

# Nectriaceous fungi collected from forests in Taiwan

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**ABSTRACT.** Nineteen fungi of the family Nectriaceae collected from forests in Taiwan are reported, including *Albonectria albida*, *A. rigidiuscula*, *Cosmospora* cf. *consors*, *C. diminuta*, *C. cf. glabra*, *C. joca*, *C. triqua*, *C. vilior*; *Haematonectria haematococca*, *Lanatonectria flavolanata*, *L. flocculenta*, *Nectria balsamea*, *N. pseudotrichia*, *Neonectria coronata*, *Neo. discophora*, *Neo. jungneri*, *Neo. lucida*, *Neo. rugulosa*, and *Ophionectria trichospora*. Most of them were found on recently dead broad-leaved trees. Only *A. rigidiuscula*, *H. haematococca*, and *N. pseudotrichia* have previously been reported in Taiwan; others represent new records. *Nectria albida* is newly combined into *Albonectria* as *A. albida* on the basis of its ascomatal color and *Fusarium* anamorph. A dichotomous key to these species is also given.

**Keywords:** *Albonectria*; Bionectriaceae; *Cosmospora*; *Haematonectria*; Hypocreales; *Neonectria*; *Nectria*; Nectriaceae; *Neonectria*; *Ophionectria*; Systematics.

## INTRODUCTION

Species of *Nectria* (Fr.) Fr. *sensu lato* are characterized by bright-colored, mainly red to orange perithecia, which are mostly formed superficially on their substrata and solitary or aggregated into pustules. Most of the species have two-celled, hyaline ascospores, which are smooth, warted or striated. Unitunicate asci, with or without an apical apparatus, and apical paraphyses place these fungi in the order Hypocreales. Fungi of *Nectria sensu lato* have been segregated from the genus and redistributed among a number of genera mainly in the families Nectriaceae and Bionectriaceae (Rossman et al., 1999; Samuels et al., 2002). These two families are separated primarily by ascomatal color, color reactions in KOH and lactic acid (Rossman et al., 1999). Species with red or orange-red perithecia, which change color in KOH or lactic acid are assignable to the Nectriaceae, whereas those with orange, pale yellow or white perithecia, which lack a color reaction in either reagent, are assignable to the Bionectriaceae. Nectriaceous fungi have anamorphs in several hyphomycetous form-genera (Seifert, 1985; Samuels and Seifert, 1987) and in most cases the form-genera do not overlap in the two families, with *Acremonium* as the only exception which can be found in taxa of both families, such as *Cosmospora vilior* (Nectriaceae) and *Hydropisphaera suffulta* (Bionectriaceae). Common

anamorphs of Nectriaceae are in *Acremonium* Link, *Actinostilbe* Petch, *Antipodium* Piroz., *Chaetopsina* Rambelli, *Cylindrocarpon* Wollenw., *Fusarium* Link, *Tubercularia* Tode, and *Volutella* Fr., whereas those of Bionectriaceae are in *Acremonium*, *Clonostachys* Corda, *Dendrodochium* Bonord., and *Stilbella* Lindau (Schroers, 2001). The recognition of these two families is also supported by molecular phylogenetic studies (e.g., Rehner and Samuels, 1994, 1995; Ogawa et al., 1997).

Nineteen nectriaceous fungi have previously been reported in Taiwan. Sawada (1928, 1931, 1959a, b) recorded *Nectria citri* Henn., *N. diversispora* Petch, *N. durantae* Sawada, *N. elephantopodis* Sawada, and *N. pterospermi* Sawada, and *Gibberella fujikuroi* (Sawada) Wollenw. *Nectria swieteniae-mahogani* C.-C. Chen was reported to grow on *Swietenia mahogani* (Chen, 1965). *Nectria flammea* (Tul. & C. Tul.) Dingley was found on scale insects on *Paulownia* (Chen, 1975). *Calonectria theae* Loos and *C. crotalariae* (Loos) D. K. Bell & Sobers caused a root rot (Chang, 1992) on *Cinnamomum osmophloeum* Kanehira and a black rot on *Sassafras* sp. (Chang, 1994), respectively. *Nectria galligena* Bres., now accepted as *Neonectria galligena* (Bres.) Rossman & Samuels (Rossman et al., 1999), caused an apple canker in Li-shan (Sun and Yu, 1975). *Nectria haematococca* Berk. & Broome [ $\equiv$  *Haematonectria haematococca* (Berk. & Broome) Samuels & Rossman], with the anamorph *Fusarium solani* (Mart.) Sacc., caused a collar and root rot on passion fruit *Passiflora edulis* Sims (Lin and Chang, 1982). Chen and Hsieh (1996) recorded *Thyronectria pseudotrichia* (Schwein.) Seeler a common encounter

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on dead branches. Wang (2000) described a new species *Nectria caricae* C.-L. Wang from dead papaya stems. Sun and Huang (1996) reported two *Nectria* species, *N. haematococca* and *N. rigidiuscula* Berk. & Broome [= *Albonectria rigidiuscula* (Berk. & Broome) Rossman & Samuels] and six *Gibberella* species. Unlike most of the specimens included in our study, which were collected from recently dead, broad-leaved trees in forests, those previously recorded species were mostly reported from crops. This apparently accounts for the fact that the majority of the species that we deal with herein have not been recorded in Taiwan before.

In the present study, we report nineteen species of the Nectriaceae found in Taiwan, including two *Albonectria* species, seven *Cosmospora* species, one *Haematonectria* species, two *Lanatonectria* species, one *Nectria* species, five *Neonectria* species, and one *Ophionectria* species. In addition, efforts were made to show teleomorph-anamorph connections of these taxa via culturing. Anamorphs of these nineteen nectriaceous fungi are distributed among eight form-genera, with *Cosmospora* connected to *Acremonium*, *Chaetopsina* and *Volutella*, *Lanatonectria* to *Actinostilbe*, *Ophionectria* to *Antipodium*, *Neonectria* to *Cylindrocarpon*, *Haematonectria* to *Fusarium*, and *Nectria* to *Tubercularia* and *Zythiostroma* Höhn. ex Falck.

## MATERIALS AND METHODS

Perithecia were immersed in 10% KOH and lactophenol to observe color changes. Perithecia becoming purple or deeply red in 10% KOH but pale red or yellowish in lactophenol were recorded as positive color changes. Perithecial wall layers were described based on longitudinal sections made by a freezing microtome (Yamatokohki FX-801). Sections of perithecia were approximately 15  $\mu\text{m}$  thick. Cultures were initiated from single or multiple ascospores on Difco potato dextrose agar (PDA). Resulting colonies were transferred to 9-cm plastic Petri plates containing PDA, from which the culture descriptions were made. Cultures were incubated under 12-hour fluorescent light at 20°C. The cited specimens were deposited in HAST (Botanical Herbarium, Academia Sinica, Taipei). Obtained cultures were deposited in the BCRC (the Bioresource Collection and Research Center) in Taiwan. Descriptions of teleomorphs, cultures, and anamorphs were prepared in brief formats due to 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 were measured to form the size ranges in the descriptions are 20, 20, 5, 5, and 5, respectively.

## TAXONOMY

### Key to the nectriaceous fungi studied

1. Perithecia not changing color in 10% KOH or lactophenol ..... 2
1. Perithecia red, becoming purple or deeply red in 10% KOH but pale red or yellowish in lactophenol..... 4 (Nectriaceae)
  2. Ascospores mostly two-celled; anamorph often *Acremonium*-like or *Clonostachys* ..... Bionectriaceae (not further treated herein)
  2. Ascospores phragmosporous; anamorph *Fusarium* ..... 3 (*Albonectria*, Nectriaceae)
3. Perithecia white or pale yellow, with coarsely concolorous warts on the surface; ascospores 3-septate, 22.5-27  $\times$  6.5-8.5  $\mu\text{m}$  ..... *A. rigidiuscula*
3. Perithecia light yellow, smooth; ascospores 3-septate, 32-39  $\times$  7-8  $\mu\text{m}$  ..... *A. albida*
  4. Ascospores muriform ..... 5 (*Nectria*)
  4. Ascospores didymosporous or phragmosporous ..... 6
5. Perithecia red, covered with white scales; asci filled with ascoconidia; ascospores (18-)20-25.5(-30)  $\times$  4.5-)5.5-6(-6.5)  $\mu\text{m}$  ..... *N. balsamea*
5. Perithecia red to dark red, covered with concolorous scales; asci not filled with ascoconidia; ascospores (15-)19-25(-30)  $\times$  9-11(-13)  $\mu\text{m}$  ..... *N. pseudotrichia*
  6. Ascospores scolecosporous, 13- to 20-septate, 190-210  $\times$  9-11  $\mu\text{m}$  ..... *Ophionectria trichospora*
  6. Ascosporous didymosporous ..... 7
7. Perithecia covered with echinulate, golden-yellow hairs ..... 8 (*Lanatonectria*)
7. Perithecia lacking hairs on the surface ..... 9
  8. Ascospores 11-13  $\times$  3-4  $\mu\text{m}$ ; anamorph sporodochial ..... *L. flocculenta*
  8. Ascospores 15-20  $\times$  5-5.5  $\mu\text{m}$ ; anamorph synnematous ..... *L. flavolanata*
9. Perithecia greater than 250  $\mu\text{m}$  diam; anamorph *Cylindrocarpon* ..... 10 (*Neonectria*)
9. Perithecia less than 250  $\mu\text{m}$  diam, smooth or coarsely warted; anamorph *Fusarium*, *Volutella*, *Chaetopsina*, *Acremonium*-like, often found on natural substrata ..... 14

10. Ostioles encircled with a crown ..... *Neo. coronata*  
 10. Ostioles not encircled with a crown ..... 11  
 11. Perithecia with apapillate ostioles, tending to be orange-red, covered with red warts ..... *Neo. rugulosa*  
 11. Perithecia with papillate ostioles, smooth, red to blood-red ..... 12  
 12. Ostioles slightly papillate ..... *Neo. discophora*  
 12. Ostioles coarsely papillate ..... 13  
 13. Ascospores echinulate, 13-15 × 5-6 μm ..... *Neo. lucida*  
 13. Ascospores striated, 20-21.5 × 8-9.5 μm ..... *Neo. jungneri*  
 14. Perithecia roughened or scaly, cupulate when dry ..... *Haematonectria haematococca*  
 14. Perithecia smooth, laterally pinched or not deformed when dry ..... 15 (*Cosmospora*)  
 15. Ascospores longer than 20 μm ..... 16  
 15. Ascospores shorter than 20 μm ..... 17  
 16. Ascospores (28-)34-48 × (6-)7-8(-9) μm, smooth ..... *C. cf. glabra*  
 16. Ascospores 22-40 × 7.5-10.5 μm, striate ..... *C. diminuta*  
 17. Ascospores less than 3 μm broad, 7.5-9(-9.5) × 2-2.5 μm; anamorph *Volutella* sp. .... *C. cf. consors*  
 17. Ascospores more than 3 μm broad; anamorph *Acremonium* sp. .... 18  
 18. Ascospores warted ..... 19  
 18. Ascospores granulated ..... *C. triqua*  
 19. Ascospores constricted at the septum, 5-8.5 × 3-4 μm ..... *C. vilior*  
 19. Ascospores not constricted at the septum, 9.5-13 × (4.5-)5-5.5(-6) μm ..... *C. joca*

***Albonectria albida*** (Rossman) J.-R. Guu & Y.-M. Ju,  
*comb. nov.* Figures 1B, 2F-I

*Basionym.* *Nectria albida* Rossman, Mycol. Pap. 150: 79.  
 1983.

