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Bionectriaceous fungi collected from forests in Taiwan

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ABSTRACT. Twenty-two fungi of the family Bionectriaceae (Hypocreales, Ascomycota), collected from forests in Taiwan are reported, including *Bionectria byssicola, B. compactiuscula, B. grammicospora, B. ochroleuca, B. parviphialis, B. pseudostriata, B. verrucispora, Hydropisphaera ciliata, H.* cf. *cyatheae, H. peziza, H. suffulta, H.* cf. *rufofusca, Ijuhya parilis, Ijuhya* sp., *Nectriella* cf. *luteola, Nectriopsis cupulata, N. lasiodermopsis, N. sibicola, Ochronectria* cf. *calami, Stephanonectria keithii, Stilbocrea gracilipes* and *S. macrostoma*. Most of them were found on recently dead broad-leaf trees. All of these species are newly recorded in Taiwan. A dichotomous key to these species is given.

Keywords: *Bionectria*; *Hydropisphaera*; Hypocreales; *Ijuhya*; Nectriaceae; *Nectriella*; *Nectriopsis*; *Ochronectria*; *Stephanonectria*; *Stilbocrea*; Systematics.

INTRODUCTION

Fungi belonging to *Nectria* (Fr.) Fr. *sensu lato*, which are also referred to as *Nectria*-like fungi, have been revised and reassigned to various genera mainly in the families Bionectriaceae and Nectriaceae (Rossman et al., 1999). Investigations of these fungi in Taiwan have been preliminary, and much effort is needed in order to know how they are represented on the island. Our recent collecting activities in Taiwan have primarily been conducted in forested areas at lower altitudes, mainly below 2,000 m. Our first contribution to the *Nectria*-like fungi was devoted to 19 species of the Nectriaceae (Guu et al., 2007). Species of the Bionectriaceae are dealt with in the present study. Recognition of the Bionectriaceae is well supported by several recent molecular phylogenetic studies (Rehner and Samuels, 1994, 1995; Rossman et al., 2001; Schroers, 2000). Bionectriaceous fungi are characterized by orange, pale yellow, or white ascomata, which lack a color change in 3% KOH solution, and often have two-celled, hyaline ascospores. Anamorphs of the Bionectriaceae belong to *Acremonium* Link, *Clonostachys* Corda, *Dendrodochium* Bonord., *Myrothecium* Tode, and *Stilbella* Lindau. *Acremonium* features simple conidiophores; *Clonostachys* has dimorphic conidiophores while *Dendrodochium* and *Myrothecium* have sporodochial conidiomata, and *Stilbella* has synnematal conidiomata.

In the present study, we report 22 species of the Bionectriaceae found in Taiwan, including seven *Bionectria* species, five *Hydropisphaera* species, two *Ijuhya* species, one *Nectriella* species, three *Nectriopsis* species, one *Ochronectria* species, one *Stephanonectria* species, and two *Stilbocrea* species. We also report cultures and anamorphs for most of these species. Anamorphs of these bionectriaceous fungi are distributed among four form-genera, with *Bionectria* connected to *Clonostachys*; *Hydropisphaera*, *Ijuhya*, *Nectriella*, *Nectriopsis*, and *Ochronectria* to *Acremonium*; *Stephanonectria* to *Myrothecium*; and *Stilbocrea* to *Stilbella*.

MATERIALS AND METHODS

Perithecial wall layers were described based on longitudinal sections of approximately 15 μm thick made by a freezing microtome (Yamatokohki FX-801). Cultures were initiated from single or multiple ascospores on water agar (WA). Resulting colonies were transferred to 9-cm plastic Petri plates containing Difco potato dextrose agar (PDA) and Difco cornmeal agar plus dextrose 2 g per liter (CMD, see Samuels and Braydford, 1994), from which the culture descriptions were made. Cultures were incubated under 12-h fluorescent light at 20°C. The cited specimens were deposited in HAST (Botanical Herbarium, Academia Sinica, Taipei, Taiwan), and the obtained cultures were deposited in BCRC (the Bioresource Collection and Research Center, Taiwan). Descriptions of teleomorphs, cultures, and anamorphs were prepared in brief formats because detailed descriptions can readily be found in recent literature. Terminology used in descriptions of teleomorphs and anamorphs follows Kirk et al. (2001). The numbers of ascospores, conidia, perithecia, asci, and conidiophores that we measured to form the size ranges

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in the descriptions are 20, 20, 5, 5, and 5, respectively. Collector names of cited specimens were abbreviated as follows: *CKT* for *Chang, K.-T.*, *CTH* for *Chao, T.-H.*, *GJR* for *Guu, J.-R.*, *HHM* for *Hsieh, H.-M.*, *JYM* for *Ju, Y.-M.*, *KHP* for *Kuo, H.-P.*, *SSH* for *Shih, S.-H.*, *WJH* for *Wu, J.-H.*, and *YRL* for *Yuan, R.-L.*

TAXONOMY

Key to the bionectriaceous fungi studied

1. Stromata well-developed, enclosing perithecia; anamorph with conidiophores aggregated into synnemata, commonly associated with teleomorph ..... 21 (*Stilbocrea*)

1. Stromata inconspicuous to well-developed, flattened to pulvinate, seated underneath perithecia; anamorph with conidiophores simple or aggregated into sporodochia, uncommonly associated with teleomorph 2

2. Ascospores 32-35(-38.5) × 5-5.5 µm, with several thread-like appendages on each end ..... *Hydropisphaera ciliata*

2. Ascospores smaller than 30 µm, without thread-like appendages on each end 3

3. Perithecial surface lacking fasciculate hairs 4

3. Perithecial surface with fasciculate hairs 16

4. Ascospores (4-)5-septate, 20.5-23.5 × 4-4.5(-5) µm ..... *Ochronectria* cf. *calami*

4. Ascospores 1-septate 5

5. Perithecia greater than 200 µm diam; anamorph *Clonostachys* ..... 6 (*Bionectria*)

5. Perithecia less than 200 µm diam; anamorph acremonium-like or myrothecium-like 12

6. Ascospores smooth to finely roughened 7

6. Ascospores striate or coarsely warted 10

7. Perithecia dull orange; ascospores with warts arranged in striations ..... *B. pseudostriata*

7. Perithecia orange, pale orange or yellowish; ascospores finely roughened 8

8. Perithecia coarsely warted; ascospores (9.5-)10-15(-21) × (3-)4-5(-5.5) µm ..... *B. byssicola*

8. Perithecia smooth or verruculose 9

9. Perithecia smooth, slightly sunken when dry; ascospores (10-)12-13.5(-15) × 3-3.5(-4) µm ..... *B. compactiuscula*

9. Perithecia verruculose, laterally pinched or not when dry; ascospores (8.5-)9-12(-14.5) × (2.5-)3-4(-4.5) µm ..... *B. ochroleuca*

10. Ascospores striate, (11-)11.5-13.5(-16) × (3-)3.5-4.5(-6) µm ..... *B. grammicospora*

10. Ascospores coarsely warted 11

11. Perithecial wall two-layered; ascospores (14.5-)15-17.5 × (4.5-)5-6 µm ..... *B. parviphialis*

11. Perithecial wall three-layered; ascospores (12.5-)16-17.5(-18) × (5.5-)6-7.5(-8) µm ..... *B. verrucispora*

12. Perithecial wall one-layered; often fungicolous ..... 13 (*Nectriopsis*)

12. Perithecial wall two-layered; not fungicolous 15

13. Perithecia ovoidal, parasitizing perithecia of *Bionectria* sp.; ascospores (9-)10-10.5(-11) × (3.5-)4-4.5 µm ..... *N. lasiodermopsis*

13. Perithecia obpyriform, parasitizing perithecia of *Stilbocrea gracilipes* or other ascomycetes 14

14. Perithecia pale orange, on bark or perithecia of *S. gracilipes*; ascospores pale yellow, (4.5-)5-6(-6.5) × (2-)3-3.5 µm ..... *N. cupulata*

14. Perithecia pale yellow, parasitizing a black pyrenomycete; ascospores hyaline, (4.5-)5-7.5(-8) × 3-3.5(-4) µm ..... *N. sibicola*

15. Perithecia roughened, with thickened cells arranged in a fringe around ostioles in coronal appearance; ascospores hyaline, (8-)9-10(-10.5) × 2.5-3 µm, faintly striate ..... *Stephanonectria keithii*

15. Perithecia smooth, lacking thickened cells around ostioles; ascospores pale yellow, 9.5-11 × 4.5-5 µm, echinulate ..... *Nectriella* cf. *luteola*

16. Perithecial hairs fasciculate or without hairs, distributed on entire surface ..... 17 (*Hydropisphaera*)

[Notes: *H. ciliata* is keyed out at entry 2 because it differs from the other species of the genus found in Taiwan in lacking fasciculate hairs on the perithecial surface and in having larger ascospores with thread-like appendages on each end.]

