilson and Desjardin, 2005).

This new record from Taiwan represents an additional northernmost known occurrence of a basidiomycete, comparable to previous new records of basidiomycetes (Kirschner and Chen, 2007; Kirschner and Wu, 2005).

Physalacria stilboidea (Cooke) Sacc., Syll. fung. 9: 256. 1891. (Figs. 3 & 4)

(Based on dried material). Basidiomata erumpent through collar-like ruptures of epidermis of both sides of fallen leaves, white to pale yellowish, solitary, approx. 0.5–1.5 mm high. Stipe cylindrical, up to 1300 × 100 µm, composed of parallel, sparsely septate, clamped

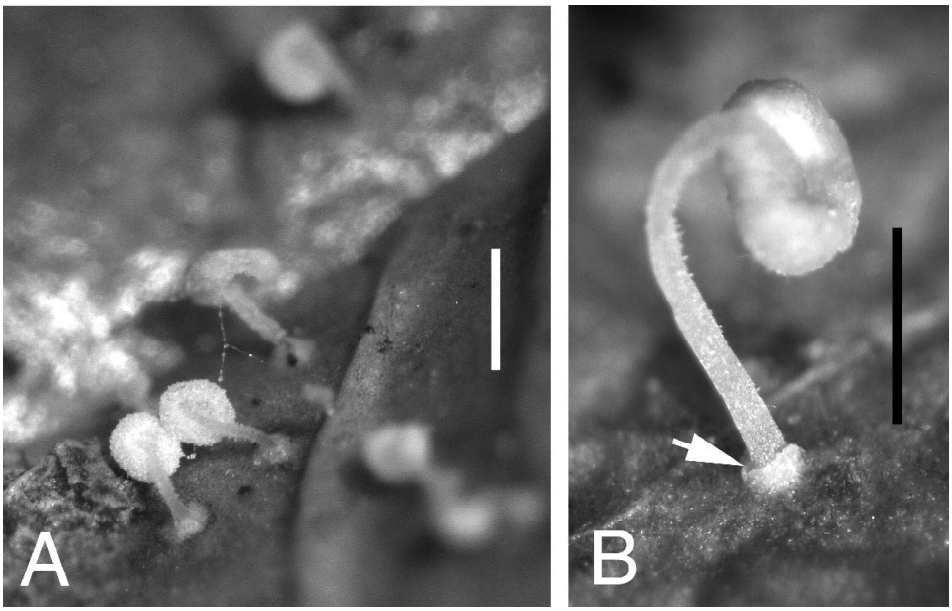

Fig. 3. *Physalacria stilboidea*, dried basidiomata. A. Several basidiomata with collapsed heads. B. Basidioma erumpent through collar-like ruptured leaf epidermis (arrow). Scale bars = 500 µm.

