Selbyana 16(1): 49–73

THE FUNGAL COMMUNITY ASSOCIATED WITH THE ROOTS OF SOME RAINFOREST EPIPHYTES OF COSTA RICA

KATHERINE A. RICHARDSON

Microfungus Collection & Herbarium, Devonian Botanic Garden, University of Alberta, Edmonton, Alberta, Canada T6G 2E1

R. S. CURRAH*

Department of Biological Sciences, CW-405 Biological Sciences Building University of Alberta, Edmonton, Alberta, Canada T6G 2E9

ABSTRACT. At La Selva Biological Station, Costa Rica, we carried out a survey of the microfungi (Ascomycotina and Fungi Imperfecti (Hyphomycetes and Coelomycetes)) associated with the roots of epiphytic orchids and with selected epiphytes from the Araceae, Bromeliaceae, Piperaceae and Polypodiaceae. Numerous isolations were recovered from surface sterilized roots. The Xylariaceae and Nectriaceae were the major groups of ascomycetes isolated. A large number of Fungi Imperfecti including in the Hyphomycetes, the Ingoldian aquatic *Tetracladium,* and an unidentified species of *Acrogenospora,* were recovered. Numerous isolates of *Pestalotiopsis* and *Colletotrichum* species comprised the majority of the Coelomycetes identified. Enumerating and analysing the components of the mycobiota in this habitat presents a major challenge as the taxa are mostly microscopic and require painstaking isolation procedures that introduce serious sampling bias to results. Our isolates represent a small part of the spectrum of the mycorrhizal, saprophytic and parasitic fungi that play important roles in sequestering, transforming and translocating nutrients among the primary producers in the epiphytic habitat.

INTRODUCTION

There are relatively few reports concerning the microfungal flora of the neotropics (e.g. Dreyfuss & Petrini 1984, Farrow 1954, Goos 1960, Morris 1972, Bills & Polishook 1994) and only a small subset of these has dealt with fungi associated with roots of plants in forest canopies (e.g. Bermudes & Benzing 1989, Lesica & Antibus 1990, Richardson *et al.* 1993). The ecological role played by microfungi in this unique environment must be at least as great as in soil-based systems (Christensen 1989). Understanding this role depends ultimately on information concerning the composition and structure of the fungal communities present.

During a study of the mycorrhizal endophytes of the epiphytic orchids native to La Selva Biological Station, Costa Rica, we isolated a broad range of fungi from surface sterilized root segments of both orchids and other epiphytic families (Bromeliaceae, Araceae, Piperaceae and Polypodiaceae). This paper presents a floristic account of the Ascomycotina and anamorphic fungi in two classes of the Fungi Imperfecti, the Hyphomycetes and the Coelomycetes. An account of most of the Basidiomycotina recovered can be found in Richardson *et al.* (1993). Detailed descriptions are provided to expedite future investigations of the fungal community of canopy habitats.

MATERIALS AND METHODS

Collections of orchids as well as a limited number of species in five other epiphytic tropical families (Araceae, Bromeliaceae, Piperaceae and Polypodiaceae) were made between March and May 1991 and again during October and November 1991 at La Selva Biological Station located in the Atlantic lowland rainforest of Costa Rica between 10°24′–26′ N latitude and 84°00′–02′ W longitude at the junction of the Rio Sarapi and Rio Puerto Viejo.

Plants were collected from recently fallen limbs and trees and from tree sites within reach. Orchid identifications follow Atwood (1988) and fern identifications follow Grayum and Churchill (1989). Voucher specimens have been deposited in the University of Alberta Herbarium (ALTA), the Marie Selby Botanic Garden Herbarium (SELBY) or the Herbarium of the National Museum, Costa Rica (CR). Samples of roots from each plant collection were excised, rinsed in tap water, wrapped in moistened paper towelling, and again in aluminum foil, and kept refrigerated until used for isolating fungi.

* Author to whom correspondence should be addressed.

TABLE 1. Epiphytic orchid species native to La Selva Biological Station, Costa Rica, which yielded endophytic fungal isolates.

Ref. #	Orchid species	Ref. #	Orchid species
1	*Campylocentrum micranthum* (Lindl.) Rolfe	27	*Oncidium stenotis* Rchb. f.
2	*Catasetum maculatum* Kunth	28	*Platystele lancilabris* (Rchb. f.) Schltr.
3	*Dichaea stanleyi* Ames	29	*Pleurothallis corniculata* (Sw.) Lindl.
4	*D. trulla* Rchb. f.	30	*P. guanacastensis* Ames & Schweinf.
5	*Dimerandra emarginata* (Lindl.) Siegrist	31	*P. pantasmi* Rchb. f.
6	*Dryadella pusiola* (Rchb. f.) Luer	32	*P. periodica* Ames
7	*Encyclia fragrans* (Sw.) Lamee	33	*P. phyllocardioides* Schltr.
8	*Epidendrum difforme* Jacq.	34	*P. uncinata* Fawc.
9	*E. isomerum* Schltr.	35	*P. verecunda* Schltr.
10	*E. nocturnum* Jacq.	36	*Pleurothallis* sp.
11	*E. octomerioides* Schltr.	37	*Polystachya foliosa* (Hook.) Rchb. f.
12	*E. schlecterianum* Ames	38	*Rodriguezia compacta* Schltr.
13	*E. stangeanum* Rchb. f.	39	*Scaphyglottis gracilis* (Schltr.) Schltr.
14	*Gongora unicolor* Schltr.	40	*S. minutiflora* Ames & Correll
15	*Hexisea imbricata* (Lindl.) Rchb. f.	41	*S. prolifera* Cogn.
16	*Jacquiniella globosa* (Jacq.) Schltr.	42	*Sobralia mucronata* Ames
17	*Maxillaria confusa* Ames & Schweinf.	43	*S. powellii* Schltr.
18	*M. endresii* Rchb. f.	44	*Sobralia* sp.
19	*M. neglecta* (Schltr.) L. O. Wms.	45	*Stelis endresii* Rchb. f. vel aff.
20	*M. nicaraguensis* (Hamer & Garay) Atwood	46	*Stelis* sp.
21	*M. uncata* Lindl.	47	*Trichosalpinx blasdellii* (S. Wats.) Luer
22	*M. xylobiiflora* Schltr.	48	*T. orbicularis* (Lindl.) Luer
23	*Maxillaria* sp.	49	*Trichosalpinx* sp.
24	*Myoxanthus scandens* (Ames) Luer	50	*Trigonidium egertonianum* Bateman ex Lindl.
25	*Nidema boothii* (Lindl.) Schltr.	51	*T. riopalenquense* Dodson
26	*Octomeria graminifolia* (L.) R. Br.		

A portion of each root sample was cleared and stained to observe the fungi on and within the root. Each root segment was cut into five 1–2 cm long pieces, cleared in 20% KOH for 90 min at 90° C, washed in a 1% HCl solution, and rinsed in 50% ethanol. Root pieces were placed on microscope slides, stained for 5 min in lactophenol cotton blue and made permanent using glycerine jelly as a mounting medium. A segment from each sample was examined for the presence, morphology and disposition of fungal cells.

To obtain fungal endophytes in culture, segments of intact, healthy roots were surface sterilized in 20–30% household bleach followed by two rinses in distilled water. Four pieces, chosen at random, were plated onto 9 cm diam Petri dishes containing cornmeal agar (CMA, Difco) to which 0.01% tetracycline had been added to inhibit bacterial growth. Fungi growing out from the roots were subcultured onto CMA or potato dextrose agar (PDA, Difco) to obtain pure cultures for identification. Colour descriptions of colonies (MHC numbers in brackets) follow Kornerup and Wanscher (1983). Some of the isolates have been deposited in the University of Alberta Microfungus Collection and Herbarium (UAMH). Growth rates were monitored on PDA and CMA (12 hr light/12 hr dark) until the mycelium reached the edge of the Petri dish and then averaged. For some of the xylariaceous isolates, malt extract agar (MEA) was used for comparison purposes. In a few cases, septal ultrastructure was examined by transmission electron microscopy following the methods in Currah and Sherburne (1992).

RESULTS

From the 436 root collections, 763 fungal isolates were obtained from 55 epiphytic orchid species (TABLE I). A portion of the isolates were discarded because of bacterial contamination or redundancy. Some died in storage. Fifty fungal genera representing 67 species are reported as endophytes from neotropical orchid roots and are correlated to the orchid species from which they were obtained (TABLES II–IV). A large number of isolates (18.0%) remained sterile and could not be identified further. The largest group of fungi recovered was the Hyphomycetes (44.7%), followed by the Coelomycetes (29.5%), Ascomycotina (5.0%) and the Basidiomycotina (2.8%) (FIGURE I). Cultural and morphological descriptions are provided below. Where both anamorph and teleomorph stages formed, the anamorph is described under the teleomorph name.

TABLE 2. Ascomycetes isolated from tropical epiphyte roots. Numbers for hosts refer to orchid species listed in TABLE 1. * Non-orchids are referred to by family: AR = Araceae, PO = Polypodiaceae, BR = Bromeliaceae. Taxa in parentheses represent the anamorphic state of the ascomycete.

Endophytic fungi (Ascomycetes)	Number of isolates	Recorded hosts (refer to TABLE 1)
Calonectria kyotensis (stat. an. *Cylindrocladium scoparium*)	1	1
Chaetomium aureum	1	51
C. funicola	1	36
C. homopilatum (stat. an. *Humicola* sp.)	2	6, AR*
C. subspirale (stat. an. *Botryotrichum* sp.)	3	19, 27, 32
Eupenicillium shearii	1	PO
Glomerella cingulata (stat. an. *Colletotrichum gloeosporioides*)	5	2, 7, 19, 44, AR
Hypoxylon cf. *unitum*	4	2, 14, 30, 46
Leptosphaerulina australis	2	25, 38
Nectria alata (stat. an. *Penicillifer bipapillatus*)	4	3, 46, 48
N. haematococca (stat. an. *Fusarium solani*)	8	12, 19, 33, 34, 39, 44, 45, 51
N. ochroleuca (stat. an. *Gliocladium roseum*)	5	11, 19, 39, 41, 46
N. peziza	1	31
N. radicicola (stat. an. *Cyclindrocarpon destructans*)	1	46
Pseudallescheria boydii (stat. an. *Graphium* sp.)	2	7, 42
Xylaria sp. I	6	12, 14, 32, 37, 43, 46
Xylaria sp. II	1	30
Xylaria sp. III	4	19, 23, 46, BR

ASCOMYCETES

Calonectria kyotensis Terashita, Trans. Mycol. Soc. Japan 8: 124. 1968.

Cultural characteristics: On PDA growth rate 0.09–0.12 mm/hr; reverse mahogany brown (MHC 8E7), margin whitish-cream, wrinkled; surface mycelium caramel brown (MHC 6C6), low, with white mycelial tufts, margin white, narrow, irregular, partly submerged; ascomata appearing in 13 days. On CMA growth rate 0.16–0.18 mm/hr; reverse pale yellow to cream; surface mycelium white, aerial, fluffy. *Ascomata*: spherical, orange-red, walls of textura globulosa, 360–400 μm. *Asci*: cylindric, 50–72 × 12–14 μm. *Ascospores*: hyaline, cylindric, slightly curved, 1-septate, attenuated at the ends, 30 × 6 μm.

Anamorph: **Cylindrocladium scoparium** Morgan, Bot. Gaz. 17: 191. 1892.

Conidiophores: hyaline, septate, phialidic, stalked with penicillately branched, aseptate phialides at the apex, 80–95 × 3 μm, apical vesicle extending beyond phialides, swelling to 5 μm diam. *Conidia*: hyaline, (0–)1(–2)-celled, smooth, long cylindric, rounded-truncate ends, 19–29 × 4–4.8 μm.

Material examined: UAMH 7192 ex substrate roots of *Campylocentrum micranthum*. Distribution: temperate and tropical.

Notes: Holliday (1980) describes this species as a competitive soil saprophyte, rarely infecting aerial parts. It occurs on decaying leaves and fruits and roots of pines, tea and *Eucalyptus* (Myrtaceae) but is found rarely on monocots. It has been recorded once from rotting roots of *Paphiopedilum callosum* (Orchidaceae). Illustrations are provided in Rossman (1983).

Chaetomium aureum Chivers, Proc. Amer. Acad. Arts Sci. 48: 86. 1912.

Cultural characteristics: On PDA growth rate 0.08 mm/hr; reverse with a red diffusing pigment in the medium (MHC 6F7), changing to dark brown after 2 wk; surface mycelium yellow with a pink tinge at the margin, low. On CMA growth rate 0.10 mm/hr; reverse pinkish-orange; surface mycelium light yellow, low, cottony, margin uniform, ascomata present after 13 d. *Ascomata*: subglobose, walls of textura intricata, 120–150 × 75–125 μm; setae dark brown, warted, distantly septate, tips circinate, 4.5–5 μm at base tapering to 2.5 μm. *Asci*: clavate, stalked, 20–30 × 7–10 μm. *Ascospores*: smoky, lenticular to lunate, smooth, with 2 germ pores, 7–10 × 4–5 μm. *Anamorph*: absent.

Material examined: UAMH 7193 ex *Trigonidium riopalenquense*, on fallen branch 2–3 cm diam. Distribution: worldwide.

Chaetomium funicola Cooke, Grevillea 1: 176. 1873.

Cultural characteristics: On PDA growth rate 0.06–0.07 mm/hr; reverse orange-brown, wrinkled, margin cream; surface mycelium greyish black, aerial mycelium absent, medium buck-

TABLE 3. Hyphomycetes isolated from tropical epiphyte roots. Numbers for hosts refer to orchid species listed in TABLE 1. * Non-orchids are referred to by family: AR = Araceae, BR = Bromeliaceae, CY = Cyclanthaceae, PI = Piperaceae, PO = Polypodiaceae.

Endophytic fungi (Hyphomycetes)	Number of isolates	Recorded hosts (refer to TABLE 1)
Acremonium sp.	1	PI
Acrogenospora sp.	1	2
Alternaria alternata	2	7, 46
Arthrinium state of *Apiospora montagnei*	5	15, 17, 40, 42, 46
Chloridium virescens v. *chlamydosporum*	1	46
Cladosporium cladosporioides	1	32
Codinaea parva	1	2
Curvularia cymbopogonis	1	45
Dactylaria sp.	2	7, 25
Drechslera australiensis	3	19, 30, PO
Drechslera ellisii	1	18
Epicocchum nigrum	2	22, 44
Epicoccum andropogonis	11	2, 5, 7, 10, 14, 25, 35, 38, 46, 50
Fussarium oxysporum	1	13
Geotrichopsis sp.	1	32
Gliocladium penicillioides	1	12
Hadrotrichum sp.	32	1, 2, 3, 5, 7, 13, 15, 19, 21, 23, 31, 32, 37, 38, 46, 49, BR, PO
Humicola sp.	3	19, 27, 31
Malbranchea sp.	1	17
Monilia sp.	1	44
Mycelia sterilia group A	6	19, 23, 46, 49
Mycelia sterilia group B	11	2, 7, 13, 15, 36, 38, 46, BR
Nigrospora sphaerica	1	27
Nodulisporium sp.	7	7, 9, 13, 14, 51
Periconiella sp.	2	12, 51
Pithomyces maydicus	7	8, 13, 30, 34, 46, AR, CY
Ramichloridium cf. *subulatum*	1	36
Scytalidium lignicola	1	PO
Stilbella aciculosa	1	BR
Tetracladium maxilliforme	3	8, 12, 25
Troposporella sp.	1	2
Verticillium albo-atrum	1	BR

TABLE 4. Coelomycetes isolated from tropical epiphyte roots. Numbers for hosts refer to the orchid species listed in TABLE 1. * Non-orchids are referred to by family: AR = Araceae, BR = Bromeliaceae, CY = Cyclanthaceae, HA = Haemedoraceae, PI = Piperaceae, PO = Polypodiaceae.