16. Perithecial hairs fasciculate, arranged in a discoidal fashion around ostiole ..... 20 (*Ijuhya*)
17. Ascospores echinulate, narrower than 3 µm, (12-)12.5-15(-16) × 2.5-3 µm ..... *H.* cf. *rufofusca*
17. Ascospores striate, broader than 3 µm 18
18. Ascospores (17-)17.5-18(-20) × 6-7 µm ..... *H.* cf. *cyatheae*
18. Ascospores smaller than 17 µm 19
19. Perithecial hairs abundant, longer than 70 µm; ascospores (10.5-)11.5-13.5(-14) × (3.5-)4.5-5.5(-6) µm ..... *H. suffulta*
19. Perithecial hairs sparse or lacking, 15-30 µm long; ascospores (12.5-)13-14 × (5-)5.5-6 µm ..... *H. peziza*
20. Fasciculate hairs forming a stellate disc; ascospores (9-)10-10.5(-11) × (2-)2.5-3 µm ..... *Ijuhya* sp.
20. Fasciculate hairs arranged in coronal appearance; ascospores (15.5-)17.5-19(-21) × (3.5-)4-4.5 µm ..... *I. parilis*
21. Stromata pale brown; perithecia brown, associated with black synnemata; ascospores 13-15 × 4.5-5 µm ... *S. gracilipes*
21. Stromata pale orange; perithecia orange, associated with orange synnemata; ascospores 9-14 × 4-6 µm .*S. macrostoma*

Bionectria byssicola (Berk. & Broome) Schroers & Samuels, Z. Mykol. 63: 152. 1997. Figures 1A, 2A, B

Anamorph. *Clonostachys byssicola* Schroers, Stud. Mycol. 46: 80. 2001.

Stromata inconspicuous. *Perithecia* aggregated in groups of 5-30, superficial, orange, subglobose, 200-350 µm diam, laterally pinched or not when dry, ornamented with large, white, coarsely warts, up to 50 µm high × 80 µm broad; perithecial wall 25-40 µm thick, three-layered; ostiolar openings slightly papillate. *Asci* clavate, 40-70 × 6-8.5 µm, with an apical ring. *Ascospores* hyaline, oblong-ellipsoidal, 1-septate, (9.5-)10-15(-21) × (3-)4-5(-5.5) µm, finely roughened.

Cultures and anamorph. *Colonies* 5 cm in 7 days at 20°C, diffusing a pale orange pigment into the medium. *Conidiophores* dimorphic, verticillate and penicillate. *Verticillate conidiophores* up to 200 µm high, solitary, bearing 2 or 3 divergent phialides at each whorl, sometimes with lateral branches arising from main axis; phialides cylindrical, 15-30 × 1.5-2 µm. *Penicillate conidiophores* solitary or aggregated into sporodochia, bi- to terverticillate, bearing 2-4 phialides at each terminus; phialides flask-shaped to cylindrical, 9-12 × 1.5-2.5 µm. *Intercalary phialides* absent. *Conidia borne on verticillate conidiophores* hyaline, ellipsoidal to ovoidal, aseptate, 5-8 × 2-3 µm, aggregated into spore balls. *Conidia borne on penicillate conidiophores* hyaline, ovoidal to subglobose, with a lateral hilum, aseptate, 3-6 × 1.5-2.5 µm, arranged in imbricate chains adhering laterally to form white to pale orange columns.

Specimens examined. Taipei County, Sunshai, Man-yue-yuan, on bark, 27 Sep 2000, *JYM 89092711*. Nantou County, Pulee, Lien-hwa-chee, on *Castanopsis carlesii* (Hemsl.) Hayata var. *sessilis* Nakai, 19 Jul 2001, *JYM 90071907*. Nantou County, Pulee, Tsuifong, on bark, 24 Apr 2003, *JYM 92042401*. Taipei City, Shihlinn. Ping-ding-gu-jyun, on bark, 14 Sep 2003, *GJR 92091402* (cultured); *92092501* (cultured). Taipei County, Hsintien, Jhih-tan-shan, on bark, 9 Oct 2003, *GJR 92100903* (cultured). Taipei County, Hsintien, Yinhodong, on bark, 16 Oct 2004, *GJR 92101607* (cultured). Taipei County, Pingshi, Chung-yang-chien-shan, on bark, 20 Nov 2003, *GJR 92112002*. Taipei County, Sungi, Datunshi historical trail, on bark, 6 Dec 2003, *GJR 92120602* (cultured). Taipei County, Jingtung, Shu-lung-chien, on bark, 5 Jan 2004, *GJR 93010502*. Taipei City, Shihlinn, Ping-ding-gu-jyun, on bark, 22 Apr 2004, *GJR 93042201*. Taipei County, Hsintien, Shih-tzu-tou-shan, on bark, 2 May 2004, *GJR 93050205*. Ilan County, Tatung, Chi-lan-shan, on bark, 1 Jun 2004, *GJR 93062001* (cultured). Taipei City, Yong-ming-shan, Lu-jiao-keng shi, on bark, 10 Jul, *GJR 93071002* (cultured). Ilan County, Tatung, Chi-lan-shan, on bark, 31 Aug 2004, *GJR 93083101*. Taipei County, Hsintien, Da-tung-shan, on bark, 19 Sep 2004, *GJR 93091904*. Taipei County, Shaoyi, A-yu-shan, on bark, 25 Sep 2004, *GJR 93092502* (cultured). Taipei County, Hsintien, Da-tung-shan, on bark, 9 Oct 2004, *GJR 93100905* (cultured). Taipei County, Pingshi, Chou-tou-shan, on bark, 31 Oct 2004, *GJR 93103114*. Taipei County, Shihdin, Huang-di-dian east peak, on bark, 13 Nov 2004, *GJR 93111303* (cultured). Taipei County, Hsintien, Yinhodong, on bark, 25 Nov 2004, *GJR 93112505* (cultured). Taipei County, Sungi, Datunshi historical trail, on bark, 22 Jan 2005, *GJR 94012204*; on other dematiaceous fungi, 22 Jan 2005, *GJR 94012207*. Taipei City, Peitou, Chintien Temple, on bark, 22 Jan 2005, *SSH & CTH 94012219* (cultured). Ilan County, Fushan, 24 Jan 2005, *GJR 94012406* (cultured); *GJR 94012502*. Kaohsiung County, Liouguei, Shan-ping, on bark, 10 Mar 2005, *GJR 94031012*. Taipei County, Wanlee, Rueichuan historical trail, on bark, 23 Jul 2005, *GJR 94072309* (cultured). Pingdong County, Heng-chun, Nan-ren-shan, on bark, 19 Nov 2005, *GJR 94111902*. Chiayi County, Shihjhuo, on bark, 20 Nov 2005, *GJR 94112002*. Taipei City, Chi-shinn-shan, on bark, 26 Nov 2005, *SSH & CTH 94112601*. Ilan County, Tatung, Chi-lan-shan, on bark, 3 Feb 2006, *WJH 95020301*. Taipei City, Shilinn, Neiliao historical trail, on bark, 12 Mar 2006, *GJR 95031202*. Taipei City, Nankang, Nankang-shan, on bark, 22 Mar 2006, *GJR 95032205*. Taipei City, Nankang, Hushih elementary school, on bark, 27 Apr 2006, *GJR 95042701*. Taipei County, Shihdin, Huang-di-dian north peak trail, on bark, 13 Jun 2006, *GJR 95061303*. Taipei County,

