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A monograph of *Allantonectria*, *Nectria*, and *Pleonectria* (*Nectriaceae*, *Hypocreales*, *Ascomycota*) and their pycnidial, sporodochial, and synnematous anamorphs

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Abstract: Although *Nectria* is the type genus of *Nectriaceae* (*Hypocreales*, *Sordariomycetes*, *Pezizomycotina*, *Ascomycota*), the systematics of the teleomorphic and anamorphic state of *Nectria sensu* Rossman has not been studied in detail. The objectives of this study are to 1) provide a phylogenetic overview to determine if species of *Nectria* with *Gyrostroma*, *Tubercularia,* and *Zythiostroma* anamorphs form a monophyletic group; 2) define *Nectria*, segregate genera, and their species using morphologically informative characters of teleomorphic and anamorphic states; and 3) provide descriptions and illustrations of these genera and species. To accomplish these objectives, results of phylogenetic analyses of DNA sequence data from six loci (*act,* ITS, LSU, *rpb1*, *tef1* and *tub*), were integrated with morphological characterisations of anamorphs and teleomorphs. Results from the phylogenetic analyses demonstrate that species previously regarded as the genus *Nectria* having *Gyrostroma, Tubercularia,* and *Zythiostroma* anamorphs belong in two major paraphyletic clades. The first major clade regarded as the genus *Pleonectria* contains 26 species with ascoconidia produced by ascospores in asci, perithecial walls having bright yellow scurf, and immersed or superficial pycnidial anamorphs (*Zythiostroma* = *Gyrostroma*). A lineage basal to the *Pleonectria* clade includes *Nectria miltina* having very small, aseptate ascospores, and trichoderma-like conidiophores and occurring on monocotyledonous plants. These characteristics are unusual in *Pleonectria*, thus we recognise the monotypic genus *Allantonectria* with *Allantonectria miltina.* The second major clade comprises the genus *Nectria sensu stricto* including the type species, *N. cinnabarina,* and 28 additional species. Within the genus *Nectria*, four subclades exist. One subclade includes species with sporodochial anamorphs and another with synnematous anamorphs. The other two paraphyletic subclades include species that produce abundant stromata in which the large perithecia are immersed, large ascospores, and peculiar anamorphs that form pycnidia or sporodochia either on their natural substrate or in culture. In this study the evolution of species, morphology, and ecology of the three genera, *Allantonectria, Nectria,* and *Pleonectria,* are discussed based on the phylogenetic analyses. In addition, descriptions, illustrations, and keys for identification are presented for the 56 species in *Allantonectria, Nectria,* and *Pleonectria.*

Key words: *act*, *Ascomycetes*, *Gyrostroma*, ITS, LSU, molecular systematics, *Nectriaceae*, plant pathogen, *rpb1*, *tef1*, *tub*, *Tubercularia*, *Zythiostroma*.

Taxonomic novelties: New species: *Nectria argentinensis* Hirooka, Rossman & P. Chaverri, *Nectria berberidicola* Hirooka, Lechat, Rossman, & P. Chaverri, *Nectria himalayensis* Hirooka, Rossman, & P. Chaverri, *Nectria magnispora* Hirooka, Rossman, & P. Chaverri, *Nectria mariae* Hirooka, Fournier, Lechat, Rossman, & P. Chaverri, *Nectria pyriformis* Hirooka, Rossman & P. Chaverri, *Pleonectria boothii* Hirooka, Rossman & Chaverri, *Pleonectria clavatispora* Hirooka, Rossman & P. Chaverri, *Pleonectria ilicicola* Hirooka, Rossman & P. Chaverri, *Pleonectria okinawensis* Hirooka, Rossman & P. Chaverri, *Pleonectria pseudomissouriensis* Hirooka, Rossman & P. Chaverri, *Pleonectria quercicola* Hirooka, Checa, Areual, Rossman & P. Chaverri, *Pleonectria strobi* Hirooka, Rossman & P. Chaverri. **New combinations:** *Cosmospora proteae* (Marinc., M.J. Wingf. & Crous) Hirooka, Rossman & P. Chaverri, *Nectricladiella viticola* (Berk. & M.A. Curtis) Hirooka, Rossman & P. Chaverri, *Neocosmospora guarapiensis* (Speg.) Hirooka, Samuels, Rossman & P. Chaverri, *Neocosmospora rehmiana* (Kirschstein) Hirooka, Samuels, Rossman & P. Chaverri, *Pleonectria aquifolii* (Fr.) Hirooka, Rossman & P. Chaverri, *Pleonectria aurigera* (Berk. & Rav.) Hirooka, Rossman & P. Chaverri, *Pleonectria chlorinella* (Cooke) Hirooka, Rossman & P. Chaverri, *Pleonectria coryli* (Fuckel) Hirooka, Rossman & P. Chaverri, *Pleonectria cucurbitula* (Tode : Fr.) Hirooka, Rossman & P. Chaverri, *Pleonectria lonicerae* (Seeler) Hirooka, Rossman & P. Chaverri, *Pleonectria rosellinii* (Carestia) Hirooka, Rossman & P. Chaverri, *Pleonectria rubicarpa* (Cooke) Hirooka, Rossman & P. Chaverri, *Pleonectria sinopica* (Fr. : Fr.) Hirooka, Rossman & P. Chaverri, *Pleonectria sphaerospora* (Ellis & Everh) Hirooka, Rossman & P. Chaverri, *Pleonectria virens* (Harkn.) Hirooka, Rossman & P. Chaverri, *Pleonectria zanthoxyli* (Peck) Hirooka, Rossman & P. Chaverri.

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INTRODUCTION

Traditionally the genus *Nectria* (*Ascomycota, Pezizomycotina, Sordariomycetes, Hypocreales, Nectriaceae*) has been applied to species having light to bright coloured, soft-textured, superficial, uniloculate perithecia, unitunicate asci, and phialidic anamorphs. Recently, many species of *Nectria sensu lato* were placed in segregate genera in the *Bionectriaceae* and *Nectriaceae* (Rossman *et al.* 1999). In that study the genus *Nectria* was restricted to 28 species and is here regarded as *Nectria sensu* Rossman. Although a key to species was provided, these species were not described and illustrated nor were type and other specimens examined. Here we provide a detailed account of the species included in *Nectria sensu* Rossman and related species based on a multigene phylogeny of these species combined with an examination of type and additional herbarium specimens plus many fresh collections.

Fries (1849) recognised the genus *Nectria* based on *Hypocrea* sect. *Nectria*. Subsequently, many species were described or classified in *Nectria* and today these fungi are referred to as the nectrioid or nectria-like fungi. For many years the concept of *Nectria* was extremely broad; more than 1000 species have been described in *Nectria sensu lato*. Fries (1825, 1849) did not specify ascospore characteristics and included species with amerosporous, phragmosporous, and scolecosporous ascospores. Saccardo

(1878, 1883) emended the description of *Nectria* limiting it to species having 1-septate ascospores. Saccardo (1883) recognised a number of generic segregates from *Nectria*, often based on a single character such as ascospore septation. For example, species with medium length ascospores with more than one septum were placed in *Calonectria* and those with very long ascospores and multiple septa in *Ophionectria*. Seaver (1909) included 23 species of *Nectria* in North America and cited *N. peziza* as the type species. This lectotypification is not considered legitimate because he was following the first-species rule of the American Code of Botanical Nomenclature, a code that was never officially recognised. The first legitimate typification of *Nectria* was made by Clements & Shear (1931) who designated *N. cinnabarina* as the lectotype. The genus *Nectria* 1849 was proposed for conservation with *N. cinnabarina* as the type over *Ephedrosphaera* Dumort. 1822 and *Hydropisphaera* Dumort. 1822 by Cannon & Hawksworth (1983) and this proposal was approved as listed in Greuter *et al*. (1994).

In recent years, *Nectria sensu lato* has been segregated into a number of genera based on suites of characteristics such as perithecial wall structure and anamorphic states (Hirooka *et al*. 2010; Rossman *et al*. 1999) combined with LSU phylogenetics (Rehner & Samuels 1995). In Rossman *et al.* (1999), a number of new genera were described while others previously regarded as synonyms of *Nectria* were resurrected. For example, species of *Nectria* having cylindrocarpon-like anamorphs were placed in the genus *Neonectria*, which has now been subdivided into four genera (Chaverri *et al*. 2011). The genus *Bionectria*, type genus of the *Bionectriaceae*, was recognised by Rossman *et al*. (1999) for species with yellowish to orange perithecia and *Clonostachys* anamorphs. This genus was studied in detail by Schroers (2001) who recognised 44 holomorphic or anamorphic species. Ongoing studies of the genera in the *Bionectriaceae* and *Nectriaceae* using both morphological characteristics and molecular sequence data are revealing and confirm that characteristics of the teleomorphic and anamorphic states are important in defining both genera and species of nectria-like fungi (Rossman *et al*. 1999, Schoch *et al*. 2000, Luo & Zhuang 2010, Chaverri *et al.* 2011).

An account of the British species of *Nectria* was provided by Booth (1959) who, following Weese (1919), recognised nine groups: Aquifolii group, Arenula group, Cinnabarina group, Coccinea group, Episphaeria group, Lasionectria group, Mammoidea group, Ochroleuca group, and Peziza group. These groups were based on stromatal development, characters of the ascomatal wall, anamorph, and host. Booth (1959) included three species in the Cinnabarina group: *N. aurantiaca*, *N. cinnabarina*, and *N. ralfsii*. When Rossman (1989) and Rossman *et al*. (1999) restricted *Nectria sensu stricto* to species considered congeneric with *N. cinnabarina*, they included *N. aurantiaca* and other species with a similar perithecial wall structure in *Nectria sensu stricto. Nectria ralfsii* is now regarded a species of *Bionectria*, *B. ralfsii* (Schroers 2001). The Aquifolii group included seven species, namely *N. aquifolii*, *N. coryli*, *N. sinopica*, *Scoleconectria cucurbitula*, *Thyronectria balsamea*, *T. berolinensis*, and *T. lamyi*, which were all regarded as species of *Nectria* by Rossman *et al*. (1999). The other *Nectria* groups defined by Booth (1959) are now recognised as different genera. The Coccinea group is *Neonectria sensu stricto* (Chaverri *et al.* 2011), the Episphaeria group is *Cosmospora* (Samuels *et al*. 1991, Rossman *et al*. 1999), the Lasionectria group is *Nectriopsis* or unknown (Sérusiaux *et al*. 1999), the Mammoidea group is *Thelonectria* (Chaverri *et al*. 2011), the Ochroleuca group is *Bionectria* (Schroers 2001), and the Peziza and Arenula groups are *Hydropisphaera* (Rossman *et al*. 1999).

The concept of the genus *Nectria* was restricted to species having a characteristic perithecial wall structure and specific anamorphic states by Rossman (1989) who provided a synopsis and a key to the 28 species. Rossman *et al.* (1999) followed this treatment and, after examining and redescribing their type species, listed ten genera as synonyms of *Nectria sensu stricto*: *Allantonectria*, *Aponectria*, *Chilonectria*, *Creonectria*, *Ephedrosphaera*, *Megalonectria*, *Pleonectria*, *Scoleconectria*, *Sphaerostilbe,* and *Stilbonectria*.

The genus *Thyronectria* was established by Saccardo (1875) for species with immersed ascomata and muriform ascospores similar to *Thyridium* and later monographed by Seeler (1940b) who did not examine the type specimen of the type species of *Thyronectria*, *T. patavina.* Following examination of this type specimen, Rossman *et al*. (1999) concluded that *T. patavina* was not a hypocrealean fungus based on the dark stroma and ascomatal walls and cellular, branching pseudoparaphyses. Many of the names described or placed in *Thyronectria* had been transferred to *Nectria* by Rossman *et al*. (1989). The genus *Pleonectria* was described by Saccardo (1876) for nectria-like fungi having muriform, primary ascospores that produce numerous, small ascoconidia in the asci. Seeler (1940b) regarded *Pleonectria* as a synonym of *Thyronectria* and transferred many *Pleonectria* names to that genus. The type species of *Pleonectria* is recognised as *Nectria lamyi*, a species placed in the *Nectria cinnabarina*-group (Booth 1959) and regarded as a member of the genus *Nectria* (Rossman 1989, Rossman *et al*. 1999).

Species in *Nectria sensu* Rossman have subglobose perithecia on a well-developed stroma that are smooth to rough, change colour in 3 % potassium hydroxide (KOH) and lactic acid (LA), and have a perithecial wall > 25 µm diam, and have *Gyrostroma*, *Tubercularia*, or *Zythiostroma* anamorphs (Rossman *et al.* 1999). Anamorphs among the 28 species in *Nectria sensu* Rossman encompass varying conidiomatal characters, include 14 sporodochial or synnematal species (*Tubercularia*), two species producing immersed pycnidia (*Gyrostroma*), three species producing superficial pycnidia (*Zythiostroma*), and nine with no known anamorph. Seifert (1985) recognised the close relationship of the *Tubercularia* states of *Nectria* to the pycnidial ones, *i.e. Gyrostroma* and *Zythiostroma*, and suggested that these anamorphs be included in *Tubercularia*. He later demonstrated the morphological relationship among these teleomorphic and anamorphic states (Samuels & Seifert 1987, Seifert & Okada 1990). None of these anamorphic genera have been monographed although many species of *Tubercularia* were included in Seifert (1985).

The genus *Tubercularia* was originally described by Tode (1790) for all sporodochial fungi; later the genus was restricted to fungi with black sporodochia (Fries 1832). Saccardo (1886) divided species of *Tubercularia* into four genera, *i.e. Cephalosporium*, *Dendrodochium*, *Spicaria*, and *Tubercularia* based on differences in substrate. His taxonomic concept was revised by Paoletti (1887) who, according to Seifert (1985), "recognised the acropleurogenously developing phialides of *T. vulgaris* as a valuable taxonomic character". Petch (1940) revised the British records of *Tubercularia*. Considering the genus to encompass both sporodochial and synnematal species, Seifert (1985) provided an account of *Tubercularia*, with eight species including *Tubercularia vulgaris* with many synonyms.

The genera *Gyrostroma* and *Zythiostroma* were described for species with pycnidial anamorphs. *Gyrostroma* was described by Naoumoff (1914) based on *Gyrostroma sinuosum* as the type species. The genus produces "immersed pycnidia; conidiophores simple, 28–54 µm long, 1 µm wide; conidia cylindrical, hyaline, 0-septate, 4 × 1 µm" (Naoumoff 1914). Seeler (1940b) included two species, *G. austroamericanum* as the anamorph of *Thyronectria austroamericana* and *G. missouriense* as the anamorph of *Thyronectria missouriensis*. *Zythiostroma* was established in a key published by Höhnel (1923) but without designating a type species. Later Höhnel & Weese (1931) designated *Z. mougeotii* as the type species. Petch (1943) recognised the genus for species with "pycnidia subcortical, ostiolum erumpent, or exposed by abscission of the outer layers of the cortex, scattered, subglobose or conoid; conidia are oblong-oval, hyaline, 2.5–3.5 × 1 µm" and considered *Nectria sinopica* to be the teleomorph. Booth (1959) recognised *Zythiostroma pinastri* as the anamorph of *Scoleconectria cucurbitula*, a species that was redescribed and illustrated by Sutton (1980).

Most morphological studies of *Nectria* did not include detailed anamorph and/or cultural characterisations with the exception of *Nectria cinnabarina*. Since the 18th century *Tubercularia vulgaris*, the anamorph of *N. cinnabarina*, was noted in detail including the morphological heterogeneity of conidia in culture (Mayr 1883, Brefeld 1891). Beck (1902) observed that conidia of this species in culture were much larger than normal and suggested that their size depended on the nutritional content of the media. To standardise cultural conditions, Jørgensen (1952) grew this species on a detached branch instead of artificial media. He determined that the range of conidial size was variable but not useful in distinguishing taxa within specimens identified as *N. cinnabarina*. Hirooka *et al*. (2011) observed hundreds of specimens of *N. cinnabarina* and 45 isolates on a low nutrient agar. Based on characteristics of these specimens and cultures combined with a multi-gene phylogeny, they determined that *N. cinnabarina* was a species complex. They recognised four species: *N. asiatica*, *N. cinnabarina, N. nigrescens,* and *N. dematiosa* with three subclades, based on colony growth rate, size, and shape of young and mature conidia, and geographic source. Within *N. dematiosa* the shape of the germ tube and molecular sequence data were used to distinguish the three subclades.

Despite their economic importance and taxonomic issues surrounding *Nectria*, a detailed treatment of the genus using molecular and morphological approaches has not been completed. The objectives of this study are to: 1) provide a phylogenetic overview of species of *Nectria sensu* Rossman; 2) define the species of *Nectria* and segregate genera using morphologically informative characters of the teleomorphic and anamorphic states; and 3) provide descriptions and illustrations of these genera and species. To accomplish these objectives, recently collected and herbarium specimens were examined to determine morphological characteristics. In addition, cultures were obtained from specimens and culture collections for use in developing a multi-locus phylogeny. Analyses were conducted using sequences obtained from a-actin (*act*), β-tubulin (*tub*), the internal transcribed spacer (ITS) and large subunit (LSU) of the nuclear ribosomal DNA, RNA polymerase II subunit one (*rpb1*), and translation elongation factor 1-a (*tef1*). These analyses combined with the results of the morphological observations are the basis for both generic and species definitions. Descriptions and illustrations are provided to one species of *Allantonectria*, 29 species of *Nectria*, and 26 species of *Pleonectria* as well as keys for identification of species on natural substrata and in culture using both teleomorphic and anamorphic characteristics.

MATERIALS AND METHODS

Fieldwork and preservation of specimens

Specimens were collected by the authors and collaborators in Australia, Costa Rica, France, Japan, New Zealand, USA (Maryland, Michigan, Pennsylvania and Utah), and Venezuela. In addition, many collaborators around the world kindly sent fresh materials. All plant substrata such as twigs, trunks, stems, leaves and fruits were targeted as hosts of *Nectria.* From each specimen a few fruiting bodies in good condition were removed and air-dried for later single ascospore isolation. The rest of the specimens were heat-dried, placed in silica gel, and kept in a low humidity room, for later accession in the herbarium. Specimens were deposited in the U.S. National Fungus Collection (BPI), Beltsville, Maryland, USA.

Isolation and deposition of cultures from field-collected specimens

To obtain cultures from fresh material, a suspension in sterilised water was made from ascospores or conidia from a crushed fruiting body, streaked onto 2 % (w/v) water agar (WA) with streptomycin (streptomycin sulfate; Sigma Chemicals, St. Louis, Missouri, USA) or Difco™ cornmeal dextrose agar (CMD; Difco, Detroit, Michigan, USA, cornmeal agar + 2 % w/v dextrose) supplemented with antibiotic 0.2 % neomycin (neomycin trisulfate salt hydrate; Sigma Chemicals, St. Louis, Missouri, USA), and incubated at 25 °C. After 24 h, a single germinating ascospore or conidium was transferred directly to Difco™ potato dextrose agar (PDA) with a tungsten needle (Nissin EM Co., Tokyo, Japan) or a fine insect pin. Representative isolates were preserved at the CBS Fungal Biodiversity Centre (CBS, Utrecht, Netherlands), and/or Genebank, National Institute of Agrobiological Sciences (NIAS, Tsukuba, Ibaraki, Japan).

Additional specimens and cultures

Herbarium specimens including type specimens were obtained from various herbaria as listed in the Acknowledgements. Cultures were obtained from the CBS Fungal Biodiversity Center (Utrecht, The Netherlands), the National Institute of Agrobiological Sciences (NIAS, Tsukuba, Ibaraki, Japan), and the ATCC: The Global Bioresource Center (ATCC, Manassas, Virginia, USA).

Morphological characterisation

For morphological characterisation of the teleomorph and anamorph in the natural environment, the macromorphology of the fruiting bodies, *i.e.* perithecia, pycnidia, synnemata, sporodochia, and stromata was observed and described as follows: distribution of fruiting bodies on the host and their shape, colour, and reaction to 3 % w/v potassium hydroxide (KOH) and 100 % lactic acid (LA) using a stereoscope (Zeiss, STEMI SV11, Jena, Germany). To observe internal and microscopic characteristics of the perithecial wall and stroma, the fruiting bodies were sectioned by hand and rehydrated in water, KOH, and LA. Characteristics such as asci, ascospores, conidiophores, ascoconidia, and conidia were observed by rehydrating fruiting bodies in water, removing part of the centrum or conidial mass with a fine glass needle, and placing it onto a glass slide. To observe the surface of spores and morphology of conidiogenous cells and phialides, cotton blue was used as the

Table 1. Isolates and accession numbers used in the phylogenetic analyses.

Species	**Isolate No.**	**Herbarium No.**	**Substrate/Host**	**Country**	**GenBank Accession No.**					
					act	**ITS**	**LSU**	***rpb1***	***tef1***	***tub***
Allantonectria miltina	A.R. 4391, CBS 121121	BPI 878442	Leaves decaying, *Agave americana*	Italy	HM484514 [a]	HM484547 [a]	HM484572 [a]	HM484587 [a]	HM484524 [a]	HM484609 [a]
Calonectria acicola	CBS 114813	PDD	*Phoenix canariensis*	New Zealand	–	GQ280547 [a]	GQ280669 [a]	–	GQ267292 [a]	DQ190591 [a]
Calonectria asiatica	CBS 112711	PDD	Debris	Thailand	–	GQ280551	GQ280673	–	AY725702 [a]	AY725613
Calonectria densa	CBS 125249, CMW 31184		Soil	Ecuador	–	GQ280645	GQ280767	–	GQ267350	GQ267230
Corallomycetella sp.	A.R. 4547, CBS 123826, C.L.L. 8064	BPI 881071	Bark	French Guiana	JF832440	JF832594	JF832679	JF832763	JF832517	JF832838
Cosmospora coccinea	A.R. 2741, CBS 114050	BPI 802729	*Inonotus nodulosus*	Germany	GQ505967 [a]	HM484537 [a]	GQ505990 [a]	GQ506020 [a]	HM484515 [a]	HM484589 [a]
Cosmospora magnusiana	A.R. 4453, CBS 129430	BPI 878454	*Rhus typhina*	USA	JF832441	JF832595	JF832680	JF832764	JF832593	JF832839
Cosmospora vilior	CBS 126109, G.J.S. 90-217	BPI 744778	*Xylaria* sp.	Venezuela	JF832442	JF832596	JF832681	JF832765	JF832518	JF832840
Cosmospora viliuscula	CBS 455.96, G.J.S. 96-6	BPI 744671	*Xylaria* sp.	Puerto Rico	GQ505966 [a]	HM484855 [a]	GQ506003 [a]	GQ506032 [a]	HM484851 [a]	HM484876 [a]
Cosmospora wegeliniana	CBS 128986, G.J.S. 93-15	BPI 802567	*Diatrypaceae*	France	GQ505968 [a]	HM484856 [a]	GQ506006 [a]	GQ506035 [a]	HM484849 [a]	HM484878 [a]
Cyanonectria cyanostoma	CBS 101734, G.J.S. 98-127	BPI 748307	*Buxaceae*	France	GQ505961 [a]	HM484558 [a]	FJ474081 [a]	GQ506017 [a]	HM484535 [a]	HM484611 [a]
Emericellopsis glabra	A.R. 3614, CBS 125295	BPI 871323	Soil	Mexico	GQ505969 [a]	HM484860 [a]	GQ505993 [a]	GQ506023 [a]	HM484843 [a]	HM484879 [a]
Haematonectria illudens	G.J.S. 85-67, ICMP 9708	PDD 50076	Bark	New Zealand	JF832443	JF832660	JF832762	JF832837	–	JF832841
Hydropisphaera fungicola	A.R. 4170, CBS 122304	BPI 878275	*Ulocladium atrum*, associated with Melampsora rust on decaying leaves of *Populus trichocarpa*	USA	GQ505970 [a]	HM484863 [a]	GQ505995 [a]	GQ506025 [a]	HM484845 [a]	HM484877 [a]
Lanatonectria flocculenta	CBS 126441, G.J.S. 01-66		Bark	Ecuador	JF832481	JF832656	JF832713	–	JF832546	JF832913
Lanatonectria flocculenta	MAFF 241413	TUA-TPP-h 105-2	Bark	Japan	–	JF832657	JF832714	–	JF832547	JF832914
Leuconectria clusiae	ATCC 22228		Soil	USA	–	–	AY489732 [a]	AY489664 [a]	–	–
Nectria antarctica	A.R. 2767, ATCC 204178, CBS 115033	BPI 746217	Dead stem of *Berberis aquifolium*	USA	HM484501 [a]	HM484556 [a]	HM484560 [a]	HM484575 [a]	HM484516 [a]	HM484601 [a]
Nectria asiatica	MAFF 241439	BPI 879972	Bark of dead wood	Japan	HM484505 [a]	HM484701 [a]	HM484563 [a]	–	–	HM484604 [a]
Nectria aurantiaca	CBS 308.34		*Ulmus* sp.	UK	JF832482	JF832628	JF832682	JF832766	JF832519	JF832886
Nectria balansae	MAFF 241419	BPI 881057, TUA-TPP-h 152	Bark of dead wood	Japan	JF832483	JF832651	JF832709	–	JF832520	JF832906
Nectria balansae	A.R. 4446, CBS 123351	BPI 878477	*Coronilla* sp.	France	GQ505977 [a]	HM484552 [a]	GQ505996 [a]	GQ506026 [a]	HM484525 [a]	HM484607 [a]
Nectria balansae	CBS 124070		Twigs	China	JF832484	JF832652	JF832710	–	JF832521	JF832907
Nectria balansae	A.R. 4635, CBS 129349		Twigs	China	JF832485	JF832653	JF832711	JF832790	JF832522	JF832908
Nectria berberidicola	A.R. 4662, C.L.L. 7199, CBS 128669	LIP YMNC083	*Berberis vulgaris*	France	JF832487	JF832662	JF832712	JF832767	JF832538	JF832887
Nectria cinnabaarina	A.R. 4477, CBS 125165	BPI 879981	Dead twigs of *Aesculus* sp.	France	HM484503 [a]	HM484548 [a]	HM484562 [a]	HM484577 [a]	HM484527 [a]	HM484606 [a]
Nectria dematiosa Subclade A	CBS 126570, G.J.S. 94-37	BPI 749337	Bark	USA	HM484502 [a]	HM484557 [a]	HM484561 [a]	HM484576 [a]	HM484534 [a]	HM484603 [a]

Table 1. (Continued).

Species	Isolate No.	Herbarium No.	Substrate/Host	Country	GenBank Accession No.					
					act	ITS	LSU	*rpb1*	*tef1*	*tub*
Nectria dematiosa Subclade B	A.R. 2699, CBS 125125	BPI 802212	Dead twigs of *Acer macrophyllum*	Canada	HM484612 [a]	HM484676 [a]	HM484717 [a]	HM484757 [a]	HM484645 [a]	HM484797 [a]
Nectria dematiosa Subclade C	MAFF 241430	BPI 879985	Branches standing	Japan	HM484617 [a]	HM484704 [a]	HM484750 [a]	HM484795 [a]	HM484653 [a]	HM484803 [a]
Nectria magnispora	CBS 129362, TPP-h122	TUA-TPP-h122	Twigs	Japan	JF832496	JF832663	JF832683	JF832786	JF832539	JF832896
Nectria magnispora	CBS 129361, TPP-h141	TUA-TPP-h141	Twigs	Japan	JF832497	JF832664	JF832685	JF832787	JF832540	JF832897
Nectria magnispora	MAFF 241418, TPP-h142	BPI 881044, TUA-TPP-h142	Twigs	Japan	JF832498	JF832665	JF832686	JF832788	JF832541	JF832898
Nectria mariae	A.R. 4274, CBS 125294	BPI 881045	*Buxus sempervirens*	France	JF832499	JF832629	JF832684	JF832789	JF832542	JF832899
Nectria nigrescens	A.R. 4211, CBS 125148	BPI 871083	Dead twigs of dicotyledonous tree	USA	HM484618 [a]	HM484707 [a]	HM484720 [a]	HM484781 [a]	HM484672 [a]	HM484806 [a]
Nectria nigrescens	A.R. 4271, CBS 128988		*Elaeagnus angustifolia*	USA	JF832488	JF832630	JF832687	JF832768	–	JF832888
Nectria nigrescens	A.R. 4270, CBS 128983		*Elaeagnus angustifolia*	USA	JF832490	JF832633	JF832692	JF832769	–	JF832889
Nectria nigrescens	A.R. 4268		*Elaeagnus angustifolia*	USA	JF832493	JF832634	JF832688	JF832771	–	JF832890
Nectria nigrescens	A.R. 4266, CBS 129808		*Ulmus pumila*	USA	JF832495	JF832632	JF832690	JF832773	–	JF832894
Nectria nigrescens	A.R. 4267, CBS 129426		*Gleditsia triacanthos* var. *inermis*	USA	JF832491	JF832636	JF832693	JF832772	–	JF832891
Nectria nigrescens	A.R. 4272, CBS 128987		*Ulmus pulmila*	USA	JF832489	JF832635	JF832691	JF832770	–	JF832892
Nectria nigrescens	A.R. 4269, CBS 128982		*Gleditsia triacanthos* var. *inermis*	USA	JF832494	JF832631	JF832694	JF832774	–	JF832893
Nectria nigrescens	A.R. 4306, CBS 128984	BPI 878879	*Tilia* sp.	USA	JF832492	JF832637	JF832689	JF832775	–	JF832895
Nectria polythalama	A.R. 4586, CBS 128672	BPI 879097, PC 961	Twigs	New Zealand	–	JF832638	JF832695	JF832776	JF832523	JF832900
Nectria polythalama	A.R. 4579, CBS 129240	BPI 879111, PC 975	Dead log of *Disoxylon*? sp.	New Zealand	–	–	JF832707	JF832779	JF832525	–
Nectria polythalama	A.R. 4575, CBS 128671	BPI 879115, PC 979	*Corynocarpus laevigatus*	New Zealand	–	JF832666	JF832708	JF832778	JF832526	–
Nectria polythalama	ICMP 2505	PDD 26407	*Eucalyptus ficifolia*	New Zealand	JF832500	JF832641	JF832696	JF832777	JF832524	JF832901
Nectria pseudocinnabarina	CBS 129366, G.J.S. 09-1359	BPI 881037	Dead wood	Venezuela	JF832501	JF832642	JF832697	–	JF832533	–
Nectria pseudocinnabarina	CBS 129364, G.J.S. 09-1356	BPI 881035	Dead wood	Venezuela	JF832504	JF832644	JF832698	–	JF832534	–
Nectria pseudocinnabarina	CBS 129365, G.J.S. 09-1358	BPI 881036	Dead wood	Venezuela	JF832503	JF832645	JF832700	–	JF832536	JF832904
Nectria pseudocinnabarina	A.R. 4548, CBS 128673	BPI 881034, C.L.L. 8299	Dead wood	Martinique	–	JF832643	JF832716	–	JF832537	–
Nectria pseudocinnabarina	A.R. 4567, CBS 123496, Y.H. 08-21	BPI 881033	Dead wood	French Guiana	JF832502	JF832646	JF832699	–	JF832535	JF832905
Nectria pseudotrichia	CBS 551.84		Bark	Japan	GQ505976 [a]	HM484554 [a]	GQ506000 [a]	GQ506030 [a]	HM484532 [a]	HM484602 [a]
Nectria pseudotrichia	MAFF 241394	BPI 881039	Twigs	Japan	JF832507	JF832639	JF832705	JF832785	JF832527	–

Table 1. (Continued).

Species	Isolate No.	Herbarium No.	Substrate/Host	Country	GenBank Accession No.					
					act	**ITS**	**LSU**	***rpb1***	***tef1***	***tub***
Nectria pseudotrichia	ICMP 2245	J.M. Dingley 6857	*Theobroma cacao*	Papua New Guinea	JF832508	JF832640	JF832701	JF832780	JF832532	–
Nectria pseudotrichia	MAFF 241452	BPI 881038	Bark	Japan	–	JF832649	JF832706	JF832781	JF832531	JF832903
Nectria pseudotrichia	CBS 652.83, C.T.R. 72-72	PDD 7908	Bark	Venezuela	JF832505	JF832648	JF832703	JF832782	JF832528	–
Nectria pseudotrichia	CBS 128670, Y.H. 10-04	BPI 881040	*Acer* sp.	USA	–	JF832650	JF832704	JF832783	JF832529	–
Nectria pseudotrichia	G.J.S. 09-1329	BPI 881041	Dead wood	Venezuela	JF832506	JF832647	JF832702	JF832784	JF832530	JF832902
Nectria sordida	CBS 125119, G.J.S. 86-117	NY	Living woody vine	French Guiana	JF832486	HM484857[a]	HM484868[a]	HM484871[a]	HM484848[a]	HM484874[a]
Nectriopsis exigua	CBS 126110, G.J.S. 98-32	BPI 748377	*Myxomycete*	Puerto Rico	GQ505979[a]	HM484865[a]	GQ505986[a]	GQ506014[a]	HM484852[a]	HM484883[a]
Neocosmospora haematococca MP 4	ATCC 42366, NRRL 22277		*Zanthoxylum* sp.	Japan	–	AF178401[a]	AF178370[a]	–	–	–
Neocosmospora haematococca MP 3	ATCC 44934, NRRL 22230		*Morus* sp.	Japan	–	AF178420[a]	AF178389[a]	–	–	–
Neocosmospora vasinfecta	A.R. 3587, CBS 122565	BPI 871326	Soil	South Africa	–	HM484864[a]	–	–	HM484842[a]	HM484881[a]
Ophionectria trichospora	CBS 109876, G.J.S. 01-206	BPI 863854	Bark	Cameroon	–	HM484867[a]	–	–	HM484847[a]	HM484886[a]
Pleonectria aquifolii	CBS 307.34	BPI 550125	*Ilex aquifolium*	UK	JF832444	JF832597	JF832718	JF832792	JF832548	JF832842
Pleonectria aurigera	A.R. 3717, CBS 109874	BPI 841465	Twigs dead, *Fraxinus excelsior*	France	HM484511[a]	HM484551[a]	HM484573[a]	HM484586[a]	HM484521[a]	HM484600[a]
Pleonectria austroamericana	A.R. 3491, CBS 125134	BPI 746395, NCSU	*Gleditsia triacanthos*	USA	JF832513	JF832654	JF832759	JF832834	JF832587	JF832881
Pleonectria austroamericana	A.R. 3492, CBS 125135	NCSU	*Robinia pseudoacacia*	USA	JF832514	JF832655	JF832760	JF832835	JF832588	JF832882
Pleonectria austroamericana	A.R. 2808, CBS 126114	BPI 746395	*Gleditsia triacanthos*	USA	GQ505960[a]	HM484555	GQ505988[a]	GQ506016[a]	HM484520[a]	HM484597[a]
Pleonectria balsamea	A.R. 2798, CBS 125132	BPI 746322	*Abies fraseri*	USA	JF832453	JF832598	JF832719	JF832800	JF832556	JF832846
Pleonectria balsamea	CBS 129159, Y.H. 10-07b	BPI 881047	*Abies balsamea*	USA	JF832456	JF832601	JF832721	JF832803	JF832557	–
Pleonectria balsamea	A.R. 3493, CBS 125136	NCSU	*Abies fraseri*	USA	JF832455	JF832600	JF832727	JF832804	JF832559	JF832847
Pleonectria balsamea	CBS 129160, Y.H. 10-08c	BPI 881050	*Abies balsamea*	USA	JF832457	JF832667	JF832731	JF832807	JF832558	JF832851
Pleonectria balsamea	A.R. 4568, CBS 129371, Y.H. 09-01	BPI 881046	*Abies balsamea*	Canada	–	JF832609	–	–	–	JF832852
Pleonectria balsamea	CBS 129429, Y.H. 10-11f	BPI 881048	*Abies balsamea*	USA	JF832458	JF832610	JF832730	JF832802	JF832562	JF832850
Pleonectria balsamea	A.R. 3495, CBS 125137	NCSU	*Abies fraseri*	USA	JF832454	JF832599	JF832729	JF832805	JF832561	JF832849
Pleonectria balsamea	CBS 129340, Y.H. 10-13h	BPI 881051	*Abies balsamea*	USA	JF832459	JF832669	JF832728	JF832806	–	JF832853
Pleonectria balsamea	CBS 129428, Y.H. 10-10e	BPI 881049	*Abies balsamea*	USA	JF832460	JF832668	JF832732	JF832801	JF832560	JF832848
Pleonectria berolinensis	A.R. 2776, CBS 126112	BPI 746346	*Ribes rubrum*	Austria	HM484510[a]	HM484543[a]	HM484568[a]	HM484583[a]	HM484517[a]	HM484594[a]
Pleonectria berolinensis	A.R. 4618, CBS 128980	HB7896A	*Ribes nigrum*	Mongolia	JF832479	JF832623	JF832750	JF832829	JF832584	JF832875
Pleonectria boothii	A.R. 4481, CBS 128977	BPI 881052	*Picea abies*	Slovakia	JF832475	JF832617	JF832755	JF832796	JF832552	JF832871
Pleonectria coryli	A.R. 4583, CBS 129358	BPI 881053, C.L.L. 651	*Corylus avellana*	France	JF832476	JF832672	JF832740	JF832797	JF832553	JF832872

Table 1. (Continued).

Species	Isolate No.	Herbarium No.	Substrate/Host	Country	GenBank Accession No.					
					act	ITS	LSU	*rpb1*	*tef1*	*tub*
Pleonectria coryli	A.R. 2777, CBS 115619	BPI 746347	*Viburnum lantana*	Austria	JF832477	JF832618	JF832741	JF832798	JF832554	JF832873
Pleonectria coryli	A.R. 4561, CBS 129156, Y.H. 08-15	BPI 880697	Twigs of *Rhus copallinum*	USA	HM484509[a]	HM484539[a]	HM484566[a]	HM484581[a]	HM484536[a]	HM484596[a]
Pleonectria coryli	A.R. 4566, CBS 129744, Y.H. 08-20	BPI 881054	Twigs of *Celastrus orbiculatus*	USA	JF832478	JF832619	JF832742	JF832799	JF832555	JF832874
Pleonectria cucurbitula	CBS 301.75		*Pinus nigra*	France	JF832461	JF832621	JF832720	JF832808	JF832563	JF832854
Pleonectria cucurbitula	CBS 259.58		*Pinus sylvestris*	Netherlands	GQ505974[a]	HM484541[a]	GQ505998[a]	GQ506028[a]	HM484530[a]	HM484592[a]
Pleonectria cucurbitula	CBS 541.70		Dead twig in witch's broom	Netherlands	JF832463	JF832602	JF832722	JF832809	JF832565	JF832856
Pleonectria cucurbitula	A.R. 2778, CBS 125130	BPI 746348	*Pinus sylvestris*	Austria	JF832464	JF832603	JF832723	JF832811	JF832564	JF832855
Pleonectria cucurbitula	CBS 178.73		*Pinus sylvestris*	Netherlands	JF832462	JF832607	JF832733	JF832810	JF832566	JF832857
Pleonectria ilicicola	A.R. 4108, CBS 125147	BPI 880698	*Ilex aquifolium*	UK	HM484506[a]	HM484538[a]	HM484565[a]	HM484579[a]	HM484522[a]	HM484590[a]
Pleonectria ilicicola (isolated from ascospore)	A.R. 4497, CBS 125170	BPI 881055, C.L.L. 7159	*Ilex aquifolium*	France	JF832445	JF832625	JF832756	JF832793	JF832549	JF832843
Pleonectria ilicicola (isolated from conidium)	A.R. 4498, CBS 125171	BPI 881055, C.L.L. 7159	*Ilex aquifolium*	France	JF832446	JF832626	JF832758	JF832794	JF832550	JF832844
Pleonectria ilicicola	A.R. 4574, CBS 128978	BPI 879857, C.L.L. 7184	*Ilex aquifolium*	France	JF832447	JF832673	JF832757	JF832795	JF832551	JF832845
Pleonectria lamyi	A.R. 2779, CBS 115034	BPI 746349	*Berberis vulgaris*	Austria	HM484507[a]	HM484544[a]	HM484569[a]	HM484582[a]	HM484518[a]	HM484593[a]
Pleonectria lamyi	CBS 417.89		*Berberis vulgaris*	Germany	JF832516	–	–	JF832830	JF832580	–
Pleonectria okinawensis	CBS 129369, MAFF 241410, TPP-h92	BPI 881058, TUA-TPP-h92	*Castanopsis* sp.	Japan	JF832451	JF832674	JF832751	JF832827	JF832585	JF832878
Pleonectria okinawensis	CBS 129745, TPP-h93	TUA-TPP-h93	*Castanopsis* sp.	Japan	JF832452	JF832675	JF832752	JF832828	JF832586	JF832879
Pleonectria pinicola	A.R. 4608, CBS 128979			Taiwan	–	–	JF832746	JF832821	JF832571	–
Pleonectria pinicola	MAFF 241458, TPP-h543	BPI 881061, TUA-TPP-h543	*Pinus koraiensis*	Japan	JF832469	JF832676	JF832748	JF832823	JF832572	JF832862
Pleonectria pinicola	A.R. 4478, CBS 125166	BPI 881059	*Pinus sylvestris*	Germany	HM484508[a]	HM484540[a]	HM484567[a]	HM484580[a]	HM484528[a]	HM484591[a]
Pleonectria pinicola	CBS 242.30		*Pinus sylvestris*	Russia	–	JF832615	JF832747	JF832822	JF832573	JF832863
Pleonectria pinicola	A.R. 4479, CBS 125167	BPI 881060	*Pinus sylvestris*	Germany	JF832470	JF832616	JF832749	JF832824	JF832574	JF832864
Pleonectria pyrrhochlora	A.R. 2786, CBS 125131	BPI 746398	*Acer campestre*	Austria	HM484512[a]	HM484545[a]	HM484570[a]	HM484584[a]	HM484519[a]	HM484598[a]
Pleonectria quercicola	A.R. 3805, CBS 128976	BPI 871328	*Quercus ilex* ssp. *rotundifolia* (as ssp. *ballota*)	Spain	JF832450	JF832624	JF832743	JF832831	JF832581	JF832880
Pleonectria rosellinii	MAFF 241403	BPI 881063	*Abies sachalinensis*	Japan	–	JF832670	JF832735	–	JF832575	JF832865
Pleonectria rosellinii	MAFF 241459, NITE 102242	BPI 881062	Dead twigs	Japan	JF832471	JF832611	JF832736	JF832816	JF832576	JF832866
Pleonectria rosellinii	A.R. 3494, CBS 128975	BPI 747280	*Abies fraseri*	USA	JF832472	JF832612	JF832737	JF832817	–	JF832868
Pleonectria rosellinii	CBS 129427, Y.H. 10-14i	BPI 881065	*Abies balsamea*	USA	JF832473	JF832613	JF832738	JF832819	JF832577	JF832869

Table 1. (Continued).

Species	Isolate No.	Herbarium No.	Substrate/Host	Country	GenBank Accession No.					
					act	**ITS**	**LSU**	***rpb1***	***tef1***	***tub***
Pleonectria rosellinii	CBS 129162, Y.H. 10-12g	BPI 881066	*Abies balsamea*	USA	JF832474	JF832614	JF832739	JF832820	JF832578	JF832870
Pleonectria rosellinii	CBS 129161, Y.H. 10-09d	BPI 881064	*Abies balsamea*	USA	–	JF832671	–	JF832818	JF832579	JF832867
Pleonectria sinopica	A.R. 4669, CBS 128981	C.L.L. 9237	*Hedera* sp.	France	JF832448	JF832622	JF832744	JF832825	JF832582	JF832876
Pleonectria sinopica	A.R. 4495, CBS 125169	BPI 881067, C.L.L. 7156	*Hedera helix*	France	JF832449	JF832620	JF832745	JF832826	JF832583	JF832877
Pleonectria sinopica	CBS 462.83	CBS H-19479, CBS H-19485	*Hedera helix*	Netherlands	GQ505973[a]	HM484542[a]	GQ506001[a]	GQ506031[a]	HM484531[a]	HM484595[a]
Pleonectria strobi	CBS 102036, G.J.S. 90-45	BPI 1107115	*Pinus strobus*	USA	JF832465	JF832604	JF832734	JF832812	JF832567	JF832858
Pleonectria strobi	CBS 129363, G.J.S. 91-107	BPI 1112876	*Pinus strobus*	USA	JF832468	JF832608	JF832724	JF832815	JF832568	JF832860
Pleonectria strobi	CBS 125107, C.T.R. 71-382	NY	*Pinus strobus*	USA	JF832467	JF832605	JF832725	JF832813	JF832569	JF832861
Pleonectria strobi	A.R. 1425, CBS 125122	NY	*Pinus strobus*	USA	JF832466	JF832606	JF832726	JF832814	JF832570	JF832859
Pleonectria virens	A.R. 4558, Y.H. 08-11	BPI 881068, C.L.L. 7181	Twigs	France	JF832509	JF832677	JF832754	JF832832	JF832589	JF832883
Pleonectria zanthoxyli	CBS 129157, Y.H. 09-03	BPI 881069	Dead bark	USA	JF832510	JF832627	JF832753	JF832833	JF832590	JF832884
Pleonectria zanthoxyli	A.R. 4616, CBS 124736	C.L.L. 7132	*Crataegus* sp.	France	JF832511	–	–	–	JF832591	JF832885
Pleonectria zanthoxyli	A.R. 4280, CBS 126113	BPI 878445	*Crataegus* sp.	France	HM484513[a]	HM484546[a]	HM484571[a]	HM484585[a]	HM484523[a]	HM484599[a]
Pseudonectria pachysandricola	A.R. 4592, CBS 128674	BPI 879936	*Pachysandra* sp.	USA	JF832512	JF832658	JF832715	JF832791	JF832544	JF832909
Pseudonectria rousseliana	A.R. 2716, CBS 114049		*Buxus sempervirens*	Spain	–	–	U17416[a]	AY489670[a]	–	–
Rodentomyces reticulatus	A.R. 4677, DSM 23301, F. Doveri #8348, CBS 128675		Rodent dung	Italy	JF832480	JF832659	JF832717	–	JF832543	JF832910
Rugonectria rugulosa	CBS 129158, Y.H. 10-01	BPI 881070	Bark	USA	JF832515	JF832661	JF832761	JF832836	JF832545	JF832911
Thelonectria westlandica	CBS 112464, G.J.S. 83-156		*Dacrydium cupressinum*	New Zealand	GQ505959[a]	HM484559[a]	GQ505987[a]	GQ506015[a]	HM484533[a]	HM484610[a]
Verrucostoma freycinetiae	MAFF 240100, TPP-h523	BPI 878948	*Freycinetia boninensis*	Japan	GQ505984[a]	HM484866[a]	GQ506013[a]	GQ506018[a]	HM484853[a]	HM484885[a]
Viridispora alata	A.R. 1770, CBS 125123		Bark	Madeira	GQ505985[a]	JF832678	GQ505989[a]	GQ506019[a]	JF832592	JF832912
Viridispora diparietispora	ATCC MYA 627	BPI 802202	*Crataegus crus-galli*	USA	–	–	AY489735[a]	AY489668[a]	–	–

A.R.: Amy Y. Rossman, USDA-ARS MD USA; **ATCC**: American Type Culture Collection, Manassas, VA, USA; **BPI**: U.S. National Fungus Collections USDA-ARS MD USA; **CBS**: Centraalbureau voor Schimmelcultures, Utrecht, The Netherlands; **C.L.L.**: Christian Lechat, Ascofrance, Villiers en Bois, France.; **CMW**: represents cultures in the culture collection of the Forestry and Agricultural Biotechnology Institute (FABI), Pretoria, South Africa; **C.T.R.**: Clark T. Rogerson, The New York Botanical Garden, NY, USA; **G.J.S.**: Gary J. Samuels, USDA-ARS MD USA; **ICMP**: ICMP culture collection, Auckland, New Zealand; **MAFF**: MAFF Genebank, National Institute of Agrobiological Sciences, Ibaraki, Japan; **NITE**: NBRC, National Institute of Technology and Evaluation, Chiba, Japan; **NCSU**: The Mycological Herbarium, North Carolina State University, NC, USA; **NY**: William and Lynda Steere Herbarium, The New York Botanical Garden, NY, USA; **PC:** Herbier Cryptogamique, Départment de Systématique et Évolution, Muséum National d'Histoire Naturelle, Paris, France; **PDD**: New Zealand Fungus Herbarium, Auckland, New Zealand; **TUA-TPP-h**: Yuuri Hirooka, Tropical Plant Protection Lab Herbarium, Tokyo University of Agriculture, Tokyo Japan; **TPP-h**: Yuuri Hirooka, Tropical Plant Protection Lab Culture Collection, Tokyo University of Agriculture, Tokyo Japan; **Y.H.**: Yuuri Hirooka, USDA-ARS MD USA.

[a] Sequences obtained from GenBank

mounting medium. Microscopic observations were made using a compound microscope (Zeiss, Axioskop 2 Plus, Jena, Germany).

To determine colony characteristics such as colour and odour, isolates were grown on PDA in 9-cm plastic dishes at 25 C for 7 d in the dark. For the observation of sporulating structures, cultures were grown on a low nutrient agar (SNA; Nirenberg 1976). Cultures on SNA were incubated at 25 °C with alternating 12 h/12 h fluorescent light/darkness for 2–3 wk to induce conidiogenesis. To observe cultural morphology, pieces of the colony were cut into squares (1.5 mm × 1.5 mm) and directly observed under the microscope. The species of nectria-like fungi studied here form two types of conidia, hereafter referred to as “young conidia” and “mature conidia.” Young conidia are those that develop after 1–2 d on SNA while mature conidia are generally 4–5 d old. To stimulate budding, mature conidia produced on SNA were suspended in distilled water and then streaked on SNA. After 24 h, budding mature conidia and germ tubes were produced. Images were captured with a Nikon DXM1200 digital camera. Composite images were made with Helicon Focus v. 4.21.5 Pro (Helicon Soft, www.heliconfocus.com). Colours are described using the terminology of Kornerup & Wanscher (1978).

Growth trials

Disks of 5 mm diam were cut from the edge of young colonies after 7 d at 25 °C in the dark and placed in the centre of PDA plates, then incubated at temperatures from 15 to 35 °C at 5 °C intervals in complete darkness. Diameters of the colonies on three plates for each isolate at each temperature were measured every day for 1 week. Two replicates of the trials were completed.

Statistical analysis

Measurements of continuous characters such as length and width were made using Scion Image software beta v. 4.0.2 (Scion Corporation, Frederick, Maryland, USA) and are based on up to 50 measurements for structures in each isolate/specimen. For morphological structures, descriptive statistics (minimum, mean, median, maximum and standard deviation) were computed; variation of morphological characters is displayed graphically using mean values and their corresponding 95 % confidence intervals. All computations were performed using Systat 10 (Systat Software, San José, California, USA). Only isolates for which all data are available were included in the analysis. Ranges are reported as mean values ± one standard deviation; the number of items measured is given in parentheses together with maximum and minimum.

DNA extraction, PCR, and sequencing

One hundred thirty cultures of *Nectria sensu* Rossman and various other *Nectriaceae* and *Bionectriaceae* were used for the phylogenetic analyses as listed in Table 1. All isolates were grown in Difco™ potato dextrose broth in 6 cm diam Petri plates for about 3 wk. Mycelial mats were harvested in a biological safety cabinet and dried with clean, absorbent paper towels. DNA was extracted with Ultra Clean™ Plant DNA Isolation Kit (MO BIO Laboratories Inc., Solana Beach, California, USA).

Six loci were sequenced, namely a-actin (*act*) (Carbone & Kohn 1999), the internally transcribed spacer (ITS) (White *et al.* 1990), large subunit nuclear ribosomal DNA (LSU) (Vilgalys n.d.), RNA polymerase II subunit one (*rpb1*) (Castlebury *et al.* 2004), translation elongation factor 1-a (*tef1*) (Carbone & Kohn 1999, Rehner 2001), and β-tubulin (*tub*) (O’Donnell & Cigelnik 1997). The primers and PCR protocols are listed in Table 2. PCR products were cleaned with ExoSAP-IT® (USB Corporation, Cleveland, Ohio, USA) following the manufacturer’s instructions. Clean PCR products were sequenced at the DNA Sequencing Facility (Center for Agricultural Biotechnology, University of Maryland, College Park, Maryland, USA) and at MCLAB (Molecular Cloning Laboratories, San Francisco, California, USA). Sequences were assembled and edited with Sequencher v. 4.9 (Gene Codes, Madison, Wisconsin, USA). Sequences are deposited in GenBank (Table 1).

Phylogenetic analyses

Sequences were aligned with MAFFT v. 6 (Katoh 2008) and the alignment was visually improved with Mesquite v. 2.6 (Maddison & Maddison 2009). Bayesian inference (BI), Maximum likelihood (ML), and Maximum Parsimony (MP) analyses were done with all sequences, first each locus separately, then with the combined/concatenated data sets. Gaps (insertion/deletions) were treated as missing data. *Emericellopsis glabra*, *Hydropisphaera fungicola*, *Nectriopsis exigua*, and *Verrucostoma freycinetiae,* representative members of the *Bionectriaceae*, were used as the outgroup for inferring intrageneric relationships. MP analyses were conducted with PAUP* v. b10 (Swofford 2002) with a heuristic search; starting trees were obtained by stepwise addition using a simple addition sequence. Bootstrap analysis was performed with 1000 replicates, and a 70 % majority rule consensus tree was constructed in PAUP*. JMODELTEST (Posada 2008) was used to calculate the models of nucleotide substitutions of each gene/partition for the ML and BI analyses. The number of substitution schemes was set to 11; base frequencies +F, rate variation +I and +G and the base tree for likelihood calculations were set to ML optimised. After the likelihood scores were calculated, the models were selected according to the Akaike information criterion (AIC) (Posada & Buckley 2004). After jMODELTEST was run, likelihood settings for the tree were set for each gene. For the ML and bootstrap analyses (BP), GARLI v. 0.96 (Zwickl 2006) was computed through the Grid computing (Cummings & Huskamp 2005) and The Lattice Project (Bazinet & Cummings 2009), which includes many clusters and desktops in one integrated network (Myers *et al.* 2008). In GARLI, the starting tree was made by stepwise-addition and the number of runs or search replicates was set to 50. 2000 ML BP replicates were completed in GARLI, with the starting tree chosen randomly. Bayesian analysis (BI) was done using MrBayes v. 3.1.2 (Huelsenbeck *et al.* 2001, 2002). In MrBayes, data were partitioned by locus and the parameters of the nucleotide substitution models for each partition were set as described (Table 2). For this analysis, two independent analyses of two parallel runs and four chains were carried out for 10 000 000 generations with MrBayes. Convergence of log likelihoods was assessed with Tracer v. 1.5 (Rambaut & Drummond 2007). Analyses were initiated from a random tree and trees sampled every 100th generation. The first 20 % of the resulting trees were eliminated (= "burn in"). A consensus tree ("sumt" option) and posterior probabilities (PP) were calculated in MrBayes, which combines the results from both parallel runs. A reciprocal 70 % BP threshold was used to detect topological incongruence among genes/partitions (Mason-Gamer & Kellogg 1996, Reeb *et al.* 2004).

Table 2. Genes/loci used in the phylogenetic analyses for members of the genus *Allantonectria*, *Nectria*, and *Pleonectria*. Information on the primers, including bases pairs, PCR protocols, and models of nucleotide substitution are indicated.

Locus	*Act*	ITS	LSU	*Rpb1*	*Tef1*	*Tub*	Combined
Included sites (# of excluded sites)	585 (197)	475 (331)	501 (414)	634 (219)	817 (457)	481 (354)	3493
Phylogenetically informative sites (%)	151 (26 %)	185 (39 %)	110 (22 %)	347 (55 %)	377 (46 %)	283 (59 %)	1453 (42 %)
Uninformative polymorphic sites	29	52	27	47	34	21	210
Invariable sites	405	238	364	240	406	177	1830
Consistency Index	0.289	0.378	0.326	0.272	0.239	0.259	0.263
Homoplasy Index	0.711	0.767	0.674	0.728	0.761	0.741	0.737
Retention Index	0.787	0.622	0.821	0.769	0.737	0.753	0.748
Nucleotide substitution models	SYM+I+G	TIM1+I+G	TIM3ef+I+G	TIM2+I+G	TIM3+I+G	HKY+I+G	
Primers used (reference)	Tact1, Tact2	ITS5, ITS4	LR5, LROR	crpb1a, rpb1c	tef1-728, tef1-1567	Btub-T1, Btub-T2	
	(Samuels *et al.* 2006)	(White *et al.* 1990)	(Vilgalys n.d.)	(Castlebury *et al.* 2004)	(Carbone & Kohn 1999, Rehner 2001)	(O'Donnell & Cigelnik 1997)	
PCR protocol: Annealing temp. & cycles	65 °C, 30 s, 15× 48 °C, 30 s, 30×	53 °C, 1 min, 35×	53 °C, 1 min, 35×	50 °C, 2 min, 40×	66 °C, 55 s, 9× 56 °C, 55 s, 35×	55 °C, 30 s, 35×	

RESULTS

Phylogenetic analyses

In our six-loci phylogeny, most external branches show high Bayesian inference posterior probabilities (BI PP), Maximum Likelihood bootstrap (ML BP), and Maximum Parsimony bootstrap (MP BP) (Figs 1–3). Sequencing and alignment of the six loci for 130 isolates include 3493 base pairs of which 1453 bp (42 %) are phylogenetically informative, 1830 bp are invariable sites, and 210 bp are unique, non-informative, and polymorphic (Table 2). Ambiguously aligned and poly-T/A regions were excluded from the analyses especially in the ITS, *tef1*, and *tub* loci, which possess highly variable regions, *i.e.* introns. The BI and ML analyses of the combined six loci produced one tree (Fig. 3) with log likelihoods of −55689.665 and −55203.154, respectively (Table 2). The topologies of individual gene trees did not contradict each other at the species level. Among these trees, the *act* tree provided the best resolution with best ML BP support.

The combined BI, ML, and MP analyses of six loci revealed two major clades (clades I and II) of *Nectria sensu* Rossman that are paraphyletic within the *Nectriaceae* represented by the 13 additional genera*, Calonectria*, *Cosmospora*, *Corallomycetella*, *Cyanonectria*, *Lanatonectria*, *Leuconectria*, *Neocosmospora* (= *Haematonectria*), *Ophionectria*, *Pseudonectria*, *Rodentomyces*, *Rugonectria*, *Thelonectria and Viridispora* (Fig. 1). Clade I is highly supported (BI PP 100 %, ML BP 99 %, MP BP 100 %) and includes species with perithecia having bright yellow scurf. These species constitute the genera *Allantonectria* and *Pleonectria*, both of which are recognised here as distinct genera. *Allantonectria* is represented by one isolate of the type and only species, *A. miltina*. The remaining isolates of clade I include species of the moderately supported *Pleonectria* clade with BI PP of 100 %, ML BP of 83 %, and MP BP of < 70 % (Figs 1, 2).

The other clade includes all other members of the *Nectriaceae* with species having perithecia lacking bright yellow scurf. Clade II includes species placed in the genus *Nectria* in a sense even more restricted than that of Rossman *et al.* (1999). The *Nectria* clade has four main monophyletic groups (Clade II-1, II-2, II-3, and II-4). Among them, clades II-1, II-3, and II-4 are supported by high BI PP, ML BP, and MP BP values while clade II-2 is moderately supported by BI PP (100 %), ML BP (78 %), and MP BP (74 %) (Figs 1, 3). With the exception of *N. antarctica*, clades II-1 and II-2 are morphologically distinct in having red perithecia immersed in a stroma and this assemblage is referred to as the *N. balansae* group. Two species of this group occasionally produce sporodochia and immature pycnidia. Sister to clade II-2, *Nectria antarctica* produces concave sporodochia. Clade II-3 and II-4 are morphologically similar to *Nectria sensu* Rossman having superficial perithecia but lacking yellow scurf, and here we call this assemblage *Nectria* excluding the *N. balansae* group. Clade II-3 supported by 100 % BI PP, ML BP, and MP BP values includes species with synnematous anamorphs (Figs 1, 3). Clade II-4 includes *Nectria* species with sporodochial anamorphs and is supported by 100 % BI PP and ML BP, but 72 % MP BP (Figs 1, 3).

Phylogenetic analyses: clade I *Allantonectria* and *Pleonectria*

Based on the results of the phylogenetic analyses of DNA sequence data and observations of morphological characteristics of species of *Nectria sensu* Rossman, it was determined that these species represent three genera (Fig. 1). Clade I includes *Allantonectria* as well as species of the sister genus *Pleonectria*. The monotypic genus *Allantonectria* includes a single isolate of *A. miltina* (Figs 1, 2). This genus is considered distinct because the type and only species has small, non-septate, allantoid ascospores and is known to occur only on members of the *Asparagaceae*, both unusual characteristics for nectria-like fungi.

The genus *Pleonectria* represented by clades I-1, I-2, I-3, and I-4 includes species with perithecia often covered with yellow scurf and variously septate ascospores that produce ascoconidia within the asci or soon after release. They generally occur on newly killed woody plants and tend to be host specific. The nineteen species of *Pleonectria* constitute a weakly supported monophyletic clade (I-1) (Figs 1, 2). Within the *Pleonectria* clade the combined DNA

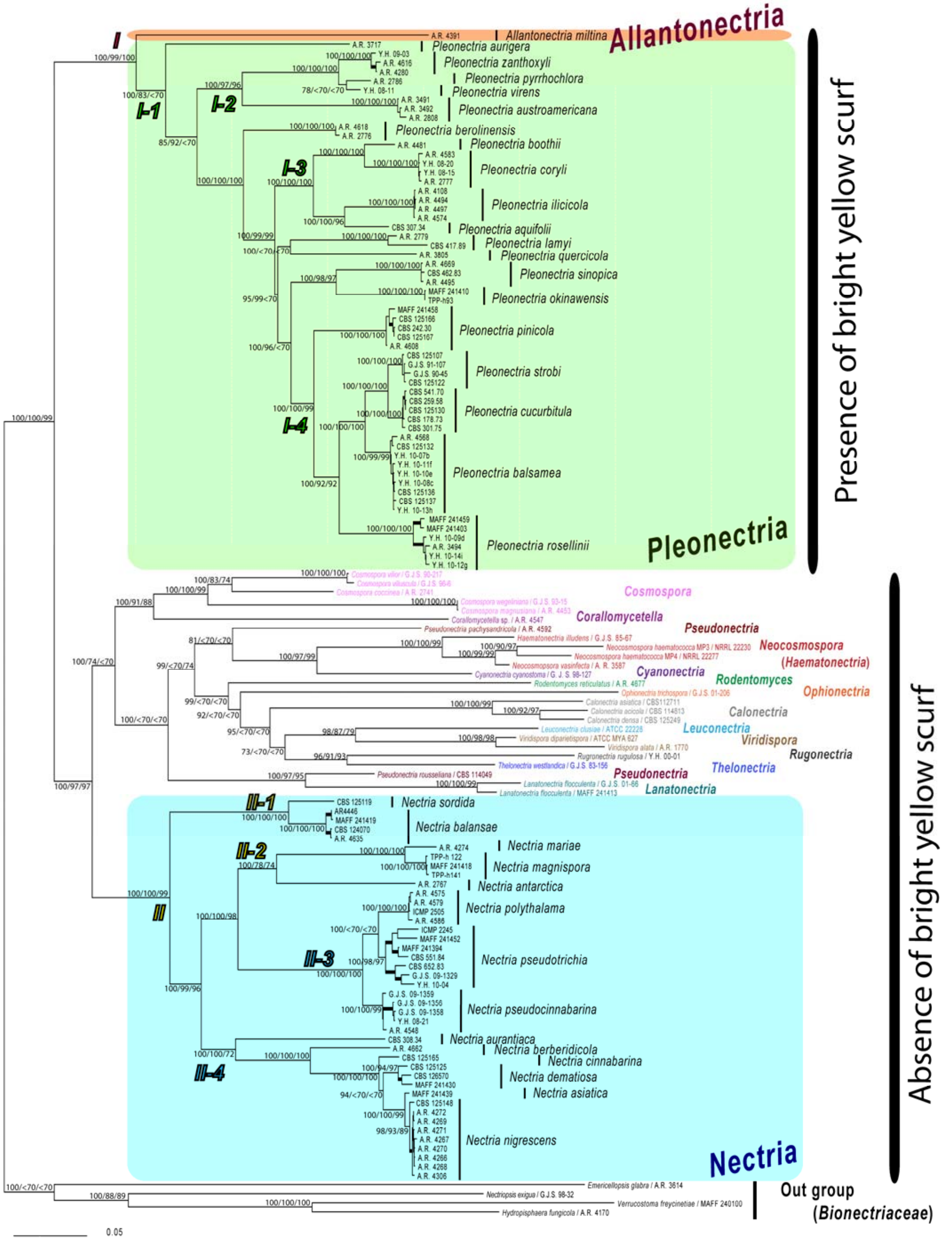

Fig. 1. Cladogram of combined *act*, *tub*, *rpb1*, ITS, LSU, and *tef1* based on Bayesian analysis (−55689.665). Values at branches indicate Bayesian posterior probabilities (BI PP)/Maximum Likelihood bootstrap (ML BP)/Maximum parsimony bootstrap (MP BP). Only values for species clades are listed. Other branch support values > 70 % are indicated by thicker lines.

sequence analyses showed significant support for most internal and external nodes. *Pleonectria aurigera*, a basal species in *Pleonectria*, was moderately supported with BI PP of 100 %, ML BP of 83 % and MP BP of < 70 %. Although phylogenetically this species might be placed in a separate genus, *P. aurigera* is morphologically similar to other species of *Pleonectria*. Clade I-2 includes *P. austroamericana*, *P. pyrrhochlora*, *P. virens*, and *P. zanthoxyli*, all of which possess abundant bright yellow scurf on the perithecia, and is supported by BI PP (100 %), ML BP (97 %), and MP BP (96 %) values. Among these species, sequences of *P.*

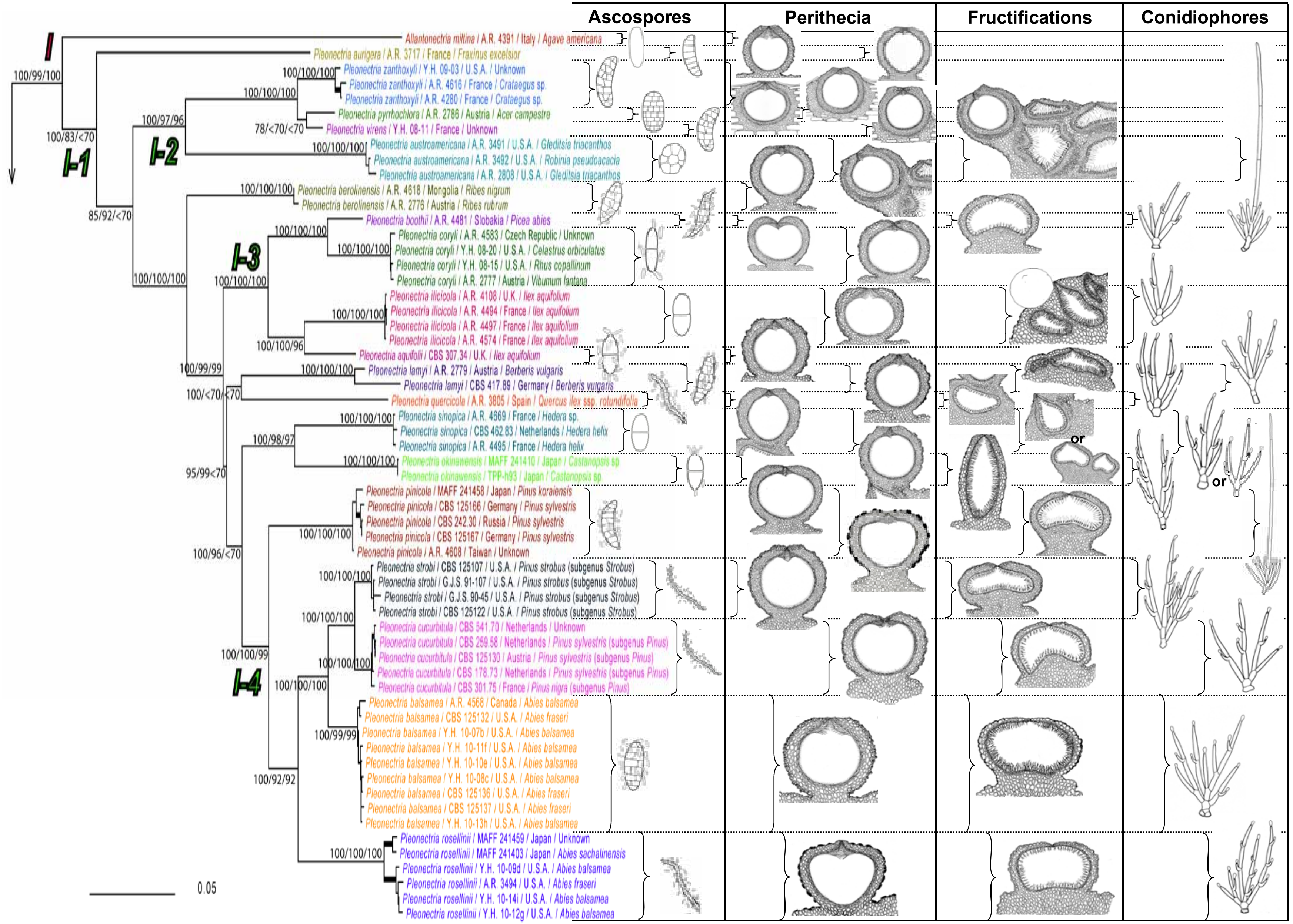

Fig. 2. Cladogram of Clade I of the combined *act*, *tub*, *rpb1*, ITS, LSU, and *tef1* based on Bayesian analysis with geography, host, and morphological characters.

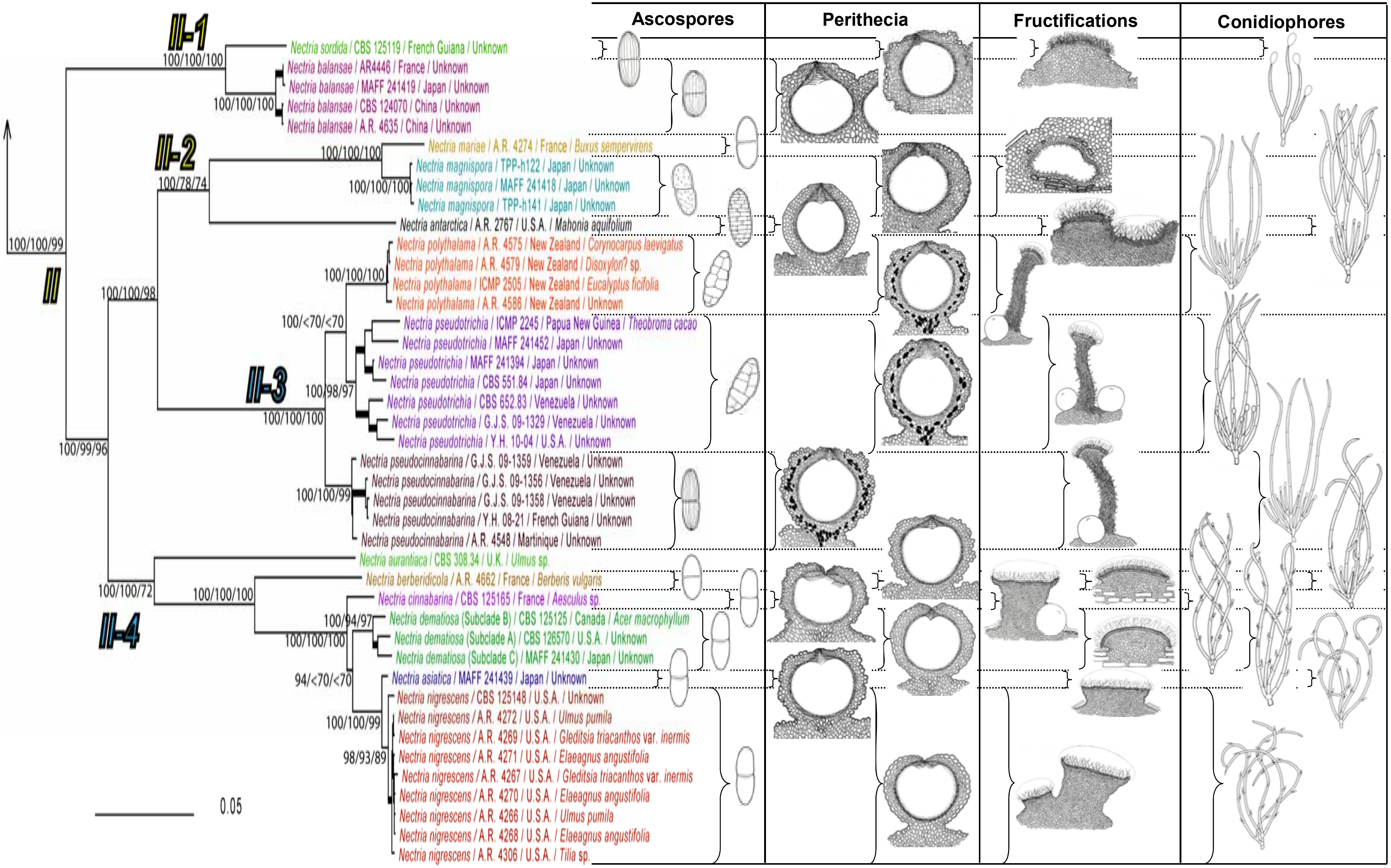

Fig. 3. Cladogram of Clade II of the combined *act*, *tub*, *rpb1*, ITS, LSU, and *tef1* based on Bayesian analysis with geography, host, and morphological characters.

austroamericana form a distinct clade sister to *P. pyrrhochlora*, *P. virens*, and *P. zanthoxyli* (BI PP 1.00, ML BP 100 % and MP BP 100 %). The stromata of *P. austroamericana* possess superficial perithecia while stromata of the other species are immersed in the substratum. Sequences of *P. zanthoxyli* are divided into North American and European subclades. Clade I-3 supported by 100 % BI PP, ML BP, and MP BP values includes four species, *P. aquifolii*, *P. boothii*, *P. coryli*, and *P. ilicicola*, all of which have a perithecial wall with three regions around the apex. Terminal clade I-4 strongly supported by BI PP (100 %), ML BP (100 %) and MP BP (99 %) values in the *Pleonectria* clade is composed of species on conifers, specifically, *P. balsamea*, *P. cucurbitula, P. pinicola, P. rosellinii,* and *P. strobi*. Sequences of *P. pinicola* and *P. rosellinii* are divided into subclades supported by more than 70 % BI PP, ML BP, and MP BP values that are linked to geography. Subclades of *P. pinicola* include isolates from Asia and Europe and those of *P. rosellinii* from Asia and North America (Fig. 2).

Phylogenetic analyses: clade II *Nectria*

Clade II includes 14 species of *Nectria* mostly with sporodochial or synnematous tubercularia-like anamorphs that represent a subset of species within *Nectria sensu* Rossman. Clade II includes four clades (II-1, II-2, II-3, and II-4) that generally correlate with anamorph and teleomorph morphology (Figs 1, 3).

In clade II, the two species of clade II-1, namely *N. balansae* and *N. sordida*, was supported by 100 % BI PP, ML BP and MP BP values. These species possess relatively unusual morphological characters distinct from the genus *Nectria sensu* Rossman; specifically, they have perithecia that are immersed in a well-developed stroma. *Nectria balansae* is further divided into two subclades supported by more than 70 % BI PP, ML BP and MP BP values, but these clades do not correlate with morphology, host specificity, or geography (Fig. 3). The poorly supported clade II-2 (BI 100 % PP, ML BP 78 %, MP BP 74 %) includes two *Nectria* species, *N. magnispora* and *N. mariae*, which forms a well-supported clade (BI 100 % PP, ML BP 100 %, MP BP 100 %) and are macromorphologically similar to *N. balansae* and *N. sordida.* These four species plus *N. hoheriae* and *N. paraguayensis* and the recently described *N. eustromatica* (Jaklitsch & Voglmayr 2011) constitute what we refer to as the *N. balansae* group. Within clade II-2 but basal to *N. magnispora* and *N. mariae* is *N. antarctica* having superficial perithecia.

Clades II-3 and II-4 constitute the majority of species of *Nectria* excluding the *N. balansae* group. Species of the well-supported clade II-3 (100 % BI PP, ML BP, MP BP values) are distinct in having synnematous anamorphs, specifically *N. polythalama*, *N. pseudocinnabarina*, and *N. pseudotrichia*. Each of these species is supported by almost 100 % BI PP, ML BP, and MP BP values. Within *N. pseudotrichia* are four lineages that correlate with geography as previously reported (Hirooka *et al.* 2010). Within *N. pseudocinnabarina,* three isolates, G.J.S. 09-1356, G.J.S. 09-1358 and Y.H. 08-21, form a group, supported by more than 70 % BI PP, ML BP, and MP BP values, that is distinct from the other two isolates but no morphological heterogeneity or geographic differences were found (Fig. 3).

Clade II-4 contains species of *Nectria* excluding the *N. balansae* group with sporodochial anamorphs. Five species and one species complex are included in this highly supported clade and each of the included species is supported by high BI PP, ML BP, and MP BP values. As previously reported, this clade includes all members of the *Nectria cinnabarina* species complex recently recognised by Hirooka *et al.* (2011). *Nectria nigrescens* is moderately supported by BI PP (98 %), ML BP (93 %), and MP BP (89 %) as a species sister to *N. asiatica* in a strongly supported clade with BI PP (100 %), ML BP (100 %), and MP BP (99 %) values (Figs 1, 3).

Morphological characterisation of *Allantonectria*, *Nectria*, and *Pleonectria*

Allantonectria

The stromata of *Allantonectria* are basal, well-developed, and pseudoparenchymatous similar to those of *Pleonectria* and *Nectria* excluding the *N. balansae* group (Fig. 4A–D). The size of the stromata (0.5–1.0 × 0.2–0.8 mm) of *Allantonectria* is smaller than those of the other genera and each bear up to 75 perithecia (Fig. 4A). The size of the stromata is relatively constant, pulvinate with a wide base, becoming convex, generally orange to sienna, turning blood-red in KOH. The tissue structure of the stromatal surface is *textura angularis* to *t. globulosa.* The perithecia are superficial and densely aggregated on the stromata. The perithecia are subglobose to primarily globose, bay to scarlet, with a slightly darker apex (Fig. 4B, C). The surface of the perithecia is often covered with bright yellow scurf or scales (Fig. 4C). The perithecial wall is 25–45 µm thick and consists of two regions. The outer region is 20–35 µm thick, intergrading with the stroma, and composed of cells that form *textura globulosa* to *t. angularis* (Figs 4D, 5A). The inner region is 7–13 µm thick, and composed of cells that form *textura prismatica*. The asci are narrowly clavate with a thin apex lacking a ring. The arrangement of the ascospores in the asci is biseriate above and uniseriate below. The size of the asci is relatively smaller than in the other genera (20–40 × 3–5 µm in *Allantonectria*) and correlates with ascospore size (Figs 4F–H, 5B). The ascospores are allantoid to short-cylindrical, rounded at both ends, non-septate, hyaline, and smooth (Figs 4I, 5C). Because only one species is known in *Allantonectria* and ascospore characteristics are not usually constant at the generic level, it is difficult to generalise about the ascospore characteristics. In the natural environment an anamorph for *A. miltina* is unknown. Although we sometimes observed sporodochia-like stromata, no conidiophores and conidia were present. Based on the morphology of the teleomorph and its phylogenetic position, the anamorph of *Allantonectria* is predicted to be pycnidial. The anamorph in culture produces trichoderma-like conidiophores and rhizomorph-like strands (Fig. 6F–H, J, K). The growth on PDA at 25 °C after 7 d of *A. miltina* is relatively faster than in the other genera. The colour of the colonies is whitish yellow to whitish luteous in the centre and white at the margins and the odour is slightly fruity (Fig. 6A). Flask-shaped lateral phialidic pegs develop after 1–2 d and produce abundant conidiophores and conidia. The branching pattern of the conidiophores is similar to *Trichoderma*, being unbranched or branching in pairs but sometimes unilateral, consisting of a single conidiogenous cell near the tip of the conidiophore (Fig. 6E–I). The conidiogenous cells are cylindrical, enteroblastic monophialides, tapering or slightly flask-shaped toward the opening. Rhizomorph-like strands made up of a single hypha with a larger diameter than normal hyphae were observed on SNA. The strands form wide lateral phialidic pegs and conidiophores (Fig. 6L). Young conidia are formed from monophialides on aerial, submerged, or repent hyphae. Young conidia are ellipsoidal, oblong, to cylindrical, rounded at both ends, and non-septate (Fig. 6N, O). Mature swollen conidia are 0–1-septate, oblong or ellipsoidal with a strongly constricted centre, hyaline, straight or slightly curved, rounded at both ends, not germinating or budding on media, and 6.1–16.9 × 2.6–4.9 µm (Fig. 6O, P). Pycnidia, chlamydospores, and perithecia are not produced on SNA or PDA.

Nectria excluding the *N. balansae* group

The stromatal morphology in species of *Nectria* is similar to that of *Allantonectria* and *Pleonectria*, although the size of the stromata varies greatly. For example, *N. canadensis* forms long stipitate stromata that resemble synnemata, and its perithecia are produced at the apex. The stromata are difficult to distinguish from synnemata at first glance, but the anatomy of the long stipitate stroma consists of pseudoparenchymatous tissue that has never been observed in true synnemata. *Nectria antarctica*, *N. novaezelandiae*, and *N. tucumanensis* produce relatively large stromata. Species that produce sporodochia have larger stromata than those that form synnemata. The colour of the stroma is orange when young, then turning umber with age, and blood-red to purple in KOH. The shape of the stroma is pulvinate with a wide base, becoming convex, finally producing superficial perithecia. The stroma is formed of *textura angularis* to *t. globulosa* similar to that of *Allantonectria* and *Pleonectria*. The perithecia in species of *Nectria* excluding the *N. balansae* group are usually densely aggregated, rarely solitary, and superficial on the well-developed stroma. Only *N. antarctica* and *N. tucumanensis* have perithecia with their bases immersed in the stromata (Fig. 7A–C). The perithecia are red to umber becoming darker with age and having a slightly darker apex; the perithecia of *N. neorehmiana* are scarlet to dark scarlet, a distinctive characteristic of this species. The shape of the perithecia is subglobose to globose, although some have an acute apex. Most species have roughened perithecia, although the perithecia are warted in *N. asiatica*, *N. berberidicola*, *N. cinnabarina*, *N. dematiosa*, *N. himalayensis*, *N. neorehmiana*, *N. nigrescens*, *N. polythalama*, *N. pseudocinnabarina,* and *N. pseudotrichia*. This character varies according to the environment as well as perithecial age. The perithecial walls are 25–100 µm thick and may consist of two or three regions. Species with two regions have an outer region 30–85 µm thick that intergrades with the stroma. Cells of the outer region form *textura globulosa* or *t. angularis.* The inner region is 7–30 µm thick and the cells form *textura prismatica*. Six species of *Nectria* (*N. cingulata*, *N. lateritia*, *N. polythalama*, *N. pseudadelphica*, *N. pseudocinnabarina,* and *N. pseudotrichia*) have perithecia with walls composed of three regions. The outer region is 20–54 µm thick and forms *textura globulosa* or *t. angularis*. The middle region is 5–26 µm thick and forms *textura globulosa* filled with brown to red-brown pigmented droplets. The inner region is 7–24 µm thick, of elongated, thin-walled cells that form *textura prismatica*. The asci are cylindrical, narrowly clavate to clavate, and sometimes swollen in the middle, with a thin apex without a ring. The size of asci is somewhat variable. *Nectria pyriformis* has relatively small asci while *N. antarctica*, *N. novaezelandiae*, and *N. tucumanensis* have relatively large asci. The arrangement of ascospores in the asci is biseriate above and uniseriate below. The ascospores of species of *Nectria* excluding the *N. balansae* group are highly variable, sometimes even within species such as in *N. antarctica* and *N. pseudotrichia*. The shape of the ascospores is more or less conserved. The majority of the ascospores are ellipsoidal, oblong, to fusiform. However, *N. pseudadelphica* and *N. tucumanensis* produce allantoid ascospores rounded at both ends and *N. pyriformis* forms pyriform ascospores. Ascospore ornamentation is useful as a diagnostic character, with smooth, striate, and spinulose ascospores produced in nine, six, and seven species, respectively. Ascospores are generally hyaline, but sometimes pigmented brown to dark brown when mature in *N. polythalama* and *N. pseudotrichia*. Ascospore septation is also an informative character. *Nectria canadensis*, *N. lateritia*, and *N. neorehmiana* consistently produce three-septate ascospores. *Nectria novaezelandiae* forms up to four-septate ascospores. Muriform ascospores are observed in three species of *Nectria* excluding the *N. balansae* group, specifically *N. antarctica*, *N. polythalama*, and *N. pseudotrichia*.

In the natural environment conidiomata in species of *Nectria* produce sporodochia or synnemata. Although these fructifications appear quite different, they are not indicative of major groups and are useful only at the species level. The stromata from which sporodochia arise are erumpent through the epidermis with sporodochia and perithecia developing at the same time. Sporodochia are generally solitary, occasionally caespitose. Colour of the stromata is generally orange to umber, except for *N. asiatica* and *N. nigrescens*, which often produce reddish brown stromata. The absence or presence of a stipe is variable and useful in identifying species of *Nectria*. The anamorph of *N. canadensis* possesses an extremely long stipe (500–8000 µm high, averaging > 2500 µm), which resembles a synnema but that are considered stalked sporodochia because of their cell structure. Sessile sporodochia were observed in the anamorph of *N. argentinensis*, *N. berberidicola*, and *N. dematiosa*. Unlike other *Nectria* anamorphs, *N. antarctica* produces concave as well as convex sporodochia (Figs 7I–N, 8D). The morphology of the stromata beneath the conidiophores is similar for these species. While most species have "...a small zone of *textura porrecta* at the top of the stipe…", according to Seifert & Okada (1990), the anamorph of *N. aurantiaca* has "…about half of the stipe being *textura porrecta*…". The conidiophores may be long or short verticillate. The long verticillate conidiophores are mixed with short verticillate conidiophores and are observed only in *N. antarctica* (Figs 7P–T, 8F). Short verticillate conidiophores were observed in three other species, *i.e. N. argentinensis*, *N. berberidicola*, and *N. canadensis*. The number of branches and conidiogenous cells in the short verticillate conidiophores is conserved. Short conidiophores are densely branched, generally with 1–4 branched, straight, slightly curved, and hyaline. Conidiogenous cells are enteroblastic, monophialidic, cylindrical, subulate, with the widest point in the middle, 15–37 µm long, 1.2–3 µm wide at base with inconspicuous collarettes. The acropleurogenous conidiophores mixed with short verticillate conidiophores may be short or long in the sporodochial anamorph. Short acropleurogenous conidiophores are 34–78 × 1.5 –3.3 µm, observed only in *N. argentinensis*, *N. aurantiaca*, and *N. canadensis*. The long, acropleurogenous conidiophores have been observed in six species, *N. asiatica*, *N. berberidicola, N. cinnabarina*, *N. dematiosa*, *N. himalayensis,* and *N. nigrescens*. Among these, *N. asiatica*, *N. cinnabarina*, *N. dematiosa, N. himalayensis,* and *N. nigrescens* do not possess short and long verticillate conidiophores. Long acropleurogenous conidiophores are more than 100 µm long. Acropleurogenously developing phialides are generally intercalary occurring below each septum, or rarely terminal. The size of intercalary phialides is highly conserved (2.5–10 µm long, 1.0–3.0 µm wide). In the natural environment conidia are generally ellipsoidal to cylindrical, straight or slightly curved, somewhat variable in size and always smooth. *Nectria berberidicola* and *N. himalayensis* have relatively large conidia (7.6–13.3 × 2.3–6.8 µm), while *N. argentinensis* has small conidia (3.4–4.6 × 1.8 –2.9 µm). Five species, *N. asiatica*, *N. canadensis*, *N. cinnabarina*, *N. dematiosa*, and *N. nigrescens*, possess moderately sized conidia (4.5–9.5 × 1.0 –3.6 µm).

All stromata from which synnemata arise are erumpent through the epidermis sometimes having perithecia in clusters. Synnemata may be solitary or aggregated. The synnemata are cylindrical-capitate, subulate-capitate, or claviform, and erect or nodding. They are unbranched or rarely up to 3-times branched at the base. The colour of the synnemata is generally flesh to ochraceous when fresh, red-brown at the base, turning blood-red in KOH, and fading upwards to almost black when old. However, *N. neorehmiana* possesses salmon- to flesh-coloured synnemata, a distinguishing morphological characteristic for this species. The size of synnemata is conserved (1000–3000 µm long and 100–400 µm wide at the base). The external structure of the stipe is morphologically different from the internal structure. The external cells are pigmented, golden brown at the base, becoming paler towards the apex, and react with KOH, turning umber. The internal cells are hyaline and do not react to KOH. The surface hyphae on the stipe are straight, curved, sinuous, or twisted and may vary within a species. The apical cell of the surface hyphae is subglobose and ornamented in *N. australiensis*. *Nectria neorehmiana* and *N noackiana* do not form surface hyphae on the synnematal stipe. The conidiophores of species of *Nectria* are generally elongated with one or two branches often mixed with long, sterile hyphae. Only *N. neorehmiana* lacks sterile hyphae. The sterile hyphae are acicular, straight, or curved, unbranched or dichotomously branched, and 65–163 × 1.5–5 µm. The conidiogenous cells can be enteroblastic, monophialidic, cylindrical, subulate, straight or curved. The conidiogenous cells do not vary greatly in size; they are 6–40 × 1.1–4.0 µm. The conidial mass is generally whitish yellow when fresh and sienna when dry except those of *N. neorehmiana* that are white to saffron when fresh and red to scarlet when dry. The conidia are obovate, ellipsoidal, or sometimes allantoid, smooth, hyaline, and generally 3.0–9.6 × 1.4–5.1 µm, except *N. noackiana* having larger conidia (12.3–18.7 × 5.8–8.3 µm).

Species having sporodochial anamorphs in the natural environment often produce sporodochia on SNA and PDA in culture. Synnemata and perithecia were produced on SNA and PDA by some isolates of *N. pseudocinnabarina*. All species form abundant lateral phialidic pegs and verticillate conidiophores that develop on submerged, aerial, or repent hyphae after 7 d at 25 °C on PDA. The colonies of the four temperate species, *N. asiatica*, *N. cinnabarina*, *N. dematiosa*, and *N. nigrescens,* are 37–85 mm diam after 7 d at 25 °C on PDA. The possibly psychrophilic species, *Nectria antarctica* and *N. berberidicola*, are relatively slow growing, 11–27 mm diam. The three subtropical species, *N. polythalama*, *N. pseudocinnabarina,* and *N. pseudotrichia* attain 90 mm diam after 3 d. The colour of the colonies on PDA is generally whitish yellow to whitish luteous except for *N. polythalama, N. pseudocinnabarina,* and *N. pseudotrichia*, which are yellowish brown. The odour of most species on PDA is slightly fruity. The lateral phialidic pegs are produced after 2–3 d with abundant conidia. The phialidic pegs are ellipsoidal and slightly tapering toward the tip or flask-shaped, 1.5–7.9 × 1.0–3.0 µm. The conidiophores produced after 3 d may be aerial or form sporodochia. The aerial conidiophores are unbranched, sometimes verticillate, 1–3-branched, becoming loosely to moderately densely branched. The sporodochial conidiophores are 2–3 branched, becoming densely branched with terminal whorls of 2–4. The conidiogenous cells are monophialidic, cylindrical, slightly tapering toward the tip. Young conidia produced on monophialides on aerial, submerged, or repent hyphae are ellipsoidal, oblong, to cylindrical, smooth, and hyaline, although those of *N. polythalama*, *N. pseudocinnabaina,* and *N. pseudotrichia* are subglobose to obovate, rarely ellipsoidal to fusiform. Young conidia are generally 3.0–17.3 × 1.5–5.1 µm although those of *N. asiatica* are relatively large (averaging 10 µm long). Mature conidia after 2–3 d are ellipsoidal, oblong, cylindrical to allantoid, smooth except roughened in *N. antarctica*, hyaline, and 5.0–29.3 × 2.3–7.9 µm (Fig. 9L, M). Mature conidia of *N. berberidicola*, *N. cinnabarina*, and *N. polythalama* are constricted in the middle. Chlamydospores are globose, subglobose, or broadly ellipsoidal, 0(–1)-septate, although are rarely seen on SNA and PDA.

Nectria balansae group

The stromata of species in the *N. balansae* group are more or less conserved, 1.0–4.0 mm diam, 0.5–2.5 mm high and red, sienna, to umber, turning blood-red to purple in KOH except for *N. eustromatica* having black stromata. The stromata are pulvinate with a wide base, becoming convex when producing immersed perithecia and pycnidia or superficial sporodochia. The tissue of the stromata forms *textura angularis.* The perithecia are densely aggregated, rarely solitary, and immersed or semi-immersed in a stroma. Although the stroma may produce the teleomorph and anamorph at the same time, the morphology of the stroma remains the same. The colour of the perithecia is generally red to sienna, except in *N. eustromatica* in which the perithecia are black. The apical region is slightly darker, but the intensity of the colour depends on the age of the perithecia, *i.e.* older perithecia have a darker apical region. The immersed perithecia are subglobose to globose with a conspicuous, acute apex. Some specimens of *N. hoheriae* have inconspicuous ostioles because its stroma almost covers the ostiole.The surface of the perithecia where it emerges from the stroma is somewhat informative at the species level. *Nectria balansae*, *N. eustromatica*, *N. mariae, N. paraguayensis*, and *N. sordida* possess warted walls, while *N. magnispora* has a smooth wall. The perithecial wall of *N. hoheriae* is difficult to interpret because most perithecia are completely immersed in a stroma. The ascomatal wall at the stromatal margin in *N. hoheriae* is roughened. The perithecial wall or ascomatal wall at the stromatal edge is 51–135 µm thick and consists of two regions. The perithecial wall of *N. mariae* is relatively thin (51–85 µm). The outer perithecial region of species in the *N. balansae* group is 41–117 µm thick, intergrading with the stroma, forming *textura globulosa* or *t. angularis*. The inner region is 13–35 µm thick, forming *textura prismatica*. The asci are narrowly clavate to clavate with a thin apex lacking a ring, larger than those in *Allantonectria*, *Nectria* except *N. balansae*, and *Pleonectria*. The ascospores in the asci are arranged biseriately above and uniseriately below. The ascospores are informative at the species level. The shape of the ascospores is more or less conserved. The ascospores range from ellipsoidal, fusiform, long oblong, to allantoid, hyaline, with the surface varying from smooth, roughened, to striate. *Nectria balansae*, *N. paraguayensis*, and *N. sordida* have striate ascospores. The other species have ascospores that are smooth to roughened, sometimes spinulose or verruculose. The ascospore size is relatively large compared to *Allantonectria, Nectria* except *N. balansae* group, and *Pleonectria*. They are 18.4–43 × 6.2–15.4 µm, with an average of more than 25 µm long. Ascospore size can be used to distinguish between *N. eustromatica* and *N. mariae* or between *N. balansae* and *N. sordida*.

In the natural environment conidiomata in the *N. balansae* group may be sporodochial or pycnidial. Only two species have sporodochia, *N. hoheriae* and *N. sordida*, while one species is known to have pycnidia, *N. magnispora.* The stromata from which sporodochia arise are erumpent through the epidermis with perithecia sometimes occurring simultaneously on the same stroma. The sporodochia are generally caespitose, orange to red, with no stipe. The hymenium arises directly from *textura prismatica* tissue elongating from *textura angularis*. The conidiophores have monochasial, monoverticillate, or biverticillate branching with compact or diffuse whorls. The conidiogenous cells are monophialidic, cylindrical, straight, or curved in terminal whorls of 2–4 with sterile hyphae, or lateral and terminal. The shape and surface of conidia are generally conserved, although the size of conidia can be used to distinguish between *N. hoheriae* and *N. sordida*. In *N. magnispora* the stroma from which pycnidia arise may also contain perithecia. The pycnidia are globose, immersed, eustromatic, and smooth. The very short, unbranched conidiogenous cells are enteroblastic and monophialidic. The conidia are subglobose to ellipsoidal, aseptate, and hyaline similar to other species of *Nectria*.

The anamorph in culture of species in the *N. balansae* group exhibits considerable variability. Colony diameter of the two temperate species, *N. magnispora* and *N. mariae,* on PDA at 25 °C after 7 d is 7–32 mm diam. while the sub-tropical or tropical species, *N. balansae* and *N. sordida,* grow more quickly, reaching 45–85 mm diam. The colour of colonies is the same for all species ranging from whitish yellow to yellowish brown. The odour on PDA is slightly fruity (*N. balansae*), putrid (*N. magnispora* and *N. sordida*), or absent (*N. mariae*). The conidiophores that produce microconidia are short while those that produce macroconidia are long. Lateral phialidic pegs were never observed. The short conidiophores producing microconidia are usually unbranched or loosely branched, generally with 1(–3) branches. The morphology of the microconidia is conserved and thus not useful in distinguishing species. The microconidia are 5.0–13 × 1.6–5.4 µm, smooth, and hyaline, similar for all species. The long conidiophores producing macroconidia are monochasial, unbranched or loosely branched, generally with 1(–2) branches. The smooth, hyaline macroconidia of *N. eustromatica* and *N. magnispora* are ellipsoidal to long fusiform and curved while those of *N. mariae* and *N. sordida* are subglobose to ellipsoidal. *Nectria eustromatica* produces longer macroconidia (20–54 µm) than the other species (11.5–27.6 µm). Immature pycnidia are produced on SNA and PDA by some isolates of *N. magnispora* and *N. sordida*. Neither microconidia nor macroconidia are known for *N. balansae*. Perithecia are not produced on SNA or PDA. Chlamydospores are produced on SNA and PDA by *N. balansae* and *N. magnispora*. Swollen hyphae are often produced on SNA and PDA by *N. balansae, N. magnispora*, and *N. mariae*.

Pleonectria

The stromatal morphology in *Pleonectria* is similar to that of *Allantonectria* and *Nectria.* The size of the stroma of most species of *Pleonectria* is generally constant and smaller than in species of *Nectria.* Two exceptions are *P. austroamericana* and *P. sphaerospora* in which the stroma are large (1.0–7.0 mm diam, 0.5–2.5 mm tall) each bearing up to 200 perithecia. The colour of the stroma is variable depending on the extent of formation of bright yellow scurf. Most species of *Pleonectria* produce red to umber stromata, but the stromata of *P. austroamericana*, *P. chlorinella*, *P. pyrrhochlora*, *P. virens,* and *P. zanthoxyli* appear pale yellow to yellow or greenish yellow because of the abundant scurf. The reaction of the stromatal tissue to KOH is generally positive, slightly darker, but *P. austroamericana*, *P. chlorinella*, *P. lonicerae*, *P. pyrrhochlora*, *P. sphaerospora*, *P. virens,* and *P. zanthoxyli* have only a weak or no reaction because of the abundant scurf covering the stromata. The tissue structure of the stromatal surface is pseudoparenchymatous producing *textura angularis* to *t. globulosa*. The perithecia of most species of *Pleonectria* are superficial, densely aggregated on the stromata. Perithecia of *P. austroamericana*, *P. chlorinella*, and *P. sphaerospora* are covered by abundant yellow scurf and appear immersed in a stroma. Perithecia of *P. lonicerae*, *P. pyrrhochlora*, *P. virens,* and *P. zanthoxyli* are also covered by abundant scurf as well as immersed in the substratum. The ostioles of perithecia are not conspicuously acute similar to *Allantonectria* and *Nectria*. Perithecia colour depends on the presence of bright yellow scurf or scales, although young perithecia generally lack scurf or scales. When mature, the perithecia are subglobose to globose, red to umber, becoming blood colour to dark purple in KOH, although *P. austroamericana*, *P. chlorinella*, *P. lonicerae*, *P. pyrrhochlora*, *P. sphaerospora*, *P. virens,* and *P. zanthoxyli* have a weak reaction or sometimes negative. Perithecia of *P. austroamericana*, *P. chlorinella*, *P. pyrrhochlora*, *P. sphaerospora*, *P. virens,* and *P. zanthoxyli* produce abundant scurf. Only *P. lonicerae* forms abundant scurf around the ascomatal apex. The surface of the perithecia is roughened. The perithecial wall is generally 20–70 µm thick and consists of two regions. An outer region 15–50 µm thick intergrades with the stroma and forms *textura globulosa* or *t. angularis* and the inner region 5–30 µm thick forms *textura prismatica*. *Pleonectria aquifolii*, *P. boothii*, *P. coryli*, and *P. ilicicola* possess three regions around the apex, thus the apex is relatively thick (65–80 µm diam). The asci are narrowly clavate to clavate. The ascal apex is thin with an indistinct ring. The arrangement of the ascospores in the asci is generally biseriate above and uniseriate below, but the asci of *P. berolinensis* and *P. lonicerae* are always uniseriate. The size of asci gradually increases because most species have ascospores that bud and produce ascoconidia inside the asci. The ascospores are highly diverse and thus have characteristics that are informative at the species level. The shape of ascospores varies greatly. Eighteen species, *P. aquifolii*, *P. aurigera*, *P. balsamea*, *P. berolinensis*, *P. chlorinella*, *P. coryli*, *P. ilicicola, P. lamyi*, *P. lonicerae*, *P. missouriensis*, *P. okinawensis*, *P. pinicola*, *P. pseudomissouriensis*, *P. pyrrhochlora*, *P. rubicarpa*, *P. sinopica*, *P. virens,* and *P. zanthoxyli,* have ascospores that are ellipsoidal to fusiform. Four species, *P. cucurbitula*, *P. quercicola*, *P. rosellinii,* and *P. strobi,* generally have filiform ascospores. Ascospores of *Pleonectria austroamericana* and *P. sphaerospora* are subglobose to ellipsoidal, while those of *P. boothii* are cylindrical to long-cylindrical. Only *P. clavatispora* produces clavate ascospores, a diagnostic characteristic. *Pleonectria okinawensis* and *P. pseudomissouriensis* have spinulose and striate ascospores, respectively. The ascospores of *Pleonectria* are mainly hyaline, although in some species such as *P. aurigera*, *P. missouriensis,* and *P. okinawensis* they become pale brown. Ascospore septation of *Pleonectria* is informative at the species level. Seven species, *P. aquifolii*, *P. coryli*, *P. ilicicola*, *P. okinawensis*, *P. pseudomissouriensis*, *P. rubicarpa,* and *P. sinopica,* have (0–)1-septate ascospores; five species, *P. aurigera*, *P. cucurbitula*, *P. quercicola*, *P. rosellinii,* and *P. strobi,* have multiseptate ascospores; and fourteen species, *P. austroamericana*, *P. balsamea*, *P. berolinensis*, *P. boothii*, *P. chlorinella*, *P. clavatispora*, *P. lamyi*, *P. lonicerae*, *P. missouriensis*, *P. pinicola*, *P. pyrrhochlora*, *P. sphaerospora*, *P. virens,* and *P. zanthoxyli,* have muriform ascospores. The size of ascospores is also variable due to the different shapes. Part-ascospores are observed only in *P. chlorinella*.

The conidiomata in *Pleonectria* are pycnidial, generally orange or red to umber. They may be superficial on the substratum, previously regarded as *Gyrostroma,* or immersed as in *Zythiostroma*; however, these characteristics may overlap and this varies with species. All pycnidial stromata are erumpent through the epidermis; sometimes pycnidia and perithecia are formed simultaneously on the same stroma. Nine species, *P. balsamea*, *P. boothii*, *P. cucurbitula*, *P. lamyi*, *P. missouriensis*, *P. okinawensis*, *P. pinicola*, *P. rosellinii*, and *P. strobi,* form superficial pycnidia; two species, *P. ilicicola* and *P. quercicola,* form immersed pycnidia; and three species, *P. austroamericana*, *P. sinopica*, and *P. sphaerospora,* possess both morphologies. The pycnidia are generally aggregated or caespitose. The superficial pycnidia are generally orange, red to sienna, smooth to slightly roughened, rarely with bright yellow scurf. Most superficial pycnidia are subglobose, although they are discoidal in *P. austroamericana*, *P. sphaerospora*, *P. missouriensis,* and *P. lamyi*. The wall of superficial pycnidia is 15–55 µm thick and consists of two regions. The outer region is 6–25 µm thick, intergrading with the stroma, and forms *textura globulosa* or *t. angularis*. The inner region is 5–23 µm thick and forms *textura prismatica*. Immersed pycnidia are generally irregular in shape. Immersed pycnidia are multilocular in the stroma. The verticillate conidiophores of species of *Pleonectria* are highly conserved. The number of branches in the conidiophores is generally 1–3, but in *P. missouriensis* the number of branches is up to 5. The size of verticillate conidiophores is 5–30 µm long, 0.8–4.3 µm wide. The conidiogenous cells are enteroblastic and monophialidic. The intercalary phialides are abundant in all species except *P. austroamericana*, *P. boothii, P. ilicicola*, *P. quercicola, P. pinicola*, and *P. sphaerospora*. Each conidiophore bears 1–3 intercalary phialides, but *P. okinawensis* may bear up to seven. The size of the intercalary phialides is 4–6 µm long. Sterile hyphae intermixed with phialides were observed in *P. austroamericana* and *P. pinicola*. Although not seen in the natural environment, *P. virens* and *P. zanthoxyli* also form sterile hyphae in pycnidia produced in culture. The sterile hyphae can be acicular, straight, or curved, sometimes 1–3 branched. The morphology of the conidia does not vary greatly. The smooth conidia are generally ellipsoidal to allantoid similar to the ascoconidia, 1.7–6.6 × 0.4–2.6 µm.

In culture the anamorphs of species of *Pleonectria* form lateral phialidic pegs and sometimes verticillate conidiophores when cultures are old. In general, lateral phialidic pegs develop on submerged, aerial or repent hyphae. The growth rate of colonies on PDA at 25 °C after 7 d varies somewhat. Eight species, *P. balsamea*, *P. cucurbitula*, *P. pinicola*, *P. strobi*, *P. rosellinii*, *P. berolinensis*, *P. pyrrhochlora*, and *P. zanthoxyli* grow relatively faster (average > 50 mm) than the others (average < 50 mm). The colony colour is mainly white to whitish yellow. The odour of most species on PDA is slightly fruity or putrid, although *P. boothii* does not produce any odour. The lateral phialidic pegs develop after 2–3 d and produce abundant conidia. The shape of the lateral phialidic pegs is somewhat variable, generally narrowly flask-shaped pegs, 1.5–6.8 × 1.0–4.2 µm, but in some species such as *P. coryli*, *P. okinawensis,* and *P. sinopica* only ellipsoidal pegs are produced tapering slightly toward the tip. Conidiophores are generally produced after 3 d, but two species, *P. aurigera* and *P. rosellinii,* do not form conidiophores in culture. Although the majority of species have simple aerial verticillate conidiophores, a few species, *P. ilicicola*, *P. okinawensis*, *P. pyrrhochlora*, *P. quercicola*, and *P. sinopica,* produce both aerial and sporodochial conidiophores, *i.e.* conidiophores aggregated to form a hymenium. The aerial conidiophores are unbranched, sometimes verticillate, 1–3-branched, becoming loosely to moderately densely branched. The size of the aerial conidiophores is 6.5–40.9 µm long and 1.0–4.6 µm diam at the base. The conidiophores on the sporodochia are densely branched, with terminal whorls of 2–5 phialidic conidiogenous cells. Sporodochial conidiophores are 10–44.7 µm long and 1.1–3.3 µm wide at the base. The conidiogenous cells are generally enteroblastic, monophialidic, cylindrical, and slightly tapering toward the tip. Only *P. aquifolii* forms polyphialides. The young conidia are formed from monophialides on aerial, submerged, or repent hyphae. Young conidia are smooth, hyaline, ellipsoidal, oblong, to long-cylindrical, and generally 2.3–7.9 × 0.9–2.7 µm. Mature conidia appear after 2–3 d; their shape varies with species. Mature conidia are smooth, hyaline, subglobose, ellipsoidal, oblong, long-cylindrical, to allantoid. *Pleonectria berolinensis* has allantoid to ellipsoidal mature conidia swollen at both ends and with a strongly constricted middle septum; *P. lamyi* has C-shape conidia. Pycnidia are produced on SNA and PDA by some isolates of *P. austroamericana, P. balsamea, P. virens,* and *P. zanthoxyli* while chlamydospores, 6–14 µm diam, are produced on SNA and PDA by some isolates of *P. aquifolii, P. ilicicola, P. quercicola,* and *P. virens*. Perithecia are not produced on SNA and PDA.

DISCUSSION

Generic concepts

Historically, the genus *Nectria* has been the repository for all uniloculate, bright-coloured, perithecial fungi. Because this genus was broadly conceived, it included diverse anamorphs forming various types of conidiomata, although usually in culture only simple morphological structures were produced. The concept of the genus *Nectria* was restricted in a narrow sense by Rossman (1989) and Rossman *et al.* (1999). Species excluded from *Nectria sensu* Rossman were placed in various genera in the two families, *Bionectriaceae* and *Nectriaceae*. Recent studies with DNA sequence data have confirmed the relationships of nectria-like fungi, now segregated into genera such as *Bionectria*, *Lasionectria*, and *Nectriopsis* in the *Bionectriaceae* and *Calonectria*, *Lanatonectria*, and *Neonectria* in the *Nectriaceae* among others (Rehner & Samuels 1995, Rossman *et al.* 2001, O'Donnell 1993, Castlebury *et al.* 2004).

This study was initiated to examine the species included in *Nectria sensu* Rossman having anamorphs placed in the three genera *Gyrostroma*, *Tubercularia*, and *Zythiostroma.* The relationship of species of *Nectria* to the three anamorph genera contradicted recent taxonomic studies of hypocrealean fungi in which the telemorph-anamorph connections and recognition of monophyletic groups suggested a one-to-one relationship of teleomorph to anamorph genera, the so-called "genus-for-genus" hypothesis (Rossman *et al*. 1999, Rossman 2000, Schroers 2001, Crous 2002, Chaverri *et al*. 2008, 2011, Luo & Zhuang 2010).

Our phylogenetic tree revealed two major clades of species previously recognised in *Nectria sensu* Rossman (Fig. 1). One phenotypic difference between species in these clades is the presence or absence of bright yellow scurf on the perithecia. Initially it was thought that *Nectria* could be segregated into two genera, namely *Nectria* lacking scurf and *Pleonectria* producing yellow scurf (Hirooka *et al*. 2009). The name *Pleonectria* is the oldest generic name available for this group of nectria-like species having bright yellow scurf. However, at the base of the *Pleonectria* clade is an isolate representing an unusual nectria-like species, *Allantonectria miltina*, type and only species in the genus *Allantonectria* (Figs 1, 2). Although this species has bright yellow scurf on the perithecia, the fungus is clearly distinguishable from the other species of *Pleonectria* based on teleomorphic and anamorphic morphology, cultural morphology, and host specificity (Table 3). Thus, *Allantonectria miltina* is segregated from *Pleonectria* as a monotypic genus.

Unlike *Allantonectria* and *Pleonectria*, the *Nectria* clade encompasses a great deal of morphological diversity. The genus can be divided into two groups, *i.e.* species of *Nectria* having superficial perithecia and species of the *N. balansae* group. The relatively large perithecia of species in the *N. balansae* group are nearly or completely immersed in the stroma and the ascospores are also generally larger than other species of *Nectria*. Species in the *N. balansae* group possess not only sporodochial but also pycnidial anamorphs in the natural environment and culture, although the pycnidia in the natural environment are rarely detected and the pycnidia in culture are immature (Table 3). In addition, their cultural characteristics are unique in producing two sizes of conidia and the conidiophores are monochasial as recently described by Jaklitsch & Voglmayr (2011). This distinctive morphology suggests potential recognition at the generic level. However, species in the *Nectria balansae* group are paraphyletic in two clades (II-1, II-2) (Figs 1, 3). The closest affinity of clade II-2 is with species of *Nectria* having synnematous anamorph clade (II-3), rather than to clade II-1. Although we carefully observed the sexual and asexual states of the two clades, no significant morphological differences other than the macromorphology were found. Therefore, the *N. balansae* group cannot be recognised as a distinct genus. Clades II-3 and II-4 correlate with anamorph fructification in the natural environment. Clade II-3 includes species with synnematous anamorphs while clade II-4 has species with sporodochial anamorphs (Figs 1, 3).

Species concepts

Three major concepts are currently used to define species, namely Genealogical Concordance Phylogenetic Species Recognition (GCPSR) (Taylor *et al.* 2000), the Morphological Species Concept (MSC) (John & Maggs 1997), and the Phylogenetic Species Concept (PSC) (Cracraft 1983). These three species concepts were used by Hirooka *et al.* (2011) to define four species in the *Nectria cinnabairna* species complex. In this study, we continue to combine these species concepts in defining species in *Allantonectria*, *Nectria*, and *Pleonectria*.

In recent years the species of nectria-like fungi have increasingly been defined by combining morphological characteristics of the teleomorph with those of the anamorph representing the whole fungus or holomorph (Rossman *et al.* 1999, Rossman 2000, Schoch *et al.* 2000, Schroers 2001, Luo & Zhuang 2010). Teleomorph-anamorph connections are sometimes equivocal especially when the connection is based on their co-occurrence on natural substrata. Before molecular tools existed, one of the most effective methods for determining teleomorph-anamorph connections was by comparing cultures grown from ascospores and conidia. This method is tedious and sometimes results in mistakes because two or three hypocrealean fungi often occur on the same branch or grow adjacent to each other (Samuels 1988, Rossman *et al.* 1999, Schroers 2001). One example involves *P. coryli*, a species that was mistakenly said to have a sporodochial anamorph (Samuels *et al.* 2006). By using molecular sequence analyses, we have clarified the taxonomic confusion in species of *Allantonectria*, *Nectria*, and *Pleonectria* and can hypothesise the teleomorph-anamorph relationship even if only one morph is known. As an example, the anamorph of *N. berolinensis* has historically been considered to be sporodochial. Despite the examination of numerous specimens and cultures, no sporodochia were found. Our phylogenetic data suggest that the anamorph of this species is most likely pycnidial. The species concept that combines the three approaches results in the ability to predict teleomorph-anamorph connections and evolutionary relationships.

Evaluation of morphological characters

Stroma

The stromata in species of *Allantonectria*, *Nectria,* and *Pleonectria* are well-developed on the plant substratum. The tissue of the stromata is generally pseudoparenchymatous consisting of cells that no longer appear hyphal-like. The stromata may range from 1–3 mm diam without a stipe, but some species such as *N. canadensis*, *N. cinnabarina*, and *N. nigrescens* have long stipitate sporodochia. The pseudoparenchymatous basal stroma is often continuous with the outer region of the ascomatal wall and is frequently associated with the anamorph. Species with sporodochia and pycnidia produce relatively large stromata on which perithecia are produced, often simultaneously. The teleomorph and anamorph relationship is easily recognised when the two states occur closely together.

In general, the stromatal anatomy of *Allantonectria*, *Nectria*, and *Pleonectria* is the same in all species, *i.e.* well developed, pseudoparenchymatous, but the stromata vary in size, shape, presence or absence of scurf, and superficial or immersed in the substratum. Species of *Nectria* produce relatively abundant stromata compared to *Pleonectria*. Within the *N. balansae* group of *N. balansae*, *N. eustromatica*, *N. hoheriae*, *N. magnispora*, *N. mariae*, *N. paraguayensis*, and *N. sordida,* abundant stromata up to 2.5 mm high and 4 mm diam develop on the natural substratum. Unlike species of *N. balansae* group, most species of *Allantonectria* and *Pleonectria* produce only basal stromata, although *P. austroamericana* and *P. sphaerospora* produce large stromata up to 7 mm tall. In the natural environment perithecia of *Allantonectria*, *Nectria,* and *Pleonectria* are generally superficial on the stromata, although species in the *N. balansae* group are immersed in a well-developed stromata. Three species of *Pleonectria*, *P. pyrrhochlora*, *P. virens*, and *P. zanthoxyli* are covered with abundant bright yellow scurf and are immersed in the substratum. Although the majority of *Pleonectria* species form superficial perithecia, three species do not produce pycnidia on natural substratum but two of these species, *P. virens* and *P. zanthoxyli*, produce pycnidia in culture. Our phylogenetic tree suggests that these three species belong in the *Pleonectria* clade. *Pleonectria austroamericana* also possesses abundant yellow scurf and stromata that completely cover the ascomata (Figs 1, 2). As a result the ascomatal wall is difficult to discern, but, by observing the KOH reaction, one can distinguish the perithecial wall cells.

Ascomata and ascomatal wall structure

The ascomata of species of *Allantonectria*, *Nectria*, and *Pleonectria* are generally light- to bright-coloured, soft-textured, uniloculate perithecia that are bright yellow, yellowish green, orange, red or reddish brown becoming slightly darker in dried specimens. The ascomata react with KOH darkening to a blood-red colour or purple and turn yellow in lactic acid, although some species such as *N. pyrrhochlora* and *N. zanthoxyli* change only slightly or not at all. The ascomatal wall structure is often useful in defining species. The ascomatal wall generally consists of two to three regions of cells with each region of three to five cell layers. The outer region is usually composed of *textura angularis* to *textura globulosa* with walls that are uniformly, but sometimes irregularly, thickened. A middle region exists in a few species such as *N. pseudocinnabarina* and *N. pseudotrichia*. The cells of the middle region often contain brown to red-brown pigment droplets. The morphology of the inner region is highly conserved, almost always consisting of thin-walled, hyaline cells, elongated parallel to the centrum. The cells near the ascomatal surface are uniformly or sometimes irregularly thick-walled, but in some species the cells are irregularly thickened especially those species having bright yellow scurf or scales. Centrum characters, such as the absence or presence of the apical paraphyses and the periphyses lining the ostiole, are similar for all nectria-like fungi. The ostiolar canal is always periphysate in species of *Allantonectria*, *Nectria*, and *Pleonectria*.The structure of the perithecial wall has been emphasised as an informative character within the nectria-like fungi (Booth 1959, Samuels & Rossman 1979, Rossman *et al.* 1999). In this paper the majority of the species of *Nectria* having synnematous anamorphs, such as *N. lateritia*, *N. polythalama*, *N. pseudocinnabarina*, and *N. pseudotrichia*, have a perithecial wall consisting of three regions. Three of these species clustered as a monophyletic group in our phylogenetic tree (Figs 1, 3). *Pleonectria* clade I-3 with four species, *P.aquifolii*, *P. boothii*, *P. coryli*, and *P. ilicicola,* is united by the formation of perithecia with three regions around the apex (Figs 1, 2). The perithecial wall of *Allantonectria miltina* has two regions (Figs 4D, E, 5A).

Asci and ascospores

As for all species in the *Hypocreales*, the asci of *Allantonectria*, *Nectria*, and *Pleonectria* are unitunicate. Within these species a ring in the ascus apex was inconspicuous. Neither the apex nor any other part of the ascus or centrum reacts with iodine. Each ascus has eight ascospores that are generally arranged biseriately, rarely uniseriately. The ascal morphology in *Allantonectria*, *Nectria*, and *Pleonectria* is more or less conserved. In regard to ascal size, some species of *Nectria* such as those in *N. balansae* group have asci larger than other species, whereas those of *Allantonectria* are relatively small. The size of the asci correlates with the size of the ascospores. Species of *Nectria* have relatively large ascospores, while those of *Allantonectria* have small ascospores. The asci of species of *Pleonectria* become gradually swollen as ascoconidia develop inside the asci up to almost double the original size.

Ascospores in *Allantonectria*, *Nectria*, and *Pleonectria* are variable in shape, size, and septation, and are useful in distinguishing these species (Table 3). *Allantonectria miltina* has non-septate, minute ascospores (Figs 4I, 5C). Ascospore morphology in *Nectria* and *Pleonectria* is highly diverse. Species of *Nectria* have variable septation ranging from 1-septate to multiple, transverse septation but generally do not have filiform or budding ascospores, although, in two specimens of *N. canadensis*, "ascoconidia-like spores" were observed (see the note under *N. canadensis* in this study). Most species of *Nectria* have ascospores that are ellipsoidal to fusiform with one to many transverse septae except *N. antarctica*, *N. polythalama*, and *N. pseudotrichia* with muriform ascospores. Most species of *Pleonectria* produce ascospores with budding ascoconidia inside or outside of the asci, a characteristic unique to *Pleonectria*. Septation in *Pleonectria* ranges from 1-, multiseptate, to muriform. The shape may be ellipsoidal, clavate, fusiform, long-filiform, or clavate. Ascospores of *P. cucurbitula* and *P. strobi* are very long and multiseptate. Surprisingly, ascospores of *P. chlorinella* can disarticulate in the asci forming part-ascospores, a feature not previously reported for any other nectria-like fungus. Ascospore colour is generally hyaline to slightly golden-yellow. Ascospore ornamentation is variable, ranging from smooth to spinulose or striate.

Ascospore and conidial morphology of fungi often correlates with ecological niche. For instance, Ingold (1975) speculated that convergent evolution has occurred in aquatic hyphomycetes, and later, his hypothesis was supported by molecular studies (Campbell *et al*. 2006, Shenoy *et al*. 2006). As another example, species of *Geosmithia*, *Bionectriaceae*, isolated from plants, have small ellipsoidal to cylindrical conidia (Pitt 1979), but species of *Geosmithia* associated with ambrosia beetles possess large, globose conidia with thickened walls. This might be symbiont-forced evolution because nutrient-rich protoplasts and indigestible cell walls can be helpful for dispersal by the fecal pellets of ambrosia beetles (Kolařík & Kirkendall 2010). From this evidence, one could speculate that the morphological variation of ascospores of *Allantonectria*, *Nectria*, and *Pleonectria* is linked to ecological niches. Ascospores that bud inside the asci may be a mechanism to ensure an increased numbers of propagules and thus better dispersal.

Anamorphs on natural substrata

Although emphasis in *Allantonectria*, *Nectria*, and *Pleonectria* has traditionally been placed on the teleomorphic state, anamorphs are commonly encountered in association with the teleomorph. The anamorphs in nature range from non-existent to immersed or superficial, and pycnidial, sporodochial, or synnematal. Conidia are usually aseptate and ellipsoidal to oblong.

The characteristics of the anamorphic states of these fungi are useful in distinguishing species of *Nectria* from *Pleonectria*; an anamorph of *Allantonectria* is unknown in the natural environment (Table 3). Most species of *Nectria* possess tubercularia-like anamorphs that form sporodochia and synnemata. Within *Nectria*, sporodochia- and synnemata-forming species clearly clustered in distinct clades, thus these two types of conidiomata are phylogenetically informative mostly at the species level (Fig. 3). Some exceptions in *Nectria* are the anamorphs of *N. antarctica* and *N. magnispora*. Based on our observations, *N. antarctica* forms concave sporodochia (Figs 7N, 8D) and *N. magnispora* produces immersed pycnidia in the natural environment. The pycnidal state of *N. magnispora* developed on PDA, and SNA, although conidia were not produced. Anamorphs of *Pleonectria* form immersed or superficial pycnidia, but some species such as *P. austroameriana* and *P. sphaerospora* can form both immersed and superficial pycnidia at the same time. Species of *Pleonectria* on conifers produce only superficial pycnidia (Table 3).

In contrast to ascospores, conidial morphology in the natural environment and in culture of *Nectria* and *Pleonectria* are surprisingly similar and highly conserved. In the natural environment, species of *Nectria* produce sporodochia or synnemata while species of *Pleonectria* form pycnidia. These fructifications facilitate dispersal of the small conidia (Fitt *et al*. 1989, Sérusiaux 1995, Schmid-Hempel 1998). We speculate that conidia of the synnematous anamorphs of *Nectria* may attach to insects when the insects move through the "miniature forest" of synnemata.

Anamorphs in culture

To date, cultural characteristics have not been stressed in systematic studies of *Allantonectria*, *Nectria*, and *Pleonectria*. A few mycologists have reported their morphological characteristics in culture (Booth 1959, Seifert 1985, Hirooka *et al*. 2011). Lateral phialides referred to as primary conidiophores by Booth (1959) are generally abundant; these have a short base with a narrowly flask-shaped apical region. Many species produce verticillium-like conidiophores, referred to as secondary conidiophores by Booth (1959). As on natural substratum, conidia in culture may also be aseptate to rarely 1-septate and allantoid to ellipsoidal. The morphological heterogeneity of conidia in the *Nectria cinnabarina* species complex has been reported (Mayr 1883, Brefeld 1891, Beck 1902, Jørgensen 1952, Hirooka *et al.* 2011).

In culture, the anamorph of *Allantonectria* varies from that of *Nectria* and *Pleonectria. Allantonectria miltina* in culture produces trichoderma-like conidiophores and rhizomorph-like strands each made up of a single hypha with a large diameter (Fig. 6F–M). Surprisingly, the cultural morphology of *Nectria* excluding the *N. balansae* group and *Pleonectria* are almost identical. The size of young conidia is somewhat useful for segregating the two genera, *i.e.* 3.0–23.0 × 1.5–5.0 µm in *Nectria vs.* 2.3–7.9 × 0.6–2.7 µm in *Pleonectria.* Within *Nectria*, the *N. balansae* group has a unique morphology: microconidia are produced in verticillate conidiophores while macroconidia develop on conidiophores with monochasial branching. Monochasial branching conidiophores producing large macroconidia were never observed in any other nectria-like fungi.

Evaluation of teleomorphs in the natural environment

Our six-loci phylogenetic analysis demonstrates that *Nectria sensu* Rossman is paraphyletic within the *Nectriaceae* (Fig. 1). The major clade of *Allantonectria* and *Pleonectria* is distinct from the other major clade that includes the genus *Nectria*. This distinction had not previously been recognised because the perithecial morphology of *Allantonectria*, *Nectria*, and *Pleonectria* is highly conserved. The two major clades clearly correlate with absence or presence of bright yellow scurf on the perithecia. Species of *Allantonectria* and *Pleonectria* have a bright yellow scurf while such a scurf is absent in *Nectria* and other genera of the *Nectriaceae*. Some perithecia, especially young ones, do not always produce the yellow scurf. On the other hand the abundant yellow scurf of some species of *Pleonectria, P. austroamericana*, *P. pyrrhochlora*, *P. sphaerospora*, *P. virens,* and *P. zanthoxyli,* may obscure the perithecial wall or stroma when the scurf completely covers the perithecia; these species form a strongly supported monophyletic group. The most basal taxon, *A. miltina*, having scanty light yellow scurf, is sister to the *Pleonectria* clade (Figs 1, 2).

The perithecial position of immersed or superficial is an easily recognised character. In this monograph, the position of perithecia appears to be a significant phenotypic character for identifying species. Species in the genus *Nectria* and those in the *N. balansae* group can be segregated by the perithecial position. Perithecia of species in *Nectria* are not immersed in the stroma whereas species in the *N. balansae* group are immersed or rarely semi-immersed in the stroma. Perithecia of *N. antarctica* and *N. tucumanensis* are rarely immersed at the base (Figs 7A–C) while other species of *Nectria* produce completely superficial perithecia. Our phylogenetic tree places *N. antarctica* in a basal position to *Nectria* in clade II-2 with two species of the *N. balansae* group (Figs 1, 3). The anamorph of *N. antarctica* in culture forms a typical tubercularia-like morphology that may be either convex or concave (Fig. 9). Within the clade that includes species having bright yellow scurf, four species of *Pleonectria* possess perithecia basally or completely immersed in a stroma or substratum, *P. austroamericana*, *P. pyrrhochlora*, *P. virens,* and *P. zanthoxyli;* the sequenced taxa in this group compose clade I-2 (Figs 1, 2).

Perithecial wall structure appears to be a somewhat significant phenotypic character. Among species of *Pleonectria*, four species have perithecia with walls that form three regions around the perithecial apex and these four species form a well-support clade I-3, *P. aquifolii*, *P. boothii*, *P. coryli*, and *P. ilicicola* (Figs 1, 2). This morphological characteristic was noted for *P. aquifolii* and *P. coryli* by Booth (1959). The three species of *Nectria* having a synnematous anamorph and forming clade II-3 have a perithecial wall composed of three regions (Figs 1, 3). However, *Nectria australiensis* and *N. noackiana*, both of which have asynnematous anamorphs, do not produce three perithecial wall regions. Because no sequence data of the two species were available in this study, we are not sure whether or not species having three perithecial regions are monophyletic.

Historically, species of *Nectria sensu lato* have been segregated into genera based on ascospore morphology. In our study, we recognise that ascospore morphology is informative at the generic level only for *Allantonectria* (Table 3). The small, allantoid ascospores of *A. miltina* are not known for any other nectria-like fungi. Among species of *Nectria* and *Pleonectria,* ascospore morphology is not an information character except for the characteristic of producing ascoconidia as occurs in many species of *Pleonectria*. Many species of *Nectria* have one-septate ascospores as in most of the *N. balansae* group and those species having sporodochial anamorphs. Among the species of *Nectria* having synnematous anamorphs, *N. polythalama* and *N. pseudotrichia* have muriform ascospores as does *N. antarctica*, the phylogenetically anomalous member of the *N. balansae* group. Ascospore morphology in *Pleonectria* is highly variable, but this morphology does not correlate with phylogeny (Fig. 2). Many species of *Pleonectria* have muriform ascospores but a few are one-septate while others are multiseptate. Among those for which we have phylogenetic data, only five species of *Pleonectria* have one-septate ascospores. Two of these, *P. aquifolii* and *P. ilicicola*, occur only on *Ilex aquifolii* in Europe and form a well-supported clade while the other two, *P. sinopica* on *Hedera* in Europe and *P. okinawensis* on *Castanopsis* in Japan, also form a well-supported clade. Among the four species of *Pleonectria* having very long, multiseptate ascospores, two species, *P. strobi* and *P. cucurbitula* occurring on different subgenera of *Pinus,* form a well-supported clade while the other two species, *P. rosellinii* on *Abies* and *P. quercicola* on *Quercus,* are unrelated (Fig. 2).

Evaluation of anamorphs in the natural environment

Traditionally the classification of anamorphic fungi was based on the type of fructification, specifically acervuli, pycnidia, sporodochia, synnemata, or absent. This system was gradually rejected as artificial. Early examples that demonstrated this include Mason (1937) who demonstrated that *Heteropatella antirrhini* produces both acevuli and pycnidia as asexual states. Similarly, Dube & Bilgrami (1965) determined that *Pestalotia* sp. could form both acervuli and pycnidia varying with the host species. Sutton (1973) mentioned that species having acervuli and sporodochia could have a close affinity based on his observation of the ontogeny of fructifications. The macroscopic fructification is no longer considered important in the classification of asexual fungi. When Sutton (1980) published the monograph of the coelomycetous fungi, he focused on conidiogenesis as a reliable morphological indication of relationships especially for fungi in culture.

Table 3. Morphology, geography and host identity of *Allantonectria*, *Nectria* and *Pleonectria*.

Genera	Species	Teleomorph in natural environment			Anamorph in natural environment	Geography	Host
		Perithecial position	Ascospore shape	Ascospore septation	Fructification (shape and position)		
Allantonectria	*A. miltina*	Superficial	Allantoid	Aseptate	Unknown	Central America, Europe, North America	Monocots, especially *Agavaceae*
Nectria	*N. antarctica*	Superficial or rarely immersed only at the base	Usually ellipsoidal	Muriform	Sporodochia (convex or concave)	North America, South America	Dead woody substrata
	N. argentinensis	Superficial	Long-ellipsoidal to fusiform	1-septate	Sporodochia (sessile)	South America	Dead woody substrata
	N. asiatica	Superficial	Ellipsoidal to fusiform	(0–)1-septate	Sporodochia (short stipitate)	Asia	Dead woody substrata
	N. aurantiaca	Superficial	Ellipsoidal	1-septate	Sporodochia (long stipitate)	Europe	Dead woody substrata
	N. australiensis	Superficial	Ellipsoidal to rarely fusiform	1-septate	Synnemata	Oceania	*Hoheria populum*
	N. balansae	Nearly or completely immersed	Ellipsoidal, fusiform to long oblong	(0–)1-septate	Unknown	Asia, Europe, South America	Dead woody substrata
	N. berberidicola	Superficial	Ellipsoidal to fusiform	1-septate	Sporodochia (sessile)	Europe	*Berberis vulgaris*
	N. canadensis	Superficial	Ellipsoidal to long-ellipsoidal	(1–)3-septate	Sporodochia (extremely long stipitate)	North America	*Ulmus* tree
	N. cingulata	Superficial	Ellipsoidal to fusiform	1-septate	Unknown	South America	Dead woody substrata
	N. cinnabarina	Superficial	Ellipsoidal to fusiform	(0–)1(–2)-septate	Sporodochia (long stipitate)	Europe, North America	Dead woody substrata
	N. dematiosa	Superficial	Ellipsoidal to fusiform	(0–)1(–2)-septate	Sporodochia (short stipitate)	Asia, Europe, North America	Dead woody substrata
	N. eustromatica	Completely immersed	Allantoid to bean-shaped	1-septate	Unknown	Europe	*Hippocrepis (Coronilla) emerus*
	N. himalayensis	Superficial	Ellipsoidal to fusiform	1-septate	Sporodochia (short stipitate)	Asia	Dead woody substrata
	N. hoheriae	Completely immersed	Ellipsoidal to long oblong	(0–)1(–3)-septate	Sporodochia (sessile)	Oceania	*Plagianthus regius*
	N. lateritia	Superficial	Ellipsoidal to cylindrical	3-septate	Synnemata	Asia, Central America, South America	*Manihot utilissima*
	N. magnispora	Nearly or completely immersed	Ellipsoidal to long oblong	(0–)1(–2)-septate	Pycnidia (immersed)	Asia	Dead woody substrata
	N. mariae	Nearly or completely immersed	Ellipsoidal to fusiform	(0-)1-septate	Unknown	Europe	*Buxus sempervirens*
	N. neorehmiana	Superficial	Fusiform	(1–)3-septate	Synnemata	South America	Dead woody substrata

Table 3. (Continued).

Genera	Species	Teleomorph in natural environment			Anamorph in natural environment	Geography	Host
		Perithecial position	Ascospore shape	Ascospore septation	Fructification (shape and position)		
Nectria	*N. nigrescens*	Superficial	Ellipsoidal to fusiform	(0–)1(–3)-septate	Sporodochia (short to long stipitate)	Europe, North America	Dead woody substrata
	N. noackiana	Superficial	Ellipsoidal to fusiform	1-septate	Synnemata	South America	Bark of unknown liana
	N. novaezelandiae	Superficial	Long-ellipsoidal to cylindrical	(1–)3(–4)-septate	Unknown	Oseania	*Discaria toumatou*
	N. paraguayensis	Nearly or completely immersed	Ellipsoidal, fusiform to long oblong	1-septate	Unknown	South America	*Cedrela brasiliensis*, scale insects, lichen and possibly *Patellina amoena*
	N. polythalama	Superficial	Ellipsoidal to fusiform	Muriform	Synnemata	Oceania	Dead woody substrata
	N. pseudadelphica	Superficial	Fusiform to allantoid	(0–)1(–3)-septate	Unknown	South America	Dead woody substrata
	N. pseudocinnabarina	Superficial	ellipsoidal to fusiform	1-septate	Synnemata	Central America, South America	Dead woody substrata
	N. pseudotrichia	Superficial	ellipsoidal to fusiform	Muriform	Synnemata	Asia, Africa, Europe, Oceania, North America, Central America, South America	Dead woody substrata
	N. pyriformis	Superficial	Obovoid or pyriform	1-septate	Unknown	Asia	*Capparis sepiaria*
	N. sordida	Nearly or completely immersed	Ellipsoidal, fusiform to long oblong	(0–)1(–2)-septate	Sporodochia (sessile)	South America	Dead woody substrata
	N. tucumanensis	Superficial or rarely immersed only at the base	Cylindrical to allantoid	1(–3)-septate	Unknown	South America	Dead woody substrata
Pleonectria	*P. aquifolii*	Superficial	Ellipsoidal to fusiform	(0–)1-septate	Unknown	Europe	*Ilex aquifolium*
	P. aurigera	Superficial	Ellipsoidal, long-ellipsoidal to allantoid	(3–6)7-septate	Unknown	Europe, North America	Dead woody substrata, especially *Oleaceae*
	P. austroamericana	Superficial or immersed	Subglobose to ellipsoidal	Muriform	Pycnidia (immersed and superficial)	North America, South America	Dead woody substrata, especially *Fabaceae*
	P. balsamea	Superficial	Ellipsoidal, fusiform to long-fusiform	Muriform	Pycnidia (superficial)	North America	*Abies* (Conifer)
	P. berolinensis	Superficial	Ellipsoidal, fusiform to cylindrical	Muriform	Unknown	Asia, Europe, North America	*Ribes*
	P. boothii	Superficial	Long-fusiform, cylindrical to long-cylindrical	Muriform	Pycnidia (superficial)	Europe	*Picea abies* (Conifer)
	P. chlorinella	Superficial	Fusiform	Muriform	Unknown	North America	Dead woody substrata
	P. clavatispora	Superficial	Clavate	Muriform	Unknown	North America	*Ribes*
	P. coryli	Superficial	Narrowly fusiform to cylindrical	1-septate	Unknown	Europe, North America	Dead woody substrata

Table 3. (Continued).

Genera	Species	Teleomorph in natural environment			Anamorph in natural environment	Geography	Host
		Perithecial position	Ascospore shape	Ascospore septation	Fructification (shape and position)		
Pleonectria	*P. cucurbitula*	Superficial	Long-filiform	15–39-septate	Pycnidia (superficial)	Europe, North America	*Pinus*, subgenus *Pinus* (Conifer)
	P. ilicicola	Superficial	Ellipsoidal	(0–)1-septate	Pycnidia (immersed)	Europe	*Ilex aquifolium*
	P. lamyi	Superficial	Ellipsoidal to fusiform	Muriform	Pycnidia (superficial)	Asia, Europe, North America	*Berberis*
	P. lonicerae	Nearly or completely immersed	Ellipsoidal to fusiform	Muriform	Unknown	North America	*Lonicera involucrata*
	P. missouriensis	Superficial	Ellipsoidal to cylindrical	Muriform	Pycnidia (superficial)	North America	*Carya alba*
	P. okinawensis	Superficial	Ellipsoidal to rarely fusiform	1-septate	Pycnidia (superficial)	Asia	*Castanopsis* sp.
	P. pinicola	Superficial	Fusiform to long-fusiform	Muriform	Pycnidia (superficial)	Asia, Europe, North America	*Pinus* (conifer)
	P. pseudomissouriensis	Superficial	Ellipsoidal to fusiform	1-septate	Unknown	South America	Dead woody substrata
	P. pyrrhochlora	Nearly or completely immersed	Ellipsoidal, rarely subglobose	Muriform	Unknown	Europe	*Acer campestre*
	P. quercicola	Superficial	Filiform	8–15-septate	Pycnidia (immersed)	Europe	*Quercus ilex* ssp. *rotundifolia*
	P. rosellinii	Superficial	Long-filiform	8–31-septate	Pycnidia (superficial)	Asia, Europe, North America	*Abies* (conifer)
	P. rubicarpa	Superficial	Ellipsoidal to fusiform	1-septate	Unknown	Europe, North America, Central America	Dead woody substrata
	P. sinopica	Superficial	Ellipsoidal to fusiform	1-septate	Pycnidia (immersed and superficial)	Europe	*Hedera*
	P. sphaerospora	Superficial or immersed	Subglobose to ellipsoidal	Muriform	Pycnidia (immersed and superficial)	North America	Dead woody substrata
	P. strobi	Superficial	Long-filiform	12–44-septate	Pycnidia (superficial)	Europe, Norh America	*Pinus* subgenus *Strobus* (conifer)
	P. virens	Superficial or sometimes immersed at base	Ellipsoidal to rarely fusiform	Muriform	Presumably pycnidia	Europe, North America	Dead woody substrata
	P. zanthoxyli	Almost immersed	Narrowly ellipsoidal to allantoid	Muriform	Presumably pycnidia	Europe, North America, South America	Dead woody substrata

Seifert (1985) and Seifert & Okada (1990) suggested that the anamorphs of *Nectria sensu* Rossman *et al*. (1999) should be placed in only one genus, namely *Tubercularia*, based on careful anatomical observation of fructifications. The anamorphs of *Nectria sensu* Rossman included those with sporodochia, synnemata, and pycnidia because of the continuum of morphological characters.

In this study, we found that the pycnidial anamorphs of *Pleonectria* in clade I-1 showed phylogenetic distance from the sporodochial and synnematous anamorphs of *Nectria* in clade II (Fig. 1). Within *Pleonectria*, the position of pycnidia such as immersed or superficial seems to be correlated with host identity (Table 3). Subglobose, superficial pycnidia develop in species on conifer trees as in clade I-4 and *P. boothii* on *Picea abies* in clade I-3. Other species of *Pleonectria* on hardwood trees and woody shrubs produce immersed or discoidal, superficial pycnidia that are often flattened and immersed at the base. The only exception is *P. okinawensis* on *Castanopsis* sp. in Japan that produces navicular, superficial pycnidia (Fig. 2).

For some species such as *N. canadensis* and *N. cinnabarina*, both of which can produce long stipitate sporodochia, it is difficult to determine whether the anamorphic fructifications are synnematous or sporodochial. To distinguish the two fructifications, Seifert (1985) clarified that a synnema is "a stipitate Hyphomycete conidioma in which, when sporulation begins, the stipe, in longitudinal section, is seen to be composed of undifferentiated hyphae, either in textura *porrecta*, *t. intricata,* or rarely, in a *t. prismatica*; conidiophores or conidiogenous cells arise from the hyphae of the synnemata". In this study species forming synnemata form clade II-3 while those producing sporodochia form clade II-4 (Fig. 3). In addition the synnematous clade II-3 and sporodochial clade II-4 are also linked to absence or presence of sterile hyphae and acropleurogenous conidiophores. Sterile hyphae mixed with phialides but without acropleurogenous conidiophores were only observed in the synnematal anamorphs of species in clade II-3, while the sporodochial anamorphs and acropleurogenous conidiophores of species in clade II-4 did not produce sterile hyphae. Correlated with their phylogenetic relationship, the anamorphs of *N. pseudocinnabarina* and *N. pseudotrichia* were completely identical in the natural environment as well as culture. An additional member of clade II-3, *N. polythalama* differs in having conidia larger than those of *N. pseudocinnabarina* and *N. pseudotrichia*. Based on the anatomy of the synnemata, four species, *N. australiensis*, *N. lateritia*, *N. neorehmiana*, and *N. noackiana* appear to be morphologically related to the synnematous clade II-3 although cultures are lacking. Among species having a sporodochial anamorph, the length of the stipe does not appear to have phylogenetic importance (Fig. 3). For instance, *N. cinnabarina* with long, stipitate sporodochia falls phylogenetically between *N. berberidicola* and *N. dematiosa*, both of which form sessile or short stipitate sporodochia. Further, *N. berberidicola* in culture forms long stipitate sporodochia on SNA although we observed only sessile sporodochia on natural substratum. Unlike the other members of clade II, all members of the sporodochial clade II-4 produce acropleurogenous conidiophores (Fig. 3). Most species of *Nectria* produce complexly verticillate conidiophores, however, species in the *N. cinnabarina* species complex, *N. asiatica*, *N. cinnabarina*, *N. dematiosa*, and *N. nigrescens,* produce only acropleurogenous conidiophores (Hirooka *et al*. 2011).

A comparision between pycnidia and synnemata was presented by Seifert (1985) and Okada & Tubaki (1986). They speculated that the cupulate synnemata-like fructification was a transitional form between synnemata and pycnidia according to previous studies of fungi such as *Chaetomella*, *Cornucopiella, Endocalyx*, *Morrisographium*, and *Tubercularia*. Brubacher *et al*. (1984) discussed the stalked fructifications with a pycnidioid cavity of *Crucellisporiopsis prolongatum.* In our study, this hypothesis was considered by comparing the anamorph of *P. okinawensis*, the other species of *Pleonectria*, and the synnematous anamorph of *Nectria*. *Pleonectria okinawensis* forms naviculate pycnidia that macroscopically resemble synnemata, especially when the apex produces a conidial mass that is extruded from the cavity. In our phylogenetic tree, *P. okinawaensis* clustered with other species of *Pleonectria* having pycnidial anamorphs while species of *Nectria* having true synnematous anamorphs are only distantly related (Figs 1–3).

Although the anamorph fructification is generally an informative character in hypocrealean fungi, some contradictions exist. For example, *Hypocrella hirsuta* produces both a synnematous hirsutella-like and pycnidial anamorph on the surface of the stroma while the other species of *Hypocrella* produce only a pycnidial anamorph (Chaverri *et al*. 2008). In this study, only species of *Pleonectria* produce pycnidia with the exception of the rudimentary pycnidia of the *N. balansae* group. Seven related species of *Nectria* produce synnemata while other species produce sessile or stalked sporodochia.

When *Sphaerostilbe aurantiaca*, a nomenclatural synonym of *N. aurantiaca*, was described by Tulasne & Tulasne (1861), *Stilbum aurantiacum* was first determined to be the synnematous anamorph of *S. aurantiaca*. Our phylogenetic results suggest that *Nectria aurantiaca* is basal to a sporodochial clade, not to a synnematous clade (Figs 1, 3). This phylogenetic result was anticipated by some mycologists, *i.e.* Booth 1959, Samuels & Seifert 1987, Seifert & Okada 1990, although they called the anamorph a synnema. In cultures of *N. aurantiaca* CBS 236.29 and CBS 308.34, both of which were also examined in this study, Booth (1959) found not only synnemata but also sporodochia. Samuels & Seifert (1987) and Seifert & Okada (1990) illustrated the anatomy of the stipe of *N. aurantiaca* with the lower half of the stipe being *textura porrecta* and the upper half of *textura globulosa* or *t. angularis*, thus revealing the combined sporodochial and synnematal characters of this anamorph. Although the anatomical characteristics of the anamorph of *N. aurantiaca* could not be examined because of the poor condition of the type specimen, we determined that the fructification of *N. aurantiaca* should be consider sporodochial based on our molecular data and past reports. We suggest that sporodochia should be defined as composed of *textura globulosa* or *t. angularis* while synnemata of *textura porrecta*. This example also suggests that species having sporodochia and synnemata may show a close affinity. The *textura porrecta* of *N. aurantiaca* is produced above an extensive basal stroma (Fig. 3) similar to the sporodochial anamorph of other species of *Nectria*.Our phylogenetic trees show that species having pycnidial anamorphs, *Allantonectria* and *Pleonectria*, are only distantly related to species having sporodochial and synnematous anamorphs, *Nectria* (Fig. 1). Species in the *N. balansae* group produce not only sporodochial but rarely pycnidial anamorphs although the pycnidia in the natural environment were observed for only one species (*N. magnispora*) and no mature pycnidia of *N. magnispora* and *N. sordida* were found in culture. Surprisingly, *N. antarctica*, phylogenetically sister to *N. magnispora*, produced concave sporodochia and immature, immersed pycnidia developing on the stroma between perithecia even though the teleomorph and cultural characters of *N. antarctica* are morphologically typical of *Nectria* (Fig. 7N, O). This suggests that the concave sporodochia of *N. antarctica* may be an ancestral character of the pycnidial anamorphs of the *N. balansae* group. This is similar to *Cosmospora* with *Fusarium* anamorphs that generally produces sporodochial anamorphs, yet *Cosmospora kurdica* has a pycnidial anamorph (Samuels & Seifert 1987, Rossman *et al*. 1999).

Evaluation of anamorphs in culture

As is the case with many ascomycetous genera, teleomorphic characters of hypocrealean fungi are conserved while variation among genera and species can be observed in the anamorph. Anamorph characters in culture were found to be more diverse than characters in the natural environment as exemplified for the *Neocosmospora haematococca-Fusarium solani* species complex (O'Donnell 2000, Covert *et al*. 2007), *Gibberella-Fusarium* (Kvas *et al*. 2009) and *Hypocrea-Trichoderma* (Chaverri & Samuels 2003). Unlike the examples above, the cultural characters of *Nectria* and *Pleonectria* are somewhat similar even though these genera are paraphyletic and exhibit considerable morphological differences in their teleomorphs. However, some differences exist. The size of conidia in culture are diagnostic for distinguishing these genera, > 5 µm long in *Nectria vs.* < 5 µm long in *Pleonectria*. In culture, species in the *Nectria balansae* group produce two sizes of conidia while *Allantonectria*, most species of *Nectria,* and *Pleonectria* produce only one kind of conidia. Based on the basal position of the *N. balansae* group in clades II-1 and II-2, the production of different kinds of conidia may be considered an ancestral character (Fig. 3).

Morphologically, both the holomorph in the natural environment as well as cultures of species in the *N. balansae* group show considerable differences from *Allantonectria*, other species of *Nectria*, and *Pleonectria* (Table 3). These morphological characters suggest that the *N. balansae* group might be recognised as a distinct genus. However, our molecular data show serious discrepancies between the phenotypic and genotypic characters of the *N. balansae* group (Figs 1, 3). Based on our phylogenetic tree, species of the *N. balansae* group are paraphyletic, *i.e.* clade II-1 and II-2, and, surprisingly, clade II-2, *N. mariae* and *N. magnispora,* is basal to clade II-3, species of *Nectria* having synnematous anamorphs. *Nectria magnispora* rarely formed pycnidia in the natural environment. Jaklitsch & Voglmayr (2011), who described *N. eustromatica*, a species morphologically similar to *N. mariae*, suggested that *N. pseudotrichia* was sister to *N. eustromatica* based on their four locus phylogeny. They described the yellowish fruiting body produced on oatmeal-agar (OA) after 42 d as a "sporodochium" (fig.1q), but it seems likely that this 'sporodochium' is actually a cluster of immature pycnidia; similar clusters of immature pycnidia of *N. magnispora* and *N. mariae* were often observed on PDA. Although clade II-1 diverged from clades II-2, II-3, and II-4, species of *Nectria* have retained many plesiomorphic characters of clade II-1. No major morphological differences were found between clade II-1 and II-2 except for the anomalous *N. antartica* (Fig. 3).

Host specificity and substrata

Species of the three genera monographed in this study have varying degrees of host specificity (Table 3). The host of *Allantonectria miltina* is limited to five genera of the woody, fibrous members of the *Asparagaceae*, previously regarded as the *Agavaceae*. Three of these host genera, *Agave*, *Furcrarea*, and *Yucca*, are now placed in the *Agavoideae* while two, *Dasylirion* and *Nolinia*, belong in the *Nolinoideae*. Many more genera having fibrous plants are assigned to the *Asparagaceae* worldwide (Fishbein *et al*. 2010), thus, it is expected that additional hosts will be discovered.

Based on past reports and our study, most species of *Nectria* appear to have a broad range of woody plant hosts although some species are only found from unknown woody hosts (Table 3). *Nectria cinnabarina* and the related species *N. asiatica*, *N. dematiosa*, and *N. nigrescens* as well as *N. polythalama* and *N. pseudotrichia* occur on a range of hardwood trees and woody shrubs. Only *N. aurantiaca* may be limited to *Ulmaceae*. In addition to occurring on the genus *Ulmus*, Seifert (1985) reported this species on the genus *Planera* in the *Ulmaceae*. *Nectria australiensis* on *Hoheria* and *N. berberidicola* on *Berberis* occur on only one host genus. *Nectria paraguayensis* is unique in occurring not only on plants, but also on scale insects, lichens, and other fungi; this species may have stronger saprophytic activity than the other *Nectria* species. Eight species of *Nectria* are known only from the type specimen, and thus it cannot be determined if they are host specific.

In contrast to *Nectria*, most species of *Pleonectria* appear to be host specific (Table 3). Five species of *Pleonectria* are each specific to one genus or group of conifers and form the monophyletic clade I-4, with the exception of *P. boothii* on *Picea abies* (Fig. 2). Previously only *P. cucurbitula* and *P. balsamea* were known from conifers (Rossman *et al*. 1999). Among the species on the host genus *Pinus*, *Pleonectria cucurbitula* is limited to subg. *Pinus* while *P. strobi* is limited to subg. *Strobus*. *Pleonectria boothii* does not fall into the conifer clade (clade I-4), rather it appears sister to *P. coryli*. *Pleonectria aquifolii* and *P. ilicicola* are specific to *Ilex aquifolium* and *P. sinopica* to *Hedera helix,* common plants in the Europe. Three species are restricted to a single host genus, namely *P. berolinensis* and *P. clavatispora* on *Ribes*, *P. lamyi* on *Berberis*, and *P. pyrrochlora* on *Acer.* Two species are known predominantly on one host genus but with a few specimens from other hosts, namely *P. virens* primarily known from *Rhus* and *P. zanthoxyli* on *Zanthoxylum*. A few species tend to occur on hosts in specific plant families, namely *P. aurigera* on *Oleaceae* and *P. austroamericana* on *Fabaceae*. Similar to *Nectria*, a few species of *Pleonectria* occur on a range of woody hosts; *P. coryli* is known from 14 unrelated, woody dicotyledonous plant genera and *P. chlorinella* and *P. rubicarpa* occur on unrelated hosts. A number of species are known only from the type specimen.

Species of *Nectria* and *Pleonectria* occur primarily on living or decaying plant material, especially bark, while *Allantonectria miltina* is known from the woody fibers within the leaves of the host. Most species of *Nectria* and *Pleonectria* are produced on well-developed stromata that are often erumpent through the bark of recently killed woody substrata. Some species appear to function as endophytes residing harmlessly in the healthy plant but sporulating profusely following the death of the host (Rossman 1989, Rossman *et al*. 1999). The anamorph of *Nectria cinnabarina* was reported as an endophyte of the Chinese southern yew (*Taxus mairei*) (Wang *et al.* 2000). Based on past reports Hirooka *et al.* (2011) suggested that *N. cinnabarina* might exist as an endophyte in the bark that sporulates when the substratum dies (Jørgensen 1952, Bedker & Blanchette 1984, Yasuda & Izawa 2007).

Geographical distribution

The genus *Allantonectria* represented by *A. miltina* is distributed in temperate to subtropical regions where the host plants occur (Table 3).

Species of *Nectria* are common in the temperate, sub-tropical, or tropical regions of the world, with some species apparently endemic such as *N. argentinensis* and *N. canadensis*. The type species of *Nectria*, *N. cinnabarina*, is found only in temperate regions, while *N. lateritia*, *N. pseudocinnabarina,* and *N. pseudotrichia*, are encountered in tropical and subtropical regions (Rossman 1989, Rossman *et al*. 1999). Reports of *N. cinnabarina* have been misleading because this species is now recognised as a complex with four species, three of which have limited distribution. For example *Nectria asiatica*, segregated within the *N. cinnabarina* species complex by Hirooka *et al*. (2011), has been collected only from Asia. Clades in *N. pseudotrichia* show four lineages that correlate with continental origin (Hirooka *et al*. 2010). The broadly conceived *N. pseudotrichia* is here determined to consist of two species, one of which, *N. polythalama*, is confined to New Zealand. *Nectria antarctica*, *N. aurantiaca,* and *N. berberidicola*, have been collected from high elevations or cold latitudes. These species are relatively slower growing (< 40 mm after 7 d at 25 °C) than other species of *Nectria* and suggest that they are psychrophilic. Although we were not able to study the cultural morphology and phylogenetic position of *N. himalayensis*, the fungus may also be psychrophilic because it was found at high elevations. This evidence suggests that most species of *Nectria* are more widespread in temperate or colder regions than in tropical or subtropical ones. The geographical distribution of the *N. balansae* group is similar to that of other species of *Nectria*. *Nectria sordida* is known only from tropical regions (Argentina, French Guiana) and *N. paraguayensis* from Brazil, but the other four species were collected from temperate regions. *Nectria magnispora* from Japan and *N. hoheriae* from New Zealand appear to be endemic. *Nectria mariae* and *N. eustromatica* were collected from Europe and share morphological similarities such as warted perithecia and shape of ascospores and micro-conidia but differ in colour of perithecia and size of ascospores and macro-conidia.

Most species of *Pleonectria* are known from temperate regions especially North America and Europe although a few species have been collected during the winter in subtropical regions. Some species are known only from North America, *P. balsamea, P. chlorinella, P. clavatispora, P. lonicerae, P. missouriensis,* and *P. sphaerospora,* while others are known only from Europe, *P. aquifolii, P. boothii, P. ilicicola, P. quercicola, P. pyrrhochlora,* and *P. sinopica.* A few species appear to be pan-temperate known from Asia as well as Europe and North America, *P. berolinensis, P. lamyi, P. pinicola,* and *P. rosellini*. In these cases the specimens from Asia are from mountainous, temperate regions such as the Kaghan Valley of Pakistan or Nagano Prefecture of Japan. Although *P. okinawensis* in Japan and *P. pseudomissouriensis* in Argentina were found from sub-tropical areas, they were collected in winter, January in Japan and July in Argentina, when the temperature is relatively cold. *Pleonectria austroamericana*, *P. pseudomissouriensis*, and *P. zanthoxyli* are the only species of *Pleonectria* known from the southern hemisphere. Because most species of *Pleonectria* occur on specific host plants, their geographical distribution depends on the distribution of the host.

Economic and ecological importance

Although most species of *Allantonectria*, *Nectria,* and *Pleonectria* appear to be saprophytic, some species are reported as symbionts, *i.e.* endophytes, while a few are known to cause diseases of hardwood trees. Aggregations of ascomata of *Nectria* are often found erumpent through the bark of recently killed woody substrata suggesting that the fungus was already present in the tissue when the host was killed. Our explanation for simple conidia is that usually these species function as endophytic fungi in which the simple conidia serve as spermatia and/or are dispersed by insects or water.

Species of the *Nectria cinnabarina* species complex and *N. pseudotrichia* occur on a wide range of woody shrubs and trees in many families including the *Arecaceae* and *Pinaceae*; they are occasionally reported on herbaceous hosts (Farr & Rossman 2010). *Nectria cinnabarina* causes a disease known as "coral spot *Nectria* canker" because of the conspicuous erumpent pink sporodochia (Sinclair & Lyon 2005). Trees and woody plants growing in plantations and nurseries or those damaged by frost or other causes appear to be especially susceptible. The pathogenicity of this fungus was proven by host inoculation studies (Bedker & Blanchette 1984, Yasuda & Izawa 2007). Although *Nectria nigrescens* as *Tubercularia ulmea* is widely recognised as a facultative parasite of stressed trees, shrubs, and woody vines (Farr *et al*. 1989, Sengpiel 1977), this species is also known to cause stem canker disease of Siberian elm (*Ulmus pumila*) in North Dakota (Carter 1947) and, more recently, to inflict considerable damage to Siberian elm, Russian-olive (*Elaeagnus angustifolia*), and honey-locust (*Gleditsia triacanthos*) tree plantings in North Dakota (Sengpiel 1977, Walla & Stack 1988). During 1971 to early 1975 the damage to Siberian elm and Russian olive inflicted by this fungus cost the state of North Dakota $1.4 million in highway planting losses (Sengpiel 1977). Although Samuels & Dumont (1982) suggested that *N. pseudotrichia* colonises freshly cut wood, this species occasionally functions as a plant pathogen in tropical areas. Pathogenicity of *N. pseudotrichia* on *Pyrus pirifolia* in Brazil was confirmed by Becker (2003); likewise, Akinsanmi & Drenth (2006) reported that this species produced a canker disease on macadamia (*Macadamia integrifolia* and *M. tetraphylla*) in Australia based on artificial inoculation tests. Thus, members of the *Nectria cinnabarina* species complex and *N. pseudotrichia* must be considered to be facultative parasites.

Pleonectria austroamericana causes cankers on honey locust (*Gleditsia triacanthos*) in the midwestern United States. This species was first identified causing cankers on honey locust on Nantucket Island, Massachusetts (Seeler 1940a). To date, the disease has been found in Alabama, Colorado, Kansas, Mississippi, Massachusetts, Oklahoma, and Tennessee (Seeler 1940a, Crandall 1942, Hudler & Oshima 1976, Crowe *et al*. 1982, Conway & Morrison 1983). To protect trees from the threat of this disease, Jacobi & Riffle (1989) screened honey locust cultivars for resistance to *P. austroamericana*. *Pleonectria austroamericana* also appears to function as a facultative parasite (Crandall 1942, Jacobi & Riffle 1989).