Endophytic fungi (Coelomycetes)	Number of isolates	Recorded hosts (refer to TABLE 1)
Chaetostica cf. *perforata*	3	48, 50, BR
Colletotrichum acutatum	1	51
C. crassipes	14	1, 4, 7, 16, 19, 23, 24, 27, 38, 46, 48, 51
Cryptosporiopsis sp.	5	19, 21, 29, 46
Lasiodiplodia theobromae	14	1, 7, 8, 11, 25, 30, 33, 42, 44, 47, AR, BR
Lasmeniella sp.	1	14
Microsphaeropsis olivacea	1	CY
Neoplaconema napelli	1	46
Pestalotiopsis cf. *aquatica*	1	38
P. gracilis	1	20
P. papposa	7	11, 12, 14, 18, 25, 29, HA
Phomopsis cf. *orchidophila*	13	1,3, 11, 19, 25, 45, BR, PI, PO
Pyrenochaeta cf. *rubi-idaei*	1	36

ling, producing a yellow diffusing pigment, margin cream, irregular, partly submerged. On CMA growth rate 0.01–0.02 mm/hr; reverse cream; surface mycelium pale cream, aerial mycelium absent, margin undulating, ascomata abundant in 12 d. *Ascomata*: globose to ovate, walls of textura angularis, (75–)85–110(–120) μm; dimorphic warted setae, one type unbranched, dark brown, septate, tapering towards the apex, 4–5 μm, the second type dichotomously branching, pale brown, septate, 2.5–3.5 μm. *Asci*: fasciculate, clavate. *Ascospores*: light brown, lenticular to ovate, smooth, one apical germ pore, 4.5–6 × 3–4 μm. *Anamorph*: absent.

Material examined: UAMH 7194 ex *Pleurothallis* sp. on 20–30 cm diam branch. Distribution: cosmopolitan.

Notes: This isolate differs from the description given in von Arx *et al.* (1986) by having smaller ascomata. It was isolated from soil on Barro Colorado Island, Panama (Farrow 1954).

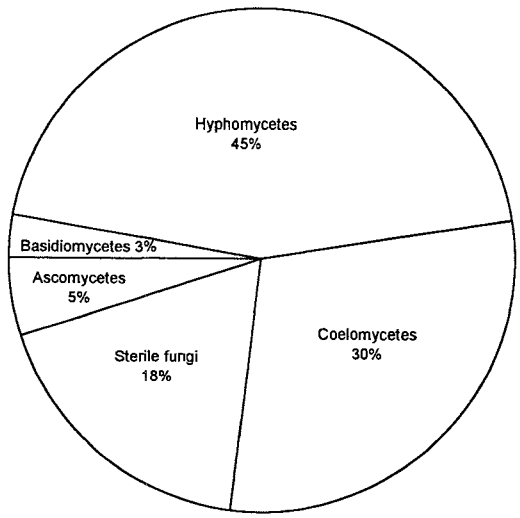


FIGURE 1. Percent of fungi from each fungal group, isolated from tropical epiphytic orchid roots.

Chaetomium homopilatum Omvik, Mycologia 47: 749. 1955.

Cultural characteristics: On PDA growth rate 0.15–0.17 mm/hr; reverse tan (MHC 6E6) to bronze (MHC 5E5), furrowed; surface mycelium yellow ochre (MHC 5C7) near center, hair brown to bronze (MHC 5E4–5F4) near margin, flat, furrowed, margin pale grey, irregular. On CMA growth rate 0.15–0.16 mm/hr; reverse pale brown; surface mycelium yellowish white (MHC 4A2), low, margin irregular, partly submerged, ascomata present after 9 d. *Ascomata*: obpyriform, walls of textura angularis, 155–220 × 75–125 μm, ostiolar beak cylindrical, 35–45 μm; setae straight to flexuous, septate, brown, tapering to a hyaline tip, unbranched, basal cells swollen, minutely punctate, 3–4.8 μm at the base, tapering to 2.4 μm. *Asci*: clavate, stalked, 25–31 × 9–10 μm. *Ascospores*: limoniform, biseriate, bilaterally flattened, umbonate at both ends, one apical germ pore, 7.5–10 × 6.5–7.5 × 4–5 μm.

Anamorph: **Humicola** state of **Chaetomium homopilatum**

Conidiophores: hyaline, unbranched, aseptate, 7–10 μm. *Conidia*: hyaline to pale brown, thick-walled, terminal, spherical to obovate, 8–12 μm.

Material examined: UAMH 7195 ex *Dryadella pusiola*. UAMH 7196 ex *Anthurium* sp. (Araceae). Distribution: Norway; on paper from soil.

Chaetomium subspirale Chivers, Proc. Amer. Acad. Arts Sci. 48: 84. 1912.

Cultural characteristics: On PDA growth rate 0.10–0.13 mm/hr; reverse dust to mouse grey (MHC 5D2–5E3), wrinkled, margin cream (MHC 4A2); surface mycelium white, light yellow (MHC 4A4) in center, aerial, margin sunken. On CMA growth rate 0.10–0.13 mm/hr; reverse yellow-cream, zonate; surface mycelium white, aerial, hairy. *Ascomata*: ovate, walls of textura angularis, 120–180 × 105–160 μm; setae unbranched, septate, slightly warted, dark brown at base tapering to hyaline tip, straight to undulating, occasionally coiled at the apex, 4–5 μm tapering to 2 μm. *Asci*: fasciculate, clavate, 26–36(–40) × 7–7.5 μm. *Ascospores*: hyaline becoming light brown, aseptate, limoniform, bilaterally flattened, umbonate at both ends, one germ pore, 7–7.5 × 4.8–6 × 4–4.5 μm.

Anamorph: **Botryotrichum** state of **Chaetomium subspirale**

Conidiophores: hyaline, simple, aseptate, 7–12 μm. *Conidia*: hyaline, subglobose, aseptate, thick-walled, 9–10 × 7–8 μm.

Material examined: UAMH 7197 ex *Maxillaria neglecta*. UAMH 7198 ex *Oncidium stenotis*. UAMH 7199 ex *Pleurothallis periodica*. Distribution: North and South America.

Eupenicillium shearii Stolk & Scott, Persoonia 4: 396. 1967.

Cultural characteristics: On PDA growth rate 0.08–0.09 mm/hr; reverse nougat to dark blond (MHC 5D3–5D4), wrinkled; surface mycelium metal to medium grey (MHC 5E2–5E1), flat, wrinkled near the center, metallic, with abundant globose structures giving it a grainy appearance,

margin white, sunken, undulating. On CMA growth rate 0.05–0.09 mm/hr; reverse yellowish white (MHC 3A2); surface mycelium white, beaded near center, smooth near periphery, margin regular, appressed. *Ascomata*: pale, globose to subglobose, sclerotioid, non-ostiolate, up to 400 μm, walls thick, composed of textura angularis. *Asci*: hyaline, globose, 8-spored, 6–7 μm. *Ascospores*: hyaline, lenticular, aseptate, with 2 equatorial bands extending beyond the ascospore, 2.8–3.0 × 1.6–1.9 μm (excluding equatorial band). *Anamorph*: absent.

Material examined: UAMH 7283 ex *Asplenium* sp. (Polypodiaceae). Distribution: widespread in soil, Africa, Australia, Austria, Colombia, Honduras, Japan, New Guinea.

Glomerella cingulata (Stonem.) Spauld. & v. Schrenk, Sci. ser. II. 17: 751. 1903.

Cultural characteristics: On PDA growth rate 0.34–0.39 mm/hr; reverse smoky brown (MHC 4F2) to brownish grey (MHC 4C2–4D2) with taupe (MHC 4F1) regions; surface mycelium cream to earth-coloured (MHC 5F2), aerial mycelium low, dense, cottony, margin regular. On CMA growth rate 0.34 mm/hr; aerial mycelium scant, central region with submerged and superficial ascomata. *Ascomata*: dark brown, spherical, walls of textura angularis or textura intricata, 145 × 180 μm, walls about 12 μm thick. *Asci*: bitunicate, cylindrical to slightly clavate, fasciculate, 45–80 × 9.5–10.5 μm. *Ascospores*: hyaline, cylindrical, biseriate, aseptate, smooth, often slightly curved, tips rounded, 14–16 × 4–5 μm.

Anamorph: **Colletotrichum gloeosporioides** (Penz.) Sacc., Fung. Agrum. 2: 6. 1882.

Conidiomata: acervular, globose or rounded, setose, 150–300 μm; setae brown, septate, tapering at the apex, 50–100 × 4–5 μm. *Conidiophores*: branched, phialidic, 20–45 × 3.5–4.8 μm. *Conidia*: hyaline, orange in mass, cylindrical, constricted at the center, granular, apices rounded, base tapered slightly, 12–24 × 3.5–4.8 μm.

Material examined: UAMH 7200 ex *Maxillaria neglecta* growing on *Pentaclethra macroloba* (Fabaceae). UAMH 7201 ex *Catasetum maculatum* growing on *Bactris gasipaes* (Arecaceae). UAMH 7241 ex *Sobralia* sp. UAMH 7275 ex *Encyclia fragrans*. K387a ex *Anthurium* sp. (Araceae). Distribution: widespread pathogen in tropical countries.

Notes: Reported from tropical orchid leaves and stems (Dreyfuss & Petrini 1984).

Hypoxylon cf. **unitum** (Fr.) Nitschke, Pyrenomycetes Germanici p. 44. 1867–1870.

Cultural characteristics: On PDA growth rate 0.09–0.15 mm/hr; reverse dark to black in center, margin dull orange; surface mycelium white, aerial hyphae abundant, mycelium appressed to medium, becoming black and crustose; stromata present in some isolates, black with cream apices, cylindrical, unbranched. On CMA growth rate 0.12–0.15 mm/hr; reverse white to yellowish white (MHC 3A2); surface mycelium white, pulvinate, margin regular. On MEA growth rate 0.10–0.13 mm/hr; reverse greyish-yellow (MHC 4B5) with dark brown center (MHC 5F3); surface mycelium white, black in center, aerial mycelium abundant, margin entire. *Conidia*: absent.

Material examined: K220c ex *Pleurothallis* cf. *guanacastensis*. K317Ag ex *Catasetum maculatum*. K358e ex *Stelis* sp. K372Ab, Ac ex *Gongora unicolor*. Distribution: unknown.

Notes: Stromata remained sterile but the key to endophytic xylariaceous fungi (Petrini & Petrini 1985) permitted us to propose a name for this isolate. A distinguishing feature of *H. unitum* is the production of tall, dark stromata covered with short protuberances.

Leptosphaerulina australis McAlp., Syll. Fung. 18: 746. 1905.

Cultural characteristics: On PDA growth rate 0.15 mm/hr; reverse dark brown-black (MHC 5F8); surface mycelium chocolate brown to negro (MHC 6F3–6F4), buckling, zonate, felty, margin orange-brown, ascomata after 4 d. On CMA growth rate 0.15 mm/hr; reverse putty (MHC 4B2); surface mycelium white, submerged, ascomata after 4 d. *Ascomata*: yellowish-brown, single or gregarious, pyriform to ovate, ostiolate, walls of textura angularis, 200–225 × 140–180 μm. *Asci*: sac-like, thick-walled, bitunicate, 50–68 × 28–35 μm. *Ascospores*: hyaline, ovate to clavate, muriform, with 3–4 transverse septa and (0–)1–2(–3) longitudinal septa, with a mucilaginous sheath, 24–34 × (8.5–)9.5–10(–11) μm. *Anamorph*: absent.

Material examined: UAMH 7202 ex *Nidema boothii*. UAMH 7203 ex *Rodriguezia compacta* growing on log 10 cm diam. Distribution: widespread.

Notes: Graham and Luttrell (1961) illustrate and provide a key to the six recognized species of *Leptosphaerulina*.

Nectria alata Samuels, Mycologia 81: 347. 1989. FIGURE 2

Cultural characteristics: On PDA growth rate 0.05 mm/hr; reverse dark brown (MHC 7F8) with reddish brown (MHC 8F8) diffusing pigment; surface mycelium pale yellow (MHC 3A3) and white, reddish golden (MHC 6C7) near center, low, buckled, with dark red exudate. On CMA growth rate 0.04–0.06 mm/hr; reverse pale to light yellow (MHC 4A3–4A4); surface mycelium

(MHC 4A5) in center, cream (MHC 4A2) near periphery, appressed to medium, margin regular. *Ascomata*: orange, globose to subglobose, solitary, superficial to submerged, warted, walls composed of textura angularis, 360–480 × 260–340 μm. *Asci*: hyaline, cylindrical, 8-spored, 50–58 × 9–14.5 μm. *Ascospores*: green in mass, hyaline singly, broadly ellipsoid, evenly bicelled, smooth, biseriate, filling entire ascus, slightly constricted at the septum, 18.5–22 × 6.5–7.5 μm.

Anamorph: **Penicillifer bipapillatus** Samuels, Mycologia 81: 347. 1989. FIGURE 3

Conidiophores: hyaline, unbranched or occasionally branched, blastic, phialidic, (20–)40–60 × 3–4.5 μm; conidiogenous cells long-cylindric, in groups of 3–5, 22–30 × 4.8 μm *Conidia*: white in mass, hyaline singly, cylindrical, (0–)1 septate, curved to occasionally straight, with a prominent basal scar, 20–24 × 4.8 μm.

Material examined: UAMH 7281 ex *Dichaea standleyi*. K379d, K382a ex *Stelis* sp. K380e ex *Trichosalpinx orbicularis*. Distribution: neotropical.

Notes: *N. alata* is unique in the genus, having both a *Penicillifer* anamorph and large ascospores which are green in mass. Samuels (1989) describes two species, *N. alata* and *N. penicilliferi* from the American tropics, both with *Penicillifer* anamorphs. Perithecia of both species occurred together in his collections. Samuels differentiated these on the basis of ascospore and conidium size and on ascospore arrangement in the asci. The ascospores of *N. alata* are biseriate whereas those of *N. penicilliferi* are biseriate to multiseriate. Ascospores in our isolates are uniformly biseriate and the conidial size and shape are closest to *P. bipapillatus*. Recently, Polishook *et al.* (1991) described a new hypocrealean endophyte, *Neocosmospora endophytica* with a *Penicillifer* anamorph, from living twigs of *Chaemaecyparis thyoides* (L.) B.S.P. and from stems of *Hudsonia ericoides* L.

Nectria haematococca Berk. & Br., J. Linn. Soc. London. Botany 14: 116. 1873.

Cultural characteristics: On PDA growth rate 0.15–0.16 mm/hr; reverse orange-brown (MHC 7E7–7F7), darker towards the center; surface mycelium white near periphery, old silver (MHC 4C2) to violet brown (MHC 11E4) in center, cottony, aerial, producing dark red-brown exudate. On CMA growth rate 0.19–0.22 mm/hr; reverse cream (MHC 4A2); surface mycelium cream to pale yellow, appressed to medium. *Ascomata*: yellowish-orange, ovate, ostiolate, walls warted, 35–40 μm, composed of loosely arranged textura globulosa, 300–460 × 200–335 μm. *Asci*: clavate with a long stalk, upper four ascospores biseriate, lower four uniseriate, 50–70 × 7–10 μm. *Ascospores*: hyaline, ellipsoid, striate, bicelled, constricted at the septa, ends rounded, 10–11 × 5 μm.

Anamorph: **Fusarium solani** (Mart.) Sacc., Michelia 2: 296. 1881.

Conidiophores: variable in length, phialidic. *Conidia*: of two kinds: a) microconidia hyaline, cylindric, 0–1 septate, 10–15 × 2.4–4 μm; b) macroconidia hyaline, slightly curved to falcate, formed in cream-coloured sporodochia, 4–5 septate, with a distinct foot cell and a blunt apical cell, 25–50 × 4–6 μm. *Chlamydospores*: globose to subglobose, single, warted, terminal or occasionally intercalary, 8–11 μm.

Material examined: UAMH 7204 ex *Scaphyglottis gracilis*. UAMH 7205 ex *Stelis endresii*. UAMH 7206 ex *Sobralia* sp. UAMH 7207 ex *Pleurothallis phyllocardioides*. K127a ex *Trigonidium riopalenquense*. K149a ex *Pleurothallis uncinata*. K190g (anamorph only) ex *Maxillaria neglecta*. K197c ex *Epidendrum schlecterianum*. Distribution: neotropical.