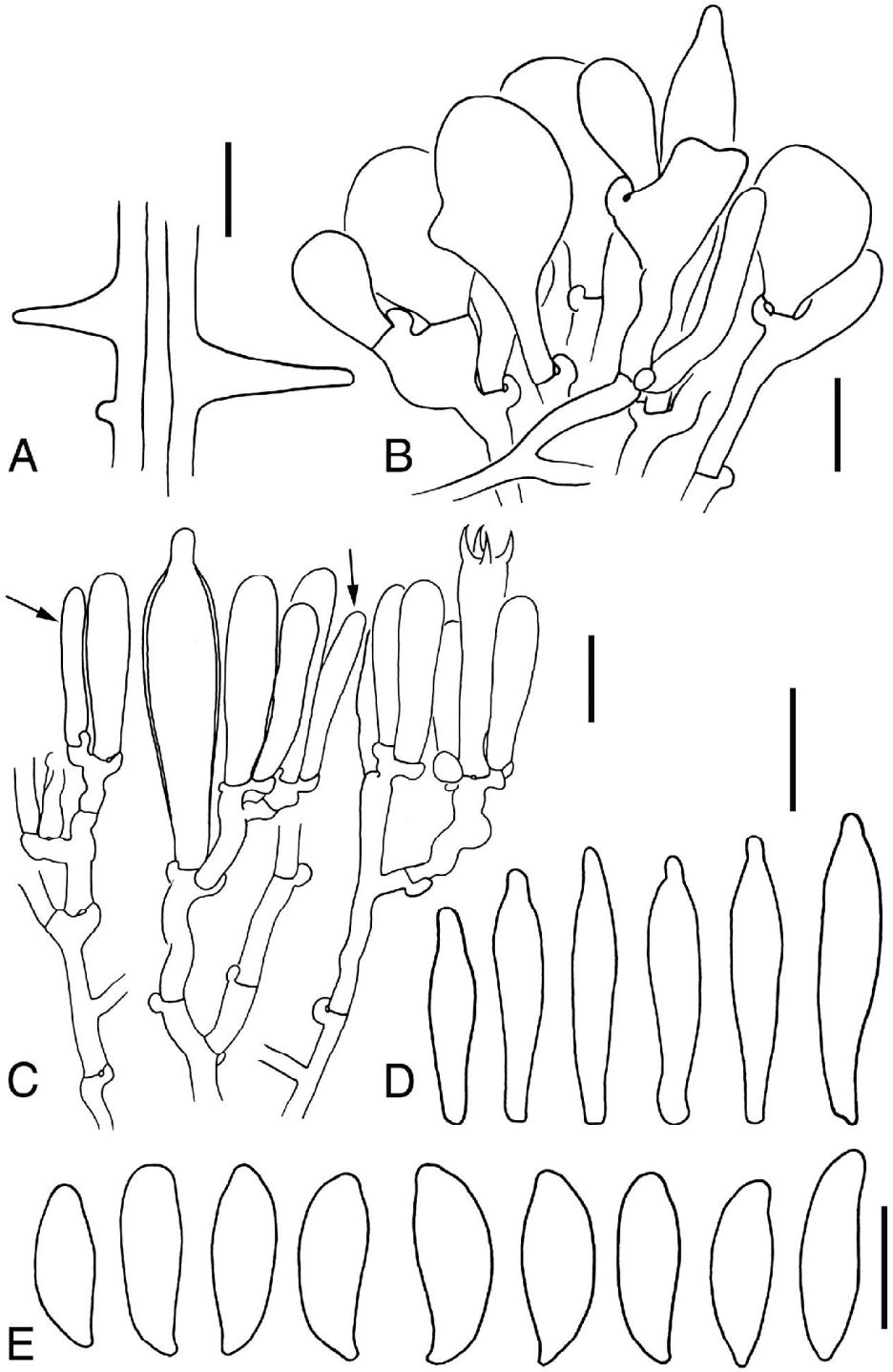

Fig. 4. *Physalacria stilboidea* (from dried material). A. Caulocystidia. B. Vesicle-like, swollen cells from base of head of basidioma. C. Details from hymenium and subhymenium showing cystidia, basidia, and paraphyse-like, cylindrical cells (arrows). D. Hymenial cystidia. E. Basidiospores. Scale bars = 10 µm, except for D: scale bar = 20 µm.

and branched, 2–8 µm wide hyphae, smooth except for caulocystidia which appear mostly triangular in lateral view, protruding 10–40 µm above the hyphae, 5–8 µm wide at the base, gradually narrowing to 2 µm at the apex which is covered with some mucilaginous, non-refractive material. Head subglobose, hollow, mostly collapsed and depressed in dried mate-

rial, approx. 320–700 µm wide and 120–460 µm high, with isodiametric crystals 10–20 µm diam. between the hyphae, at the base composed of swollen cells with or without basal stalk, swollen part 10–25 × 8–18 µm, and cystidia similar to hymenial cystidia. Hymenium covering the head except for a narrow zone around the apex of the stipe, composed of cystidia, basidia, and cylindrical cells. Cystidia arising from the clamped subhymenium, fusoid or slightly ventricose with apical nipple, hyaline, smooth, slightly thick-walled (wall 1 µm thick), (30–)32–43(–49) × (6–)7–9(–10) µm, 3–5 µm wide at the base, apical nipple 3–7 × 2.5–4 µm, refractive material not seen. Basidia cylindrical or slightly clavate, with four 5–6 µm long sterigmata, approx. 20–25 × 4–5 µm when young, extending to approx. 30–40 × 7 µm when mature. Cylindrical cells (= abortive basidia?) arising terminally on the same hyphae as basidia, similar in shape and size as young basidia, but narrower, 2–3 µm wide. Basidiospores hyaline, smooth, thin-walled, elongated pip-shaped or broadly navicular, (12–)13–16(–17) × 5–6(–6.5) µm.