Contradictions between phenotypic and genotypic characters, and the way forward

Phenotypic and genotypic characters are generally used to classify organisms at all taxonomic levels. As mentioned above, our six loci phylogeny showed contradictions between phenotypic and genotypic characters of the *N. balansae* group at the generic level. Although the multilocus phylogeny often confirms the recognition of fungal taxa, it still represents very little of the fungal genome. It could be assumed that the morphological characteristics of the *N. balansae* group that we consider critical, specifically perithecia immersed in a well-developed stroma, were not transcribed in the portion of the genome sequenced in this study. It would be possible to determine the "true" relationships among these fungi, for example, those having perithecia immersed in a well-developed stroma, using genome sequencing analysis, *i.e.* phylogenomics. To resolve the contradictions between phenotypic and genotypic characters, these four approaches could be applied. The first is to seek novel aspects of the biology and/or biochemistry as new taxonomical criteria. For instance, secondary metabolite profiles have been used to define species within fungal groups, such as *Alternaria*, *Aspergillus*, *Penicillium*, and *Pestalotiopsis*, (Andersen *et al*. 2008, Houbraken *et al*. 2011, Maharachchikumbura *et al*. 2011, Samson *et al*. 2011). This approach generally is used to evaluate inter- and intraspecific level relationships. A second approach is increased taxon sampling especially of alternative morphs. In our monograph, relatively few specimens and isolates of species in the *N. balansae* group were available. Additional specimens and isolates would provide increased taxonomic data and possibly resolve the conflict. The third approach is increased development of advanced algorithms for phylogenetic analyses. It is nessesary to apply the most appropriate analyses. The last is to search for additional genes suitable for phylogenetic reconstruction. As an example, Andrew *et al*. (2009) discovered that an expanded multi-locus phylogeny did not resolve morphological species with the small-spored *Alternaria* species complex. Ideally, gene regions that code for critical morphological characters in a specific group should be sequenced although discovering these gene regions is often difficult. Overall, a polyphasic taxonomic approach combining a thorough morphological study of abundant material with advanced phylogenetic analysis of the ideal genes would hopefully reveal the "true" fungal relationships among species in the *N. balansae* group.

GENERA AND SPECIES DESCRIPTIONS

ALLANTONECTRIA Earle in Greene, Plantae Bakerianae 2: 11. 1901.

Anamorph: trichoderma-like

Type species: *Allantonectria miltina* (Mont.) Weese, in Höhnel & Weese, Ann. Mycol. 8: 464. 1910.

Teleomorph on natural substrata: *Mycelium* not visible around ascomata or on host. *Stromata* erumpent through epidermis, orange to sienna, KOH+ blood-red, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis* to *t. globulosa*, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, scattered to aggregated, subglobose to globose, about 250 µm high × 200 µm diam, rarely slightly cupulate upon drying, sometimes with a depressed apical region, bay to scarlet, apical region slightly darker, KOH+ blood-red, LA+ yellow, sometimes surface scurfy or scaly, slightly orange. *Ascomatal wall* about 40 µm thick, of two regions. *Asci* narrowly clavate with inconspicuous ring at apex, 8-spored, ascospores biseriate above, uniseriate below. *Ascospores* allantoid to short-cylindrical with rounded corners, straight to slightly curved, non-septate, hyaline, smooth.

Anamorph in culture: *Colony surface* cottony with aerial mycelium, whitish yellow to whitish luteous. Sporulation on SNA from *lateral phialidic pegs* abundant, enteroblastic, monophialidic, flask-shaped, about 5 µm long, 2 µm wide at base. *Conidiophores* abundantly formed, unbranched, sometimes trichoderma-like, 1(–2)-branched, becoming loosely branched. *Conidiogenous cells* enteroblastic, monophialidic, cylindrical, tapering toward tip or slightly flask-shaped. *Rhizomorph-like strands* each of a single hypha with large diameter produce lateral phialidic pegs and normal hyphae. *Lateral phialidic pegs* on rhizomorph-like strands formed abundantly, enteroblastic, monophialidic, cylindrical, tapering toward tip. *Young conidia* formed from monophialides on aerial, submerged, or repent hyphae, formed abundantly on slimy heads, ellipsoidal, oblong, to cylindrical, hyaline, smooth, straight or slightly curved, rounded at both ends, non-septate. *Mature conidia* swollen, 0–1-septate, oblong or ellipsoidal with strongly constricted centre, hyaline, straight or slightly curved, rounded at both ends.

Habitat: On leaf of members of monocots, especially *Asparagaceae* (previously known as the *Agavaceae)*

Distribution: Europe, Central America, North America

Notes: *Allantonectria* based on *Allantonectria miltina* was described by Earle in Greene (1901) based on its unique ascospores. Rossman *et al*. (1999) reassigned this species to the genus *Nectria*. Our molecular data and cultural morphology show that this species is distinct from other nectria-like fungi (Figs 1, 2, 6). Unlike species of *Nectria sensu stricto* and *Pleonectria*, *Allantonectria* occurs on monocots. Based on this evidence, *Allantonectria* is herein revived as a monotypic genus.

Allantonectria miltina (Mont.) Weese in Höhnel & Weese, Ann. Mycol. 8: 464. 1910. Figs 4–6.

Basionym: *Sphaeria militina* Mont. in Durieu, Expl. Sci. Algérie, Bot. I, 1: 477. 1848 [1849].

≡ *Nectria miltina* (Mont.) Mont., Syll. Gen. Sp. crypt. 225. 1856.
≡ *Nectriella miltina* (Mont.) Sacc., Michelia 1: 278. 1878.
= *Allantonectria yuccae* Earle in Greene, Plantae Bakerianae 2: 11. 1901.
= *Nectriella bacillispora* Traverso & Spessa, Bol. Soc. Broteriana 25: 172. 1910.

Anamorph: trichoderma-like morphology

Teleomorph on natural substrata: *Mycelium* not visible around ascomata or on host. *Stromata* erumpent through epidermis, up to 1.0 mm high and 0.8 mm diam, orange to sienna, KOH+ blood-red, LA+ yellow, pseudoparenchymatous, cells forming textura *angularis* to *t. globulosa*, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, scattered to aggregated in groups of 5–75, subglobose to globose, 145–245 µm high × 140–205 µm diam, rarely slightly cupulate upon drying, sometimes with only a depressed apical region, bay to scarlet, apical region slightly darker, KOH+ blood-red, LA+ yellow, sometimes surface scurfy or scaly, slightly orange. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis*, sometimes including bright yellow scurf, 8–13 µm diam, walls pigmented, uniformly about 1.5 µm thick. *Ascomatal wall* 25–45 µm thick, of two regions: outer region 20–35 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.5 µm thick; inner region 7–13 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* narrowly clavate, 20–40 × 3–5 µm, with inconspicuous ring at apex, 8-spored, ascospores biseriate above, uniseriate below. *Ascospores* allantoid to short-cylindrical, rounded at both ends, straight to slightly curved, (3.4–)4.3-5.9(–7.6) × 1.3–1.9(–2.5) µm (*n* = 124), aseptate, hyaline, smooth.

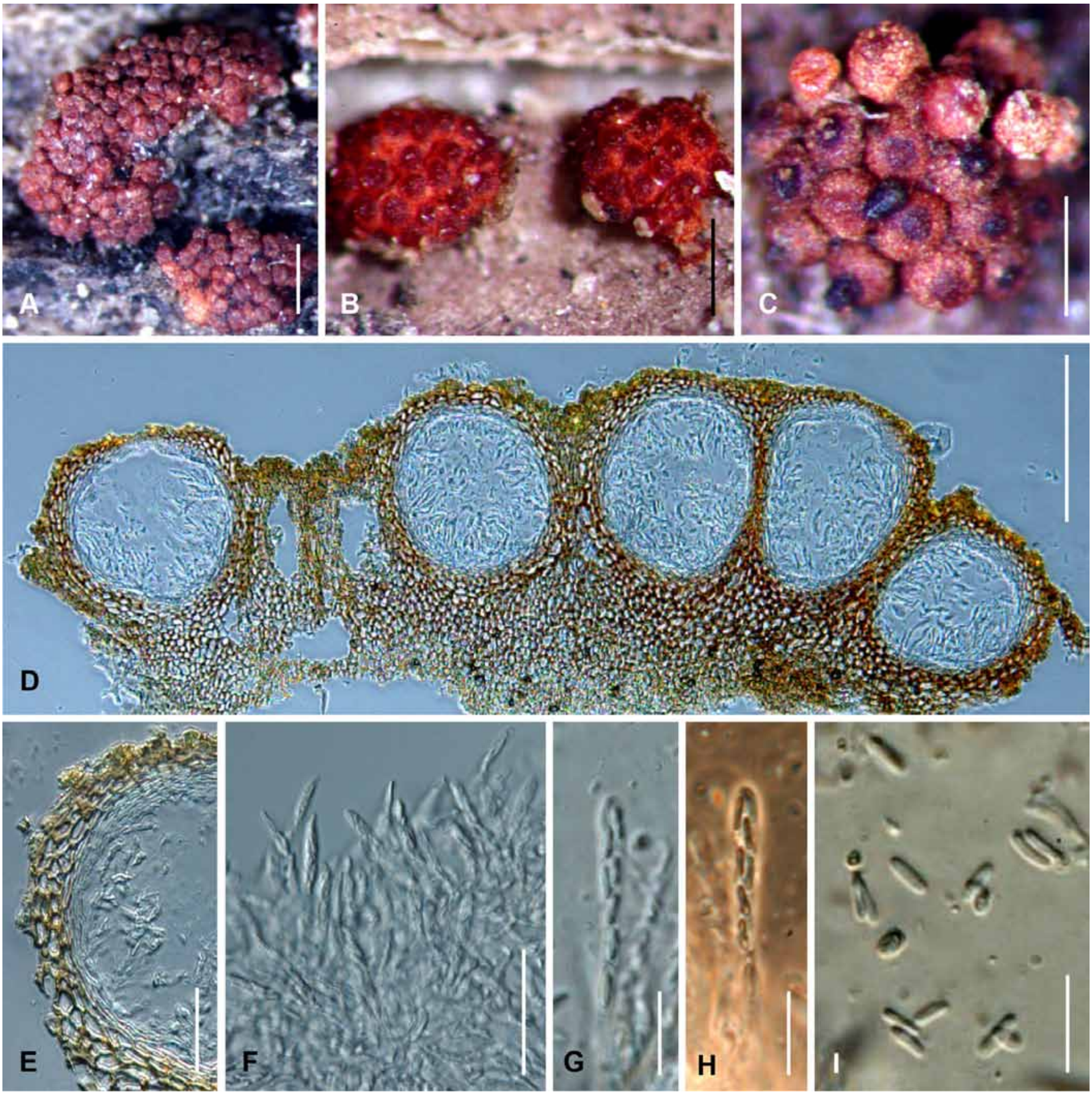

Fig. 4A–I. *Allantonectria miltina* on natural substrata (teleomorph). A–C. Perithecia on natural substrata; D. Median section of perithecia; E. Median section of perithecial wall; F–H. Asci; I. Ascospores. Scale bars: A = 2 mm; B = 1 mm; C = 500 µm; D = 200 µm; E, F = 50 µm; G–I = 10 µm.

Anamorph in culture: After 7 d at 25 °C, colonies 60–67 mm (average 65 mm) diam. *Colony surface* cottony with aerial mycelium, whitish yellow to whitish luteous; *aerial mycelium* developed, rarely small, whitish luteous, sporodochial conidial masses produced after 2 wk; *reverse* whitish yellow to whitish luteous in centre and white at margin. *Odour* on PDA slightly fruity. Sporulation on SNA from *lateral phialidic pegs* abundant, enteroblastic, monophialidic, flask-shaped, 4.2–9.8 µm long, 1.6–3.2 µm wide at base. *Conidiophores* abundantly formed, trichoderma-like, unbranched, or branched tending to be paired but also commonly unilateral, consisting of a single cell near tip of conidiophores, 7.6–34.6 µm long, 2.1–5.4 µm wide at base. *Conidiogenous cells* enteroblastic, monophialidic, cylindrical, tapering toward tip or slightly flask-shaped, 5.0–11.1 µm long, 1.4–4.5 µm wide at base. Unusually differentiated single hypha of large diameter (6.8–12.4 µm) producing lateral phialidic pegs and thin hyphae. *Lateral phialidic pegs on wide hyphae* abundantly formed, enteroblastic, monophialidic, cylindrical, tapering toward tip, 2.2–3.4 µm long, 3.0–5.3 µm wide at base. *Young conidia* formed from monophialides on aerial, submerged, or repent hyphae, formed abundantly on slimy heads, ellipsoidal, oblong to cylindrical, hyaline, smooth, straight or slightly curved, rounded at both ends, non-septate, (2.8–)3.4–4.4(–5.3) × (1.1–)1.5–2.3(–2.6) µm (*n* = 50). *Mature conidia* swollen, 0–1-septate, oblong or ellipsoidal with strongly constricted centre, hyaline, straight or slightly curved, rounded at both ends, not germinating and budding on media, (6.1–)6.6–11.8(–16.9) × (2.6–)3.0–4.2(–4.9) µm (*n* = 50). *Pycnidia*, *chlamydospores,* and *ascomata* not produced in culture.

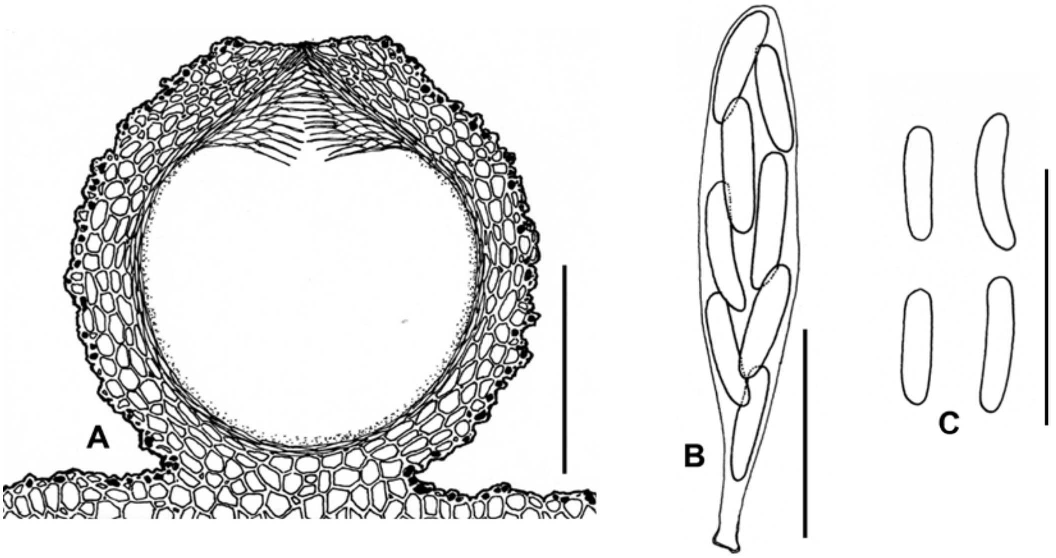

Fig. 5A–C. *Allantonectria miltina* on natural substrata (teleomorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores. Scale bars: A = 100 µm; B, C = 10 µm.

Habitat: On fibrous to woody leaves of monocotyledonous plans, especially *Asparagaceae* (previously known as *Agavaceae)*: *Agave americana*, *A. neomexicana*, *Agave* sp., *Dasylirion*, *Furcraea gigantea*, *Nolina* sp., *Yucca glauca*, *Y. harrimaniae*, *Yucca* sp.

Distribution: Europe (Croatia, France, Greece, Italy, Montenegro, Portugal, Spain), North America (Mexico, USA), Central America (Panama).

Holotype of Allantonectria miltina: **Algeria**, On *Agave americana*, 1847, Bommes, FH ex Herb. PC.

Additional type specimens examined: Type of *Allantonectria yuccae*: **USA**, Colorado, Hermosa, on *Yucca*, Mar. 1899, C.F. Baker, **Holotype** BPI 630106; **Topotype** BPI 630105, BPI 630107. Type of *Nectriella bacillispora*: **Portugal**, Coimbera, Horto botanico Conimbricensi, on leaves of *Furcraea gigantean,* Nov. 1906, A. Möller, **Holotype** PAD.

Additional specimens and isolates examined: **Croatia** as Yugoslavia, Istrien, in Abbazia, on leaves of *Agave americana*, 25 Apr. 1912, O. Jaap, Otto Jaap, Fungi selecti exsiccati No 561, BPI-bound exsiccati, BPI 552606. **France**, Cannes, on leaves of *Agave* sp., Duby?, Rabenhorst, Herb. Mycologicum Ed. 2. No. 631, BPI-bound exsiccati. **Greece**, Korfu, on leaves of *Agave americana*, Apr. 1912, Rechinger, Rehm Ascomyceten No. 1962b as *Nectriella miltina*, BPI 629387; Neapoli, on leaves of *Agave* sp., Rabenhorst, Fungi europaei et extraeuropaei No. 1828, BPI-bound exsiccati. **Italy**, Arco-Merano, S. Tirol, on leaves of *Agave americana*, 1911, Dietrich-Kalkhoff, BPI 630124; Calambrone (PI), sand dunes, on decaying leaves of *Agave americana*, 12 Feb. 2006, G. Cacialli, culture CBS 121121 = A.R. 4391, BPI 878442; Rome, Villa Pamphili, on leaves of *Agave americana*, Mar. 1902, BPI 629375; Rome, Villa Pamphili, on leaves of *Agave americana*, Mar. 1902, BPI 629473. **Mexico**, Intercepted Nogales Arizona #77179, on leaves of *Agave* sp., 26 Nov. 1957, D.E. Noel & F.A. Allen, BPI 630109. **Montenegro** (as Yugoslavia), Ulcinj (Dulcigno), on leaves of *Agave americana*, 20 Apr. 1903, F. Bubák, Vestergren, Micromycetes rariores selecti No 829, BPI-bound exsiccati, BPI 629332, BPI 629414. **Panama**, Chriqui Prov., Llanos del Volcan. alt. 1250-1300 m, on leaves of *Yucca* sp., 14 Jul. 1935, G.W. Martin, BPI 630108. **Spain**, Trinidad (Seville), on leaves of *Agave americana*, 06 Mar. 1913, Gonzalez-Fragoso, BPI 629420. **USA**, Arizona, Santa Rita Mtns., 22 Oct. 1914, O.F. Cook, BPI 630120; California, Camp Kearney, San Diego Co., on leaves of *Yucca* sp., Apr. 1935, O.A. Plunkett, BPI 630110; Colorado, Denver, E. Bethel, BPI 630111, 630119; Durango. Fort Lewis College Campus, on dead leaves of *Yucca harrimaniae*, 12 Oct. 1993, A.W. Ramaley, BPI 745134; La Plata Co., Cactus Ridge, on leaves of *Yucca* sp., 10 Feb. 1992, A.W. Ramaley, BPI 1113191; Leyden, on leaves of *Yucca glauca*, 05 Feb. 1910, E. Bethel, BPI 747157; Nebraska, Valentine, on leaves of *Yucca* sp., 23 Feb. 1898, C.L. Shear, BPI 630104; New Mexico, Lincoln Co. US Hwy 380, mile 59.25, Valley of Fires, on dead leaves of *Nolina* sp., 23 May 1993, A.W. Ramaley, BPI 745136; Pecos Co. Roadside, US Hwy 385, mile 490, on dead leaves of *Dasylirion* sp., 22 May 1993, A.W. Ramaley, BPI 745135; Texas, Culberson Co., Guadalupe Mountains National Park, along trail to Smith Springs, on dead leaves of *Agave neomexicana*, 11 Oct. 2002, A.W. Ramaley, BPI 842101; on *Yucca glauca*, 11 Oct. 1913, C.L Shear, BPI 630114; on stems of *Yucca glauca*, E. Bethel, BPI 630115; on dead leaves of *Yucca glauca*, 28 Mar. 1910, E. Bethel, BPI 630122; on dead leaves of *Yucca glauca*, 28 Mar. 1910, E. Bethel, BPI 630123; Jan. 1910, E. Bethel, BPI 630117, BPI 630118; on *Yucca glauca*, 05 Feb. 1910, E. Bethel, BPI 630112; on *Yucca glauca*, 02 May 1910, E. Bethel, BPI 630113; on *Yucca glauca*, E. Bethel, BPI 630121; Mesa Verde. alt. 2400 m, on leaves of *Yucca harrimaniae*, 06 Jul. 1907, F.E. Clements & E.S. Clements, BPI 630116.

Notes: In this study, we recognise *Allantonectria* as a monotypic genus because the type species is morphologically and phylogenetically unusual among the nectria-like fungi (Figs 1, 2, 4–6). Previously Höhnel & Weese (1910) and Rossman *et al*. (1999) had reassigned this species to the genus *Nectria*. Based on our phylogenetic tree, *A. militina* is distinct although it shows some affinity for species of *Pleonectria* (Figs 1, 2).A morphological correlation exists among species having bright yellow scurf on the ascomata as in *Allantonectria* and *Pleonectria*. Unlike all other species of nectria-like fungi, *A. miltina* has very small, non-septate ascospores and is known only on monocotyledonous hosts. The anamorph of *A. militina* is also unusual morphologically in having trichoderma-like conidiophores (Fig. 6F–H). However, *A. militina* is not closely related to the genus *Trichoderma* and its teleomorph, *Hypocrea*, based on phylogenetic data and morphological characters of its sexual state. Although appearing trichoderma-like, the conidiophores of *A. miltina* are analogous to the long, flask-shaped, lateral phialidic pegs typical of *Nectria* and *Pleonectria* anamorphs.

In our phylogenetic tree, the species most closely related to *A. miltina* is *Pleonectria aurigera*, a species not morphologically similar to *A. miltina*. Moreover, *P. aurigera* occurs primarily on members of the dicotyledonous family *Oleaceae*, unlike *A. miltina* that occurs on monocotyledonous plants in the *Asparagaceae*. *Allantonectria miltina* and *P. aurigera* are separated at a basal point in our phylogeny suggesting that they have evolved independently (Figs 1, 2).

No anamorph of *A. militina* has been observed in the natural environment. However, BPI 629414 shows abundant stromatal tissue emerging through the epidermis suggesting that, if this is the anamorph of *A. militina,* it is sporodochial. However, based on the relationship of *A. militina* to *Pleonectria*, the anamorph would be expected to be pycnidial.

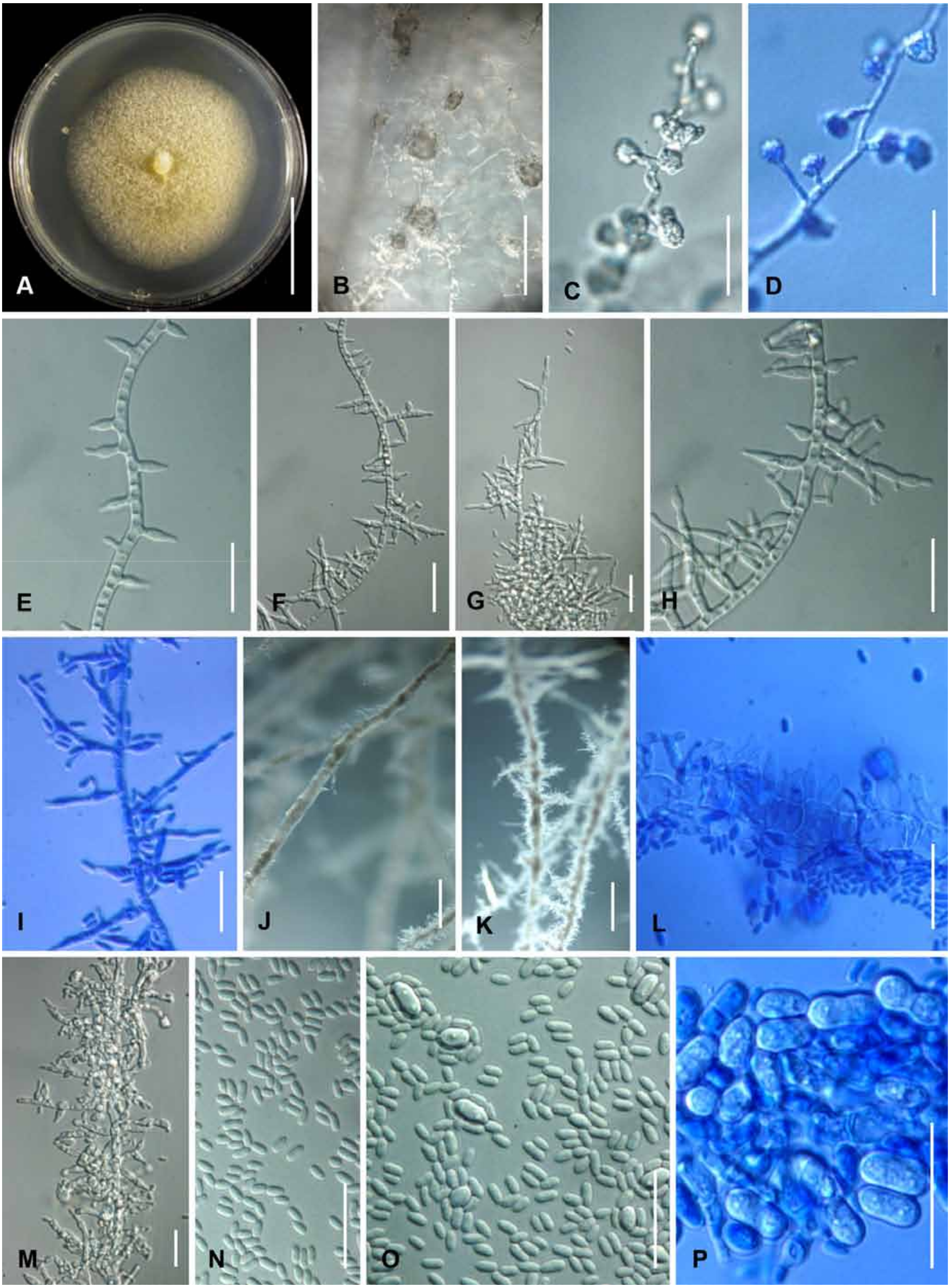

Fig. 6A–P. Anamorph of *Allantonectria miltina* in culture. A. Cultures after 7 d at 25 °C on PDA; B. Abundant conidiophores and conidial mass produced on the SNA surface; C, D. Conidiophores and conidial mass on SNA; E. Lateral phialidic pegs on SNA; F–I. Trichoderma-like conidiophores and conidia on SNA; J–M. Rhizomorph-like hyphae on SNA; N. Conidia on SNA; O, P. Mature conidia and young conidia on SNA. Scale bars: A = 30 mm; B, J, K = 50 µm; C–I, L–P = 20 µm.

The holotype of *Nectriella bacillispora* preserved in PAD includes only a few ascomata, thus we did not destroy any of them to observe ascospores. However, based on its host and macroscopic morphology, this name appears to be correctly synonymised with *A. miltina*.

NECTRIA (Fr.) Fr., Summa Veg. Scand. 2: 387. 1849.
Basionym: *Hypocrea* Fr. sect. *Nectria* Fr., Syst. Orb. Veg. p. 105. 1825. Lectotype designated by Clements & Shear (1931): *N. cinnabarina* (Tode : Fr.) Fr. (≡ *Sphaeria cinnabarina* Tode : Fr.).

= *Ephedrophaera* Dumort., Commentat. Bot. p. 90. 1822. Lectotype designated by Cannon & Hawksworth (1983): *Sphaeria decolorans* Pers., a synonym of *Nectria cinnabarina* (Tode : Fr.) Fr.

= *Sphaerostilbe* Tul. & C. Tul., Sel. Fung. Carpol. 1: 130. 1861. Lectotype designated by Seaver (1909): *S. aurantiaca* Tul. & C. Tul., recognised as *Nectria aurantiaca* (Tul. & C. Tul.) Jacz.

= *Megalonectria* Speg., Anales Soc. Ci. Argent. 12: 211. 1881. Type: *M. pseudotrichia* (Berk. & M.A. Curtis) Speg., recognised as *Nectria pseudotrichia* Berk. & M.A. Curtis.

= *Stilbonectria* P. Karst., Hedwigia 28: 194. 1889. Type: *S. lateritia* P. Karst., recognised as *Nectria lateritia* (P. Karst.) Rossman.

= *Creonectria* Seaver, Mycologia 1: 183. 1909. Type: *C. purpurea* (L.) Seaver (≡ *Tremella purpurea* L. 1753), a synonym of *Nectria cinnabarina* (Tode : Fr.) Fr.

Anamorph: *Tubercularia* Tode : Fr., Tode, Fungi Mecklenb. sel. 1: 18. 1790 : Fries, Syst. Mycol. 1: 41. 1821.

Type species: *Nectria cinnabarina* (Tode : Fr.) Fr., Summa Veg. Scand. 2:388, 1849.

Teleomorph on natural substrata (*Nectria* excluding the *N. balansae* group): *Mycelium* rarely visible around ascomata and on host. *Stromata* erumpent through epidermis, KOH+ dark red, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis* to *t. prismatica*. *Ascomata* superficial on well-developed stromata, solitary or caespitose, subglobose to globose, about 350 µm high × 300 µm diam, generally red to bay, sometimes cupulate upon drying, apical region darker, KOH+ dark red, LA+ yellow, surface smooth to warted. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis*, with walls pigmented *ca.* 1.5 µm thick. *Ascomatal wall ca.* 40–60 µm thick, of two regions. *Asci* unitunicate, cylindrical to narrowly clavate, with inconspicuous ring at apex, 8-spored, ascospores biseriate above, uniseriate below. *Ascospores* ellipsoidal, oblong, fusiform, pyriform or allantoid, rounded at both ends, smooth or spinulose, hyaline, up to 4 septate, sometimes muriform.

Teleomorph on natural substrata (*N. balansae* group): *Mycelium* not visible around ascomata or on host. *Stromata* erumpent through epidermis, up to 2.5 mm high and 4.0 mm diam, generally red to sienna, KOH+ blood red, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*, intergrading with ascomatal wall. *Ascomata* nearly or completely immersed in erumpent stroma, aggregated in groups, red, subglobose to globose, about 500 µm high × 500 µm diam, not collapsing when dry, apical region slightly darker, KOH+ dark purple, LA+ yellow, warted wall. *Ascomatal surface cells* at edge of stroma forming *textura globulosa* or *t. angularis*. *Ascomatal wall* of two regions. *Asci* clavate, with inconspicuous ring at apex, 8-spored, mainly biseriate, rarely uniseriate. *Ascospores* ellipsoidal, to long fusiform oblong, straight to rarely slightly curved, 18.4–43 × 6.2–15.4 µm, (0–)1(–3)-septate, hyaline.

Anamorph on natural substrata (*Nectria* except *N. balansae* group): Sporodochial and/or synnematous. *Stromata of sporodochia* erumpent through epidermis, mainly pale yellow to orange, rarely reddish brown. *Sporodochia* superficial on well-developed stromata, smooth, cerebriform or tuberculate, scattered, solitary or gregarious, sessile to long stipitate, discoid or cylindrical-capitate, up to 8000 µm high including stipe, whitish yellow to orange, sometimes darker red. *Stipe* white to whitish red, rarely darker red, solitary or gregarious; *stipe cells* almost *textura angularis*, continuous with stroma, usually with wider cells in centre. *Hymenium* arising directly from *textura prismatica,* elongating from *t. angularis*. *Conidiophores* verticillate, if present, branching twice or three times, then developing acropleurogenously, hyaline. *Conidiogenous cells* enteroblastic, monophialidic, straight to slightly curved, cylindrical, subulate with widest point in middle to base. *Acropleurogenous conidiophores* monoverticillate or rarely biverticillate, then developing acropleurogenously for up to 10 levels, straight, curved. *Acropleurogenously developing phialides* intercalary, occurring below each septum, rarely terminal. *Conidia* hyaline, narrowly ellipsoidal to cylindrical, straight or slightly curved, non-septate, smooth-walled.

Synnemata usually erumpent through epidermis, solitary or gregarious, emerging from ascomatal cluster or independently, crowded to caespitose, cylindrical-capitate, subulate-capitate, or claviform, erect or nodding, unbranched or rarely branched at base, sometimes distinctly hispid at base, medium, red-brown at base, turning blood-red in KOH, fading upwards to almost black in age, up to 3000 µm high, up to 400 µm wide. *Hyphae on stipe* external hyphae golden brown at base, becoming pale brown towards apex. *Ornamental cells,* if present, cylindrical to clavate, straight, curved, sinuous, or twisted, arising laterally at more or less right angles, distributed evenly over surface of synnemata or concentrated near base or apex, usually unbranched but occasionally dichotomously branched, aseptate or with up to 3-septae. *Conidiophores* with phialides or long sterile hyphae, branching monoverticillate or biverticillate, whorls compact or diffuse. *Conidiogenous cells* enteroblastic, monophialidic, cylindrical to subulate, straight or curved. *Sterile hyphae,* if present, mixed with phialides, acicular, straight, or usually curved, unbranched or dichotomously branched, septate, arising from hyphae, often in groups of 1–4 from conidiophores together with phialides. *Conidia* hyaline, ellipsoidal, obovate, sometimes allantoid, non-septate, smooth-walled.

Anamorph on natural substrata (*N. balansae* group): Sporodochial and/or pycnidial. *Stromata* erumpent through epidermis, orange to red. *Sporodochial fructification* superficial on well-developed stromata, cottony, scattered, caespitose, rarely solitary, astipitate, sessile, up to 640 µm high, 1300 µm wide, white. *Hymenium* arising directly from *textura prismatica* elongating from *textura angularis*, up to 140 µm long, 4.5 µm wide, not curved at margin. *Conidiophores* monochasial branching. *Conidiogenous cells* monophialidic, cylindrical, straight or curved in terminal whorls of 2–4 together with sterile hyphae, collarette not conspicuous. *Conidia* hyaline, subglobose to ellipsoidal, straight, non-septate, smooth-walled. *Stromata of pycnidia* developing in stroma with ascomata, orange to umber. *Pycnidia* globose, immersed, eustromatic. *Conidiogenous cells* enteroblastic, monophialidic, oblong phialides, with an indistinct collarette. *Conidia* similar to ascoconidia, subglobose to ellipsoidal, 0-septate, hyaline.

Anamorph in culture (*Nectria* excluding *N. balansae* group): *Colony surface* radial, sometimes wavy, slightly cottony with aerial mycelium, white, whitish luteous, whitish saffron to yellowish brown. Sporulation on SNA from *lateral phialidic pegs* common, up to 7.9

µm long, up to 3.0 µm wide near aperture. *Aerial conidiophores* abundantly formed, unbranched, sometimes verticillate, 1–3 branched, becoming loosely to moderately densely branched. *Conidiogenous cells* enteroblastic, monophialidic, cylindrical, slightly tapering toward tip or narrowly flask-shaped with widest point in middle. *Young conidia* formed from monophialides on submerged or aerial hyphae, formed abundantly on slimy heads or sporodochia, ellipsoidal, oblong, fusiform to cylindrical, hyaline, smooth, straight or slightly curved, rounded at both end, non-septate. *Mature conidia* swollen, mostly 0-, rarely 1-septate, ellipsoidal, oblong, cylindrical to allantoid sometimes with strongly constricted centre, hyaline, smooth, straight or slightly curved, rounded at both ends, sometimes germinating and budding on media. *Chlamydospores* rarely present.

Anamorph in culture (*N. balansae* group): *Colony surface* cottony with aerial mycelium, whitish yellow to yellowish brown. *Conidiophores* of two types on SNA. *Short conidiophores* producing microconidia, usually unbranched or loosely branched. *Conidiogenous cells* long-cylindrical to subulate, straight to slightly curved, enteroblastic, monophialidic. *Microconidia* hyaline, ellipsoidal to fusiform, rarely curved, non-septate. *Long conidiophores* producing macroconidia, monochasial branching, unbranched or loosely branched. *Conidiogenous cells* long-cylindrical, straight to slightly curved, enteroblastic, monophialidic. *Macroconidia* hyaline, subglobose to ellipsoidal, curved, non-septate, thick-walled cells. *Chlamydospores* or *swollen hyphae* present.

Habitat: On hardwood trees and woody shrubs.

Distribution: Temperate to tropical regions.

Notes: Based on the lack of bright yellowish scurf on the ascomata, the genus *Nectria* is easily distinguished from *Allantonectria* and *Pleonectria.* Within *Nectria* two morphologically different groups are recognised, namely, *Nectria* and the *N. balansae* group. Most species of *Nectria* excluding the *N. balansae* group have individual, superficial ascomata aggregated on a well-developed stroma, ascospores usually less than 25 µm long, and macroconidia absent in culture, while those in the *N. balansae* group have ascomata immersed in a reddish stroma, ascospores usually more than 25 µm, and macroconidia produced in culture. In addition, in the *N. balansae* group anamorphs in the natural environment produce pycnidia as well as sporodochia and the macroconidia develop from monochasial branches. Although the two groups are morphologically distinct, our phylogenetic analyses suggest that the *N. balansae* group is paraphyletic within the genus *Nectria* (Figs 1, 3). Thus, species in the *N. balansae* group are included in *Nectria*.

With the upcoming changes in the rules governing the nomenclature of fungi (Miller *et al.* 2011, Norvell 2011), the generic name *Tubercularia* 1790 has priority over *Nectria* 1849 and should be used. However, it seems likely that *Nectria* will be successfully proposed for conservation over *Tubercularia* based on its nearly ubiquitous usage over the past two hundred years and the significant number of name changes that would be required if *Nectria* were not conserved.

Nectria antarctica (Speg.) Rossman, Mem. New York Bot. Gard. 49: 257. 1989. Figs 7–9.

Basionym: *Pleonectria antarctica* Speg., Bol. Acad. Nac. Ci. 11: 236. 1888.

≡ *Thyronectria antarctica* (Speg.) Seeler, J. Arnold Arbor. 21: 437. 1940.

= *Pleonectria vagans* Speg., Bol. Acad. Nac. Ci. 11: 236. 1888.

Anamorph: sporodochial, tubercularia-like

Teleomorph on natural substrata: *Mycelium* not visible around ascomata or on host. *Stromata* erumpent through epidermis, up to 3 mm high and 3 mm diam, bay, KOH+ dark red, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*, intergrading with ascomatal wall. *Ascomata* superficial or rarely immersed only at base on well-developed stromata, aggregated in groups of 14–42, subglobose to globose, 315–548 µm high × 270–520 µm diam, not collapsing when dry, sometimes with only a depressed apical region, red to sienna, KOH+ dark red, LA+ yellow, surface rough. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis*, 5–17 µm diam, with pigmented *ca.* 1.5 µm thick walls. *Ascomatal wall* 50–100 µm thick, of two regions: outer region 30–85 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.5 µm thick; inner region 10–30 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* clavate, sometimes broadly clavate, increasing in size as ascospores mature, 95–125 × 15–25 µm, with inconspicuous ring at apex, 8-spored, biseriate above, uniseriate below. *Ascospores* ellipsoidal to short-cylindrical, straight to slightly curved, muriform, with 5–8 transverse septa and 1–2 longitudinal septum, not constricted at each septum, (19.4–)23.0–30.4(–35.1) × (6.8–)8.1–10.9(–13.6) µm (*n* = 100), hyaline, becoming slightly pale brown, smooth-walled.

Anamorph on natural substrata: *Stromata* erumpent through epidermis, red to bay. *Sporodochial conidiomata* without stipe, convex or concave on well-developed stromata, smooth, cerebriform or tuberculate, scattered, solitary, astipitate, sessile, patellate, discoid or cylindrical-capitate, up to 100–1300 µm high, 550–1000 µm wide, white, whitish yellow to orange. *Stipe* absent. *Hymenium* arising directly from *textura prismatica* elongating from *textura angularis*, up to 55 µm long, of cells 2.5–6 µm wide, not curved at margin. *Conidiophores* dimorphic, short and long. *Short conidiophores* densely branched, generally with 1–4 branched, straight, slightly curved, hyaline. *Conidiogenous cells* enteroblastic, monophialidic, cylindrical and subulate with widest point in middle to base, 15–34 µm long, 1.2–2.7 µm wide at base, collarette not conspicuous. *Long conidiophores* mixed with short conidiophores, monochasial branching, usually curved, loosely branched, generally with 1–2(–3)-branched, septate, 66–170 × 1.9–2.4 µm, arising from hyphae often in groups of 1–3 from conidiophores together with short conidiophores. *Conidia* hyaline, narrowly long ellipsoidal to cylindrical, straight or slightly curved, non-septate, (5.1–)5.7–6.9(–7.8) × (1.8–)2.3–2.9(–3.3) µm (*n* = 94).

Anamorph in culture: After 7 d at 25 °C, colonies 22–27 mm (average 24 mm) diam. *Colony surface* sometimes cottony with aerial mycelium, white to whitish yellow; *aerial mycelium* developed, sometimes small white to whitish yellow sporodochial conidial masses produced after 2 wk; *reverse* white to slightly whitish yellow. *Odour* on PDA slightly putrid. Sporulation on SNA from *lateral phialidic pegs* somewhat rare, enteroblastic, monophialidic, ellipsoidal tapering toward tip, 3.1–6.6 µm long, 1.8–2.9 µm wide at base. *Conidiophores* abundantly formed, unbranched, sometimes verticillate, 1(–3)-branched, becoming loosely to moderately densely branched, 12.5–45.6 µm long, 1.5–4.0 µm wide at base. *Conidiogenous cells* enteroblastic, monophialidic, cylindrical and slightly tapering toward tip or narrowly flask-shaped with widest point in middle or base, 6.1–22.3 µm long, 1.4–2.8 µm wide at base.

Fig. 7A–U. *Nectria antarctica* on natural substrata (A–H teleomorph, I–M teleomorph and anamorph, N–U anamorph). A–C. Perithecia on natural substrata; D, E. Median section of perithecia; F. Median section of perithecial wall; G. Ascus; H. Ascospores; I, J. Concave sporodochia and perithecia on natural substrata; K, L. Convex sporodochia and perithecia on natural substrata; M. Median section of convex sporodochium and perithecium; N. Median section of convave sporodochia (black arrows); O. Median section of immature, immersed pycnidia-like conidiomata (black arrows); P–R. Long and short conidiophores on natural substrata; S. long conidiophore on natural substrata; T. Short conidiophores on natural substrata; U. Conidia on natural substrata. Scale bars: A, I–L = 1 mm; B, C, M = 500 µm; D, E = 200 µm; F, G, N, O = 50 µm; H = 10 µm, P–U = 20 µm.

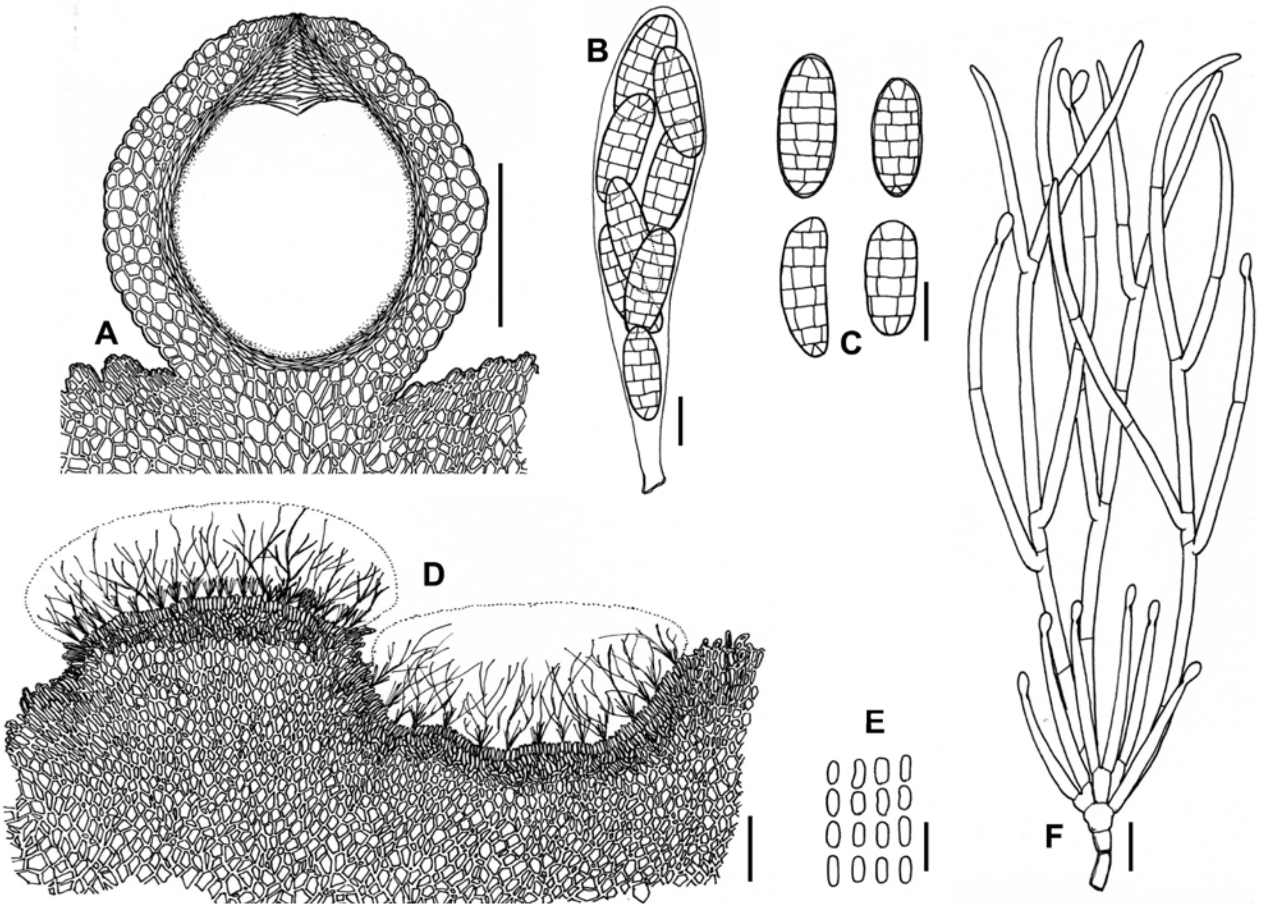

Fig. 8A–F. *Nectria antarctica* on natural substrata (A–C teleomorph, D–F anamorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores; D. Median section of convex and concave sporodochia; E. Conidia; F. Long and short conidiophores. Scale bars: A, D = 200 µm; B, C, E, F = 10 µm.

Young conidia formed from monophialides on aerial, submerged, or repent hyphae, formed abundantly in slimy heads, ellipsoidal, oblong to cylindrical, hyaline, smooth, straight or slightly curved, rounded at both ends, non-septate, (4.4–)5.4–6.8(–8.0) × (2.0–) 2.5–3.1(–3.5) µm (*n* = 50). *Mature conidia* swollen, 0–1-septate, oblong, ellipsoidal to allantoid with sometimes strongly constricted centre, hyaline, rough, straight or slightly curved, rounded at both ends, germinating and budding on media, (8.3–)9.0–13.4(–19.0) × (3.0–)3.7–4.7(–5.3) µm (*n* = 50). *Chlamydospores* and *ascomata* not produced in culture.

Habitat: On dead woody stems of dicotyledonous plants, known from *Berberis aquifolium*, *B. ilicifolia*, *Berberis* sp., also reported by Seeler (1940b) on *Drimys winteri*, *Fagus betuloides*., *F. antarctica*, and *Maytenus magellanica*.

Distribution: North America (USA), South America (Chile).

Holotype of Nectria antarctica: **Chile**, Tierra del Fuego, Isla de los Estados, on *Berberis ilicifolia*, Mar. 1882, C. Spegazzini, **Holotype** LPS 1638, **Isotype** FH 80857 microscope slide only.

Additional type specimen examined: Holotype of *Pleonectria vagans*: **Chile**, Tierra del Fuego, Ushuaia, 1882, C. Spegazzini, **Holotype** LPS 1639.

Additional specimens and isolates examined: **Chile**, Punta Arenas, on stems of *Berberis* sp., Feb. 1906, R. Thaxter, FH 301307; Punta Arenas, on stems of *Berberis* sp., Feb.-Mar.? 1906, R. Thaxter, FH 301308; Punta Arenas, on stems of *Berberis* sp., Mar. 1906, R. Thaxter, FH 301309; Punta Arenas, on stems of *Berberis* sp., Feb. 1906, R. Thaxter, FH 301310; Punta Arenas, on stems of *Berberis* sp., Mar. 1906, R. Thaxter, FH 301311, FH 80855 microscope slide only, FH 80856 microscope slide only. **USA**, Oregon, Corvallis, residential garden, on dead stems of *Berberis aquifolium,* 30 Mar. 1971, A.Y. Rossman, BPI 1107421 as *Nectria missouriensis*; Washington, King Co., Seattle, Washington Memorial Park, on dead stem of *Mahonia* (*Berberis*) *aquifolium*, 29 Jul. 1998, W. Jaklitsch WJ 1180, culture CBS 115033 = A.R. 2767, BPI 746217.

Notes: *Pleonectria antarctica* and *Pleonectria vagans* were described by Spegazzini (1888) who illustrated subtle differences in ascospore morphology. *Pleonectria vagans* possesses ascospores that are acute at both ends and slightly larger than those of *P. antarctica*. In examining the type specimens, these morphological heterogeneities were observed. However, we agree with Seeler (1940b) who concluded that these species are conspecific. We retain *P. vagans* as a synonym of *N. antarctica* despite these morphological differences. A similar species with muriform ascospores, *Nectria pseudotrichia,* has wide morphological variability in ascospore size even though the isolates are monomorphic and determined to be monophyletic.

Nectria antarctica is morphologically similar to *N. pseudotrichia* in having muriform ascospores. However, *N. antarctica* with ascomatal wall with two regions and ascospores with unconstricted septae differs from *N. pseudotrichia* having ascomatal walls with three regions and ascospores with constricted septae. The anamorph of *N. antarctica* in culture is also morphologically similar to the anamorph of *N. pseudotrichia*, but the growth rate of colonies after 7 d at 25 °C on PDA was different, specifically 10–40 mm in *N. antarctica* and more than 80 mm in *N. pseudotrichia*. *Nectria antarctica* in culture is almost identical with that of *N. berberidicola* but the surface of mature conidia of *N. antarctica* are roughened while those of *N. berberidicola* are smooth.

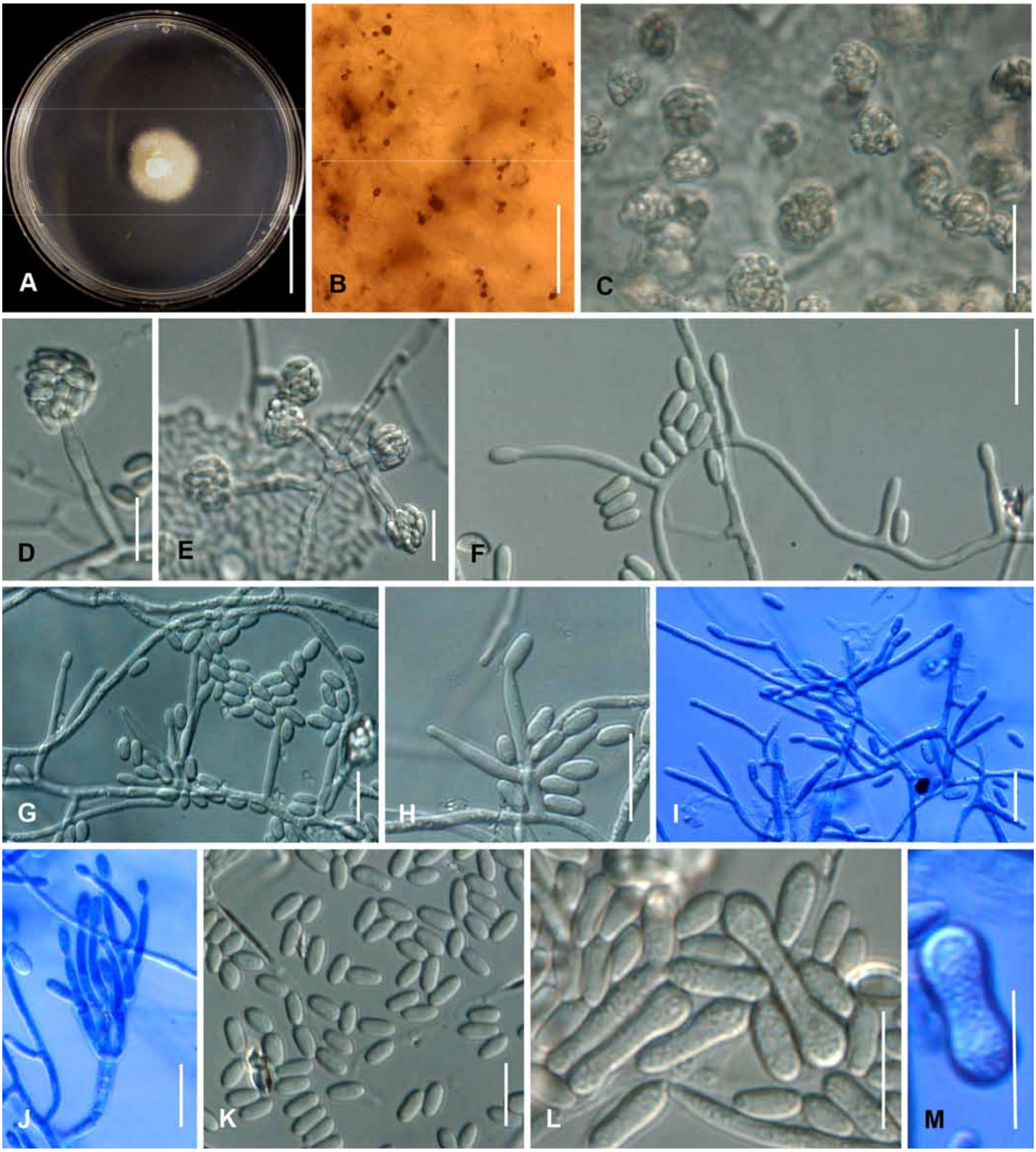

Fig. 9A–M. Anamorph of *Nectria antarctica* in culture. A. Cultures after 7 d at 25 °C on PDA; B, C. Abundant conidiophores and conidial mass produced on the SNA surface; D, E. Conidiophores and conidial mass on SNA; F. Lateral phialidic pegs, conidiophores and conidia on SNA; G–J. Conidiophores and conidia on SNA; K. Young conidia on SNA; L, M. Mature conidia on SNA. Scale bars: A = 30 mm; B = 1 mm; C = 20 µm; D–M = 10 µm.

Seeler (1940b) mentioned a specimen collected by R. Thaxter (Thaxter no. 5308 = FH 301311) with a "naked cushion", and he expected that the cushion may prove to be the remains of a tuberculate conidial phase. On the cushion of the specimen that Seeler (1940b) observed, we could find conidiophores and conidia that are described here. The sporodochial anamorph possess a unique morphology because some of them are concave sporodochia although anamorph of *N. antarctica* in culture showed the typical tubercularia-like morphology (Fig. 7N). In addition, immature, immersed pycnidia-like conidiomata were occasionally observed (Fig. 7O). The presence of concave sporodochia and immersed pycnidia-like conidiomata correlate with our molecular data. In our phylogenetic tree *Nectria antarctica* is sister to *Nectria magnispora* that forms a pycnidial anamorph (Figs 1, 3).

Nectria argentinensis Hirooka, Rossman & P. Chaverri, **sp. nov.** Mycobank MB519698. Figs 10, 11.

Anamorph: sporodochial, tubercularia-like.

Holotype: **Argentina**, Misiones, Piray Mini, on twigs, 12 Sep. 1978, Wright, del Busto, **Holotype** NY ex BAFC 24.477 previously identified as *Nectria* sp., associated with *Rugonectria rugulosa*.

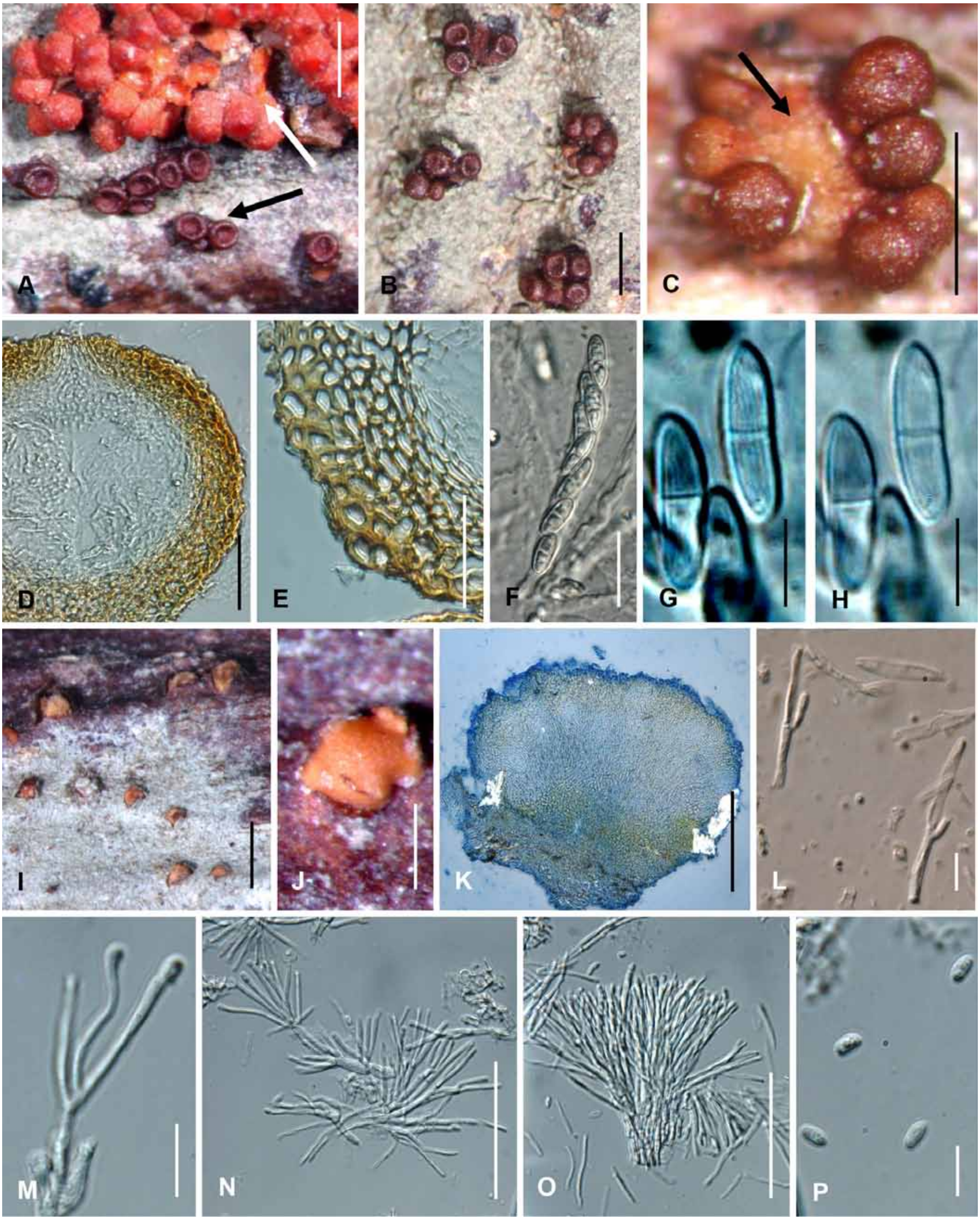

Fig. 10A–P. *Nectria argentinensis* on natural substrata (A–H teleomorph, I–P anamorph). A. Perithecia of *N. argentinensis* (black arrow) and *Rugonectria rugulosa* (white arrow) on natural substrata; B. Perithecia on natural substrata; C. Perithecia and sporodochium (arrow) on natural substrata; D. Median section of perithecium; E. Median section of perithecial wall; F. Ascus; G. Ascospores in surface view; H. Ascospores in optical section; I, J. Astipitate sporodochia on natural substrata; K. Median section of astipitate sporodochium; L. Short acropleurogenous conidiophores on natural substrata; M–O. Verticillate conidiophores on natural substrata; P. Conidia on natural substrata. Scale bars: A–C, K = 500 µm; D, N, O = 50 µm; E, F = 20 µm; G, H, L, M, P = 5 µm; I, J = 1 mm; K = 200 µm.

Etymology: *argentine* + *-ensis*; indicates the area from which this species is known.

Teleomorph on natural substrata: *Mycelium* not visible around ascomata or on host. *Stromata* up to 0.5 mm high and 1.5 mm diam, erumpent through epidermis, sienna to bay, sometimes

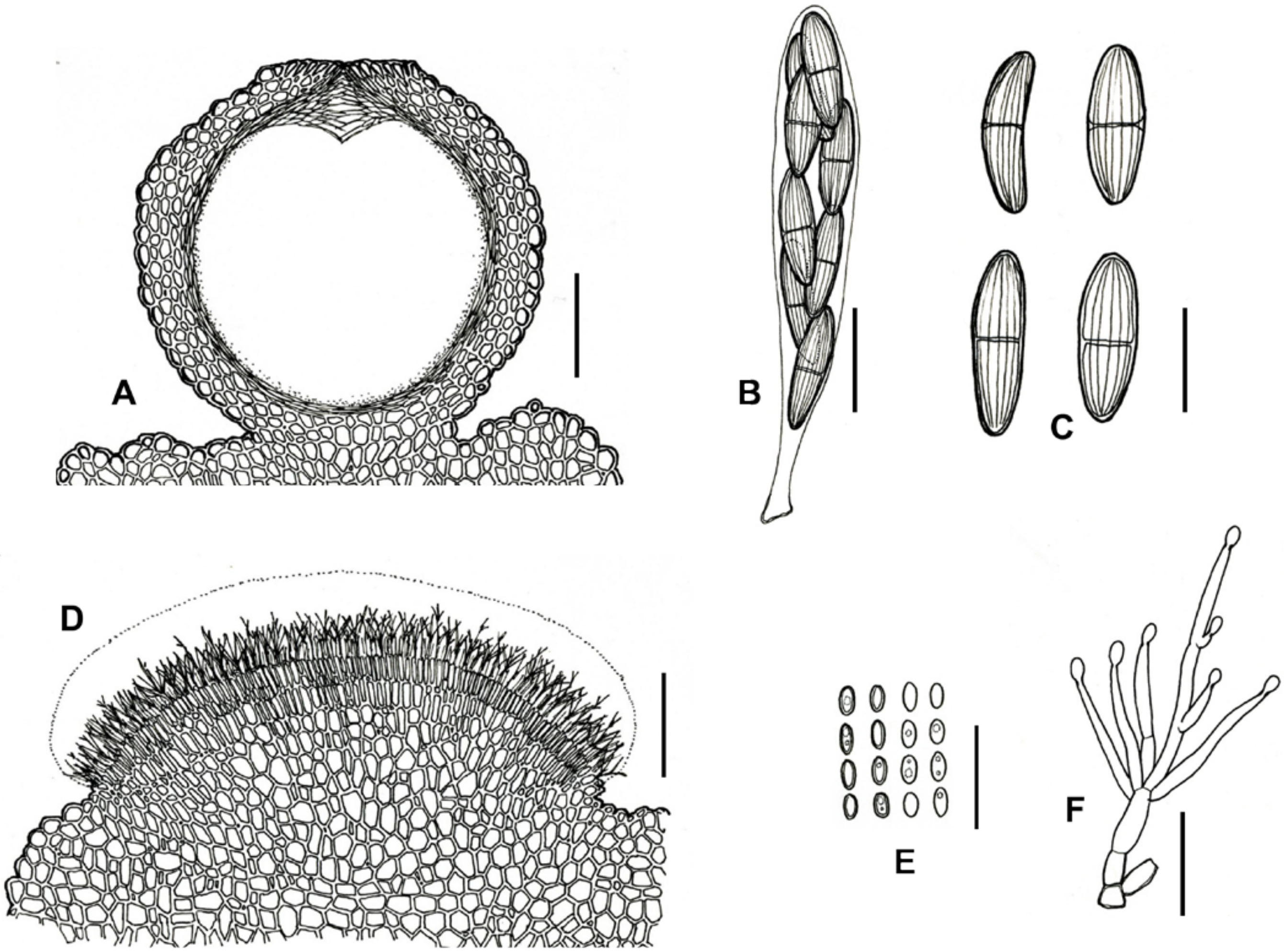

Fig. 11A–F. *Nectria argentinensis* on natural substrata (A–C teleomorph, D–F anamorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores; D. Median section of astipitate sporodochium; E. Conidia; F. Short acropleurogenous and verticillate conidiophores. Scale bars: A, D = 100 µm; B, C, E, F = 10 µm.

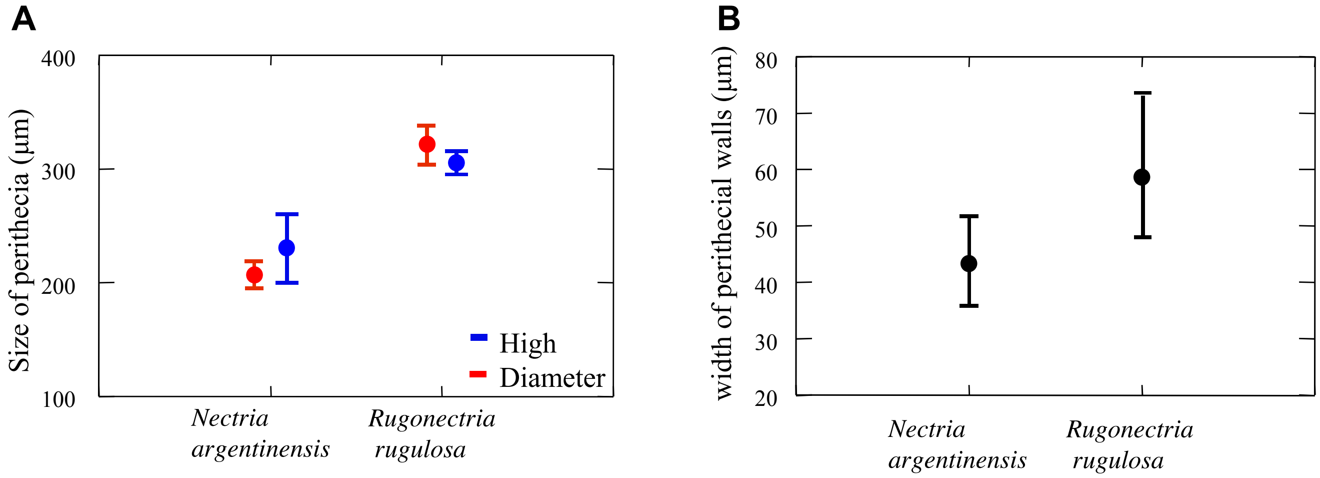

Fig. 12A–B. Graphs of 95 % confidence intervals of high and diameter ratios of perithecia in *Nectria argentinensis* and *Rugonectria rugulosa* on the holotype specimen of *N. argentinensis*. B. Graphs of 95 % confidence intervals of width ratios of perithecial wall in *Nectria argentinensis* and *Rugonectria rugulosa* on the holotype specimen of *N. argentinensis*.

darker red, KOH+ dark red, LA+ yellow, pseudoparenchymatous; cells forming *textura prismatica* to *t. angularis*, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, solitary or caespitose, up to 6 on stroma, rarely clustered around base of sporodochia, subglobose to globose, 190–250 µm high × 200–270 µm diam, red to bay, sometimes cupulate upon drying, non-papillate, apical region slightly darker, KOH+ dark red, LA+ yellow, surface with smooth to slightly rough. *Ascomatal surface cells* forming *textura globulosa* to *t. angularis*, *ca.* 1.5 µm thick walls. *Ascomatal wall* 25–50 µm thick, of two regions: outer region 25–37 µm thick, intergrading with stroma, cells forming *textura globulosa* to *t. angularis*, walls pigmented, about 1.0 µm thick; inner region

8–18 µm thick, of elongated, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* unitunicate, (50.9–)57.9–75.5(–79.3) × (4.8–)5.2–6.4(–7.3) µm (*n* = 50), cylindrical to narrowly clavate, with an inconspicuous ring at apex, 8-spored, ascospores biseriate above, uniseriate below. *Ascospores* long-ellipsoidal to fusiform, straight or slightly curved, hyaline, 1-septate, (11.0–)13.2–16.4(–19.9) × (4.8–)5.2–6.4(–7.3) µm (*n* = 50), striate.

Anamorph on natural substrata: *Stromata* erumpent through epidermis, orange to umber. *Sporodochial conidiomata* without stipe, superficial on well-developed stromata, smooth to rough, scattered, solitary, rarely caespitose, astipitate, sessile, discoid, up to 150–500 µm high, 250–800 µm wide, peach to orange, sometimes sienna. *Stipe* absent. *Hymenium* arising directly from *textura prismatica* elongating from *textura angularis*, up to 60 µm long, cells 2.0–5.0 µm wide, not curved at margin. *Conidiophores* with phialides or acropleurogenous conidiophores, branching verticillate, 1(–3)-branched, whorls compact or diffuse. *Conidiogenous cells* enteroblastic, monophialidic, cylindrical to subulate, straight or curved, 12–22 µm long, 1.8–3.0 µm wide, without collarettes or not conspicuous. *Short acropleurogenous conidiophores* mixed with phialides, acicular, straight or usually curved, unbranched or dichotomously branched, then developing acropleurogenously for 1–2 levels, septate, 34–68 × 1.5–3.3 µm, arising from hyphae in whorls, or more often in groups of conidiophores together with phialides. *Acropleurogenously developing phialides* intercalary, occurring below each septum, rarely terminal; *intercalary phialides* monophialidic, 2.3–7.1 µm long, 1.4–2.2 µm wide at base; *terminal cells* monophialidic, often sterile, without collarettes. *Conidia* hyaline, ellipsoidal, straight or slightly curved, non-septate, (3.4–)3.8–4.6(–4.9) × (1.8–)1.9–2.5(–2.9) µm (*n* = 50).

Habitat: On dead twigs.

Distribution: South America (Argentina, known only from the type collection).

Notes: *Nectria argentinensis* is a previously undescribed species placed in the genus *Nectria* based on the absence of scurf on the ascomata and a sporodochial anamorph. The holotype specimen of *N. argentinensis* was in NY as *Nectria* sp. This species occurs on the same twigs with *Rugonectria rugulosa* (Figs 10A, 12). Although *N. argentinensis* is similar to *R. rugulosa* in having similar-sized, striate ascospores, *N. argentinensis* has a narrow ascomatal wall, long-ellipsoidal to fusiform ascospores, and a *Tubercularia* anamorph (Fig. 11A, B). Molecular data are not available for this species. The critical morphology of acropleurogenous conidiophores on the anamorph were hard to find because of the poor condition of the sporodochia on this specimen; the conidiophores are comparatively short in this species. *Nectria argentinensis* is somewhat similar to *N. pseudocinnabarina* in having striate ascospores that average less than 20 µm long. The ascomatal wall of *N. argentinensis* is composed of two regions while that of *N. pseudocinnabarina* has three regions. In addition, the anamorph of *N. pseudocinnabarina* forms synnemata.

Nectria asiatica Hirooka, Rossman & P. Chaverri, Stud. Mycol. 68: 35-56. 2011. Figs 13–15.

Anamorph: tubercularia vulgaris-like.

Teleomorph on natural substrata: *Mycelium* not visible around ascomata or on host. *Stromata* up to 1.0 mm high and 3 mm diam, erumpent through epidermis, whitish yellow to bay, sometimes darker red, KOH+ dark red, LA+ yellow, pseudoparenchymatous; cells forming *textura angularis* to *t. prismatica* with cells oriented more or less vertically; cells 3–15 µm diam with walls 1–1.5 µm thick, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, solitary or caespitose, up to 20 on stroma, rarely clustered around base of stipitate sporodochia, subglobose to globose, 285–400 µm high × 250–380 µm diam (*n* = 39), red to reddish brown, sometimes cupulate upon drying, non-papillate, apical region darker, KOH+ dark red, LA+ yellow, surface with rough or concolourous warts, but sometimes smooth. *Ascomatal surface cells* forming *textura globulosa* to *t. angularis*, with pigmented walls *ca.* 1.5 µm thick. *Ascomatal wall ca.* 40–70 µm thick, of two regions: *outer region ca.* 30–50 µm thick, intergrading with stroma, cells forming *textura globulosa* to *t. angularis*, walls pigmented, about 1.5 µm thick; *inner region* about 10–18 µm thick, of elongated, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* unitunicate, (74–)89–101(–117) × (8.5–)10.0–12.5(–14.0) µm (*n* = 89), cylindrical to narrowly clavate, with an inconspicuous ring at apex, 8-spored, ascospores biseriate above, uniseriate below. *Ascospores* ellipsoidal to fusiform, straight, rarely slightly curved, hyaline, (0–)1-septate, (10.5–)14.5–17.5(–19.0) × (3.0–)3.5–5.0(–6.0) µm (*n* = 251), smooth-walled.

Anamorph on natural substrata: *Stromata* erumpent through epidermis, orange to red. *Sporodochial conidiomata* with stipe, superficial on well-developed stromata, smooth or cerebriform, scattered, solitary, or 2–4 gregarious, stipitate, pustular, discoid or cylindrical-capitate, up to 250–800 µm high including stipe, 300–2000 µm diam, chestnut to black, sometimes whitish yellow to orange. *Stipe* chestnut to black, sometimes dark green, up to 440–610 µm wide; *stipe cells* almost *textura angularis*, continuous with stroma, usually with wider cells in centre. *Hymenium* arising directly from *textura prismatica,* elongating from *textura angularis*, up to 110 µm long, of cells 2.0–7.0 µm wide, without curved margin. *Acropleurogenous conidiophores* monoverticillate or rarely biverticillate, then developing acropleurogenously for 3–6 levels, strongly coiled, hyaline, rarely slightly pale green. *Acropleurogenously developing phialides* intercalary, occurring below each septum, rarely terminal; *intercalary phialides* monophialidic, up to 3.5–7.5 µm long, 1.5–2.5 µm wide; *terminal cells* monophialidic, sometimes sterile, without collarettes. *Conidia* hyaline, narrowly long ellipsoidal to cylindrical, straight or slightly curved, non-septate, (4.5–)5.5–7.5(–9.5) × (1.0–)2.0–2.5(–3.0) µm (*n* = 258), smooth-walled.

Anamorph in culture: Optimum temperature for growth on PDA 25 °C, maximum temperature 30 °C; after 7 d at 25 °C colonies 40–75 mm diam (average 51 mm). *Colony surface* on PDA radiating sometimes wavy, slightly cottony with aerial mycelium, white to whitish saffron; *aerial mycelium* developing in a few isolates (CBS 125151, MAFF 241448); after 3 wk abundant white to whitish yellow sporodochial conidial masses produced; *reverse* white to slightly whitish yellow. *Odour* on PDA slightly fruity. Sporulation on SNA from *lateral phialidic pegs* on submerged or aerial hyphae, enteroblastic, monophialidic, ellipsoidal tapering toward tip, 3.0–5.0 µm long, 1.5–2.5 µm wide at base. *Aerial conidiophores* developing abundantly on aerial hyphae, unbranched, sometimes verticillate, 1–3 branched, becoming loosely to moderately densely branched, 6.0–25.5 µm long, 2.0–5.0 µm wide at base. *Conidiogenous cells* monophialidic, cylindrical, slightly tapering toward tip or narrowly flask-shaped with widest point in middle 7.5–22.5 µm long, 2.0–3.0 µm wide at base. *Young conidia* developing from monophialides on submerged or aerial hyphae, produced abundantly

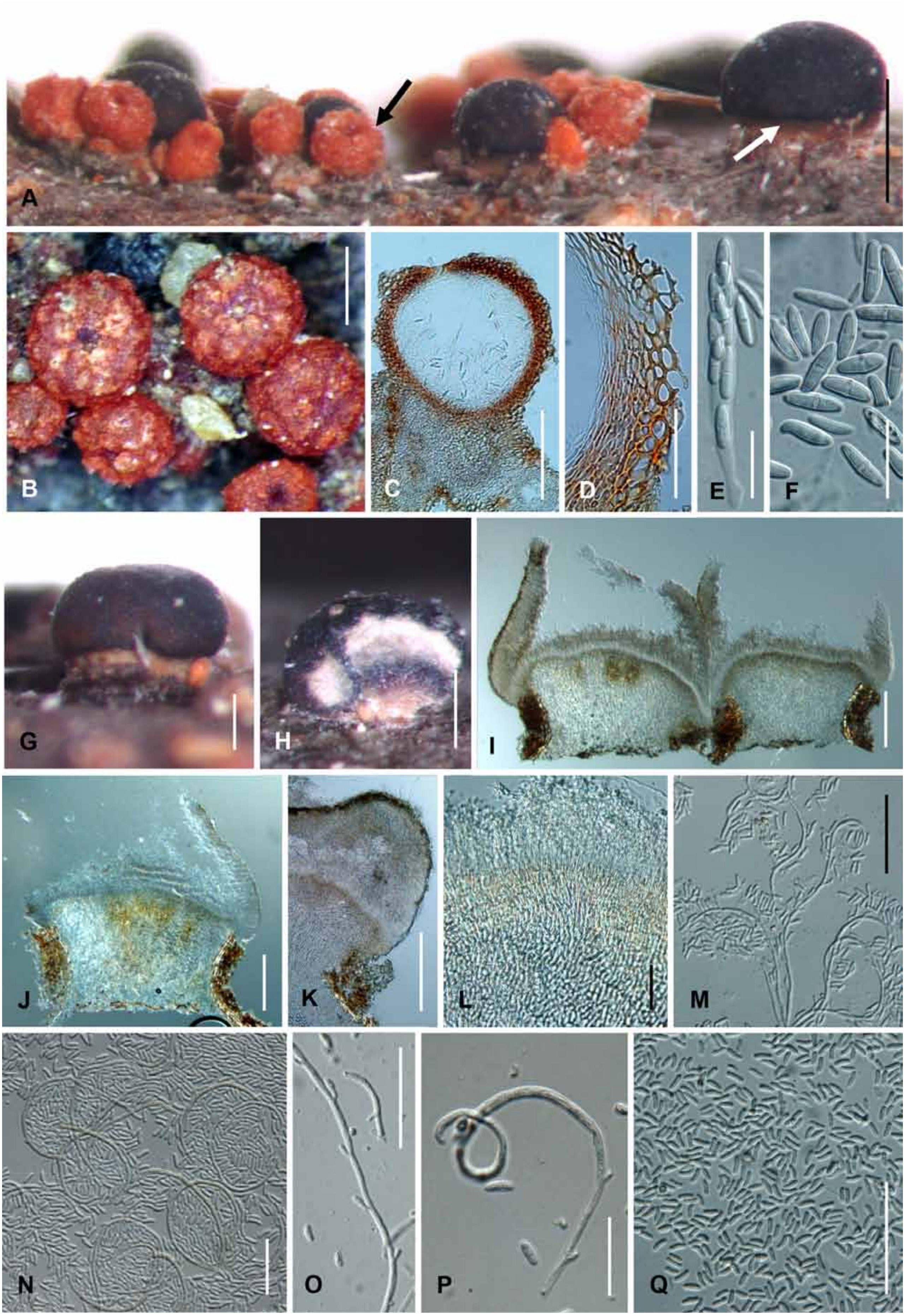

Fig. 13A–Q. *Nectria asiatica* on natural substrata (A teleomorph and anamorph, B–F teleomorph, G–Q anamorph). A. Perithecia (black arrow) and sporodochia (white arrow) on natural substrata; B. Perithecia on natural substrata; C. Median section of perithecium; D. Median section of perithecial wall; E. Ascus; F. Ascospores; G, H. Short stipitate sporodochium on natural substrata; I–K. Median section of short stipitate sporodochia; L. Hymenium on natural substrata; M–P. Acropleurogenous conidiophores on natural substrata; Q. Conidia on natural substrata. Scale bars: A = 1 mm; B, C, G–K = 300 µm; D, L–Q = 50 µm; E, F = 20 µm.

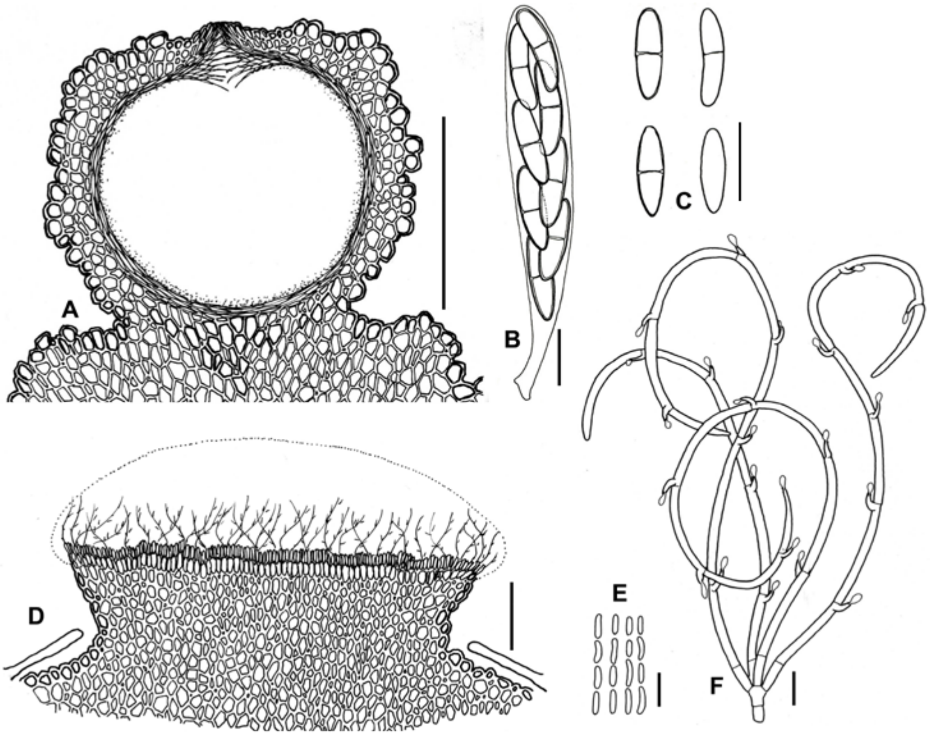

Fig. 14A–F. *Nectria asiatica* on natural substrata (A–C teleomorph, D–F anamorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores; D. Median section of astipitate sporodochium; E. Conidia; F. Acropleurogenous conidiophores. Scale bars: A, D = 200 µm; B, C, D, F = 10 µm.

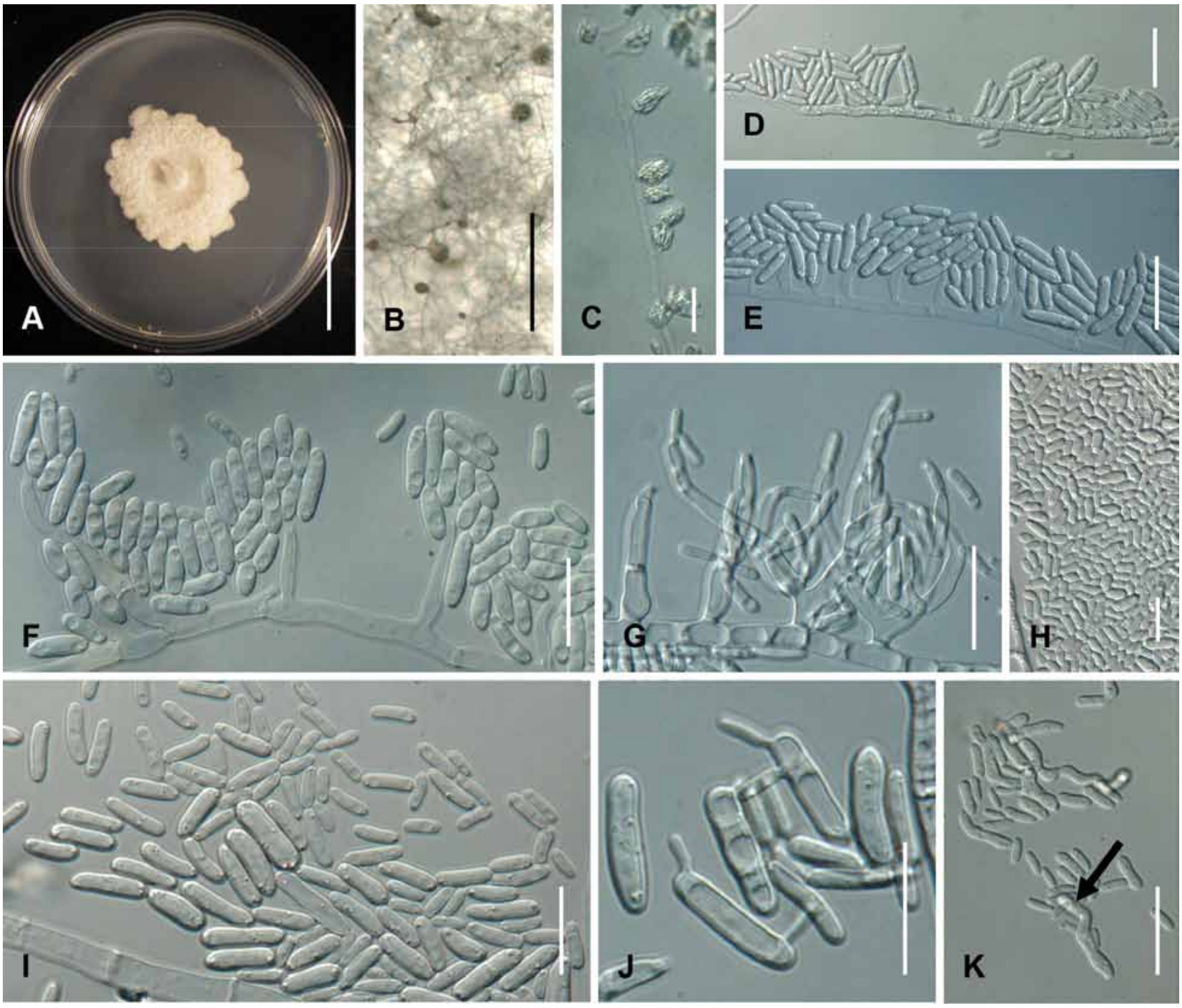

Fig. 15A–K. Anamorph of *Nectria asiatica* in culture. A. Cultures after 7 d at 25 °C on PDA; B. Abundant aerial conidiophores and conidial mass produced on the SNA surface; C–E. Lateral phialidic pegs on SNA; F, G. Conidiophores and conidia on SNA; H. Young conidia on SNA; I. Young conidia and mature conidia on SNA; J. Budding mature conidia on SNA; K. Budding and germinating mature conidia (arrow) that were streaked onto SNA. Scale bars: A = 30 mm; B = 500 µm; C–K = 10 µm.

Fig. 16A–C. *Nectria aurantiaca* on natural substrata (A–C anamorph). A–C. Long sporodochia on natural substrata. Scale bars: A–C = 500 µm.

on slimy heads, non-septate, ellipsoidal, oblong to cylindrical, hyaline, smooth, straight or slightly curved, rounded at both ends, (4.0–)6.0–12.0(–23.0) × (1.5–)2.0–3.0(–5.0) µm (*n* = 210). *Mature conidia* swollen, mostly 0-, rarely 1-septate, ellipsoidal, oblong or allantoid, rarely ellipsoidal with slightly constricted centre, smooth, straight or slightly curved, rounded at both ends, germinating or budding mature conidia (7.0–)11.5–17.5(–25.5) × (3.0–)3.5–4.5(–6.0) µm (*n* = 168). *Chlamydospores* and *ascomata* not produced in culture.

Habitat: On dead woody substrata, *Acer* sp., *Betula lutea*, *Prunus* sp., *Sorbus commixta*, and *Zelkova serrata*.

Distribution: Asia (China, Japan).

Holotype of Nectria asiatica: **Japan**, Kanagawa Prefecture, Ashigarakami-gun, on dead wood, Oct., Y. Hirooka, **Holotype** BPI 879972, **ex-holotype** culture MAFF 241439.

Additional specimens and isolate examined, see Hirooka *et al.* (2011).

Note: *Nectria asiatica* was described by Hirooka *et al.* (2011).

Nectria aurantiaca (Tul. & C. Tul.) Jacz., Opredelitel Gribov, t. 1, p. 215. 1913. Figs 16, 17.
Basionym: *Sphaerostilbe aurantiaca* Tul. & C. Tul., Select. Fung. Carpol. 1: 131. 1861.
Anamorph: *Tubercularia aurantiaca* (Bab.) Seifert, Stud. Mycol. 27: 106. 1985.
Basionym: *Stilbum aurantiacum* Bab. in Berkeley & Broome, Ann. Mag. Nat. Hist, Ser. 1, 6: 432. 1841.
≡ *Botryonipha aurantiaca* (Bab.) O. Kuntze, Rev. Gen. Pl. 2: 845. 1891.
≡ *Stilbella aurantiaca* (Bab.) Lindau, Rabenhorst's Kryptog.-Fl. 1, Pilze 9: 298. 1910.
= *Ditiola tubercularioides* Lib., Herb. Cryptog. Arden. No. 470.
≡ *Cilicipodium tubercularioides* (Lib.) Sacc., Fungi italici autogr. delin. t. 755. 1881.
= *Dendrostilbella moravica* Petrak, Ann. Mycol. 22: 65. 1924.

Teleomorph on natural substrata: See Booth (1959), Seifert (1985) and Samuels & Brayford (1994).

Anamorph on natural substrata: See Seifert (1985), Samuels & Seifert (1987) (illustration, figs 3.33), and Seifert & Okada (1990) (only illustration,fig. 2c).

Anamorph in culture: After 7 d at 25 °C, colonies 18–30 mm (average 25 mm) diam. *Colony surface* sometimes cottony with aerial mycelium, white to whitish yellow; *aerial mycelium* sometimes with small white to whitish yellow sporodochial conidial masses produced after 3 wk; *reverse* white to slightly whitish yellow. *Odour* on PDA slightly fruity. Sporulation on SNA from *lateral phialidic pegs* somewhat rare, enteroblastic, monophialidic, ellipsoidal tapering toward tip, 4.5–7.6 µm long, 1.3–2.2 µm wide at base. *Conidiophores* sparsely formed, unbranched, sometimes verticillate, 1–3 branched, becoming loosely to moderately densely branched, 17.3–52.8 µm long, 1.6–2.5 µm wide at base. *Conidiogenous cells* enteroblastic, monophialidic, cylindrical, slightly tapering toward tip or narrowly flask-shaped with widest point in middle, 12.9–16.8 µm long, 1.7–2.5 µm wide at base. *Young conidia* formed from monophialides on aerial, submerged, or repent hyphae, formed abundantly on slimy heads, ellipsoidal, oblong to fusiform, hyaline, smooth, straight or slightly curved rounded at both ends, non-septate, (6.0–)7.3–9.1(–10.0) × (2.2–)2.7–3.5(–4.3) µm (*n* = 100). *Mature conidia* swollen, 0–1-septate, oblong, ellipsoidal to cylindrical sometimes strongly constricted at centre, hyaline, smooth, straight or slightly curved, rounded at both ends, (10.3–)10.8–16.6(–18.5) × (2.0–)2.6–4.4(–4.6) µm (*n* = 50). *Chlamydospores* terminal or intercalary in hyphae, globose to subglobose, sometimes ellipsoidal, smooth, hyaline, 5.5–10.5 µm. *Ascomata* and long stipitate sporodochia not produced.

Habitat: On dead twigs of species of *Ulmaceae* (*Ulmus campestris* and *Ulmus* sp.), also reported by Seifert (1985) on *Planera* sp. (*Ulmaceae*).

Distribution: Europe (Czech Republic, France, UK).

Lectotype of Nectria aurantiaca *designated by Seifert (1985)*. "In Ulmi ramis, Chartres, 7bre, 1854", **Lectotype** PC.

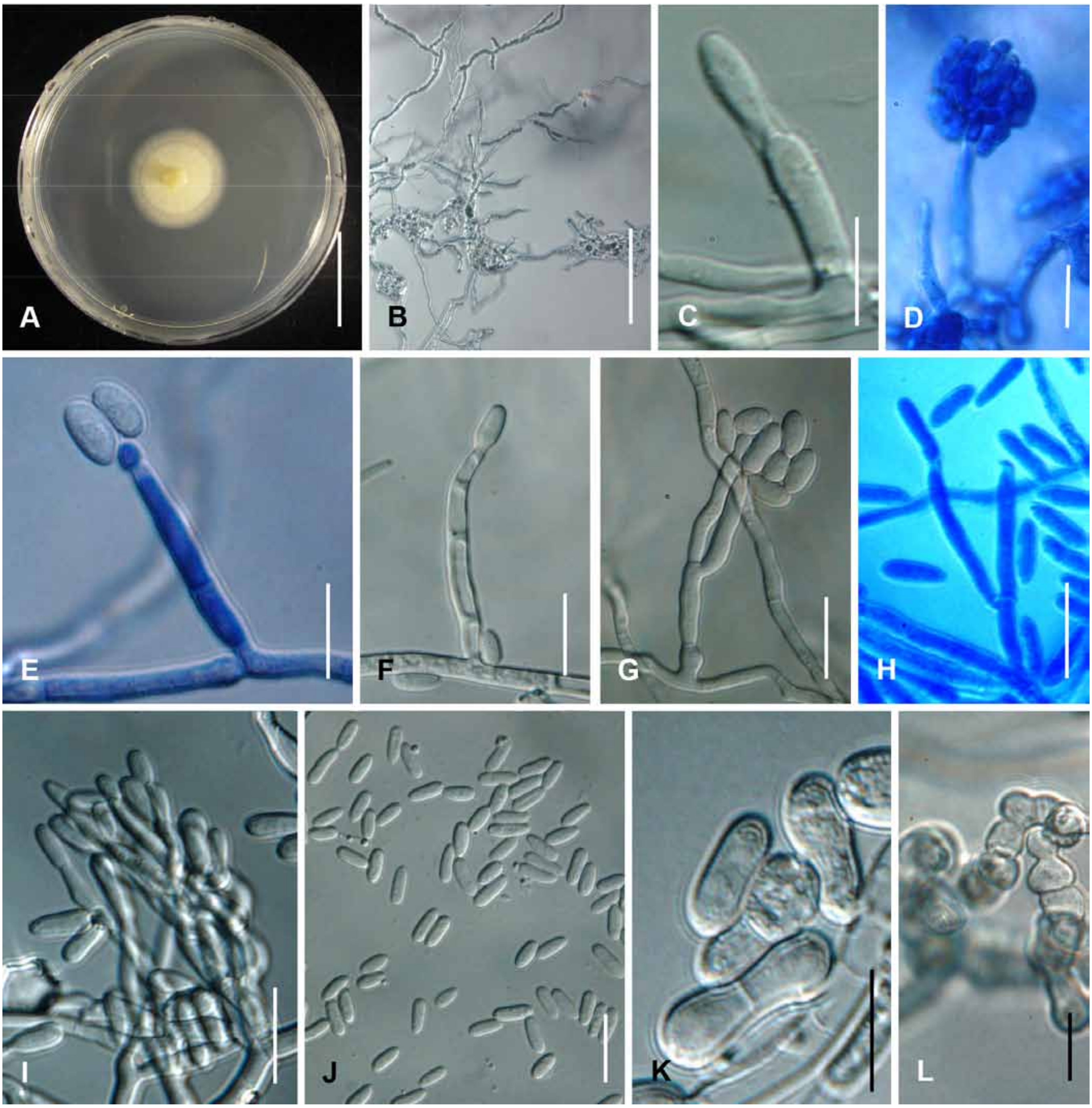

Fig. 17A–L. *Nectria aurantiaca* in culture. A. Cultures after 7 d at 25 °C on PDA; B. Conidiophores and conidial mass produced on the SNA surface; C. Lateral phialidic peg on SNA; D–I. Conidiophores and conidia on SNA; J. Young conidia on SNA; K. Mature conidia on SNA; L. Chlamydospores on SNA. Scale bars: A = 30 mm; B = 500 µm; C = 5 µm; D–L = 10 µm.

Additional type specimens examined: Type of *Dendrostilbella moravica*: **Czech Republic** (as Czechoslovakia), Southern Moravia, Thozatrule, on branches of *Ulmus* sp. or *Acer campestre*, Jul. 1923, J. Hruby, **Holotype** W 20389. Type of *Ditiola tubercularioides*: **France**, "Herb. Cryptog. Arden. No. 470.", **Holotype** Probably in PC but not available. Type of *Stilbum aurantiacum* designated by Seifert in 1985: **Unknown**, on branches of *Ulmus* sp., **Neotype** K 163333.

Additional specimens and isolates examined: **UK**, England, Bristol, on *Ulmus campestris*, CBS 236.29; England, Gloucestershire, on decaying twig of *Ulmus* sp., 23 Sep. 1934, C.G.C. Chesters, CBS 308.34.

Notes: Seifert (1985), Samuels & Seifert (1987), and Seifert & Okada (1990) described and/or illustrated *Tubercularia aurantiaca* and determined that the upper portion of the stipe of *T. aurantiaca* is composed of *textura porrecta* while the lower half is *textura globulosa* or *t. angularis.* The acropleurogenous conidiophores in *T. aurantiaca* are reminiscent of the characteristics of sporodochial *Tubercularia* and this relationship was confirmed by our molecular data (Figs 1, 3). The cultures of *N. aurantiaca* CBS 236.29 and CBS 308.34 were extremely slow growing as also observed by Booth (1959) and produced few conidia and conidiophores after 2 wk at 25 °C. He also confirmed that the anamorph of *N. aurantiaca* is sporodochial in culture.

According to Saccardo (1886) and Seifert (1985), *Ditiola tubercularioides* is a taxonomic synonym of *T. aurantiaca*. The type specimen from PC of *D. tubercularioides* was not available, thus this synonymy could not be confirmed. This synonymy is based on Seifert (1985) who examined this type specimen.

Nectria australiensis Seifert, Stud. Mycol. 27: 109. 1985. Figs 18, 19.

Anamorph: *Tubercularia australiensis* Seifert, Stud. Mycol. 27: 109. 1985.

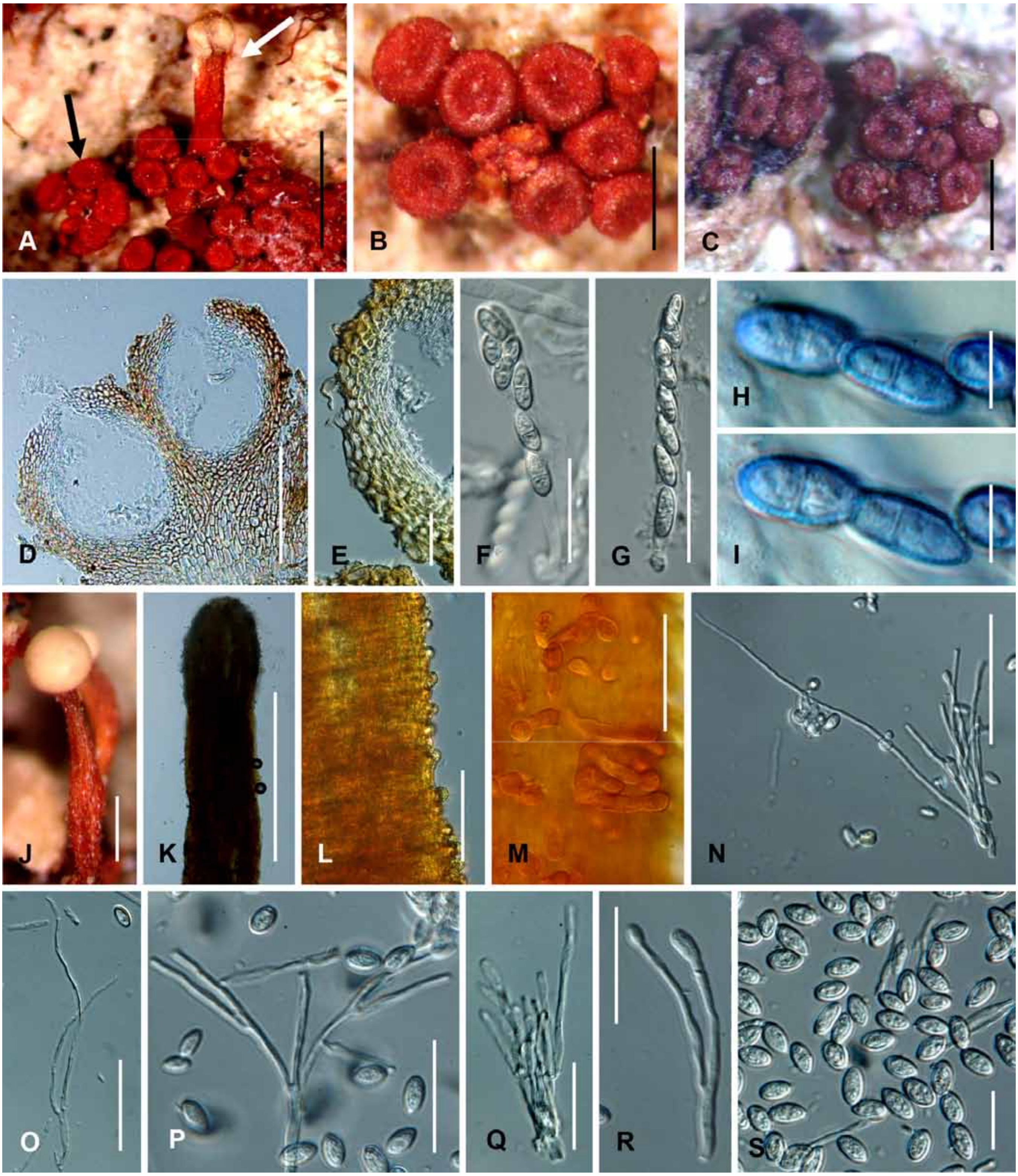

Fig. 18A–S. *Nectria australiensis* on natural substrata (A teleomorph and anamorph, B–I teleomorph, J–S anamorph). A. Perithecia (black arrow) and synnema (white arrow) on natural substrata; B, C. Perithecia on natural substrata; D. Median section of perithecia; E. Median section of perithecial wall; F, G. Asci; H. Ascospores in surface view; I. Ascospores in optical section; J, K. Synnemata on natural substrata; L, M. Ornamental hyphae on stipe; N. Sterile hyphae and conidiophores on natural substrata; O. Sterile hyphae on natural substrata; P–R. Conidiophores on natural substrata; S. Conidia on natural substrata. Scale bars: A = 1 mm; B, C, J, K = 500 µm; D = 300 µm; E–G, L–R = 40 µm; H, I, S = 10 µm.

Teleomorph on natural substrata: *Mycelium* not visible around ascomata or on host. *Stromata* erumpent through epidermis, up to 1.0 mm high and 1.5 mm diam, red to umber, KOH+ dark purple, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, scattered to aggregated in groups of 5–35, subglobose to globose, 200–330 µm high × 200–325 µm diam, slightly cupulate upon drying, sometimes with only a depressed apical region, red to umber, apical region slightly darker, KOH+ dark purple, LA+ yellow, smooth to roughened. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis*, 4–16 µm diam, with pigmented, uniformly *ca.* 1.5 µm thickened walls. *Ascomatal wall* 43–63 µm thick, of two regions: outer region 28–49 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.5 µm thick; inner region 8–16 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* narrowly clavate, 92–

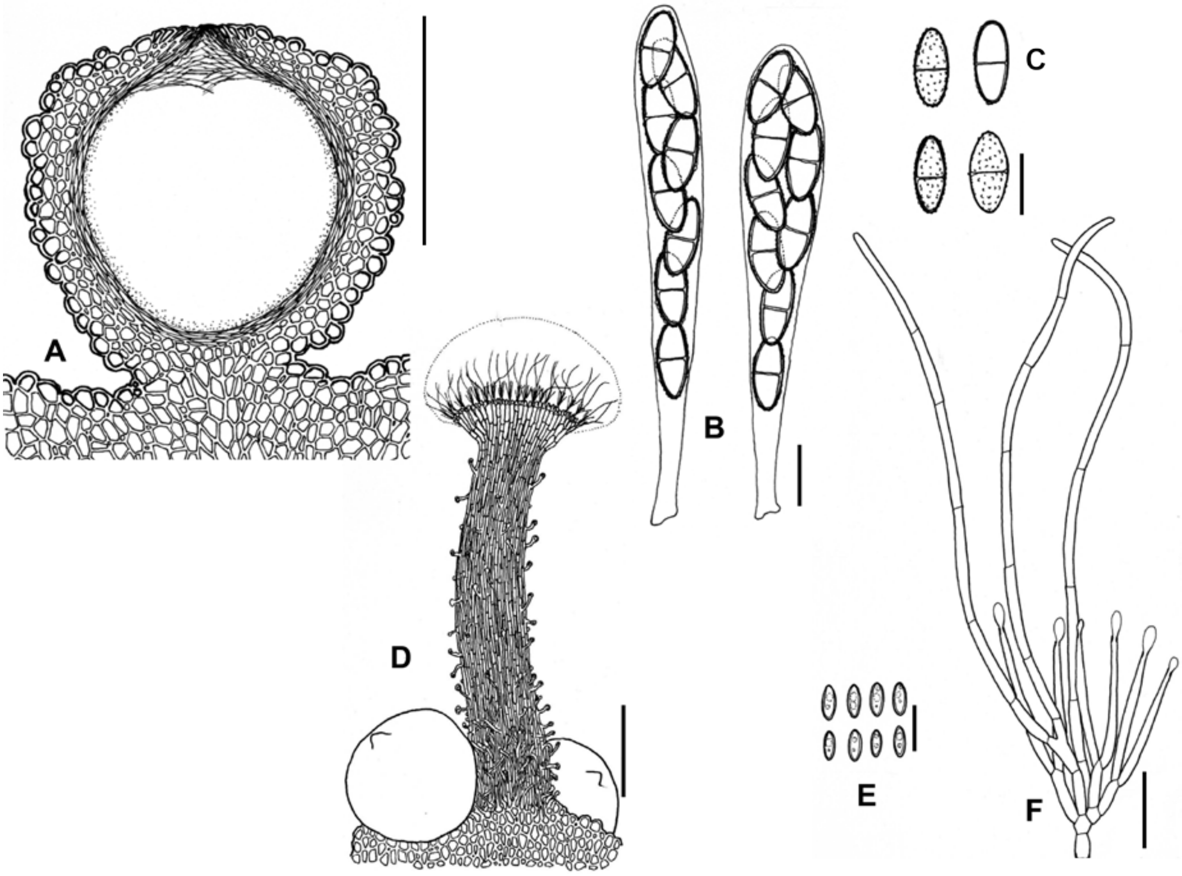

Fig. 19A–F. *Nectria australiensis* on natural substrata (A–C teleomorph, D–F anamorph). A. Median section of mature perithecium; B. Asci; C. Ascospores; D. Median section of synnema; E. Conidia; F. Sterile hyphae and conidiophores. Scale bars: A, D = 200 µm; B, C, E, F = 10 µm.

140 × 7–14 µm, with inconspicuous ring at apex, 8-spored, usually uniseriate, rarely biseriate above, uniseriate below. *Ascospores* ellipsoidal to rarely fusiform, straight, (10.9–)12.0–14.4(–16.4) × (4.6–)5.2–6.6(–8.0) µm (*n* = 90), 1-septate, hyaline to yellowish-brown, weakly spinulose.

Anamorph on natural substrata: *Synnemata* usually erumpent through epidermis, solitary, rarely gregarious, emerging from ascomatal cluster or independently, caespitose, cylindrical-capitate, subulate-capitate, or claviform, erect or nodding, unbranched, slender to medium stature, distinctly hispid at base to mid-level of stalk, some young synnemata smooth to granular, fleshy gelatinous when fresh, red-brown at base, turning blood-red in KOH, almost black in age, 800–1000 µm high including stipe, 250–350 µm wide at base. *Hyphae on stipe* pigmented golden brown at base, becoming less pigmented towards apex, KOH+, 6–10 µm wide; internal hyphae hyaline, KOH–, 4–7 µm wide. *Ornamental hyphae on stipe* cylindrical, straight or curved, rarely sinuous or twisted, arising laterally at more or less right angles, distributed evenly over surface of synnemata or concentrated near base in some collections, or near apex in others, 6–13 µm long, 1.4–2.5 µm wide, usually unbranched but occasionally dichotomously branched, aseptate or with up to 2-septae, septa thin or up to 1 µm thick, terminal hyphae clavate to subglobose, 6–13 µm wide, cell walls 1.5–2 µm thick. *Conidiophores* with long sterile hyphae, branching monoverticillate or biverticillate, whorls compact or diffuse, metulae, if present, 36–65 × 2.0–3.5 µm. *Conidiogenous cells* enteroblastic, monophialidic, cylindrical to subulate, straight or curved, 15–32 × 1.6–3.1 µm, collarette not conspicuous. *Sterile hyphae* mixed with phialides, acicular, curved, rarely straight, unbranched or dichotomously branched, septate, 84–145 × 1.6 –3.7 µm, arising from hyphae in whorls, or more often in groups of conidiophores together with phialides. *Conidial masses* globose, hemisphaerical or more or less discoid, white to saffron when fresh, drying reddish black, 300–500 µm diam. *Conidia* hyaline, ellipsoidal to fusiform, rarely obovate, straight, non-septate, (5.8–)6.7–8.1(–9.6) × (3.3–) 3.7–4.5(–5.1) µm, (*n* = 60), smooth-walled.

Habitat: On bark of *Hoheria populnea (Malvaceae).*

Distribution: Oceania (Australia, New Zealand).

Holotype of Nectria australiensis: **Australia**, Queensland, Brisbane, on bark, F.M. Bailey, No. 157, ex herb. Broome ex herb. F. Currey, **Holotype** K 163335, designated in Seifert, 1985, p. 109.

Additional specimens and isolates examined: **Australia**, Queensland, Brisbane, on bark, ex herb. Broome ex herb. F. Currey, K 163334, possibly **Isotype**. **New Zealand**, Auckland, on *Hoheria populnea*, 4 Jun 1983, A. Rossman, G. Samuels, T. Matsushima, BPI 1105494.

Notes: *Nectria australiensis* has been collected only from Oceania. This species resembles with *Nectria noackiana* in having spinulose ascospores. However, these species differ in ascospore size, *i.e.* 10.9–16.4 × 4.6–8.0 µm in *N. australiensis* and 18.5–30.0 × 7.0–11.0 µm in *N. noackiana*, and distribution, *i.e.* Oceania for *N. australiensis* and South America for *N. noackiana*. Currently, seven species of the genus *Nectria* having synnematal anamorphs are known, namely *N. aurantiaca, N. australiensis, N. neorehmiana*, *N. noackiana*, *N. polythalama*, *N. pseudocinnabarina,* and *N. pseudotrichia.* Among them the anamorph of *N. australiensis* is easily recognised by the clavate to subglobose ends of the synnematal hyphae. The specimen K 163334 is possibly an isotype of *N. australiensis* because most of associated data are the same

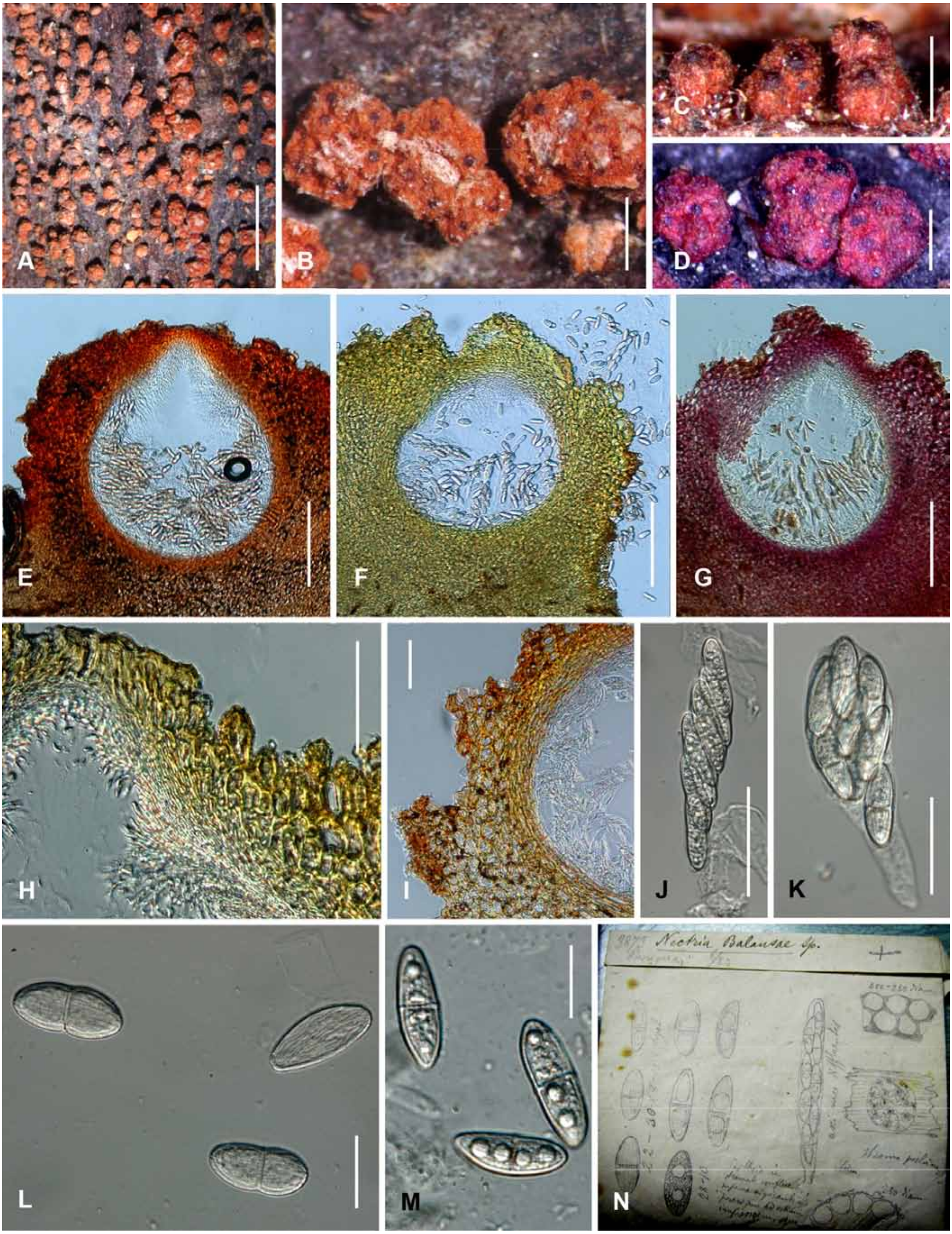

Fig. 20A–N. *Nectria balansae* on natural substrata (A–M teleomorph, N. specimen packet of *Nectria balansae* Holotype: LPS 1574). A–D. Perithecia on natural substrata; E. Median section of perithecium; F. Median section of perithecium in LA; G. Median section of perithecium in KOH; H. Median section of perithecial apex; I. Median section of perithecial wall; J, K. Asci; L. Ascospores in surface view; M. Ascospores in optical section; N. Specimen packet of *Nectria balansae* Holotype: LPS 1574. Scale bars: A = 5 mm; B–D = 500 µm; E–G = 100 µm; H–K = 50 µm; L, M = 20 µm.

as the holotype, and the specimen came from the herb. Broome. However, we did not find the collector name, collecting date, and specimen number on the packet of K 163334; thus, we did not include this specimen as a type.

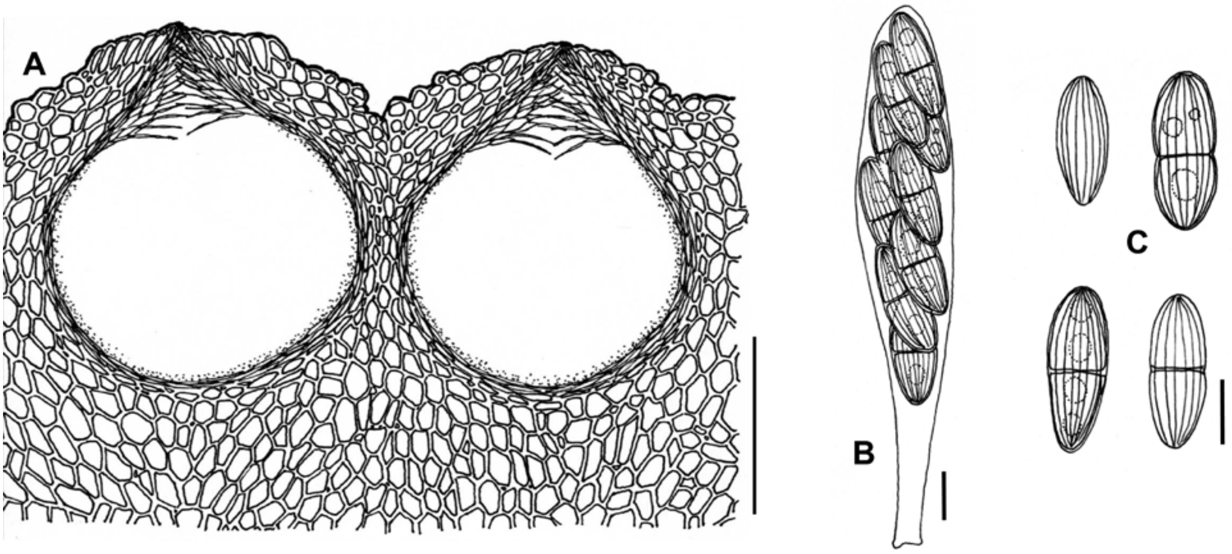

Fig. 21A–C. *Nectria balansae* on natural substrata (A–C teleomorph). A. Median section of mature perithecia; B. Ascus; C. Ascospores. Scale bars: A = 200 µm; B, C = 10 µm.

Fig. 22A–D. Anamorph of *Nectria balansae* in culture. A. Cultures after 7 d at 25 °C on PDA; B. Swollen hyphae on SNA; C, D. Chlamydospores on SNA. Scale bars: A = 3 mm; B–D = 10 µm.

Nectria balansae Speg., Anales Mus. Nac. Hist. Nat. Buenos Aires 19: 36. 1885. Figs 20–22.

= *Nectria sinensis* Teng, Sinensia, Shanghai 4: 272. 1934.

Anamorph: not seen on natural substratum; not sporulating in culture.

Teleomorph on natural substrata: *Mycelium* not visible around ascomata or on host. *Stromata* erumpent through epidermis, up to 3.0 mm high and 3.5 mm diam, red to sienna, KOH+ blood red, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*, intergrading with ascomatal wall. *Ascomata* nearly or completely immersed in erumpent, aggregated in groups of 3–28, red, subglobose to globose, 318–520 µm high × 326–587 µm diam, not collapsing when dry, apical region slightly darker, KOH+ dark purple, LA+ yellow, wall warted. *Ascomatal surface cells* at edge of stroma forming *textura globulosa* or *t. angularis*, 5–17 µm diam, with pigmented, uniformly *ca.* 2.5 µm thickened walls; ascomatal warts apricot to red, 45–75 µm high, larger in upper part of ascomata or around ostiole. *Ascomatal wall* at edge of stroma 68–103 µm thick, of two regions: outer region 55–75 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 2.0 µm thick; inner region 21–30 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* clavate, 97–132 × 20–27 µm, with inconspicuous ring at apex, 8-spored, mainly biseriate above, uniseriate below. *Ascospores* ellipsoidal, fusiform to long oblong, straight to rarely slightly curved, (19.0–)23.7–29.9(–32.6) × (6.2–)8.3–11.1(–13.0) µm (n = 90), (0–)1-septate, hyaline to slightly yellowish-brown, finely striate.

Anamorph in culture: After 7 d at 25 °C, colonies 45–85 mm (average 65 mm) diam. *Colony surface* cottony with aerial mycelium whitish yellow; *aerial mycelium* restricted to centre; *reverse* whitish yellow to yellow in centre and white at margin. *Odour* on PDA slightly fruity. *Conidiophores* and *conidia* absent. *Chlamydospores* intercalary in hyphae, golobose to subglobose, sometimes ellipsoidal, smooth, hyaline, 10–17 µm. *Swollen hyphae* abundantly formed, intercalary in normal hyphae, smooth, hyaline, of 2–8 cells, 37–140 µm long, 5–11 µm wide.

Habitat: On dead or living woody bark of twigs or branches, known from *Coronilla* sp. (*Fabaceae*).

Distribution: Asia (China, India, Japan), Europe (France), South America (Brazil, Paraguay).

Holotype of Nectria balansae: **Paraguay**, Guarapí, on bark, Jun. 1883, B. Balansa, No. 3873, **Holotype** LPS 1574, **Isotype** BPI 802555 microscope slide only.

Additional type specimens examined: Type of *Nectria sinensis*: **China**, Foochow, Fukien, Teng's Garden, on twigs, 8 Nov. 1933, S.C. Teng, No. 1899, **Lectotype** designated herein, BPI 551019; Anhwei, Chiu-Hua-Shan, on twigs, 18 Sep. 1933, S.C. Teng, No. 358, **Paratype** BPI 551021; Anhwei, Chiu-Hua-Shan, on twigs, 18 Sep. 1933, S.C. Teng, No. 359, **Paratype** BPI 553091.

Additional specimens and isolates examined: **Brazil**, no additional data, BPI 1109082; J. Rick, BPI 715458. **China**, Hainan, China Yen–Hsien, on twigs, 18 Jun. 1934, S.Q. Deng, BPI 553092; Hainan, Yen–Hsien, on twigs, 18 Jun. 1934, S.Q. Deng, BPI 553092; Hainan, Ledong County, Jianfengling, on twig, 9 Dec. 2000, W.Y. Zhuang, X.M. Zhang, Z.H. Yu, culture CBS 129349 = A.R. 4635; Hainan, Ledong County, Jianfengling, on twig, 9 Dec. 2000, W.Y. Zhuang, X.M. Zhang, Z.H. Yu, culture CBS 124070; Kwangsi, Yangso, on twigs, 28 Mar. 1938, S.C. Teng, BPI 550739, BPI 550742; Kwangsi, Yangso, on twigs, 23 Mar. 1938, S.C. Teng, BPI 551018; on twigs, 6 Jun. 1934, S.Q. Deng, BPI 551015. **France**, Villiers en Bois, on *Coronilla* sp., 2 Jul. 2007, C. Lechat CLL 7123, BPI 878477, culture CBS 123351 = A.R. 4446; Villiers en Bois (79), Virollet, on *Coronilla* sp., 15 Jul 2010, C. Lechat CLL 10009, BPI 881080. **India**, Glen, Simla, Himachal Pradesh, 26 Jul. 1971, J.S. Dargan, BPI 550144 as *Nectria aurantiaca*. **Japan**, Tokyo, Minato-ku, Akisinomiya Tei, on bark, 11 Jul. 2003, S. Inaba, BPI 881057 = TUA-TPP-h152, culture MAFF 241419.

Notes: *Nectria balansae* was redescribed and illustrated by Samuels & Brayford (1994). This fungus is morphologically similar to *N. sordida* that has been considered a taxonomic synonym of *N. balansae* especially in having striate ascospores (Fig. 20L). However, the two species have subtle differences including the number of septae and size of the ascospores and absence/presence of a pycnidial anarmoph in culture. Our molecular phylogeny also suggests that, although closely related, these species are distinct (Figs 1, 3).

Nectria sinensis, a synonym of *N. balansae*, was collected in China and described by Teng (1934). Unfortunately, the holotype specimen was destroyed during the Second Sino-Japanese War. We designate here a duplicate type specimen at BPI as lectotype.

Nectria berberidicola Hirooka, Lechat, Rossman & P. Chaverri, **sp. nov.** MycoBank MB519699. Figs 23–25.

Holotype: **France**, Hautes-Alpes (05), commune of Saint André d'Embrun, hameau des Jourcins, western side of the Mont Orel, 1040 m., N44 °35'59.3", E006 °33'03.1", on *Berberis vulgaris*, 22 Dec. 2008, Y. Mourgues, comm. C. Lechat CLL 7199, **Holotype** LIP YMNC083; **ex-holotype** culture A.R. 4662 = CIRM 1207 = CBS 128669.

Etymology: *berberidi* + *-cola*; indicates the host, *Berberis*, of this fungus.

Anamorph: sporodochial, tubercularia-like

Teleomorph on natural substrata: *Ascomata and pycnidia* sometimes formed on same or discrete stroma. *Mycelium* not visible around ascomata or on host. *Stromata* erumpent through epidermis, up to 1.5 mm high and 2.5 mm diam, red to umber, KOH+ purple, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*, intergrading with ascomatal wall. *Ascomata* superficial, aggregated in groups of 4–32, sienna to umber, subglobose to globose, 337–447 µm high × 298–388 µm diam, rarely cupulate when dry, apical region darker, KOH+ dark purple, LA+ yellow, warted wall. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis*, 6–14 µm diam, with pigmented, uniformly *ca.* 2.0 µm thickened walls; ascomatal warts orange to red, 36–52 µm high. *Ascomatal wall* 44–71 µm thick, of two regions: outer region 37–55 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 2.0 µm thick; inner region 10–28 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* clavate, 80–97 × 11–15 µm, with inconspicuous ring at apex, 8-spored, mainly uniseriate to partly biseriate. *Ascospores* ellipsoidal to fusiform, rounded at both ends, straight to slightly curved, (13.3–)15.9–19.5(–24.7) × (3.9–)5.3–6.6(–7.6) µm (*n* = 50), 1-septate, hyaline, finely spinulose.

Anamorph on natural substrata: *Stromata* erumpent through epidermis, red. *Sporodochial conidiomata* without stipe, superficial on well-developed stromata, smooth, cerebriform or tuberculate, scattered, solitary, astipitate, sessile, pustular, discoid or cylindrical-capitate, up to 100–400 µm high, 250–400 µm wide, white, whitish yellow to orange. *Stipe* absent. *Hymenium* arising directly from *textura prismatica* elongating from *textura angularis*, up to 60 µm long, cells 2.0–5.5 µm wide, not curved at margin. *Conidiophores* monoverticillate or sometimes biverticillate, then developing acropleurogenously for 2–4 levels, straight, curved hyaline. *Conidiogenous cells* enteroblastic, monophialidic, cylindrical to subulate, straight or curved, 15–37 µm long, 1.5–2.3 µm wide, collarette not conspicuous. *Acropleurogenous conidiophores* mixed with phialides, acicular, usually curved, unbranched or dichotomously branched, then developing acropleurogenously for 2–4 levels, septate, 128–178 × 2.5–4.4 µm, arising from hyphae in whorls, or more often in groups of conidiophores together with phialides. *Acropleurogenously developing phialides* intercalary occurring below each septum, or rarely terminal; *intercalary phialides* monophialidic, 2.5–5.5 µm long, 1.5–2.5 µm wide at base; *terminal cells* monophialidic, sometimes sterile, no collarettes, 4.5–12 µm long, 2.0–2.5 µm wide at base. *Conidia* hyaline, narrowly long ellipsoidal to cylindrical, straight or slightly curved, non-septate, (7.6–)8.5–10.3(–11.8) × (2.3–)2.6–3.4(–3.9) µm (*n* = 50).

Anamorph in culture: After 7 d at 25 °C, colonies 11–15 mm (average 13 mm) diam. *Colony surface* sometimes slightly cottony with aerial mycelium, white to whitish yellow; *aerial mycelium* developed; *reverse* white to slightly whitish yellow. *Odour* on PDA slightly fruity. *Sporodochia* long stipitate, orange, two developed in culture. Sporulation on SNA from *lateral phialidic pegs* abundant, ellipsoidal and slightly tapering toward tip or flask-shaped, 2.5–5.0 µm long, 1.7–2.7 µm wide at base. *Conidiophores* occasionally developing on aerial hyphae, unbranched, sometimes verticillate, 1-2-branched, becoming loosely to moderately densely branched, 13.2–47 µm long, 2.1–3.4 µm wide at base. *Conidiogenous cells*, monophialidic, cylindrical and slightly tapering toward tip, 10.8–19.5 µm long, 2.3–3.6 µm wide at base. *Young conidia* formed by monophialides on submerged, aerial hyphae or repent, formed abundantly on slimy heads, non-septate, ellipsoidal, oblong to cylindrical, hyaline, smooth, straight or slightly curved, rounded at both ends, (4.8–)5.6–7.4(–8.2) × (1.9–)2.2–3.0(–3.3) µm (*n* = 50). *Mature conidia* swollen, 0–1-septate, oblong to cylindrical with sometimes constricted centre, hyaline, smooth, straight or slightly curved, rounded at both ends, (10.4–)12.6–14.1(–18.3) × (2.4–)2.9–3.8(–4.2) µm (*n* = 50). *Chlamydospores* intercalary in hyphae, golobose to subglobose, sometimes ellipsoidal, smooth, hyaline, 5.7–13.5 µm. *Ascomata* not produced in culture.

Habitat: On *Berberis vulgaris (Berberidaceae)*.

Distribution: Europe (France).

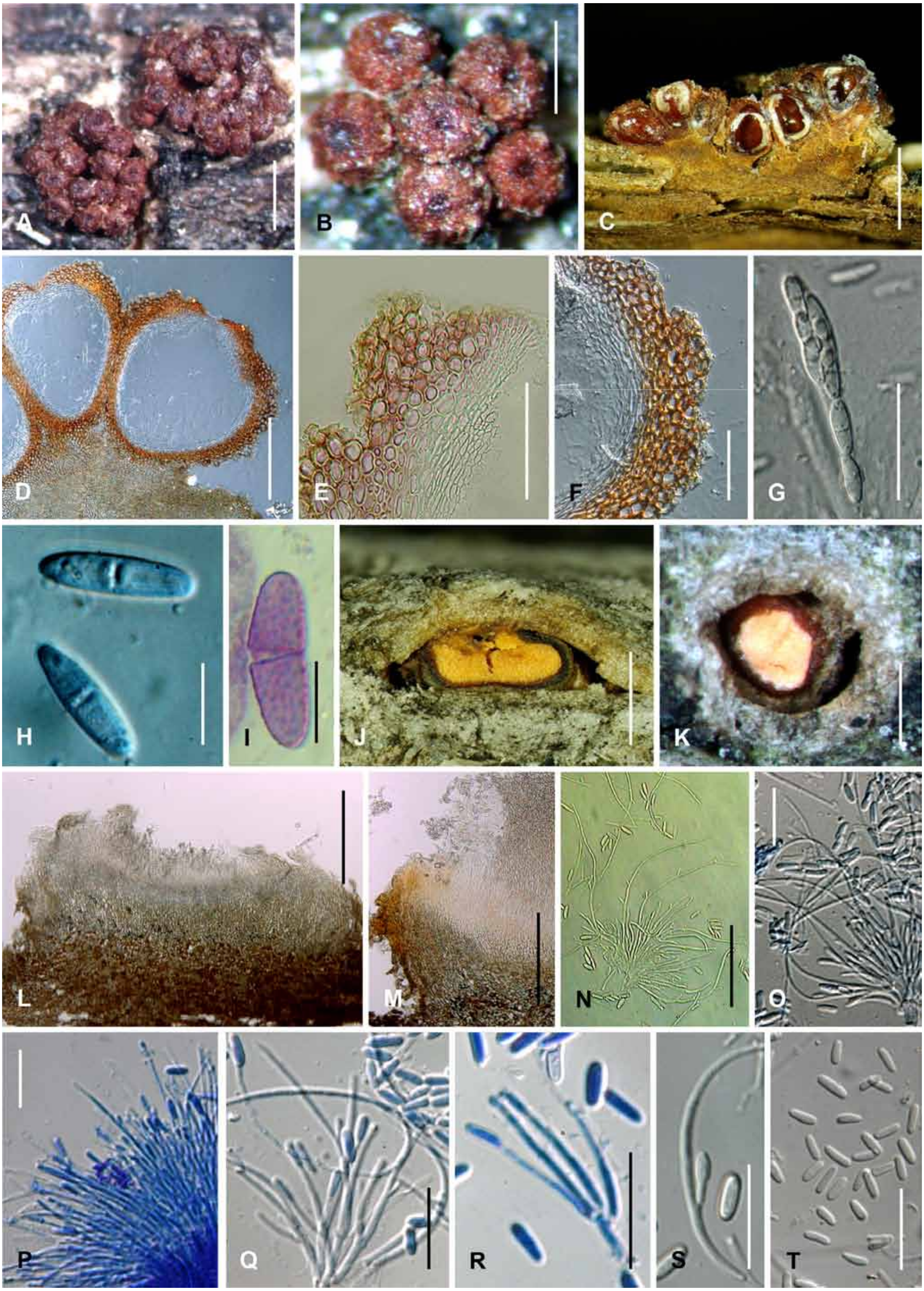

Fig. 23A–T. *Nectria berberidicola* on natural substrata (A–I teleomorph, J–T anamorph). A, B. Perithecia on natural substrata; C, D. Median section of perithecia; E. Median section of perithecial apex; F. Median section of perithecial wall; G. Ascus; H, I. Ascospores in surface view; J, K. Sporodochia on natural substrata; L, M. Median section of sporodochia; N–Q. Acropleurogenous conidiophores and verticillate conidiophores on natural substrata; R. Verticillate conidiophores on natural substrata; S. Acropleurogenously developing phialides on natural substrata; T. Conidia on natural substrata. Scale bars: A = 1 mm; B, C, J, K = 300 µm; D, L = 100 µm; E–G, M, N, O = 50 µm; H, I = 10 µm; P–T = 20 µm.

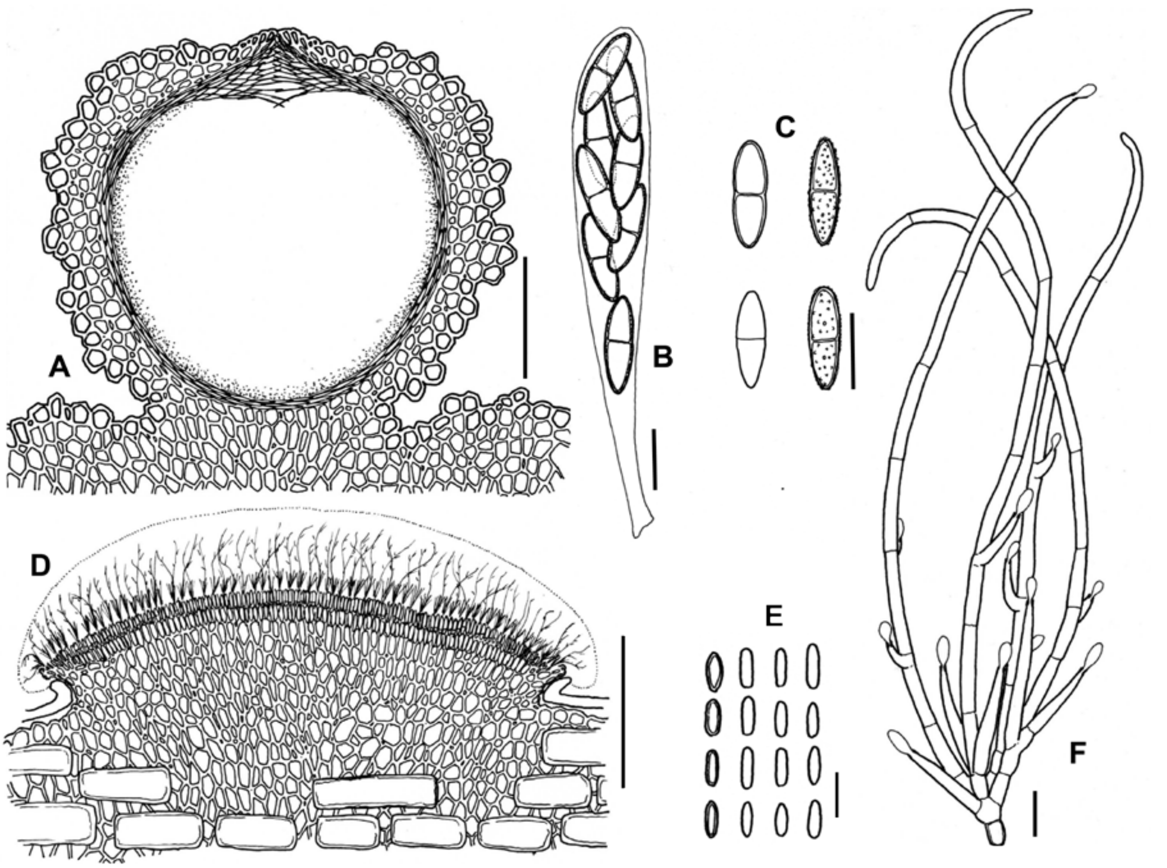

Fig. 24A–F. *Nectria berberidicola* on natural substrata (A–C teleomorph, D–F anamorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores; D. Median section of astipitate sporodochium; E. Conidia; F. Acropleurogenous conidiophores and verticillate conidiophores. Scale bars: A, D = 100 µm; B, C, E, F = 10 µm.

Additional specimens and isolates examined: **France**, Jourcin (05), on *Berberis vulgaris*, 22 Dec. 2008, Y. Mourgues, LIP = C.L.L. 644 = BPI 881032; culture A.R. 4582 = CBS 131746.

Notes: *Nectria berberidicola* is similar to *Nectria himalayensis*, however, *N. berberidicola* possesses narrower ascospores (3.9–7.6 µm *vs.* 7.3–10.6 µm), smaller conidia in nature (7.6–11.8 × 2.3–3.9 µm *vs.* 9.4–13.3 × 3.8–6.8 µm), and astipitate sporodochial anamorph, which are short stipitate in *N. himalayensis*, and was collected only from France while *N. himalayensis* is known only from the Himalayas. In terms of morphological characters in culture, *N. berberidicola* is almost identical with *N. antaractica*. However, the surface of mature conidia is smooth in *N. berberidicola* while roughened in *N. antarctica*, and *N. antarctica* produces abundant lateral phialidic pegs.

In our phylogenetic tree, *N. berberidicola* groups with *N. aurantiaca* and *N. cinnabarina*, both of which possess long stipitate sporodochia (Figs 1, 3). Surprisingly, *N. berberidicola* in culture forms long stipitate sporodochia on SNA although we observed only sessile sporodochia of *N. berberidicola* on natural substratum (Figs 23J, K, 24D, 25P).

These three species, *N. aurantiaca*, *N. berberidicola*, and *N. himalyensis*, were collected from relatively high elevations or cold latitudes. The colony growth rate of *N. aurantiaca* and *N. berberidicola* on PDA at 25 °C is slow. These three species are morphologically similar to the *Nectria cinnabarina* species complex known from low elevations in temperate regions. Among these species only *N. aurantiaca*, *N. berberidicola,* and *N. himalayensis* appear to be adapted to high elevations or cold latitudes.

Nectria canadensis Ellis & Everh., Bull. Torrey Bot. Club 11: 74. 1884. Figs 26, 27.

≡ *Calonectria canadensis* (Ellis & Everh.) Berl. & Voglino, Syll. Fung. Addit. 1–4: 212. 1886.

≡ *Scoleconectria canadensis* (Ellis & Everh.) Seaver, Mycologia 1: 199. 1909.

Anamorph: *Tubercularia grayana* (Sacc. & Ellis) Seifert, Stud. Mycol. 27: 112. 1885.

≡ *Ciliciopodium grayanum* Sacc. & Ellis, Michelia 2: 581. 1882.

= *Dendrostilbella ulmi* Dearness, Mycologia 16: 175. 1924.

Teleomorph on natural substrata: *Mycelium* not visible around ascomata or on host. *Stromata* erumpent through epidermis, up to 8.0 mm high and 1.5 mm diam, sienna, KOH+ dark purple, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis* or *t. globulosa*, intergrading with ascomatal wall. *Ascomata* superficial on stroma, well-developed stipe of anamorph, or around base, aggregated in groups of 5–20, subglobose to globose, 300–425 µm high × 300–350 µm diam, cupulate when dry, sometimes with only a depressed apical region, red to bay, apical region slightly darker, KOH+ dark purple, LA+ yellow, smooth to rough. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis*, 4–10 µm diam, with pigmented, uniformly *ca.* 1.5 µm thickened walls. *Ascomatal wall* 35–60 µm thick, of two regions: outer region 25–40 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.5 µm thick; inner region 10–20 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* clavate, 60–100 × 15–23 µm, with inconspicuous ring at apex, 8-spored, mainly biseriate. *Ascospores* ellipsoidal to long-ellipsoidal, straight to slightly curved, with broadly rounded ends, (18.6–)19.6–22.6(–24.8) × (5.5–)8.0–9.0(–10.0) µm (*n* = 50), (1–)3-septate, sometimes slightly constricted at middle or all septae, hyaline, straight or curved, smooth. Two specimens (BPI 631953 and BPI 631954) producing ascoconidia-like structures outside asci.

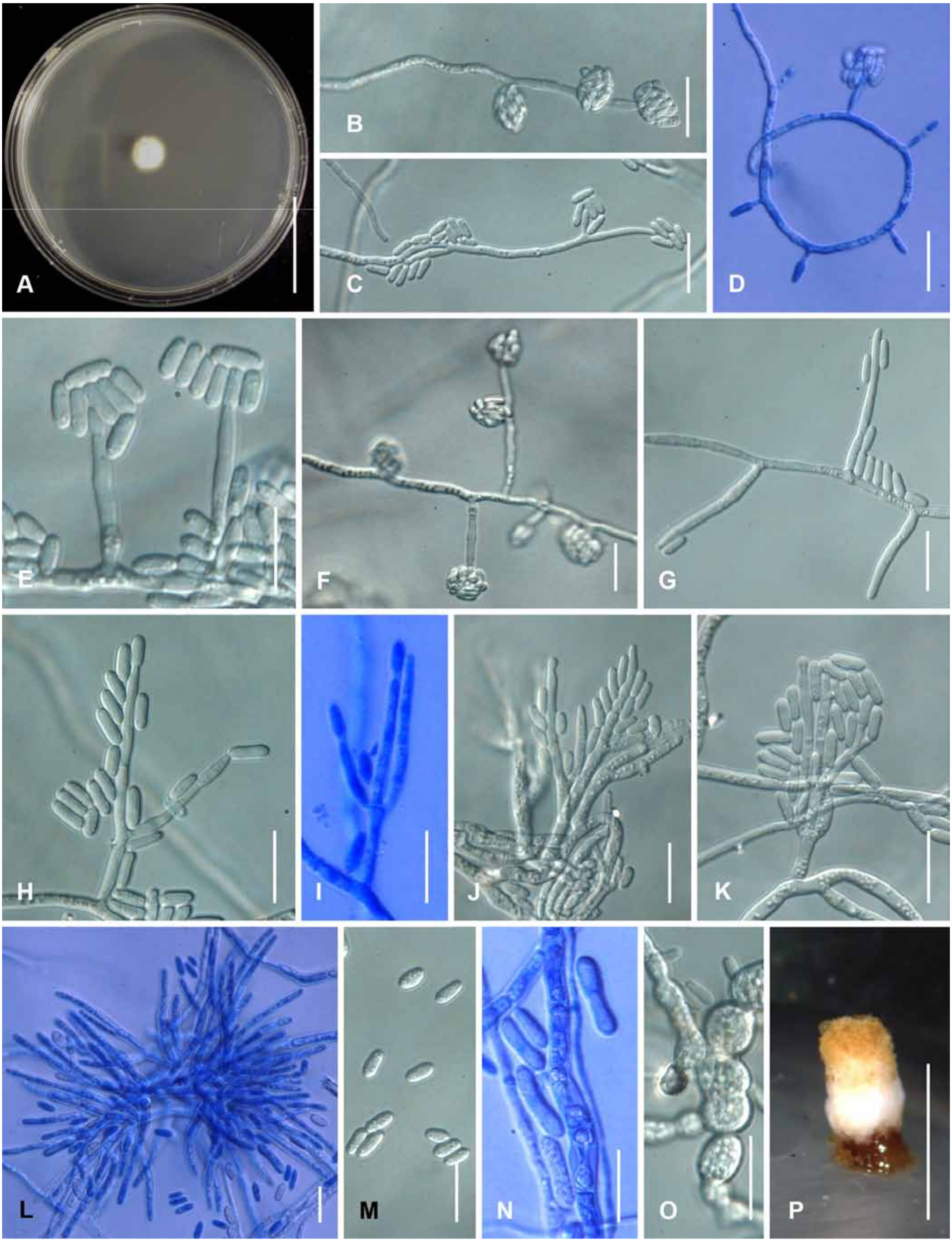

Fig. 25A–P. Anamorph of *Nectria berberidicola* in culture. A. Cultures after 7 d at 25 °C on PDA; B–D. Lateral phialidic pegs and conidia on SNA; E–L. Conidiophores on SNA; M. Young conidia on SNA; N. Mature conidia on SNA; O. Chlamydospores on SNA; P. Long stipitate sporodochia on SNA. Scale bars: A = 30 mm; B–O = 10 µm; P = 500 µm.

Anamorph on natural substrata: *Stromata* erumpent through epidermis, red to sienna. *Sporodochial conidiomata* developing on stroma having long stipe, smooth or cerebriform, scattered, solitary, or 2–6 gregarious, unbranched, erumpent through epidermis, 500–8000 µm tall (averaging > 2500 µm), 500–1500 µm diam at base, lower part of stipe scarlet to bay, KOH+ dark purple, stipe becoming pale toward apex. *Stipe wall* of two regions: outer region 100–530 µm thick, cells forming *textura globulosa* or *t. prismatica*,

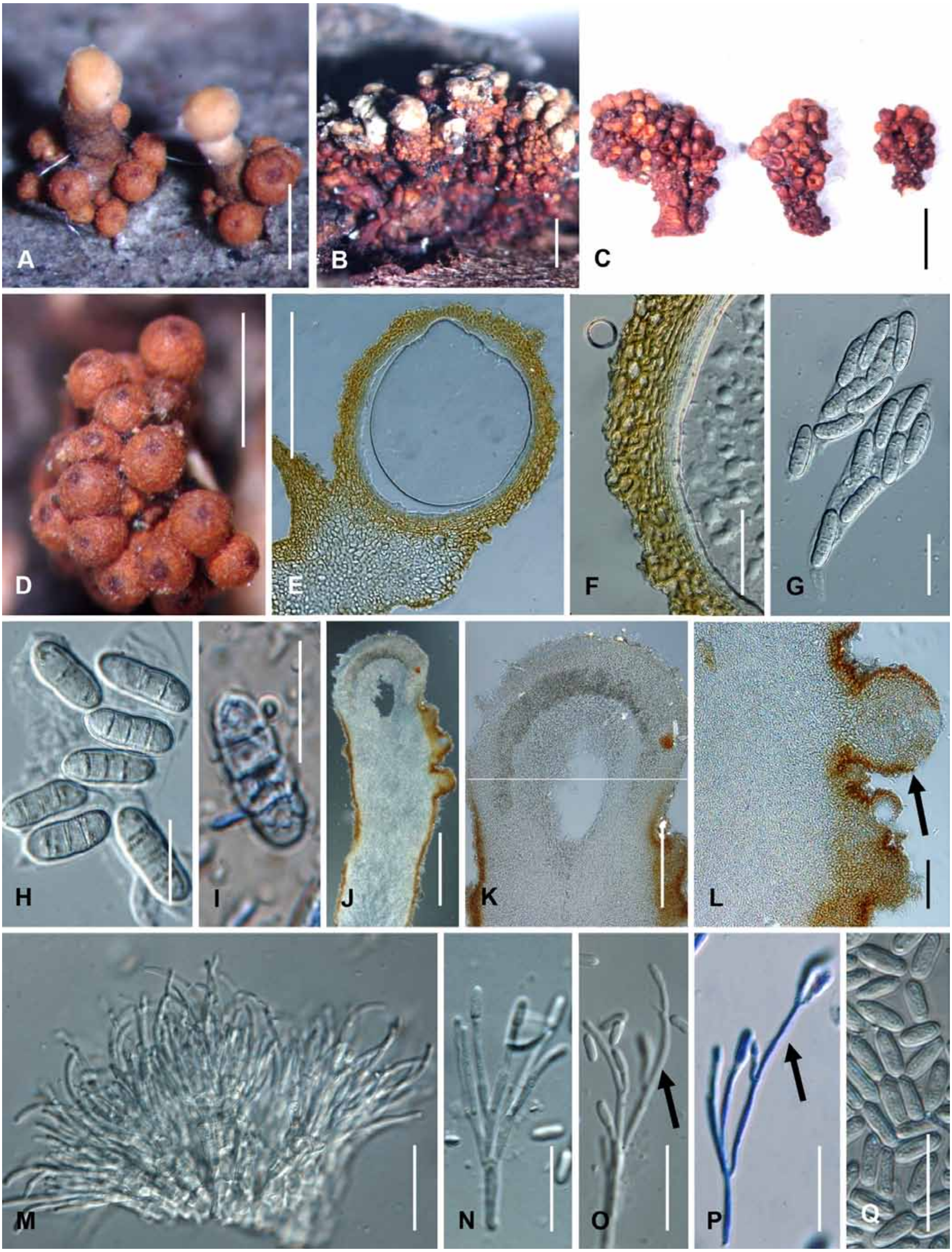

Fig. 26A–Q. *Nectria canadensis* on natural substrata (A–C teleomorph and anamorph, D–I teleomorph, J–Q. anamorph). A–C. Perithecia and long stipitate sporodochia on natural substrata; D. Perithecia on natural substrata; E. Median section of perithecium; F. Median section of perithecial wall; G. Asci; H. Ascospores; I. Budding ascospore; J. Median section of long stipitate sporodochia; K. Median section of hymenium; L. Median section of long stipitate sporodochial wall and immature perithecium (arrow); M. Abundant conidiophores on natural substrata; N. Verticillate conidiophores on natural substrata; O, P. Short acropleurogenous conidiophores (black arrows) and verticillate conidiophores on natural substrata; Q. Conidia on natural substrata. Scale bars: A, D, J = 1 mm; B, C = 3 mm; E, K = 300 µm; F, L, M = 50 µm; G, H, I, N–P = 20 µm; Q = 10 µm.

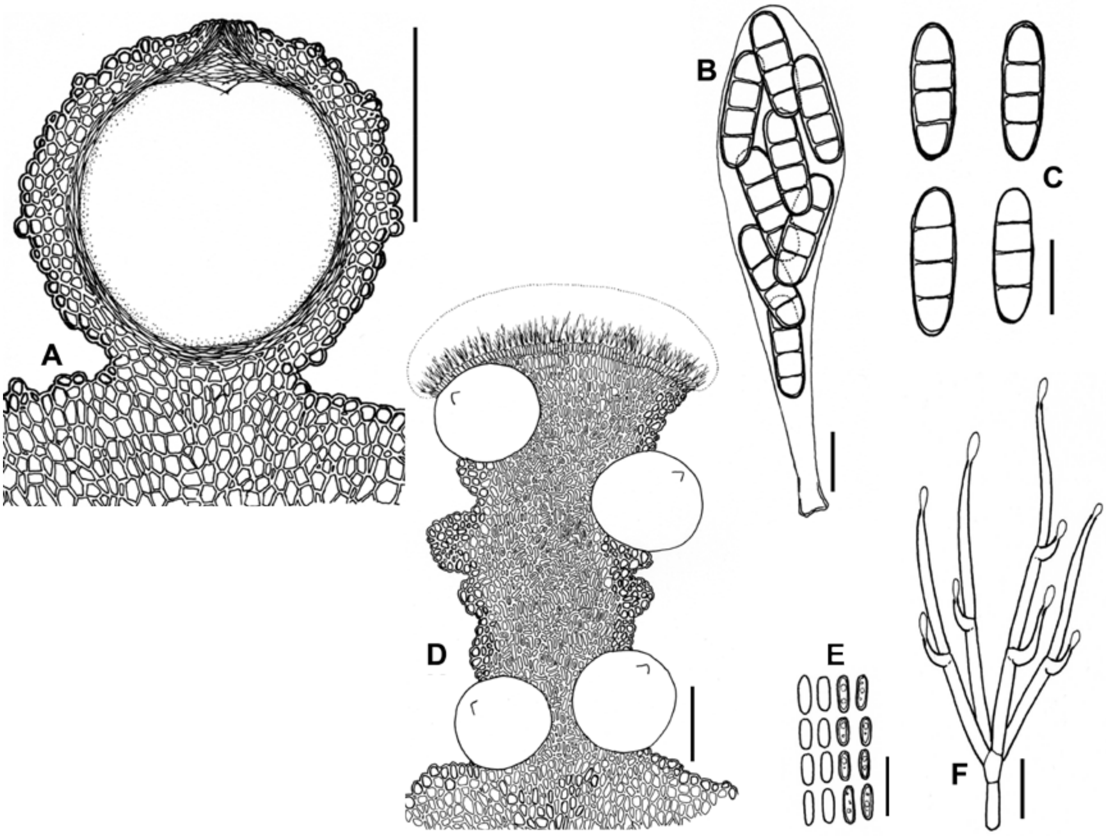

Fig. 27A–F. *Nectria canadensis* on natural substrata (A–C teleomorph, D–F anamorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores; D. Median section of long stipitate sporodochia; E. Conidia; F. Short acropleurogenous and verticillate conidiophores. Scale bars: A, D = 200 µm; B, C, E, F = 10 µm.

walls hyaline, about 0.5 µm thick; inner region 150–1000 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica* or *t. epidermoidea*. *Middle of stipe* sometimes hollow. *Hymenium* arising directly from *textura prismatica,* elongating from *textura angularis*, up to 86 µm long, of cells 2.0–6.0 µm wide, without curved margin. *Conidiophores* verticillate, branching twice or three times, 30–75 µm long, 1.5–4.0 µm wide, then developing acropleurogenously for 1–3 levels, curved, hyaline. *Conidiogenous cells* enteroblastic, monophialidic, cylindrical to subulate, straight to slightly curved, cylindrical and subulate with widest point in middle to base, 15–35 × 1.5–3 µm. *Conidiophores* with phialides or shirt acropleurogenous conidiophores, branching verticillate, 1–3 branched, whorls compact or diffuse, 30–75 µm long, 1.5–4.0 µm wide. *Conidiogenous cells* enteroblastic, monophialidic, subulate, straight or curved, 13–35 µm long, 1.5–2.5 µm wide, collarette not conspicuous. *Short acropleurogenous conidiophores* mixed with phialides, acicular, curved, unbranched or dichotomously branched, then developing acropleurogenously for 1–3 levels septate, 44–78 × 1.7–3.0 µm, arising in groups of conidiophores together with phialides. *Acropleurogenously developing phialides* intercalary, occurring below each septum, rarely terminal; *intercalary phialides* monophialidic, up to 3.0–5.5 µm long, 1.5–2.5 µm wide; *terminal cells* monophialidic, sometimes sterile, without collarette. *Conidia* hyaline, ellipsoidal, sometimes slightly curved, non-septate, (5.1–) 5.9–7.5(–8.6) × (2.1–)2.5–3.3(–3.6) µm (*n* = 50), smooth-walled.

Habitat: On bark of dead *Ulmus americana* and *Ulmus* sp. (*Ulmaceae*).

Distribution: North America (Canada, USA).

Neotype of Nectria canadensis *designated by Rossman (1983)*: **Canada**, Ontario, Ottawa, on limb bark, 28 Sep. 1883, J.M. Macoun, No. 225, **Neotype** NY 00927908.

Holotype of Tubercularia grayana: **USA**, Michigan, on dead limb, Oct. 1881, J.B. Gray, **Holotype** NY 00936856.

Additional type specimens examined: Type of *Dendrostilbella ulmi*: **USA**, New York, Washington Co., Vaughns, on limbs of *Ulmus americana*, 26 Jun. 1916, S.H. Bernham, **Holotype** DAOM.

Additional specimens and isolates examined: **USA**, New York, Clyde, Sep. 1887, O.F. Cook, BPI 1107514; New York, Clyde, Sep. 1887, O.F. Cook, BPI 1107515; Vermont, Middleburg, Swamp, 26 Mar. 1896, A.B. Langlois, BPI 631950: **Canada**, Ontario, London, Jan. 1892, J. Dearness, BPI 550747; Ontario, London, Aug. 1893, J. Dearness, BPI 550747; Ontario, London, Aug. 1893, J. Dearness, BPI 631951; Ontario, London, on *Ulmus* sp., Aug. 1893, J. Dearness, BPI 631952; Ontario, London, on *Ulmus* sp., May 1893, J. Dearness, BPI 631953; Ontario, London, on *Ulmus* sp., May 1893, J. Dearness, BPI 631954; Ontario, London, on *Ulmus* sp., May 1893, J. Dearness, BPI 631955; Ontario, London, on *Ulmus* sp., Aug. 1893, J. Dearness, BPI 631956; Ontario, London, on bark fragments, Dec. 1889, J. Dearness, NY 00927909; Ontario, London, on bark fragments, Dec. 1889, J. Dearness, NY 00927910; Ontario, London, Des. 1889, J. Dearness, Ellis & Everhart, North American Fungi. No. 2547, BPI-bound exsiccati.

Notes: *Nectria canadensis* has been collected only on *Ulmus* in Canada and the United States. At first glance, the morphology of this species is reminiscent of the genus *Corallomycetella* in the *Nectriaceae* that also produces ascomata around the stipe of the synnematal anamorph. However, these fungi are easily distinguished by differences in ascomatal wall anatomy. Within the genus *Nectria*, *N. canadensis* resembles *N. neorehmiana* in having smooth, three-septate ascospores, but these species differ in ascomatal colour, red to bay in *N. canadensis* and scarlet to dark scarlet in *N. neorehmiana*, and ascospore size, 18.6–24.8

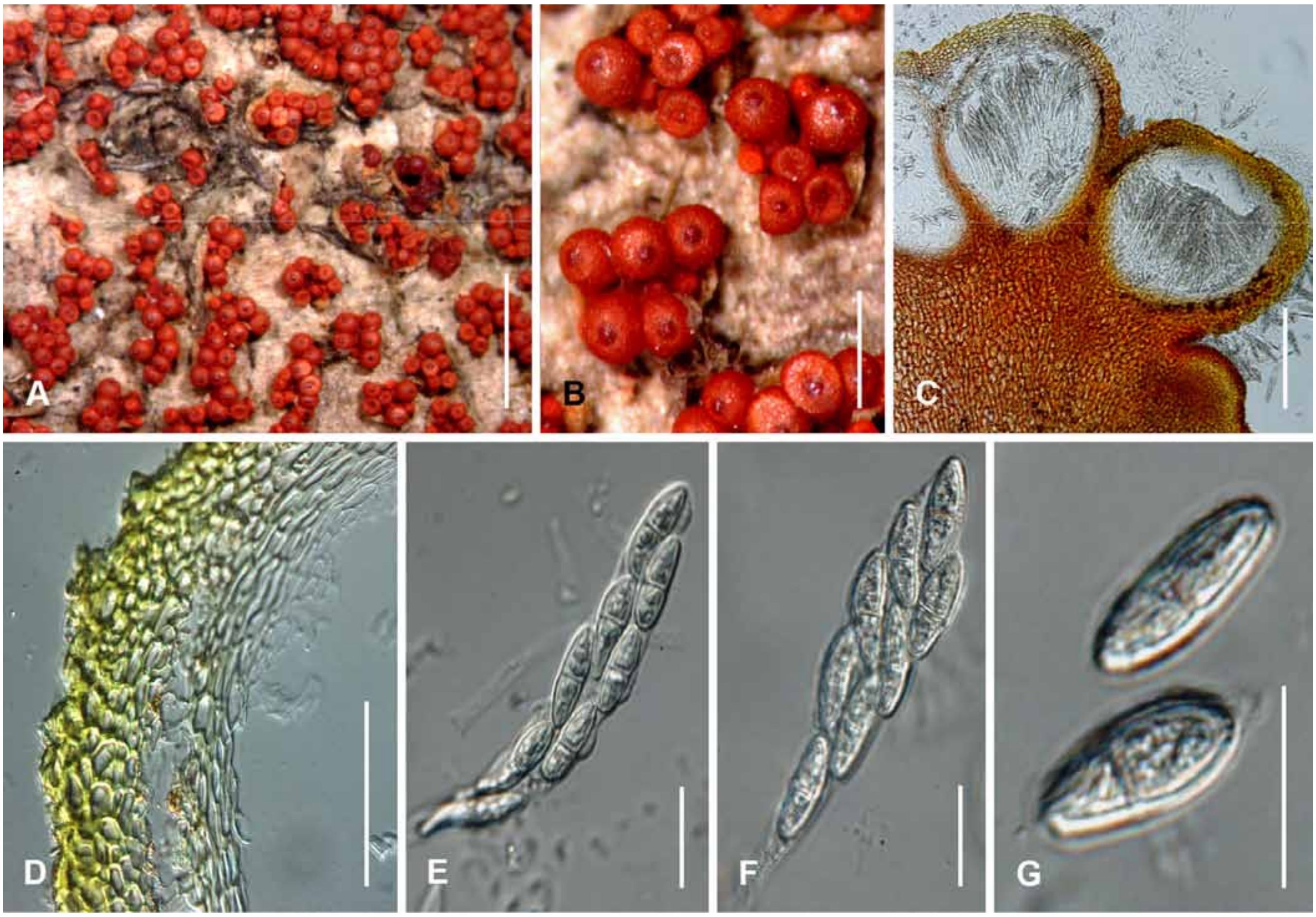

Fig. 28A–G. *Nectria cingulata* on natural substrata. A, B. Perithecia on natural substrata; C. Median section of perithecia; D. Median section of perithecial wall; E, F. Asci; G. Ascospores. Scale bars: A = 1 mm; B = 500 µm; C= 100 µm; D = 50 µm; E–G = 20 µm.