Notes: *N. haematococca* was the most commonly isolated Hypocrealean teleomorph, found in eight orchid taxa. It is a well-known species in the tropics where it is common on woody hosts, dead roots and other plant debris (Dennis 1970, Samuels & Dupont 1982, Holliday 1980).

Nectria ochroleuca (Schweinitz) Berk., Grevillea 4: 16. 1875.

Cultural characteristics: On PDA growth rate 0.06 mm/hr; reverse yellow (MHC 3A6); surface mycelium pale yellow (MHC 3A3) to white, low, with yellow diffusing pigment. On CMA growth rate 0.05–0.08 mm/hr; surface mycelium white to cream (MHC 4A2), low, granular, growing in concentric rings. *Ascomata*: brownish orange, globose to ovate, ostiolate, walls of textura angularis, 200–235 μm. *Asci*: cylindrical, uniseriate, slightly falcate, 40–55 × 4.5–5 μm. *Ascospores*: hyaline, ovate with rounded ends, uniseriate, one-septate, minutely warted, 7–7.5 × 3–4.5 μm.

Anamorph: **Gliocladium roseum** Bainier, Bull. Soc. Mycol. France 23: 111. 1907. FIGURE 4

Cultural characteristics: On PDA growth rate 0.09–0.13 mm/hr; reverse reddish golden (MHC 6C7) to cream or light yellow (MHC 4A3–4A4), margin lighter; surface mycelium white to pale yellow with varying amounts of orange-brown to pale orange conidial masses, aerial near periphery. On CMA growth rate 0.11–0.14 mm/hr; reverse yellowish white to pale yellow (MHC 4A2–4A3); surface mycelium white, sparse, flocculose; conidial masses light orange to orange-brown, sometimes arranged in concentric rings. *Conidiophores*: of two kinds: a) moderately branched,

septate, phialidic, in whorls of 3–4 phialides, divergent, tapering towards the apex, 20–24 × 2.4 μm; conidiophores 100–155 μm in length; b) highly branched with 3–4 layers, phialides densely clustered tapering to the apex, 10 × 2–2.5 μm; conidiophores 60–130 μm in length. *Conidia*: orange in mass, hyaline singly, slimy, smooth, aseptate, ellipsoid to cylindric, asymmetrical, guttulate, apex rounded, base truncate, 4–7.2 × 2.4–2.8 μm.

Material examined: UAMH 7208 ex *Scaphyglottis gracilis*, on fallen *Naucleopsis naga* (Moraceae). K124a ex *Stelis* sp. K185a ex *Scaphyglottis* cf. *prolifera*. K294c ex *Epidendrum octomerioides*. K421a ex *Maxillaria neglecta*. Distribution: widespread in temperate and tropical regions.

Notes: *N. ochroleuca* occurs commonly on wood, bark and herbaceous debris. Farrow (1954) and Petrini and Dreyfuss (1981) recorded the anamorph of this species from soil. Dreyfuss and Petrini (1984) report its occurrence in epiphytic orchid roots.

Nectria peziza (Tode:Fr.) Fr., Summa Veget. Scand. 388. 1849.

Cultural characteristics: On PDA growth rate 0.06–0.08 mm/hr; reverse wax yellow (MHC 3B5) margin pale yellow (MHC 3A2); surface mycelium pale yellow (MHC 3A3), low, margin regular. On CMA growth rate 0.08–0.10 mm/hr; reverse cream (MHC 4A2); surface mycelium cream, low, margin regular; whitish-cream crystalline inclusions in the medium, restricted to the region directly beneath the growing colony. *Ascomata*: light orange, subglobose, ostiolate, walls of textura angularis, 270–300 × 240 μm. *Asci*: hyaline, clavate, 8-spored, 55–70 × 7.2–9.6 μm. *Ascospores*: hyaline, ellipsoidal, striate, bicelled, not constricted at the septum, biseriate above, uniseriate below, 11–12 × 5 μm. *Anamorph*: not observed in culture.

Material examined: UAMH 7227 ex *Pleurothallis pantasmi*. Distribution: Europe, China, North and South America.

Notes: This species occurs on decorticated wood, bark, dung, herbaceous tissue and decaying cloth. *N. peziza* is temperate in distribution, but it has been recorded from tropical countries by Dennis (1970) and Samuels (1976).

Nectria radicicola Gerlach & Nilsson, Phytopath. Zeitsch. 48: 255. 1963.

Cultural characteristics: On PDA growth rate 0.12 mm/hr; reverse dark orange-brown; surface mycelium white to yellow-brown, low, flocculose, margin entire. On CMA growth rate 0.18 mm/hr; reverse cream (MHC 4A2); surface mycelium cream to white, appressed to medium, margin regular. *Ascomata*: pyriform, ostiolate, walls of textura globulosa, 175–290 × 170–220 μm. *Asci*: hyaline, cylindric to clavate, uniseriate or top four spores biseriate, bottom four spores uniseriate, 36–55 × 7–7.5 μm. *Ascospores*: smooth, ellipsoidal, bicelled, not constricted at the septa, 12 × 3.5–4 μm.

Anamorph: **Cylindrocarpon destructans** (Zinssm.) Scholten, Neth. J. Pl. Path. 70 suppl. 2: 9. 1964.

Conidiophores: hyaline, branched or unbranched, phialidic, 1–2 septate, occasionally more, 36–50 × 4–4.5 μm wide tapering to 2.5 μm. *Conidia*: microconidia hyaline, cylindric to ellipsoid, 0(–1) septate, 5–9.6 × 2–2.5 μm, with a prominent basal scar; macroconidia straight, cylindrical to occasionally curved, apex rounded, 1–2 septate, 19–26 × 4.5–5 μm, with prominent basal scar. *Chlamydospores*: hyaline to light brown, smooth, globose, thick-walled, 0(–1) septate, 12–17 μm, single or in chains of 2–6 cells, on short stalks 10 × 2.5 μm.

Material examined: UAMH 7226 ex *Stelis* sp. Distribution: widespread, mostly temperate but also from South America.

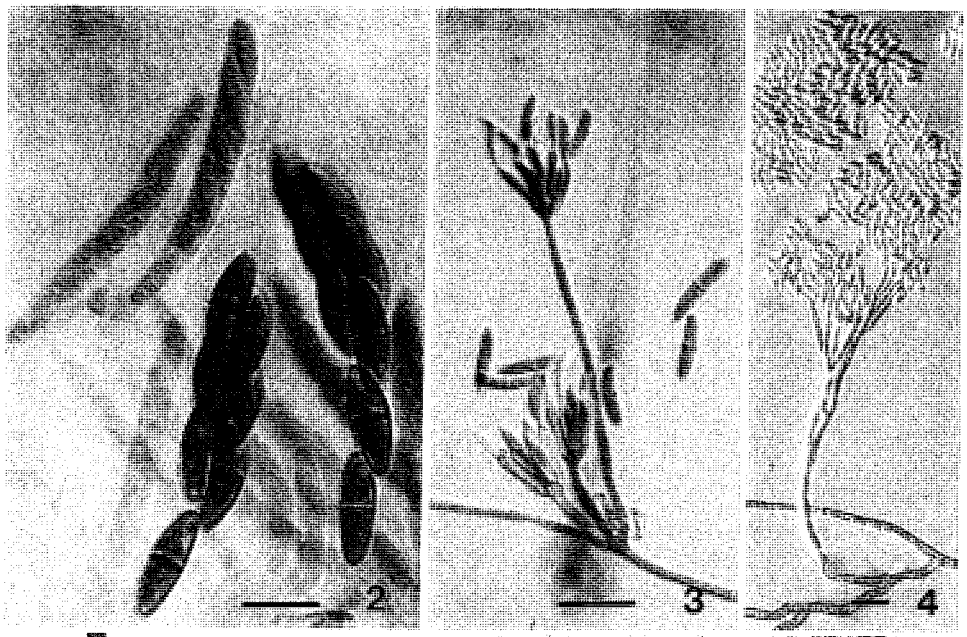
Notes: Recorded as both a plant pathogen and a saprophyte in soil, on roots and on wood.

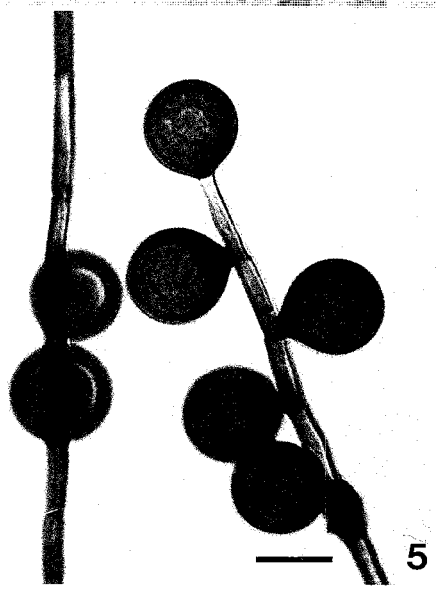
Pseudallescheria boydii (Shear) McGinnis, Padhye & Ajello, Mycotaxon 14: 97. 1982.

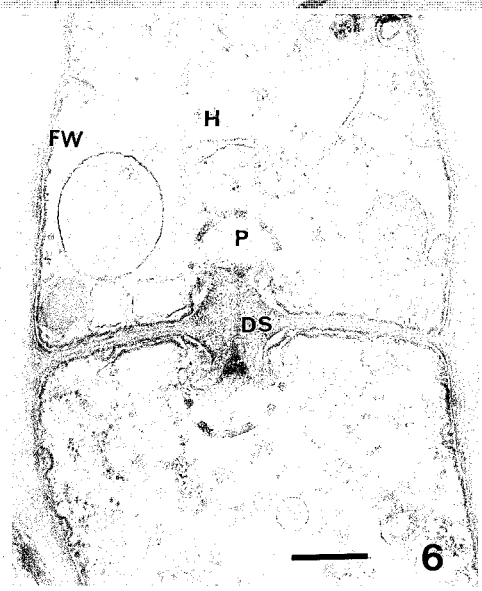
Cultural characteristics: On PDA growth rate 0.08–0.10 mm/hr; reverse pale to dull yellow

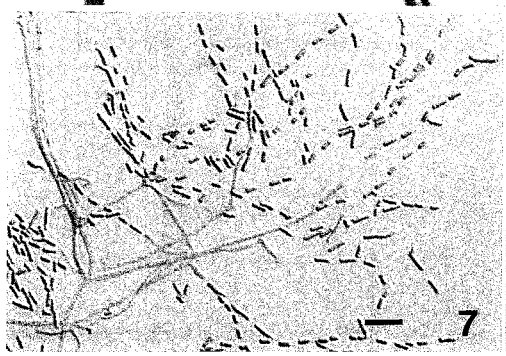
→

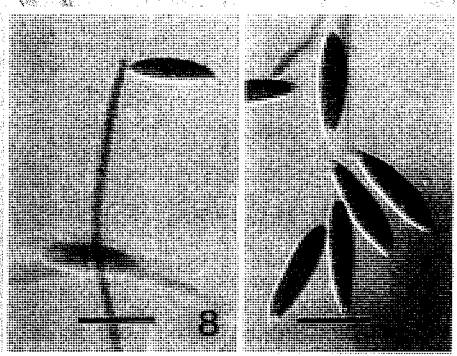
FIGURE 2. *Nectria alata* (UAMH 7281) from *Dichaea standleyi*. Asci and ascospores. Bar=13 μm. FIGURE 3. *Penicillifer bipapillatus* (UAMH 7281) from *Dichaea standleyi*. Branched conidiophore and bicelled conidia with papillate ends. Bar=20 μm. FIGURE 4. *Gliocladium roseum* (UAMH 7208) anamorph of *Nectria ochroleuca* from *Scaphyglottis gracilis*. Conidiophores with divergent phialides and conidia. Bar=10 μm. FIGURE 5. *Acrogenospora* sp. (UAMH 7284) from *Catasetum maculatum*. Dark, globose conidia, broadly attached along upper length of conidiophore. Bar=17 μm. FIGURES 6–7. *Geotrichopsis* sp. (K96b) from *Pleurothallis periodica*. 6. Transmission electron micrograph of fungal hypha with a perforated dolipore septum. H=hypha, P=septal pore cap, DS=dolipore septum, fw=fungal cell wall. Bar=0.5 μm. 7. Arthroconidia produced from rhexolytically dehiscing vegetative hyphae. Bar=15 μm. FIGURES 8–9. *Dactylaria* sp. (K297g) from *Encyclia fragrans*. 8. Minutely denticulate conidiophore with attached conidium. Bar=14 μm. 9. Conidia 3(–4) septate with hyaline, attenuated apices. Bar=15 μm.


2
3
4


5


FW
H
P
DS
6


7


8

(MHC 3A3–3B3); surface mycelium white to yellowish grey (MHC 3B2–3D2), darker towards the center, floccose; aerial mycelium low, margin white, raised. On CMA growth rate 0.11–0.12 mm/hr; reverse hair brown to smoky (MHC 5E4), dust (MHC 5D2) near the margin; surface mycelium grey to pale brown, floccose, slightly aerial. *Ascomata*: hyaline to pale brown, globose, non-ostiolate, thin-walled, 70–120 μm. *Asci*: globose to subglobose, unitunicate, evanescent at maturity. *Ascospores*: hyaline, ovate, aseptate, 6 × 2.6–3 μm.

Anamorph: **Graphium** sp.

Synnemata: slender, stalk of dark reddish-brown parallel hyphae, 170–190 × 9–10 μm. *Conidiophores*: monoverticillate, phialidic, up to 30 μm long. *Conidia*: hyaline, ellipsoid to cylindrical, smooth, 5.5–7.5 × 2.5–4 μm, produced in slimy masses at the apex of the synnema. *Chlamydospores*: hyaline, globose, ellipsoid or ovate, terminal or intercalary, bases truncate, 7–12 μm.

Material examined: UAMH 7272 ex *Encyclia fragrans*. UAMH 7273 ex *Sobralia mucronata*. Distribution: temperate and tropical; from soils and human mycetomas.

Notes: McGinnis *et al.* (1982) illustrate both anamorph and teleomorph.

Xylaria sp. I FIGURE 17

Cultural characteristics: On PDA growth rate 0.23–0.24 mm/hr; reverse mottled, centre dark to black with cream to bright yellow areas interspersed; surface mycelium low, with varying amounts of aerial mycelium; surface of media covered with appressed, black, crustose mycelium; stromata sterile, sparse, black, long, up to 3 mm diam. On CMA growth rate 0.18–0.26 mm/hr; reverse cream; surface mycelium white, appressed to medium, radiating outward in distinct strands, slightly aerial at periphery. On MEA growth rate 0.07–0.09 mm/hr; reverse cream (MHC 4A3); surface mycelium white, aerial hyphae concentrated near center, long, narrow strands of mycelium radiating outward from center. *Conidia*: absent.

Material examined: K6a ex *Sobralia powellii*. K7b ex *Gongora unicolor*. K197a ex *Epidendrum schlecterianum*. K302c ex *Polystachya* cf. *foliosa*. K336(1)c ex *Stelis* sp. K456f ex *Pleurothallis periodica*.

Notes: Determination to species level requires the teleomorph.

Xylaria sp. II FIGURE 18

Cultural characteristics: On PDA growth rate 0.12–0.13 mm/hr; surface mycelium low, felty, dark brown, with white mycelium around outer edge, growing in concentric rings; stromata sterile, dark to nearly black, apices white, narrowly cylindrical, occasionally with forked apices; reverse ivory to champagne (MHC 4B3–4B4), dark brown at center. On CMA growth rate 0.10–0.12 mm/hr; surface mycelium appressed, with scattered white aerial tufts; reverse cream (MHC 4B2). *Conidia*: absent.

Material examined: K220b ex *Pleurothallis* cf. *guanacastensis*.

Notes: Species identification requires the teleomorph.