Material examined. Taiwan, Hsinchu County, Guanwu, ca. 1,250 m, on fallen dead leaves of an unidentified tree species, April 3, 2002, R. Kirschner and C.-J. Chen 1096 (TNM).

Known distribution. New Zealand, United Kingdom (Berthier, 1985; Corner, 1950; Laessøe and Spooner, 1993; McKenzie, 1991; NZFUNGI, 2008), Taiwan (new record).

Notes. The species was identified mainly based on the spores being unusually large when compared to other *Physalacria* species as well as on slightly thick-walled cystidia (according to Berthier, 1985; Corner, 1950). Cystidia are, however, smaller and basidiospores slightly wider than given in the previous descriptions. The base of the head is composed of large, vesicle-like swollen cells intermingled with cystidia forming the "narrow sterile hymenium at the base of the head" (Corner, 1950). Cylindrical cells as shown here for *Physalacria stilboidea* for the first time were hitherto reported for some other species and called "paraphyses" by Baker (1941). Karyogamy indicated by Baker (1941) and the terminal position of the "paraphyses" shown here, however, support the assumption by Corner (1950) that these "paraphyses" are abortive basidia, i.e. that karyogamy might take place without following meiosis.

The collar-like rupture of leaf epidermis considered diagnostic for this species was also found in the specimen from Taiwan. The substrate given as leaves of *Panax* sp. in the older literature is based on old concepts of this plant genus. Since *Panax* in the current sense is not represented in New Zealand, but species recorded under the name *Panax* for New Zealand were transferred to other genera like *Pseudopanax* (Allan, 1982; Philipson, 1965; Webb *et al*., 1988), the predominant substrate of *Physalacria stilboidea* has been updated as leaves of *Pseudopanax* spp. in several recent collections in New Zealand (McKenzie, 1991; NZFUNGI, 2008). In New Zealand, the fungus was also collected on unidentified dead leaves and twigs (NZFUNGI, 2008). According to an assumption by Laessøe and Spooner (1993), the fungus was introduced from New Zealand to the United Kingdom, where it was found on leaves of *Hedera helix* L. in a garden. The host tree was not identified in the Taiwanese specimen.

Stilbum vulgare Tode : Fr., Syst. Mycol. 3: 305. 1832. (Fig. 5)

Basidiomata approx. 1100 high, stipe 100 µm wide, head slightly wider, appearing mealy under the dissecting microscope. Stipe smooth, composed of hyaline, parallel, rarely branched and rarely septate, slightly thick-walled, smooth, 1–2.5 µm wide hyphae. Basidia including basal stalk cell thin-walled, arising in clusters of 2–3 from thick-walled hyphae. Stalk cell approx. 40 µm long and of the same width as the supporting hyphae, bearing two fertile cells separated from each other by a horizontal or slightly oblique septum, lower cell 6–21 × 1.5–4 µm, upper cell 3–4 µm diam., both cells provided with an apical 1–2.5 µm long sterigma. Basidiospores hyaline, ellipsoidal, slightly thick-walled (0.5–1 µm), with symmetrical apiculus, giving rise to secondary yeast cells by multiple budding.