× 5.5–10.0 µm in *N. canadensis* and 30.2–39.1 × 6.0–9.3 µm in *N. neorehmiana*. In addition, the anamorph of *N. canadenisis* forms long stipitate sporodochia while *N. neorehmiana* forms synnemata.

Nectria canadensis was first described by Ellis & Everhart (1884) and re-described by Rossman (1983) and Seifert (1985). According to their descriptions, *N. canadensis* possesses "ascoconidia" outside the asci as often seen in species of *Pleonectria*. However, *N. canadensis* has a *Tubercularia* anamorph and no yellowish green scurf on the ascomata, both of which are critical evidence of the genus *Pleonectria*. In this study of numerous specimens including types, ascoconidia were not observed in asci. In two specimens of *N. canadensis* (BPI 631953 and BPI 631954), a few budding ascospores and "ascoconidia-like spores" were observed in association with germinating ascospores (Fig. 26I). In another species of *Nectria, N. pseudotrichia*, germinating ascospores in culture often bud producing conidia. This suggests that in overmature ascomata after the asci have broken down ascospores occasionally bud and produce conidia within the fruiting bodies.

Acropleurogenous conidiophores are only observed in sporodochial tubercularia-like anamorphs, but not in synnematous tubercularia-like anamorphs. The anamorph of *N. canadensis* has short acropleurogenous conidiophores although it appears to be synnematous (Figs 26A, B, O, P, 27F). This acropleurogenous characteristic indicates that the synnematous-like anamorph of this species is actually an extremely long stipitate sporodochia. In addition, the surface of a synnematous structure is not prosenchymatous as generally found in synnematous *Tubercularia* anamorphs (Figs 26J–L, 27D). Thus, the anamorph of *N. canadensis* is considered a sporodochia with an extremely long stipe. This hypothesis is also evidenced by the fact that ascomata are often produced on the middle or near the top of the stipe (Figs 26B, C, L, 27D).

Nectria cingulata Starbäck, Bih. Kongl. Svenska Vetensk.-Akad. Handl. 25: 26, 1899. Figs 28, 29.

Anamorph: unknown.

Teleomorph on natural substrata: *Mycelium* not visible around ascomata or on host. *Stromata* erumpent through epidermis, up to 1.5 mm high and 3.0 mm diam, dark scarlet, KOH+ blood colour, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, aggregated in groups of 7–26, subglobose to globose, 300–380 µm high × 280–360 µm diam, scarlet to sienna, slightly cupulate upon drying, apical region slightly darker, KOH+ dark red, LA+ yellow, smooth to roughened. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis*, 5–13 µm diam, with pigmented, uniformly *ca.* 1.5 µm thickened walls. *Ascomatal wall* 40–60 µm thick, of three regions: outer region 35–45 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.5 µm thick; middle region 10–20 µm thick, cells forming *textura globulosa* to *t. prismatica*, containing scarlet to bay, pigmented droplets, walls pigmented to gold, about 1.5 µm thick; inner region 10–20 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* clavate, 70–120 × 11–20 µm, with inconspicuous ring at apex, 8-spored, ascospores biseriate.

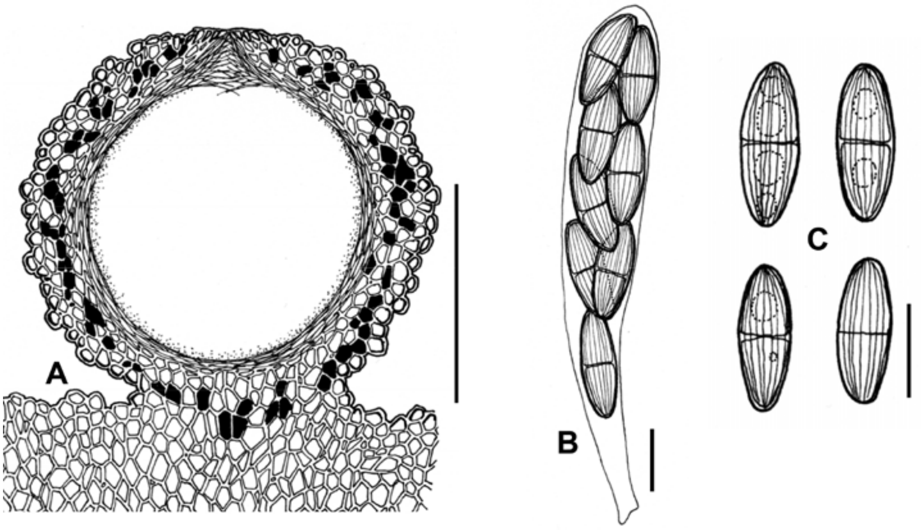

Fig. 29A–C. *Nectria cingulata* on natural substrata (A–C teleomorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores. Scale bars: A = 200 µm; B, C = 10 µm.

Ascospores ellipsoidal to fusiform, straight to rarely slightly curved, (15.6–)16.8–19.6(–22.3) × (5.9–)6.3–8.5(–9.7) µm (*n* = 50), 1-septate, hyaline, striate.

Habitat: On bark of *Cedrela brasiliensis* (*Meliaceae*).

Distribution: South America (Brazil).

Lectotype of Nectria cingulata *designated herein*: **Brazil**, Rio Grande do Sul, on bark, 21 Oct. 1892, C.A.M. Lindman, **Lectotype** S F46419, **Isolectotypes** S F10115, S F10116.

Additional specimen examined: **Brazil**, Bono Principio, Muninipio, Montenegro, on *Cedrela brasiliensis*, 1928, J. Rick, BPI 631889 as *Hypocreopsis moriformis*.

Notes: *Nectria cingulata* is one of the most difficult species to identify within the nectria-like fungi because its anamorph in the natural environment and in culture is not known, and the morphology of the asci and ascospores looks like the genus *Neonectria* at first appearance (Fig. 28A). However, this species is included in *Nectria sensu stricto* based on the cupulate ascomata when dry and ascomatal wall composed of three regions (Figs B, C), both of which characters are reminiscent of the genus *Nectria* as exemplified by *N. pseudocinnabarina* and *N. pseudotrichia*. *Nectria cingulata* may produce a synnematous anamorph because all *Nectria* species possessing ascomatal walls with three regions produce a synnematous anamorph.

Because Starbäck (1899) did not designate a holotype, we lectotypify this name with F 46419 preserved in S; the other duplicate specimens at S (F 10115 & F 10116) are considered isolectotypes.

Nectria cinnabarina (Tode : Fr.) Fr., Summa Veg. Scand. 2:388. 1849. Figs 30–32.

Basionym: *Sphaeria cinnabarina* Tode : Fr., Tode, Fungi Mecklenb. sel. 2: 9. 1791 : Fries, Syst. Mycol. 2: 412. 1823.

≡ *Cucurbitaria cinnabarina* (Tode : Fr.) Grev., Scot. Crypt. Fl. 3: 135. 1825.
= *Sphaeria tremelloides* Weigel, Obs. Bot. p. 46. 1772.
= *Sphaeria decolorans* Pers. : Fr., Persoon, Neues Magazin für Botanik, Rőmer 1: 83, 1794 : Fries, Syst. Mycol. 2: 412. 1823.
= *Sphaeria celastri* Fr., Elenchus Fungorum 2: 81. 1827.
= *Nectria russellii* Berk. & M.A. Curtis, in Berkeley, Grevillea 4: 45. 1875.
= *Nectria offuscata* Berk. & M.A. Curtis, in Berkeley, Grevillea 4: 45. 1875.

Anamorph: *Tubercularia vulgaris* Tode : Fr., Tode, Fungi Mecklenb. sel. 1:18. 1790 : Fries, Syst. Mycol. 3:464. 1832.

Teleomorph on natural substrata: *Mycelium* rarely visible around ascomata and on host. *Stromata* up to 2.0 mm high and 5 mm diam, erumpent through epidermis, whitish yellow to bay, KOH+ dark red, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis* to *t. prismatica* with cells oriented more or less vertically; cells 5–20 µm diam, with walls 1–2 µm thick, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, solitary or caespitose, up to 25 on stroma, sometimes clustered around base of stipitate sporodochia, subglobose to globose, 275–400 µm high × 250–370 µm diam (*n* = 55), red to reddish brown, sometimes cupulate upon drying, non-papillate, apical region darker, KOH+ dark red, LA+ yellow, surface roughened with concolourous warts, but sometimes smooth. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis*, with walls pigmented *ca.* 1.5 µm thick. *Ascomatal wall ca.* 40–60 µm thick, of two regions: *outer region ca.* 35–55 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, *ca.* 1.5 µm thick; *inner region ca.* 15–20 µm thick, of elongated, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* unitunicate, (81–)85–96(–105) × (7.5–)8.0–9.5(–11.0) µm (*n* = 129), cylindrical to narrowly clavate, with inconspicuous ring at apex, 8-spored, ascospores biseriate above, uniseriate below. *Ascospores* ellipsoidal to fusiform, straight, sometimes slightly curved, hyaline, (0–)1(–2)-septate, (11.5–)14.0–17.5(–21.5) × (3.0–)4.0–5.5(–7.0) µm (*n* = 558), smooth-walled.

Anamorph on natural substrata: *Stromata* erumpent through epidermis, pale yellow to orange, rarely reddish brown. *Sporodochial conidiomata* with stipe, superficial on well-developed stromata, smooth, cerebriform or tuberculate, scattered, solitary or 2–4 gregarious, stipitate, pustular, discoid or cylindrical-capitate, up to 700–1600 µm high including stipe, 300–2500 µm wide, white, whitish yellow to orange, sometimes darker red. *Stipe* white to whitish red, rarely darker red, up to 250–600 µm wide, solitary or 2–6 gregarious; *stipe cells* almost *textura angularis*, continuous with stroma, usually with wider cells in centre. *Hymenium* arising directly from *textura prismatica,* elongating from *textura angularis*, up to 150 µm long, of cells 2.5–5 µm wide; in stipitate forms marginal cells arranged in a palisade as described above for surface of stroma; curved margin, up to 100 µm long, of parallel hyphae 1.5–2.5 µm

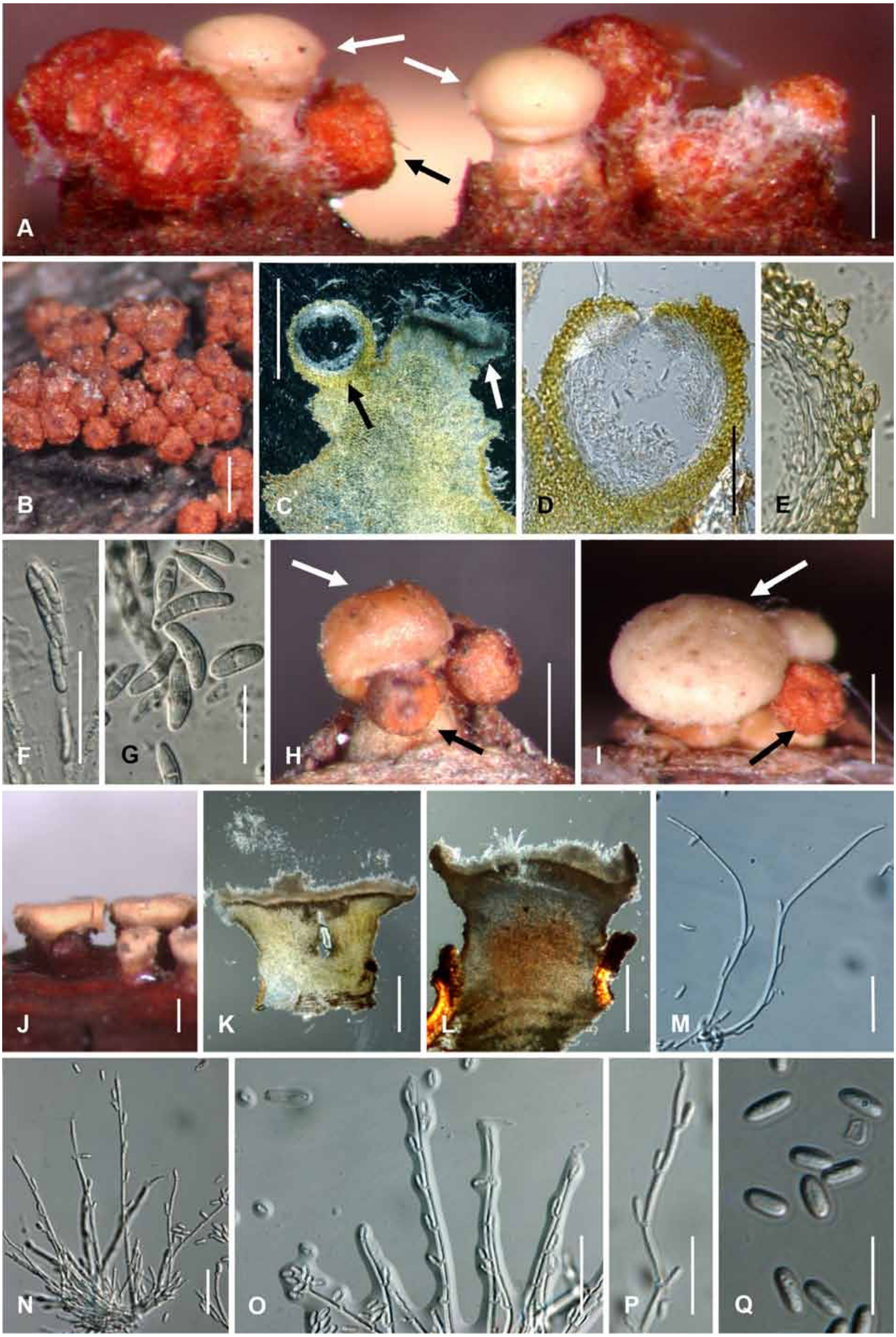

Fig. 30A–Q. *Nectria cinnabarina* on natural substrata (A, C, H, I teleomorph and anamorph, B, D–G teleomorph, J–Q anamorph). A, H, I. Perithecia (black arrows) and long stipitate sporodochia (white arrows) on natural substrata; B. Perithecia on natural substrata; C. Median section of perithecium (black arrow) and sporodochium (white arrow); D. Median section of perithecium E. Median section of perithecial wall; F. Ascus; G. Ascospores; J. Long stipitate sporodochium; K, L. Median section of long stipitate sporodochia; M, N. Acropleurogenous conidiophores on natural substrata; O, P. Acropleurogenously developing phialides on natural substrata; Q. Conidia on natural substrata. Scale bars: A–C, H, I = 500 µm; D = 100 µm; E, F = 50 µm; G, M–P = 20 µm; J–L = 1 mm; Q = 10 µm.

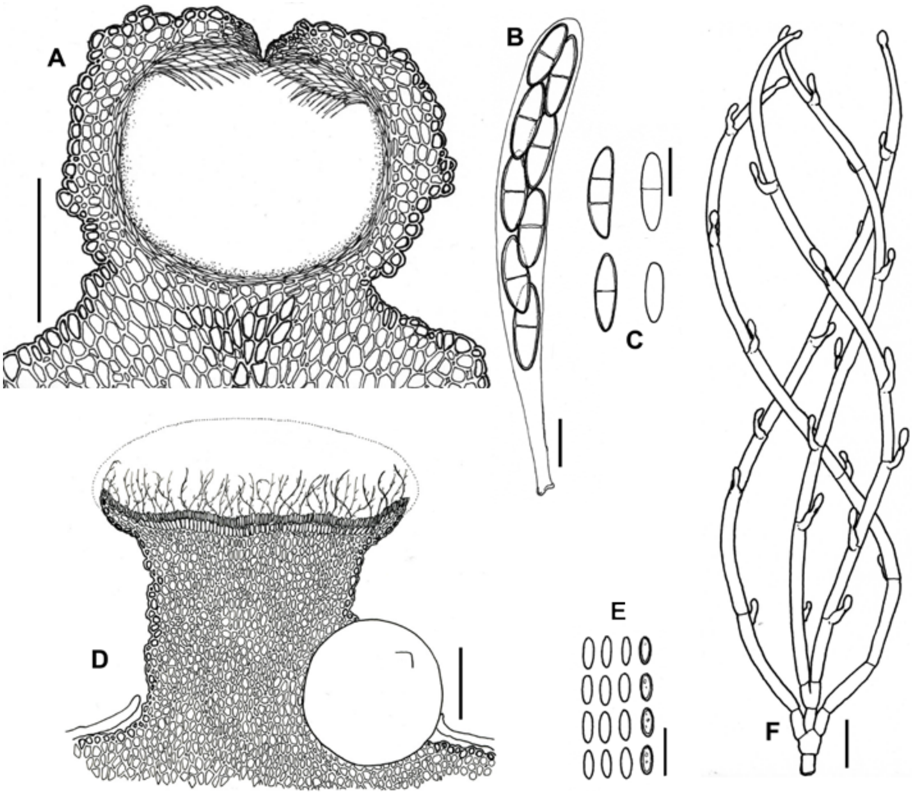

Fig. 31A–F. *Nectria cinnabarina* on natural substrata (A–C teleomorph, D–F anamorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores; D. Median section of long stipitate sporodochium; E. Conidia; F. Acropleurogenous conidiophores. Scale bars: A, D = 200 µm; B–F = 10 µm.

wide. *Acropleurogenous conidiophores* monoverticillate or rarely biverticillate, then developing acropleurogenously for 3–10 levels, straight, curved. *Acropleurogenously developing phialides* intercalary, occurring below each septum, or rarely terminal; *intercalary phialides* monophialidic, up to 3–9 µm long, 1.5–2 µm wide; *terminal cells* monophialidic, sometimes sterile, without collarettes. *Conidia* hyaline, narrowly long ellipsoidal to cylindrical, straight or slightly curved, non-septate, (4.0–)5.2–7.0(–8.5) × (1.3–)1.9–2.7(–3.4) µm (*n* = 355), smooth-walled.

Anamorph in culture: Optimum temperature for *growth* on PDA 25 °C, maximum temperature 30 °C. After 7 d at 25 °C, colonies 60–85 mm (average 73 mm) diam. *Colony surface* radial, sometimes wavy, slightly cottony with aerial mycelium, white to whitish saffron; *aerial mycelium* developing, in some isolates (A.R. 4327, A.R. 4337, A.R. 4338, A.R. 4341, A.R. 4477) abundant, white to whitish yellow sporodochial conidial masses produced after 2 wk; *reverse* white to slightly whitish yellow. *Odour* on PDA slightly fruity. Sporulation common on SNA from *lateral phialidic pegs*, enteroblastic, monophialidic, ellipsoidal tapering toward tip, 1.5–4.5 µm long, 1.0–1.5 µm wide near aperture. *Aerial conidiophores* abundantly formed, unbranched, sometimes verticillate, 1–3 branched, becoming loosely to moderately densely branched, 5.5–38.0 µm long, 2.0–3.5 µm wide at base. *Conidiogenous cells* enteroblastic, monophialidic, cylindrical and slightly tapering toward tip or narrowly flask-shaped with widest point in middle, 5–22 µm long, 2.0–3.2 µm wide at base. *Young conidia* formed from monophialides on submerged or aerial hyphae, abundant on slimy heads or sporodochia, ellipsoidal, oblong to cylindrical, hyaline, smooth, straight or slightly curved, rounded at both ends, non-septate, (3.0–)5.5–9.0(–15.0) × (1.5–)2.0–3.0(–3.5) µm (*n* = 764), smooth-walled. *Mature conidia* swollen, mostly 0-, rarely 1-septate, ellipsoidal, oblong, allantoid or ellipsoidal with strongly constricted centre, hyaline, smooth, straight or slightly curved, rounded at both ends, germinating and budding in culture, (5.5–)10.5–17.0(–27.0) × (3.0–)4.0–5.0(–7.0) µm (*n* = 668). *Chlamydospores* rarely present, globose, subglobose, broadly ellipsoidal, 0(–1)-septate, solitary or chains, 8.5–12 µm diam. *Ascomata* not produced in culture.

Habitat: On dead woody substrata including *Acer campestre*, *A. platanoides*, *A. pseudoplatanus*, *A. saccharum*, *Acer* sp., *Aesculus* sp., *Celastris scandens, Fagus* sp., *Gleditsia* sp., *Populus tremula*, *Sorbus aria*, *Spiraea trilobata*, *Tilia* sp., and *Ulmus* x *hollandica*.

Distribution: Europe (Austria, Denmark, France, Germany, Ireland, Netherlands, Poland, UK, Ukraine), North America (Canada, USA).

Lectotype of Nectria cinnabarina *designated by Hirooka et al. (2011)*: **Lectotype** Figures 68a-e in the copy of Tode HJ (1791). Fungi Mecklenburgenses selecti. 2:9 associated with BPI.

Epitype of Nectria cinnabarina *designated by Hirooka et al. (2011)*: **France**, Villiers en Bois, on dead twigs of *Aesculus* sp., Feb. 13, 2008, C. Lechat C.L.L. 7152, **Epitype** BPI 879981, **ex-epitype** culture CBS 125165 = A.R. 4477.

Additional type specimens examined: The type specimen of *Sphaeria tremelloides* exists at K but could not be examined. This name is retained as a synonym of *N. cinnabarina*. Lectotype material of *Sphaeria decolorans* was examined but this lacked the anamorphic structures needed to identify species within the *Nectria cinnabarina* species complex. This name is retained as a synonym of *N. cinnabarina*. Lectotype of *Sphaeria decolorans* designated in Hirooka *et al.* (2011): Country unknown: on branch of *Acer platanoides*, ex Herb. Persoon, BPI 799523. Additional Persoon material examined: Country unknown: on bark of *Ribes rubrum*, Mougeot, ex Herb. Persoon, BPI 799524. Type specimen of *Sphaeria celastri*: **USA**, Philadelphia, on dead branch of *Celastrus scandens* L., possibly L.D. Schweinitz, **Holotype** Schweinitz Syn. PH 1421. Type of *Nectria russellii*: **USA**, Massachusetts, Jan. 1856, J.L. Russell, **Holotype** FH 284394. Type of *Nectria offuscata*: **USA**, South Carolina, on *Hibiscus syriacus* L., **Lectotype**, Michener Collection 32, Sheet 12, BPI.

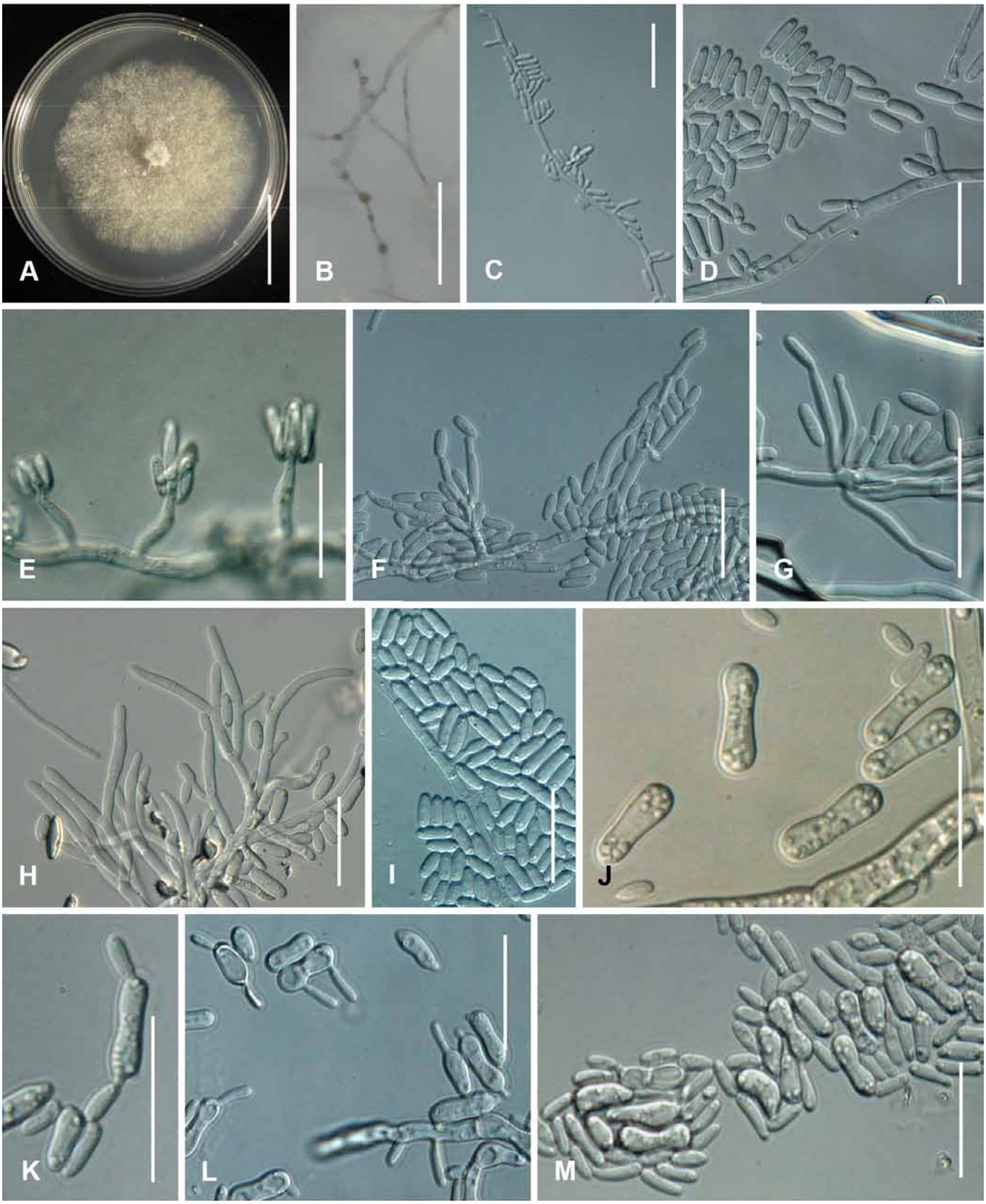

Fig. 32A–M. Anamorph of *Nectria cinnabarina* in culture. A. Cultures after 7 d at 25 °C on PDA; B. Aerial conidiophores and conidial mass produced on the SNA surface; C, D. Lateral phialidic pegs and conidia on SNA; E–H. Conidiophores and conidia on SNA; I. Young conidia on SNA; J. Mature conidia on SNA; K–M. Budding mature conidia on SNA. Scale bars: A = 30 mm; B = 500 µm; C–M = 20 µm.

For additional specimens and isolate examined, see Hirooka *et al*. (2011).

Note: *Nectria cinnabarina* was described in detail by Hirooka *et al.* (2011).

Nectria dematiosa (Schwein.) Berk., Grevillea, 4: 16, 1875. Figs 33–35.

Basionym: *Sphaeria dematiosa* Schwein., Trans. Amer. Philos. Soc. II, 4: 205, 1832.

≡ *Cucurbitaria dematiosa* (Schwein.) Kuntze, Revisio Generum Plantarum 3: 461, 1898.

= *Nectria sambuci* Ellis & Everh., Proc. Acad. Nat. Sci. Philadelphia 1890: 246, 1891.

= *Nectria cinnabarina* subsp. *amygdalina* P. Karst., Rev. Mycol. 37: 205, 1889.

≡ *Nectria amygdalina* (P. Karst.) Mussat in Saccardo, Syll. Fung. 15: 225, 1901.]

Anamorph: tubercularia vulgaris-like.

Teleomorph on natural substrata: *Mycelium* not visible around ascomata and on host. *Stromata* up to 0.3 mm high and 2 mm diam, erumpent through epidermis, orange to bay, sometimes darker red, KOH+ dark red, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis* to *t. prismatica* with cells oriented more or less vertically; cells 3–10 μm diam, with 1–1.5 μm thick walls, intergrading with ascomatal wall. *Ascomata* superficial on well-developed, erumpent stroma, solitary or caespitose, up to 20 on a stroma, rarely clustered around sessile sporodochia, subglobose to globose, 260–380 μm high × 220–380 μm diam (n = 40), red to reddish brown, sometimes cupulate upon drying, non-papillate, apical region darker, KOH+ dark red, LA+ yellow, surface roughened or with concolourous warts, but sometimes smooth. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis*, with walls pigmented, *ca.* 1.5 μm thick. *Ascomatal wall ca.* 35–60 μm thick, of two regions: *outer region ca.* 25–40 μm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, *ca.* 1.5 μm thick; *inner region ca.* 10–20 μm thick, of elongated, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* unitunicate, (64–) 77–91 (–108) × (6.3–) 9.4–11.0 (–12.0) μm (n = 68), cylindrical to narrowly clavate, with an inconspicuous ring at apex, 8-spored, ascospores biseriate above, uniseriate below. *Ascospores* ellipsoidal to fusiform, sometimes long fusiform, straight or slightly curved, hyaline, smooth-walled, (0–)1(–2)-septate, (12.6–)15.2–17.2(–22.2) × (3.2–)4.3–5.7(–6.4) μm (n = 150). Subclade A (12.6–)13.9–16.9(–18.5) × (3.4–) 3.9–4.9(–5.3) μm (n = 30); subclade B (13.6–)14.7–17.9 (–20.5) × (3.8–)4.7–5.7(–6.4) μm (n = 60); subclade C (12.6–)14.3–18.9(–22.2) × (3.2–)4.3–5.7(–6.2) μm (n = 60).

Anamorph on natural substrata: *Stromata* erumpent through epidermis, orange to red. *Sporodochial conidiomata* without stipe, superficial on well-developed stromata, smooth, cerebriform or tuberculate, scattered, solitary, rarely caespitose, astipitate, sessile, pustular, discoid or cylindrical-capitate, up to 200–700 μm high, 250–1000 μm wide, white, whitish yellow to orange, sometimes brown. *Hymenium* arising directly from *textura prismatica* elongating from *textura angularis*, up to 90 μm long, of cells 2.0–7.5 μm wide, not curved at margin. *Acropleurogenous conidiophores* monoverticillate or sometimes biverticillate, then developing acropleurogenously for 3–6 levels, straight, curved hyaline. *Acropleurogenously developing phialides* intercalary occurring below each septae, or rarely terminal; intercalary phialides monophialidic, 2.5–8.5 μm long, 1.3–2.4 μm wide at base; terminal cells monophialidic, sometimes sterile, no collarettes, 10.5–15 μm long, 2.3–2.8 μm wide at base. *Conidia* hyaline, narrowly long ellipsoidal to cylindrical, straight or slightly curved, non-septate, (4.5–)5.7–7.1(–8.8) × (1.7–)2.2–2.8(–3.1) μm (n = 60). Subclade A (4.5–)5.5–7.1(–8.8) × (2.0–)2.2–2.6(–2.9) μm (n = 30), subclade B (5.2–)5.8–7.0(–7.8) × (1.7–)2.3–2.9(–3.1) μm (n = 30), subclade C none present.

Anamorph in culture: Optimum temperature for growth on PDA 20 °C, colonies 37–67 mm (average 45 mm) diam at 25 °C after 7 d, maximum temperature 30 °C. *Colony surface* on PDA, radial, sometimes wavy, slightly cottony with aerial mycelium, white to whitish saffron; aerial mycelium developing in a few isolates (CBS 125127, CBS 126570), white to whitish yellow sporodochial conidial masses produced after 2 wk; *reverse* white to slightly whitish yellow. *Odour* slightly fruity. Sporulation on SNA from *lateral* phialidic pegs on submerged or aerial hyphae common, enteroblastic, monophialidic, ellipsoidal tapering toward tip, 2.5–4.5 μm long, 1.5–3.0 μm wide at base. *Aerial conidiophores* occasionally developing on aerial hyphae, unbranched, sometimes verticillate, 1-2-branched, becoming loosely to moderately densely branched, 6.0–34 μm long, 2.1–4.5 μm wide at base. *Conidiogenous cells* monophialidic, cylindrical and slightly tapering toward tip or narrowly flask-shaped with widest point in middle, 8–26 μm long, 2.5–3.5 μm wide at base. Young *conidia* formed by monophialides on submerged or aerial hyphae, formed abundantly on slimy heads, non-septate, ellipsoidal, oblong to cylindrical, hyaline, smooth, straight or slightly curved, rounded at both ends, (4.1–)6.0–10.6(–17.3) × (1.6–)2.4–3.4(–5.1) μm (n = 496). Subclade A (4.6–)5.9–10.1(–14.0) × (1.6–)2.3–3.1(–4.0) μm (n = 200); subclade B (4.1–)6.0–10.6(–16.8) × (1.6–)2.4–3.6(–5.1) μm (n = 213); subclade C (5.0–)6.5–11.5(–17.3) × (2.2–)2.6–3.4(–4.0) μm (n = 83). *Mature conidia* swollen, mostly 0-, rarely 1-septate, smooth, ellipsoidal, oblong or allantoid, straight or slightly curved and round at both ends, germinating, never budding secondary conidia on media, (7.1–)10.0–17.4(–29.3) × (2.8–)3.8–5.6(–7.9) μm (n = 429). Subclade A (8.2–)10.7–19.1(–27.8) × (2.9–)3.6–5.0(–6.1) μm (n = 136); subclade B (7.1–)9.7–16.7(–29.3) × (3.5–) 4.3–6.1(–7.9) μm (n = 211); subclade C (8.0–)10.7–15.9(–23.2) × (2.8–)3.3–4.7(–5.6) μm (n = 82). *Chlamydospores* and *ascomata* not produced in culture.

Habitat: On dead woody substrata including *Acer macrophyllum* Pursh, *A. pseudoplatanus*, *Acer* sp., *Morus* sp., *Prunus tenella, Ribes* sp., *Rosa* sp., *Sambucus nigra* ssp. *canadensis*, and *Weigela coraeensis*.

Distribution: Asia (China, Japan), Europe (Finland, Poland), Oceania (New Zealand), North America (Canada, USA).

Lectotype of Nectria dematiosa *designated in Hirooka et al. (2011)*: **USA**, Pennsylvania, on *Morus* sp., Bethlehem, Schweinitz, **Lectotype** BPI 799536, **Isolectotype** BPI 799535 anamorph only. The two isotype specimens of *S. dematiosa* have sessile sporodochia; on BPI 799536 ascospores up to 2-septate were observed. This specimen has only 4 or 5 ascomata and a few sessile sporodochia.

Epitype of Nectria dematiosa *designated in Hirooka et al. (2011)*: **USA**, North Carolina, Highlands, Macon Co. Highlands Biological Station, Lake Ravenel, on bark, 31 Aug. 1994, G.J. Samuels, H.-J. Schroers, **Epitype** BPI 749337, **ex-epitype** culture CBS 126570 = G.J.S. 94-37.

Additional type specimens examined: Type of *Nectria sambuci*: **USA**, Nebraska, Lincoln, on *Sambucus nigra* L. ssp. *canadensis* (L.) R. Bolli, Aug. 1888, H.J. Webber, **Holotype** NY 00927949. Type of *Nectria cinnabarina* subsp. *amygdalina*: **Finland**, Mustiala, on dead branch of *Amygdalus nana*, now considered to be *Prunus tenella* Batsch., 28 May 1889, P.A. Karsten , **Holotype** H 6009374.

For additional specimens and isolates examined, see Hirooka *et al.* (2011).

Notes: This species was described and illustrated by Hirooka *et al.* (2011).

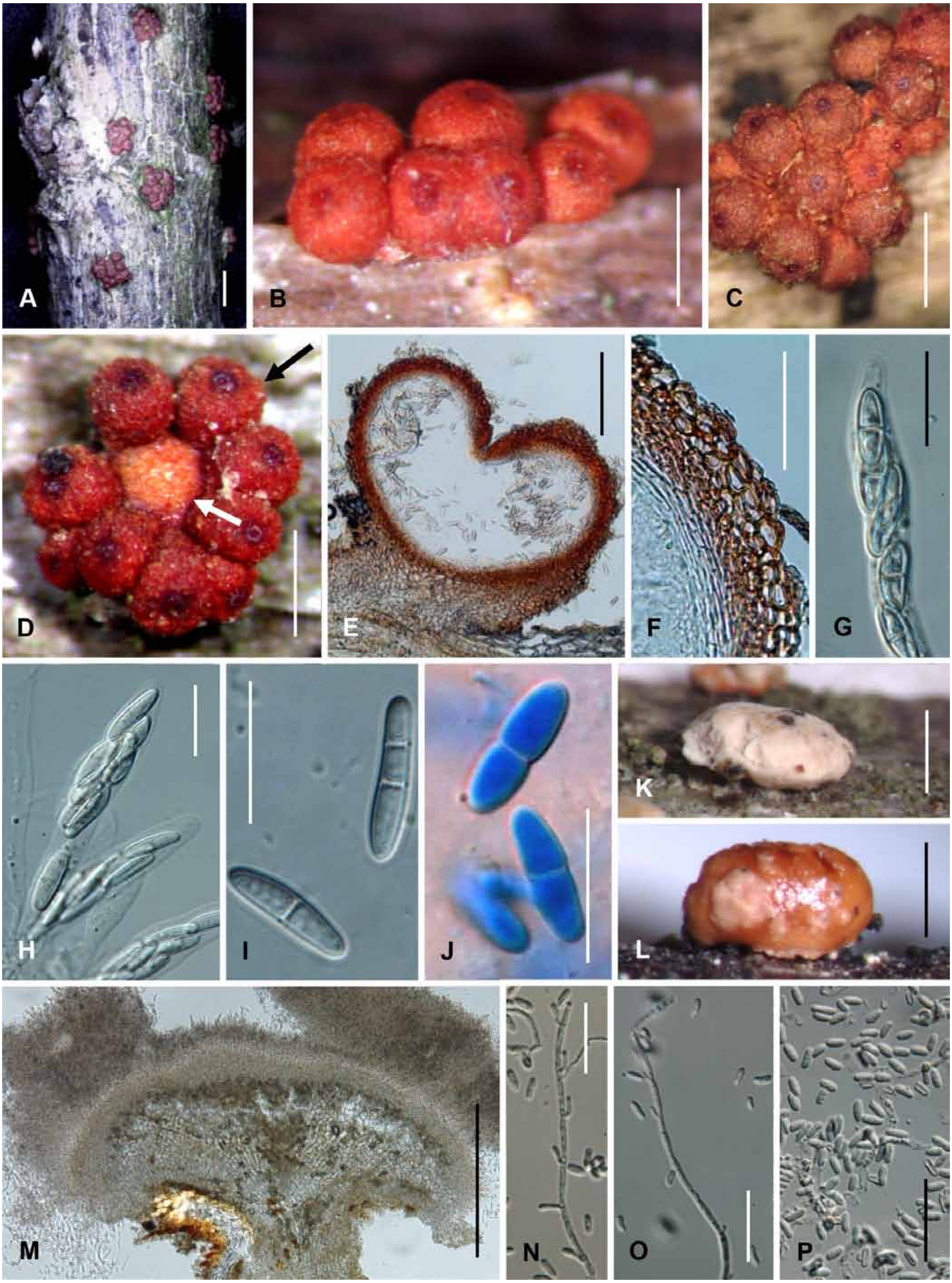

Fig. 33A–P. *Nectria dematiosa* on natural substrata (A–C, E–J teleomorph, D teleomorph and anamorph, K–P anamorph). A–C. Perithecia on natural substrata; D. Perithecia (black arrow) and astipitate sporodochium (white arrow) on natural substrata; E. Median section of perithecium; F. Median section of perithecial wall; G. Apex of ascus; H Asci; I, J. Ascospores; K, L. Astipitate sporodochia; M. Median section of astipitate sporodochium; N, O. Acropleurogenous conidiophores and acropleurogenously developing phialides on natural substrata; P. Conidia on natural substrata. Scale bars: A = 1 mm; B–D, K–M = 500 µm; E = 100 µm; F = 50 µm; G–J, N–P = 20 µm.

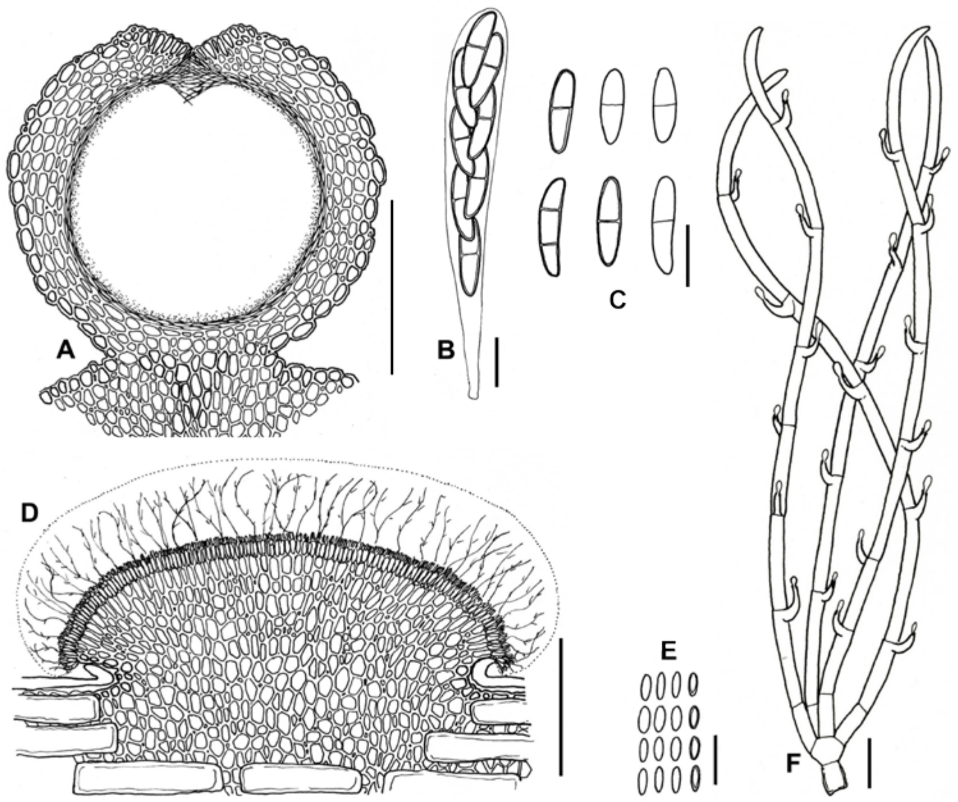

Fig. 34A–F. *Nectria dematiosa* on natural substrata (A–C teleomorph, D–F anamorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores; D. Median section of astipitate sporodochium; E. Conidia; F. Acropleurogenous conidiophores. Scale bars: A, D = 200 µm; B, C, E, F = 10 µm.

Nectria eustromatica Jaklitsch & Voglmayr, Mycologia 103: 209. 2011.

For a description of the teleomorph on natural substratum and anamorph in culture, see Jaklitsch & Voglmayr (2011).

Habitat: On recently dead, standing branches and trunks; known from *Hippocrepis emerus (Fabaceae)*.

Distribution: Europe (Croatia, Italy fide Jaklitsch and Voglmayr, 2011).

Holotype of Nectria eustromatica (not seen): **Croatia**, Primorsko-goranska, Opatija, Mošcenička Draga, village area, on dead twigs of twigs of *Hippocrepis emerus*, soc. *Cucurbitaria coronillae*, 29 Mar. 2007, W. Jaklitsch, H. Voglmayr, **Holotype** WU 30194, **ex-holotype** culture CBS 121896.

Notes: *Nectria eustromatica* was described by Jaklitsch & Voglmayr (2011). *Nectria eustromatica* is morphologically similar to *N. magnispora* and *N. mariae* in having ascomata immersed in a stroma but *N. eustromatica* has dark ascomata and longer macroconidia in culture. *Nectria magnispora* produces pycnidia in the natural environment and culture, thus one might expect the same type of anamorph for *N. eustromatica*. In comparing sequences of *N. eustromatica* with our sequences of *Nectria*, ITS, LSU, and *tef1* of *N. eustromatica* showed the highest homology with *N. magnispora* (ITS 97 %, LSU 99 %, and *tef1* 94 %).

Nectria himalayensis Hirooka, Rossman & P. Chaverri, **sp. nov.** MycoBank MB519700. Figs 36, 37.

Holotype of Nectria himalayensis: **India**, Himalayan Mountains, near Mussoorie, Uttarakhand?, 6000–6500 m, on twigs, 14 Aug. 1934, R.R. Stewart, **Holotype** NY.

Etymology: *himalay* + *-ensis*; indicates the geographic origin of this fungus.

Anamorph: sporodochial, tubercularia-like.

Teleomorph on natural substrata: *Mycelium* not visible around ascomata or on host. *Stromata* erumpent through epidermis, up to 1.5 mm high and 3.0 mm diam, red to umber, KOH+ purple, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*, intergrading with ascomatal wall. *Ascomata* superficial, aggregated in groups of 2–50, sienna to umber, subglobose to globose, 340–430 µm high × 290–420 µm diam, rarely cupulate when dry, apical region darker, KOH+ dark purple, LA+ yellow, warted wall. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis*, 6–16 µm diam, with pigmented, uniformly *ca.* 2.0 µm thickened walls; ascomatal warts orange to red, 40–60 µm high. *Ascomatal wall* 50–90 µm thick, of two regions: outer region 35–60 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 2.0 µm thick; inner region 15–25 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* clavate, 90–122 × 12–17 µm, with inconspicuous ring at apex, 8-spored, mainly uniseriate to partly biseriate. *Ascospores* ellipsoidal to fusiform with rounded ends, straight, (16.0–)18.7–21.7(–22.7) × (7.3–)7.9–9.5(–10.6) µm (*n* = 50), 1-septate, hyaline, finely spinulose.

Anamorph on natural substrata: *Stromata* erumpent through epidermis, reddish orange to red. *Sporodochial conidiomata* with short stipe, superficial on well-developed stromata, smooth,

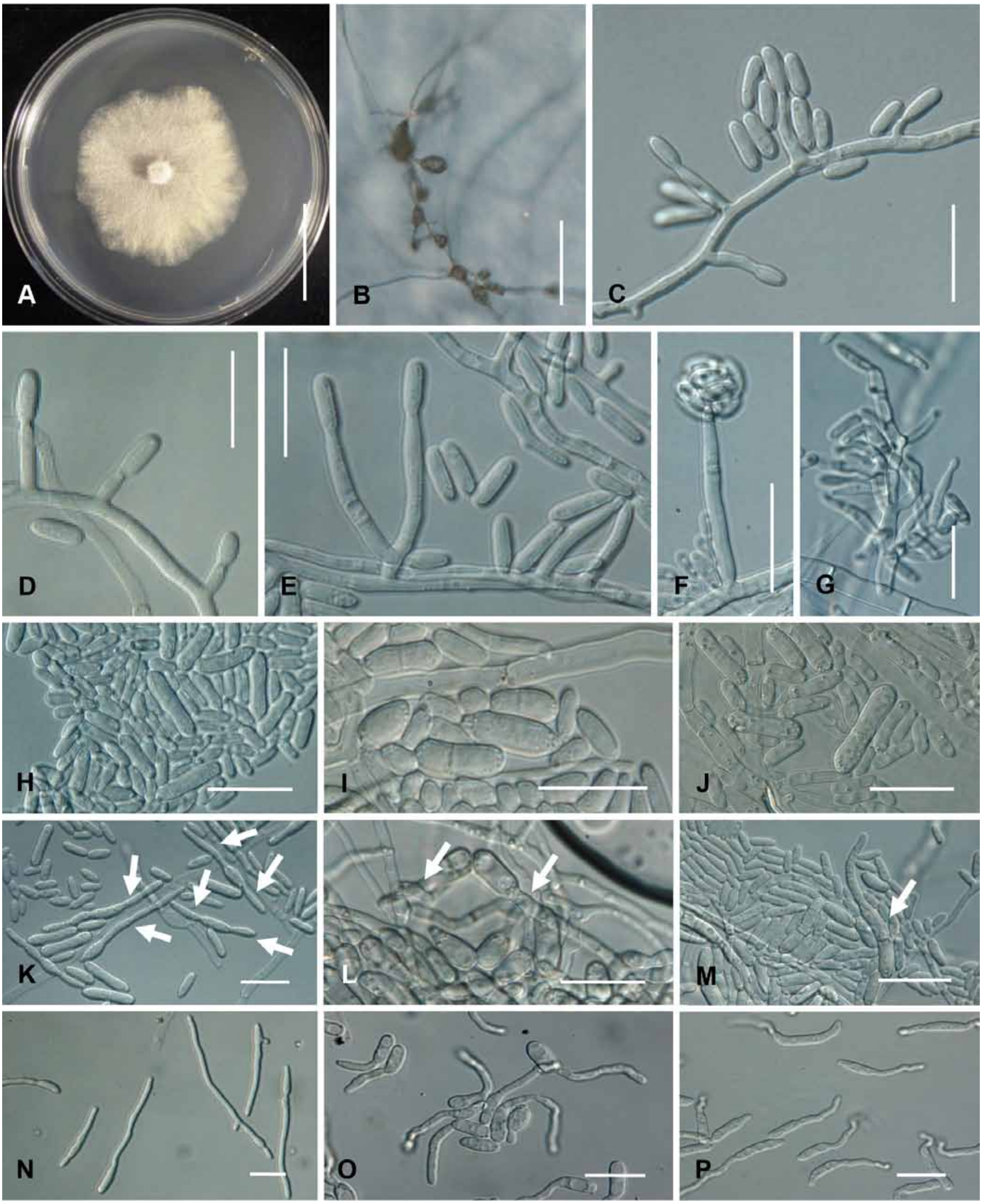

Fig. 35A–P. Anamorph of *Nectria dematiosa* in culture. A. Cultures after 7 d at 25 °C on PDA; B. Aerial conidiophores and conidial mass produced on the SNA surface; C. D. Lateral phialidic pegs and conidia on SNA; E, F. Conidiophores and conidia on SNA; G. Densely blanched aerial conidiophores on SNA; H. Mature conidia and young conidia of *N. dematiosa* subclade A. I. Mature conidia and young conidia of *N. dematiosa* subclade B. J. Mature conidia and young conidia of *N. dematiosa* subclade C. K. Germinating mature conidia (arrows) of *N. dematiosa* subclade A on SNA. L. Germinating mature conidia (arrows) of *N. dematiosa* aubclade B on SNA. M. Germinating mature conidia (arrow) of *N. dematiosa* subclade C on SNA. N. Germinating mature conidia of *N. dematiosa* subclade A that were streaked onto SNA. O. Germinating mature conidia of *N. dematiosa* subclade B that were streaked onto SNA. P. Germinating mature conidia of *N. dematiosa* subclade C that were streaked onto SNA. Scale bars: A = 3 mm; B = 30 µm; C–P = 15 µm.

cerebriform or tuberculate, scattered, solitary, or 2–3 gregarious, discoid or cylindrical-capitate, up to 200–500 µm high including stipe, 100–400 µm diam, white to whitish yellow; *stipe* orange, sometimes red, up to 340–530 µm wide; *stipe cells* almost *textura angularis*, continuous with stroma, usually with wider cells in centre. *Hymenium* arising directly from *textura prismatica,* elongating from *textura angularis*, up to 40 µm long, of cells 2.0–7.0 µm wide, without curved margin. *Acropleurogenous*

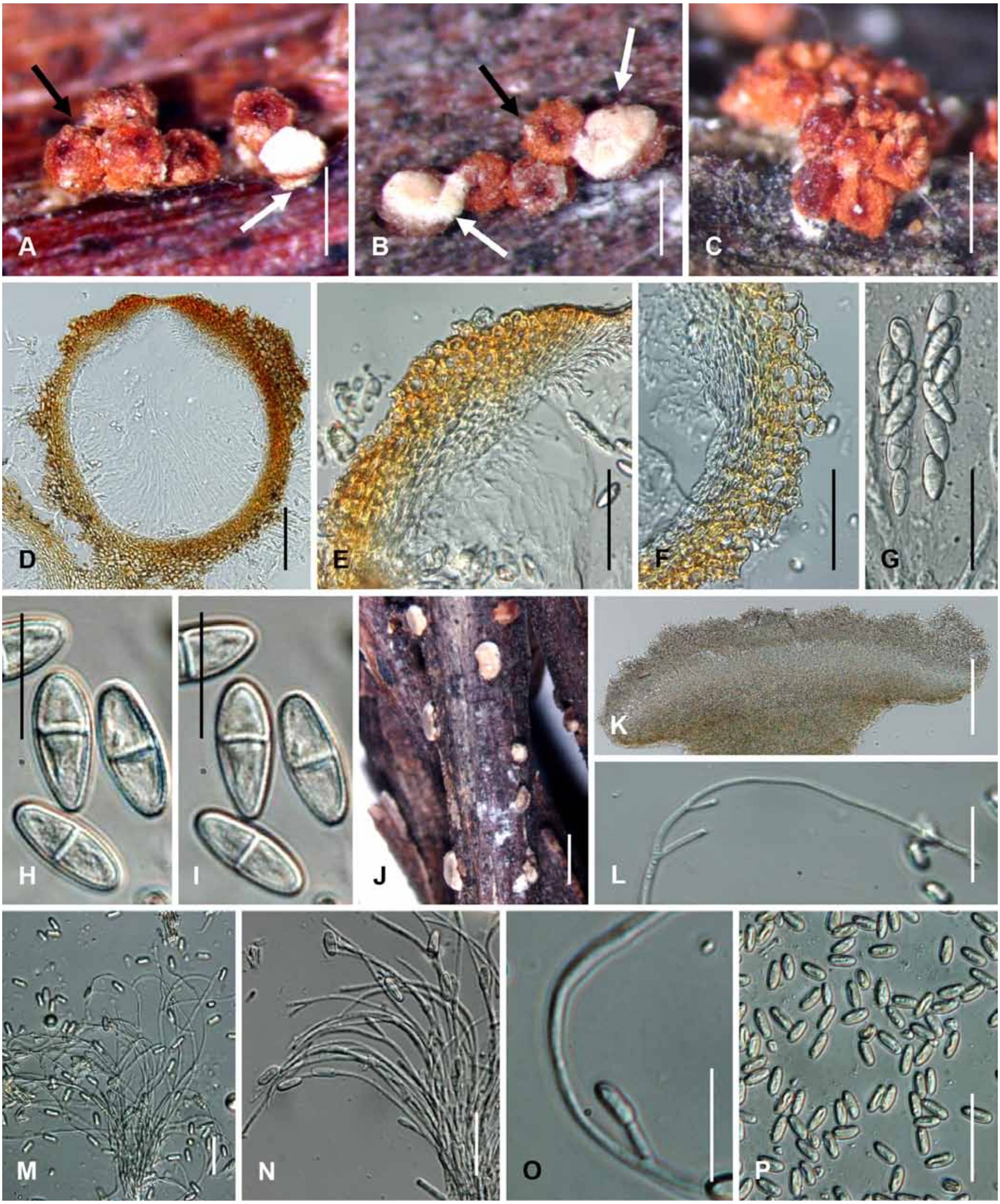

Fig. 36A–P. *Nectria himalayensis* on natural substrata (A, B teleomorph and anamorph, C–I teleomorph, J–P anamorph). A, B. Perithecia (black arrows) and short stipitate sporodochium (white arrows) on natural substrata; C. Perithecia on natural substrata; D. Median section of perithecium; E. Median section of perithecial apex; F. Median section of perithecial wall; G. Asci; H. Ascospores in surface view; I. Ascospores in optical section; J. Short stipitate sporodochia on natural substrata; K. Median section of short stipitate sporodochium on natural substrata; L–N. Acropleurogenous conidiophores on natural substrata; O. Acropleurogenously developing phialides on natural substrata; P. Conidia on natural substrata. Scale bars: A–C, J = 500 µm; D–F, K = 100 µm; G = 50 µm; H, I, L–P = 20 µm.

conidiophores monoverticillate or biverticillate, then developing acropleurogenously for 1–3 levels, sometimes coiled, hyaline, rarely slightly pale green. *Acropleurogenously developing phialides* intercalary, occurring below each septum, rarely terminal; *intercalary phialides* monophialidic, up to 2.5–12 µm long, 1.5–2.5 µm wide; *terminal cells* rarely produced, monophialidic, sometimes sterile, without collarette. *Conidia* hyaline, narrowly long ellipsoidal to cylindrical, straight or slightly curved, non-septate, (9.4–)10.7–12.5(–13.3) × (3.8–)4.3–5.3(–6.8) µm (*n* = 50), smooth-walled.

Habitat: On twigs.

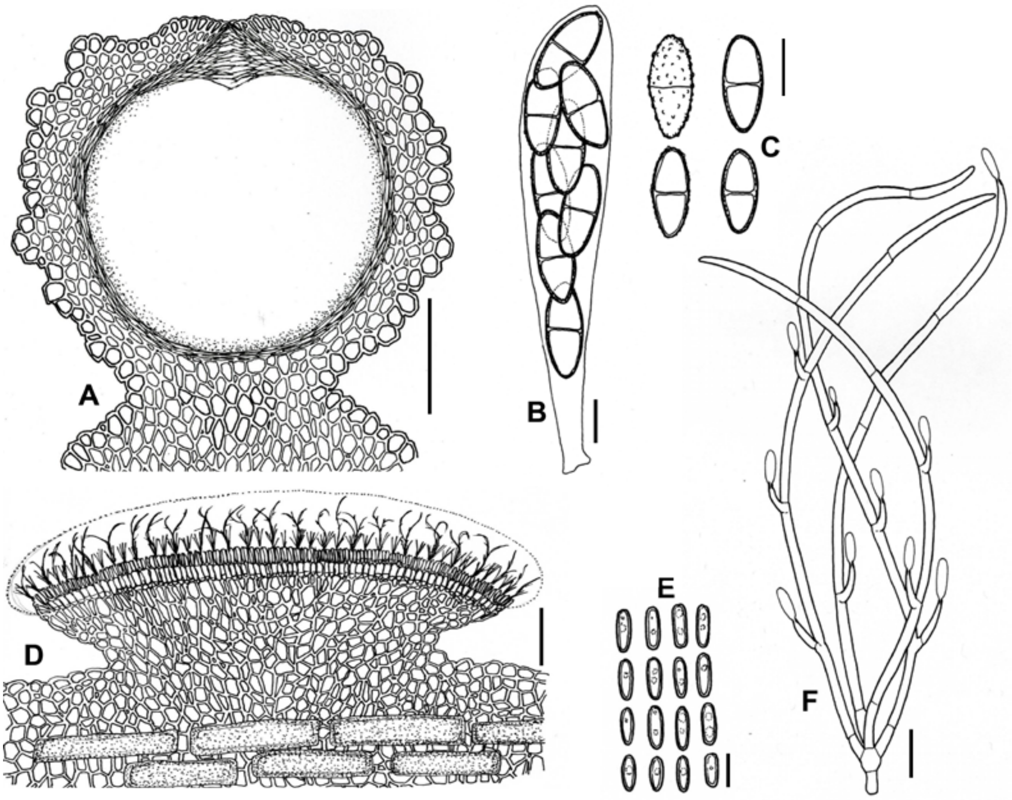

Fig. 37A–F. *Nectria himalayensis* on natural substrata (A–C teleomorph, D–F anamorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores; D. Median section of short stipitate sporodochium; E. Conidia; F. Acropleurogenous conidiophores. Scale bars: A, D = 100 µm; B, C, E, F = 10 µm.

Distribution: Asia (India, Himalayan Mountains, known only from the type collection).

Notes: *Nectria himalayensis* had been preserved in NY as *Nectria* sp. Although we could not observe the anamorph in culture nor obtain molecular data, we are describing this specimen as a new species based on its sexual state morphology and unusual geographic distribution. Although morphologically similar to *Nectria berberidicola* collected from high elevations in France, these species differs in ascospore and conidial width in nature as well as the presence or absence of a stipe in the sporodochial anamorph (see the note under *N. berberidicola*). *Nectria himalayensis* is also morphologically similar to the *Nectria cinnabarina* species complex. *Nectria cinnabarina* has smooth ascospores and intercalary phialides up to 9 µm long, while ascospores of *N. himalayensis* are finely spinulose and the intercalary phialides are up to 12 µm long (Figs 36H, 37C).

Nectria hoheriae Dingley, Mem. New York Bot. Gard. 49: 208. 1989. Figs 38, 39.

Anamorph: *Tubercularia hoheriae* (J.D. Atk.) Dingley, Mem. New York Bot. Gard. 49: 208. 1989 .

≡ *Myxosporium hoheriae* J.D. Atk., New Zealand J. Sci. Technol. A22: 120. 1940.

Teleomorph on natural substrata: *Ascomata and sporodochia* rarely form on same or discrete stroma. *Stromata* erumpent through epidermis, up to 1.0 mm high and 4.0 mm diam, red to sienna, KOH+ blood red, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*, intergrading with ascomatal wall. *Ascomata* completely immersed in stroma, aggregated in groups of 3–31, red to sienna, subglobose to globose, 324–483 µm high × 326–539 µm diam, not collapsing when dry, apical region slightly darker, KOH+ dark purple, LA+ yellow, roughened. *Ascomatal surface cells* at edge of stroma forming *textura globulosa* or *t. angularis*, 7–13 µm diam, with pigmented, uniformly *ca.* 2.5 µm thickened walls. *Ascomatal wall at edge of stroma* 81–104 µm thick, of two regions: outer region 55–75 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 2.0 µm thick; inner region 14–34 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* clavate, 81–104 × 17–22 µm, with inconspicuous ring at apex, 8-spored, biseriate. *Ascospores* ellipsoidal to long oblong, straight to rarely slightly curved, (20.0–)23.9–30.3(–37.3) × (6.8–)8.7–11.3(–12.3) µm (n = 50), (0–)1(–3)-septate, hyaline to slightly yellowish-brown, smooth to rough, finely spinulose.

Anamorph on natural substrata: *Stromata* erumpent through epidermis, orange to red. *Sporodochial conidiomata* without stipe, superficial on well-developed stromata, powdery, scattered, caespitose, rarely solitary, astipitate, sessile, up to 200–640 µm high, 250–1200 µm wide, white. *Hymenium* arising directly from *textura prismatica,* elongating from *textura angularis*, up to 150 µm long, of cells 2.0–5.5 µm wide, not curved at margin. *Conidiophores* with phialides or long sterile hyphae, monochasial branching, monoverticillate or biverticilate, whorls compact or diffuse, if present, metulae 37–118 × 2.2–4.4 µm. *Conidiogenous cells* monophialidic, cylindrical, straight or curved in terminal whorls of 2–4, with sterile hyphae, or lateral and terminal, 14–23 × 1.9–3.6 µm, collarette not conspicuous. *Sterile hyphae* mixed with phialides, acicular, straight or usually curved, unbranched or dichotomously branched, septate, 193–242 × 3.1–4.3 µm, arising from hyphae often in groups of 1–3 from conidiophores together with phialides. *Conidia* hyaline, ellipsoidal to oblong, sometimes slightly curved, non-septate, (15.7–)18.4–22.6(–26.1) × (5.6–)7.1–8.9(–9.6) µm, (n = 50), smooth-walled.

Habitat: On bark of *Plagianthus regius* (*Malvaceae*).

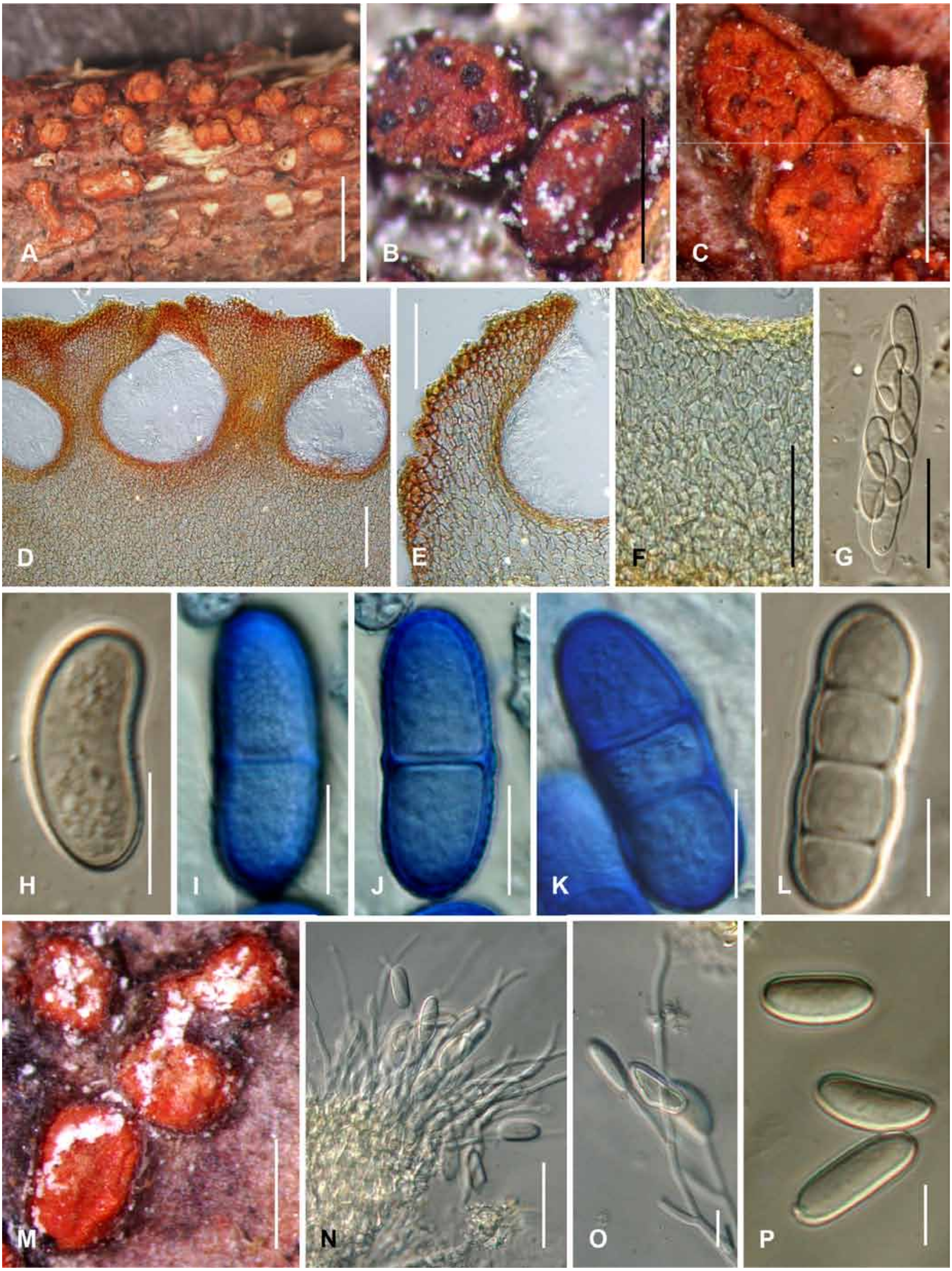

Fig. 38A–P. *Nectria hoheriae* on natural substrata (A–L teleomorph, M–P anamorph). A–C. Perithecia on natural substrata; D. Median section of perithecia; E. Median section of perithecial wall at edge of stroma; F. Median section of stroma; G Ascus; H–L. Ascospores; M. Sporodochia on natural substrata; N, O. Conidiophores, long sterile hyphae and conidia on natural substrata; P. Conidia on natural substrata. Scale bars: A = 5 mm; B, C, M = 1 mm; D–F = 100 µm; G, N = 50 µm; H–L, O, P = 10 µm.

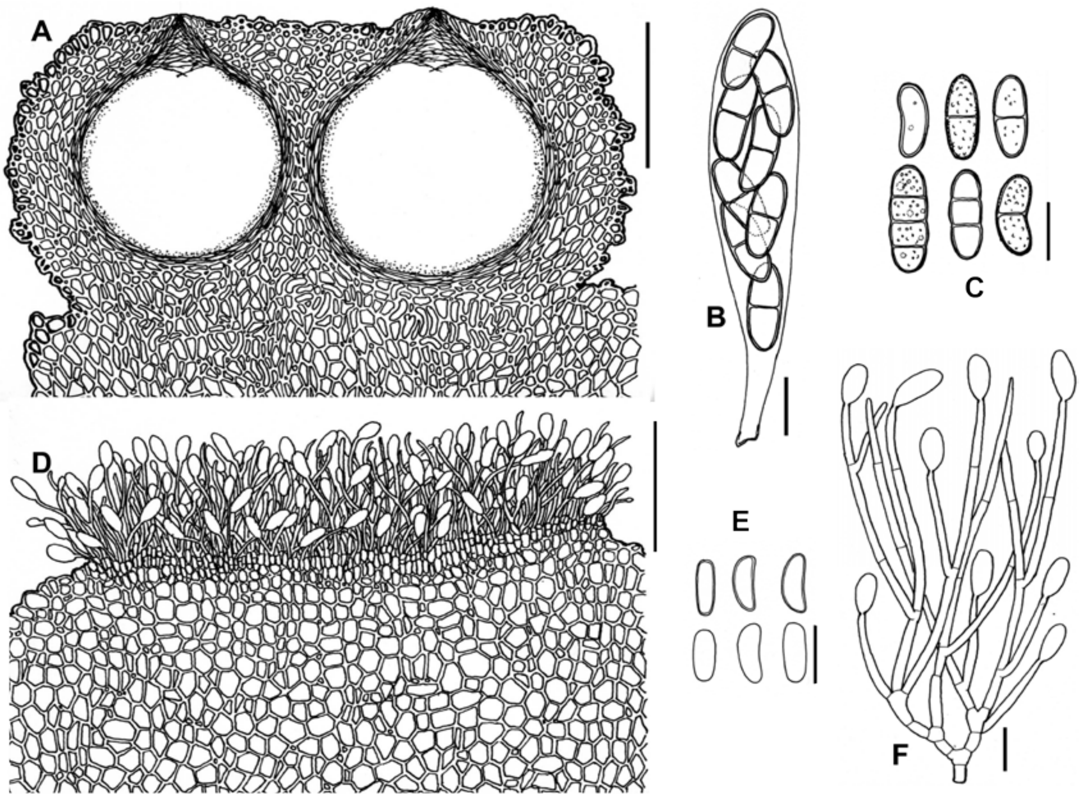

Fig. 39A–F. *Nectria hoheriae* on natural substrata (A–C teleomorph, D–F anamorph). A. Median section of mature perithecia; B. Ascus; C. Ascospores; D. Median section of Sporodochium; E. Conidia; F. Conidiophores. Scale bars: A, D = 200 µm; B¸C, E, F = 20 µm.

Distribution: Oceania (New Zealand).

Holotype of Nectria hoheriae: **New Zealand**, Mid Canterbury, Banks Peninsula, on bark of *Plagianthus regius*, 07 Apr. 1958, J.M. Dingley, **Holotype** PDD 21879, includes anamorph.

Lectotype of Myxosporium hoheriae *designated herein*: An illustration in the original paper of *Mycosporium hoheriae*, **Lectotype** Atkinson 1940, p 119A Fig. 3.

Additional specimens and isolates examined: **New Zealand**, Waiheke Island, near house of Peter Johnston, on recently cut log, 08 Mar. 2009, P. Chaverri, P. Johnston, BPI 879118 = PC 982; Waiheke Island, near house of Peter Johnston, on recently cut log, 08 Mar. 2009, P. Chaverri, P. Johnston, BPI 879119 = PC 983.

Notes: Morphologically *N. hoheriae* resemble *N. eustromatica* and *N. magnispora* in having ascomata immersed or covered by a stroma and spinulose ascospores that are greater than 25 µm long. These species differ from each other in characteristics of the ascomatal surface and size and septation of ascospores.

According to Dingley (1989), *Myxosporium hoheriae* based on PDD 1236 is the anamorph of *N. hoheriae*, but the protologue of *M. hoheriae* (Atkinson 1940) does not mention any type specimen. Fortunately the protologue includes a beautiful illustration, which is herein designated as lectotype (Atkinson 1940, p. 119A, Fig. 3). *Nectria hoheriae* exhibits the diversity of sporodochial, pycnidial, and synnematous anamorphs observed in nectria-like fungi. The anamorph of *N. hoheriae* produces sporodochia with sterile hyphae as commonly found on synnematal anamorphs (Figs 38N, O, 39F). Moreover, *N. magnispora,* which is morphologically similar to *N. hoheriae,* forms pycnidia on SNA.

Nectria lateritia (P. Karst.) Rossman, Mycol. Pap. 150: 22. 1983. Figs 40, 41.

Basionym: *Stilbonectria lateritia* P. Karst., Hedwigia 28: 194. 1889.
= *Calonectria erythrina* Syd. & P. Syd., Ann. Mycol. 10: 81. 1912.
≡ *Nectria erythrina* (Syd. & P. Syd.) Rossman, Mycotaxon 8: 508. 1979.

Anamorph: synnematous, tubercularia-like.

Teleomorph on natural substrata: *Stromata* erumpent through epidermis, up to 1.0 mm high and 2.0 mm diam, sienna to umber, KOH+ dark purple, LA+ yellow, pseudoparenchymatous, cells forming textura *angularis*, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, scattered to aggregated in groups of 4–42, subglobose to turbinate, 260–380 µm high × 275–380 µm diam, with short, pointed papilla, cupulate upon drying, sometimes with only a depressed apical region, scarlet to bay, apical region darker, KOH+ dark purple, LA+ yellow, smooth to roughened. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis*, 3–10 µm diam, with pigmented, uniformly *ca.* 1.5 µm thickened walls. *Ascomatal wall* 40–70 µm thick, of three regions: outer region 20–35 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.5 µm thick; middle region 5–20 µm thick, cells forming *textura globulosa*, with brown to red-brown globules, walls amber about 0.5 µm thick; inner region 7–15 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* clavate, 50–75 × 8–14 µm, with inconspicuous ring at apex, 8-spored, mainly biseriate. *Ascospores* ellipsoidal to cylindrical, rarely slightly curved, with broadly rounded ends, (14.3–)16.2–19.0(–20.8) × (3.9–)4.6–5.8(–6.4) µm (*n* = 150), (1–)3-septate, hyaline, slightly striate.

Anamorph on natural substrata (doubtful): *Synnemata* usually erumpent through epidermis, solitary, rarely gregarious, emerging from ascomatal cluster or individually, caespitose, cylindrical-capitate, subulate-capitate, or claviform, erect or nodding, unbranched, rarely branched, medium to slender stature, hispid at base to mid-level some young synnemata smooth to granular, red-

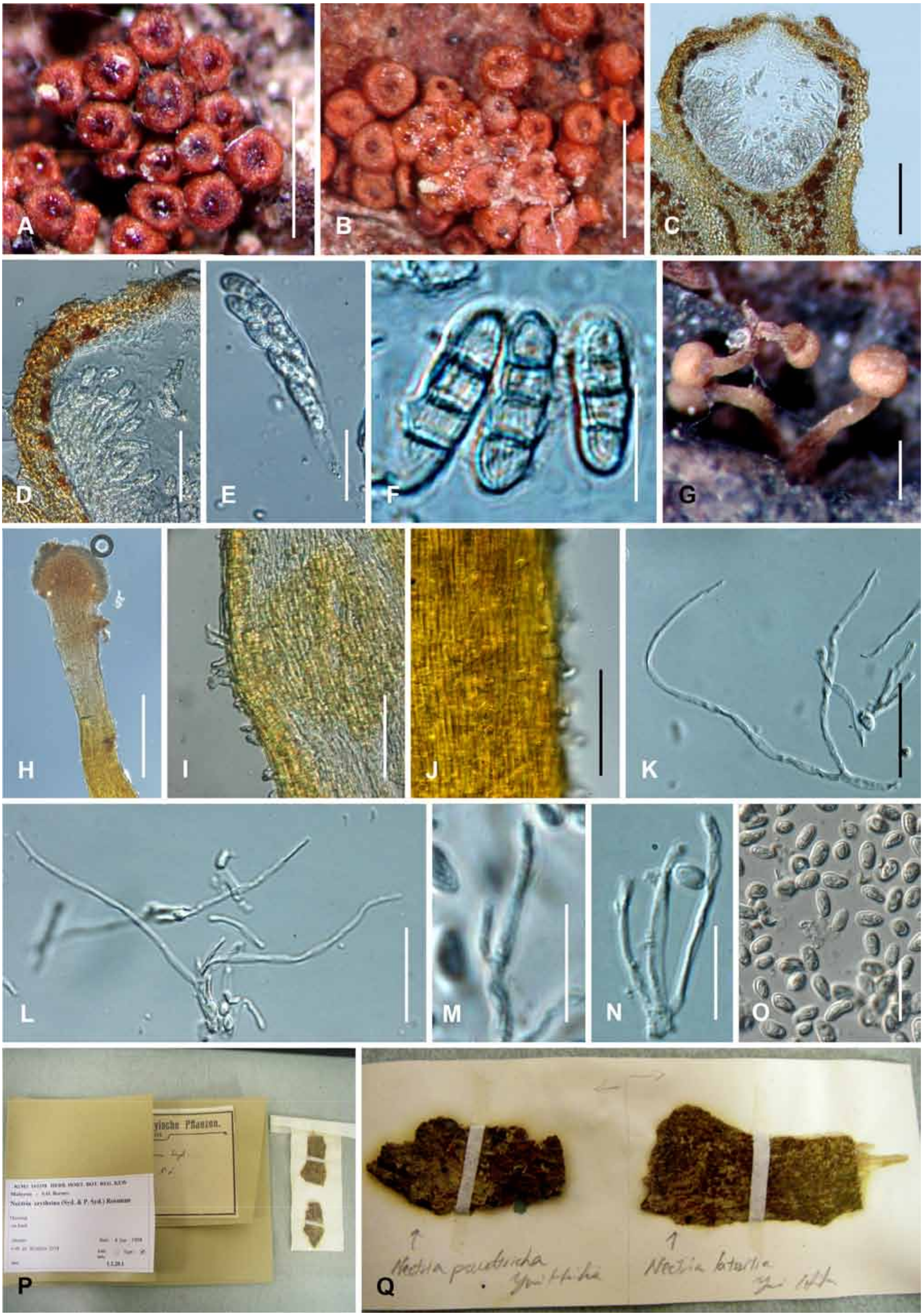

Fig. 40A–Q. *Nectria lateritia* on natural substrata (A–F teleomorph, G–O anamorph, P, Q packet and specimen of *Calonectria erythrina* K 163338). A, B. Perithecia on natural substrata; C. Median section of perithecium; D. Median section of perithecial wall; E. Ascus; F. Ascospores in surface view; G, H. Synnemata on natural substrata; I, J. Ornamental hyphae on stipe; K, L. Sterile hyphae on natural substrata; M, N. Conidiophores on natural substrata; O. Conidia on natural substrata; P, Q. Packet and specimen of *Calonectria erythrina* K 163338. Scale bars: A, B, G, H = 500 µm; C = 100 µm; D, K, L = 50 µm; E, I, J = 20 µm; F, M–O = 10 µm.

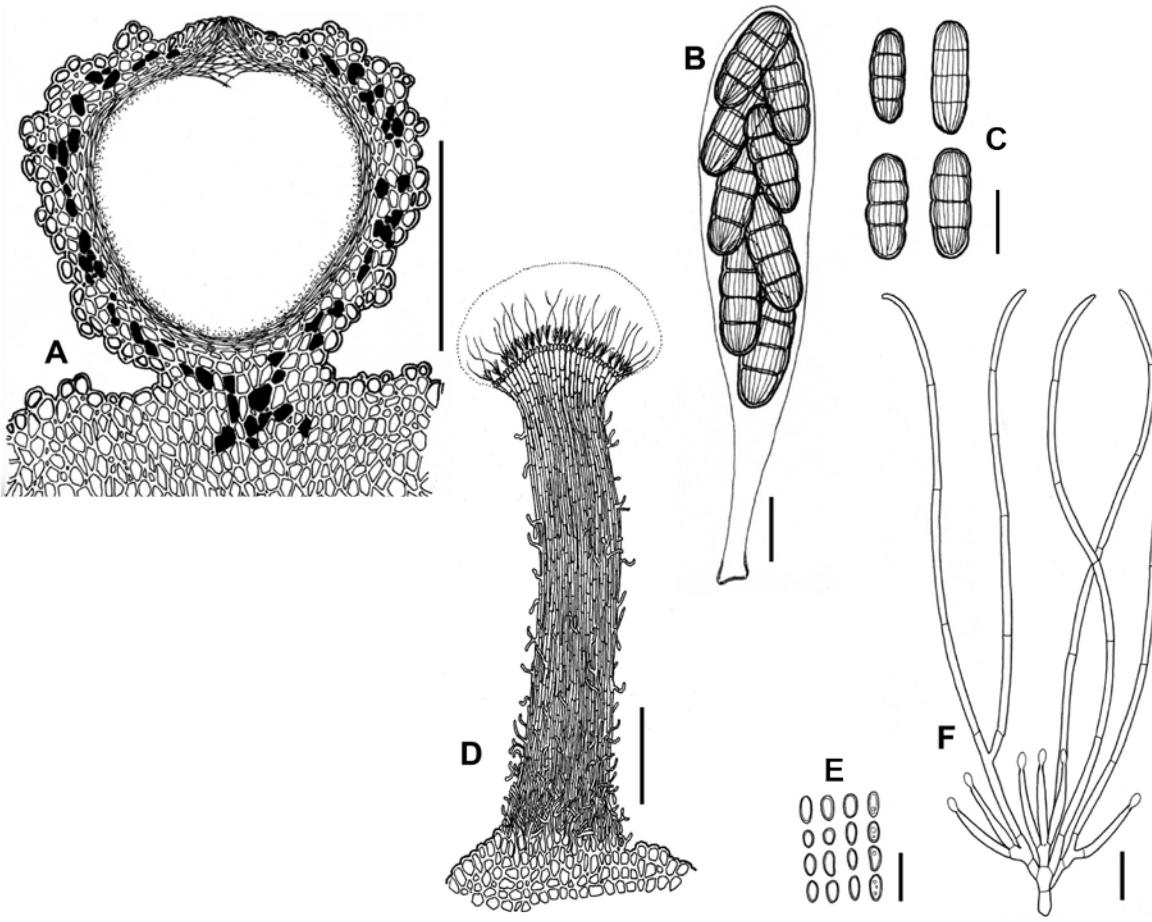

Fig. 41A–F. *Nectria lateritia* on natural substrata (A–C teleomorph, D–F anamorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores; D. Median section of synnema; E. Conidia; F. Sterile hyphae and conidiophores. Scale bars: A, D = 200 µm; B–F = 10 µm.

brown at base, stalk becoming pale toward apex, turning blood-red in KOH, almost black in age, 700–1500 µm high including stipe, 150–300 µm wide at base. *Hyphae on stipe* externally pigmented golden brown at base, becoming less pigmented towards apex, KOH+, 5–10 µm wide; internal hyphae hyaline, KOH–, 4–7 µm wide. *Ornamental hyphae on stipe* cylindrical, straight or curved, sinuous or rarely twisted, arising laterally at more or less right angles, distributed evenly over surface of synnemata or concentrated near base in some collections, or near apex in others, 5–10 µm long, 1.3–2.1 µm wide, usually unbranched but occasionally dichotomously branched, aseptate or with up to 2-septae, septa thin or up to 1 µm thick, terminal hyphae with bluntly rounded tips, 4–7 µm wide, cell walls 1.5–2 µm thick. *Conidiophores* with long sterile hyphae, branching monoverticillate or biverticillate, whorls compact or diffuse, if present, metulae 37–59 × 2.0–3.5 µm. *Conidiogenous cells* enteroblastic, monophialidic, cylindrical to subulate, straight or curved, 10–25 × 1.3–2.1 µm, collarette not conspicuous. *Sterile hyphae* mixed with phialides, acicular, straight or usually curved, unbranched or dichotomously branched, septate, 77–163 × 1.5 –3.5 µm, arising from hyphae in whorls, or more often in groups of conidiophores together with phialides. *Conidial mass* globose, hemisphaerical, or more or less discoid, white to saffron when fresh, drying reddish black, 250–500 µm diam. *Conidia* hyaline, ellipsoidal, obovate or oblong-ellipsoidal, sometimes slightly curved, non-septate, (3.9–)4.6–5.8(–7.1) × (2.1–)2.4–3.2(–3.7) µm (*n* = 85), smooth-walled.

Habitat: On bark and dead wood of dicotyledonous trees including *Manihot utilissima (Euphorbiaceae)*.

Distribution: Asia (China, Malaysia), South America (Brazil, Venezuela).

Holotype of Stilbonectria lateritia: **Brazil**, Minas, Lafayette, on bark of frondose trees, E. Wainio, No. 1952, **Holotype** H 7003454.

Additional type specimens examined: Type of *Calonectria erythrina*: **Malaysia** (Süd-Öst Borneo), Hayoep, Urwald, on dead and dead wood, 8 Jun. 1908, H. Winkler 2338, **Lectotype** designated by Rossman (1983) GZU, **Isolectotypes** K 163338, FH.

Additional specimens and isolates examined: **China**, Yen-Hsien, Hainan, on bark, 16 Jun. 1934, S.Q. Deng, BPI 552479. **Venezuela**, Amazonas, Dpto. Rio Negro, Cerro de la Neblina, along Rio Mawarinuma, just outside Cañon Grande, vic. Neblina base camp, 00 °50'N, 66 °10'W, elev. *ca.* 140 m, on bark of recently dead tree, May 1984, G.J. Samuels, NY, culture G.J.S. 84-423 now contaminated.

Notes: *Nectria lateritia* was described and illustrated by Rossman (1983) and Samuels & Brayford (1994). This species is similar to *Nectria pseudocinnabarina* and *N. pseudotrichia* in structure of ascomatal wall, synnematous anamorph, and occurrence in tropical and sub-tropical regions. However, *N. lateritia* clearly differs from these species in having 3-septate, striate ascospores (Figs 40F, 41C).

According to previous papers (Samuels & Brayford 1994, Rossman *et al*. 1999), the anamorph of *N. lateritia* was listed as *T*. cf. *lateritia*. Seifert (1985) carefully observed and discussed the anamorphs of *N. lateritia* and *N. pseudotrichia*. He found a few depauperate synnemata on specimens of *N. lateritia*, but could not distinguish them morphologically from *T. lateritia,* the anamorph of *N. pseudotrichia*. He concluded that the concept of *T. lateritia* included both the anamorph of *N. pseudotrichia* and *N. lateritia*.

Another possible explanation for the presumed similarity of the anamorph of *N. lateritia* to that of *N. pseudotrichia* is that the anamorph of *N. pseudotrichia* was mistaken for that of *N. lateritia*. In the isolectotype of *Calonectria erythrina* at K, both *N.lateritia* and *N. pseudotrichia* with its anamorph were present. Portions of this specimen included ascomata of *N. lateritia* without synnemata while other portions contained *N. pseudotrichia* with the synnemata of *T. lateritia* (Fig. 40P, Q). Seifert (1985) mentioned that according to G.J. Samuels (pers. comm.) these species are culturally distinct. Unfortunately, the culture of *N. lateritia* (G.J.S. 84-423) is no longer available.

Nectria magnispora Hirooka, Rossman & P. Chaverri, **sp. nov.** MycoBank MB519701. Figs 42–44.

Holotype: **Japan**, Kanagawa Prefecture, Odawara-shi, Iryuda, on bark of fallen twigs, 12 Jul. 2003, Y. Hirooka, **Holotype** BPI 881044, **ex-holotype** culture MAFF 241418 = TPP-h142.

Etymology: *magni* + *-spora*; indicates the large size of the ascospores.

Anamorph: pycnidial in the natural environment.

Teleomorph on natural substrata: *Mycelium* not visible around ascomata or on host. *Stromata* erumpent through epidermis, up to 2.5 mm high and 3.0 mm diam, red to sienna, KOH+ blood red, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*, intergrading with ascomatal wall. *Ascomata* nearly or completely immersed in stroma, aggregated in groups of 2–5, red, subglobose to globose, 410–700 µm high × 230–1350 µm diam, not collapsing when dry, apical region darker, KOH+ dark purple, LA+ yellow, smooth wall. *Ascomatal surface cells* at edge of stroma forming *textura globulosa* or *t. angularis*, 6–15 µm diam, with pigmented, uniformly *ca.* 2.5 µm thickened walls. *Ascomatal wall at edge of stroma* 78–130 µm thick, of two regions: outer region 71–117.5 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 2.5 µm thick; inner region 17–27 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* clavate, 98–137 × 15–20 µm, with inconspicuous ring at apex, 8-spored, biseriate. *Ascospores* ellipsoidal to long oblong, straight to rarely slightly curved, 0-septate, (20.4–)25.8–32.0(–35.3) × (7.9–)9.5–13.3(–14.7) µm (*n* = 30), 1-septate, (22.3–)26.9–35.1(–40.2) × (8.2–)10.8–14.6(–15.2) µm (*n* = 30), 2-septate, (28.0–)33.8–38.1(–42.5) × (10.4–)12.5–14.6(–15.4) µm (*n* = 30), (0–)1(–2)-septate, hyaline to slightly yellowish-brown, smooth to roughened, finely spinulose.

Anamorph on natural substrata: *Stromata* developing in stroma with ascomata, orange to umber. *Pycnidia* globose, immersed, eustromatic, smooth, 360–460 µm diam, wall 20–36 µm thick, angular cells *ca.* 10 µm diam. *Conidiogenous cells* enteroblastic, monophialidic, oblong phialides 3–7 µm long, 1–1.5 µm wide at base, with an indistinct collarette. *Conidia* similar to ascoconidia, subglobose to ellipsoidal, 0-septate, (2.3–)2.5–3.5(–4.1) × (1.2–)1.6–2.7(–4.0) µm (*n* = 30), hyaline. Sporodochia not observed.

Anamorph in culture: After 7 d at 25 °C, colonies 25–32 mm (average 28 mm) diam. *Colony surface* cottony with aerial mycelium salmon to flesh; *aerial mycelium* restricted to centre, often small yellow sporodochial conidial masses produced after one wk; *reverse* whitish yellow to yellow in centre and white at margin. *Odour* on PDA slightly putrid. On SNA, *conidiophores* of two types: short conidiophores producing microconidia, usually unbranched or loosely branched, generally with 1(–3)-branched, 27–86 µm long, 2.5–3.8 µm wide; *conidiogenous cells* long-cylindrical, straight to slightly curved, enteroblastic, monophialidic, 13–26 × 1.3–3.0 µm; *microconidia* hyaline, ellipsoidal to long fusiform, slightly curved, non-septate, 5.0–9.0(–13.3) × (1.6–)2.0–2.6(–3.1) µm (*n* = 50). Long conidiophores producing macroconidia, monochasial branching, unbranched or loosely branched, generally with 1–2-branched, 65–157 µm long, 1.9–3.7 µm wide; *conidiogenous cells* long-cylindrical, straight to slightly curved, enteroblastic, monophialidic, 20–42 × 2.2–4.0 µm; *macroconidia* hyaline, ellipsoidal to long fusiform, curved, non-septate, thickened wall cells, (11.5–)14.1–23.1(–27.6) × (4.2–)4.9–7.7(–9.8) µm (*n* = 50). *Chlamydospores* or *swollen hyphae* present. *Chlamydospores* intercalary in hyphae or rarely terminal, golobose to subglobose, sometimes ellipsoidal, smooth, hyaline, 15–20 µm. *Swollen hyphae* abundantly formed, intercalary in nomal hyphae, smooth, hyaline, producing 2–8 cells, 37–140 µm long, 5–12 µm wide. *Immature pycnidia* formed on SNA and PDA (MAFF 241418).

Habitat: On dead woody substrata.

Distribution: Asia (Japan).

Additional specimens and isolates examined: **Japan**, Kanagawa Prefecture, Odawara–shi, Iryuda, on bark of fallen twigs, 12 Jul. 2003, Y. Hirooka, TUA TPP-h141, culture TPP-h141 = CBS 129361; Tokyo, Meguro–ku, on bark of fallen twigs, 10 May 2003, Y. Hirooka, TUA TPP-h122, culture TPP-h122 = CBS CBS 129362.

Notes: *Nectria magnispora* has been collected only in the temperate regions of Japan. Within the genus *Nectria*, *N. magnispora* is similar to *N. eustromatica*, *N. hoheriae*, and *N. mariae* in having roughened ascospores (Figs 42H, I, 43C). However, the ascomata of *N. magnispora* are smooth while those of *N. eustromatica*, *N. hoheriae*, and *N. mariae* are slightly roughened to warty (Figs 42A–F, 43A).

The immersed pycnidial anamorph of *N. magnispora* is difficult to locate on specimens from the natural environment. These were observed only one time in sections of the sexual state (Figs 42K, 43D). The ex-holotype culture, MAFF 241418, produced superficial pycnidia on SNA and PDA (Fig. 44P).

Nectria mariae Hirooka, Fournier, Lechat, Rossman & P. Chaverri, **sp. nov.** MycoBank MB519702. Figs 45–47.

Holotype: **France**, Ariège, Seix, state forest, Bois de Mirabat, chemin de Mounétou (760 m) to the ruined castel of Mirabat, (1270 m), on dead bark of *Buxus sempervirens*, 16 Nov. 2005, M. Caster, **Holotype** BPI 881045 = C.L.L.7124 = C.L.L. 7187, **ex-holotype** culture CBS 125294 **=** A.R. 4274.

Etymology: *mari* + *-ae*; the first name of the collector Marie Casters.

Anamorph: unknown in the natural environment.

Teleomorph on natural substrata: *Mycelium* not visible around ascomata or on host. *Stromata* erumpent through epidermis, up to 2.5 mm high and 2.5 mm diam, red to umber, KOH+ blood red, LA+ yellow, pseudoparenchymatous, cells forming *textura*

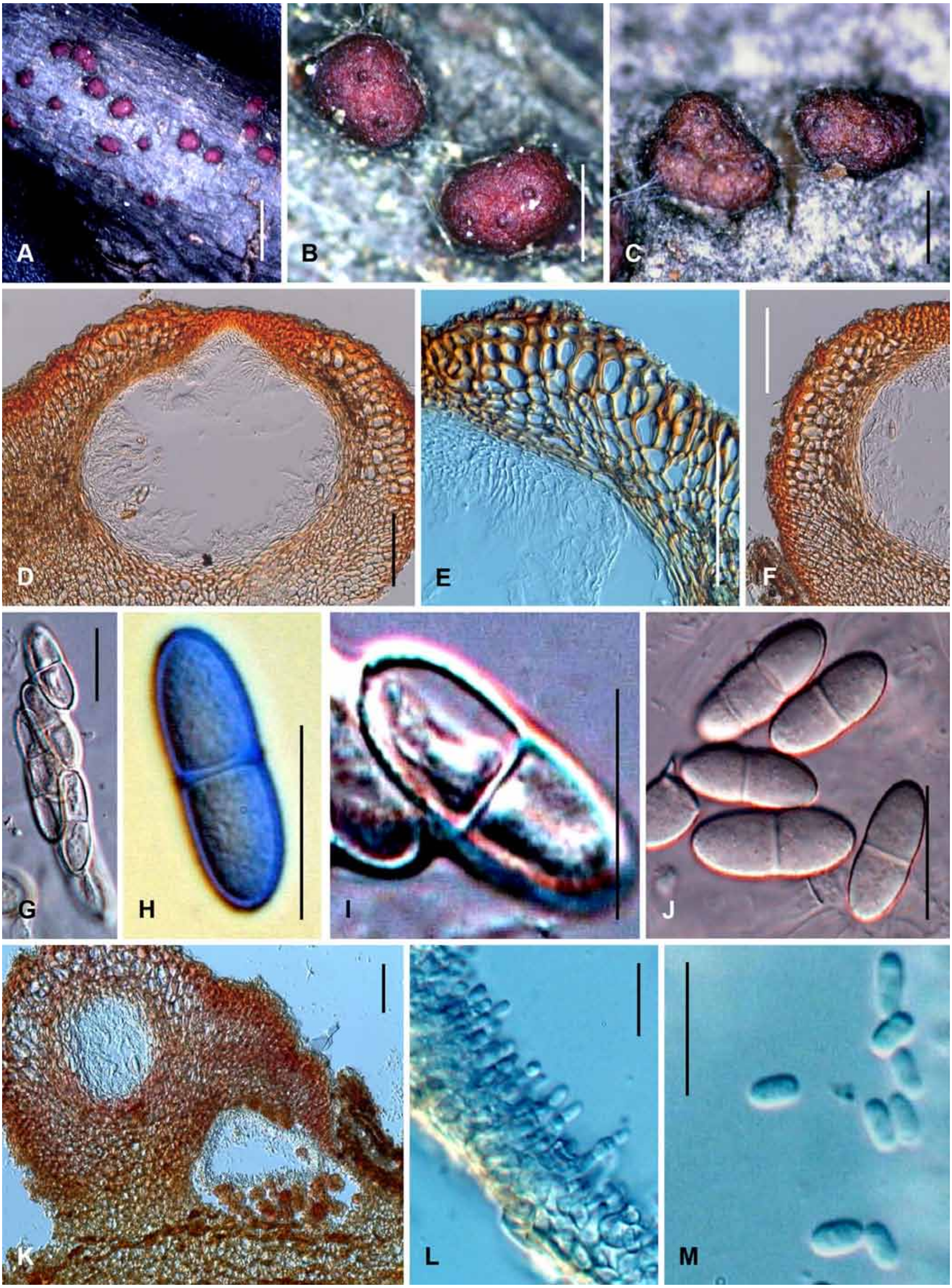

Fig. 42A–M. *Nectria magnispora* on natural substrata (A–J teleomorph, K–M anamorph). A–C. Perithecia on natural substrata; D. Median section of perithecium; E. Median section of perithecial apex; F. Median section of perithecial wall; G. Ascus; H–J. Ascospores; K. Median section of pycnidium on natural substrata; L. Conidiophores on natural substrata; M. Conidia on natural substrata. Scale bars: A = 5 mm; B, C = 1 mm; D–F, K = 100 µm; G–J = 30 µm; L, M = 10 µm.

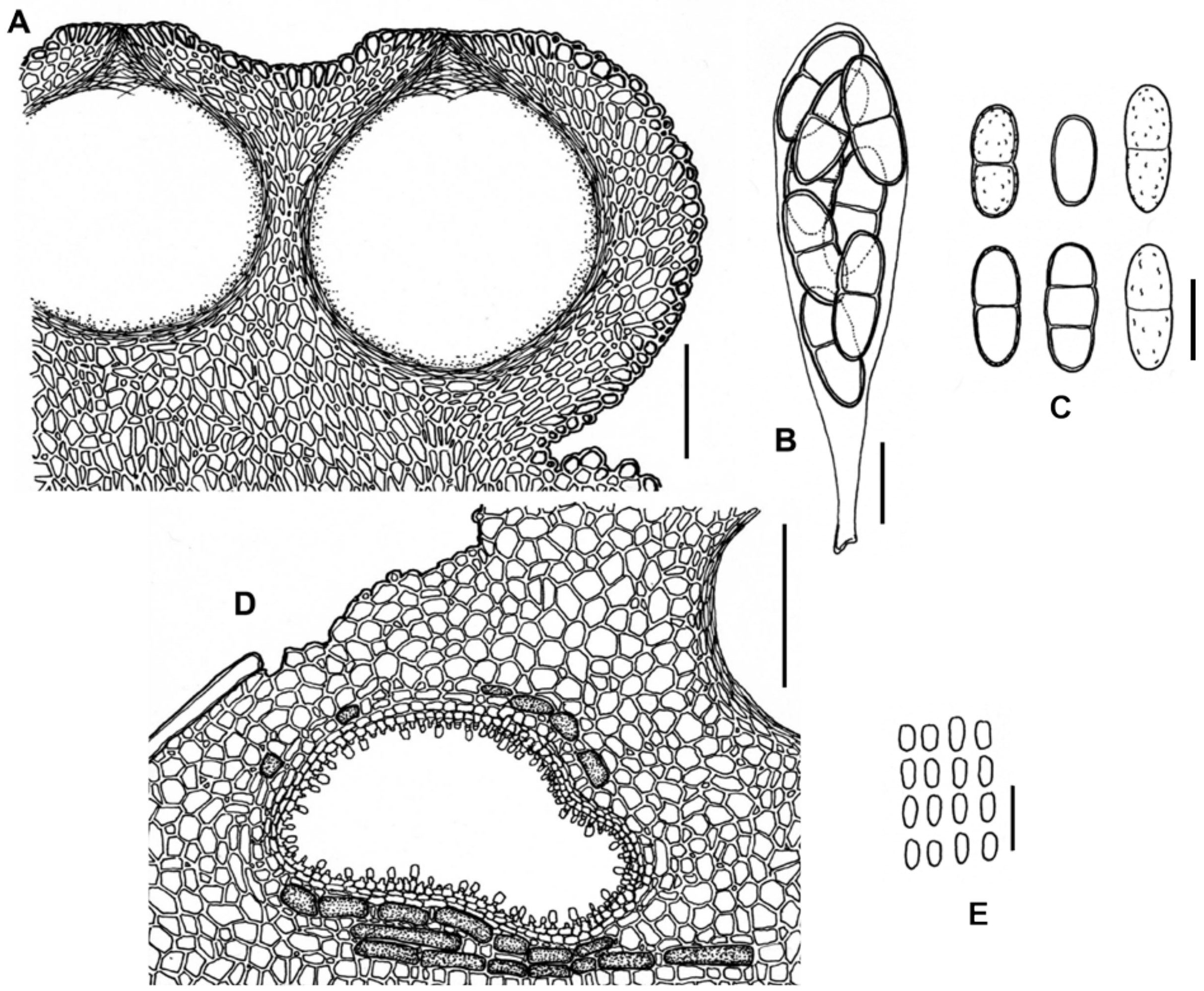

Fig. 43A–E. *Nectria magnispora* on natural substrata (A–C teleomorph, D, E anamorph). A. Median section of mature perithecia; B. Ascus; C. Ascospores; D. Median section of pycnidium; E. Conidia. Scale bars: A, D = 200 µm; B, C, E = 20 µm; , F = 10 µm.

angularis, intergrading with ascomatal wall. *Ascomata* nearly or occasionally completely immersed in stroma, aggregated in groups of 2–18, red to sienna, subglobose to globose, 323–491 µm high × 326–462 µm diam, not collapsing when dry, apical region darker, KOH+ dark purple, LA+ yellow, surface with concolourous warts up to 70 µm high. *Ascomatal surface cells* at edge of stroma forming *textura globulosa* or *t. angularis*, 6–14 µm diam, with pigmented, uniformly *ca.* 2.0 µm thickened walls. *Ascomatal wall at edge of stroma* 51–85 µm thick, of two regions: outer region 41–71 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 2.0 µm thick; inner region 13–21 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* narrowly clavate to clavate, 114–145 × 18–23 µm, with inconspicuous ring at apex, 8-spored, biseriate. *Ascospores* ellipsoidal to fusiform with rounded ends, straight to rarely slightly curved, (0–)1 septate, (18.4–)20.8–30.6(–37.4) × (7.6–)8.1–11.7(–13.6) µm (*n* = 50), hyaline, smooth to roughened, finely spinulose.

Anamorph in culture: After 7 d at 25 °C, colonies 7–10 mm (average 8 mm) diam. *Colony surface* cottony with aerial mycelium saffron to whitish yellow; *aerial mycelium* restricted to centre, small whitish yellow sporodochial conidial masses produced after 1 wk; *reverse* saffron to whitish yellow in centre and white at margin. *Odour* on PDA absent. On SNA, c*onidiophores* of two types: short conidiophores producing microconidia, 1–2-branched, becoming loosely to moderately densely branched, generally with 1–4 branches, 23–71 µm long, 1.5–4.0 µm wide; *conidiogenous cells* long-cylindrical, straight to slightly curved, enteroblastic, monophialidic, 9.8–26 × 1.1–2.8 µm; *microconidia* hyaline, ellipsoidal, oblong to long fusiform, rarely slightly curved, non-septate, (5.7–)7.7–10.3(–12.4) × (2.4–)3.3–4.5(–5.4) µm (*n* = 50); long conidiophores producing macroconidia, monochasial branching, unbranched or loosely branched, generally 1(–2)-branched, 36–98 µm long, 2.5–4.1 µm wide; *conidiogenous cells* long-cylindrical, straight to slightly curved, enteroblastic, monophialidic, 17–40 × 2.2–3.8 µm; *macroconidia* hyaline, subglobose to ellipsoidal, non-septate, thickened wall cells, (14.7–)16.3–20.3(–22.3) × (8.5–)9.4–11.4(–13.5) µm (*n* = 50). *Chlamydospores* or *swollen hyphae* rarely present. *Chlamydospores* intercalary in hyphae or rarely terminal, globose to subglobose, sometimes ellipsoidal, smooth, hyaline, 12–18 µm. *Swollen hyphae* rarely formed, intercalary in nomal hyphae, smooth, hyaline, producing 2–4 cells, 26–79 µm long, 5–6 µm wide.

Habitat: On recently dead standing branches or trunks of *Buxus sempervirens* (*Buxaceae*).

Distribution: Europe (France, Spain).

Additional specimens examined: **Spain,** Huesca, Fuente del Paco, *ca.* 1400 m, on dead twigs of *Buxus sempervirens* in an *Abies* forest, 10 Oct. 2010, J. Fournier JF 10149, LIP.

Notes: *Nectria mariae* is almost identical with *N. eustromatica* described by Jaklitsch & Voglmayr (2011) both having immersed ascomata in stromata, warted ascomatal walls, and spinulose

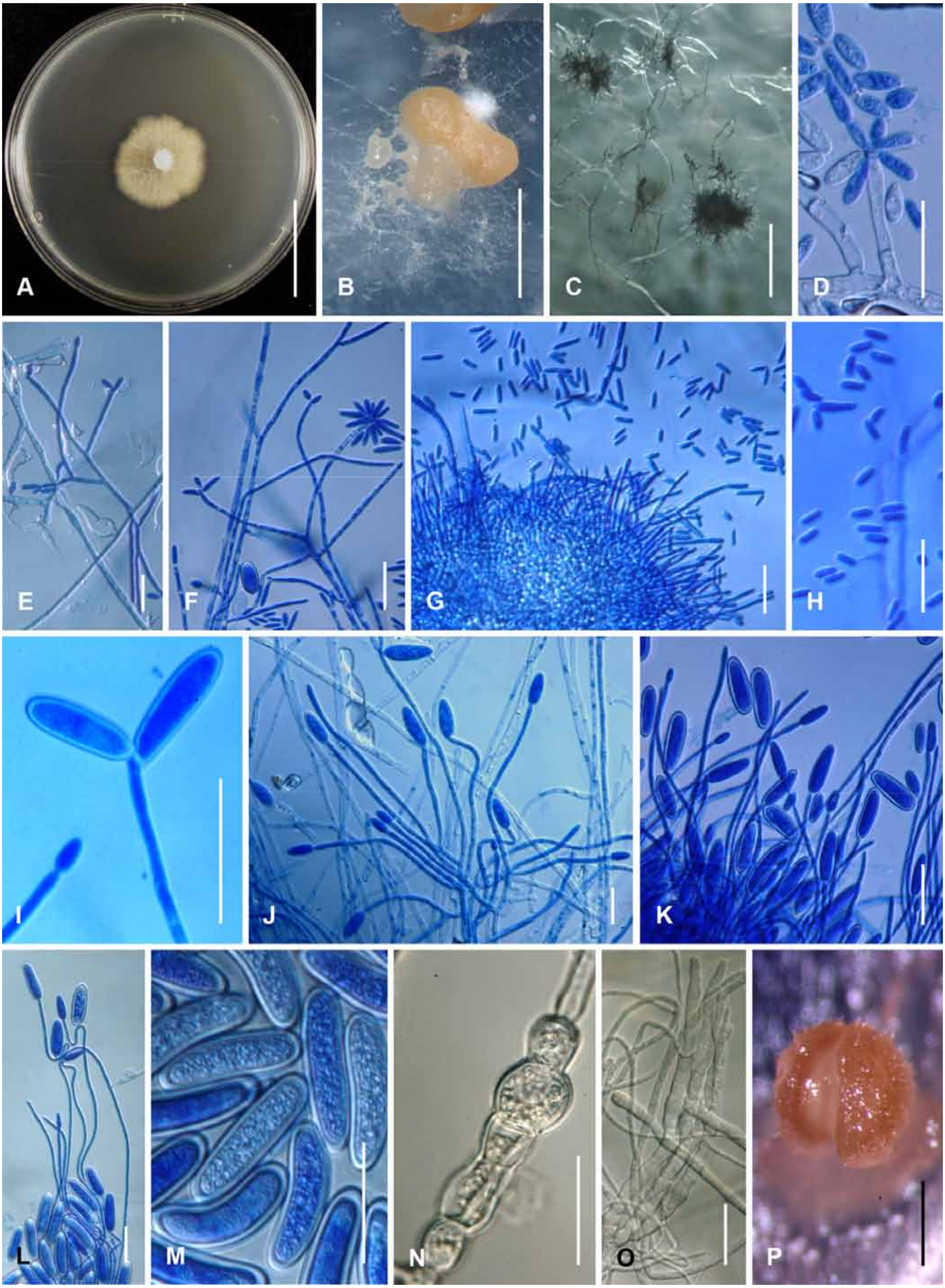

Fig. 44A–P. Anamorph of *Nectria magnispora* in culture. A. Cultures after 7 d at 25 °C on PDA; B, C. Abundant conidial mass on SNA; D–G. Short conidiophores producing microconidia on SNA; H. Microconidia on SNA; I–L. Long conidiophores producing macroconidia on SNA; M. Macroconidia on SNA; N. Chlamydospores on SNA; O. Swollen hyphae on SNA; P. Pycnidium on SNA. Scale bars: A = 3 mm; B, C, P = 100 µm; D–O = 20 µm.

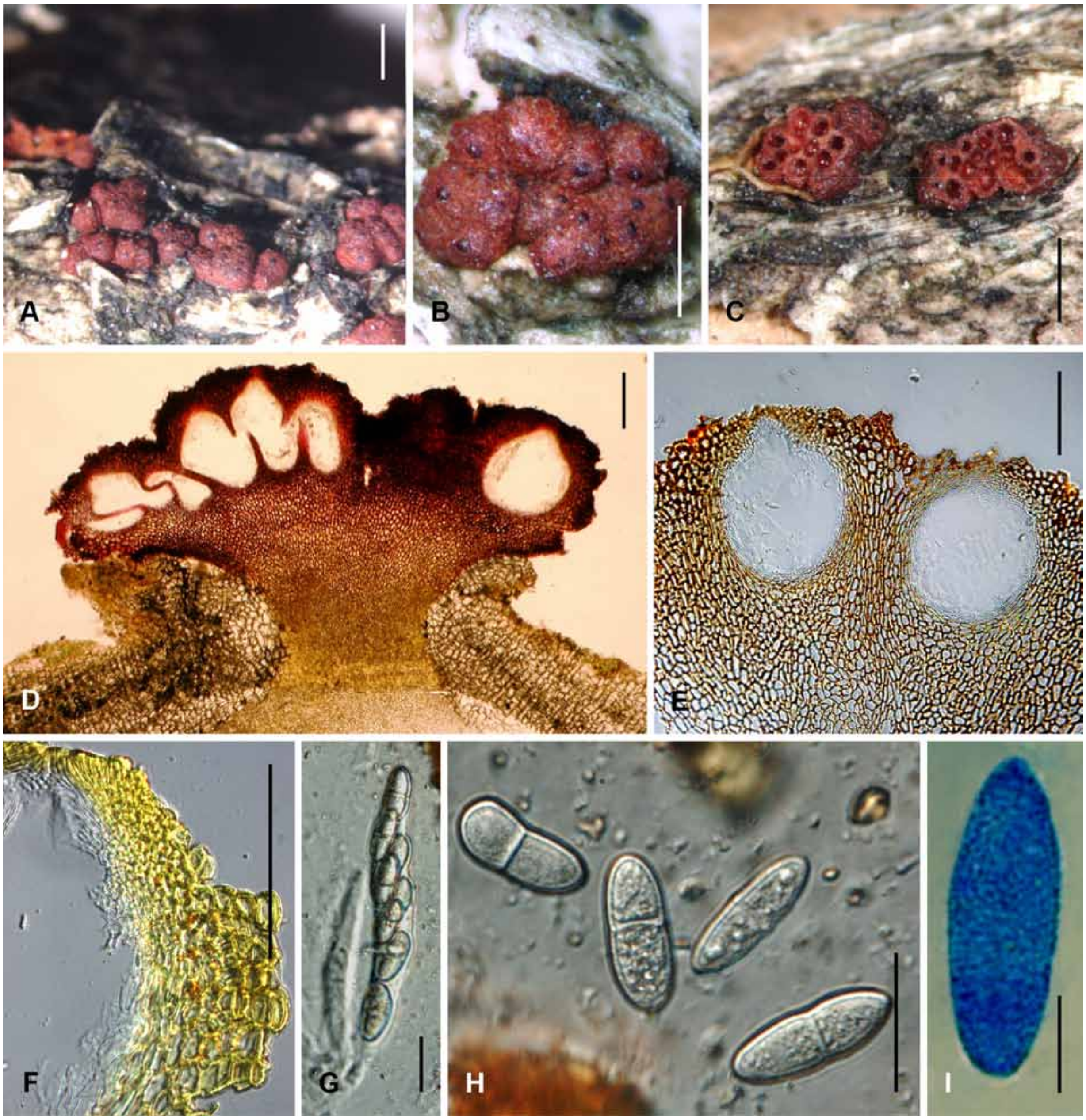

Fig. 45A–I. *Nectria mariae* on natural substrata (teleomorph). A, B. Perithecia on natural substrata; C. Section of fresh mature perithecia on natural substrata; D, E. Median section of perithecia; F. Median section of perithecial wall; G. Ascus; H. Ascospores; I. Ascospore in surface view. Scale bars: A–C = 1 mm; D–F = 100 µm; G, H = 30 µm; I = 10 µm.

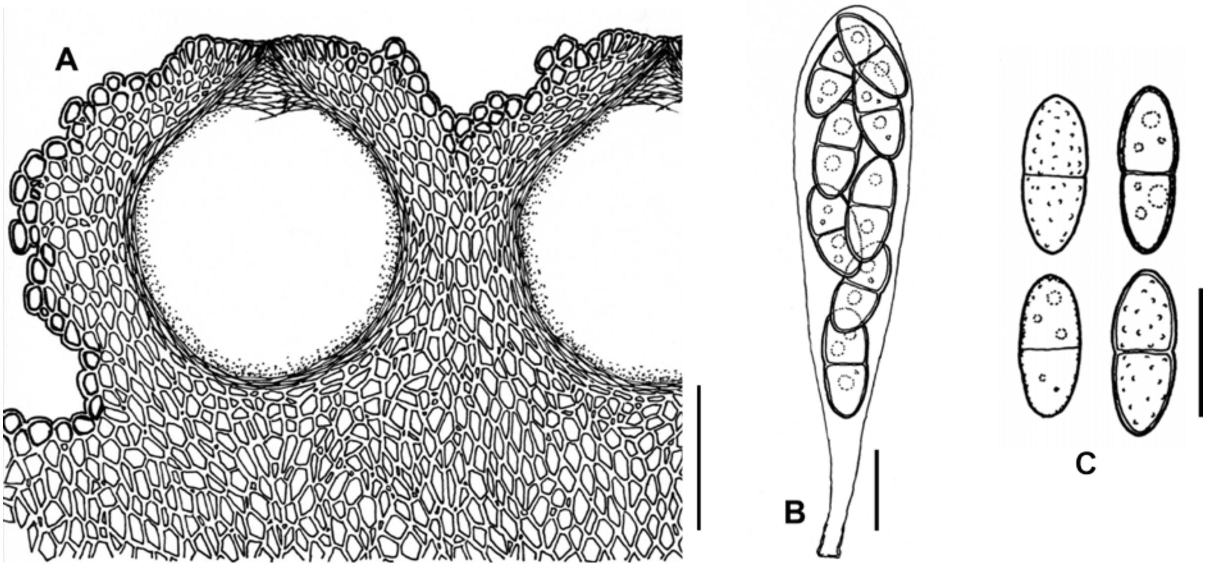

Fig. 46A–C. *Nectria mariae* on natural substrata (A–C teleomorph). A. Median section of mature perithecia; B. Ascus; C. Ascospores. Scale bars: A = 200 µm; B, C = 20 µm.

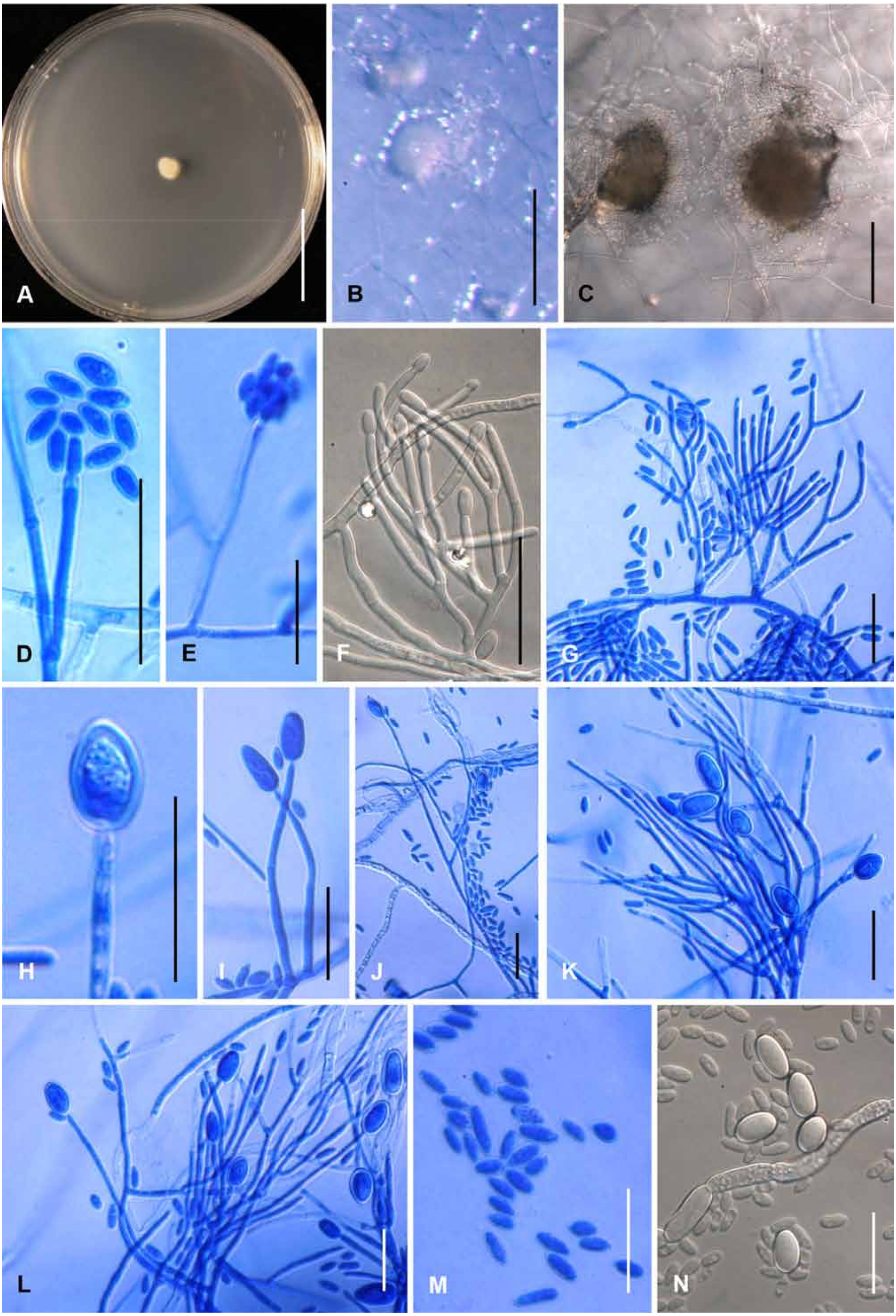

Fig. 47A–N. Anamorph of *Nectria mariae* in culture. A. Cultures after 7 d at 25 °C on PDA; B, C. Conidial mass on SNA; D. Short conidiogenous cell producing microconidia on SNA; E–G. Short conidiophores producing microconidia on SNA; H. Long conidiogenous cell producing macroconidia on SNA; I–L. Long conidiophores producing macroconidia on SNA; M. Microconidia on SNA; N. Microconidia and macroconidia on SNA. Scale bars: A = 3 mm; B, C = 100 µm; D–N = 30 µm.

ascospores, producing micro- and macroconidia in culture, and known only in Europe. However, *N. mariae* has red ascomata while those of *N. eustromatica* are dark red. In addition, *N. mariae* has smaller ascospores and macroconidia when compared with those of *N. eustromatica* having ascospores 24–43 × 8–15 µm and macroconidia 20–54 × 8.7–14.8 µm on MEA and OA (Jaklitsch & Voglmayr 2011). Closely related to *N. mariae*, *Nectria magnispora* produces a pycnidial anamorph in the natural environment and culture. Although we carefully observed the specimen and culture of *N. mariae*, no pynicida were found.

Nectria neorehmiana Rossman, Mycol. Pap. 150: 23. 1983. Figs 48, 49.

Anamorph: synnematous, tubercularia-like.

Teleomorph on natural substrata: *Mycelium* not visible around ascomata or on host. *Stromata* erumpent through epidermis, up to 1.0 mm high and 2.0 mm diam, dark scarlet, KOH+ blood colour, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, aggregated in groups of 5–20, subglobose to globose, 250–320 µm high × 220–290 µm diam, scarlet to dark scarlet, collapsing laterally when dry, apical region darker, KOH+ blood colour, LA+ yellow, papilla pointed, 20–40 µm high, surface with large, concolourous warts up to 30–50 µm high. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis*, 6–10 µm diam, with pigmented, uniformly *ca.* 1.5 µm thickened walls. *Ascomatal wall* 35–45 µm thick, of two regions: outer region 20–35 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.5 µm thick; inner region 10–20 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* clavate, 70–140 × 17–25 µm, with inconspicuous ring at apex, 8-spored, ascospores biseriate above, uniseriate below. *Ascospores* fusiform with narrowly rounded ends, straight to slightly curved, (30.2–)31.5–36.7(–39.1) × (6.0–)6.8–8.4(–9.3) µm (*n* = 30), (1–)3-septate, hyaline, smooth.

Anamorph on natural substrata: *Synnemata* usually erumpent through epidermis, solitary, rarely gregarious, emerging from ascomatal cluster or independently, caespitose, cylindrical-capitate, subulate-capitate, or claviform, erect or nodding, unbranched, medium to slender stature, hispid at base to mid region, some young synnemata smooth to granular, salmon to flesh at base, stalk becoming paler toward apex, KOH–, 1000–1500 µm high including stipe, 200–300 µm wide at base. *Hyphae on stipe* external hyphae slightly pigmented whitish salmon at base, becoming less pigmentied toward apex, KOH–, 4–9 µm wide; internal hyphae hyaline, KOH–, 4–6 µm wide. *Conidiophores* with phialides, branching monoverticillate or biverticillate, whorls compact or diffuse. *Conidiogenous cells* enteroblastic, monophialidic, cylindrical to subulate, straight or curved in terminal whorls of 3 together, or lateral, 6–27 × 1.5–2.5 µm, collarette not conspicuous. *Sterile hyphae* absent. *Conidial masses* globose, hemisphaerical, or more or less discoid, white to saffron when fresh, drying red to scarlet, 300–500 µm diam. *Conidia* hyaline, ellipsoidal, sometimes slightly curved, non-septate, (5.0–)5.6–7.0(–8.4) × (2.3–)2.7–3.5(–3.8) µm (*n* = 50), smooth-walled.

Habitat: On bark.

Distribution: South America (Ecuador, known only from the type collection).

Holotype of Nectria neorehmiana *designated by Rossman (1983)*: **Ecuador**, Prov. Tungurahua, Hacienda San Antonio, Los Banos, on rotting branches, Jan. 1938, H. Sydow, **Holotype** BPI 552615, **Isotype** designated by Rossman (1983), NY, M.

Notes: *Nectria neorehmiana* was described and illustrated by Rossman (1983) without its anamorph. In our reexamination, we discovered the anamorph on the holotype specimen. The unusual synnematous tubercularia-like anamorph includes a salmon to flesh stalk and red to scarlet conidial masses (Fig. 48F). The formation of warted ascomata, collapsing laterally when dry, and 3-septate ascospores of this species are characteristic of the genus *Albonectria*, *Nectriaceae*, especially *A. albosuccinea* and *A. rigidiuscula* (Figs 48A–C, E, 49A, C). However, it differs from *Albonectria* by the scarlet to dark scarlet ascomata and its tubercularia-*like* anamorph. *Nectria neorehmiana* is readily distinguished from all other species of *Nectria* by the scarlet to dark scarlet, warted ascomata. We did not observe the sterile hyphae that are consistently present in the synnematal tubercularia-like anamorphic states of other species of *Nectria*; only one synnemata of *N. neorehmiana* was observed microscopically of the three or four synnemata on the type specimen (Fig. 48G, H).

Nectria nigrescens Cooke, Grevillea 7: 50. 1878. Figs 50–52.

= *Nectria cinnabarina* forma *dendroidea* Fuckel, Fungi rhenani 2657. 1874.
  ≡ *Nectria cinnabarina* var. *dendroidea* (Fuckel) Wollenw., Angew. Bot. 8: 186. 1926.
= *Nectria cinnabarina* var. *minor* Wollenw., Angew. Bot. 8: 185. 1926.
= *Nectria meliae* Earle, Bull. Torrey Bot. Club 25: 364. 1898.
= *Nectria fuscopurpurea* Wakef., Kew Bull., p. 232. 1918.

Anamorph: *Tubercularia ulmea* J.C. Carter, Phytopathology 37: 246. 1947.

Teleomorph on natural substrata: *Mycelium* rarely visible around ascomata and on host. *Stromata* up to 2.0 mm high and 4 mm diam, erumpent through epidermis, whitish yellow to bay, sometimes darker red, KOH+ dark red, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis* to *t. prismatica* with cells oriented more or less vertically; cells 4–17 µm diam, with 1–1.5 µm thick walls, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, solitary or caespitose, up to 20 on an erumpent stroma, rarely clustered around base of stipitate sporodochia, subglobose to globose, 265–420 µm high × 236–410 µm diam (*n* = 38), red to reddish brown, sometimes cupulate upon drying, non-papillate, apical region darker, KOH+ dark red, LA+ yellow, surface roughened or with concolourous warts, but sometimes smooth. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis*, with walls pigmented, *ca.* 1.5 µm thick. *Ascomatal wall ca.* 40–65 µm thick, of two regions: *outer region* about 25–45 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, *ca.* 1.5 µm thick; *inner region ca.* 7–18 µm thick, of elongated, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* unitunicate, (62–)70–98(–113) × (6.5–)7.5–10.0(–11.5) µm (*n* = 63), cylindrical to narrowly clavate, with an inconspicuous ring at apex, 8-spored, ascospores biseriate above, uniseriate below. *Ascospores* ellipsoidal to fusiform, straight, sometimes slightly curved, hyaline, (0–)1(–3)-septate, (10.5–)13.5–18.0(–22.0) × (2.5–)3.5–5.5(–8.0) µm (*n* = 320), smooth-walled.

Anamorph on natural substrata: *Stromata* erumpent through epidermis, pale yellow to orange, rarely reddish brown.

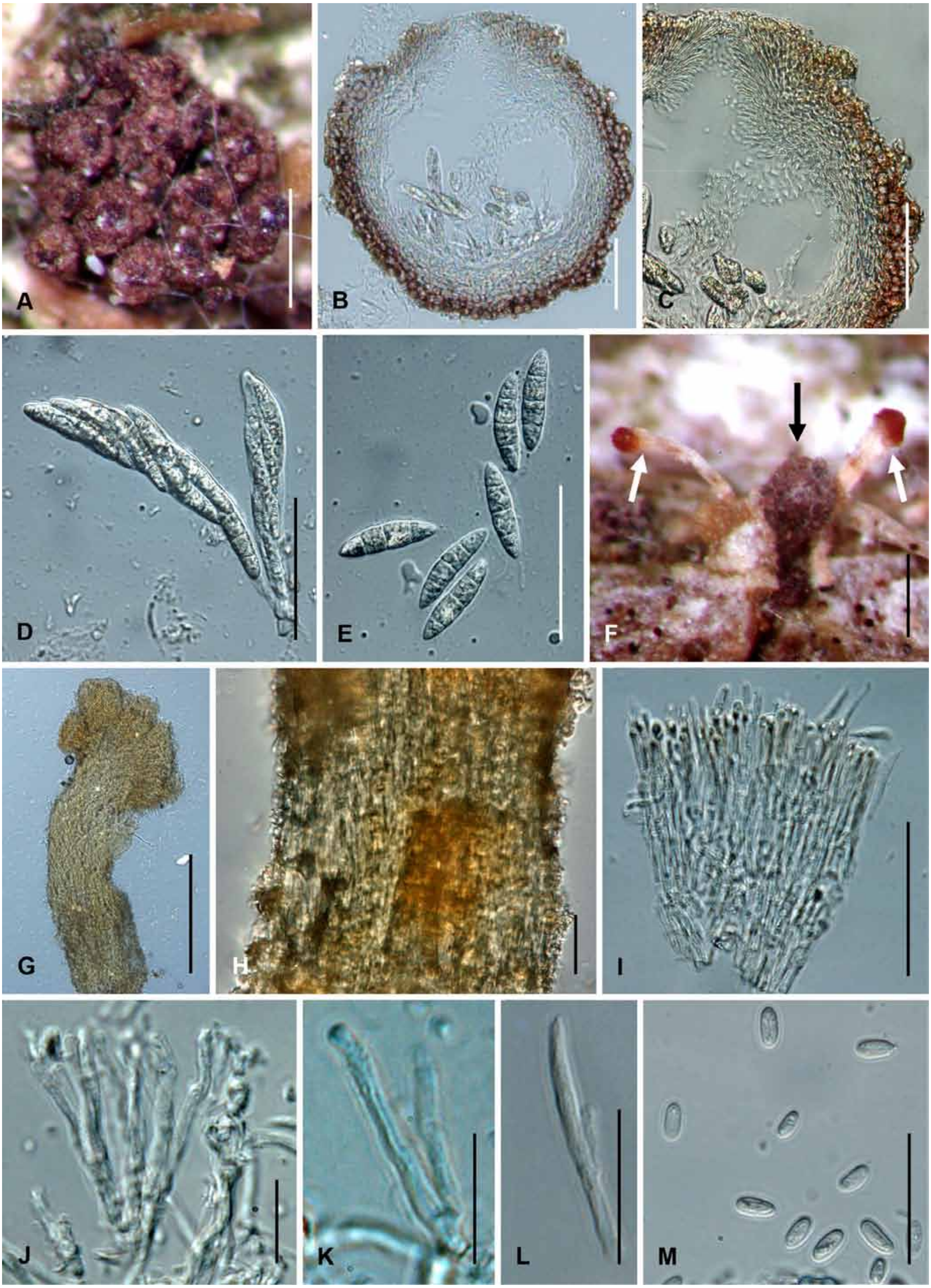

Fig. 48A–M. *Nectria neorehmiana* on natural substrata (A–E teleomorph, F teleomorph and anamorph. G–M. anamorph). A. Perithecia on natural substrata; B. Median section of perithecium; C. Median section of perithecial wall; D. Asci; E. Ascospores; F. Perithecium (black arrow) and synnemata (white arrows) on natural substrata; G. Synnema on natural substrata; H. Surface of stalk; I–L. Conidiophores on natural substrata; M. Conidia on natural substrata. Scale bars: A, F, G = 500 µm; B–D, H = 50 µm; E, I–L = 20 µm; M = 10 µm.

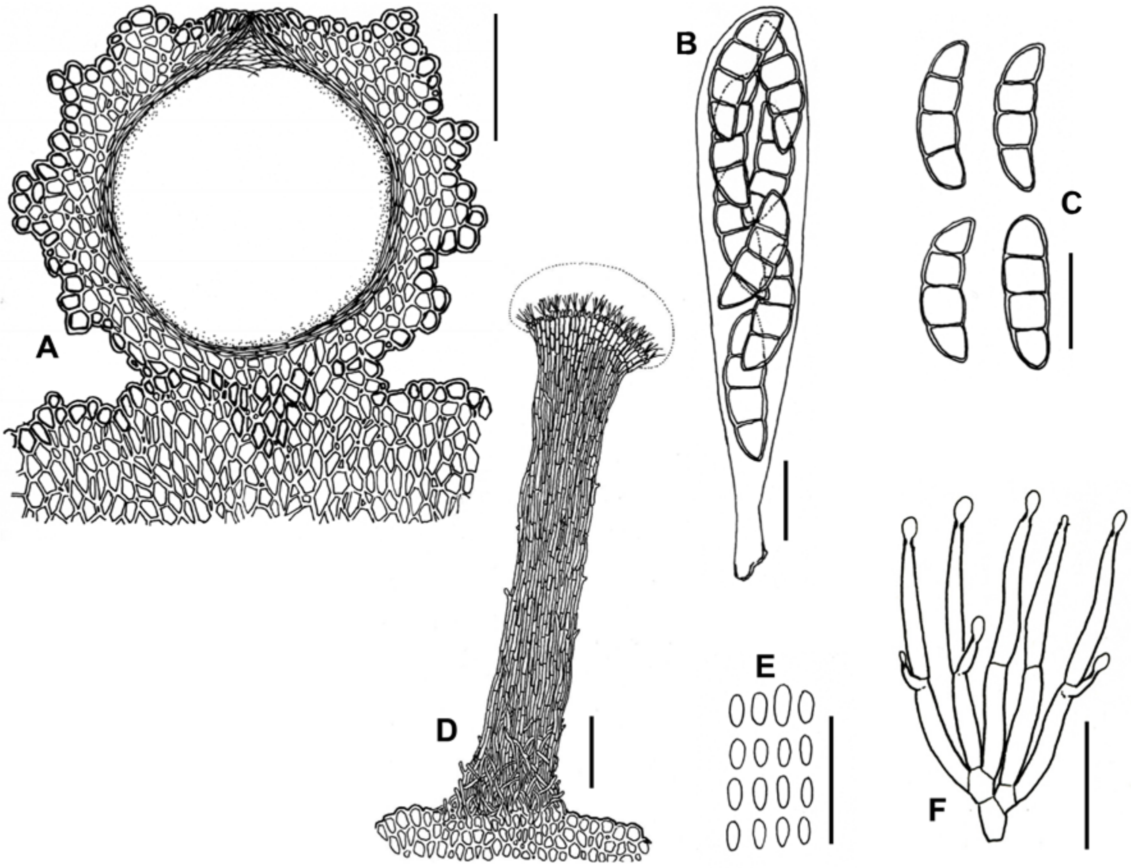

Fig. 49A–F. *Nectria neorehmiana* on natural substrata (A–C teleomorph, D–F anamorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores; D. Median section of synnema; E. Conidia; F. Conidiophores. Scale bars: A, D = 100 µm; B, C, E, F = 20 µm.

Sporodochial conidiomata with stipe, superficial on well-developed stromata, smooth, cerebriform or tuberculate, scattered, solitary, or 2–4 gregarious, stipitate, pustulate, discoid or cylindrical-capitate, up to 250–1700 µm high, 300–1700 µm wide, white, whitish yellow to orange, sometimes brown, red or dark red; *stipe* white to whitish red, rarely dark red, up to 340–640 µm wide; *stipe cells* almost *textura angularis*, continuous with stroma, usually with wider cells in centre. *Hymenium* arising directly from *textura prismatica* elongating from *textura angularis*, up to 120 µm long, of cells 2.5–6.0 µm wide, curved margin, up to 150 µm long, of parallel hyphae, 1.5–2.5 µm wide. *Acropleurogenous conidiophores* monoverticillate or rarely biverticillate, then developing acropleurogenously for 3–7 levels, straight, curved to coiled. *Acropleurogenously developing phialides* intercalary, occurring below each septum, rarely terminal; *intercalary phialides* monophialidic, 3.0–5.0 µm long, 1.0–2.0 µm wide; *terminal cells* monophialidic, sometimes sterile, without collarette. *Conidia* hyaline, narrowly long ellipsoidal to cylindrical, straight or slightly curved, (4.7–)5.5–6.9(–8.4) × (1.6–)2.1–2.7(–3.0) µm (*n* = 343), non-septate.

Anamorph in culture: Optimum temperature for *growth* on PDA 25 °C, maximum temperature 35 °C, after 7 d colonies 70–85 mm (average 80 mm) diam. *Colony surface* on PDA, radial, sometimes wavy, slightly cottony with aerial mycelium, white to whitish saffron; *aerial mycelium* developing only in CBS 125148, white to whitish yellow, sporodochial conidial masses produced after 2 wk; *reverse* white to slightly whitish yellow. *Odour* on PDA slightly fruity. Sporulation on SNA from *lateral phialidic pegs* on submerged or aerial hyphae common, enteroblastic, monophialidic, ellipsoidal tapering toward tip, 2.4–5.3 µm long, 1–1.9 µm wide near aperture. *Aerial conidiophores* abundantly developed on aerial hyphae, unbranched, sometimes verticillate, 1–2-branched, becoming loosely to moderately densely branched, 5.5–21.5 µm long, 2.0–3.0 µm wide at base. *Conidiogenous cells* monophialidic, cylindrical, slightly tapering toward tip or narrowly flask-shaped with widest point in middle, 9.5–17.0 µm long, 1.5–2.0 µm wide at base. *Young conidia* formed on monophialides on submerged or aerial hyphae, forming abundantly on slimy heads, non-septate, ellipsoidal, oblong to cylindrical, hyaline, smooth, straight or slightly curved with rounded ends, (3.0–)4.0–7.0(–14.5) × (1.5–)2.0–2.5(–3.5) µm (*n* = 250). *Mature conidia* swollen, mostly 0-, rarely 1-septate, ellipsoidal, oblong or allantoid, rarely ellipsoidal with slightly constricted centre, hyaline, smooth, straight or slightly curved and rounded at both ends, germinating or budding secondary conidia, (5.0–)7.6–14.6(–24.3) × (2.3–)3.5–4.9(–6.6) µm (*n* = 180). *Chlamydospores* rare, globose, subglobose, broadly ellipsoidal, 0(–1)-septate, solitary or chains, 8.0–13.0 µm wide. *Ascomata* not produced in culture.

Habitat: On dead woody substrata including *Acer* sp., *Betula lutea*, *Celtis occidentalis*, *Elaeagnus angustifolia, Fagus sylvatica*, *Gleditsia triacanthos* var. *inermis, Tilia* sp., *Ulmus pumila*.

Distribution: Europe (France, Germany, UK), North America (Canada, USA).

Holotype of Nectria nigrescens: **USA**, South Carolina, *on Gleditsia* sp., S.C. Aiken, **Holotype** K 165219, Ravenel, American Fungi 2380a.

Epitype of Nectria nigrescens *designated by Hirooka et al. (2011)*: **USA**, North Carolina, Haywood Co., Great Smoky Mountains National Park, Purchase Knob, Cataloochees Divide Trail, alt. 5000

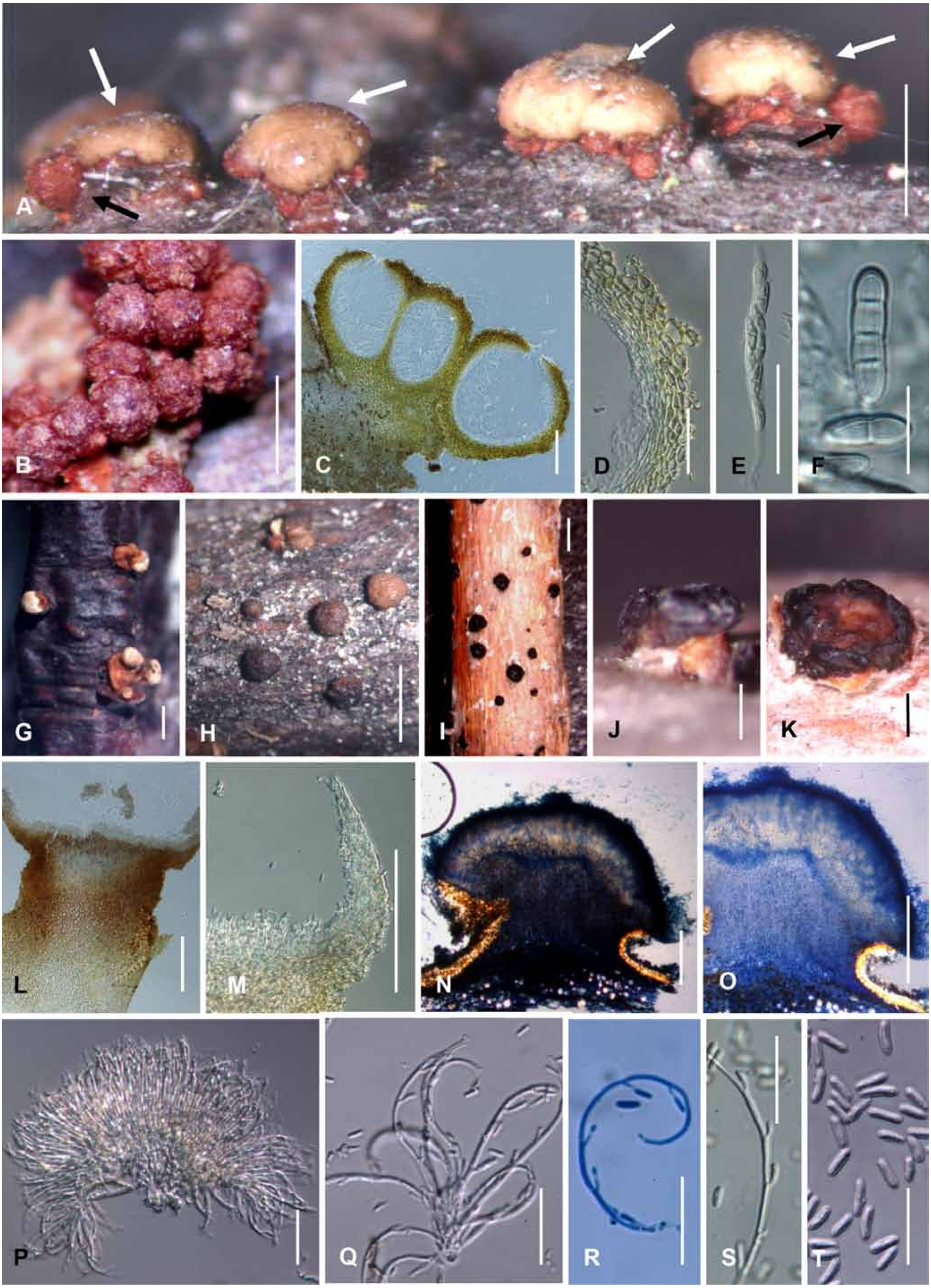

Fig. 50A–T. *Nectria nigrescens* on natural substrata (A teleomorph and anamorph, B–F teleomorph, G–T anamorph). A. Perithecia (black arrows) and astipitate sporodochia (white arrows) on natural substrata; B. Perithecia on natural substrata; C. Median section of perithecia; D. Median section of perithecial wall; E. Ascus; F. Ascospores; G–K. Long and short stipitate sporodochia; L. Median section of long stipitate sporodochium; M. Edge of long stipitate sporodochium; N. Median section of short stipitate sporodochium; O. Edge of short stipitate sporodochium; P–S. Acropleurogenous conidiophores and acropleurogenously developing phialides on natural substrata; T. Conidia on natural substrata. Scale bars: A, G–I = 1 mm; B, J–O = 500 µm; C = 100 µm; D, E, P = 50 µm; F, T = 10 µm; Q–S = 20 µm.

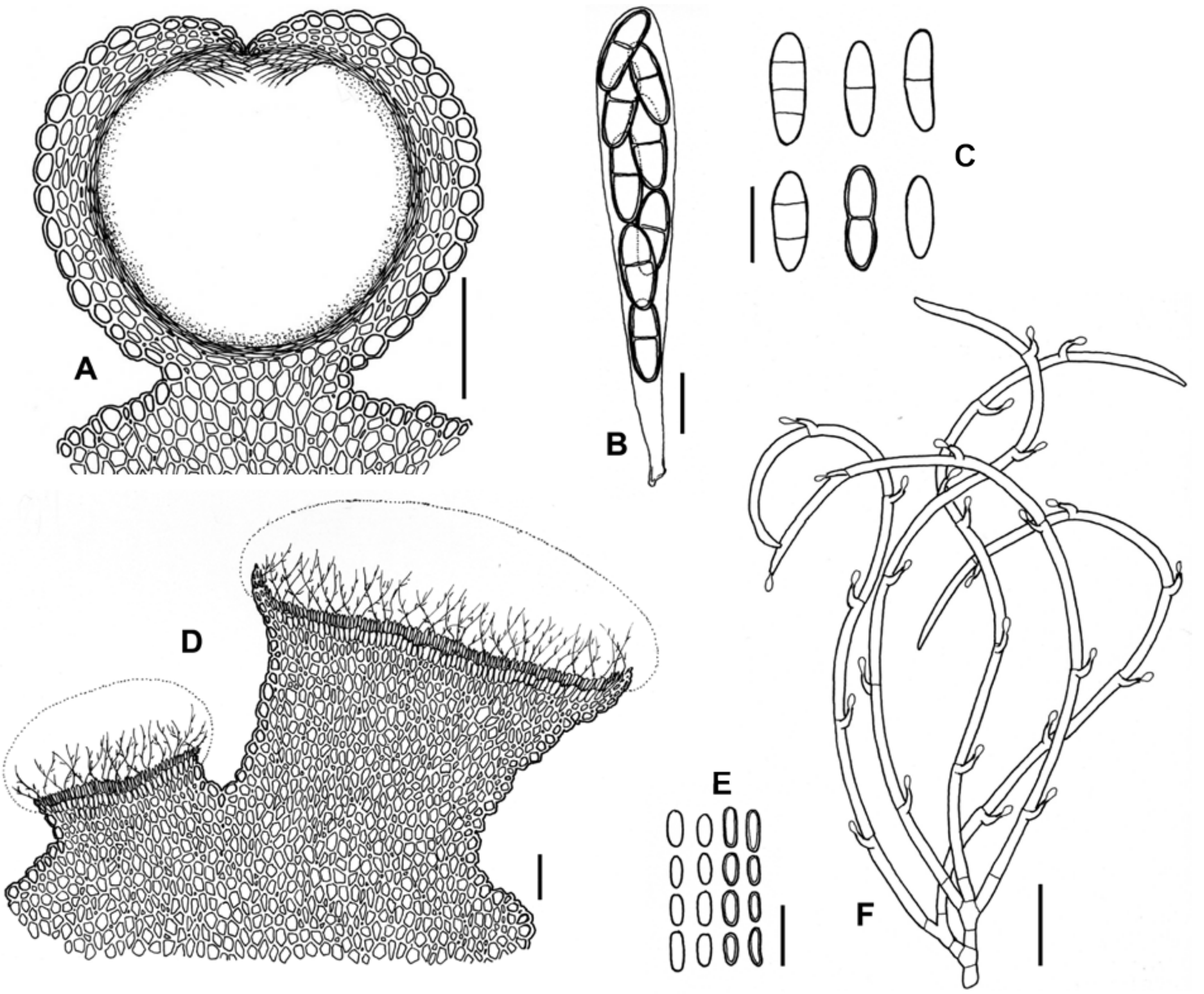

Fig. 51A–F. *Nectria nigrescens* on natural substrata (A–C teleomorph, D–F anamorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores; D. Median section of short and long stipitate sporodochia; E. Conidia; F. Acropleurogenous conidiophores. Scale bars: A, D = 100 µm; B, C, E, F = 10 µm.

ft, 35 °35’9.9”N 83 °4’25.5”W, on dead twig of dictyledonous tree, 7 Sep. 2005, A.Y. Rossman, **Epitype** BPI 871083, **ex-epitype** culture CBS 125148 = A.R. 4211.

Holotype of Tubercularia ulmea: **USA**, Illinois, Iroquois County, Onarga, on *Ulmus pumila* L.*,* 16 Aug. 1939, J.C. Carter, **Holotype** ILLS 29559.

Additional type specimens examined: Type of *Nectria cinnabarina* f. *dendroidea*: **Germany**, Fungi Rehnani 2657, FH. Type of *Nectria fuscopurpurea*: **UK**, Wisbech, on dead branch of *Prunus domestica* L., 1917, J.C.F. Fryer or A.D. Cotton, **Holotype** K 98615. Type of *Nectria meliae*: **USA**, Alabama, on *Melia* sp., 1 Dec. 1896, C.F. Baker, **Neotype** designated in Hirooka *et al*. (2011), BPI 552588.

For additional specimens and isolates examined, see Hirooka et al. (2011). **USA**, Illinois, Cache River State Natural Area (Smith Foray), on dead twigs, Sep. 2009, D. Minnis, BPI 881081; North Dakota, North Dakota State University, on *Ulmus pumila* (only anamorph), culture CBS 129808 = A.R. 4266 = R 1550; North Dakota, North Dakota State University, on *Gleditsia triacanthos* var. *inermis,* only anamorph, culture A.R. 4267 = R 1551; North Dakota, Sweet Briar Lake, on *Elaeagnus angustifolia*, only anamorph, culture A.R. 4268 = R 1552; North Dakota, Bismarck, Kirkwood Mall, on *Gleditsia triacanthos* var. *inermis* only anamorph, culture CBS 128982 = A.R. 4269 = R 1553; North Dakota, Bismarck, River Road, on *Elaeagnus angustifolia,* only anamorph, culture CBS 128983 = A.R. 4270 = R 1555; North Dakota, Bismarck, River Road, on *Elaeagnus angustifolia,* only anamorph, culture CBS 128988 = A.R. 4271 = R 1556; North Dakota, North Dakota State University, on *Ulmus pumila,* only anamorph, culture CBS 128987 = A.R. 4272 = R 1557; North Dakota, North Dakota State University, on *Gleditsia triacanthos* var. *inermis,* only anamorph, culture A.R. 4273 = R 1558; North Dakota, Cass Co., Fargo, on *Tilia* sp., 22 Apr. 2006, Hansen, only anamorph, BPI 878879; culture CBS 128984 = A.R. 4306.

Notes: *Nectria nigrescens* was recently redescribed by Hirooka *et al*. (2011). Here the anamorph of *N. nigrescens* is newly determined as *Tubercularia ulmea* based on morphological and phylogenetic evidence (Figs 1, 3).

Tubercularia ulmea was described by Carter (1947) as a pathogen causing stem canker disease of Siberian elm (*Ulmus pumila*); the dark-coloured sporodochia were considered a critical morphological characteristic of *T. ulmea*. Hirooka *et al*. (2011) discovered that *Nectria asiatica* and *N. nigrescens* also have dark-coloured sporodochia. Based on other morphological characteristics in the natural environment as well as in culture, the anamorph of *N. nigrescens* is considered the same as *T. ulmea* as confirmed by molecular data.

Nectria noackiana Syd. & P. Syd., Ann. Mycol. 5: 358. 1907. Figs 53, 54.
Anamorph: synnematous, tubercularia-like.

Teleomorph on natural substrata: *Stromata* erumpent through epidermis, up to 1.0 mm high and 2.5 mm diam, dark scarlet, KOH+ blood colour, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, aggregated in groups of 5–20, subglobose to globose, 250–350 µm high × 250–390 µm diam, scarlet to sienna, cupulate upon drying, apical region slightly darker, KOH+ dark red, LA+ yellow, smooth to rough. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis*, 6–19 µm diam, with pigmented, uniformly *ca.*

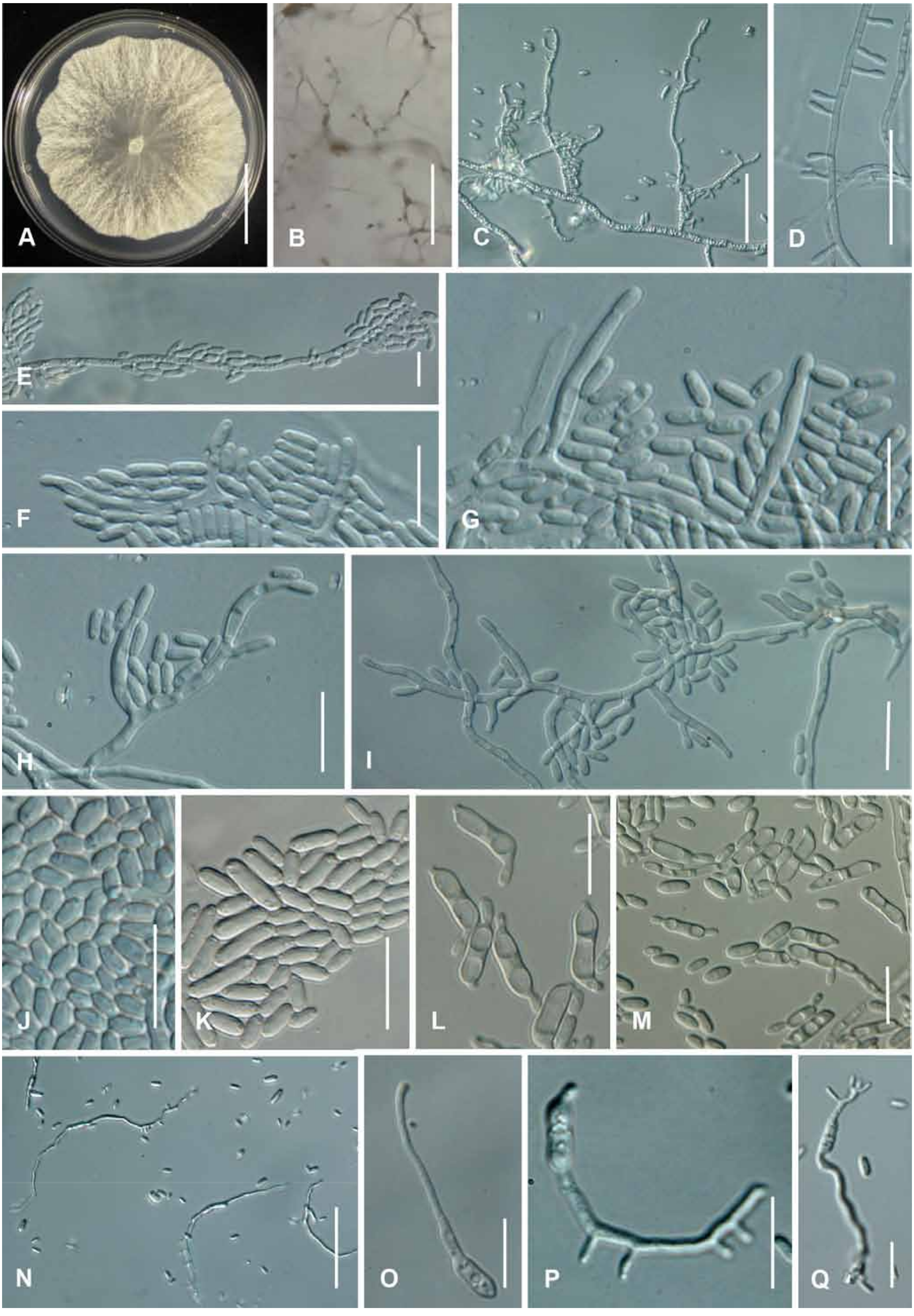

Fig. 52A–Q. Anamorph of *Nectria nigrescens* in culture. A. Cultures after 7 d at 25 °C on PDA; B. Aerial conidiophores and conidial mass produced on the SNA surface; C–F. Lateral phialidic pegs and conidia on SNA; G–I. Conidiophores and conidia on SNA; J. Young conidia on SNA; K. Young and mature conidiaon SNA; L, M. Budding mature conidia on SNA; N–Q. Germinating mature conidia that were streaked onto SNA. Scale bars: A = 3 mm; B = 500 µm; C, D, N = 30 µm; E–M, O–Q = 10 µm.

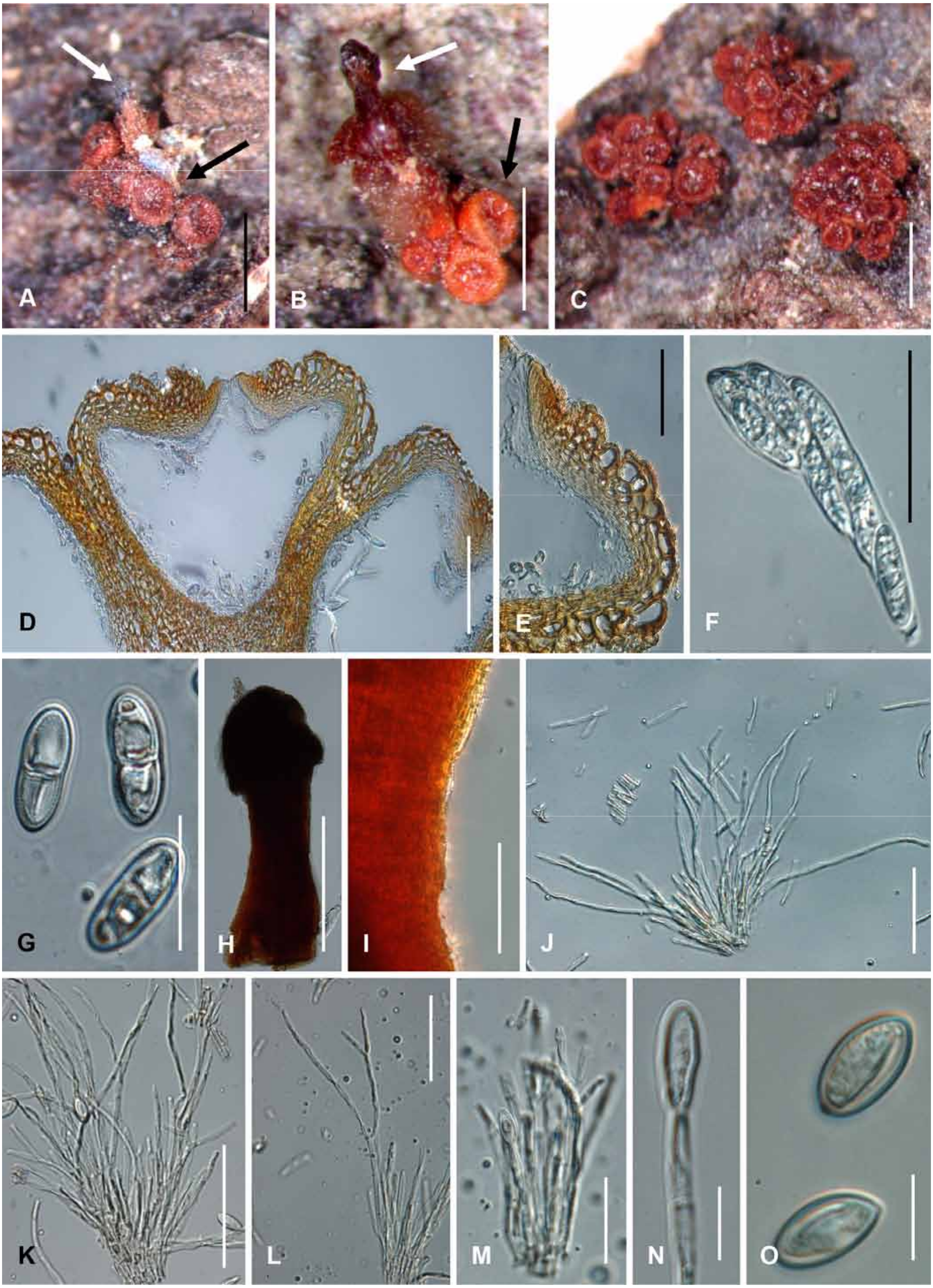

Fig. 53A–O. *Nectria noackiana* on natural substrata (A, B teleomorph and anamorph. C–G teleomorph, H–O anamorph). A, B. Perithecia (black arrows) and synnemata (white arrows) on natural substrata; C. Perithecia on natural substrata; D. Median section of perithecia; E. Median section of perithecial wall; F. Ascus; G. Ascospores; H. Synnema on natural substrata; I. Surface of stalk; J–L. Sterile hyphae and conidiophores on natural substrata; M. Conidiophores on natural substrata; N. Conidiogenous cells on natural substrata; O. Conidia on natural substrata. Scale bars: A–C, H = 500 µm; D = 100 µm; E, F, I–L = 50 µm; G, M = 20 µm; N, O. = 10 µm.