Xylaria sp. III FIGURE 19

Cultural characteristics: On PDA slow growing, 0.01–0.03 mm/hr; reverse dark brown to black, medium changing to light or dark orange, cracking, often with air pockets to the bottom of dish; surface mycelium white, pale yellow or olive green in central area, dark brown to black near edge of colony, closely appressed to medium, aerial mycelium absent, growing in concentric rings with deep furrows at each ring, margin submerged; stromata arising from each concentric ring, sterile, 5–6 mm long, cylindrical, narrow, tips white. On CMA growth rate 0.03–0.05 mm/hr; reverse clear, appressed to medium; surface mycelium white. Stromata short, narrow, cylindrical, few. On MEA growth rate 0.05–0.07 mm/hr; reverse pale yellow (MHC 4A3); surface mycelium pale yellow (MHC 4A3), becoming light brown to nearly black in center, submerged, margin entire. *Conidia*: absent.

Material examined: K49b ex *Tillandsia festucoides* (Bromeliaceae). K323g,h ex *Maxillaria neglecta*. K357e ex *Stelis* sp. K398c ex *Maxillaria* sp.

Notes: The peak of abundance and diversity of the Xylariales occurs in the tropics (Dennis 1956, 1957, Rogers *et al.* 1987, 1988, San Martín-Gonzales & Rogers 1989) where their conspicuous and carbonaceous stromatic ascomata are common on coarse woody substrata, litter and dung. The order not only encompasses saprobic wood decay species and weak parasites of woody plants but also apparently harmless endophytes in a wide range of vascular plants in both temperate and tropical regions (Rogers 1979; Carroll *et al.* 1977, Petrini & Dreyfuss 1981, Petrini 1984, Petrini 1986, Rodrigues & Samuels 1990). Gäumann et al. (1960) isolated a new xylariaceous fungus, *Hansfordia granulosa*, from the mycorrhizas of the orchid *Loroglossum hircinum* (L.) Rich. Whether this fungus exerted any effect on the orchid was not discussed.

In spite of their obvious importance in tropical ecosystems there are few taxonomic monographs that describe teleomorph and connected anamorph states in sufficient detail to permit accurate identification of asexual strains in pure culture. Recently, Callan and Rogers (1990, 1993) studied anamorph-teleomorph connections of North American *Xylaria* species by culturing single ascospores and describing the morphological characteristics of the anamorphs.

With the rapid rates of wood decomposition in tropical rainforests, these primary and secondary colonizers figure prominently in the breakdown of woody substrates (Lodge 1993). It is possible that the Xylariales are degrading components of the substrates, such as lignin and cellulose, providing orchid hosts at least with carbon and other nutrients in much the same way as the peloton forming basidiomycetes.

Hyphomycetes

Acremonium sp.

Cultural characteristics: On PDA growth rate 0.04–0.06 mm/hr; reverse pale yellow to yellowish white, slightly furrowed; surface mycelium white, raised, hairy, margin regular, sunken. On CMA growth rate 0.06–0.07 mm/hr; reverse pale yellow (MHC 3A3), growing in concentric rings; surface mycelium yellowish white to pale yellow (MHC 4A2–4A3), flat, granular, aerial mycelium lacking. *Conidiophores*: hyaline to slightly darkened, flask-shaped, phialidic, straight to flexuous, aseptate or septate, smooth, single or branching, broad at the base (2.5 μm) tapering to 1 μm at the apex, varying in length but mostly 15–25 μm. *Conidia*: light orange in mass, slimy, aseptate, ellipsoid with rounded ends, usually biguttulate, 3.5–4 × 1.5–2 μm.

Material examined: K263g ex *Peperomia obtusifolia* (Piperaceae). Distribution: widespread.

Acrogenospora sp. FIGURE 5

Cultural characteristics: On PDA growth rate 0.02–0.03 mm/hr; reverse teak brown (MHC 6F5), margin cream (MHC 4A3); surface mycelium grey (MHC 6E2) to black, aerial tuft at center, margin cream, sunken. On CMA growth rate 0.02 mm/hr; reverse chocolate brown to negro (MHC 6F4), greyish beige (MHC 4C2) at center; surface mycelium negro (MHC 6F3), mostly submerged, margin pale, submerged, growing in concentric rings. *Conidiophores*: dark brown, straight and unbranched, with up to 30 percurrent proliferations, smooth, septate, erect on the medium, often in bundles of 2–6, up to 1200 × 4–4.8 μm, conidiogenous cells monoblastic, terminal. *Conidia*: hyaline becoming dark brown, globose to subglobose, solitary, dry, smooth, aseptate, thick-walled, mostly on upper half of the conidiophore, 20–24 × 19–24 μm, base truncate with a scar 2.4–3.6 μm wide.

Material examined: UAMH 7284 ex *Catasetum maculatum*. Distribution: Australia, Europe, New Zealand; on rotten wood, bark and branches of *Nothofagus, Weinmannia* and *Podocarpus*.

Notes: Hughes (1978) noted that distinguishing among species in *Acrogenospora* is based mostly on conidial shape and size. Ellis (1971) introduced the genus with two combinations: *A. sphaerocephala* (Berk. & Br.) Ellis and *A.* state of *Farlowiella carmichaeliana* (Berk.) Sacc. The present isolate differs from these two species in that the conidiophores are up to 1200 μm long in the former but only up to 400 μm long in the latter 2 species. Hughes (1978) described two additional species from New Zealand. *A. gigantospora* Hughes differs from our isolate in that the conidia are considerably larger (25–55 × 21–50 μm) and the conidiophores are shorter and broader. The other species, *A. novae-zealandiae* Hughes, has distinctly obovoid conidia.

Alternaria alternata (Fr.) Keissler, Beih. Bot. Zbl. 29: 434. 1912.

Cultural characteristics: On PDA growth rate 0.22–0.24 mm/hr; reverse old silver to smoke brown, (MHC 4E2–4F2), margin cream (MHC 4A2); surface mycelium stone grey to olive (MHC 3E2–3E3), pulvinate, dense, margin white, narrow. On CMA growth rate 0.22–0.23 mm/hr; reverse yellowish grey to olive (MHC 3D2–3D3), margin pale, growing in concentric rings; surface mycelium grey to white, sparse, aerial. *Conidiophores*: pale brown, simple, straight to somewhat curved, occasionally branched, septate, with one to several conidial scars, 20–50 × 2.5 μm; conidiogenous cells blastic, acropetal. *Conidia*: dark, muriform, verrucose, catenate, with a short blunt beak, 20–38 × 11–15 μm, beak up to 4.8 μm thick.

Material examined: K155b ex *Encyclia fragrans*. K336e ex *Stelis* sp. Distribution: cosmopolitan.

Arthrinium state of **Apiospora montagnei** Sacc., Nuovo G. bot. ital. 7: 306. 1875.

Cultural characteristics: On PDA growth rate (0.19–0.22–) 0.37–0.43 mm/hr; reverse cream (MHC 4A2) to putty or ivory (MHC 4B2–4B3); surface mycelium white or yellowish white to light yellow (MHC 3A2–4A4), aerial, fluffy. On CMA growth rate (0.19–0.24–) 0.28–0.33 mm/hr; reverse champagne to golden blonde (MHC 4B4–4C4); surface mycelium white, sparsely aerial, flocculose. *Conidiophores*: erect, simple, smooth, basauxic, 1–4 × 0.5–1 μm. *Conidia*: hyaline becoming dark brown, with hyaline band, globose in top view, lenticular in side view, smooth, thick-walled, 5.5–8 μm in top view, 3.5–5 μm thick.

Material examined: K152e ex *Sobralia* cf. *mucronata*. K273a ex *Maxillaria* cf. *confusa*. K350e ex *Hexisea imbricata*. 356f ex *Stelis* sp. K270e ex *Scaphyglottis* minutiflora. Distribution: widespread.

Notes: Our isolates fall into two groups, based on cultural characteristics. Two isolates (K152e and K356f) have slower growth rates (included in brackets above). Microscopically there is little to distinguish them.

Botryotrichum state of **Chaetomium subspirale** (q.v.)

Chloridium virescens (Pers.:Pers.) Gams & Hol.-Jech. var. **chlamydosporum** (van Beyma) Gams & Hol.-Jech., Stud. Mycol. 13: 21. 1976.

Cultural characteristics: On PDA growth rate 0.06–0.07 mm/hr; reverse chocolate brown (MHC 6F4), buckled, center raised from bottom of Petri dish, margin cream; surface mycelium medium grey (MHC 6E1) appressed to medium, center raised then depressed, furrowed at regular intervals from center of colony out to margin, felty, margin slightly submerged. On CMA growth rate 0.06 mm/hr; reverse sallow (MHC 4D3); surface mycelium olive brown (MHC 4E4), appressed to medium, growing in concentric rings, margin submerged. *Conidiophores*: yellowish-brown becoming hyaline at apex, unbranched, percurrent, phialidic, 2–4 septate, 60–70 × 2.4 μm. *Conidia*: hyaline, ovate, arising in groups from the apex, 3.8–4.5 × 1.9–2.4 μm. *Chlamydospores*: hyaline to slightly pigmented, globose, 3.8–5.0 μm.

Material examined: UAMH 7279 ex *Stelis* sp. Distribution: widespread.

Notes: Gams and Holubová-Jechová (1976) state that varieties of *C. virescens* are more easily separated while on their natural substrates than when in culture. *C. virescens* var. *chlamydosporum* differs from *C. virescens* var. *virescens* and var. *caudigerum* in that the vegetative hyphae are hyaline in the former and pigmented in the latter two and the conidia are abundant and arranged in heads in the former and few and in cirrhi in the latter two.

One species in this genus, *Chloridium paucisporum*, formed ectomycorrhizal associations with 7-month old seedlings of pine, spruce and birch (Wilcox & Wang 1987). There was no evidence that our isolate formed a mycorrhizal association with *Stelis* sp.

Cladosporium cladosporioides (Fres.) de Vries, Contributions to the knowledge of the genus *Cladosporium*. p. 57. 1952.

Cultural characteristics: On PDA growth rate 0.13 mm/hr; reverse olive brown (MHC 4F5), wrinkling, diffusing pigment greyish yellow (MHC 2B6); surface mycelium olive (MHC 3E3–4E3), immersed, granular to velvety when superficial, growing in concentric rings, margin entire. On CMA growth rate 0.10–0.11 mm/hr; reverse olive (MHC 3E3–3F3), growing in concentric rings, margin yellowish grey (MHC 3B2); surface mycelium olive brown (MHC 4E3–4E4), floccose near center, slightly aerial, margin pale, entire. *Conidiophores*: hyaline to light brown, branched, septate, 25–70(–200) × 3 μm; conidiogenous cells blastic, acropetal. *Conidia*: hyaline to pale brown, 0(–1)-septate, smooth to minutely roughened, ellipsoid to ovate, catenate, basal scar prominent, 3–6.5(–10) × 1.9–3.5 μm.

Material examined: K215b ex *Pleurothallis periodica*. Distribution: cosmopolitan.

Codinaea parva Hughes & Kendrick, New Zealand J. Bot. 6: 354. 1968.

Cultural characteristics: On PDA growth rate 0.05–0.07 mm/hr; reverse negro (MHC 6F3), margin light yellow-brown, slightly furrowed; surface mycelium compact, old silver (MHC 4E2) in center, raised, wrinkled, margin aluminum (MHC 4C1), slightly depressed. On CMA growth rate 0.06–0.08 mm/hr; reverse ivory (MHC 4B3); surface mycelium ivory (MHC 4B3), flat, granular, growing in concentric rings, pale yellow where conidia produced, margin entire. *Conidiophores*: pale brown at base becoming subhyaline at the apex, phialidic, septate, occasionally branching, to 100(–180) × 4–5 μm; collarettes hyaline, funnel-shaped, outer walls thick, flaring; distal wall thin, occasionally formed laterally, 4–5 μm wide and 2–2.5 μm deep. *Conidia*: hyaline, aseptate, with setulae on each end, curved, one end rounded the other end blunt, with a detachment scar, 10–15 × 1.9–3 μm, setulae straight to somewhat curved, (3–)4–4.8(–5.5) μm.

Material examined: UAMH 7280 ex *Catasetum maculatum* protocorms. Distribution: New Zealand, Hawaii; on bark of *Weinmannia racemosa* (Cunoniaceae) (Hughes & Kendrick 1968) and *Eucalyptus* (Myrtaceae).

Curvularia cymbopogonis (Dodge) Groves & Skolko, Can. J. Res. Sect. C. Bot. Sci. 23: 96. 1945.

Cultural characteristics: On PDA growth rate 0.13–0.14 mm/hr; reverse slate grey (MHC 3F2) with whitish-yellow (MHC 4A2) margin; surface mycelium olive grey (MHC 2E2–2F2), aerial, raised in center, margin regular, appressed to medium. On CMA growth rate 0.23–0.28 mm/hr; reverse sallow to olive brown (MHC 4D3–4E3), margin entire, growing in concentric rings; surface mycelium grey, tufted in center. *Conidiophores*: light yellow brown, blastic, sympodial, up to 650 × 2.5–4 μm. *Conidia*: dark, end cells lighter, 3–4 septate, middle cell causing a bulge in conidium, hilum protuberant, 29–38.5 × 9.5–14 μm.

Material examined: K120c ex *Stelis endresii*. Distribution: tropical and subtropical.

Cylindrocarpon destructans see **Nectria radicicola**

Cylindrocladium scoparium see **Calonectria kyotensis**

Dactylaria sp. FIGURES 8, 9

Cultural characteristics: On PDA growth rate 0.27–0.28 mm/hr; reverse greyish brown to negro (MHC 6E3–6F3) in center, dark hyphae with interspersed cream hyphae radiating outward from center, margin cream (MHC 4A2); surface mycelium olive brown to sepia (MHC 4E3–4F4), pulvinate, depressed in center, margin white. On CMA growth rate 0.26–0.27 mm/hr; reverse putty to ivory (MHC 4B2–4B3); surface mycelium putty (MHC 4B2), flat, with aerial tufts of hyphae near periphery, margin regular. *Conidiophores*: hyaline, flexuous, few septate, occasionally branched, tapered towards the apex, polyblastic, apices minutely denticulate, 50–130 × 2–2.5 μm. *Conidia*: hyaline, narrowly ellipsoid to fusiform, smooth, phragmosporous, (2–)3(–4) septate, attenuated at the ends, small empty regions present in the apices, 19–25 × 4.5–5 μm.

Material examined: K192b ex *Nidema boothii*. K297g ex *Encyclia fragrans*. Distribution: The genus is widespread on wood, leaves and litter.

Notes: Placement of these isolates in *Dactylaria* are made with some hesitation because the conidiophores in our isolates have the minute apical denticles typical of the genus, but do not become swollen as noted by Bhatt and Kendrick (1968). Furthermore, the conidia of *Dactylaria*, according to Bhatt and Kendrick (1968), have a flat basal scar while our conidia are attenuate at either end.

Drechslera australiensis (Bugnicourt) Subram. & Jain ex Ellis, Curr. Sci. 35: 354. 1966.

Cultural characteristics: On PDA growth rate 0.16–0.18 mm/hr; reverse mahogany (MHC 8F7) to sepia (MHC 5F4), with reddish brown (MHC 6D7) diffusing pigment, medium buckling, margin cream; surface mycelium greyish-brown (MHC 6E3) to cinnamon brown (MHC 6D6), felty, buckling, margin cream, entire, slightly depressed in medium, dark blond (MHC 5D4) diffusing pigment, grey black exudate produced. In culture, producing numerous jet black stromata, arranged in tufts up to 4 mm high. On CMA growth rate 0.18–0.21 mm/hr; reverse olive brown (MHC 4E4); surface mycelium olive brown (MHC 4E4), aerial, hairy, growing in concentric rings, margins appressed to medium. *Conidiophores*: light brown, blastic, acropetal, elongate, up to 200 × 2.4 μm, swelling to 7.2 μm wide near conidial attachments. *Conidia*: light brown, 3-pseudoseptate, straight to slightly curved, hilum absent, 19.2–24 × 7.2–10 μm.

Material examined: K286e ex *Pleurothallis guanacastensis*. K392e ex *Maxillaria neglecta*. K420e ex *Asplenium* sp. (Polypodiaceae). Distribution: Australia, Kenya, India, USA. Davidson & Christensen (1977) isolated this species while studying root-microfungal and mycorrhizal associations in a shortgrass prairie in north-eastern Colorado.