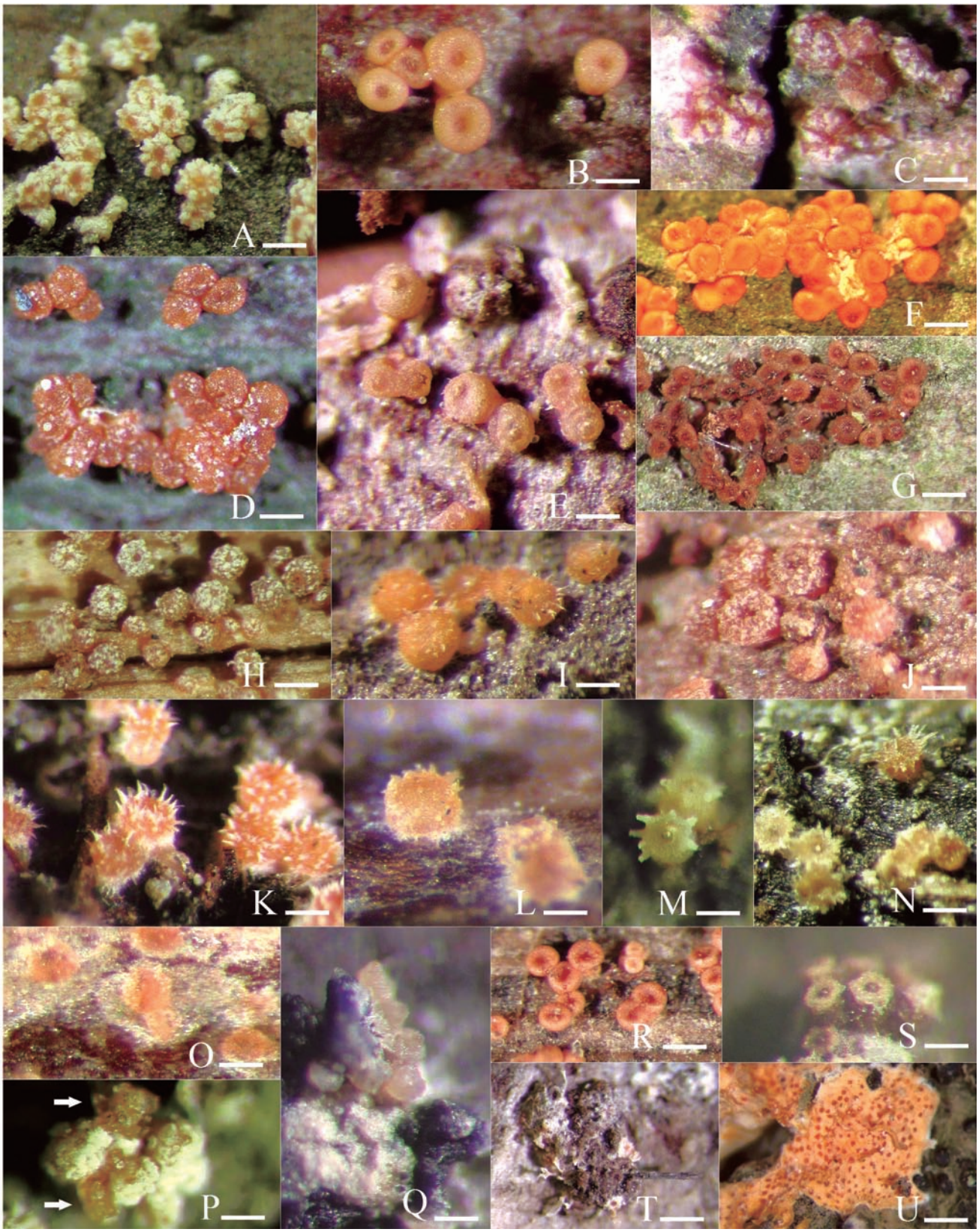

Figure 1. Macroscopic details of ascomata of bionectriaceous fungi on natural substrata. A, *Bionectria byssicola*; B, *B. compactiuscula*; C, *B. grammicospora*; D, *B. ochroleuca*; E, *B. parviphialis*; F, *B. verrucispora*; G, *B. pseudostriata*; H, *Hydropisphaera ciliata*; I, *H. cyatheae*; J, *H. peziza*; K, *H. suffulta*; L, *H.* cf. *rufofusca*; M, *Ijuhya parilis*; N, *Ijuhya* cf. *dentifera*; O, *Nectriella* cf. *luteola*; P, *Nectriopsis lasiodermopsis*; Q, *N. sibicola*; R, *Ochronectria* cf. *calami*; S, *Stephanonectria keithii*; T, *Stilbocrea gracilipes*; U, *S. macrostoma*. Scale bars: A, B, C, H, K, P, R = 300 μm. D, G = 400 μm. E, F = 350 μm. I, J = 250 μm. L, M, S = 200 μm. O, Q = 150 μm. T, U = 80 μm.

Shuangsi, Mudan, on bark, 21 Oct 2006, *GJR 95102101*.

Notes. *Bionectria byssicola* and *B. ochroleuca* often grow on the same substrata in tropical and neotropical regions (Samuels, 1976a; Samuels et al., 1990; Schroers and Samuels, 1997; Schroers, 2001). The ascomatal morphology of *B. byssicola* resembles that of *B. grammicospora* but differs from the latter in having white warts on the perithecial wall composed of large, unevenly thickened cells and in having finely roughened ascospores. Also, the pigment produced by *B. byssicola* in culture is pale orange while that produced by *B. ochroleuca* and *B. grammicospora* is yellow.

Bionectria compactiuscula Schroers, Stud. Mycol. 46: 104. 2001. Figure 1B

Anamorph. *Clonostachys compactiuscula* (Sacc.) D. Hawksw. & W. Gams, in Hawksworth & Punithalingam, Trans. Brit. Mycol. Soc. 64: 90. 1975.

Stromata slightly erumpent from bark. *Perithecia* aggregated in groups of 5-20, rarely solitary, superficial, orange, subglobose, 250-350 µm diam, slightly sunken when dry, smooth; perithecial wall 35-50 µm thick, three-layered; ostiolar openings slightly papillate. *Asci* clavate, 40-65 × 5-7.5 µm, with an apical ring. *Ascospores* hyaline, oblong-ellipsoidal, 1-septate, (10-)12-13.5(-15) × 3-3.5(-4) µm, finely roughened.

Cultures and anamorph. *Colonies* 3 cm in 7 days at 20°C, with scanty aerial hyphae, diffusing a pale yellow pigment near margins. Conidiophores dimorphic, verticillate and penicillate. *Verticillate conidiophores* less frequently observed, up to 250 µm high, solitary, bearing 2 or 3 divergent phialides at each whorl; phialides cylindrical, 15-30 × 2-2.5 µm. *Penicillate conidiophores* frequently bearing 2-3 branches, solitary to somewhat aggregated, but not forming sporodochia, bi- to terverticillate, bearing 2-5 phialides at each terminus; phialides flask-shaped to cylindrical, 7-11 × 1.5-2.5 µm. *Intercalary phialides* infrequently produced, short-cylindrical, 2.5-4 × 1.5-2 µm. *Conidia borne on verticillate conidiophores* hyaline, ellipsoidal, aseptate, (5-)6-7.5(-8.5) × 2.5-3(-4) µm. *Conidia borne on penicillate conidiophores* hyaline, oblong-ellipsoidal to cylindrical, with a lateral hilum, aseptate, 6-6.5(-7) × 2-2.5 µm, with imbricate conidial chains adhered laterally to form white conidial columns.

Specimens examined. Chiayi County, Shihjhuo, on bark, 20 Nov 2005, *GJR 94112001* (cultured). Taichung County, Pilushi, on twig of *Pinus armandii* Franchet, 19 Aug 2006, *GJR 95081901* (cultured).

Notes. *Bionectria compactiuscula* resembles *B. verrucispora* but differs from it in having smaller ascospores, in having finely roughened ascospores, and in not having conidiophores aggregated into sporodochia. *Bionectria compactiuscula* has a worldwide distribution and has been collected mainly from broad-leaf trees except for two specimens reported from *Pinus* sp. (Schroers, 2001).

Bionectria grammicospora (Ferd. & Winge) Schroers & Samuels in Schroers, Stud. Mycol. 46: 154. 2001. Figure 1C

Anamorph. *Clonostachys grammicospora* Schroers & Samuels in Schroers, Stud. Mycol. 46: 154. 2001.

Stromata flattened to pulvinate. *Perithecia* aggregated in groups of 5-20, yellowish or pale orange, globose to subglobose, 280-400 × 280-350 µm, laterally pinched or not when dry, ornamented with whitish warts up to 80 µm high × 100 µm broad; perithecial wall 40-50 µm thick, two-layered; ostiolar openings slightly papillate. *Asci* clavate, 40-60 × 8-10 µm, with an apical ring. *Ascospores* hyaline, ellipsoidal, 1-septate, (11-)11.5-13.5(-16) × (3-)3.5-4.5(-6) µm, striate.

Cultures and anamorph. *Colonies* 3 cm diam in 7 days at 20°C, with scanty aerial hyphae, diffusing a yellow pigment into medium. *Conidiophores* dimorphic, verticillate, and penicillate. *Verticillate conidiophores* less frequently observed, up to 200 µm high, solitary, divergent, bearing 1-2 phialides; phialides cylindrical, appressed to the main axis, 20-30 × 1.5-2.5 µm. *Penicillate conidiophores* divergent, solitary, not forming sporodochia, penicillate, bi- to terverticillate, bearing 2-5 phialides; phialides flask-shaped to cylindrical, 6-15 × 1.5-2.5 µm. *Intercalary phialides* infrequent, short cylindrical, 2.5-3 × 1.5-2 µm. *Conidia* borne on verticillate conidiophores hyaline, ovoidal, aseptate, (5-)5.5-6(-6.5) × 3-3.5 µm. *Conidia* borne on penicillate conidiophores hyaline, ellipsoidal to ovoidal, aseptate, with a median hilum, 5.5-7(-8) × 2.5-3.5 µm, with imbricate conidial chains adhering laterally to form white to pale orange conidial columns.

Specimens examined. Nantou County, Pulee, Lienhwa-chee, on *Castanopsis carlesii* (Hemsl.) Hayata var. *sessilis* Nakai, 19 Jul 2001, *JYM 90071902* (cultured). Taipei County, Shihdin, Huang-di-dian north peak trail, on bark, growing together with *Bionectria verrucispora*, *Haematonectria haematococca* and *Ophionectria trichospora*, 27 Nov 2003, *GJR 92112706* (cultured). Taipei County, Jingtung, Jingtung historical trail, on bark, 21 Dec 2003, *GJR 92122106* (cultured). Ilan County, Tatung, Chi-lan-shan, on bark, 31 Aug 2004, *GJR 93083102* (cultured). Taipei County, Sungi, Datunshi historical trail, on bark, 22 Jan 2005, *GJR 94012206* (cultured). Pingtung County, Maja, liang-shan waterfall, on bark, 14 Sep 2005, *GJR 94091411* (cultured). Pingtung County, Heng-chun, Nan-ren-shan, on bark, 19 Nov 2005, *GJR 94111904*.

Notes. *Bionectria grammicospora* can easily be distinguished from other *Bionectria* species in possessing conspicuously warted perithecia and striate ascospores, and in not producing sporodochia in nature or in culture. Furthermore, unlike other *Bionectria* species, *B. grammicospora* has the phialides of the verticillate conidiophores appressed to the main axis. *Bionectria grammicospora* resembles *B. parviphialis* in having a two-layered perithecial wall but differs from it in having striate

ascospores and dimorphic conidiophores (Schroers, 2001). This fungus is commonly found on the recently dead trees in the pantropical areas (Samuels, 1988a; Samuels et al., 1990).