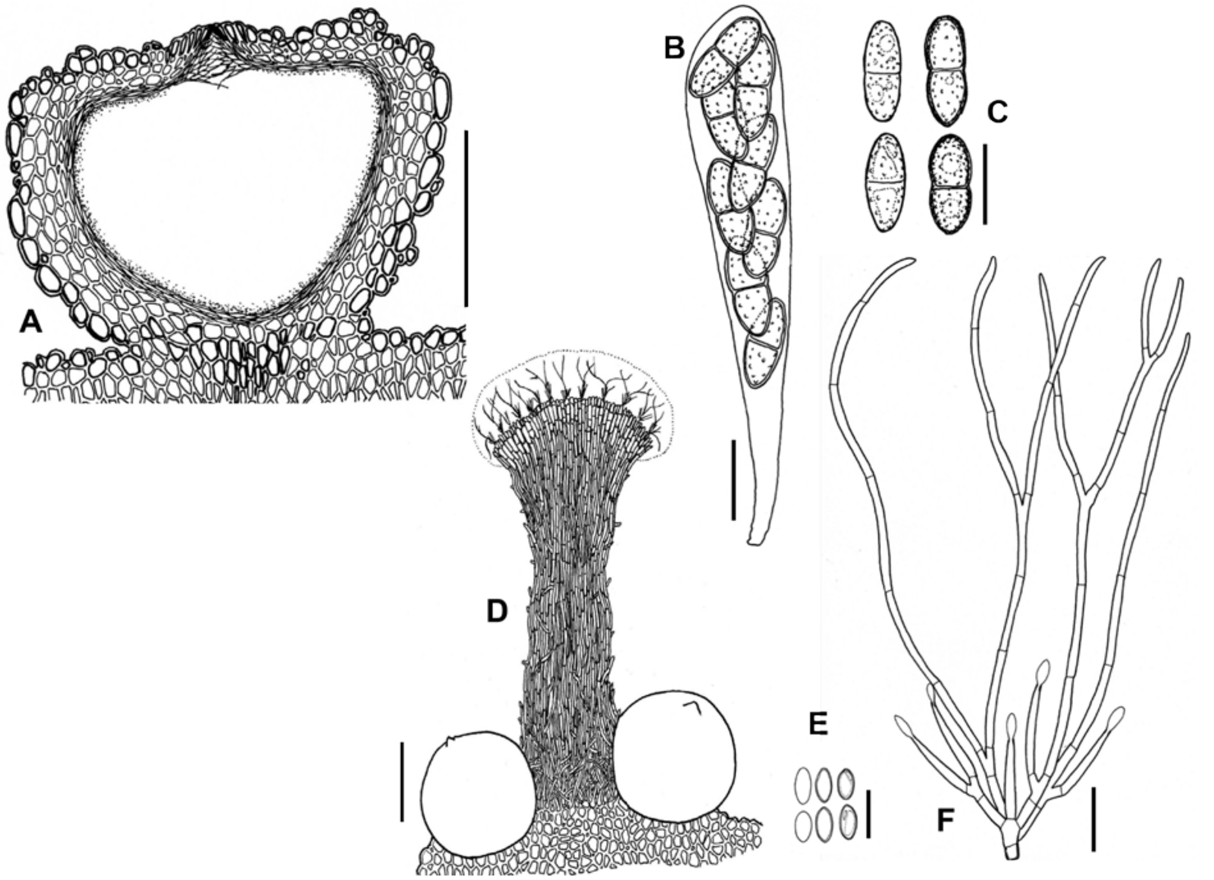

Fig. 54A–F. *Nectria noackiana* on natural substrata (A–C teleomorph, D–F anamorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores; D. Median section of synnema; E. Conidia; F. Sterile hyphae and conidiophores. Scale bars: A, D = 200 µm; B, C, E, F = 20 µm.

1.5 µm thickened walls. *Ascomatal wall* 40–60 µm thick, of two regions: outer region 20–45 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.5 µm thick; inner region 10–20 µm thick, of elongated, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* clavate, 70–105 × 13–20 µm, with inconspicuous ring at apex, 8-spored, ascospores biseriate above, uniseriate below. *Ascospores* ellipsoidal to fusiform, straight to rarely, slightly curved, (18.5–)20.0–25.4(–30.0) × (7.0–)8.0–9.0(–11.0) µm (*n* = 210), 1-septate, hyaline, spinulose.

Anamorph on natural substrata: *Synnemata* usually erumpent through epidermis, solitary, rarely gregarious, emerging from ascomatal cluster or individually, caespitose, cylindrical-capitate, subulate-capitate, or claviform, not erect or nodding, unbranched, rarely branched, medium to slender stature, smooth, dark red at base, stalk becoming pale toward apex, turning dark purple in KOH, fading upward to almost black in age, 600–1500 µm high including stipe, 100–250 µm wide at base. *Hyphae on stipe* external hyphae pigmented golden brown at base and becoming paler towards apex, KOH+, 5–9 µm wide; internal hyphae hyaline, KOH–, 5–8 µm wide. *Ornamental hyphae on stipe* absent. *Conidiophores* with long sterile hyphae, branching monoverticillate or biverticillate, whorls compact or diffuse, if present, metulae 10–45 × 2–4 µm. *Conidiogenous cells* enteroblastic, monophialidic, cylindrical to subulate, straight or curved, 10–35 × 2–4 µm, collarette not conspicuous. *Sterile hyphae* mixed with phialides, acicular, straight or usually curved, unbranched or dichotomously branched, septate, 100–150 × 3.5–5 µm, arising from hyphae in whorls, or more often in groups of conidiophores together with phialides. *Conidial masses* subglobose, hemisphaerical or more or less discoid, blood colour, 200–400 µm diam. *Conidia* hyaline, ellipsoidal to fusiform tapering to both ends, sometimes striate, non-septate, (12.3–)13.6–16.8(–18.7) × (5.8–)6.5–7.9(–8.3) µm (*n* = 60), smooth-walled.

Habitat: On bark of unknown liana.

Distribution: South America (Brazil, known only from the type collection).

Lectotype of Nectria noackiana *designated herein*: **Brazil**, Araraquara, Prov. São Paulo, "*auf Lianenrinde"*, Aug. 1898, F. Noack, **Lectotype** Rehm, Ascomycetes, No. 1744, BPI-bound exsiccati, **Isolectotypes** BPI 552617, S F 46420, S F 46421, S F 10233, S F 46422.

Notes: Based on the spinulose ascospores and *Tubercularia* anamorph, *Nectria noackiana* is morphologically similar to *N. australiensis*. However, *N. noackiana* has larger ascospores, 18.5–30.0 × 7.0–11.0 µm, while those of *N. australiensis* are 11.0–16.3 × 4.5–8.0 µm. In addition conidia of *N. noackiana* in the natural environment are 12.3–18.7 × 5.8–8.3 µm while those of *N. australiensis* are 4.5–8 × 1.5–2.5 µm. Other differences include the smooth surface of the synnematal stalk in *N. noackiana* and occurrence in South America. *Nectria australiensis* has hairs on the surface of the synnematal stalk and is known only from Oceania. In our observations of the synnemata of *N. noackiana*, we did not find ornamental hyphae on the stipe (Figs 53I, 54D).

In the protologue of *N. noackiana* (Sydow & Sydow 1907), a type specimen is mentioned that apparently was divided and sent to several herbaria as Rehm's exsiccatae. The specimen in the BPI bound exsiccati no. 1744 is herein designated as lectotype and the other portions of the type specimen are considered isolectotypes.

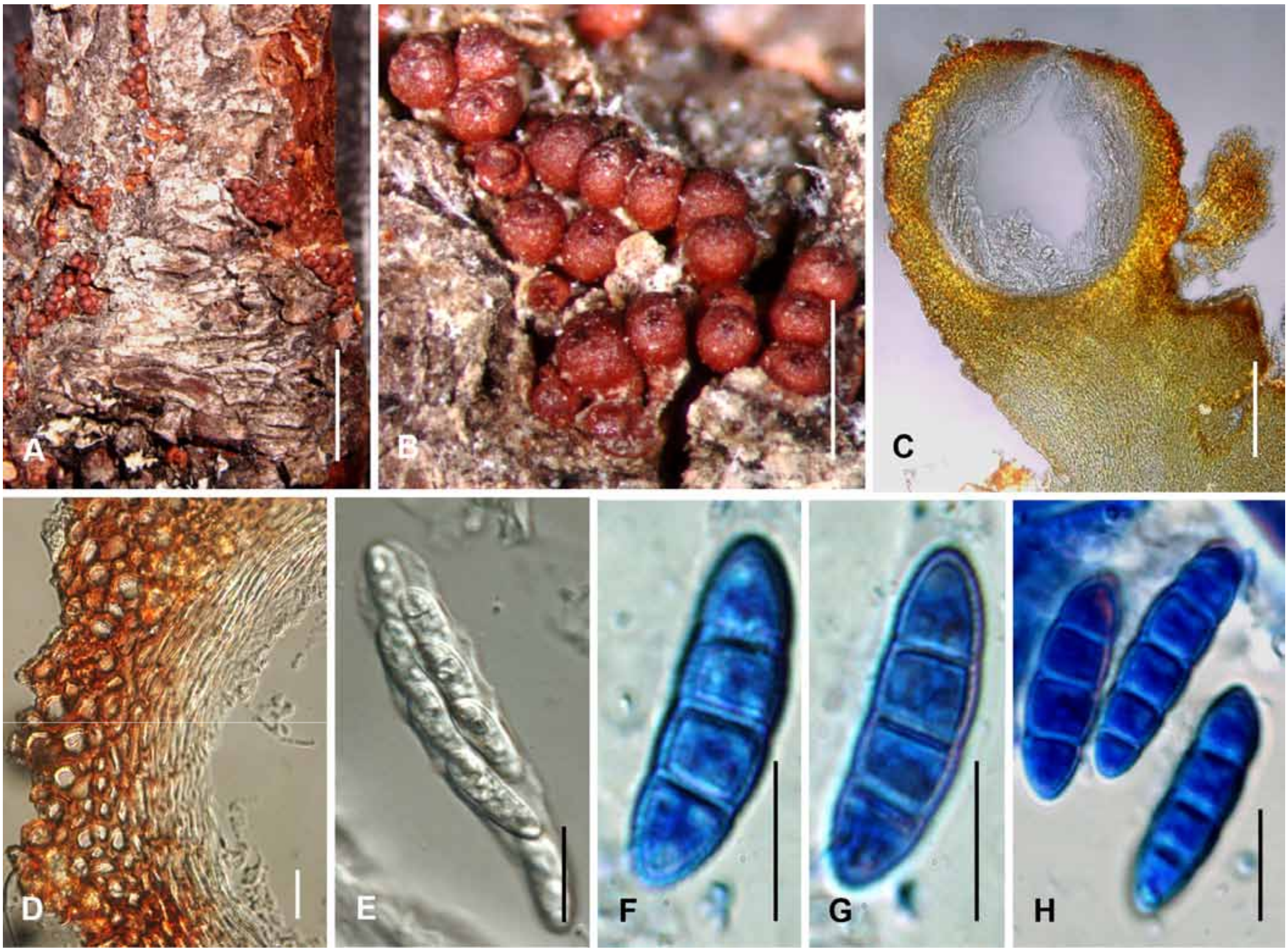

Fig. 55A–H. *Nectria novaezelandiae* on natural substrata (A–H teleomorph). A, B. Perithecia on natural substrata; C. Median section of perithecium; D. Median section of perithecial wall; E. Ascus; F. Ascospore in surface view; G, H. Ascospores in optical section. Scale bars: A = 5 mm; B = 1 mm; C = 100 µm; D, E = 20 µm; F–H = 10 µm.

Nectria novaezelandiae (Dingley) Rossman, Mycotaxon 8: 531. 1979 (as "*novaezealandica*"). Figs 55, 56.

Basionym: *Calonectria novaezelandiae* Dingley, Trans. & Proc. Roy, Soc. New Zealand 79: 404. 1952.
Anamorph: unknown.

Teleomorph on natural substrata: *Mycelium* not visible around ascomata or on host. *Stromata* erumpent through epidermis, up to 1.5 mm high and 2.0 mm diam, orange to red, KOH+ blood colour, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, aggregated in groups of 5–25, subglobose to globose, 350–510 µm high × 350–520 µm diam, red to scarlet, not cupulate when dry, apical region darker, KOH+ dark red, LA+ yellow, smooth to slightly roughened. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis*, 6–19 µm diam, with pigmented, uniformly *ca.* 1.5 µm thickened walls. *Ascomatal wall* 50–97 µm thick, of two regions: outer region 42–66 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.5 µm thick; inner region 12–26 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* clavate, 69–92 × 14–18 µm, with inconspicuous ring at apex, 8-spored, ascospores biseriate above, uniseriate below. *Ascospores* long-ellipsoidal to cylindrical, straight to slightly curved, with rounded ends, (1–)3(–4)-septate, (17.3–) 9.3–22.1(–23.9) × (6.3–)6.7–8.1(–8.9) µm (*n* = 50), hyaline, smooth, finally spinulose.

Habitat: On bark of *Discaria toumatou (Rhamnaceae)*.

Distribution: Oceania (New Zealand, known only from the type collection).

Holotype of Calonectria novaezelandiae: **New Zealand**, Canterbury, the Hermitage, Hooker Valley, *Discaria toumatou*, 21 Feb. 1947, J.M. Dingley, **Holotype** PDD 10426.

Notes: *Nectria novaezelandiae* is known only from the holotype specimen collected in New Zealand. Some morphological characters of *N. novaezelandiae* such as the firmly attached ascomata that do not become cupulate upon drying are similar to species of *Neonectria*. However, three septate ascospores of *N. novaezelandiae* are unknown in species of *Neonectria* (Figs 55F–H, 56C). On the other hand, a number of species of *Nectria* have phragmosporous ascospores such as *Nectria canadensis*, *N. lateritia*, and *N. neorehmiana*. Although the anamorph in the natural environment and in culture was not observed nor do we have molecular data for this species, we include *N. novaezelandiae* in the genus *Nectria* based on the ascomatal structure and three septate ascospores.

Nectria paraguayensis Speg., Anales Mus. Nac. Hist. Nat. Buenos Aires 19: 38. 1885. Figs 57, 58.

Basionym: *Endothia paraguayensis* (Speg.) Höhn., Sitzungsber. Kais. Akad. Wiss. Wien. Math. - Naturwiss. Cl., 1 Abt., 121: 380. 1912.

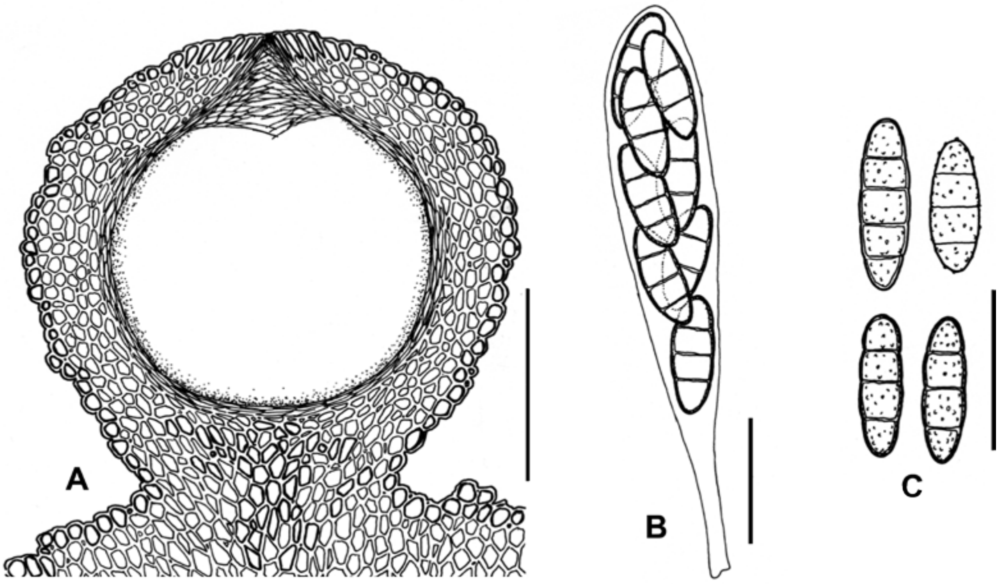

Fig. 56A–C. *Nectria novaezelandiae* on natural substrata (A–C teleomorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores. Scale bars: A = 200 µm; B, C = 20 µm.

= *Nectria cinnabarina* var. *guaranitica* Speg., Bol. Acad. Nac. Cienc. Cordóba 23: 474. 1885.

= *Hypocreopsis moriformis* Starbäck, Bih. Koningl. Svenska Vet.–Akad. Handl. 25 (III1): 35. 1899.

≡ *Nectria moriformis* (Starbäck) Theiss., Ann. Mycol. 9: 51. 1911.

Anamorph: unknown.

Teleomorph on natural substrata: *Mycelium* not visible around ascomata or on host. *Stromata* erumpent through epidermis, up to 1.0 mm high and 4.0 mm diam, red to sienna, KOH+ blood red, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*, intergrading with ascomatal wall. *Ascomata* nearly or completely immersed in erumpent stroma, aggregated in groups of 5–59, red, subglobose to globose, 298–397 µm high × 296–436 µm diam, not collapsing when dry, apical region darker, KOH+ dark purple, LA+ yellow, smooth to slightly roughened wall. *Ascomatal surface cells* at edge of stroma forming *textura globulosa* or *t. angularis*, 4–14 µm diam, with pigmented, uniformly *ca.* 2.0 µm thickened walls. *Ascomatal wall at edge of stroma* 40–72 µm thick, of two regions: outer region 17–52 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 2.0 µm thick; inner region 15–30 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* clavate, 53–94 × 8–14 µm, with inconspicuous ring at apex, 8-spored, biseriate. *Ascospores* ellipsoidal, fusiform to long oblong, straight to rarely slightly curved, (13.4–)15.6–18.4(–22.2) × (4.5–)5.6–7.2(–8.1) µm (*n* = 195), 1-septate, hyaline, striate.

Habitat: On bark of *Cedrela brasiliensis*, scale insects, lichens, and possibly *Patellina amoena*.

Distribution: South America (Argentina, Brazil, Paraguay).

Holotype of Nectria paraguayensis: **Brazil**, Paraguarí, on wood, June 1882, Balansa 3420, **Holotype** LPS 1605.

Additional type specimens examined: Type of *Nectria cinnabarina* var. *guaranitica*: **Paraguay**, Villa Morra, on twigs, 1892, **Holotype** LPS 1577. Type of *Hypocreopsis moriformis*: **Brazil**, Ijul, Rio Grande do Sul, on trunks, 29 Mar. 1903, G.O. Malme, **Holotype** S, Imae Regnellian Fungi No 305, **Isotype** K, Vestergren, Micromycetes rariores selecti 820, BPI 631888.

Additional specimens and isolates examined: **Argentina**, Buenos Aires, Montes Veloz, on *Celtis tala*, 25 Oct. 1936, J.C. Lindquist, LPS 35261. **Brazil**, Nova Petropolis, on bark, Jun. 1923, J. Rick, BPI 631885; Sao Leopoldo, on frondose wood, 1905, J. Rick, BPI 631887; Serra Azul, Rio Grande Du Sol, on wood, 1923, J. Rick, BPI 631886; on wood, 1927, J. Rick, BPI 737549; ex Herb. Theissen, Rick, Fungi austro-americana 196, Shear Types and Rarities, BPI 798078 as *Hypocreopsis moriformis*.

Notes: *Nectria paraguayensis* has been collected only from South America. Because the aggregated ascomata are semi-immersed or immersed in a stroma, this fungus belongs to *N. balansae* group although no anamorph in the natural environment or culture was observed (Figs 57A–E, 58A). Within the *N. balansae* group, *N. paraguayensis* resembles *N. balansae* and *N. sordida* in having striate ascospores; the ascospore size of *N. paraguayensis* is smaller than those two species. *Nectria paraguayensis* is also similar to *N. cingulata* in having small, striate ascospores and occurring in South America (Figs 57H, I, 58C). The ascomata of *N. cingulata* are superficial and the ascomatal walls are composed of three regions.

Samuels & Brayford (1994) included *Hypocreopsis moriformis* as a taxonomic synonym of *N. paraguayensis.* The original description of *H. moriformis* documented the presence of sporodochia described as *Patellina amoena* (Starbäck 1899). Samuels & Brayford (1994) presumed that *P. amoena* was the anamorph of *H. moriformis* because *Nectria cinnabarina* var. *guaranitica,* another taxonomic synonym of *N. paraguayensis*, was also observed with *P. amoena*. In our observation of the type specimen, no conidiophores or conidia were observed because of the poor condition and limited samples of *P. amoena*. Among the specimens of *N. paraguayensis* we observed, ascomata of BPI 631887, BPI 737549, and BPI 798078 were associated with scale insects while ascomata of BPI 631886 were associated with lichens. It seems likely that *N. paraguayensis* exists as a saprobe that associates with various substrata.

Nectria polythalama Berk., Hooker's Flora Novae-Zelandiae 2: 203. 1855. Figs 59–61.

Basionym: *Calonectria polythalama* (Berk.) Sacc., Michelia 1: 308. 1878.

= *Sphaerostilbe nigrescens* Kalchbr. & Cooke, Grevillea 9: 15. 1880.

≡ *Megalonectria nigrescens* (Kalchbr. & Cooke) Sacc., Syll. Fung. 2: 561. 1883.

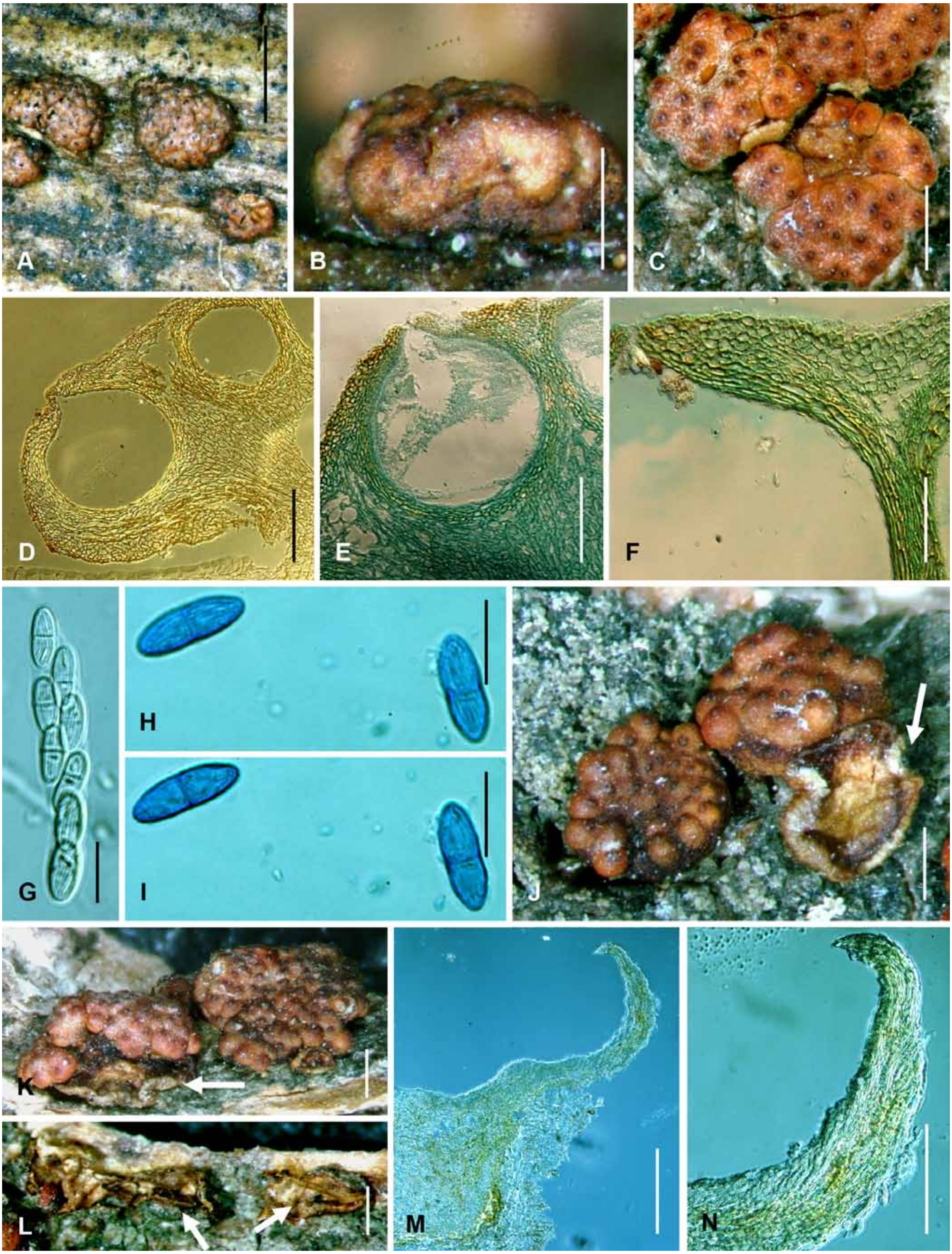

Fig. 57A–N. *Nectria paraguayensis* on natural substrata (A–I teleomorph, J, K teleomorph and *Patellina amoena*, L–N. *Patellina amoena*). A–C. Perithecia on natural substrata; D, E. Median section of perithecia; F. Median section of perithecial wall; G. Ascus; H. Ascospore in surface view; I. Ascospores in optical section; J, K. teleomorph and *Patellina amoena* on natural substrata (white arrows); L. *Patellina amoena* on natural substrata (white arrows); M. Median section of apothecium of *Patellina amoena*; N. Median section of apothecial wall of *Patellina amoena*. Scale bars: A = 5 mm; B, C, J–L = 1 µm; D, E, M = 100 µm; F, N = 50 µm; G–I = 20 µm.

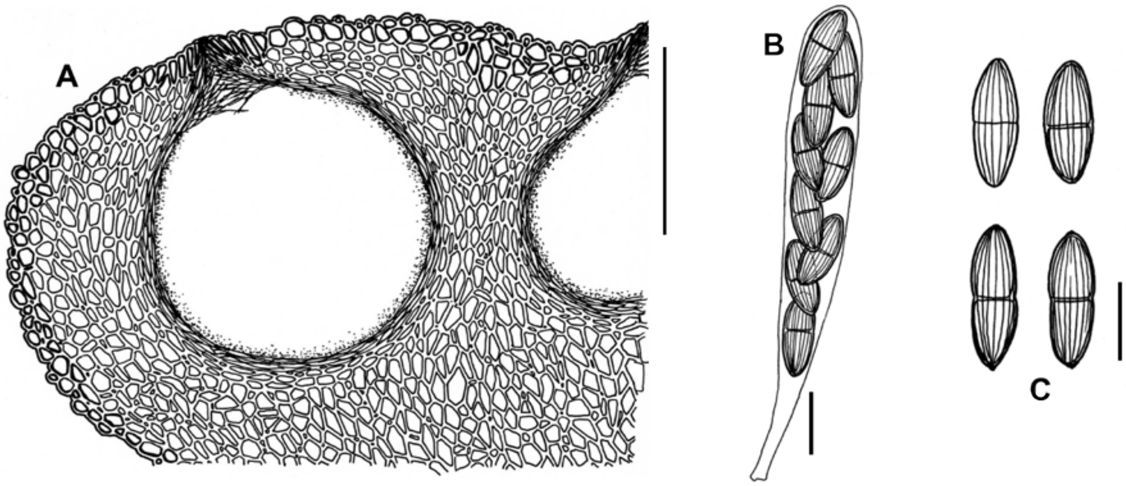

Fig. 58A–C. *Nectria paraguayensis* on natural substrata (A–C teleomorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores. Scale bars: A = 200 µm; B, C = 10 µm.

Anamorph: synnematous, tubercularia-like.

Teleomorph on natural substrata: *Mycelium* not visible around ascomata and on host. *Stromata* up to 1.5 mm high and 2.0 mm diam, erumpent through epidermis, whitish orange to bay, KOH+ dark red, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis* to *t. prismatica*, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, solitary or caespitose, up to 18 on stroma, often associated with synnemata of anamorph, globose, 300–435 µm high × 290–345 µm diam, red to reddish brown, sometimes cupulate upon dry, papillate, apical region darker, KOH+ dark red, LA+ yellow, surface roughened with concolourous warts. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis*, with walls pigmented 1.5 µm thick. *Ascomatal wall* 42–62 µm thick, of three regions: *outer region* 25–35 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, *ca.* 1.5 µm thick; *middle region* 10–15 µm thick, cells forming *textura globulosa* including brown to red-brown pigment droplets; *inner region* 15–20 µm thick, of elongated, thin-walled, hyaline cells, intergrading with stroma, forming *textura prismatica*. *Asci* unitunicate, 70–96 × 15.7–17.9 µm, clavate with inconspicuous ring at apex, 8-spored, ascospores biseriate above, uniseriate below. *Ascospores* muriform, with 5–8 transverse septate and 1–2 longitudinal septate, often constricted at each septum, ellipsoidal to fusiform, hyaline, brown to dark brown when mature, straight, sometimes slightly curved, (17.9–)21.8–29.0(–35.4) × (6.1–)7.3–10.1(–12.3) µm, (*n* = 60), smooth-walled.

Anamorph on natural substrata: *Synnemata* usually erumpent through epidermis, solitary to gregarious, emerging from ascomatal cluster or independently, crowded to caespitose, cylindrical-capitate, subulate-capitate, or claviform, erect or nodding, unbranched or rarely up to 4 branched at base, medium to slender stature, distinctly hispid at base to mid level, some young synnemata smooth to granular, soft-textured when fresh, red-brown at base, becoming darker to black with age, turning blood-red in KOH, 1500–3000 µm high including stipe, 120–400 µm wide. *Hyphae on stipe* external hyphae pigmented golden brown at base and becoming less pigmented towards apex, KOH+, 5–9 µm wide; internal hyphae hyaline, KOH–, 4–7 µm wide. *Ornamental hyphae on stipe* cylindrical, straight, curved, sinuous or twisted, arising laterally at more or less right angles, distributed evenly over surface of synnemata or concentrated near base in some collections, or near apex in others, 5–20 × 2.0–3.0 µm, usually unbranched, occasionally dichotomously branched, or with lateral branches; aseptate or with up to 3 septae, septa thin or up to 1 µm thick, terminal hyphae with bluntly rounded tips, 5–8 µm wide, cell walls 1.5–2 µm thick. *Conidiophores* with long sterile hyphae, branching monoverticillate or biverticillate, whorls compact or diffuse, if present, metulae 20–70 × 1.7–3.0 µm. *Conidiogenous cells* enteroblastic, monophialidic, cylindrical to subulate, straight or curved in terminal whorls of 2–5 together with sterile hyphae or lateral and terminal, 13–22 × 1.5–2.0 µm, collarette not conspicuous. *Sterile hyphae* mixed with phialides, acicular, straight or usually curved, unbranched or dichotomously branched, septate, 73–118 × 2.0–2.7 µm, arising from hyphae often in groups of 1–3 from conidiophores together with phialides. *Conidial masses* globose, hemisphaerical or more or less discoid, dark purple when fresh, drying purplish black, 100–300 µm wide. *Conidia* hyaline, ellipsoidal, obovate or oblong, sometimes slightly curved, non-septate, (4.5–)5.9–7.5(–9.2) × (2.5–)3.0–3.8(–4.9) µm, (*n* = 129), smooth-walled.

Anamorph in culture: Optimum temperature for *growth* on PDA 25 °C. After 3 d at 25 °C, colonies 29–33 mm (average 32 mm) diam. *Colony surface* cottony with aerial mycelium, pink to orange, sometimes yellowish brown; *aerial mycelium* slightly developed, white to whitish yellow; *sporodochial conidial masses* abundantly produced after 1 wk; *reverse* orange to yellowish brown. *Odour* on PDA slightly fruity. Sporulation on SNA from *lateral phialidic pegs* common, enteroblastic, monophialidic, ellipsoidal tapering toward tip, 2.5–8.5 µm long, 1.0–2.5 µm wide near aperture. *Aerial conidiophores* usually verticillate, 1–3 branched, becoming loosely to moderately densely branched, 15.3–35.0 µm long, 2.0–3.5 µm wide at base. *Aerial conidiogenous cells* monophialidic, cylindrical and slightly tapering toward tip 8.4–12.3 µm long, 1.7–2.2 µm wide at base. *Sporodochial conidiophores*, 2–3 branched, becoming densely branched, then terminal whorls of 2–4 together, 27.6–45.2 µm long, 2.0–3.6 µm wide at base. *Sporodochial conidiogenous cells* monophialidic, cylindrical and slightly tapering toward tip or narrowly flask-shaped with widest point in middle, 9.9–14.2 µm long, 2.0–2.8 µm wide at base. *Young conidia* developing from monophialides on submerged or aerial hyphae, produced abundantly on slimy heads, non-septate, subglobose to obovate, rarely ellipsoidal to fusiform, hyaline, smooth, straight or slightly curved, rounded at both ends, (4.9–)5.3–6.5(–7.7) × (2.2–)2.7–3.7(–4.0) µm (*n* = 150). *Mature*

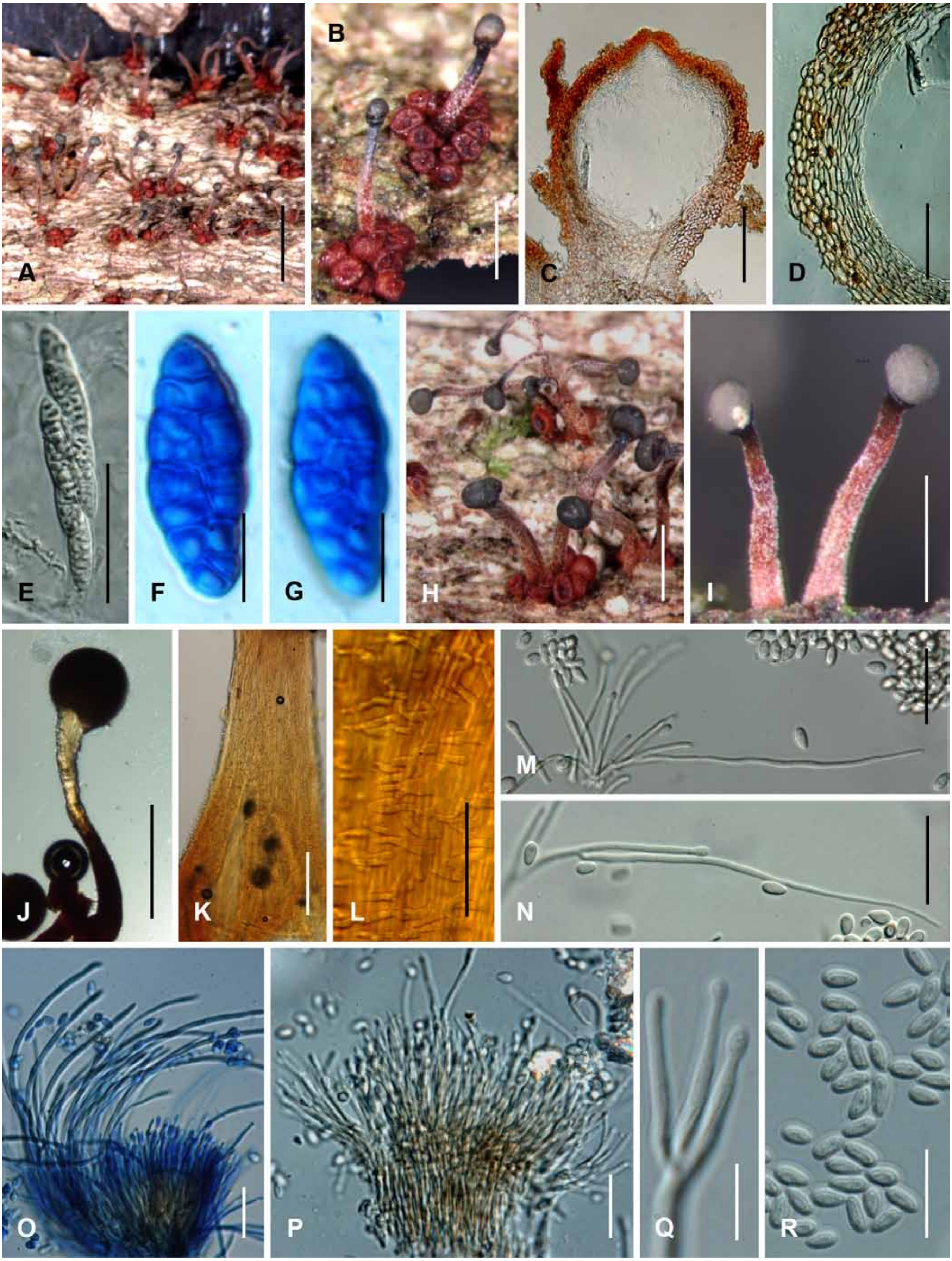

Fig. 59A–R. *Nectria polythalama* on natural substrata (A, B, H teleomorph and anamorph, C–G teleomorph, I–R anamorph). A, B, H. Perithecia and synnemata on natural substrata; C. Median section of perithecium; D. Median section of perithecial wall; E. Ascus; F. Ascospore in optical section; G. Ascospores in surface view; I, J. Synnemata on natural substrata; K, L. Ornamental hyphae on stipe; M–O. Sterile hyphae and conidiophores on natural substrata; P, Q. Conidiophores on natural substrata; R. Conidia on natural substrata. Scale bars: A = 5 mm; B, H–J = 1 mm; C, K = 100 µm; D, E, L = 50 µm; F, G, Q, R = 10 µm; M–P = 20 µm.

conidia swollen, mostly 0-, rarely 1-septate, oblong or allantoidal, smooth, straight or slightly curved, swollen at both ends, (7.0–)11.5–17.5(–25.5) × (3.0–)3.5–4.5(–6.0) µm (*n* = 124). *Chlamydospores*, *sporodochia*, and *perthecia* not produced on SNA.

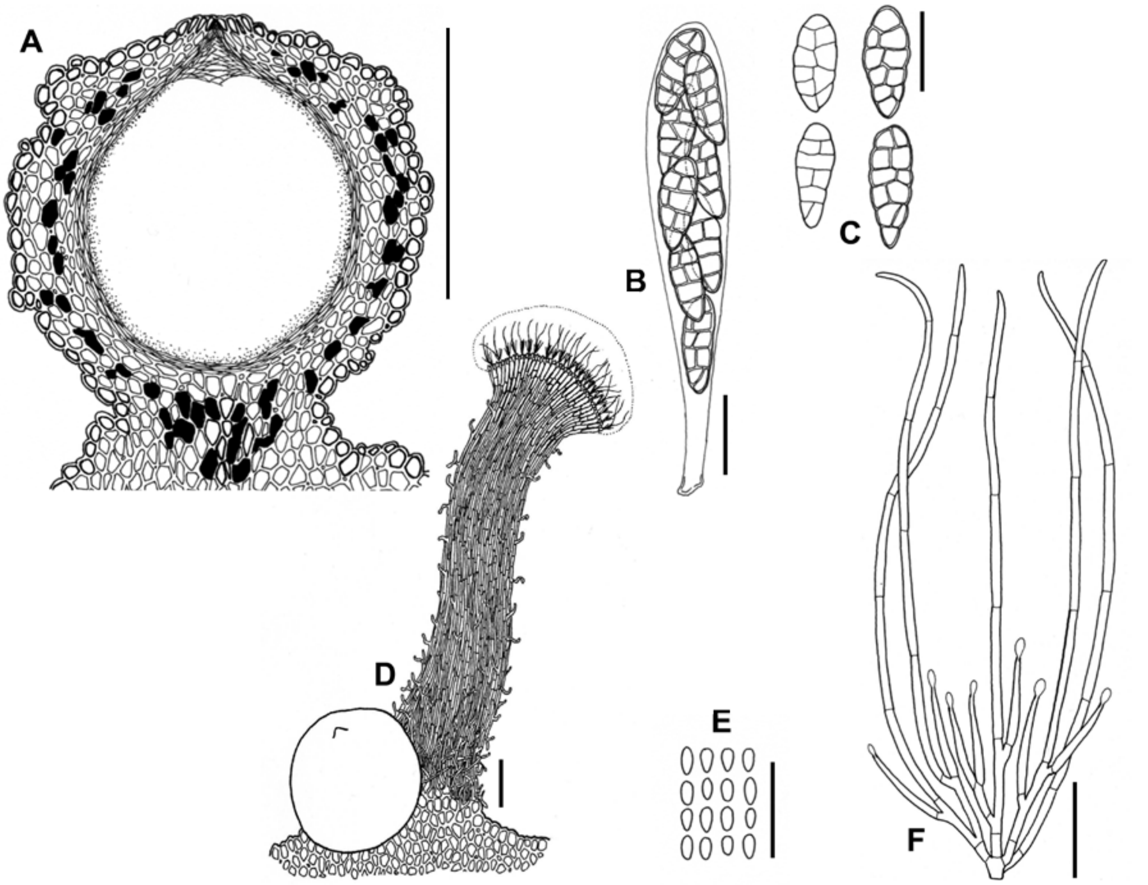

Fig. 60A–F. *Nectria polythalama* on natural substrata (A–C teleomorph, D–F anamorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores; D. Median section of synnema; E. Conidia; F. Sterile hyphae and conidiophores. Scale bars: A, D = 200 µm; B, C, E, F = 20 µ

Distribution: Oceania (New Zealand).

Habitat: On dead woody substrata including *Corynocarpus laevigatus*, *Disoxylon*? sp., and *Eucalyptus ficifolia.*

Holotype of Nectria polythalama. **New Zealand**, Middle Island, on bark, **Holotype** K (M) 163342.

Epitype of Nectria polythalama *designated herein*: **New Zealand**, North Island, Warkworth, Wenderholm Regional Park, on dead log, 09 Mar. 2009, P. Chaverri, A.Y. Rossman, P. Johnston, **Epitype** BPI 879111= PC 975, **ex-epitype** culture: CBS 129240 = A.R. 4579.

Additional type specimens examined: Type specimen of *Sphaerostilbe nigrescens*: **New Zealand**, Wellington, on dead, J. Kirk, K (M) 165364.

Additional specimens and isolates examined: **New Zealand**, North Island, Auckland, on *Eucalyptus ficifolia*, May 1968, J.M. Dingley, PDD 26407, culture ICMP 2505; North Island, Waitakere City, Auckland, Waitakere Ranges, on bark, 4 Jun. 1983, A.Y. Rossman, G.J. Sameuls, T. Matsushima, BPI 1105486; North Island, Auckland, Domain Park, on *Corynocarpus laevigatus*, 09 Mar. 2009, P. Chaverri, A.Y. Rossman, P. Johnston, BPI 879115 = PC 979, culture A.R. 4575 = CBS 128671; North Island, Auckland, Domain Park, on decaying twigs, 09 Mar. 2009, P. Chaverri, A.Y. Rossman, P. Johnston, BPI 879097 = P.C. 961, culture CBS 128672 = A.R. 4586.

Notes: *Nectria polythalama* is known only from New Zealand. This fungus was first observed by Darwin when he explored New Zealand almost two hundred years ago. The type specimen was sent to Berkeley by Darwin, and Berkeley (1855) described this species. Saccardo (1878) transferred *N. polythalama* to *Calonectria.* Seifert (1985) synonymised *N. polythalama* under the older epithet of *N. pseudotrichia*. Although somewhat similar especially in having muriform ascospores, *N. polythalama* is distinct from *N. pseudotrichia*. The lectotype specimen of *N. polythalma* has smooth ascospores unlike the spinulose ascospores of *N. pseudotrichia* (Figs 59F, 60C). Characteristics of the asexual state are also useful in distinguishing these species. In the natural environment, the anamorph of *N. polythalama* produces dark purple conidial masses at the synnematal apex and the conidia of *N. polythalama* are larger than those of *N. pseudotrichia* (Figs 59A, B, H, I, R, 60E). In culture, conidia of *N. polythalama* are swollen at both ends unlike those of *N. pseudotrhicia.* The optimum temperate for growth of *N. polythalama* on PDA is 25 °C while that for *N. pseudotrichia* is between 25 to 30 °C or 30 °C. Based on our phylogenetic analysis *N. polythalama* is clearly distinct from *N. pseudotrichia* with each species forming highly supported branches (Hirooka *et al*. 2010) (Figs 1, 3).

Because the lectotype of *N. polythalama* lacks abundant ascomata and synnemata, we epitypified *N. polythalama* with BPI 879111, a specimen collected recently in New Zealand that has many mature ascomata and anamorphic structures as well as a living culture.

Nectria pseudadelphica Rehm, Hedwigia 31: 303. 1892. Figs 62, 63.

≡ *Cucurbitaria pseudadelphica* (Rehm) Kuntze, Revis. gen. pl. (Leipzig) 3: 461. 1898.

Anamorph: unknown.

Teleomorph on natural substrata: *Mycelium* not visible around ascomata and on host. *Stromata* erumpent through epidermis, up to 1.5 mm high and 2.0 mm diam, dark scarlet, KOH+ blood colour, LA+ yellow, pseudoparenchymatous, cells forming

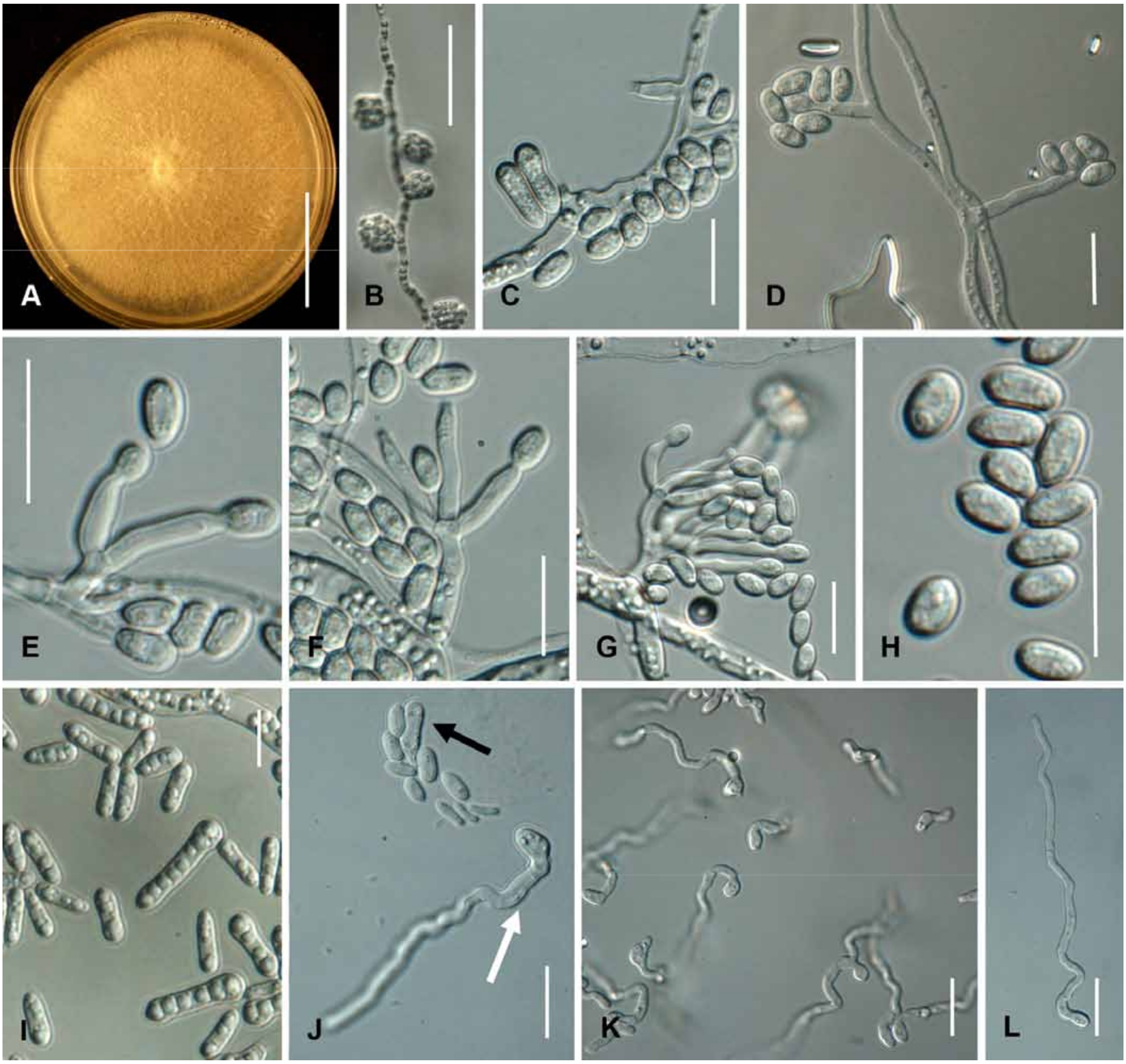

Fig. 61A–L. Anamorph of *Nectria polythalama* in culture. A. Cultures after 7 d at 25 °C on PDA; B. Lateral phialidic pegs and conidial mass on SNA; C. Lateral phialidic pegs and conidia on SNA; D–G. Conidiophores and conidia on SNA; H. Young conidia on SNA; I. Mature conidiaon SNA; J. Budding (black arrow) and germinating (white arrow) mature conidia on SNA; K, L. Germinating mature conidia that were streaked onto SNA. Scale bars: A = 3 mm; B = 100 µm; C–L = 10 µm.

textura angularis, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, aggregated in groups of 3–15, subglobose to globose, 270–390 µm high × 250–390 µm diam, scarlet to sienna, not cupulate upon drying, apical region slightly darker, KOH+ dark red, LA+ yellow, smooth to roughened. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis*, 5–14 µm diam, with pigmented, uniformly *ca.* 1.5 µm thickened walls. *Ascomatal wall* 50–70 µm thick, of three regions: outer region 30–45 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.5 µm thick; middle region *ca.* 7–18 µm thick, cells forming *textura globulosa* containing brown to red-brown pigment droplets; inner region 10–15 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* clavate, 90–140 × 7–15 µm, with inconspicuous ring at apex, 8-spored, ascospores biseriate. *Ascospores* fusiform to allantoid, straight to curved, (25.1–)26.8–31.4(–36.7) × (7.5–)8.7–11.1(–13.2) µm (n = 60), (0–)1(–3)-septate, hyaline, smooth to weakly spinulose.

Habitat: On dead branches.

Distribution: South America (Ecuador).

Lectotype of Nectria pseudadelphica *designated herein*: **Ecuador**, Pichincha, Cotocollas, on wood, 24 Feb. 1892, N.G. Lagerheim, **Lectotype** NY 01013167, **Isolectotypes** NY 01013168, S F10211, S F10213.

Additional specimens and isolates examined: **Ecuador**, Chimborazo, alt. 3500 m, on dead of twig, 26 Jan. 1994, J.N. Hedger ex IMI 361831, BPI 737865, BPI 802791.

Notes: *Nectria pseudadelphica* is a difficult species to identify within the genus *Nectria* because its anamorph has not been observed nor does a living culture exist to determine its phylogenetic position. Further, this species is similar to species of *Neonectria* in having firmly attached ascomata in natural substrata that do not become cupulate upon drying (Fig. 62A, B). This species

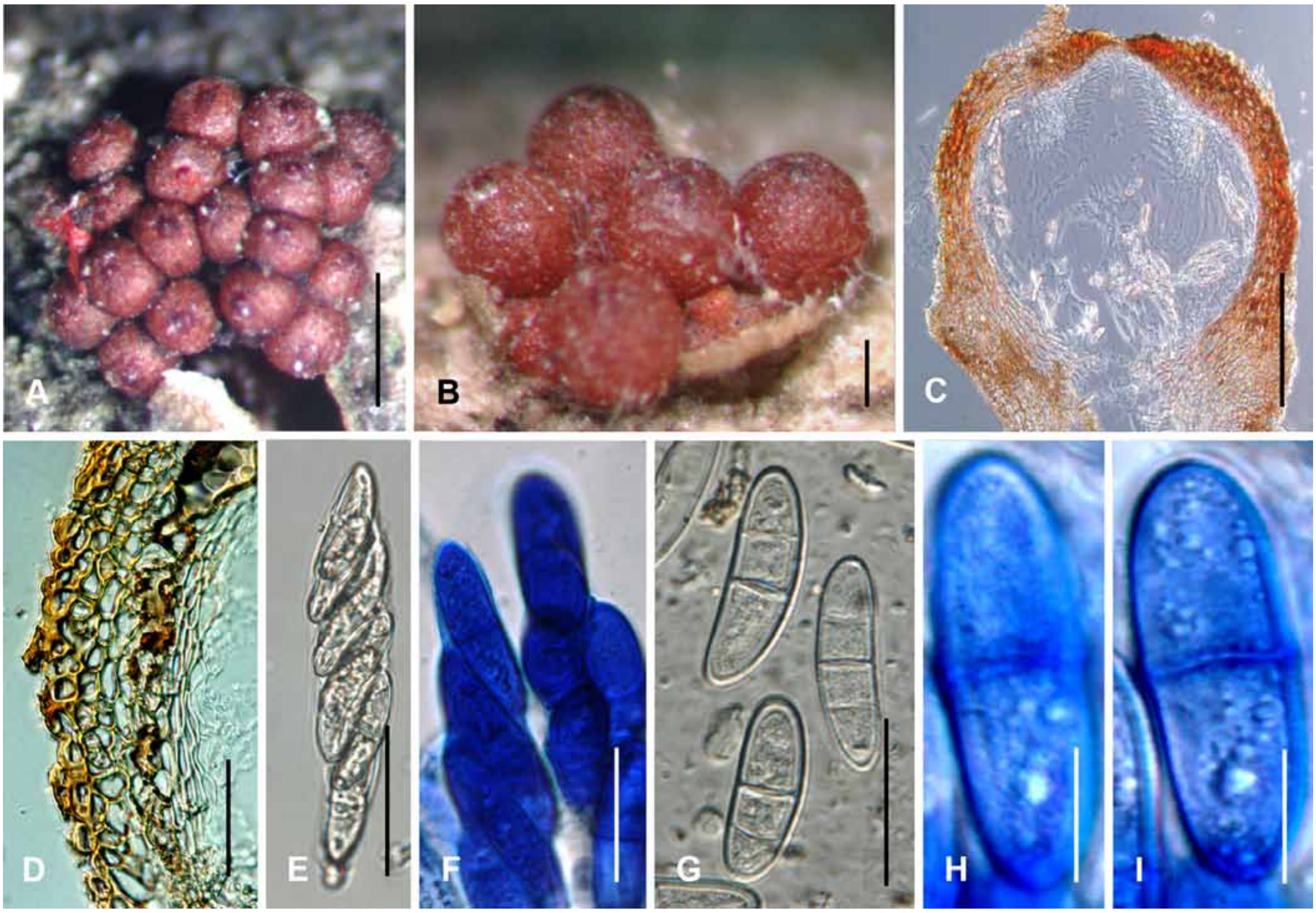

Fig. 62A–I. *Nectria pseudadelphica* on natural substrata (teleomorph). A, B. Perithecia on natural substrata; C. Median section of perithecium; D. Median section of perithecial wall; E. Ascus; F. Apex of asci; G. Ascospores; H. Ascospore in surface view; I. Ascospore in optical section. Scale bars: A = 500 µm; B, C = 100 µm; D, E = 50 µm; F, G = 30 µm; H, I = 10 µm.

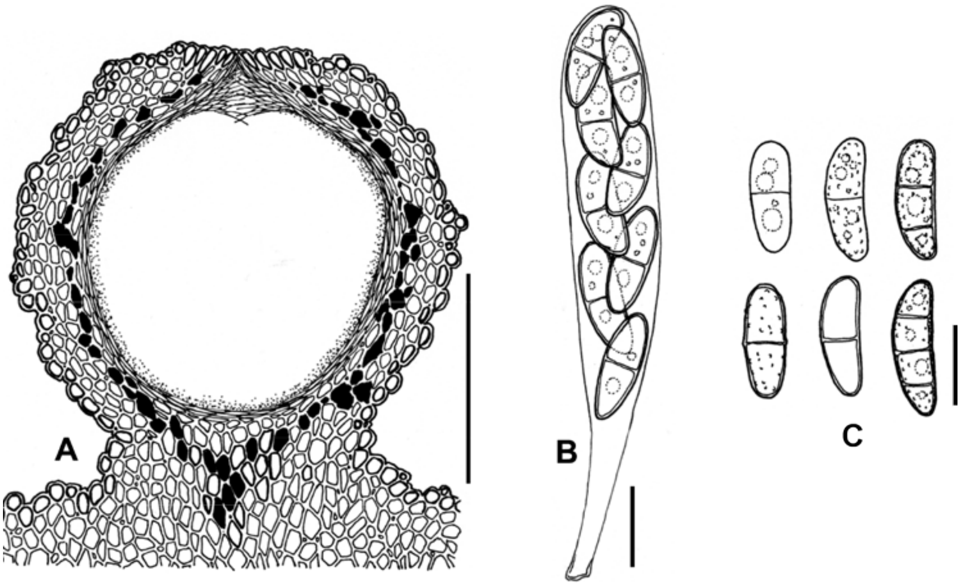

Fig. 63A–C. *Nectria pseudadelphica* on natural substrata (A–C teleomorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores. Scale bars: A = 200 µm; B, C = 20 µm.

is included in *Nectria* for two reasons. First, up to three septate ascospores as occurring in *N. pseudadelphica* have never been observed in species of *Neonectria* (Figs 62G, 63C). Second, the middle region of the ascomatal wall includes dark brown pigment droplets as observed only in species of *Nectria* such as *N. lateritia, N. pseudocinnabarina*, and *N. pseudotrichia* (Figs 62D, 63A). For these reasons, this species is retained in the genus *Nectria*. *Nectria pseudadelphica* may produce a synnematous anamoph because all species of *Nectria* having an ascomatal wall of three regions also produce a synnematous anamorph, thus one suspects that *N. pseudadelphica* will have a similar anamorph.

In this study, we designate the lectotype of *N. pseudadelphica* as NY 01013167, and the other specimens of this collection are isolectotypes.

Nectria pseudocinnabarina Rossman, Mem. New York Bot. Gard. 49: 260. 1989. Figs 64–66.
Anamorph: tubercularia lateritia-like.

Teleomorph on natural substrata: *Mycelium* not visible around ascomata and on host. *Stromata* erumpent through epidermis, up to 1.0 mm high and 1.0 mm diam, sienna, KOH+ dark purple, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*, intergrading with ascomatal wall. *Ascomata* superficial on stroma, scattered to sometimes aggregated in groups of up to 10, subglobose to globose, 200–360 μm high × 170–300 μm diam, deeply cupulate upon drying, sometimes with only a depressed apical region, bay to scarlet, apical region slightly darker, KOH+ dark purple, LA+ yellow, slightly rugose with concolourous warts. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis*, 4–11 μm diam, with pigmented, uniformly *ca.* 1.5 μm thickened walls. *Ascomatal wall* 40–65 μm thick, of three regions: outer region 20–34 μm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.5 μm thick; middle region 7–15 μm thick, cells forming *textura globulosa*, containing brown to red-brown pigment droplets, walls pigmented to gold, about 1.5 μm thick; inner region 8–15 μm thick, of elongate, thin–walled, hyaline cells, forming *textura prismatica*. *Asci* broadly cylindrical to narrowly clavate, 47–89 × 8–15 μm, with inconspicuous ring at apex, 8-spored, ascospores usually biseriate. *Ascospores* ellipsoidal to fusiform, sometimes slightly curved, (8.0–)9.8–13.8(–16.3) × (3.1–)3.7–5.3(–6.0) μm (*n* = 100), 1-septate, hyaline, striate.

Anamorph on natural substrata: *Synnemata* usually erumpent through epidermis, solitary to gregarious, emerging from ascomatal cluster or independently, caespitose, cylindrical-capitate, subulate-capitate, or claviform, erect or nodding, unbranched or rarely up to 2 branched at base, medium to slender stature, distinctly hispid at base to mid-level, some young synnemata smooth to granular, red-brown at base, slightly turning blood-red in KOH, 700–1500 μm high including stipe, 100–200 μm wide. *Hyphae on stipe* external hyphae pigmented golden brown at base, becoming less pigmentied towards apex, KOH+, 1.5–3.0 μm wide; internal hyphae hyaline, KOH–, 1.5–2.5 μm wide. *Ornamental hyphae on stipe* cylindrical, straight, curved, sinuous or twisted, arising laterally at more or less right angles, distributed evenly over surface of synnemata, concentrated near base or near apex, 5–15 μm long, 3–4 μm wide, usually unbranched, occasionally dichotomously branched or with lateral branches; aseptate or with up to 2-septae, septa thin or up to 1 μm thick, terminal hyphae with bluntly rounded tips, 4–8 μm wide, cell walls 1.5–2 μm thick. *Conidiophores* with long sterile hyphae, branching monoverticillate or biverticillate, whorls compact or diffuse, if present, metulae 18–30 × 2.2–3.2 μm. *Conidiogenous cells* enteroblastic, monophialidic, cylindrical to subulate, straight or curved at apex, 6–12 × 1.3–2.1 μm, collarette not conspicuous. *Sterile hyphae* mixed with phialides, usually curved, acicular or straight, unbranched or dichotomously branched, septate, 83–121 × 2.1–3.0 μm, in groups of conidiophores together with phialides, less commonly arising from hyphae in whorls. *Conidial masses* globose, hemisphaerical or more or less discoid, reddish white when fresh, drying reddish brown, 350–600 μm wide. *Conidia* hyaline, ellipsoidal, obovate or oblong, sometimes slightly curved, non-septate, (3.0–)4.0–5.6(–6.4) × (2.2–)2.4–3.0(–3.2) μm (*n* = 50), smooth-walled.

Anamorph in culture: Optimum temperature for *growth* on PDA 25 °C. After 3 d at 30 °C, colonies 20–35 mm (average 27 mm) diam. *Colony surface* cottony with aerial mycelium saffron to ochreous, rarely pale green; *aerial mycelium* whitish yellow to saffron; *sporodochial conidial masses* abundantly produced after 3–4 wk; *reverse* orange to yellowish brown, rarely pale green. *Odour* on PDA slightly fruity. Sporulation on SNA from *lateral phialidic pegs* common, enteroblastic, monophialidic, ellipsoidal tapering toward tip, 2.9–7.9 μm long, 1.7–2.8 μm wide near aperture. *Aerial conidiophores* usually verticillate, 1–3 branched, becoming loosely to moderately densely branched, 15–31 μm long, 2.2–6.2 μm wide at base. *Sporodochial conidiophores* 2–3 branched, becoming densely branched, then terminal whorls of 2–4 together, 15–37 μm long, 2.6–9.9 μm wide at base. *Conidiogenous cells* enteroblastic, monophialidic, cylindrical, slightly tapering toward tip, 6.2–24.5 μm long, 1.4–3.7 μm wide at base. *Young conidia* developing from monophialides on submerged, aerial hyphae, or repent hyphae, produced abundantly on slimy heads, non-septate, subglobose to obovate, rarely ellipsoidal to fusiform, hyaline, smooth, straight or slightly curved, rounded at both ends, (3.3–)4.2–6.0(–8.2) × (1.7–)2.4–3.4(–4.0) μm (*n* = 100). *Mature conidia* mostly 0-, rarely 1-septate, oblong to allantoidal, smooth, straight or slightly curved, rounded at both ends, (8.6–)10.3–13.5(–14.8) × (3.2–)3.5–4.3(–4.9) μm (*n* = 124). *Chlamydospores* not produced in culture. *Synnemata* (G.J.S. 09–1358 & G.J.S. 09–1359) and *perthecia* (A.R. 4548 = CBS 128673) produced on SNA.

Habitat: On bark of dicotyledonous trees.

Distribution: Caribbean (Cuba, Guadeloupe, Martinique), South America (Brazil, French Guiana, Venezuela).

Holotype of Nectria pseudocinnabarina: **Venezuela**, Territorio Federal Amazonas, San Carlos de Rio Negro along road to airport, on twigs, 24 Jan. 1985, A.Y. Rossman, **Holotype** BPI 552864, **Isotypes** BPI 552862, BPI 552863, BPI 552865.

Additional specimens and isolates examined: **Brazil**, Callert forest and adjacent cerrado, *ca.* 3 Km S. of São Joãda Alianga, near Riacho, *ca.* 850m. elev., on dead twig, 15 Mar. 1971, H.S. Irwin, R.M. Harley, G.L. Smith, NY. **Cuba**, Sancti Spiritus. alt. 100 m, 20 °50'N, 80 °00'W, above El Cubana, on branch, 01 Jul. 1993, S.M. Huhndorf, BPI 802674, culture G.J.S. 93–17. **French Guiana**, Saül, Boucle des Gros Arbres, on newly killed woody branch, 03 May 2008, C. Lechat, BPI 881033, culture CBS 123496 = A.R. 4567 = Y.H. 08-21. **Guadeloupe**, Marie Galante, Ravine Pour Biere, on bark, 18 Feb. 1993, G.J. Samuels, BPI 802443; Terre de Bos, on bark, Jan. 1994, J. Vivant, BPI 802477. **Martinique**, Robert, Bois Pothau, on bark, 24 Aug. 2008, C. Lechat C.L.L. 8299, BPI 881034, culture A.R. 4548 = CBS 128673. **Venezuela**, Edo. Aragua, Henry Pittier National Park. alt. 1200–1300 m, *ca.* 10 °21'N,67 °41'W, Rancho Grande Biological Station, Toma Trail to water source, on tree dead bark, 03 Dec. 1990, G.J. Samuels, B. Hein, S.M. Huhndorf, BPI 802837; La Gran Sabana, on dead bark, 29 Jun. 2009, Y. Hirooka, C. Salgado, BPI 881035, culture CBS 129364 = G.J.S. 09-1356; La Gran Sabana, on dead bark, 29 Jun. 2009, Y. Hirooka, C. Salgado, BPI 881036, culture CBS 129365 = G.J.S. 09-1358; La Gran Sabana, on dead bark, 29 Jun. 2009, Y. Hirooka, C. Salgado, BPI 881037, culture CBS 129366 = G.J.S. 09-1359.

Notes: *Nectria pseudocinnabarina* was described by Rossman (1989) and re-assessed by Samuels & Brayford (1994). Our description of *N. pseudocinnabarina* agrees well with their descriptions, except in the observation of three regions of the ascomatal wall (Figs 64D–F, 65A). A similar ascomatal wall structure was observed in *N. lateritia, N. pseudadelphica,* and *N. pseudotrichia,* all known only from tropical regions. The middle region generally includes reddish brown pigment droplets. This peculiar morphology may protect the centrum contents from high

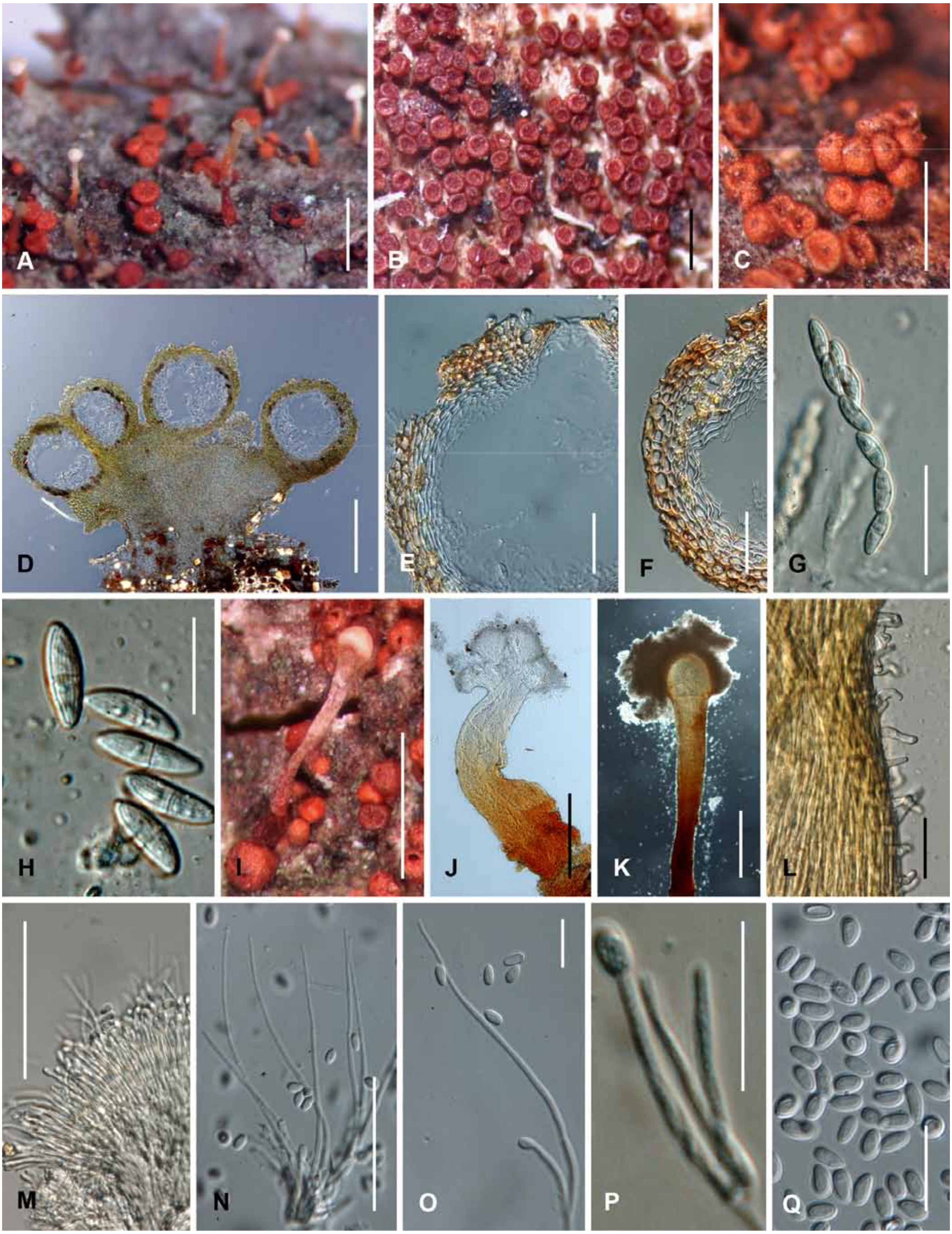

Fig. 64A–Q. *Nectria pseudocinnabarina* on natural substrata (A, I teleomorph and anamorph, B–H teleomorph, J–Q anamorph). A, I. Perithecia and synnemata on natural substrata; B, C. Perithecia on natural substrata; D. Median section of perithecia; E, F. Median section of perithecial walls; G. Ascus; H. Ascospores; J, K. Synnemata on natural substrata; L. Ornamental hyphae on stipe; M. Abundant conidiophores on natural substrata; N, O. Sterile hyphae and conidiophores on natural substrata; P. Conidiophores on natural substrata; Q. Conidia on natural substrata. Scale bars: A–C, I = 1 mm; D, J, K = 300 µm; E–G, M, N = 50 µm; H, L, O–Q = 10 µm.

temperature conditions. Ascospore differences clearly distinguish these four species.

Although we observed the anamorph numerous times in the natural environment as well as in culture, the anamorph of *N.*

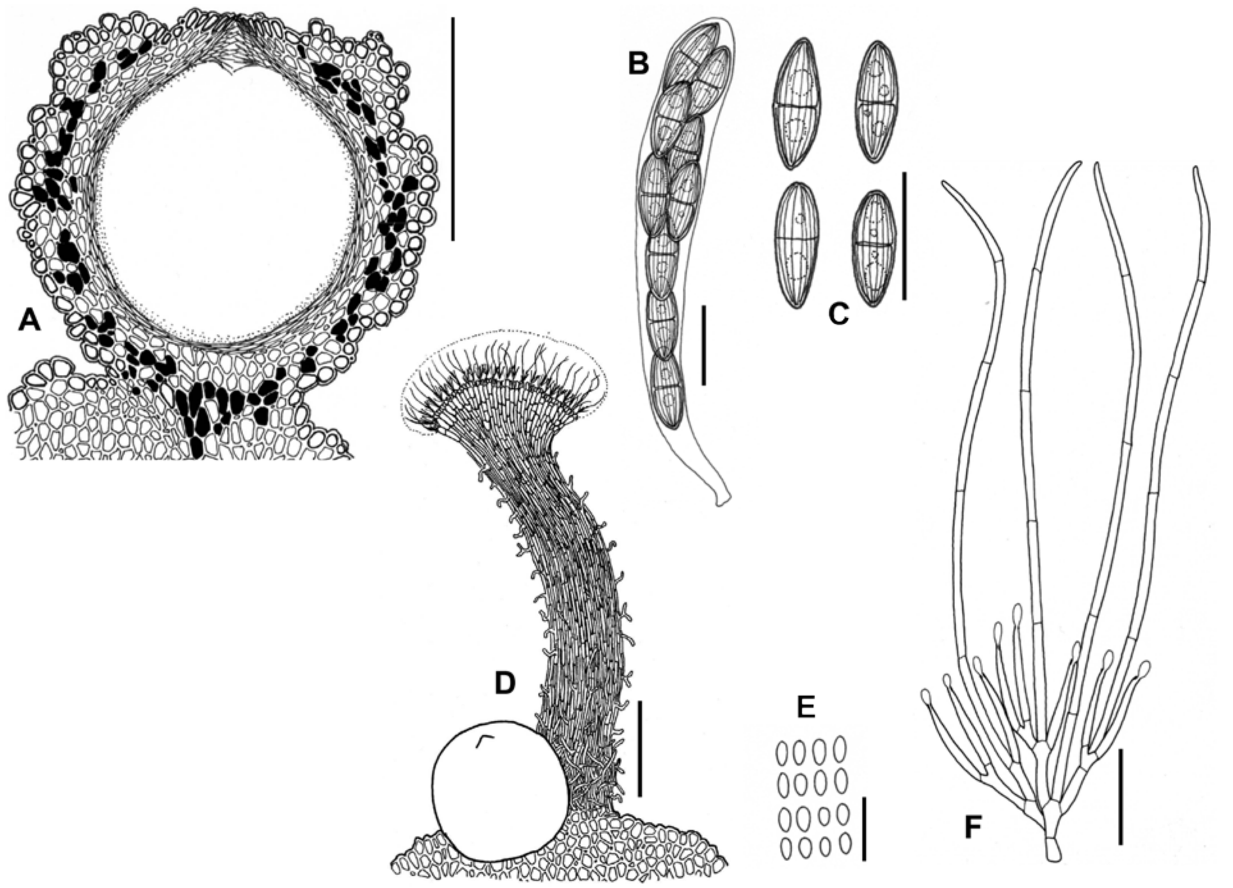

Fig. 65A–F. *Nectria pseudocinnabarina* on natural substrata (A–C teleomorph, D–F anamorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores; D. Median section of synnema; E. Conidia; F. Sterile hyphae and conidiophores. Scale bars: A, D = 200 µm; B, C, E, F = 10 µm.

pseudocinnabarina is morphologically identical with the anamorph of *N. pseudotrichia*, including the 95 % confidence intervals of conidia of length to width ratios (data not shown). In Venezuela, both *N. pseudocinnabarina* and *N. pseudotrichia* were observed at the same location but never on the same substratum. Based on our molecular data, these two species are closely related but distinct, with isolates of each species forming highly supported clades (Figs 1, 3). This species pair demonstrates that some species in *Nectria* exhibit morphological differences only in their teleomorphic rather than anamorphic states.

Nectria pseudotrichia Berk. & M.A. Curtis, J. Acad. Nat. Sci. Philadelphia 2, 2: 289. 1853. Figs 67–70.

≡ *Sphaerostilbe pseudotrichia* (Berk. & M.A. Curtis) Berk. & Broome, J. Linn. Soc. 14: 114. 1875.

≡ *Calonectria pseudotrichia* (Berk. & M.A. Curtis) Sacc., Michelia 1: 208. 1878.

≡ *Megalonectria pseudotrichia* (Berk. & M.A. Curtis) Speg., An. Soc. Cient. Argent. 2: 16. 1881.

≡ *Pleonectria pseudotrichia* (Berk. & M.A. Curtis) Wollenw., Angew. Bot. 8: 195. 1921.

≡ *Thyronectria pseudotrichia* (Berk. & M.A. Curtis) Seeler, J. Arnold Arbor. 21: 438. 1940.

= *Sphaerostillbe cinnabarina* Tul. & C. Tul., Sel. Fung. Carpol. 1: 129 1861.

= *Sphaerostillbe lateritia* Berk. & M.A. Curtis, J. Linn. Soc., Bot. 10: 377. 1869.

= *Sphaerostillbe incerta* Ces., Atti Accad. Sci. Fis. Mat., Napoli 8:14. 1879.

= *Pleonectria megalospora* Speg., An. Soc. Cient. Argent. 12: 216. 1881.

= *Megalonectria caespitosa* Speg., Bol. Acad. Nac. Cienc. Cordoba 11: 538. 1889.

= *Pleonectria caespitosa* (Speg.) Wollenw., Angew. Bot. 8: 195. 1926.

= *Megalonectria verrucosa* A. Moller, Phycom. Ascom. Bras. p. 298. 1901.

= *Megalonectria polytrichia* (Schwein.) Speg. var. *australiensis* Henn., Hedwigia 42: 79. 1903.

= *Megalonectria madagascariensis* Henn. in Voeltzkow, Reise in Ostafrika 3: 29. 1908.

= *Megalonectria yerbae* Speg., An. Mus. Nac. Hist. Nat. Buenos Aires 17: 129. 1908.

= *Pleonectria riograndensis* Theissen, Broteria, Ser. Bot. 9: 143. 1910.

= *Pleonectria heveana* Sacc., Boll. Orto Bot., Napoli 24: 13. 1918.

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

≡ *Stilbum lateritium* Berk., J. Bot., London 2: 642. 1843.

≡ *Botryonipha lateritia* (Berk.) O. Kuntze, Rev. Gen. Pl. 2: 845. 1891.

≡ *Stilbella lateritia* (Berk.) Bres., Ann. Mycol. 9: 276. 1911.

= *Stillbum caespitosum* Welw. & Curr., Trans. Linn. Soc. Lond. 26: 291. 1867.

≡ *Ciliciopodium caespitosum* (Welw. & Curr.) Sacc., Syll. Fung. 4: 577. 1886.

= *Stilbum inconspicuum* Curr., Trans. Linn. Soc. Lond., Ser. 2 (Bot.) 1: 129. 1874.

[= *Stilbum kurzianum* Cooke, Grevillea 16:71. 1888, unnecessary name change for *S. inconspicuum*]

= *Crinula aurantiocinnabarina* Speg., An. Soc. Cient. Argent. 9: 167. 1880.

≡ *Stilbum aurantiocinnabarinum* (Speg.) Speg., An. Soc. Cient. Argent. 13: 30. 1882.

≡ *Calocera aurantiocinnabarina* (Speg.) Sacc., Syll. Fung. 6: 734. 1888.

≡ *Botryonipha aurantiocinnabarina* (Speg.) O. Kuntze, Rev. Gen. Pl. 2: 845. 1891.

= *Sphaerostilbe rosea* Kalchbr., Grevillea 9: 26. 1880.

≡ *Stilbella rosea* (Kalchbr.) Weese, Sitzungsber. Kaiserl. Akad. Wiss. 128: 44. 1919.

= *Stilbum kalchbrenneri* Sacc., Syll. Fung. 4: 570. 1886.

= *Stilbum aurantiocinnabarinum* var. *fuscipes* Speg., An. Soc. Cient. Argent. 13: 30. 1882.

[= *Stilbum physaroides* Speg., Bol. Acad. Nac. Cienc. Cordoba 11: 615. 1889, non Kalchbr. 1882].

= *Stilbum spegazzinianum* Sacc., Syll. Fung. 10: 682. 1892.

= *Stilbum fuscocinnabarinum* Speg., Bol. Acad. Nac. Cienc. Cordoba 11: 616. 1889.

= *Stilbum javanicum* Henn., Hedwigia 32: 227. 1893.

= *Stilbum proliferum* Marchal, Bull. Soc. Belge. Microsc. 20: 267. 1894.

= *Stilbum camerunense* Henn., Bot. Jahrb. Syst. 22: 81. 1895.

[= *Stilbum nanum* Massee, Kew Bull. 1898: 112, non (Ehrenb.) Sprengel 1827.].

= *Stilbum fructigenum* Penz. & Sacc., Malpighia 15: 250. 1901.

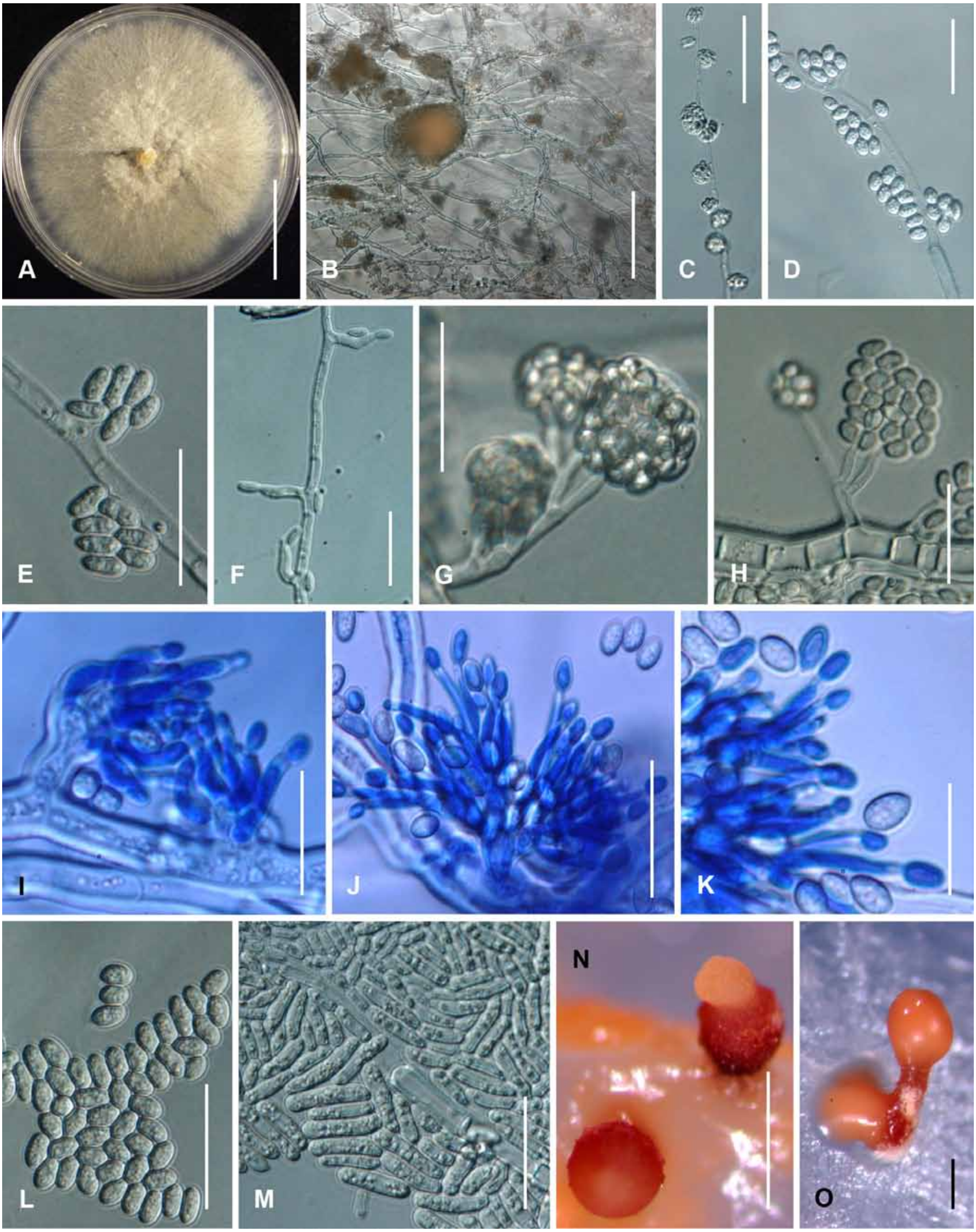

Fig. 66A–O. Anamorph of *Nectria pseudocinnabarina* in culture. A. Cultures after 7 d at 25 °C on PDA; B. Conidial mass on SNA surface; C–E. Lateral phialidic pegs and conidia on SNA; F–K. Conidiophores and conidia on SNA; L. Young conidia on SNA; M. Mature conidia on SNA; N. Perithecia on SNA; O. Synnema on SNA. Scale bars: A = 3 mm; B, N, O = 500 µm; C = 50 µm; D–J, L, M = 20 µm; K = 10 µm.

= *Stilbella rubescens* Sydow, Bull. Herb. Boisser 1901: 85. 1901.
  ≡ *Stilbella rubescens* (Sydow) Sacc., Syll. Fung. 16: 1082. 1901.
= *Stilbella heveae* Zimm., in Henn., Hedwigia 41: 148. 1902.
  ≡ *Stilbum heveae* (Zimm.) Sacc. & D. Sacc., Syll. Fung. 18: 631 1906.
= *Stilbella theae* Ch. Bernard, Bull. Dep. Agric. Indes Neerl. 11: 25. 1907.
  ≡ *Stilbum theae* (Ch. Bernard) Sacc. & Trotter, Syll. Fung. 22: 1437. 1913.
= *Ciliciopodium costaricense* Speg., Bol. Acad. Nac. Cienc. Cordoba 23: 591. 1919.
[= *Ciliciopodium costaricense* Speg., An. Mus. Nac. Hist. Nat. Buenos Aires 31: 442. 1992, non (Welw. & Curr.) Sacc., 1886].
= *Stilbum minutulum* Penz. & Sacc., Malpighia 15: 250. 1902.
= *Polycephalum subaurantiacum* Peck, Bull. New York St. Mus. 167: 46. 1912.

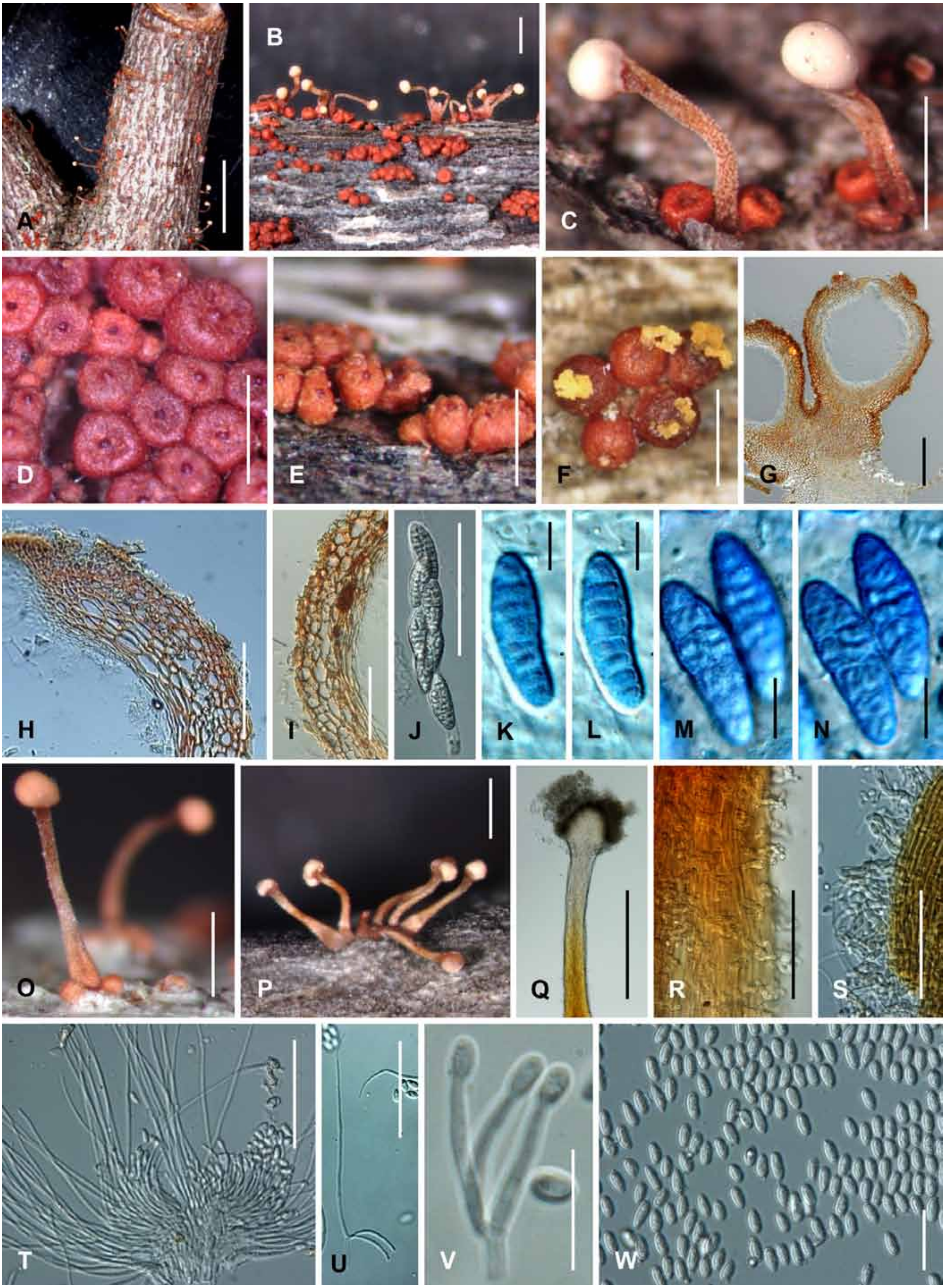

Fig. 67A–W. *Nectria pseudotrichia* on natural substrata (A–C teleomorph and anamorph, D–N teleomorph, O–W anamorph). A–C. Perithecia and synnemata on natural substrata; D–F. Perithecia on natural substrata; G. Median section of perithecia; H. Median section of perithecial apex; I. Median section of perithecial wall; J. Ascus; K, M. Ascospore in surface view; L N. Ascospores in optical section; O–Q. Synnemata on natural substrata; R, S. Ornamental hyphae on stipe; T, U. Sterile hyphae and conidiophores on natural substrata; V. Conidiophores on natural substrata; W. Conidia on natural substrata. Scale bars: A = 5 mm; B, C, O–Q = 1 mm; D–F = 500 µm; G = 100 µm; H–J, R–U = 50 µm; K–N, V, W = 10 µm.

Fig. 68A–C. *Nectria pseudotrichia* in culture (teleomorph). A. Budding ascospores streaked onto SNA; B, C. Budding and germinating ascospores streaked onto SNA.Scale bars: A–C = 30 µm.

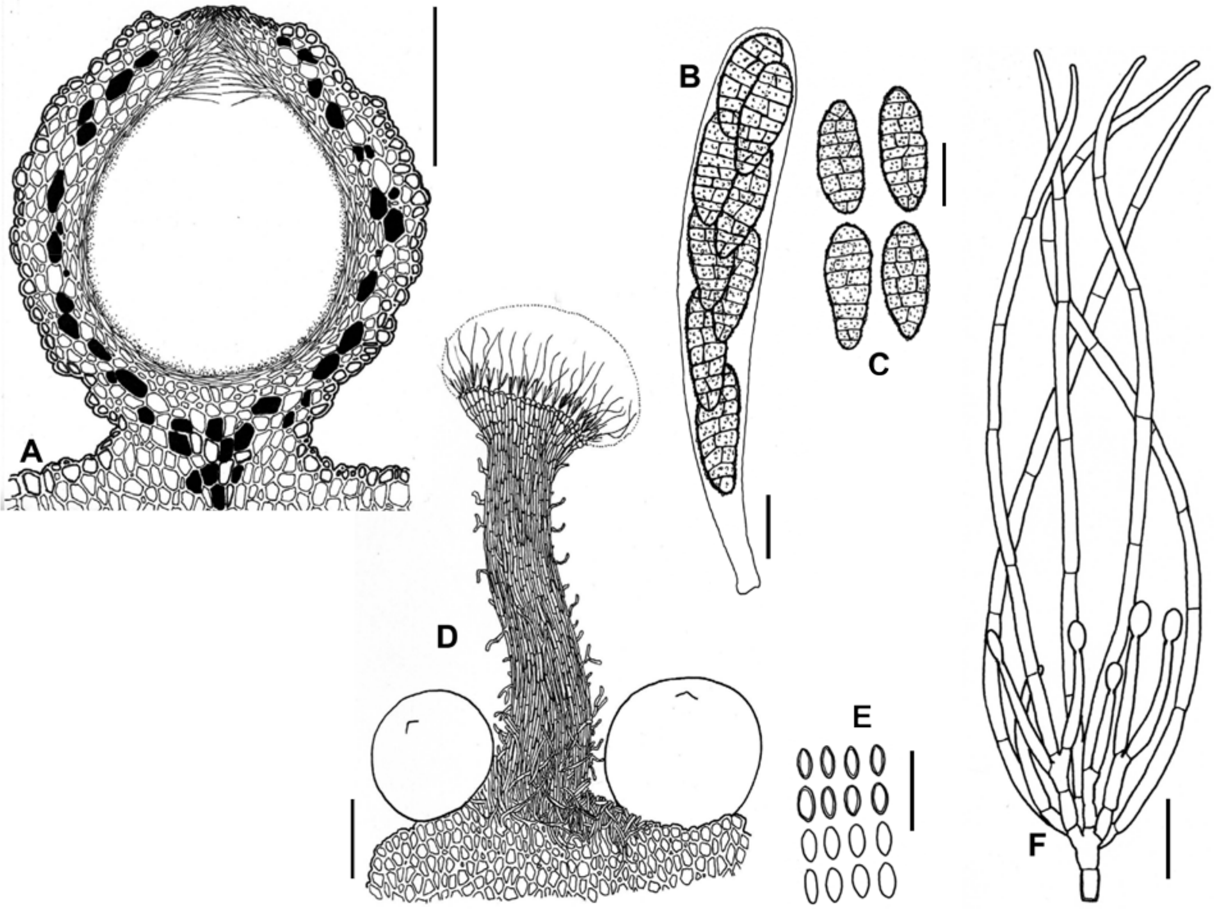

Fig. 69A–F. *Nectria pseudotrichia* on natural substrata (A–C teleomorph, D–F anamorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores; D. Median section of synnema; E. Conidia; F. Sterile hyphae and conidiophores. Scale bars: A, D = 200 µm; B, C, E, F = 10 µm.

Teleomorph on natural substrata: Ascomata and synnemata sometimes formed on same or discrete stroma. *Mycelium* not visible around ascomata and on host. *Stromata* up to 1.5 mm high and 2.5 mm diam, erumpent through epidermis, whitish orange to bay, KOH+ dark red, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis* to *t. prismatica* with cells oriented more or less vertically; cells 5–15 µm diam, with walls 1–2 µm thick, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, solitary or caespitose, up to 18 on stroma, often associated with synnemata of anamorph, globose, 333–548 µm high × 296–534 µm diam, red, sometimes cupulate upon drying, papillate, apical region darker, KOH+ dark red, LA+ yellow, surface smooth or sometimes roughened with concolourous warts. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis*, with walls pigmented 1.5 µm thick. *Ascomatal wall* 36–70 µm thick, of three regions: *outer region* 23–54 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, *ca.* 1.5 µm thick; *middle region* 6–23 µm thick, cells forming *textura globulosa* containing brown to red-brown pigment droplets, wall pigmented *ca.* 0.5 µm thick; *inner region* 9–24 µm thick, of elongated, thin-walled, hyaline cells, intergrading with stroma, forming *textura prismatica*. *Asci* unitunicate, 65–125 × 13–32 µm, clavate with inconspicuous ring at apex, 8-spored, ascospores biseriate above, uniseriate below. *Ascospores*

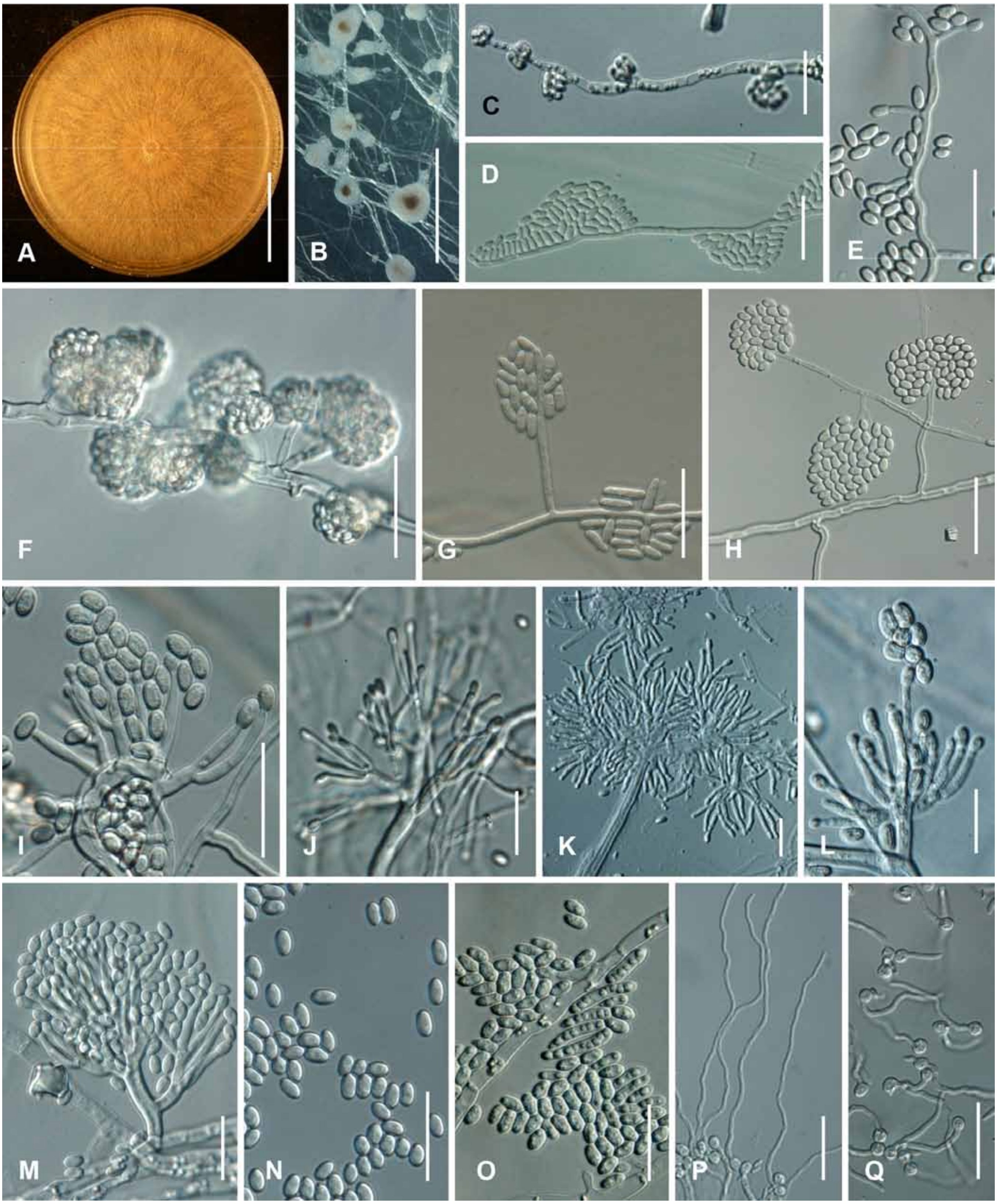

Fig. 70A–Q. Anamorph of *Nectria pseudotrichia* in culture. A. Cultures after 7 d at 25 °C on PDA; B. Abundant conidiophores and conidial mass produced on the SNA surface; C–E. Lateral phialidic pegs and conidia on SNA; F–M. Conidiophores and conidia on SNA; N. Young conidia on SNA; O. Young conidia and mature conidia on SNA; P, Q. Germinating mature conidia that were streaked onto SNA. Scale bars: A = 3 mm; B = 50 µm; C–Q = 20 µm.

muriform, with 5–8 transverse septa and 1-2 longitudinal septum, often constricted at each septum, ellipsoidal to fusiform, hyaline, brown to dark brown when mature, straight, sometimes slightly curved, (14.8–)21.0–28.8(–41.3) × (4.6–)7.5–11.4(–15.0) µm, (*n* = 645), finally spinulos.

Anamorph on natural substrata: *Synnemata* usually erumpent through epidermis, solitary or gregarious, emerging from ascomatal cluster or independently, crowded to caespitose, cylindrical-capitate, subulate-capitate, or claviform, erect or nodding, unbranched or rarely up to 3 branched at base, medium to slender, distinctly hispid at base to mid-level, young synnemata smooth to granular, soft-textured when fresh, red-brown at base, turning blood-red in KOH, toward base becoming almost black with age, 1038–2700 µm high including stipe, 93–384 µm wide. *Hyphae on stipe* external hyphae pigmented golden brown at base, becoming less pigmentied toward apex, KOH+, 4–9 µm wide; internal hyphae hyaline, KOH–, 4–8 µm wide. *Ornamental cells* cylindrical, straight, curved, sinuous or twisted, arising laterally at more or less right angles, distributed evenly over surface of synnemata or concentrated near base or apex, 7–16 µm long, 1.5–2.5 µm wide, usually unbranched but occasionally dichotomously branched, aseptate or with up to 3-septate, septa thin or up to 1 µm thick, terminal hyphae with bluntly rounded tips, 4–9 µm wide, cell walls 1.8–2.3 µm thick. *Conidiophores* with long sterile hyphae, branching monoverticillate or biverticillate, whorls compact or diffuse, if present, metulae 15–80 × 1.8–1.9 µm. *Conidiogeonus cells* enteroblastic, monophialidic, cylindrical to subulate, straight or curved in terminal whorls of 2–5 together with sterile hyphae or lateral and terminal, 18–40 × 1.1–2.8 µm, collarette not conspicuous. *Sterile hyphae* mixed with phialides, acicular, straight, or usually curved, unbranched or dichotomously branched, septate, 65–128 × 1.9–3.3 µm, arising from hyphae often in groups of 1–3 from conidiophores together with phialides. *Conidial masses* globose, hemisphaerical or more or less discoid, whitish yellow when fresh, drying sienna, 120–350 µm wide. *Conidia* hyaline, ellipsoidal, obovate or oblong, sometimes slightly curved, non-septate, (3.1–)4.3–5.9(–7.0) × (1.4–)2.5–3.3(–4.6) µm, (n = 618), smooth-walled.

Anamorph in culture: Optimum temperature for *growth* on PDA 30 °C. After 3 d at 25 °C, colonies 37–48 mm (average 43 mm) diam. *Colony surface* cottony with aerial mycelium orange, sometimes yellowish brown; *aerial mycelium* white to whitish yellow; *sporodochial conidial masses* abundantly produced after 1 wk; *reverse* orange to yellowish brown. *Odour* on PDA slightly fruity. Sporulation on SNA from *lateral phialidic pegs* common, enteroblastic, monophialidic, ellipsoidal tapering toward tip, 2.7–6.3 µm long, 1.0–2.3 µm wide near aperture. *Aerial conidiophores* usually verticillate, 1–3 branched, becoming loosely to moderately densely branched, 13.9–34.7 µm long, 1.2–3.5 µm wide at base. *Aerial conidiogenous cells* enteroblastic, monophialidic, cylindrical, slightly tapering toward tip, 4.7–12.2 µm long, 1.1–2.7 µm wide at base. *Sporodochial conidiophores*, 2–4 branched, becoming densely branched, then terminal whorls of 2–4 together, 25.8–34.4 µm long, 2.6–4.3 µm wide at base. *Sporodochial conidiogenous cells* monophialidic, cylindrical, slightly tapering toward tip or narrowly flask-shaped with widest point in middle, 6.5–14.4 µm long, 0.7–3.1 µm wide at base. *Young conidia* developing from monophialides on submerged or aerial hyphae, produced abundantly on slimy heads, non-septate, subglobose to obovate, rarely ellipsoidal to fusiform, hyaline, smooth, straight or slightly curved, rounded at both ends, (3.7–)4.4–6.0(–7.3) × (1.5–)2.4–3.2(–3.9) µm (n = 294). *Mature conidia* swollen, mostly 0-, rarely 1-septate, oblong or allantoid, smooth, straight or slightly curved, rounded at both ends, (6.0–) 8.7–13.7(–21.0) × (2.3–)2.5–4.2(–5.7) µm (n = 189).

Habitat: On dead woody plants; known from *Acacia* sp., *Acer* sp., *Albizia julibrissin*, *Bixa orellana*, *Cajanus indicus*, *Carya glabra*, *Carya* sp., *Cedrela toona*, *Citrus* × *sinensis*, *Cordia macrophylla*?, *Cordia myxa*, *Corynocarpus laevigatus*, *Cryptostegia* sp., *Disoxylon* sp., *Erythrina indica*, *Ficus* sp., *Gliricidia sepium*, *Guarea guidonia*, *Grevillea robusta*, *Hevea brasiliensis*, *Hydrangea* sp., *Hymenostegia afzelii*, *Indigofera stachyodes*?, *Inga* sp., *Jussiaea peruviana*, *Ludwigia peruviana*, *Leucaena leucocephala*, *Litchi chinensis*, *Mallotus* sp., *Manihot esculenta*, *Mucuna* sp., *Persea americana*, *Pinus caribaea*, *Rosa* sp., *Schinus myrtifolia*?, *Stryphnodendron excelsum*?, *Theobroma cacao* L., and *Vitex* sp.

Distribution: Africa (Cameroon, Gabon, Ghana, Tanzania, Uganda), Asia (China, India, Indonesia, Japan, Malaysia, Papua New Guinea, Philippines, Sri Lanka, Taiwan, Thailand), Caribbean and Central America (Costa Rica, Cuba, Dominica, El Salvador, Guatemala, Jamaica, Panama, Puerto Rico), North America (Mexico, USA), Oceania (Australia), South America (Argentina, Bolivia, Brazil, Colombia, Ecuador, French Guiana, Guyana, Paraguay, Peru, Surinam, Venezuela).

Lectotype of Nectria pseudotrichia *designated by Seeler (1940b)*: **Surinam**, on bark, **Lectotype** PH 00060330, Herb. Schweinitz, **Isolectotypes** K, BPI-bound Michener collection, vol 32, sheet 14.

Epitype of Nectria pseudotrichia *designated here*: **Venezuela**, La Gran Sabana, Bolivar, on dead wood, 26 Jun. 2009, Y. Hirooka, C. Salgado, BPI 881072 = Y.H. 09-43, ex-epitype culture CBS 129368 = G.J.S. 09-1240.

Additional specimens examined. **Argentina**, Misiones, Garuhape, Rosada Frente A La Casa, on woody substrate, 01 Feb. 1962, J.E. Wright, C.E Gomez., B.E. Del, BPI 552867; Tucuman, Tierra de San Javier, Auta Muerte, on woody substrate, Jan. 1950, R. Singer, BPI 552886; Tucuman, Yarten Der Impobules Mjsul Tille, on *Schinus myrtifolia*, Sep. 1949, R. Singer, BPI 552957. **Australia**, North Queensland, Ingham, on *Litchi chinensis*, Mar. 1994, B. Summerell, BPI 737840. **Bolivia**, near Warner, Santa Cruz, on *Persea americana*, Feb. 1954, F.H. Bell, BPI 552954. **Brazil**, Timor, on woody substrate, 1910-1913, M. Ferreira, J. Tavares, BPI 552871. **Cameroon**, Reserve Faunal de Dja, Ca 400 m W of the river Dja, ECOFAC camp, in highly disturbed forest, clay soil, alt. 630 m. 3 °23'N 12 °44'E, on recently dead tree, 10 Jul. 2001, G.J. Samuels, A. Guinwith, D. Begoude, P. Togo, BPI 863827; Reserve Faunal de Dja, Ca 400 m W of the river Dja, ECOFAC camp, in highly disturbed forest, clay soil, alt. 630 m, 3 °23'N 12 °44'E, on recently dead tree, 10 Jul. 2001, G.J. Samuels, A. Guinwith, D. Begoude, P. Togo, BPI 863831; Reserve du Dja, In forest 2 h walk S of the main route toward Bournville, 6 km E of Dja River, alt. 600 m. 3 °17'N 12 °47'E, on bark, 14 Jul. 2001, G.J. Samuels, A. Guinwith, D. Begoude, P. Togo, BPI 863844; SW Region, vic Mundemba, Korup National Park, Smithsonian Plot East-West Trail from Chimpanzee Camp, N 05 °04', E008 °51', elev 166 m to N05 °03', E 08 °51', elev 129 m, on *Hymenostegia afzelii*, 06 Dec. 2008, G.J. Samuels, K. Ivors, M. mbenoun, V. Mfegue, S. Moses, BPI 881079; culture G.J.S. 08-224 = CBS 131751. **China**, Menghua, Yunnan, on *Hydrangea* sp., 19 Sep. 1933, Y. Tsiang, BPI 552943; Menghua, Yunnan on *Hydrangea* sp., 19 Sep. 1933, Y. Tsiang, BPI 552944; Szemao, Yunnan, on *Mallotus* sp., 26 Nov. 1933, Y. Tsiang, BPI 552949; Szemao, Yunnan, on *Mallotus* sp., 26 Nov. 1933, Y. Tsiang, BPI 552950; Szemao, Yunnan, on *Mucuna* sp., 26 Nov. 1933, Y. Tsiang, BPI 552952; Szemao, Yunnan, on *Mucuna* sp., 26 Nov. 1933, Y. Tsiang, BPI 552953; Ling-Shui, Hainan, on woody substrate, 21 Apr. 1934, S.Q. Deng, BPI 552883; Yen-Hsien, Hainan, on woody substrate, 15 Jun. 1934, S.Q. Deng, BPI 552884; Yen-Hsien, Hainan, on woody substrate, 28 Jun. 1934, S.Q. Deng, BPI 552887; Pao-Hua-Shan, Kiangsu, on woody substrate, 29 Jul. 1933, S.Q. Deng, BPI 552888; Tan-Hsien, Hainan, on woody substrate, 29 Sep. 1934, S.Q. Deng, BPI 552889; Ling-Shui, Hainan, on woody substrate, 15 Sep. 1934, S.Q. Deng, BPI 552890; Yen-Hsien, Hainan, on woody substrate, 07 Jun. 1934, S.Q. Deng, BPI 552891; Yen-Hsien, Hainan, on woody substrate, 16 Jun. 1934, S.Q. Deng, BPI 552892; Yen-Hsien, Hainan, on woody substrate, 16 Jun. 1934, S.Q. Deng, BPI 552893; Ling-Shui, Hainan, on woody substrate, 12 Sep. 1934, S.Q. Deng, BPI 552895; Ling-Shui, Hainan, on woody substrate, 12 Sep. 1934, S.Q. Deng, BPI 552896; Yen-Hsien, Hainan, on woody substrate, 16 Jun. 1934, S.Q. Deng, BPI 552916. **Colombia**, Est. Central La Esperanza, Cundinamarca, on *Inga* sp., Jul. 1937, R. Obregon, BPI 552946; La Vega, on *Manihot utilissima*, 27 Nov. 1932, F.R. Barrios, BPI 552951; Antioquia, between Yarumal and Medellin, elev. 2700 m, on woody substrate, 20 Jul. 1942, J. Cuatrecasas, BPI 552882; Hacienda Cincinnati, on woody substrate, 10 Aug. 1935, G.W. Martin, BPI 552885. **Costa Rica**, Guanacaste Conservation Area, Pitilla, on newly killed wood, 13 Jun. 1995, A.Y. Rossman, BPI 746074; Heredia, Sarapiqui, Estacion Biologica La Selva, on *Stryphnodendron excelsum*, M. Arguedas, BPI 748186. **Cuba**, Soledad, on *Cryptostegia* sp., 16 Nov. 1924, Weir, BPI 552937. **Dominica**, near Springfield, on *Bixa orellana*, Jun. 1970, A.Y. Rossman, BPI 552918; 7 miles NE of Roseau, on *Bixa orellana*, 20 Jun. 1970, A.Y. Rossman, BPI 552920. **Ecuador**, Prov. Carchi, Paramo El Angel, old road from El Angel to Tulcan, “Voladero”, alt. 3500-4000 m, on woody substrate, 10 Apr. 1987-11 Apr.

1987, R.E. Halling, BPI 747148. **El Salvador**, on *Rosa* sp., Jul. 1957, R.C. Rose, BPI 552956; Zapotitan, on woody substrate, 25 Jan. 1944, F.L. Wellman, BPI 552913. **French Guiana**, Cayenne, Montagne Cacao, Piste Coralie. 70 km. E. of, on dead log, 14 Feb. 1988, A.Y. Rossman, C. Feuillet, BPI 1104491; Cayenne, Remire. 52 °18'W, 4 °52'N, Trail to Vidal, old farm, secondary forest, 15 km. from Cayenne, on dead stick, 12 Feb. 1988, A.Y. Rossman, C. Feuillet, BPI 1107220; Saint Laurent, Piste de Paul Isnard, alt. 10 m, 54 °0'W, 5 °26'N, on Wood, 17 Nov. 1986, A.Y. Rossman, C. Feuillet, L. Skog, BPI 1107221; Piste Balate, alt. 20 m, 54 °3'W, 5 °23'N, 12 km from Saint Laurent, on dead log of *Melastomaceae*, 19 Nov. 1986, A.Y. Rossman, C. Feuillet, L. Skog, BPI 1107310; Cayenne, Montagne Cacao, Piste Coralie. 70 km east of Cayenne, on woody substrate, 14 Feb. 1988, A.Y. Rossman, C. Feuillet, BPI 552868. **Gabon**, Estuaire Prov., Komo Mondah Dept., Mondah forest, *ca.* 20 km north from Libreville, 0.58433 °N, 9.38507 °E, on bark, 8 May 2009, K. Põldmaa, BPI 881078 = TU 112174, culture TFC 201238 = G.J.S. 09-1355. **Ghana** as Gold Coast Colony, Bunsu, on *Hevea brasiliensis*, 17 Jun. 1949, S.J. Hughes, BPI 552942. **Guatemala**, Dept. Alta Verapaz, along Rio Polochic, above Tamahu, alt. *ca.* 1200 m, on *Bixa orellana*, 10 Apr. 1941, P.C. Standley, BPI 552919; Tenadores, on *Citrus sinensis*, 25 Dec. 1916, W.A. Kellerman, BPI 552934; Coban, elev. 5000 ft, on woody substrate, 07 Jan. 1937, J.H. Faull, BPI 552894. **Guyana**, Bartica, on woody substrate, 15 Dec. 1923, D.H. Linder, BPI 552914. **India**, Amtala, 24-Parganas, West Bengal, on *Erythrina indica*, 18 Aug. 1968, A. Kar, BPI 552938; Darjeeling, West Bengal, on *Indigofera stachyodes*, 24 Jun. 1968, A. Kar, BPI 552945. **Indonesia**, Java, Botanical Garten zu Buitenzorg, on *Stilbella cinnabarina*, 1907-1908, F. Hohnel, BPI 552958; Timor, on woody substrate, Ferreira, BPI 552874; Sumatra, on woody substrate, 1926, Boedijn, BPI 552898. **Jamaica**, Chesterville Youth Dev, Camp, Newcastle, on *Bixa orellana*, 08 Jan. 1971, A.Y. Rossman, BPI 552921; Portland Parish, between Woodcutter's Gap and Silver Hill Gap, alt. 1500 m., on *Eugenia jambos*, 09 Jan. 1971, A.Y. Rossman, BPI 552922; Clydesdale Forest Camp and Rest House. alt. 3500 ft, on *Pinus caribaea*, 08 Jan. 1971, A.Y. Rossman, BPI 552955. **Japan**, Tokyo, Ogasawara-mura, Hahajima, Tamagawa Dam, on bark of dead wood, Jun. 2005, Y. Hirooka, BPI 881038; culture MAFF 241452; Tokyo, Hachijo Island, Yoshimi, on twigs, Jun. 2001, Y Hirooka, BPI 881039; culture MAFF 241394; Kagoshima Prefecture, Yakushima, Oko Falls near Kurio, on bark and wood, 19 May 1983, R.J. Bandoni, culture CBS 551.84; **Malaysia**, Kuala Lumpur, on woody substrate, 14 Jun. 1928, J.R. Weir, BPI 552872; Kuala Lumpur, Selangor, F.m.s., on woody substrate, 14 Jun. 1928, J.R. Weir, BPI 552897. **Mexico**, Jalapa, Veracruz, on woody substrate, 02 Aug. 1945, A.J. Sharp, BPI 552910A, B. **Panama**, Barro Colorado Island, along Wheeler Trail, on woody substrate, 04 Aug. 1925, C.W. Dodge, BPI 552869; Prov. Chiriqui, Casita Alta above Boquete, alt 2000-2200 m, on woody substrate, 01 Aug. 1952, G.W. Martin, A.L. Welden, BPI 552909A; Prov. Chiriqui, Casita Alta above Boquete, alt 2000-2200 m, on woody substrate, 01 Aug. 1952, G.W. Martin, A.L. Welden, BPI 552909B. **Papua New Guinea**, Keravat on *Theobroma cacao*, Mar. 1968, P.J. Brook, PDD 26409 = J.M. Dingley 6857, culture ICMP 2245. **Paraguay**, Conchas, on woody substrate, 01 May 1881, BPI 552899; San Pedeo, on woody substrate, 02 Jul. 1907, F. Guar, BPI 552904. **Peru**, Province of Loreto, primary forest, 3 °37'14.90"S, 72 °14'48.33"W, on decaying log, 15 May 2010, R. Gazis, BPI 881082. **Philippines**, Los Banos, on *Cordia myxa*, 02 Oct. 1920, A. abesimio, BPI 552936; Mt. Maquiling, on *Gliricidia sepium*, 01 Oct. 1920, S. Babao, BPI 552940; Mt. Maquiling, on *Leucaena glauca*, 03 Oct. 1920, A. Rocafort, BPI 552948; on woody substrate, H.A. Lee, BPI 1107627; Lamao, Bataan Province, Luzon, on woody substrate, Feb. 1920, H.A. Lee, BPI 552877; Palo, Leyte, on woody substrate, Jan. 1906, A.D.E. Elmer, BPI 552879; Palo, Leyte, on woody substrate, Jan. 1906, BPI 552880; Province of Rizal, Luzon, on woody substrate, Jan. 1906, F.W. Foxworthy, BPI 552881; Mt. Maquiling, on *Vitex* sp., 24 Sep. 1920, P. Sison, BPI 552959. **Puerto Rico**, El Toro Trail, El Yungue National Forest, on *Guarea guidonia* (possibly), 20 Feb. 2009, D.J. Lodge, BPI 881075 = PR-6567, culture A.R. 4577 = CBS 131750; Luquillo Mountains, Bisley Watershed 3, Vogt wood addition plot. 18 °19'0"N 65 °0'0"W, on branch, 08 May 1995, S.M. Huhndorf, D.J. Lodge, BPI 745419; Caribbean National Forest, Luquillo Mountains, Rio Grande, trail to El Toro from Rt 186., alt. 650-750 m, on recently dead shrub, 24 Feb. 1996, G.J. Samuels, H.-J. Schroers, D.J. Lodge, BPI 745544; Espinosa, on *Cajanus indicus,* 27 Mar. 1916, J.A. Stevenson, BPI 552923; Pueblo Viejo, on *Cajanus indicus,* 24 Mar. 1916, J.A. Stevenson, BPI 552924; Pueblo Viejo, on woody substrate, 24 Mar. 1916, J.A. Stevenson, BPI 552875; Espinosa, on *Cajanus indicus,* 27 Mar. 1916, J.A. Stevenson, BPI 552925, 552926, 552927, 552929; Maricao, 3 km on Mesas road to Mayaguez, on *Cajanus indicus,* 30 Apr. 1922, C.E. Chardon, BPI 552928; Mayaguez, La Jagua, on *Cordia macrophylla*, 27 Feb. 1916, H.H. Whetzel, E.W. Olive, BPI 552930, 552935; Rio Piedras, on woody substrate, 04 Jul. 1916, J.A. Stevenson, BPI 552870; Rio Piedras, on woody substrate, 04 Dec. 1915, J.A. Stevenson, BPI 552876; Pueblo Viejo, on woody substrate, 24 Mar. 1916, J.A. Stevenson, BPI 552900; College Finca, Mayaguez, on woody substrate, 14 Jul. 1920, C.E. Chardon, BPI 552901; Rio Piedras, on woody substrate, 04 Jul. 1916, Stevenson, BPI 552902; N. Slope of Luquillo Mts., on woody substrate, 08 Mar. 1899, A.A. Heller, BPI 552903; Narayeto, on woody substrate, 26 Nov., B. Fink 1915, BPI 552905; Maricao, on woody substrate, 23 Mar. 1916, H.H. Whetzel, E.W. Olive, BPI 552906; Rio Piedras, on woody substrate, 04 Dec. 1915, J.A. Stevenson, BPI 552908; Rio Piedras, on woody substrate, 09 Apr. 1917, J.A. Stevenson, BPI 552911; Rio Piedras, on woody substrate, 04 Jul. 1916, J.A. Stevenson, BPI 552912. **Sri Lanka**, Central Province, on bark, Nov. 1867, Berkeley?, K (M) 163336 as *Nectria fenestrata*. **Taiwan**, Taroko Park, on newly killed wood, Oct. 2009, A.Y. Rossman, BPI 879862, culture CBS 129367 = A.R. 4667; Taipei County, Mudan, Diaoshan Historical Trail, on bark, 2 Nov. 2003, J.-R. Guu 92110201, comm. Yu-ming Ju, BPI 881076, culture A.R. 4606; Taipei County, Wanlee, Linnshih Historical Trail, on bark. 14 Jan. 2005, J.-R. Guu 94011505, comm. Yu-ming Ju, BPI 881077, culture A.R. 4607 = CBS 131749. **Tanzania**, Amani, Usambara, on *Cedrela toona*, Oct. 1912, M. Grote, BPI 552933. **Thailand**, Saraburi Province, Khao Yai National Park, trail to Jed Khot Waterfall., alt. 100 m, on bark of recently dead tree, 28 Jul. 1997, G.J. Samuels, P. Chaverri, K. Põldmaa, Somsak, BPI 745604; Saraburi Province, Khao Yai National Park, vicinity of park headquarters., alt. 700 m, on twig, dead, 30 Jul. 1997, G.J. Samuels, P. Chaverri, K. Põldmaa, Somsak, BPI 745626; Nakorn Nayok Province, Khao Yai National Park, Phakrajai., alt. 650 m, on bark, 06 Aug. 1997, G.J. Samuels, P. Chaverri, K. Põldmaa, P. Lutthisuvigneon, BPI 745845; Nakhorn Nayok Provinc, Khao Yai National Park, W of Park Headquarters from point where Mo Sing To and Nong Pak Chi trails separate to ridge leading to Nong Pak Chi, mainly in forest and dry ridge, alt. 775-800 m, 14 °26'N 101 °22'E, on bark of recently fallen branch, 07 Sep. 2001, G.J. Samuels, BPI 863815; Prachinburi Province, Khao Yai National Park. In primary forest between 14 °28'N 101 °12'E elev. 800 m and Bun Phai, 14 °29'N 101 °22'E, elev. 760 m, on bark of recently dead tree, 18 Aug. 2001, G.J. Samuels, R. Nasit, BPI 863901; Petburi Province, Kaen Krachan National Park. Pa La-U waterfall in disturbed forest, alt. 105 m, 12 °32'N 99 °28'E, on wood decorticated, 22 Aug. 2001, G.J. Samuels, M. Reblova, R. Nasit, BPI 863930; Saraburi Province, Khao Yai National Park, trail to Jed Khot Waterfall., alt. 100 m, on *Acacia* sp., 28 Jul. 1997, G.J. Samuels, P. Chaverri, K. Põldmaa, Somsak, BPI 745617. **Uganda**, Font, Kipayo, Kyagwe, 4000 Feet, on woody substrate, May 1915, R.A. Dummer, BPI 552873. **USA**, Florida. Jacksonville, on *Albizia julibrissin*, 19 Apr. 1970, A.S. Rhoads, BPI 552917; Florida, Lloyd, on *Carya* sp., Jun. 1925, R.E. Nolen, BPI 552931; Florida, Gainesville, on *Ficus* sp., 12 Sep. 1928, West, Archer, Jenkins, BPI 552939; Florida, Avon Park, on *Grevillea robusta*, 31 Mar. 1937, C.L. Shear, BPI 552941; Florida, Highlands Hammock, on *Jussiaea peruviana*, 05 Feb. 1937, C.L. Shear, BPI 552947; Florida, Highlands Hammock, on *Acer* sp., 29 Dec. 2009, Y. Hirooka, BPI 881040, culture CBS 128670 = Y.H. 10-04; Nebraska, Lincoln, in greenhouse, on woody substrate, 05 Dec. 1896, C.E. Bessey, BPI 552878; Tennessee, Knoxville, on woody substrate, 02 Sep. 1942, A.J. Sharp, BPI 552907. **Venezuela**, Sierra Nevada National Park, Coromoto, La Mucuy, Merida. alt. 2300 m, 08 °36'N, 71 °02'W, above Tabay, on dead bark of tree, 09 Nov. 1990, G.J Samuels, B. Hein, S. M. Huhndorf, T. Iturriaga, G. Rodriguez, M. Hererra, BPI 1109908; Edo Miranda, El Avila, on bark, 2 Jul. 1972, G.J. Samuels, PDD 7908, culture CBS 652.83; Edo, Miranda, Parque Nacional Guatopo, Trail between Agua Blanca and La Cruceta, alt. 500-600 m, 10 °3'N 66 °26'W, on recently dead tree, 27 Nov. 1990 or 30 Nov. 1990, G.J. Samuels, B. Hein, S.M. Huhndorf, BPI 744830; Edo, Trujillo, Parque Nacional Guaramacal, *ca.* 10 km SW of Batatal, La Defensa, Campamiento Granja Bocono, in disturbed vegetation along river, alt. 2000 m, 9 °19'N 70 °9'W, on bark, 20 Nov. 1990, G.J. Samuels, B. Hein, S.M. Huhndorf, BPI 744930; La Gran Sabana, Bolivar, on dead bark of tree, 29 Jun. 2009, T. Iturriaga, Y. Hirooka, C. Salgado, BPI 881041, culture G.J.S. 09-1329; La Gran Sabana, Bolivar, on dead wood, 28 Jun. 2009, Y. Hirooka, C. Salgado, BPI 881073 = Y.H. 09-105, culture G.J.S. 09-1346; La Gran Sabana, on dead wood, 29 Jun. 2009, Y. Hirooka, C. Salgado, BPI 881074 = Y.H. 09-154, culture CBS 129359 = G.J.S. 09-1362.

Notes: *Nectria pseudotrichia* is a one of the common tropical fungi in the genus *Nectria* and is distinguished in this genus by having muriform ascospores and a synnematous anamorph.

In the protologue of *N. pseudotrichia*, Berkeley & Curitis (1853) referred to the basionym as *Sphaeria pseudotrichia* Schw. However, Seifert (1985) concluded that Schweinitz never published *S. pseudotrichia*, thus the name should not be attributed to Schweinitz, as had been done for much of the last century. Tulasne & Tulasne (1861) established the genus *Sphaerostilbe* with five species each having synnematous anamorphs and 'pyrenomycetous asci' in nectria-like fungi. Following their generic concept, Berkeley & Broome (1875) transferred *N. pseudotrichia* to *Sphaerostilbe pseudotrichia* (Berk. & M.A. Curitis) Berk. & Broome. Later, Saccardo (1878) transferred *N. pseudotrichia* to the genus *Calonectria*. According to Saccardo (1883), *Calonectria* included nectria-like fungi having two or more septate ascospores. The monotypic genus *Megalonectria* with *M. pseudotrichia* was proposed by Spegazzini (1881) based on the combination of muriform ascospores and synnematous anamorph. Wollenweber (1926) accepted the genus *Pleonectria* for nectria-like

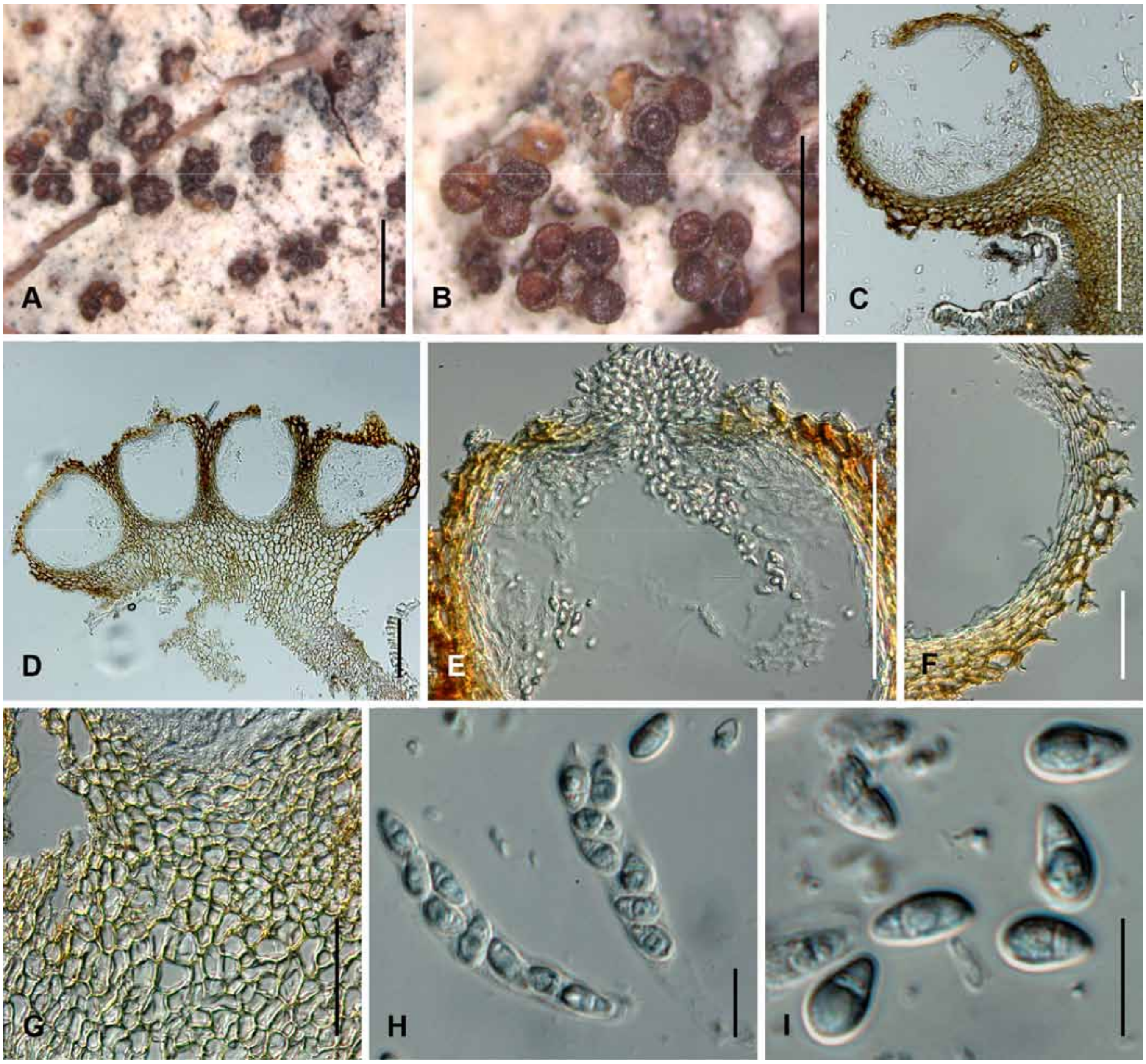

Fig. 71A–I. *Nectria pyriformis* on natural substrata (teleomorph). A, B. Perithecia on natural substrata; C, D. Median section of perithecia; E. Median section of perithecial apex; F. Median section of perithecial wall; G. Median section of stroma; H. Asci; I. Ascospores. Scale bars: A, B = 1 mm; C–E = 100 µm; F, G = 50 µm; H, I = 10 µm.

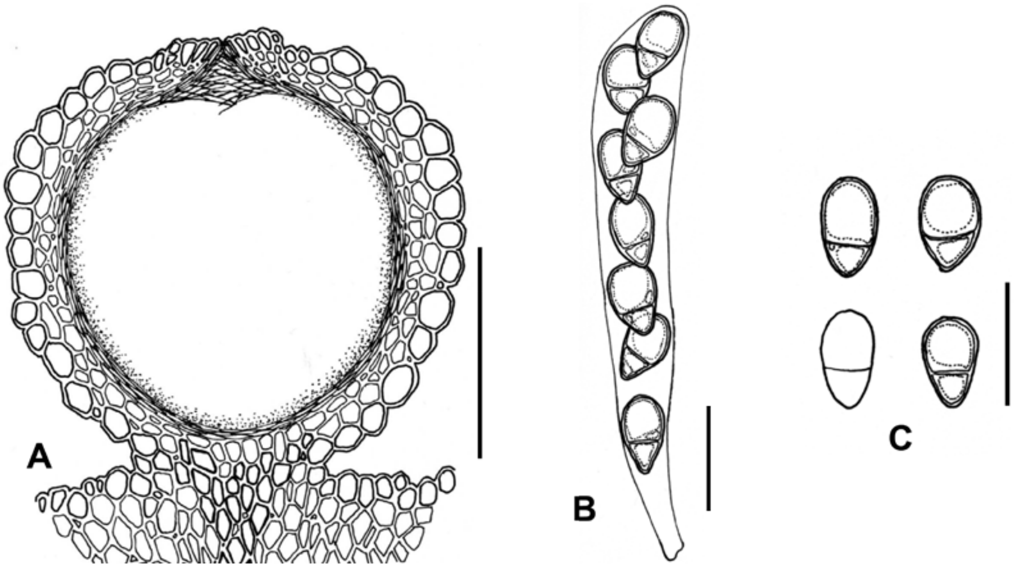

Fig. 72A–C. *Nectria pyriformis* on natural substrata (A–C teleomorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores. Scale bars: A = 100 µm; B, C = 10 µm.

fungi having muriform ascospores such as *Pleonectria pseudotrichia*, but Seeler (1940b) regarded the genus *Pleonectria* as a synonym of *Thyronectria* and transferred many *Pleonectria* names to that genus. Recent mycologists based their concept of genera of nectria-like fungi on ascomatal wall structure and characteristics of both of the sexual and asexual state (Rossman *et al.* 1999). Rossman (1989) and Rossman *et al.* (1999) accepted Booth's concept of groups within the nectria-like fungi recognising those groups at the generic level. They regarded this species under its original name *Nectria pseudotrichia*. The *Tubercularia lateritia*, anamorph of *N. pseudotrichia*, is recognised by the colouration of the synnemata, pink to orange conidial masses, distinctive thick-walled ornamenting cells on the stipe, hispid surface of the stipes, and long curved sterile hyphae in the capitulum (Figs 67A–C, O–S, 69D). *Tubercularia lateritia* is often observed with its teleomorph. Seifert (1985) determined the correct name for the anamorph to be *Tubercularia lateritia* based on *Stilbum lateritium*, and listed the numerous synonyms. Based on Seifert (1985) and the specimens examined for this study, it appears that *T. lateritia* is more common than its teleomorph.

Nectria pseudotrichia is well known as a saprobe in tropical and warm temperate regions. Samuels & Dumont (1982) suggested that this species is a frequent coloniser of freshly cut wood. Becker (2003) confirmed pathogenisity of *N. pseudotrichia* on *Pyrus pirifolia* Nakai in Brazil. Thus, this fungus might also be a facultative parasite similar to its temperate counterpart, *N. cinnabarina* (Hirooka *et al.* 2011).

Our phylogenetic results based on a multiple-locus analysis of 65 isolates from throughout the world support the monophyly of *N. pseudotrichia* with a second distinct clade from New Zealand. The New Zealand strains are herein recognised as *Nectria polythalama,* a name previously considered a synonym of *N. pseudotrichia*. Within *Nectria pseudotrichia*, six subclades exist that are strongly correlated with geography but these cannot be distinguished morphologically (Hirooka *et al.* 2010).

Because Berkeley & Curtis (1853) described *N. pseudotrichia* without a type specimen, Seeler (1940b) and Seifert (1985) typified this name using specimens preserved in PH and K, respectively. The typification of Seeler (1940b) has priority over Seifert (1985), thus the specimen in PH is considered the lectotype. In this study, we designated BPI 881041 as the epitype specimen and associated living culture; it was collected from Venezuela, close to the original collecting locality of Surinam.

Nectria pyriformis Hirooka, Rossman & P. Chaverri, **sp. nov.** MycoBank MB519703. Figs 71, 72.

Holotype: **India**, Rohtak, on dead branches of *Capparis sepiaria*, 13 Oct. 1942, **Holotype** NY No. 610.

Etymology: *pyriform* + *-is*; indicates the shape of its ascospores.

Anamorph: unknown.

Teleomorph on natural substrata: *Mycelium* not visible around ascomata and on host. *Stromata* erumpent through epidermis, up to 1.5 mm high and 1.5 mm diam, umber to bay, KOH+ dark red, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, solitary to aggregated in groups of 3–24, *textura globulosa* or *t. angularis*, 170–241 µm high × 195–270 µm diam, scarlet to bay, cupulate when dry, apical region slightly darker, KOH+ blood colour, LA+ yellow, smooth to roughened. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis*, 5–14 µm diam, with pigmented *ca.* 1.5 µm thick walls. *Ascomatal wall* 26–52 µm thick, of two regions: outer region 20–37 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.0 µm thick; inner region 9–17 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* cylindrical to clavate, 40–57 × 7–11 µm, with inconspicuous ring at apex, (4, 6) 8-spored, ascospores uniseriate or biseriate above. *Ascospores* obovoid or pyriform, rarely turbinate, hyaline, unequally 1-septate, rarely septum submedian, (5.5–)6.2–8.4(–9.0) × (3.5–)3.8–5.0(–5.8) µm (*n* = 50), smooth-walled.

Habitat: On dead branches of *Capparis sepiaria (Capparaceae)*.

Distribution: Asia (India, known only from the type collection).

Notes: *Nectria pyriformis* is described as a new species even though it is known only from the holotype specimen because this species possesses an extremely peculiar shape of ascospores that have never been observed in *Nectria* or nectria-like fungi (Figs 71I, 72C). Although placed in the genus *Nectria, N. pyriformis* may be a species of *Pleonectria*; however, the critical morphological characteristics of *Pleonectria* such as yellowish green scurf on the ascomata, budding ascospores, and pycnidial anamorph are lacking.

Nectria sordida Speg., Anales Mus. Nac. Hist. Nat. Buenos Aires 6: 289. 1899. Figs 73–75.

= *Nectria catalinensis* Lima in Lima, Forchiassin & Ranalli, Nova Hedwigia 46: 150. 1988.

Anamorph: irregularly sporodochial in the natural environment.

Teleomorph on natural substrata: *Mycelium* not visible around ascomata or on host. *Stromata* erumpent through epidermis, up to 1.0 mm high and 3.5 mm diam, red to sienna, KOH+ blood red, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*, intergrading with ascomatal wall. *Ascomata* nearly or completely immersed in erumpent stroma, aggregated in groups of 3–35, red, subglobose to globose, 350–525 µm high × 330–585 µm diam, not collapsing when dry, apical region slightly darker, KOH+ dark purple, LA+ yellow, warted wall. *Ascomatal surface cells* at edge of stroma forming *textura globulosa* or *t. angularis*, 7–17 µm diam, with pigmented, uniformly *ca.* 2.5 µm thickened walls; ascomatal warts apricot to red, 40–80 µm high, larger in upper part of ascomata or around ostiole. *Ascomatal wall at edge of stroma* 70–135 µm thick, of two regions: outer region 55–95 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 2.0 µm thick; inner region 15–35 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* clavate, 97–155 × 20–30 µm, with inconspicuous ring at apex, 8-spored, mainly biseriate, rarely uniseriate. *Ascospores* ellipsoidal, fusiform to long oblong, straight to rarely slightly curved, (25.0–)26.6–32.0(–35.3) × (10.5–)11.5–13.5(–15.6) µm (*n* = 90), (0–)1(–2)-septate, hyaline to slightly yellowish-brown, finely striate.

Anamorph on natural substrata: *Stromata* erumpent through epidermis, orange to red. *Sporodochial conidiomata*, superficial on well-developed stromata, cottony, scattered, caespitose, rarely solitary, astipitate, sessile, up to 180–640 µm high, 220–1300 µm wide, white. *Hymenium* arising directly from *textura prismatica* elongating from *textura angularis*, up to 140 µm long, 2.0–4.5 µm

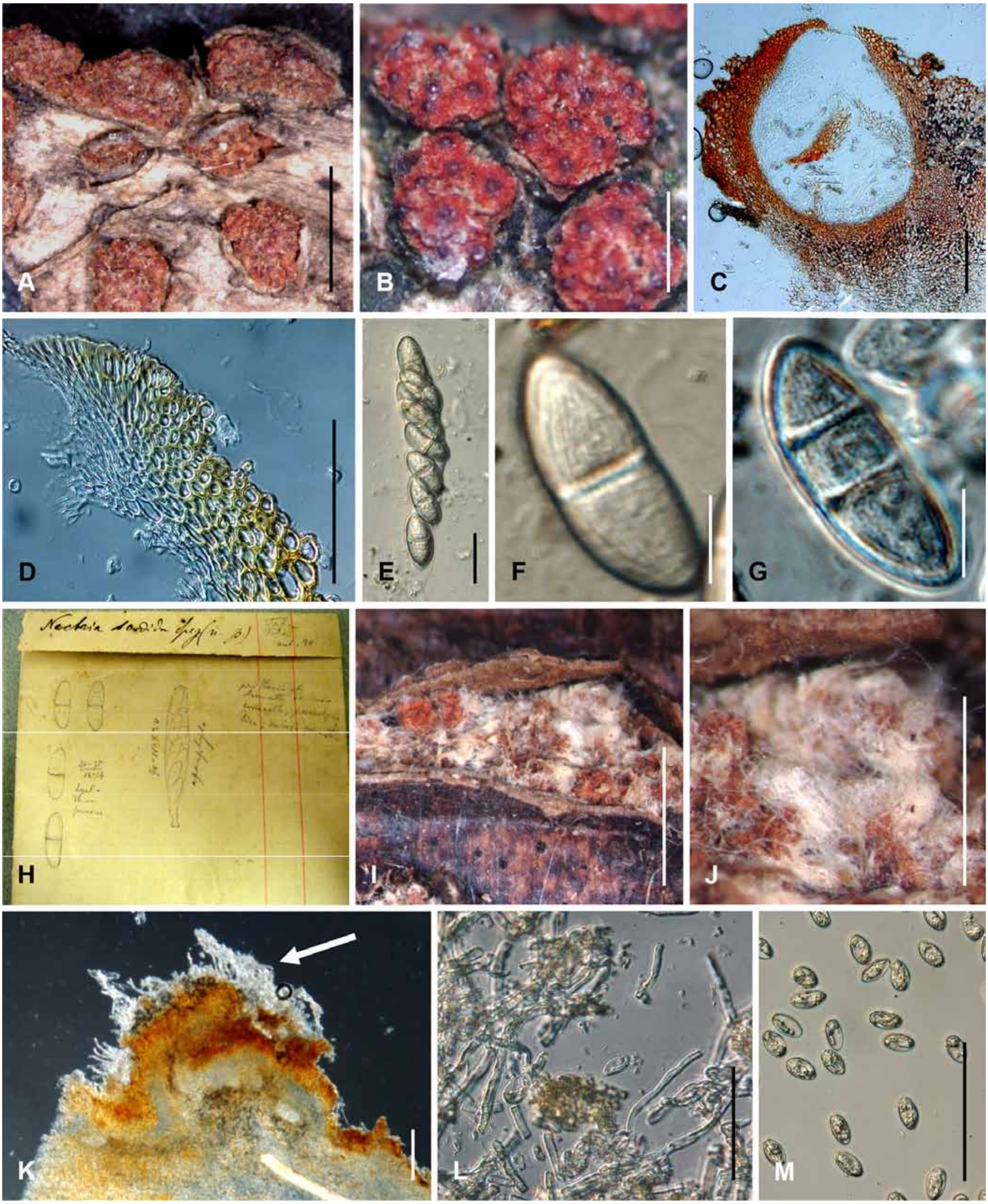

Fig. 73A–M. *Nectria sordida* on natural substrata (A–G teleomorph, H packet of *Nectria sordida* Holotype: LPS 1619, I–M anamorph). A, B. Perithecia on natural substrata; C. Section of perithecium on natural substrata; D. Median section of perithecial wall; E. Ascus; F, G. Ascospores; H. Packet of *Nectria sordida* Holotype: LPS 1619; I, J. Sporodochia on natural substrata; K. Median section of sporodochium (white arrow); L. Hyphae of sporodochia; M. Conidia on natural substrata. Scale bars: A, B, I, J = 1 mm; C, D, K–M = 100 µm; E = 30 µm; F, G = 10 µm.

wide, not curved at margin. *Conidiophores* monochasial branching, 32–85 × 2.0–3.1 µm. *Conidiogenous cells* monophialidic, cylindrical, straight or curved, 15–22 × 1.5–2.6 µm, collarette not conspicuous. *Conidia* hyaline, subglobose to ellipsoidal, straight, non-septate, (12.2–)13.3–15.3(–17.0) × (6.5–)7.3–8.5(–9.5) µm, (*n* = 50), smooth-walled.

Anamorph in culture: After 7 d at 25 °C, colonies 70–80 mm (average 78 mm) diam. *Colony surface* cottony with aerial mycelium whitish yellow to whitish brown; *aerial mycelium* restricted to centre, small yellow sporodochial conidial masses produced after 2 wk; *reverse* whitish yellow to yellowish brown in centre and white at margin. *Odour* on PDA slightly putrid. *Conidiophores* of two types on SNA.

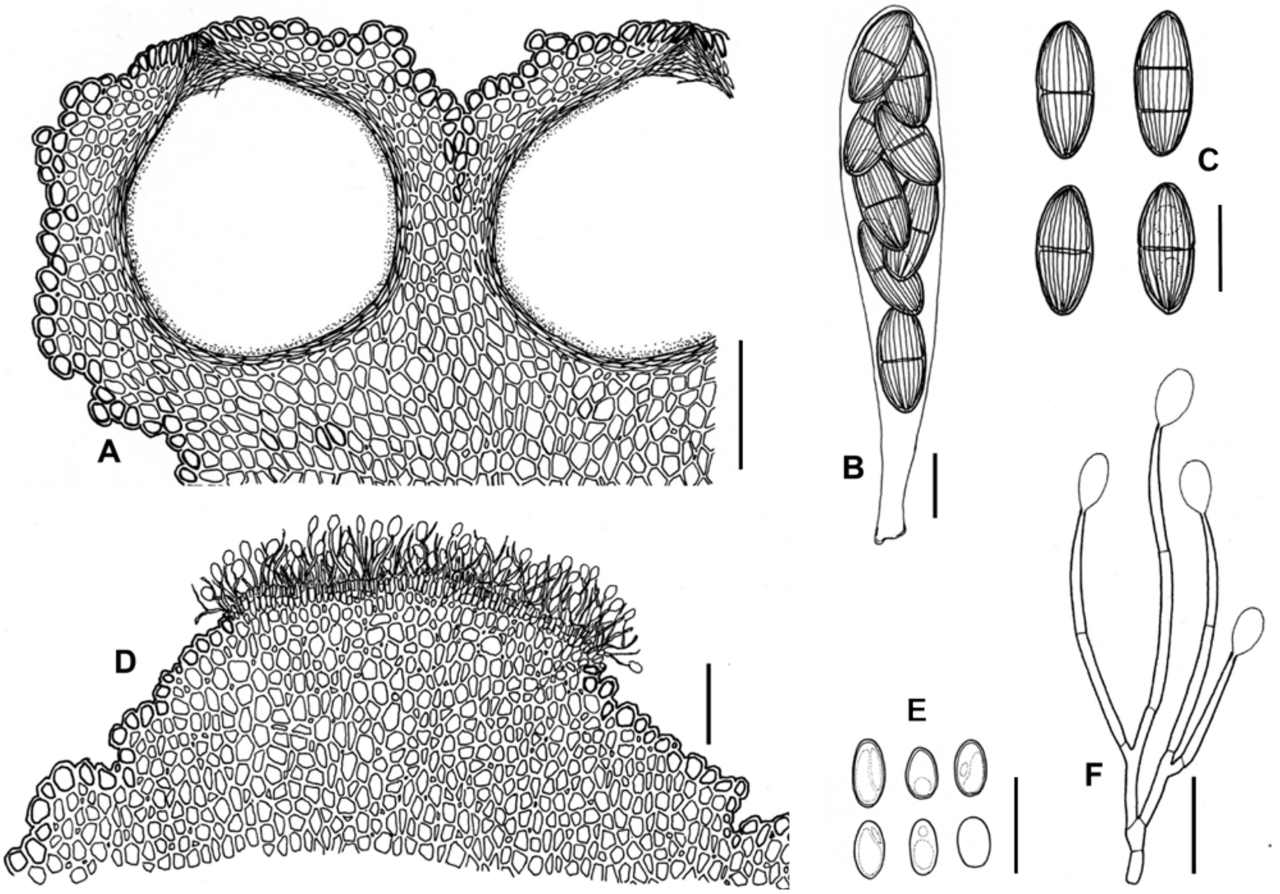

Fig. 74A–F. *Nectria sordida* on natural substrata (A–C teleomorph, D–F anamorph). A. Median section of mature perithecia; B. Ascus; C. Ascospores; D. Median section of sporodochium; E. Conidia; F. Conidiophores. Scale bars: A = 200 µm; B–E = 20 µm.

Short conidiophores producing microconidia, usually unbranched or loosely branched, generally with 1(–3)-branched, 18–47 µm long, 2.6–3.6 µm wide; *conidiogenous cells* long-cylindrical to subulate, straight to slightly curved, enteroblastic, monophialidic, 9.5–14.5 × 2.3–3.6 µm; *microconidia* hyaline, ellipsoidal to fusiform, rarely curved, non-septate, (5.1–)6.4–9.0(–9.1) × (2.4–)2.9–3.9(–4.6) µm (*n* = 50). Long conidiophores producing macroconidia, monochasial branching, unbranched or loosely branched, generally 1–2-branched, 40–69 µm long, 3.1–4.6 µm wide; *conidiogenous cells* long-cylindrical, straight to slightly curved, enteroblastic, monophialidic, 8.8–23.4 × 1.8–4.1 µm; *macroconidia* hyaline, subglobose to ellipsoidal, curved, non-septate, thickened wall cells, (16.6–)18.4–22.6(–24.6) × (6.9–)9.2–12.0(–14.1) µm (*n* = 50). *Chlamydospores* or *swollen hyphae* present. *Chlamydospores* intercalary in hyphae or rarely terminal, globose to subglobose, sometimes ellipsoidal, smooth, hyaline, 12–17 µm. *Swollen hyphae* abundantly formed, intercalary in normal hyphae, smooth, hyaline, 2–9 cells, 26–128 µm long, 5–11 µm wide. *Immature pycnidia* (G.J.S. 86-117) formed on SNA. *Ascomata* absent.

Habitat: On dead and living woody vine or roots (*Cedrela brasiliensis*, *Celtis tala*, *Gleditsia triacanthos*).

Distribution: South America (Argentina, Brazil, French Guiana).

Holotype of Nectria sordida: **Argentina**, La Plata, Los Talas, on *Celtis tala*, Mar. 1890, C. Spegazzini, **Holotype** LPS 1619.

Additional type specimens examined: Type of *Nectria catalinensis*: **Argentina**, Buenos Aires, Llavallol, Sta. Catalina, on dead bark of *Gleditsia triacanthos*, Apr. 1983, C.E. Lima, **Lectotype** illustration at BPI designated here, Lima *et al*. (1988) Nova Hedwigia 46: 149-156, figs 1–12.

Additional specimens and isolates examined: **Brazil**, Bono Principio, Muninipio, Montenegro, on *Cedrela brasiliensis*, 1928, Rick, BPI 631890 as *Hypocreopsis moriformis*. **French Guiana**, on living woody vine, G.J. Samuels 3257, NY, culture CBS 125119 = G.J.S. 86-117 as *Nectria balansae*.

Notes: *Nectria sordida* was described by Spegazzini (1899) as having ascospores 30–35 × 12–14 µm. Superficially similar he also described *N. balansae* (Spegazzini 1885) with ascospores 22–30 × 8–10 µm. Samuels & Brayford (1994) observed both holotype specimens preserved in LPS and suggested that *N. sordida* was a synonym of *N. balansae*. However, in this study the two holotype specimens were determined to be statistically different in ascospore size. Ascospores of *N. sordida* are (25.0–)26.6–32.0(–35.3) × (10.5–)11.5–13.5(–15.6) µm while those of *N. balansae* are slightly smaller, (19.0–)23.7–29.9(–32.6) × (6.2–)8.3–11.1(–13.0) µm. Further we noticed that *N. sordida* occasionally produces two septate ascospores (Figs 73G, 74C). Thus, these two species are considered distinct.

Nectria catalinensis was collected in Argentina (Lima *et al*. 1988), where the type of *N. sordida* was also collected. Lima *et al*. (1988) compared morphological differences between *N. sordida* and *N. catalinensis* and determined that these two species were distinct based on subtle size differences in the ascospores. In our morphological examination, the ascospores of these species are identical, although we only observed an authentic specimen of *N. catalinensis* from BAFC because the type specimen of *N. catalinensis* is missing (see below). According to Lima *et al*. (1988) the pycnidial anamorph of *N. catalinensis* was observed in culture with micro- and macroconidia around the pycnidia. The French Guiana specimen (NY, culture G.J.S. 86-117) identified as *N. sordida* also produced a pycnidial anamorph in culture; thus we determined that *N. catalinensis* should be synonymised under *N.*

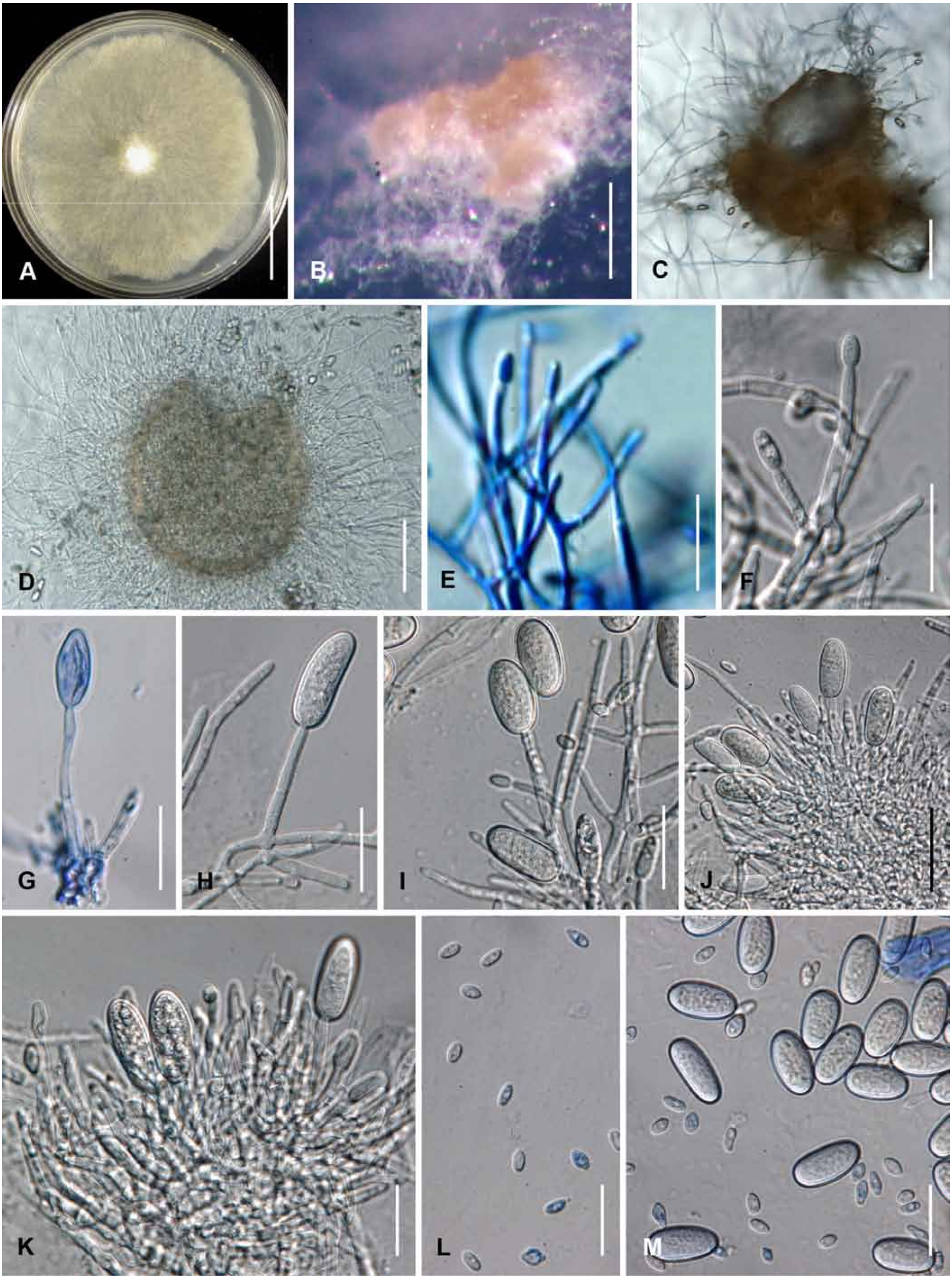

Fig. 75A–M. Anamorph of *Nectria sordida* in culture. A. Cultures after 7 d at 25 °C on PDA; B-D. Immature pycnidia on SNA; E, F. Short conidiophores producing microconidia on SNA; G–K. Long conidiophores producing macroconidia on SNA; L. Microconidia on SNA; M. Micro- and macroconidia on SNA. Scale bars: A = 3 mm; B–D = 100 µm; E–M = 20 µm.

sordid. Because the holotype specimen of *N. catalinensis* (BAFC 30698) has been lost, we typified this name using the illustration of the original paper as a lectotype (Lima *et al*. (1988) Nova Hedwigia 46 149–156, figs 1–12).

On the French Guiana specimen preserved in NY, we found sporodochia around the ascomata (Figs 73K, 74D), although the isolate of this specimen produced immature pycnidia on SNA (Fig. 75B–D). Apparently *N. sordida* produces both pycnidial and sporodochial anamorphs. This phenomenon was also noted in *N. catalinensis* according to Lima *et al*. (1988) who observed mature pycnidia in culture with micro- and macroconidia around the pycnidia. We made a number of sections to confirm pycnidial production in the French Guianan specimen, but no pycnidia were observed. The phenotypicially similar *Nectria magnispora* produces pycnidia in nature and culture.