Drechslera ellisii Danquah, Trans. Br. mycol. Soc. 64: 545. 1975.

Cultural characteristics: On PDA growth rate 0.14–0.20 mm/hr; reverse dark grey to negro (MHC 6F3), margin yellowish-white to cream, medium buckling; surface mycelium slate grey (MHC 2F2–3F2), low, dense, felty, margin cream (MHC 4A2) to pale grey, entire. On CMA growth rate 0.16–0.21 mm/hr; reverse olive grey (MHC 2F3), darker near center; surface mycelium olive to olive-brown (MHC 2E3–4E4); aerial mycelium low, partly submerged. *Conidiophores*: light brown, rarely branched, blastic, acropetal, up to 250 × 4–5 μm, conidial scars on upper half. *Conidia*: slightly darkened, curved with rounded apices, 3–4 pseudoseptate, middle cell often enlarged causing bulge in conidium, 24–30 × 9.6–12 μm.

Material examined: K160b ex *Maxillaria endresii*. Distribution: Australia, Ghana, India, Kuwait, Pakistan.

Epicoccum andropogonis (Ces.) Schol-Schwarz, Trans. Br. mycol. Soc. 42: 171. 1959.

Cultural characteristics: On PDA growth rate 0.11–0.13 mm/hr, reverse dark reddish brown (MHC 8F8) with yellow (MHC 4A6) diffusing pigment, medium buckling, margin reddish brown (MHC 9E8), irregular; surface mycelium partly submerged, partly superficial, dark green (MHC 29F6), margin cardinal red (MHC 10D8) submerged, densely compact, aerial mycelium absent. On CMA growth rate 0.21 mm/hr; reverse titan red (MHC 7D6), partially colouring the medium; surface mycelium titan red (MHC 7D6), closely appressed to medium, margin undefined. *Conidiophores*: pale, short, septate, blastic, arranged in sporodochia, 2–4 × 5–8 μm. *Conidia*: hyaline becoming dark, verrucose, 2 to many celled with longitudinal, transverse and oblique septa, constricted at the septa, broadly clavate to variously shaped, with hyaline protuberant hilum, 10–12 × 7–9 μm.

Material examined: UAMH 7277 ex *Epidendrum nocturnum*. UAMH 7278 ex *Stelis* sp. K209a ex *Nidema boothii*. K212e ex *Rodriguezia compacta*. K219a ex *Trigonidium egertonianum*. K296e ex *Dimerandra emarginata*. K363d ex *Encyclia fragrans*. K367f, K373e ex *Catasetum maculatum*. K372Ae ex *Gongora unicolor*. K432a ex *Pleurothallis verecunda*. Distribution: cosmopolitan.

Notes: The above cultural description is based on a

heavily sporulating culture of *E. andropogonis*, but most isolates on PDA were degenerate, lacking conidia and having a dense mycelial mat of various shades of white, pale orange, pale olive green or light brown. Schol-Schwarz (1959) found that sporulation is erratic in *Epicoccum* and that sporulation decreases and cultures develop extensive aerial mycelia after prolonged culturing.

Epicoccum nigrum Link, Mag. Ges. Naturf. Freunde, Berlin 7: 32. 1815.

Cultural characteristics: On PDA growth rate 0.12–0.15 mm/hr; reverse caput mortuum (MHC 8F7), diffusing pigment maize yellow (MHC 4A6), margin pale yellow (MHC 4A3); surface mycelium jet black, pulvinate, appressed to medium, producing droplets of black exudate. On CMA growth rate 0.14–0.16 mm/hr; reverse orange white (MHC 6A2); surface mycelium pale orange (MHC 6A3), appressed to medium, with small aerial tuft at center, margin entire, sporodochial masses black and abundant. *Conidiophores*: short, inflated, unbranched, blastic, annelidic. *Conidia*: dark, spherical to pyriform, muriform, with a hyaline, truncate basal protuberance, verrucose, 16–22 μm.

Material examined: UAMH 7276 ex *Sobralia* sp. K307Ba ex *Maxillaria xylobiiflora*. Distribution: cosmopolitan.

Fusarium oxysporum Schlecht., Flora Berol. 2 (Cryptogamia) p. 139. 1824.

Cultural characteristics: On PDA growth rate 0.18–0.21 mm/hr; surface mycelium white to pale cream, with a faint purplish tinge, cottony, margin undulating; reverse cream (MHC 4A2). On CMA growth rate 0.23–0.24 mm/hr; surface mycelium white, appressed to medium, flocculose; reverse white. *Conidiophores*: blastic, phialidic, short, arising laterally from vegetative hyphae. *Conidia*: of two kinds: a) microconidia hyaline, oval to ellipsoid, straight or occasionally curved, 0–1 septate, 5–10 × 1.9–3 μm and b) macroconidia hyaline, curved to falcate, in sporodochial masses, 3–5 septate, pointed at the apex, base pedicillate, up to 55 × 3–4.8 μm.

Material examined: K360e ex *Epidendrum stangeanum*. Distribution: *F. oxysporum* is common in grassland soils and is a cosmopolitan pathogen in numerous plants.

Notes: Dreyfuss and Petrini (1984) recorded this fungus from the roots of the epiphytic orchid *Epidendron porpax* Reichb.

Fusarium solani see **Nectria haematococca**

Geotrichopsis sp. FIGURES 6, 7

Cultural characteristics: On PDA growth rate 0.04–0.05 mm/hr; reverse maize yellow to amber yellow (MHC 4A6–4B6), margin pale to light yellow (MHC 4A3–4A4), wrinkled; surface mycelium white, low, dense, felty, furrowed, with slight butter yellow (MHC 4A5) diffusing pigment. On CMA growth rate 0.13–0.14 mm/hr; reverse cream (MHC 4A3); surface mycelium cream, flat in center, becoming dense and aerial near periphery. Conidiogenous hyphae similar to vegetative hyphae, simple, septate, thallic, arthric. *Conidia*: hyaline, cylindrical, dry, smooth, 4.8–9.6 × 2–2.5 μm, walls of fertile hyphae breaking down, producing chains of widely spaced arthroconidia; vegetative hyphae 2–2.5 μm, with perforated dolipore septa.

Material examined: K96b ex *Pleurothallis periodica*. Distribution: unknown.

Notes: Arthroconidial states of Basidiomycotina are discussed in Sigler and Carmichael (1976). *Geotrichopsis* was suggested as a genus name for arthroconidial fungi with basidiomycetous affinities (Tzean & Estey 1991). Genera of wood decay Aphyllophorales (polypores) often have dry arthroconida as a means of vegetative reproduction. At present, there is no taxonomic treatment available to identify these imperfect Hyphomycetes.

Gliocladium penicillioides Corda, Icon. Fung. 4: 31. 1840.

Cultural characteristics: On PDA growth rate 0.11 mm/hr; reverse champagne to greyish orange (MHC 4B4–5B4); surface mycelium white, dense, aerial near periphery, with abundant pale orange to brownish orange conidial masses. On CMA growth rate 0.09 mm/hr; reverse cream (MHC 4A2); surface mycelium white, flat becoming aerial near periphery; brownish orange masses of conidia forming a concentric band. *Conidiophores*: hyaline, phialidic, stalks roughened, branching, with densely penicillate heads, up to 120 × 4.8 μm, phialides slender, 10 × 2 μm. *Conidia*: hyaline taken singly, pale orange in mass, aseptate, smooth, symmetrical, arising from the conidiophores at an angle, 4–7 × 2.4–2.8 μm.

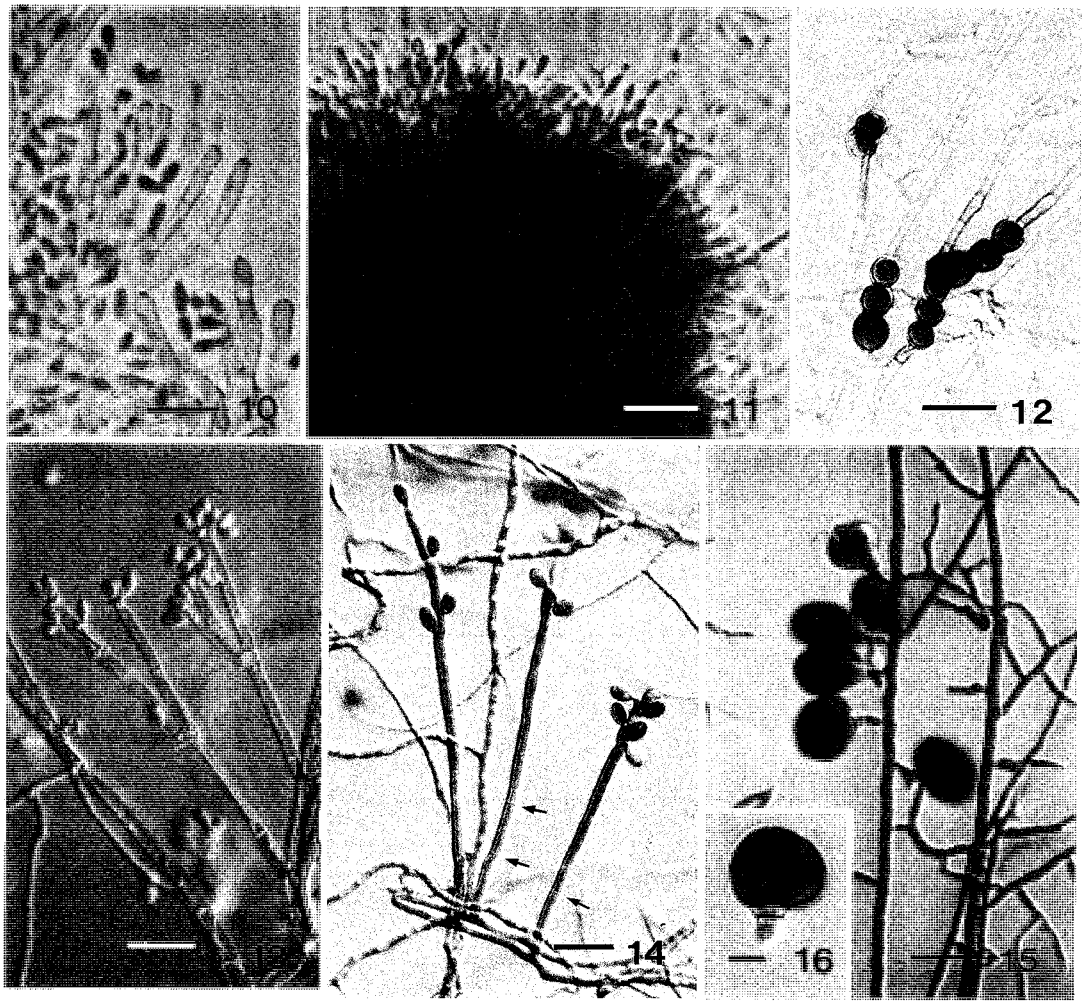
Material examined: K205b ex *Epidendrum schlecterianum*. Distribution: widespread.

Gliocladium roseum see **Nectria ochroleuca**

Graphium sp. see **Pseudallescheria boydii**

Hadrotrichum sp. FIGURES 10, 11

Cultural characteristics: On PDA growth rate 0.13–0.17 mm/hr; reverse mottled, amber yellow (MHC 4B6) around edges, dark brown (MHC 6F7) in center; surface mycelium white, with scattered aerial tufts, cottony, black crustose mycelium on the surface, margin irregular. On CMA growth rate 0.12–0.16 mm/hr; reverse yellowish white (MHC 2A2); surface mycelium white, ap-



FIGURES 10–11. *Hadrotrichum* sp. (K394a) from *Pleurothallis periodica*. 10. Conidiophores with conidia emerging from the apex; conidia tear-shaped. Bar=9 μm. 11. Stroma with conidiophores arranged in a palisade layer. Bar=21 μm. FIGURE 12. *Humicola* sp. (K314b) from *Oncidium stenotis*. Intercalary, dematiaceous arthroconidia, occurring in chains. Bar=24 μm. FIGURE 13. *Nodulisporium* sp. I (K51a) from *Epidendrum stangeanum*. Branched conidiophores with subglobose conidia borne near the apices. Bar=13.2 μm. FIGURE 14. *Ramichloridium* cf. *subulatum* (K420f) from *Pleurothallis* sp. Aseptate conidia and septate conidiophores (arrows). Bar=10 μm. FIGURES 15–16. *Troposporella* sp. (K224b) from *Catasetum maculatum*. 15. Conidia and conidiophores. Bar=6 μm. 16. Smooth cruciately septate conidium with a short basal denticle. Bar=15 μm.

pressed, margin regular. On MEA reverse champagne (MHC 4B4) with regions of chocolate brown (MHC 6F4); surface mycelium white, velvety, aerial, with dark brown crusty patches on medium. *Conidiophores*: long, cylindrical, blastic, unbranched at least above, occurring in a palisade layer arising from aerial stromata, conidia arising mostly from conidiophore apices, scars remaining. *Conidia*: hyaline, smooth, ovoid to obovoid, flattened at the base with a conidial scar, 4.2–4.5 × 2.2–2.4 μm, present only in some isolates.

Material examined: K8a, K25a, K381e ex *Encyclia fragrans*. K172e, K272c, K455–2f ex *Rodriguezia compacta*. K215a, K267a, K293c ex *Pleurothallis periodica*. K296c ex *Dimerandra emarginata*. K302b,d, K359e ex *Polystachya foliosa*. K317f, K444e, K445a, K450f ex *Catasetum maculatum*. K323a,e,f ex *Maxillaria neglecta*. K324a ex *Pleurothallis pantasmi*. K326b,e ex *Maxillaria* sp. K336-d1, K355c, K356c, K358g ex *Stelis* sp. K349e ex *Dichaea standleyi*. K360f ex *Epidendrum stangeanum*. K377a ex *Maxillaria uncata*. K385b,c ex *Campylocentrum micranthum*. K390b ex *Asplenium* sp. (Polypodiaceae). K394a ex *Trichosalpinx* sp. K153b, K417e ex *Hexisea imbricata*. K401dd ex *Tillandsia*

monadelpha (Bromeliaceae). Distribution: Europe and North America.

Notes: This fungus was identified using a key to endophytic xylariaceous fungi by Petrini and Petrini (1985). The presence of tiny conidia arising from conidiophores arranged in a palisade layer distinguish it from other taxa. In culture, *Hadrotrichum* produces white stromatic structures bearing conidiophores and conidia.

Humicola state of **Chaetomium homopilatum** (q.v.)

Humicola sp. FIGURE 12

Cultural characteristics: On PDA growth rate 0.07–0.10 mm/hr; reverse with strong reddish brown (MHC 9F7) diffusing pigment, turning dark ruby (MHC 12F8); surface mycelium reddish grey in the center turning yellowish to cream at the margin, colony pulvinate with compact aerial mycelium. On CMA growth rate 0.05–0.11 mm/hr, reverse pale yellow to cream becoming medium brown, smooth, margin regular; surface mycelium grey, aerial, pulvinate. *Conidia*: dematiaceous, globose to laterally compressed, in chains of 2–6, occasionally more, thick-walled, intercalary or occasionally terminal, arising from vegetative hyphae, 7–8 × 12 μm.

Material examined: K34b ex *Pleurothallis pantasmi.* K190e, K406f ex *Maxillaria neglecta.* K314b ex *Oncidium stenotis.* Distribution: Species in this genus are well-studied in temperate regions.

Notes: This isolate is tentatively placed in the genus *Humicola* but it only rarely produced single, terminal aleurioconidia. Most species of *Humicola* produce abundant aleurioconidia and only rarely produce chains of intercalary conidia (Ellis 1971).

Malbranchea sp.

Cultural characteristics: On PDA growth rate 0.08–0.11 mm/hr; reverse chestnut brown (MHC 6F7) margin orange-grey (MHC 5B2); surface mycelium white, granular, low. On CMA growth rate 0.10–0.12 mm/hr; reverse yellowish white (MHC 3A2); surface mycelium white, low, slightly pulvinate, flocculose, margin regular. *Conidia*: hyaline, cylindrical, straight to curved, smooth, 3–5(–7.2) × 1.5–2 μm, thallic, arthric and alternate. Conidiogenous hyphae arising as short, lateral branches from the vegetative hyphae (2–2.4 μm diam), branches loosely or tightly coiled, curved.