*Anamorph.* *Fusarium* sp.

*Stromata* well-developed, pulvinate, white or buff-colored. *Perithecia* aggregated, superficial, light yellow, not changing color in 10% KOH or lactophenol, obpyriform, 200-260 × 160-180 μm, smooth, not collapsed when dry; perithecial wall 15-20 μm thick, two-layered; ostioles obtuse. *Asci* clavate, 55-87 × 14-16 μm, lacking an apical ring. *Ascospores* hyaline, fusiform, 3-septate, 32-39 × 7-8 μm, smooth.

*Cultures and anamorph.* Colonies attaining 2.5 cm diam in 14 days at 20°C, with scanty aerial hyphae, diffusing luteous to light yellow pigments into the medium. *Conidiophores* producing macroconidia only, aggregated into sporodochia, irregularly branched, bearing a phialide at each terminus, with the phialides cylindrical, 10-22 × 4-6 μm. *Macroconidia* hyaline, fusiform, slightly curved, with a pointed tip and foot cell, 3- to 7-septate, 72-90 × 6-7 μm.

*Specimens examined.* Nantou County, Luku, Shitou, on bark, with *Haematonectria haematococca* and *Valettoniella* sp., 19 Apr 2003, Ju, Y.-M. 92041906 (cultured) & 92041907 (cultured). Taipei County, Hsintien, Shih-tzu-tou-shan, on bark, 11 Dec 2004, Guu, J.-R. 93121106 (cultured).

*Notes.* The perithecia of *Albonectria* do not change

color in KOH or lactophenol and are therefore atypical for the Nectriaceae. Nonetheless, the *Fusarium* anamorphs and molecular phylogenies based on sequences of the 28S rDNA suggest the disposition of *Albonectria* in the Nectriaceae rather than Bionectriaceae (Guadet et al., 1989; O'Donnell, 1993; Rehner and Samuels, 1995). Rossman (1983) described the anamorph of *A. albida* and assigned it to *Fusarium*. The anamorph that we obtained from the Taiwan specimens fits well her description. We feel justified to combine the epithet of *Nectria albida* with *Albonectria* due to its possession of light yellow perithecia and a *Fusarium* anamorph. Also see notes on *A. rigidiuscula*.

***Albonectria rigidiuscula*** (Berk. & Broome) Rossman & Samuels in Rossman, Samuels, Rogerson & Lowen,  
 Stud. Mycol. 42: 105. 1999. Figures 1D, 2A-E

*Anamorph.* *Fusarium decemcellulare* Brick, Jahresber. Vereinigung Angew. Bot. 6: 277. 1908.

*Stromata* flattened to pulvinate, sometimes inconspicuous. *Perithecia* solitary to aggregated in groups of up to 30, white or pale yellow, not changing color in 10% KOH or lactophenol, globose to subglobose, 225-350 × 180-325 μm, uncollapsed when dry, ornamented with large, concolorous, coarse warts up to 50 μm high; perithecial wall 25-80 μm thick, three-layered; ostioles slightly papillate, darker than perithecial body. *Asci* clavate, 70-90 × 10-14 μm, lacking an apical ring. *Ascospores* hyaline, oblong-ellipsoidal, 3-septate, 22.5-27 × 6.5-8.5 μm, faintly striated.



**Figure 1.** Macroscopical details of ascomata of selected nectriaceous fungi on their natural substrata. A, *Nectria pseudotrichia*; B, *Albonectria albida*; C, *Haematonectria haematococca*; D, *Albonectria rigidiuscula*; E, *Neonectria discophora*; F, *Neonectria lucida*; G, *Neonectria rugulosa*; H, *Neonectria jungneri*; I, *Neonectria coronata*; J, *Lanatonectria flocculenta*; K, *Lanatonectria flavolanata*; L, *Ophionectria trichospora*; M, *Nectria balsamea*; N, *Cosmospora* cf. *consors*; O, *Cosmospora* cf. *glabra*; P, *Cosmospora joca*; Q, *Cosmospora vilior*. Scale bars: A, D = 500  $\mu$ m; E, L, M = 400  $\mu$ m; C, H, K, T = 300  $\mu$ m; B, F, G, J, N, O, Q = 200  $\mu$ m; P = 100  $\mu$ m; I = 100  $\mu$ m.

*Cultures and anamorph.* Colonies attaining 7 cm diam in 14 days at 20°C, with short aerial hyphae, diffusing a rosy pigment into the medium. *Conidiophores* producing macroconidia and microconidia; those bearing macroconidia densely aggregated into slimy, pale luteous sporodochia, arising from the aerial hyphae and agar surface, scarcely branched, producing a phialide at each terminus, with the phialides cylindrical, up to 100 µm long; those bearing microconidia simple, producing verticillate phialides, 25-37 × 4-5 µm. *Macroconidia* slightly curved, cylindrical to fusiform, 7-septate, hyaline, smooth, 55-120 × 6-9 µm. *Microconidia* formed in chains, ovoid, aseptate or, occasionally, 1-septate, hyaline, smooth, 5-8 × 2-4 µm. *Chlamydospores* absent.

*Specimens examined.* Taipei County, Sunshai, Mann-yue-yuan, on bark, 27 Sep 2000, Ju, Y.-M. and Hsieh, H.-M. 89092703 (cultured). Taipei City, Nankang, Hu-shih park, on bark, 6 Apr 2003, Ju, Y.-M. and Hsieh, H.-M. 92040603 (cultured). Taipei City, Nankang, Hu-shih park, on bark, 31 Jul 2003, Guu, J.-R. 92073104. Taipei City, Songshan, Hu-shan trail, on bark, 4 Aug 2003, Guu, J.-R. 92080404. Taipei County, Hsintien, Jih-tan-shan, on bark, with *Bionectria ochroleuca*, 9 Oct 2003, Guu, J.-R. 92100905. Taipei County, Hsintien, Yinhdong, on bark, mixed with *Bionectria ochroleuca*, *Cosmospora* sp., and *Haematonectria haematococca*, 16 Oct 2003, Guu, J.-R. 92101603. Taipei County, Pingshi, Chung-yang-chien-shan, on bark, 20 Nov 2003, Guu, J.-R. 92112003 (cultured). Taipei County, Sungi, Datunshi historical trail, on bark, 6 Dec 2003, Guu, J.-R. 92120603 (cultured). Taipei County, Jingtung, Shu-lung-chien, on bark, 5 Jan 2004, Guu, J.-R. 93010503 (cultured). Taipei County, Hsintien, Shih-tzu-tou-shan, on bark, 2 May 2004, Guu, J.-R. 93050203. Pingtung County, Chaochou, on bark of *Leucaena leucocephala*, 27 Aug 2004, Shih, H.-H. and Chao, T.-H. 93082702. Taipei County, Jingtung, Jingtung historical trail, on bark, 4 Sep 2004, Kuo, H.-P. 93090406. Taipei City, Muja, on bark, 25 Sep 2004, Shih, H.-H. 93092507. Taipei County, Pingshi, Chou-tou-shan, on bark of *Ficus septica*, 31 Oct 2004, Guu, J.-R. 93103107. Taipei County, Hsintien, Yinhdong, on bark, 25 Nov 2004, Shih, H.-H. 93112501 (cultured). Taipei County, Hsintien, Shih-tzu-tou-shan, on bark, 11 Dec 2004, Guu, J.-R. 93121103. Kaohsiung County, Maolinn, on bark, mixed with *Haematonectria haematococca*, 14 Sep 2005, Guu, J.-R. 94091405.

*Notes.* Although both four- and eight-spored asci have been found in this species (Rossman, 1983), only four-spored asci were observed among the Taiwan collections. Some of the cultures that we obtained produced the teleomorph. The teleomorph, cultures, and anamorph of the Taiwan material match those described by Rossman (1983) and Rossman et al. (1999). *Albonectria rigidiuscula* differs from *A. albida* in having warted perithecia and smaller, oblong-ellipsoidal ascospores ornamented with faint striations.

***Cosmospora* cf. *consors*** (Ellis & Everh.) Rossman & Samuels in Rossman, Samuels, Rogerson & Lowen, Stud. Mycol. 42: 119. 1999. Figure 1N, 2Q

*Anamorph.* *Volutella* sp.

*Stromata* lacking. *Perithecia* mostly solitary, superficial, rarely aggregated, red, changing color to dark red in 10% KOH and yellow in lactophenol, obpyriform, 200-270 × 150-200 µm, smooth; perithecial wall 15-20 µm thick, two-layered; ostioles papillate. *Asci* narrowly clavate, 45-60 × 5-8 µm, with an apical ring. *Ascospores* hyaline, fusiform, 1-septate, 7.5-9(-9.5) × 2-2.5 µm, smooth.

*Anamorph* not obtained in culture but found on natural substrate, sporodochial, produced among the perithecia. *Sporodochia* stipitate, white to pale yellow, bearing hemispherical conidial masses. *Setae* arising from the sporodochial base, cylindrical, ca 240 µm long, septate, tapering toward the tip. *Conidiophores* aggregated, branched, bearing 1, 3 or 4 cylindrical phialides. *Conidia* hyaline, ellipsoidal, aseptate, (4.5-)5.5-6.5 × 1-1.5 µm.