Nectria tucumanensis Speg., Anales Mus. Nac. Hist. Nat. Buenos Aires 12: 407. 1885. Figs 76, 77.

≡ *Creonectria tucumanensis* (Speg.) Chardón & Toro, J. Dept. Agric. Proto Rico 14: 242. 1930.

Anamorph: unknown.

Teleomorph on natural substrata: *Stromata* erumpent through epidermis, up to 1.0 mm high and 2.5 mm diam, red to sienna, KOH+ blood red, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stroma or immersed at base, aggregated in groups of 3–17, sienna to red, subglobose to globose, 400–590 µm high × 350–585 µm diam, not collapsing when dry, apical region slightly darker, KOH+ dark purple, LA+ yellow, wall warted. *Ascomatal surface cells* forming *textura globulosa* to *t. angularis*, 9–22 µm diam, with pigmented, uniformly *ca.* 3 µm thickened walls; ascomatal warts apricot to red, 11–43 µm high, largest in middle to upper part of ascomata. *Ascomatal wall* 56–89 µm thick, of two regions: outer region 42–75 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 3 µm thick; inner region 13–20 µm thick, of elongated, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* clavate, 93–122 × 26–35 µm, with inconspicuous ring at apex, 8-spored, ascospores mainly biseriate. *Ascospores* cylindrical to allantoid, curved, (28.8–)31.8–38.0(–41.6) × (9.5–)10.8–13.2(–14.6) µm (n = 50), 1(–3)-septate, hyaline to slightly yellowish-brown, striate.

Habitat: On twigs of *Albizia carbonaria* (as *A. malacocarpa*) fide Chardon & Toro (1930) and *Annona cherimola*.

Distribution: Central America (Costa Rica fide Rowlee, 1924), South America (Argentina, Colombia fide Chardon & Toro, 1930).

Holotype of Nectria tucumanensis. **Argentina**, Tucumá, on dead twigs of *Annona cherimola*, 14 Apr. 1906, **Holotype** LPS 1564.

Notes: At first glance, *Nectria tucumanensis* is similar to *N. antarctica* in having large perithecia and ascospores. However, the 1–3-septate ascospores of *N. tucumanensis* are clearly different from the muriform ascospores of *N. antarctica* (Figs 76H–M, 77C). Only the holotype specimen at LPS exists.

PLEONECTRIA Sacc., Mycotheca Ven. no. 688. 1876. Type species: *Pleonectria lamyi* (Desm.) Sacc. (≡ *Sphaeria lamyi* Desm.)

= *Chilonectria* Sacc., Michelia 1: 279. 1878. Lectotype designated by Clements & Shear (1931): *C. cucurbitula* (Tode : Fr.) Sacc. (≡ *Sphaeria cucurbitula* Tode : Fr.), here recognised as *Pleonectria cucurbitula* (Tode : Fr.) Fr.

= *Nectria* subgenus *Aponectria* Sacc., Michelia 1: 296. 1878. Type: *A. inaurata* (Berk. & Broome) Sacc. (≡ *Nectria inaurata* Berk. & Broome), here recognised as *Pleonectria aquifolii* (Fr.) Berk.

≡ *Aponectria* (Sacc.) Sacc., Syll. Fung. 2: 516. 1883.

= *Scoleconectria* Seaver, Mycologia 1: 197. 1909. Type: *S. scoleconectria* (Brefeld & Tavel) Seaver (≡ *Ophionectria scolecospora* Brefeld & Tavel 1891), here recognised as *Pleonectria cucurbitula* (Tode : Fr.) Fr.

Anamorph: *Zythiostroma* Höhn., Mykol. Untersuch. Ber. 1: 335. 1923. Type: *Z. mougeotii* (Fr.) Höhn. (≡ *Sphaeria mougeotii* Fr.), here considered the anamorph of *Pleonectria sinopica* (Fr. : Fr.) Hirooka, Rossman & P. Chaverri.

Teleomorph on natural substrata: *Ascomata and pycnidia* rarely formed on same or discrete stroma. *Mycelium* not visible around ascomata and on host. *Stromata* erumpent through epidermis, up to 2.5 mm high and 7.0 mm diam, bay, KOH+ dark red, LA+ yellow, pseudoparenchymatous, cells forming textura *angularis*, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, aggregated in groups of up to 200, subglobose to globose, cupulate when dry, generally red to umber, apical region nearly black, KOH+ slightly purple, LA+ yellow, surface scurfy or scaly, yellowish green. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis*. *Ascomatal wall* generally 20–70 µm thick, of two regions, but sometimes three regions around the apex. *Asci* widely clavate, increasing in size as ascospores mature, with inconspicuous ring at apex, 8-spored, ascospores mainly biseriate. *Ascospores* ellipsoidal, fusiform, long-cylindrical to filiform, hyaline, (0–)1-septate, multiseptate to muriform, smooth or striate, budding to produce hyaline, thin-walled, bacillar ascoconidia, that fill inside or outside of the asci.

Anamorph on natural substrata: *Stromata* erumpent through epidermis or developing in stroma with ascomata, orange to bay. *Pycnidia* solitary or aggregated in groups, superficial on stroma or immersed, subglobose to irregularly discoidal, orange to red, cerebriformis or cupulate upon drying, KOH+ slightly darker, LA+ slightly yellow. *Pycnidial wall* up to 55 µm thick, of two regions. *Conidiophores* densely branched, generally verticillately 1–3 branched. *Conidiogenous cells* cylindrical to subulate, straight to slightly curved, enteroblastic, monophialidic. *Intercalary phialides* generally observed, bearing 1–3 terminal phialides, up to 6 µm long, similar to short acropleurogenous conidiophores. *Sterile hyphae* sometimes present. *Conidia* hyaline, ellipsoidal to oblong, sometimes slightly curved, non-septate.

Anamorph in culture: *Colony surface* cottony with aerial mycelium, whitish to whitish yellow. Sporulation on SNA from *lateral phialidic pegs* abundant, basically up to 6 µm long, monophialidic. *Conidiophores* unbranched, sometimes verticillate, 1(–3)-branched, becoming loosely, but sometimes densely branched and becoming sporodochial. *Conidiogenous cells* enteroblastic, monophialidic, cylindrical, slightly tapering toward tip. *Young conidia* formed from monophialides on aerial, submerged, or repent hyphae, formed abundantly on slimy heads or sporodochia, ellipsoidal, oblong to long-cylindrical, hyaline, straight or slightly curved, rounded at both end, non-septate, smooth-walled. *Mature conidia* swollen, 0(–1)-septate, subglobose, ellipsoidal, oblong, long-cylindrical to allantoid, sometimes C- or dumbbell-shaped, hyaline, smooth.

Habitat: On dead and living woody plants.

Distribution: Asia, Caribbean, Central America, Europe, North America, South America.

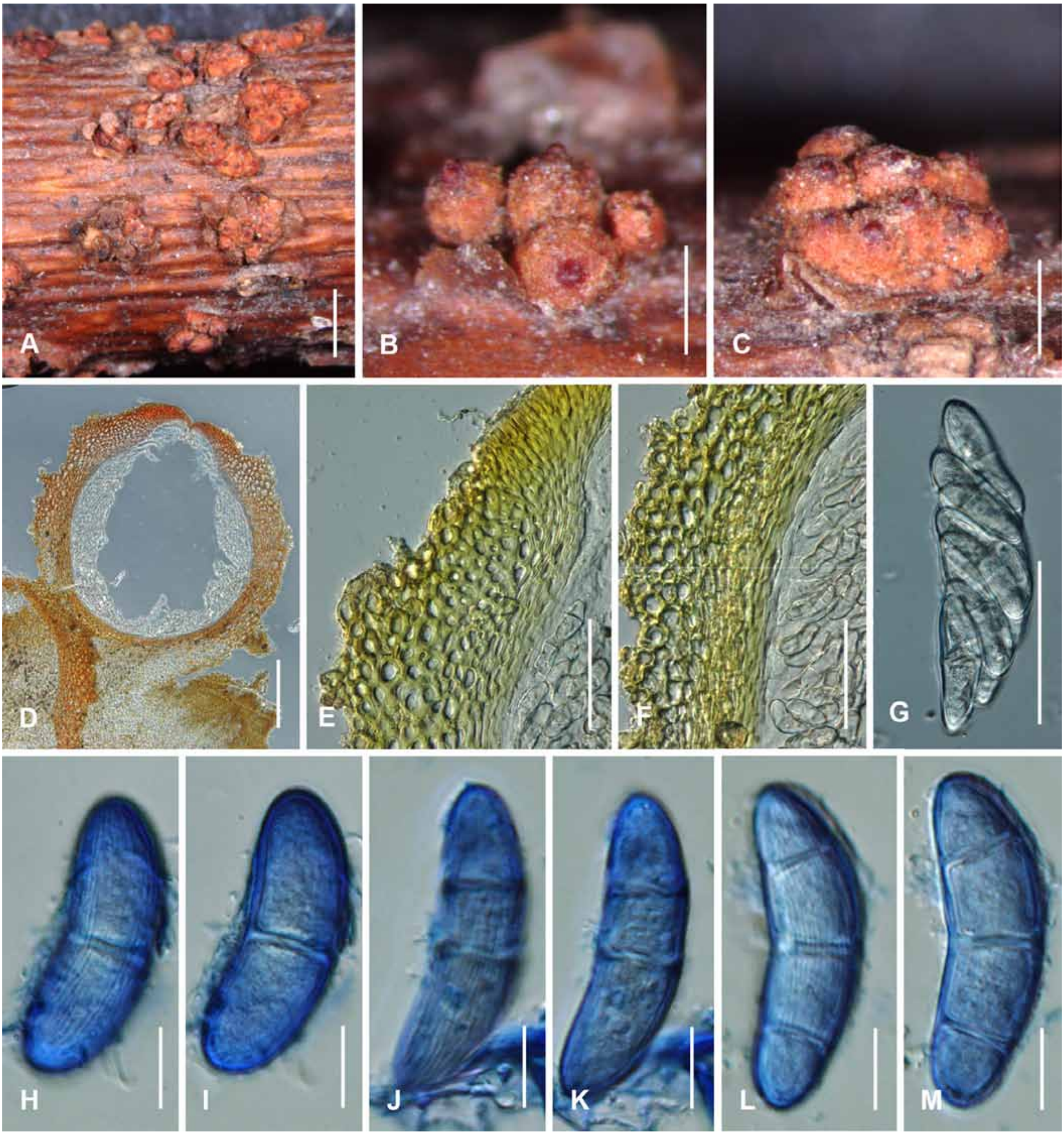

Fig. 76A–M. *Nectria tucumanensis* on natural substrata (teleomorph). A–C. Perithecia on natural substrata; D. Median section of perithecium; E. Median section of perithecial apex; F. Median section of perithecial wall; G. Ascus; H, J, L. Ascospores in surface view; I, K, M. Ascospores in optical section. Scale bars: A = 1 mm; B, C = 500 µm; D = 100 µm; E–G = 50 µm; H–M = 10 µm.

Notes: The genus *Pleonectria* is characterised by having ascomata with bright yellow scurf, ascospores that bud to produce ascoconidia inside or outside of the asci, and/or a pycnidial anamorph. Not all species have these three characteristics. For example, although *P. austroamericana*, *P. ilicicola*, *P. missouriensis*, and *P. sinopica* did not produce ascoconidia, they have bright yellow scurf on the ascomata and a pycnidial anamorph. Our phylogenetic inference shows that most species of *Pleonectria* are limited to one host genus or even one subgenus.

The name *Pleonectria* was retrieved from synonymy with *Nectria* because it is the oldest name for these segregate species. Rossman *et al*. (1999) list both *Gyrostroma* and *Zythiostroma* as the anamorph of pycnidial species of *Nectria*. Only *Zythiostroma* is retained as the name for the superficial pycnidial states of species of *Pleonectria.* The holotype specimen of the type of *Gyrostroma, G. sinuosum*, was examined and determined not to be a hypocrealean fungus.

Pleonectria aquifolii (Fr.) Hirooka, Rossman & P. Chaverri, **comb. nov.** MycoBank MB519704. Figs 78–80.

Basionym: *Sphaeria aquifolii* Fr., Elench. Fung. 2: 82. 1828.

≡ *Nectria aquifolii* (Fr.) Berk., Outl Brit. Fungol., p. 393. 1860.

= *Nectria inaurata* Berk. & Broome, Ann. Mag. Nat. Hist., Ser. 2, 8: 467. 1854.

≡ *Aponectria inaurata* (Berk. & Broome) Sacc., Michelia 1: 296. 1878.

= *Nectria aquifolii* (Fr.) Berk. var. *appendiculata* Feltgen, Vorstud. Pilzfl. Luxemb. 3: 305. 1903.

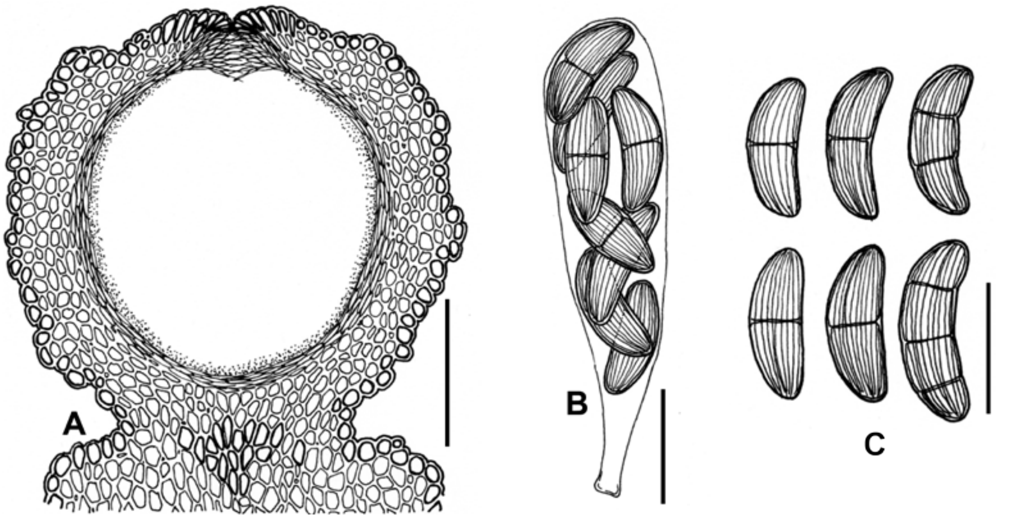

Fig. 77A–C. *Nectria tucumanensis* on natural substrata (A–C teleomorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores. Scale bars: A = 200 µm; B, C = 30 µm.

Anamorph: zythiostroma-like.

Teleomorph on natural substrata: *Mycelium* not visible around ascomata or on host. *Stromata* erumpent through epidermis, up to 3.0 mm high and 1.5 mm diam, bay, KOH+ dark red, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, aggregated in groups of 3–46, subglobose to globose, 207–481 µm high × 197–464 µm diam, slightly cupulate upon drying, sometimes with only a depressed apical region, bay to scarlet, apical region slightly darker, KOH+ dark red, LA+ yellow, often surface scurfy, bright yellow to yellowish green. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis* sometimes including bright yellow scurf, 5–13 µm diam, with pigmented, irregularly *ca.* 1.5–2.0 µm thickened walls. *Ascomatal wall* 37–65.6 µm thick, around apex to about 75 µm thick, of two regions, around apex of three regions: outer region 17–42 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.5 µm thick; middle region produced around apex, 6–15 µm thick, cells forming *textura globulosa*, 4–8 µm diam, walls pigmented, about 1.0 µm thick; inner region 10–33 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* clavate, increasing in size as ascospores mature, 60–115 × 6–12.5 µm, with inconspicuous ring at apex, 8-spored, ascospores biseriate above, uniseriate below. *Ascospores* ellipsoidal to fusiform, sometimes rounded at both ends, straight, hyaline, (0–)1-septate, (8–)8.9–11.1(–12.8) × (3.2–)4–5.4(–6.5) µm (*n* = 217), smooth, budding to produce hyaline, thin-walled, *bacillar ascoconidia*, (2.7–)3.5–5.1(–7.2) × (1.0–)1.5–2.3(3.2) µm (*n* = 281), that fill asci.

Anamorph in culture: After 7 d at 25 °C, colonies 34–37 mm (average 35 mm) diam. *Colony surface* slightly cottony with aerial mycelium, white to whitish yellow; *aerial mycelium* sparse, small white to whitish yellow sporodochial conidial masses produced after 3 wk; *reverse* white to slightly whitish yellow. *Odour* on PDA slightly putrid. Sporulation on SNA from *lateral phialidic pegs* somewhat rare, ellipsoidal and slightly tapering toward tip, monophialidic, rarely polyphialidic, 1.5–3.3 µm long, 1.1–2.2 µm wide at base. *Conidiophores* rarely formed, unbranched, sometimes verticillate, 1–2(–3)-branched, becoming loosely to moderately densely branched, 6.7–24.1 µm long, 1.5–3.0 µm wide at base. *Conidiogenous cells* enteroblastic, monophialidic, rarely polyphialidic, cylindrical, slightly tapering toward tip or narrowly flask-shaped with widest point in middle, 6.0–11.3 µm long, 1.7–3.0 µm wide at base. *Young conidia* formed from monophialides on aerial, submerged, or repent hyphae, formed abundantly on slimy heads or sporodochia, oblong to long cylindrical, hyaline, smooth, straight or slightly curved, rounded at both ends, non-septate, (3.1–)3.7–5.0(–6.6) × (1.1–)1.4–2.1(–2.3) µm (*n* = 56), smooth-walled. *Mature conidia* swollen, 0-septate, ellipsoidal or oblong, hyaline, smooth, straight or slightly curved, rounded at both ends, rarely budding on media, (5.6–)6.7–9.3(–12.9) × (1.7–)2.1–2.9(–3.7) µm (*n* = 60). *Chlamydospores* intercalary, globose to subglobose, very rare, smooth, 6–13 µm. *Ascomata* and *pycnidia* not produced in culture.

Habitat: On dead bark or twigs of *Ilex aquifolium (Aquifoliaceae)*.

Distribution: Europe (France, Germany, UK).

Neotype of Pleonectria aquifolii *designated herein*: **UK**, Surrey, Ranmore Common Latitude, on twig of *Ilex aquifolium*, 16 Sep. 1934, E.W. Mason, **Neotype** BPI 550125, **ex-neotype** culture CBS 307.34.

Additional type specimens examined: Type of *Nectria inaurata*: **UK**, Dover, Shooter's Hill, on dead twigs of holly F. Currey, **Holotype** K 163332 ex herb. Broome ex herb. F. Currey. Type of *Nectria aquifolii* var. *appendiculata*: **Luxembourg**, Kockelscheuer, on twigs of *Ilex aquifolium*, Apr. 1902, **Lectotype** designated herein as illustration on packet **LUX** 042143. *Additional specimens and isolates examined*: **France**, on branch of *Ilex aquifolium*, summer, Mougeot & Nestler, Stirpes cryptogamicae, No. 879, BPI-bound exsiccati as *Sphaeria aquifolii*; summer, M. A. Libert PL. Crypt. Arduenna Fasc. as *Nectria aquifolii*, BPI 550123. **Germany**, Schleswig, Holstein, Sachsenwald, on *Ilex aquifolium*, 10 Apr. 1904, O. Jaap, Jaap, Fungi Selecti 53, BPI–bound exsiccati; Bottrop, Westphalen, on *Ilex aquifolium*, 12 Oct. 1923, H. Rupprecht, BPI 550126; Westfalen, on *Ilex aquifolium*, 21 Oct. 1923, H. Rupprecht, BPI 550128; Kr. Siegen, Hoher Wald Bai Burgholdinghausen, on *Ilex aquifolium*, 13 Apr. 1936, C.A. Ludwig, BPI 552407; Kölnischer wald bei Bottrop, on *Ilex aquifolium*, 21 Oct. 1923, H. Rupprecht, Sydow, Mycotheca Germanica 2138, BPI-bound exsiccati. **UK**, on *Ilex aquifolium*, C.E. Broome, Rabenhorst, Fungi europaei 46, BPI-bound exsiccati; Sphaeriacei Britannici Chas. B. Plowright, 1873, as *Nectria inaurata*, BPI 552405.

Notes: *Pleonectria aquifolii* is presently restricted to one host and has been collected only in Europe. Although we have not observed the asexual state in the natural environment, this species produces typical anamorphic characteristics of *Pleonectria* in culture as do species closely related to *P. aquifolii*. Morphologically, *Pleonectria aquifolii* is almost identical with *P. sinopica* in shape of ascomata and ascospores. However, *P. aquifolii* produces budding ascospores and occurs on *Ilex aquifolium* while *P. sinopica* does not produce

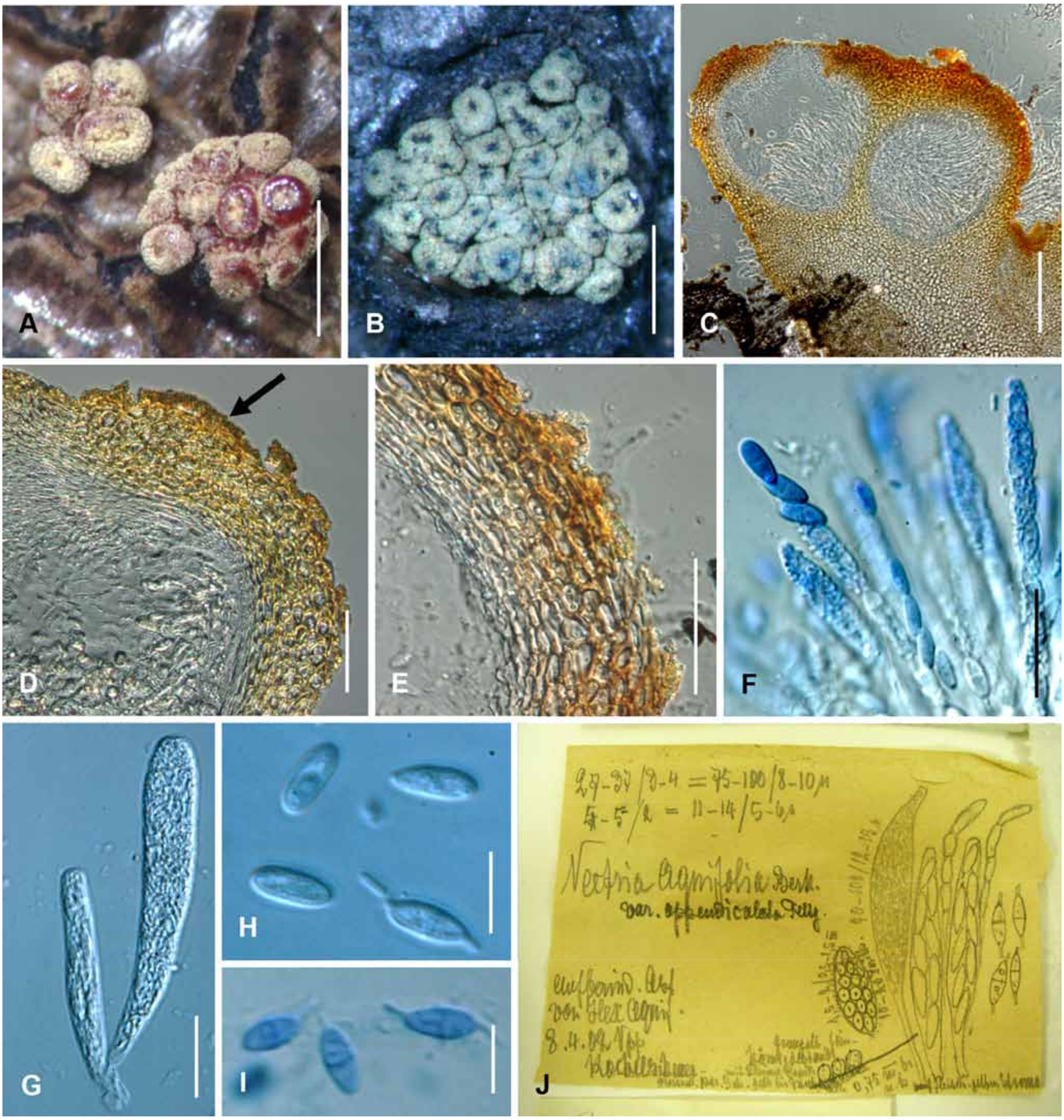

Fig. 78A–J. *Pleonectria aquifolii* on natural substrata (A–I teleomorph, J. Packet of *Nectria aquifolii* var. *appendiculata* Lectotype: LUX 042143). A, B. Perithecia on natural substrata; C. Median section of perithecia on natural substrata; D. Median section of perithecial apex (black arrow); E. Median section of perithecial wall; F, G. Asci; H, I. Ascospores; J. Packet of *Nectria aquifolii* var. *appendiculata* Lectotype: LUX 042143. Scale bars: A, B = 1 mm; C = 100 µm; D, E = 50 µm; F, G = 20 µm; H, I = 10 µm.

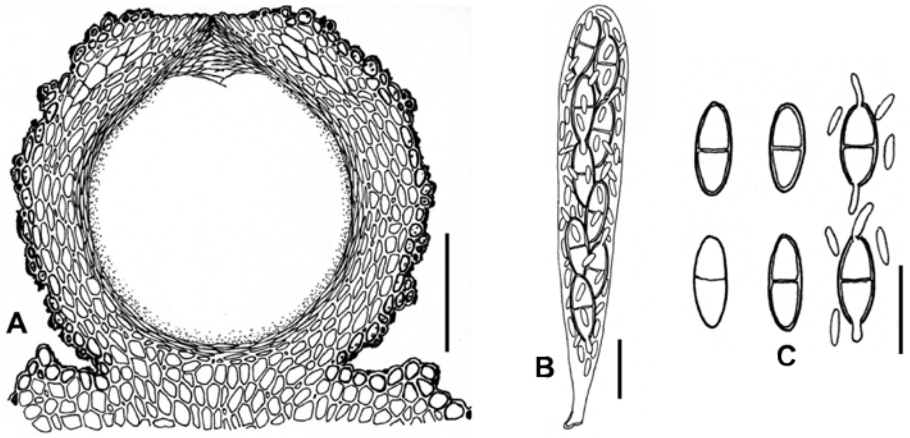

Fig. 79A–C. *Pleonectria aquifolii* on natural substrata (A–C teleomorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores and ascocoidia. Scale bars: A = 100 µm; B, C = 10 µm.

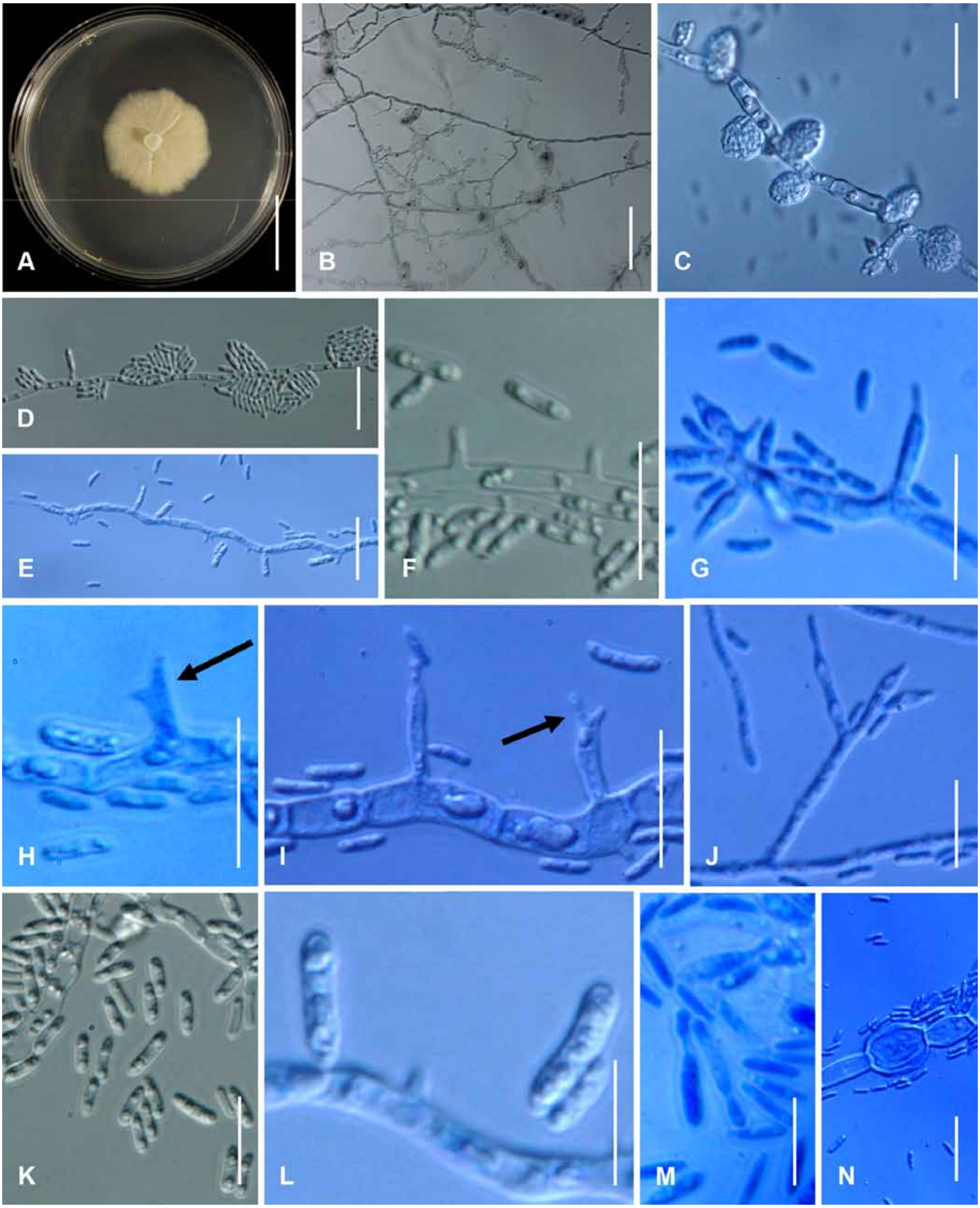

Fig. 80A–N. Anamorph of *Pleonectria aquifolii* in culture. A. Cultures after 7 d at 25 °C on PDA; B, C. Conidial mass on SNA; D–G. Lateral phialidic pegs and young conidia on SNA; H, I. Polyphialidic lateral phialidic pegs (black arrows) and young conidia on SNA; J. Conidiophores on SNA; K. Young conidia on SNA; L. Mature conidia on SNA; M. Budding mature conidia on SNA; N. Chlamydospore on SNA. Scale bars: A = 3 mm; B = 100 µm; C–E = 20 µm; F–N = 10 µm.

budding ascospores and occurs on *Hedera helix* (Figs 78H, I, 79C). On SNA, *P. aquifolii* does not produce flask-shaped lateral phialidic pegs, but *P. sinopica* does (Fig. 80F).

The ascomatal apex of *P. aquifolii* forms three regions as seen here and documented by Booth (1959) (Fig. 78D). This characteristic may be hard to find because the middle region may be narrow in some specimens especially in immature ascomata. Within *Pleonectria* a similar wall structure in the ascomatal apex also is found in *P. boothii, P. coryli*, and *P. ilicicola.* These four species clustered together in one monophyletic group supported by high BI PP, ML BP and MP BP suggesting that the structure of the ascomatal wall is an informative characteristic in *Pleonectria* (Fig. 2).

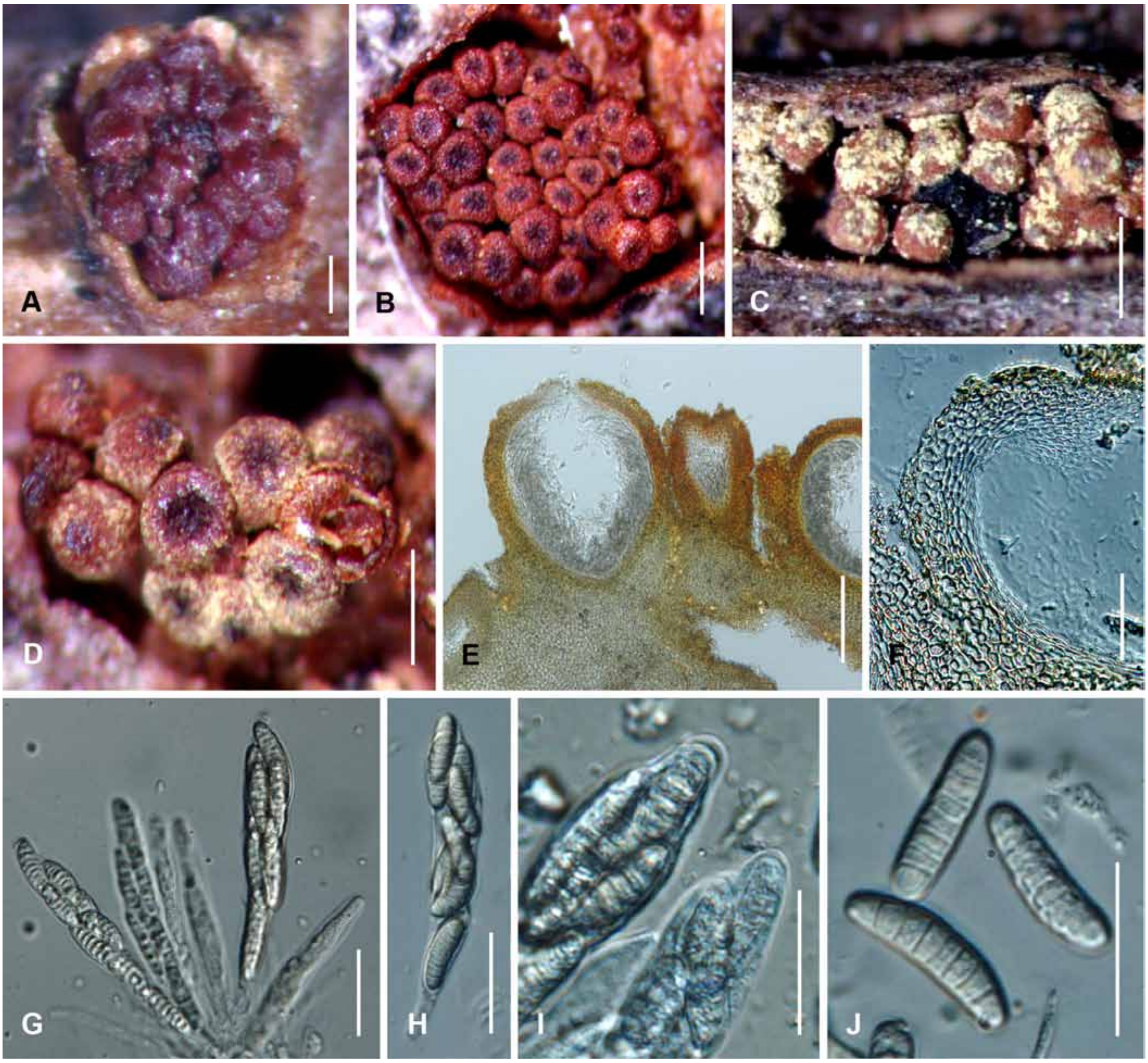

Fig. 81A–J. *Pleonectria aurigera* on natural substrata (teleomorph). A–D. Perithecia on natural substrata; E. Median section of perithecia on natural substrata; F. Median section of perithecial wall; G, H. Asci; I. Apex of ascus; J. Ascospores. Scale bars: A–D =500 µm; E, F = 100 µm; G = 20 µm; H–J = 10 µm.

Pleonectria aquifolii was first described by Fries (1828) as *Sphaeria aquifolii*. Although we communicated with B and UPS, both of which preserve Fries specimens, we could not find the type specimen of this name. Thus, we neotypify *N. aquifolii* with BPI 550125. The holotype specimen of *N. aquifolii* var. *appendiculata* (LUX 042143) was not useful because no ascomata remain. We recognise this name as a synonym of *P. aquifolii* because the holotype specimen includes an image on its packet as illustrated in Fig. 78J. Thus, *Nectria aquifolii* var. *appendiculata* is lectotypified with the Feltgen's illustration on the holotype packet.

Pleonectria aurigera (Berk. & Rav.) Hirooka, Rossman & P.Chaverri, **comb. nov.** MycoBank MB519705. Figs 81–83.
Basionym: *Nectria aurigera* Berk. & Rav., Grevillea 4: 46. 1875.
≡ *Calonectria aurigera* (Berk. & Rav.) Sacc., Michelia 1: 308. 1878.
Anamorph: zythiostroma-like.

Teleomorph on natural substrata: *Mycelium* not visible around ascomata or on host. *Stromata* erumpent through epidermis, up to 1.5 mm high and 2.0 mm diam, sienna to umber, KOH+ dark purple, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, scattered to aggregated in groups of 4–22, subglobose to globose, 205–305 µm high × 215–280 µm diam, cupulate upon drying, sometimes with only depressed apical region, bay to scarlet, apical region slightly darker, KOH+ dark purple, LA+ yellow, smooth to roughened, sometimes surface scurfy, bright yellow to yellowish green. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis* sometimes including bright yellow scurf, 3–7 µm diam, with pigmented, irregularly *ca.* 1.5 µm thickened walls. *Ascomatal wall* 35–50 µm thick, of two regions: outer region 20–35 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.5 µm thick; inner region 10–20 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* clavate, 55–90 × 10–20 µm, with inconspicuous ring at apex, 8-spored, biseriate above, uniseriate below. *Ascospores* ellipsoidal, oblong to allantoid, curved, with broadly rounded ends, (14.9–)17.0–20.8(–24.7) × (4.4–)5.0–6.4(–7.3) µm (*n* = 150), (3–6)7-septate, hyaline to slightly yellowish-brown, smooth.

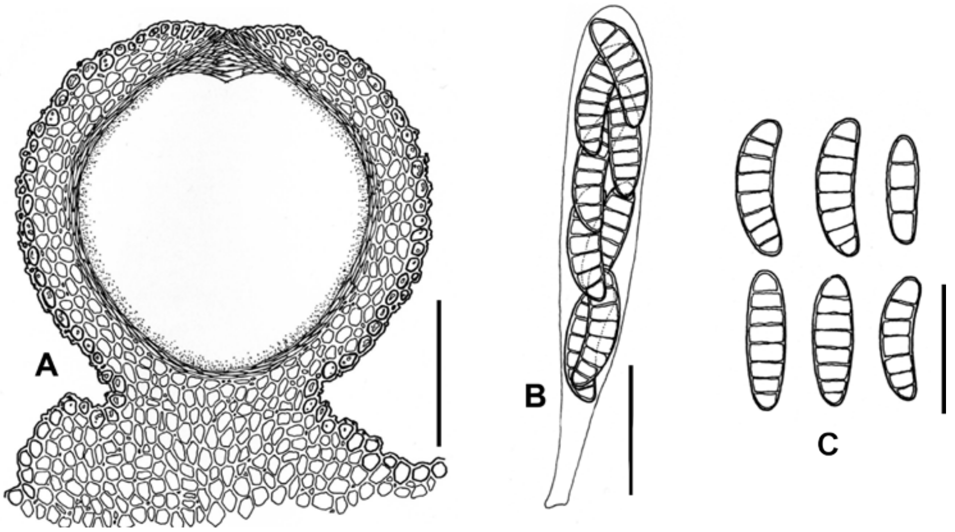

Fig. 82A–C. *Pleonectria aurigera* on natural substrata (A–C teleomorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores. Scale bars: A = 100 µm; B, C = 20 µm.

Anamorph in culture: After 7 d at 25 °C, colonies 22–25 mm (average 24 mm) diam. *Colony surface* slightly cottony with aerial mycelium, white to whitish yellow; *aerial mycelium* sometimes forming small white to whitish yellow sporodochial conidial masses after 3 wk; *reverse* white to whitish yellow. *Odour* on PDA slightly putrid. Sporulation on SNA from *lateral phialidic pegs* abundant, narrowly or widely flask-shaped, rarely strongly curved, 1.5–6.5 µm long, 1.1–2.5 µm wide at base. *Sporodochial lateral phialidic pegs* abundant, subglobose or ovate, 2.5–4.5 µm long, 2.1–3.5 µm wide at base. *Aerial conidiophores* and *sporodochial conidiophores* not produced in culture. *Young conidia* formed from monophialides on aerial, submerged, or repent hyphae, formed abundantly on slimy heads or sporodochia, oblong to long-cylindrical, hyaline, smooth, straight or slightly curved, rounded at both ends, non-septate, (2.7–)3.2–4.2(–4.7) × (1.1–)1.3–1.7(–2.1) µm (*n* = 50), smooth-walled. *Mature conidia* swollen, 0-septate, long-cylindrical, hyaline, smooth, slightly curved, rounded at both ends, (7.2–)8.7–11.3(–12.7) × (1.3–)1.6–2.2(–2.9) µm (*n* = 50). *Chlamydospores*, *pycnidia* and *ascomata* not produced in culture.

Habitat: On bark dead deciduous trees, especially *Oleaceae* (*Chionanthus virginicus*, *Fraxinus americana, F. excelsior*, *F. nigra*., *Fraxinus* sp., *Jasminum mesnyi*, *J. primulinum*, *Ligustrum japonicum*, *L. lucidum*, *Ligustrum* sp.) and *Liquidambar* sp.?.

Distribution: Europe (France), North America (USA).

Lectotype of Pleonectria aurigera *designated herein*: **USA**, South Carolina, on bark of *Fraxinus* sp., Ravenel 1830, **Lectotype** BPI 550167, **Isolectotypes** BPI 550168, BPI 550169, FH, slide at IMI based on Rossman (1983).

Additional specimens and isolates examined: **France**, on dead twigs of *Fraxinus excelsior*, Jun 2001, C. Lechat, BPI 841465, culture CBS 109874 = A.R. 3717, **USA**, Alabama, Tuskegee, on *Fraxinus americana*, 17 Aug. 1935, G.W. Carver, BPI 550170; Alabama, Tuskegee, on *Fraxinus nigra*, 28 Nov. 1935, G.W. Carver, BPI 550164; Alabama, Tuskegee, on *Jasminum mesnyi*, 1 Jan. 1936, G.W. Carver, BPI 550165A, BPI 550165B; Alabama, Tuskegee, on *Jasminum primulinum*, 15 Feb. 1936, G.W. Carver, BPI 550163; Alabama, Tuskegee, on *Ligustrum japonicum*, 4 Jan. 1936, G.W. Carver, BPI 550160; Alabama, Tuskegee, on *Ligustrum lucidum*, 12 Jan. 1936, G.W. Carver, BPI 550161; Alabama, Tuskegee, on *Ligustrum* sp., 17 Aug. 1935, G.W. Carver, BPI 550162; Alabama, on *Liquidambar* sp., Peters, K 163340 ex herb. Berkeley 6082 as *Thyronectria pseudotrichia*; Delaware, Wilmington, on *Chionanthus virginicus*, Feb. 5? 1890, NY; New Jersey, Newfield, on *Chionanthus virginicus*, Ellis, North American Fungi, 79, BPI 632090; New Jersey, Vineland, on *Chionanthus virginicus*, 12 Nov. 1876, J.B. Ellis, BPI 550158; on *Chionanthus virginicus*, Nov. 1876, J.B. Ellis, BPI 550159; South Carolina, Charleston, on *Fraxinus* sp., 29 Oct. 1923, C.L. Shear, BPI 550166B; South Carolina, on *Fraxinus* sp., H.W. Ravenel, K 163341 ex herb. Berkeley 1549 as *Thyronectria pseudotrichia*.

Notes: Within *Pleonectria*, *P. aurigera* can be easily identified by its multiseptate ascospores (Figs 81J, 82C). In culture, this species is distinguished from the other anamorphs of *Pleonectria* in lacking conidiophores typical of *Pleonectria*. *Pleonectria aurigera* was described and illustrated by Rossman (1983 as *Nectria aurigera*) who reported that, on the label of his North American Fungi 79, J.B. Ellis noted that *Sphaeropsis diatrypea* Cooke & Ellis (*Botryosphaeriaceae, Botryosphaeriales, Dothideomycetes*) could be the "stylosporous state", *i.e.* the anamorph of *P. aurigera*. Although we could not find the anamorph of the fungus in the natural environment, we suspect that the anamorph of this fungus is zythiostroma-like for two reasons. First, in culture *P. aurigera* produces abundant lateral phialidic pegs, which are typical anamorphic characteristics of *Pleonectria* (Fig. 83B–K). Second, based on our phylogeny, *P. aurigera* is basal in the *Pleonectria* clade (Figs 1, 2).

Rossman (1983) listed Ravenel 1830 as an isotype preserved in FH and mentioned that the holotype is presumably in K; however, we could not find the holotype there. Therefore, BPI 550167, another specimen of Ravenel 1830, is herein designated the lectotype.

Pleonectria austroamericana Speg., Anales Mus. Nac. Hist. Nat. Buenos Aires 10: 22. 1880. Figs 84–86.

≡ *Nectria austroamericana* (Speg.) Rossman, Mem. New York Bot. Gard. 29: 257. 1989.
≡ *Thyronectria austroamericana* (Speg.) Seeler, J. Arnold Arbor. 21: 405. 1940.
= *Pleonectria denigrata* G. Winter, Bull. Torrey Bot. Club 10: 49. 1883.
≡ *Thyronectria denigrata* (G. Winter) Seaver, Mycologia 1: 204. 1909.
= *Pleonectria guaranitica* Speg., Anales Mus. Nac. Hist. Nat. Buenos Aires 19: 44. 1885.
= *Pleonectria nigropapillata* Starbäck, Ark. Bot. 2: 13. 1904.

Anamorph: zythiostroma-like.
≡ *Gyrostroma austroamericanum* Seeler, J. Arnold Arbor. 21: 447. 1940.

Teleomorph on natural substrata: *Ascomata and pycnidia* generally formed on same or discrete stroma. *Mycelium* not visible around ascomata or on host. *Stromata* erumpent through epidermis, up to

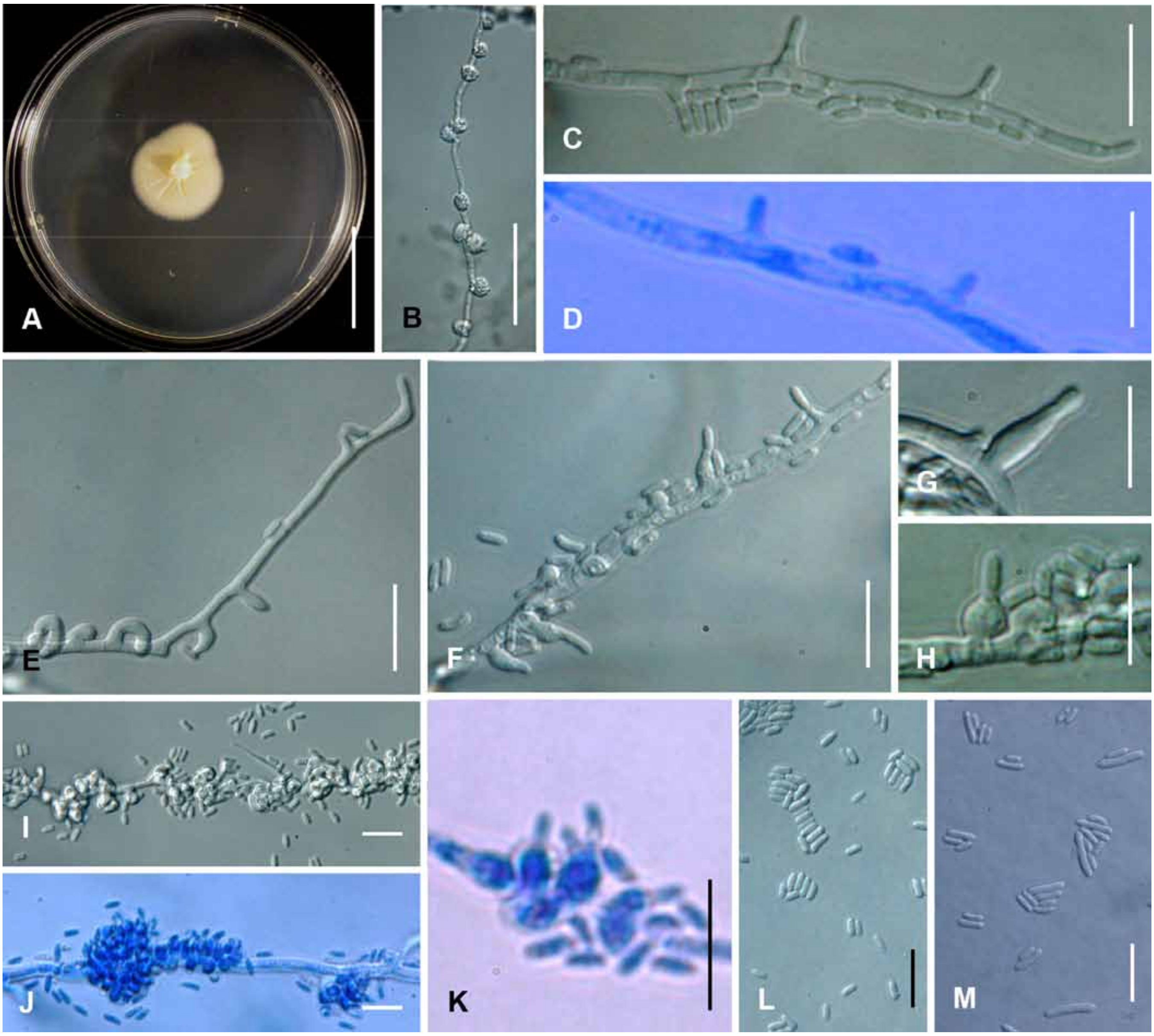

Fig. 83A–M. Anamorph of *Pleonectria aurigera* in culture. A. Cultures after 7 d at 25 °C on PDA; B. Conidial mass on SNA; C–H. Lateral phialidic pegs and young conidia on SNA; I–K. Sporodochial lateral phialidic pegs and young conidia on SNA; L. Young conidia on SNA; M. Young and mature conidia on SNA. Scale bars: A = 3 mm; B = 100 µm; C–F, I–M = 10 µm; G, H = 5 µm.

2.5 mm high and 7.0 mm diam, bright yellow to umber, KOH+ slightly darker or sometimes negative, LA+ slightly yellow or sometimes negative, pseudoparenchymatous, cells forming *textura prismatica* to *t. globulosa*, intergrading with ascomatal wall. *Ascomata* superficial or immersed on well-developed stromata, aggregated in groups of 5–200, subglobose to globose, 240–400 µm high × 220–370 µm diam, yellowish brown or reddish grey with dark often black, shining apical region, not collapsing or rarely cupulate when dry, KOH+ slightly darker, LA+ slightly yellow, smooth to slightly roughened. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis* sometimes including bright yellow scurf, 3–9 µm diam, with pigmented, irregularly *ca.* 1.0 µm thickened walls. *Ascomatal wall* 40–65 µm thick, around apex to about 100 µm thick, fully covered by bright yellow to umber scurf, of two regions: outer region 25–40 µm thick, not intergrading with stroma, cells forming t*extura globulosa* or *t. angularis*, walls pigmented, about 1.5 µm thick; inner region 10–20 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* narrowly clavate, 60–100 × 7–17 µm, with inconspicuous ring at apex, 8-spored, ascospores, uniseriate or rarely biseriate above. *Ascospores* subglobose to ellipsoidal, muriform, with 1–2(–3) transverse septa and usually 1 longitudinal septum or 2 angular septae, (9.7–)10.0–12.6(–14.8) × (4.8–)6.0–7.6(–10.2) µm (*n* = 400), hyaline to pale greenish yellow, smooth.

Anamorph on natural substrata: *Stromata* erumpent through epidermis or developing in stroma with ascomata, orange to umber. *Pycnidia* dimorphic, superficial and immersed in stroma *Superficial pycnidia* multilocular, eustromatic, aggregated in groups of 3–9, 200–450 mm µm, 200–520 mm diam, yellowish brown or reddish grey, KOH+ slightly darker, LA+ slightly yellow. *Superficial pycnidial wall* 15–25 µm thick, of two regions: outer region 10–20 µm thick, intergrading with stroma, cells forming *textura globulosa*, walls pigmented, about 1.5 µm thick; inner region 5–10 µm thick, of elongate, thin-walled, hyaline cells, forming t*extura prismatica*. *Immersed pycnidia* multilocular, eustromatic, embedded in a chink between ascomata or pycnidia at bases, solitary or aggregated in groups of 3-5, irregular multiple chambers with shared walls, 75–173 µm high × 63–177 µm diam, KOH+ darker, LA+ yellow. *Immersed pycnidial wall* 6–16 µm thick,

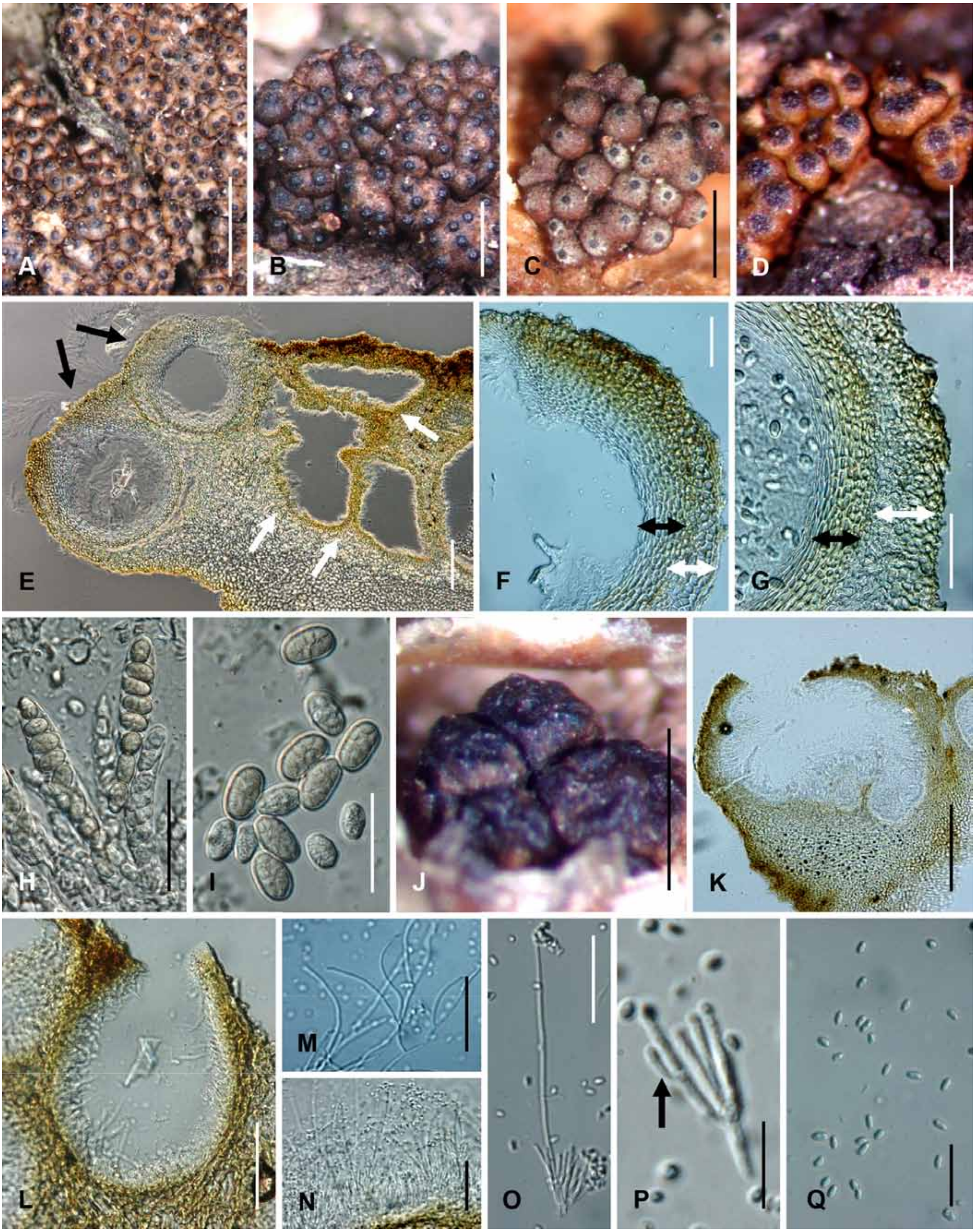

Fig. 84A–Q. *Pleonectria austroamericana* on natural substrata (A–E teleomorph and anamorph, F–I teleomorph, J–Q anamorph). A–D. Perithecia and immersed pycnidia on natural substrata; E. Median section of perithecia (black arrows) and pycnidia (white arrows) on natural substrata; F, G. Median section of perithecial wall (black regions) and abundant yellow scurf (white regions); H. Asci; I. Ascospores; J. Superficial pycnidia on natural substrata; K, L. Median section of superficial pycnidia; M–O, Sterile hyphae and conidiophores on natural substrata; P. Conidiophores and intercalary phialides (black arrow) on natural substrata; Q. Conidia on natural substrata. Scale bars: A–D, J =1 mm; E, K, L = 100 µm; F–H, M–O = 50 µm; I, P, Q = 20 µm.

of 1–2 region, cells forming *textura prismatica*, about 1.0 µm thick, elongate, thin-walled, hyaline cells. *Conidiophores* loosely to densely branched, generally 1–4 branched, 18–35 µm long, 1.5–2.5 µm wide. *Conidiogenous cells* cylindrical to subulate, straight to slightly curved, enteroblastic, monophialidic, 10–30 × 1.3–2.0 µm. *Intercalary phialides* sometimes observed, bearing

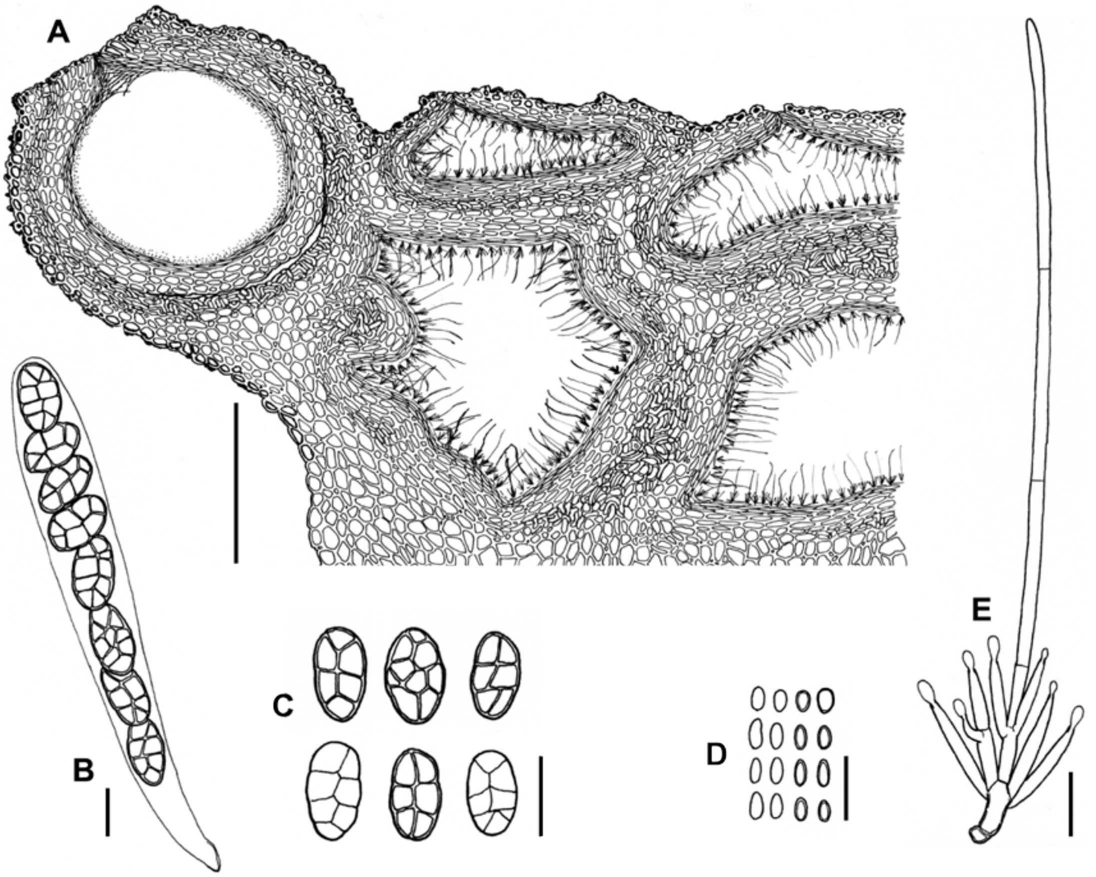

Fig. 85A–E. *Pleonectria austroamericana* on natural substrata (A teleomorph and anamorph, B, C teleomorph, D, E anamorph). A. Median section of mature perithecium and pycnidia; B. Ascus; C. Ascospores; D. Conidia; E. Sterile hypha and conidiophores. Scale bars: A = 200 µm; B–E = 10 µm.

one terminal phialides, up to 4 µm long. *Sterile hyphae* mixed with phialides, acicular, straight or usually curved, unbranched, sometimes 1–3 branched, septate, 55–140 µm long, 1.0–2.0 µm wide. *Conidia* hyaline, ellipsoidal, obovate or oblong-ellipsoidal, sometimes slightly curved, non-septate, (1.7–)2.3–3.1(–3.6) × (1.0–)1.3–1.9(–2.5) µm (*n* = 350).

Anamorph in culture: After 7 d at 25 °C, colonies 30–50 mm (average 36 mm) diam. *Colony surface* sometimes wavy, cottony with aerial mycelium, whitish yellow to yellow; *aerial mycelium* developed, restricted to centre, rarely small yellow sporodochial conidial masses produced after 3 wk; *reverse* whitish yellow to yellow in centre and white at margin. *Odour* on PDA slightly fruity. Sporulation on SNA from *lateral phialidic pegs* not abundant, ellipsoidal, slightly tapering toward tip or rarely narrowly flask-shaped, 2.0–4.0 µm long, 1.4–2.0 µm wide at base. *Conidiophores* abundantly formed, unbranched, sometimes verticillate, 1(–2)-branched, becoming loosely to moderately densely branched, 9.1–21.9 µm long, 1.3–2.7 µm wide at base. *Conidiogenous cells* enteroblastic, monophialidic, cylindrical, slightly tapering toward tip or narrowly flask-shaped, 3.5–7.7 µm long, 1.4–2.7 µm wide at base. *Young conidia* formed from monophialides on aerial, submerged, or repent hyphae, formed abundantly on slimy heads, ellipsoidal, oblong to cylindrical, hyaline, smooth, straight or slightly curved, rounded at both ends, non-septate, (2.3–)2.9–3.5(–4.6) × (1.1–) 1.3–1.7(–1.9) µm (*n* = 50). *Mature conidia* swollen, 0–1-septate, oblong or ellipsoidal, hyaline, straight or slightly curved, rounded at both ends, not germinating and budding on media, (4.0–)4.4–6.0(–7.0) × (2.1–)2.4–3.2(–3.5) µm (*n* = 50). *Pycnidia* produced in PDA after 1–2 month (CBS 126114). *Chlamydospores* and *ascomata* not produced in culture.

Habitat: On newly killed and weakened *Fabaceae* (*Acacia* sp., *Albizia julibrissin*, *Cerasus* sp., *Gleditsia japonica*, *Gleditsia* sp., *Gleditsia triacanthos*, *Gleditsia triacanthos* var. *inermis*, *Mimosa* sp., *Robinia* sp., *Robinia pseudoacacia*).

Distribution: North America (USA), South America (Argentina, Brazil, Paraguay).

Holotype of Pleonectria austroamericana: **Argentina**, Palermo, Buenos Airos, on peeling old bark of *Acacia* sp., Mar. 1880, C. Spegazzini, **Holotype** LPS 960.

Additional type specimens examined: Type of *Pleonectria denigrata*: **USA**, Kentucky, Lexington, on dead twigs of *Gleditsia triacanthos*, Jun. 1882, W.A. Kellermann, **Lectotype** designated herein, Rabenhorst, Fungi europaei, No. 2948, BPI 550196; **Isolectotype** Rabenhorst, Fungi europaei, No. 2948, BPI-bound exsiccati, F 84471 (S), BPI 550179, Ellis, North American fungi, No. 1334, BPI-bound exsiccati. Type of *Pleonectria guaranitica*: **Brazil**, Guarapi (possibly Guarapari), on bark of decaying logs, 2 Aug. 1881, *Balansa*, **Holotype** LPS 1624. Type of *Pleonectria nigropapillata*: **Paraguay**, San Antonio prope Asuncion, on bark, 20 Jul. 1893, C. Lindman, **Lectotype** designated herein, F 6220 (S), **Isolectotypes** F 6221 (S); F 61157 (S).
Additional specimens and isolates examined: **Argentina**, Palermo, Buenos Airos, on bark chip, NY 01013428. **USA**, Delaware, Wilmington, on *Gleditsia triacanthos*, Oct. 1889, A. Commons, BPI 550180; Iowa, Woodbine, on *Gleditsia triacanthos*, 23 Nov. 1909, C.J. Humphrey, C.W. Edgerton, BPI 550200; Iowa, Woodbine, on *Gleditsia triacanthos*, 23 Nov. 1909, C.J. Hurnphrey, BPI 632517; Kansas, Strong City, on *Gleditsia triacanthos*, 7 Nov. 1910, G.G. Hedgcock, BPI 550188; Kentucky, Lexington, on *Gleditsia* sp., 20 Jun. 1882, BPI 550178; Louisiana, Pointe A La Hache, on *Gleditsia* sp., 11 Nov. 1886, A.B. Langlois, BPI 550192; Louisiana, Monroe, 22 Feb. 1914, C.L. Shear, BPI 550675 as *Nectria berolinensis*;Louisiana, Sterlington, on *Gleditsia triacanthos*, 2 Oct. 1934, C.L. Shear, BPI 550203; Missouri, Palmyra, on *Gleditsia triacanthos*, 11 May 1936, J.R. Hansbrough, BPI 550187; Nebraska, Hastings, on *Gleditsia triacanthos*, 24 May 1910, J.M. Bates, BPI 550193; Nebraska, Lincoln, on *Gleditsia* sp., 19 Feb. 1899, L.J. Sheldon, BPI 550190; Nebraska, Hastings, on *Gleditsia triacanthos*, 24 May 1910, J.M. Bates, BPI 550194; North Carolina, New Bern, on *Albizia julibrissin*, 23 Jun. 1938, G.G. Hedgecock, BPI

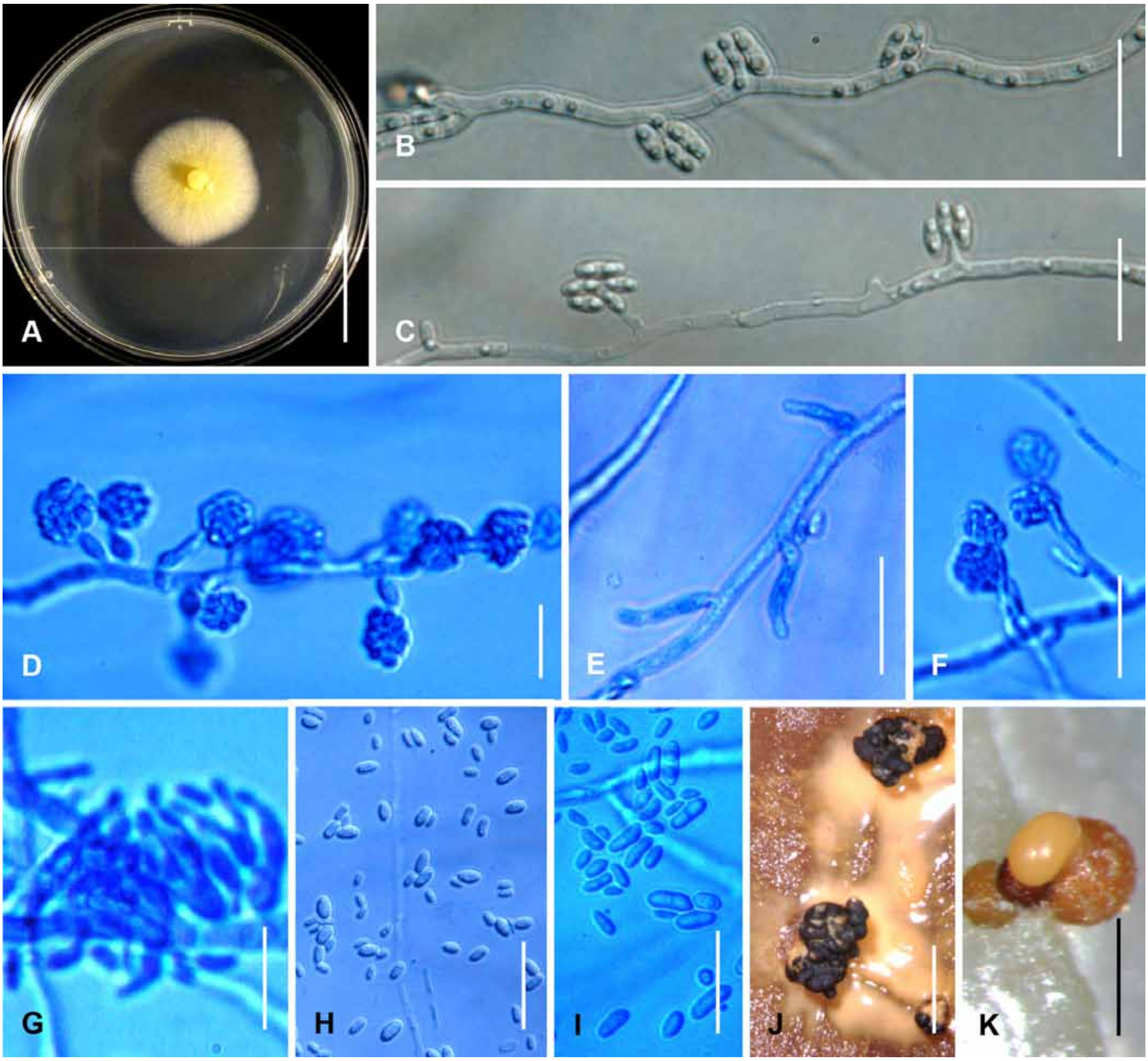

Fig. 86A–K. Anamorph of *Pleonectria austroamericana* in culture. A. Cultures after 7 d at 25 °C on PDA; B–D. Lateral phialidic pegs and young conidia on SNA; E–G. Conidiophores and young conidia on SNA; H, I. Young and mature conidia on SNA; J, K. Pycnidia on SNA. Scale bars: A = 3 mm; B–I = 10 µm; J = 1 mm; K = 300 µm.

550184; North Carolina, Wake Co., on *Robinia pseudoacacia*, Jun. 2000, L. Grand, Vernia, NCSU, culture CBS 125135 = A.R. 3492; Kentucky. Lexington, on *Gleditsia triacanthos*, Jun. 1892, L. Kellerman, BPI 550197; Kansas, Rooks Co., on *Gleditsia triacanthos*, May 1899, E. Bartholomew, BPI 550198; Massachusetts, Nantucket, on *Gleditsia triacanthos*, 25 Des. 1936, E.V. Seeler, BPI 550199; Missouri, Palmyra, on *Gleditsia triacanthos*, 11 May 1936, J.R. Hansbrough, BPI 550202; New Jersey, Somerset Co., Manville. Near, on trunk of *Gleditsia triacanthos* var. *inermis*, 30 Sep. 2000, G. Bills, BPI 748478; Georgia, Athens, on *Mimosa* sp., 1 Apr. 1942, G. Thompson, W.R. Jackson, BPI 550174; Indiana, Union County, on *Robinia* sp., 26 Oct. 1918, Fink, BPI 550183; Kansas, Manhattan, Nov. 1884, W.A. Kellerman, BPI 550171; Nebraska, Nov. 1899, L. Chambers, J.L. Sheldon, BPI 550172; Nebraska, Lincoln, 17 Oct. 1929, Lieneman, BPI 550173; Indiana, Union County, 10 Oct. 1918, F. Bruce, BPI 550173; Georgia, Athens, on *Albizia julibrissin*, 5 Aug. 1943, G.H. Hepting, BPI 632496A; Georgia, Athens, on *Albizia julibrissin*, 5 Aug. 1943, G.H. Hepting, BPI 632496B; Virginia, Stratford, on *Gleditsia triacanthos*, 30 Sep. 1947, C.D. Winn, BPI 632521; Kansas, Columbus, on *Gleditsia triacanthos*, 26 May 1941, R.W. Davidson, BPI 632522; North Carolina, Randolph Co., Asheboro. N.C. Zoo, on *Gleditsia triacanthos*, 19 Aug. 1999, L.F. Grand, BPI 746395, culture CBS 126114 = A.R. 2808 = A.R. 2809; New Jersey, Oldwick, Hunterdon Co. Fox Hill road, near, on dead trunk of *Gleditsia triacanthos*, 10 Dec. 1994, G. Bills, BPI 802825; Nebraska, Lincoln, East of Asylum Woods, on *Gleditsia triacanthos*, 17 Oct. 1929, C. Lieneman, BPI 859030; Nebraska, on *Gleditsia triacanthos*, 24 May 1910, J.M. Bates, BPI 632056; Massachusetts, Nantucket Island, on trunk of large dead *Gleditsia triacanthos*, 25 Oct. 1936, E.V. Seeler Jr., BPI 876728; Massachusetts. Nantucket Co., on *Gleditsia triacanthos*, 17 Oct. 1936, E.V. Seeler Jr., BPI 877224; New Jersey, Wilmington, Delaware, on *Gleditsia triacanthos*, Oct. 1889, A. Commons, Ellis & Everhart, North American Fungi. No 2372, BPI-bound exsiccati; Nebraska, Hastings, on *Gleditsia triacanthos*, 24 May 1910, J.M. Bates, Bartholomew, Fungi Columbiani. No 3248, BPI-bound exsiccati; North Carolina, Randolph County, Asheboro, N.C. Zoo, on *Gleditsia triacanthos*, 19 Aug. 1999, L. Grand, NCSU = BPI 746395, culture CBS 125134 = A.R. 3491; South Carolina, Clemson College, on *Gleditsia triacanthos*, 12 Oct. 1926, D.B. Rosenkrans, BPI 550201; West Virginia, Morgantown, on *Gleditsia triacanthos*, 1 Apr. 1909, L.J. Sheldon, BPI 550195. **Unknown**, on *Cerasus* sp., S.E.J., BPI 550185; on *Gleditsia japonica*, Sep. 1938, E.V. Seeler Jr., BPI 550186; on *Gleditsia* sp., 23 Aug. 1901, BPI 550175; on *Gleditsia* sp., 23 Aug. 1901, BPI 550176; on *Gleditsia* sp., 23 Aug. 1901, BPI 550177; on *Gleditsia* sp., 23 Aug. 1901, BPI 550181; on *Gleditsia* sp., 06 Des. 1896, BPI 550189; on *Gleditsia* sp., 29 Feb. 1904, BPI 550191; on *Albizia julibrissin*, 20 Apr. 1942, BPI 632523; on *Albizia julibrissin*, 15 Apr. 1942, Crandall?, BPI 632519.

Notes: *Pleonectria austroamericana* is most often restricted to *Fabaceae* and has been collected in North and South America only. This species is a plant pathogenic fungus causing honey locust canker disease in the midwestern United States (Seeler 1939, 1940a, 1940b). *Pleonectria austroamericana* is the subject of several studies of ontogeny (Subramanian & Bhat 1985), taxonomy (Bedker & Wingfield 1983), and biology and pathogenicity (Crowe *et al*. 1982, Roth 1982, Jacobi 1984, Riffle & Peterson 1986), because of its peculiar morphological characters.

This species has a unique morphology in the genus *Pleonectria* as well as nectria-like fungi. Hundreds of ascomata are aggregated and the ascomatal walls are fully covered by abundant bright yellow to umber scurf (Figs 84F, G, 85A). Based on our phylogenetic tree, this species clusters in a clade nearest to *P. pyrrhochlora*, *P. virens*, and *P. zanthoxyli*, all of which possess ascomata covered by abundant bright yellow to yellowish green scurf (Figs 1, 2).

The anamorph of *P. austroamericana* shares pycnidial characters with *P. sphaerospora*, but they differ in the presence/absence of sterile hyphae mixed with phialides and size and shape of conidia. In culture, *P. austroamericana* produces relatively small mature conidia, < 5 µm long, similar to only two species in *Pleonectria*, *P. austroamericana* and *P. aurigera*, but the anamorph of *P. austroamericana* is distinguishable from *P. aurigera* in the shape of the lateral phialidic pegs, rarely narrowly flask-shaped in *P. austroamericana* and widely flask-shaped in *P. aurigera* (Fig. 86B, C).

According to original description of *Pleonectria denigrata* (Winter 1883), the holotype of this fungus is Kellermann No. 9. We observed several exsiccati of this fungus preserved in BPI and S; however, Kellermann No. 9 was not found on any packets; thus, Rabenhorst-Winter, Fungi europaei, No. 2948 (BPI-bound exsiccati) with abundant ascomata and pycnidia is designated the lectotype herein. In the original description of *Pleonectria nigropapillata,* a synonym of *P. austroamericana,* a single type specimen was not mentioned. Because F 6220 (S) has more ascomata than the other type specimens (F 6221 & F 61157), we designate a lectoype with F 6220 herein and the other specimens (F 6221 & F 61157) are considered isolectotypes.

Pleonectria balsamea (Cooke & Peck) Vassilyeva, Plantae non Vasc., Fungi et Bryopsidae, Orientis Extremi Rossica, Fungi, Pyrenomycetidae et Loculoascomycetidae 4: 167. 1998. Figs 87–89.

Basionym: *Nectria balsamea* Cooke & Peck, in Cooke, Grevillea 12: 81. 1884.

≡ *Calonectria balsamea* (Cooke & Peck) Sacc., Syll. Fung. 9: 986. 1891.
≡ *Thyronectria balsamea* (Cooke & Peck) Seeler, J. Arnold Arbor. 21: 442. 1940.
≡ *Scoleconectria balsamea* (Cooke & Peck) Seaver, Mycologia 1: 200. 1909.
= *Pleonectria calonectrioides* Wollenw., Z. Parasitenk. (Berlin) 3: 493. 1931.

Anamorph: zythiostroma-like.

Teleomorph on natural substrata: *Ascomata and pycnidia* sometimes formed on same or discrete stroma. *Mycelium* not visible around ascomata or on host. *Stromata* erumpent through epidermis, up to 1.0 mm high and 1.5 mm diam, orange to sienna, KOH+ dark purple, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, scattered to aggregated in groups of 3–34, subglobose to globose, 162–338 µm high × 200–382 µm diam, red to bay, cupulate upon drying, sometimes with only a depressed apical region, apical region slightly darker, KOH+ purple, LA+ yellow, surface usually scurfy bright yellow or yellowish green. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis* sometimes including bright yellow scurf, 3–13 µm diam, with pigmented, uniformly or rarely irregularly *ca.* 1.5 µm thickened walls. *Ascomatal wall* 38–57 µm thick, of two regions: outer region 21–44 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.5 µm thick; inner region 8–18 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* narrowly clavate, increasing in size as ascospores mature, 58–139 × 6.7–17.5 µm, with inconspicuous ring at apex, 8-spored, mainly biseriate. *Ascospores* ellipsoidal, fusiform to long-fusiform, cylindrical, muriform, with 5–9 transverse septa and one longitudinal septum, hyaline, (16.0–)19.7–23.9(–28.6) × (3.0–)4.0–5.6(–6.8) µm (*n* = 167), smooth, budding to produce hyaline, thin-walled, tapering apex, slightly curved, *bacillar ascoconidia*, (1.3–)2.2–3.4(–4.7) × (0.9–)1.2–2.0(–3.2) µm (*n* = 206), that fill asci.

Anamorph on natural substrata: *Stromata* erumpent through epidermis, orange to red. *Pycnidia* solitary or aggregated in groups of 3–15, superficial on stroma or rarely immersed at base, subglobose, smooth to slightly rough, cerebriformis or cupulate upon drying, 108–288 µm, 160–413 µm diam, red to umber, KOH+ slightly darker, LA+ slightly yellow. *Pycnidial wall* 17–41 µm thick, of two regions: outer region 8–12 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.5 µm thick; inner region 14–23 µm thick, of elongate, thin-walled, hyaline cells, forming t*extura prismatica*. *Conidiophores* densely branched, generally with 1–4 branched, 11–40 µm long, 1.1–3.2 µm wide. *Conidiogenous cells* cylindrical to subulate, straight to slightly curved, enteroblastic, monophialidic, 8–15 × 1.0–2.5 µm. *Intercalary phialides* generally observed, bearing 1–3 terminal phialides, up to 6 µm long, similar to short acropleurogenous conidiophores. *Sterile hyphae* absent. *Conidia* hyaline, ellipsoidal to oblong, sometimes slightly curved, non-septate, (1.4–)2.5–3.9(–5.0) × (0.9–)1.2–2.0(–2.6) µm (*n* = 150).

Anamorph in culture: After 7 d at 25 °C, colonies 50–78 mm (average 67 mm) diam. *Colony surface* cottony with aerial mycelium, whitish to whitish saffron; *aerial mycelium* usually developed, often small white sporodochial conidial masses produced after 2 wk; *reverse* white to slightly whitish yellow. *Odour* on PDA slightly putrid. Sporulation on SNA from *lateral phialidic pegs* abundant, ellipsoidal and slightly tapering toward tip or flask-shaped, 2.5–6.5 µm long, 1.1–4.2 µm wide at base, monophialidic. *Conidiophores* sometimes formed, unbranched, sometimes verticillate, 1(–2)-branched, becoming loosely to moderately densely branched, 9.2–28.4 µm long, 1.2–3.2 µm wide at base. *Conidiogenous cells* enteroblastic, monophialidic, cylindrical and slightly tapering toward tip or narrowly flask-shaped, 2.2–8.8 µm long, 1.4–3.0 µm wide at base. *Young conidia* formed from monophialides on aerial, submerged, or repent hyphae, formed abundantly on slimy heads or sporodochia, ellipsoidal, oblong, hyaline, straight or slightly curved , rounded at both ends, non-septate, (3.4–)3.9–5.1(–6.4) × (1.2–)1.5–1.9(–2.5) µm (*n* = 150), smooth-walled. *Mature conidia* swollen, 0-septate, subglobose to ellipsoidal, hyaline, smooth, striate, rounded at both ends, (6.1–)6.4–7.2(–9.0) × (2.2–)2.5–3.3(–3.4) µm (*n* = 150). *Pycnidia* produced in PDA after 1–2 months (A.R. 4568, A.R. 3493, MAFF 241458, A.R. 3495). *Ascomata* and *chlamydospores* not produced in SNA and PDA.

Habitat: On bark and twigs of *Abies balsamea* and *A. fraseri (Pinaceae).*

Distribution: North America (Canada, USA).

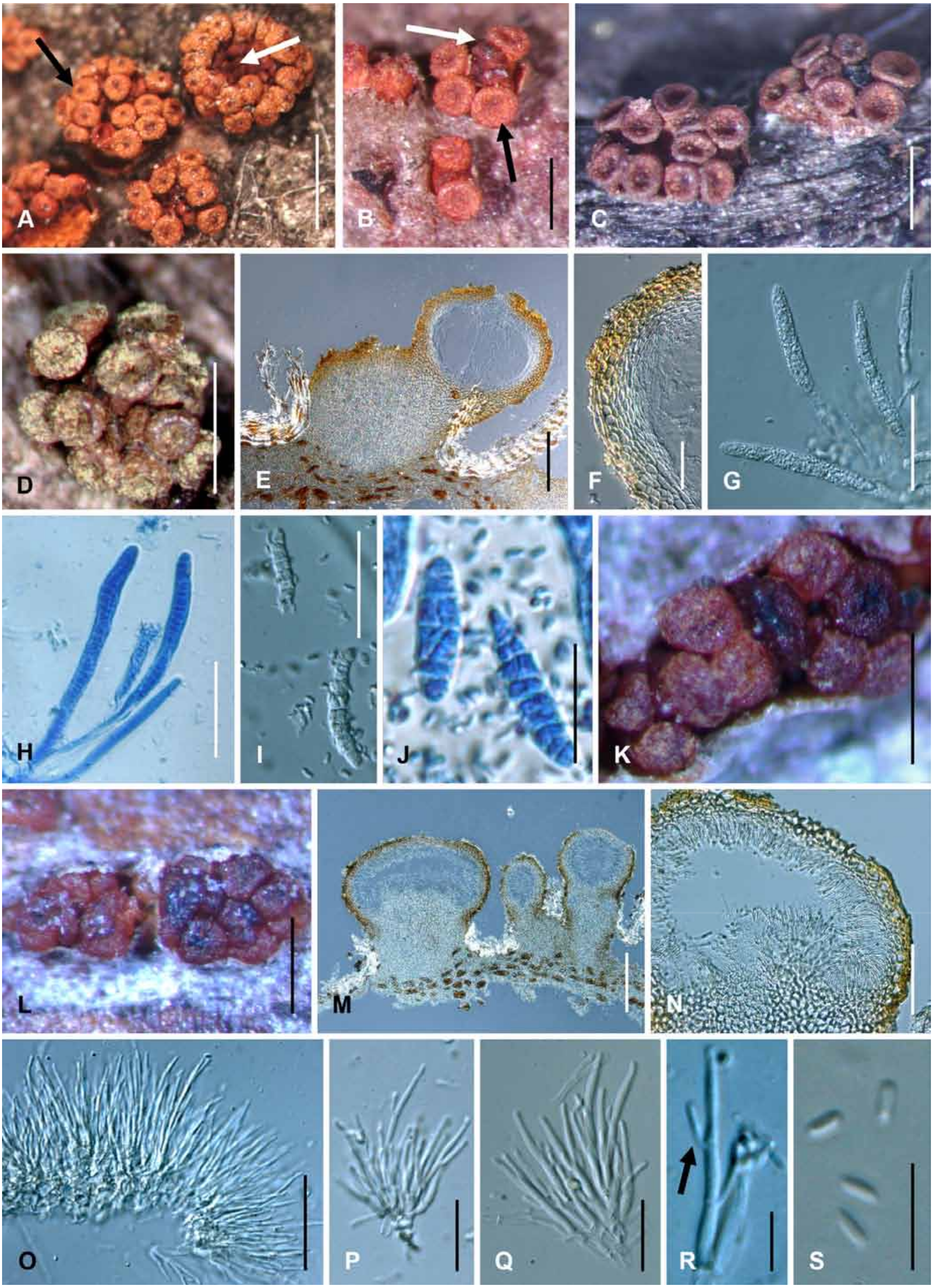

Fig. 87A–S. *Pleonectria balsamea* on natural substrata (A, B teleomorph and anamorph, C–J teleomorph, K–S anamorph). A. B. Perithecia (black arrows) and pycnidia (white arrows) on natural substrata; C, D. Perithecia on natural substrata; E. Median section of perithecium on natural substrata; F. Median section of perithecial wall; G, H. Asci; I, J. Ascospores; K, L. Superficial pycnidia on natural substrata; M. Median section of superficial pycnidia; N. Median section of superficial pycnidial wall; O–R. Conidiophores and intercalary phialides (black arrow) on natural substrata; S. Conidia on natural substrata. Scale bars: A =1 mm; B–D, K, L = 500 µm; E, M = 100 µm; F–H, N, O = 50 µm; I, J, P, Q = 20 µm; R, S = 10 µm.

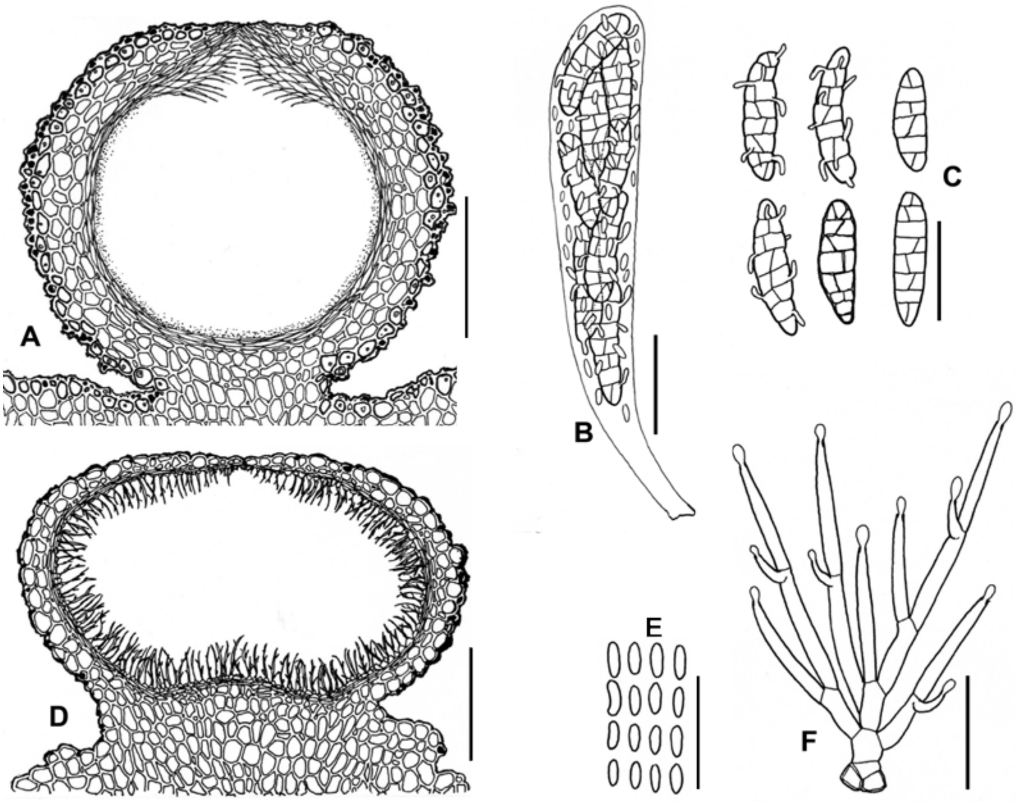

Fig. 88A–F. *Pleonectria balsamea* on natural substrata (A–C teleomorph, D–F anamorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores; D. Median section of mature Pycnidium; E. Conidia; F. Conidiophores. Scale bars: A, D = 100 µm; B, C = 20 µm; E, F = 10 µm.

Lectotype of Pleonectria balsamea *designated herein*: **USA**, New York, North Elba, on dead branches of *Abies balsamea*, Aug. 1872, C.H. Peck, **Lectotype** NYS 417, **Isolectotype** NYS 418.

Additional type specimens examined: Type of *Pleonectria calonectrioides*: **Canada**, Ontario, Clarksons Island, Lake Temagami, on *Abies balsamea*, 21 Jun. 1928, J.H. Faull, **Neotype** designated herein, BPI 632630.

Additional specimens and isolates examined: **Canada**, Ontario, Holland River Marsh, York Co., on *Abies balsame*, 06 May 1936, D.H. Linder, BPI 1107510; Ontario, Oakland, on *Abies balsame*, May 1915, J. Dearness, BPI 1107512; Ontario, on *Abies balsame*, 15 Jul. 1922, J.H. Faull, BPI 550209; Ontario, Stittsville, 13 Lucas Lane, 45 11.9 N 75 58.8 W, on *Abies balsamea*, 01 Feb. 2009, K.A. Seifert, BPI 881046, culture CBS 129371 = A.R. 4568 = Y.H. 09-01; Ontario, Guelph., on *Abies balsamea*, 15 Sep. 1930, J.H. Faull, BPI 632629 as *Ophionectria scolecospora*; Ontario, Bear Island, Lake Temagami, on *Abies balsamea*, 25 Jul. 1920, J.H. Faull, BPI 632631 as *Ophionectria scolecospora*; Ontario, Bear Island, Lake Temagami, on *Abies balsamea*, Aug. 1928, J.H. Faull, BPI 632632 as *Ophionectria scolecospora*; Quebec, Duchesnay, vicinity of Forest Rangers' Schoo, on *Abies balsamae*, 26 Aug. 1938, J.A. Stevenson, BPI 1107509; Quebec, Dorothee Ste., Ile Jesus, on *Abies balsamea*, 26 Aug. 1941, R.F. Cain, BPI 632758 as *Scoleconectria cucurbitula*. **USA**, Maine, Westbrook, on *Abies balsamea*, Jun. 1897, P.L. Ricker, BPI 551623 as *Nectria cucurbitula*; Michigan, Michigamme, Van Riper State Park, River Trail, 46º 31' 802" N, 88º 00' 028" W, elev. 277 m, on *Abies balsamea*, 30 May 2010, Y. Hirooka, D. Walker, BPI 881047, culture CBS 129159 = Y.H. 10-07b; Michigan, Grand Marais, Grand Marais Truck Trail, 46º 40' 621" N, 85º 45' 605" W, elev. 177 m, on *Abies balsamea*, 29 May 2010, Y. Hirooka, D. Walker, BPI 881048, culture CBS 129429 = Y.H. 10-11f; Michigan, Grand Marais, Grand Sable Lake, 46º 40' 025" N, 86º 00' 776" W, elev. 220 m, on *Abies balsamea*, 29 May 2010, Y. Hirooka, D. Walker, BPI 881049, culture CBS 129428 = Y.H. 10-10e; Michigan, Houghton, Jasberg St., 47º 08' 341" N, 88º 37' 331" W, elev. 191 m, on *Abies balsamea*, 31 May 2010, Y. Hirooka, D. Walker, BPI 881050, culture CBS 129160 = Y.H. 10-08c; Michigan, Grand Marais, Au Sable Point Trail, 46º 38' 283" N, 86º 06' 675" W, elev. 242 m, on *Abies balsamea*, 30 May 2010, Y. Hirooka, D. Walker, BPI 881051, culture CBS 129340 = Y.H. 10-13h; New York, Saranac Inn, on *Abies balsame*, 03 Jun. 1910, P. Spaulding, BPI 550135; New Hampshire. Coos Co., Cherry Mountain. near Twin Mountain, on *Abies balsame*, 19 Jun. 1932, BPI 550136; North Carolina, Alleghany Co., Sparta. *ca.* 8 miles W, on *Abies fraseri*, 04 Aug. 1995, L.F. Grand, BPI 746321; North Carolina, Wautaga Co., Boone. Christmas tree plantation owned by Bob Flanagan, on *Abies fraseri*, 29 Jun. 1999, L.F. Grand, BPI 746322, culture CBS 125132 = A.R. 2798; North Carolina, Wautaga Co., Boone. Christmas tree plantation owned by Bob Flanagan, on *Abies fraseri*, 29 Jun. 1999, L.F. Grand, BPI 746323; North Carolina, Watauga Co., Phytophthora study plot #93, on *Abies fraseri*, 07 Jun. 2000, L.F. Grand, BPI 747277; North Carolina, Avery Co., on *Abies fraseri*, 06 Jun. 2000, L.F. Grand, BPI 747278; North Carolina, Jackson Co., Phytophthora survey field #87 off SR 1129, Big Ridge Rd., on *Abies fraseri*, 13 Jun. 2000, L.F. Grand, BPI 747279; North Carolina, Avery Co., Phytophthora survey field, Pitts plantation, on *Abies fraseri*, 06 Jun. 2000, L.F. Grand, BPI 747281; North Carolina, Avery Co., on *Abies fraseri*, 06 Jun. 2000, L.F. Grand, BPI 747282; North Carolina, Avery Co. Phytophthora survey plot #85, on *Abies fraseri*, 08 Jun. 2000, L.F. Grand, BPI 747283; North Carolina, Avery Co. Phytophthora survey plot #82, on *Abies fraseri*, 08 Jun. 2000, L.F. Grand, BPI 747284; North Carolina, Avery Co., Phytophthora survey plot along N. Toe River, on *Abies fraseri*, 06 Jun. 2000, L.F. Grand, BPI 747285; Maine, Piscataquis Co., Medford township, on Bark, 28 Aug. 1905, W.A. Murrill, NY no. 1842; North Carolina, Haywoos Co., ¼ mile SW of Richland Balsam overlook, on *Abies fraseri*, 30 Jun. 2000, L.F. Grand, NCSU, culture CBS 125137 = A.R. 3495; North Carilina, Haywood Co., ¼ mile SW of Richland Balsam overlook (Blue Ridfe Parkway), on *Abies fraseri*, 30 Jun. 2000, L. Grand, Vernia, NCSU, culture CBS 125136 = A.R. 3493; New York, North Creek, on *Abies balsamea,* 15 Aug. 1919, C.L. Shear, BPI 632633 as *Ophionectria scolecospora*; New York, North Ellis, Essex Co., on *Abies balsamea,* C. Peck, BPI 629752. **Unknown**: on *Abies balsamea*, ex Herbarium of W. H. Seaman, BPI 1108889 as *Nectria balsamea.*

Notes: *Pleonectria balsamea* is characterised by bright yellow or yellowish green scurfy ascomatal wall, muriform ascospores budding within the asci, *Zythiostroma* anamorph, and occurrence on only one host, *Abies*. Our phylogenetic tree demonstrates that the broad concept of *Nectria balsamea* includes two species that correlate with host plants (Fig. 2). Based on our morphological examination, we recognise that these two species are distinguishable by ascospore size, absence or presence of sterile hyphae in pycnidia, growth trial on PDA at 25 °C for 7 d, and host genus. The lectotype of *Pleonectria balsamea* as typified herein was collected on *Abies balsamea*; thus the fungus on *Abies* is recognised as true *P. balsamea*.

The pycnidial anamorph of *P. balsamea* in the natural environment is morphologically identical with the anamorph of

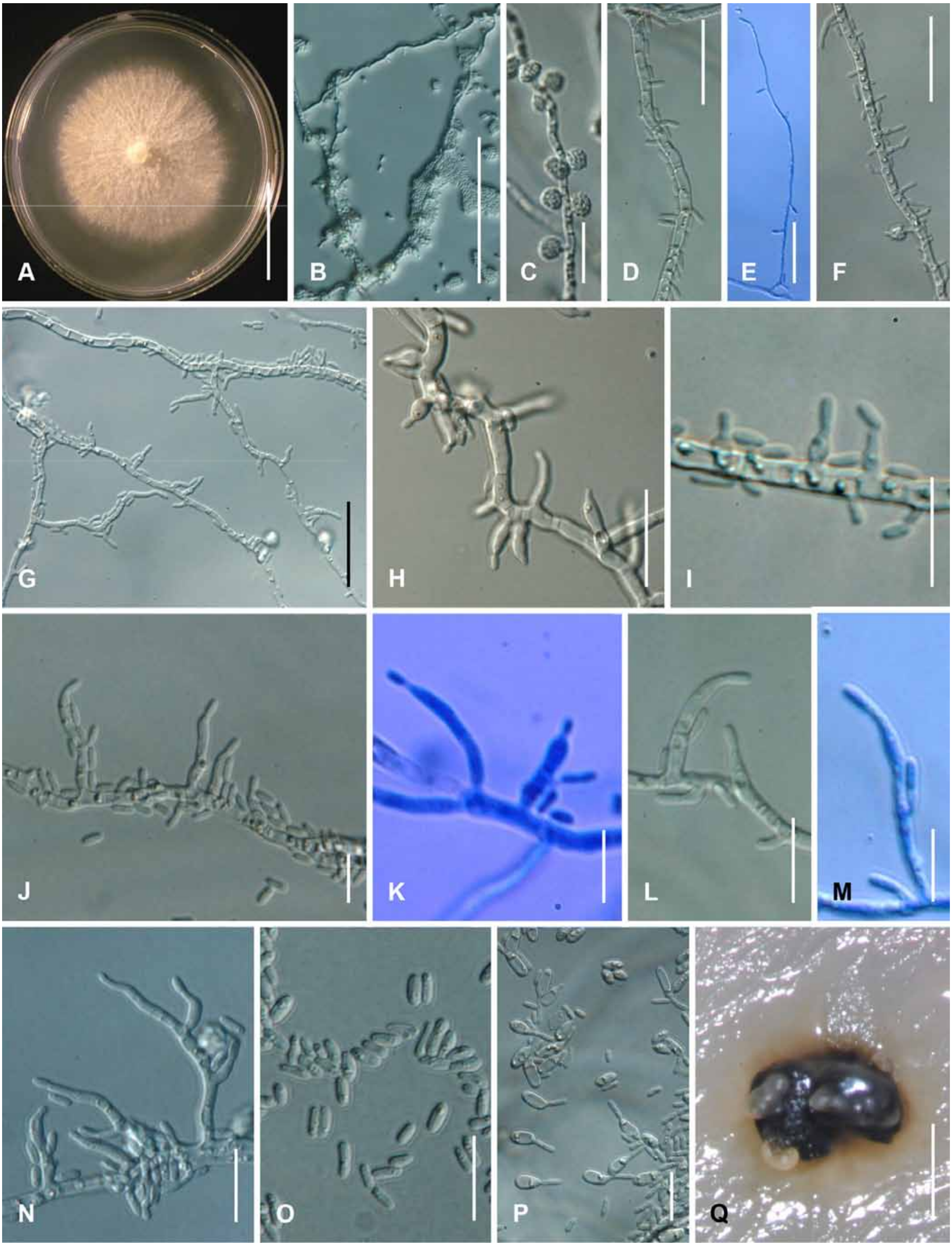

Fig. 89A–Q. Anamorph of *Pleonectria balsamea* in culture. A. Cultures after 7 d at 25 °C on PDA; B, C. Lateral phialidic pegs and conidial mass on SNA; D–I. Lateral phialidic pegs on SNA; J–N. Conidiophores and conidia on SNA; O. Young conidia on SNA; P. Budding mature conidia on SNA; Q. Pycnidia on SNA. Scale bars: A = 3 mm; B = 50 µm; C–G = 30 µm; H–P = 10 µm; Q = 200 µm.

P. rosellinii, also on *Abies*. However, the teleomorph of these two species is clearly distinct based on shape and septation of ascospores. The ascospores are muriform and ellipsoidal to fusiform in *P. balsamea* while those of *P. rosellinii* are long-filiform and multiseptate. Further, our phylogenetic tree showed that the two species were related but distinct based on their BI PP, ML BP, and MP BP values (Figs 1, 2). Because of similar morphological characters of pycnidia and occurrence on the same host (*Abies*), specimens of both species may have been placed in the same packet. On our collecting trip in Michigan, United States, from May 25 to June 2, 2010, *P. balsamea* and *P. rosellinii* were common and often collected at the same place. In culture, we could distinguish these species using subtle morphological characters such as size and shape of mature conidia. The conidia are subglobose to ellipsoidal, (6.1–)6.4–7.2(–9.0) × (2.2–)2.5–3.3(–3.4) µm in *P. balsamea* but oblong to long-cylindrical, rarely allantoid, slightly or strongly curved, (6.4–)6.9–9.3(–10.0) × (1.9–)2.1–2.9(–3.1) µm in *P. rosellinii*. In addition the lateral phialidic pegs are flask-shaped in *P. balsamea* but not flask-shaped in *P. rosellinii*.

Pleonectria calonectrioides, a taxonomic synonym of *P. balsamea*, was not examined here because the type specimen at B was destroyed during the 1943 fire. According to the original observations of *P. calonectrioides*, the species is conspecific with *P. balsamea* based on size of ascospores and host identify. Based on the description, *P. calonectrioides* is neotypified by BPI 632630, a specimen collected on the same host and almost the same locality as the original type. As mentioned above, the NYS 417 collected by Peck (Cooke 1884) is designated herein as lectotype of *P. balsamea*.

Pleonectria berolinensis Sacc., Michelia 1: 123. 1878. Figs 90–92.

≡ *Nectria berolinensis* (Sacc.) Cooke, Grevillea 12: 107. 1884.
≡ *Thyronectria berolinensis* (Sacc.) Seaver, Mycologia 1: 205. 1909.
= *Nectria fenestrata* Berk. & M.A. Curtis, in Cooke, Grevillea 12: 81. 1884.
≡ *Pleonectria fenestrata* (Berk. & M.A. Curtis) Berl. & Voglino, Syll. Fung. Addit. 1–4: 216. 1886.

Anamorph: zythiostroma-like.

Teleomorph on natural substrata: *Mycelium* not visible around ascomata and on host. *Stromata* erumpent through epidermis, up to 3.0 mm high and 3.0 mm diam, red to bay, KOH+ dark red, LA+ yellow, pseudoparenchymatous, cells forming textura *angularis*, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, aggregated in groups of 5–85, subglobose to globose, 250–375 µm high × 200–340 µm diam, cupulate upon drying, often with only a depressed apical region, bay to scarlet, apical region slightly darker, KOH+ dark red, LA+ yellow, smooth to slightly rough, sometimes surface scurfy. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis* sometimes including bright yellow scurf, 3–12 µm diam, with pigmented, sometimes irregularly *ca.* 1.5 µm thick walls. *Ascomatal wall* 30–65 µm thick, of two regions: outer region 20–40 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.5 µm thick; inner region 8–20 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* narrowly clavate, 70–140 × 8–18 µm (n = 642), with inconspicuous ring at apex, 8-spored, ascospores mainly uniseriate. *Ascospores* narrowly ellipsoidal, fusiform to cylindrical, straight, hyaline, muriform, with 4–7 transverse septa and usually one longitudinal septum, (14.4–)15.7–19.3(–23.3) × (5.0–)6.5–8.1(–10.1) µm (n = 1502), smooth, slightly curved, a few specimens budding to produce hyaline, thin-walled, tapering apex, slightly curved, *bacillar ascoconidia*, (2.1–)2.9–4.1(–5.1) × (1.2–)1.4–2.1(–2.5) µm (n = 100), produced outside of asci (BPI 550671 & BPI 550691).

Anamorph in culture: After 7 d at 25 °C, colonies 72–85 mm (average 76 mm) diam. *Colony surface* cottony with aerial mycelium, whitish orange to yellow; *aerial mycelium* developed, rarely small yellow sporodochial conidial masses produced after 2 wk; *reverse* whitish yellow. *Odour* on PDA slightly putrid. Sporulation on SNA from *lateral phialidic pegs* abundant, ellipsoid and slightly tapering toward tip or flask-shaped, 1.6–4.8 µm long, 1.1–2.6 µm wide at base, monophialidic. *Conidiophores* unbranched, 7.1–23.4 µm long, 2.3–3.7 µm wide at base. *Intercalary phialides* rarely observed, bearing 1 terminal phialides, up to 4 µm long. *Conidiogenous cells* enteroblastic, monophialidic, cylindrical and slightly tapering toward tip or narrowly flask-shaped with widest point in middle, 5.6–11.1 µm long, 1.8–3.0 µm wide at base. *Young conidia* formed from monophialides on aerial, submerged, or repent hyphae, formed abundantly on slimy heads or sporodochia, oblong to long cylindrical, hyaline, straight or slightly curved, rounded at both ends, non-septate, (3.8–)4.5–6.5(–7.9) × (1.1–)1.6–2.2(–2.7) µm (n = 87), smooth-walled. *Mature conidia* swollen, (0-)1(-2)-septate, ellipsoidal, oblong, allantoid or ellipsoidal with strongly constricted centre, swollen at both ends, hyaline, smooth, straight or slightly curved, rounded at both ends, occasionally budding, (8.8–)10.2–14.2(–19.9) × (2.2–)3.3–4.7(–5.5) µm (n = 162). *Chlamydospores*, *pycnidia* and *ascomata* not produced in culture.

Habitat: On dead bark or twigs of *Ribes* including *Ribes aureum, R. floridum, R. longiflorum, R. nigrum., R. oxyacanthoides, R. rotundifolium*, *R. rubrum,* and *R. vulgare (Grossulariaceae)*.

Distribution: Asia (Mongolia), Europe (Austria, Bosnia, Czech Republic, Finland, Germany, Italy, Latvia, Poland), North America (Canada, USA).

Holotype of Pleonectria berolinensis: **Germany**, Berlin Botanical Garden, on dead branch of *Ribis aureum*, P. Magnus, **Holotype** PAD.

Epitype of Pleonectria berolinensis: **Austria**, St. Margareten im Rosental, Karnten, in the village, mapping grid square 9452/4, on standing branches of *Ribes rubrum*, 25 Oct. 1998, W. Jaklitsch WJ 1248, **Epitype** BPI 746346, **ex-epitype** culture CBS 126112 = A.R. 2776.

Additional type specimens examined: Type of *Nectria fenestrata*: **Canada**, Saskatchewan, on bark, 1886, Poe, **Lectotype** designated herein, FH 258957; **Isolectotype** FH 81118 microscope slide only.

Additional specimens and isolates examined. **Austria**, Grinzing–Wier, on *Ribes rubrum*, Oct. 1929, J. Weese, BPI 550732. **Bosnia**, Sarajevo, Garden, on *Ribes rubrum*, 28 Oct. 1918, F. Petrak, BPI 550730; Stanisbon Garden, on *Ribes rubrum*, 24 Jan. 1918, F. Petrak, BPI 550727. **Canada**, Newfoundland, Labrador, on *Ribes*, A.C. Waghorne, BPI 550671 as *Nectria berolinensis*; Newfoundland, Labrador, on *Ribes* sp., 15 Sep. 1894, A.C. Waghorne, ex Missouri Botanical Gardent 17755, BPI 550683 *as Nectria berolinensis*; Ontario, Holland River Marsh, York County, on *Ribes floridum*, 6 May 1936, G.D. Darker, BPI 550712; Ontario, New Durham, Brant Co., on *Ribes nigrum*, 28 Mar. 1932, R.F. Cain, BPI 550713; Ontario, Nashville, York Co., on *Ribes nigrum*, 6 Nov. 1954, R.F. Cain, BPI 550715; Ontario, New Durham, Brant Co., on *Ribes* sp., 28 Mar. 1932, H.S. Jackson, BPI 550687; Ontario, Maple, York County, on *Ribes* sp., 24 Aug. 1941, G.D. Darker, BPI 550697; Ontario, Brant Co., New Durham, on *Ribes* sp., 28 Mar. 1932, R.F. Cain, BPI 859321. **Czech Republic**, Velvary, on *Ribes aureum*, 20 Mar. 1900, J.E. Kabat, BPI 550702; Bohemia, Turnov, tree nursery, on *Ribes aureum*, 16 Apr. 1915, J.E. Kabat, BPI 550703; Bohemia, on *Ribes rubrum*, 27 Mar. 1904, F. Bubak, BPI 550718; on *Ribes rubrum*, May 1907, F. Bubak, BPI 550719; Bohemia, on *Ribes rubrum*, Apr. 1904, F. Bubak (BPI 550720); Moravia, West-Beskiden, in a garden near Roznau, on *Ribes rubrum*, May 1922, F. Petrak, BPI 550734. **Europe**, on *Ribes* sp., Rabenhorst, Fungi europaei No. 264, BPI-bound exsiccati. **Finland**, Fennia, Mustiala, on *Ribes rubrum*, Apr. 1887, P.A. Karsten, BPI 550729. **Italy**, Vallombrosa, on *Ribes rubrum*, autumn, 1892, Briosi & Cavara, Funghi Parassiti. No 216, BPI-bound exsiccati. **Germany**, Ziebigk to Dessau, on *Ribes rubrum*, Apr. 1913, R. Staritz (BPI 550721); Brandenburg, Sophienstadt bei Ruhlsdorf, Kreis Nieder–Barnim, on *Ribes rubrum*, 5 Aug. 1920, H. Sydow, BPI 550726;

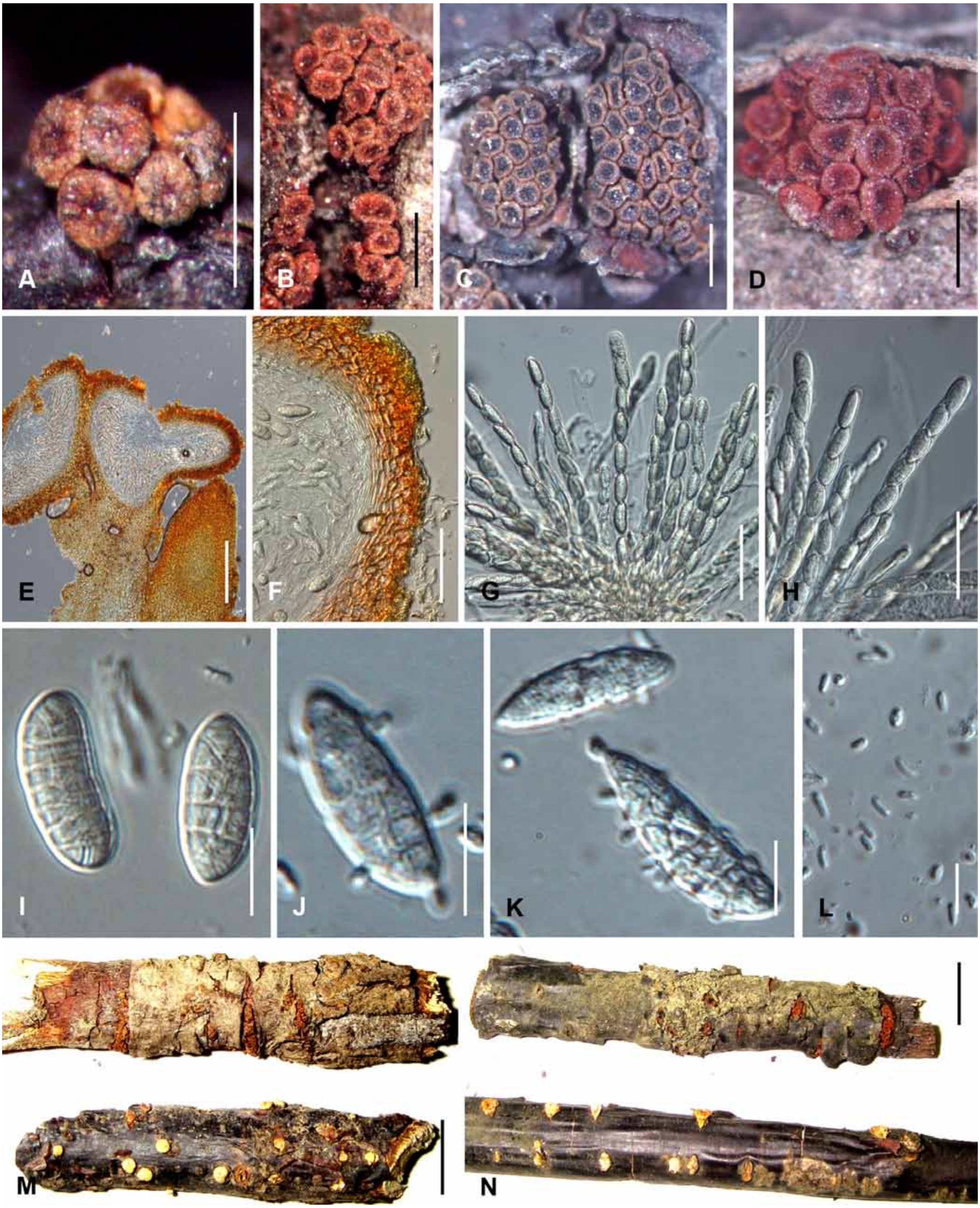

Fig. 90A–N. *Pleonectria berolinensis* on natural substrata (A–L teleomorph, M. Specimen of BPI 550721, N. Specimen of BPI 550726). A–D. Perithecia on natural substrata; E. Median section of perithecia on natural substrata; F. Median section of perithecial wall; G, H. Asci; I. Ascospores; J, K. Budding ascospores; L. Ascoconidia; M. Perithecia of *P. berolinensis* (top) and sporodochia of *N. cinnabarina* (bottom) included in BPI 550721; N. Perithecia of *P. berolinensis* (top) and sporodochia of *N. cinnabarina* (bottom) included in BPI 550726. Scale bars: A–D = 500 µm; E = 100 µm; F–H = 50 µm; I–L = 10 µm; M, N = 10 mm.

Sternberg, on *Ribes rubrum*, Mar. 1930, J. Piskor, BPI 550731; Munchen, Sendling, on *Ribes nigrum*, Oct. 1891, Schnabl, Allescher & Schnabl, Fungi bavarici. No 152A, BPI-bound exsiccati; Munchen, Sendling, on *Ribes rubrum*, Oct. 1891, Schnabl, Allescher & Schnabl, Fungi bavarici. No 152B, BPI-bound exsiccati; Brandenburg, Baumschulen zu Tamsel, on *Ribes aureum*, 12 Feb. 1909, P. Vogel, Sydow, Mycotheca germanica. No. 896, BPI-bound exsiccati; Brandenburg, Baumschulen zu Tamsel, on *Ribes aureum*, 12 Feb. 1909, P. Vogel, Sydow, Mycotheca germanica. No. 896, PAD; Brandenburg, Baumschulen zu Tamsel, on *Ribes rubrum*, Apr. 1887, O. Karsten, Rabenhorst, Winter Fungi europaei. No. 3650, BPI-bound exsiccati; Brandenburg, Tábor in ramis mortuisl, on *Ribes rubrum*, Apr. 1904, F. Bubak, Vestergren,

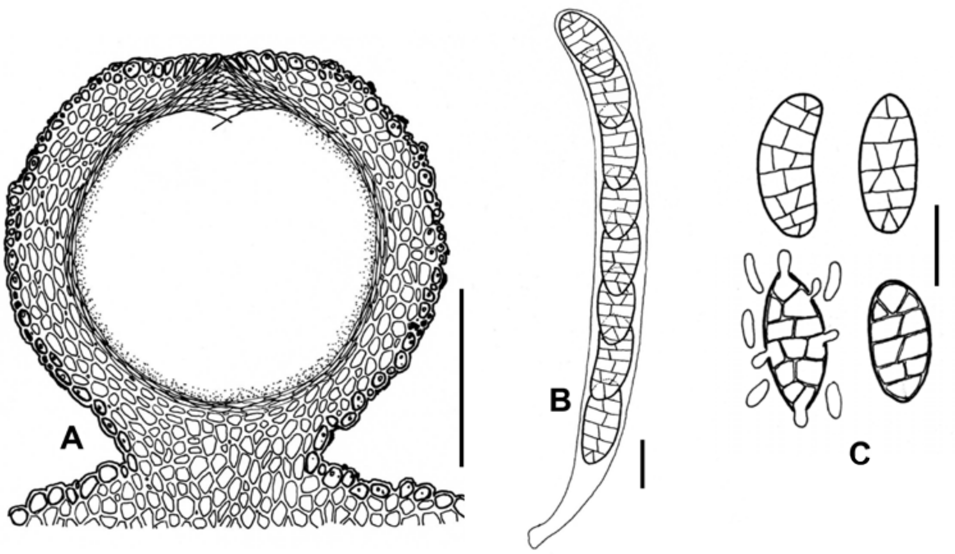

Fig. 91A–C. *Pleonectria berolinensis* on natural substrata (A–C teleomorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores and ascoconidia. Scale bars: A = 100 µm; B, C = 10 µm.

Micromycetes rariores selecti. No. 925, BPI-bound exsiccati; München, Sendling, on *Ribes nigrum* (a), *Ribes rubrum* (b), Oct. 1891, Schnabl, Allescher & Schnabl, Fungi bavarici. No. 152, PAD. **Latvia**, Prov. Latgale, Vidsmuiza, on *Ribes rubrum*, 1984, K. Starcs, BPI 550733; on *Ribes rubrum*, 2 Dec. 1909, P. Vogel, BPI 632062. **Mongolia**, on *Ribes nigrum*, 2005, C. Lechat, HB7896A, culture CBS 128980 = A.R. 4618. **Poland**, Brandenburg, Baumschulen Zu Dabroszyn (Tamsel, Brandenburg), on *Ribes aureum*, 2 Dec. 1909, P. Vogel, BPI 550701. **USA**, California, Dana, Shasta Co., on *Ribes aureum*, 19 Aug. 1932, L.N. Goodding, BPI 1107321; California, Pinehurst, on *Ribes* sp., 20 Apr. 1918, E. Vethel, BPI 550678; Connecticut, Bethany, on *Ribes nigrum*, 10 Oct. 1916, G.P. Clinton, BPI 550714; Kansas, Stockton, on *Ribes aureum*, 21 Mar. 1899, E. Bartholomew, BPI 550704; Kansas, Rooks Co., on *Ribes aureum*, 21 Mar. 1899, E. Bartholomew, BPI 550705; Kansas, Rooks Co., on *Ribes aureum*, 21 Mar. 1899, *E*. Bartholomew, BPI 550707; Illinois, Evanston, on *Ribes nigrum*, 13 Mar. 1930, C.B. Stifler, BPI 550716; Michigan, Grand Rapids, on *Ribes* sp., 2 Aug. 1911, C.L. Shear, BPI 550684; Michigan, Lawton, on *Ribes* sp., 1 Apr. 1910, C.L. Shear, BPI 550686; Montana, Sheridan, on *Ribes* sp., L.A. Fitch, BPI 550688; Iowa, Decorah, on *Ribes* sp., May 1892, E.W.D. Holway, BPI 550689; Montana, Sand Coulee, on *Ribes rotundifolium*, 6 Dec. 1888, F.W. Anderson, BPI 550717; Montana, Armstead, on *Grossularia setosa?* (*Ribes oxyacanthoides* L.), 31 Aug. 1919, Stillurger, BPI 550673; Michigan, Agr. College, on *Ribes rubrum*, 31 May 1907, C.L. Shear, BPI 550722; New Jersey, Moorstown, on *Ribes* sp., 19 Sep. 1915, N.E. Stevens, BPI 550679; New York, North of Highland, on *Ribes* sp., 16 May 1921, N.E. Stevens, BPI 550680; North Dakota, Nyland Grove, Lamoure Co., on *Ribes floridum*, 4 May 1913, Brenckle, BPI 550709; North Dakota, Nyland Grove, Lamoure Co., on *Ribes floridum*, 4 May 1913, Brenckle, BPI 550710; North Dakota, Nyland Grove, Lamoure Co., on *Ribes floridum*, 4 May 1913, Brenckle, BPI 550711; North Dakota, Kulm, on *Ribes rubrum*, Jul. 1909, J.F. Brenckle, BPI 550724; North Dakota, Kulm, on *Ribes rubrum*, Oct. 1909, J.F. Brenckle, BPI 550725; North Dakota, Kulm, on *Ribes rubrum*, Jul. 1909, J.F. Brenckle, BPI 550728; Vermont, Bellows Falls, on *Ribes* sp., 21 Aug. 1917, A.A. Haliday, BPI 550681; Washington, Colfax, Whitman Co., on *Ribes* sp., 12 Dec. 1984, R. Scott, BPI 550676; Wisconsin, Madison, on *Ribes rubrum*, 18 May, J.B. Ellis, BPI 550723; Iowa, Decorah, on *Ribes* sp., May 1892, E.W.D. Holway, BPI 550690; Montana, Sheridan, on *Ribes* sp., L.A. Fitch, BPI 550691; New York, Ithaca, Cornell Univ., on *Ribes* sp., 27 May 1902, T. Charles, BPI 550682; New York, Ithaca, on *Ribes* sp., 29 May 1904, H.H. Whetzel, BPI 550692; Massachusetts, Peabody, on *Ribes* sp., W.G. Farlow, BPI 550693; New North Dakota, Fargo, on *Ribes* sp., 1908, F.J. Seaver, BPI 550694; Montana, Missoula, on *Ribes* sp., 17 Jul. 1917, J.R. Weir, BPI 550695; New Hampshire, Mt. Wash., on *Ribes* sp., Jul. 1927, C.L. Shear, BPI 550697; New York, Catskills, on *Ribes* sp., 11 May 1921, N.E. Stevens, BPI 550698; Montana, Boulder, on *Ribes* sp., 14 Sep. 1917, F.S. Wolpert, BPI 550699; Colorado, Woodmen, on *Ribes* sp., 11 Oct. 1912, C.L. Shear, BPI 550700A; Colorado, Woodmen, on *Ribes* sp., 11 Oct. 1912, C.L. Shear, BPI 550700B; Michigan, Douglas, on *Ribes vulgare*, 2 Aug. 1911, C.L. Shear, BPI 550735; Connecticut, E. Granby, on *Ribes vulgare*, 8 Apr. 1928, P. Spaulding, BPI 550736; Colorado, Antonito, on *Ribes vulgare*, 22 May 1917, B. Hedgcock, BPI 550737; New York, H.P. Sartwell, BPI 550677; Kansas, Stockton, 21 Mar. 1899, E. Bartholomew, BPI 632057; Colorado, Fort Garland. alt. 2400 m, on *Ribes longiflorum*, 23 Jun. 1907, F.E. Clements, E.S. Clements, BPI 632058; North Dakota, Kulm, on *Ribes rubrum*, 1909, J.F. Brenckle, BPI 632060; Michigan, Douglas, on *Ribes* sp., 1 Aug. 1911, C.L. Shear, BPI 632052; Utah, on *Ribes* sp., 8 May 1914, B.J. O'gara, BPI 632053; North Dakota, Fargo, on *Ribes* sp., 1908, F.J.S., BPI 867299; Michigan, on *Ribes vulgare*, 20 Jul. 1911, L.A. Hawkins, BPI 632054; Colorado, Grand Messa Mtn., 11 Jun. 1935, R.W. Davidson, BPI 632520; North Dakota, Kulm, on *Ribes rubrum*, Oct. 1909, J.F. Brenckle, BPI 859028; Connecticut, Norfolk, on dead twigs of *Ribes* sp., Jul. 1916, E.M.S., BPI 632493; Pennsylvania, Centre Co., State College, on *Ribes* sp., 22 Apr. 1932, W.L. White, BPI 859029; Pennsylvania, Centre Co., State College, on *Ribes* sp., 22 Apr. 1932, W.L. White, BPI 867357; Pennsylvania, Centre Co., State College., 401 W. Beaver Ave., on *Ribes* sp., 15 Aug. 1915, C.R. Orton, BPI 867358; Montana, Helena, on *Ribes rotundifolium*, 8 Oct. 1888, F.D.K., BPI 867359; Massachusetts, Peabody, on *Ribes* sp., W.G. Farlow., Ellis, North American Fungi. No. 470, BPI-bound exsiccati; Iowa, Decorah, on *Ribes* sp., May 1892, E.W.D. Holway, Ellis & Everhart, Fungi Columbiani. No. 619, BPI-bound exsiccati; South Dakota, Tecoma Park, on *Ribes floridum*, Apr. 1894, Griffiths, Griffiths, West American Fungi 195, BPI-bound exsiccati = BPI 796714; North Dakota, on *Ribes rubrum*, Jul. 1909, Kulm, J. F. Brenckle, Fungi Dakotenses 125, PAD; North Dakota, Nyland Grove, Lamoure County, on *Ribes floridum*, 4 May 1913, J. F. Brenckle, Fungi Dakotenses 239, PAD; on *Ribes rubrum*, Oct. 1909, J.F. Brenckle, J. F. Brenckle No. 261, PAD; Vermont, Middlebury, on dead branches of cultivated currant, 23 Aug. 1901, Herbarium A.B. Langlois, BPI 55067

Notes: *Pleonectria berolinensis* is one of most common species of the genus *Pleonectria* easily recognised by its uniseriate asci and muriform ascospores (Figs 90G–K, 91B, C). In the natural environment, this species produces ascospores that bud outside the asci as does *Pleonectria okinawensis* (Figs 90J, K, 91C). However, *P. berolinensis* has muriform ascospores that are more than 15 µm long, while *P. okinawensis* has 1-septate ascospores that are less than 15 µm long. In culture, the anamorph of *P. berolinensis* is similar to *P. lamyi* in the size of the mature conidia, however, the shape of mature conidia of *P. berolinensis* are ellipsoidal, strongly constricted, while those of *P. lamyi* are cylindrical or C-shaped (Fig. 92L–N). In addition, *P. berolinensis* occurs on *Ribes*, and *P. lamyi* occurs on *Berberis*.

Historically, the anamorph of *P. berolinensis* had been placed in the genus *Tubercularia* because this species was often collected with a tubercularia-like fungus, sometimes on the same substrate. Booth (1959) mentioned a 'nomen confusum' between *P. berolinensis* and *Nectria ribis* Nießl that also bears a tubercularia-like anamorph. This 'nomen confusum' arose due to the short original protologue, imprecise designation of type specimens for these names, and confusion about the host and the teleomorph-anamorph relationship. *Pleonectria berolinensis* and *N. ribis* both occur on *Ribes*. In this study, we observed exsiccati specimens of *P. berolinensis* (Rabenhorst, Fungi europaei. No 264; Winter Fungi europaei. No 3650) at BPI, but these did not include the *Tubercularia* anamorph. We have also observed additional specimens identified

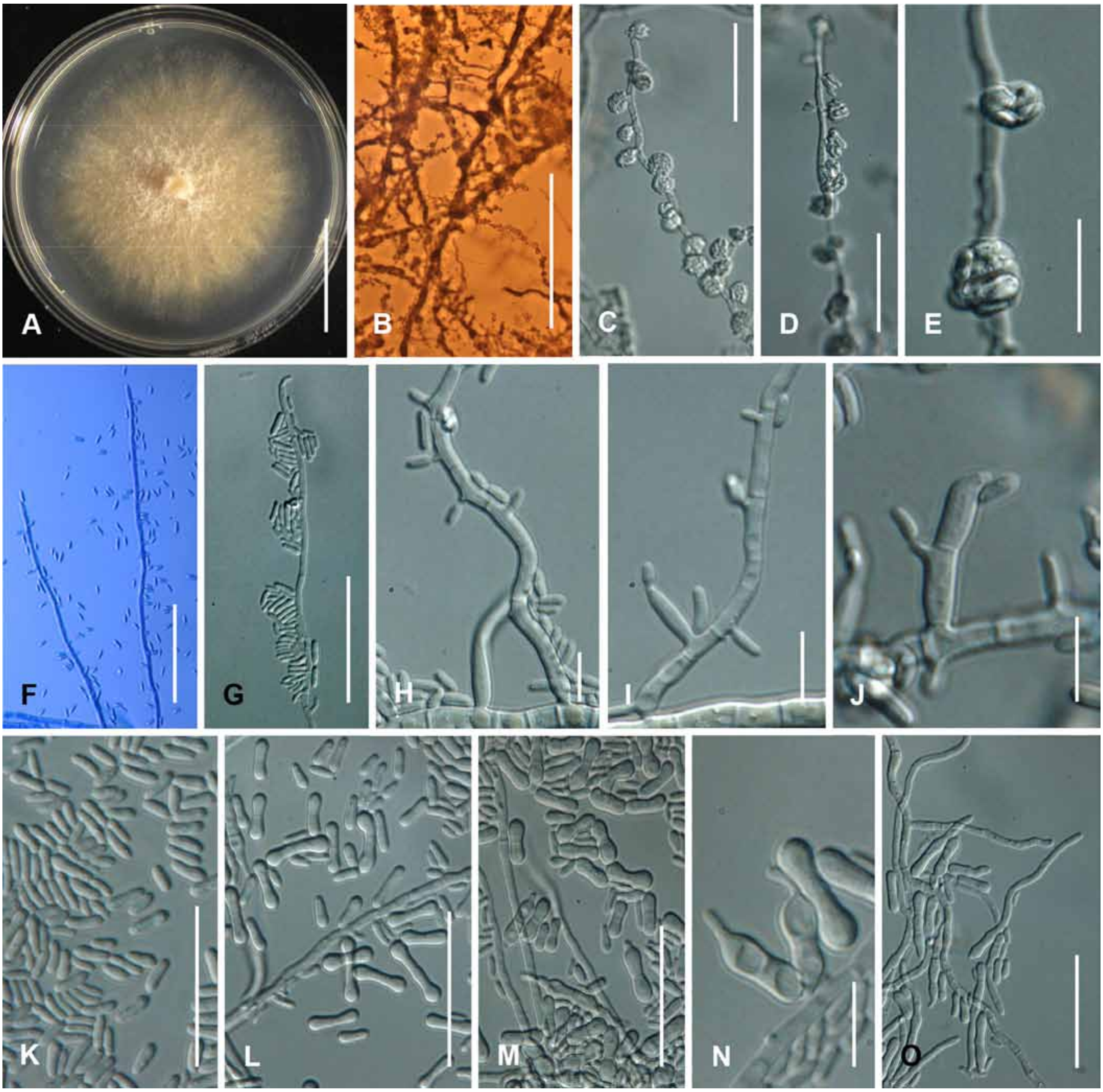

Fig. 92A–O. Anamorph of *Pleonectria berolinensis* in culture. A. Cultures after 7 d at 25 °C on PDA; B–E. Lateral phialidic pegs and conidial mass on SNA; F–I. Lateral phialidic pegs on SNA; J. Conidiophores on SNA; K. Young conidia on SNA; L. Mature conidia on SNA; M, N. Budding mature conidia on SNA; O. Germinating mature conidia on SNA. Scale bars: A = 3 mm; B = 100 µm; C, D, F, G, K–M, O = 30 µm; E, H–J, N. = 10 µm.

as *Nectria ribis* and *P. berolinensis* from BPI, NY, and PAD. A few specimens included pieces with *P. berolinensis* with other pieces of a tubercularia-like anamorph in the same packet. However, these two fungi have never been observed on the same branch (see Fig. 90M, N). In specimens of *N. ribis*, a few *P. berolinensis* were observed but most specimens labelled *N. ribis* were re-identified as *N. cinnbarina* or *N. dematiosa* (Hirooka *et al*. 2011). Our phylogenetic inference suggests that *P. berolinensis* belongs in *Pleonectria* with species having pycnidial anamorphs (Figs 1, 2). Two specimens (BPI 550671 & BPI 550691) have budding ascospores typical of the genus *Pleonectria* (Figs 90J, K, 91C). Although *N. ribis* was considered a synonym of *P. berolinensis* by Rossman *et al*. (1999), the type specimen of *Sphaeria ribis* suggests that this name is of uncertain status (Hirooka *et al*. 2011), but not a synonym of *P. berolinensis*. Booth (1959) noted that the terminal cells of conidiophores of "the sporodochial anamorph of *P. berolinensis*" were roughened; however, Seifert (1985) was not able to observe this characteristic. In our study, the sporodochial anamorphs observed on specimens of *P. berolinensis* appear to belong to *N. cinnbarina* or *N. dematiosa*. Based on cultures that do not appear tubercularia-like, the anamorph of *P. berolinesis* most likely has a zythiostroma-like anamorph (Fig. 92).

The name *Dendrodochium berolinense* was not published in Wollenweber (1931), although this name was erroneously listed by Seeler (1940b) as the anamorph of *P. berolinensis*, and is thus a *nomen nudem*.

Although the protologue of *P. berolinensis* states that this species occurs in Sri Lanka as Ceylon, no specimens from this locality were located even though the protologue lists such a specimen. It seems unlikely that this temperate species occurs in that country.

Pleonectria boothii Hirooka, Rossman & P. Chaverri, **sp. nov.** MycoBank MB519706. Figs 93–95.

Holotype of Pleonectria boothii. **Slovakia**, High Tatra Mountains, Podbanke, on dead twigs of *Picea abies*, A. Kunca, **Holotype** BPI 881052; **ex-holotype** culture CBS 128977 = A.R. 4481.

Etymology: *booth* + *-ii*: in reference to Dr Colin Booth in honor of his work on the genus *Nectria*.

Anamorph: zythiostroma-like.

Teleomorph on natural substrata: *Ascomata and pycnidia* sometimes formed on same or discrete stroma. *Mycelium* not visible around ascomata or on host. *Stromata* erumpent through epidermis, up to 1.0 mm high and 1.5 mm diam, orange to sienna, KOH+ dark purple, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, scattered to aggregated in groups of 3–20, subglobose to globose, 280–410 µm high × 308–363 µm diam, red to umber, cupulate upon drying, sometimes with only a depressed apical region, apical region slightly darker, KOH+ purple, LA+ yellow, surface sometimes bright yellow to yellowish green scurfy. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis* sometimes including bright yellow scurf, 4–11 µm diam, with pigmented, uniformly or irregularly, *ca.* 1.5 µm thickened walls. *Ascomatal wall* 27–67 µm thick, around apex to about 70 µm thick, of two regions, around apex with three regions: outer region 14–37 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, 5–10 µm diam, walls pigmented, about 1.0 µm thick; middle region produced around apex 7–19 µm thick, cells forming *textura globulosa*, 5–7 µm diam, walls pigmented, about 1.0 µm thick; inner region 10–15 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* narrowly clavate, increasing in size as ascospores mature, 72–104 × 8–11 µm, with inconspicuous ring at apex, 8-spored. *Ascospores* long-fusiform, cylindrical to long-cylindrical, muriform, with 7–25 transverse septa and usually one longitudinal septum, hyaline, (15.6–)20.3–29.7(–36.0) × (2.8–)3.2–4.2(–4.6) µm (*n* = 50), smooth, budding to produce hyaline, thin-walled, tapering apex, slightly curved, *bacillar ascoconidia*, (1.9–)2.8–3.6(–4.1) × (0.6–)0.9–1.7(–2.0) µm (*n* = 50), that fill asci.

Anamorph on natural substrata: *Stromata* erumpent through epidermis or developing with ascomata, orange to red. *Pycnidia* solitary or aggregated in groups of 3–10, superficial on stroma or rarely immersed at base, subglobose, smooth to slightly rough, cerebriformis upon drying, bay to umber, 248–444 µm, 144–294 µm diam, KOH+ slightly darker, LA+ slightly yellow. *Pycnidial wall* 17–30 µm thick, of two regions: outer region 11–19 µm thick, intergrading with stroma, cells forming *textura globulosa*, walls pigmented, about 1.0 µm thick; inner region 5–11 µm thick, of elongate, thin-walled, hyaline cells, forming t*extura prismatica*. *Conidiophores* densely branched, generally 1–3-branched, 19–30 µm long, 0.8–1.3 µm wide. *Conidiogenous cells* cylindrical to subulate, straight to slightly curved, enteroblastic, monophialidic, 7.3–10.0 × 1.2–1.6 µm. *Intercalary phialides* generally observed, bearing 1(–3) terminal phialides, up to 4 µm long, similar to short, acropleurogenous conidiophores. *Sterile hyphae* absent. *Conidia* hyaline, oblong to allantoid, curved, non-septate, (1.9–)2.4–3.0(–3.2) × (0.6–)0.8–1.0(–1.2) µm (*n* = 150).

Anamorph in culture: After 7 d at 25 °C, colonies 7–8 mm (average 7.4 mm) diam. *Colony surface* cottony with aerial mycelium, saffron to whitish yellow; *aerial mycelium* rarely developed, usually small white to whitish yellow sporodochial conidial masses produced after 3 wk; *reverse* withish yellow. *Odour* on PDA absent. Sporulation on SNA from *lateral phialidic pegs* abundant, enteroblastic, monophialidic, ellipsoidal, tapering toward tip or rarely narrowly flask-shaped, 2.0–3.0 µm long, 0.7–1.1 µm wide at base. *Conidiophores* unbranched, sometimes 1(–2)-branched, becoming loosely to moderately densely branched, 16–24 µm long, 1.7–3.0 µm wide at base. *Conidiogenous cells* monophialidic, enteroblastic, cylindrical, slightly tapering toward tip or narrowly flask-shaped with widest point in middle, 3.6–10.0 µm long, 1.1–1.9 µm wide at base. *Young conidia* formed from monophialides on aerial, submerged, or repent hyphae, formed abundantly on slimy heads or sporodochia, oblong to cylindrical, hyaline, straight or slightly curved, rounded at both ends, non-septate, (3.1–)3.6–4.8(–5.5) × (0.9–)1.0–1.6(–2.1) µm (*n* = 50), smooth-walled. *Mature conidia* swollen, 0-septate, long-cylindrical to allantoid, hyaline, smooth, sometimes curved, rounded at both ends, (7.5–)8.9–10.9(–12.3) × (1.3–)1.5–1.9(–2.0) µm (*n* = 50). *Chlamydospores, pycnidia, and ascomata* not produced in culture.

Habitat: On dead branch of dead twigs of *Picea abies* (*Pinaceae*).

Distribution: Europe (Slovakia, known only from the type collection).

Notes: Observing the muriform ascospores of *Pleonectria boothii* may be difficult because the longitudinal septatum is obscure and sometimes absent especially when the ascospores are immature. However, using cotton blue, the longitudinal septum becomes visible (Fig. 93G–K).

Among species of *Pleonectria*, *P. boothii* resembles *P. balsamea* and *P. pinicola* in the muriform ascospores with budding ascoconidia in the asci. Host specificity and width of ascospores are useful characteristics to distinguish these species. The anamorphic states of *P. boothii*, *P. balsamea,* and *P. pinicola* in nature and culture have only subtle differences between them.

Based on our phylogenetic tree, most species of *Pleonectria* on conifers group into one large monophyletic clade (clade I-4). Surprisingly, *P. boothii* does not fall into that clade although the fungus was collected on *Picea. Pleonectria coryli* shows the closest affinity to *P. boothii* (Figs 1, 2). The ascospores of *P. boothii* are muriform while those of *P. coryli* are 2-septate. The two species both have ascomata with walls of three regions around the apex as also observed in *P. aquifolii* and *P. ilicicola* (Figs 93D, 94A). Booth (1959) was the first to describe and illustrate the three regions of the ascomatal wall around the apex of *P. aquifolii* and *P. coryli*. Because he discovered this important diagnostic characteristic, we name this species in honor of Dr C. Booth for his careful observations.

Pleonectria chlorinella (Cooke) Hirooka, Rossman & P. Chaverri, **comb. nov.** MycoBank MB519707. Figs 96, 97.
Basionym: *Nectria chlorinella* Cooke, Grevillea 11: 108. 1883.
≡ *Calonectria chlorinella* (Cooke) Sacc., Syll. Fung. 2: 543. 1883.
≡ *Thyronectria chlorinella* (Cooke) Seeler, J. Arnold Arbor. 21: 444. 1940.
Anamorph: unknown.

Teleomorph on natural substrata: *Mycelium* not visible around ascomata and on host. *Stromata* formed on epidermal region of outer bark, 0.2 mm high and 0.6 mm diam, cells forming *textura intericata* to *t. angularis*, KOH- and LA-, intergrading with

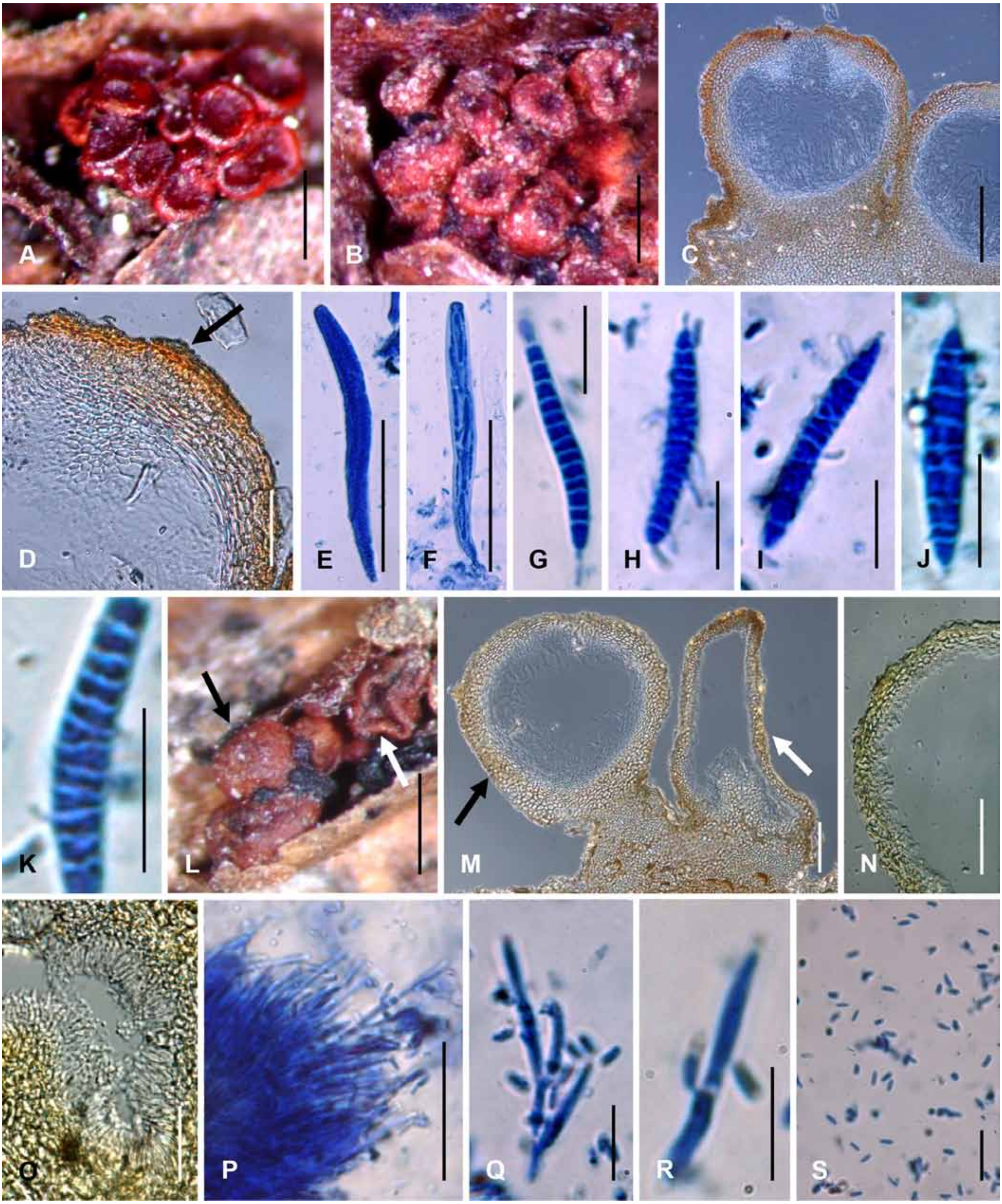

Fig. 93A–S. *Pleonectria boothii* on natural substrata (A–K teleomorph, L, M teleomorph and anamorph, N–S anamorph). A, B. Perithecia on natural substrata; C. Median section of perithecia on natural substrata; D. Median section of perithecial apex of three regions (black arrow); E. Ascus having budding ascospores; F. Ascus having unbudding ascospores; G–K. Budding ascospores; L. Perithecium (black arrow) and pycnidia (white arrow) on natural substrata; M. Median section of perithecium (black arrow) and pycnidium (white arrow) on natural substrata; N. Median section of pycnidial wall; O–R. Conidiophores on natural substrata; S. Conidia on natural substrata. Scale bars: A, B, L = 500 µm; C, M = 100 µm; D–F, N–P = 50 µm; G–K, Q–S = 10 µm.

ascomatal wall. *Ascomata* scattered to aggregated in groups of 2–15, superficial, subglobose to pyriform, 280–360 µm high × 255–320 µm diam, not collapsing when dry, sienna, often fully covered with whitish yellow, bright yellow to yellowish green scurf, with a slightly darkened papilla, KOH+ slightly dark red, LA+ slightly yellow. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis* sometimes including bright yellow scurf, 4–11 µm diam, with pigmented, irregularly, *ca.* 1.5 µm thick walls. *Ascomatal wall* 40–50 µm thick, often fully covered by bright yellow scurf, of two regions: outer region 22–34 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls slightly pigmented, about 1.5 µm thick; inner region 9–13 µm thick, of

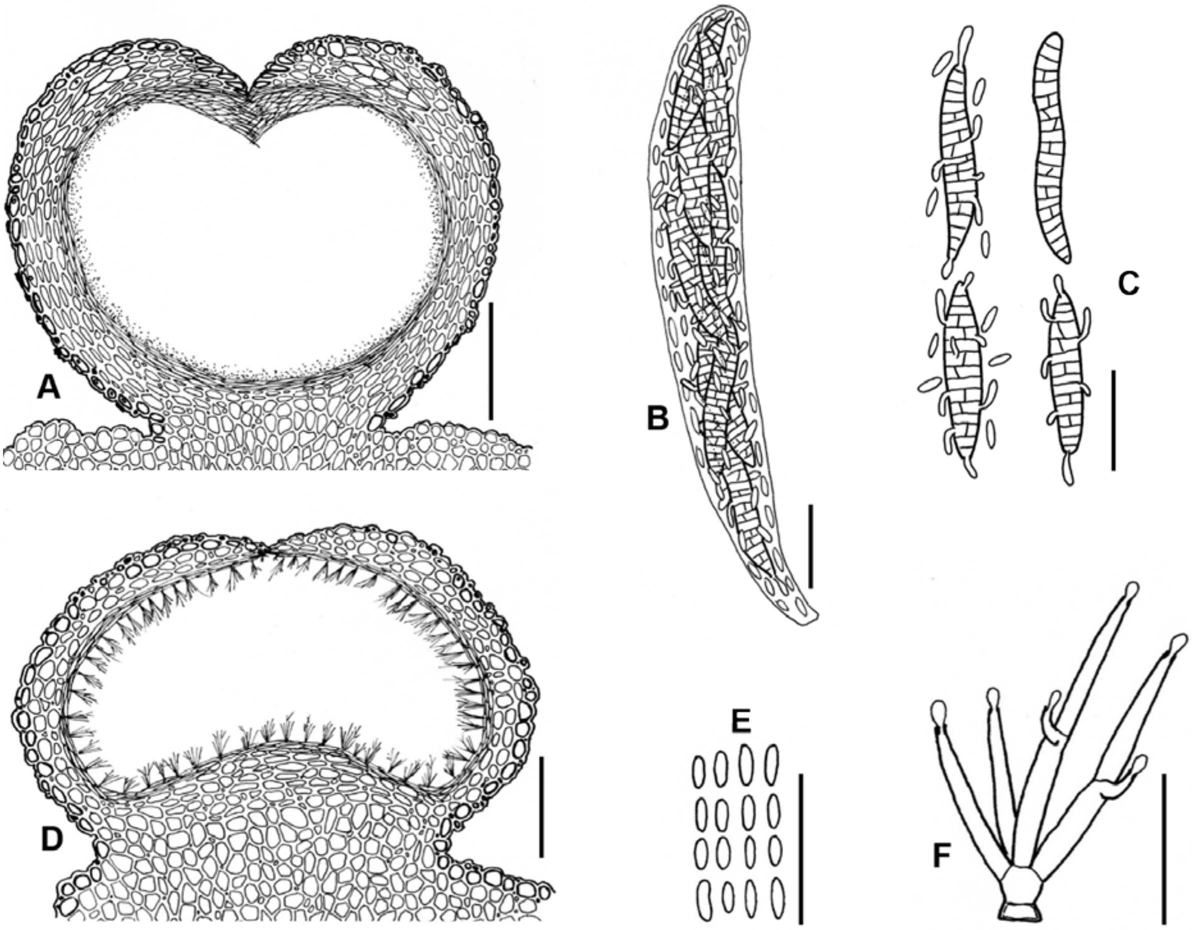

Fig. 94A–F. *Pleonectria boothii* on natural substrata (A–C teleomorph, D–F anamorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores and ascoconidia; D. Median section of mature Pycnidium; E. Conidia; F. Conidiophores. Scale bars: A, D = 100 µm; B, C, E, F = 10 µm.

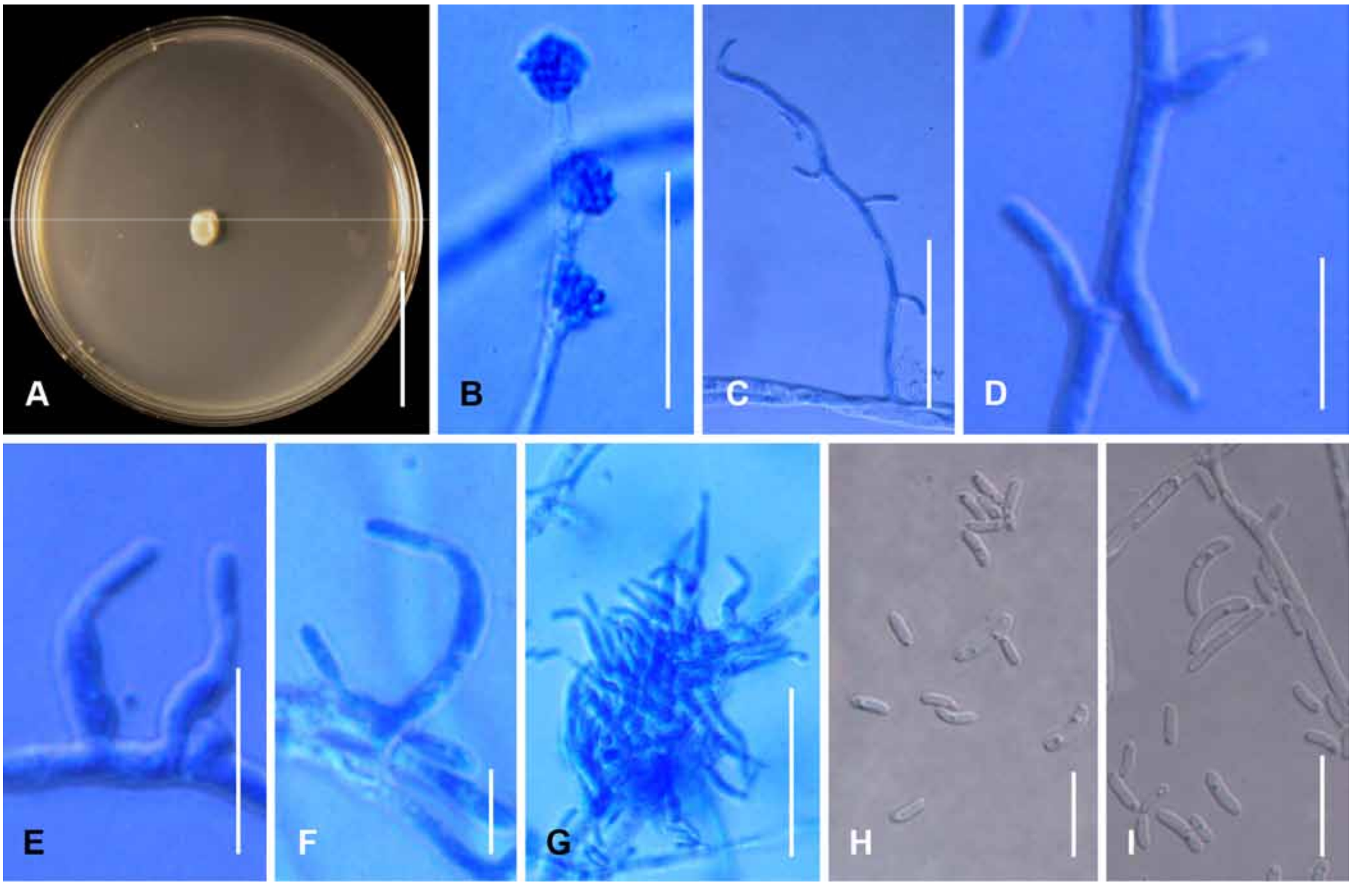

Fig. 95A–I. Anamorph of *Pleonectria boothii* in culture. A. Cultures after 7 d at 25 °C on PDA; B. Lateral phialidic pegs and conidial mass on SNA; C–E. Lateral phialidic pegs on SNA; F, G. Conidiophores on SNA; H. Young conidia on SNA; I. Young and mature conidia on SNA. Scale bars: A = 3 mm; B, C, G = 50 µm; D–F = 5 µm; H, I = 10 µm.

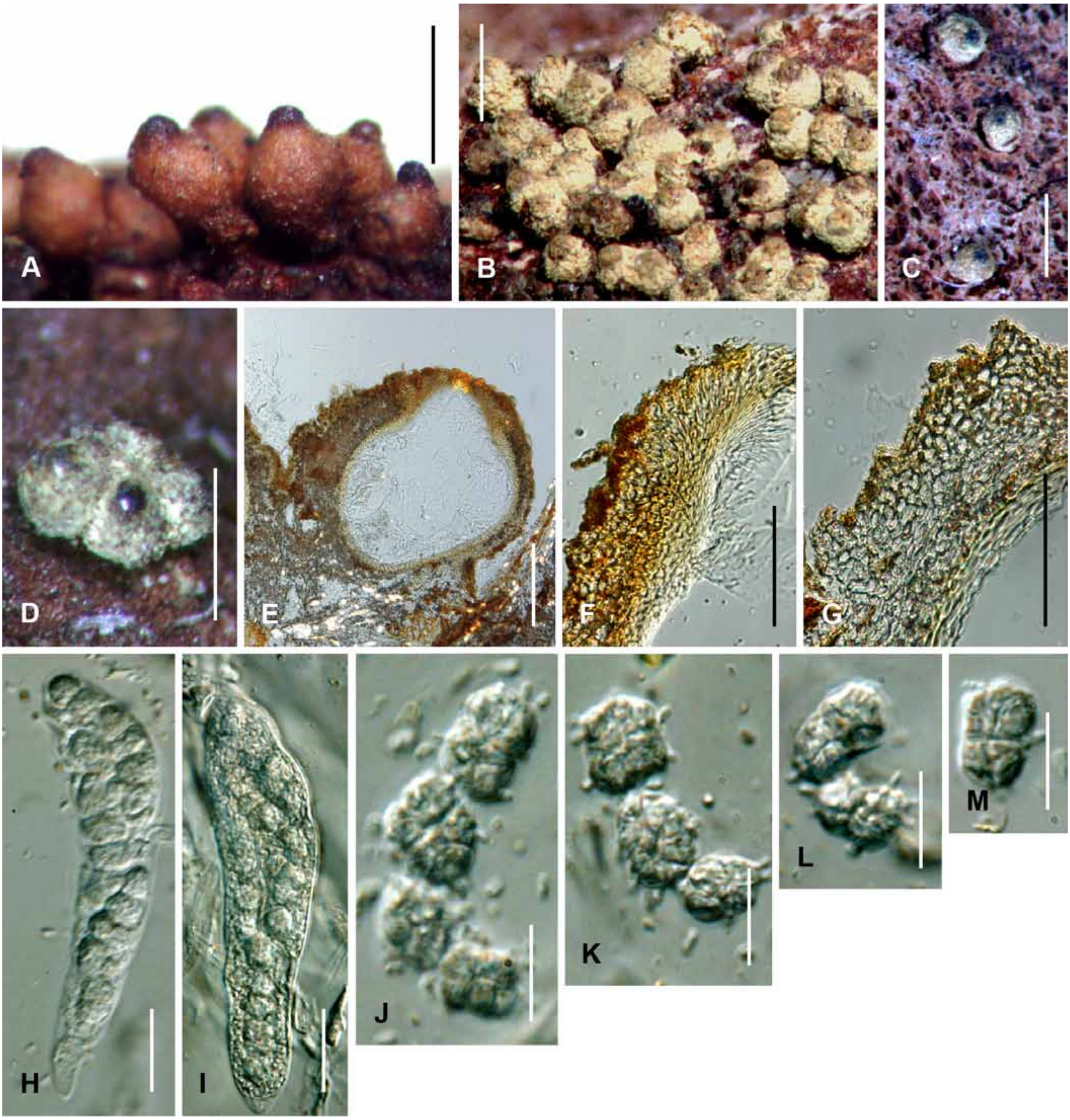

Fig. 96A–M. *Pleonectria chlorinella* on natural substrata (teleomorph). A–D. Perithecia on natural substrata; E. Median section of perithecium on natural substrata; F. Median section of perithecial apex; G. Median section of perithecial wall; H. Ascus having unbudding ascospores; I. Ascus having budding ascospores; J–M. Budding part–ascospores. Scale bars: A–D = 500 µm; E = 100 µm; F, G = 50 µm; H, I = 20 µm; J–M = 10 µm.

elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* clavate, increasing in size as ascospores mature, 70–105 × 10–25 µm, with inconspicuous ring at apex, 4–8-spored, ascospores mainly biseriate. *Ascospores* muriform, with 3–4 transverse septa, usually 1 longitudinal septum, hyaline, fusiform, constricted at each septum, (19.9–)20.0–27.4(–30.8) × (6.2–)6.7–8.7(–10.0) mm (*n* = 30), disarticulating in asci. *Part-ascospores* subglobose to ellipsoidal, hyaline, (7.7–)8.7–12.1(–13.4) × (5.0–)6.4–8.4(–9.0) µm (*n* = 30), smooth, muriform, with 1(–2) transverse septa, usually 1 longitudinal septum, constricted at each septum, budding to produce hyaline, thin-walled, *bacillar ascoconidia* (2.1–)2.5–3.3(–3.5) × (1.4–)1.6–2.2(–2.6) µm (*n* = 30), filling asci.