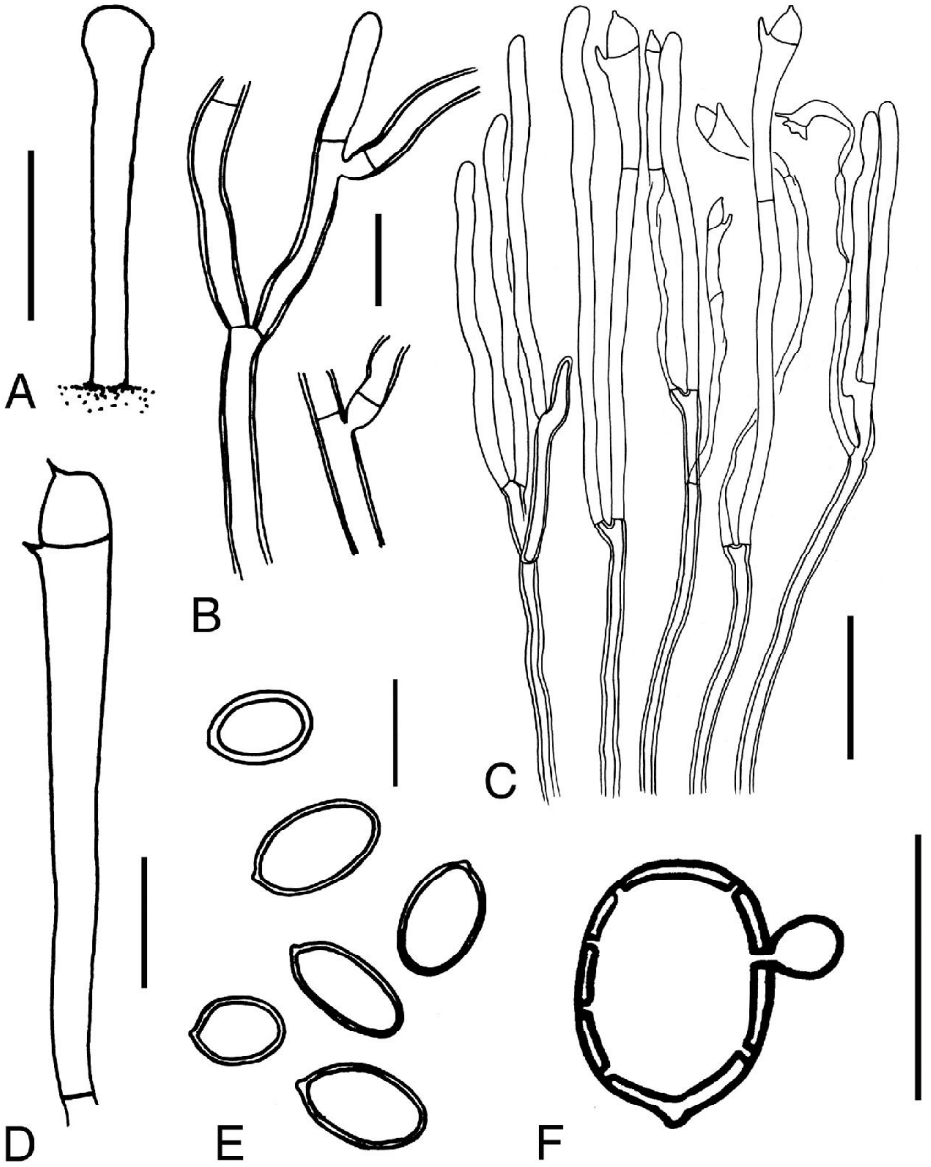

Fig. 5. *Stilbum vulgare*. A. Basidioma, habit sketch. Scale bar = 500 µm. B. Basal hyphae of stipe. Scale bar = 10 µm. C. Hyphae bearing basidia. Scale bar = 20 µm. D. Two-celled basidium. Scale bar = 10 µ. E. Basidiospores. Scale bar = 10 µm. F. Germinated basidiospore. Scale bar = 10 µm.

Material examined. Taiwan, Hsinchu County, Guanwu, approx. 2,000 m, on dead branch of deciduous tree on ground, April 3, 2002, R. Kirschner and C.-J. Chen 1116 (TNM).

Known distribution. Australia, Europe, America (Oberwinkler and Bandoni, 1982; Seifert *et al*., 1992), Taiwan (new record for Asia).

Notes. The genus *Stilbum* contains species now known to belong to the Chionosphaeraceae, (Pucciniomycotina, Basidiomycota) (Bauer *et al*., 2006), whereas most other species originally accommodated in *Stilbum* were transferred to anamorphic genera with relationships to Ascomycota, or their systematic positions could not be clarified, because their type specimens could not be found or interpreted (Seifert, 1985). We tried to clarify the position of a further species based on studies of the type material, namely of *Stilbum erythrinae* Hansf.