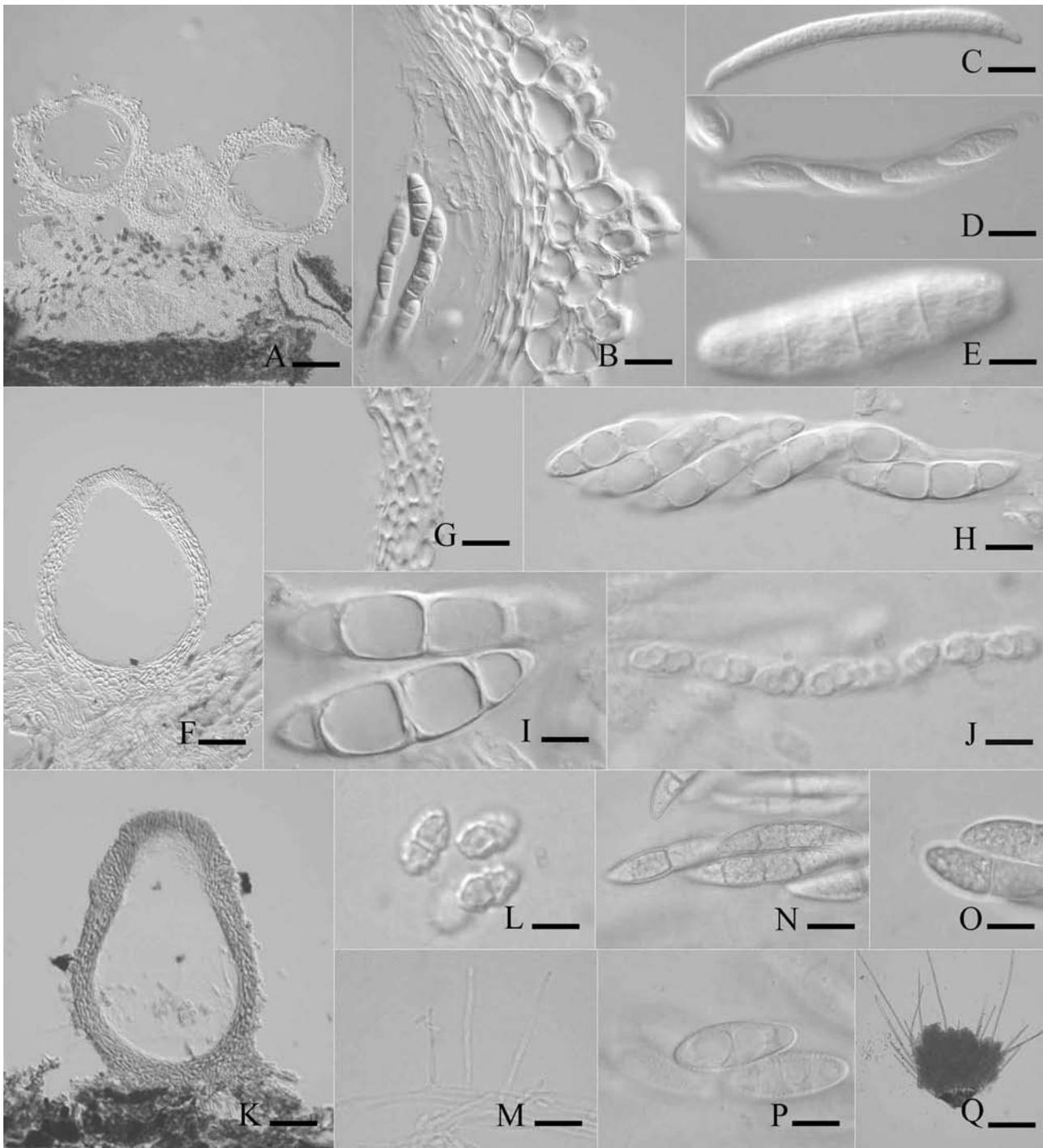
*Specimens examined.* Taipei City, Muja, campus of National Chengchi Univ., on bark, mixed with *Albonectria rigidiuscula* and *Haematonectria haematococca*, 25 Sep 2004, Shih, S.-H. 93092505. Taipei County, Sungi, Datunshi historical trail, on bamboo culm, 10 Jul 2005, Guu, J.-R. 94071001.

*Notes.* Our specimens have ascospores smaller than those reported in Samuels (1977), i.e., 7.5-9(-9.5) × 2-2.5 µm vs. (9-)10-11(-13) × (2.5-)3-4 µm. While typical *C. consors* was reported to be constantly associated with decaying herbaceous debris (Samuels, 1977), our specimens were collected from the bark of a woody plant and bamboo culm. The anamorph of *C. consors* is *Volutella minima* Höhn. (Samuels, 1977). Unfortunately, we were unable to obtain cultures from our specimens. However, the anamorph produced on the natural substrate is in general as described by Samuels (1977) except for the conidia being slightly narrower, i.e., 1-1.5 µm vs. 1.5-2.5(-3) µm. It is likely that our specimens represent an undescribed taxon of *Cosmospora*, but we prefer to defer the decision of making a new taxon until further culturable material is available. The present fungus differs from the other species of the genus found in Taiwan in having a purported *Volutella* anamorph.

***Cosmospora diminuta*** (Berk.) Rossman & Samuels in Rossman, Samuels, Rogerson & Lowen, Stud. Mycol. 42: 120. 1999. Figure 2P

*Anamorph.* Unknown.

*Stromata* lacking. *Perithecia* solitary, superficial, red, changing color to dark red in 10% KOH and yellow in lactophenol, obpyriform, 150-190 × 160-210 µm, smooth; perithecial wall 15-20 µm thick, two-layered; ostioles obtuse. *Asci* clavate, 55-70 × 17-22 µm, lacking an apical ring. *Ascospores* hyaline, of two types; one type fusiform, 1-septate, 30-40 × 8.5-10.5 µm, striate; the other type oblong-ovoid, 3-septate, 22-28.5 × 7.5-9 µm, granulated.



**Figure 2.** A-E, *Albonectria rigidiuscula*. A, Median section of ascomata; B, Lateral wall; C, Macroconidium; D, Ascus; E, Ascospore. F-I, *Albonectria albida*. F, Median section of ascoma; G, Lateral wall; H, Ascus; I, Ascospores. J-M, *Cosmospora vilior*. J, Ascus; K, Median section of ascoma; L, Ascospores; M, Conidiophores. N-O, *Cosmospora* cf. *glabra*. N, Ascospores; O, Ascus tip with an apical ring; P, Ascospores of *Cosmospora diminuta*; Q, Sporodochium of *Cosmospora* cf. *consor*. Scale bars: A = 100  $\mu$ m; B = 20  $\mu$ m; C, O = 12  $\mu$ m; D, G = 15  $\mu$ m; E, J = 6  $\mu$ m; F = 30  $\mu$ m; H, I, L, P = 8  $\mu$ m; K = 50  $\mu$ m; M, N = 10  $\mu$ m; Q = 250  $\mu$ m.

*Specimen examined.* Taipei County, Hsintien, Shih-tzu-tou-shan, on bark, 21 Mar 2004, *Guu, J.-R.* 93032101.

*Notes.* This fungus has previously been reported from North America and Sri Lanka only (Samuels and Brayford, 1994). The Taiwan material is much as described by Samuels and Brayford (1994) and Rossman et al. (1999).

Unfortunately, we were unable to obtain cultures from our material. Rossman et al. (1999) observed a *Volutella*-like hyphomycete associated with the type material of *Dialonectria gigaspora* Cooke & Masee, which was considered a synonym of *C. diminuta* by these authors, and suspected that the hyphomycete is the anamorph of

*C. diminuta*. As with Samuels and Brayford (1994) and Rossman et al. (1999), we also observed two types of ascospores in the Taiwan specimen.

**Cosmospora** cf. **glabra** (Rossman) Rossman & Samuels in Rossman, Samuels, Rogerson & Lowen, Stud. Mycol. 42: 122. 1999. Figures 1O, 2N, O  
*Anamorph*. Unknown.

*Stromata* lacking. *Perithecia* solitary to aggregated, superficial, red, not changing color in 10% KOH but becoming yellow in lactophenol, obpyriform, 220 × 190 µm, smooth; perithecial wall 10-14 µm thick, one-layered; ostioles obtuse. *Asci* clavate, 60-75 × 9-15 µm, with an apical ring. *Ascospores* hyaline, fusiform, 1- or 3-septate, usually constricted at septa in 3-septate ascospores, (28-)34.5-48 × (6-)7-8(-9) µm, smooth.

*Specimen examined*. Taipei County, Hsintien, Yinhdong, on bark, 16 Oct 2003, Guu, J.-R. 92101604, mixed with *A. rigidiuscula* and *H. haematococca*.

*Notes*. Rossman (1983) described *C. glabra* possessing 3-septate ascospores in most of her cited specimens. Three of her specimens, however, were described as having mainly 1-septate but also some 3-septate ascospores. Both 1-septate and 3-septate ascospores can be found in the Taiwan specimen. Although our specimen in general agrees with the protologue of *C. glabra* in Rossman (1983), it deviates in having an ascal apical ring. Our specimen is also similar to *C. kurdica* (Petr.) Rossman & Samuels, which has a distinct ascal apical ring, but differs in having larger ascospores. Therefore, we are uncertain in respect to the conspecificity of the Taiwan specimen and *C. glabra*. The former probably represents another taxon. It is rather unfortunate that we were unable to germinate ascospores from the Taiwan specimen.

**Cosmospora joca** (Samuels) Rossman & Samuels in Rossman, Samuels, Rogerson & Lowen, Stud. Mycol. 42: 122. 1999. Figure 1P

*Anamorph*. *Acremonium* sp.

*Stromata* inconspicuous. *Perithecia* solitary, superficial, red, changing color to dark red in 10% KOH and yellow in lactophenol, obpyriform, 200-235 × 175-200 µm, smooth, laterally collapsed when dry; perithecial wall 15-20 µm thick, one-layered; ostioles obtuse. *Asci* cylindrical, 55-70 × 6-8 µm, lacking an apical ring. *Ascospores* yellowish, broadly ellipsoidal, 1-septate, not constricted at septum, 9.5-13 × (4.5-)5-5.5(-6) µm, warty.

*Cultures and anamorph*. Colonies attaining 1 cm diam in 21 days at 20°C, lacking aerial hyphae, usually slimy, salmon-colored. *Conidiophores* scarcely produced, usually unbranched, unseptated; phialides cylindrical, 10-25 × 1-3 µm, tapering to 1 µm near apex. *Conidia* hyaline, oblong ellipsoidal, aseptate, 3-5 × 1-2.5 µm, smooth.

*Specimens examined*. Pingtung County, Hengchun, Kenting, on *Biscogniauxia* stromata, 12 Apr 2000, Ju, Y.-M. 89041201 (cultured). Taipei County, Hsintien, Shih-

tzu-tou-shan, on depauperate *Biscogniauxia* stromata, 11 Dec 2004, Guu, J.-R. 93121108 (cultured).

*Notes*. This fungicolous species is not commonly encountered and has only been reported once from Brazil (Samuels, 1991). It greatly resembles *C. vilior* but differs in having broader ascospores and producing a salmon-colored pigment in culture. The *Acremonium* anamorph produced by the Taiwan material much agrees with that reported by Samuels (1991).

**Cosmospora triqua** (Samuels) Rossman & Samuels in Rossman, Samuels, Rogerson & Lowen, Stud. Mycol. 42: 125. 1999.

*Anamorph*. *Acremonium* sp.

*Stromata* absent. *Perithecia* solitary, superficial, red, changing color to dark red in 10% KOH and yellow in lactophenol, obpyriform, 180-210 × 160-190 µm, smooth, laterally collapsed when dry; ostioles obtuse. *Asci* cylindrical, 50-65 × 6-8 µm, with an apical ring. *Ascospores* yellowish, broadly ellipsoidal, 1-septate, not constricted at septum, 8-11 × 4-5 µm, warty.

*Cultures and anamorph*. Colonies attaining 1 cm diam in 20 days at 20°C, lacking aerial hyphae, slimy, salmon-colored around the inoculation points. *Conidiophores* scarcely produced, mostly unbranched, unseptated; phialides cylindrical, 12-25 × 1.5-2 µm, tapering to 1 µm near apex. *Conidia* hyaline, oblong ellipsoidal, aseptate, 2.5-4 × 1-2 µm, smooth.