Habitat: On dead wood (*Platanus occidentalis*, *Ulmus americana*, *Ulmus* sp.).

Distribution: North America (USA).

Lectotype of Nectria chlorinella *designated herein*: **USA**, South, Carolina, Seaboard, on bark of *Ulmus americana*, Apr. 1881, M.C. Cooke, **Lectotype** Ravenel, Fungi Americani, No.736, BPI-bound exsiccati; **Isolectotype** BPI 631964, NY 01041525, NY 01041526, NY 01041527.

Additional specimens and isolates examined: **USA**, Alabama, Montgomery, on bark, Sep. 1916, R.P. Burke, BPI 632607 as *Nectria pyrrhochlora*; Tennessee, on *Platanus occidentalis*, 17 Mar. 1927, Hesler, NY.

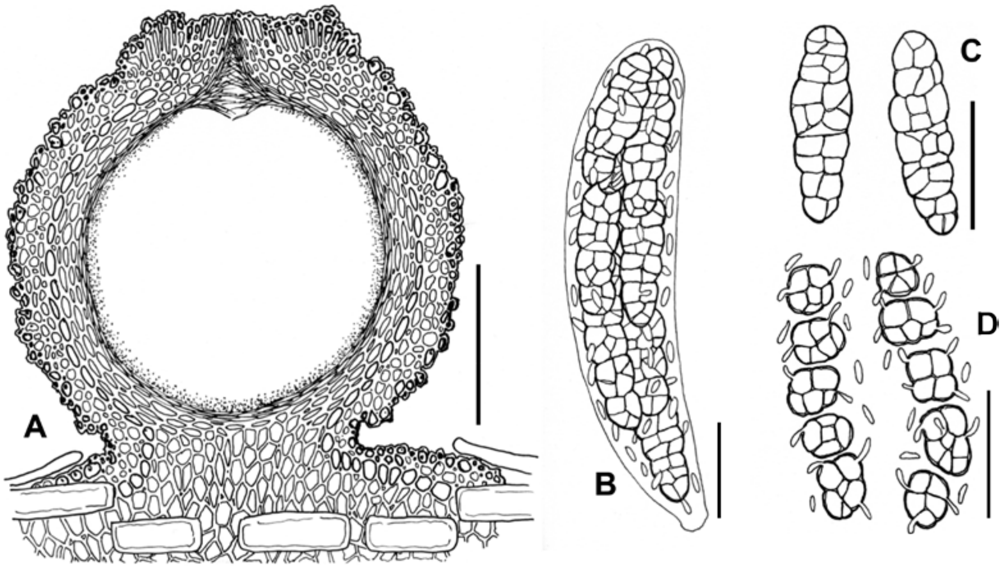

Fig. 97A–D. *Pleonectria chlorinella* on natural substrata (A–D teleomorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores; D. Part–ascospores and ascoconidia. Scale bars: A = 100 µm; B–D = 20 µm.

Notes: This species was re-described and re-illustrated by Seeler (1940b as *Thyronectria chlorinella*) and Samuels *et al*. (2006 as *Nectria chlorinella*). It is placed in *Pleonectria* based on the ascospores that bud to produce ascoconidia in the asci and the whitish to yellowish green scurf on the ascomatal wall, both of which are critical morphological characteristics of *Pleonectria*. This species can be easily identified by the disarticulating ascospores that are unknown in other species of *Pleonectria* and nectria-like fungi (Figs 96J–M, 97D). The abundant bright yellow scurf on the ascomata also occurs in *P. austroamericana, P. virens,* and *P. zanthoxyli* that constitute a monophyletic clade within *Pleonectria* in our phylogenetic tree (Figs 1, 2). Based on the characteristics that suggest placement in *Pleonectria*, we predict that *Pleonectria chlorinella* has a pycnidial anamorph in the natural environment.

In the protologue of *Nectria chlorinella* (Cooke 1883), no single type specimen is mentioned. Thus, we lectotypify this name with Ravenel, Fungi Americani, No.736, BPI-bound exsiccati; a second specimen of this number (BPI 631964) is an isolectotype.

Pleonectria clavatispora Hirooka, Rossman & P. Chaverri, **sp. nov.** MycoBank MB519708. Figs 98, 99.

Holotype of Pleonectria clavatispora: **USA**, California, Big Dalton Canon, E. Los Angeles County, on *Ribes speciosum*, 2 Jan. 1935, O.A. Plunkett, **Holotype** BPI 552452 as *Nectria lamyi*, **Isotype** BPI 552453 as *Nectria lamyi*).

Etymology: *Clavati* + *-spora*; indicates the shape of its asocpsores.

Anamorph: unknown.

Teleomorph on natural substrata: *Mycelium* not visible around ascomata and on host. *Stromata* erumpent through epidermis, 2.0 mm high and 2.0 mm diam, bay, KOH+ dark red, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, basically aggregated in groups of 2–55, subglobose to globose, 260–480 µm high × 250–440 µm diam, cupulate upon drying, sometimes with a depressed apical region, red to bay, apical region nearly black, KOH+ purple, LA+ yellow, sometimes outer surface scurfy, yellowish green. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis* including bright yellow scurf, 4–13 µm diam, with pigmented, irregularly, *ca.* 1.5 µm thick walls. *Ascomatal wall* 35–65 µm thick, around apex up to about 80 µm thick, of two regions: outer region 26–48 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.5 µm thick; inner region 9–21 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* clavate, increasing in size as ascospores mature, 72–141 × 9–17 µm, with inconspicuous ring at apex, 8-spored, ascospores mainly biseriate above, uniseriate below. *Ascospores* clavate, hyaline, muriform with 6–14 transverse septa, usually 1 longitudinal septum, (15.8–)17.7–22.7(–36.4) × (4.3–)4.8–6.2(–7.0) µm (*n* = 55), smooth, budding to produce hyaline, thin-walled, *bacillar ascoconidia*, (2.2–)2.5–3.5(–4.2) × (1.0–)1.3–2.1(–2.5) µm (*n* = 50), that fill asci.

Habitat: On dead twigs of *Ribes* including *R. indecorum* and *R. speciosum (Grossulariaceae)*.

Distribution: North America (USA).

Additional specimen examined: **USA**, California, Eagle Canon, Corona, on *Ribes indecorum*, 26 Jan. 1939, H.S. Fawcett, C.L. Shear, BPI 550708 as *Nectria* sp.

Notes: Specimens of this fungus were originally preserved and identified as *N. berolinensis* or *N. lamyi* in BPI. These specimens have clavate ascospores, an unusal characteristic in *Pleonectria* (Figs 98G, H, 99C). The greenish yellow scurf on the ascomata and budding ascospores are typical morphological characteristics of *Pleonectria. Pleonectria clavatispora* is known only on the dead wood of *Ribes.*

Pleonectria coryli (Fuckel) Hirooka, Rossman & P. Chaverri, **comb. nov.** MycoBank MB519709. Figs 100–102.

Basionym: *Nectria coryli* Fuckel, Fung. Rhen. Exs., suppl. 1, no. 1582. 1865.

≡ *Chilonectria coryli* (Fuckel) Ellis & Everh., N. Amer. Pyrenomyc. p.117. 1892.

≡ *Creonectria coryli* (Fuckel) Seaver, Mycologia 1: 186. 1909.

= *Coelosphaeria acervata* P. Karst., Meddeland. Soc. Fauna Fl. Fenn. 5: 56. 1879.

= *Nectria coryli* f. *salicis* Rehm, Ascomyceten Exsicc. No. 680. 1882.

Anamorph: zythiostroma-like.

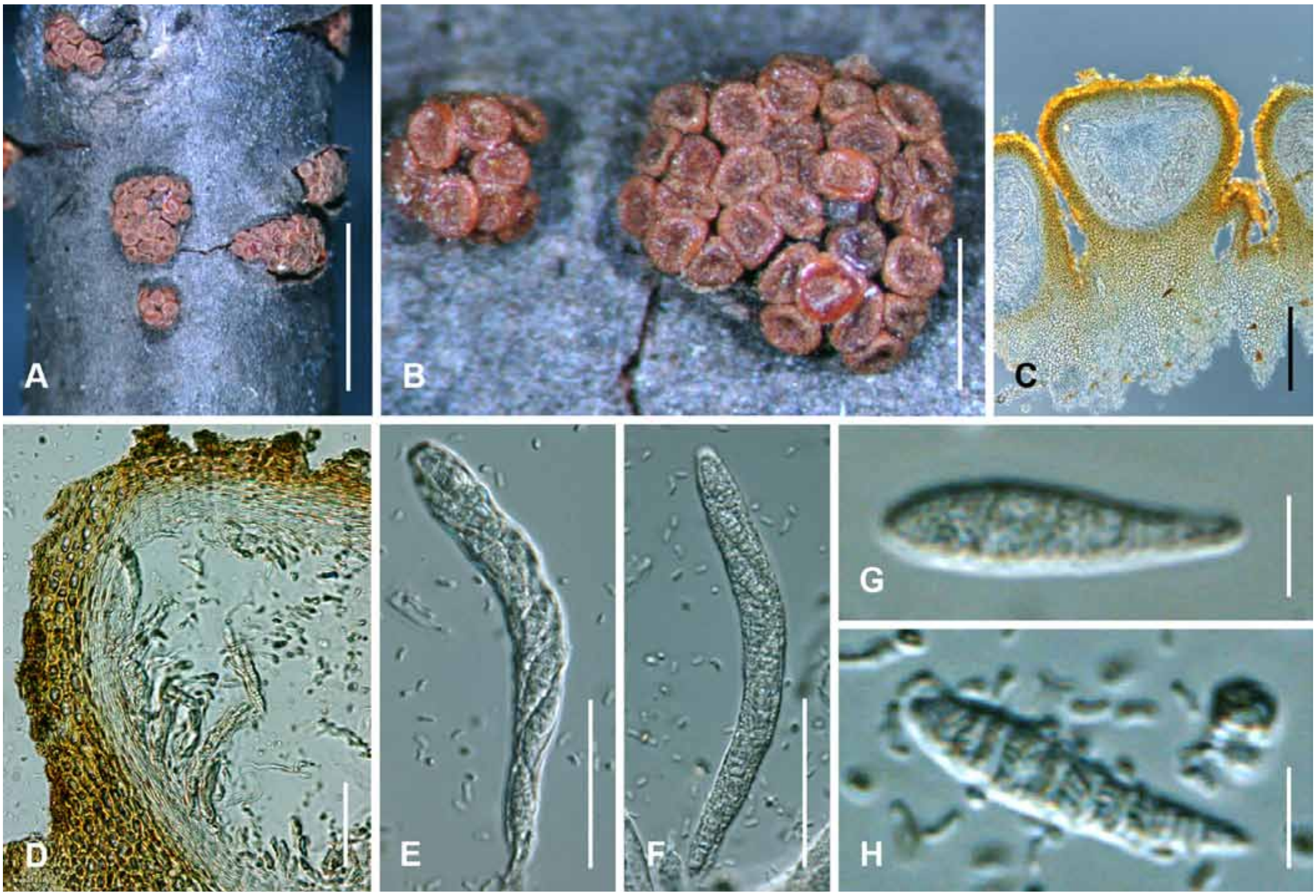

Fig. 98A–H. *Pleonectria clavatispora* on natural substrata (teleomorph). A, B. Perithecia on natural substrata; C. Median section of perithecia on natural substrata; D. Median section of perithecial wall; E. Ascus having unbudding ascospores; F. Ascus having budding ascospores; G. Ascospore; H. Budding ascospore and ascoconidia. Scale bars: A = 3 mm; B = 500 µm; C = 200 µm; D–F = 50 µm; G, H = 5 µm.

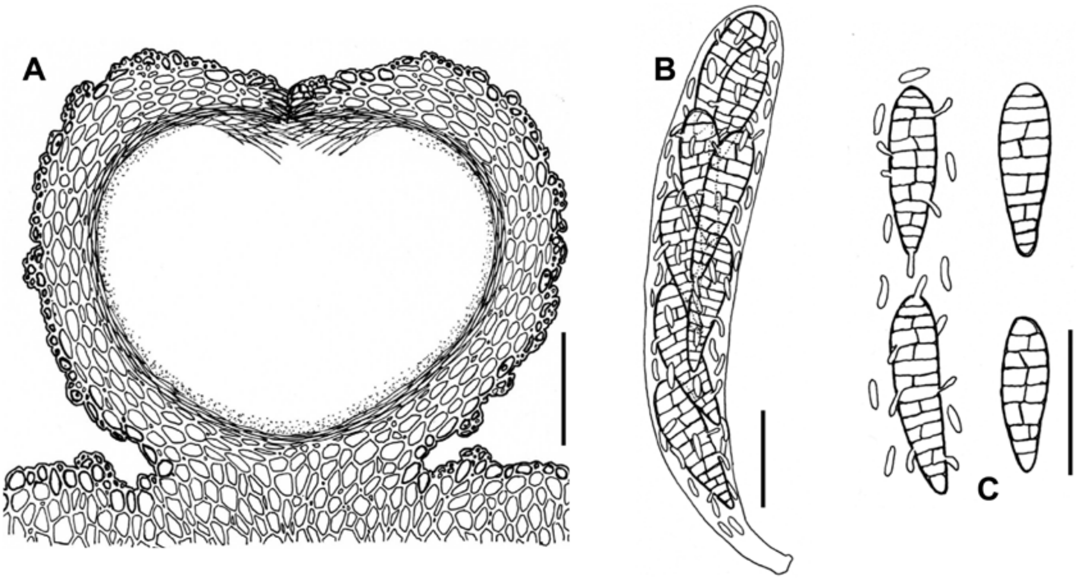

Fig. 99A–C. *Pleonectria clavatispora* on natural substrata (A–C teleomorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores and ascoconidia. Scale bars: A = 100 µm; B, C = 20 µm.

Teleomorph on natural substrata: *Mycelium* not visible around ascomata and on host. *Stromata* erumpent through epidermis, 3.0 mm high and 3.0 mm diam, bay, KOH+ dark red, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, aggregated in groups of 5–60, subglobose to globose, 150–435 µm high × 150–380 µm diam, cupulate upon drying, sometimes with a depressed apical region, scarlet to bay, apical region slightly darker, KOH+ dark red, LA+ yellow, smooth, rarely surface yellow to yellowish green scurfy, sometimes scaly when dry. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis* sometimes including bright yellow scurf, 3–15 µm diam, with pigmented, sometimes irregularly, *ca.* 1.5 µm thick walls. *Ascomatal wall* 25–70 µm thick, around apex up to about 80 µm thick, of two regions, around apex with three regions: outer region 15–35 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.0 µm thick;

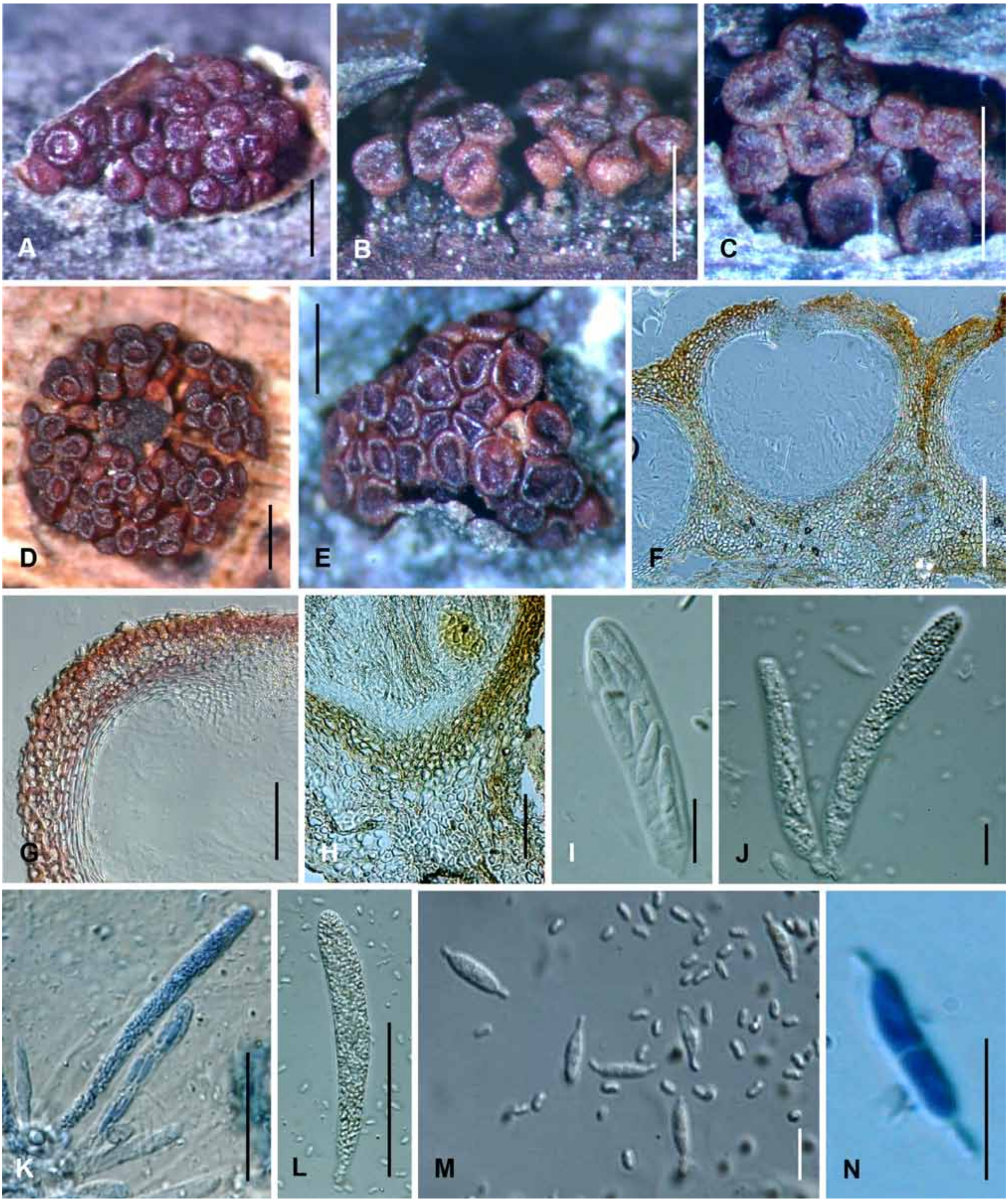

Fig. 100A–N. *Pleonectria coryli* on natural substrata (teleomorph). A–E. Perithecia on natural substrata; F. Median section of perithecia on natural substrata; G. Median section of perithecial apex; H. Median section of stroma; I. Ascus having unbudding ascospores; J–L. Asci having budding ascospores; M, N. Budding ascospores and ascoconidia. Scale bars: A–E. = 1 mm; F = 200 µm; G, H, K, L = 50 µm; I, J, M, N = 10 µm.

middle region produced around apex, 10–15 µm thick, cells forming *textura globulosa*, 5–10 µm diam, walls pigmented, about 1.0 µm thick; inner region 10–20 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* clavate, increasing in size as ascospores mature, 40–115 × 5–15 µm, with inconspicuous ring at apex, 8-spored, ascospores mainly biseriate. *Ascospores* narrowly fusiform to cylindrical, straight, hyaline, 1-septate, (8.3–)10.2–12.8(–15.3) × (2.2–)2.8–4(–5.3) µm (*n* = 347), smooth, budding to produce hyaline, thin-walled, *bacillar ascoconidia*, (2.2–)3.5–5.1(–10.8) × (1.1–)1.7–2.5(–3.7) µm (*n* = 528), that fill asci.

Anamorph in culture: After 7 d at 25 °C, colonies 21–44 mm (average 36 mm) diam. *Colony surface* slightly cottony with aerial mycelium, whitish yellow, with sparse aerial mycelium; *reverse* white to slightly whitish yellow. *Odour* on PDA slightly fruity. Sporulation on SNA from *lateral phialidic pegs* abundant, ellipsoidal, slightly tapering toward tip or flask-shaped, 1.7–4.7 µm long, 1.0–2.2 µm wide at base, monophialidic. *Conidiophores* rarely formed, unbranched, 7.3–15.2 µm long, 1.5–2.6 µm wide at base. *Conidiogenous cells* monophialidic, enteroblastic, cylindrical, slightly tapering toward tip, 4.2–9.0 µm long, 1.5–2.5 µm wide at base. *Young conidia* formed

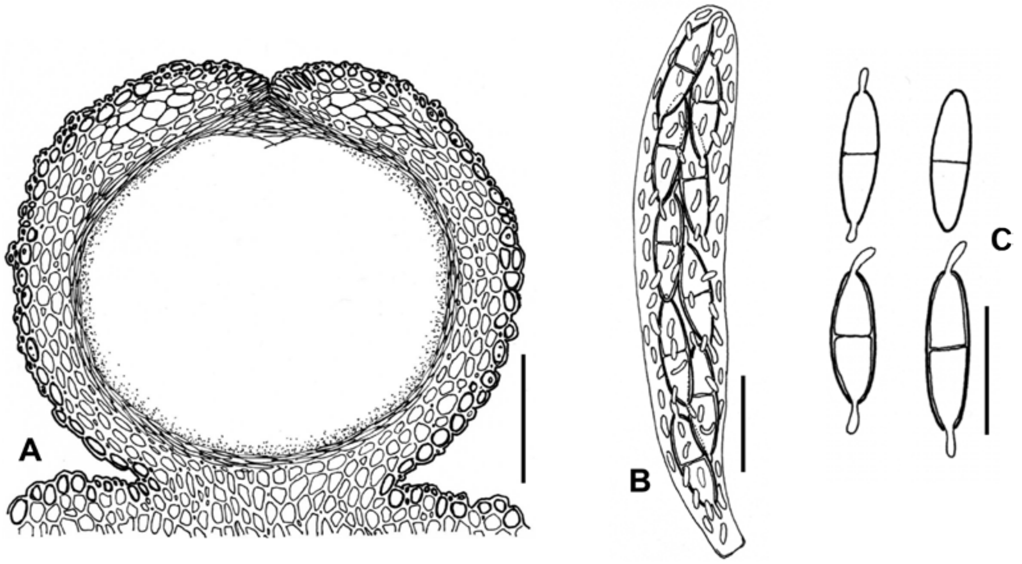

Fig. 101A–C. *Pleonectria coryli* on natural substrata (A–C teleomorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores. Scale bars: A = 100 µm; B, C = 10 µm.

on monophialides on aerial, submerged, or repent hyphae, formed abundantly on slimy heads or sporodochia, oblong to long cylindrical or allantoid, hyaline, smooth, straight or often curved, rounded at both ends, non-septate, (3.1–)4.0–5.4(–6.0) × (1.0–)1.4–1.8(–2.0) µm (*n* = 50), smooth-walled. *Mature conidia* swollen, non-septate, ellipsoidal or oblong, hyaline, smooth, straight or curved, rounded at both ends, germinating (H.Y. 08-20), budding on media (CBS 114603), (6.0–)8.6–10.6(–12.9) × (1.6–)2.0–3.0(–3.4) µm (*n* = 30). *Chlamydospores*, *ascomata* and *pycnidia* not produced in culture.

Habitat: On dead bark or twigs of deciduous trees (*Acer spicatum*, *Alnus* sp., *Betula alba*, *Celastrus orbiculatus*, *Corylus avellana*, *Diospyros virginiana*, *Fraxinus americana*, *Lalis baprea*?, *Ligustrum vulgare*, *Liriodendron tulipifera*, *Liriodendron* sp., *Populus* sp., *Prunus maritima*, *Prunus spinosa*, *Pyrus communis*, *Rhus copallinum*, *R. glabra*, *R. typhina*, *Salix aurita*, *S. caprea*, *Salix* sp., *Viburnum dentatum*, *V. lantana*., *Viburnum* sp.).

Distribution: Europe (Austria, Belgium, Czech Republic, Finland, France, Germany, Sweden), North America (Canada, USA).

Lectotype of Nectria coryli *designated herein*: **Germany**, on twigs of *Corylus avellana*, **Lectotype** Fuckel, Fungi Rhenani Exsiccati 1582, FH.

Additional type specimens examined: Type of *Coelosphaeria acervata*: **Finland**, Tammela, Mustiala, 7 Apr. 1866, P.A. Karsten, **Lectotype** designated herein, H 6011373). Type of *Nectria coryli* f. *salicis*: **Germany**, Sachsen, on *Salix caprea*, Feb. 1877, Krieger, **Lectotype** designated herein, S F 84579S; **Isolectotype** S F 84581).

Additional specimens and isolates examined: **Austria**, St. Margareten im Rosental, Karnten, on the edge of the little forest Stariwald, mapping grid square 9452/4, alt. 600 m, on *Viburnum lantana*, 26 Oct. 1998, W.M. Jaklitsch WJ 1262, BPI 746347, culture CBS 115619 = A.R. 2777). **Belgium**, Brussels, on *Salix* sp., 17 Jan. 1923, A.J. Watson, BPI 551421. **Canada**, Ontario, Bear Island, Lake Temagami, on *Rhus typhina*, 20 Aug. 1935, J.R. Hansbrough, BPI 551411. **Czech Republic**, Bohemia, on *Prunus spinosa*, 1 Oct. 1918, Petrak, BPI 551411; **France**, Rimbaud (79) Forêt de Chizé, on *Corylus avellana*, C. Lechat CLL 651, BPI 881053, culture CBS 129358 = A.R. 4583. **Germany**: Koenigstein, on *Betula alba*, 7 Aug. 1885, W. Krieger, BPI 551411; Prov. Brandenburg, on *Corylus avellana*, 22 Mar. 1910, O. Jaap, BPI 550397; Olpe Kr., Rhode, on *Corylus avellana*, 30 Apr. 1921, C.A. Ludwig, BPI 551412; Olpe Kr., Rhode, on *Corylus avellana*, 30 Apr. 1921, C.A. Ludwig, BPI 551413; Koenigstein, on *Salix aurita*, Jun. 1894, W. Krieger, BPI 551422; Hamburg, im Diekmoor Bei Langenhorn, on *Salix aurita*, 28 May 1908, O. Jaap, BPI 551427; Siegen Kr., on *Salix caprea*, 23 Jan. 1938, C.A. Ludwig, BPI 551423; Siegen Kr., on *Salix caprea*, 1938, C.A. Ludwig, BPI 551424; Prencow, Kiepr, 17 Jun. 1896, K. Andr., BPI 551405; München, Isarauen, on *Ligustrum vulgare*, Nov. 1889, Schnabl., Allescher & Schnabl, Fungi bavarici, No. 65, BPI-bound exsiccati; Königstein, nicht häufig, on *Salix aurita*, Jun. 1894, W. Krieger., Krieger, Fungi saxonici, No. 1067, BPI-bound exsiccati; Königstein, selken, on *Betula alba*, Aug. 1885, W. Krieger., Krieger, Fungi saxonici, No. 125, BPI-bound exsiccati); Hamburg, im Diekmoor bei Langenhorn, on *Salix aurita*, May 1908, O. Jaap, Jaap, Fungi selecti exsiccati, No. 316, BPI-bound exsiccati; Landsberg, Foret Marwitz, on *Salix caprea*, Jul. 1886, P. Sydow, Sydow, Mycotheca Marchica, No. 1151, BPI-bound exsiccati. **Germany**, Windscheim, on *Corylus avellana*, Apr. 1874, Rehm, Rehm, Ascomyceten, No. 231, BPI-bound exsiccati. **Sweden**, Fries, Scler. Suec. No. 183, BPI-bound exsiccati. **USA**, Alaska, Kodiak, on *Salix* sp. 27 Aug. 1838, D.V. Baxter, BPI 551420; Maryland, Takoma Park, 14 Dec. 1902, C.L. Shear, BPI 550404; Connecticut, Stamford, on *Diospyros virginiana*, 10 Apr. 1946, F.A. Bartlett, R.P. Marshall, BPI 551414; Connecticut, East Granby, on *Fraxinus americana*, 15 Nov. 1936, H.G. Eno, BPI 551415; Maryland, Takoma Park, on *Liriodendron* sp., May 1916, C.L. Shear, BPI 550401; Maryland, on *Pyrus communis*, 29 Aug. 1893, C.L. Shear, det. A.J. Watson, BPI 551418 as *N. coryli*; Maryland, Beltsville, on *Rhus copallinum*, 30 Sep. 2008, Y. Hirooka, A. Minnis, A.Y. Rossman, BPI 880697, culture CBS 129156 =A.R. 4561 = Y.H. 08-15; Maryland, Beltsville, on *Celastrus orbiculatus*, 31 Oct. 2008, Y. Hirooka, A. Minnis, BPI 881054, culture CBS 129744 = A.R. 4566 = Y.H. 08-20; North Carolina, Bent Creek, Asheville, on *Liriodendron tulipifera*, 3 Jun. 1935, G.H. Hepting, BPI 551416; Oregon, Wallowa Lake, on *Populus* sp. 20 Aug. 1899, C.L. Shear, BPI 551417; New York, MCLEAN, 02 Jun.1919 - 07 Jun. 1919, E.W. Olive, F.J. Seaver, A.H.W. Povah, H.H. Whetzel, L.R. Hesler, H.M. Fitzpatrick, *et al*., BPI 551406; New York, McLean Swamps, 02 Jun.1919 - 07 Jun. 1919, E.W. Olive, F.J. Seaver, A.H.W. Povah, H.H. Whetzel, L.R. Hesler, H.M. Fitzpatrick, *et al*., BPI 551407; New York, Westbury, Nassau Co., Long Island, 25 Jun. 1915, H. Metcalf, BPI 630474; Maryland, Prince Georges Co., Beltsville Agricultural Research Center, east side, on dead branches of *Viburnum dentatum*, 13 May 2003, A.Y. Rossman, BPI 863587; Virginia, Falls Church, on *Viburnum* sp., Apr. 1936, C.L. Shear, BPI 551425; New York, Rockland Co., Harriman State Park, 24 Sep. 1966, C.T. Rogerson, NY, culture C.T.R. 66-82; New York, Bronx county the New York Botanical Garden, 19 Nov. 1977, C.T. Rogerson, NY, culture C.T.R. 77-352; New Jerssey, Newfield, on *Prunus maritima*, May, 1881, J.B. Ellis, BPI 551651 as *Nectria cucurbitula*; New Jersey, Newfield, on Alnus sp. (Alder sp.), 25 Dec. 1874, J.B. Ellis, BPI 631984 as *Nectria cucurbitula*; Vermont, Chittendon, on *Acer spicatum*, 26 Jul. 1935, H.G. Eno, BPI 550395; Virginia, Airmont, on *Viburnum* sp., 19 Jul. 1903, C.L. Shear, BPI 551426; on dead branches, BPI 631976 = Ellis North American Fungi 159 as *Calonectria cucurbitula*.

Notes: *Pleonectria coryli* is recognised by the narrowly fusiform to cylindrical ascospores budding within the asci (Figs 100I–N, 101B, C). Based on the numerous specimens examined this species is known from many host plants. Previously it had been reported on only two host genera: *Corylus* and *Salix*. In culture, *P. coryli* is morphologically similar to *P. okinawensis* and *P. sinopica* in the shape of the lateral phialidic pegs. However, *P. coryli* does not produce branched conidiophores while *P. okinawensis* and *P.*

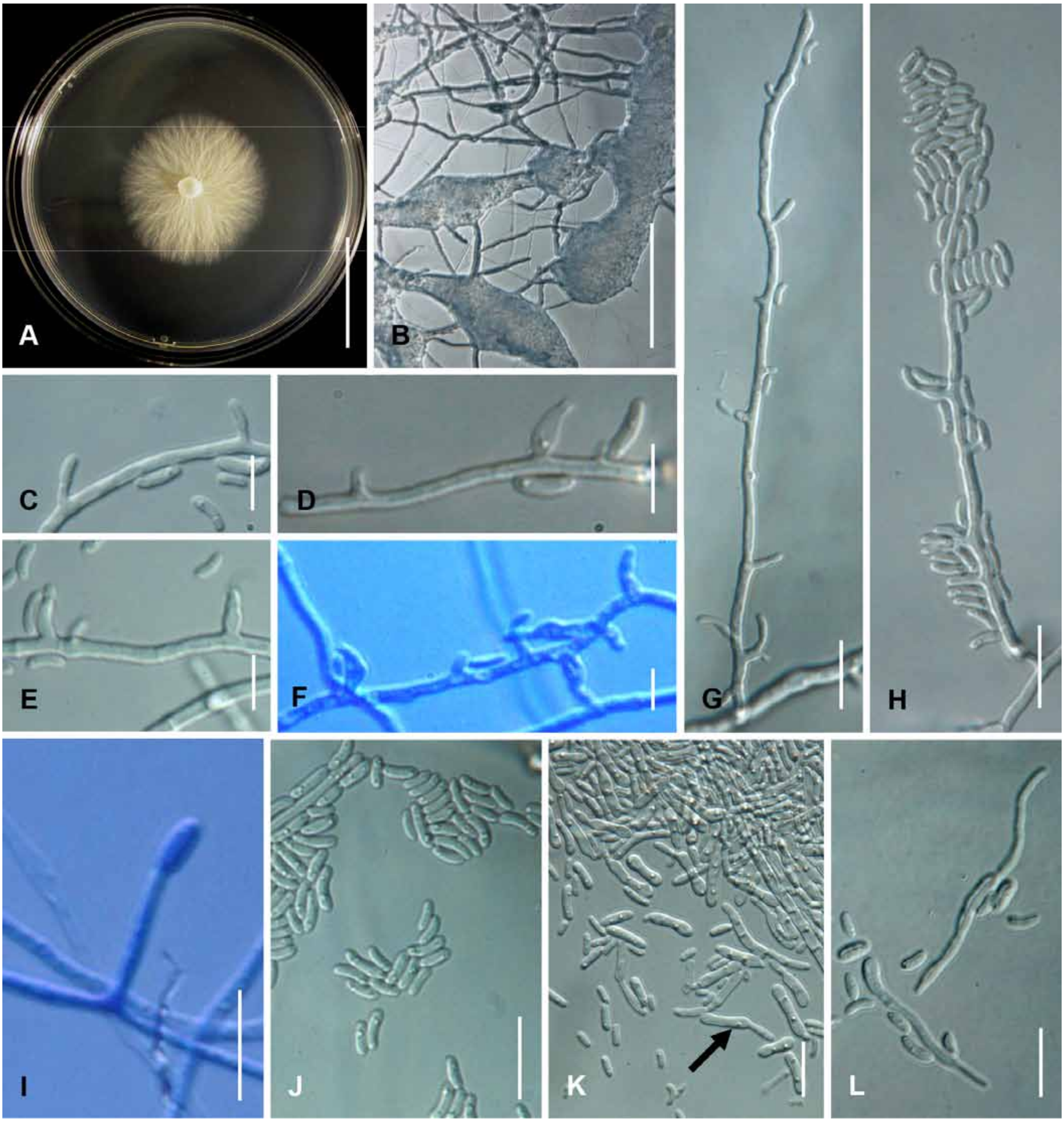

Fig. 102A–L. Anamorph of *Pleonectria coryli* in culture. A. Cultures after 7 d at 25 °C on PDA; B. Conidial mass on SNA surface; C–H. Lateral phialidic pegs and conidia on SNA; I. Conidiophores on SNA; J. Young conidia on SNA; K. Budding (black arrow) and germinating mature conidia on SNA; L. Germinating mature conidia on SNA. Scale bars: A = 3 mm; B = 50 µm; C–F = 5 µm; G–L = 10 µm.

sinopica produce abundant branched conidiophores (Fig. 102). Also *P. okinawensis* is known on *Castanopsis* while *P. sinopica* is reported on *Hedera*.

Samuels *et al*. (2006) described the anamorph of *P. coryli* in the natural environment based on BPI 551408. Although this specimen included ascomata of *P. coryli* and yellowish sporodochia, these were never observed on the same branch. We hypothesise that *Pleonectria coryli* produces pycnidia in the natural environment as found in most species of *Pleonectria*. Thus, we assume that the sporodochia in BPI 551408 are not the anamorph of *P. coryli*.

Pleonectria cucurbitula (Tode: Fr.) Hirooka, Rossman & P. Chaverri, **comb. nov.** MycoBank MB519710. Figs 103–105.

Basionym: *Sphaeria cucurbitula* Tode : Fr., Tode, Fungi Mecklenb. sel. 2: 38. 1791 : Fries, Syst. Mycol. 2: 415. 1823.

≡ *Nectria cucurbitula* (Tode : Fr.) Fr., Summa Veg. Scand. 2: 388. 1849.

≡ *Scoleconectria cucurbitula* (Tode : Fr.) C. Booth, Mycol. Pap. 73: 15. 1959.

= *Nectria cylindrospora* Sollm., Bot. Zeitung (Berlin) 22: 265. 1864.

≡ *Ophionectria cylindrospora* (Sollm.) Berl. & Voglino, Syll. Fung. Addit. 1-4: 217. 1886.

= *Ophionectria scolecospora* Bref. & Tav., in Brefeld, Unters. Gesamtgeb. Mykol. 10: 178. 1891.

≡ *Scoleconectria scolecospora* (Bref. & Tav.) Seaver, Mycologia 1: 198. 1909.

Anamorph: *Zythiostroma pinastri* (P. Karst.) Höhn. ex Weese, Mitt. Bot. Lab. Techn. Hochsch. Wien 8: 90. 1931.

≡ *Zythia pinastri* P. Karst., Rev. Mycol. (Toulouse) 7: 106. 1885.

Teleomorph on natural substrata: *Ascomata and pycnidia* sometimes formed on same or discrete stroma. *Mycelium* not visible around ascomata or on host. *Stromata* erumpent through epidermis, 1.0 mm high and 1.5 mm diam, orange to sienna, KOH+ dark purple, LA+ yellow, pseudoparenchymatous, cells forming textura *angularis*, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, scattered to aggregated in groups of 3–24, subglobose to globose, 242–333 µm high × 281–370 µm diam, red to umber, cupulate upon drying, sometimes with a depressed apical region, apical region slightly darker, KOH+ purple, LA+ yellow, surface usually bright yellow to yellowish green scurfy. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis* sometimes including bright yellow scurf, 4–11 µm diam, with pigmented, uniformly or irregularly, *ca.* 1.5 µm thickened walls. *Ascomatal wall* 30–66 µm thick, of two regions: outer region 22–47 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.5 µm thick; inner region 7–15 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* narrowly clavate, increasing in size as ascospores mature, 71–99 × 9–10 µm, with inconspicuous ring at apex, 8-spored. *Ascospores* long-filiform, 15–39 septate, hyaline, (32.9–)43.2–64.8(–74.7) × (2.3–)2.7–3.5(–3.7) µm (*n* = 100), smooth, budding to produce hyaline, thin-walled, tapering apex, slightly curved, *bacillar ascoconidia*, (1.9–)2.8–3.8(–4.5) × (0.8–)1.1–1.7(–2.1) µm (*n* = 150), that fill asci.

Anamorph on natural substrata: *Stromata* erumpent through epidermis or developing with ascomata, orange to red. *Pycnidia* solitary or aggregated in groups of 3–17, superficial on stroma or rarely immersed at base, subglobose, smooth to slightly rough, cerebriform upon drying, 183–471 µm, 133–544 µm diam, red to bay, KOH+ slightly darker, LA+ slightly yellow. *Pycnidial wall* 21–43 µm thick, of two regions: outer region 12–25 µm thick, intergrading with stroma, cells forming *textura globulosa*, walls pigmented, about 1.0 µm thick; inner region 8–15 µm thick, of elongate, thin-walled, hyaline cells, forming t*extura prismatica*. *Conidiophores* densely branched, generally with 1–3 branched, 18–34 µm long, 1.2–2.5 µm wide. *Conidiogenous cells* cylindrical to subulate, straight to slightly curved, enteroblastic, monophialidic, 6–11 × 0.5–1.5 µm. *Intercalary phialides* generally observed, bearing (1–)3 terminal phialides, up to 6 µm long, similar to short acropleurogenous conidiophores. *Sterile hyphae* absent. *Conidia* hyaline, ellipsoidal to oblong, sometimes slightly curved, non-septate, (2.2–)2.6–3.4(–4.3) × (0.7–)0.8–1.2(–1.9) µm (*n* = 150).

Anamorph in culture: After 7 d at 25 °C, colonies 50–83 mm (average 71 mm) diam. *Colony surface* cottony with aerial mycelium, whitish brown (A.R. 2778) or whitish yellow (CBS 178.73, CBS 259.58, CBS 301.75, CBS 541.70); *aerial mycelium* usually developed (A.R. 2778), often small white to whitish yellow sporodochial conidial masses produced after 3 wk; *reverse* whitish brown (CBS 178.73, CBS 259.58, CBS 301.75, CBS 541.70) or white to slightly whitish yellow (A.R. 2778). *Odour* on PDA slightly fruity. Sporulation on SNA from *lateral phialidic pegs* abundant, enteroblastic, monophialidic, ellipsoidal, tapering toward tip, 2.3–5.0 µm long, 1.1–2.1 µm wide at base. *Conidiophores* unbranched, sometimes 1(–2)-branched, becoming loosely to moderately densely branched, 7.8–25.3 µm long, 1.0–2.9 µm wide at base. *Conidiogenous cells* monophialidic, enteroblastic, cylindrical, slightly tapering toward tip or narrowly flask-shaped with widest point in middle, 5.1–12.7 µm long, 1.2–2.1 µm wide at base. *Young conidia* formed from monophialides on aerial, submerged, or repent hyphae, formed abundantly on slimy heads or sporodochia, ellipsoidal to oblong, hyaline, straight or slightly curved, rounded at both ends, non-septate, (2.6–)3.4–4.6(–5.5) × (0.9–)1.1–1.7(–2.0) µm (*n* = 476), smooth-walled. *Mature conidia* swollen, 0-septate, oblong with slightly swollen at both ends or sometimes long-cylindrical, hyaline, smooth, slightly curved, rounded at both ends, (7.3–)8.7–11.7(–14.8) × (1.1–)1.6–2.1(–2.5) µm (*n* = 238). *Chlamydospores*, *pycnidia* and *ascomata* not produced in culture.

Habitat: On bark or twigs of *Pinus* subgenus *Pinus (Pinaceae)*.

Distribution: Europe (Austria, France, Germany, Netherlands, Sweden), North America (USA).

Lectotype of Sphaeria cucurbitula *designated herein*: **Sweden**, **Lectotype** *designated herein*, Figures 110a-f in the copy of Tode (1791). Fungi Mecklenburgenses selecti. **2**: 38 associated with BPI.

Epitype of Pleonectria cucurbitula *designated herein*: **Austria**, St. Margareten im Rosental, Karnten, on the edge of the little forest Stariwald, mapping grid square 9452/4, alt. 600 m, on *Pinus sylvestris*, 26 Oct. 1998, W. Jaklitsch WJ 1263, **Epitype** BPI 746348, **ex-epitype** culture CBS 125130 = A.R. 2778.

Additional specimens and isolates examined: **France**, Lozère, on *Pinus nigra*, 1974, M. Morelet, culture CBS 301.75. **Germany**, Triglitz in der Prignitz, on *Pinus sylvestris*, Mar. 1910, Jaap, BPI 632552; Tabor, on *Pinus sylvestris*, 17 Nov. 1907, F. Bubak, BPI 632654;Triglitz in the Prignitz, on *Pinus sylvestris*, Mar. 1910, O. Jaap, BPI 632771; Brandenburg Prov., Triglitz in der Prignitz, on *Pinus sylvestris*, 27 Mar. 1904, O. Jaap, BPI 632659; Mecklenburg-Vorpommern, Laase bei Köslin in Pommern, on *Pinus sylvestris*, 28 Aug, Ruhland, S - F 49442. **Netherlands**, Baarn, Groeneveld, on *Pinus sylvestris*, Nov. 1972, W. Gams, culture CBS 178.73; Valkenswaard, Malpie, Mar. 1970, J. Gremmen, culture CBS 541.70; Wageningen, De Dorschkamp, on *Pinus sylvestris*, Jun. 1958, J. Gremmen, culture CBS 259.58. **USA**, Wisconsin, Goodman, Marinette Co., on *Pinus banksiana*, 03 Jun. 1944, R.H. Gruenhagen, BPI 629741; Wisconsin, Windsor Dam, Nicolet National Forest, Vilas Co., on *Pinus resinosa*, 25 Oct. 1951, J.R. Hansbrough, BPI 629742; West Virginia, Fayette Co., on *Pinus virginiana*, 05 May 1897, L.W. Nuttall, BPI 629747; West Virginia, Fayette Co., on *Pinus virginiana*, 05 May 1897, L.W. Nuttall, BPI 6297482; New York, Tompkins Co., Treman State Park, Finger Lakes Trail, on *Pinus resinosa*, 23 Feb. 1980, A.Y. Rossman, BPI 1104743; Maryland, Takoma Park, on *Pinus virginiana*, 09 Mar. 1902, A.J. Watson, BPI 551650; New York, Cattaraugus Co., Camp Allegany, Allegany State Park, on *Pinus sylvestris*, 28 Sep. 1996, G. Bills, BPI 746483; Michigan, Pigeon River State Forest, on *Pinus banksiana*, 09 Aug. 1934, J.R. Hansbrough, BPI 632641; Michigan, Alpena State Forest, on *Pinus banksiana*, 06 Aug. 1934, J.R. Hansbrough, BPI 632642; Idaho, Wallace, on *Pinus contorta*, Sep. 1915, J.R. Weir, BPI 632643; Connecticut, Windsor, on *Pinus nigra*, 19 May 1934, H.G. Eno, BPI 632645; Massachusetts, Petersham, on *Pinus ponderosa*, 10 Aug. 1928, J.R. Hansbroug, BPI 632647; California,Santa Clara Co. Stanford University, on *Pinus radiata*, 12 Oct. 1901, C.F. Baker, BPI 632648; Vermont, Bennington, on *Pinus resinosa*, 08 Jul. 1937, J.R. Hansbrough, BPI 632649; New York, Canadice Lake, Canadice, on *Pinus resinosa*, 06 Aug. 1935, J.R. Hansbrough, BPI 632650; New York, Salamanca, on *Pinus resinosa*, 11 Jul. 1937, J.R. Hansbrough, BPI 632651; Maryland, Beltsville, on *Pinus rigida*, 09 Apr. 1950, F. Petrak, BPI 1112063; Pennsylvania, Stone Valley, Hunt Co., on *Pinus rigida*, 15 Nov. 1927, L.O. Overholts, BPI 632652; Pennsylvania, Bedford, on *Pinus rigida*, 19 May 1936, J.R. Hansbrough, BPI 632653; Rhode Island, Greene, on *Pinus sylvestris*, 10 Apr. 1936, J.R. Hansbrough, BPI 632690; Vermont. Sharon, Downer State Forest, on *Pinus sylvestris*, 04 Jun 1935, H.G. Eno, BPI 632691; New Hampshire, Tamworth, on *Pinus sylvestris*, 21 Aug. 1940, J.R. Hansbrough, BPI 632692; Vermont, Sharon, Downer State Forest, on *Pinus sylvestris*, 04 Jun. 1935, H.G. Eno, J.R. Hansbrough, BPI 632693; New Hampshire, Bartlett, on *Pinus sylvestris*, 09 Jun. 1933, H.G. Eno, J.R. Hansbrough, BPI 632694; Connecticut, Windsor, on *Pinus sylvestris*, 19 May 1934, H.G. Eno, BPI 632695; Maryland, Oxon Run, on *Pinus virginiana*, 21 Oct. 1924, W.W. Diehl, BPI 632550; Virginia, Radnor Heights, on *Pinus virginiana*, 17 Mar. 1936, C.L. Shear, BPI 632696; Pennsylvania, Stone Creek, on *Pinus virginiana*, 24 Nov. 1927, L.O. Overholts, P. Spaulding, BPI 632697; Michigan, Alpena, alt. 1000 ft., on *Pinus banksiana*, 06 Aug. 1934, J.R. Hansbrough, BPI 632554; Michigan, Alpena, on *Pinus banksiana*, 06 Aug. 1934, J.R. Hansbrough, BPI 632778; Nebraska, Halsey, on *Pinus banksiana*, 12 Aug. 1925, E. Bethel, BPI 632779; Connecticut, Windsor, on *Pinus nigra*, 19 May

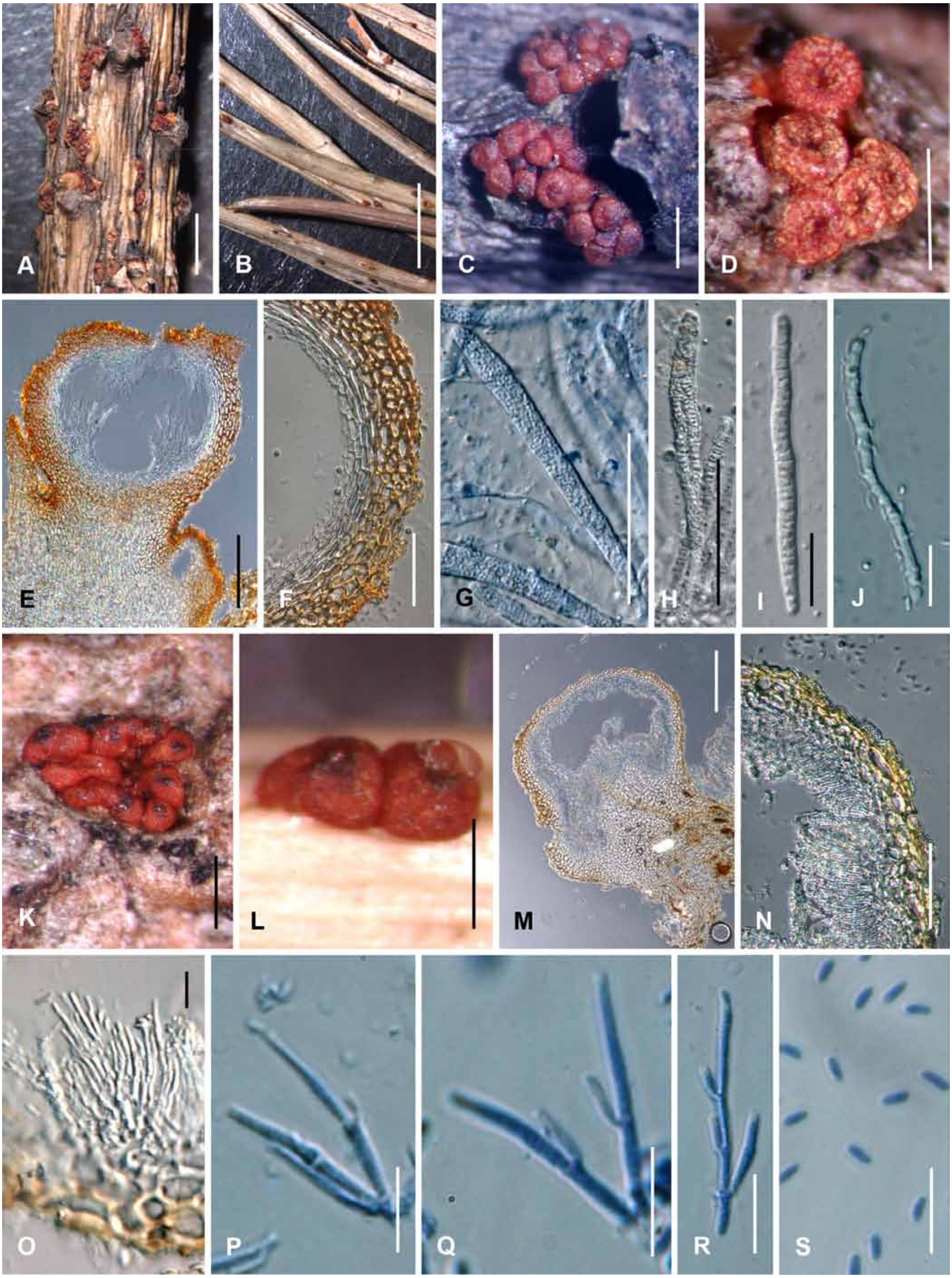

Fig. 103A–S. *Pleonectria cucurbitula* on natural substrata (A–J teleomorph, K–S anamorph). A–D. Perithecia on natural substrata; E. Median section of perithecium on natural substrata; F. Median section of perithecial wall; G, H. Ascus having budding ascospores; I. Unbudding ascospore; J. Budding ascospore; K. Pycnidia on bark; L. Pycnidia on leaf; M. Median section of pycnidium on natural substrata; N. Median section of pycnidial wall; O–R. Conidiophores on natural substrata; S. Conidia on natural substrata. Scale bars: A, B = 1 mm; C, D, K, L = 500 µm; E, M = 100 µm; F–H, N = 50 µm; I, J, O–S = 10 µm.

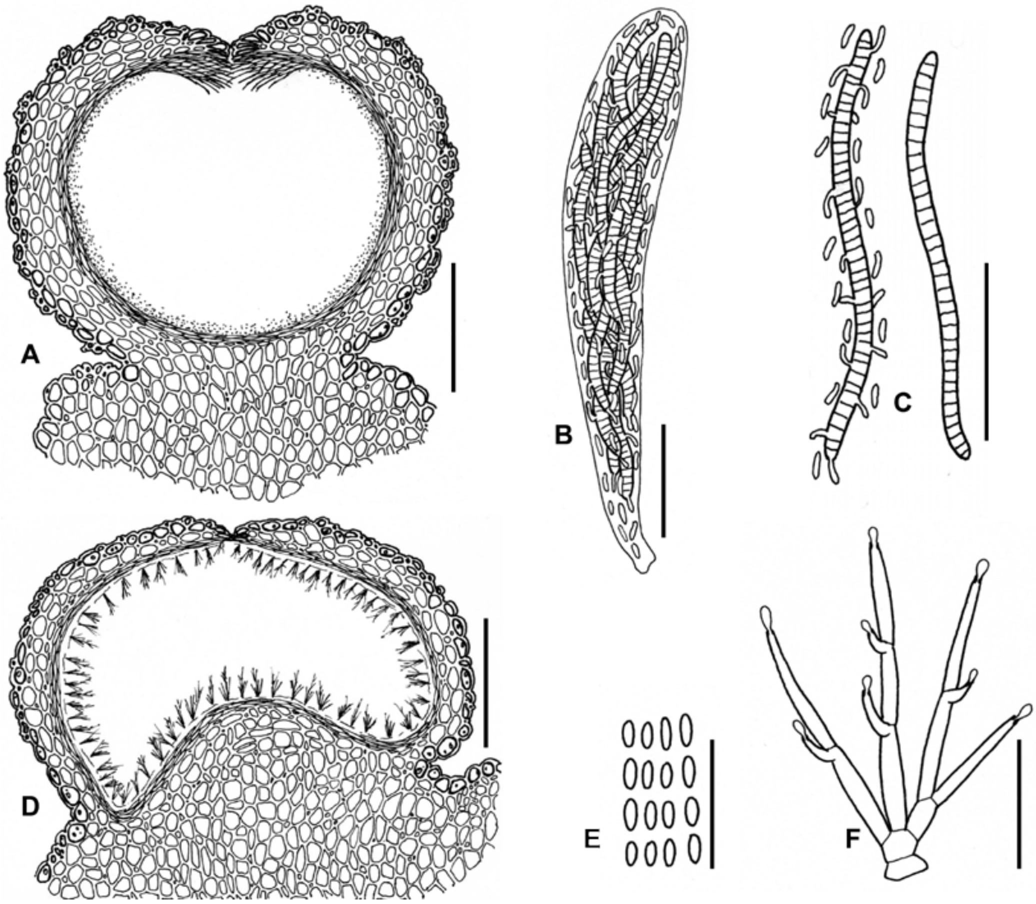

Fig. 104A–F. *Pleonectria cucurbitula* on natural substrata (A–C teleomorph, D–F anamorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores and ascoconidia; D. Median section of mature pycnidium; E. Conidia; F. Conidiophores. Scale bars: A, D = 100 µm; B, C = 20 µm; E, F = 10 µm.

1934, H.G. Eno, BPI 632781; Connecticut, Windsor, on *Pinus nigra* var. *austriaca*, 19 May 1934, H.G. Eno, BPI 632782; New Hampshire, North Conway, on *Pinus nigra*, 20 Aug. 1935, J.D. Diller, BPI 632783; California, Santa Clara Co., *Pinus ponderosa*, 22 Oct. 1937, Hahn, Wagener, BPI 632556; Pennsylvania, Greenwood Furnace, on *Pinus ponderosa*, 18 Oct. 1919, L.O. Overholts, BPI 632646; Nebraska, Halsey, on *Pinus ponderosa*, 12 Aug. 1925, E. Bethel, BPI 632784; Pennsylvania, Greenwood Furnace, on *Pinus ponderosa*, 18 Oct. 1919, L.O. Overholts, BPI 859499; Pennsylvania, Greenwood Furnace, on *Pinus ponderosa*, 25 May 1925, BPI 867616; Pennsylvania, Greenwood Furnace, on *Pinus ponderosa*, 18 Oct. 1919, L.O. Overholts, BPI 867617; Pennsylvania, Greenwood Furnace, on *Pinus pungens*, 26 Nov. 1927, L.O. Overholts, P.S. Spaulding, BPI 859488; Pennsylvania, Greenwood Furnace, on *Pinus pungens*, 26 Nov. 1927, L.O. Overholts, P.S. Spalding, BPI 867615; California, Alameda Co., on *Pinus radiata*, 20 Oct. 1937, Hahn, A.W. Dimock, BPI 632785; New York, Canadice, on *Pinus resinosa*, 06 Aug. 1935, J.R. Hansbrough, BPI 632558; Michigan, Watersmeet, on *Pinus resinosa*, 06 Nov. 1936, C.L. Bennett Jr., BPI 632567; Connecticut, Woodbridge, on *Pinus resinosa*, 22 Nov. 1935, J.R. Hansbrough, BPI 632786; New York, Olive, on *Pinus resinosa*, 11 Aug. 1935, J.R. Hansbrough, BPI 632787; Pennsylvania, Bedford, on *Pinus rigida*, 19 May 1936, J.R. Hansbrough, BPI 632788; Pennsylvania, Huntingdon Co., Stone Valley, on *Pinus rigida*, 15 Nov. 1927, L.O. Overholts, BPI 859494; Pennsylvania, Huntingdon Co., Stone Valley, on *Pinus rigida*, 15 Nov. 1927, L.O. Overholts, BPI 867618; Vermont, Sharon, alt. 1400 ft., on *Pinus sylvestris*, 04 Jun. 1935, H.G. Eno, BPI 632821; New York, Saranac Lake, Essex Co., on *Pinus sylvestris*, 07 Sep. 1932, J.R. Hansbrough, BPI 632822; New York, Olive, on *Pinus sylvestris*, 11 Aug. 1935, J.R. Hansbrough, BPI 632823; Connecticut, Windsor, on *Pinus sylvestris*, 19 May 1934, H.G. Eno, BPI 632824; New Hampshire, Bartlett, on *Pinus sylvestris*, 09 Jun. 1933, J.R. Hansbrough, BPI 632825; Connecticut, Windsor, alt. 100 ft., on *Pinus sylvestris*, 19 May 1934, H.G. Eno, BPI 632826; Pennsylvania, Huntingdon Co., Stone Valley, on *Pinus sylvestris*, 29 Oct. 1921, L.O. Overholts, BPI 859493; Pennsylvania, Allegheny Co., Allison Park, on *Pinus sylvestris*, 06 Oct. 1921, L.O. Overholts, BPI 859495; Pennsylvania, Allegheny Co., Allison Park, on *Pinus sylvestris*, 06 Oct. 1921, L.O. Overholts, BPI 859496; Pennsylvania, Allegheny Co., Allison Park, on *Pinus sylvestris*, 06 Oct. 1921, L.O. Overholts, BPI 867609; Newfield, N. J., on *Pinus rigida*, May 1885, E.W.D. Holway, Ellis & Everhart, North American Fungi, No 1551, BPI-bound exsiccati; on *Pinus rigida*, 12 Oct. 1901, C.F. Baker, C. F. Baker, Pacific Slope Fungi, No 68, BPI-bound exsiccati.

Notes: *Pleonectria cucurbitula* occurs on bark or rarely needles of *Pinus* subgenus *Pinus* and is characterised by long-fusiform, multiseptate ascospores budding within the asci. *Pleonectria cucurbitula* is similar to *P. rosellinii* in having long filiform, multiseptate ascospores that bud within the asci, and a zythiostroma-like anamorph. *Pleonectria cucurbitula* differs from *P. rosellinii* in ascomatal surface, which is scurfy in *P. cucurbitula* and warty in *P. rosellinii*, and in the host with *P. cucurbitula* on *Pinus* subg. *Pinus* and *P. rosellinii* on *Abies* (Figs 103C–F, 104A).

In our phylogenetic study, isolates of "*N. cucurbitula*" on *Pinus* are assigned to two different species, *P. cucurbitula* and *P. strobi*, that are congruent with the two host subgenera *Pinus* and *Strobus* (Strauss & Doerksen 1990; Wang & Szmidt 1993; reviewed in Price *et al.* 1998). Phylogenetically the two species group together with high BP and BB values within a group of five species all of which occur on conifers. Although the two species are morphologically almost identical, they can be distinguished by the shorter ascospores of *P. strobi* and anamorph characteristics in culture.

When Tode (1791) described *Sphaeria cucurbitula*, the basionym of *Pleonectria cucurbitula*, he included two varieties, *S. cucurbitula* var. *flavescens* and *S. cucurbitula* var. *nigrescens*, neither of which was designated as the type variety. Because Fries (1823) synonymised *S. cucurbitula* var. *nigrescens* with *Sphaeria cupularis* Pers., now considered *Nitschkia cupularis* (Pers.) P. Karst., *S. cucurbitula* var. *flavescens* is regarded as the type variety of *S. cucurbitula*. Although Tode (1791) did not mention the host of *S. cucurbitula* var. *flavescens*, it seems like that this species occurs on *Pinus* subgenus *Pinus* because hosts in this subgenus especially *P. sylvestris* are common in Europe. Because Tode's specimens

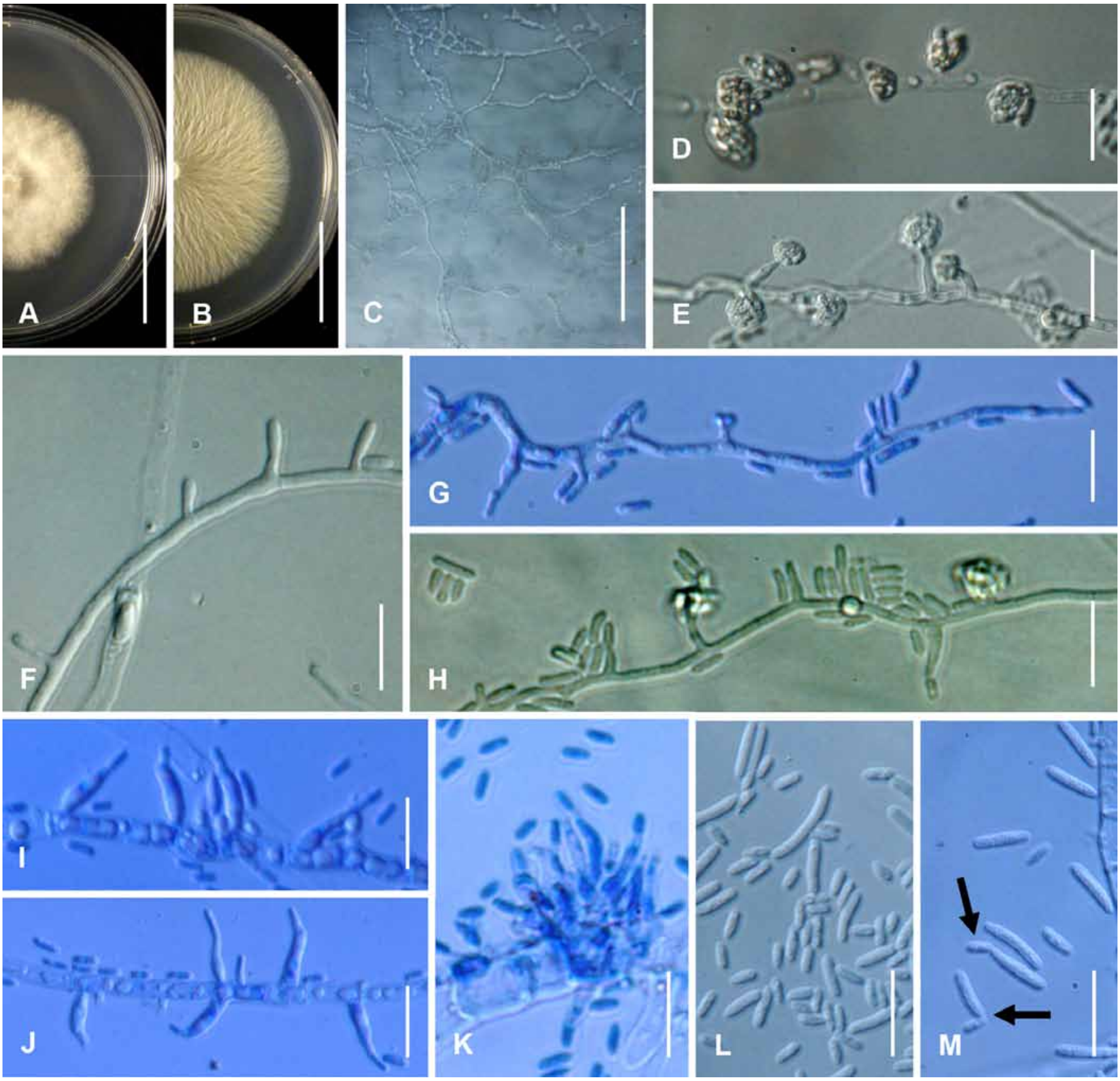

Fig. 105A–M. Anamorph of *Pleonectria cucurbitula* in culture. A, B. Cultures after 7 d at 25 °C on PDA; C. Conidial mass on SNA; D, E. Lateral phialidic pegs and conidial mass on SNA; F–H. Lateral phialidic pegs and conidia on SNA; I–K. Conidiophores and conidia on SNA; L. Young and mature conidia on SNA; M. Budding mature conidia (black arrows) on SNA. Scale bars: A, B = 3 mm; C = 100 µm; D–M = 10 µm.

were destroyed (Kirk *et al*. 2008), the original illustrations at BPI, specifically figs 110a–f in Tode (1791), are designated here as the lectotype. We also designate an epitype of *S. cucurbitula* as BPI 746348 with ex-epitype culture CBS 125130 collected in Europe.

According to Rossman *et al*. (1999) and our study, two teleomorph names (*Nectria cylindrospora* and *Ophionectria scolecospora*) and one anamorph name (*Zythia pinastri*) are taxonomic synonyms of *P. cucurbitula*. *Nectria cylindrospora* and *Ophionectria scolecospora* were described based on a specimen collected on *Pinus sylvestris* (subgenus *Pinus*). Unfortunately, the type specimens of *Nectria cylindrospora*, *Ophionectria scolecospora,* and *Zythia pinastri* could not be located at B, S, or UPS. They may have been destroyed. Because the protologues of these names did not include any illustrations, we retain them as unverified taxonomic synonyms of *P. cucurbitula*. Although Rossman *et al*. (1999) regarded *Nectria rosellinii* as a synonym of *N. cucurbitula*, this species occurs on *Abies* and is here regarded as a distinct species, *P. rosellinii.*

Pleonectria ilicicola Hirooka, Rossman & P. Chaverri, **sp. nov.** MycoBank MB519711. Figs 106–108.

Holotype of Pleonectria ilicicola: **France**, Forêt de L'Hermitain, on twig of *Ilex aquifolium*, 8 Mar. 2008, C. Lechat CLL 7159, **Holotype** BPI 881055; **ex–holotype** culture CBS 125170 = A.R. 4497 (CBS 125171 = A.R. 4498 isolated from conidium).

Etymology: *ilici* + *-cola*; indicates the host plant.

Anamorph: zythiostroma-like.

Teleomorph on natural substrata: *Ascomata and pycnidia* rarely formed on same or discrete stroma. *Mycelium* not visible around ascomata or on host. *Stromata* erumpent through epidermis, 2.0 mm high and 3.0 mm diam, bay, KOH+ dark red, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*,

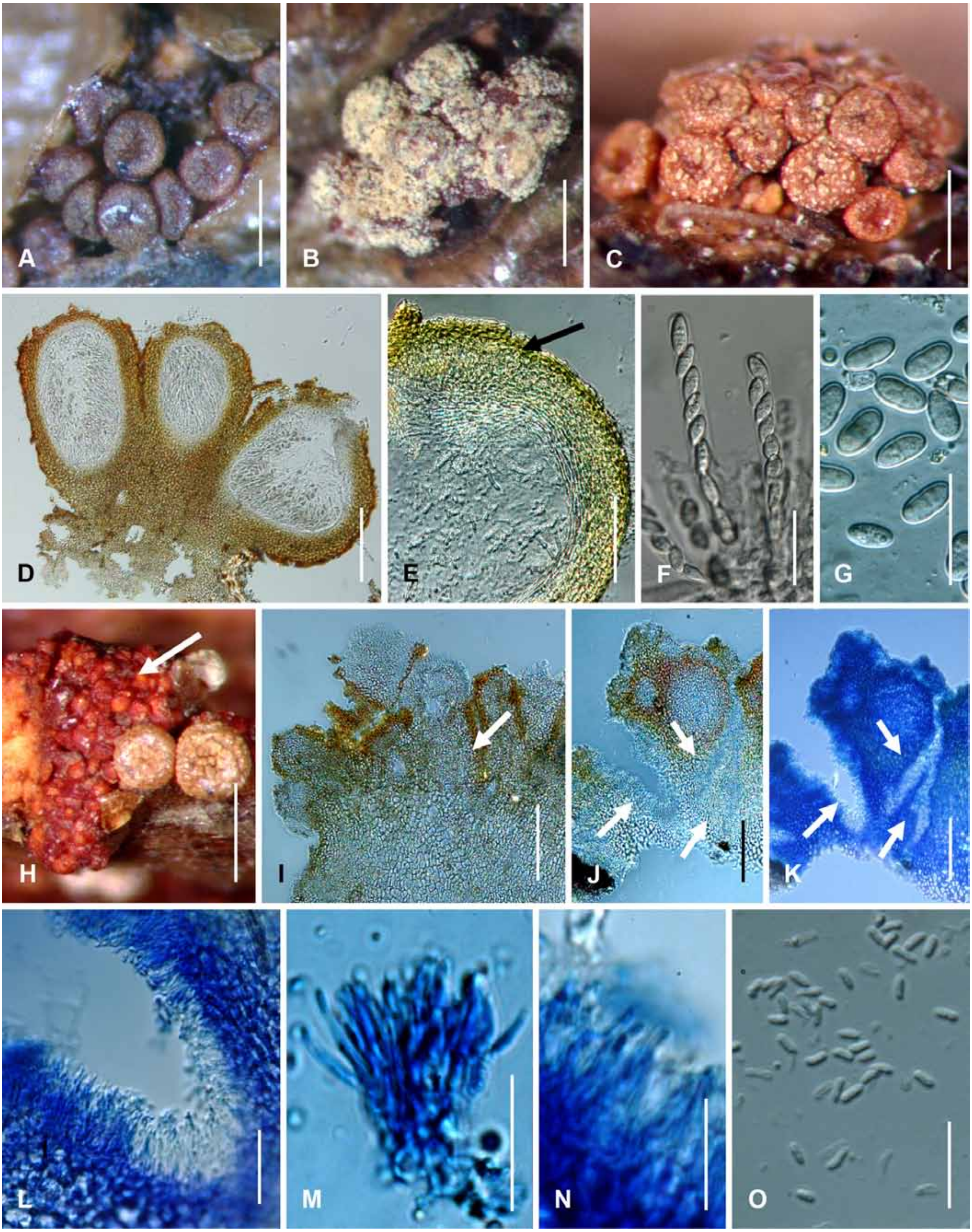

Fig. 106A–O. *Pleonectria ilicicola* on natural substrata (A–G teleomorph, H teleomorph and anamorph, I–O anamorph). A–C. Perithecia on natural substrata; D. Median section of perithecia on natural substrata; E. Median section of perithecial apex of three regions (black arrow); F. Asci; G. Ascospores; H. Perithecia and immersed pycnidia on natural substrata (white arrow); I–K. Median section of immersed pycnidia (white arrows) on natural substrata; L–N. Conidiophores on natural substrata; O. Conidia on natural substrata. Scale bars: A–C, H = 500 µm; D, I–K = 100 µm; E, L, M = 50 µm; F, G, N, O = 20 µm.

intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, aggregated in groups of 3–30, subglobose to globose, 247–414 µm high × 180–392 µm diam, slightly cupulate upon drying, sometimes with only a depressed apical region, bay to scarlet, apical region slightly darker, KOH+ dark red, LA+ yellow, surface often scurfy, yellow to yellowish green, sometimes scaly. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis* sometimes including bright yellow scurf, 3–13 µm diam, with

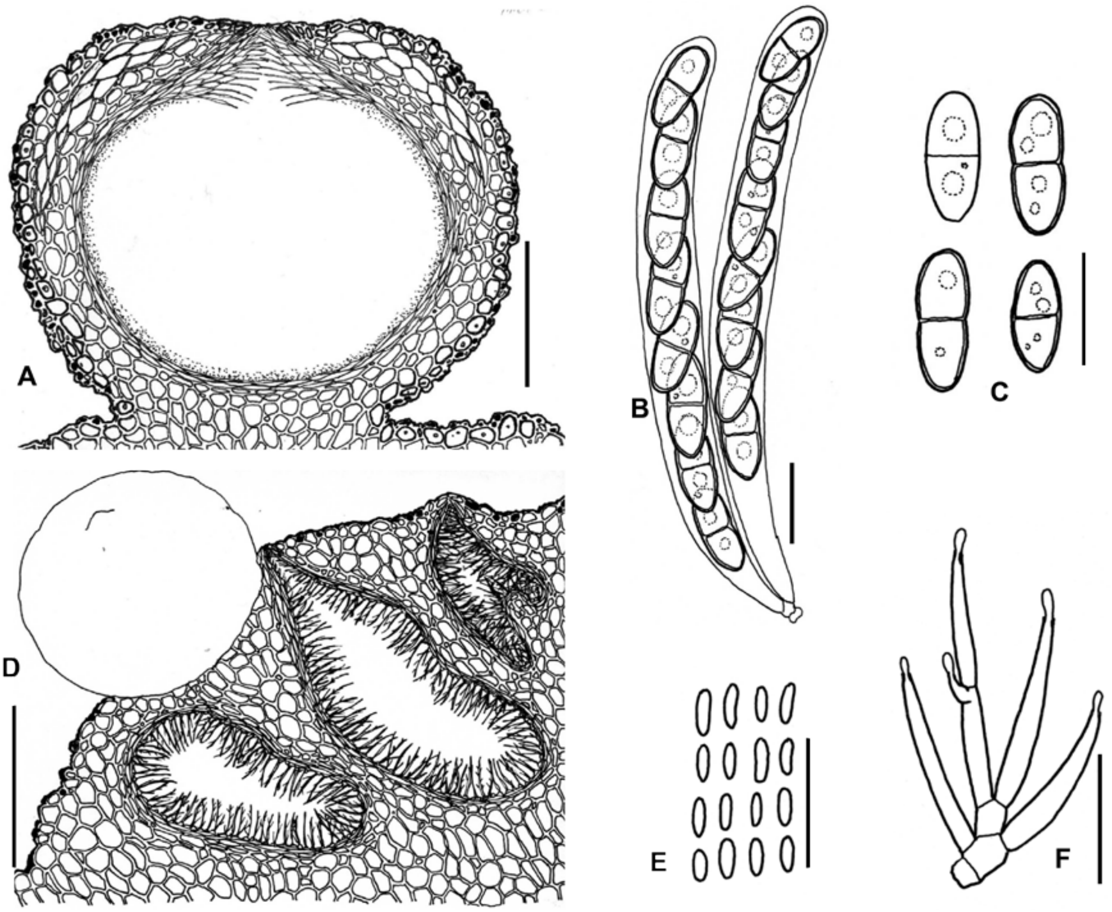

Fig. 107A–F. *Pleonectria ilicicola* on natural substrata (A–C teleomorph, D–F anamorph). A. Median section of mature perithecium; B. Asci; C. Ascospores; D. Median section of immersed pycnidia; E. Conidia; F. Conidiophores. Scale bars: A, D = 100 µm; B, C, E, F = 10 µm.

pigmented, irregularly, 1.5–2.0 µm thick walls. *Ascomatal wall* 37–68 µm thick, around apex to about 65 µm thick, of two regions, around apex to three regions: outer region 16–45 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.5 µm thick; middle region produced around apex, 9-17 µm thick, cells forming *textura globulosa*, 4-7 µm diam, walls pigmented, about 1.0 µm thick; inner region 9–20 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* clavate, 54–115 × 6.2–12.3 µm, with inconspicuous ring at apex, 8-spored, ascospores mainly biseriate. *Ascospores* ellipsoidal with slightly constricted centre, straight, hyaline, (0–)1-septate, (8.9–)10.8–13.4(–15.4) × (4.1–)5.4–6.8(–7.5) µm (*n* = 100), smooth, not budding in asci.

Anamorph on natural substrata: *Stromata* smooth or sometimes cerebriform, erumpent through epidermis, orange to umber. *Pycnidia* immersed between ascomata or in stroma, irregular subglobose, eustromatic, sienna, solitary or aggregated in groups of 3-9, 35–210 µm high × 40–260 µm diam, KOH+ darker, LA+ yellow. *Pycnidial wall* 5–15 µm thick, of one region intergrading with stroma, cells forming *textura prismatica*, about 1.0 µm thick, elongate, thin-walled, hyaline cells. *Conidiophores* densely branched, generally with 1–2-branched, 15–25 µm long, 1.4–2.6 µm wide. *Conidiogenous cells* cylindrical to subulate, straight to slightly curved, enteroblastic, monophialidic, 5–14 × 1.0–2.5 µm. *Intercalary phialides* bearing 1–2 terminal phialides, up to 5 µm long, similar to short acropleurogenous conidiophores. *Sterile hyphae* absent. *Conidia* hyaline, ellipsoidal, or oblong, sometimes slightly curved, non-septate, (2.3–)3.0–4.0(–4.6) × (0.9–)1.2–1.8(–2.4) µm (*n* = 50).

Anamorph in culture: After 7 d at 25 °C, colonies 23–35 mm (average 29 mm) diam. *Colony surface* slightly cottony with aerial mycelium, whitish yellow to yellow; *aerial mycelium* developed, small white to whitish yellow sporodochial conidial masses produced after 3 wk; *reverse* white to whitish yellow. *Odour* on PDA slightly putrid. Sporulation on SNA from *lateral phialidic pegs* rare, ellipsoidal, slightly tapering toward tip, 1.9–4.5 µm long, 1.2–2.5 µm wide at base, monophialidic. *Conidiophores* unbranched, sometimes 1–2-branched, becoming loosely to moderately densely branched, 6.5–15.7 µm long, 1.5–2.5 µm wide at base. *Sporodochial conidiophores* sometimes formed, densely branched, 10–30 µm long, 1.5–3.0 µm wide at base. *Conidiogenous cells* monophialidic, enteroblastic, cylindrical, slightly tapering toward tip or narrowly flask-shaped with widest point in middle, 4.0–17.5 µm long, 1.0–3.0 µm wide at base. *Young conidia* formed from monophialides on aerial, submerged, or repent hyphae, formed abundantly on slimy heads or sporodochia, oblong to long cylindrical, hyaline, smooth, straight or slightly curved, rounded at both ends, non-septate, (4.0–)4.5–5.1(–7.2) × (1.0–)1.3–1.9(–2.3) µm (*n* = 60), smooth-walled. *Mature conidia* swollen, 0-septate, ellipsoidal or oblong, hyaline, smooth, straight or slightly curved, rounded at both ends, rarely budding, (5.4–)6.6–9.6(–12.5) × (2.1–)2.3–3.1(–3.3) µm (*n* = 56). *Chlamydospores* intercalary, globose to subglobose, rare, smooth, 7–14 µm. *Ascomata and pycnidia* not produced in culture.

Habitat: On dead bark or twigs of *Ilex aquifolium (Aquifoliaceae)*.

Distribution: Europe (France, UK).

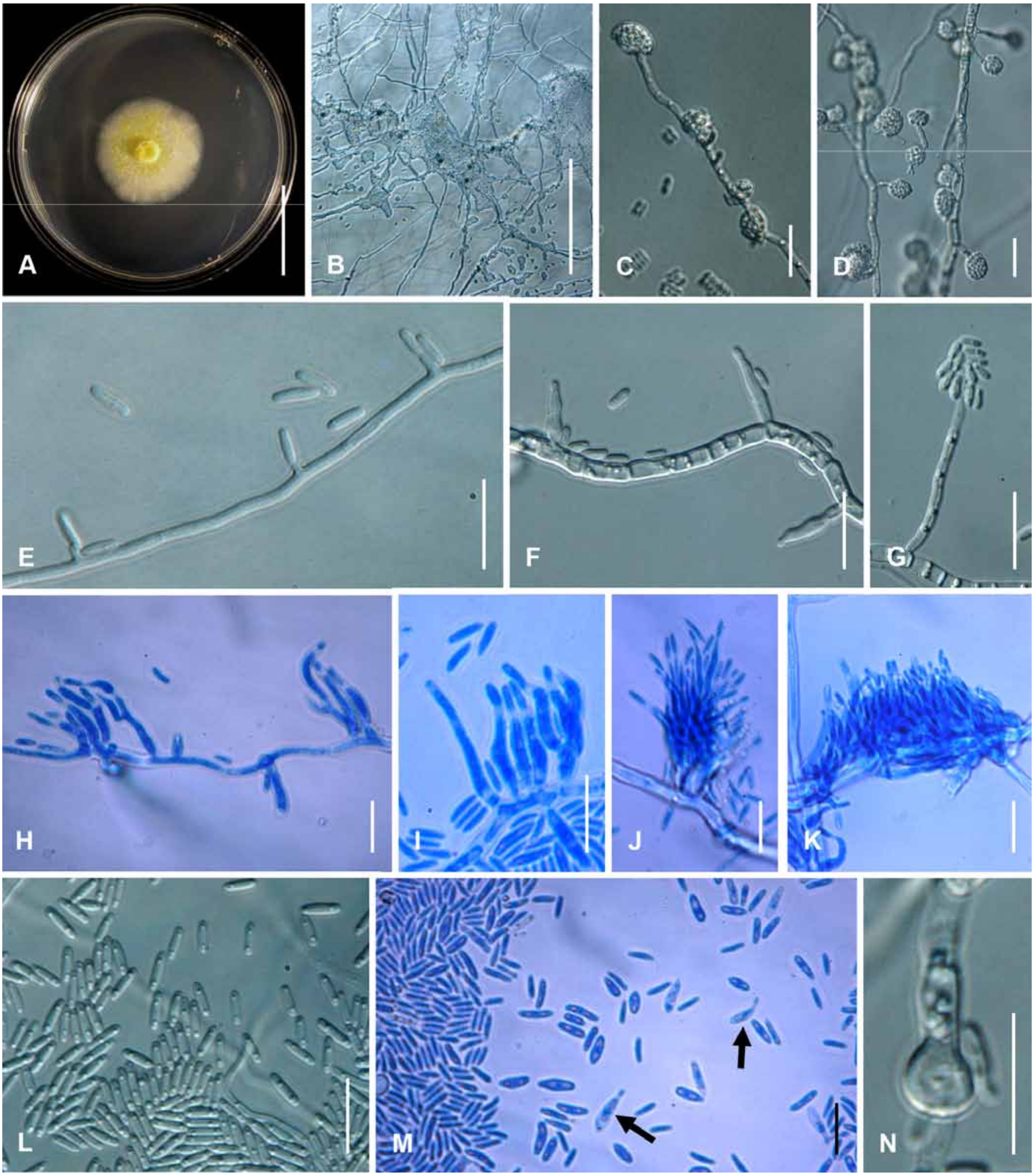

Fig. 108A–N. Anamorph of *Pleonectria ilicicola* in culture. A. Cultures after 7 d at 25 °C on PDA; B. Conidial mass on SNA; C. Lateral phialidic pegs and conidial mass on SNA; D. Conidiophores and conidial mass on SNA; E. Lateral phialidic pegs and young conidia on SNA; F–K. Conidiophores and conidia on SNA; L. Young conidia on SNA; M. Budding mature conidia (black arrow) on SNA; N. Chlamydospore on SNA. Scale bars: A = 3 mm; B = 50 µm; C–N = 20 µm.

Additional specimens and isolates examined: **France**, Forêt de l'Hermitain, on dead twigs of *Ilex aquifolium*, 20 Feb. 2008, C. Lechat, BPI 881056, culture CBS 125168 = A.R. 4494; Foret de L'Hermitain, on bark of *Ilex aquifolium*, 2 Feb. 2009, C. Lechat CLL 7184, BPI 879857, culture CBS 128978 = A.R. 4574. **UK**, Burnham Beeches, Slough, Buckinghamshire, on *Ilex aquifolium*, 15 Sep. 2004, W.J. Jaklitsch WJ 2720, BPI 880698, culture CBS 125147 = A.R. 4108.

Notes: *Pleonectria ilicicola* resembles *P. aquifolii*, however, *P. ilicicola* differs in having ascospores that are ellipsoidal to fusiform with a slightly constricted centre, not budding in the asci, and a monophialidic anamorph on SNA (Figs 106G, 107C, 108E–K). Our phylogenetic study also suggests that *P. ilicicola* is closely related to *P. aquifolii* but is distinct with strong statistical support (BI PP 100 %, ML BP 100 %, MP BP 100 %) (Figs 1, 2). *Pleonectria ilicicola* is also similar to *P. sinopica* in ascomatal characteristics and size of ascospores. However, *P. sinopica* has ascospores that do not bud to produce ascoconidia and occurs on the genus *Hedera*. Based on our phylogenetic data *P. ilicicola* is only distantly related to *P. sinopica* (Figs 1, 2).

The zythiostroma-like (pycnidial) anamorph of *P. ilicicola* has been found only on BPI 881055, the holotype of this fungus. This relationship was confirmed by molecular data; CBS 125170 isolated from ascospores had identical sequences to CBS 125171 isolated from conidia.

Pleonectria lamyi (Desm.) Sacc., Mycotheca Ven. No. 688. 1876. Figs 109–111.

Basionym: *Sphaeria lamyi* Desm., Pl. Crypt. France, no. 839. 1836.
≡ *Nectria lamyi* (Desm.) De Not., Sfer. Ital., 1: 13. 1863.
≡ *Thyronectria lamyi* (Desm.) Seeler, J. Arnold Arbor. 21: 449. 1940.
Anamorph: zythiostroma-like.

Teleomorph on natural substrata: *Ascomata and pycnidia* rarely formed on same or discrete stroma. *Mycelium* not visible around ascomata and on host. *Stromata* erumpent through epidermis, 2.5 mm high and 2.5 mm diam, bay, KOH+ dark red, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, aggregated in groups of 5–55, subglobose to globose, 245–450 µm high × 230–455 µm diam, not cupulate when dry, rarely with only a depressed apical region, bay to scarlet, apical region nearly black, KOH+ slightly purple, LA+ yellow, sometimes surface scurfy or scaly, yellowish green. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis* sometimes including bright yellow scurf, 2–15 µm diam, with pigmented, irregularly, *ca.* 1.5 µm thick walls. *Ascomatal wall* 30–80 µm thick, around apex to about 100 µm thick, of two regions: outer region 25–50 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.5 µm thick; inner region 9–20 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* widely clavate, increasing in size as ascospores mature, 70–145 × 10–40 µm, with inconspicuous ring at apex, 8-spored, ascospores mainly biseriate. *Ascospores* ellipsoidal to fusiform, hyaline, constricted at septae, muriform, with 5–8 transverse septa, 1(–2) longitudinal septum, (14.5–18.9–26.1(–32.2) × (5–)5.2–8(–10.8) µm (*n* = 391), smooth, budding to produce hyaline, thin-walled, bacillar ascoconidia, (1.5–)3.0–4.2(–6.3) × (0.7–)1.0–1.8(–2.2) µm (*n* = 393), that fill asci.

Anamorph on natural substrata: *Stromata* erumpent through epidermis or developing in stroma with ascomata, orange to bay. *Pycnidia* solitary or aggregated in groups of 3–8, superficial on stroma or rarely immersed at base, irregularly discoidal, smooth to slightly roughened, cerebriformis or cupulate upon drying, 91–244 µm high, 193–446 µm diam, bay to umber, KOH+ slightly darker, LA+ slightly yellow. *Pycnidial wall* 35–55 µm thick, of two regions: outer region 10–18 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.5 µm thick; inner region 14–35 µm thick, of elongate, thin-walled, hyaline cells, forming t*extura prismatica*. *Conidiophores* densely branched, generally with 1–3 branched, 22–44 µm long, 2.2–4.3 µm wide. *Conidiogenous cells* cylindrical to subulate, straight to slightly curved, enteroblastic, monophialidic, 9.6–14.1 × 1.2–2.1 µm. *Intercalary phialides* generally observed, bearing 1–3 terminal phialides, up to 6 µm long, similar to short acropleurogenous conidiophores. *Sterile hyphae* absent. *Conidia* hyaline, ellipsoidal to oblong, sometimes slightly curved, non-septate, (3.3–)3.4–4.0(–4.2) × (1.0–)1.1–1.3(–1.5) µm (*n* = 50).

Anamorph in culture: After 7 d at 25 °C, colonies 35–45 mm (average 41 mm) diam. *Colony surface* cottony with aerial mycelium, whitish to whitish saffron; *aerial mycelium* usually developed, often small, white sporodochial conidial masses produced after 3 wk; *reverse* white to slightly whitish yellow. *Odour* on PDA slightly pungent. Sporulation on SNA from *lateral phialidic pegs* abundant, 1.5–5.3 µm long, 1.1–2.2 µm wide at base, monophialidic. *Conidiophores* sometimes formed, unbranched, sometimes verticillate, 1(–3)-branched, becoming loosely to densely branched, 16.9–23.5 µm long, 2.0–3.5 µm wide at base. *Conidiogenous cells* enteroblastic, monophialidic, cylindrical, slightly tapering toward tip, 4.6–9.8 µm long, 1.1–2.3 µm wide at base. *Young conidia* formed from monophialides on aerial, submerged, or repent hyphae, formed abundantly on slimy heads or sporodochia, ellipsoidal, oblong to cylindrical, hyaline, straight or slightly curved, rounded at both ends, non-septate, (2.8–)3.7–5.2(–6.6) × (1.0–)1.3–2.1(–2.3) µm (*n* = 50), smooth-walled. *Mature conidia* swollen, 0-septate, long cylindrical, sometimes C-shape, hyaline, smooth, sometimes strongly curved, rounded at both ends, (7.8–)9.6–12.8(–14.3) × (1.4–)1.8–2.6(–3.1) µm (*n* = 50). *Ascomata*, *pycnidia,* and *chlamydospores* not produced in SNA and PDA.

Habitat: On dead bark or twigs of *Berberis vulgaris* and *Berberis* sp. (*Berberidaceae*).

Distribution: Asia (Pakistan), Europe (Austria, France, Germany, Hungary, Italy, Sweden, Ukraine), North America (Canada).

Lectotype of Pleonectria lamyi *designated by Seeler* (1940b): **France**, Limoges, on dead branches of *Berberis* sp., **Lectotype** Desmazières, Plantes Cryptogames France No839., FH – not examined in this study; **Isolectotype** listed by Rossman *et al*. (1999), BPI – bound exsiccati examined.

Additional specimens and isolates examined: **Austria**, St. Margareten im Rosental, Karnten, on the edge of the little forest Stariwald, mapping grid square 9452/4, alt. 600 m, on *Berberis vulgaris*, 26 Oct. 1998, W. Jaklitsch WJ 1264, BPI 746349, culture CBS 115034 = A.R. 2779; Kalvarienberg, on *Berberis vulgaris*, 29 Jun. 1936, J. Weese, J. Weese, Eumycetes selecti exsiccati. No 752, BPI-bound exsiccati. **Canada**, Ontario, Wilcox Lake, on *Berberis vulgaris*, 29 May 1933, R.F. Cain, BPI 552463; Ontario, near Wilcox Lake, S. Aurora, on *Berberis vulgaris*, 22 Apr. 1934, H.S. Jackson, BPI 552465; Ontario, near Wilcox Lake, on *Berberis vulgaris*, 01 May 1932, H.S. Jackson, BPI 552467. **Germany**, Coburg, Aug. 1864, A. Sollman, Rabenhorst, Fungi europaei. No 752, BPI-bound exsiccati; Velvary, on *Berberis vulgaris*, 14 Apr. 1900, J.E. Kabat, BPI 552460; Kalvarienberg Bei Gumpoldskirchen, Nieder–Osterreich, on *Berberis vulgaris*, 29 Jun. 1936, J. Weese, BPI 552464; Chiemgauer Alpen, Kaitelalm, on dead twigs of *Berberis vulgaris*, 20 Jul. 1989, H. Schmid, culture CBS 417.89. **Hungary**, Muhltal Prope Pozsony, on *Berberis vulgaris*, J. Baumler, BPI 552462; Com. Pozsony, Muhltal Prope Pozsony, on *Berberis vulgaris*, J. Baumler, BPI 552448. **Italy**, Montello (Treviso), on *Berberis vulgaris*, Aug. 1903, BPI 552446; Montello, on *Berberis vulgaris*, Aug. 1903, BPI 552461 as *Nectria lamyi*; Venetia, Susigana, on *Berberis vulgaris*, 1876, *C. Spegazzini*, BPI 552447; Venetia, Susigana, in ramulis emortuis Beridis Vulgaris Lin. Hieme, on *Berberis vulgaris*,1876, C. Spegazzini, F. De Thuemen, Mycotheca Universalis. No 765, BPI-bound exsiccati; Trento, Tebnario, on *Berberis vulgaris*, Feb. 1923, Roup, BPI 552456 as *Nectria lamyi*. **Pakistan**, Kaghan Valley, Shogran. West Pakistan, on *Berberis* sp., 27 Jul. 1956, S. Ahmad, BPI 552469; Naran, West Pakistan, on *Berberis* sp., 12 Aug. 1968, BPI 552470; Naran, Nathia Gali, on *Berberis* sp., 22 Aug. 1968, BPI 552471. **Sweden**, ad Tursleo prope Upsala, on *Berberis vulgaris*, 23 May 1895, A.G. Eliasson, BPI 552459; Upsaliam, on *Berberis vulgaris*, 10 Nov. 1889, L. Romell, BPI 552451; ad Upsaliam, on *Berberis vulgaris*, 10 Nov. 1876, L. Romell, L. Romell, Fungi exsiccati præsertim scandinavici. No 80, BPI-bound exsiccati. **Ukraine**, Prov, Cernigov, prope Borzna, on *Berberis* sp., 22 Mar. 1912, G. Newodowski, BPI 552454; Czernigow, Borzna, on *Berberis vulgaris*, 22 Mar. 1912, G. Newodowski, BPI 552466.

Note: *Pleonectria lamyi* has only been collected on *Berberis*. Morphologically this species is similar to *P. balsamea* and *P. pinicola* in having oblong to fusiform ascospores that produce ascoconidia in the asci and a pycnidial anamorph. However, the

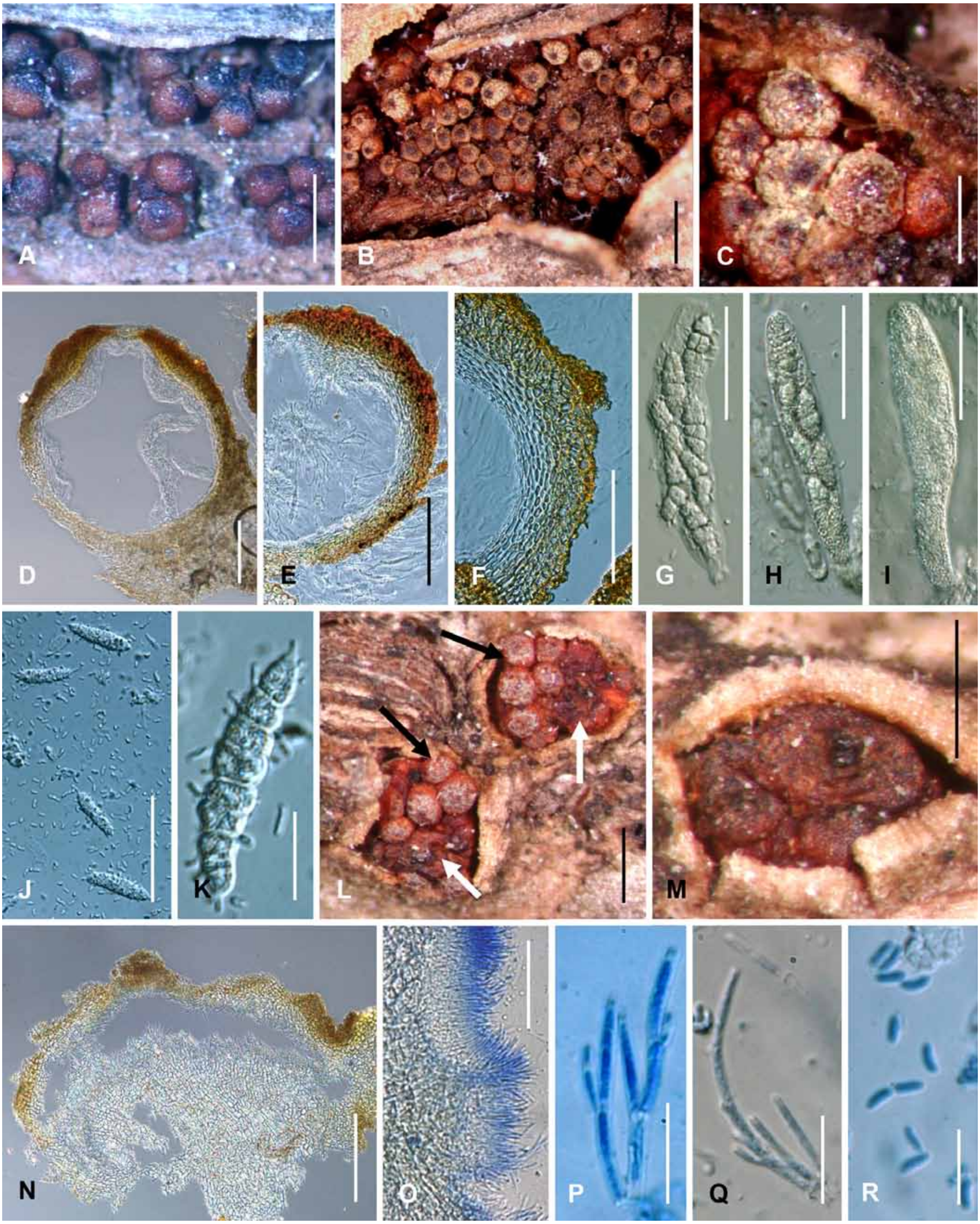

Fig. 109A–R. *Pleonectria lamyi* on natural substrata (A–K teleomorph, L teleomorph and anamorph, M–R anamorph). A–C. Perithecia on natural substrata; D. Median section of perithecium on natural substrata; E, F. Median section of perithecial walls; G–I. Ascus having budding ascospores; J, K. Budding ascospores; L. Perithecia (black arrows) and pycnidia (white arrows) on natural substrata; M. Pycnidia on natural substrata; N. Median section of pycnidium on natural substrata; O–Q. Conidiophores on natural substrata; R. Conidia on natural substrata. Scale bars: A, B, L = 1 mm; C, M = 500 µm; D–F, N = 100 µm; G–J, O = 50 µm; K, P–R = 10 µm.

ascospores of *P. lamyi* are > 5 µm wide while ascospores are < 5 µm wide in *P. balsamea* and *P. pinicola*. In terms of their anamorph in the natural environment, the pycnidia in *P. lamyi* are irregularly discoidal whereas the pycnidia of *P. balsamea* and *P. pinicola* are subglobose (Figs 109L–M, 110D). In culture, the anamorph of *P. lamyi* is easily distinguished from other *Pleonectria* species based on that C-shaped, mature conidia (Fig. 111M).

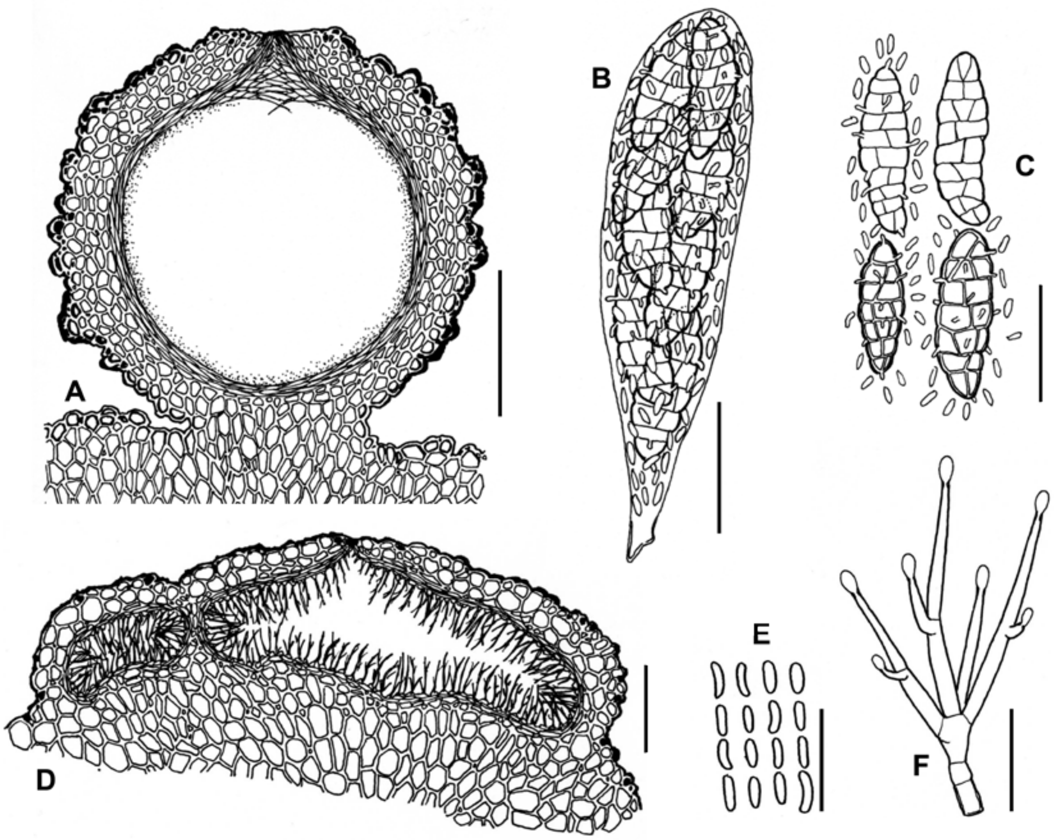

Fig. 110A–F. *Pleonectria lamyi* on natural substrata (A–C teleomorph, D–F anamorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores and ascoconidia; D. Median section of mature Pycnidium; E. Conidia; F. Conidiophores. Scale bars: A, D = 100 µm;B, C = 20 µm; E, F = 10 µm.

Pleonectria lonicerae (Seeler) Hirooka, Rossman & P. Chaverri, **comb. nov**. MycoBank MB519712. Figs 112, 113.
Basionym: *Thyronectria lonicerae* Seeler, J. Arnold Arbor. 21: 450. 1940.
≡ *Nectria lonicerae* (Seeler) Rossman, Mem. New York Bot. Gard. 49: 260. 1989.
Anamorph: unknown

Teleomorph on natural substrata: *Stromata* immersed in substrate, 1.0 mm high and 3.5 mm diam, cells forming pseudoparenchymatous, saffron to sienna, KOH– and LA–, prosenchymatous, cells forming t*extura intricata*. *Ascomata* nearly or completely immersed, aggregated in groups of 2–15, subglobose to pyriform, 290–450 µm high × 300–460 µm diam, not collapsing when dry, rarely with a depressed apical region, sienna, apical region rust to chestnut, slightly KOH+ slightly dark red, LA+ slightly yellow, surface smooth to rarely with scurf that varies to saffron, with protuberances around ascomatal apex. *Ascomatal surface cells* forming *textura globulosa*, 3–9 µm diam, with walls pigmented *ca.* 1.0 µm thick. *Ascomatal wall* 34–40 µm thick, of two regions: outer region 14–25 µm thick, intergrading with stroma, cells forming *textura globuosa*, walls pigmented, about 1.0 µm thick; inner region10–15 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* clavate, 105–157 × 9–14 µm, with inconspicuous ring at apex, 8-spored, ascospores uniseriate. *Ascospores* hyaline, ellipsoidal to fusiform, tapering slightly toward both ends, straight or slightly curved, usually with (5–)7(–8) distinct transverse septa, sparsely muriform, rarely with one or two discontinuous divisions, (16.8–)18.2–21.4(–23.6) × (6.2–)6.7–8.1(–8.9) µm (n = 50), smooth.

Distribution: North America (USA, known only from the type collection).

Habitat: On dead branches of *Lonicera involucrata (Caprifoliaceae)*.

Holotype of Pleonectria lonicerae: **USA**, Colorado, Clear Creek County, Empire, on *Lonicera involucrata*, 22 May 1897, E. Bethel, **Holotype** FH 00258958.

Notes: *Pleonectria lonicerae* was first described by Seeler (1940b) as *Thyronectria lonicerae* with a new combination as *Nectria lonicerae* made by Rossman (1989). *Pleonectria lonicerae* is unusual in having ascomata that are sienna in colour, a rare characteristic in nectria-like, although occurring in *Nectria neorehmiana*, *Pleonectria austroamericana*, and *P. sphaerospora* (Fig. 112A–C). This species is included in *Pleonectria* based on the scurf around the ascomatal apex; this scurf forms a distinct layer on the ascomatal surface (Figs 112E, F, 113A). Although appearing rust to chestnut macroscopically, in section this layer appears orange. *Pleonectria lonicerae* is similar to *P. pyrrhochlora*, *P. virens*, and *P. xanthoxyli* in having immersed ascomata. These three species, however, have a red to umber apex, not protuberances around ascomatal apex, and occur on *Acer*, *Rhus,* or *Zanthoxylum*, while *P. lonicerae* has a rust to chestnut ascomatal apex, protuberances around ascomatal apex, and occurs on *Lonicera involucrata*.

Pleonectria missouriensis (Ellis & Everh.) Sacc., Syll. Fung. 9: 990. 1891. Figs 114, 115.
Basionym: *Nectria missouriensis* Ellis & Everh., J. Mycol. 4: 57. 1888.
≡ *Paranectria missouriensis* (Ellis & Everh.) Rabenhorst, in Winter, Fungi europaei no. 3748. 1891.
≡ *Thyronectria missouriensis* (Ellis & Everh.) Seaver, Mycologia 1: 205. 1909.
Anamorph: zythiostroma-like.
≡ *Gyrostroma missouriense* Seeler, J. Arnold Arnold Arbor. 21: 441. 1940.

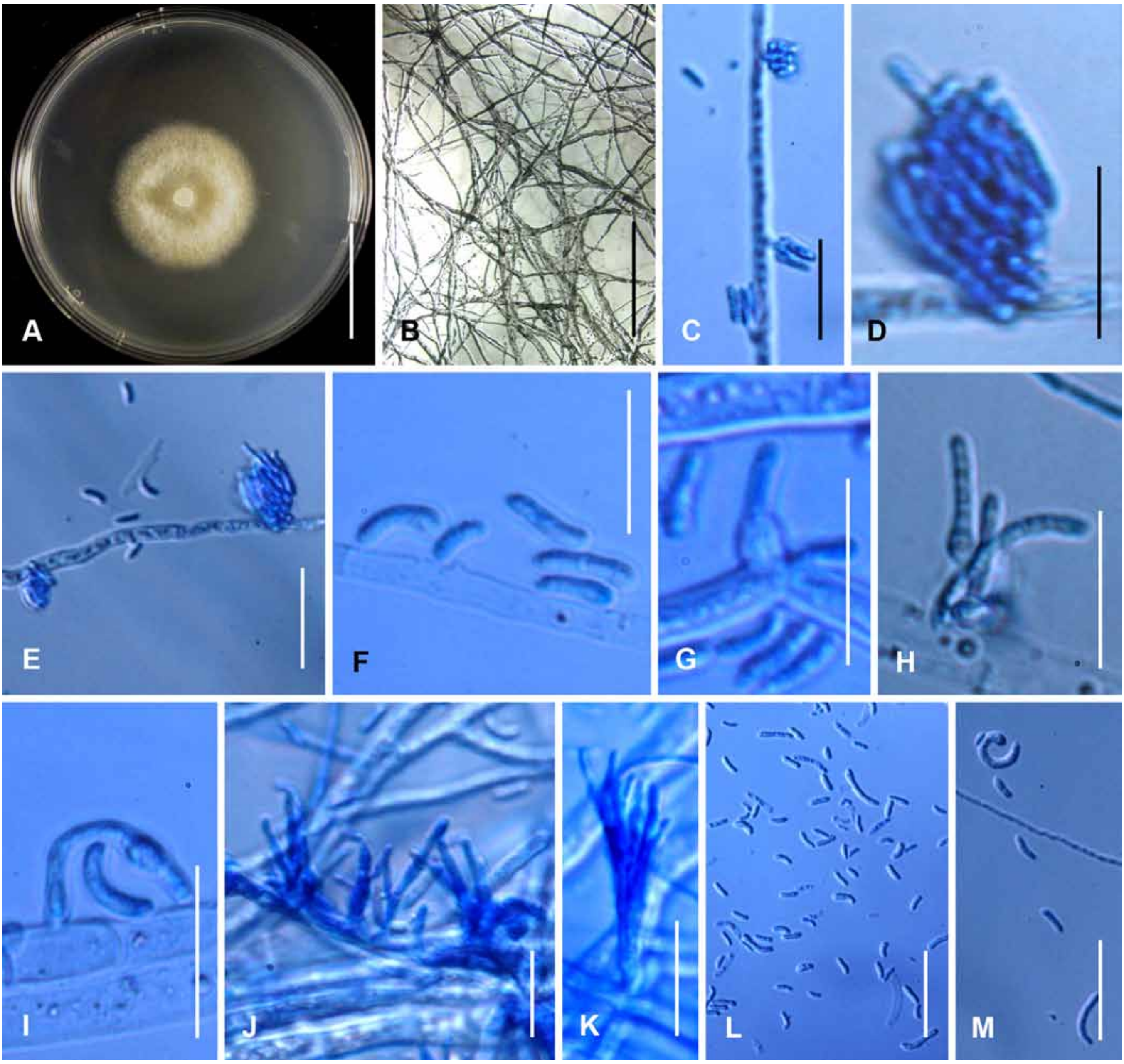

Fig. 111A–M. Anamorph of *Pleonectria lamyi* in culture. A. Cultures after 7 d at 25 °C on PDA; B. Conidial mass on SNA surface; C–E. Lateral phialidic pegs and conidial mass on SNA; F–I. Lateral phialidic pegs and conidia on SNA; J, K. Conidiophores on SNA; L, M. Young and mature conidia on SNA. Scale bars: A = 3 mm; B = 50 µm; C, E, L, M = 20 µm; D, F–K = 10 µm.

Teleomorph on natural substrata: *Ascomata and pycnidia* sometimes formed on same or discrete stroma. *Mycelium* not visible around ascomata and on host. *Stromata* erumpent through epidermis, 1.5 mm high and 2.0 mm diam, bay, KOH+ dark red, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, aggregated in groups of 3–10, subglobose to globose, 350–450 µm high × 350–450 µm diam, not collapsing when dry, red to bay, apical region darker, KOH+ dark red, LA+ yellow, surface scaly furfuraceous, olive yellow or yellow-green. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis* sometimes including bright yellow scurf, 5–10 µm diam, with pigmented, irregularly, *ca.* 1.5 µm thick walls. *Ascomatal wall* 35–50 µm thick, of two regions: outer region 27–40 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.5 µm thick; inner region 7–15 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* broadly clavate, 90–140 × 20–30 µm, with inconspicuous ring at apex, 8-spored, biseriate above, uniseriate below. *Ascospores* of two types: *microascospores* ellipsoidal to short-cylindrical with rounded ends, straight to slightly curved, muriform, with 5–8 transverse septa, 1–2 longitudinal septum, (20.9–)25.0–30.0(–32.5) × (8.2–)9.5–11.9(–13.1) µm (*n* = 50), hyaline, smooth. *Macroascospores* cylindrical with slightly rounded corners, curved, muriform, with 6–9 transverse septa, 1–2 longitudinal septum, (37.1–)39.1–46.7(–49.4) × (10.1–)10.4–12.2(–13.1) µm (*n* = 30), hyaline, becoming pale brown, smooth.

Anamorph on natural substrata: *Stromata* erumpent through epidermis or developing in stroma with ascomata, orange to bay. *Pycnidia* solitary or aggregated in groups of 3–7, superficial on stroma or rarely immersed at base, irregulary subglobose, smooth to slightly roughened, cerebriformis or cupulate upon drying, 100–250 µm high, 100–200 µm diam, bay to umber, KOH+ slightly darker, LA+ slightly yellow. *Pycnidial wall* 15–30 µm thick, of two regions: outer region 10–20 µm thick, intergrading with stroma, cells forming

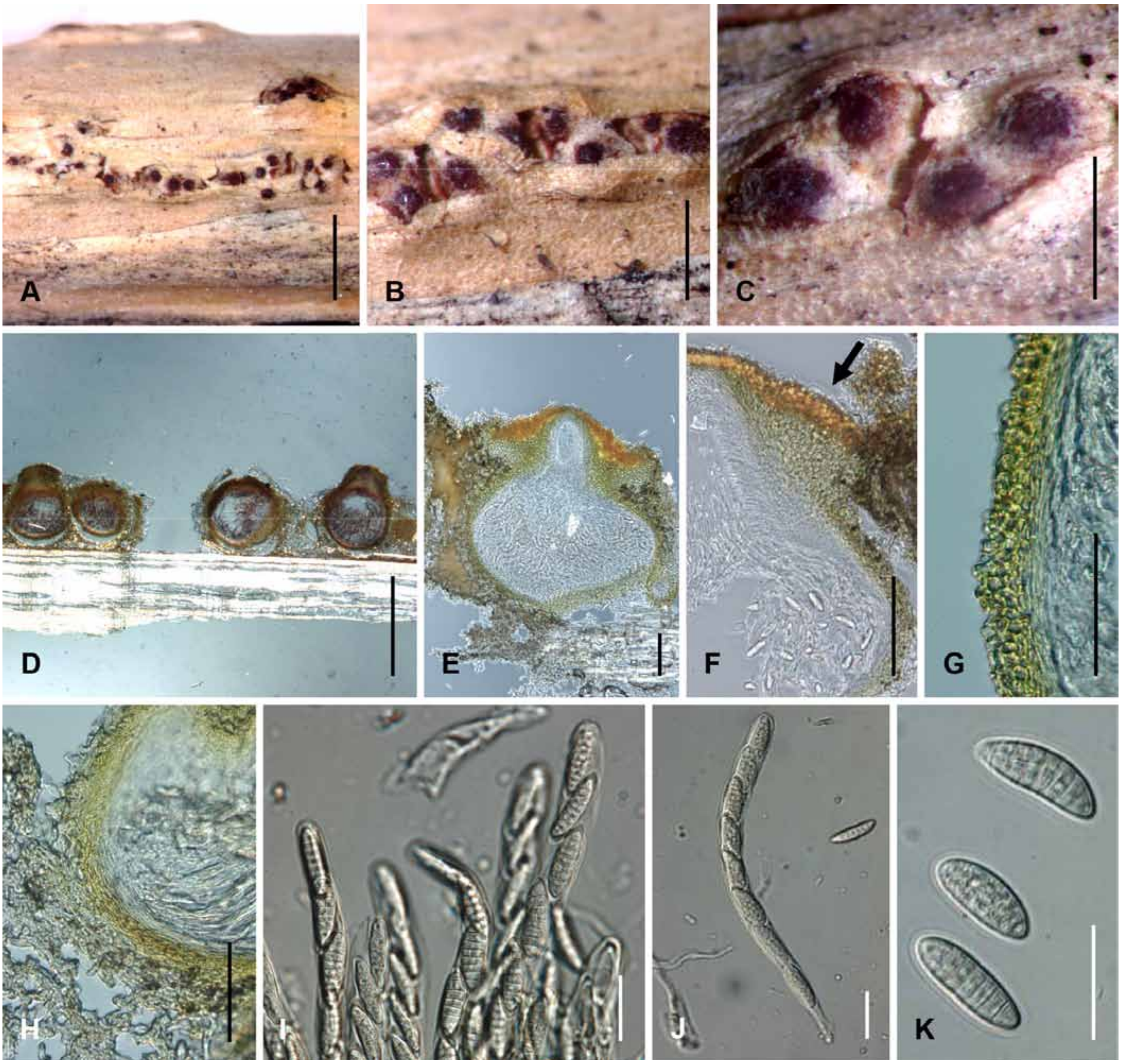

Fig. 112A–K. *Pleonectria lonicerae* on natural substrata (teleomorph). A–C. Perithecia on natural substrata; D, E. Median section of perithecia on natural substrata; F. Median section of perithecial apex (black arrow); G. Median section of perithecial wall; H. Median section of perithecium at base; I. Apex of asci; J. Ascus; K. Ascospores. Scale bars: A = 1 mm; B–D = 500 µm; E–H = 100 µm.

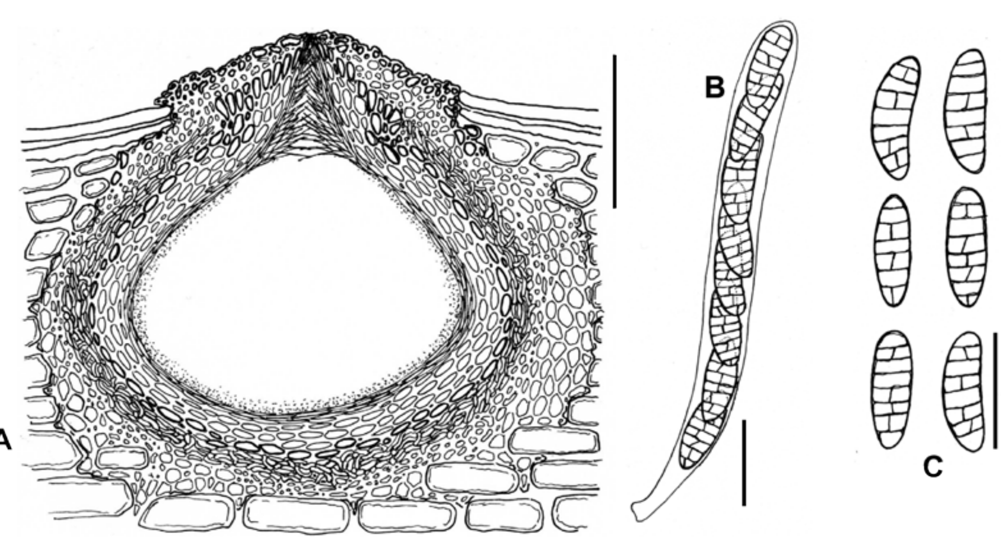

Fig. 113A–C. *Pleonectria lonicerae* on natural substrata (A–C teleomorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores. Scale bars: A = 100 µm; B, C = 20 µm

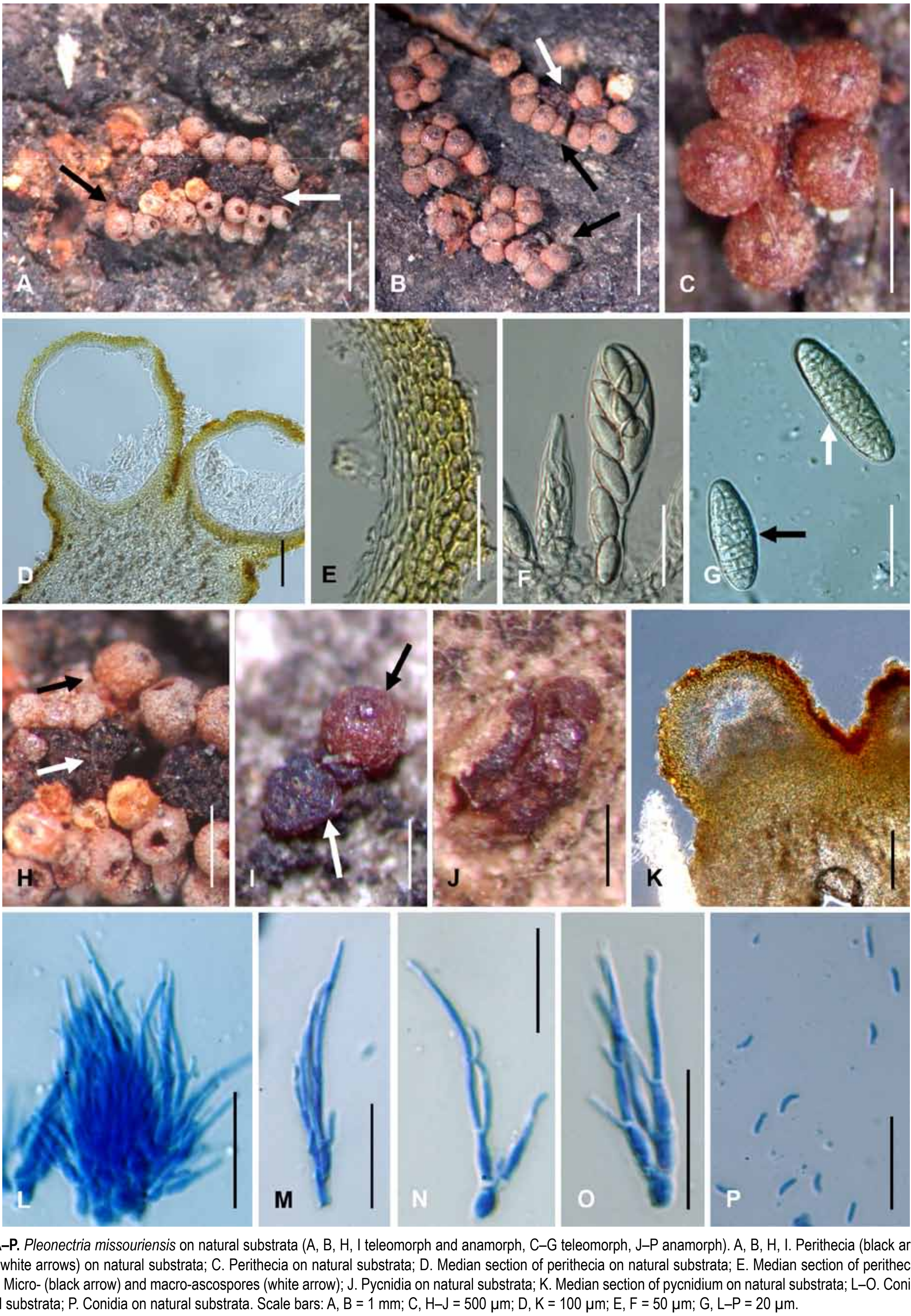

Fig. 114A–P. *Pleonectria missouriensis* on natural substrata (A, B, H, I teleomorph and anamorph, C–G teleomorph, J–P anamorph). A, B, H, I. Perithecia (black arrows) and pycnidia (white arrows) on natural substrata; C. Perithecia on natural substrata; D. Median section of perithecia on natural substrata; E. Median section of perithecial wall; F. Ascus; G. Micro- (black arrow) and macro-ascospores (white arrow); J. Pycnidia on natural substrata; K. Median section of pycnidium on natural substrata; L–O. Conidiophores on natural substrata; P. Conidia on natural substrata. Scale bars: A, B = 1 mm; C, H–J = 500 µm; D, K = 100 µm; E, F = 50 µm; G, L–P = 20 µm.

textura globulosa or *t. angularis*, walls pigmented, about 1.5 µm thick; inner region 5–10 µm thick, of elongate, thin-walled, hyaline cells, forming t*extura prismatica*. *Conidiophores* densely branched, generally with (1–)3(–5)-branched, 17–49 µm long, 1.5–2.7 µm wide. *Conidiogenous cells* cylindrical to subulate, straight to slightly curved, enteroblastic, monophialidic, 10.2–13.2 × 1.3–2.0 µm. *Intercalary phialides* observed, bearing 1–3(–5) terminal phialides, up to 6 µm, similar to acropleurogenous conidiophores. *Sterile hyphae* absent. *Conidia* hyaline, oblong-ellipsoidal to allantoid, sometimes slightly curved, non-septate, (1.9–)2.4–3.6(–4.8) × 0.5–0.8(–1.2) µm (*n* = 50).

Habitat: On dead branches of *Carya tomentosa* as *C. alba (Juglandaceae)*.

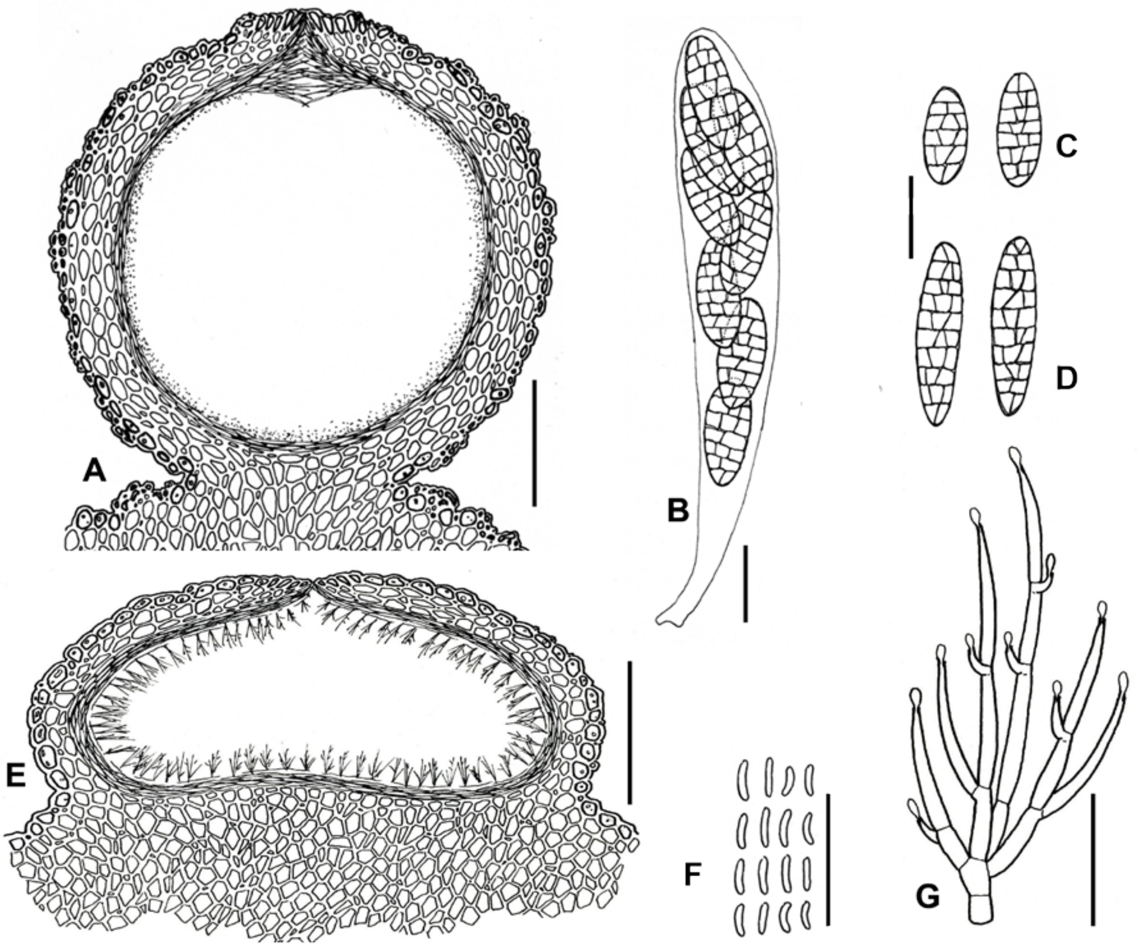

Fig. 115A–G. *Pleonectria missouriensis* on natural substrata (A–D teleomorph, E–G anamorph). A. Median section of mature perithecium; B. Ascus; C. Microascospores; D. Macroascospores; E. Median section of mature Pycnidium; F. Conidia; G. Conidiophores. Scale bars: A, E = 100 µm; B–D = 20 µm; F, G = 10 µm.

Distribution: North America (USA).

Lectotype of Pleonectria missouriensis *designated herein*: **USA**, Missouri, Concordia, on dead branches of *Carya alba*, Mar. 1888, C.H. Demetrio, **Lectotype** NY ID 00927928; **Isolectotype** NY 00927928, NY “specimen 1”, NY “specimen 2”.

Additional specimen examined: **USA**, Indiana, Scottsburg, on *Carya glabra*, J.R. Weir, BPI 552932 as *Megalonectria pseudotrichia*; Oregon, Corvallis, residential garden, on dead twigs, 30 Mar. 1971, A.Y. Rossman, BPI 632606. **Unknown**, possibly Louisiana: on woody substrate, BPI 552915 as *Thyronectria pseudotrichia*.

Notes: At first glance, *Pleonectria missouriensis* resembles *P. pseudomissouriensis* in the morphology of the ascomata and asci. However, this species with muriform ascospores can be readily distinguished from *P. pseudomissouriensis* having one-septate ascospores (Figs 114G, 115C, D). In *Pleonectria*, this is the only species having two different sizes of ascospores; this characteristic distinguishes *P. missouriensis* from other species of *Pleonectria* as well as other nectria-like fungi (Figs 114G, 115C, D). The anamorph of *P. missouriensis* forms pycnidia in the natural environment that are similar to the anamorph of *P. lamyi* in having superficial, irregularly discoidal pycnidia; the shape of the conidia and host distinguish these species. *Pleospores missouriensis* has oblong-ellipsoidal to allantoid conidia and occurs on *Carya* while *P. lamyi* has ellipsoidal to oblong conidia and occurs on *Berberis* (Figs 114P, 115F).

Pleonectria okinawensis Hirooka, Rossman & P. Chaverri, **sp. nov.** MycoBank MB519714. Figs 116–118.

Holotype of Pleonectria okinawensis. **Japan**, Okinawa Pref. Ishikawa-shi, Ireibaru, Okinawa Island, on dead twigs of *Castanopsis* sp., 20 Jan. 2003, Y. Hirooka, **Holotype** BPI 881058, **ex-holotype** culture MAFF 241410 = TPP-h92.

Etymology: *okinaw* + *-ensis*; indicates collection place.

Anamorph: zythiostroma-like.

Teleomorph on natural substrata: *Ascomata and pycnidia* sometimes formed on same or discrete stroma. *Mycelium* not visible around ascomata and on host. *Stromata* erumpent through epidermis, 1.5 mm high and 1.5 mm diam, sienna to bay, KOH+ dark red, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, solitary to aggregated in groups of 2–10, subglobose to globose, 240–350 µm high × 240–380 µm diam, red to bay, cupulate when dry, apical region slightly darker, KOH+ blood colour, LA+ yellow, smooth to roughened. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis*, 6–14 µm diam, with pigmented *ca.* 1.5 µm thick walls. *Ascomatal wall* 40–60 µm thick, of two regions: outer region 27–50 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.5 µm thick; inner region 7–13 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* clavate, 55–70 × 8–12.5 µm, with inconspicuous ring at apex, 8-spored, ascospores biseriate above, uniseriate below. *Ascospores* ellipsoidal to rarely fusiform, straight, hyaline to pale greenish brown, 1-septate, (8.7–)9.8–12.4(–13.5) × (3.7–)4.6–

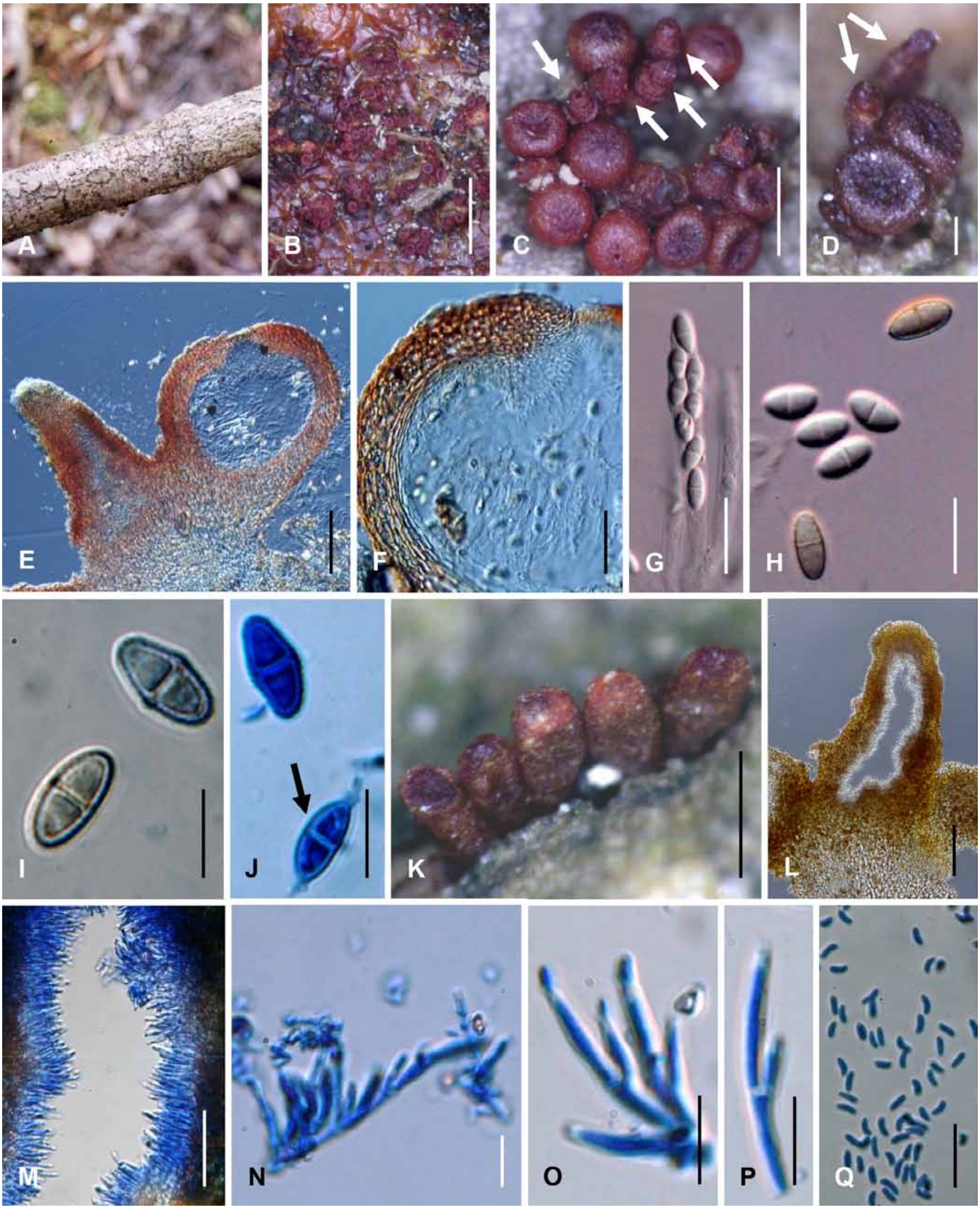

Fig. 116A–Q. *Pleonectria okinawensis* on natural substrata (A–E teleomorph and anamorph, F–J teleomorph, K–Q anamorph). A–D. Perithecia and navicular pycnidia (white arrows) on natural substrata; E. Median section of perithecium and navicular pycnidium on natural substrata; F. Median section of perithecial wall; G. Ascus; H, I. Ascospores; J. Budding ascospores (black arrow); K. Navicular pycnidia on natural substrata; L Median section of navicular pycnidium on natural substrata; M–P. Conidiophores on natural substrata; Q. Conidia on natural substrata. Scale bars: B = 5 mm; C, K = 500 µm; D, E, L = 100 µm; F, M. = 50 µm; G = 20 µm; H–J, N–Q = 10 µm.

6.0(–6.8) µm (*n* = 100), smooth to spinulose, budding to produce hyaline, thin-walled, *bacillar ascoconidia*, (2.2–)2.4–3.2(–3.6) × (0.6–)0.8–1.4(–1.7) µm (*n* = 100) µm, hyaline, forming outside asci.

Anamorph on natural substrata: *Stromata* erumpent through epidermis or developing in stroma with ascomata, sienna to bay. *Pycnidia* solitary or aggregated in groups of 3–7, superficial on stroma,fusiform to navicular, smooth to slightly roughened, collapsing laterally or not collapsing when dry, 190–564 µm high, 122–276 µm diam, sienna to bay, KOH+ slightly darker, LA+ slightly yellow. *Pycnidial wall* 22–30 µm thick, of two regions: outer region 13–24 µm thick, intergrading with stroma, cells forming *textura*

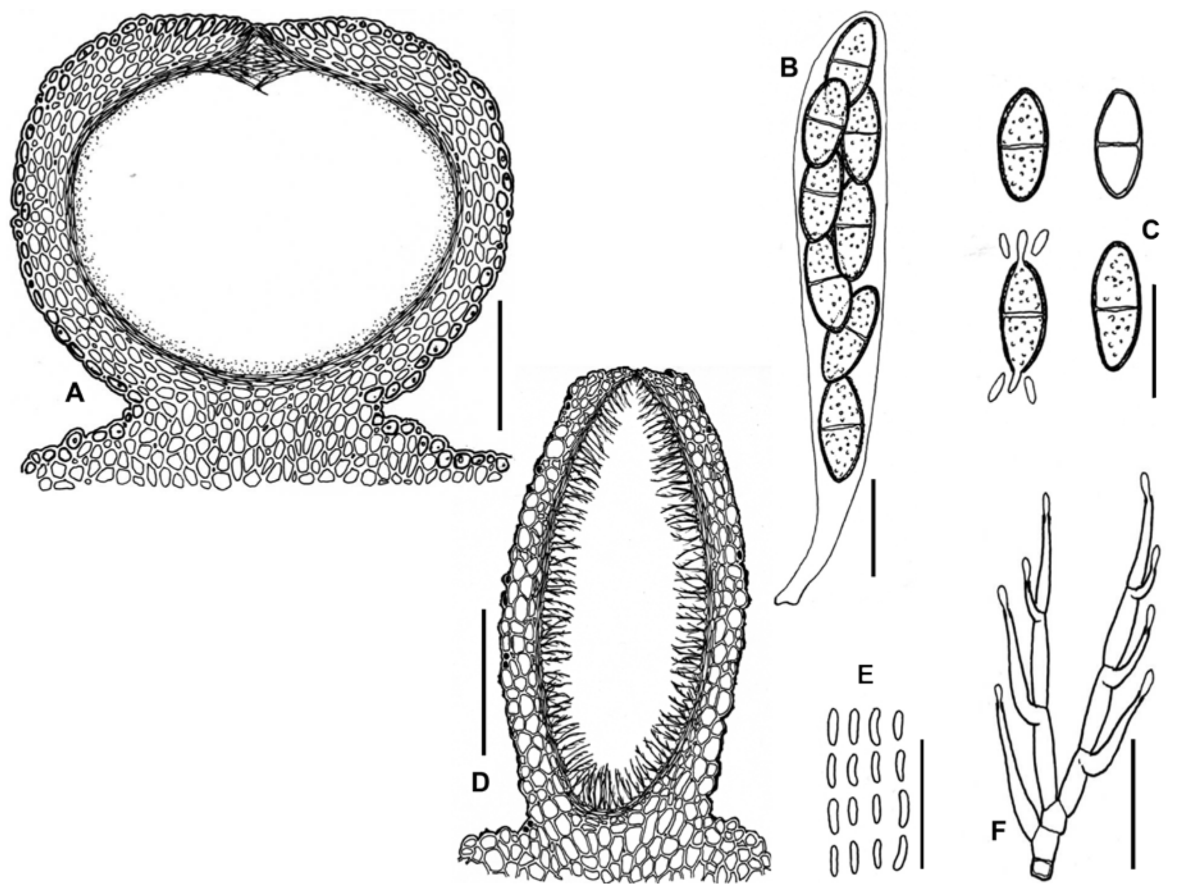

Fig. 117A–F. *Pleonectria okinawensis* on natural substrata (A–C teleomorph, D–F anamorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores and ascoconidia; D. Median section of mature Pycnidium; E. Conidia; F. Conidiophores. Scale bars: A, D = 100 µm; B, C, E, F = 10 µm.

globulosa or *t. angularis*, walls pigmented, about 1.5 µm thick; inner region 8–18 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Conidiophores* densely branched, generally with 1–4 branched, 18–33 µm long, 1.1–2.8 µm wide. *Conidiogenous cells* cylindrical to subulate, straight to slightly curved, enteroblastic, monophialidic, 6–10 × 1.0–1.7 µm. *Intercalary phialides* observed, bearing 1– 3(–7) terminal phialides, up to 4 µm long, similar to short acropleurogenous conidiophores. *Sterile hyphae* absent. *Conidia* hyaline, ellipsoidal, oblong to allantoid, sometimes curved, non-septate, (2.5–)2.7–3.3(–3.9) × (0.7–)0.8–1.2(–1.4) µm (*n* = 50).

Anamorph in culture: After 7 d at 25 °C, colonies 23–45 mm (average 29 mm) diam. *Colony surface* slightly cottony with aerial mycelium, white to whitish yellow; *aerial mycelium* developed, small white to whitish yellow sporodochial conidial masses produced after 3 wk; *reverse* whitish yellow. *Odour* on PDA slightly fruity. Sporulation on SNA from *lateral phialidic pegs* somewhat rare, ellipsoidal, slightly tapering toward tip or flask-shaped, 2.3–4.6 µm long, 1.5–2.1 µm wide at base, enteroblastic, monophialidic. *Aerial conidiophores* unbranched, sometimes 1–2 branched, becoming loosely to moderately densely branched, 11.5–32.2 µm long, 2.3–3.2 µm wide at base. *Aerial conidiogenous cells* monophialidic, enteroblastic, cylindrical, slightly tapering toward tip with widest point in middle, 9.5–11.9 µm long, 1.4–3.0 µm wide at base. *Sporodochial conidiophores* sometimes formed, densely branched, 23.3–44.7 µm long, 1.6–3.3 µm wide at base. *Sporodochial conidiogenous cells* monophialidic, enteroblastic, cylindrical, slightly tapering toward tip or narrowly flask-shaped with widest point in middle, 7.6–12.7 µm long, 1.7–2.9 µm wide at base. *Young conidia* formed from monophialides on aerial, submerged, or repent hyphae, formed abundantly on slimy heads or sporodochia, ellipsoidal to fusiform, hyaline, smooth, straight or slightly curved, rounded at both ends, non-septate, (3.2–)3.6–4.8(–5.6) × (1.3–)1.6–2.2(–2.6) µm (*n* = 50). *Mature conidia* swollen, non-septate, ellipsoidal fusiform or allantoid, hyaline, smooth, slightly or sometimes strongly curved, rounded at both ends, (5.1–) 7.1–10.1(–11.5) × (1.8–)2.0–2.8(–3.3) µm (*n* = 50). Cylindrical to navicular *pycnidia* produced on SNA and PDA (MAFF 241410). *Chlamydospores* and *ascomata* not produced in culture.

Habitat: On dead twigs of *Castanopsis* sp. (*Fagaceae*).

Distribution: Asia (Japan).

Additional specimens and isolates examined: **Japan**, Okinawa Pref., Ishikawa-shi, Ireibaru (Okinawa Island), On *Castanopsis* sp., 20 Jan. 2003, Y. Hirooka, TUA-TPP-h93, culture TPP-h93.

Notes: *Pleonectria okinawensis* was found on Okinawa Island in the south part of Japan. This species is included in the genus *Pleonectria* despite the lack of yellow-green scurf on the ascomata (Fig. 116C–F). The budding ascospores, pycnidial anamorph, and phyologenetic tree provide strong evidence for placement in *Pleonectria*. *Pleonectria aquifolii* and *P. sinopica* are morphologically similar to *P. okinawensis* in the natural environment. Only *P. okinawensis* produces spinulose ascospores and occurs on *Castanopsis* sp. (Figs 116I, 117C). The cylindrical to navicular pycnidia of *P. okinawensis* are unusual; most species of *Pleonectria* produce subglobose to irregular discoidal pycnidia (Figs 116C–E, K, L, 117D). In culture, the anamorph of *P. okinawensis* resembles that of *P. sinopica* in producing mature conidia more than 5 µm long and sporodochial conidiophores; however, *P. okinawensis* produces usually straight young conidia while those of *P. sinopica*

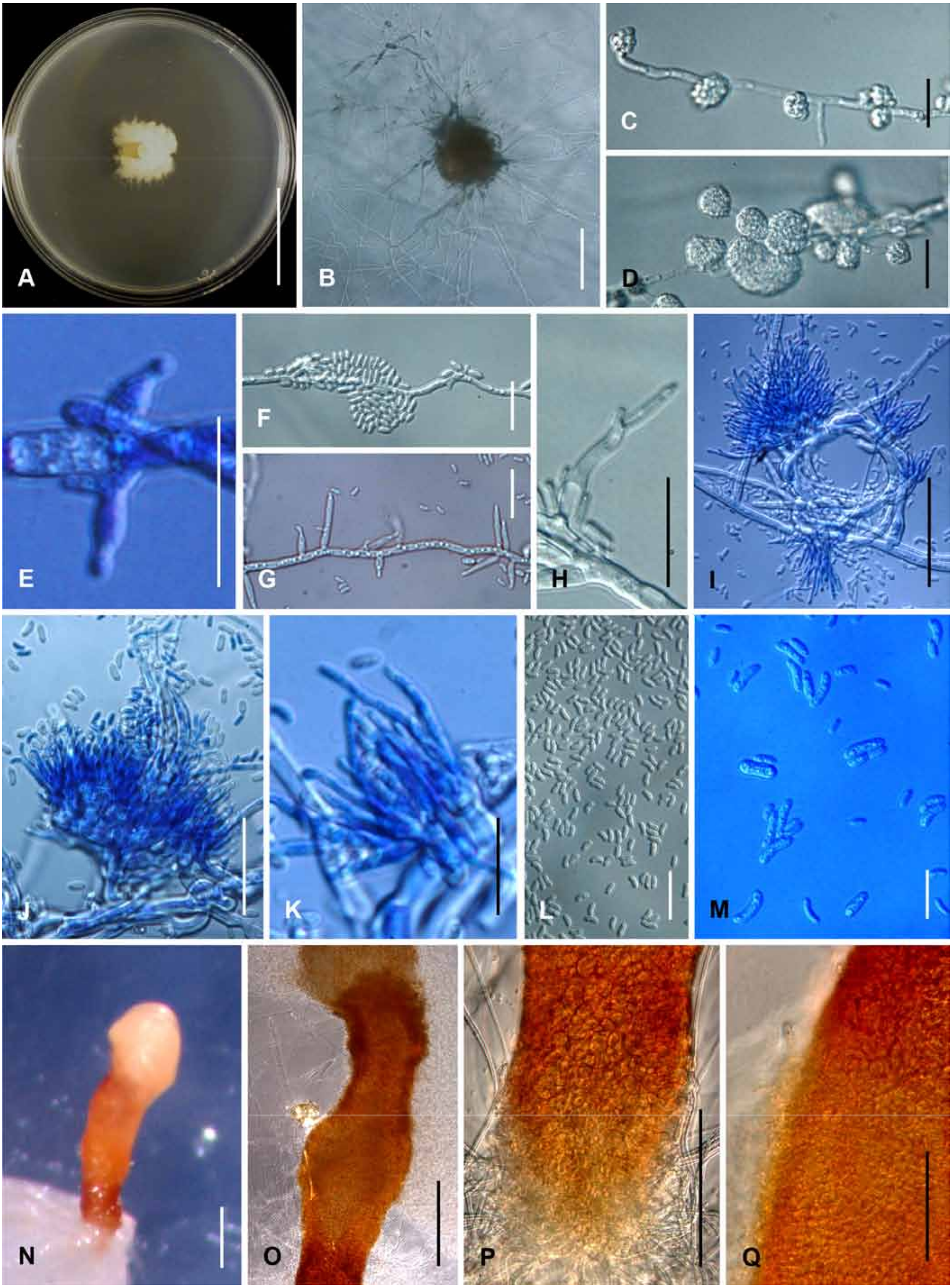

Fig. 118A–Q. Anamorph of *Pleonectria okinawensis* in culture. A. Cultures after 7 d at 25 °C on PDA; B. Conidial mass on SNA; C. Lateral phialidic pegs and conidial mass on SNA; D. Conidiophores and conidial mass on SNA; E, F. Lateral phialidic pegs and conidia on SNA; G, H. Conidiophores on SNA; I–K. Sporodochial conidiophores on SNA; L. Young conidia on SNA; M. Young and mature conidia on SNA; N, O. Pycnidia on SNA; P. Basal part of pycnidium on SNA; Q. Pycnidial wall on SNA. Scale bars: A = 3 mm; B, I = 50 µm; C, D, F–H, J, Q = 20 µm; E, K–M = 10 µm; N–P = 200 µm.

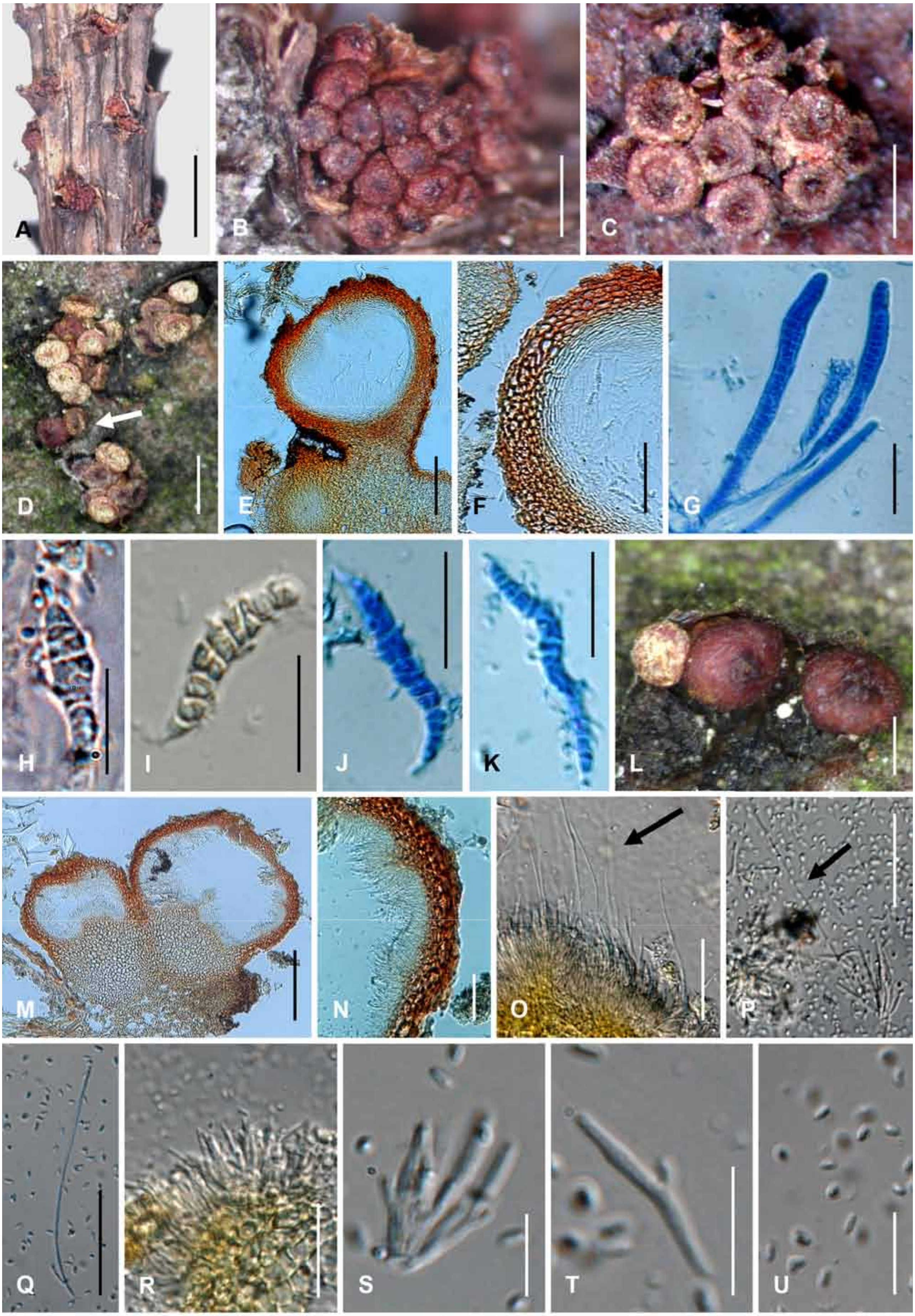

Fig. 119A–U. *Pleonectria pinicola* on natural substrata (A–C, E–K teleomorph, D teleomorph and anamorph, L–U anamorph). A–C. Perithecia on natural substrata; D. Perithecia and pycnidia (white arrow) on natural substrata; E. Median section of perithecium on natural substrata; F. Median section of perithecial wall; G. Asci; H–K. Budding ascospores; L. Pycnidia on natural substrata; M. Median section of pycnidia on natural substrata; N. Median section of pycnidial wall on natural substrata; O–Q. Conidiophores and sterile hyphae on natural substrata; R–T. Conidiophores on natural substrata. U. Conidia on natural substrata. Scale bars: A = 5 mm; B–D = 500 µm; E, L, M = 100 µm; F, N–Q 50 µm; G–K, R = 20 µm; S–U = 10 µm.

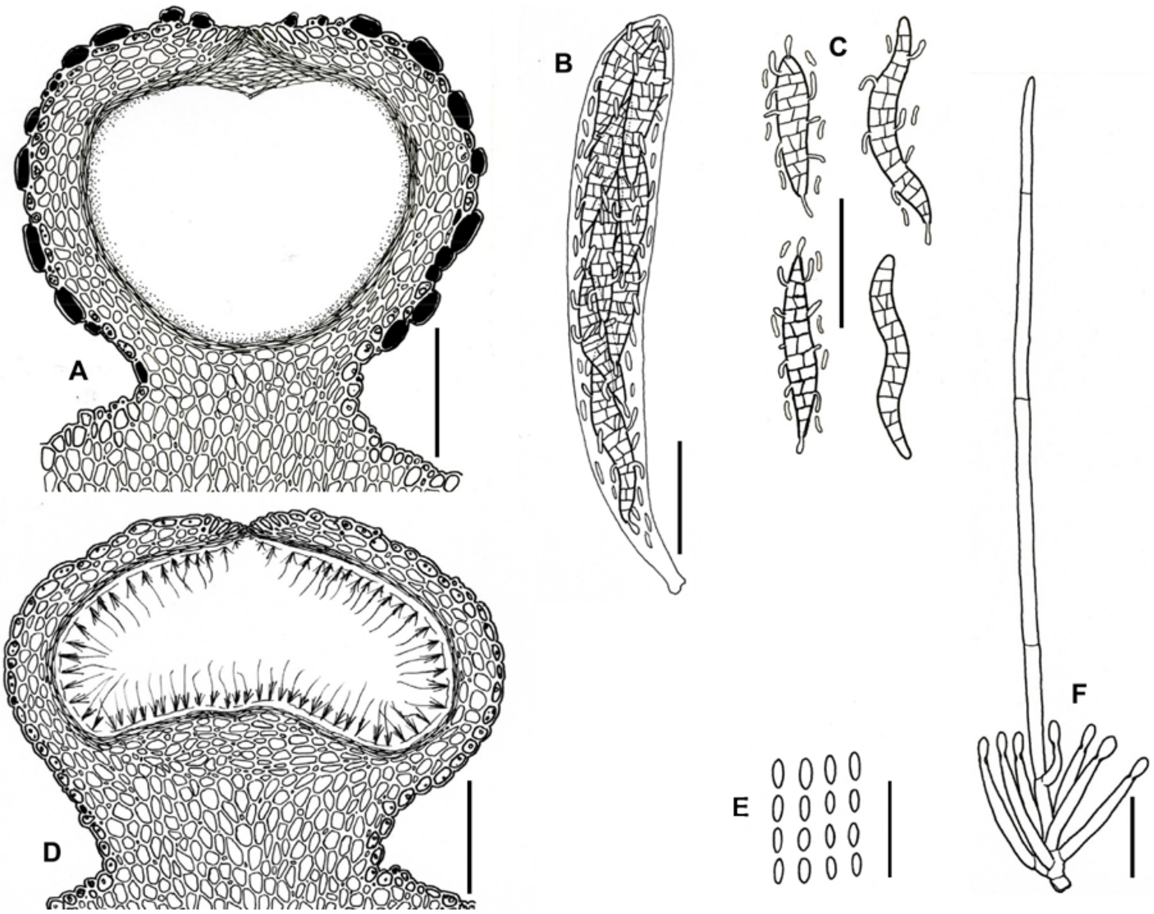

Fig. 120A–F. *Pleonectria pinicola* on natural substrata (A–C teleomorph, D–F anamorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores and ascoconidia; D. Median section of mature pycnidium; E. Conidia; F. Conidiophores and sterile hyphae. Scale bars: A, D = 100 µm; B, C, E, F = 20 µm.

are sometimes strongly curved (Fig. 118L). The pycnidial anamorph of *P. okinawensis* was induced to form on SNA after one month. Initially, the pycnidia in culture were morphologically similar to synnemata (Fig. 118N). However, based on the anatomical morphology of the fruiting bodies, the synnematous fruiting bodies are pycnidia that have walls composed of *textura globulosa* or *t. globulosa* and bear conidia internally (Fig. 118O–Q). The relationship of *P. okinawensis* to other species is difficult to determine based on gross morphology. *Pleonectria sinopica*, the species most closely related to *P. okinawensis* in our phylogeny, does not produce cylindrical to navicular pycnidia although the morphology of the teleomorph in the natural environment and anamorph in culture are almost identical (Figs 1, 2).

Pleonectria pinicola Kirschst., Abh. Bot. Ver. Prov. Brandenburg 48: 59. 1906. Figs 119–121.

≡ *Ophionectria cylindrospora* (Sollm.) Berl. & Voglino var. *tetraspora* Weese, Centralbl. Bakteriol., Abt. 2, 42: 601. 1914.

Anamorph: zythiostroma-like.

Teleomorph on natural substrata: *Stromata and pycnidia* sometimes formed on same or discrete stroma. *Mycelium* not visible around ascomata or on host. *Stromata* erumpent through epidermis, 1.0 mm high and 1.5 mm diam, bay to umber, KOH+ dark red, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, scattered to aggregated in groups of 2–22, subglobose to globose, 250–410 µm high × 213–385 µm diam, cupulate upon drying, sometimes with only a depressed apical region, scarlet to bay, apical region slightly darker, KOH+ slightly purple, LA+ yellow, sometimes surface bright yellow to yellowish green scurfy or scaly. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis* sometimes including bright yellow scurf, 3–9 µm diam, with pigmented, irregularly *ca.* 1.5 µm thick walls. *Ascomatal wall* 31–60 µm thick, of two regions: outer region 27–44 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.5 µm thick; inner region10–15 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* narrowly clavate, increasing in size as ascospores mature, 64–107 × 7–12 µm, with inconspicuous ring at apex, 8-spored, mainly biseriate. *Ascospores* fusiform to long-fusiform, muriform, with 5–15 transverse septa and one longitudinal septum, hyaline, (14.2–)18.1–28.3(–46.4) × (3.2–)4.3–5.3(–6.9) µm (*n* = 82), smooth, budding to produce hyaline, thin-walled, tapering apex, slightly curved, *bacillar ascoconidia*, (1.8–)2.8–3.8(–4.7) × (0.8–)1.2–1.6(–1.9) µm (*n* = 150), that fill asci.