Bionectria ochroleuca (Schwein.) Schroers & Samuels, Z. Mykol. 63: 151. 1997. Figure 1D, 2I

Anamorph. *Clonostachys rosea* (Link: Fr.) Schroers, Samuels, Seifert & W. Gams, Mycologia 91: 369. 1999. Figure 2C, D, Q

Stromata flattened to pulvinate. *Perithecia* aggregated in groups of 5-20, yellowish or pale orange, globose to subglobose, 200-350 µm diam, laterally pinched or not when dry, smooth or roughened; perithecial wall 20-55 µm thick, three-layered, orange droplets in the cells of the outermost wall layer; ostiolar openings nonpapillate. *Asci* clavate, 40-70 × 5-8.5 µm, with an apical ring. *Ascospores* hyaline, ellipsoidal, 1-septate, (8.5-)9-12(-14.5) × (2.5-)3-4(-4.5) µm, finely roughened.

Cultures and anamorph. *Colonies* 3-4 cm diam in 7 days at 20°C, with aerial hyphae forming strands, diffusing a yellow pigment into the medium, not forming sporodochia. *Conidiophores* dimorphic, verticillate and penicillate. *Verticillate conidiophores* frequently observed, up to 200 µm high, solitary, bearing 2 or 3 divergent phialides; phialides cylindrical, 15-30 × 1.5-2 µm. *Penicillate conidiophores* solitary or aggregated into sporodochia, bi- to terverticillate, bearing 2-4 divergent phialides; phialides flask-shaped to cylindrical, 9-12 × 1.5-2.5 µm. *Intercalary phialides* absent. *Conidia* borne on verticillate conidiophores hyaline, ellipsoidal, slightly curved, aseptate, (5.5-)6-9(-10.5) × (2-)2.5-4 (-4.5) µm. *Conidia* borne on penicillate conidiophores hyaline, ovoidal to subglobose, with a lateral hilum, aseptate, 4-6 × 2.5-3 µm, with imbricate conidial chains adhered laterally to form yellowish or white conidial columns.

Specimens examined. Taipei County, Sunshai, Manyue-yuan, on bark, 27 Sep 2000, *JYM 89092712*. Tainan County, Nansi, on bark, 14 Apr 2001, *JYM & HHM 90041411*. Taipei City, Nankang, Hu-shih park, on bark, 6 Apr 2003, *JYM & HHM 92040604*. Taipei City, Shihlinn, Ping-ding-gu-jyun, on bark, 9 Aug 2003, *GJR 92080905*. Taipei City, Shihlinn, Ping-ding-gu-jyun, on bark, 25 Sep 2003, *GJR 92092502* (cultured). Taipei County, Hsintien, Jhih-tan-shan, on bark with *Albonectria rigidiuscula* and *Gibberella* sp., 9 Oct 2003, *GJR 92100901* (cultured). Taipei County, Hsintien, Yinhodong, on bark, 16 Oct 2003, *GJR 92101602* (cultured). Taipei County, Jingtung, Shih-shun-chien, on bark, 5 Jan 2004, *GJR 93010505* (cultured). Taipei County, Wulai, Fusan, Ha-pen, on bark, 6 Mar 2004, *GJR 93030601*. Taipei County, Jingtung, Jing-tung historical trail, on bark, 18 Mar 2004, *GJR 93031806*. Taipei County, Hsintien, Shih-zih-tou-shan, on bark, 21 Mar 2004, *GJR 93032104* (cultured). Taipei City, Kungguan, National Taiwan Univ., on *Cycas taitungensis* Shen, Hill, Tsou & Chen, 26 Apr 2004, *WJH & YRL 93042601* (cultured). Taipei County, Jingtung, Jing-tung historical trail, on bark, 4 Sep 2004, *GJR & KHP 93090405*. Taipei City, Muja, on bark, 25 Sep 2004, *SSH 93092509*. Taipei County, Pingshi, Chou-tou-shan, on *Sphaeropteris lepifera* (J. Sm. ex Hook.) Copel., 31 Oct 2004, *GJR 93103108*. Taipei County, Hsintien, Yinhodong, on bark, 25 Nov 2004, *GJR 93112504*. Taipei County, Hsintien, Shih-zih-tou-shan, on bark, 11 Dec 2004, *GJR 93121110*. Taipei County, Wanlee, Linnshih historical trail, on bark, 15 Jan 2005, *GJR 94011506* (cultured). Taipei County, Wanlee, Linnshih historical trail, on bark, 15 Jan 2005, *GJR 94011509*. Taipei City, Peitou, Chintien Temple, on bark, 22 Jan 2005, *SSH & CTH 94012209* (cultured). Kaohsiung County, Liouguei, Shanping, on bark, 10 Mar 2005, *GJR 94031013* (cultured). Ilan County, Yuanshan, Fushan, on bark, 29 Apr 2005, *HHM 94042906* (cultured); *94042909*. Taipei City, Kungguan, National Taiwan Univ., on bark, 12 Jun 2005, *GJR 94061201* (cultured). Taipei County, Wanlee, Rueichuan historical trail, on bark, 23 Jul 2005, *GJR 94072305* (cultured). Taipei County, Wanlee, Rueichuan historical trail, on *Sphaeropteris lepifera*, 23 Jul 2005, *GJR 94072313* (cultured). Kaohsiung County, Maolin, on bark, 14 Sep 2005, *GJR 94091404* (cultured). Chiayi County, Shihjhuo, on bark, 20 Nov 2005, *GJR 94112008*. Taipei City, Chi-shinn-shan, on bark, 26 Nov 2005, *SSH & CTH 94112603*. Ilan County, Yuanshan, Fushan, on bark, 6 Dec 2005, *GJR 94120605*.

Notes. *Bionectria ochroleuca* is frequently encountered in tropical and neotropical regions (Samuels, 1976a; Schroers and Samuels, 1997; Schroers, 2001) and is well represented among our Taiwan collections. Its perithecial wall possesses unevenly thickened cells as in *B*. *byssicola*; however, *B. byssicola* has coarse warts on the perithecial surface. The orange droplets are located in the cells of the outermost wall layer, which distinguishes *B*. *ochroleuca* from other members of *Bionectria*. Droplets present in other species of *Bionectria* are essentially hyaline. While most of our collections were made from the bark of broad-leaf trees, some were from tree ferns: specimens *93103108* and *94072313* were from *Sphaeropteris lepifera*. Like Samuels (1976a) and Schroers (2001), we were also able to obtain the teleomorph in cultures from specimens *92101602*, *93010505*, *93032104*, and *94061201*.

Bionectria parviphialis (Samuels) Schroers, Stud. Mycol. 46: 182. 2001. Figures 1E, 2E, F

Anamorph. *Clonostachys pseudosetosa* (Samuels) Schroers, Stud. Mycol. 46: 182. 2001.

Stromata lacking. *Perithecia* aggregated, superficial, pale orange, globose, 250-350 µm diam, not collapsed when dry, roughened; perithecial wall 40-50 µm thick, two-layered; ostiolar openings nonpapillate. *Asci* clavate, 55-70 × 10-15 µm, with an apical ring. *Ascospores* hyaline, ellipsoidal, 1-septate, (14.5-)15-17.5 × (4.5-)5-6 µm, with coarse warts up to 1 µm diam.

Specimen examined. Taipei County, Pingshi, Chung-yang-chien-shan, on bark, 20 Nov 2003, *GJR 92112008*.