*Specimen examined*. Pingtung County, Hengchun, Kenting, on *Eutypella* stromata, 29 Jul 2001, Ju, Y.-M. & Hsieh, H.-M. 90072904 (cultured).

*Notes*. This is another fungicolous *Cosmospora* species that is uncommonly encountered. It has only been reported from French Guiana previously (Samuels, 1991). The *Acremonium* anamorph that we obtained is consistent with that reported by Samuels (1991). *Cosmospora triqua* greatly resembles *C. joca* but differs in having an ascal apical ring and granulated ascospores. Unlike the colonies of *C. joca*, which diffused a salmon-colored pigment into the medium, those of the present fungus form a salmon-colored pigment that remain restricted to the inoculation sites.

**Cosmospora vilior** (Starb.) Rossman & Samuels in Rossman, Samuels, Rogerson & Lowen, Stud. Mycol. 42: 126. 1999. Figures 1Q, 2J-M

*Anamorph*. *Acremonium berkeleyanum* (P. Karst.) W. Gams, Netherlands J. Pl. Pathol. 88: 76. 1982.

*Stromata* inconspicuous. *Perithecia* solitary, rarely aggregated, superficial, red, changing color to dark red in 10% KOH and yellow in lactophenol, obpyriform, 212-250 × 187-215 µm, smooth, laterally collapsed when dry; perithecial wall 20-40 µm thick, one-layered; ostioles obtuse. *Asci* cylindrical, 51-65 × 5-7 µm, with an apical ring. *Ascospores* yellowish, broadly ellipsoidal, 1-septate, constricted at septum, 5-8.5 × 3-4 µm, warty.

*Cultures and anamorph.* Colonies attaining 1-1.8 cm diam in 7 days at 20°C, with abundant aerial hyphae, usually slimy, yellow-green; aerial hyphae often aggregated into acute strands. *Conidiophores* arising from aerial hyphae and agar surface, usually unbranched, aseptate; phialides cylindrical, 40-60 × 2-4 µm, tapering to 1 µm near apex. *Conidia* hyaline, oblong ellipsoidal, aseptate, 3-5 × 1-2.5 µm, smooth.

*Specimens examined.* Tainan County, Hsinhwa, on *Kretzschmaria* sp., 15 May 2000, Ju, Y.-M & Hsieh, H.-M. 89051501 (cultured). Taipei County, Wulai, Hsinsian elementary school, on *Rosellinia*, 29 Jun 2000, Ju, Y.-M. 89062901 (cultured). Ilan County, Fu-shan, on *Rosellinia*, 27 Oct 2001, Ju, Y.-M & Hsieh, H.-M. 90102708. Pingtung County, Hengchun, Kenting, on decaying stromata of a fungus, 26 Nov 2000, Ju, Y.-M & Hsieh, H.-M. 89112603. Pingtung County, Hengchun, Kenting, on decaying *Hypoxyton* stromata, 23 Sep 2002, Ju, Y.-M & Hsieh, H.-M. 91092332 (cultured). Miaoli County, Taiann, on decayed twigs, 8 Jul 2005, Ju, Y.-M & Hsieh, H.-M. 94070809 (cultured). Taipei City, Tienmu historical trail, on bark, 25 Aug 2005, Ju, Y.-M & Hsieh, H.-M. 94082503 (cultured). Taipei County, Nankang-shan, on stromata of *Kretzschmaria pavementosa*, 1 Nov 2005, Guu, J.-R. 94110102 (cultured). Hwalien County, Showlinn, Sacadung trail, on stromata of *Kretzschmaria pavementosa*, 10 Dec 2005, Guu, J.-R. 94121003 (cultured).

*Notes.* This fungus is commonly encountered in tropical and subtropical areas. It has been found to grow on the stromata of various xylariaceous fungi in Taiwan. Cultures of *C. vilior* are peculiar in abundantly diffusing a yellow-green pigment into the medium. The anamorph produced by the Taiwan material is much as described in Samuels et al. (1990).

**Haematonectria haematococca** (Berk. & Broome) Samuels & Nirenberg in Rossman, Samuels, Rogerson & Lowen, Stud. Mycol. 42: 135. 1999. Figures 1C, 5G-K

*Anamorph.* *Fusarium solani* (Martius) Saccardo, Michelia 2: 296. 1881.

*Stromata* lacking. *Perithecia* solitary to aggregated in groups of 20, superficial, red, becoming dark red in 10% KOH and yellow in lactophenol, subglobose to broadly obpyriform, 225-270 × 230-250 µm, surface with red to yellowish warts up to 70 µm high, collapsed when dry; perithecial wall 60-95 µm thick, two-layered; ostioles acute, paler than perithecial body. *Asci* cylindrical to clavate, 55-90 × 8-11 µm, lacking an apical ring. *Ascospores* yellowish, oblong-ellipsoidal, 1-septate, 10-14 × 4-6.5 µm, striate.

*Cultures and anamorph.* Colonies averaging 7 cm diam in 7 days at 20°C, floccose, white, sometimes becoming pale brown in the center. *Conidiophores* producing macroconidia and microconidia; those bearing macroconidia aggregated into cream-colored sporodochia, cylindrical, 9-12 × 5-7 µm, irregularly branched, bearing

1-3 phialides at each terminus, with the phialides cylindrical, 11-23 × 3-5 µm; those bearing microconidia usually unbranched, with the phialides cylindrical, 22-31 × 3-4 µm. *Macroconidia* hyaline, cylindrical to fusoid, with wedge-shaped to obtuse foot cells, 3- to 5-septate, 32-77 × 4-6 µm, smooth. *Microconidia* hyaline, allantoid to cylindrical, (6-)9-13 × 2-4 µm, smooth, produced singly or in small, slimy droplets. *Chlamydospores* globose, hyaline, smooth to roughened, 7-10 µm, produced singly or in chains.

*Specimens examined.* Kaohsiung County, Maolinn, on bark, 14 Sep 2005, Guu, J.-R. 94091406 (cultured). Taipei County, Wanlee, Ruei-chuan historical trail, on bark, 23 Jul 2005, Guu, J.-R. and Kuo, H.-P. 94072307. Taipei County, Pingshi, Chou-tou-shan, on bark, Guu, J.-R. 94043010 (cultured). Ilan County, Fu-shan botanical garden, on bark, 24 Jan 2005, Guu, J.-R. 94012410. Taipei County, Sungi, Datunshi historical trail, on bark, 22 Jan 2005, Guu, J.-R. 94012205. Taipei County, Wanlee, Linnshih historical trail, on bark, 15 Jan 2005, Guu, J.-R. 94011504 (cultured). Ilan County, Guei-shan-dao, on bark, 9 Jun 2003, Ju, Y.-M. 92060901 (cultured); Nantuo County, Tsuifong, on bark, 6 Apr 2003, Ju, Y.-M. 92040605 (cultured). Taipei County, Hsintien, Shih-tzu-tuo-shan, on bark, 11 Dec 2004, Guu, J.-R. 93121104. Taipei City, Shilinn, Shengren waterfall, on bark, 10 Oct 2004, Guu, J.-R. 93101003. Taipei County, Sijih, Hsin-shan-mon-hu, on bark, 14 Nov 2004, Guu, J.-R. 93111402. Taipei County, Pingshi, Chou-tuo-shan, on bark, 31 Oct 2004, Guu, J.-R. 93103104. Taipei City, Muja, campus of National Chenchi Univ., on bark, 25 Sep 2004, Shih, H.-H. 93092506. Taipei County, Hsintien, Ta-tung-shan, on bark, 19 Sep 2004, Kuo, H.-P. 93091906. Ilan County, Tatung, Chi-lan-shan, on bark, 7 Sep 2004, Ju, Y.-M. 93090706; Hwalien County, Jaofong farm, on bark, 22 Jul 2004, Shih, H.-H. 93072201 (cultured). Taipei County, Jingtung, Jingtung historical trail, on bark, 21 Dec 2003, Guu, J.-R. 92122103 (cultured). Taipei County, Pingshi, Chung-yang-chien-shan, on bark, 4 Dec 2003, Guu, J.-R. 92120403. Taipei County, Pingshi, Chung-yang-chien-shan, on bark, 20 Nov 2003, Guu, J.-R. 92112007 (cultured). Taipei County, Hsintien, Yinhdong, on bark, 16 Oct 2003, Guu, J.-R. 92101606. Taipei City, Shihlinn, Ping-ding-gu-jyun, on bark, 9 Aug 2003, Guu, J.-R. 92080906.

*Notes.* The teleomorph of this species is frequently encountered on decaying branches and fruits. As with Samuels (1976) and Samuels et al. (1990), the teleomorph was also produced in cultures obtained from the Taiwan collections. The anamorph that we obtained from the Taiwan material fits well the description in Booth (1960). It is interesting to note that perithecia of *Ophionectria trichospora* and *H. haematococca* were found to be mixed on the same substrata in several occasions.

**Lanatonectria flavolanata** (Berk. & Broome) Samuels & Rossman in Rossman, Samuels, Rogerson & Lowen, Stud. Mycol. 42: 139. 1999. Figures 1K, 3H, I

*Anamorph: Actinostilbe* sp.

*Stromata* usually erumpent from the bark, sometimes with conidiomata. *Perithecia* sometimes accumulating at base of synnemata or formed without anamorph, mostly aggregated, in groups of 5-15, rarely solitary, superficial, red, changing color to dark red in 10% KOH and yellow in lactophenol, subglobose to broadly obpyriform, 300-450 × 200-320 µm, uncollapsed when dry, with surface slightly roughened with perithecial hairs; perithecial wall 25-35 µm thick, two-layered; perithecial hairs septate, unbranched, flexuous, verrucose, golden yellow, hooked, 40-60 × 4-6 µm, usually collapsed in age; ostioles slightly papillate, paler than perithecial body. *Asci* clavate, 45-60 × 7-8 µm, with an apical ring. *Ascospores* hyaline, oblong-ellipsoidal, 1-septate, 15-20 × 5-5.5 µm, striated.

*Cultures and anamorph.* Colonies 2-3 cm in 7 days at 20°C, with abundant aerial hyphae; reverse yellowish brown. *Synnemata* abundant, 0.5-5 mm long × 0.1-0.3 mm broad, white, furfuraceous with short, golden, septate, 3-4-µm-wide hairs along the length, bearing a terminal, hemispherical conidial mass; hairs often covered with droplets of golden exudates. *Conidiophores* aggregated at top of synnemata, anastomosing laterally, branched, bearing 2-3 phialides at each terminus; phialides smooth or finely roughened, cylindrical, 20-35 × 1.5-3 µm. *Conidia* hyaline, oblong-ellipsoidal, 1-septate, 10-14 × 4-5 µm, smooth, with a flat base.

*Specimens examined.* Nantou County, Luku, Shitou, on *Brugmansia suaveolens* (Willd.) Bercht. & Presl, 19 Apr 2003, Ju, Y.-M. & Hsieh, H.-M. 92041910 (cultured). Taipei County, Jingtung, Jingtung historical trail, 21 Dec 2003, Guu, J.-R. 92122105 (cultured). Taipei County, Jingtung, Jingtung historical trail, 18 Mar 2004, Guu, J.-R. 93031804.