Anamorph on natural substrata: *Stromata* erumpent through epidermis, orange to red. *Pycnidia* solitary or aggregated in groups of 3–15, superficial on stroma or rarely immersed at base, subglobose, smooth to slightly roughened, cerebriformis or slightly cupulate upon drying, 126–254 µm high, 145–365 µm diam, red to bay, KOH+ slightly darker, LA+ slightly yellow. *Pycnidial wall* 19–38 µm thick, of two regions: outer region 10–14 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.5 µm thick; inner region 10–21 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Conidiophores* densely branched, generally with 1–3 branched, 15–30 µm long, 1.7–2.3 µm wide. *Conidiogenous cells* cylindrical

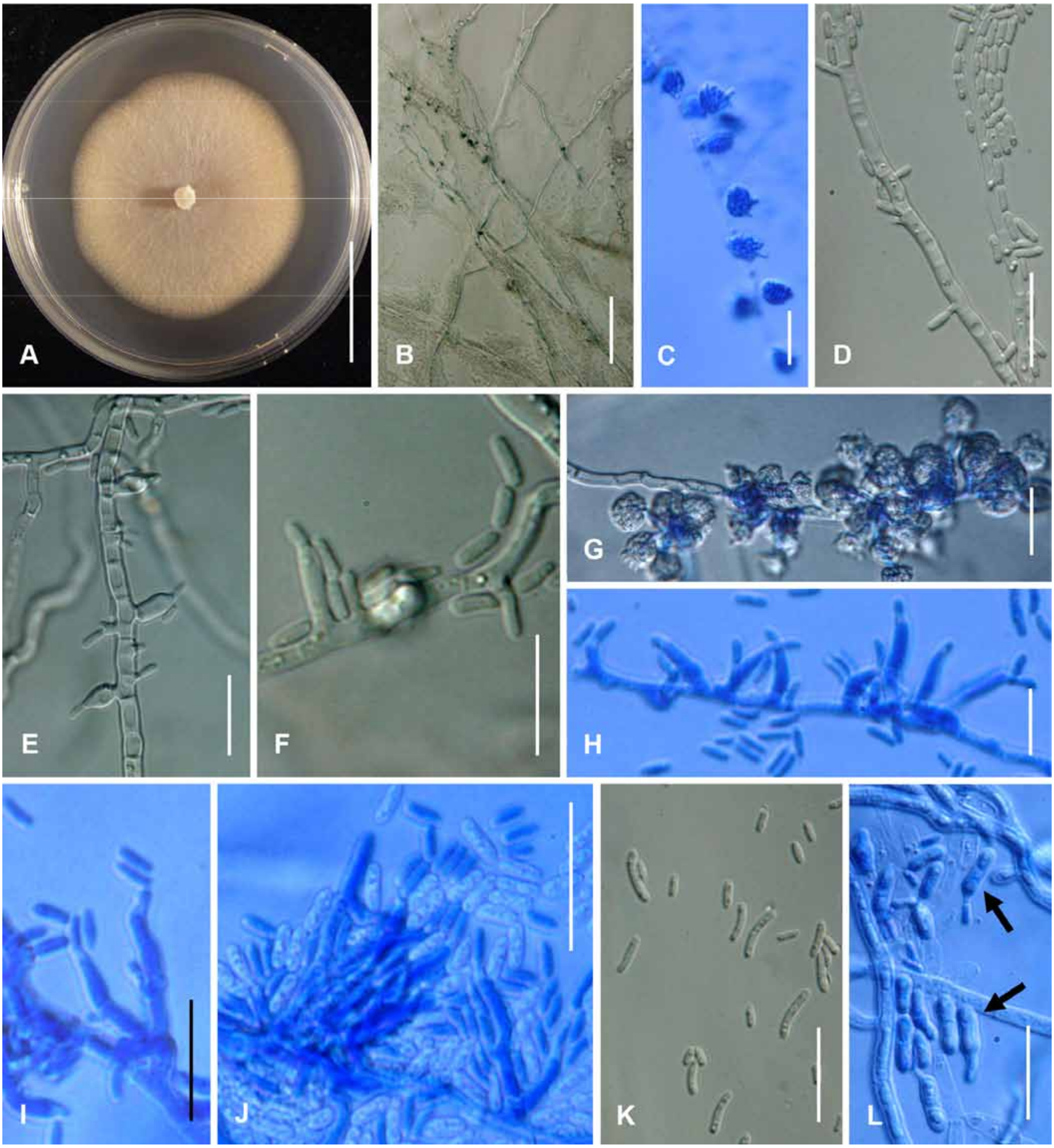

Fig. 121A–L. Anamorph of *Pleonectria pinicola* in culture. A. Cultures after 7 d at 25 °C on PDA; B. Conidial mass on SNA surface; C. Lateral phialidic pegs and conidial mass on SNA; D–F. Lateral phialidic pegs and conidia on SNA; G. Conidiophores and conidial mass on SNA; H–J. Conidiophores on SNA; K. Young and mature conidia on SNA; L. Budding mature conidia (black arrows) on SNA. Scale bars: A = 3 mm; B = 50 µm; C–E, G = 20 µm; F, H–L. = 10 µm.

to long-cylindrical, slightly tapering toward tip, straight to slightly curved, enteroblastic, monophialidic, 8–16 × 1.2–2.4 µm. *Intercalary phialides* generally observed, bearing 1–2 terminal phialides, up to 5 µm long, similar to short acropleurogenous conidiophores. *Sterile hyphae* mixed in with phialides, acicular, straight or curved, usually unbranched, sometimes 1–3 branched, septate, 65–95 µm long, 0.7–2.1 µm wide. *Conidia* hyaline, ellipsoidal to oblong, sometimes slightly curved, non-septate, (2.1–)2.6–3.4(–3.9) × (0.9–)1.0–1.4(–1.6) µm (*n* = 100).

Anamorph in culture: After 7 d at 25 °C, colonies 45–70 mm (average 57 mm) diam. *Colony surface* cottony with aerial mycelium, whitish greenish to greenish yellow; *aerial mycelium* developed, rarely small greenish yellow sporodochial conidial masses produced after 2–3 wk; *reverse* greenish yellow to hazel in centre and greenish yellow at margin. *Odour* on PDA slightly putrid. Sporulation on SNA from *lateral phialidic pegs* abundant, ellipsoidal, slightly tapering toward tip or flask-shaped, 1.9–6.8 µm long, 1.1–3.7 µm wide at base, monophialidic enteroblastic. *Conidiophores* sometimes formed, unbranched, sometimes verticillate, 1(–2)-branched, becoming loosely to moderately densely branched, 9.5–22.0 µm long, 1.2–4.2 µm wide at base. *Conidiogenous cells* enteroblastic, monophialidic, cylindrical, slightly tapering toward tip or flask-shaped, 3.5–11.0 µm long, 1.1–3.1 µm wide at base. *Young conidia* formed from monophialides on aerial, submerged, or repent hyphae, formed abundantly on slimy heads, ellipsoidal to oblong, hyaline, straight or slightly curved, rounded at both endscurved, rounded at both ends, non-septate, (2.8–)3.7–4.9(–5.9) × (1.0–) 1.4–2.0(–2.6) µm (*n* = 150), smooth-walled. *Mature conidia* swollen, 0-septate, oblong, slightly swollen at both ends, hyaline, smooth, straight or curved, rounded at both ends, (5.5–)6.8–11.0(–13.2) × (1.7–)1.9–2.7(–3.1) µm (*n* = 50). *Ascomata*, *pycnidia,* and *chlamydospores* not produced in SNA and PDA.

Habitat: On bark or twigs of *Pinus* spp. Including *Pinus excelsa, Pinus koraiensis, Pinus strobus, Pinus sylvestris,* and *Pinus* sp. (*Pinaceae*).

Distribution: Asia (Japan, Pakistan, Taiwan), Europe (Germany, Russia), North America (USA).

Holotype of Pleonectria pinicola *and* O. cylindrospora: **Germany**, Rathenower Stadtforst, on *Pinus sylvestris*, 11 Dec. 1904, W. Kirschstein, **Holotype** B 70 0021601. These two names are based on the same specimen.

Additional specimens and isolates examined: **Germany**, Thuringia, south of Freestate, Sonneberg (MTB 5632), on dead branches of *Pinus sylvestris*, 02 Feb. 2008, I. Wagner, BPI 881059, culture CBS 125166 = A.R. 4478; Thuringia, south of Freestate, Sonneberg (MTB 5632), on dead branches of *Pinus sylvestris*, 02 Feb. 2008, I. Wagner, BPI 881060, culture CBS 125167 = A.R. 4479. **Japan**, Nagano Pref., Ueda city, Sugadaira, on dead branches of *Pinus koraiensis*, Sep. 2006, Y. Hirooka, BPI 881061 = TUA-TPP-h543, culture MAFF 241458 = TPP-h543. **Pakistan**, Loon Bagla, Muzaffarabad, on dead branches of *Pinus excelsa*, 26 Jul. 1963 C. Booth, BPI 632600 as *Thyronectria balsamea*; Loon Bagla, Muzaffarabad, on dead branches of *Pinus excelsa*, 26 Jul. 1963 C. Booth, BPI 632601 as *Thyronectria balsamea*. **Russia**, Siberia, Tara District, on *Pinus sylvestris*, K. Murashkinsky, culture CBS 242.30. **Taiwan**, Taichung, Pilushi, Heping, on twig of *Pinus taiwanensis*, 24 May 2005, Jia-Ron Guu, comm. Yu-ming Ju 94052402, BCRC 34289 = CBS 128979 = A.R. 4608. **USA**, New Hampshire. Waterville, on *Pinus strobus*, 21 Jul. 1932, J.R. Hansbrough, BPI 632796 as *Scoleconectria scolecospora*; New Hampshire. Jackson, on *Pinus strobus*, 14 May 1929, P. Spaulding, BPI 632677 as *Scoleconectria scolecospora*; Indiana, Hennysville, on *Pinus strobus*, 20 Feb. 1936, R.M. Lindgren, BPI 632572 as *Scoleconectria scolecospora*; Maine, Kittery Point, on *Pinus strobus*, 23 Apr. 1934, G.G. Hahn, BPI 629745 as *Chilonectria cucurbitula*; Maryland, Takoma Park, on *Pinus* sp., 01 Apr. 1900, C.L. Shear, BPI 629739 as *Chilonectria cucurbitula*.

Notes: *Pleonectria pinicola* collected on *Pinus sylvestris* was described by Kirschstein (1906) and was synonymised with *Nectria balsamea* by Booth (1959). Our phylogenetic data show that there are two species in the *N. balsamea* clade that correlate with host identity: *Abies* and *Pinus* (Figs 1, 2). *Pleonectria pinicola* is the correct name for the species on *Pinus*. In the natural environment, the morphology of *P. pinicola* is similar to that of *P. balsamea*, but the size and number of transverse septa in the ascospores varies. In *P. pinicola* the ascospores are 14.2–46.4 × 3.2–6.9 µm with 5–15 transverse septa while in *P. balsamea* the ascospores are 16.0 –28.6 × 3.0–6.8 µm with 5–9 transverse septa. The anamorph of *P. pinicola* in the natural environment has long, sterile hyphae extending from the hymenium and abundant conidiophores (Figs 119O–Q, 120F). It is easily distinguished from *P. balsamea* that lacks such distinctive sterile hyphae.

According to the protologue *Ophionectria cylindrospora* var. *tetraspora* was described based on the same type specimen as *P. pinicola*, thus *O. cylindrospora* var. *tetraspora* is a nomenclatural synonym of *P. pinicola.* Although many specimens preserved in B were destroyed during World War II, the holotype of *P. pinicola* survived and we observed this specimen. Although the specimen was in poor condition, typical morphology of *P. pinicola* was observed.

A number of specimens identified as "*Nectria balsamea*" were examined on hosts such as *Abies*, *Picea*, *Pinus*, *Thuja,* and *Tsuga*. Our detailed morphological and molecular results suggest that these represent three different species, *P. balsamea* on *Abies*, *P. boothii* on *Picea*, and *P. pinicola* on *Pinus*, each one on a different conifer host genus. Because of limited number of specimens, the identity of those on *Thuja* and *Tsuga* could not be determined.

Pleonectria pseudomissouriensis Hirooka, Rossman & P. Chaverri, **sp. nov.** MycoBank MB519715. Figs 122, 123.

Holotype of Pleonectria pseudomissouriensis: **Argentina**, Urundel, Salta, 400 m elevation, on dead twigs, 13 Jul. 1946, Digilio-Grassi, **Holotype** NY.

Etymology: *pseudo* + *-missouriensis*; indicates the similarity of this species to *Pleonectria missouriensis*.

Anamorph: unknown.

Teleomorph on natural substrata: *Mycelium* not visible around ascomata and on host. *Stromata* erumpent through epidermis, 1.5 mm high and 2.0 mm diam, sienna to bay, KOH+ dark red, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, solitary to aggregated in groups of 3–21, subglobose to globose, 410–460 µm high × 400–430 µm diam, orange to umber, cupulate when dry, apical region darker, KOH+ blood colour, LA+ yellow, roughened, surface scurfy to small scaly, whitish yellow to bright yellow. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis* sometimes including bright yellow scurf, 5–16 µm diam, with pigmented, irregularly *ca.* 2.0 µm thick walls. *Ascomatal wall* 50–74 µm thick, of two regions: outer region 36–55 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.5 µm thick; inner region 13–20 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica. Asci* clavate, 68–103 × 10–16 µm, with inconspicuous ring at apex, 8-spored, ascospores biseriate above, uniseriate below. *Ascospores* ellipsoidal to fusiform, straight, hyaline, 1-septate, (13.0–)13.9–16.7(–18.5) × (4.6–)5.3–6.7(–7.3) µm (*n* = 50), striate

Habitat: On dead twigs.

Distribution: South America (Argentina, known only from the type collection).

Notes: *Pleonectria pseudomissouriensis* is described as a new species, although only the holotype specimen is known. This species is characterised by a scurfy to scaly ascomatal wall characteristic of the genus *Pleonectria* (Figs 122B–E, 123A). *Pleonectria pseudomissouriensis* is readily differentiated from the other species of *Pleonectria* by the striate ascospores (Figs 122G, H, 123C). *Pleonectria pseudomissouriensis* is morphologically similar to *P. missouriensis*. However, *P. missouriensis* has two types of muriform ascospores *i.e.* microascospores and macroascospores.

Pleonectria pyrrhochlora (Auersw.) G. Winter, Rabenh. Krypt.-Fl. Ed. 2, 1(2), II. Abt.: Ascomyc.: Gymnoasceen p. 108. 1884. Figs 124–126.

Basionym: *Nectria pyrrhochlora* Auersw., in Rabenh., Hedwigia 8: 88. 1869.

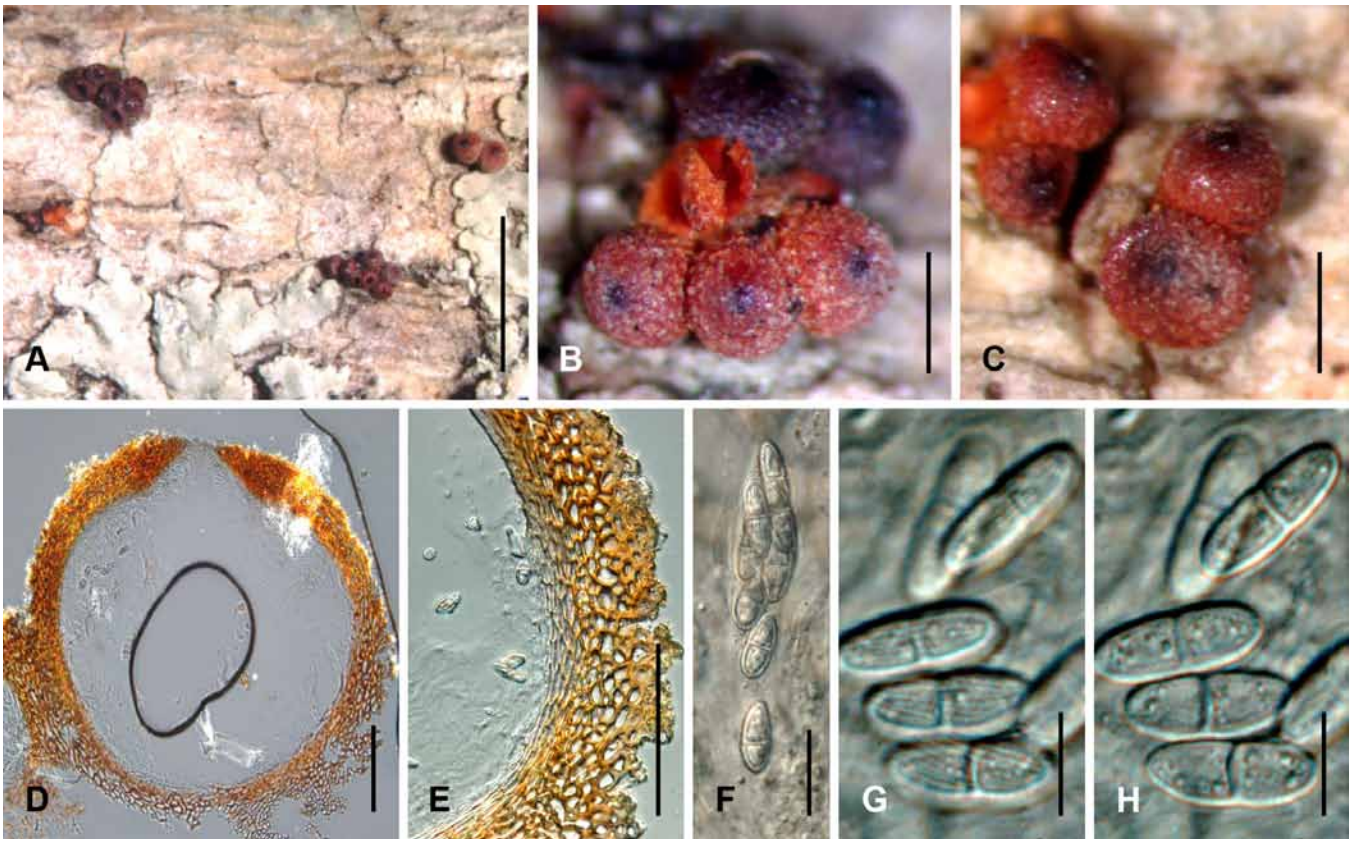

Fig. 122A–H. *Pleonectria pseudomissouriensis* on natural substrata (teleomorph). A–C. Perithecia on natural substrata; D. Median section of perithecium on natural substrata; E. Median section of perithecial wall on natural substrata; F. Ascus; G. Ascospores in surface view; H. Ascospores in optical section. Scale bars: A = 3 mm; B, C = 500 µm; D, E = 100 µm; F = 20 µm; G, H = 10 µm.

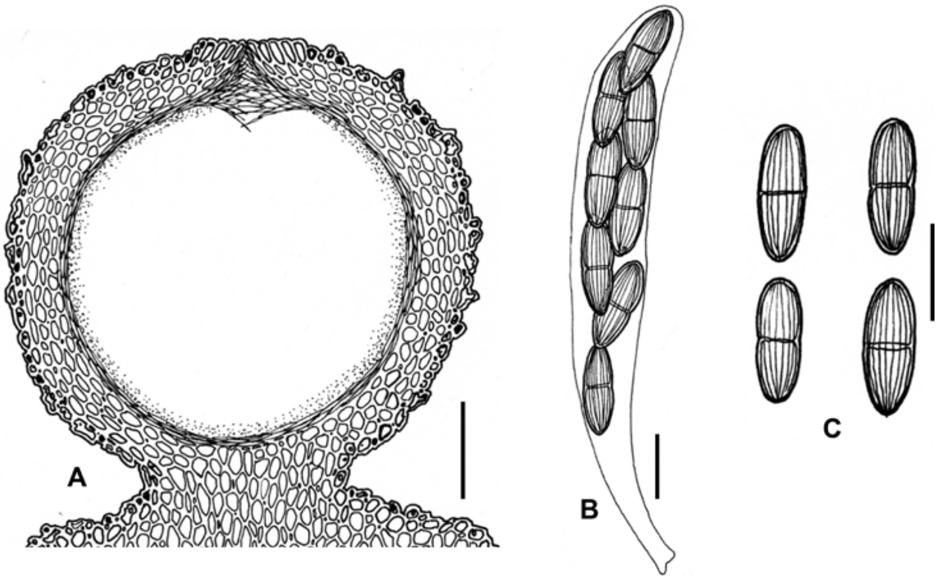

Fig. 123A–C. *Pleonectria pseudomissouriensis* on natural substrata (A–C teleomorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores. Scale bars: A = 100 µm; B, C = 10 µm.

≡ *Calonectria pyrrhochlora* (Auersw.) Sacc., Michelia 1: 251. 1878.
≡ *Tyronectria pyrrhochlora* (Auersw.) Sacc., Michelia 1: 325. 1878.
≡ *Pleonectria pyrrhochlora* (Auersw.) G. Winter, Rabenh. Krypt.-Fl. Ed. 2, 1(2), II. Abt.: Ascomyc.: Gymnoasceen p. 108. 1884.

Anamorph: zythiostroma-like.

Teleomorph on natural substrata: *Stromata* immersed in epidermis, 1.5 mm high and 3 mm diam, cells forming pseudoparenchymatous, bright yellow to greenish yellow, KOH–, LA–. *Ascomata* nearly or completely immersed, scattered to aggregated in groups of 3–21, subglobose to globose, 230–450 µm high × 180–380 µm diam, amber to greenish yellow, apical region slightly darker, KOH–, LA–. *Ascomatal surface cells* forming *textura globuosa* to *t. angularis* sometimes including bright yellow scurf, 3–10 µm diam, with pigmented, irregularly *ca.* 1.0 µm thick walls. *Ascomatal wall* 30–60 µm thick, of two regions: outer region 20–40 µm thick, intergrading with stroma, cells forming *textura globuosa* to *t. angularis*, walls slightly pigmented, about 1.0 µm thick; inner region 10–20 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* clavate, 70–110 × 15–30 µm, with inconspicuous ring at apex, 8-spored, ascospores biseriate. *Ascospores* hyaline to pale

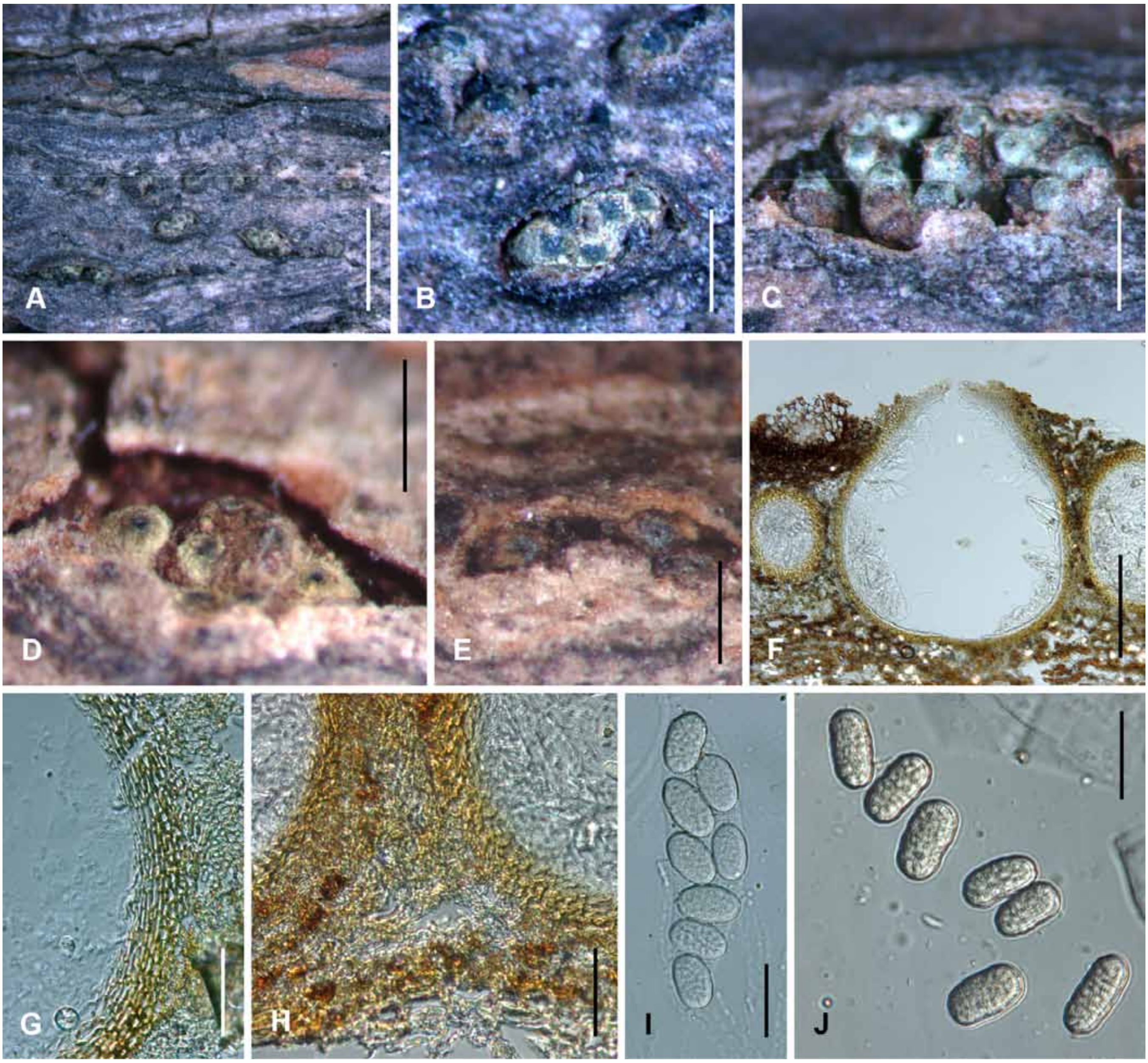

Fig. 124A–J. *Pleonectria pyrrhochlora* on natural substrata (teleomorph). A–E. Perithecia on natural substrata; F. Median section of perithecia on natural substrata; G. Median section of perithecial wall on natural substrata; H. Median section of perithecia at base on natural substrata; I. Ascus; J. Ascospores. Scale bars: A = 5 mm; B–E = 1 mm; F = 100 µm; G, H = 50 µm; I, J = 20 µm.

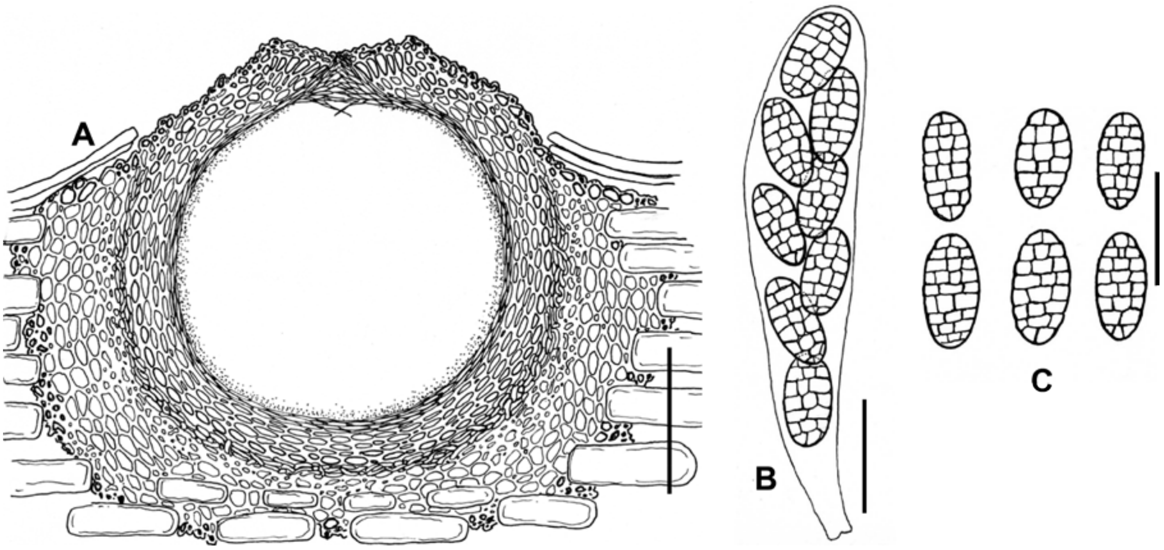

Fig. 125A–C. *Pleonectria pyrrhochlora* on natural substrata (A–C teleomorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores. Scale bars: A = 100 µm; B, C = 20 µm.

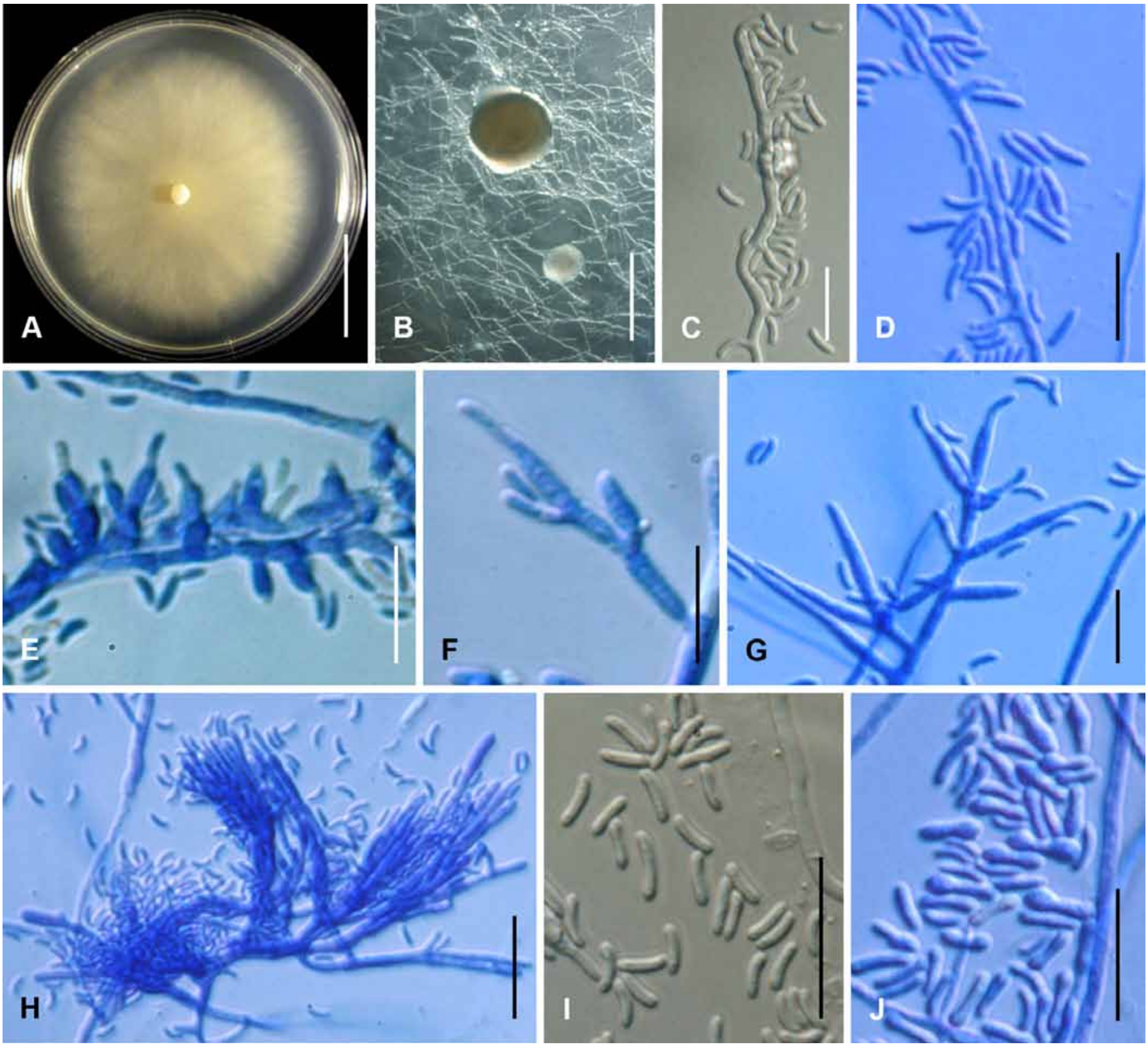

Fig. 126A–J. Anamorph of *Pleonectria pyrrhochlora* in culture. A. Cultures after 7 d at 25 °C on PDA; B. Conidial mass on SNA surface; C–E. Lateral phialidic pegs and conidia on SNA; F–H. Conidiophores and conidial mass on SNA; I. Young conidia on SNA; J. Mature conidia on SNA. Scale bars: A = 3 mm; B = 50 µm; C–G, I, J = 10 µm; H = 20 µm.

greenish yellow, ellipsoidal, rarely subglobose, muriform, with 5–7 transverse septa and usually two longitudinal septum, (15.4–)16.9–20.5(–23.3) × (7.8–)8.7–11.1(–12.3) µm (*n* = 90), smooth.

Anamorph in culture: After 7 d at 25 °C, colonies 68–75 mm (average 71 mm) diam. *Colony surface* cottony with aerial mycelium, white to whitish yellow to greenish yellow; *aerial mycelium* developed, rarely small yellow sporodochial conidial masses produced after 2 wk; *reverse* whitish yellow in centre and white at margin. *Odour* on PDA slightly fruity. Sporulation on SNA from *lateral phialidic pegs* abundant, enteroblastic, monophialidic, ellipsoidal, slightly tapering toward tip or flask-shaped, 1.5–3.8 µm long, 1.3–1.6 µm wide at base. *Aerial conidiophores* unbranched, sometimes 1–2 branched, becoming loosely to moderately densely branched, 13.5–33.7 µm long, 1.6–2.2 µm wide at base. *Aerial conidiogenous cells* monophialidic, enteroblastic, cylindrical, slightly tapering toward tip or narrowly flask-shaped with widest point in middle, 8.5–14.3 µm long, 1.5–2.7 µm wide at base. *Sporodochial conidiophores* sometimes formed, densely branched, 21.6–30.6 µm long, 1.1–1.8 µm wide at base. *Sporodochial conidiogenous cells* monophialidic, enteroblastic, cylindrical, slightly tapering toward tip, 7.6–13.8 µm long, 0.7–1.3 µm wide at base. *Young conidia* formed from monophialides on aerial, submerged, or repent hyphae, formed abundantly on slimy heads or sporodochia, ellipsoidal, fusiform to allantoid, hyaline, smooth, curved, rounded at both ends, non-septate, (2.4–)2.7–3.5(–3.8) × (0.6–)0.7–0.9(–1.2) µm (*n* = 50). *Mature conidia* swollen, 0-septate, ellipsoidal to oblong, irregularly swollen at both ends or clavate, hyaline, smooth, slightly or sometimes strongly curved, rounded at both ends, (5.4–)6.3–7.5(–8.2) × (1.4–)1.8–2.4(–2.8) µm (*n* = 50). *Pycnidia*, *chlamydospores,* and *ascomata* not produced in culture.

Habitat: On dead branchs of *Acer campestre (Aceraceae)*.

Distribution: Europe (Austria, Czech Republic, Germany).

Lectotype of Pleonectria pyrrhochlora *designated by Seeler (1940b)*: **Germany**, Arnstad, on *Acer campestre*, Fleischhack, Rabenhorst, Fungi europaei. No 1234, **Lectotype** FH; **isolectotype** S F6222, S F6223, BPI-bound exsiccati.

Additional specimens and isolates examined: **Austria**, Wien, Cobenzl, near Himmelstrasse, on dead branches of *Acer campestre*, 24 Apr. 1999, W.M. Jaklitsch WJ 1306, BPI 746398, culture CBS 125131 = A.R. 2786. **Czech Republic** (as Czechoslovakia), Prencow, Kotling, on dead branches of *Acer campestre*, 14 Mar. 1902, A. Kmet, BPI 553008; Prencow, Kotling, on dead branches of *Acer campestre*, 14 Mar. 1897, A. Kmet, BPI 553007.

Notes: *Pleonectria pyrrhochlora*, *P. virens,* and *P. zanthoxyli* have ascomata immersed in bright yellow, yellowish green or olive-green stroma and the substrate appear almost identical to each other. *Pleonectria pyrrhochlora* is distinguished from the other species by the ascospores averaging > 9 µm wide ascospores and mostly two longitudinal septa (Figs 124J, 125C). In addition, *P. pyrrhochlora* occurs only on *Acer campestre*. In culture, the anamorph of *P. pyrrhochlora* is similar to that of *P. virens* and *P. zanthoxyli* but produces shorter mature conidia than the other two species. Although a pycnidial anamorph was not observed in culture, the two most closely related species, *P. virens* and *P. zanthoxyli*, produce pycnidia in culture.

Seeler (1940b) designated a lectotype preserved in FH for this name because Rabenhorst (1869) did not mention a specific type specimen. In this study, three additional isolectotype specimens were located and examined.

Pleonectria quercicola Hirooka, Checa, Arenal & P. Chaverri, **sp. nov.** MycoBank MB519713. Figs 127–129.

Holotype of Pleonectria quercicola. **Spain**, Madrid, Colmenarejo, on dead branch of *Quercus ilex* ssp. *rotundifolia* (as ssp. *ballota*), 25 Mar. 2001, F. Prieto, comm. J. Checa, **Holotype** BPI 871328, Isotype AH 30502, culture CBS 128976 = A.R. 3805.

Etymology: *quer* + *-icola*; indicates the unusual occurrence on oak (*Quercus*).

Anamorph: zythiostroma-like.

Teleomorph on natural substrata: *Ascomata and pycnidia* generally formed on same stroma. *Mycelium* not visible around ascomata or on host. *Stromata* erumpent through epidermis, 1.0 mm high and 1.0 mm diam, rust to chestnut, KOH+ dark purple, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, scattered to aggregated in groups of 3–9, subglobose to globose, 262–379 µm high × 270–373 µm diam, sienna to chestnut, cupulate upon drying, sometimes with a depressed apical region, apical region slightly darker, surface slightly scaly yellowish red. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis* sometimes including bright yellow scurf, 5–11 µm diam, with pigmented, irregularly *ca.* 1.5 µm thickened walls. *Ascomatal wall* 40–70 µm thick, of two regions: outer region 40–55 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.5 µm thick; inner region 12–20 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* narrowly clavate, increasing in size as ascospores mature, 86–130 × 12–17 µm, with inconspicuous ring at apex, 8-spored. *Ascospores* filiform, 8–15 septate, hyaline, (26.7–)31.6–44.0(–48.6) × (1.3–)2.3–3.9(–4.7) µm (*n* = 30), smooth, budding to produce hyaline, thin-walled, slightly curved, bacillar ascoconidia, (3.7–)4.1–5.1(–5.4) × (0.9–)1.2–1.6(–1.9) µm (*n* = 50), that fill asci.

Anamorph on natural substrata: *Stromata* shared with ascomata, sienna to chestnut. *Pycnidia* solitary or aggregated in groups of 3–6, immersed in stroma, eustromatic, irregulary subglobose, sienna to chestnut, 63–144 µm high, 41–190 µm diam, KOH+ slightly darker, LA+ slightly yellow. *Pycnidial wall* 12–23 µm thick, of one region intergrading with stroma, cells forming *textura prismatica*, about 1.0 µm thick, elongate, thin-walled, hyaline cells. *Conidiophores* densely branched, generally with 1(–3)-branched, 14–23 µm long, 1.1–2.2 µm wide. *Conidiogenous cells* cylindrical to subulate, straight to slightly curved, enteroblastic, monophialidic, 7.0–9.7 × 0.8–1.3 µm. *Intercalary phialides* observed, bearing 1(–2) terminal phialides, up to 4 µm long, similar to short acropleurogenous conidiophores. *Sterile hyphae* absent. *Conidia* hyaline, oblong to sub-allantoid, curved, non-septate, (2.8–)3.5–5.0(–5.4) × (1.0–)1.1–1.3(–1.6) µm (*n* = 30).

Anamorph in culture: After 7 d at 25 °C, colonies 10–15 mm (average 13.5 mm) diam. *Colony surface* cottony with aerial mycelium, whitish brown; *aerial mycelium* usually developed, often small white to whitish yellow sporodochial conidial masses produced after 3 wk; *reverse* whitish brown. *Odour* on PDA slightly fruity. Sporulation on SNA from *lateral phialidic pegs* somewhat rare, 3.1–6.6 µm long, 1.8–2.7 µm wide at base, ellipsoidal, slightly tapering toward tip, monophialidic. *Conidiophores* abundant, unbranched, sometimes 1–2 branched, becoming loosely to moderately densely branched, 10.5–36.6 µm long, 1.8–4.6 µm wide at base. *Sporodochial conidiophores* sometimes formed, densely branched, 19.7–44.6 µm long, 1.7–2.7 µm wide at base. *Conidiogenous cells* monophialidic, enteroblastic, cylindrical, slightly tapering toward tip or narrowly flask-shaped with widest point in middle, 5.3–10.0 µm long, 1.3–3.0 µm wide at base. *Young conidia* formed from phialides on aerial, submerged, or repent hyphae, formed abundantly on slimy heads or sporodochia, oblong to allantoid, rounded at both ends, hyaline, smooth, curved non-septate, (3.6–)4.3–5.7(–6.6) × (1.0–)1.3–1.9(–2.5) µm (*n* = 50), smooth-walled. *Mature conidia* swollen, 0-septate, ellipsoidal to oblong, hyaline, smooth, straight or slightly curved, rounded at both ends, (5.4–)5.5–7.4(–8.4) × (2.6–)2.8–3.2(–3.5) µm (*n* = 50). *Chlamydospores* intercalary or terminal, globose to subglobose, rare, smooth, 7–10 µm. *Ascomata and pycnidia* not produced in culture.

Habitat: On dead branch of *Quercus ilex* ssp. *Rotundifolia (Fagaceae)*.

Distribution: Europe (Spain, known only from the type collection).

Notes: *Pleonectria quercicola* resembles *P. cucurbitula*, *P. rosellinii,* and *P. strobi* in having budding, filiform ascospores; the ascospore length of *P. quercicola* is shorter than for the three similar species (Figs 127H–J, 128C). In addition, *P. quercicola* occurs on *Quercus* while the other three species occur on *Pinaceae* (*P. rosellinii* on *Abies, P. cucurbitula* on *Pinus* subgenus *Pinus,* and *P. strobi* on *Pinus* subgenus *Strobus*). *Pleonectria quercicola* is the first species having filiform ascospores budding to produce ascoconidia in the asci that does not occur conifers. The anamorphic states of these four species vary morphologically. Our molecular data confirm that these four species are distinct from each other (Figs 1, 2).

Pleonectria rosellinii (Carestia) Hirooka, Rossman & P. Chaverri, **comb. nov.** MycoBank MB519716. Figs 130–132.

Basionym: *Nectria rosellinii* Carestia, in Rabenh., Fung. Europ. Exs. No. 923. 1866

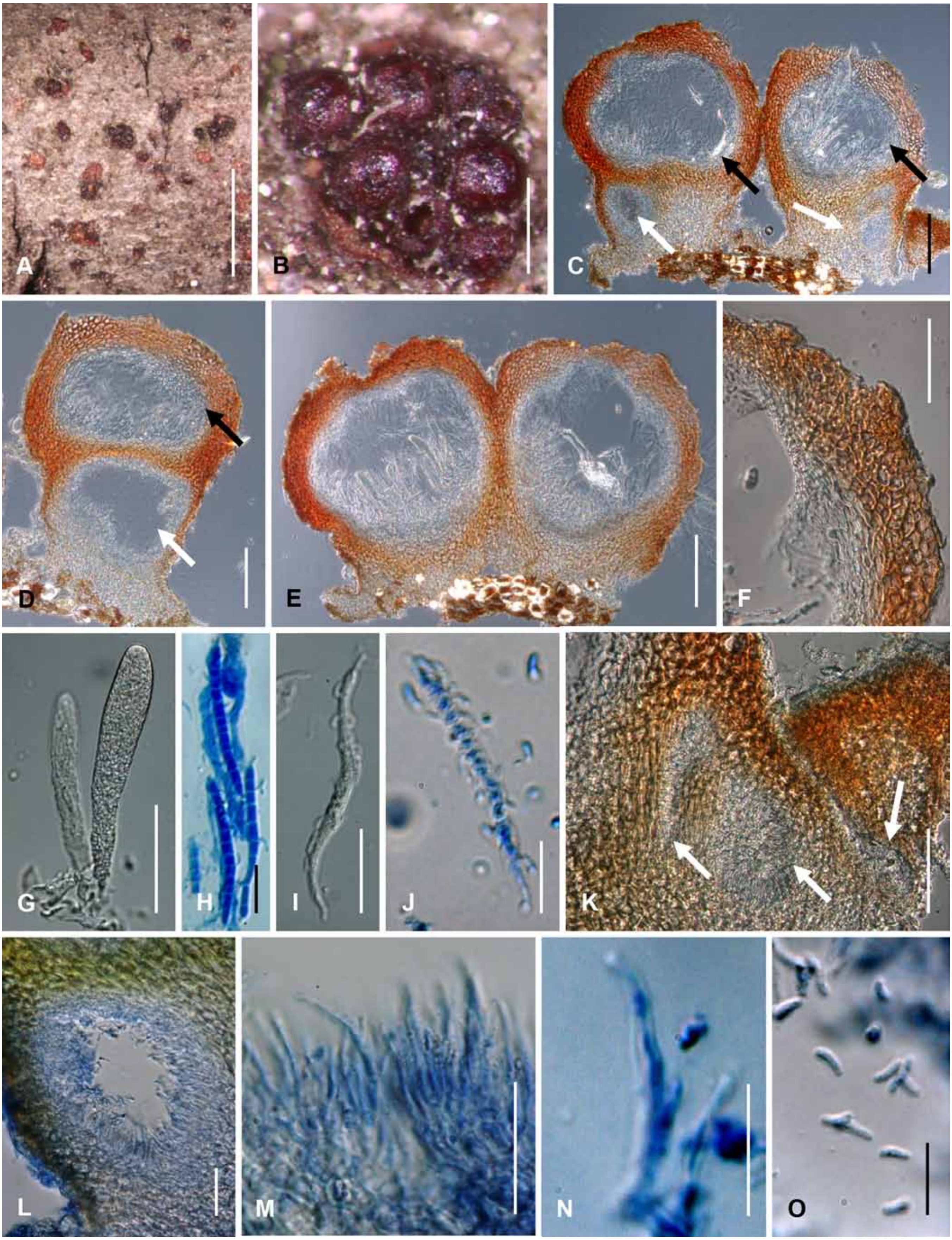

Fig. 127A–O. *Pleonectria quercicola* on natural substrata (A, B, E–J teleomorph, C, D teleomorph and anamorph, K–O anamorph). A, B. Perithecia on natural substrata; C, D. Median section of perithecia (black arrows) and immersed pycnidia (white arrows) on natural substrata; E. Median section of perithecia on natural substrata; F. Median section of perithecial wall; G. Asci; H–J. Budding ascospores; K. Median section of immersed pycnidia (white arrows) on natural substrata; L–N. Conidiophores on natural substrata; O. Conidia on natural substrata. Scale bars: A = 5 mm; B = 500 µm; C–E = 100 µm; F, G, K = 50 µm; H–J, N, O = 10 µm; L, M = 20 µm.

Anamorph: zythiostroma-like.

Teleomorph on natural substrata: *Ascomata and pycnidia* often formed on same or discrete stroma. *Mycelium* not visible around

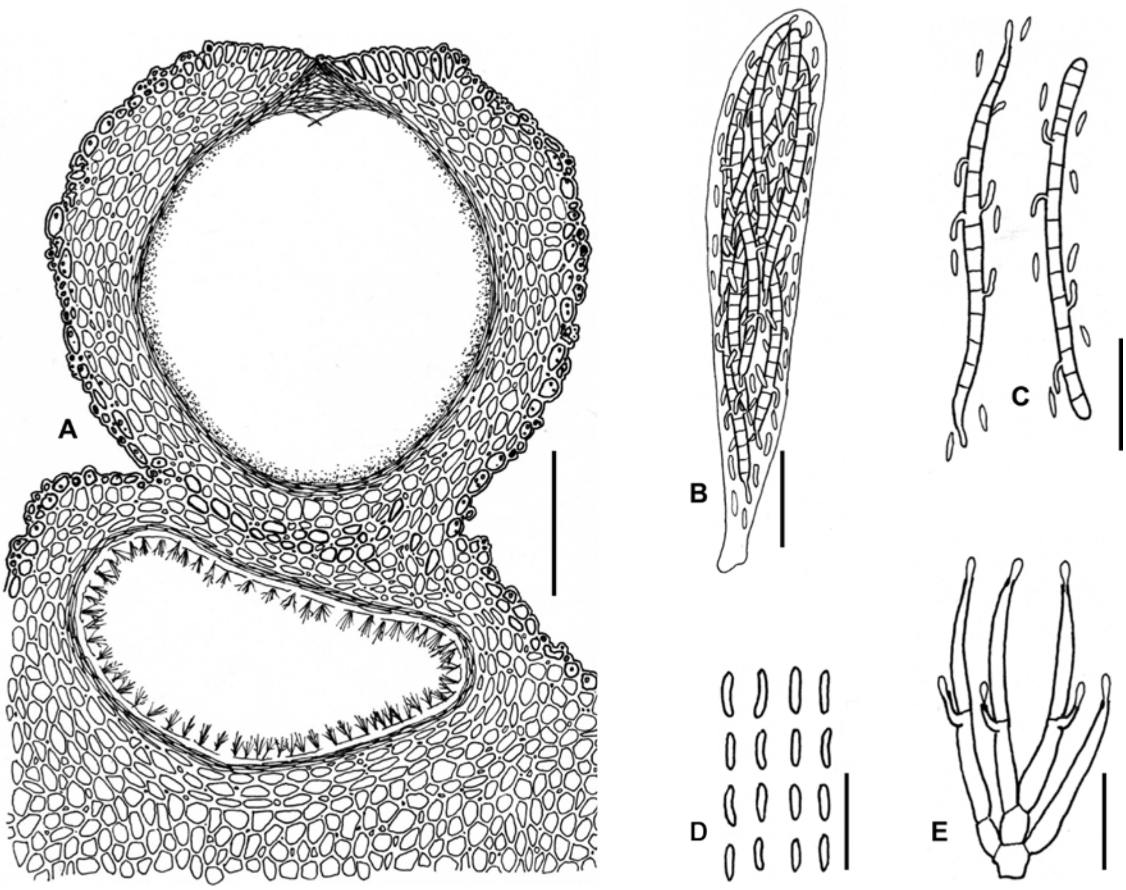

Fig. 128A–E. *Pleonectria quercicola* on natural substrata (A teleomorph and anamorph, B, C teleomorph, D, E anamorph). A. Median section of mature perithecium and pycnidium; B. Ascus; C. Ascospores and ascoconidia; D. Conidia; E. Conidiophores. Scale bars: A = 100 µm; B, C = 20 µm; D, F = 10 µm.

ascomata or on host. *Stromata* erumpent through epidermis, up to 1.0 mm high and 2.0 mm diam, orange to sienna, KOH+ dark purple, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, scattered to aggregated in groups of 3–48, subglobose to globose, 215–350 µm high × 200–315 µm diam, red to bay, cupulate upon drying, sometimes with only a depressed apical region, apical region slightly darker, KOH+ purple, LA+ yellow, surface usually bright yellow or yellow-green scaly. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis* sometimes including bright yellow scurf, 3–10 µm diam, with pigmented, uniformly to irregularly *ca.* 1.5 µm thickened walls. *Ascomatal wall* 32–50 µm thick, of two regions: outer region 17–39 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.5 µm thick; inner region 6–19 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* narrowly clavate, increasing in size as ascospores mature, 49–104 × 6–13 µm, with inconspicuous ring at apex, 8-spored. Ascospores long-filiform, 8–31 septate, hyaline, (22.4–)29.5–45.1(–60.2) × (1.6–)2.0–3.2(–3.9) µm (*n* = 61), smooth, budding to produce hyaline, thin-walled, tapering apex, slightly curved, *bacillar ascoconidia*, (19–)2.6–3.6(–4.5) × (0.9–)1.2–2.0(–3.0) µm (*n* = 126), that fill asci.

Anamorph on natural substrata: *Stromata* erumpent through epidermis or developing in stroma with ascomata, orange to red. *Pycnidia* solitary or aggregated in groups of 3–8, superficial on stroma or rarely immersed at base, subglobose, smooth to slightly roughened, cerebriform upon drying, 150–264 µm, 190–335 µm diam, scarlet to bay, KOH+ slightly darker, LA+ slightly yellow. *Pycnidial wall* 23–34 µm thick, of two regions: outer region 10–20 µm thick, intergrading with stroma, cells forming *textura globulosa*, walls pigmented, about 1.5 µm thick; inner region 15–20 µm thick, of elongate, thin-walled, hyaline cells, forming t*extura prismatica*. *Conidiophores* densely branched, generally 1–4 branched, 11–33 µm long, 1.0–2.9 µm wide. *Conidiogenous cells* cylindrical to subulate, straight to slightly curved, enteroblastic, monophialidic, 7–13 × 1.0–2.3 µm. *Intercalary phialides* bearing (1–)3 terminal phialides, up to 6 µm long, similar to short acropleurogenous conidiophores. *Sterile hyphae* absent. *Conidia* hyaline, ellipsoidal to oblong, sometimes slightly curved, non-septate, (2.8–)3.4–4.2(–5.1) × (1.1–)1.3–1.7(–2.0) µm (*n* = 102).

Anamorph in culture: After 7 d at 25 °C, colonies 50–75 mm (average 73 mm) diam. *Colony surface* cottony with aerial mycelium, whitish brown (MAFF 241403, and 241459) or whitish yellow (A.R. 3494); *aerial mycelium* usually developed, often small white to whitish yellow sporodochial conidial masses produced after 3 wk; *reverse* whitish brown (MAFF 241403, and 241459) or white to slightly whitish yellow (A.R. 3494). *Odour* on PDA slightly fruity. Sporulation on SNA from *lateral phialidic pegs* abundant, ellipsoidal, slightly tapering toward tip, 1.9–4.3 µm long, 1.4–1.9 µm wide at base, monophialidic. *Conidiophores* absent. *Young conidia* formed from monophialides on aerial, submerged, or repent hyphae, formed abundantly on slimy heads or sporodochia, oblong, hyaline, straight or slightly curved, rounded at both ends, non-septate, (3.2–)4.1–5.1(–6.9) × (1.2–)1.6–2.2(–2.6) µm (*n* = 50), smooth-walled. *Mature conidia* swollen, 0-septate, oblong to long-cylindrical, rarely allantoid, hyaline, smooth, slightly or strongly curved, rounded at both ends, (6.4–)6.9–9.3(–10.0) × (1.9–)2.1–2.9(–3.1) µm (*n* = 50). *Chlamydospores*, *pycnidia,* and *ascomata* not produced in culture.

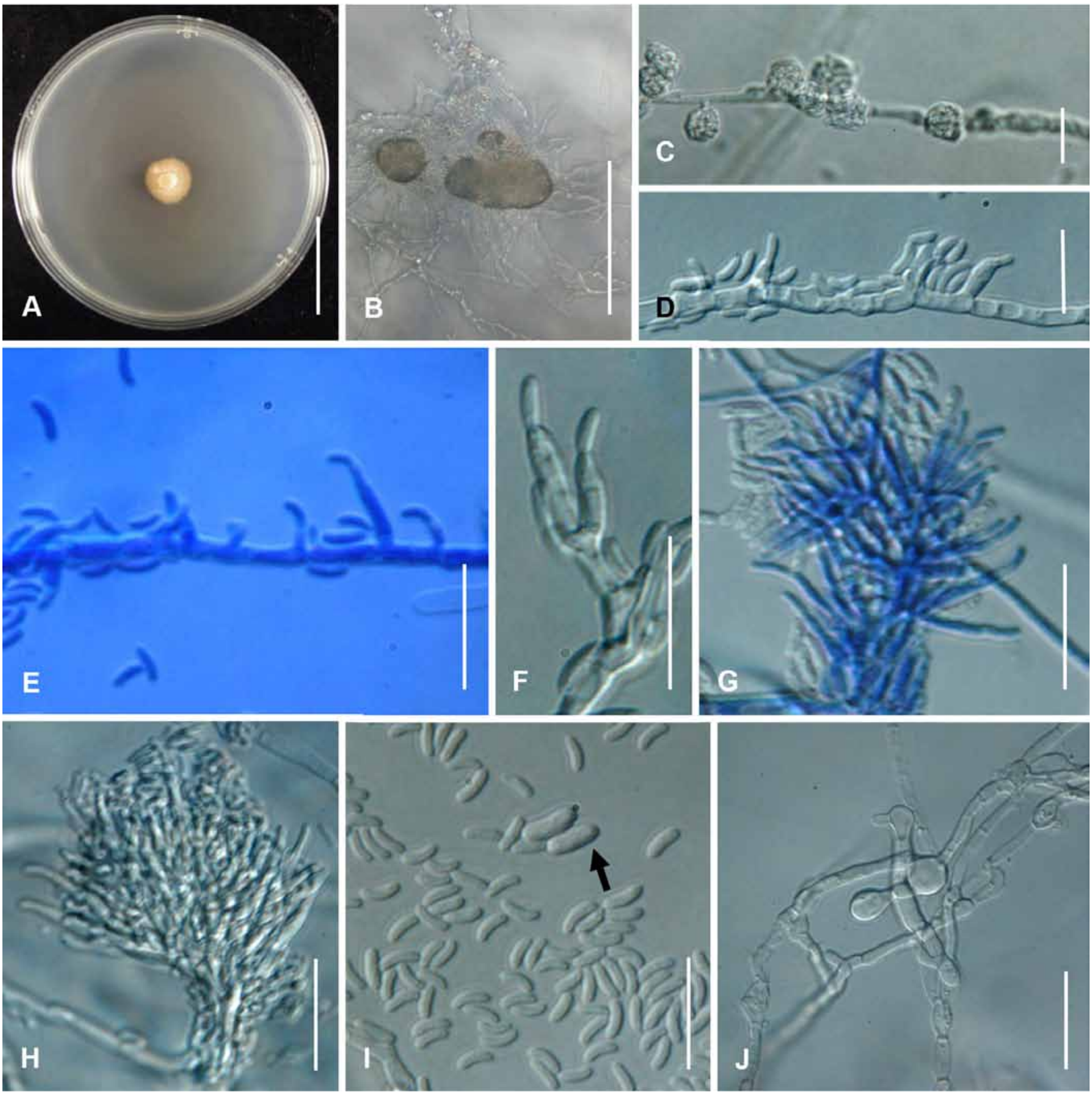

Fig. 129A–J. Anamorph of *Pleonectria quercicola* in culture. A. Cultures after 7 d at 25 °C on PDA; B. Conidial mass on SNA surface; C. Lateral phialidic pegs and conidial mass on SNA; D. Lateral phialidic pegs and conidia on SNA; E. Lateral phialidic pegs, conidiophores and conidia on SNA; F–H. Conidiophores and conidia on SNA; I. Young and mature conidia (black arrow) on SNA; J. Chlamydospores on SNA. Scale bars: A = 3 mm; B = 50 µm; C–F, I = 10 µm; G, H, J = 20 µm.

Habitat: On dead bark or twigs of *Abies* spp. including *Abies alba, A. balsamea*, *A. concolor***,** *A. fraseri, A. lasiocarpa*, *A. pectinata*, and *A. sachalinensis (Pinaceae)*.

Distribution: Asia (Japan), Europe (France, Germany, Italy), North America (Canada, USA).

Lectotype of Nectria rosellinii designated herein: **Italy**, Riva, On *Abies pectinata*, 1864, Carestia, **Lectotype** Rabenhorst, Fungi europaei No. 923, BPI-bound exsiccati, **Isolectotype** S F49443.

Additional specimens and isolates examined: **Canada**, Ontario, Bear Island, Lake Temagami, Timagami Forest Reserve, on dead twigs of *Abies balsamea*, 14 Aug. 1930, H.S. Jackson, BPI 1107511 as *Nectria balsamea*; Ontario, Oakland, on dead twigs of *Abies balsamea*, 03–14 May 1915, J. Dearness, BPI 632759 as *Scoleconectria cucurbitula*; British Columbia, Revelstoke, on dead twigs of *Abies lasiocarpa*, 28 Sep. 1931, J.R. Hansbrough, BPI 632762 as *Scoleconectria cucurbitula*; British Columbia, Revelstoke, on dead twigs of *Abies lasiocarpa*, 12 Sep. 1931, J.L. Mielke, BPI 632763 as *Scoleconectria cucurbitula*; Ontario, Bear Island, Lake Temagami, on dead twigs of *Abies balsamea*, 20 Aug. 1935, L.O. Overholts, BPI 859484 as *Scoleconectria scolecospora*; Ontario, Bear Island, Lake Temagami, on dead twigs of *Abies balsamea*, 13 Aug. 1930, L.O. Overholts, BPI 867614 as *Scoleconectria balsamea*. **France**, Colmars les Alpes, on dead branches of *Abies alba*, 6 Jun. 2010, C. Lechat CLL 10012 = A.R. 4700 = CBS 131747, BPI 881710. **Germany**, Sugenheim in Franken, Sep. 1865, **S** F7063. **Japan**, Hyogo Pref., Kobe city, Rokko Mountains, on *Abies sachalinensis*, 26 Sep. 2002, Y. Hirooka, BPI 881063, culture MAFF 241403; Nagano Pref., Ueda city, Sugadaira, on dead twigs, 26 Sep. 2006, Y. Hirooka, BPI 881062, culture MAFF 241459 = NITE 102242. **USA**, North Carolina, Jackson Co., Blue Ridge Parkway below Spruce Ridge. near milepost 450 (about 449.5), alt. *ca.* 5500 ft, on *Abies fraseri*, 15 Jun. 2000, L.F. Grand, BPI 747280 as *Nectria balsamea*, culture CBS 128975 = A.R. 3494; Virginia, Hawksbill Mt., Shenandoah Nat. Park, on dead twigs of *Abies fraseri*, 31 Oct. 1933, C.L. Shear, BPI 551628 as *Nectria cucurbitula*; Minnesota, Vermilion Lake, on dead twigs of *Abies* sp., 22 Jul. 1886, BPI 629730 as *Chilonectria cucurbitula*; Minnesota, Vermilion Lake Lat. 48d, on dead twigs of *Abies* sp., 22 Jul. 1886, J.C. Arthur, L.H. Bailey Jr., E.W.D. Holway, BPI 629731 as *Chilonectria cucurbitula*; Michigan, Michigamme, Van Riper State Park, River Trail, 46º 31' 802" N, 88º 00' 028" W, elev. 277 m, on *Abies balsamea*,

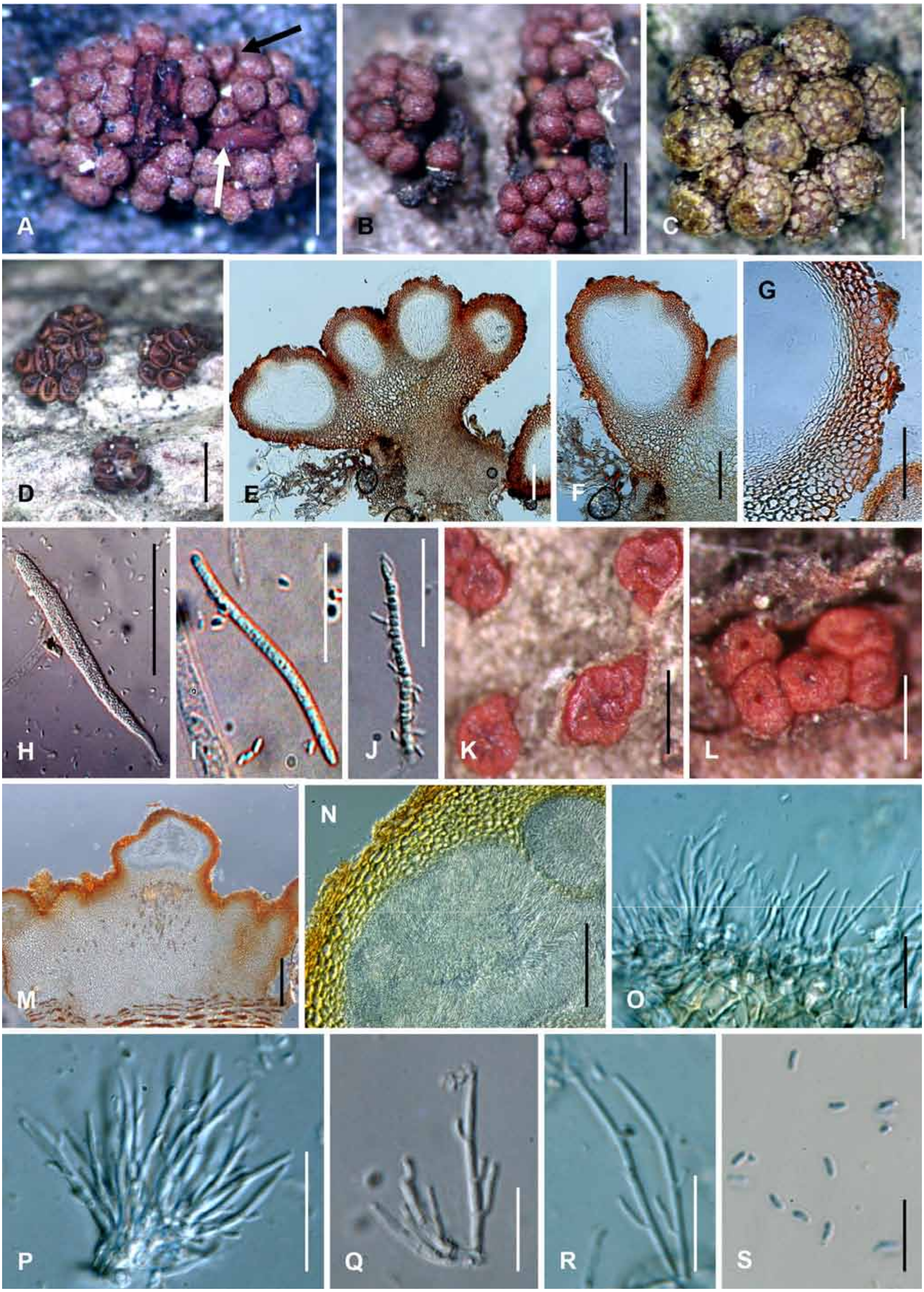

Fig. 130A–S. *Pleonectria rosellinii* on natural substrata (A teleomorph and anamorph, B–J teleomorph, K–S anamorph). A. Perithecia (black arrow) and pycnidia (white arrow) on natural substrata; B–D. Perithecia on natural substrata; E, F. Median section of perithecia on natural substrata; G. Median section of perithecial wall; H. Ascus having budding ascospores; I. Unbudding ascospores; J. Budding ascospores; K, L. Pycnidia on natural substrata; M. Median section of pycnidium on natural substrata, N. Median section of pycnidial wall; O–R. Conidiophores on natural substrata; S. conidia on natural substrata. Scale bars: A–D, K, L = 500 µm; E, F, M = 100 µm; G, H, N = 50 µm; I, J, O, P = 20 µm; Q–S = 10 µm.

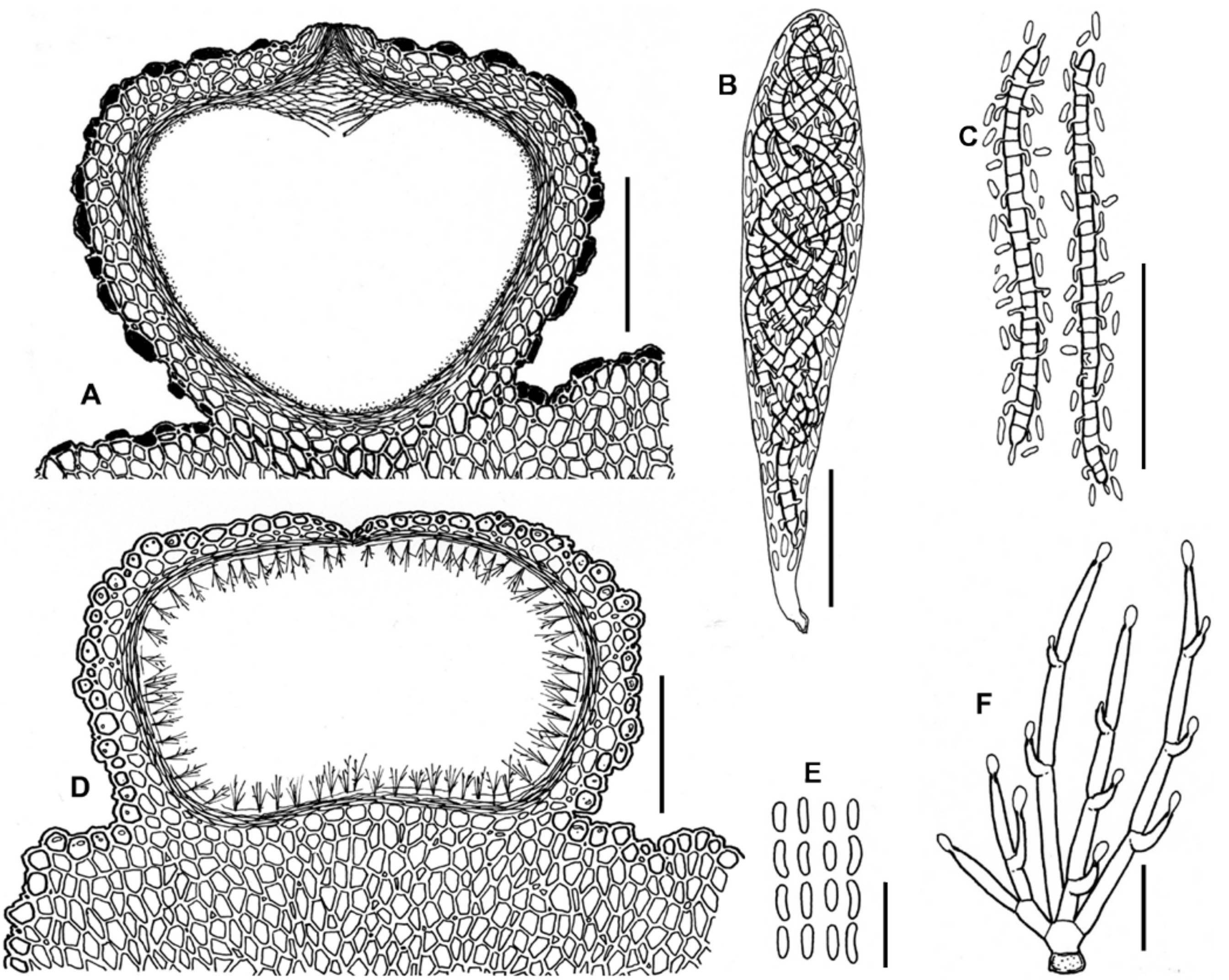

Fig. 131A–F. *Pleonectria rosellinii* on natural substrata (A–C teleomorph, D–F anamorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores and ascoconidia; D. Median section of mature Pycnidium; E. Conidia; F. Conidiophores. Scale bars: A, D = 100 µm; B, C = 20 µm; E, F = 10 µm.

30 May 2010, Y. Hirooka, D. Walker, BPI 881064, culture CBS 129161 = Y.H. 10-09d; Michigan, Grand Marais, Au Sable Point Trail, 46º 38' 283" N, 86º 06' 675" W, elev. 242 m, on *Abies balsamea*, 29 May 2010, Y. Hirooka, D. Walker, BPI 881065; culture CBS 129427 = Y.H. 10-14i; Michigan, Grand Marais, Grand Marais Truck Trail, 46º 40' 621" N, 85º 45' 605" W, elev. 177 m, on *Abies balsamea*, 29 May 2010, Y. Hirooka, D. Walker, BPI 881066, culture CBS 129162 = Y.H. 10-12g; Colorado, Grand Mesa Mtn., on dead twigs of *Abies lasiocarpa*, 13 Jun. 1930, R.W. Davidson, BPI 632638 as *Scoleconectria scolecospora*; Michigan, Upper Falls, Tahquamenon Falls State Park, Luce Co. near, on dead twigs of *Abies* sp., 25 Jul. 1962, C.T. Rogerson, BPI 632756 as *Scoleconectria cucurbitula*; New York, Warrensburg, Warren Co. Pack Experimental Forest, on dead of *Abies balsamea*, 09 Sep. 1978, A.Y. Rossman, BPI 632757 as *Scoleconectria cucurbitula*; New Mexico. Santa Fe National Forest, on *Abies concolor*, 21 Sep. 1937, T.R. Moberg, BPI 632760 as *Scoleconectria cucurbitula*; New Mexico. Sandia Mtns, on *Abies concolor*, 15 Sep. 1937, Gill, S. Andrews, BPI 632761 as *Scoleconectria cucurbitula*; New Hampshire, Marlow, on *Abies balsamea*, 18 Jun. 1935, H.G. Eno, BPI 632776 as *Scoleconectria scolecospora*; North Carolina, Wake Co., Falls Lake Dam, on *Abies fraseri*, Dec. 2002, L.F. Grand, BPI 842130 as *Nectria cucurbitula*; Pennsylvania, Centre Co., Bear Meadows, on *Abies balsamea*, 08 Apr. 1922, L.O. Overholts, BPI 859492 as *Scoleconectria scolecospora*; Pennsylvania, Centre Co., Bear Meadows, on *Abies balsamea*, 08 Apr. 1922, L.O. Overholts, BPI 867613 as *Scoleconectria balsamea*.

Notes: *Pleonectria rosellinii* occurs only on *Abies*. Specimens of this species had been identified as *Nectria cucurbitula*, now a synonym of *Pleonectria cucurbitula*, based on the filiform ascospores with budding ascoconidia in the asci and occurrence on conifers. The six-loci phylogeny demonstrated that, within what has been known as *Nectria cucurbitula,* three species, *P. cucurbitula, P. rosellinii,* and *P. strobi,* can be distinguished based on host and subtle morphological differences. These species are supported by high BI PP, ML BP, and MP BP values (Figs 1, 2). Among these species, *P. rosellinii* with a scaly ascomatal surface and relatively short ascospores differs from *P. cucurbitula* and *P. strobi* (Figs 130A–J, 131A, C). Although the anamorph in the natural environment for *P. cucurbitula, P. rosellinii,* and *P. strobi* does not reveal any morphological differences, the shape of mature conidia on SNA are distinct (Fig. 132K, L). In the culture of *P. rosellinii*, we observed only lateral phialidic pegs, not the typical conidiophores that *P. cucurbitula* and *P. balsamea* generally produce (Fig. 132).

To lectotypify *P. rosellinii*, we selected the specimen at BPI of Rabenhorst, Fungi europaei No. 923. One isolectotype specimen at S was also observed.

Pleonectria rubicarpa (Cooke) Hirooka, Rossman & P. Chaverri, **comb. nov.** MycoBank MB519717. Figs 133, 134.
Basionym: *Nectria rubicarpa* Cooke, Grevillea 7: 50. 1878.
≡ *Creonectria rubicarpa* (Cooke) Seaver, Mycologia 1: 187. 1909.
Anamorph: unknown.

Teleomorph on natural substrata: *Mycelium* not visible around ascomata or on host. *Stromata* erumpent through epidermis, up to 0.5 mm high and 2.0 mm diam, scarlet to red, KOH+ dark red, LA+ yellow, pseudoparenchymatous, cells forming *textura globulosa* or *t. angularis*, intergrading with ascomatal wall. *Ascomata* superficial

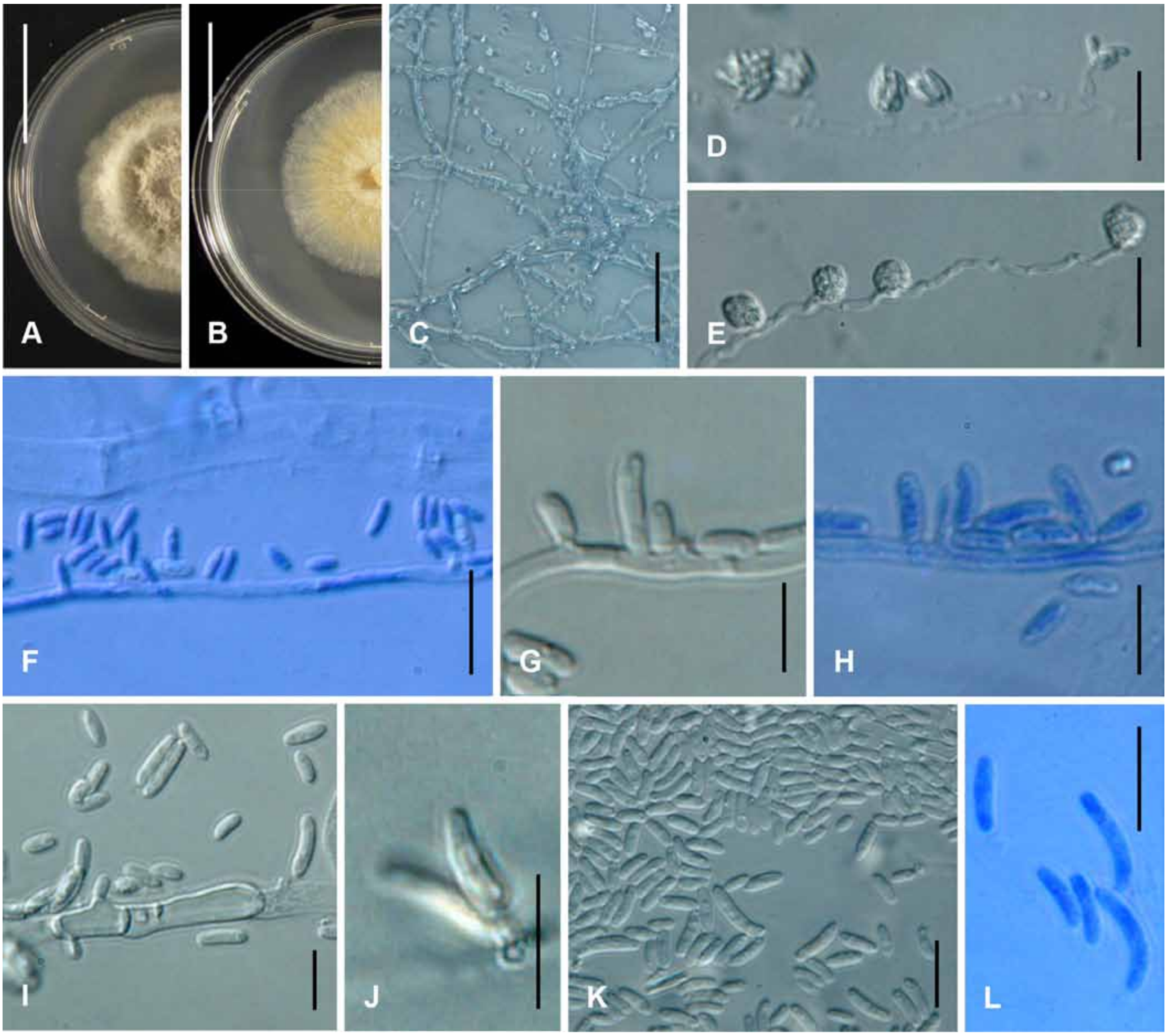

Fig. 132A–L. Anamorph of *Pleonectria rosellinii* in culture. A, B. Cultures after 7 d at 25 °C on PDA; C. Conidial mass on SNA surface; D, E. Lateral phialidic pegs and conidial mass on SNA; F–J. Lateral phialidic pegs and conidia on SNA; K, L. Young and mature conidia on SNA. Scale bars: A, B = 3 mm; C = 50 µm; D–F, K, L = 10 µm; G–J = 5 µm.

on developed stroma, scattered to aggregated in groups of 4–16, subglobose to globose, 200–270 µm high × 210–270 µm diam, cupulate upon drying, sometimes with only a depressed apical region, scarlet to red, apical region slightly darker, non-papillate, KOH+ dark purple, LA+ yellow, roughened, sometimes surface scurfy, yellowish green. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis* sometimes including bright yellow scurf, 3–7 µm diam, with pigmented irregularly *ca.* 2.0 µm thickened walls. *Ascomatal wall* 30–45 µm thick, of two regions: outer region 20–35 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.5 µm thick; inner region 10–15 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* clavate, 55–85 × 7–10 µm, with inconspicuous ring at apex, 8-spored, ascospores biseriate above, uniseriate below. *Ascospores* ellipsoidal to fusiform, slightly curved, with rounded ends, (8.9–)10.2–12.2(–13.6) × (3.3–)4.1–4.9(–5.7) µm (*n* = 90), hyaline to slightly yellowish-brown, smooth, 1-septate, with median septum.

Habitat: On bark dead deciduous trees of *Citrus* sp., *Gelsemium sempervirens*, *Gelsemium* sp., and *Ilex verticillata*.

Distribution: Caribbean (Puerto Rico), Europe (UK), North America (USA).

Lectotype of Nectria rubicarpa *designated herein*: **USA**, South Carolina, Aiken, on *Gelsemium* sp., possibly *G. sempervirens*, H.W. Ravenel, **Lectotype** Ravenel, Fungi Americani Exsiccati No. 341, BPI-bound exsiccati, **Isolectotype** NY).

Additional specimens and isolates examined: **UK**, Lyndhurst, on *Ilex* sp., 7 Jul. 1912, A.J. Watson, BPI 553023. **Puerto Rico**, Mayagüez, on bark of dead *Citrus*, 14 Jul. 1920, C.E. Chardon, NY. **USA**, Alabama, Auburn, Lee County, on *Gelsemium* sp., 15 Feb. 1896, F.S. Earle, BPI 553071; Alabama, Auburn, Lee County, on *Gelsemium sempervirens*, 15 Feb. 1896, F.S. Earle, BPI 553073; New Jersey, Newfield, on *Ilex verticillata*, Mar. 1897, J.B. Ellis, BPI 553074.

Notes: *Pleonectria rubicarpa* was recently redescribed by Samuels *et al.* (2006). This species is morphologically similar to *N. cinnabarina*, type of the genus *Nectria*; however, the ascomata and ascospores of *P. rubicarpa* are smaller than those of *N. cinnabarina*. The scurfy ascomata of *P. rubicarpa* are characteristic of the genus *Pleonectria* (Figs 133C–G, 134A). Among the species of *Pleonectria*, *P. rubicarpa* is similar to *P. ilicicola*; these species

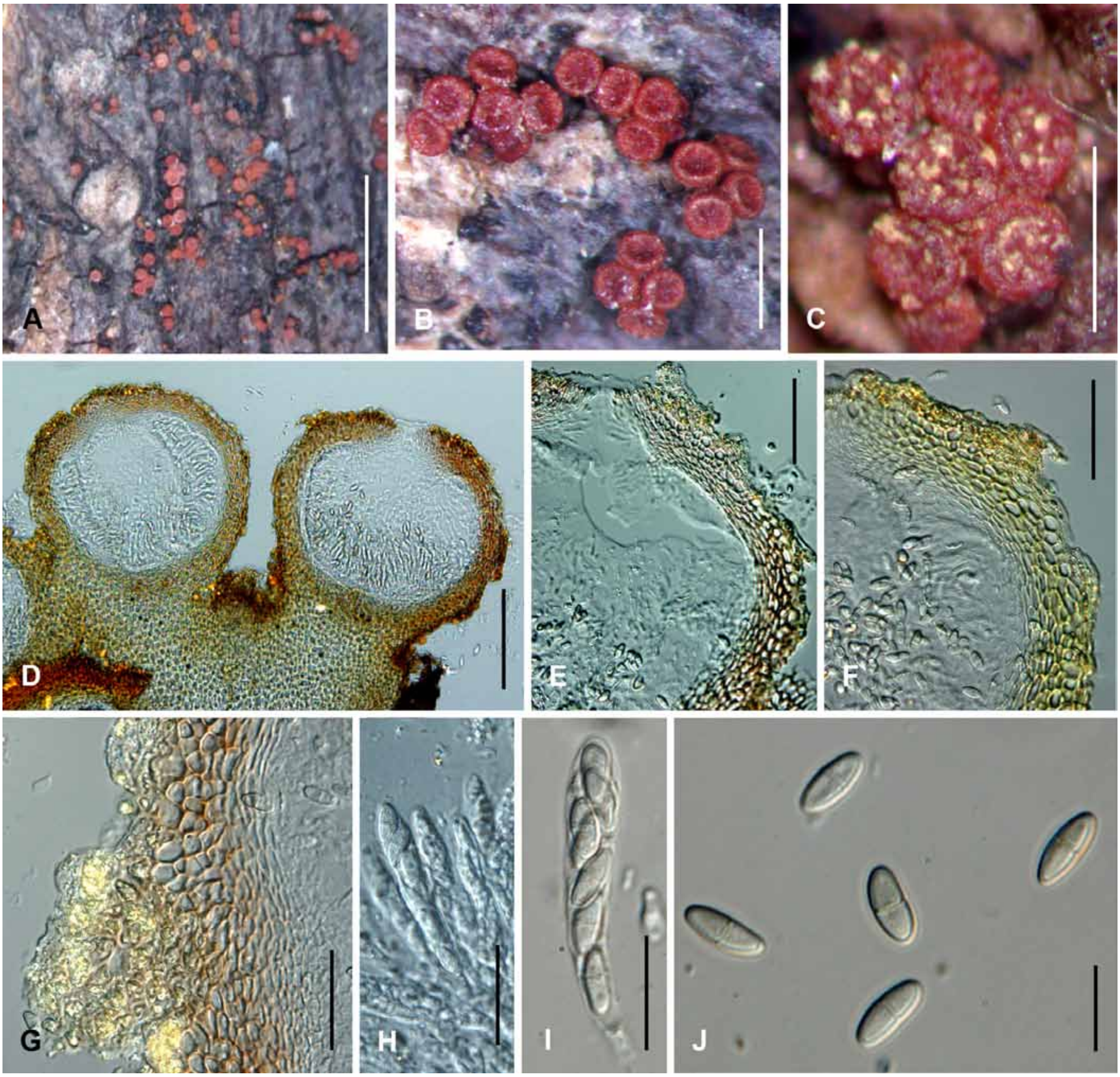

Fig. 133A–J. *Pleonectria rubicarpa* on natural substrata (teleomorph). A–C. Perithecia on natural substrata; D. Median section of perithecia on natural substrata; E–G. Median section of perithecial wall on natural substrata; H, I. Asci; J. Ascospores. Scale bars: A = 5 mm; B, C = 500 µm; D–F = 100 µm; G, H, I = 20 µm; J = 10 µm.

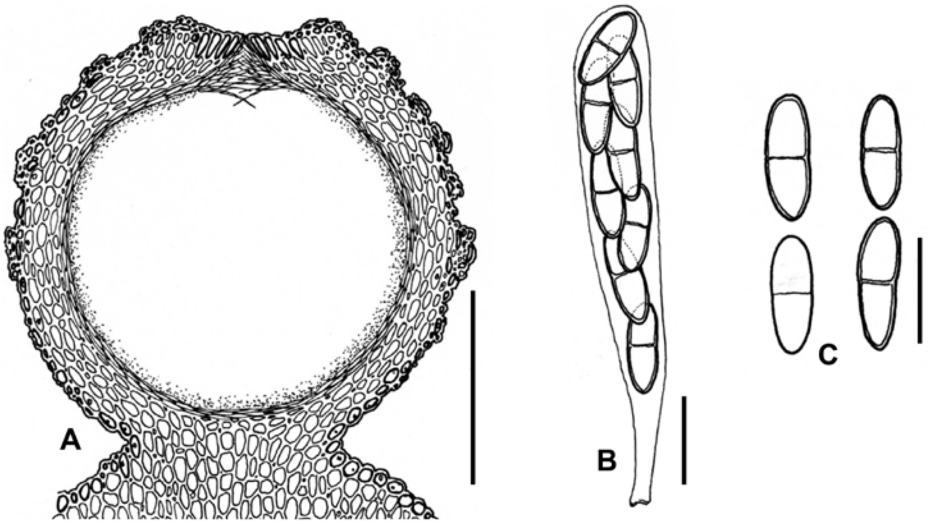

Fig. 134A–C. *Pleonectria rubicarpa* on natural substrata (A–C teleomorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores. Scale bars: A = 100 µm; B, C = 10 µm.

can be distinguished by differences in the shape and width of the ascospores and the host.

Pleonectria sinopica (Fr. : Fr.) Hirooka, Rossman & P. Chaverri, **comb. nov.** MycoBank MB519718. Figs 135–137.
Basionym: *Sphaeria sinopica* Fr. : Fr., Elench. Fung. 2: 81. 1828.
≡ *Nectria sinopica* (Fr. : Fr.) Fr., Summa Veg. Scand. 2: 388. 1849.
Anamorph: *Zythiostroma mougeotii* (Fr. : Fr.) Höhn., Mitt. Bot. Tech. Hochsch. Wien 8: 88. 1931.
≡ *Sphaeria mougeotii* Fr. : Fr., Elench. Fung. 2: 100. 1828.
≡ *Zythia mougeotii* (Fr. : Fr.) Jacz., Nouv. Mém. Soc. Imp. Naturalistes, Moscou. 15: 367. 1898.
≡ *Sphaeronaemella mougeotii* (Fr. : Fr.) Sacc., Syll. Fung. 3: 617. 1884.

Teleomorph on natural substrata: *Mycelium* not visible around ascomata or on host. *Stromata* erumpent through epidermis, up to 1.5 mm high and 3.0 mm diam, bay, KOH+ dark red, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, aggregated in groups of 3–42, subglobose to globose, 176–480 µm high × 143–462 µm diam (*n* = 163), slightly cupulate upon drying, with only a depressed apical region, bay to scarlet, apical region slightly darker, KOH+ dark red, LA+ yellow, sometimes surface scurfy, concolourous, slightly rugose when dry. *Ascomatal surface cells* forming *textura angularis* sometimes including bright yellow scurf, 3–17 µm diam, with pigmented, irregularly *ca.* 1.5 µm thick walls. *Ascomatal wall* 38–63 µm thick, of two regions: outer region 23–53 µm thick, intergrading with stroma, cells forming *textura angularis*, walls pigmented, about 1.5 µm thick; inner region 7–21 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* narrowly clavate, 45–107 × 6–14 µm, with inconspicuous ring at apex, 8-spored, ascospores uniseriate or sometimes biseriate. *Ascospores* ellipsoidal to fusiform with slightly constricted centre, straight, hyaline, 1-septate, (8.1–)10.5–12.7(–14.6) × (3.7–)4.9–6.5(–8.1) µm (*n* = 300), smooth.

Anamorph on natural substrata: *Stromata* erumpent through epidermis or developing in stroma with ascomata, orange to red. *Pycnidia* dimorphic. superficial or immersed in stroma. *Superficial pycnidia* solitary or aggregated in groups of 3–5, superficial or immersed in stroma, subglobose to irregulary subglobose, smooth to slightly roughened, cerebriforme when dry, 79–261 µm, 92–310 µm diam, scarlet to bay, KOH+ slightly darker, LA+ slightly yellow. *Superficial pycnidial wall* 12–35 µm thick, of two regions: outer region 6–14 µm thick, intergrading with stroma, cells forming *textura globulosa*, walls pigmented, about 1.5 µm thick; inner region 15–13 µm thick, of elongate, thin-walled, hyaline cells, forming t*extura prismatica*. *Immersed pycnidia* embedded between ascomata at base, solitary or aggregated in groups of 3–7, eustromatic, 110–193 µm high × 60–192 µm diam, KOH+ darker, LA+ yellow. *Immersed pycnidial wall* 6–20 µm thick, of one region intergrading with stroma, cells forming *textura prismatica*, about 1.0 µm thick, elongate, thin-walled, hyaline cells. *Conidiophores* densely branched, generally with 1–2 branched, 12–26 µm long, 1.5–2.3 µm wide. *Conidiogenous cells* cylindrical to subulate, straight to slightly curved, enteroblastic, monophialidic, 4.7–9.9 × 0.9–1.2 µm. *Intercalary phialides* bearing 1(–2) terminal phialides, up to 4 µm, similar to short acropleurogenous conidiophores. *Sterile hyphae* absent. *Conidia* of two types: *microconidia* produced from superficial pycnidia, hyaline, ellipsoidal to oblong, sometimes slightly curved, non-septate, (2.2–)2.7–3. (–4.1) × (0.7–)0.8–1.2(–1.4) µm (*n* = 50); *macroconidia* produced from immersed pycnidia, hyaline, oblong to sub-allantoid, curved, non-septate, (4.2–)5.1–6.1(–6.6) × (1.1–)1.3–1.7(–2.0) µm (*n* = 33).

Anamorph in culture: After 7 d at 25 °C, colonies 22–40 mm (average 31 mm) diam. *Colony surface* cottony with aerial mycelium, whitish yellow; *aerial mycelium* usually developed, often small white to whitish yellow sporodochial conidial masses produced after 3 wk; *reverse* whitish yellow. *Odour* on PDA slightly fruity. Sporulation on SNA from *lateral phialidic pegs* abundant, ellipsoidal, slightly tapering toward tip or flask-shaped, 3.6–6.2 µm long, 1.0–2.5 µm wide at base, enteroblastic, monophialidic. *Conidiophores* unbranched, sometimes 1–2-branched, becoming loosely to moderately densely branched, 9.9–25.3 µm long, 1.5–2.9 µm wide at base. *Sporodochial conidiophores* dimorphic, short and long. Short sporodochial conidiophores densely branched, up to 12.7–28.6 µm long, 1.7–2.7 µm wide at base. Long sporodochial conidiophores densely branched, up to 35.4–43.3 µm long, 2.7–3.2 µm wide at base. *Conidiogenous cells* monophialidic, enteroblastic, cylindrical, slightly tapering toward tip or narrowly flask-shaped with widest point in middle, 4.8–8.3 µm long, 0.7–1.7 µm wide at base. *Young conidia* formed from phialides on aerial, submerged, or repent hyphae, formed abundantly on slimy heads or sporodochia, oblong to allantoid, rounded at both ends, hyaline, smooth, sometimes strongly curved, non-septate, (3.4–)4.1–5.3(–6.2) × (1.0–)1.4–2.2(–2.6) µm (*n* = 100), smooth-walled. *Mature conidia* swollen, 0-septate, oblong, cylindrical to allantoid, hyaline, smooth, slightly curved, rounded at both ends, (5.2–)6.0–11.0(–13.4) × (1.1–)1.4–2.6(–3.1) µm (*n* = 50). *Chlamydospores*, *pycnidia,* and *ascomata* not produced in culture.

Distribution: Europe (Austria, Czech Republic, France, Germany, Ireland, Italy, Netherlands, Switzerland, UK).

Habitat: On dead bark and recently killed roots of *Hedera helix* and *Hedera* sp. (*Araliaceae*).

Holotype of Pleonectria sinopica: possible **Holotype** at UPS as *Sphaeria sinopica*-not available for examination.

Additional type specimens: **Holotype** of *Sphaeria mougeotii*: (**Holotype** unavailable from UPS).

Additional specimens and isolates examined: **Austria**, Nassau, on *Hedera helix*, Fuckel, BPI 553101. **Czech Republic** (as Czechoslovakia), Trebon, on *Hedera helix*, 1890, Weidmann, BPI 5530107. **France**, Parc Chateau de Levc (71) Aude, on ?*Buxus* sp., Mar. 1993, J.F. Magni, BPI 744711; Sur les raciness et les sarments languissants du Lierre?, Desmazieres, Plant crypt. De France Fasc. 26, BPI–bound exsiccati; Foret de Chize, on *Hedera helix*, 28 Feb. 2008, C. Lechat CLL 7156, BPI 881067, culture CBS 125169 = A.R. 4495; Foret de Chize, on *Hedera* sp., 14 Dec. 2009, C. Lechat C.L.L. 9237, LIP, culture CBS 128981 = A.R. 4669; Forêt de Chamois, near Nogna, Buxus forest, on *Hedera helix*., 24 Sep. 1996, H.J. Schroers, CBS 100006 = H.J.S. 190; ad sarmenta Hederae apud nos, Dr Guépin circa Andegavum et am. Roussel Meloduni, Mougeot, Nestler et schimper, stirp. Crypt. Vogeso–Rhen. Fasc. 16 No. 1335, BPI–bound exsiccati. **Germany**, Bottrop, Westphalia, on *Hedera helix*, 21 Dec. 1922, H. Rupprecht, BPI 553098; Bottrop, Westphalia, on *Hedera helix*, 21 Dec. 1922, H. Rupprecht, Sydow, Myc. Germani 1930, BPI bound exsiccati; Prov. Brandenburg, on *Hedera helix*, 28 Dec. 1906, O. Jaap, BPI 551023; on *Hedera helix*, BPI 553099 ascomata no longer present; Westfalen, am Spechtsbach Im Kolnischen Wald Bei Bottrop, on *Hedera helix*, 21 Dec. 1922, H. Rupprecht, BPI 553104; Westfalen, am spechtsbach im Kölnischen wald bei Bottrop, on *Hedera helix*, 21 Dec. 1922, H. Rupprecht, BPI 553098; Brandenburg, Triglitz in der Prignitz, on *Hedera helix*, 28 Dec. 1906, O. Jaap, Jaap, Fungi selecti exsic. 216 1930, BPI–bound exsiccati; Brandenburg, Glindow bel Werder, on *Hedera helix*, May 1941, H. Sydow, BPI 1111765, only anamorph; Charlottsburg, Piklopgarten, on *Hedera helix*, Oct. 1887, H. Sydow, Sydow, Mycotheca Marchica 1837 BPI– bound exsiccati. **Ireland**, Maynooth, Co. Kildare, on *Hedera helix*, 25 May 1952, D.P. O'Connor, BPI 553096. **Italy**, Padova, on *Hedera helix*, Jan 1881, BPI 553103. **Netherlands**, Baarn, Groeneveld, on *Hedera*

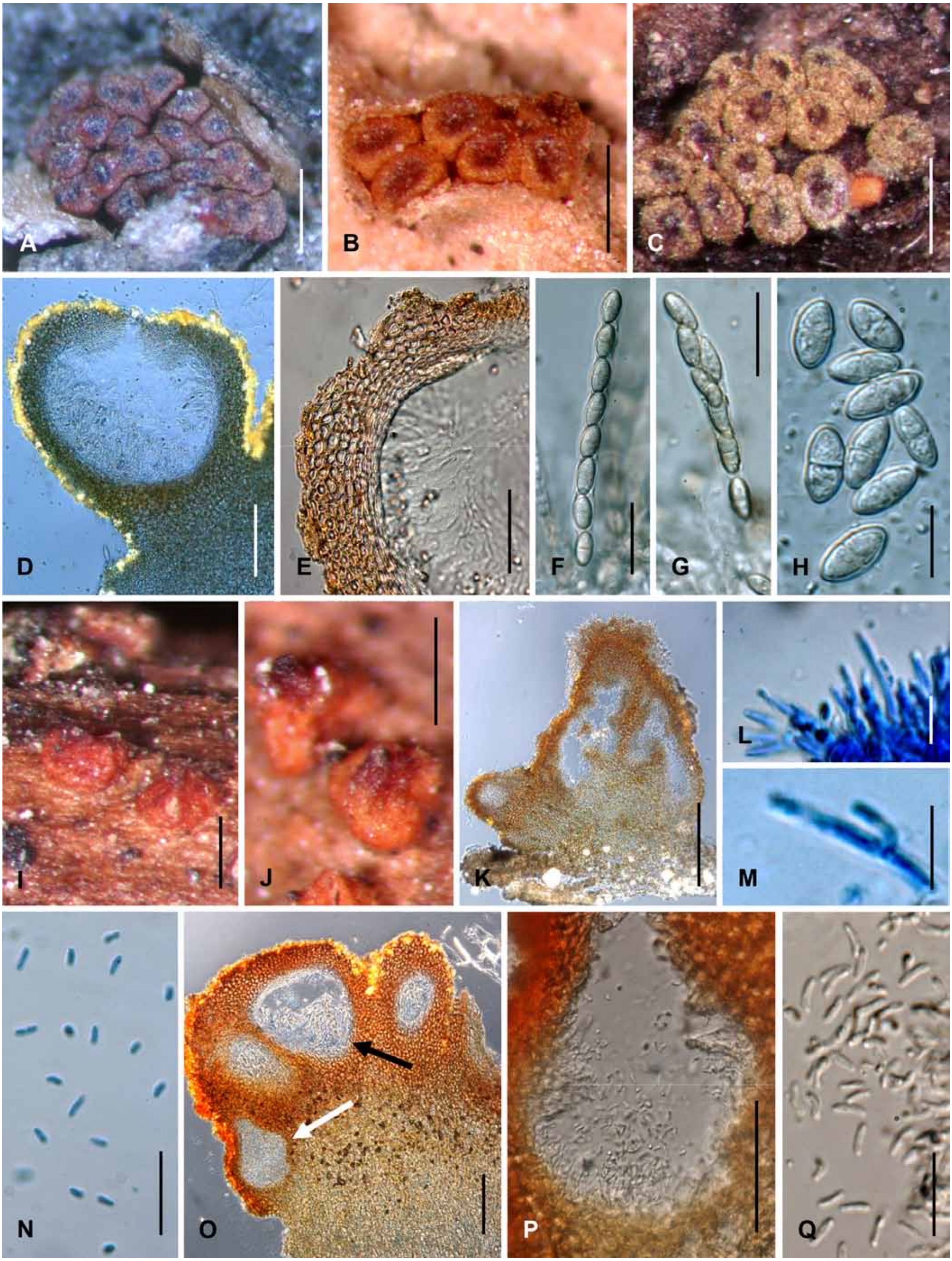

Fig. 135A–Q. *Pleonectria sinopica* on natural substrata (A–H teleomorph, I–Q anamorph). A–C. Perithecia on natural substrata; D. Median section of perithecium on natural substrata; E. Median section of perithecial wall on natural substrata; F, G. Asci; H. Ascospores; I, J. Pycnidia on natural substrata; K. Median section of superficial pycnidia on natural substrata, L, M. Conidiophores of superficial pycnidia on natural substrata; N. conidia of superficial pycnidia, O. Median section of immersed pycnidium (white arrow) and perithecia (black arrow) in natural environment; P. Median section of immersed pycnidium in natural environment; Q. Conidia of immersed pycnidia. Scale bars: A–C = 500 µm; D, I–K, O = 100 µm; E, P = 50 µm; F, G = 20 µm; H, L–N, Q = 10 µm.

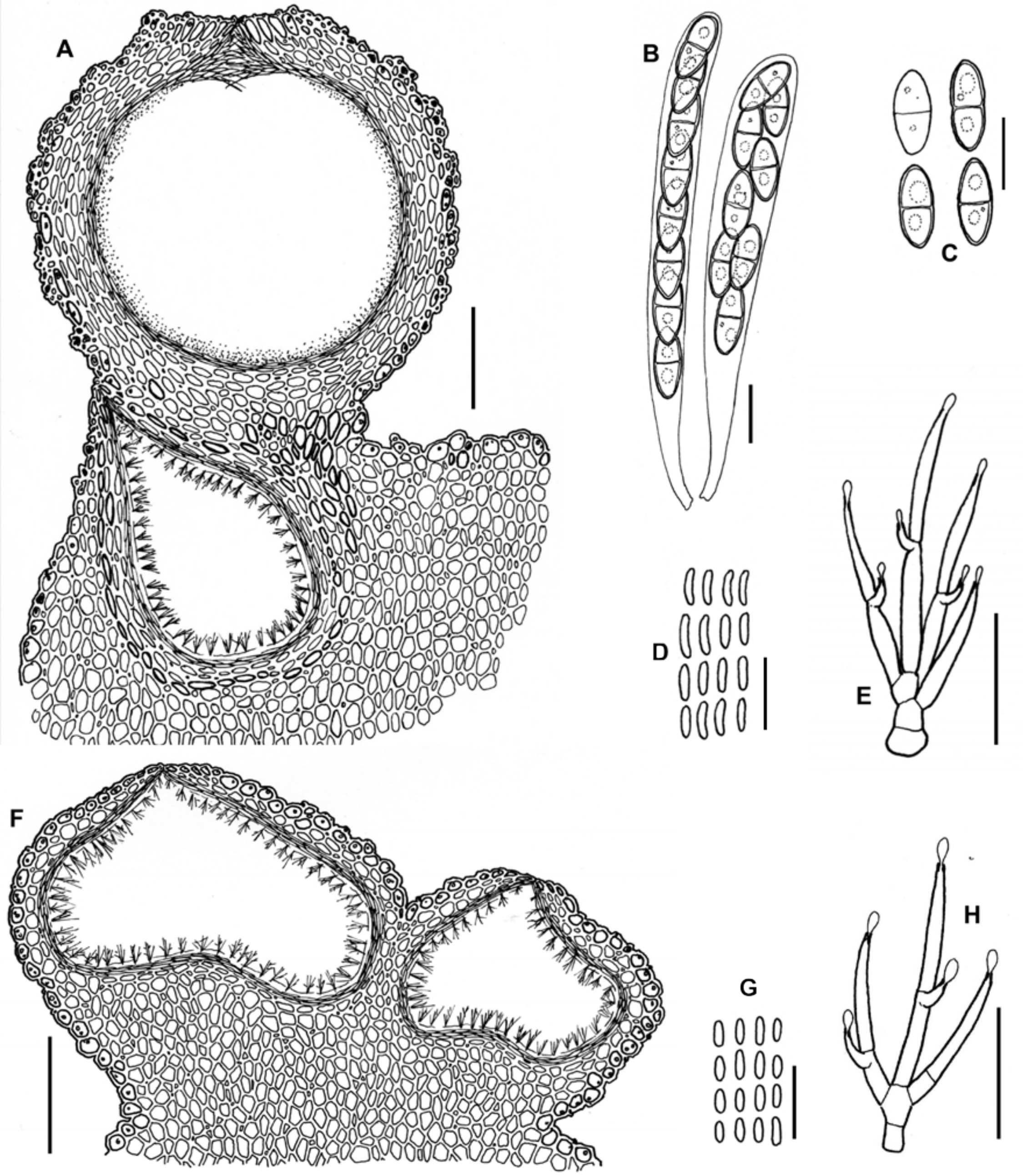

Fig. 136A–H. *Pleonectria sinopica* on natural substrata (A teleomorph and anamorph, B, C teleomorph, D–H anamorph). A. Median section of mature perithecium and immersed pycnidium; B. Asci; C. Ascospores; D. Conidia of immersed pycnidia; E. Conidiophores of immersed pycnidia; F. Superficial pycnidia: G. Conidia of superficial pycnidia; H. Conidiophores of superficial pycnidia. Scale bars: A, F = 100 µm; B–E, G, H = 10 µm.

helix, 12 May 1983, H.A. van der Aa, CBS H-19479, H-19485, culture CBS 462.83. **Switzerland**, on *Hedera helix*, Aug. 1878, G. Winter, BPI 551022; In silva "Sihlwald" prope Zürich (Helvetiae) raro, on *Hedera helix*, Aug. 1878, G. Winter, Kunze Fungi selecti 343, BPI– bound exsiccati. **UK**. England, Glenhell Wood, Pickering, Yorkshire, on *Hedera helix*, 17 Feb. 1957, W.G. Branlly, BPI 553097; Pickering, on *Hedera helix*, 18 Sep. 1930, Mason, BPI 553100; Anglia, Kings-Lynn, Norfolk, on *Hedera helix*, 1874, C.B. Plowright, BPI 553105; C.B. Plowright, Sphaeriacei Britannici 9, BPI 553093; Pickering, on *Hedera helix*, 18 Sep. 1930, C.L. Shear, BPI 553106; Pickering, Yorks, on *Hedera* sp., 17 Mar. 1956, W.G. Bramley, BPI 553094; Cooke, Fungi Brit. Ed. 2 477 BPI– bound exsiccati.

Notes: *Pleonectria sinopica* occurs on *Hedera helix* in Europe. This species is almost identical with *Pleonectria ilicicola* on *Ilex*. They can be distinguished by host and subtle ascospore morphology. In addition, our phylogeny showed that the species are congeneric but only distantly related (Figs 1, 2). This is an example of convergent evolution within the genus *Pleonectria.*

The pycnidial anamorph of *P. sinopica*, *Zythiostroma mougeotii*, is the type species of *Zythiostroma* and was redescribed by several mycologists (Petch 1943, Booth 1959, Sutton 1980). However, pycnidia and ascomata on the same branch were observed on only one specimen (BPI 553098), although we examined more than 20 specimens of teleomorph and anamorph and made a number of sections for all specimens, some of which Booth (1959) also examined. Surprisingly, the pycnidia in BPI 553098 were completely immersed in the stroma with conidia longer than those produced in the superficial pycnidia on BPI 553099 with only an anamorph present (Figs 135O–Q, 136A, D, E). Among other species of *Pleonectria*, dimorphic conidia were never observed in the natural environment. However, large conidia in immersed stroma may be considered 'mature conidia' as observed on SNA. Immersed pycnidia may be the true anamorph of *P. sinopica*, while the superficial pycnidia are another *Pleonectria* species as occurs with *Pleonectria berolinensis.* We could not observe the holotype specimens of *P. sinopica* and *Z. mougeotii* because they are Fries' specimens preserved in UPS.

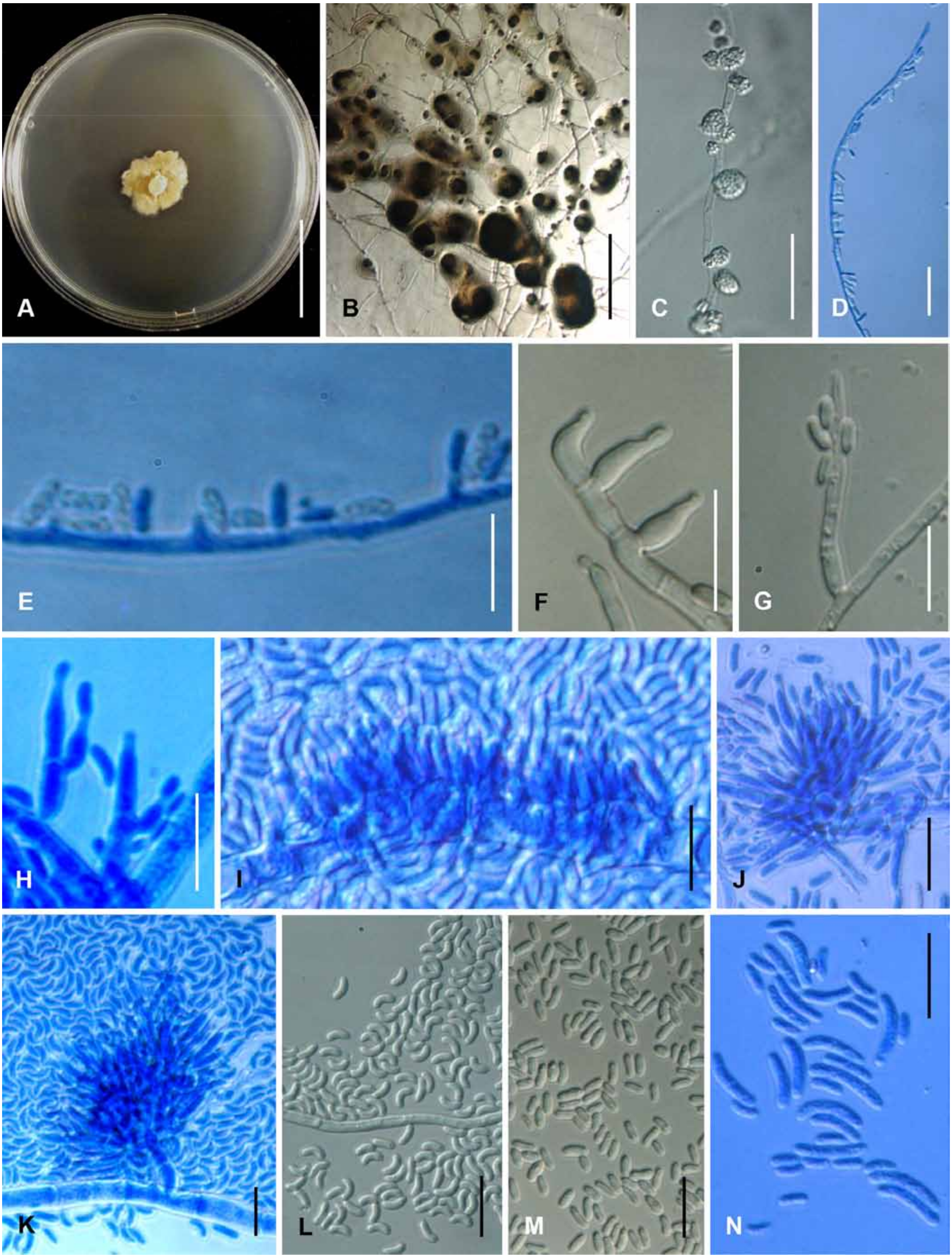

Fig. 137A–N. Anamorph of *Pleonectria sinopica* in culture. A. Cultures after 7 d at 25 °C on PDA; B. Conidial mass on SNA; C. Lateral phialidic pegs and conidial mass on SNA; D–F. Lateral phialidic pegs and conidia on SNA; G, H. Conidiophores and conidia on SNA; I, J. Short sporodochial conidiophores on SNA; K. Long sporodochial conidiophores on SNA; L, M. Young conidia on SNA; N. Young and mature conidia on SNA. Scale bars: A = 3 mm; B = 50 µm; C, D = 20 µm; E–N = 10 µm.

The name *Zythiostroma* was established in a key published by Höhnel (1923) but without designating a type species. Later Höhnel & Weese (1931) designated *Z. mougeotii* as the type species. Since then, three mycologists (Petch 1943, Booth 1959, Sutton 1980) discussed the taxonomic history of *Zythiostroma*. According to these authors, *Sphaeronaema hederae* is a synonym of *Z. mougeotii* but our macroscopic examination of the lectotype specimen of *S. hederae* at FH suggests that this specimen is not hypocrealean. Type specimen of *Sphaeronaema hederae*: **Holotype** Fuckel, Fungi Rhenani Exsiccati. No. 775, FH.

Pleonectria sphaerospora (Ellis & Everh) Hirooka, Rossman & P. Chaverri, **comb. nov.** MycoBank MB519719. Figs 138, 139.

Basionym: *Nectria sphaerospora* Ellis & Everh., in Bessey & Webber, Nebraska State Board Agric. Annual Rep. 1889: 53. 1890.

≡ *Chilonectria crinigera* Ellis & Everh., Proc. Acad. Nat. Sci. Philadelphia 1890: 246. 1891.

≡ *Thyronectria sphaerospora* (Ellis & Everh.) Seaver, Mycologia 1: 206. 1909.

Anamorph: zythiostroma-like.

Teleomorph on natural substrata: *Ascomata and pycnidia* often formed on same or discrete stroma. *Mycelium* not visible around ascomata or on host. *Stromata* erumpent through epidermis, up to 2.0 mm high and 4.0 mm diam, sienna to umber, KOH+ slightly darker, LA+ slightly yellow, pseudoparenchymatous, cells forming *textura globulosa* or *t. angularis*, intergrading with ascomatal wall. *Ascomata* superficial or immersed at the base on well-developed stromata, aggregated in groups of 5–20, subglobose to globose, 200–300 µm high × 200–280 µm diam, yellowish brown or reddish grey with dark often black, shining apical region, not collapsing or rarely cupulate when dry, KOH+ slightly darker, LA+ slightly yellow, smooth to slightly roughened. *Ascomatal surface cells* forming *textura globulosa* or *t. angularis* sometimes including bright yellow scurf, 3–8 µm diam, with pigmented, uniformly or irregularly *ca.* 1.0 µm thickened walls. *Ascomatal wall* 30–45 µm thick, around apex up to about 70 µm thick, fully covered by bright yellow scurf, of two regions: outer region 25–35 µm thick, intergrading with stroma, cells forming t*extura globulosa* or *t. angularis*, walls pigmented, about 1.0 µm thick; inner region 6–15 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* clavate, 51–77 × 7–15 µm, with inconspicuous ring at apex, 8-spored, ascospores, uniseriate or rarely biseriate above. *Ascospores* subglobose to ellipsoidal, muriform, with 1–2 transverse septa and usually 1 longitudinal septum, (5.1–)5.6–7.6(–9.4) × (4.0– 4.6–6.6(–8.6) µm (*n* = 50), hyaline, smooth, budding hyaline, 4–8 µm long, filaments segmented, hyaline, thin-walled; *bacillar ascoconidia*, (2.8–)3.1–4.1(–4.7) × (1.5–)1.8–2.4(–2.7) µm (*n* = 50), that fill asci.

Anamorph on natural substrata: *Stromata* erumpent through epidermis or developing in stroma with ascomata, orange to umber. *Pycnidia* dimorphic. superficial and immersed in stroma. *Superficial pycnidia* aggregated in groups of 3–7, irregulary subglobose, 170–300 µm, 90–240 µm diam, sienna to umber, KOH+ slightly darker, LA+ slightly yellow. *Superficial pycnidial wall* 14–23 µm thick, of two regions: outer region 7–18 µm thick, intergrading with stroma, cells forming *textura globulosa*, walls pigmented, about 1.0 µm thick; inner region 5–12 µm thick, of elongate, thin-walled, hyaline cells, forming t*extura prismatica*. *Immersed pycnidia* embedded between ascomata or pycnidia at bases, eustromatic, solitary or aggregated in groups of 3–5, irregular multiple chambers with shared walls, 115–190 µm high × 70–154 µm diam, KOH+ darker, LA+ yellow. *Immersed pycnidial wall* 6–18 µm thick, of 1–2 regions, cells forming *textura prismatica*, about 1.0 µm thick, elongate, thin-walled, hyaline cells. *Conidiophores* loosely to densely branched, generally with 1–4 branched, 16–25 µm long, 1.3–1.8 µm wide. *Conidiogenous cells* cylindrical to subulate, straight to slightly curved, enteroblastic, monophialidic, 6.9–10 × 0.8–1.5 µm. *Intercalary phialides* bearing one terminal phialide, up to 6 µm. *Sterile hyphae* absent. *Conidia* hyaline, ellipsoidal to allantoid, curved, non-septate, (2.4–)2.5–3.7(–5.4) × (0.4–)0.7–1.1(–1.2) µm (*n* = 50).

Habitat: On dead barks or twigs (*Fraxinus viridis*?, *Gleditsia triacanthos*).

Distribution: North America (USA).

Lectotype of Nectria sphaerospora *designated herein*: **USA**, Nebraska, Lancaster Co. Lincoln, on bark of dead *Fraxinus viridis*?, 18 Nov. 1888, H.J. Webber, **Lectotype** NY 00883501, **Isolectotype** NY 00883502, E. Bartholomew, Fungi Columbiani no. 3248 in FH.

Additional specimens and isolates examined: **USA**, Nebraska, Lincoln, on bark of dead *Gleditsia triacanthos*, Sep. 1889, H.J. Webber, BPI 629728 as *Nectria austroamericana*.

Notes: *Nectria sphaerospora*, the basionym of *Pleonectria sphaerospora*, was described as a new species having ascospores surrounded by radiating filaments. Based on our observations, the radiating filaments are germ tubes developing from the gerinating ascospores with budding ascoconidia developing in the asci at the same time (Figs 138F–J, 139B, C). Seeler (1940b) examined type specimens of these fungi and decided that *N. sphaerospora* is a synonym of *N. austroamericana* based on the morphology and host. In his monograph, he did not stress the characteristic of germinating and budding ascospores. In our study, specimens of *Nectria aquifolii* are recognised as two species, *Pleonectria aquifolii* and *P. ilicicola,* based on the presence or absence of budding ascospores in the asci. The importance of this characteristic is supported by our cultural observations and molecular data. Therefore, we separate *P. sphaerospora* from *P. austroamericana* although no molecular data are available.

According to Rossman (1989) and Rossman *et al.* (1999), *Chilonectria crinigera* is a taxonomic synonym of *N. austroamericana*, but this name was described based on the same type specimen as *N. sphaerospora* (H.J. Webber, specimen no. 18), thus *C. crinigera* is a nomenclatural synonym of *P. sphaerospora*.

Pleonectria strobi Hirooka, Rossman & P. Chaverri, **sp. nov.** MycoBank MB519720. Figs 140–142.

Holotype of Pleonectria strobi: **USA**, New York, Warren Co., Pack Forest, on *Pinus strobus*, 25 Sep. 1971, C.T. Rogerson, **Holotype** NY, **ex-holotype** culture CBS 125107 = C.T.R. 71-382

Etymology: *strob* + *-i*; refers to the subgenus of the known hosts.

Anamorph: zythiostroma-like.

Teleomorph on natural substrata: *Ascomata and pycnidia* sometimes formed on same or discrete stroma. *Mycelium* not visible around ascomata or on host. *Stromata* erumpent through epidermis, up to 1.0 mm high and 1.0 mm diam, orange to sienna, KOH+ dark purple, LA+ yellow, pseudoparenchymatous, cells forming *textura angularis*, intergrading with ascomatal wall. *Ascomata* superficial on well-developed stromata, scattered to aggregated in groups of 3–17, subglobose to globose, 174–302 µm high × 210–340 µm

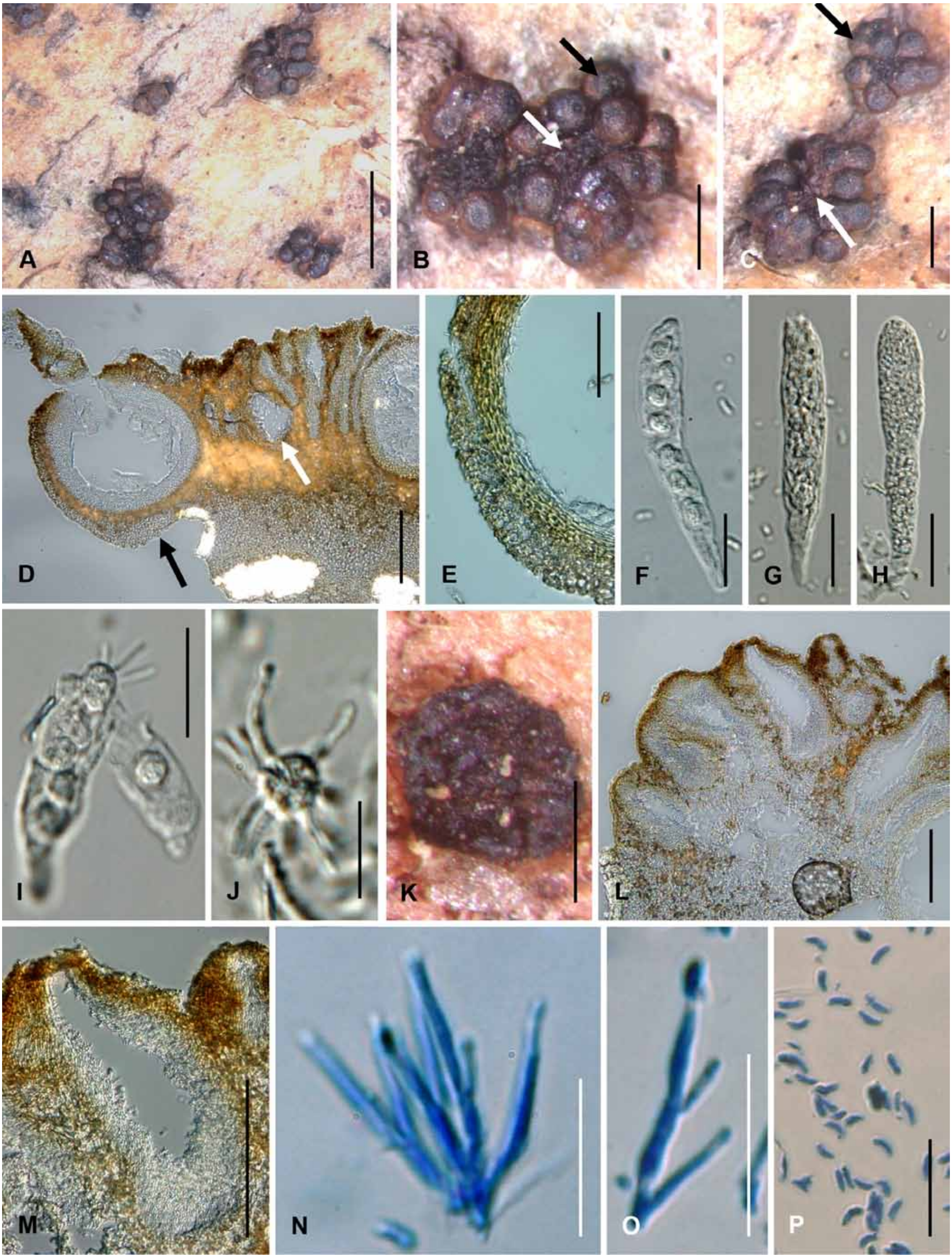

Fig. 138A–P. *Pleonectria sphaerospora* on natural substrata (A–D teleomorph and anamorph, E–J teleomorph, K–P anamorph). A–C. Perithecia (black arrows) and pycnidia (white arrows) on natural substrata; D. Median section of perithecia (black arrow) and pycnidia (white arrow) on natural substrata; E. Median section of perithecial wall; F. Ascus having unbudding ascospores; G–I. Asci having budding ascospores; J. Ascospore; K. Pycnidia on natural substrata; L, M. Median section of pycnidia on natural substrata; N, O. Conidiophores on natural substrata; P. Conidia on natural substrata. Scale bars: A = 5 mm; B, C, K = 500 µm; D, L, M = 100 µm; E = 50 µm; F–I = 20 µm; J, N–P = 10 µm.

diam, red to umber, cupulate upon drying, sometimes with only a depressed apical region, apical region slightly darker, KOH+ purple, LA+ yellow, surface usually bright yellow to yellowish green scurfy. *Ascomatal surface cells* forming *textura globulosa*

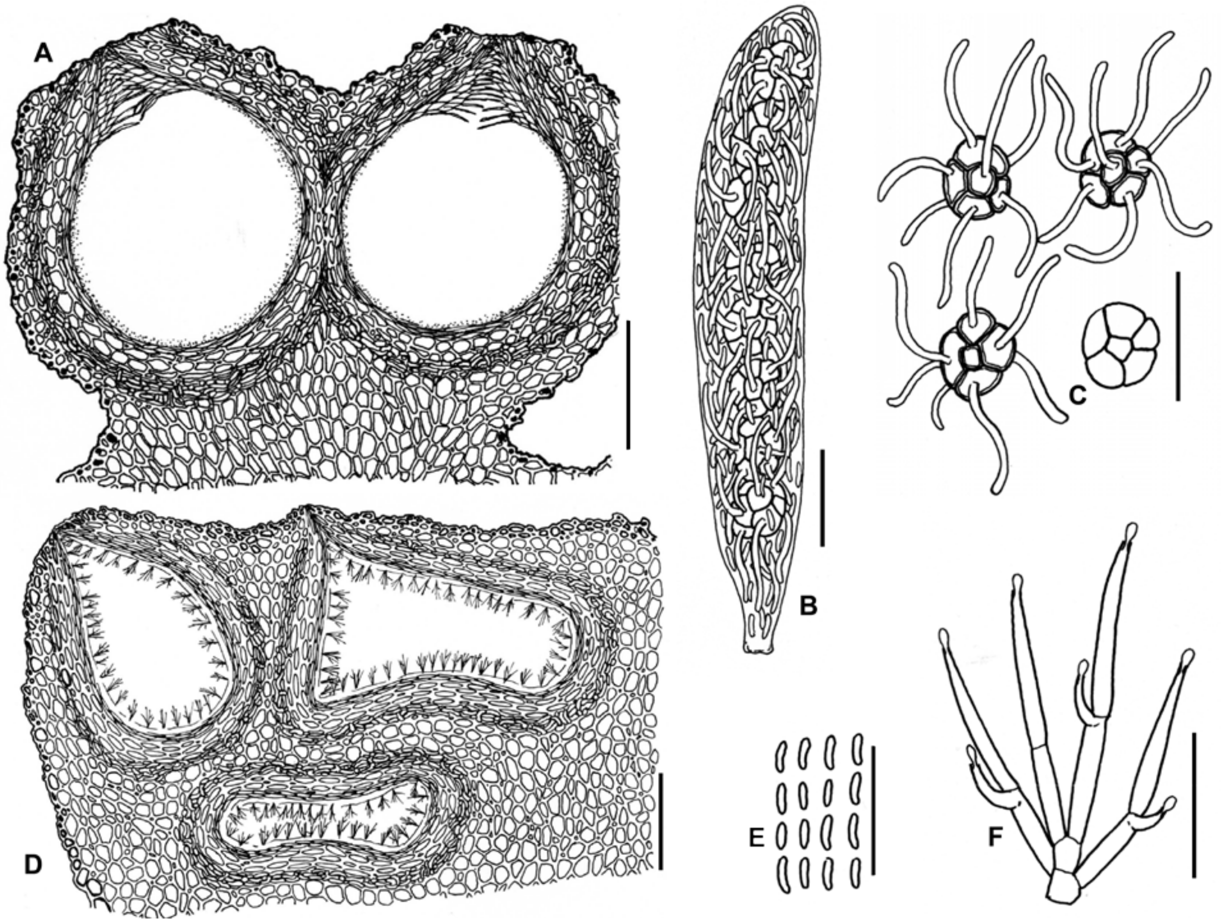

Fig. 139A–F. *Pleonectria sphaerospora* on natural substrata (A–C teleomorph, D–F anamorph). A. Median section of mature perithecia; B. Ascus; C. Ascospores; D. Median section of mature Pycnidia; E. Conidia; F. Conidiophores. Scale bars: A, D = 100 µm; B, C, E, F = 10 µm.

or *t. angularis,* sometimes including bright yellow scurf, 3–10 µm diam, with pigmented, uniformly or irregularly, *ca.* 1.5 µm thickened walls. *Ascomatal wall* 30–51 µm thick, of two regions: outer region 25–40 µm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.5 µm thick; inner region 7–15 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* narrowly clavate, increasing in size as ascospores mature, 45–112 × 8–12 µm, with inconspicuous ring at apex, 8-spored. *Ascospores* long-filiform, 12–44 septate, hyaline, (21.8–)32.9–52.1(–64.3) × (1.9–)2.2–3.2(–3.9) µm (*n* = 120), smooth, budding to produce hyaline, thin-walled, tapering apex, slightly curved, *bacillar ascoconidia*, (0.2–)2.3–3.5(–3.9) × (0.9–)1.1–1.9(–2.3) µm (*n* = 125), that fill asci.

Anamorph on natural substrata: *Stromata* erumpent through epidermis or developing with ascomata, orange to red. *Pycnidia* solitary or aggregated in groups of 4–12, superficial on stroma or rarely immersed at base, subglobose, smooth to slightly roughened, cerebriform upon drying, 195–311 µm, 186–468 µm diam, scarlet to bay, KOH+ slightly darker, LA+ slightly yellow. *Pycnidial wall* 19–33 µm thick, of two regions: outer region 10–23 µm thick, intergrading with stroma, cells forming *textura globulosa*, walls pigmented, about 1.0 µm thick; inner region 8–14 µm thick, of elongate, thin-walled, hyaline cells, forming t*extura prismatica*. *Conidiophores* densely branched, generally with 1–3-branched, 12–27 µm long, 1.3–2.5 µm wide. *Conidiogenous cells* cylindrical to subulate, straight to slightly curved, enteroblastic, monophialidic, 8–12 × 1.0–2.0 µm. *Intercalary phialides* bearing (1–)3 terminal phialides, up to 5 µm long, similar to short acropleurogenous conidiophores. *Sterile hyphae* absent. *Conidia* hyaline, ellipsoidal to oblong, sometimes slightly curved, non-septate, (1.9–)2.6–3.4(–3.8) × (1.1–)1.2–1.6(–1.8) µm (*n* = 100).

Anamorph in culture: After 7 d at 25 °C, colonies 70–85 mm (average 79 mm) diam. *Colony surface* cottony with aerial mycelium, whitish brown; *aerial mycelium* often sparse, white to whitish, yellow, sporodochial conidial masses produced after 3 wk; *reverse* whitish brown. *Odour* on PDA slightly putrid. Sporulation on SNA from *lateral phialidic pegs* abundant, enteroblastic, monophialidic, ellipsoidal, tapering toward tip or flask-shape, 2.2–4.0 µm long, 1.1–1.9 µm wide at base. *Conidiophores* unbranched, sometimes 1(–2)-branched, becoming loosely to moderately densely branched, 9.6–30.5 µm long, 1.5–2.3 µm wide at base. *Conidiogenous cells* monophialidic, enteroblastic, cylindrical, slightly tapering toward tip or narrowly flask-shaped with widest point in middle, 7.0–11.1 µm long, 1.4–2.1 µm wide at base. *Young conidia* formed from monophialides on aerial, submerged, or repent hyphae, formed abundantly on slimy heads or sporodochia, ellipsoidal to oblong, hyaline, straight or slightly curved, rounded at both ends, non-septate, (3.5–)3.8–4.6(–5.1) × (1.1–)1.3–1.7(–2.0) µm (*n* = 118), smooth-walled. *Mature conidia* swollen, 0-septate, oblong with slightly swollen at both ends or sometimes long-cylindrical, hyaline, smooth, slightly curved, rounded at both ends, (7.1–)7.5–9.5(–12.5) × (1.3–)1.5–2.1(–2.4) µm (*n* = 50). *Chlamydospores*, *pycnidia,* and *ascomata* not produced in culture.

Habitat: On bark or twigs of *Pinus* subgenus *Strobus*, primarily *P. strobus*, also known from *P. flexilis* and *P. monticola*.

Distribution: Europe (Germany), North America (Canada, USA).

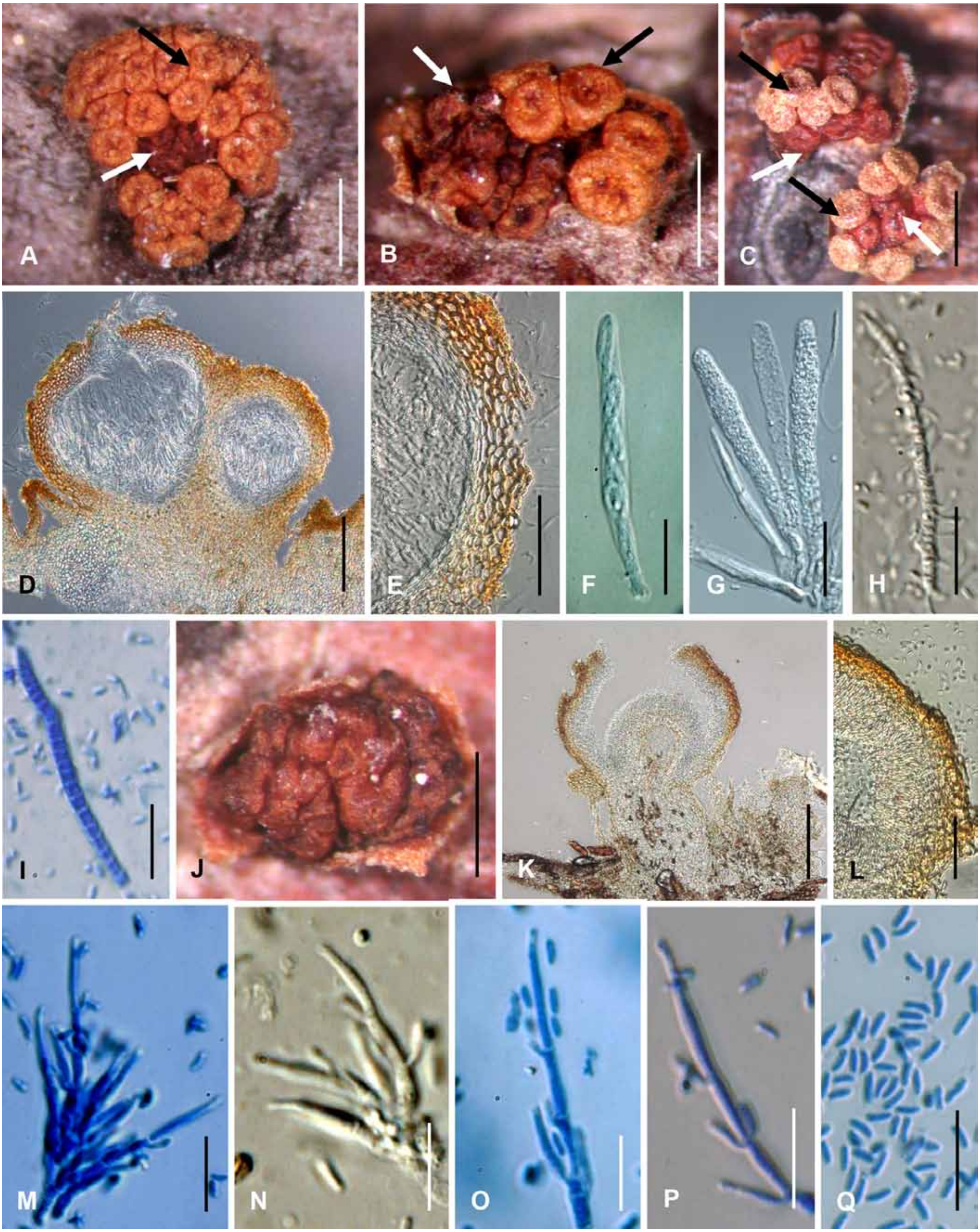

Fig. 140A–Q. *Pleonectria strobi* on natural substrata (A–C teleomorph and anamorph, D–I teleomorph, J–Q anamorph). A–C. Perithecia (black arrows) and pycnidia (white arrows) on natural substrata; D. Median section of perithecia on natural substrata; E. Median section of perithecial wall; F. Ascus having unbudding ascospores; G. Asci having budding ascospores; H. Budding ascospore; I. Unbudding ascospore; J. Pycnidia on natural substrata; K. Median section of pycnidium on natural substrata; L. Median section of pycnidial wall; M–P. Conidiophores on natural substrata; Q. Conidia on natural substrata. Scale bars: A–C, J = 500 µm; D, K = 100 µm; E, L = 50 µm; F, G = 20 µm; H, I, M–Q = 10 µm.

Additional specimens and isolates examined: **Canada**, Ontario, St. Williams, Government Nursery, on *Pinus strobus*, Sep. 1918, E. J. Zavitz, BPI 632657 as *Ophionectria scolecospora*; Ontario, Bells Lake, N. Parry Sound, on *Pinus strobus*, 20 Sep.1934 -22 Sep. 1934?, H.S. Jackson, BPI 632683 as *Ophionectria scolecospora*; Ontario, Komoka, on *Pinus strobus*, May 1915, J. Dearness, BPI 632794 as *Ophionectria scolecospora*; Ontario, Komoka, on *Pinus strobus*, May 1915, J. Dearness, BPI 632799 as *Ophionectria scolecospora*; Quebec, Old Chelsea, on *Pinus strobus*, 05 May 1935, I.L. Conners, BPI 632769 as *Scoleconectria*

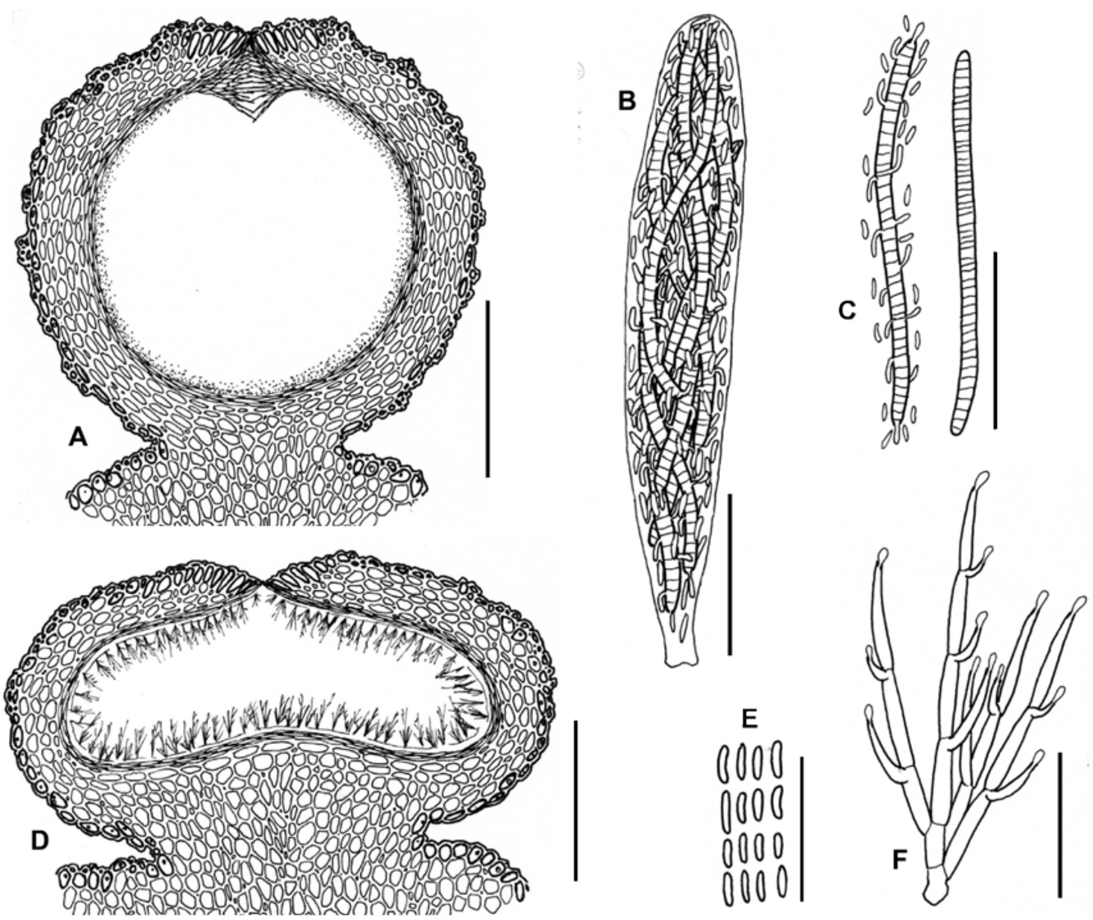

Fig. 141A–F. *Pleonectria strobi* on natural substrata (A–C teleomorph, D–F anamorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores and ascoconidia; D. Median section of mature pycnidium; E. Conidia; F. Conidiophores. Scale bars: A, D = 100 µm; B, C = 20 µm; E, F = 10 µm.

cucurbitula. **Germany**, Dabroszyn (Tamsel, Brandenburg), on *Pinus strobus*, 05 Jan. 1913, F. Bubak, BPI 632658 as *Ophionectria scolecospora*. **USA**, Connecticut, Saltonstall, on *Pinus strobus*, 19 Nov. 1927, C.G. Riley, BPI 629743 as *Chilonectria cucurbitula*; New Jersey, Newfield, on *Pinus strobus*, BPI 629744A as *Chilonectria cucurbitula*; New Jersey, Newfield, on *Pinus strobus*, BPI 629744B as *Chilonectria cucurbitula*; New Jersey, Newfield, on *Pinus strobus*, BPI 6299744A as *Chilonectria cucurbitula*; Connecticut, Saltonstall Lake, near Branford, New Haven Co. alt. 200 ft., on *Pinus strobus*, 27 Sep. 1931, J S. Boyce, BPI 1107505 as *Nectria cucurbitula*; Connecticut, near Middlebury, Whittemore Estate, on *Pinus strobus*, 05 Nov. 1930, J.S. Boyce, BPI 1107506 as *Nectria cucurbitula*; New York, Wilmington, on *Pinus strobus*, 23 Aug. 1929, P. Spaulding, BPI 632551 as *Ophionectria scolecospora*; North Carolina, Blue Valley, Macon Co. 35d00'n,83d15'w, off Clear Creek road, along Overflow Creek, on *Pinus strobus*, 16 Oct. 1990, Y. Doi, A.Y. Rossman, G.J. Samuels, BPI 1109346 as *Scoleconectria cucurbitula*; North Carolina, Macon Co. Ellicott Rock Trail, off Bull Pen road, alt. 3000 ft. 35 °1'N 83 °8'W, on *Pinus strobus*, 14 Oct. 1990, Y. Doi, A.Y. Rossman, G.J. Samuels, BPI 1109348 as *Scoleconectria cucurbitula*; Maryland, Beltsville, on *Pinus strobus*, May 1950, F. Petrak, BPI 1110626 as *Scoleconectria cucurbitula*; Virginia, Giles Co., Mt. Lake Biological Station. alt. 1170 m, 37 °22'N 80 °31'W, Little Spruce Bog, on *Pinus strobus*, 17 Sep. 1991, G.J. Samuels, BPI 1112876 as *Scoleconectria cucurbitula*, culture CBS 129363 = G.J.S. 91-107; New York, Alcove, on *Pinus strobus,* Feb. 1893, C.L. Shear, BPI 632766 as *Scoleconectria cucurbitula*; Massachusetts, Pepperell, on *Pinus strobus*, 08 Jun. 1926, L.B. Smith, BPI 632767 as *Scoleconectria cucurbitula*; North Carolina, Big Creek, Horse Cove, Macon Co., on *Pinus strobus*, 21 Oct. 1960, R.H. Petersen, C.T. Rogerson, BPI 632768 as *Scoleconectria cucurbitula*; North Carolina, Fowler Creek along state.rd. 1102, Macon Co. along Bull Pen Rd. (State Rd. 1100) by Pleasant Grove Baptist Church, E., on *Pinus strobus*, 15 Aug. 1978, A.Y. Rossman, L. Spielman, BPI 632770 as *Scoleconectria cucurbitula*; North Carolina, Macon Co. alt. 3000 ft., 35 °01'N, 83 °08'W, Ellicott Rock Trail, off Bull Pen road, on *Pinus strobus* (as *Thuja* sp.), 14 Oct. 1990, G.J. Samuels, Y. Doi, A.Y. Rossman, BPI 1107115 as *Scoleconectria cucurbitula*, culture CBS 102036 = G.J.S. 90-45; New York, Warrensburg, on *Pinus flexilis*, 18 Jun. 1946, J.R. Hansbrough, BPI 632549 as *Ophionectria scolecospora*; New York, Warrensburg, Pack Forest, on *Pinus monticola*, 18 Jun. 1946, J.R. Hansbrough, BPI 632644 as *Ophionectria scolecospora*; Maryland, Beltsville, on *Pinus strobus*, May 1950, F. Petrak, BPI 1112062 as *Ophionectria scolecospora*; Connecticut, Windsor, on *Pinus strobus*, 28 Apr. 1935, H.G. Eno, BPI 632547 as *Ophionectria scolecospora*; Vermont, Rutland, on *Pinus strobus*, 12 Apr. 1938, L.W. Hodgkins, BPI 632548 as *Ophionectria scolecospora*; West Virginia, Morgantown, on *Pinus strobus*, 17 Mar. 1907, J.L. Sheldon, BPI 632655 as *Scoleconectria scolecospora*; West Virginia, Morgantown, on *Pinus strobus*, 21 Jul. 1907, J.L. Sheldon, BPI 632656 as *Ophionectria scolecospora*; Wisconsin, Madison, Dane Co., on *Pinus strobus*, 09 May 1951, H.C. Greene, BPI 629746 as *Chilonectria cucurbitula*; New York, Wilmington, on *Pinus strobus*, 10 May 1928, P. Spaulding, J.R. Hansbrough, BPI 632660 as *Ophionectria scolecospora*; Pennsylvania, Greenwood Furnace, on *Pinus strobus*, 26 Nov. 1927, L.O. Overholts, P. Spaulding, BPI 632661 as *Ophionectria scolecospora*; New York, Watson, on *Pinus strobus*, 09 Aug. 1945, J.R. Hansbrough, BPI 632662 as *Ophionectria scolecospora*; New Hampshire, Keene. Yale Forest, on *Pinus strobus*, 04 Sep. 1928, P. Spaulding, BPI 632663 as *Ophionectria scolecospora*; Connecticut, Bethany, on *Pinus strobus*, 02 Jun. 1933, J.R. Hansbrough, BPI 632664 as *Ophionectria scolecospora*; Ohio, Mt. Airy State Park, Cincinnati, on *Pinus strobus*, 04 May 1936, J.R. Hansbrough, BPI 632666 as *Ophionectria scolecospora*; Ohio, Mt. Airy State Park, Cincinnati, on *Pinus strobus*, 04 May 1936, J.R. Hansbrough, BPI 632667 as *Ophionectria scolecospora*; Michigan, East Lansing, on *Pinus strobus*, 03 Aug. 1934, J.R. Hansbrough, BPI 632668 as *Ophionectria scolecospora*; New Hampshire, Waterville, on *Pinus strobus*, 29 Jul. 1928, P. Spaulding, BPI 632669 as *Ophionectria scolecospora*; Vermont, Benson, on *Pinus strobus*, 27 Sep 1935, J.R. Hansbrough, BPI 632670 as *Ophionectria scolecospora*; New York, Hemlock Lake, Canadice, on *Pinus strobus*, 02 Aug. 1935, J.R. Hansbrough, BPI 632671 as *Ophionectria scolecospora*; New Hampshire, Winchester, on *Pinus strobus*, 11 Jun. 1940, P. Spaulding, BPI 632673 as *Ophionectria scolecospora*; Vermont, Reading, on *Pinus strobus*, 07 Jul. 1946, J.R. Hansbrough, BPI 632674 as *Ophionectria scolecospora*; Pennsylvania, Charter Oak, on *Pinus strobus*, 23 Nov. 1927, L.O. Overholts, P. Spaulding, BPI 632675 as *Ophionectria scolecospora*; New Hampshire, Thornton, on *Pinus strobus*, 26 Jun. 1931, H.G. Eno, BPI 632676 as *Ophionectria scolecospora*; Ohio, Gates Mill, on *Pinus strobus*, 29 Apr. 1936, J.R. Hansbrough, BPI 632678 as *Ophionectria scolecospora*; New York, Dannemora, Clinton Co., on *Pinus strobus*, 06 Sep. 1932, J.R. Hansbrough, BPI 632679 as *Ophionectria scolecospora*; New York, Hemlock Lake, Canadice, on *Pinus strobus*, 11 Sep. 1935, H.G. Eno, BPI 632680 as *Ophionectria scolecospora*; Vermont, Bridport, on *Pinus strobus*, 27 Sep. 1935, P. Spaulding, BPI 632681 as *Ophionectria scolecospora*; Pennsylvania, Charter Oak, on *Pinus strobus*, 26 Nov. 1927, L.O. Overholts, P. Spaulding, BPI 632682 as *Ophionectria scolecospora*; New York, Alder Creek, on *Pinus strobus*, 08 Aug. 1935, J.R. Hansbrough, BPI 632684 as

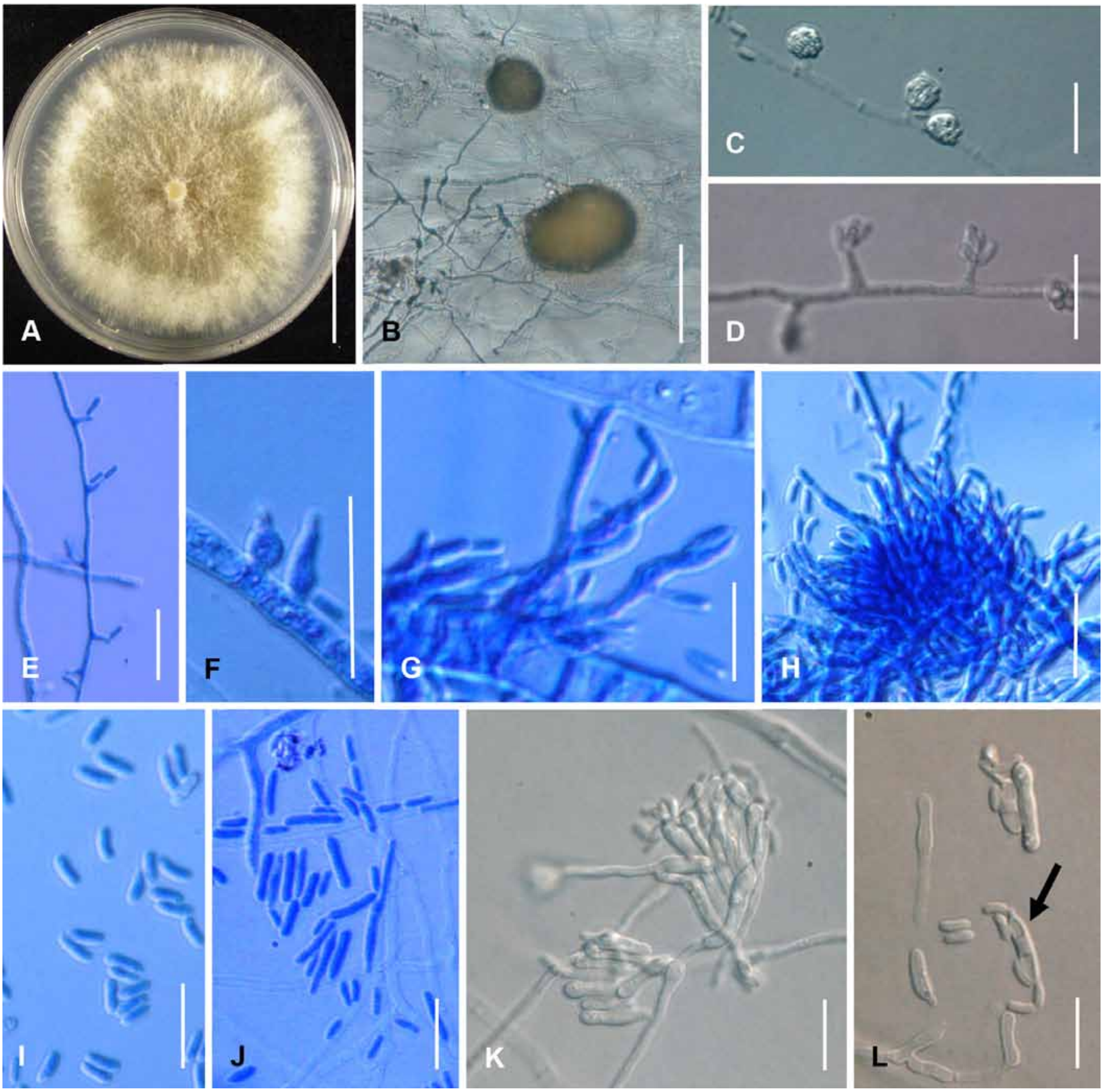

Fig. 142A–L. Anamorph of *Pleonectria strobi* in culture. A. Cultures after 7 d at 25 °C on PDA; B. Conidial mass on SNA surface; C, D. Lateral phialidic pegs and conidial mass on SNA; E, F. Lateral phialidic pegs and conidia on SNA; G–H. Conidiophores and conidia on SNA; I. Young conidia on SNA; J. Young and mature conidia on SNA; K. Germinating mature conidia on SNA; L. Budding mature conidia (black arrow) on SNA. Scale bars: A = 3 mm; B = 50 µm; C, E = 20 µm; D, F–L = 10 µm.