Material examined: UAMH 7274 ex *Maxillaria confusa.* Distribution: unknown.

Notes: This strain displayed cellulolytic activity, found by placing a piece of inoculum on Murashige and Skoog Basal Salts with Minimal Organics (MSMO) (Sigma Chemical Co., St. Louis, Missouri) agar with cellulose azure added. A dull violet (MHC 16D4–16D5) cast was produced in the medium, indicating cellulolytic activity.

Monilia sp.

Cultural characteristics: On PDA growth rate 1.31 mm/hr; reverse ivory (MHC 4B3); surface mycelium white, flat in center becoming loosely aerial. On CMA growth rate 1.13–1.18 mm/hr; reverse yellowish-white (MHC 3A2); surface mycelium white, loosely aerial, margin irregular. Conidiogenous cells blastic, acropetal. *Conidia*: globose to subglobose, catenate, branching, 12–14 μm; vegetative hyphae to 14 μm wide.

Material examined: K239a ex *Sobralia* sp. Distribution: cosmopolitan.

Notes: The branching chains of hyaline, globose conidia are distinctive for the genus. *Monilia* is infrequently isolated from soil (Barron 1968) and is difficult to identify to species. The genus represents an artificial assemblage of fungi with diverse ascomycete teleomorphs (Dennis 1970). It has a very rapid growth rate and is a nuisance as a laboratory contaminant.

Mycelia sterilia Group A FIGURE 20

Cultural characteristics: On PDA growth rate 0.03 mm/hr; reverse light orange, mostly concentrated at center; surface mycelium ivory to cream, submerged, bumpy at medium surface. On CMA growth rate 0.06–0.08 mm/hr; reverse ivory; surface mycelium ivory, submerged, superficial at center, feathery appearance. *Vegetative characteristics*: hyphae sterile, septate, 3.5–4 μm.

Material examined: K382NRa, K383NRe ex *Stelis* sp. K397a, e, K398a, b ex *Maxillaria* sp. K394e ex *Trichosalpinx* sp. K403a ex *Maxillaria neglecta.*

Notes: The growth habit of this group in culture superficially resembles that of the orchid mycorrhizal basidiomycete *Epulorhiza,* but monilioid cells were not observed.

Mycelia sterilia Group B FIGURE 21

Cultural characteristics: On PDA growth rate 0.20–0.24 mm/hr; reverse reddish-brown to dark brown, margin corn (MHC 4B5); surface mycelium varying from light or greyish yellow (MHC 4A4–4B4), to light or chocolate brown, flat, felty, with scant to abundant reddish-brown exudate. On CMA growth rate 0.20–0.21 mm/hr; reverse cream (MHC 4A2); surface mycelium white, scant, low. *Vegetative characteristics*: hyphae sterile, septate, 4–4.8 μm.

Material examined: K11a ex *Encyclia fragrans.* K212f ex *Rodriguezia compacta.* K317Ae ex *Catasetum maculatum.* K354a, K357a, f, K378b, c ex *Stelis* sp. K360c ex *Epidendrum stangeanum.* K400b, K422e ex *Pleurothallis* sp. K407a ex *Aechmea* sp. (Bromeliaceae). K412a, e ex *Hexisea imbricata.*

Notes: Even though sporulation did not occur in these isolates, cultural and microscopic characteristics

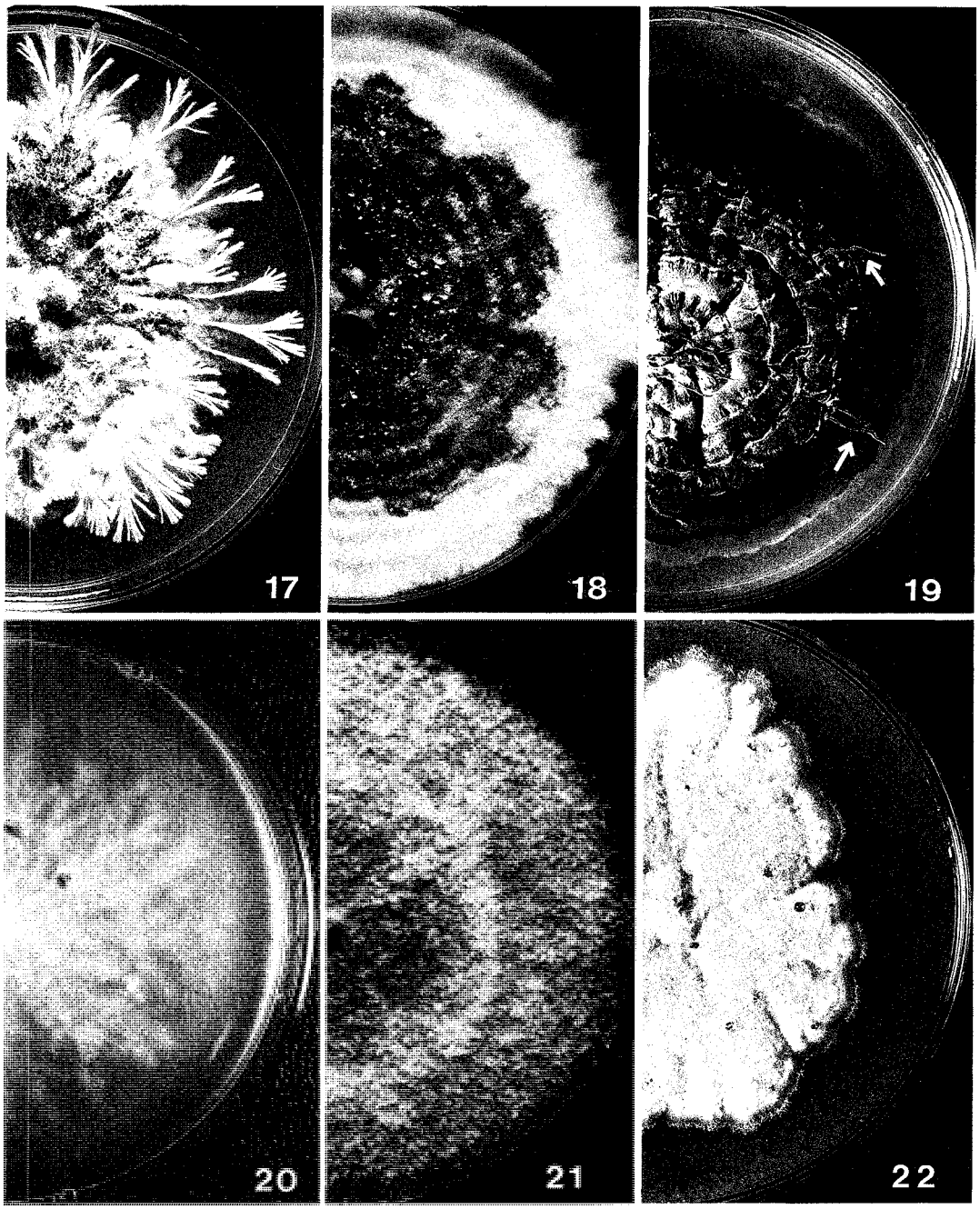


FIGURE 17. *Xylaria* sp. I (K456f) from *Pleurothallis periodica*. On PDA after 2 wk, colony with appressed and aerial mycelia, the former radiating out in thick strands. Actual size. FIGURE 18. *Xylaria* sp. II (K220b) from *Pleurothallis* cf. *guanacastensis*. On PDA after 2 wk, colony with aerial mycelium. Actual size. FIGURE 19. *Xylaria* sp. III (K323g) from *Maxillaria neglecta*. On PDA after 10 wk, colony growing in concentric rings, aerial mycelium absent, producing abundant stromata (arrows). Actual size. FIGURE 20. Mycelia sterilia Group A (K397a) from *Maxillaria* sp. On CMA after 14 wk, mycelium slow growing, submerged, with characteristic feathery growth. Actual size. FIGURE 21. Mycelia sterilia Group B (K407a) from *Aechmea* sp. (Bromeliaceae). On PDA after 2 wk, mycelium aerial, fluffy, with dark exudate near center. Actual size. FIGURE 22. *Cryptosporiopsis* sp. (K379c) from *Stelis* sp. On carrot agar after 7 wk, mycelium pulvinate, margin undulating, with dark, globose conidiomata. Actual size.

of the vegetative hyphae were distinctive enough to place all 14 in the same group.

Nigrospora sphaerica (Sacc.) Mason, Trans. Br. mycol. Soc. 12: 158. 1927.

Cultural characteristics: On PDA growth rate 0.44–0.45 mm/hr; reverse white to pale yellow; surface mycelium white, aerial, loosely arranged. On CMA growth rate 0.36 mm/hr; reverse white; surface mycelium white, aerial, loosely arranged, margin entire. *Conidiophores*: hyaline, short, bulbous, blastic, 1–2 celled, 10 μm. *Conidia*: dark to nearly black, oblate, solitary, smooth, 16–18 × 11–14.5 μm.

Material examined: K176e ex *Oncidium stenotis*. Distribution: cosmopolitan.

Nodulisporium sp. FIGURE 13

Cultural characteristics: On PDA growth rate 0.23–0.24 mm/hr; reverse greyish-brown (MHC 7F3); surface mycelium brownish-grey (MHC 7E2), appressed to medium. On CMA growth rate 0.18–0.26 mm/hr; reverse sunburn (MHC 6D5), orange-grey (MHC 5B2) near periphery; surface mycelium greyish-orange (MHC 5B3), camel (MHC 6D4) in center, low, granular. *Conidiophores*: hyaline to pale brown, flexuous, septate, blastic, highly branched, fertile only at the tips, producing conidia in groups of 3–10, conidial scars barely discernible, up to 270 × 2.4 μm. *Conidia*: hyaline, ovate to ellipsoidal, aseptate, smooth, 3.8–4.8 × 1.8–2.2 μm.

Material examined: K7a, K35a ex *Gongora unicolor*. K8a ex *Encyclia fragrans*. K31a, K275a ex *Epidendrum isomerum*. K2b ex *Trigonidium riopalenquense*. K51a ex *Epidendrum stangeanum*. Distribution: widespread.

Notes: This is a common xylariaceous anamorph and has been recorded in other studies of endophytic fungi (Petrini and Dreyfuss 1981, Rodrigues and Samuels 1990, Dreyfuss and Petrini 1984, Petrini and Muller 1979).

Penicillifer bipapillatus see **Nectria alata**

Periconiella sp.

Cultural characteristics: On PDA growth rate 0.13–0.19 mm/hr; surface mycelium dense, slightly aerial, mottled with grey, white, cream and nutria (MHC 5F3), producing small amounts of exudate; reverse dark grey to dark reddish-brown with some interspersed paler regions. On CMA growth rate 0.13–0.17 mm/hr; surface mycelium white, floccose, sparse; reverse golden grey (MHC 4C2). *Conidiophores*: warted along their length, branched, blastic, producing exudate, up to 300 μm. *Conidia*: hyaline to pale brown, one-celled, smooth, cylindrical, rounded at the apex, 4.8–6 × 1.5–2 μm.

Material examined: K15a ex *Epidendrum schlechterianum*. K112b ex *Trigonidium riopalenquense*. Distribution: widespread in the tropics.

Notes: Petrini and Petrini (1985) give a detailed account of xylariaceous endophytes, including descriptions and keys to genera and some species. These isolates are placed in *Periconiella* because the conidiophores are scattered and are differentiated into a main axis with verticillate conidiogenous cells.

Pithomyces maydicus (Sacc.) Ellis, Mycol. Pap. 76: 15. 1960.

Cultural characteristics: On PDA growth rate 0.12–0.13 mm/hr; reverse sepia (MHC 4F4), margin yellowish white (MHC 3A2); surface mycelium yellowish white (MHC 3A2) to yellowish grey (MHC 3D1–3D2) or olive green, dense, margin pale. On CMA growth rate 0.13 mm/hr; reverse yellowish white (MHC 3A2); surface mycelium yellowish white (MHC 3A2), flat, margin entire. *Conidiophores*: hyaline, micronematous, blastic, smooth, 8–12 × 1.5–2 μm. *Conidia*: hyaline when young, dark at maturity, broadly ellipsoidal, with two transverse and occasionally one longitudinal septa, often constricted at the septa, verrucose, with a small denticle remaining attached to the conidial base, 14–19(21.6) × 7–10 μm.

Material examined: K130e ex *Epidendrum difforme*. K281b ex *Pleurothallis guanacastensis*. K360d ex *Epidendrum stangeanum*. K368e ex *Pleurothallis uncinata*. K382f ex *Stelis* sp. K409a ex *S phaeradenia pendula* (Cyclanthaceae). K416b ex *Peperomia montecristana* (Araceae). Distribution: British Guiana, Japan, Trinidad.

Notes: This species differs from the more common *P. chartarum* (Berk. & Curt.) Ellis by having larger conidia with two rather than three transverse septa.

Ramichloridium cf. **subulatum** de Hoog, Stud. Mycol. 15: 83. 1977. FIGURE 14

Cultural characteristics: On PDA growth rate 0.03–0.04 mm/hr; reverse ivory (MHC 4B3) with darker patches, wrinkled; surface mycelium yellowish-white (MHC 4A2), brownish-grey to brownish-orange in center, wrinkled, raised in center; aerial mycelium absent, margin sunken, entire. On CMA growth rate 0.03–0.04 mm/hr; reverse yellowish-white (MHC 4A2); surface mycelium cream (MHC 4A3) to nougat (MHC 5E3), flat, margin slightly furrowed, entire. *Conidiophores*: pale brown, darker than the vegetative hyphae, blastic, sympodial, unbranched, erect, 3–7 septate, slightly rachiform, 40–65(80) × 2.5 μm. *Conidia*: olivaceous to light brown, smooth, lenticular to ellipsoid, aseptate, basal scars ab-

sent, clustered near the apex of the conidiophores, 4.8–5.5 × 2.5–3 μm.

Material examined: K410f ex *Pleurothallis* sp. Distribution: cosmopolitan.

Notes: The genus is frequent from soil and plant parts in tropical and temperate areas (de Hoog 1977). Our isolate differs from de Hoog's (1977) description of *R. subulatum* in having septate conidiophores and wider conidia (2.5–3 vs. 1.7–2.2 μm).

Scytalidium lignicola Pesante, Annali Sper. agr. N. S., 11 suppl. 261–265. 1957.

Cultural characteristics: On PDA growth rate 0.48–0.49 mm/hr; reverse hair brown (MHC 5E4) to brownish grey (MHC 6F8) or dark brown with age; surface mycelium white to grey, aerial near periphery, scant near center, flat, crustose, dark brown mycelium. On CMA growth rate 0.44–0.46 mm/hr; reverse yellowish-grey (MHC 4B2); surface mycelium white, low, scant, uniform. *Conidia*: of two types: a) hyaline arthroconidia, 2.5–3 × 5–7.5 μm (same width as the vegetative hyphae), thallic, rhexolytically dehiscing; b) dematiaceous arthroconidia, blastic, ellipsoid or barrel-shaped, 1–2 celled, when 2-celled, usually constricted at the septa, arising from vegetative hyphae (2 μm diam) in chains of 10 or more, intercalary or terminal, not readily detaching, each conidium 8–10 × 5.5–7 μm.

Material examined: K390f ex *Asplenium* sp. (Polypodiaceae). Distribution: widespread.

Stilbella aciculosa (Ell. & Ev.) Seifert, Stud. Mycol. 27: 44. 1985.

Cultural characteristics: On PDA growth rate 0.07–0.08 mm/hr; reverse champagne (MHC 4B4) to brownish orange (MHC 7C4), margin cream (MHC 4A2); surface mycelium cream to brownish orange (MHC 6C3), abundant synnemata, butter yellow (MHC 4A5), margin undulating, sunken. On CMA growth rate 0.09–0.10 mm/hr; reverse cream (MHC 4A3); surface mycelium butter yellow (MHC 4A5), appressed to medium. *Synnemata*: pale, slender, unbranched, scattered, formed in concentric rings, up to 200 × 14–22 μm. *Conidiophores*: hyaline, phialidic, verticillately branching, phialides terminal, in whorls of 3–4, up to 24 × 1 μm. *Conidia*: pale orange in mass, ovoid, aseptate, smooth, 4–6 × 1.9–2.4 μm.