*Notes.* *Lanatonectria* is mainly characterized by the golden-yellow hairs covering the perithecia. Our material of *L. flavolanata* produced an *Actinostilbe* anamorph in culture, which is much as that described by Rossman et al. (1999). *Lanatonectria flavolanata* differs from *L. flocculenta* in having larger ascospores and a synnematous anamorph. The anamorph of *L. flocculenta* is sporodochial.

**Lanatonectria flocculenta** (Henn. & E. Nyman) Samuels & Rossman in Rossman, Samuels, Rogerson & Lowen, Stud. Mycol. 42: 138. 1999. Figures 1J, 3A-G

*Anamorph. Actinostilbe macalpinei* (Agnihotr. & G.C.S. Barua) Seifert & Samuels, Stud. Mycol. 42: 138. 1999.

*Stromata* erumpent from bark, usually associated with conidiomata, inconspicuous. *Perithecia* solitary or in groups of 2-20, superficial, red, changing color to dark red in 10% KOH and yellow in lactophenol, globose to subglobose, 180-300 × 200-295 µm, uncollapsed when dry, slightly roughened with perithecial hairs on the surface; perithecial wall 25-30 µm thick, two-layered; perithecial hairs straight or hooked, septate, unbranched, golden yellow, conspicuously verrucose, 30-70 × 4-6 µm;

ostioles usually papillate, paler than perithecial body. *Asci* clavate, 35-70 × 6-10 µm, with an apical ring. *Ascospores* hyaline, oblong-ellipsoidal, 1-septate, 11-13 × 3-4 µm, striated.

*Cultures and anamorph.* Colonies attaining 5 cm diam in 7 days at 20°C, with abundant floccose aerial hyphae; reverse yellow. *Conidiophores* aggregated into well-developed, solitary or gregarious sporodochia, irregularly branched, usually anastomosing laterally. *Conidia* hyaline, yellow in masses, oblong ellipsoidal, 1-septate, 6-8 × 2-3.5 µm, smooth.

*Specimens examined.* Tainan County, Hsinhwa, on bark, 14 May 2000, Ju, Y.-M. & Hsieh, H.-M. 89051406 (cultured). Taipei City, Nankang, campus of Academia Sinica, 8 Jun 2001, Ju, Y.-M. 90060801. Nantou County, Luku, Shitou, on *Brugmansia suaveolens* (Willd.) Bercht. & Presl, 19 Apr 2003, Ju, Y.-M. & Hsieh, H.-M. 92041905 (cultured). Taipei City, Nankang, Tu-ku-yue, on bark, 10 Aug 2003, Guu, J.-R. 92081001. Taipei County, Shihding, Huang-di-dian north peak trail, on bark, 27 Nov 2003, Guu, J.-R. 92112705 (cultured). Taipei City, Muja, Jihnan temple, on bark, 7 Dec 2003, Guu, J.-R. 92120701 (cultured). Taipei City, Muja, Chanshan temple, on bark, 11 Apr 2004, Guu, J.-R. 93041104. Hwaiien County, Jaofong farm, on bark of *Zelkova serrata* (Thunb.) Makino, 22 Jul 2004, Shih, S.-H. and Chao, T.-H. 93072202 (cultured). Taipei City, Muja, Changshan temple, on bark, 25 Sep 2004, Shih, S.-H. 93092511 (cultured). Taipei County, Wulai, Chia-jiou-liao trail, on bark, 21 Aug 2005, Guu, J.-R. 94082102 (cultured). Tainan County, Meilinn, on *Areca catechu* L., 29 Aug 2005, Ju, Y.-M. & Hsieh, H.-M. 94082904 (cultured).

*Notes.* This species is one of the most commonly encountered nectriaceous fungi in pantropical regions (Rossman et al., 1999; Samuels et al., 1990; Samuels and Brayford, 1994). The other *Lanatonectria* species found in Taiwan has larger ascospores and a synnematous anamorph. The cultures from specimen 94082904 produced the teleomorph on PDA. Like Rossman et al. (1999), we also observed an *Actinostilbe macalpinei* anamorph produced in the cultures initiated from our collections of *L. flocculenta*.

**Nectria balsamea** Cooke & Peck in Cooke, Grevillea 12: 81. 1884. Figures 1M, 5E, F

*Anamorph. Zythiostroma* sp.

*Stromata* inconspicuous. *Perithecia* solitary, superficial, red, changing color to dark red in 10% KOH and yellow in lactophenol, subglobose, 250-380 µm, overlain with white scales, uncollapsed when dry; ostioles papillate. *Asci* clavate, 72-89 × 9-13 µm, lacking an apical ring. *Ascospores* hyaline, broadly fusiform, muriform, (18-)20-25.5(-30) × (4.5-)5.5-6(-6.5) µm, smooth.

*Cultures and anamorph.* Colonies attaining 3 cm diam in 10 days at 20°C, submerged, with scarce aerial hyphae, slimy at the inoculation points; reverse light yellow first

but becoming brown after 14 days. *Conidiomata* dark red, pulvinate, multiloculate. *Conidiophores* cylindrical, 5-10 × 1-2 µm. *Conidia* hyaline, allantoid, 4-6 × 1-2 µm, smooth, usually aggregated into orange-red, slimy masses at ostioles.

*Specimen examined.* Taichung County, Pilushi, on twig of *Pinus taiwanensis* Hayata cone, 24 May 2005, *Guu, J.-R.* 94052402 (cultured).

*Notes.* *Nectria balsamea* features muriform ascospores that produce ascoconidia within asci. It is the only *Nectria* species found to be associated with a conifer in Taiwan. Our specimen agrees well with the descriptions and illustrations given by Seeler (1940), Booth (1959), and Rossman (1985) [as *Thyronectria*]. The anamorph that we obtained from the Taiwan material closely resembles that described and illustrated in Booth (1959). Rossman et al. (1999) assigned the anamorph to the form-genus *Zythiostroma*.

***Nectria pseudotrichia*** (Schwein.) Berk. & M. A. Curtis, J. Acad. Nat. Sci. Philadelphia 2, 2: 289. 1853. Figures 1A, 5A-D

*Anamorph.* *Tubercularia lateritia* (Berk.) Seifert, Stud. Mycol. 27: 119. 1985.

*Stromata* inconspicuous. *Perithecia* solitary or aggregated, superficial, red, changing color to dark red in 10% KOH and yellow in lactophenol, globose or subglobose, usually associated with synnemata, 250-400 µm, scaly, cupulate when dry; perithecial wall 50-85 µm, three-layered; ostioles slightly papillate. *Asci* clavate, 60-90 × 12-22 µm, lacking an apical ring. *Ascospores* hyaline, light yellow in age, broadly ellipsoidal, muriform, 19-24 × 9-12 µm, smooth.

*Cultures and anamorph.* *Colonies* attaining 9 cm in 5 days at 20°C with scanty aerial hyphae, a pink pigment diffusing into the medium. *Conidiophores* mononematous, monovercillate or biverticillate, bearing cylindrical phialides; stipes warted, cylindrical, straight, curved or twisted. *Conidia* ellipsoidal, hyaline, 3-7 × 2-3 µm. *Synnemata* produced in nature but lacking in culture, solitary to aggregated, erected, unbranched, 500-5000 × 50-250 µm, red-brown, grading into light cream-yellow towards the top, bearing a spherical conidial mass.

*Specimens examined.* Taipei County, Wulai, Chia-jiou-liao trail, on bark, 21 Aug 2005, *Guu, J.-R.* 94082103 (cultured). Taipei County, Wanlee, Ruei-chuan historical trail, on bark, 23 Jul 2005, *Guu, J.-R.* and *Kuo, H.-P.* 94072304 (cultured). Taipei City, campus of National Taiwan Univ., on bark, 17 Jul 2005, *Guu, J.-R.* 94071701 (cultured). Kaohsiung County, Liogwei, Shanping, on bark, 10 Mar 2005, *Guu, J.-R.* 94031010 (cultured). Taipei County, Wanlee, Linnshih historical trail, on bark, 15 Jan 2005, *Guu, J.-R.* 94011505 (cultured). Taipei County, Hsintien, Shih-tzu-tuo-shan, on bark, 11 Dec 2004, *Guu, J.-R.* 93121109; Taipei County, Hsintien, Yinhdong, on bark, 25 Nov 2004, *Shih, H.-H.* 93112506 (cultured).

Pingtung County, Hengchun, Kenting, on bark, 28 Aug 2004, *Ju, Y.-M.* and *Hsieh, H.-M.* 93082818. Pingtung County, Meinong, on bark of *Swietenia macrophylla* King, 27 Aug 2004, *Shih, H.-H.* 93082701. Taipei City, campus of National Taiwan Univ., on bark, 1 Aug 2004, *Guu, J.-R.* 93080101. Taipei City, Wolong street, on bark, 8 May 2004, *Shih, H.-H.* 93050801; Taipei County, Hsintien, Shih-tzu-tuo-shan, on bark, 2 May 2004, *Guu, J.-R.* 93050201 (cultured). Tainan County, Tungshan, on bark of *Mangifera indica*, 4 Apr 2004, *Guu, J.-R.* and *Chang, K.-T.* 93040403. Taipei County, Shihding, Huang-di-dian north peak trail, on bark, 27 Nov 2003, *Guu, J.-R.* 92112708 (cultured). Taipei County, Shihding, Huang-di-dian, on bark, 13 Nov 2003, *Guu, J.-R.* 92111301 (cultured). Taipei County, Mudan, Diaoshan historical trail, on bark, 2 Nov 2003, *Guu, J.-R.* 92110201 (cultured). Taipei County, Hsintien, Yinhdong, on bark, 16 Oct 2003, *Guu, J.-R.* 92101605. Taipei County, Hsintien, Jih-tan-shan, on bark, 9 Oct 2003, *Guu, J.-R.* 92100904. Taipei City, Shihlinn, Ping-ding-gu-jyun, on bark, 14 Sep 2003, *Guu, J.-R.* 92091404. Taipei City, Songshan, Hu-shan trail, on bark, 10 Sep 2003, *Guu, J.-R.* 92091003. Ilan County, Fu-shan, on fruit of persimmon, 12 Nov 2002, *Ju, Y.-M.* 91111221; Ilan County, Fu-shan, on bark, 19 Aug 2001, *Ju, Y.-M.* 90081911. Taipei County, Sunshai, Mann-yue-yuan, on bark, 27 Sep 2000, *Ju, Y.-M.* 89092709. Pingtung County, Hengchun, Kenting, on bark, 16 Sep 2000, *Ju, Y.-M.* and *Hsieh, H.-M.* 89091638. Taipei City, Nankang-shan, on bark, 22 Mar 2000, *Ju, Y.-M.* and *Hsieh, H.-M.* 89032211.

*Notes.* This is a frequently encountered species in the tropics and subtropics (Seifert, 1985; Samuels et al., 1990). It features muriform ascospores and a synnematus anamorph, with which the perithecia are constantly associated. Chen and Hsieh (1996, as *Thyronectria*) has previously reported this species in Taiwan. Also see Seifert (1985) for a description of the anamorph.