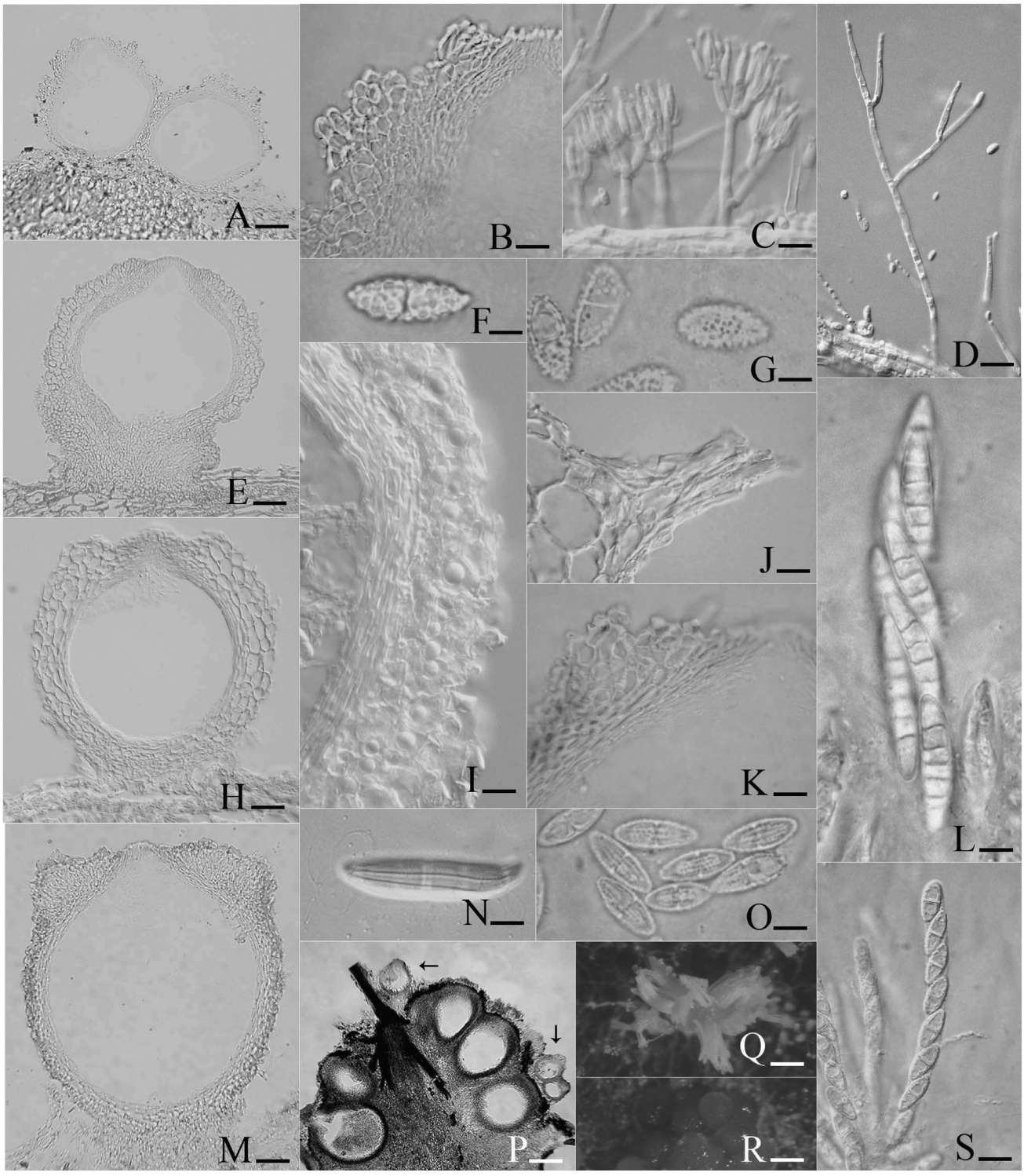

Figure 2. A-B, *Bionectria byssicola*. A, Median section of ascoma; B, Warts with thick-walled cells; C-D, I, R, *Bionectria ochroleuca*; C, Penicillate conidiophores; D, Verticillate conidiophores; I, Orange droplets in the perithecial wall; R, Ascomata forming in the culture; Q, Imbricate conidia arranged in the top of *Clonostachys rosea* penicillate conidiophores; E-F, *Bionectria parviphialis*; E, Median section of ascoma; F, Coarsely warted ascospore; G, *Bionectria verrucispora* warted ascospores; H, N, *Hydropisphaera ciliata*; H, Median section of ascoma; N, Ascospore with ridge-like striations and attaching appendages on each end; J, Perithecial hair of *Hydropisphaera suffulta*; K, M, *Stephanonectria keithii*; K, Thick-walled cells consisting coronal manner; L, Ascus and ascospores of *Ochronectria* cf. *calami*; O, Ascospores of *Bionectria pseudostriata*; P, Ascomata of *Nectriopsis cupulata* (arrows); S, Ascus and ascospores of *Stilbocrea gracilipes*. Scale bars: A = 30 µm. B, I, J, K = 10 µm. C, D = 15 µm. E = 50 µm. F, L, O = 5 µm. G = 6 µm. H = 40 µm. M = 18 µm. N = 7 µm. P = 100 µm. Q = 50 µm. R = 200 µm. S = 3 µm.

Notes. The ascospores of the Taiwan collection of *Bionectria parviphialis* is slightly lower than that given in Schroers (2001), i.e., (14.5-)15-17.5 × (4.5-)5-6 µm vs. (13.2-)16.2-18.8-21.6(-24.8) × (4.4-)5.60-6.8-8(-10) µm. The ascospore warts of *B. parviphialis* are conspicuously coarser than those of *B. verrucispora*. We were unable to germinate ascospores from the Taiwan specimen. Samuels (1989) assigned the anamorph to *Sesquicillium* W. Gams, which is considered a synonym of *Clonostachys* by Schroers (2001). This fungus grows on tree bark or other fungi in the neotropics (Schroers, 2001).

Bionectria pseudostriata Schroers, Stud. Mycol. 46: 127. 2001. Figures 1G, 2O

Anamorph. *Clonostachys pseudostriata* Schroers, Stud. Mycol. 46: 127. 2001.

Stromata flattened to pulvinate. *Perithecia* aggregated in groups of 5-20, dull orange, globose, 280-320 µm diam, laterally pinched when dry, roughened; perithecial wall 40-50 µm thick, three-layered; ostiolar openings nonpapillate. *Asci* clavate, 45-68 × 7.5-9 µm, with an apical ring. *Ascospores* hyaline, ellipsoidal, 1-septate, 10-12(-13) × (3-)3.5-4.5 µm, roughened with warts arranged in striations.

Cultures and anamorph. *Colonies* 4 cm diam in 7 days at 20°C, with scanty aerial hyphae, diffusing pale orange pigment into medium, forming sporodochia. *Conidiophores* dimorphic, verticillate and penicillate. *Verticillate conidiophores* frequently observed, mono- to biverticillate, up to 350 µm high, solitary to divergent, bearing 2 or 3 phialides; phialides cylindrical, 15-30 × 1.5-2 µm. *Penicillate conidiophores*, solitary or aggregated forming sporodochia, bi- to terverticillate, bearing 2-4 phialides; phialides flask-shaped to cylindrical, 10-17 × 1.5-2.5 µm. *Conidia* borne on verticillate conidiophores hyaline, oblong-ellipsoidal to ovoidal, aseptate, (5.5-)7-8.5 × (3-)3.5-4.5 µm. *Conidia* borne on penicillate conidiophores hyaline, ovoidal, with a lateral hilum, aseptate, 4-5.5 × (2.5-)3-4 µm, forming orange or gray-orange, dome-shaped conidial masses.

Specimen examined. Kaohsiung County, Maolin, on bark, 14 Sep 2005, *GJR 94091403* (cultured).

Notes. *Bionectria pseudostriata* has dull orange perithecia and conspicuous warts arranged in striations on the ascospore surface. This species resembles *B. ochroleuca* but differs from it in having darker perithecia, lacking orange droplets in the perithecial wall cells, having striately arranged ascospore warts, and having appressed penicillate conidiophores. This fungus was reported to grow on the bark of woody plants in Indonesia and Japan (Schroers, 2001).

Bionectria verrucispora Schroers & Samuels in Schroers, Stud. Mycol. 46: 100. 2001. Figures 1F, 2G

Anamorph. *Clonostachys verrucispora* Schroers, Stud. Mycol. 46: 100. 2001.

Stromata flattened or pulvinate. *Perithecia* solitary to aggregated in groups of 5-20, orange, subglobose, 300-450 µm diam, not collapsed when dry, slightly roughened; perithecial wall 75-90 µm thick, three-layered; ostiolar openings nonpapillate. *Asci* clavate, 64-85 × 8-11 µm, without an apical ring. *Ascospores* yellowish, ellipsoidal, 1-septate, (12.5-)16-17.5(-18) × (5.5-)6-7.5(-8) µm, coarsely warted.

Cultures and anamorph. *Colonies* 3-4 cm diam in 7 days at 20°C, with abundant aerial hyphae frequently aggregated into strands and forming sporodochia. *Conidiophores* dimorphic, verticillate, and penicillate. *Verticillate conidiophores* divergent, up to 150 µm high, bearing 2 or 3 phialides; phialides cylindrical, 17-28 × 1.5-2 µm. *Penicillate conidiophores* terverticillate, bearing 2-4 phialides; phialides flask-shaped, 9-13(-15) × 1.5-2.5(-3) µm. *Intercalary phialides* sometimes observed, short cylindrical, 3-5(-6) × 1.5-2 µm. *Conidia* boron on verticillate conidiophores hyaline, oblong-ellipsoidal, aseptate, (5-)6-8.5 × 2-2.5(-3) µm. *Conidia* borne on penicillate conidiophores hyaline, ellipsoidal, with a lateral hilum, aseptate, (3-)4-5.5(-6) × 2-3.5 µm, infrequently with imbricate conidial chains adhering laterally to form white to pale orange conidial columns.

Specimens examined. Taipei County, Pingshi, Chung-yang-chien-shan, on bark, 20 Nov 2003, *GJR 92112006* (cultured); *92120402* (cultured). Taipei County, Shihdin, Huang-di-dian north peak trail, on bark, 27 Nov 2003, *GJR 92112703* (cultured). Taipei County, Jingtung, Jingtung historical trail, on bark, 21 Dec 2003, *GJR 92122112* (cultured). Taipei County, Hsintien, Da-tung-shan, on bark, 10 Oct 2004, *GJR 93101001* (cultured). Taipei County, Pingshi, Chou-tou-shan, on bark, 31 Oct 2004, *GJR 93103109*. Taipei County, Shihding, Huang-di-dian north peak trail, on bark, 13 Nov 2004, *GJR 93111302* (cultured). Taipei County, Wanlee, Linnshih historical trail, on bark, 23 Jul 2005, *GJR 94072308* (cultured). Kaohsiung County, Maolin, on bark, 14 Sep 2005, *GJR 94091402* (cultured). Taipei City, Peitou, Chintien Temple, on bark, *SSH & CTH 94012217* (cultured).

Notes. *Bionectria verrucispora* resembles *B. parviphialis*, which, however, differs from the former in having pale orange perithecia, a two-layered perithecial wall, hyaline ascospores, and conidiophores in one morph only. Previously *B. verrucispora* has been reported only once from a palmaceous plant in New Zealand (Schroers, 2001). Our collections appear to match well the New Zealand material despite the fact that they occur on the bark of broad-leaved trees. Specimen *92122112* has darker ascomata than other specimens collected in Taiwan.

Hydropisphaera ciliata Taylor, Hyde & Jones in Taylor & Hyde, Microfungi of tropical and temperate palms, p. 72. 2003. Figures 1H, 2H, N

Anamorph. acremonium-like.