Material examined: K257c ex *Guzmania lingulata* (Bromeliaceae). Distribution: North temperate, occasionally tropical.

Tetracladium maxilliforme (Rostrup) Ingold, Trans. Br. mycol. Soc. 25: 372. 1942.

Cultural characteristics: On PDA growth rate 0.04–0.05 mm/hr; reverse maize yellow (MHC 4A6), margin paler; surface mycelium maize yellow (MHC 4A6), white aerial hyphae toward the center, medium buckled, margin slightly submerged. On CMA growth rate 0.06–0.08 mm/hr; reverse yellowish white (MHC 3A2); surface mycelium yellowish white (MHC 3A2), flat, margin entire. *Conidiophores*: hyaline, blastic, undifferentiated, 0–1 septate, 19 × 2 μm. *Conidia*: hyaline, tetraradiately branched, smooth, main axis 3.6–3.8 μm wide, 3-septate, 3 side branches, one long and pointed, the others with rounded apices, side branches not exceeding length of main axis, total length of conidium 16–18 μm.

Material examined: K195f ex *Epidendrum difforme*. K197e ex *Epidendrum schlecterianum*. K262e ex *Nidema boothii*. Distribution: Spain, Britain and North America, in streams and on leaf litter.

Notes: Aquatic hyphomycetes have been isolated from aquatic and terrestrial roots of *Alnus glutinosa* (Fisher & Petrini 1989, Fisher *et al.* 1991) and Bandoni (1981) reports them in the throughfall of an Oregon coniferous forest but species of *Tetracladium* were notably absent from these reports. Given the amount of stem flow and throughfall in tropical rainforests an abundance of these species should be expected. Examination of foam (Bärlocher 1992) forming along stem flow routes should reveal a heavy spore load of these fungi. In culture recovery studies it is possible that they are missed because sporulation is suppressed or reduced when colonies are dry. Flooding culture plates increased spore production in *Tetracladium maxilliforme*. A detailed account of conidial development and variation of *T. maxilliforme* is given in Roldán et al. (1989).

Troposporella sp. FIGURES 15, 16

Cultural characteristics: On PDA growth rate 0.05 mm/hr; reverse chocolate brown (MHC 6F4), margin cream (MHC 4A2), narrow, entire; surface mycelium dark grey to white, dense, pulvinate, raised, producing a thick gelatinous matrix, margin appressed, cream. On CMA growth rate 0.05–0.06 mm/hr; reverse sallow (MHC 4D3), margin white; surface mycelium cement (MHC 4D2), flat, raised slightly in center, margin submerged. *Conidiophores*: hyaline, micronematous, occasionally branched, blastic, septate, 4.5–5 × 1.5–2 μm. *Conidia*: hyaline becoming brown, globose to subglobose, closely coiled 1–1.5 times, smooth, thick-walled, 4–6 celled, slightly constricted at the septa, basal cell truncate, hyaline, 14–17 × 12–14.5 × 8–9 μm.

Material examined: K224b ex *Catasetum maculatum*. Distribution: Europe, Panama.

Notes: This isolate does not match the recognized

species *Troposporella fumosa* as described in Linder (1929). The conidia have a definite helical orientation, however, ours differs from *T. fumosa* by the reduced number of septations and the much reduced coil.

Verticillium albo-atrum Reinke & Berthold, Zersetz. Kartoff. 75. 1879.

Cultural characteristics: On PDA growth rate 0.15–0.16 mm/hr; reverse pale orange (MHC 5A3), margin creamy (MHC 4A2); surface mycelium white, floccose, margin regular. On CMA growth rate 0.13–0.15 mm/hr; reverse cream (MHC 4A2); surface mycelium white, flocculose, with small pale orange conidial masses, margin undulating. *Conidiophores*: hyaline, erect, septate, phialidic, 60–100 × 2.4 μm; verticillately branched with whorles of long, slender, divergent phialides, 24–34 × 2.4 μm. *Conidia*: hyaline, aseptate, cylindric to ellipsoid, smooth, 4.8–8 × 2.4–2.8 μm.

Material examined: K82a ex *Tillandsia* cf. *venusta* (Bromeliaceae). Distribution: widespread.

Notes: *V. albo-atrum* is associated frequently with plant roots and causes important diseases in many crops.

COELOMYCETES

Chaetosticta cf. **perforata** (Ell. & Ev.) Petrak & H. Syd. Annls mycol. 23: 270. 1925.

Cultural characteristics: On PDA growth rate 0.05–0.08 mm/hr; reverse cement to coal (MHC 4D2–3F1), margin cream (MHC 4A2); surface mycelium old silver to olive brown (MHC 4E2–4E3), pulvinate, lanose, margin olive (MHC 3F3). On CMA growth rate 0.03–0.09 mm/hr; reverse cream (MHC 4A2) with a mouse grey (MHC 5E3) tinge, growing in concentric rings; surface mycelium greyish beige to dust (MHC 4C2–5D2), flat to slightly aerial, lanose. *Conidiomata*: pycnidial, globose, ostiolate, walls composed of textura angularis, up to 270 μm, setae dark brown, septate, smooth, up to 150 × 2–3 μm. *Conidiophores*: absent. *Conidia*: hyaline, cylindrical to ellipsoid, one-celled, biguttulate, 2.5–4.5 × 1.5–2.4 μm.

Material examined: K183d ex *Trichosalpinx orbicularis*. K200a ex *Trigonidium egertonianum*, on branch 2 cm diam. K237e ex *Guzmania* sp. (Bromeliaceae). Distribution: Italy, United States.

Notes: Our isolate conforms to the genus concept of *Chaetosticta* in that it has ostiolate pycnidia with setae and aseptate, smooth, hyaline conidia. However, the conidia are considerably smaller (2.5–4.5 × 1.5–2.4 vs.17.5–31 × 2.5–4.5 μm) than those described for *C. perforata* in Sutton (1980).

Colletotrichum acutatum Simmonds, Qd J. Agr. Anim. Sci. 22: 458. 1965.

Cultural characteristics: On PDA growth rate 0.15 mm/hr; reverse mottled with cream and greyish brown (MHC 4A3–5D3); surface mycelium dust (MHC 5D2) with carrot red (MHC 6B7) conidial mass near center; aerial mycelium low, dense, margin partly submerged. On CMA growth rate 0.15 mm/hr; reverse yellowish grey (MHC 4B2); surface mycelium white to pale grey, low aerial, flocculose. *Conidiomata*: acervular, 100–150 μm, setae absent. *Conidiophores*: not observed. *Conidia*: hyaline, fusiform, attenuated at both ends, usually with two large guttules, 9.5–12 × 2.5–3 μm.

Material examined: K129c ex *Trigonidium riopalenquense*. Distribution: Australia, New Zealand, North America.

Colletotrichum crassipes (Speg.) Arx, Verh. Akad. Wet. Amst. 51: 77. 1957.

Cultural characteristics: On PDA growth rate 0.33–0.37 mm/hr; reverse bluish grey (MHC 23F3); surface mycelium slate to medium grey (MHC 3F2–3E1), low, white, aerial hyphae. On CMA growth rate 0.12–0.13 mm/hr; reverse cream (MHC 4A2); surface mycelium cream, appressed to medium, slightly flocculose. *Conidiomata*: acervular, superficial or submerged, setose, setae brown, smooth to slightly warted, septate, tapered toward the apex, up to 200 μm long. *Conidiophores*: hyaline to light brown, cylindrical, septate, branched, 10–20(–50) × 2.4–4 μm. *Conidia*: hyaline, cream in mass, aseptate, cylindrical, straight to slightly curved, thin-walled, guttulate, 12–17(–26) × 4–5(–7) μm.

Material examined: K113a ex *Myoxanthus scandens*. K206a ex *Jacquiniella globosa*. K326c ex *Maxillaria* sp. K335e ex *Dichaea trulla*. K353e ex *Oncidium stenotis. riopalenquense*. K369a ex *Campylocentrum micranthum*. K336e, 379a ex *Stelis* sp. K380a ex *Trichosalpinx orbicularis*. K381a ex *Encyclia fragrans*. K402a, K403e ex *Maxillaria neglecta*. K456e ex *Rodriguezia compacta*. Distribution: cosmopolitan.

Colletotrichum gloeosporioides see **Glomerella cingulata**

Cryptosporiopsis sp. FIGURE 22

Cultural characteristics: On PDA growth rate 0.01–0.02 mm/hr; reverse rust brown (MHC 6E8–6F7); surface mycelium dull yellow to silver white (MHC 2B2–3B3), floccose, raised, furrowed, margin irregular, submerged, undulating. On CMA, growth rate 0.02 mm/hr; surface mycelium ivory, appressed to medium, sporulation sparse. *Conidiomata*: acervular, superficial to partly submerged, up to 1 mm diam. *Conidiophores*: hyaline, cylindrical, 10–20 × 2.4–4.8 μm diam. *Conidia*: aseptate, hyaline, thin-walled, cytoplasm granular, cylindrical to occasionally curved, with rounded apex and slightly tapered base, with basal scar, 21–27 × 7–7.5 μm diam.

Material examined: K377e ex *Maxillaria uncata.* K379c ex *Stelis* sp. K392a,b, K406e ex *Maxillaria neglecta.* K449a,b,e ex *Pleurothallis corniculata.* Distribution: Europe, North America, Colombia, Guiana.

Notes: *Cryptosporiopsis* species produce teleomorphs in the ascomycete genus *Pezicula* but unfortunately ascomata did not form in our cultures. Sutton (1980) states that "there are little differences between *Cryptosporiopsis* species and the characters used to distinguish the taxa are few and unreliable". Clay (1988) considers *Cryptosporiopsis* a common endophyte and this is confirmed by the frequent isolations from orchids, bromeliads and aroids (Petrini & Dreyfuss 1981), Piperaceae (Dreyfuss & Petrini 1984) and *Juniperus communis* (Petrini & Muller 1979).

Lasiodiplodia theobromae (Pat.) Griff. & Maubl., Bull. trimest. Soc. Mycol. Fr. 25: 57. 1909.

Cultural characteristics: On PDA growth rate 0.33–0.39 mm/hr; reverse dark grey (MHC 6F1); surface mycelium smoke brown (MHC 4F2) to grey, dense, aerial, conidiomata forming at edge of plate. On CMA growth rate 0.27–0.33 mm/hr; reverse old silver to olive brown (MHC 4E2–4E3), margin loose; surface mycelium grey with flocculose aerial hyphae, margin appressed to medium. *Conidiomata*: dark grey to black, globose, thick-walled, composed of textura angularis, superficial to partially immersed, 2–3 mm. *Conidiophores*: absent, conidiogenous cells holoblastic. *Conidia*: hyaline becoming dark, ovate, thick-walled, evenly 2-celled, longitudinally striate, tapered to one end, 26–28 × 12–15 μm.

Material examined: K104c ex *Anthurium* sp. (Araceae). K114a ex *Pleurothallis phyllocardioides.* K123Bb ex *Trichosalpinx blasdellii.* K138a, K186a ex *Encyclia fragrans.* K143b, K294a ex *Epidendrum octomerioides.* K152a ex *Sobralia* cf. *mucronata.* K156b ex *Nidema boothii.* K195c ex *Epidendrum difforme.* K203a ex *Campylocentrum micranthum.* K220e ex *Pleurothallis guanacastensis.* K237a ex *Guzmania* sp. (Bromeliaceae). K239Ae ex *Sobralia* sp. Distribution: tropical and subtropical.

Notes: *L. theobromae* is a ubiquitous tropical and subtropical saprobe and wound parasite. It was isolated frequently in our study and the conidia were observed in large clusters on the surfaces of cleared and stained root squashes.

Lasmeniella sp.

Cultural characteristics: On PDA growth rate 0.07–0.09 mm/hr; reverse butter yellow (MHC 4A5), margin pale yellow (MHC 4A3); surface mycelium light yellow (MHC 4A4), turning dark brown to nearly black in center, extensively wrinkled, shiny, margin pale, appressed and submerged. On CMA growth rate 0.08–0.10 mm/hr; reverse brownish beige (MHC 6E2), growing in distinct concentric rings, partly immersed, partly superficial; surface mycelium absent, conidiomata superficial and immersed. *Conidiomata*: black, shiny, up to 500 μm. *Conidiophores*: hyaline, aseptate, cylindrical, tapering at the apex. *Conidia*: hyaline initially, becoming brown, globose to subglobose, with slightly truncate base, smooth, thick-walled, 4.8–6.0 × 4.5–5 μm.

Material examined: K28a ex *Gongora unicolor.* Distribution: tropical and subtropical.

Notes: This isolate closely resembles the genus *Lasmeniella* in that circular colonies are formed which have black, shiny conidiomata with dark, aseptate, globose conidia. The closest species to our isolate described by Sutton (1980) is *L. congoensis* (Har. & Pat.) Petrak & Sydow but the conidia in the latter are larger (4.8–6.0 × 4.5–5 vs. 6.5–7.5 μm diam) and have a small central spot which is lacking in our isolate.

Microsphaeropsis olivacea (Bonord.) Hohnel, Hedwigia 59: 267. 1917.

Cultural characteristics: On PDA growth rate 0.19–0.20 mm/hr; reverse yellowish white to greyish yellow (MHC 4A2–4B3), smoke brown (MHC 4F2) at center; surface mycelium white to putty (MHC 4B2) with darker central area, felty, slightly aerial, margin flat. On CMA growth rate 0.21–0.24 mm/hr; reverse cream; surface mycelium absent; conidiomata abundant, appearing within 7 d. *Conidiomata*: black, globose, superficial or immersed, ostiolate, walls thick, composed of textura angularis, 200–400 μm. *Conidiophores*: not observed. *Conidia*: light brown, ovate to ellipsoid, aseptate, smooth, 4.5–5 × 2.5–3 μm.

Material examined: K140b ex *Cyclanthus* sp. (Cyclanthaceae). Distribution: cosmopolitan.

Neoplaconema napelli (Maire & Sacc.) Sutton, Kew Bull. 31: 463. 1977.

Cultural characteristics: On PDA growth rate 0.21–0.24 mm/hr; reverse light yellow (MHC 4A4) to cement brown (MHC 4D2), cloudy; surface producing an orange pigmentation, mucilagenous, undulating, submerged, growing in irregularly lobed concentric rings, conidiomata produced readily, aerial mycelium absent. On CMA growth rate 0.32–0.34 mm/hr; reverse yellowish white (MHC 3A2); surface mycelium yellowish white (MHC 3A2), appressed to medium, loosely arranged, margin entire. *Conidiomata*: acervular, black, spherical up to 600 μm. *Conidiophores*: hyaline, blastic, 1–2 septate, smooth, 10–15 × 2.4–3.8 μm. *Conidia*: hyaline becoming light brownish-grey, with a long basal appendage (20–24 μm) and a short appendage at the tip of the conidium, conidia one-celled, ellipsoid, attenuate at both ends, straight to slightly curved, 12 × 5 μm (excluding appendages).

Material examined: K356b ex *Stelis* sp. Distribution: Germany.

Notes: This isolate closely resembles the description

in Sutton (1980) except he describes the conidia as being hyaline whereas ours are pigmented.

Pestalotiopsis Stey., Bull. Jard. Bot. Etat, Bruxelles 19: 300. 1949.

Cultural characteristics: On PDA growth rate 0.22–0.29 mm/hr; reverse varying from apricot yellow to yellow ochre (MHC 5B6–5C7) to cream or pale yellow (MHC 4A3–4A4), interspersed with dark brown-black areas, buckled in some cultures; surface mycelium white to cream, low, dense, with numerous black, shiny conidiomata. On CMA growth rate 0.22–0.25 mm/hr; reverse yellowish-white (MHC 3A2); surface mycelium white, sparse, flocculose, low, with scattered black conidiomata. *Conidiomata*: acervular, black, spherical. *Conidiophores*: blastic. *Conidia*: middle three cells dark, outer 2 cells lighter, long-cylindric, smooth, tapering at the apices, 4-septate, 2–4 basal setulae, one apical setula.