***Neonectria coronata*** (Penz. & Sacc.) Mantiri & Samuels, Canad. J. Bot. 79: 339. 2001. Figures 1I, 4F-I

*Anamorph.* *Cylindrocarpon coronatum* Brayford & Samuels, Mycologia 85: 620. 1993.

*Stromata* inconspicuous. *Perithecia* solitary to aggregated, superficial, red, changing color to dark red in 10% KOH and yellow in lactophenol, subglobose or broadly obpyriform, 200-450 × 150-300 µm, slightly roughened, uncollapsed when dry; perithecial wall 15-30 µm thick, one-layered; ostioles papillate, located in the center of a black disc 150-200 µm diam, encircled with a conspicuous crown of saccate cells. *Asci* clavate, 60-75 × 10-15 µm, lacking an apical ring. *Ascospores* hyaline, becoming yellowish, broadly fusiform, 1-septate, 19-23 × 6.5-8 µm, with discontinuous striations.

*Cultures and anamorph.* *Colonies* attaining 2-5 cm diam in 10 days at 20°C, floccose, light brown, with scanty aerial hyphae. *Conidiophores* producing macroconidia and microconidia; those bearing macroconidia aggregated into slimy, scattered sporodochia, branched, producing a

phialide at each terminus, with the phialides cylindrical,  $10\text{--}20 \times 3\text{--}5 \mu\text{m}$ , with periclinal thickening at the apex; those bearing microconidia cylindrical, unbranched,  $12\text{--}26 \times 2\text{--}4 \mu\text{m}$ . *Macroconidia* curved, fusiform, mostly 5- to 7-septate,  $60\text{--}81 \times 6\text{--}9 \mu\text{m}$ , with blunt rounded apical cell, less frequently, 1-septate,  $30\text{--}40 \times 6\text{--}7 \mu\text{m}$ , or 3-septate,  $40\text{--}52 \times 6\text{--}7 \mu\text{m}$ . *Microconidia* ellipsoidal, hyaline,  $6\text{--}8 \times 2\text{--}3.5 \mu\text{m}$ , smooth.

*Specimens examined.* Taipei County, Hsintien, Jih-tan-shan, on bark, 9 Oct 2003, *Guu, J.-R.* 92100902 (cultured). Taipei County, Pingshi, Chung-yang-chien-shan, on bark, 20 Nov 2003, *Guu, J.-R.* 92112005. Taipei County, Jingtung, Jingtung historical trail, on bark, 21 Dec 2003, *Guu, J.-R.* 92122102 (cultured). Taipei County, Jingtung, Jingtung historical trail, on bark, 18 Mar 2004, *Guu, J.-R.* 93031807. Taipei County, Hsintien, Shih-tzu-tou-shan, on bark, 21 Mar 2004, *Guu, J.-R.* 93032105. Ilan County, Fu-shan, Hapenshi, on bark, 21 Aug 2004, *Guu, J.-R.* 93082102 (cultured). Taipei County, Hsintien, Shih-tzu-tou-shan, on bark, 11 Dec 2004, *Guu, J.-R.* 93121102. Taipei County, Wanlee, Linnshih historical trail, on bark, 15 Jan 2005, *Guu, J.-R.* 94011502 (cultured). Taipei County, Pingshi, Chou-tou-shan, on bark, 30 Apr 2005, *Guu, J.-R.* 94043006 (cultured).

*Notes.* *Neonectria coronata* is commonly found on the bark of recently dead trees. It is easily recognized by the conspicuous crown around the ostiolar disc. It should be noted that perithecia were formed on PDA from cultures obtained from specimen 94043006. The anamorph that we obtained from our collections is much as described by Brayford and Samuels (1993).

***Neonectria discophora*** (Mont.) Mantiri & Samuels, *Canad. J. Bot.* 79: 339. 2001. Figures 1E, 4A-E  
*Anamorph.* *Cylindrocarpon ianthothele* Wollenweber var. *majus* Wollenweber, *Z. Parasitenk.* (Berlin) 1: 161. 1928.

*Stromata* inconspicuous. *Perithecia* solitary to aggregated, superficial or partially immersed in substratum or basal stroma, red, changing color to dark red in 10% KOH and yellow in lactophenol, smooth and shining, globose to subglobose,  $293\text{--}355 \times 390\text{--}430 \mu\text{m}$ , uncollapsed when dry; perithecial wall  $39\text{--}45 \mu\text{m}$  thick, two-layered; ostioles blackened in age, slightly papillate. *Asci* cylindrical,  $60\text{--}72 \times 6\text{--}9 \mu\text{m}$ , with an apical ring. *Ascospores* yellowish, broadly fusiform, 1-septate,  $14\text{--}16 \times 5.5\text{--}6.5 \mu\text{m}$ , echinulate.

*Cultures and anamorph.* Colonies attaining 2 cm diam in 7 days at 20°C, aerial hyphae scanty, mostly flat, arising from the inoculum; hyphae often filled with brown inclusions, diffusing a violet pigment into the medium. *Conidiophores* producing macroconidia only, aggregated into slimy sporodochia, cylindrical, smooth, usually unbranched, each producing a phialide, with the phialides cylindrical,  $10\text{--}15 \times 2\text{--}4 \mu\text{m}$ . *Macroconidia* hyaline, oblong-ellipsoidal, slightly curved, with rounded ends, 3-

to 5-septate,  $32\text{--}80 \times 6\text{--}8 \mu\text{m}$ , smooth.

*Specimens examined.* Ilan County, Fu-Shan, on bark, 23 Jun 2001, *Ju, Y.-M.* and *Hsieh, H.-M.* 90062304. Taipei County, Jingtung, Jingtung historical trail, on bark, 21 Dec 2003, *Guu, J.-R.* 92122107 (cultured). Taipei County, Jingtung, Jingtung historical trail, on bark, 18 Mar 2004, *Guu, J.-R.* 93031802. Ilan County, Fu-Shan, on bark, 24 Jan 2005, *Guu, J.-R.* 94012407 (cultured). Kaohsiung County, Liou-guei, Shan-ping, on bark, 10 Mar 2005, *Guu, J.-R.* 94031007 (cultured). Taipei County, Pingshi, Chou-tou-shan, on bark, 30 Apr 2005, *Guu, J.-R.* 94043003 (cultured). Chiayi County, Shijuo, on bark, with *Neonectria lucida*, 20 Nov 2005, *Guu, J.-R.* 94112003.

*Notes.* This fungus and *N. lucida* are the most commonly encountered species in the *N. discophora* group (Samuels et al., 1990). These two species are mainly separated by colony color. The colonies of *N. discophora* diffuse a violet pigment into the culture medium, while those of *N. lucida* yield a tan-colored pigment restricted to the surrounding area of inoculation points. The anamorph that we obtained from the Taiwan material fits well *Cylindrocarpon ianthothele* (Brayford et al., 2004).

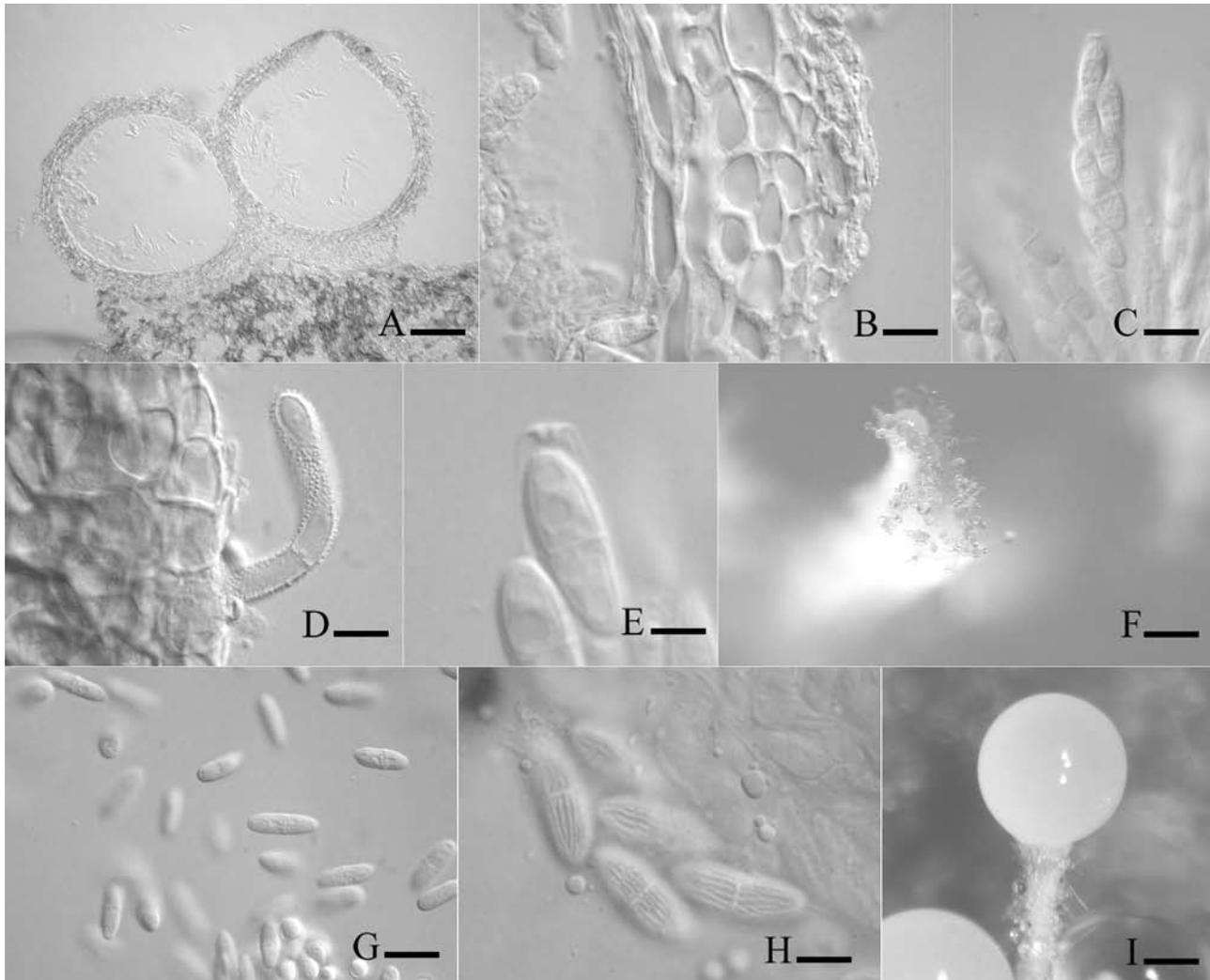
***Neonectria jungneri*** (Henn.) Samuels & Brayford, *Mycologia* 96: 580. 2004. Figures 1H, 4O-R

*Anamorph.* *Cylindrocarpon victoriae* Wollenw., *Zentbl. Bakt. ParasitKde, Abt. II* 1: 161. 1928.