Stromata lacking. *Perithecia* solitary to aggregated, orange, globose to subglobose, 200-250 × 205-265 µm,

with white scales on surface; perithecial wall 35-45 µm thick, two-layered, smooth; ostiolar openings nonpapillate. *Asci* clavate, 85-100 × 12-15 µm. *Ascospores* hyaline, fusiform, 1-septate, 32-35(-38.5) × 5-5.5 µm, 4 or 5 guttulate, bearing 4-5 curved, thread-like appendages on each end, ornamented with ridge-like striations.

Cultures and anamorph. Colonies 2 cm in 14 days at 20°C, white, with sparse, stranded hyphae appressed to agar surface, diffusing pale orange pigment into medium. *Conidiophores* solitary, unbranched, cylindrical, 30-45 × 2-3 µm, tapering into a narrow tip ca 2 µm wide, bearing a slimy conidial mass on top. *Conidia* hyaline, fusiform, aseptate, (20-)21-25(-26) × 5.5-7(-8) µm. *Teleomorph* produced in culture much as described above, homothallic.

Specimens examined. Taitung County, Lanyu, on *Areca catechu*, 8 Aug 2001, *JYM 90080802* (cultured). Tainan County, Gwang-tzu-linn, Honyah park, on *Areca catechu*, 1 Mar 2003, *GJR 92030101* (cultured).

Notes. Hydropisphaera ciliata is uncommon among the *Hydropisphaera* species in having appendaged ascospores. Previously, this species has only been reported by Taylor and Hyde (2003) from the palm *Archontophoenix alexandrae* (F. Muell.) Wendl. & Drude from Australia. The perithecia of our specimens are smaller than those reported by Taylor & Hyde (2003), i.e., 200-250 × 205-265 µm vs. 260-450 × 260-290 µm, and the ascospores are slightly longer than those reported by them, i.e., 32-35(-38.5) × 5-5.5 µm vs. 23-32 × 5-7 µm. The acremonium-like anamorph produces large, amerosporous conidia, which are aggregated in slimy masses. The teleomorph was produced in single ascospore cultures isolated from the two cited specimens.

Hydropisphaera cf. **cyatheae** (Dingley) Rossman & Samuels in Rossman, et al., Stud. Mycol. 42: 30. 1999. Figure 1I

Anamorph. Acremonium sp.

Stromata lacking. *Perithecia* solitary to aggregated, orange, subglobose, 200-300 × 300-400 µm, rarely cupulate when dry, slightly roughened; fasciculate hairs on surface hyaline, 70-100 µm long; perithecial wall 55-70 µm thick, two-layered; ostiolar openings nonpapillate. *Asci* clavate, 62-80 × 10-13 µm, lacking an apical ring. *Ascospores* hyaline, ellipsoidal, 1-septate, (17-)17.5-18(-20) × 6-7 µm, striate.

Cultures and anamorph. Colonies 1 cm diam in 20 days at 20°C, not growing further after a month, with sparse aerial hyphae arising from agar surface, producing a pale brown pigment in medium. *Anamorph* not produced.

Specimen examined. Chiayi County, Shihjhuo, on bark, growing together with *Hydropisphaera suffulta*, 20 Nov 2005, *GJR 94112005* (cultured).

Notes. *Hydropisphaera cyatheae* was originally collected from rachis of the tree fern *Cyathea medullaris* (Forst. f.) Swartz in New Zealand (Dingley, 1956) and is known only from that region (Samuels, 1976b). Although the morphological features of the Taiwan collection largely agree with those of *H. cyatheae*, it was collected from the bark of a woody dicot. The present fungus resembles *H. suffulta*, from which it differs in having larger ascospores and fewer fascicles on the perithecial surface. It is interesting to note that cultures of this fungus lost vitality easily, usually within a month after being started. Production of the teleomorph in culture has been reported by Samuels (1976b).

Hydropisphaera peziza (Tode: Fr.) Dumort., Comment. Bot. p. 90. 1822. Figure 1J

Anamorph. *Acremonium* sp.

Stromata lacking. *Perithecia* solitary to aggregated, yellowish-orange, subglobose, 250-330 × 300-400 µm, roughened, cupulate or collapsed when dry, often surrounded by white hyphae at base; fasciculate hairs on surface sparse, hyaline, 15-30 µm long; perithecial wall 25-50 µm thick, two-layered; ostiolar openings nonpapillate. *Asci* clavate, 55-70 × 9-12 µm, lacking an apical ring. *Ascospores* hyaline, ellipsoidal, 1-septate, (12.5-)13-14 × (5-)5.5-6 µm, striate.

Specimens examined. Ilan County, Tou-cheng, Guei-shan Island, on bark, 9 Jun 2003, *JYM & HHM 92060902*. Chiayi County, Shihjhuo, on bark, 20 Nov 2005, *GJR 94112013*.

Notes. *Hydropisphaera peziza* resembles *H. suffulta* but differs from it in having shorter perithecial fasciculate hairs and wider ascospores. The perithecial hairs in *H. peziza* are not always present and, when present, seem to collapse easily. We did not obtain cultures from our specimens. An *Acremonium* anamorph was reported by Samuels (1976a). This widely distributed fungus has been reported from a variety of substrates, including decayed wood, bark, and basidiocarps of *Polyporus squamosus* (Huds.: Fr.) Fr. (Booth, 1959; Samuels, 1976a). Also see notes on *H. suffulta*.

Hydropisphaera suffulta (Berk. & M. A. Curtis) Rossman & Samuels in Rossman et al., Stud. Mycol. 42: 32. 1999. Figures 1K, 2J

Anamorph. Acremonium sp.

Stromata lacking. *Perithecia*, solitary to aggregated, orange, subglobose, 290-330 × 320-420 µm, roughened, cupulate when dry, often surrounded by white hyphae at base; fasciculate hairs on surface hyaline, 80-90 µm long; perithecial wall 50-100 µm thick, two-layered; ostiolar openings nonpapillate. *Asci* clavate, 65-85 × 9-13 µm, lacking an apical ring. *Ascospores* hyaline, ellipsoidal, 1-septate, (10.5-)11.5-13.5(-14) × (3.5-)4.5-5.5(-6) µm, striate.

Cultures and anamorph. *Colonies* 4 cm diam in 20 days at 20°C, overlain with scanty, short aerial hyphae. *Conidiophores* arising from aerial hyphae or agar surface, straight, unbranched, 1-septate, 50-80 × 2-4 µm. *Conidia* hyaline, ellipsoidal, with a median hilum, aseptate, 5-9 × 2-3.5 µm.

Specimens examined. Taipei City, Shihlinn, Ping-ding-gu-jyun, on bark, 9 Aug 2003, *GJR 92080903*. Taipei City, Shihlinn, Ping-ding-gu-jyun, on fronds of *Sphaeropteris lepifera*, 14 Sep 2003, *GJR 92091401*. Taipei County, Hsintien, Da-tung-shan, on fronds of *S. lepifera*, 19 Sep 2004, *GJR & KHP 93091902* (cultured). Taipei County, Wanlee, Rueichuan historical trail, on fronds of *S. lepifera*, 23 Jul 2005, *GJR 94072301* (cultured). Pingtung County, Maja, Liang-shan waterfall, on bark, 14 Sep 2005, *GJR 94091409*. Chiayi County, Shihjhuo, on bark, 20 Nov 2005, *GJR 94112010*.

Notes. Unlike *Hydropisphaera peziza*, *H. suffulta* is heterothallic (Samuels, 1976a). The cultures from the Taiwan material did not produce a teleomorph, and we are thus unable to show if they are also heterothallic. *Hydropisphaera suffulta* typically has more abundant perithecial hairs than *H. peziza* or *H. cyatheae*. As in *H. peziza*, the perithecial bases of *H suffulta* are frequently surrounded with white hyphae, which possibly represent anamorphic residues (Samuels, 1976a). *Hydropisphaera suffulta* is commonly found in subtropical and tropical areas from a variety of substrates (Samuels, 1976a), including tree fern rachis.

Hydropisphaera cf. **rufofusca** (Penz. & Sacc.) Rossman & Samuels, Mycologia 85: 702. 1993. Figure 1L

Anamorph. *Acremonium* sp.

Stromata lacking. *Perithecia* solitary, orange or brownish-orange, subglobose, 200-250 × 250-290 µm, not conspicuously collapsed when dry, roughened; fasciculate hairs on surface sparse, hyaline, 40-60 µm long; perithecial wall 30-50 µm thick, two-layered; ostiolar openings nonpapillate. *Asci* clavate, 42-65 × 7.5-9 µm, lacking an apical ring. *Ascospores* hyaline, oblong ellipsoidal, 1-septate, (12-)12.5-15(-16) × 2.5-3 µm, echinulate.

Cultures and anamorph. *Colonies* 3-4 cm diam in 20 days at 20°C, with scanty aerial hyphae. *Conidiophores* arising from aerial hyphae and agar surface, unbranched, 1-septate; phialides cylindrical, 37-48 × 1.5-2 µm, tapering to 1 µm near apex. *Conidia* oblong ellipsoidal, aseptate, 3-6(-7) × 2-2.5 µm, smooth.

Specimens examined. Taipei City, Muja, Chanshan Temple, on bark, 11 Apr 2004, *GJR 93041101*. Taipei County, Shihding, Huang-di-dian north peak trail, on *Sphaeropteris lepifera*, 18 Jun 2006, *GJR 95061806* (cultured).