Chionosphaera erythrinae (Hansf.) R. Kirschner, comb. nov. (Fig. 6)

≡ *Stilbum erythrinae* Hansf., Proc. Linn. Soc. London 157: 212 (1946) [1944–45]

Uganda, Entebbe Road, on leaves of *Erythrina tomentosa* R. Br. (Fabaceae), May 19, 1944, C.G. Hansford 3499 (IMI 4734, type!).

Two fruiting structures were present between leaf hairs associated with a *Cladosporium*-like hyphomycete in the slide representing the type. Fruiting structures 390–395 µm long, light brown, composed of a straight, smooth stipe, 280–310 µm long, 50–60 µm wide at the base, narrowing to 15–25 µm towards the apex, formed by more or less parallel, smooth, thin-walled, 3–4 µm broad hyphae with clamps at septa, and a subglobose head, 60–115 µm high, 80–135 µm wide, internal structure of the head not recognizable, surface of the head covered by minute prominent (< 1 µm) refractive dots (conspicuous when seen with phase contrast light microscopy), spores ellipsoidal, paler than the fruiting structure or hyaline, smooth, thin-walled, 7–11 × 5–6 µm, with an inconspicuous refractive dot at one end.

Known habitat and distribution. associated with *Cladosporium*-like hyphomycete on tomentum of leaves of *Erythrina tomentosa*, Uganda, only known from the type collection.

Notes. Our own observations agree to the description by Hansford (1946), except for his slightly deviating range of measurements (fruiting structures 350–400 x 30 µm, hyphae 2–4 µm, spores 7–10 × 3.5–5 µm). The species has to be excluded from *Stilbum*, because its spores are thin-walled, clamps are present, and the two-celled basidia with denticulate sterigmata were not found. Seifert (1985) also noted clamps at the stipe and recognized the fungus as a basidiomycete, "possibly a species of *Typhula* subgen. *Pistillaria*", but did not find basidia.

The refractive dots scattered over the surface of the head are similar to the reduced sterigmata of mature and collapsed holobasidia of *Chionosphaera* species and correspond to the minute dot at the base of symmetrical-ellipsoidal spores. The identical sterigma morphology was illustrated for *Chionosphaera apobasidialis* Cox in Oberwinkler and Bandoni (1982) and *Chionosphaera phylaciicola* (Seifert and Bandoni) R. Kirschner and Oberw. (Seifert *et al*., 1992), whereas *Pistillaria* species have true sterigmata and basidiospores with asymmetrical apiculi.