*Stromata* absent. *Perithecia* aggregated, superficial, red, changing color to dark red in 10% KOH and yellow in lactophenol, obpyriform,  $350\text{--}400 \times 220\text{--}330 \mu\text{m}$ , roughened, uncollapsed when dry; perithecial wall  $20\text{--}35 \mu\text{m}$  thick, two-layered; ostioles coarsely papillate, red or gray, slightly constricted below. *Asci* clavate,  $75\text{--}90 \times 15\text{--}22 \mu\text{m}$ , lacking an apical ring. *Ascospores* hyaline, broadly fusiform, 1-septate,  $20\text{--}21.5 \times (7.5\text{--})8\text{--}9.5 \mu\text{m}$ , striated.

*Cultures and anamorph.* Colonies attaining 4 cm diam in 7 days at 20°C, velutinous, white to light yellow first, becoming brown from center outwards. *Conidiophores* producing macroconidia only, aggregated into slimy sporodochia, irregularly branched, producing 1 or 2 phialides at each terminus, with the phialides cylindrical,  $15\text{--}22 \times 3\text{--}5 \mu\text{m}$ . *Macroconidia* oblong-ellipsoidal, hyaline, 5- to 7-septate; 5-septate conidia  $93\text{--}100 \times 10\text{--}10.5 \mu\text{m}$ ; 6-septate conidia  $113\text{--}115.5 \times 10 \mu\text{m}$ ; 7-septate conidia  $106\text{--}121.5 \times 10\text{--}10.5 \mu\text{m}$ .

*Specimens examined.* Kaohsiung County, Meinong, on bark of *Swietenia macrophylla* King, 16 Sep 2005, *Guu, J.-R.* 94091601 (cultured). Pingtung County, Machia, Liang-shan waterfall, on bark, 14 Sep 2005, *Guu, J.-R.* 94091407 (cultured). Nantou County, Yuchee, Lienhwachee, on bark of *Castanopsis carlesii* (Hesml.) Hayata var. *sessilis* Nakai, 19 Jul 2001, *Ju, Y.-M.* 90071905 (cultured). Pingtung County, Hengchun, Kenting, on bark of *Castanopsis carlesii* var. *sessilis*, 26 Nov 2000, *Ju, Y.-M.* and *Hsieh, H.-M.* 89112623.



**Figure 3.** A-G, *Lanatonectria flocculenta*. A, Median section of ascoma; B, Lateral wall; C, Ascus; D, Verrucose perithecial hairs; E, Ascus tip with an apical ring; F, Sporodochium; G, Conidia; H-I, *Lanatonectria flavolanata*; H, Striated ascospores; I, Synnema bearing a conidial mass. Scale bars: A = 50  $\mu\text{m}$ ; B, C = 10  $\mu\text{m}$ ; D, G, H = 8  $\mu\text{m}$ ; E = 3  $\mu\text{m}$ ; F = 50  $\mu\text{m}$ ; I = 500  $\mu\text{m}$ .

*Notes.* This species resembles *N. coronata* but differs from the latter in lacking an ostiolar disc, in the ostiole not being surrounded with a crown, and in the ascospores ornamented with discontinuous striations. Also see Samuels and Brayford (1994) for a description of the anamorph.

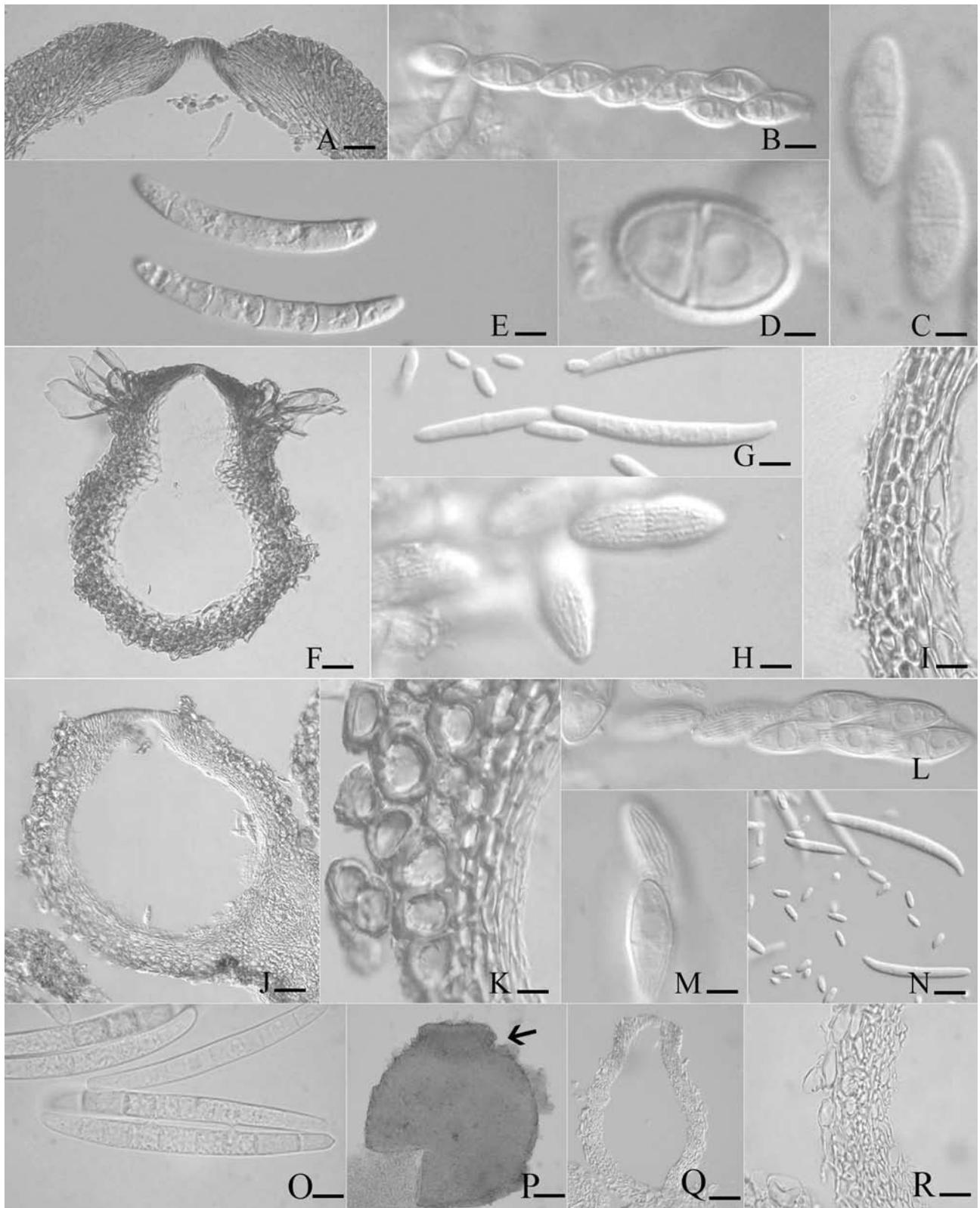
***Neonectria lucida*** (Höhn.) Samuels & Brayford, *Mycologia*. 96: 590. 2004. Figure 1F

*Anamorph.* *Cylindrocarpon lucidum* Booth, *Mycol. Pap.* 104: 21. 1966.

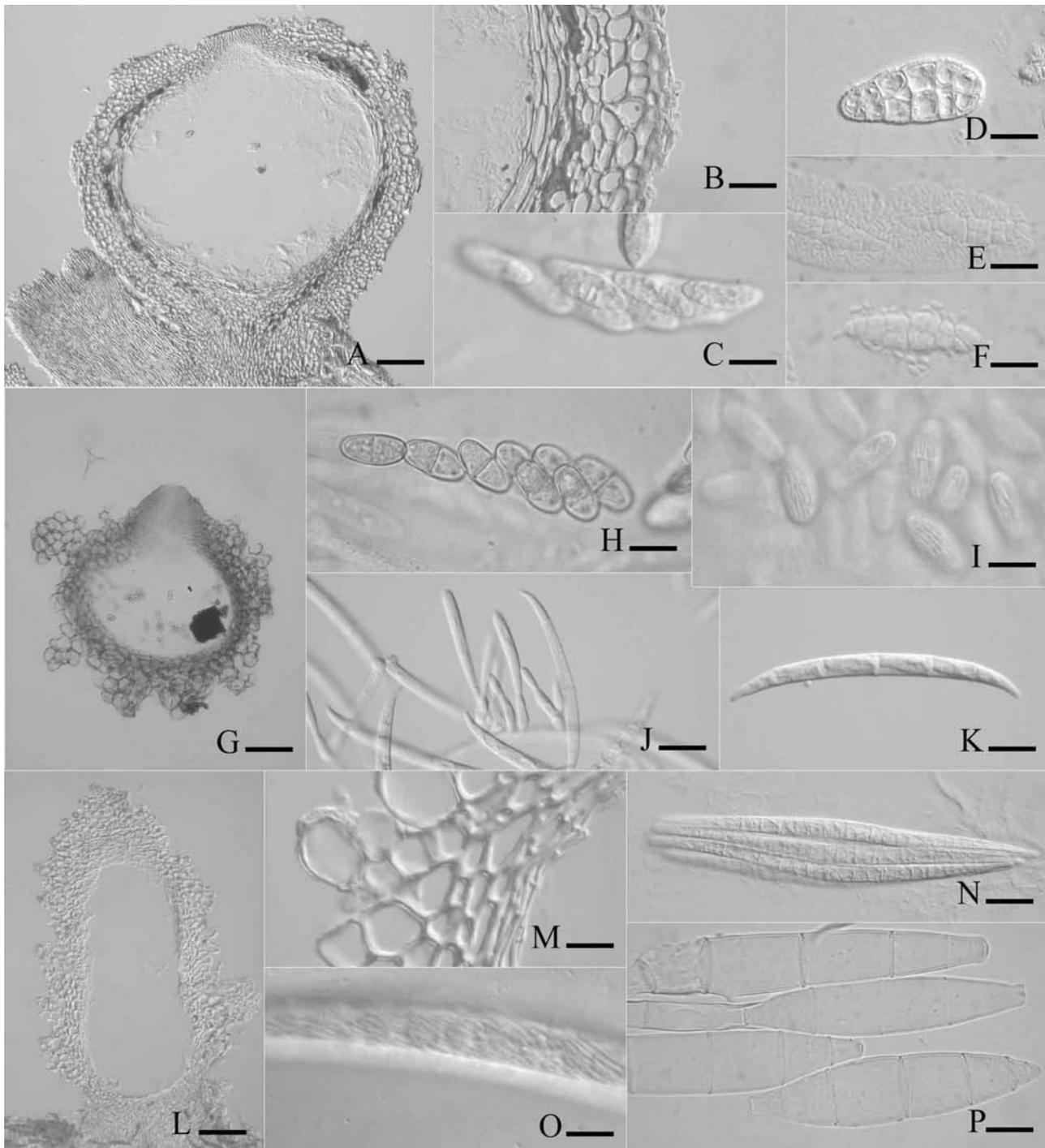
*Stromata* absent. *Perithecia* solitary or aggregated, superficial, red, changing color to dark red in 10% KOH and yellow in lactophenol, obpyriform, 400-460  $\mu\text{m}$  diam, slightly roughened, uncollapsed when dry; perithecial wall 20-35  $\mu\text{m}$  thick, two-layered; ostioles coarsely papillate, 80-110  $\mu\text{m}$  diam, 12-30  $\mu\text{m}$  high, slightly darker than the perithecial bodies. *Asci* cylindrical, 58-70  $\times$  7-9  $\mu\text{m}$ , with an apical ring. *Ascospores* hyaline, broadly fusiform, 1-septate, (12.5-)13-15  $\times$  (4.5-)5-6  $\mu\text{m}$ , echinulate.