Notes. The present fungus has narrower ascospores than the other *Hydropisphaera* species known in Taiwan. In general the Taiwan specimens agree with the description of *H. rufofusca* in Rossman et al. (1993) except for having narrower ascospores, 2.5-3 µm vs. (2.7-)3.3-4(-4.5) µm, and smaller conidia, 3-6(-7) × 2-2.5 µm vs. 7.2-9.5(-10) × (2.2-)2.4-2.8(-3) µm. Rossman et al. (1993) and Samuels et al. (1990) reported *H. rufofusca* from herbaceous debris in pantropical areas. One of our cited specimens was collected from rachis of a tree fern, and the other was from bark of a dicot tree. It is also interesting to note that ascospores of specimen *95061806* are more conspicuously echinulate than those of specimen *93041101*.

Ijuhya parilis (Syd.) Rossman & Samuels in Rossman et al., Stud. Mycol. 42: 35. 1999. Figure 1M

Anamorph. *Acremonium* sp.

Stromata lacking. *Perithecia* solitary to aggregated, brownish-orange, subglobose, 200-250 × 250-290 µm, not collapsed when dry, roughened; fasciculate hairs 30-50 µm long, forming a upward coronal disc surrounding ostioles; perithecial wall 20 µm thick; ostiolar openings nonpapillate. *Asci* clavate, 40-60 × 7-10.5 µm, with an apical ring. *Ascospores* hyaline, ellipsoidal to fusiform, 1-septate, (15.5-)17.5-19(-21) × (3.5-)4-4.5 µm, finely roughened.

Cultures and anamorph. *Colonies* 3-4 cm diam in 20 days at 20°C, white, with scanty, short aerial hyphae. *Conidiophores* arising from aerial hyphae or agar surface, straight, unbranched, 1-septate; phialides cylindrical, 25-40 × 2-3(-3.5) µm, tapering to 1.5 µm near apex. *Conidia* hyaline, ellipsoidal, with a truncate base, aseptate, 4-8 × 2.5-3.5 µm, smooth.

Specimen examined. Nantou County, Tsuifong, on bark, 23 Sep 2004, *JYM 91092312* (cultured).

Notes. The anamorph, which has not been reported elsewhere, is assignable to the form-genus *Acremonium* due to its solitary, unbranched conidiophores and aseptate conidia. This fungus has a pantropical distribution and was reported by Samuels (1988b) from diverse substrates, including herbaceous debris, bark, and fungi.

Ijuhya sp. Figures 1N

Anamorph. Unknown.

Stromata lacking. *Perithecia* solitary to aggregated, brownish-orange, subglobose, 120-170 × 150-200 µm, cupulate when dry, roughened; fasciculate hairs 60-80 µm long, forming a flattened stellate disc surrounding ostioles; perithecial wall *ca.* 20 µm; ostiolar openings nonpapillate. *Asci* clavate, 30-45 × 6-9 µm, lacking an apical ring. *Ascospores* hyaline, ellipsoidal, 1-septate, (9-)10-10.5(-11) × (2-)2.5-3 µm, striate.

Specimen examined. Taipei City, Shihlinn, Ping-ding-gu-jyun, on bark, 14 Sep 2003, *GJR 92091405*.

Notes. The gross morphology of the present fungus resembles that of *Ijuhya dentifera* (Samuels) Rossman & Samuels (Rossman et al., 1999), which has only been reported from New Zealand (Samuels, 1976b). The Taiwan fungus deviates from *I. dentifera* in having a larger ascospore size and striate ascospores. The ascospores of *I. dentifera* are 6-8(-9) × 3-4 µm and spinulose. The present fungus is likely an undescribed taxon. However, the available material is quite limited and did not yield cultures. We thus prefer not to make a formal taxonomic decision until more culturable material is available for study.

Nectriella cf. **luteola** (Roberge ex Desm.) Weese, Ann. Mycol. 12: 131. 1914. Figure 1O

Anamorph. Unknown.

Stromata lacking. *Perithecia* aggregated, surrounded with white subicular hyphae, pale orange, 155-175 × 125-155 µm, sometimes collapsed when dry, smooth; perithecial wall 9-14 µm thick, two-layered; ostiolar openings acute. *Asci* cylindrical to narrowly clavate, 45-62 × 6.5-8 µm, lacking an apical ring. *Ascospores* pale yellow, broadly ellipsoidal, 1-septate, 9.5-11 × 4.5-5 µm, echinulate.

Cultures and anamorph. *Colonies* 2 cm diam in 20 days at 20°C, with scanty aerial hyphae, pale yellow, overlain with sporadical pale brown hyphal aggregations on the surface. *Anamorph* not found.

Specimen examined. Taipei County, Pingshi, Chou-tou-shan, growing together with *Haematonectria haematococca* and *Lanatonectria* sp. on bark, 31 Oct 2004, *GJR 93103113* (cultured).

Notes. Despite the similarity of the Taiwan specimen to *Nectriella luteola*, we are uncertain if they are conspecific. Typical *N. luteola* grows on veins or petioles of leaves and is known only from Europe (Rossman et al., 1999). The Taiwan specimen, however, was collected from bark. In addition, the Taiwan specimen differs in having a smaller perithecia, a thinner perithecial wall, 9-14 µm vs. 20-30 µm, and smaller ascospores, 9.5-11 × 4.5-5 µm vs. 11-16 × 3-5(-6) µm. The anamorph of *N. luteola* is still unknown. Although we obtained cultures from the cited Taiwan specimen, the anamorph was unfortunately not produced.

Nectriopsis cupulata (Theiss.) Samuels, Mem. New York Bot. Gard. 48: 55. 1988. Figure 2P

Anamorph. Unknown.

Stromata flattened or inconspicuous. *Perithecia* aggregated, pale orange, obpyriform, 120-180 × 100-160 µm, smooth, not collapsed when dry; perithecial wall 10-15 µm thick, one-layered; ostiolar openings nonpapillate. *Asci* cylindrical or narrowly clavate, 30-48 × 4-7 µm, lacking an apical ring. *Ascospores* pale yellow, broadly ellipsoidal, 1-septate, constricted at septum, (4.5-)5-6(-6.5) × (2-)3-3.5 µm, echinulate.

Cultures and anamorph. *Colonies* 2-3 cm diam in 20 days at 20°C, with scanty aerial hyphae, white. *Anamorph* not produced.

Specimens examined. Pingtung County, Hengchun, Kenting, on stromata of *Stilbocrea gracilipes*, 28 Aug 2004, *JYM & HHM 93082827*. Taipei City, Tienmu historical trail, on stromata of *Xylaria*, 25 Aug 2005, *JYM & HHM 94082501* (cultured).

Notes. *Nectriopsis cupulata* was previously recorded from Brazil only, growing on perithecia of *Stilbocrea gracilipes* (Tul. & C. Tul.) Samuels & Seifert and a pyrenomycete (Samuels, 1988b). Our specimens were also collected from fungal substrates, including *S. gracilipes* and a *Xylaria* species. Cultures from this fungus did not produce an anamorph and none is known. While specimen *93082827* is typical based on the description in Samuels (1988b), specimen *94082501* has narrower ascospores 2-2.5 µm.

Nectriopsis lasiodermopsis Samuels, Mem. New York Bot. Gard. 48: 32. 1988. Figure 1P

Anamorph. *Acremonium* sp.

Stromata flattened. *Perithecia* aggregated in groups of 5-20, pale orange, ovoidal, 110-160 × 100-200 µm, smooth, collapsed when dry; perithecial wall 9-12 µm thick, one-layered; ostiolar openings obtuse. *Asci* cylindrical or narrowly clavate, 60-90 × 6-9 µm, lacking an apical ring. *Ascospores* yellowish, ellipsoidal, 1-septate, (9-)10-10.5(-11) × (3.5-)4-4.5 µm, echinulate.

Cultures and anamorph. *Colonies* 1 cm diam in 20 days at 20°C, white, with scanty aerial hyphae. *Conidiophores* scarcely produced, usually unbranched, cylindrical, 10-20 × 1-3 µm, tapering into a narrow tip *ca*. 1 µm wide. *Conidia* hyaline, oblong ellipsoidal, aseptate, 3-5 × 1-2.5 µm, smooth.

Specimen examined. Taipei City, Peitou, Chintien Temple, on perithecia of *Bionectria* sp., 22 Jan 2005, *SSH & CTH 94012214* (cultured).

Notes. The Taiwan collection fits well the description of Samuels (1988b) who reported *Nectriopsis lasiodermopsis* from old perithecia of *Bionectria* cf. *ochroleuca* (as *Nectria*) in Australia and New Zealand.

Nectriopsis sibicola Samuels, Mem. New York Bot. Gard. 48: 37. 1988. Figure 1Q

Anamorph. acremonium-like.

Stromata inconspicuous. *Perithecia* solitary or aggregated, pale yellow, obpyriform, 150-190 × 130-160 µm, smooth, laterally collapsed when dry; perithecial wall one-layered, 13-20 µm thick; ostiolar openings acute. *Asci* clavate, 40-60 × 7-10 µm, lacking an apical ring. *Ascospores* hyaline, ellipsoidal, 1-septate, unconstricted at septum, (4.5-)5-7.5(-8) × 3-3.5(-4) µm, echinulate.

Cultures and anamorph. *Colonies* 1-2 cm diam in 20 days at 20°C, white, with scanty aerial hyphae. *Conidiophores* unbranched, cylindrical, arising from aerial hyphae or agar surface, 10-26 × 2-3 µm, tapering into a narrow tip ca. 1.5 µm broad. *Conidia* hyaline, cylindrical, 0-4-septate, with oblong, curved cell on one end and foot-like cell on the other end, 20-47 × 3-4 µm, smooth.

Specimen examined. Taipei City, Nankang, Nankang-shan, on a black depauperate pyrenomycete, 1 Nov 2005, *GJR 94110104* (cultured).