Ophionectria scolecospora; New Hampshire, Marlow, Honey Brook State Forest, on *Pinus strobus*, 18 Jul. 1935, H.G. Eno, BPI 632685 as *Ophionectria scolecospora*; New York, Sandy Creek, on *Pinus strobus*, 12 Sep. 1935, P. Spaulding, BPI 632686 as *Ophionectria scolecospora*; Pennsylvania, Stone Creek, Huntingdon Co. near, on *Pinus strobus*, 19 Feb. 1933, L.O. Overholts, R.W. Davidson, BPI 632687 as *Ophionectria scolecospora*; North Carolina, Highlands, on *Pinus strobus*, 19 Aug. 1933, V.K. Charles, BPI 632688 as *Ophionectria scolecospora*; New York, Alcove, on *Pinus strobus*, Feb. 1892, C.L. Shear, BPI 632689 as *Ophionectria scolecospora*; Pennsylvania, State College, on *Pinus strobus*, 28 Oct. 1918, L.O. Overholts, BPI 632789 as *Ophionectria scolecospora*; Virginia, Shenandoah National Forest, Augusta Co., on *Pinus strobus*, 15 Sep., 1928, R.G. Pierce, BPI 632791 as *Ophionectria scolecospora*; Massachusetts, Hamilton, on *Pinus flexilis*, 19 Aug. 1932, J.R. Hansbrough, BPI 632780 as *Scoleconectria scolecospora*; Connecticut, Windsor. alt. 100 ft., on *Pinus strobus*, 28 Apr. 1935, H.G. Eno, BPI 632553 as *Scoleconectria scolecospora*; New York, Rhinecliff, on *Pinus strobus*, 12 Dec. 1931, E.P. Felt, BPI 632555 as *Scoleconectria scolecospora*; Pennsylvania, on *Pinus strobus*, 20 Sep. 1916, E.F. Pierce, BPI 632557 as *Scoleconectria scolecospora*; Rhode Island, Potowonut, on *Pinus strobus*, 07 Oct. 1931, G.G. Hahn, T.T. Ayers, BPI 632559 as *Scoleconectria scolecospora*; New York, Canadice, on *Pinus strobus*, 02 Aug. 1935, J.R. Hansbrough, BPI 632560 as *Scoleconectria scolecospora*; West Virginia, on *Pinus strobus*, Sep. 1923, Korstien, BPI 632561 as *Scoleconectria scolecospora*; Vermont, Dummerston, on *Pinus strobus*, 10 May 1937, T.J. Grant, J.R. Hansbrough, BPI 632562 as *Scoleconectria scolecospora*; New York, Norwich, on *Pinus strobus*, 25 Apr. 1933, R.W. Davidson, BPI 632563 as *Scoleconectria scolecospora*; Maryland, Grantsville, on *Pinus strobus* (*Cronartium ribicola*?), 05 May 1944, R.G. Pierce, BPI 632564A as *Scoleconectria scolecospora*; Maryland, Grantsville. S, on *Pinus strobus*, 05 May 1944, R.G. Pierce , BPI 632564B as *Scoleconectria scolecospora*; Ohio, Wooster, on *Pinus strobus*, 23 Feb. 1917, D.C. Babcock, BPI 632565 as *Scoleconectria scolecospora*; Pennsylvania, Pine Grove, on *Pinus strobus*, 02 Feb. 1936, L.O. Overholts, BPI 632569 as *Scoleconectria scolecospora*; Ohio, Reynaldsburg, on *Pinus strobus*, Nov. 1945, R.U. Swingle, BPI 632570 as *Scoleconectria scolecospora*; Michigan, James Lake Camp, on *Pinus strobus*, May 1936, Toole, BPI 632571 as *Scoleconectria scolecospora*; Indiana, Hennysville, on *Pinus strobus*, 20 Feb. 1936, R.M. Lindgren, BPI 632572 as *Scoleconectria scolecospora*; North Carolina, Biltmore, Asheville, on *Pinus strobus*, Aug. 1936, G.H. Hepting, BPI 632573 as *Scoleconectria scolecospora*; Pennsylvania, Lancaster, on *Pinus strobus*, 20 Sep. 1916, G.F. Pierce, BPI 632574 as *Scoleconectria scolecospora*; Ohio, Wooster, on *Pinus* *strobus*, 23 Feb. 1917, D.C. Babcock, BPI 632575 as *Scoleconectria scolecospora*; North Carolina, Newland, on *Pinus strobus*, 13 Aug. 1942, H.A. Whitman, BPI 632577 as *Scoleconectria scolecospora*; New York, Woodgate, on *Pinus strobus*, 15 Jun. 1927, J.R. Hansbrough, BPI 632777 as *Scoleconectria scolecospora*; New Hampshire, Waterville, on *Pinus strobus*, 21 Jul. 1932, J.R. Hansbrough, BPI 632796 as *Scoleconectria scolecospora*; New York, Upper Syranac Lake, on *Pinus strobus*, 08 Sep. 1932, J.R. Hansbrough, BPI 632797 as *Scoleconectria scolecospora*; New Hampshire, Littleton, on *Pinus strobus*, 23 Jul. 1932, J.R. Hansbrough, BPI 632798 as *Scoleconectria scolecospora*; Connecticut, Windsor, Loomis Forest, on *Pinus strobus*, 21 Jan. 1926, G.P. Clinton, BPI 632800 as *Scoleconectria scolecospora*; Connecticut, Woodbridge, Burnt Swamp, on *Pinus strobus*, G.P. Clinton, BPI 632801 as *Scoleconectria scolecospora*; New Hampshire, Keene, Gilsum Rd., on *Pinus strobus*, 04 Oct. 1927, G.P. Clinton, BPI 632802 as *Scoleconectria scolecospora*; New Hampshire, Wolfboro, on *Pinus strobus*, 31 Aug. 1932, J.R. Hansbrough, BPI 632803 as *Scoleconectria scolecospora*; New York, Wilmington, on *Pinus strobus*, 23 Aug. 1929, P. Spaulding, BPI 632804 as *Scoleconectria scolecospora*; Connecticut, Bethany, on *Pinus strobus*, 02 Jun. 1933, J.R. Hansbrough, BPI 632805 as *Scoleconectria scolecospora*; Minnesota, St. Croix River, on *Pinus strobus*, Jun, L.B. Ritter, BPI 632806 as *Scoleconectria scolecospora*; Maine, Bar Harbor, on *Pinus strobus*, 11 Jun. 1937, A.E. Brower, BPI 632807 as *Scoleconectria scolecospora*; Minnesota, Duluth, on *Pinus strobus*, 12 Jul. 1932, L.B. Ritter, BPI 632808 as *Scoleconectria scolecospora*; Maine, Bingham, on *Pinus strobus*, 05 May 1938, Hahn, C K. Goodling, BPI 632809 as *Scoleconectria scolecospora*; Rhode Island, Potowonut, on *Pinus strobus*, 04 Oct, 1931, T.T. Ayers, G.G. Hahn, BPI 632810 as *Scoleconectria scolecospora*; Rhode Island, Potowonut, on *Pinus strobus*, 21 Aug. 1930, T.T. Ayers, G.G. Hahn, BPI 632811 as *Scoleconectria scolecospora*; Massachusetts, on *Pinus strobus*, 11 Feb. 1936, L.W. Hodgkins, BPI 632812 as *Scoleconectria scolecospora*; North Carolina, Cove Creek, Smoky Mtn. National Park, on *Pinus strobus*, 13 Mar. 1947, H. Doyle, BPI 632813 as *Scoleconectria scolecospora*; Maine, Athens, on *Pinus strobus*, 04 May 1938, C.K. Goodling, BPI 632814 as *Scoleconectria scolecospora*; Maine, Millinocket, on *Pinus strobus*, 22 Jul. 1937, A.E. Brower, BPI 632815 as *Scoleconectria scolecospora*; Connecticut, Hamden, on *Pinus strobus*, 28 Oct. 1936, T.T. Ayers, BPI 632816 as *Scoleconectria scolecospora*; Connecticut, Storr, on *Pinus strobus*, 11 Jul. 1938, Hahn, Goodling, BPI 632817 as *Scoleconectria scolecospora*; New Hampshire, N. Conway, on *Pinus strobus*, H.H. York, BPI 632818 as *Scoleconectria scolecospora*; Pennsylvania, Mont Alto, on *Pinus strobus*, 02 Jan. 1937, J.C. Kase, BPI 632819 as *Scoleconectria scolecospora*; Michigan, Fife Lake, on *Pinus strobus*, 09 Jul. 1935, D.V. Baxter, BPI 632820 as *Scoleconectria scolecospora*; Pennsylvania, Centre Co., Pine Hall, on *Pinus strobus*, 22 Oct. 1944, L.O. Overholts, BPI 859483 as *Scoleconectria scolecospora*; Maine, Winthrop Co., on *Pinus strobus*, 21 May 1936, T.T. Ayers, BPI 859485 as *Scoleconectria scolecospora*; North Carolina, Highlands, on *Pinus strobus*, 17 Aug. 1933, L.O. Overholts, BPI 859486 as *Scoleconectria scolecospora*; Massachusetts, Amherst, on *Pinus strobus*, 23 Apr. 1934, T.T. Ayers, BPI 859487 as *Scoleconectria scolecospora*; Pennsylvania, Clarion Co., Cook Forest, on *Pinus strobus*, 19 May 1929, L.O. Overholts, BPI 859489 as *Scoleconectria scolecospora*; Pennsylvania, Huntingdon Co., Ross Run, on *Pinus strobus*, 01 Mar. 1931, L.O. Overholts, BPI 859491 as *Scoleconectria scolecospora*; New Hampshire, North Conway, on *Pinus strobus*, 03 May 1918, L.O. Overholts, BPI 859497 as *Scoleconectria scolecospora*; Pennsylvania, Huntingdon Co., Charter Oak, on *Pinus strobus*, 14 Jun. 1920, Overholts, BPI 859498 as *Scoleconectria scolecospora*; Pennsylvania, Greenwood Furnace, on *Pinus strobus*, 18 Oct. 1919, L.O. Overholts, BPI 859500 as *Scoleconectria scolecospora*; New Hampshire, Lisbon, on *Pinus strobus*, 06 May 1918, L.O. Overholts, BPI 859540 as *Scoleconectria scolecospora*; Pennsylvania, Centre Co., Barrens, State College, on *Pinus strobus*, 30 Oct. 1918, P.O'Donnell, BPI 859541 as *Scoleconectria scolecospora*; Pennsylvania, Huntingdon Co., Charter Oak, on *Pinus strobus*, 25 Apr. 1919, L.O. Overholts, M.F. Overholts, BPI 859542 as *Scoleconectria scolecospora*; Pennsylvania, Lamar, Forestry Camp, on *Pinus strobus*, 25 Jun. 1919, L.O. Overholts, BPI 859543 as *Scoleconectria scolecospora*; Pennsylvania, Huntingdon Co., Laurel Run, on *Pinus strobus*, 23 Mar. 1930, L.O. Overholts, BPI 862167 as *Scoleconectria scolecospora*; Pennsylvania, Huntingdon Co., Laurel Run, on *Pinus strobus*, 23 Mar. 1930, L.O. Overholts, BPI 862404 as *Scoleconectria scolecospora*; Pennsylvania, Cooksburg, on *Pinus strobus*, 13 Aug. 1929, L.O. Overholts, BPI 867620 as *Scoleconectria scolecospora*; Massachusetts, Mt. Toby, on *Pinus strobus*, 29 Nov. 1934, T.T. Ayers, BPI 867621 as *Scoleconectria scolecospora*; Pennsylvania, Lackawanna Co., Fleetville, on *Pinus strobus*, Jul. 1937, Richmond, BPI 867622a as *Scoleconectria scolecospora*; Pennsylvania, Huntingdon Co., Whipple Dam, on *Pinus strobus*, 10 Jul. 1939, W.L. White, BPI 867623 as *Scoleconectria scolecospora*; Pennsylvania, Ingleby, on *Pinus strobus*, 13 Jul. 1929, L.O. Overholts, BPI 867624 as *Scoleconectria scolecospora*; Pennsylvania, Huntingdon Co., Pennsylvania Furnace, on *Pinus strobus*, 06 Apr. 1923, C.R. Orton, BPI 867625 as *Scoleconectria scolecospora*; Pennsylvania, Huntingdon Co., Miller Plantation, on *Pinus strobus*, 11 Apr. 1928, L.O. Overholts, BPI 867626 as *Scoleconectria scolecospora*; Pennsylvania, Clarion Co., Cook Forest, on *Pinus strobus*, 19 May 1929, L.O. Overholts, BPI 867627 as *Scoleconectria scolecospora*; Pennsylvania, Greenwood Furnace, on *Pinus strobus*, 29 Oct. 1921, L.O. Overholts, BPI 867628 as *Scoleconectria scolecospora*; Pennsylvania. Greenwood Furnace, on *Pinus strobus*, 18 Oct. 1919, L.O. Overholts, BPI 867629 as *Scoleconectria scolecospora*; Pennsylvania, Huntingdon Co., Charter Oak, on *Pinus strobus*, 14 Jun. 1920, Overholts, BPI 867630 as *Scoleconectria scolecospora*; Pennsylvania, Centre Co., State College, on *Pinus strobus*, 28 Oct. 1918, C.R. Orton, L.O. Overholts, BPI 867631 as *Scoleconectria scolecospora*; Pennsylvania, Allegheny Co., Allison Park, on *Pinus strobus*, 06 Oct. 1921, L.O. Overholts, BPI 867632 as *Scoleconectria scolecospora*; New York, near Ithaca, on *Pinus strobus*, 10 Jun. 1979, A.Y. Rossman, NY, culture CBS 125122 = A.R. 1425.

Notes: Many specimens of *Pleonectria strobi* was previously identified as *Nectria cucurbitula*, now a nomenclatural synonym of *Pleonectria cucurbitula*, based on the long-fusiform, multiseptate ascospores budding within the asci, pycnidial anamorph, and occurrence on conifers. In this study, we segregate *P. strobi* from *P. cucurbitula* by subtle morphology, phylogenetic data, and host. Our phylogenetic tree shows that *P. cucurbitula* and *P. strobi* are closely related but their separation is supported by high BI PP, ML BP, and MP BP values (Figs 1, 2). The morphology of the teleomorph and anamorph in the natural environment of these species is identical. However, by observing the shape of lateral phialidic pegs of the anamorph in culture, these species can be segregated. In *P. strobi* the lateral phialidic pegs are sometimes flask-shaped while in *P. cucurbitula* they are absent (Fig. 142F). Host is the easiest characteristic that distinguishes these two species. Interestingly *P. strobi* occurs only on species in *Pinus* subgenus *Strobus* while *P. cucurbitula* is found on species in *Pinus* subgenus *Pinus* (Strauss & Doerksen 1990; Wang & Szmidt 1993; reviewed in Price *et al*., 1998).

For the holotype of *P. strobi*, we selected the NY specimen collected by Clark T. Rogerson because the specimen is in excellent condition with abundant ascomata and pycnidia and the culture obtained from that specimen is alive even though it was isolated almost 40 years ago. Although the host was originally said to be *Pinus resinosa* in subgenus *Pinus,* we were able to re-identify the host using several needles present in the packet as *Pinus strobus.*

Pleonectria virens (Harkn.) Hirooka, Rossman & P. Chaverri, **comb. nov.** MycoBank MB519721. Figs 143–145.
Basionym: *Thyronectria virens* Harkn., in Ellis & Everhart, North Amer. Pyrenomyc. p. 92. 1892.
Anamorph: zythiostroma-like.

Teleomorph on natural substrata: *Mycelium* not visible around ascomata or on host. *Stromata* immersed in substrate, up to 1.5 mm high and 2.5 mm diam, greenish yellow, KOH– and LA–, cells forming prosenchymatous. *Ascomata* semi-immersed in stroma or immersed only at base, aggregated in groups of 2–35, subglobose to globose, 270–410 µm high × 210–400 µm diam, not collapsing when dry, sometimes with only a depressed apical region, apical region slightly darker, KOH+ slightly purple, LA+ slightly yellow, covered by abundant yellowish green to dark green scurf. *Ascomatal surface cells* forming *textura globulosa* sometimes including bright yellow scurf, 3–10 µm diam, with pigmented, irregularly, *ca.* 1.0 µm thick walls. *Ascomatal wall* 20–70 µm thick, of two regions: outer region 20–50 µm thick, intergrading with stroma, cells forming *textura globuosa* to *t. angularis*, walls pigmented, about 1.5 µm thick; inner region 10–20 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* clavate, 55–80 × 10–20 µm, with inconspicuous ring at apex, 8-spored, ascospores biseriate. *Ascospores* hyaline, narrowly ellipsoidal to rarely fusiform, muriform, with 4–6 transverse septa and one longitudinal septum, (12.7–)15.9–20.3(–22.8) × (5.7–)6.4–8.2(–9.3) µm (*n* = 92), smooth.

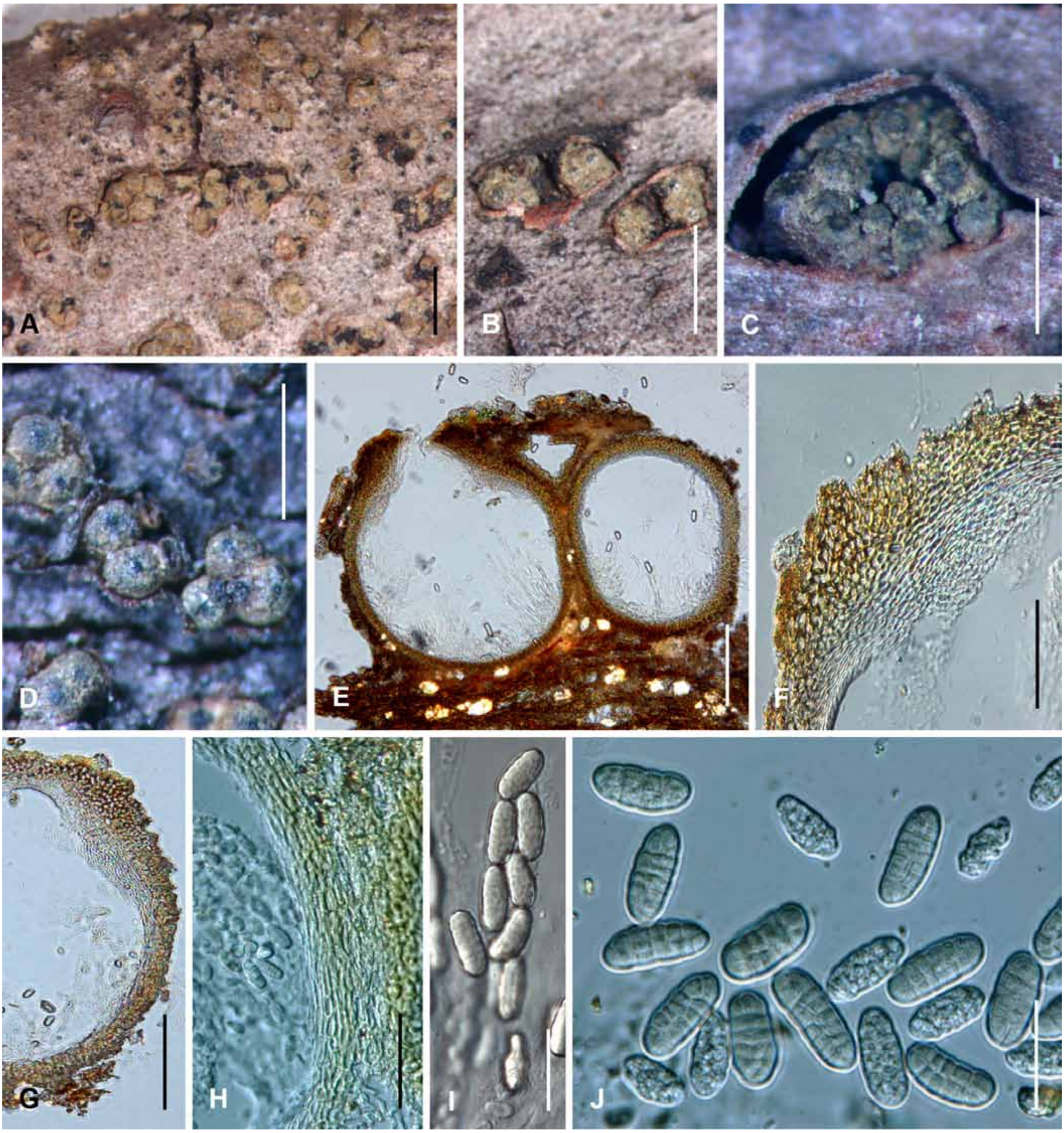

Fig. 143A–J. *Pleonectria virens* on natural substrata (teleomorph). A–D. Perithecia on natural substrata; E. Median section of perithecia on natural substrata; F. Median section of perithecial apex; G, H. Median section of perithecial walls; I. Ascus; J. Ascospores. Scale bars: A–D = 1 mm; E, G = 100 µm; F, H = 30 µm; I, J = 20 µm.

Anamorph in culture: After 7 d at 25 °C, colonies 9–17 mm (average 14 mm) diam. *Colony surface* cottony with aerial mycelium, white to whitish yellow; *aerial mycelium* sparse, yellow, sporodochial conidial masses produced after 3 wk; *reverse* whitish yellow in centre and white at margin. *Odour* on PDA slightly putrid. Sporulation on SNA from *lateral phialidic pegs* abundant, enteroblastic, monophialidic, ellipsoidal, slightly tapering toward tip or flask-shaped, 2.7–5.4 µm long, 1.3–3.0 µm wide at base. *Conidiophores* rarely formed, unbranched, sometimes verticillate, 1(–2)-branched, becoming loosely to moderately densely branched, 11.6–31.1 µm long, 1.2–1.8 µm wide at base. *Conidiogenous cells* enteroblastic, monophialidic, cylindrical, slightly tapering toward tip or narrowly flask-shaped, 4.5–12.6 µm long, 1.3–2.5 µm wide at base. *Young conidia* formed from monophialides on aerial, submerged, or repent hyphae, formed abundantly on slimy heads, ellipsoidal, oblong, cylindrical to allantoid, hyaline, smooth, slightly curved, rounded at both endss, non-septate, (2.6–)3.3–4.3(–4.9) × (0.8–)1.0–1.4(–1.7) µm (*n* = 50). *Mature conidia* swollen, 0-septate, ellipsoidal to oblong with irregularly swollen at both ends or clavate, hyaline, smooth, straight or slightly curved, (6.7–)8.4–9.1(–10.4) × (2.1–)2.5–2.8(–3.1) µm (*n* = 50). *Pycnidia* produced in PDA and SNA after 1–2 month (A.R. 4558). *Chlamydospores* in intercalary in hyphae, globose to subglobose, very rare, smooth, 7–10 µm. *Ascomata* not produced in culture.

Distribution: Europe (France), North America (Canada, USA).

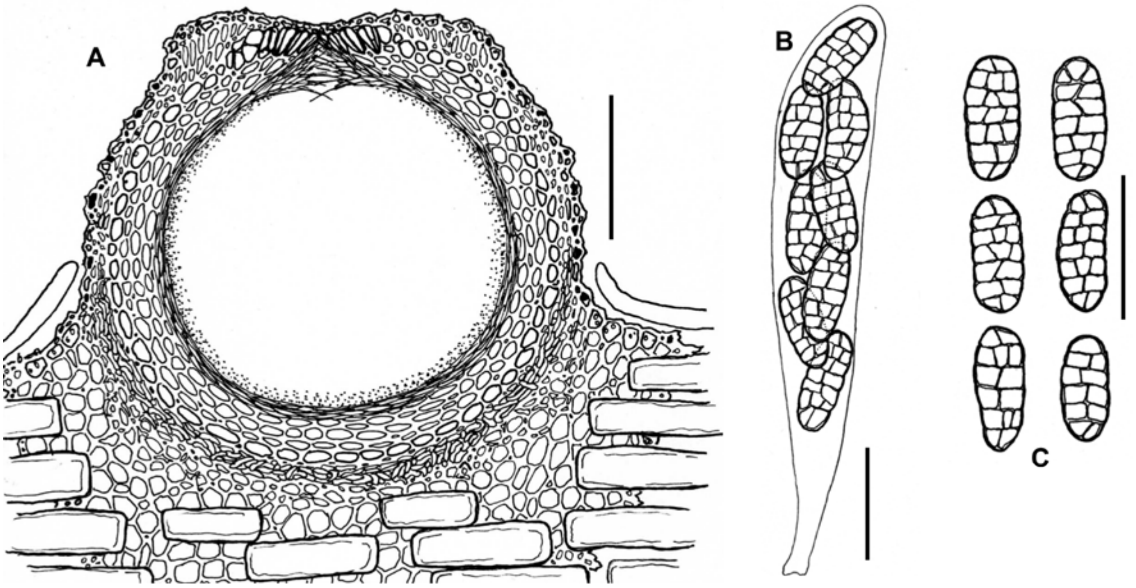

Fig. 144 A–C. *Pleonectria virens* on natural substrata (A–C teleomorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores. Scale bars: A = 100 µm; B, C = 20 µm.

Habitat: On dead woody substrata including *Carya* sp., *Crataegus* sp. *Fraxinus* sp., *Ostrya virginiana*, *Rhus diversiloba*, *Rhus glabra, Rhus* sp., *Symphoricarpos occidentalis*.

Lectotype of Thyronectria virens *designated by Seeler (1940b)*: **USA**, California, Sausalito, on *Rhus diversiloba*, H.W. Harkness, Ellis & Everhart, North American Fungi Second Series no. 1549 as *Valsonectria virens*, FH-not examined; isolectotypes examined: BPI 631193 and bound exsiccati.

Additional specimens and isolates examined: **Canada**, Ontario, London, on *Fraxinus* sp, Feb. 1890, J. Dearness, BPI 631961 as *Calonectria chlorinella*; Ontario, London, on *Fraxinus* sp., Feb. 1890, J. Dearness, Ellis & Everhart, North American Fungi Second Series no. 2546, BPI-bound exsiccati. **France**, on dead twigs, Aug. 2008, A. Gardiennet, BPI 881068 = C.L.L. 7181 = A.R. 4558. **USA**, California, Sausalito, on *Rhus diversiloba*, BPI 553331; California, San Francisco, on *Rhus diversiloba*, Jun. 1881, H.W. Harkness, BPI 553301; Connecticut, New Haven, on *Rhus glabra*, R. Thaxter, BPI 553332 as *Nectria zanthoxyli*; Connecticut, New Haven, on *Rhus glabra*, Jan. 1927, J.F. Brenckle, Ellis & Everhart, North American Fungi Second Series no. 2751, NY; Massachusetts, Arlington Heights, on *Rhus* sp., 05 Sep. 1901, J.B. Rorer, BPI 553330 as *Nectria zanthoxyli*; Kansas, Smoky Hill, Geary, 07 Mar. 1936, T.E. Brooks, BPI 553004 as *Nectria pyrrhochlora*; Ohio, on *Carya* sp., A.P. Morgan, BPI 553009 as *Nectria pyrrhochlora*; Ohio, on *Ostrya virginiana*, 05 Mar. 1904, A.P. Morgan, BPI 552831 as *Nectria pyrrhochlora*; South Dakota, on *Symphoricarpos occidentalis*, Jan. 1927, J.F. Brenckle, NY.

Notes: Rossman *et al.* (1999) treated *Pleonectria virens* (≡ *Thyronectria virens*) as a synonym of *Pleonectria zanthoxyli*. Based on our type studies of these fungi, we consider these two species to be distinct. *Pleonectria virens* has ascomata that are semi-immersed in stroma or immersed only at base and ascospores shorter than those of *P. zanthoxyli*, and generally occurs on *Crataegus* and *Rhus* (Figs 143A–D, 144A). In culture, *P. virens* resembles *P. zanthoxyli,* but the average colony growth rate after 7 d at 25 °C on PDA was 14 mm in *P. virens* and 67 mm in *P. zanthoxyli*. These differences are supported by our six-loci phylogeny (Figs 1, 2).

Although the anamorph of *P. virens* in the natural environment was not observed, a pycnidial anamorph developed on PDA and SNA. The pycnidia possess long sterile hyphae mixed with phialides similar to those produced by *P. austroamericana*, *P. pinicola*, and *P. zanthoxyli* (Fig. 145M, N). These three species appear to be closely related based on morphological characteristics of the teleomorph as well as phylogenetic inference.

According to the protologue of *T. virens*, the author observed three specimens of this species from California, Connecticut, and Canada.The California and Connecticut specimens occurred on *Rhus* spp., while the host of the Canadian specimen is on *Fraxinus* sp. We designate BPI 553301 from California as the lectotype of *T. virens*.

Pleonectria zanthoxyli (Peck) Hirooka, Rossman & P. Chaverri, **comb. nov.** (as '*xanthoxyli*'). MycoBank MB519722. Figs 146–148.

Basionym: *Valsa xanthoxyli* Peck, Annual Rep. New York State Mus. 31: 49. 1879.

≡ *Pseudovalsa xanthoxyli* (Peck) Sacc., Syll. Fung. 2: 137. 1883
≡ *Fenestella xanthoxyli* (Peck) Sacc., Syll. Fung. 2: 332. 1883
≡ *Thyronectria xanthoxyli* (Peck) Ellis & Everh., North Amer. Pyrenomyc. p. 92. 1892
≡ *Nectria xanthoxyli* (Peck) Rossman, Mem. New York Bot. Gard. 49: 264. 1989.

Anamorph: zythiostroma-like.

Teleomorph on natural substrata: *Teleomorph on natural substrata*: *Mycelium* not visible around ascomata or on host. *Stromata* immersed in substrate, up to 1.5 mm high and 2.5 mm diam, greenish yellow, KOH– and LA–, cells forming prosenchymatous. *Ascomata* immersed in stromata, scattered to aggregated in groups of 3–12, subglobose to globose, 200–400 µm high × 210–410 µm diam, constricted at black papilla, KOH– and LA–, covered by abundant yellowish green to dark green scurf. *Ascomatal surface cells* forming *textura globulosa,* sometimes including bright yellow scurf, 5–10 µm diam, with pigmented, irregularly *ca.* 1.0 µm thick walls. *Ascomatal wall* 20–40 µm thick, of two regions: outer region 10–30 µm thick, intergrading with stroma, cells forming *textura globuosa* to *t. angularis*, walls slightly pigmented, about 1.0 µm thick; inner region 5–10 µm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* clavate, 60–85 × 15–20 µm, with inconspicuous ring at apex, 8-spored, ascospores biseriate above, uniseriate below, or sometimes uniseriate throughout. *Ascospores* hyaline, narrowly ellipsoidal to allantoid, muriform, with 5–7 transverse septa and one longitudinal septum, (17.8–)19.4–23.6(–26.6) × (5.4–)7.0–8.8(–9.7) µm (*n* = 133), smooth.

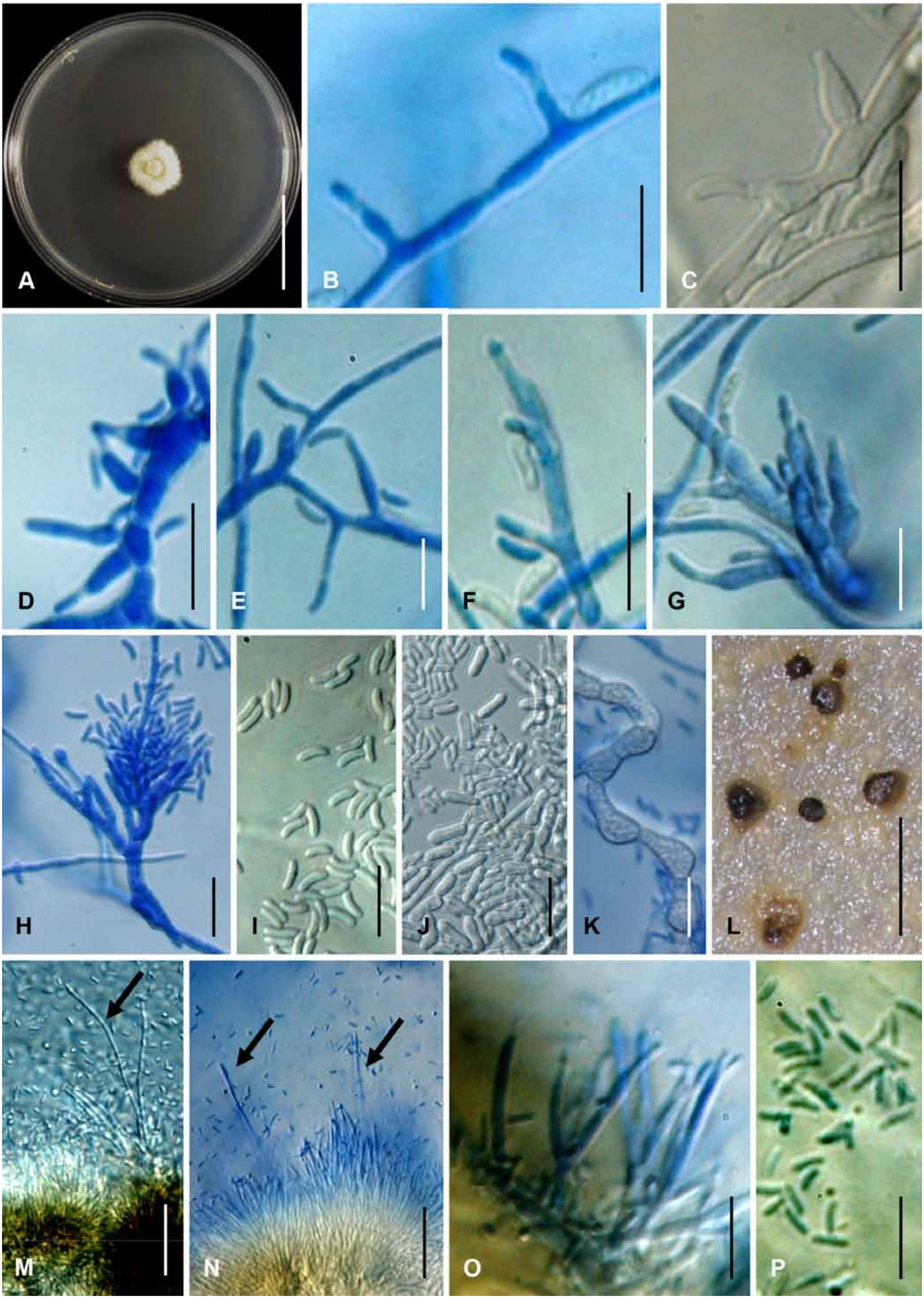

Fig. 145A–P. Anamorph of *Pleonectria virens* in culture. A. Cultures after 7 d at 25 °C on PDA; B–D. Lateral phialidic pegs and conidia on SNA; E–H. Conidiophores and conidia on SNA; I. Young conidia on SNA; J. Mature conidia on SNA; K. Chlamydospores on SNA; L. Pycnidia on SNA; M, N. Conidiophores and sterile hyphae (black arrows) of pycnidia on SNA; O. Conidiophores of pycnidia on SNA; P. Conidia of pycnidia on SNA. Scale bars: A = 3 mm; B–K, O, P = 10 µm; L = 1 mm; M, N. = 50 µm.

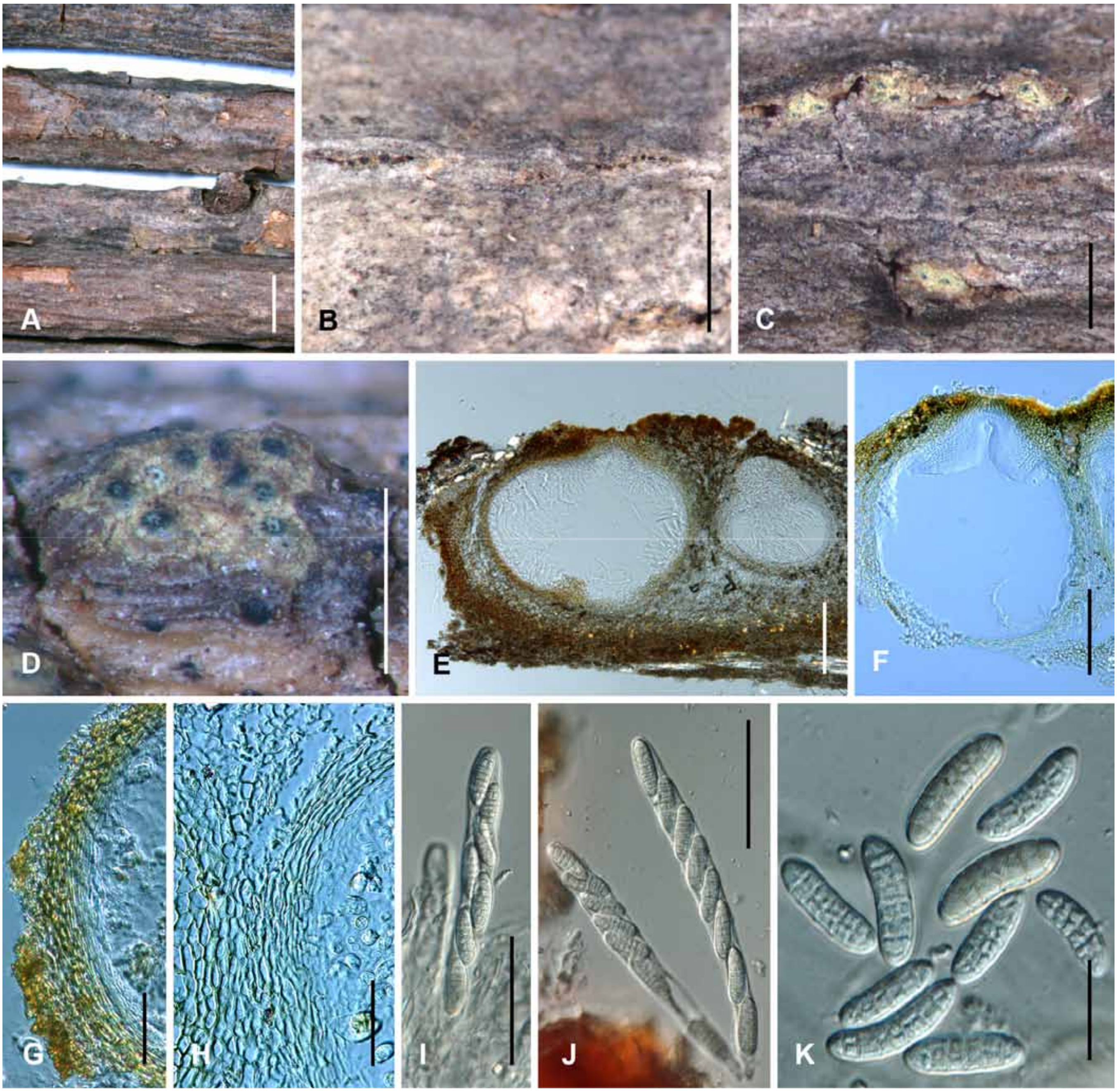

Fig. 146A–K. *Pleonectria zanthoxyli* on natural substrata (teleomorph). A–D. Perithecia on natural substrata; E, F. Median section of perithecia on natural substrata; G, H. Median section of perithecial walls; I, J. Asci; K. Ascospores. Scale bars: A = 5 mm; B = 1 mm; C, D = 500 µm; E, F = 100 µm; G–J = 50 µm; K = 20 µm.

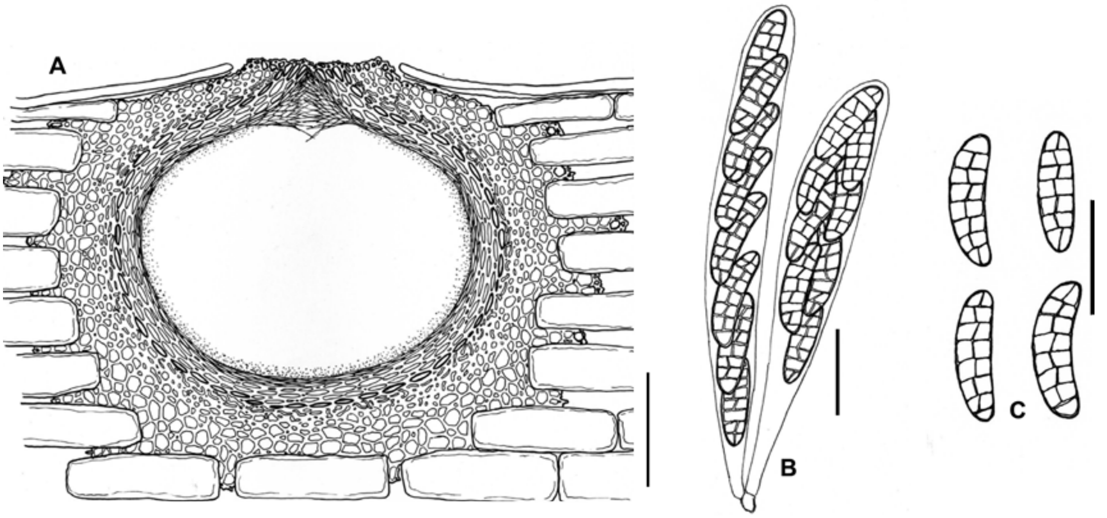

Fig. 147A–C. *Pleonectria zanthoxyli* on natural substrata (A–C teleomorph). A. Median section of mature perithecium; B. Ascus; C. Ascospores. Scale bars: A = 100 µm; B, C = 20 µm.

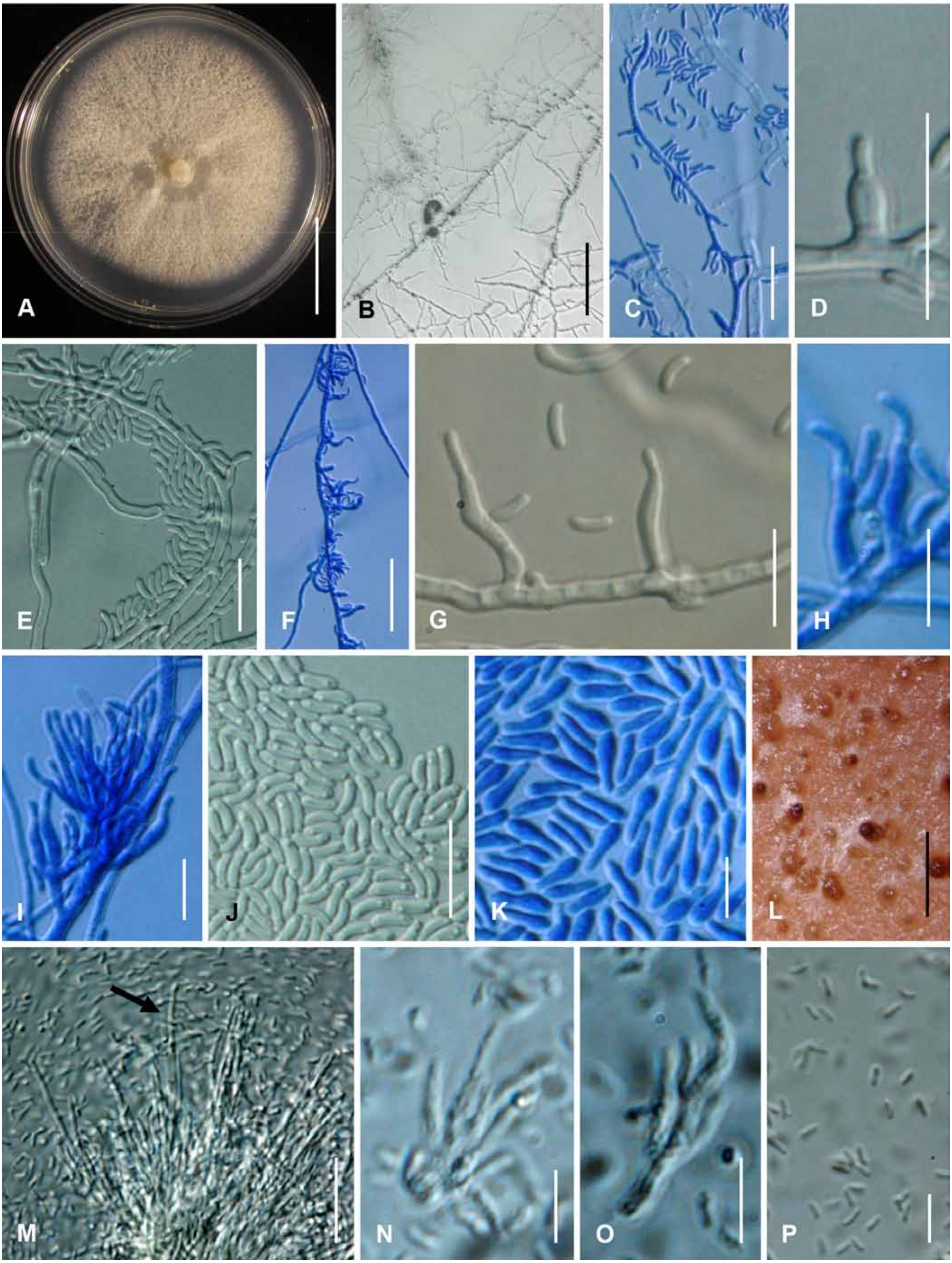

Fig. 148A–P. Anamorph of *Pleonectria zanthoxyli* in culture. A. Cultures after 7 d at 25 °C on PDA; B. Conidial mass on SNA surface; C–E. Lateral phialidic pegs and conidia on SNA; F–I. Conidiophores and conidia on SNA; J. Young conidia on SNA; K. Mature conidia on SNA; L. Pycnidia on SNA; M. Conidiophores and sterile hyphae (black arrows) of pycnidia on SNA; N, O. Conidiophores of pycnidia on SNA; P. Conidia of pycnidia on SNA. Scale bars: A = 3 mm; B = 50 µm; C, F, M = 20 µm; D, E, G–K, N–P = 10 µm; L = 1 mm.

Anamorph in culture: After 7 d at 25 °C, colonies 54–85 mm (average 67 mm) diam. *Colony surface* cottony with aerial mycelium, whitish yellow; *aerial mycelium* developed, rarely small, yellow, sporodochial conidial masses produced after 2 wk; *reverse* whitish yellow to slightly glaucous in centre and white at margin. *Odour* on PDA slightly fruity. Sporulation on SNA from *lateral phialidic pegs* abundant, enteroblastic, monophialidic, ellipsoidal, slightly tapering toward tip or flask-shaped, 2.7–6.5 µm long, 1.4–2.6 µm wide at base. *Conidiophores* rarely formed, unbranched, sometimes verticillate, 1(–2)-branched, becoming loosely to moderately densely branched, 9.6–40.9 µm long, 1.3–4.3 µm wide at base. *Conidiogenous cells* enteroblastic, monophialidic, cylindrical, slightly tapering toward tip or narrowly flask-shaped, 3.3–11.9 µm long, 1.1–3.1 µm wide at base. *Young conidia* formed from monophialides on aerial, submerged, or repent hyphae, formed abundantly on slimy heads, ellipsoidal, to cylindrical, rarely allantoid, hyaline, smooth, curved, rounded at both ends, non-septate, (3.5–)4.2–5.2(–6.4) × (1.1–)1.4–2.0(–2.5) µm (*n* = 150). *Mature conidia* swollen, 0-septate, ellipsoidal to oblong with irregularly swollen at both ends or clavate, hyaline, smooth, straight or slightly curved, (7.1–)8.0–10.0(–12.1) × (2.0–)2.3–3.1(–3.7) µm (*n* = 150). *Pycnidia* produced on SNA and PDA after 1–2 month (A.R. 4280). *Chlamydospores* and *ascomata* not produced in culture.

Habitat: On dead woody substrata including *Crataegus* sp., *Peraphyllum ramosissimum*, *Zanthoxylum americanum*, *Zanthoxylum* sp.

Distribution: Europe (France), North America (Canada, USA), South America (Brazil).

Lectotype of Valsa xanthoxyli designated herein: **USA**, New York, West Troy, on *Zanthoxylum americanum*, Oct. 1878, C.H. Peck, **Lectotype** NYS 3611, **Isolectotype** NYS 3438).

Additional specimens and isolates examined: **Brazil**, on dead twigs, 1923, J. Rick, BPI 553328; **Canada**, Ontario, London, on *Zanthoxylum americanum*, J. Deamess, BPI 553329; Ontario, London, on *Zanthoxylum americanum*, Jun. 1892, J. Deamess, BPI 553334; on *Zanthoxylum americanum*, J. Deamess, BPI 553335; Ontario, London, on *Zanthoxylum americanum*, Jul. 1895, J. Deamess, BPI 553336; Ontario, London, on *Zanthoxylum americanum*, Jul. 1895, J. Deamess, NY. **France**, Puymardier 79360, on *Crataegus* sp., 24 Apr. 2006, C. Lechat CLL 658, BPI 878445, Culture CBS 126113 = A.R. 4280; Availles sur Chize, on *Crataegus* sp., C. Lechat C.L.L. 7132, LIP Culture CBS 124736 = A.R. 4616. **USA**, Maryland, Beltsville, on dead bark, 20 Apr. 2009, Y. Hirooka, BPI 881069, culture CBS 129157 = Y.H. 09-03 ; Michigan, Ann Arbor, on *Zanthoxylum* sp., Jan. 1922, L.H. Leonian, W.A. Archer, BPI 553333; Iowa, Cebar Falls, on *Peraphyllum ramosissimum*, 1918, J. Parish, NY; South Dakota, on *Zanthoxylum americanum*, 05 Jun. 1924, Brenckle, Stevens, NY; South Dakota, on *Zanthoxylum americanum*, Jul. 1927, Stevens, NY; New York, Albany Co., on *Zanthoxylum americanum*, 04 Nov. 1969, C.T. Rogerson, NY; New York, Albany Co., on *Zanthoxylum americanum*, 29 Nov. 1969, C.T. Rogerson, NY; Wisconsin, Sauk Co, Aldo Leopold Reserve, on *Zanthoxylum* sp., 30 Sep. 1988, S.M. Huhndorf, NY.

Notes: *Pleonectria zanthoxyli* is a distinctive species in the genus *Pleonectria;* most ascomata are completely covered by yellowish green scurf and immersed in substrate (Figs 146B–H, 147A). Based on our phylogenetic analyses, this species falls in the genus *Pleonectria* (Figs 1, 2). Like *P. zanthoxyli*, *P. pyrrhochlora* and *P. virens* sometimes have ascomata immersed in substrate and muriform ascospores but *P. zanthoxyli* is distinctive in ascospore size and host. The anamorph of *P. zanthoxyli* in the natural environment was not observed in this study. After 3 wk in culture pycnidia occasionally developed that possess long sterile hyphae mixed with phialides (Fig. 148L, M). The anamorph of *P. austroamericana*, *P. pinicola*, and *P. virens* also has long sterile hyphae.

Pleonectria zanthoxyli was described by Peck (1879) without reference to any type specimen. Seeler (1940b) designated a Peck specimen preserved in NYS as the type, but he did not note the specimen number. In our type study, two potential type specimens were located at NYS: NYS 3611 and NYS 3438. Thus, we designate NYS 3611 as lectotype with the second specimen at NYS 3438 as isolectotype.

Excluded and Doubtful Species

Cosmospora proteae **(**Marinc., M.J. Wingf. & Crous) Hirooka, Rossman & P. Chaverri, **comb. nov.** MycoBank MB519724.
Basionym: *Nectria proteae* Marinc., M.J. Wingf. & Crous, in Marincowitz, Crous, Groenewald & Wingfield, CBS Biodiversity Ser. (Utrecht) 7: 74. 2008.
Anamorph: unknown.

Habitat: On twig litter of *Protea susannae (Proteaceae)*.

Distribution: Africa (South Africa, known only from the type collection).

Lectotype of Nectria proteae *designated here*: **Lectotype** Fig. 48 on p. 74 in Marincowitz *et al*. (2008), copy at BPI.

Notes: The holotype specimen of *Nectria proteae* (PREM 59562 = S.L. 505) was examined and determined to lack any ascomata resembling *Nectria*; a number of diaporthalean fungi are present. Therefore, the illustration in the protologue is here designated as lectotype. No culture exists. According to the original description, this species is similar to *Cosmopora* having small ascomata (< 300 µm), thin ascomatal walls (< 37 µm), and small ascospores < 15 µm long. From our observation of the holotype specimen, we expect that ascomata of this fungus colonise diaporthalean fungi, typical of the genus *Cosmospora*. Using the keys in Samuels *et al*. (1991) and Rossman *et al*. (1999), this fungus is similar to *Cosmospora meliopsicola* in geography and size of ascospores; however, *C. proteae* has narrower, smooth ascospores. Based on this evidence, a new combination is made herein.

Gyrostroma sinuosum Naumov, Bull. Soc. Mycol. Fr. 30: 386. 1914. Fig. 149.

Habitat: On bark of *Abies sibirica*.

Distribution: Europe (Russia, known only from the type collection).

Holotype of Gyrostroma sinuosum: **Russia**, Perm Territory, on bark of *Abies sibirica*, 14 Sep. 1911, **Holotype** VIZR 123.

Notes: In the original publication *Gyrostroma sinuosum,* type of the genus *Gyrostroma,* was listed at the beginning of section on nectria-like fungi suggesting a relationship with the *Hypocreales* and was included as the anamorph of nectria-like fungi by Seeler (1940b), Rossman (1989) and Rossman *et al*. (1999). *Gyrostroma sinuosum* is described as having sporodochial stroma, immersed ascomata, branching conidiophores, and non-septate conidia. Based on our examination of the holotype specimen, *G. sinuosum* is unlike any known hypocrealean species. It may perhaps be a member of the *Diaporthales*.

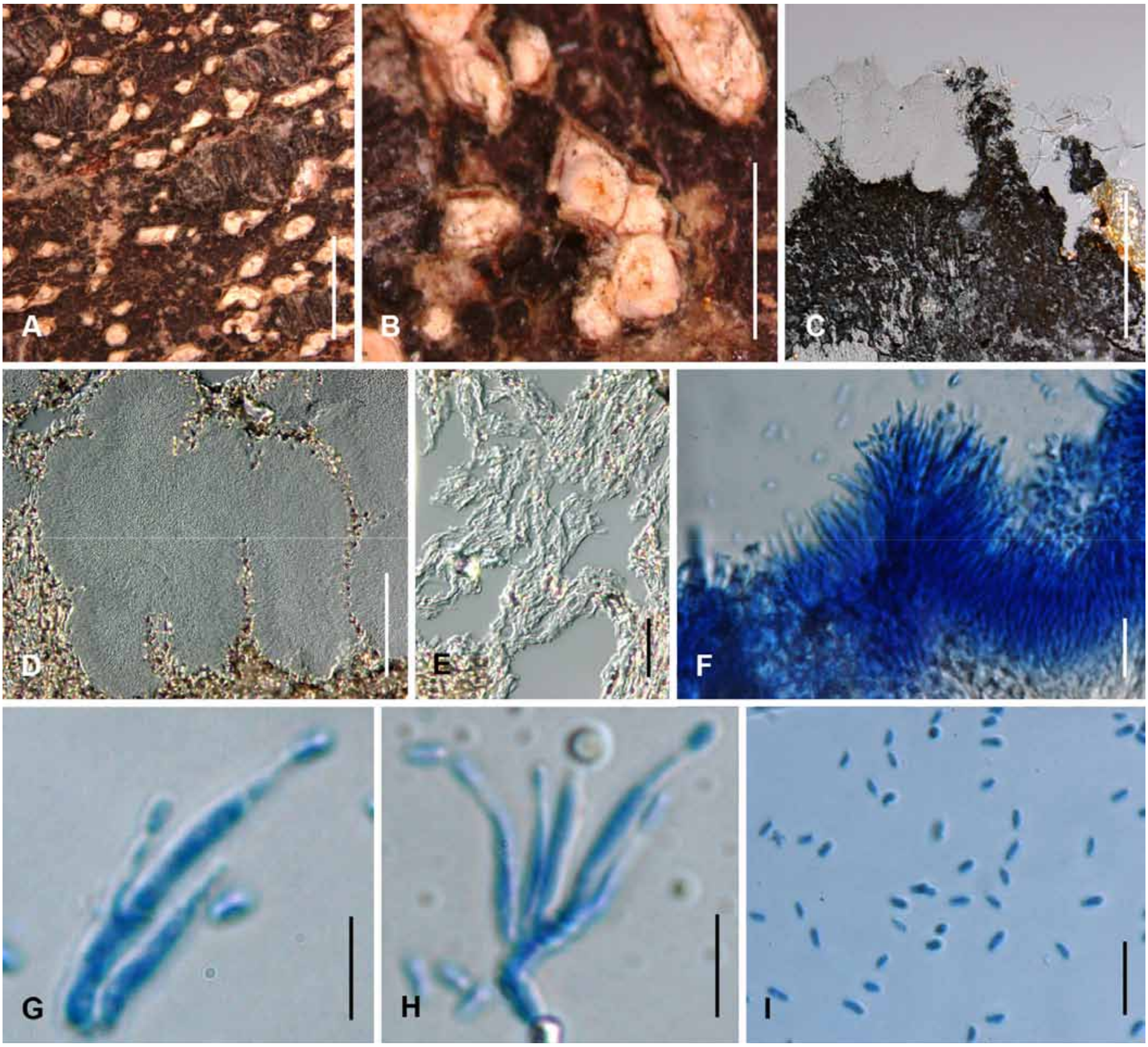

Fig. 149A–I. *Gyrostroma sinuosum* on natural substrata. A, B. Pycnidia on natural substrata; C, D. Median section of pycnidia on natural substrata; E. Tissue structure of stroma; F–H. Conidiophores and conidia; I. Conidia. Scale bars: A = 1 mm; B = 500 µm; C = 200 µm; D = 50 µm; E, F, I = 20 µm; G, H = 10 µm.

Nectria jodinae Speg., Anales Mus. Nac. Hist. Nat. Buenos Aires 23: 74. 1912. Fig. 150.

Habitat: On twigs of *Jodina rhombifolia (Cervantesiaceae)*.

Distribution: South America (Argentina, known only from the type collection).

Holotype of Nectria jodinae: **Argentina**, Lã Plata, on twigs of *Jodina rhombifolia*, Sep. 1911, C. Spegazzini, **Holotype** LPS 1589, illustration on the packet of the holotype.

Notes: Although the holotype specimen of *N. jodinae* exists in LPS, its ascomata have been destroyed. Based on the original description, we were not able to confirm this name as a distinct species. On the packet of the holotype, there are drawings of the fungus apparently by Spegazzini. However, the drawings were also not enough to identify the fungus (Fig. 150).

Nectria tropicalis Speg., Anales Mus. Nac. Hist. Nat. Buenos Aires 6: 290. 1898 [1899]. Fig. 151.

Habitat: On decaying branches of *Tabebuia*? sp. (*Bignoniaceae*).

Distribution: South America (Argentina, known only from the type collection).

Holotype of Nectria tropicalis: **Argentina**, Chaco, Colonia Resistencia, on decaying branches of *Tabebuia* sp., Jan. 1887, C. Spegazzini, **Holotype** LPS 1568.

Notes: On the holotype specimen two types of ascomata were observed, namely *Cosmospora* (Fig. 151D–F) and *Nectria* (Fig. 151A). The ascomata of the *Nectria* are in extremely poor condition (Fig. 151A). According to the original description and illustration on the packet of the holotype (LPS 1568), this fungus has one-septate ascospores (14–16 × 5 µm) (Fig. 151B, C). The species that this meager evidence suggests most closely is *N. cinnabarina,* however, it is never found in tropical regions, thus this name remains of unknown status.

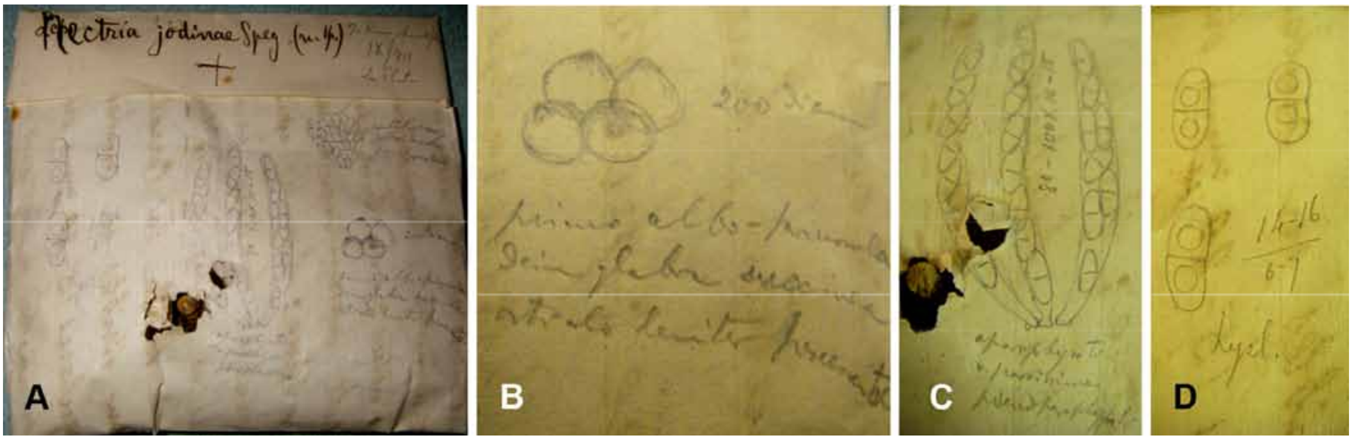

Fig. 150A–D. Illustration of *Nectria jodinae* on the packet Holotype: LPS 1589. A. Illustration on the packet of Holotype: LPS 1589; B. Illustration of perithecia; C. Illustration of asci; D. Illustration of ascospores.

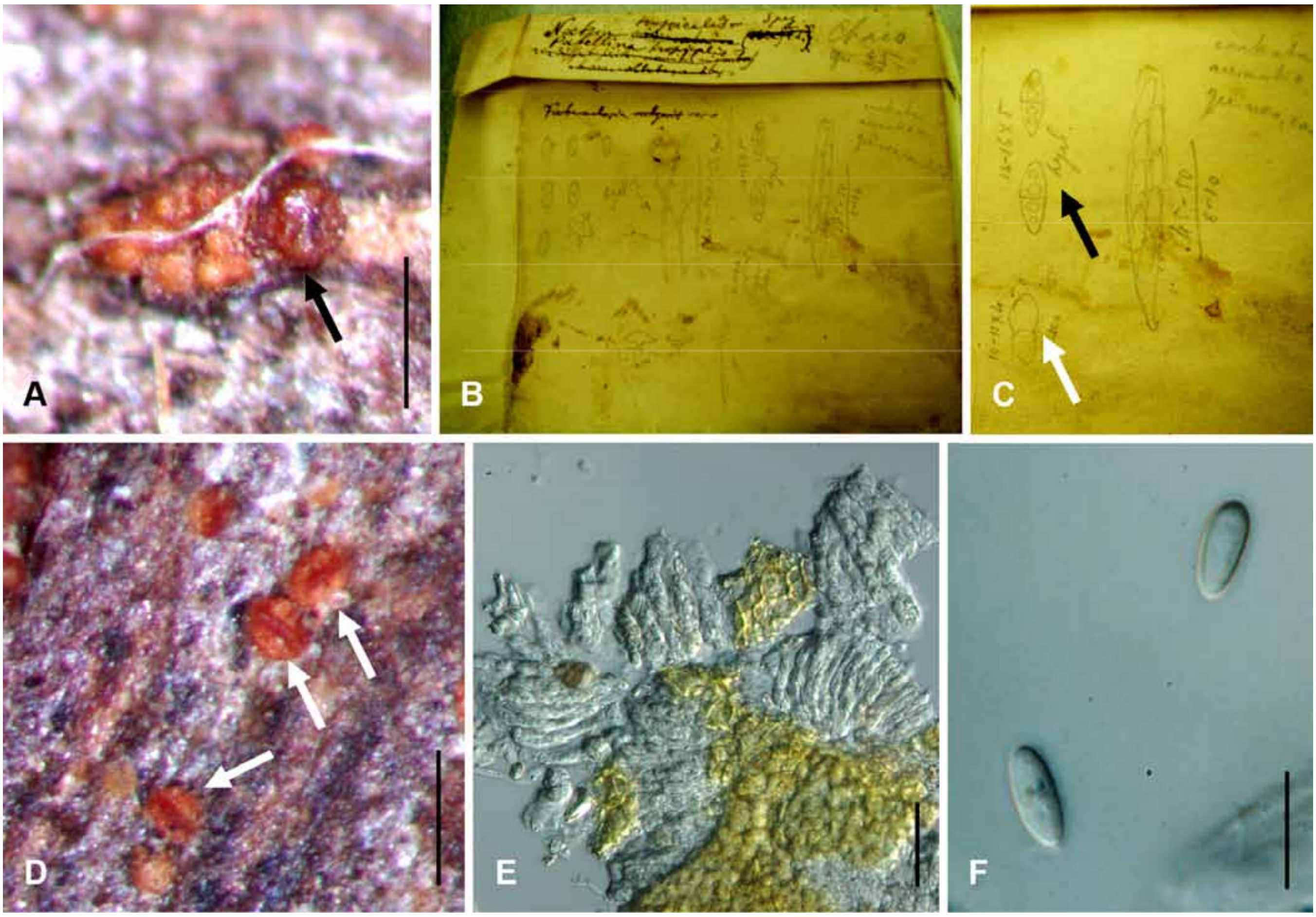

Fig. 151A–F. *Nectria tropicalis* and *Cosmospora* sp. on natural substrata (A teleomorph of *N. tropicalis*, B, C illustration on the packet of *Nectria tropicalis* Holotype: LPS 1568, D-F teleomorph of *Cosmospora* sp.). A. Perithecium of *N. tropicalis* on natural substrata (black arrow); B. Packet of *Nectria tropicalis* (Holotype: LPS 1568); C. Illustration of large ascospores (black arrow) and small ascospores (white arrow) on the packet (Holotype: LPS 1568); D. Perithecia of *Cosmospora* sp. on natural substrata (white arrows); E. Asci of *Cosmospora* sp.; F. Ascospores of *Cosmospora* sp. Scale bars: A, D = 500 µm; E = 50 µm; F = 10 µm.

Nectricladiella viticola (Berk. & M.A. Curtis) Hirooka, Rossman & P. Chaverri, **comb. nov.** MycoBank MB519726. Fig. 152.

Basionym: *Nectria viticola* Berk. & M.A. Curtis, Grevillea 4: 45. 1875.

= *Nectricladiella camelliae* (Shipton) Crous & C.L. Schoch, in Schoch, Crous, Wingfield & Wingfield, Stud. Mycol. 45: 54. 2000.

≡ *Calonectria camelliae* Shipton, Trans. Brit. Mycol. Soc. 72: 163. 1979.

Anamorph: *Cylindrocladiella microclindrica* Crous & D. Victor, Stud. Mycol. 45: 54. 2000.

Lectotype of Nectria viticola *designated herein*: **USA**, Alabama, on branches of *Vitis* sp., Peters, No. 5225, **Lectotype** BPI 798407.

Notes: Based on our study of the lectotype specimen, *Nectria viticola* agrees well with *Nectricladiella camelliae* in thickness of the ascomatal wall (15–26 µm thick), ascospore size (7.2–9.3 × 3.1–4.0 µm), and occurrence on bark (Shipton 1979, Samuels *et al.* 1991, Schoch *et al.* 2000). Based on this morphological evidence, we determined that this fungus provides an earlier name for *N. camelliae,* although the anamorph of *C. microcylindrica* was not found on the specimen of *N. viticola,* and this name is placed in the genus *Nectricladiella*.

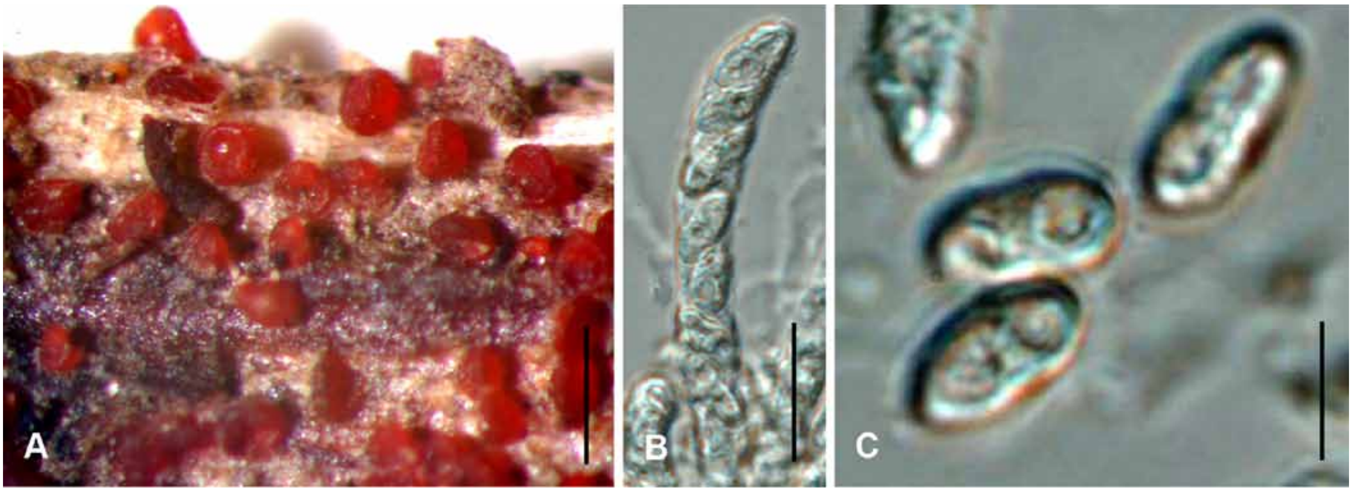

Fig. 152A–C. *Nectricladiella viticola* on natural substrata (teleomorph). A. Perithecia on natural substrata; B. Ascus; C. Ascospores: A = 500 µm; B = 20 µm; C = 10 µm.

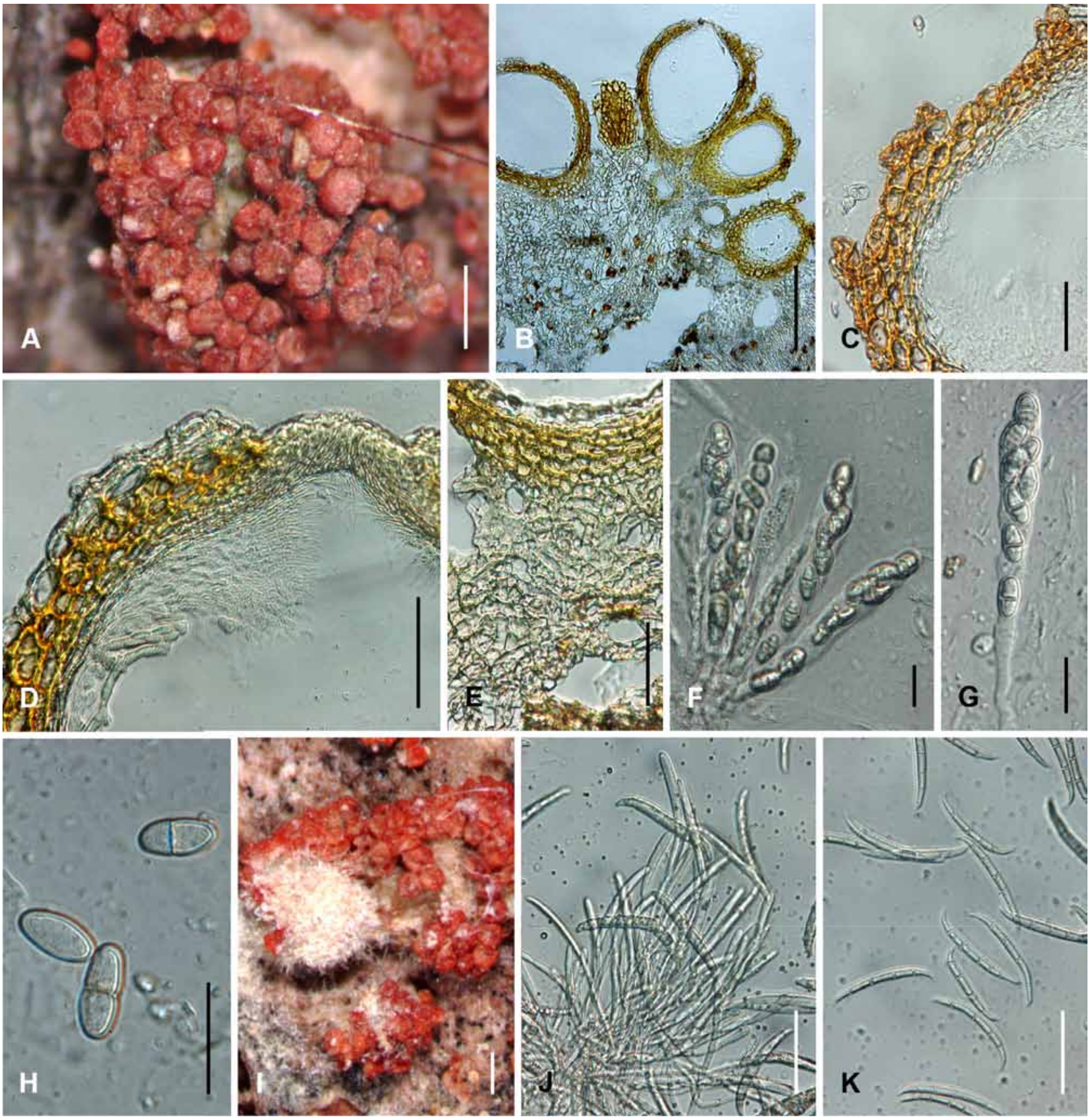

Fig. 153A–K. *Neocosmospora guarapiensis* on natural substrata (A–H teleomorph, I teleomorph and anamorph, J, K. anamorph). A. Perithecia on natural substrata; B. Median section of perithecia on natural substrata; C. Median section of perithecial wall; D. Median section of perithecial apex; E. Median section of stroma; F, G. Asci; H. Ascospores; I. Perithecia and sporodochia on natural substrata; J. Conidiophores and macroconidia on natural substrata; K. Macroconidia on natural substrata. Scale bars: A, I = 500 µm; B = 200 µm; C–E, J, K = 50 µm; F–H = 20 µm.

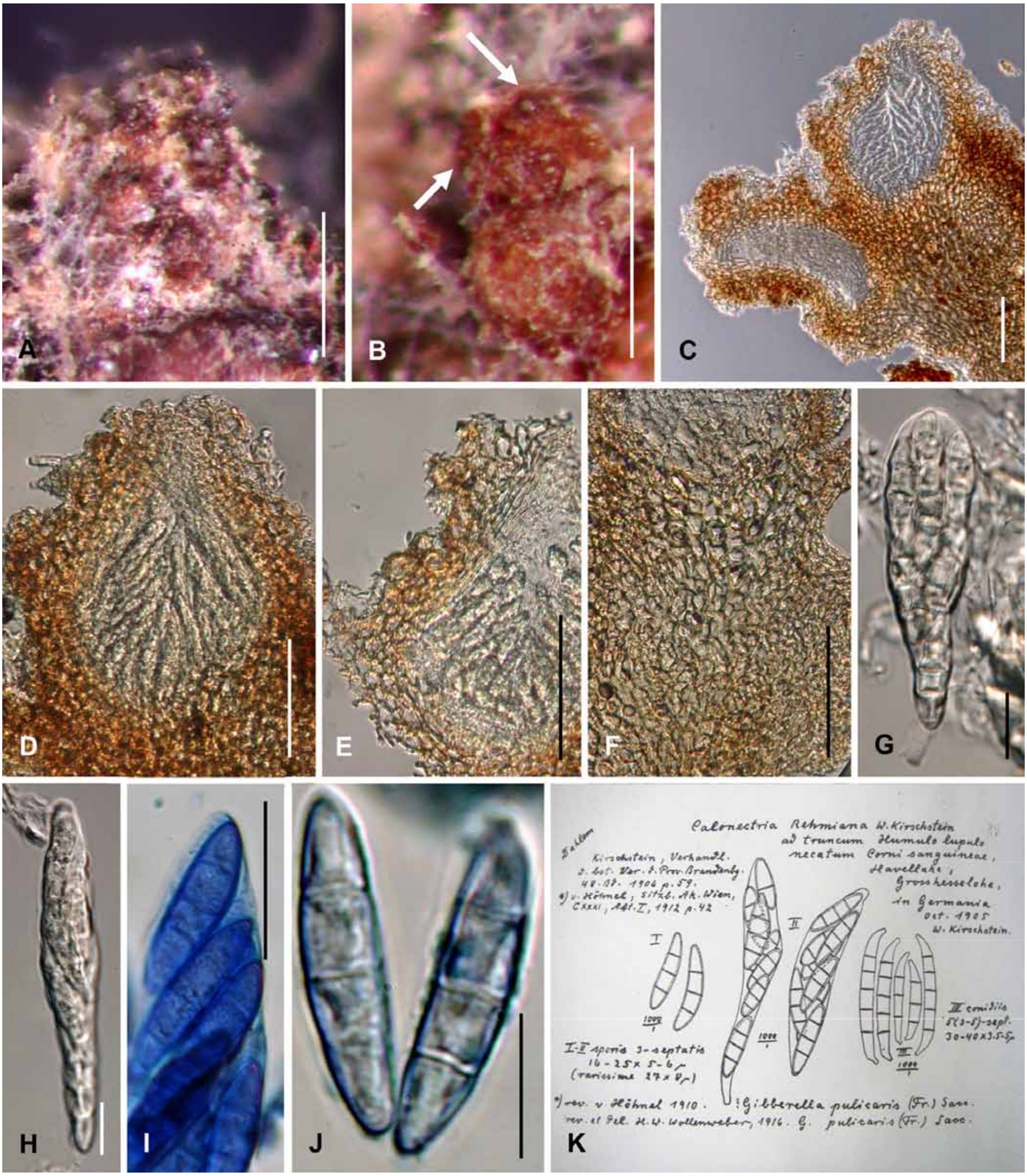

Fig. 154A–K. *Neocosmospora rehmiana* on natural substrata (A–J teleomorph, K illustration of *Calonectria rehmiana* Wollenweber 1916). A, B. Perithecia on natural substrata (white arrows); C, D. Median section of perithecia on natural substrata; E. Median section of perithecial wall; F. Median section of stroma; G, H. Asci; I. Apex of ascus; J. Ascospores; K. Illustration of *Calonectria rehmiana* (Wollenweber 1916): A, B = 500 µm; C–E = 50 µm; G-I = 20 µm; J = 10 µm.

Neocosmospora guarapiensis (Speg.) Hirooka, Samuels, Rossman & P. Chaverri, **comb. nov.** MycoBank MB519723. Fig. 153.

Basionym: *Nectria guarapiensis* Speg., Anales Mus. Nac. Hist. Nat. Buenos Aires 19: 37. 1885.

Habitat: On bark.

Distribution: Asia (China), South America (Brazil).

Holotype of Nectria guarapiensis: **Brazil,** Guarapí, on rotten wood, 1879, Balansa, No. 2758, **Holotype** LPS 1594.

Additional specimens and isolates examined of Necosmospora guarapiensis: **China**, on bark, alt. *ca.* 1500 m, 03 Oct.1993, Y. Doi, BPI 802511; alt. *ca.* 1500 m, 03 Oct. 1993, Y. Doi, BPI 802512, culture G.J.S. 93-43; alt. *ca.* 1500 m, 03 Oct. 1993, Y. Doi, BPI 802513, culture G.J.S. 93-44 = CBS 131752; alt. *ca.* 1500 m, 03 Oct. 1993, Y. Doi, BPI 802516, culture G.J.S. 93-47. **Brazil**, Guarapi, Jan. 1879, Balansa, BPI 802557.

Notes: *Nectria guarapiensis* was redescribed by Samuels & Brayford (1994) who confirmed *N. guarapiensis* as a distinctive species. In our study, we found *Fusarium* cf. *solani* on the holotype specimen as well as subsequent collections that may be the anamorph of *N. guarapiensis* (Fig. 153I–K). In terms of its sexual state, this species is similar to *Haematonectria haematococca*, *H. ipomoeae,* and the teleomorph of *Fusarium tucumaniae* (Covert *et al.* 2007; Rossman *et al.* 1999), especially to *H. ipomoeae* in regard to ascospore size.

Recently, Nalim *et al.* (2011) placed *Haematonectria haematococca* in *Neocosmospora* as *Neocosmospora haematococca*, thus *Nectria guarapiensis* is transferred to *Neocosmospora*.

Neocosmospora rehmiana (Kirschst.) Hirooka, Samuels, Rossman & P. Chaverri, **comb. nov.** MycoBank MB519725. Fig. 154.

Basionym: *Calonectria rehmiana* Kirschst., Verhandl. Bot. Ver. Prov. Brandenburg 48: 59. 1906(1907).

≡ *Nectria rehmiana* (Kirschst.) Rossman, Mycol. Pap. 150: 24. 1983.

Anamorph: unknown (presumably *fusarium*-like).

Teleomorph on natural substrata: *Mycelium* not visible around ascomata or on host. *Stromata* erumpent through epidermis, up to 0.4 mm high and 1.0 mm diam, scarlet to red, KOH+ dark red, LA+ yellow, pseudoparenchymatous, cells forming *textura prismatica* to *t. globulosa*, intergrading with ascomatal wall. *Ascomata* superficial on developed stroma, scattered to aggregated in groups of 3–12, globose to broadly pyriform, 174–246 μm high × 168–220 μm diam, collapsed laterally or cupulate when dry, dark scarlet, apical region slightly darker, with ascomatal apex acute, KOH+ dark purple, LA+ yellow, coarsely warted 25–46 μm high. *Ascomatal surface cells* forming *textura angularis*, 5–14 μm diam, with uniformly pigmented walls *ca.* 1.5 μm thick. *Ascomatal wall* 28–48 μm thick, of two regions: outer region 29–40 μm thick, intergrading with stroma, cells forming *textura globulosa* or *t. angularis*, walls pigmented, about 1.5 μm thick; inner region 8–13 μm thick, of elongate, thin-walled, hyaline cells, forming *textura prismatica*. *Asci* narrowly clavate to clavate, 67–81 × 14–17 μm, with inconspicuous ring at apex, 8-spored, ascospores mainly biseriate. *Ascospores* fusiform to slightly clavate with narrowly rounded ends, slightly curved, (17.1–)20.0–26.0(–28.8) × (5.5–)5.6–7.2(–8.5) μm (*n* = 50), hyaline, smooth, (1–)3-septate.

Habitat: On dead branches of *Cornus sanguinea (Cornaceae)*.

Distribution: Europe (Germany, known only from the type collection)

Lectotype of Nectria rehmiana *designated by Rossman (1983)*: **Germany**, Hasellake bei Gross Behnitz, "auf einem durch *Humulus lupulus* zum Absterben gebrachten Stamme von *Cornus sanguinea*", 23 Oct. 1905, W. Kirschstein, **Lectotype** S F86517, **Isolectotype** GZU inv.-Nr. 102–94, designated by Rossman (1983).

Notes: *Neocosmospora rehmiana* was first described by Kirschstein (1906) as *Calonectria rehmiana* based on Saccardo (1883); later Rossman (1983) included this species in the genus *Nectria*. The lectotype designated by Rossman (1983) and isolectotype of this fungus are in poor condition. Based on only two ascomata from the isolectoype (GZU inv.-Nr. 102-94), we determined that the species should be placed in the genus *Neocosmospora* (= *Haematonectria*) because of the broadly pyriform ascomata and coarsely warted ascomatal walls (Fig. 154C–E). In addition, Wollenweber (1916) included drawings of conidia of *Fusarium* in his illustration of *Calonectria rehmiana*, although we did not find *Fusarium* on the lectotype or isotype specimens (Fig. 154K).

KEY TO GENERA

1. On monocotyledonous plants; ascospores allantoid, non-septate; anamorph in culture with trichoderma-like conidiophores and rhizomorph-like strands; on *Asparagaceae* .... ***Allantonectria*** (***A. miltina***)
1. On woody substrata; ascospores ellipsoidal to long-fusiform, 1- to multiseptate or muriform 2

2. Ascomata covered with bright yellow scurf; anamorph pycnidial (zythiostroma-like) in the natural environment; young conidia small, averaging < 5 μm long, in culture .... ***Pleonectria***
2. Ascomata not covered with bright yellow scurf; anamorph sporodochial or synnematous (tubercularia-like); young conidia or microconidia averaging > 5 μm long in culture .... ***Nectria***

KEY TO SPECIES

NECTRIA based on teleomorph in the natural environment

1. Ascomata superficial on a stroma .... **2 (*Nectria* excluding the *N. balansae* group)**
1. Ascomata nearly or completely immersed in well-developed stroma .... **22 (*N. balansae* group)**

2. Ascospores multiseptate or muriform 3
2. Ascospores generally 1-septate 9

3. Ascospores muriform 4
3. Ascospores multiseptate, generally 3-septate 6

4. Ascomatal wall of two layers, 50–100 μm thick; ascospores not constricted at each septum, (19.4–)23.0–30.4(–35.1) × (6.8–)8.1–10.9(–13.6) μm .... ***N. antarctica***
4. Ascomatal wall of three layers, 35–70 μm thick; ascospores often constricted at each septum 5

5. Ascospores smooth, (17.9–)21.8–29.0(–35.4) × (6.1–)7.3–10.1(–12.3) μm; known from New Zealand .... ***N. polythalama***
5. Ascospores spinulose, (14.8–)21.0–28.8(–41.3) × (4.6–)7.5–11.4(–15.0) μm; tropical or subtropical regions .... ***N. pseudotrichia***

6. Ascospores striate or spinulose 7
6. Ascospores smooth 8

7. Ascospores striate, (14.3–)16.2–19.0(–20.8) × (3.9–)4.6–5.8(–6.4) µm; tropical regions .... ***N. lateritia***
7. Ascospores spinulose, (17.3–)19.3–22.1(–23.9) × (6.3–)6.7–8.1(–8.9) µm; known from New Zealand .... ***N. novaezelandiae***

8. Ascospores ellipsoidal to long-ellipsoidal, slightly curved, with broadly rounded ends, (18.6–)19.6–22.6(–24.8) × (5.5–)8.0–9.0(–10.0) µm; known from North America .... ***N. canadensis***
8. Ascospores fusiform with narrowly rounded ends, (30.2–)31.5–36.7(–39.1) × (6.0–)6.8–8.4(–9.3) µm; known from Ecuador .... ***N. neorehmiana***

9. Ascospores obovoid or pyriform, (5.5–)6.2–8.4(–9.0) × (3.5–)3.8–5.0(–5.8) µm .... ***N. pyriformis***
9. Ascospores ellipsoidal, oblong, fusiform or allantoid 10

10. Ascospores striate 11
10. Ascospores smooth or spinulose 15

11. Ascospores averaging > 20 µm long 12
11. Ascospores averaging < 20 µm long 13
12. Ascospores 1-septate, ellipsoidal, 18–30 × 6.5–9 µm .... ***N. aurantiaca*** (see Seifert 1985)
12. Ascospores 1(–3) septate, cylindrical to allantoid, (28.8–)31.8–38.0(–41.6) × (9.5–)10.8–13.2(–14.6) µm .... ***N. tucumanensis***

13. Ascomatal wall of two layers, 25–50 µm thick; ascospores long-ellipsoidal to fusiform, (11.0–)13.2–16.4(–19.9) × (4.8–)5.2–6.4(–7.3) µm; known from Argentina .... ***N. argentinensis***
13. Ascomatal wall three layers, 40–65 µm thick; ascospores ellipsoidal to fusiform; anamorph synnematous 14

14. Ascospores (15.6–)16.8–19.6(–22.3) × (5.9–)6.3–8.5(–9.7) µm; known from Brazil .... ***N. cingulata***
14. Ascospores (8.0–)9.8–13.8(–16.3) × (3.1–)3.7–5.3(–6.0) µm; known from tropical regions .... ***N. pseudocinnabarina***

15. Ascospores spinulose 16
15. Ascospores smooth 20

16. Known from alpine regions 17
16. Known from temperate to subtropical regions 18

17. Ascospores (3.9–)5.3–6.6(–7.6) µm wide; known from France (Hautes-alpes) .... ***N. berberidicola***
17. Ascospores (7.3–)7.9–9.5(–10.6) µm wide; known from India (Himalayan mountains) .... ***N. himalayensis***

18. Ascospores fusiform to allantoid, (25.1–)26.8–31.4(–36.7) × (7.5–)8.7–11.1(–13.2) µm; known only from Ecuador .... ***N. pseudadelphica***
18. Ascospores averaging < 25 µm long 19

19. Ascospores (10.9–)12.0–14.4(–16.4) × (4.6–)5.2–6.6(–8.0) µm; known from Oceania .... ***N. australiensis***
19. Ascospores (18.5–)20.0–25.4(–30.0) × (7.0–)8.0–9.0(–11.0) µm; known from Brazil .... ***N. noackiana***

20. Ascospores up to 3-septate, 1-septate (91 %), 2-septate (5 %), 3-septate (4 %); known from Europe and North America .... ***N. nigrescens***
20. Ascospores up to 1-, rarely 2-septate; known from Asia, Europe, and North America 21

21. Ascospores up to 1-septate; known from Asia .... ***N. asiatica***
21. Ascospores up to 1- or rarely 2-septate (3 %); known from Asia, Europe, and North America .... ***N. cinnabarina* or *N. dematiosa***

22. Ascospores striate.................... 23
22. Ascospores smooth to roughened, finely spinulose, or verruculose 25

23. Ascomatal wall smooth to slightly roughened; ascospores (13.4–)15.6–18.4(–22.2) × (4.5–)5.6–7.2(–8.1) µm, 1-septate .... ***N. paraguayensis***
23. Ascomatal wall warted; ascospores averaging > 20 µm long 24

24. Ascospores (19.0–)23.7–29.9(–32.6) × (6.2–)8.3–11.1(–13.0) µm, (0–)1-septate .... ***N. balansae***
24. Ascospores (25.0–)26.6–32.0(–35.3) × (10.5–)11.5–13.5(–15.6) µm, (0–)1(–2)-septate .... ***N. sordida***

25. Ascomata less than 1 mm tall; ascospores ellipsoidal to fusiform, straight to rarely slightly curved, (20.0–)23.9–30.3(–37.3) × (6.8–)8.7–11.3(–12.3) µm (0–)1(–3) septate; known from New Zealand .... ***N. hoheriae***
25. Ascomata more than 1 mm tall; ascospores (0–)1(–2) septate; known from Japan and France 26

26. Ascomata smooth; ascospores 20.4–42.5 × 7.9–15.4 µm, (0–)1(–2) septate; Japan .... ***N. magnispora***
26. Ascomata warted; Europe **27**

27. Ascomata black; ascospores (24–)29–37(–43) × (8–)9–12(–15) µm, 1-septate; known from Croatia and Italy
.... ***N. eustromatica*** (see Jaklitsch & Voglmayr 2011)
27. Ascomata red to sienna; ascospores (18.4–)20.8–30.6(–37.4) × (7.6–)8.1–11.7(–13.6) µm, (0–)1-septate; known from France
.... ***N. mariae***

NECTRIA based on anamorph in the natural environment

1. Anamorph sporodochial or synnematous(*Tubercularia*); conidiohpores branching monoverticillate or biverticillate
.... **2 (*Nectria* excluding the *N. balansae* group)**
1. Anamorph sporodochial or pycnidial; conidiophores of sporodochia monochasial branching .... **16 (*N. balansae* group)**

2. Long or short and convex or concave sporodochia **3**
2. Synnematous **12**

3. Sporodochia convex or concave; conidiophores branching not acropleurogenous .... **Anamorph of *N. antarctica***
3. Sporodochia only convex; conidiophores branching typically acropleurogenous **4**

4. Sporodochia extremely long stipitate, 500-8000 µm high (averaging > 2500 µm) .... **Anamorph of *N. canadensis***
4. Sporodochia stipitate less than 2500 µm high, or sessile **5**

5. Sporodochia long stipitate, 500-2500 µm high; conidia 8-26 × 4–9.5 µm, rarely 1-septate, oblong-ellipsoidal to cylindrical, sometimes with a truncate base; known from Europe .... **Anamorph of *N. aurantiaca*** (see Seifert 1985)
5. Sporodochia stipitate or sessile, less than 2000 µm high; conidia nonseptate, averaging > 15 µm long **6**

6. Conidia averaging > 8 µm long; sporodochia less than 500 µm high, short stipitate; known from alpine regions **7**
6. Conidia averaging < 8 µm long: sporodochia long or short stipitate **8**

7. Sporodochia less than 500 µm high, short stipitate; conidia 3.8–6.8 µm wide; known from the Himalayan mountains
.... **Anamorph of *N. himalayensis***
7. Sporodochia sessile; conidia 2.3–3.9 µm wide; known from France .... **Anamorph of *N. berberidicola***

8. Conidia averaging < 5 µm long; sporodochia sessile; known from tropical region .... **Anamorph of *N. argentinensis***
8. Conidia averaging > 5 µm long; sporodochia stipitate or sessile; known from temperate region **9**

9. Sporodochia sessile .... **Anamorph of *N. dematiosa***
9. Sporodochia short to long stipitate **10**

10. Sporodochia 700–1600 µm high, generally long stipitate, white, whitish yellow to orange; acropleurogenous conidiophores straight or curved; known from Europe or North America .... ***Tubercularia vulgaris* (Anamorph of *N. cinnabarina*)**
10. Sporodochia short to long stipitate, becoming black when old; acropleurogenous sometimes conidiophores coiled; known from Asia, Europe, or North America **11**

11. Sporodochia short(65 %)to long stipitate(35 %), 250–1700 µm high; known from Europe and North America
.... ***Tubercularia ulmea* (Anamorph of *N. nigrescens*)**
11. Sporodochia less than 800 µm high, short stipitate; known from Asia .... **Anamorph of *N. asiatica***

12. Conidial mass blood colour, saffron, or dark purple **13**
12. Conidial mass generally whitish yellow **15**

13. Conidia averaging > 10 µm long; conidial mass blood colour; known from Brazil .... **Anamorph of *N. noackiana***
13. Conidia averaging < 10 µm long; conidial mass saffron or dark purple; known from Ecuador or New Zealand **14**

14. Conidial mass saffron; conidia (5.0–)5.6–7.0(–8.4) × (2.3–)2.7–3.5(–3.8) µm; known from Ecuador ...... **Anamorph of *N. neorehmiana***
14. Conidial mass dark purple; conidia (4.5–)5.9–7.5(–9.2) × (2.5–)3.0–3.8(–4.9) µm; known from New Zealand
.... **Anamorph of *N. polythalama***

15. Terminal hyphae of ornamenting cells on stipe clavate to subglobose; conidia (5.8–)6.7–8.1(–9.6) × (3.3–)3.7–4.5(–5.1) µm; known from Oceania .... **Anamorph of *N. australiensis***
15. Terminal hyphae of ornamenting cells on stipe bluntly rounded; conidia subglobose to ellipsoidal, 3.0–7.1 × 1.4–4.6 µm
.... **Anamorph of *N. lateritia*, *N. pseudocinnabarina* or *N. pseudotrichia***

16. Pycnidia immersed in well developed stroma; conidia subglobose to ellipsoidal, (2.3–)2.5–3.5(–4.1) × (1.2–)1.6–2.7(–4.0) µm .... **Anamorph of *N. magnispora***
16. Sporodochia produced on well developed stroma **17**

17. Conidia subglobose to ellipsoidal, straight, (12.2–)13.3–15.3(–17.0) × (6.5–)7.3–8.5(–9.5) µm .... **Anamorph of *N. sordida***
17. Conidia ellipsoidal to oblong-ellipsoidal, sometimes slightly curved, (15.7–)18.4–22.6(–26.1) × (5.6–)7.1–8.9(–9.6) µm .... **Anamorph of *N. hoheriae***

NECTRIA based on anamorph in culture

1. Conidiophores branching monoverticillate or biverticillate; mature conidia averaging < 15 µm long in culture .... **2 (*Nectria* excluding the *N. balansae* group)**
1. Conidiophores monochasial branching; macroconidia averaging > 15 µm long in culture .... **10 (*N. balansae* group)**

2. Colony diameter on PDA < 40 mm after 7 d at 25 °C; conidiophores long, up to 50 µm **3**
2. Colony diameter on PDA > 40 mm after 7 d at 25 °C; conidiophores short, up to 30 µm **5**

3. Young conidia ellipsoidal, oblong to fusiform, (6.0–)7.3–9.1(–10.0) × (2.2–)2.7–3.5(–4.3) µm .... **Anamorph of *N. aurantiaca***
3. Young conidia ellipsoidal, oblong to cylindrical, averaging < 7 µm long **4**
4. Mature conidia rough; lateral phialidic pegs not abundant .... **Anamorph of *N. antarctica***
4. Mature conidia smooth; lateral phialidic pegs abundant .... **Anamorph of *N. berberidicola***

5. Colony diameter on PDA > 80 mm after 7 d at 25 °C; mature conidia basically subglobose to obovate **6**
5. Colony diameter on PDA 40–80 mm after 7 d at 25 °C; mature conidia basically ellipsoidal to fusiform **7**

6. Mature conidia oblong or allantoid, swollen at both ends; optimal temperature 20 °C after 3 d on PDA; known from New Zealand .... **Anamorph of *N. polythalama***
6. Mature conidia oblong or allantoid, rounded at both ends; optimal temperature 25 °C after 3 d on PDA .... **Anamorph of *N. pseudocinnabarina* or *N. pseudotrichia***

7. Mature conidia not budding on SNA after 7 d; optimum temperature 20 °C on PDA ....**Anamorph of *N. dematiosa***
7. Mature conidia budding on SNA after 7 d; optimum temperature 25 °C on PDA **8**

8. Mature conidia ellipsoidal, strongly constricted at centre, budding; known from Europe or North America .... ***Tubercularia vulgaris* (Anamorph of *N. cinnabarina*)**
8. Mature conidia ellipsoidal, straight, or slightly curved, rarely slightly constricted at centre, rarely budding; known from Asia, Europe or North America **9**

9. Young conidia averaging 10 µm long; mature conidia averaging 15 µm long; known from Asia .... **Anamorph of *N. asiatica***
9. Young conidia averaging 5 µm long; mature conidia averaging 10 µm long; known from Europe or North America .... ***Tubercularia ulmea* (Anamorph of *N. nigrescens*)**

10. Sterile hyphae; only chlamydospores or swollen hyphae present on SNA and PDA .... **Anamorph of *N. balansae***
10. Fertile hyphae **11**

11. Macroconidia oblong, cylindrical or narrowly ellipsoidal, (20–)27–38(–54) × (8.7–)9.7–12.5(–14.8) µm (on MEA and OA, see Jaklitsch and Voglmayr 2011) .... **Anamorph of *N. eustromatica***
11. Macroconidia averaging < 30 µm long **12**

12. Macroconidia ellipsoidal to long fusiform, curved, with thick-walled cells, (11.5–)14.1–23.1(–27.6) × (4.2–)4.9–7.7(–9.8) µm .... **Anamorph of *N. magnispora***
12. Macroconidia subglobose to ellipsoidal, straight, averaging10 µm wide **13**

13. Colony diameter on PDA 7–10 mm after 7 d at 25 °C; monochasial branching conidiophores 36–98 µm long; macroconidia (14.7–)16.3–20.3(–22.3) × (8.5–)9.4–11.4(–13.5) µm .... **Anamorph of *N. mariae***
13. Colony diameter on PDA 70–80 mm after 7 d at 25 °C; monochasial branching conidiophores 40–69 µm long; macroconidia (16.6–)18.4–22.6(–24.6) × (6.9–)9.2–12.0(–14.1) µm .... **Anamorph of *N. sordida***

PLEONECTRIA based on teleomorph in the natural environment

1. Ascospores not budding inside or outside the asci **2**
1. Ascospores budding inside or outside the asci **12**

2. Ascospores 1- to multiseptate **3**

2. Ascospores muriform **7**

3. Ascospores (3–6)7-septate, ellipsoidal, oblong to allantoid, with broadly rounded ends, (14.9–)17.0–20.8(–24.7) × (4.4–)5.0–6.4(–7.3) µm; on bark dead deciduous trees, especially *Oleaceae* .... ***P. aurigera***
3. Ascospores 1-septate, smooth to striate **4**

4. Ascospores striate, ellipsoidal to fusiform, (13.0–)13.9–16.7(–18.5) × (4.6–)5.3–6.7(–7.3) µm; known from Argentina .... ***P. pseudomissouriensis***
4. Ascospores smooth **5**

5. Ascospores ellipsoidal to fusiform, not constricted at central septum, (8.9–)10.2–12.2(–13.6) × (3.3–)4.1–4.9(–5.7) µm; on deciduous trees .... ***P. rubicarpa***
5. Ascospores ellipsoidal to fusiform, slightly constricted at central septum; on *Hedera* and *Ilex* **6**

6. Ascospores ellipsoidal, slightly constricted at central septum, (8.9–)10.8–13.4(–15.4) × (4.1–)5.4–6.8(–7.5) µm; on *Ilex* .... ***P. ilicicola***
6. Ascospores ellipsoidal to fusiform with slightly constricted central septum; (8.1–)10.5–12.7(–14.6) × (3.7–)4.9–6.5(–8.1) µm; on *Hedera* .... ***P. sinopica***

7. Stromata not immersed in substrate; perithecia superficial or sometimes immersed at the base on well-developed stroma **8**
7. Stromata immersed in substrate; perithecia immersed in stromata or at base **9**

8. Ascospores subglobose to ellipsoidal, muriform, (9.7–)10.0–12.6(–14.8) × (4.8–)6.0–7.6(–10.2) µm; on *Fabaceae* .... ***P. austroamericana***
8. Ascospores of two sizes: microascospores allantoid to short-cylindrical, (20.9–)25.0–30.0(–32.5) × (8.2–)9.5–11.9(–13.1) µm, macroascospores cylindrical (37.1–)39.1–46.7(–49.4) × (10.1–)10.4–12.2(–13.1) µm; on *Carya* .... ***P. missouriensis***

9. Ascospores ellipsoidal, (15.4–)16.9–20.5(–23.3) × (7.8–)8.7–11.1(–12.3) µm; on *Acer campestre* .... ***P. pyrrhochlora***
9. Ascospores narrowly ellipsoidal to long-fusiform, averaging < 9 µm wide **10**

10. Ascomatal apex rust to chestnut colour, protuberances; on *Lonicera* .... ***P. lonicerae***
10. Ascomatal apex red to umber, not protuberances; generally on *Rhus* or *Zanthoxylum* **11**

11. Ascomata immersed at the base; ascospores (12.7–)15.9–20.3(–22.8) µm long; generally on *Rhus* .... ***P. virens***
11. Ascomata almost immersed in stromata; ascospores (17.8–)19.4–23.6(–26.6) µm long; generally on *Zanthoxylum* .... ***P. zanthoxyli***

12. Ascospores not budding or only outside the asci **13**
12. Ascospores budding inside the asci **14**

13. Ascospores 1-septate, (8.7–)9.8–12.4(–13.5) × (3.7–)4.6–6.0(–6.8) µm; on *Castanopsis* .... ***P. okinawensis***
13. Ascospores muriform, (14.4–)15.7–19.3(–23.3) × (5.0–)6.5–8.1(–10.1) µm; on *Ribes* .... ***P. berolinensis***

14. Ascospores 1-septate **15**
14. Ascospores multiseptate or muriform **16**

15. Ascospores ellipsoidal to fusiform, (8–)8.9–11.1(–12.8) × (3.2–)4–5.4(–6.5) µm; on *Ilex aquifolium* .... ***P. aquifolii***
15. Ascospores narrowly fusiform to cylindrical, (8.3–)10.2–12.8(–15.3) × (2.2–)2.8–4(–5.3) µm; on deciduous trees .... ***P. coryli***

16. Ascospores filiform, transversely multiseptate **17**
16. Ascospores muriform **20**

17. Ascospores 8–15 septate, hyaline, (26.7–)31.6–44.0(–48.6) × (1.3–)2.3–3.9(–4.7) µm; on *Quercus ilex* ssp. *rotundifolia* .... ***P. quercicola***
17. Ascospores 8–44 septate, hyaline, 21.8–74.7 µm long; on conifers **18**

18. On *Abies*; ascomatal surface scaly; ascospores long-filiform, 8–31 septate, hyaline, (22.4–)29.5–45.1(–60.2) × (1.6–)2.0–3.2(–3.9) µm .... ***P. rosellinii***
18. On *Pinus*; ascomatal surface generally scurfy **19**

19. On *Pinus* subgenus *Pinus*; ascospores long-filiform, 15–39 septate, hyaline, (32.9–)43.2–64.8(–74.7) × (2.3–)2.7–3.5(–3.7) µm .... ***P. cucurbitula***
19. On *Pinus* subgenus *Strobus*; ascospores long-filiform, 12–44 septate, hyaline, (21.8–)32.9–52.1(–64.3) × (1.9–)2.2–3.2(–3.9) µm .... ***P. strobi***

20. Ascospores disarticulating; part-ascospores subglobose to ellipsoidal, (7.7–)8.7–12.1(–13.4) × (5.0–)6.4–8.4(–9.0) µm
.... ***P. chlorinella***
20. Ascospores not disarticulating **21**

21. Ascospores subglobose to ellipsoidal, (5.1–)5.6–7.6(–9.4) × (4.0–)4.6–6.6(–8.6) µm .... ***P. sphaero***
21. Ascospores clavate, oblong to fusiform, averaging > 10 µm long **22**

22. Ascospores clavate, (15.8–)17.7–22.7(–36.4) × (4.3–)4.8–6.2(–7.0) µm; on dead twigs of *Ribes* .... ***P. clavatispora***
22. Ascospores oblong to long-fusiform **23**

23. Ascospores ellipsoidal to fusiform, hyaline, (14.5–)18.9–26.1(–32.2) × (5–)5.2–8(–10.8) µm; on dead bark or twigs of *Berberis*
.... ***P. lamyi***
23. Ascospores fusiform, cylindrical to long-fusiform, averaging < 5 µm wide; on conifers **24**

24. On *Picea*; perithecial apex of three regions; ascospores long-fusiform, cylindrical to long-cylindrical,
(15.6–)20.3–29.7(–36.0) × (2.8–)3.2–4.2(–4.6) µm .... ***P. boothii***
24. On *Abies* or *Pinus*; perithecial apex of two regions; ascospores averaging > 4.5 µm wide **25**

25. On *Abies*; ascospores ellipsoidal to fusiform with 5–9 transverse septa and one longitudinal septum,
(16.0–)19.7–23.9(–28.6) × (3.0–)4.0–5.6(–6.8) µm .... ***P. balsamea***
25. On *Pinus*; ascospores ellipsoidal to long-fusiform with 5–15 transverse septa and one longitudinal septum,
(14.2–)18.1–28.3(–46.4) × (3.2–)4.3–5.3(–6.9) µm .... ***P. pinicola***

PLEONECTRIA based on anamorph in the natural environment

1. Pycnidia navicular, superficial; known from Japan .... **Anamorph of *P. okinawensis***
1. Pycnidia not navicular, superficial or immersed **2**

2. On conifer tree; pycnidia superficial, subglobose to discoidal **3**
2. On broad leaves tree; superficial or immersed pycnidia, irregularly discoidal **7**

3. On *Picea*; sterile hyphae absent; conidia allantoid to oblong, (1.9–)2.4–3.0(–3.2) × (0.6–)0.8–1.0(–1.2) µm ..... **Anamorph of *P. boothii***
3. On *Abies* or *Pinus* **4**

4. On *Abies* .... **Anamorph of *P. balsamea* or *P. rosellinii*** (anamorphic traits are more supportive)
4. On *Pinus* **5**

5. Sterile hyphae present; (2.1–)2.6–3.4(–3.9) × (0.9–)1.0–1.4(–1.6) µm .... **Anamorph of *P. pinicola***
5. Sterile hyphae absent **6**

6. On *Pinus* subgenus *Pinus*; conidia (2.2–)2.6–3.4(–4.3) × (0.7–)0.8–1.2(–1.9) µm........................ **Anamorph of *P. cucurbitula***
6. On *Pinus* subgenus *Strobus*; conidia (1.9–)2.6–3.4(–3.8) × (1.1–)1.2–1.6(–1.8) µm........................ **Anamorph of *P. strobi***

7. Pycnidia superficial, irregularly discoidal; on *Berberis* or *Carya* **8**
7. Pycnidia immersed and superficial or only immersed **9**

8. On *Berberis*; conidia ellipsoidal to oblong, (3.3–)3.4–4.0(–4.2) × (1.0–)1.1–1.3(–1.5) µm .... **Anamorph of *P. lamyi***
8. On *Carya*; conidia oblong-ellipsoidal to allantoid, (1.9–)2.4–3.6(–4.8)× 0.5–0.8(–1.2) µm .... **Anamorph of *P. missouriensis***

9. Pycnidia immersed; on *Ilex* or *Quercus* **10**
9. Pycnidia immersed or superficial; on *Hedera* or *Fabaceae* **11**

10. On *Ilex;* conidia hyaline, ellipsoidal, or oblong, (2.3–)3.0–4.0(–4.6) × (0.9–)1.2–1.8(–2.4) µm .... **Anamorph of *P. ilicicola***
10. On *Quercus;* conidia hyaline, oblong to sub-allantoid, curved, nonseptate, (2.8–)3.5–5.0(–5.4) × (1.0–)1.1–1.3(–1.6) µm
.... **Anamorph of *P. quercicola***

11. On *Hedera*; conidia of two types .. .. **Anamorph of *P. sinopica***
11. On *Fabaceae* **12**

12. Sterile hyphae present; conidia ellipsoidal, obovate or oblong-ellipsoidal, (1.7–)2.3–3.1(–3.6) × (1.0–)1.3–1.9(–2.5) µm
.... **Anamorph of *P. austroamericana***
12. Sterile hyphae absent; conidia ellipsoidal to allantoid, (2.4–)2.5–3.7(–5.4) × (0.4–)0.7–1.1(–1.2) µm
.... **Anamorph of *P. sphaerospora***

PLEONECTRIA based on anamorph in culture

1. On conifers **2**
1. On hardwood trees **6**

2. On *Abes* or *Picea*; conidiophores not abundant **3**
2. On *Pinus*; conidiophores abundant **5**

3. On *Picea*; mature conidia long-cylindrical to allantoid, (7.5–)8.9–10.9(–12.3) × (1.3– 1.5–1.(–2.0) µm ....**Anamorph of *P. boothii***
3. On *Abies*; mature conidia averaging < 9.0 µm long **4**

4. Mature conidia subglobose to ellipsoidal, (6.1–)6.4–7.2(–9.0) × (2.2–)2.5–3.3(–3.4) µm; lateral phialidic pegs ellipsoidal and slightly tapering toward tip or flask-shaped .... **Anamorph of *P. balsamea***
4. Mature conidia oblong to long-cylindrical, rarely allantoid, (6.4–)6.9–9.3(–10.0) × (1.9–)2.1–2.9(–3.1) µm; lateral phialidic pegs abundant, ellipsoidal, slightly tapering toward tip .... **Anamorph of *P. rosellinii***

5. Mature conidia oblong, slightly swollen at both ends, (5.5–)6.8–11.0(–13.2) × (1.7–)1.9–2.7(–3.1) µm; lateral phialidic pegs abundant, ellipsoidal and slightly tapering toward tip or flask-shaped . ... **Anamorph of *P. pinicola***
5. Mature conidia long-cylindrical **6**

6. On *Pinus* subgenus *Pinus*; lateral phialidic pegs ellipsoidal tapering toward apex .... **Anamorph of *P. cucurbitula***
6. On *Pinus* subgenus *Strobus*; lateral phialidic pegs ellipsoidal, slightly tapering toward apex or flask-shaped ...... **Anamorph of *P. strobi***

7. Mature conidia averaging > 10 µm long **8**
7. Mature conidia averaging < 10 µm long **9**

8. On *Ribes*; mature conidia swollen, ellipsoidal, oblong, allantoids, or ellipsoidal with strongly constricted centre, (0–)1(–2)-septate, (8.8)10.2–14.2(–19.9) × (2.2–)3.3–4.7(–5.5) µm .... **Anamorph of *P. berolinensis***
8. On *Berberis*; mature conidia long cylindrical or C-shape, 0-septate, (7.8–)9.6–12.8(–14.3) × (1.4–)1.8–2.6(–3.1) µm .... **Anamorph of *P. lamyi***

9. Mature conidia 1-septate, oblong or ellipsoidal, (4.0–)4.4–6.0(–7.0) × (2.1–)2.4–3.2(–3.5) µm; lateral phialidic pegs not abundant, ellipsoidal, slightly tapering toward tip or rarely narrowly flask-shaped; On *Fabaceae* .... **Anamorph of *P. austroamericana***
9. Mature conidia 0-septate **10**

10. Mature conidia irregularly swollen at both ends or clavate **11**
10. Mature conidia not irregulary swollen at both ends or clavate **13**

11. Mature conidia (5.4–)6.3–7.5(–8.2) × (1.4–)1.8–2.4(–2.8) µm; on *Acer* .... **Anamorph of *P. pyrrhochlora***
11. Mature conidia averaging > 7 µm long **12**

12. Colony diameter on PDA average 14 mm after 7 d at 25 °C; mature conidia, (6.7–)8.4–9.1(–10.4) × (2.1–)2.5–2.8(–3.1) µm .... **Anamorph of *P. virens***
12. Colony diameter on PDA > average 67 mm after 7 d at 25 °C; mature conidia, (7.1–)8.0–10.0(–12.1) × (2.0–)2.3–3.1(–3.7) µm .... **Anamorph of *P. zanthoxyli***

13. Lateral phialidic pegs ellipsoidal, slightly tapering toward tip; on *Quercus* or *Ilex* **14**
13. Lateral phialidic pegs ellipsoidal, slightly tapering toward tip or rarely narrowly flask-shaped; not on *Quercus* or *Ilex* **16**

14. On *Quercus*; mature conidia ellipsoidal to oblong, straight or slightly curved, (5.4–)5.5–7.4(–8.4) × (2.6–)2.8–3.2(–3.5) µm .... **Anamorph of *P. quercicola***
14. On *Ilex* **15**

15. Conidiogenous cells monophialidic or polyphialidic .... **Anamorph of *P. aquifolii***
15. Conidiogenous cells monophialidic .... **Anamorph of *P. ilicicola***

16. Conidiophores rarely formed, unbranched, or not form **17**
16. Conidiophores abundant, branched **18**

17. Conidiophores not form; mature conidia long-cylindrical, (7.2–)8.7–11.3(–12.7) × (1.3–)1.6–2.2(–2.9) µm; lateral phialidic pegs abundant, narrowly or widely flask-shaped; mainly on *Oleaceae* .... **Anamorph of *P. aurigera***
17. Conidiophores rarely formed, unbranched; mature conidia ellipsoidal or oblong, (6.0–)8.6–10.6(–12.9) × (1.6–)2.0–3.0(–3.4) µm .... **Anamorph of *P. coryli***

18. On *Castanopsis*; mature conidia ellipsoidal fusiform or allantoid, (5.1–)7.1–10.1(–11.5) × (1.8–)2.0–2.8(–3.3) µm .... **Anamorph of *P. okinawensis***
18. On *Hedera*; mature conidia cylindrical to allantoid, (5.2–)6.0–11.0(–13.4) × (1.1–)1.4–2.6(–3.1) µm .... **Anamorph of *P. sinopica***

SYNOPTIC KEYS

NECTRIA (*Tubercularia* anamorph)

Teleomorph on natural substrata

1. *Nectria antarctica*
2. *Nectria argentinensis*
3. *Nectria asiatica*
4. *Nectria aurantiaca*
5. *Nectria australiensis*
6. *Nectria balansae*
7. *Nectria berberidicola*
8. *Nectria canadensis*
9. *Nectria cingulata*
10. *Nectria cinnabarina*
11. *Nectria dematiosa*
12. *Nectria eustromatica*
13. *Nectria himalayensis*
14. *Nectria hoheriae*
15. *Nectria lateritia*
16. *Nectria magnispora*
17. *Nectria mariae*
18. *Nectria neorehmiana*
19. *Nectria nigrescens*
20. *Nectria noackiana*
21. *Nectria novaezelandiae*
22. *Nectria paraguayensis*
23. *Nectria polythalama*
24. *Nectria pseudadelphica*
25. *Nectria pseudocinnabarina*
26. *Nectria pseudotrichia*
27. *Nectria pyriformis*
28. *Nectria sordida*
29. *Nectria tucumanensis*

Stroma

1. Size (high)
    a. up to 0.5 mm **2, 11**
    b. up to 1 mm **3, 5, 14, 15, 18, 20, 22, 25, 28, 29**
    c. up to 2 mm **7, 9, 10, 12, 13, 17, 19, 21, 23, 24, 26, 27**
    d. up to 3 mm **1, 6, 16**
    e. up to 8 mm **8**
    f. no data **4**
2. Size (diam)
    a. up to 1 mm **25**
    b. up to 2 mm **2, 5, 8, 11, 12, 15, 18, 21, 23, 24, 27**
    c. up to 3 mm **1, 3, 7, 9, 13, 16, 17, 20, 26, 29**
    d. up to 4 mm **6, 14, 19, 22, 28**
    e. up to 5 mm **10**
    f. no data **4**

Perithecia

1. Colour
    a. bay **2, 8, 15, 25, 27**
    b. dark brown **12**
    c. dark scarlet **18**
    d. red **1–3, 5, 6, 8, 10, 11, 14, 16, 17, 19, 21–23, 26, 28, 29**

    e. reddish brown **3, 4, 10, 11, 19, 23**
    f. scarlet **9, 15, 18, 20, 21, 24, 25, 27**
    g. sienna **1, 7, 9, 13, 14, 16, 17, 20, 24, 29**
    h. umber **5, 7, 13**
2. Position in stroma
    a. immersed only at base **1, 29**
    b. nearly or completely immersed **6, 12, 14, 16, 17, 22, 28**
    c. superficial **1–5, 7–11, 13, 15, 18–21, 23–27, 29**
3. Surface
    a. rough **1–3, 5, 8–12, 14, 15, 19–22, 24, 27**
    b. smooth **2, 3, 5, 8–11, 15, 16, 19–22, 24, 27**
    c. warted **3, 4, 6, 7, 10–13, 17–19, 23, 25, 26, 28, 29**
4. Number of perithecial wall layer
    a. 2 layers **1–8, 10–14, 16–22, 27–29**
    b. 3 layers ....**9 , 15, 23, 24, 25, 26**

Ascospores

1. Shape
    a. allantoid **12, 24, 29**
    b. bean-shaped **12**
    c. cylindrical **15, 21, 29**
    d. ellipsoidal **1, 3–11, 13–17, 19, 20, 22, 23, 25, 26, 28**
    e. fusiform **2, 3, 5–7, 9–11, 13, 17–20, 22–26, 28**
    f. long-ellipsoidal **2, 8, 21**
    g. long-fusiform **11**
    h. long-oblong **6, 14, 16, 22, 28**
    i. obovoid **27**
    j. pyriform **27**
    k. short-cylindrical **1**
2. Surface
    a. smooth **1, 3, 8, 10, 11, 18, 19, 23, 27**
    b. spinulose **5, 7, 13, 14, 16, 17, 20, 21, 24, 26**
    c. striate **2, 4, 6, 9, 15, 22, 25, 28, 29**
    d. verruculose **12**
3. Septation
    a. muriform **1, 23, 26**
    b. up to 1-septate **2–7, 9, 12, 13, 17, 20, 22, 25, 27**
    c. up to 2-septate **10, 11, 16, 28**
    d. up to 3-septate **8, 14, 15, 18, 19, 24, 29**
    e. up to 4-septate **21**
4. Average length
    a. < 10 µm **27**
    b. 10–20 µm **2, 3, 5, 7, 9–11, 13, 15, 19, 22, 25**
    c. 20–30 µm **1, 4, 6, 8, 14, 17, 20, 21, 23, 24, 26, 28**
    d. 30–40 µm **12, 16, 18, 29**
5. Average width
    a. 2.5–5 µm **3, 10, 11, 19, 25, 27**
    b. 5–7.5 µm **2, 5, 7, 9, 15, 21, 22**
    c. 7.5–10 µm **4, 6, 8, 13, 17, 18, 20, 23, 24, 26**
    d. 10–12.5 µm **1, 12, 14, 29**
    e. 12.5–15 µm **16, 28**

Geographical distribution

1. Africa
    a. Cameroon **26**
    b. Gabon **26**
    c. Ghana **26**
    d. Tanzania **26**
    e. Uganda **26**
2. Asia
    a. China **3, 6, 11, 15, 26**

b. India	**6, 13, 26, 27**
c. Indonesia	**26**
d. Japan	**3, 6, 11, 16, 26**
e. Malaysia	**15, 26**
f. Papua New Guinea	**26**
g. Philippines	**26**
h. Sri Lanka	**26**
i. Taiwan	**26**
j. Thailand	**26**
3. Caribbean and Central America	
a. Costa Rica	**26, 29**
b. Cuba	**25, 26**
c. Dominica	**26**
d. El Salvador	**26**
e. Guadeloupe	**25**
f. Guatemala	**26**
g. Jamaica	**26**
h. Martinique	**25**
i. Panama	**26**
j. Puerto Rico	**26**
4. Europe	
a. Austria	**10**
b. Croatia	**12**
c. Czech Republic	**4**
d. Denmark	**10**
e. Finland	**11**
f. France	**4, 6, 7, 10, 17, 19**
g. Germany	**10, 19**
h. Ireland	**10**
i. Italy	**12**
j. Netherlands	**10**
k. Poland	**10, 11**
l. Spain	**17**
m. UK	**4, 10, 19**
n. Ukraine	**10**
5. Oceania	
a. Australia	**5, 26**
b. New Zealand	**5, 11, 14, 21, 23**
6. North America	
a. Canada	**8, 10, 11, 19**
b. Mexico	**26**
c. USA	**1, 8, 10, 11, 19, 26**
7. South America	
a. Argentina	**2, 22, 26, 28, 29**
b. Bolivia	**26**
c. Brazil	**6, 9, 15, 20, 22, 25, 26, 28**
d. Chile	**1**
e. Colombia	**26, 29**
f. Ecuador	**18, 24, 26**
g. French Guiana	**25, 26, 28**
h. Guyana	**26**
i. Paraguay	**6, 22, 26**
j. Peru	**26**
k. Surinam	**26**
l. Venezuela	**15, 25, 26**

Anamorph on natural substrata

1. Anamorph of *Nectria antarctica* (sporodochial tubercularia-like)
2. Anamorph of *Nectria argentinensis* (tubercularia-like)
3. Anamorph of *Nectria asiatica* (tubercularia vulgaris-like)
4. Anamorph of *Nectria aurantiaca* (*Tubercularia aurantiaca*)

5. *Tubercularia australiensis* (anamorph of *Nectria australiensis*)
7. Anamorph of *Nectria berberidicola* (sporodochial tubercularia-like)
8. *Tubercularia grayana* (anamorph of *Nectria canadensis*)
10. *Tubercularia vulgaris* (anamorph of *Nectria cinnabarina*)
11. Anamorph of *Nectria dematiosa* (tubercularia vulgaris-like)
13. Anamorph of *Nectria himalayensis* (tubercularia-like)
14. *Tubercularia hoheriae* (Anamorph of *Nectria hoheriae*)
15. Anamorph of *Nectria lateritia* (possibly tubercularia-like)
16. Anamorph of *Nectria magnispora* (pycnidial on natural substrata)
18. Anamorph of *Nectria neorehmiana* (synnematous tubercularia-like)
19. *Tubercularia ulmea* (anamorph of *Nectria nigrescens*)
20. Anamorph of *Nectria noackiana* (synnematous tubercularia-like)
23. Anamorph of *Nectria polythalama* (synnematous tubercularia-like)
25. Anamorph of *Nectria pseudocinnabarina* (tubercularia lateritia-like)
26. *Tubercularia lateritia* (Anamorph of *Nectria pseudotrichia*)
28. Anamorph of *Nectria sordida* (irregularly sporodochial in the natural environment)

Stroma

1. Shape of stroma
    a. pycnidia **16**
    b. sporodochia **1–4, 7, 8, 10, 11, 13, 14, 19, 28**
    c. synnemata **5, 15, 18, 20, 23, 25, 26**
2. Height of stroma (sporodochial)
    a. up to 0.5 mm **2, 7**
    b. up to 1 mm **3, 8, 11, 13, 14, 28**
    c. up to 2 mm .... **, 10, 19**
    d. up to 3 mm **4**
3. Height of stroma (synnematal)
    a. up to 1 mm **5**
    b. up to 2 mm **15, 18, 20, 25**
    c. up to 3 mm **23, 26**
4. Structure of stroma
    a. prosenchymatous **5, 15, 18, 20, 23, 25, 26**
    b. pseudoparenchymatous **1–4, 7, 8, 10, 11, 13, 14, 16, 19, 28**
    c. pseudoparenchymatous and prosenchymatous **4**

Acropleurogenous conidiophores

1. Existence of acropleurogenous conidiophores
    a. absent **1, 4, 5, 14–16, 18, 20, 23, 25, 26, 28**
    b. present **2, 3, 7, 8, 10, 11, 13, 19**
2. Number of acropleurogenously developing phialides
    a. less than 3 times **2, 8, 13**
    b. more than 3 times **3, 7, 10, 11, 19**

Sterile hyphae mixed with phialides

1. Existence of sterile hyphae mixed with phialides
    a. absent **1–4, 7, 8, 10, 11, 13, 16, 18, 19, 28**
    b. present **5, 14, 15, 20, 23, 25, 26**
2. Average length
    a. < 100 µm **23, 26**
    b. 100–150 µm **5, 15, 20, 25**
    c. > 150 µm **14**

Monochasial branching conidiophores

1. Existence of monochasial branching conidiophores
    a. absent **2–5, 7, 8, 10–13, 15, 16, 18–20, 23, 25, 26**
    b. present **1, 14, 28**
2. Length
    a. up to 100 µm **28**
    b. up to 200 µm **1, 14**

Conidia

1. Shape

a. cylindrical	**1, 3, 4, 7, 10, 11, 13, 19**
b. ellipsoidal	**1–5, 7, 8, 14–16, 18, 20, 23, 25, 26, 28**
c. fusiform	**5, 20**
d. long ellipsoidal	**10, 11, 13, 19,**
e. oblong	**4, 14, 15, 23, 25, 26**
f. obovate	**5, 15, 23, 25, 26**
g. subglobose	**16, 28**

2. Average length

a. < 5 µm	**2, 16, 25**
b. 5–10 µm	**1, 3, 5, 7, 8, 10, 11, 15, 18, 19, 23, 26**
c. 10–15 µm	**13, 28**
d. 15–20 µm	**4, 20**
e. 20–25 µm	**14**

3. Average width

a. 2.0–3.0 µm	**1, 2, 3, 8, 10, 11, 15, 16, 19, 25, 26**
b. 3.0–4.0 µm	**7, 18, 23**
c. 4.0–5.0 µm	**5, 13**
d. 5.0–6.0 µm	**4**
e. > 6.0 µm	**14, 20, 28**

Anamorph characters in culture

1. Anamorph of *Nectria antarctica* (sporodochial tubercularia-like)
3. Anamorph of *Nectria asiatica* (tubercularia vulgaris-like)
4. Anamorph of *Nectria aurantiaca* (*Tubercularia aurantiaca*)
6. Anamorph of *Nectria balansae*
7. Anamorph of *Nectria berberidicola* (sporodochial tubercularia-like)
10. *Tubercularia vulgaris* (anamorph of *Nectria cinnabarina*)
11. Anamorph of *Nectria dematiosa* (tubercularia vulgaris-like)
12. Anamorph of *Nectria eustromatica*
16. Anamorph of *Nectria magnispora* (pycnidial on natural substrata)
17. Anamorph of *Nectria mariae*
19. *Tubercularia ulmea* (anamorph of *Nectria nigrescens*)
23. Anamorph of *Nectria polythalama* (synnematous, tubercularia-like)
25. Anamorph of *Nectria pseudocinnabarina* (tubercularia lateritia-like)
26. *Tubercularia lateritia* (anamorph of *Nectria pseudotrichia*)
28. Anamorph of *Nectria sordida* (irregularly sporodochial in the natural environment)

Colony

1. Colony diameter on PDA at 25 °C after 1 wk

a. rapid (> 60 mm diam)	**6, 10, 19, 23, 25, 26, 28**
b. relatively rapid (40–60 mm diam)	**3, 11**
c.moderate (20–40 mm diam)	**1, 4, 16**
d. slow (< 20 mm diam)	**7, 12, 17**

2. Colour of colony

a. dull yellow	**12**
b. flesh	**16**
c. ochreous	**25**
d. orange	**23, 26**
e. pink	**23**
f. saffron	**17, 25**
g. salmon	**16**
h. white	**1, 3, 4, 7, 10, 11, 19**
i. whitish brown	**28**
j. whitish saffron	**3, 10, 11, 19**
k. whitish yellow	**1, 4, 6, 7, 12, 17, 28**
l. yellowish brown	**23, 26**

Lateral phialidic pegs

1. Existence of lateral phialidic pegs

a. absent **6, 12, 16, 17, 28**
b. present **1, 3, 4, 7, 10, 11, 19, 23, 25, 26**
2. Shape
a. ellipsoidal **1, 3, 4, 7, 10, 11, 19, 23, 25, 26**
b. flask-shaped **7**
3. Average length
a.< 5 µm **1, 3, 7, 10, 11, 19**
b. > 5 µm **4, 23, 25, 26**

Monochasial branching conidiophores

1. Existence of monochasial branching conidiophores
a. absent **3, 4, 7, 10, 11, 19, 23, 25, 26**
b. present **1, 12, 16, 17, 28**
2. Length
a. up to 100 µm **17, 28**
b. up to 200 µm **1, 16**
c. no data **12**

Young conidia

1. Existence of young conidia
a. absent **6, 12, 16, 17, 28**
b. present **1, 3, 4, 7, 10, 11, 19, 23, 25, 26**
2. Shape
a. cylindrical **1, 3, 7, 10, 11, 19**
b. ellipsoidal **1, 3, 4, 7, 10, 11, 19, 23, 25, 26**
c. fusiform **4, 23, 25, 26**
d. oblong **1, 3, 4, 7, 10, 11, 19**
e. obovate **23, 25, 26**
f. subglobose **23, 25, 26**
3. Average length
a. 5–7.5 µm **1, 7, 19, 23, 25, 26**
b. 7.5–10 µm **3, 4, 10, 11**
4. Average width
a. 1.5–2.5 µm **19**
b. 2.5–3.5 µm **1, 3, 4, 7, 10, 11, 23, 25, 26**

Mature conidia

1. Existence of mature conidia
a. absent **6, 12, 16, 17, 28**
b. present **1, 3, 4, 7, 10, 11, 19, 23, 25, 26**
2. Surface
a. smooth **3, 4, 7, 10, 11, 19, 23, 25**
b. rough **1**
3. Shape
a. allantoid **1, 3, 10, 11, 19, 23, 25, 26**
b. cylindrical **4, 7**
c. ellipsoidal **1, 3, 4, 10, 11, 19**
d. oblong **1, 3, 4, 7, 10, 11, 19, 23, 25, 26**
4. Average length
a. 10–12.5 µm **1, 19, 25, 26**
b. 12.5–15.0 µm **3, 4, 7, 10, 11, 23**
5. Average width
a. 3.0–4.0 µm **4, 7, 25, 26**
b. 4.0–5.0 µm **1, 3, 10, 11, 19, 23**

Microconidia

1. Existence of micro-conidia
a. absent **1, 3, 4, 7, 10, 11, 19, 23, 25, 26**
b. present **12, 16, 17, 28**
c. unknown **6**

2. Shape
   a. cylindrical **12**
   b. ellipsoidal **16, 17, 28**
   c. fusiform **28**
   d. long-fusiform **16, 17**
   e. oblong **12, 17**
3. Average length
   a. < 7.5 μm **16**
   b. > 7.5 μm **12, 17, 28**
4. Average width
   a. 1.5–2.5 μm **16**
   b. 2.5–3.5 μm **12, 28**
   c. 3.5–4.0 μm **17**

Macroconidia

1. Existence of macro-conidia
   a. absent **1, 3, 4, 7, 10, 11, 19, 23, 25, 26**
   b. present **12, 16, 17, 28**
   c. unknown **6**
2. Shape
   a. cylindrical **12**
   b. ellipsoidal **12, 16, 17, 28**
   c. long–fusiform **16**
   d. oblong **12**
   e. subglobose **17, 28**
3. Average length
   a. 10–20 μm **16, 17**
   b. 20–30 μm **28**
   c. 30–40 μm **12**
4. Average width
   a. 5–10 μm **16**
   b. 10–15 μm **12, 17, 28**

PLEONECTRIA

Teleomorph on natural substrata

1. *Pleonectria aquifoli*
2. *Pleonectria aurigera*
3. *Pleonectria austroamericana*
4. *Pleonectria balsamea*
5. *Pleonectria berolinensis*
6. *Pleonectria boothii*
7. *Pleonectria chlorinella*
8. *Pleonectria clavatispora*
9. *Pleonectria coryli*
10. *Pleonectria cucurbitula*
11. *Pleonectria ilicicola*
12. *Pleonectria lamyi*
13. *Pleonectria lonicerae*
14. *Pleonectria missouriensis*
15. *Pleonectria okinawensis*
16. *Pleonectria pinicola*
17. *Pleonectria pseudomissouriensis*
18. *Pleonectria pyrrhochlora*
19. *Pleonectria quercicola*
20. *Pleonectria rosellinii*
21. *Pleonectria rubicarpa*
22. *Pleonectria sinopica*
23. *Pleonectria sphaerospora*
24. *Pleonectria strobi*
25. *Pleonectria virens*

26. *Pleonectria zanthoxyli*

Stroma

1. Size (high)
    - a. up to 1 mm **4, 6, 7, 10, 13, 16, 18–21, 24, 26**
    - b. up to 2 mm **2, 8, 11, 14, 15, 17, 22, 23, 25**
    - c. up to 3 mm **1, 3, 5, 9, 12**
2. Size (diam)
    - a. up to 1 mm **7, 19, 24**
    - b. up to 2 mm **1, 2, 4, 6, 8, 10, 14–17, 20, 21**
    - c. up to 3 mm **5, 9, 11, 12, 18, 22, 25, 26**
    - d. up to 4 mm **13, 23**
    - e. up to 7 mm **3**

Perithecia

1. Position in stroma
    - a. nearly or completely immersed in substrate **13, 18, 25, 26**
    - b. nearly immersed in stroma (developed yellow scurf) **3, 7, 23**
    - c. superficial **1–6, 8–12, 14–17, 19–25**
2. Surface
    - a. scaly **11, 12, 14, 16, 17, 19, 20**
    - b. scurfy **1, 2, 4–6, 8–11, 12, 13, 16, 17, 20–22, 24**
    - c. smooth **15**
    - d. smooth to rough, covered by aboundant scurf **3, 7, 18, 23, 25, 26**
3. Colour
    - a. bay **1, 2, 4, 5, 8, 9, 11, 12, 14–16, 20, 22**
    - b. chestnut **13, 19**
    - c. dark green **25**
    - d. greenish yellow **18, 25, 26**
    - e. orange **17**
    - f. red **4, 6, 8, 10, 14, 15, 20, 21, 24**
    - g. reddish grey **3, 23**
    - h. rust **13**
    - i. scarlet **1, 2, 5, 9, 11, 12, 16, 21, 22**
    - j. sienna **7, 13, 19**
    - k. umber **6, 10, 17, 18, 24, 26**
    - l. yellowish brown **3, 23**

Ascospores

1. Shape
    - a. allantoid **2, 26**
    - b. clavate **8**
    - c. cylindrical **4, 5, 6, 9, 14**
    - d. ellipsoidal **1, 2, 5, 11–15, 17, 18, 21, 22, 25, 26**
    - e. filiform **19**
    - f. fusiform **1, 4, 5, 7, 9, 12, 13, 15–17, 21, 22, 25**
    - g. long cylindrical **6**
    - h. long filiform **10, 20, 24**
    - i. long fusiform **4, 16**
    - j. oblong **2**
    - k. subglobose **3, 18, 23**
2. Septation
    - a. 1-septate **1, 9, 11, 15, 17, 21, 22**
    - b. multiseptate **2, 10, 19, 20, 24**
    - c. muriform **3–8, 12–14, 16, 18, 23, 25, 26**
3. Surface
    - a. smooth **1–14, 16, 18–26**
    - b. spinulose **15**
    - c. striate **17**
4. Ascoconidia
    - a. absent **2, 3, 11, 13, 14, 17, 18, 21, 22, 25, 26**

  b. present inside asci … **1, 4, 6–10, 12, 16, 19, 20, 23, 24**
  c. present outside asci only … **5, 15**
5. Existence of part–ascospores
  a. absent … **1–6, 8–26**
  b. present … **7**
6. Average length
  a. < 10 µm … **23**
  b. 10–15 µm … **1, 3, 9, 11, 15, 17, 21, 22**
  c. 15–20 µm … **2, 5, 8, 13, 18, 25**
  d. 20–25 µm … **4, 7, 12, 16, 26**
  e. 25–30 µm … **6, 14 (microascospores)**
  f. 30–35 µm … **19**
  g. 35–40 µm … **20**
  h. 40–45 µm … **14 (macroascospores), 24**
  i. > 45 µm … **10**
7. Average width
  a. < 2.5 µm … **4**
  b. 2.5–5 µm … **1, 6, 9, 10, 16, 19–21, 24**
  c. 5–7.5 µm … **2, 3, 5, 8, 11–13, 15, 17, 22, 23, 25**
  d. 7.5–10 µm … **7, 18, 26**
  e. 10–12.5 µm … **14 (microascospores), 14 (macroascospores)**

Geographical distribution

1. Asia
  a. Japan … **15, 16, 20**
  b. Mongolia … **5**
  c. Pakistan … **12, 16**
  d. Taiwan … **16**
2. Caribbean
  a. Puerto Rico … **21**
3. Europe
  a. Austria … **5, 9, 10, 12, 18, 22**
  b. Belgium … **9**
  c. Bosnia … **5**
  d. Czech Republic … **5, 9, 10, 18, 22**
  e. Finland … **5, 9**
  f. France … **1, 2, 9–12, 20, 22, 25, 26**
  g. Germany … **1, 5, 9, 10, 12, 16, 18, 20, 22, 24**
  h. Hungary … **12**
  i. Ireland … **22**
  j. Italy … **5, 12, 20, 22**
  k. Latvia … **5**
  l. Netherlands … **10, 22**
  m. Poland … **5**
  n. Russia … **16**
  o. Slovakia … **6**
  p. Spain … **19**
  q. Sweden … **9, 10, 12**
  r. Switzerland … **22**
  s. UK … **1, 11, 21, 22**
  t. Ukraine … **12**
4. North America
  a. Canada … **4, 5, 9, 12, 20, 24, 25, 26**
  b. USA … **2–5, 7–10, 13, 14, 16, 20, 21, 23–26**
5. South America
  a. Argentina … **3, 17**
  b. Brazil … **3, 26**
  c. Paraguay … **3**

Anamorph on natural substrata

3. zythiostroma-like (Anamorph of *Pleonectria austroamericana*)

4. zythiostroma-like (Anamorph of *Pleonectria balsamea*)
6. zythiostroma-like (Anamorph of *Pleonectria boothii*)
10. *Zythiostroma pinastri* (Anamorph of *Pleonectria cucurbitula*)
11. zythiostroma-like (Anamorph of *Pleonectria ilicicola*)
12. zythiostroma-like (Anamorph of *Pleonectria lamyi*)
14. zythiostroma-like (Anamorph of *Pleonectria missouriensis*)
15. zythiostroma-like (Anamorph of *Pleonectria okinawensis*)
16. zythiostroma-like (Anamorph of *Pleonectria pinicola*)
19. zythiostroma-like (Anamorph of *Pleonectria quercicola*)
20. zythiostroma-like (Anamorph of *Pleonectria rosellinii*)
22. *Zythiostroma mougeotii* (Anamorph of *Pleonectria sinopica*)
23. zythiostroma-like (Anamorph of *Pleonectria sphaerospora*)
24. zythiostroma-like (Anamorph of *Pleonectria strobi*)

Pycnidia

1. Colour
    a. bay **6, 10, 12, 14–16, 20, 22, 24**
    b. chestnut **19**
    c. red **4, 10, 16**
    d. reddish grey **3**
    e. scarlet **20, 22, 24**
    f. sienna **11, 15, 19, 23**
    g. umber **4, 6, 12, 14, 23**
    h. yellowish brown **3**
2. Position
    a. only immersed **11, 19**
    b. only superficial **4, 6, 10, 12, 14–16, 20, 24**
    c. immersed and superficial **3, 22, 23**
3. Shape of pycnidia
    a. irregulary discoidal **12**
    b. irregulary subglobose **3, 11, 14, 19, 22–24**
    c. navicular **15**
    d. subglobose **3, 4, 6, 10, 16, 20, 22**

Conidiophores

1. Number of intercalary phialides on conidiophores
    a. up to 2 times **3, 11, 16, 19, 22, 23**
    b. up to 4 times **4, 6, 10, 12, 20, 24**
    c. up to 6 times **14**
    d. up to 8 times **15**
2. Existence of sterile hyphae mixed with phialides
    a. absent **4, 6, 10–12, 14, 15, 19, 20, 22–24**
    b. present **3, 16**

Conidia

1. Shape
    a. allantoid **6, 14, 15, 19, 22, 23**
    b. ellipsoidal **3, 4, 10–12, 15, 16, 20, 23, 24**
    c. oblong **4, 6, 10–12, 15, 16, 19, 20, 22, 24**
    d. oblong–ellipsoid **3, 14**
    e. obovate **3**
2. Average length
    a. 2.0–3.0 mm **3, 6**
    b. 3.0–4.0 mm .... **4, 10, 11, 12, 14–16, 20, 22 (microconidia)–24**
    c. 4.0–5.0 mm **19**
    d. 5.0–6.0 mm .... **22 (macroconidia)**
3. Average width
    a. < 1.0 mm **6, 14, 23**
    b. 1.0–2.0 mm **3, 4, 10–12, 15, 16, 19, 20, 22, 24**

Anamorph in culture

1. Anamorph of *Pleonectria aquifoli*
2. Anamorph of *Pleonectria aurigera*
3. zythiostroma-like (Anamorph of *Pleonectria austroamericana*)
4 zythiostroma-like (Anamorph of *Pleonectria balsamea*)
5. Anamorph of *Pleonectria berolinensis*
6. zythiostroma-like (Anamorph of *Pleonectria boothii*)
9. Anamorph of *Pleonectria coryli*
10. *Zythiostroma pinastri* (Anamorph of *Pleonectria cucurbitula*)
11. zythiostroma-like (Anamorph of *Pleonectria ilicicola*)
12. zythiostroma-like (Anamorph of *Pleonectria lamyi*)
15. zythiostroma-like (Anamorph of *Pleonectria okinawensis*)
16. zythiostroma-like (Anamorph of *Pleonectria pinicola*)
18. Anamorph of *Pleonectria pyrrhochlora*
19. zythiostroma-like (Anamorph of *Pleonectria quercicola*)
20. zythiostroma-like (Anamorph of *Pleonectria rosellinii*)
22. *Zythiostroma mougeotii* (Anamorph of *Pleonectria sinopica*)
24. zythiostroma-like (Anamorph of *Pleonectria strobi*)
25. Anamorph of *Pleonectria virens*
26. Anamorph of *Pleonectria zanthoxyli*

Colony

1. Colony diameter on PDA at 25 °C after 1 wk
    - a. rapid (> 60 mm diam) **4, 5, 10, 18, 20, 24, 26**
    - b. relatively rapid (40–60 mm diam) **12, 16**
    - c. moderate (20–40 mm diam) **1, 2, 3, 9, 11, 15, 22**
    - d. slow (< 20 mm diam) **6, 19, 25**
2. Colour of colony
    - a. greenish yellow **16, 18**
    - b. saffron **6**
    - c. white **1, 2, 4, 12, 15, 19, 25**
    - d. whitish brown **10, 19, 20, 24**
    - e. whitish green **16**
    - f. whitish orange **5**
    - g. whitish saffron **4, 12**
    - h. whitish yellow **1–3, 6, 9–11, 15, 18, 20, 22, 25, 26**
    - i. yellow **3, 5, 11**

Lateral phialidic pegs

1. Existence of lateral phialidic pegs
    - a. abundant **2–6, 9, 10, 12, 16, 18, 20, 22, 24–26**
    - b. rare **1, 3, 11, 15, 19**
2. Shape
    - a. ellipsoidal **1–6, 9–12, 15, 16, 18–20, 22, 24–26**
    - b. flask-shaped **2–6, 9, 12, 15, 16, 18, 22, 25, 26**

Conidiophores

1. Existence of conidiophores
    - a. absent **2, 20**
    - b. present **1, 3–6, 9–12, 15, 16, 18, 19, 22, 24–26**

Young conidia

1. Shape
    - a. allantoid .... **, 18, 19, 22, 25, 26**
    - b. cylindrical **3, 6, 12, 25, 26**
    - c. ellipsoidal **3, 4, 10, 15, 16, 18, 24–26**
    - d. fusiform **15, 18**
    - e. long cylindrical **1, 2, 5, 9, 11**
    - f. oblong **1–6, 9–12, 16, 19, 20, 22, 24, 25**
2. Average length
    - a. 3.0–4.0 µm **1, 2, 3, 18, 25**

b. 4.0–5.0 µm	**4, 6, 9–12, 15, 16, 20, 22, 24, 26**
c. 5.0–6.0 µm	**5, 19**
3. Average width	
a. < 1.0 µm	**18**
b. 1.0–2.0 µm	**1–4, 6, 9–12, 15, 16, 19, 20, 22, 24–26**
c. 2.0–3.0 µm	**5**

Mature conidia

1. Shape	
a. allantoid	**5, 6, 15, 20, 22**
b. clavate	**18, 25, 26**
c. C-shape	**12**
d. cylindrical	**22**
e. ellipsoidal	**1, 3, 5, 9, 11, 15, 18, 19, 25, 26**
f. fusiform	**15**
g. long cylindrical	**2, 6, 10, 12, 16, 20, 24**
h. oblong	**1, 3, 5, 9, 10, 11, 16, 18-20, 22, 24-26**
2. Septation	
a. 0-septate	**1, 2, 4, 6, 10–12, 15, 16, 18–20, 22, 24–26**
b. up to 1-septate	**3**
c. up to 2-septate	**5**
3. Average length	
a. 5.0–7.0 µm	**3, 4, 18, 19**
b. 7.0–9.0 µm	**1, 11, 12, 15, 16, 20, 22, 24, 25**
c. 9.0–11.0 µm	**2, 6, 9, 10, 26**
d. 11.0–13.0 µm	**5**
4. Average width	
a. 1.0–2.0 µm	**2, 6, 10, 24**
b. 2.0–3.0 µm	**1, 3, 4, 9, 11, 12, 15, 16, 18, 20, 22, 25, 26**
c. 3.0–4.0 µm	**19**
d. 3.0–4.0 µm	**5**
5. Existence of chlamydospores	
a. absent	**2–6, 9, 10, 12, 15, 16, 18, 20, 22, 24, 26**
b. present	**1, 11, 19, 25**
6. Existence of pycnidia in culture	
a. absent	**1, 2, 5, 6, 9–12, 16, 18–20, 22, 24**
b. present	**3, 4, 15, 25, 26**

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APPENDIX 1. Herbarium and isolate numbers used in illustrations.

Species	Fig No.	Herbarium and isolate No.
Allantonectria miltina	Fig. 4 A–I	A. BPI 629387; B. BPI 63012; C. BPI 878442; D, E. BPI 630120; F. BPI 630118; G–I. BPI 629387
	Fig. 5 A–C	A–C. BPI 630120
	Fig. 6 A–P	A–K. CBS 121121
Nectria antarctica	Fig. 7 A–U	A, B, D, F–I. LPS 1638 (Holotype); C, E. LPS 1639 (Holotype of *Pleonectria vagans*); J. FH 301310; K–U. FH 301308; M. FH 80856
	Fig. 8 A–F	A–C. LPS 1638 (Holotype); D–F. FH 301308
	Fig. 9 A–M	A–M. CBS 115033
Nectria argentinensis	Fig. 10 A–P.	A–P. NY ex BAFC 24.477 (Holotype)
	Fig. 11 A–F.	A–F. NY ex BAFC 24.477 (Holotype)
	Fig. 12 A–B.	A–B. NY ex BAFC 24.477 (Holotype)
Nectria asiatica	Fig. 13 A–Q	A, C–L, N–Q. BPI 879972 (Holotype); B, M. BPI 879980
	Fig. 14 A–F	A–F. BPI 879972 (Holotype)
	Fig. 15 A–K	A–F, H–K. MAFF 241439 (ex-holotype); G. MAFF241399
Nectria aurantiaca	Fig. 16 A–C	A–C. W 20389 (Holotype of *Dendrostilbella moravica*)
	Fig. 17 A–L	A–C, F–L. CBS 236.29; D, E. CBS 308.34
Nectria australiensis	Fig. 18 A–S	A, B, E–I, L–S. K 163335 (Holotype); C, D. BPI 1105494; J, K. K 163334 (possibly Isotype)
	Fig. 19 A–F	A–F. K 163335 (Holotype)
Nectria balansae	Fig. 20 A–N	A, B. BPI 553092; C. BPI 551019 (Lectotype of *Nectria sinensis*); D–J, L–M. BPI 878477; K. BPI 553091 (Paratype of *Nectria sinensis*); N. LPS 1574 (Holotype)
	Fig. 21 A–C	A–C. BPI 878477
	Fig. 22 A–D	A–D. CBS 129349
Nectria berberidicola	Fig. 23 A–T	A–T. LIP YMNC083 (Holotype)
	Fig. 24 A–F	A–F. LIP YMNC083 (Holotype)
	Fig. 25 A–P	A–P. CBS 128669 (ex-holotype)
Nectria canadensis	Fig. 26 A–Q	A, P. BPI 1107514; B, J–O, Q. BPI 631955; C, D, F–H. BPI 631952; E. BPI 550747; I. BPI 631953
	Fig. 27 A–F	A–F. BPI 631952
Nectria cingulata	Fig. 28 A–G	A–G. S F46419 (Lectotype)
	Fig. 29 A–C	A–C. S F46419 (Lectotype)
Nectria cinnabarina	Fig. 30 A–Q	A, C–I, BPI 1112880; B. BPI 878335; J. BPI 878313; K-Q. BPI 878310
	Fig. 31 A–F	A–C. BPI 879981 (Epitype); D–F. BPI 878313
	Fig. 32 A–M	A–M. CBS 125154
Nectria dematiosa	Fig. 33 A–P	A. BPI 879984; B. BPI 802215; C, E–J. BPI 879985; D. BPI 802212; K–P. BPI 878308
	Fig. 34 A–F	A–F. BPI 749337 (Epitype)
	Fig. 35 A–P	A–H, K, N. CBS 278.48; I, L, O. CBS 125125; J, M, P. MAFF 241416
Nectria himalayensis	Fig. 36 A–P	A–P. NY (Holotype)
	Fig. 37 A–F	A–F. NY (Holotype)
Nectria hoheriae	Fig. 38 A–P	A, C, F–P. PDD 21879 (Holotype); B, D, E. BPI 879118
	Fig. 39 A–F	A–F. PDD 21879 (Holotype)
Nectria lateritia	Fig. 40 A–Q	A, C–F. BPI 552479; B, H–Q. K 163338 (Isolectotype); G. BPI 552479
	Fig. 41 A–F	A. BPI 552479; B–F. K 163338 (Isolectotype)
Nectria magnispora	Fig. 42 A–M	A–M. TUA TPP-h122
	Fig. 43 A–E	A–E. TUA TPP-h122
	Fig. 44 A–P	A–P. MAFF 241418 (ex-holotype)
Nectria mariae	Fig. 45 A–I	A–I. BPI 881045 (Holotype)
	Fig. 46 A–C	A–C. BPI 881045 (Holotype)
	Fig. 47 A–N	A–N. CBS 125294 (ex-holotype)
Nectria neorehmiana	Fig. 48 A–M	A–M. BPI 552615 (Holotype)
	Fig. 49 A–F	A–F. BPI 552615 (Holotype)
Nectria nigrescens	Fig. 50 A–T	A, C–F, H, P–T. BPI 878449; B. BPI 879986; G, L, M. BPI 871083 (Epitype); I–K, N, O. BPI 878879
	Fig. 51 A–F	A–F. BPI 871083 (Epitype)
	Fig. 52 A–Q	A–C, E-G, J, K. CBS 125148 (ex-epitype); D, H, I. CBS 125162; L-Q. CBS 125164
Nectria noackiana	Fig. 53 A–O	A–O. Rehm, Ascomycetes, No. 1744, BPI-bound exsiccat (Lectotype)
	Fig. 54 A–F	A–F. Rehm, Ascomycetes, No. 1744, BPI-bound exsiccat (Lectotype)
Nectria novaezelandiae	Fig. 55 A–H	A–H. PDD 10426 (Holotype)
	Fig. 56 A–C	A–C. PDD 10426 (Holotype)
Nectria paraguayensis	Fig. 57 A–N	A, B, D–I. LPS 1605 (Holotype); C. BPI 631888 (Isotype of *Hypocreopsis moriformis*); J–N. BPI 631885
	Fig. 58 A–C	A–C. LPS 1605 (Holotype)
Nectria polythalama	Fig. 59 A–R	A–G. K(M) 163342 (Holotype); H–R. BPI 879097
	Fig. 60 A–F	A–F. K(M) 163342 (Holotype)
	Fig. 61 A–L	A–L. CBS 129240 (ex-epitype)

Nectria pseudadelphica	Fig. 62 A–I	A. BPI 737865; B, D, E. NY 01013167 (Lectotype); C, F–I. BPI 802791
	Fig. 63 A–C	A–C. NY 01013167 (Lectotype)
Nectria pseudocinnabarina	Fig. 64 A–Q	A, J, L, M-Q. BPI 802674; B. BPI 802443; C, D–H. BPI 881034; I, K. BPI 881037
	Fig. 65 A–F	A–F. BPI 881037
	Fig. 66 A–O	A–N. CBS 128673; O. CBS 129365
Nectria pseudotrichia	Fig. 67 A–W	A–F, O–W. BPI 881041; G–J, M, N. BPI 881074; K. L. BPI 881078
	Fig. 68 A–C	A–C. BPI 881074
	Fig. 69 A–F	A–F. BPI 881041
	Fig. 70 A–Q	A–Q. CBS 129368 (ex-epitype)
Nectria pyriformis	Fig. 71 A–I	A–I. NY No. 610 (Holotype)
	Fig. 72 A–C	A–C. NY No. 610 (Holotype)
Nectria sordida	Fig. 73 A–M	A–G, I–M. NY G.J. Samuels 3257; H. LPS 1619 (Holotype)
	Fig. 74 A–F	A–F. NY G.J. Samuels 3257
	Fig. 75 A–M	A–M. CBS 125119
Nectria tucumanensis	Fig. 76 A–M	A–M. LPS 1564 (Holotype)
	Fig. 77 A–C	A–C. LPS 1564 (Holotype)
Pleonectria aquifolii	Fig. 78 A–J	A. BPI 552405; B. BPI 550128; C–I. BPI 552407; J. LUX 042143 (Lectotype of *Nectria aquifolii* var. *appendiculata*)
	Fig. 79 A–C	A–C. BPI 550125 (Neotype)
	Fig. 80 A–N	A–N. CBS 307.34 (ex-neotype)
Pleonectria aurigera	Fig. 81 A–J	A, F–J. BPI 841465; B. BPI 550168 (Isolectotype)
	Fig. 82 A–C	A–C. BPI 841465
	Fig. 83 A–M	A–M. CBS 109874
Pleonectria austroamericana	Fig. 84 A–Q	A, F–I. BPI 550180; B. BPI 802825; C. LPS 1624 (Holotype of *Pleonectria guaranitica*); D. BPI 746395; E. BPI 632056; J. BPI 550199; K, L. BPI 632519; M–Q. BPI 550174
	Fig. 85 A–E	A–E. BPI 632056
	Fig. 86 A–K	A–J. CBS 126114; K. CBS 125134
Pleonectria balsamea	Fig. 87 A–S	A. BPI 881046; B, E, F. NCSU; C. BPI 1108889; D. BPI 747282; G–J. BPI 746321; K, L. BPI 747285; M–S. BPI 747283
	Fig. 88 A–F	A–F. BPI 746322
	Fig. 89 A–Q	A, C–Q. CBS 125132; B. CBS 129371
Pleonectria berolinensis	Fig. 90 A–N	A. BPI 859321; B. BPI 1107321; C, E, F. BPI 859029; D. BPI 867359; G–I. BPI 550718; J–L. BPI 550691; M. BPI 550721; N. BPI 550726
	Fig. 91 A–C	A, B. BPI 746346 (Epitype); C. BPI 550691
	Fig. 92 A–O	A–E, G–O. CBS 126112 (ex-epitype); F. CBS 128980
Pleonectria boothii	Fig. 93 A–S	A–S. BPI 881052 (Holotype)
	Fig. 94 A–F	A–F. BPI 881052 (Holotype)
	Fig. 95 A–I	A–I. CBS 128977 (ex-holotype)
Pleonectria chlorinella	Fig. 96 A–M	A, B, E-G. Hesler, NY; C. BPI 632607; D, H-M. Ravenel, Fungi Americani, No. 736, BPI-bound exsiccati (Lectotype)
	Fig. 97 A–D	A–D. Hesler, NY
Pleonectria clavatispora	Fig. 98 A–H	A–H. BPI 552452 (Holotype)
	Fig. 99 A–C	A–C. BPI 552452 (Holotype)
Pleonectria coryli	Fig. 100 A–N	A, F–N. BPI 881054; B. BPI 551427; C. Krieger, Fungi saxonici, No. 1067, BPI-bound exsiccati; D. H 6011373 (Lectotype of *Coelosphaeria acervata*); E. BPI 746347.
	Fig. 101 A–C	A–C. BPI 881054
	Fig. 102 A–L	A, B, K. CBS 114603; C–J. CBS 129358; L. CBS 129744
Pleonectria cucurbitula	Fig. 103 A–S	A. F7047 (S); B. F7052 (S); C. BPI 632771; D-S. BPI 746348 (Epitype)
	Fig. 104 A–F	A–F. BPI 746348 (Epitype)
	Fig. 105 A–M	A. CBS 125130 (ex-epitype); B. CBS 541.70; C, D, F, H–J. CBS 178.73; E, K. CBS 301.75; G. CBS 178.73; L, M. CBS 259.58
Pleonectria ilicicola	Fig. 106 A–O	A, C, D. BPI 880698; B. BPI 879857; E–G. BPI 881056; H–O. BPI 881055 (Holotype)
	Fig. 107 A–F	A–F. BPI 881055 (Holotype)
	Fig. 108 A–N	A–G. CBS 125147; H–N. CBS 125171 (ex-holotype)
Pleonectria lamyi	Fig. 109 A–R	A. BPI 552463; B, D-F. BPI 552462; C, G–R. BPI 746349
	Fig. 110 A–F	A–F. BPI 746349
	Fig. 111 A–M	A–M. CBS 115034
Pleonectria lonicerae	Fig. 112 A–K	A–K. FH 00258958 (Holotype)
	Fig. 113 A–C	A–C. FH 00258958 (Holotype)
Pleonectria missouriensis	Fig. 114 A–P	A, B, H. NY “specimen 2” (Isolectotype); C–G, I–P. NY ID 00927928 (Lectotype)
	Fig. 115 A–G	A–G. NY ID 00927928 (Lectotype)

Pleonectria okinawensis	Fig. 116 A–Q	A–Q. BPI 881058 (Holotype)
	Fig. 117 A–F	A–F. BPI 881058 (Holotype)
	Fig. 118 A–Q	A–Q. MAFF 241410 (ex-holotype)
Pleonectria pinicola	Fig. 119 A–U	A, B, I–K. BPI 881060; C. BPI 629745; D–H, L–U. BPI 881061
	Fig. 120 A–F	A–F. BPI 881061
	Fig. 121 A–L	A, B, D, F–J, L. CBS 125167; C. CBS 125166; E. CBS 128979; K. MAFF 241458
Pleonectria pseudomissouriensis	Fig. 122 A–H	A–H. NY (Holotype)
	Fig. 123 A–C	A–C. NY (Holotype)
Pleonectria pyrrhochlora	Fig. 124 A–J	A, B. BPI 553008; C. BPI 553007; D, G, H, J. Rabenhorst, Fungi europaei. No 1234, FH (Lectotype); E. S F6223 (Isolectotype); F. S F6222 (Isolectotype); I. BPI 746398
	Fig. 125 A–C	A–C. Rabenhorst, Fungi europaei. No 1234, FH (Lectotype)
	Fig. 126 A–J	A–J. CBS 125131
Pleonectria quercicola	Fig. 127 A–O	A–O. BPI 871328 (Holotype)
	Fig. 128 A–E	A–E. BPI 871328 (Holotype)
	Fig. 129 A–J	A–J. CBS 128976 (ex-holotype)
Pleonectria rosellinii	Fig. 130 A–S	A. BPI 1107511; B. BPI 632756; C, D, H–J. BPI 881063; E–G. BPI 881062; K–S. BPI 747280
	Fig. 131 A–F	A–C. BPI 881062; D–F. BPI 747280
	Fig. 132 A–L	A, C–I, K. MAFF 241403; B. CBS 128975; J, L. MAFF 241459
Pleonectria rubicarpa	Fig. 133 A–J	A, B. BPI 553073; C. BPI 553071; D–J. NY (Isolectotype)
	Fig. 134 A–C	A–C. NY (Isolectotype)
Pleonectria sinopica	Fig. 135 A–Q	A, D–H. BPI 881067; B. BPI 553103; C. BPI 553098; I–N. BPI 111765; O–Q. BPI 553098
	Fig. 136 A–H	A–H. BPI 881067
	Fig. 137 A–N	A, F–H. CBS 128981; B, C, J, K, M. CBS 125169; D, E, I, L, N. CBS 462.83
Pleonectria sphaerospora	Fig. 138 A–P	A–C, F–J. NY 00883502 (Isolectotype); D, E, L, M. NY 00883501 (Lectotype); K, N-P. BPI 629728.
	Fig. 139 A–F	A–F. NY 00883502 (Isolectotype)
Pleonectria strobi	Fig. 140 A–Q	A–C, M–Q. BPI 632663; D–I. BPI 632686; J–L. BPI 1112876
	Fig. 141 A–F	A–F. BPI 632663
	Fig. 142 A–L	A–L. CBS 129363
Pleonectria virens	Fig. 143 A–J	A. Ellis & Everhart, North American Fungi Second Series no. 2751, NY; B. Ellis & Everhart, North American Fungi Second Series no. 2546, BPI-bound exsiccati; C. BPI 553331; D. BPI 553004; E–J. BPI 881068
	Fig. 144 A–C	A–C. BPI 881068
	Fig. 145 A–P	A–P. A.R. 4558
Pleonectria zanthoxyli	Fig. 146 A–K	A. BPI 553334; B. NY from Canada; C. NY from USA; D–K. BPI 553328
	Fig. 147 A–C	A–C. BPI 553328
	Fig. 148 A–P	A–K. CBS 124736; L–P. CBS 126113
Gyrostroma sinuosum	Fig. 149 A–I	A–I. VIZR 123 (Holotype)
Nectria jodinae	Fig. 150 A–D	A–D. LPS 1589 (Holotype)
Nectria tropicalis	Fig. 151 A–F	A–F. LPS 1568 (Holotype)
Nectricladiella viticola	Fig. 152 A–C	A–C. BPI 798407 (Lectotype)
Neocosmospora guarapiensis	Fig. 153 A–K	A–H. BPI 802512; I. BPI 802511; J, K. BPI 802516
Neocosmospora rehmiana	Fig. 154 A–K	A–J. GZU inv.-Nr. 102-94 (Isolectotype); K. Illustration of *Calonectria rehmiana* (Wollenweber 1916)

A.R.: Amy Y. Rossman, USDA-ARS MD USA; **BAFC**: Universidad de Buenos Aires, Buenos Aires, Argentina; **BPI**: U.S. National Fungus Collections USDA-ARS MD USA; **CBS**: Centraalbureau voor Schimmelcultures, Utrecht, The Netherlands; **FH**: Farlow Reference Library and Herbarium of Cryptogamic Botany, Harvard University, MA, USA; **GZU**: Karl-Franzens-Universitaet, Austria; **H**: Botanical Herbarium, Finnish Museum of Natural History, University of Helsinki, Wien, Austria; **K**: Royal Botanic Gardens, Kew, UK; **LPS**: Instituto de Botánica Carlos Spegazzini, Buenos Aires, Argentina; **LUX**: Musée National d'Histoire Naturelle de Luxembourg, Luxembourg; **MAFF**: MAFF Genebank, National Institute of Agrobiological Sciences, Ibaraki, Japan; **NCSU**: The Mycological Herbarium, North Carolina State University, NC, USA; **NY**: William and Lynda Steere Herbarium, The New York Botanical Garden, NY, USA; **PDD**: New Zealand Fungus Herbarium, Auckland, New Zealand; **S**: Herbarium of the Botany Department, Swedish Museum of National History, Stockholm, Sweden; **TUA-TPP-h**: Yuuri Hirooka, Tropical Plant Protection Lab Herbarium, Tokyo University of Agriculture, Tokyo Japan; **VIZR**: Mycological Herbarium of the Mycology and Phytopathology Laboratory, All-Russian Institute of Plant Protection, Pushkin, Russia; **W**: Herbarium, Department of Botany, Naturhistorisches Museum, Wien, Austria.

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