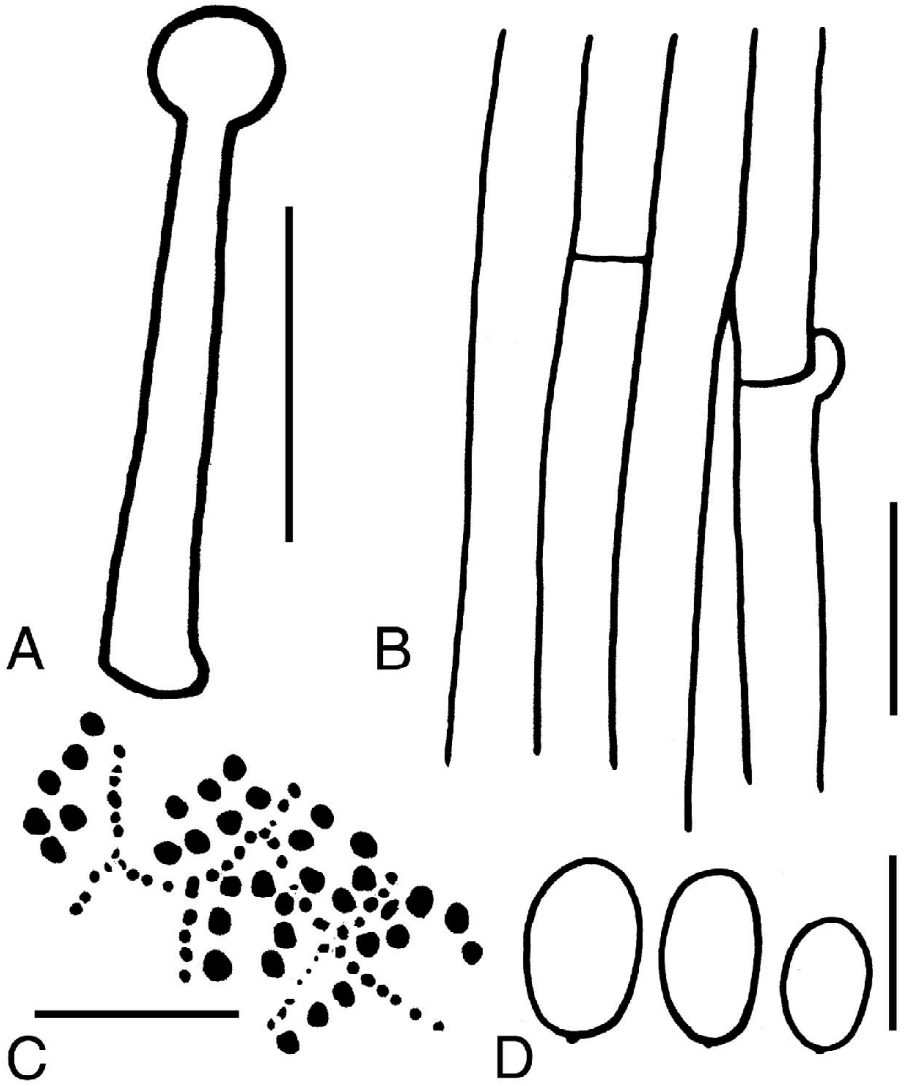

Fig. 6. *Chionosphaera erythrinae*, type (pigmentation not shown). A. Basidioma. Scale bar = 200 µm. B. Detail from stipe. Scale bar = 10 µm. C. Surface view on head of basidioma indicating reduced sterigmata (large dots) on individual cells (separated by small dots). Scale bar = 5 µm. D. Spores. Scale bar = 10 µm.

The basidiomata of *Chionosphaera* species are usually hyaline, but can become straw-coloured drying drying. The change of colour from white to pale brown might be caused during the preservation as reported for *Physalacria angustispora* Desjardin & Hemmes and *Physalacria subpeltata* Redhead [now *Anastrophella subpeltata* (Redhead) E. Horak & Desjardin] (Desjardin and Hemmes, 2001; Horak and Desjardin, 1994; Redhead, 1979). The pale brown colour of Hansford's specimen might be explained by a similar process. *Pachnocybe* with brown capitate-stipitate, holobasidiate basidiomata on rotting wood is excluded because in this genus spores are thick-walled, clamps are absent, and no mycophilic association with other fungi is known (Oberwinkler and Bandoni, 1982). *Pistillaria* species are known from leaves, but produce typical long sterigmata and asymmetrical spores (Corner, 1950). *Chionosphaera* species are not known from leaf hairs, but *Chionosphaera* species appear to require other fungi, e.g. *Cladosporium* species or lichenized fungi, for the production of basidio-

mata (Kirschner *et al*., 2001). At the present stage of knowledge based on the poor type material fixed in a slide, the species is tentatively best accommodated in *Chionosphaera*, but this placement needs re-evaluation when newly collected material will be available.

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臺灣三個擔子菌新記錄種：*Physalacria corticola*、*P. stilboidea* 及 *Stilbum vulgare*

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摘　要

臺灣三個形成球梗狀擔子的腐生型擔子菌新記錄種：*Physalacria corticola* 目前僅知在新加坡被發現過；*P. stilboidea* 僅發現於紐西蘭及美國；*Stilbum vulgare* 則未曾在亞洲發表過，我們則發現於臺灣的枯枝落葉上，根據模式標本研究結果，*Stilbum erythrinae* Hansf 這個種暫時歸到 *Chionosphaera* 屬。

關鍵詞：Agaricomycotina、Chionosphaeraceae、clavarioid basidiomata、*Physalacriaceae*、Pucciniomycotina、*Stilbum*。