Notes. This species resembles *Nectriopsis cupulata*, which differs mainly in having pale orange ascomata and pale yellow ascospores. The anamorph of the present fungus is much like that described by Samuels (1988b), featuring simple conidiophores as in *Acremonium* but

possessing conidia 0-4 septate, with a morphology reminiscing those of *Fusarium* species. Our Taiwan material differs slightly from that reported by Samuels (1988b) from New Zealand in having smaller ascomata.

Ochronectria cf. **calami** (Henn. & E. Nyman) Rossman & Samuels in Rossman et al., Stud. Mycol. 42: 53. 1999. Figures 1R, 2L

Anamorph. unknown.

Stromata lacking. *Perithecia* solitary or aggregated in groups of 3-10, orange, globose, 150-250 µm diam, cupulate when dry, smooth; perithecial wall 35-48 µm thick, three-layered; ostiolar openings nonpapillate. *Asci* clavate, 45-70 × 7-11 µm, lacking an apical ring. *Ascospores* hyaline, fusiform, (4-)5-septate, 20.5-23.5 × 4-4.5(-5) µm, faintly striate.

Specimen examined. Pingtung County, Hengchun, Kenting, on *Arenga engleri* Beccari, 16 Jun 2001, *JYM & HHM 90071628*.

Notes. Our specimen was collected from Formosan palm, *Arenga engleri*, and in general fits the description in Rossman (1983) except for having shorter ascospores, 20.5-23.5 × 4-4.5(-5) µm vs. 24-38 × 4-5.5 µm. It may eventually be proven to be a small-ascospored variety of *O. calami*. We did not obtain cultures from our specimen. *Ochronectria calami* has been recorded from monocot and dicot substrates pantropically and is associated with an acremonium-like anamorph (Rossman, 1983; Rossman et al., 1999). Like *B. ochroleuca*, *O. calami* also has orange droplets present in the perithecial wall. However, the droplets of *O. calami* are located in the middle layer of the three-layered wall while those of *B. ochroleuca* are in the outermost layer. Perithecia of *O. calami* and *B. compactiuscula* are extremely alike in gross morphology. However, these two species are readily separated by their ascospores: phragmosporous in *O. calami* and didymosporous in *B. compactiuscula*.

Stephanonectria keithii (Berk. & Broome) Schroers & Samuels in Schroers et al., Sydowia 51: 116. 1999. Figures 1S, 2K, M

Anamorph. myrothecium-like.

Stromata lacking. *Perithecia* solitary, superficial, brown, obpyriform, 190-210 × 175-190 µm, not collapsed when dry, rough; perithecial wall 15-20 µm thick, two-layered; ostiolar openings slightly papillate, encircled by a corona composed of thickened cells. *Asci* clavate, 40-55 × 5.5-7.5 µm, with an apical ring. *Ascospores* hyaline, oblong-ellipsoidal, 1-septate, (8-)9-10(-10.5) × 2.5-3 µm, faintly striate.

Cultures and anamorph. *Colonies* 10 cm in 7 days at 20°C, with scanty hyphae, diffusing pale orange pigment into medium. *Conidiophores* densely aggregated into sporodochia, arising from aerial hyphae and agar surface, bearing 2-5 phialides on each terminus; phialides cylindrical, 9-15 × 2-2.5 µm. *Conidia* hyaline, ellipsoidal, aseptate, 4-6 × 2-3 µm.

Specimens examined. Tainan County, Tungshan, on bark of *Mangifera indica* L., 4 Apr 2004, *GJR & CKT 93040403*. Taipei County, Hsintien, Da-tung-shan, on bark, 19 Sep 2004, *GJR & KHP 93091909* (cultured). Taipei City, Peitou, Chintien Temple, on bark, 22 Jan 2005, *SSH & CTH 94012223*. Pingtung County, Maja, Liang-shan waterfall, on bark, 14 Sep 2005, *GJR 94091410*.

Notes. This fungus features thickened cells forming a corona around the ostiole. Our collections slightly deviate from the description in Schroers et al. (1999) in having smaller perithecia, 175-190 µm vs. 190-240 µm, and a thinner perithecial wall, 15-20 µm vs. 25-40 µm. *Stephanonectria keithii* is a cosmopolitan species, growing on diverse substrata, including monocots, dicots, and fungi (Schroers et al., 1999).

Stilbocrea gracilipes (Tul. & C. Tul.) Samuels & Seifert in Rossman et al., Stud. Mycol. 42: 73. 1999. Figures 1T, 2S

Anamorph. *Stilbella clavulata* (Mont.) Seifert, Stud. Mycol. 27: 85. 1985.

Stromata pulvinate, pale brown. *Perithecia* aggregated in groups of up to 20, brown, globose to subglobose, 230-250 × 230-260 µm, smooth, collapsed when dry; perithecial walls 20-45 µm thick, two-layered; ostiolar openings nonpapillate. *Asci* cylindrical, 60-90 × 5-8 µm, lacking an apical ring. *Ascospores* hyaline, fusiform, 1-septate, 13-15 × 4.5-5 µm, echinulate.

Cultures and anamorph. *Colonies* 2-3 cm in 7 days at 20°C, with scanty hyphae, slimy. *Synnemata* only formed in nature, black, solitary, sometimes branched, 500-5000 × 80-200 µm, bearing a terminal, orange-brown, hemispherical conidial mass. *Conidiophores* aggregated at top of synnemata, branched, bearing 2 or 3 phialides at each terminus; phialides smooth, cylindrical, 10-22 × 1-2.5 µm. *Conidia* hyaline, oblong-ellipsoidal, aseptate, 4-8 × 2-3 µm, smooth. Conidiophores and conidia formed in culture much as those found in nature.

Specimen examined. Pingtung County, Hengchun, Kenting, on bark, 28 Aug 2004, *JYM & HHM 93082812* (cultured).

Notes. This fungus is characterized by pale brown stromata and black synnemata. It has a broad geographical distribution and is known to grow on a variety of substrates, including bark and wood of dicots as well as palm (Seifert, 1985). Also, see notes on *S. macrostoma*.

Stilbocrea macrostoma (Berk. & M. A. Curtis) Höhn., Kais. Akad. Wiss. Wien. Math. Naturw. Kl. 118: 1185. 1909. Figure 1U

Anamorph. *Stilbella aleuriata* (Berk. & M.A. Curtis) Seifert, Stud. Mycol. 27: 54. 1985.

Stromata well-developed, pulvinate, pale orange. *Perithecia* aggregated, embedded in stromata, orange, obpyriform, 220-350 × 190-280 µm, smooth, collapsed when dry; perithecial walls 12-26 µm thick, one-layered;

ostiolar openings nonpapillate. *Asci* cylindrical, 68-100 × 5-9 µm, with an apical ring. *Ascospores* hyaline, fusiform, 1-septate, 9-14 × 4-6 µm, echinulate.

Cultures and anamorph. *Colonies* 2-3 cm in 7 days at 20°C, with scanty hyphae, diffusing a pale orange pigment into medium. *Synnemata* only formed in nature, orange, solitary, erected, sometimes curved, 200-1000 × 70-150 µm, bearing a terminal, yellow-orange, hemispherical conidial mass. *Conidiophores* aggregated at top of synnemata, branched, bearing 2 or 3 phialides at each terminus; phialides smooth, cylindrical, 12-22 × 1-2 µm. *Conidia* hyaline, oblong-ellipsoidal, aseptate, 4-8 × 1.5-2 µm, smooth. Conidiophores and conidia formed in culture much as those found in nature.

Specimens examined. Pingtung County, Hengchun, Kenting, on bark, 28 Aug 2004, *Ju, Y.-M & HHM 93082801* (cultured). Kaohsiung County, Maolin, on bark, 14 Sep 2005, *GJR 94031015*.

Notes. *Stilbocrea macrostoma* produces pale orange stromata and a synnematous anamorph, which is constantly associated with the teleomorph in nature. The anamorph produced in culture, however, has mononematous conidiophores only. Seifert (1985) reported that the synnemata of *S. macrostoma* are in two colors, orange and black. Although we also observed two types of synnemata in our specimens, they appear to belong to two different *Stilbocrea* species. While the orange synnemata are closely associated with *S. macrostoma*, the black synnemata are with *S. gracilipes*, which are present in both of the cited specimens.

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台灣森林產生赤殼科真菌

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我們發表從台灣森林採集到二十二種生赤殼科真菌與一個未知的種，包括 *Bionectria byssicola*，*B. compactiuscula*，*B. grammicospora*，*B. ochroleuca*，*B. parviphialis*，*B. pseudostriata*，*B. verrucispora, Hydropisphaera ciliata, H.* cf. *cyatheae, H. peziza, H. suffulta, H.* cf. *rufofusca*，*Ijuhya parilis*，*I.* sp.，*Nectriella* cf. *luteola*，*Nectriopsis cupulata*，*N. lasiodermopsis*，*N. sibicola*，*Ochronectria* cf. *calami*，*Stephanonectria keithii*，*Stilbocrea gracilipes* 與 *S. macrostoma*。這些真菌大部份採集自最近才枯死的闊葉樹。這些種類全部是台灣新紀錄種。我們也提供一個檢索表來鑑定這些種類。

關鍵詞：*Bionectria*；*Hydropisphaera*；Hypocreales；*Ijuhya*；Nectriaceae；*Nectriella*；*Nectriopsis*；*Ochronectria*; *Stephanonectria*; *Stilbocrea*； 系統分類學。