*Cultures and anamorph.* Colonies attaining 3 cm diam in 7 days at 20°C, tan-colored close to the inoculation points, becoming white towards the edges. *Conidiophores* producing macroconidia only, aggregated into slimy sporodochia, irregularly branched, producing 1-2 phialides at each terminus, with the phialides cylindrical, 15-22  $\times$  3-5  $\mu\text{m}$ . *Macroconidia* oblong-ellipsoidal, sometimes curved, 3- to 5-septate; 3-septate conidia 40-82  $\times$  5-7  $\mu\text{m}$ ; 4-septate conidia 50-60  $\times$  5-8  $\mu\text{m}$ ; 5-septate conidia 60-85  $\times$  6-8  $\mu\text{m}$ .

*Specimens examined.* Nantou County, Tsuifong, on bark, 23 Sep 2002, Ju, Y.-M and Hsieh, H.-M. 91092333. Taipei County, Jingtung, Jingtung historical trail, 27 Nov 2003, Guu, J.-R. 92112704 (cultured). Taipei County, Pingshi, Chou-tou-shan, on bark, 30 Apr 2005, Guu, J.-R. 94043002 (cultured). Kaohsiung County, Meinong, on bark of *Swietenia macrophylla* King, 16 Sep 2005, Guu, J.-R. 94091602 (cultured). Chiayi County, Shih-jhuo, on bark, with *Neonectria discophora*, 20 Nov 2005, Guu, J.-R. 94112004.



**Figure 4.** A-E, *Neonectria discophora*. A, Median section of ascoma; B, Ascus; C, Ascospores; D, Ascus tip with an apical ring; E, Macroconidia; F-I, *Neonectria coronata*. F, Median section of ascoma; G, Macroconidia and microconidia; H, Ascospores with discontinuous striations; I, Lateral wall. J-N, *Neonectria rugulosa*. J, Median section of ascoma; K, Lateral wall; L, Ascus; M, Ascospores with continuous striations; N, Macroconidia and microconidia. O-R, *Neonectria jungneri*. O, Macroconidia; P, Coarsely papillate ostiole (arrow); Q, Median section of ascoma; R, Lateral wall. Scale bars: A, P = 50  $\mu$ m; B, E, G, K, M, O = 10  $\mu$ m; C, D = 5  $\mu$ m; F, R = 20  $\mu$ m; H = 8  $\mu$ m; I = 15  $\mu$ m; J, N, Q = 30  $\mu$ m; L = 12  $\mu$ m.



**Figure 5.** A-D, *Nectria pseudotrichia*. A, Median section of ascoma; B, Lateral wall; C, Ascus; D, Ascospore. E-F, *Nectria balsamea*. E, Ascospores forming ascoconidia in ascus; F, ascospores germinating into ascoconidia. G-K, *Haematonectria haematococca*. G, Median section of ascoma; H, Ascus; I, Ascospores; J, Conidiophores and macroconidia; K, Macroconidium; L-P, *Ophionectria trichospora*; L, Median section of ascoma; M, Lateral wall; N, Ascus; O, Ascospore with spiral striations; P, Conidia. Scale bars: A = 60  $\mu$ m; B, J, M, N, P = 20  $\mu$ m; G = 100  $\mu$ m; L = 50  $\mu$ m; C, F, H, I, K, O = 3  $\mu$ m; D, E = 8  $\mu$ m.

*Notes.* Cultures from specimens 92112704 and 94091602 produced the teleomorph on PDA. Also see notes on *Neonectria discophora*. The anamorph obtained from the Taiwan material is much as described in Booth (1966) and Brayford et al. (2004).

***Neonectria rugulosa*** (Pat. & Gaillard) Mantiri & Samuels, *Canad. J. Bot.* 79: 339. 2001.

Figures 1G, 4J-N

*Anamorph.* *Cylindrocarpon rugulosum* Brayford & Samuels, in Samuels & Brayford, *Sydowia* 46: 148. 1994.

*Stromata* absent. *Perithecia* solitary to aggregated, red or orange-red, changing color to dark red in 10% KOH and yellow in lactophenol, globose to subglobose, 300–450 µm, roughened by red warts, uncollapsed when dry; perithecial wall 15–23 µm thick, two-layered; ostioles apapillate. *Asci* clavate, 55–79 × 9–13 µm, lacking an apical ring. *Ascospores* hyaline, broadly fusiform, 1-septate, 22–25 × 7.5–9.5 µm, striate.

*Cultures and anamorph.* Colonies attaining 7 cm in 14 days at 20°C, velutinous, white, or light brown, diffusing a light brown pigment into medium. *Conidiophores* producing macroconidia and microconidia; those bearing macroconidia aggregated into slimy sporodochia, rarely branched, producing 3–5 phialides at each terminus, with the phialides cylindrical, 10–20 × 2–3 µm; those bearing microconidia cylindrical, unbranched, 30–90 × 2–3 µm. *Macroconidia* hyaline, oblong-ellipsoidal, sometimes curved, 4- to 7-septate, 53–82 × 4.5–6.5 µm. *Microconidia* hyaline, ellipsoidal or oblong-ellipsoidal, aseptate, 7–13 × 2.5–3.5 µm.

*Specimens examined.* Ilan County, Fu-shan, on bark of *Castanopsis carlesii* var. *sessilis*, 23 Jun 2001, Ju, Y.-M. 90062306 (cultured). Nantou County, Yuchee, Lienhwachee, on bark of *Castanopsis carlesii* var. *sessilis*, 19 Apr 2001, Ju, Y.-M. 90041902 (cultured). Nantou County, Yuchee, Lienhwachee, on bark of *Castanopsis carlesii* var. *sessilis*, 19 Jul 2001, Ju, Y.-M. 90071903 (cultured). Taipei County, Yong-ming-shan, Lu-jiao-keng shi, on bark, 10 Jul, Guu, J.-R. 93071001 (cultured). Kaohsiung County, Liouguei, Shanping, on bark, 10 Mar 2005, Guu, J.-R. 94031008. Tainan County, Meilinn, on *Areca catechu* L., 29 Aug 2005, Ju, Y.-M. & Hsieh, H.-M. 94082904 (cultured). Pingtung County, Machia, Liang-shan waterfall, on bark, 14 Sep 2005, Guu, J.-R. 94091408 (cultured).

*Notes.* Among the *Neonectria* species included in the present study, only this species and *N. discophora* have globose perithecia. They differ in the former having apapillate ostioles, striate ascospores, and producing both macroconidia and microconidia in culture. Samuels and Brayford (1994) reported the production of the teleomorph in culture, but no perithecia formed in cultures that we obtained from ascospores of our collections. The anamorph obtained from the Taiwan material agrees well with the description in Samuels & Brayford (1994).

**Ophionectria trichospora** (Berk. & Broome) Sacc., *Michelia* 1: 323. 1878. Figures 1L, 5L-P  
*Anamorph.* *Antipodium spectabile* Piroz., *Canad. J. Bot.* 52: 1144. 1974.

*Stromata* absent. *Perithecia* solitary to aggregated, red, changing color to dark red in 10% KOH, yellow in lactophenol, ovoidal, 400–600 × 250–300 µm, roughened by concolorous warts, sometimes collapsed when dry; perithecial wall 30–90 µm thick, two-layered; ostioles inconspicuous. *Asci* clavate, 180–220 × 25–30 µm, lacking

an apical ring. *Ascospores* hyaline, vermiform, 13- to 20-septate, 190–210 × 9–11 µm, inconspicuously striate.

*Cultures and anamorph.* Colonies attaining 2 cm diam in 14 days at 20°C, white, flat, scanty, yielding a brown pigment at the inoculation point, slowly diffusing to the colony margins with age. *Conidiophores* arising from the colony surface, cylindrical, septate, smooth, 100–200 × 10–15 µm, hyaline, unbranched, each producing a phialide; phialides cylindrical, 35–50 µm, with conspicuous periclinal thickening at tip, collarette, unflared. *Conidia* hyaline, fusiform, 3- to 5-septate, 110–140 × 25–29 µm, smooth to slight roughened.

*Specimens examined.* Taipei County, Shihding, Huang-di-dian north peak trail, on bark of *Ficus fistulosa* Reinw. ex Bl., 27 Nov 2003, Guu, J.-R. 92112702. Taipei County, Jingtung historical trail, on bark, 21 Dec 2003, Guu, J.-R. 92122101 (cultured). Nantou County, Luku, Shitou, on stem of *Brugmansia suaveolens* (Willd.) Bercht. & Presl, 19 Apr 2003, Ju, Y.-M. 92041904 (cultured). Taipei County, Hsintien, Ta-tung-shan, on bark of *Syzygium samarangense* (Bl.) Merr. & Perry, 9 Oct 2004, Guu, J.-R. 93100904.

*Notes.* This species is easily recognized by its ovoidal perithecia, cylindrical ascospores, and the *Antipodium* anamorph. The anamorph that we obtained is typical for *A. spectabile* as described in Rossman (1983). Perithecia of this fungus are frequently mixed with those of *H. haematococca* on the same substrata. The teleomorph was produced on PDA in those cultures initiated from specimen 92122101.

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## 台灣森林產叢赤殼科真菌 (nectriaceous fungi)

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我們發表從台灣森林採集到十九種叢赤殼科真菌，包括 *Albonectria albida*，*A. rigidiuscula*，*Cosmospora* cf. *consors*，*C. diminuta*，*C. cf. glabra*，*C. joca*，*C. triqua*，*C. vilior*，*Haematonectria haematococca*，*Lanatonectria flavolanata*，*L. flocculenta*，*Nectria balsamea*，*N. pseudotrichia*，*Neonectria coronata*，*Neo. discophora*，*Neo. jungneri*，*Neo. lucida*，*Neo. rugulosa* 與 *Ophionectria trichospora*。這些真菌大部份採集自最近才枯死的闊葉樹。在台灣，只有 *A. rigidiuscula*，*H. haematococca* 與 *N. pseudotrichia* 曾經被發表；其他十六種皆為新紀錄種。根據子囊殼的顏色與 *Fusarium* 的無性世代，我們將 *Nectria albida* 連結到 *Albonectria*，形成 *A. albida*。我們也提供一個檢索表來檢索這些種類。

**關鍵詞：***Albonectria*；*Bionectriaceae*；*Cosmospora*；*Haematonectria*；*Hypocreales*；*Neonectria*；*Nectria*；*Nectriaceae*；*Neonectria*；*Ophionectria*；系統分類學。