Distribution: worldwide.

Notes: Dreyfuss and Petrini (1984) studied fungal endophytes from a variety of tropical epiphytic taxa, including orchids, and noted that certain fungi, like *Pestalotia* (=*Pestalotiopsis*), were restricted to aerial plant parts such as stems and leaves, and were not isolated from roots. However, we obtained 87 isolates of *Pestalotiopsis,* constituting the most frequently isolated coelomycete, from the roots of a wide range of orchid species. Steyaert (1949) gives a detailed analysis of the various species in *Pestalotiopsis.*

P. cf. **aquatica** (Ell. & Ev.) Stey., Bull. Jard. Bot. Etat, Bruxelles 19: 334. 1949.

Conidia: 19–22 × 5–6 μm, with three basal appendages, not exceeding 18 μm.

Material examined: K116a ex *Rodriguezia compacta.* K157e ex *Hexisea imbricata.*

P. gracilis (Klebahn) Stey., Bull. Jard. Bot. Etat, Bruxelles 19: 310. 1949.

Conidia: 22–26 × 6–7 μm, with two basal appendages, up to 38 μm.

Material examined: K146e ex *Maxillaria nicaraguensis.*

P. papposa Stey., Bull. Jard. Bot. Etat, Bruxelles 19: 325. 1949.

Conidia: 20–26 × 5–7 μm, with three spathulate basal appendages, (10)15–25 μm long.

Material examined: K87a ex *Pleurothallis corniculata.* K106a ex *Epidendrum octomerioides.* K173c ex *Xiphidium caeruleum* (Haemedoraceae). K192a ex *Nidema boothii.* K197b ex *Epidendrum schlecterianum.* K214a ex *Maxillaria endresii.* K372Ad ex *Gongora unicolor.*

Phomopsis cf. **orchidophila** Cash & Watson, Mycologia 47: 739. 1955.

Cultural characteristics: On PDA growth rate 0.31–0.48 mm/hr; reverse pale yellow (MHC 3A2–3A3) with large reddish brown to black patches (some cultures with darker reverse); surface mycelium white with hint of pale orange (MHC 6B2–6B3), low, granular to cottony, abundant conidiomata, margin irregularly lobed. On CMA growth rate 0.28–0.35 mm/hr; reverse cream; surface mycelium pale, low, flocculose. *Conidiomata*: pycnidial, black, raised above the medium, sometimes branched, up to 2 × 4 mm diam. *Conidia*: hyaline, yellowish to orange in mass, mostly slimy but occasionally in cirrhi from the conidiomata, of two types: a) α-conidia hyaline, fusiform, straight, biguttulate, aseptate, attenuated at the ends, 7–8 × 2.4 μm; b) β-conidia hyaline, filiform, hamate, aseptate, 14–24 × 1 μm.

Material examined: K53a, K341e ex *Nidema boothii.* K121a ex *Stelis endresii.* K257a ex *Guzmania lingulata* (Bromeliaceae). K264a ex *Peperomia oerstedtii* (Piperaceae). K346b ex *Tillandsia bulbosa* (Bromeliaceae). K351a ex *Epidendrum octomerioides.* K386e ex *Tillandsia* cf. *montana* (Bromeliaceae). K392f ex *Maxillaria neglecta.* K413e ex *Dichaea standleyi.* K415f ex *Polypodium* sp. (Polypodiaceae). K437b ex *Peperomia obtusifolia* (Piperaceae). K451a ex *Campylocentrum micranthum.* Distribution: Neotropical, Australia, India, Philippine Islands.

Notes: Most species of *Phomopsis* are distinguished on the basis of their host. Cash and Watson (1955) found this species on stems, leaves and flower sheaths of a variety of orchids.

Pyrenochaeta cf. **rubi-idaei** Cavara, Rev. Myc. 11: 188. 1889.

Cultural characteristics: On PDA growth rate 0.08–0.09 mm/hr; reverse greyish brown (MHC 7F3); surface mycelium smoke brown (MHC 4E2), raised in center, wrinkled, felty, margin entire, sunken. On CMA growth rate 0.08 mm/hr; reverse olive (MHC 3E3); surface mycelium olive (MHC 1E3); aerial mycelium pale, scant. *Conidiomata*: pycnidial, globose, unilocular, pale brown, walls of textura angularis, 60–90 (–120) μm diam; setae light brown, restricted to apical area, mostly 1-septate, 28–45 (–60) × 2–4 μm tapering at the rounded apex. *Conidia*: hyaline, cylindrical to ellipsoid, aseptate, smooth, 3.8–4.0 × 1.7–2.4 μm.

Material examined: K400f ex *Pleurothallis* sp. Distribution: Italy.

Notes: Conidia are shorter than those described in Sutton (1980) (3.8–4 μm vs 5.5–8 μm), a discrepancy possibly due to substrate differences as Sutton's description is based on material from the host.

Discussion

The microfungi described here and in our previous paper (Richardson *et al.* 1993) represent only a small portion of the isolates recovered from epiphyte roots. Furthermore, all our isolates, both named and unnamed, represent only an undetermined fraction of the fungal community associated with roots, either as endophytes or as rhizosphere symbionts. Assembling and identifying the components of these communities involves basic logistical problems relating to the isolation and culture of fungi from the substrates because only rarely can fungi be identified in situ. As a result, serious biases enter the collection process at various points and eventually have a multiplicative effect on the data.

Isolation procedures generally favour taxa with colony forming units (CFU) that expand relatively rapidly on standard culture media. For example, a fast growing species present in root tissue as hyphae, spores and sclerotia would be more likely to culture during the isolation process than a slow growing one that does not or has not formed propagules in the substrate tissues.

The second bias enters at the point the CFU make contact with the isolation medium. Nutritionally non-specific fungi (saprophytes usually) are less sensitive to the type of medium being used than are ecologically more specialized taxa. Other factors, such as temperature, light regime, water and osmotic potential, pH, etc. should also be considered here as variables that will influence which propagules develop to form culturable hyphae.

A third bias enters during the identification process which is dependent in large part on the morphological characteristics of cells constituting and associated with spores. Cultures that remain sterile regardless of the type of medium used to encourage spore formation end up in an unidentifiable pile even though they may constitute large and important components of the fungal flora. If they cannot be named, they usually do not get listed or stored.

Fourthly, given that surveys of this nature generate many hundreds of cultures that mature at different times, it is often necessary to store isolates for extended periods until they can be sorted and studied in detail. Long storage periods increase the likelihood of degeneracy or contamination and, in many cases, death of the isolate.

Finally, taxonomic literature on the fungi is in a state of flux and evolution as might be expected in a kingdom in which only as little as 5 % of the taxa have been described (Hawksworth 1991). Identifications must be made using literature that is fragmented and dispersed throughout a wide range of journals, books and monographs.

These biases together result in a tendency for collections like this one to consist of fungi that are easily isolated, cultured, stored and identified. Our list suffers from all of these limitations and must be considered as an initial and tentative analysis of the spectrum of taxa present. Consequently, these preliminary data are too fragmentary to be of use in drawing conclusions about the specific ecological role of most of these fungi. Unlike the orchid mycorrhizal basidiomycetes discussed by Richardson *et al.* (1993), the niche filled by each of these ascomycetes and Fungi Imperfecti is largely speculative and based on predictions relating to known taxonomic affinities.

Without a doubt, release of sequestered nutrients through decomposition of intractable polymeric residues such as lignin and cellulose is one function in which many if not all of these organisms participate. Both the Sordariales (e.g. *Chaetomium*) and the Xylariales are involved in the decay of woody substrates associated with dead or moribund plants. Xylariaceous fungi may also be involved in mutualistic relationships as endophytes in plant organs that are consequently protected from herbivory (Clay 1988). The Hypocreales and many of the Hyphomycetes and Coelomycetes are degraders of cellulosic compounds and simpler carbohydrates and proteins in material of plant, insect and fungal origin. Many of the Coelomycetes are plant parasites and may be influencing species composition among the epiphytic plant community. By incorporating nutrients that are released from canopy mats, fungi aide in retaining these nutrients that would otherwise be leached from the system by heavy stem and through flow. An additional role played by the intricate network of hyphae helps to consolidate organic material as mats develop similar to the way fungal cords trap and stabilize substrates on a macroscale (Lodge 1993, Hedger *et al.* 1993).

Acknowledgments

This work was funded by a grant from the American Orchid Society. The authors acknowledge the Natural Sciences and Engineering Research Council of Canada (NSERC) for a postgraduate scholarship to KAR and operating support (A3359) to RSC, the Organization for Tropical Studies, and Mr. Richard Sherburne for assistance with the transmission electron microscopy. Sarah Hambleton provided excellent laboratory assistance. We would like to thank

Martha Christensen for providing valuable comments on a previous draft of this manuscript.

Literature Cited

Arx J. A. von, J. Guarro, and M. J. Figueras. 1986. The ascomycete genus *Chaetomium*. Nova Hedwigia 84: 1–162. J. Cramer, Berlin.

Atwood J. 1988. The vascular flora of La Selva Biological Station, Costa Rica. Orchidaceae. Selbyana 10: 76–145.

Bandoni R. J. 1981. Aquatic hyphomycetes from terrestrial litter. Pages 693–708 *in* Wicklow D. T. and G. C. Carroll (eds.) The fungal community: its organization and role in the ecosystem, vol. 2. Marcel Dekker, New York.

Bärlocher F. 1992. The ecology of aquatic hyphomycetes. Ecological studies 94. Springer-Verlag, Berlin.

Barron G. L. 1968. The genera of hyphomycetes from soil. The Williams & Wilkins Company. Baltimore, MD, USA.

Bermudes D. and D. H. Benzing. 1989. Fungi in neotropical epiphyte roots. BioSystems 23: 65–73.

Bhatt G. C. and W. B. Kendrick. 1968. The generic concepts of *Diplorhinotrichum* and *Dactylaria*, and a new species of *Dactylaria* from soil. Can. J. Bot. 46: 1253–1257.

Bills G.F. and J. D. Polishook. 1994. Abundance and diversity of microfungi in leaf litter of a lowland rain forest in Costa Rica. Mycologia 86: 187–198.

Callan B. C. and J. D. Rogers. 1990. Teleomorph-anamorph connections and correlations in some *Xylaria* species. Mycotaxon 36: 343–369.

——— 1993. A synoptic key to *Xylaria* species from continental United States and Canada based on cultural and anamorphic features. Mycotaxon 46: 141–156.

Carroll G., E. Muller, and B. C. Sutton. 1977. Preliminary studies on the incidence of needle endophytes in some European conifers. Sydowia 29: 87–103.

Cash E. K. and A. J. Watson. 1955. Some fungi on Orchidaceae. Mycologia 47: 729–747.

Christensen M. 1989. A view of fungal ecology. Mycologia 81: 1–19.

Clay K. 1988. Fungal endophytes of grasses: a defensive mutualism between plants and fungi. Ecology 69: 10–16.

Currah R. S. and R. Sherburne. 1992. Septal ultrastructure of some fungal endophytes from boreal orchid mycorrhizas. Mycol. Res. 96: 583–587.

Davidson, D. E. and M. Christensen. 1977. Root-microfungal and mycorrhizal associations in a shortgrass prairie. Pages 279–287 *in* J. K. Marshall (ed.) The belowground ecosystem: a synthesis of plant-associated processes. Science Series No. 26, Colorado State Unviersity, Fort Collins, Colorado, USA.

de Hoog G. S. 1977. *Rhinocladiella* and allied genera. Stud. Mycol. 15: 1–140.

Dennis R. W. G. 1956. Some Xylarias of tropical America. Kew Bull. 11: 401–444.

———. 1957. Further notes on tropical American Xylariaceae. Kew Bull. 12: 297–332.

———. 1970. Fungus flora of Venezuela and adjacent countries. Kew Bulletin Additional Series III. 531 pages.

Dreyfuss M. and O. Petrini. 1984. Further investigations on the occurrence and distribution of endophytic fungi in tropical plants. Botanica Helvetica 94: 33–40.

Ellis M. B. 1971. Dematiaceous hyphomycetes. Commonwealth Mycological Institute, Kew, Surrey, England.

Farrow W. M. 1954. Tropical soil fungi. Mycologia 46: 632–646.

Fisher J. and O. Petrini. 1989. Two aquatic hyphomycetes as endophytes in *Alnus glutinosa*. Mycol. Res. 92: 367–368.

———, J. Webster and O. Petrini. 1991. Aquatic hyphomycetes and other fungi living in aquatic and terrestrial roots of *Alnus glutinosa*. Mycol. Res. 95: 543–547.

Gams W. and V. Holubová-Jechová. 1976. *Chloridium* and some other dematiaceous hyphomycetes growing on decaying wood. Stud. Mycol. 13: 1–99.

Gäumann E., J. Nüesch, and R. H. Rimpau. 1960. Weitere untersuchungen Uber die chemischen abwehrreaktionen der orchideen. Phytopath. Zeit. 38: 274–308.

Goos R. D. 1960. Soil fungi from Costa Rica and Panama. Mycologia 52: 877–883.

Graham J. H. and E. S. Luttrell. 1961. Species of *Leptosphaerulina* on forage plants. Phytopath. 51: 680–693.

Grayum M. H. and H. W. Churchill. 1989. The vascular flora of the La Selva Biological Station, Costa Rica. Polypodiophyta. Selbyana 11: 66–118.

Hawksworth D. L. 1991. The fungal dimension of biodiversity: magnitude, significance, and conservation. Mycol. Res. 95: 641–655.

Hedger J., P. Lewis, and H. Gitay. 1993. Litter-trapping by fungi in moist tropical forest. Pages 15–36 *in* Isaac S., J. C. Frankland, R. Watling and A. J. S. Whalley, eds., Aspects of tropical mycology, Cambridge University Press, Great Britain.

Holliday P. 1980. Fungal diseases of tropical crops. Cambridge University Press, London.

Hughes S. J. 1978. New Zealand fungi 25. Miscellaneous species. New Zealand J. Bot. 16: 311–370.

——— and W. B. Kendrick. 1968. New Zealand fungi 12. *Menispora, Codinaea, Menisporopsis*. New Zealand J. Bot. 6: 323–375.

Kornerup A. and J. H. Wanscher. 1983. Methuen handbook of colour. 3rd ed. Methuen, London.

Lesica P. and R. K. Antibus. 1990. The occurrence of mycorrhizae in vascular epiphytes of two Costa Rican rain forests. Biotropica 22: 250–258.

Lodge D. J. 1993. Nutrient cycling by fungi in wet tropical forests. Pages 37–58 *in* Isaac S., J. C. Frankland, R. Watling and A. J. S. Whalley, eds., Aspects of tropical mycology, Cambridge University Press, Great Britain.

McGinnis M. R., A. A. Padhye, and L. Ajello. 1982. *Pseudallescheria* Negroni et Fischer, 1943 and its

later synonym *Petriellidium* Malloch, 1970. Mycotaxon 14: 94–102.

MORRIS E. F. 1972. Costa Rican hyphomycetes. Mycologia 64: 887–896.

PETRINI L. AND O. PETRINI. 1985. Xylariaceous fungi as endophytes. Sydowia 38: 216–234.

PETRINI O. 1984. Endophytic fungi in British Ericaceae: a preliminary study. Trans. Brit. mycol. Soc. 83: 510–512.

——— 1986. Taxonomy of endophytic fungi of aerial plant tissues. Pages 175–187 IN FOKKEMA, N. J. AND J. VAN DEN HEUVEL (eds.), Microbiology of the Phyllosphere. Cambridge University Press.

——— AND M. DREYFUSS. 1981. Endophytische pilze in epiphytischen Araceae, Bromeliaceae und Orchidaceae. Sydowia 34: 135–148.

——— AND E. MÜLLER. 1979. Pilzliche Endophyten, am Beispiel von *Juniperus communis* L. Sydowia 32: 224–251.

POLISHOOK J.D., G. F. BILLS, AND A. Y. ROSSMAN. 1991. A new species of *Neocosmospora* with a *Penicillifer* anamorph. Mycologia 83: 797–804.

RICHARDSON K. A., R. S. CURRAH, AND S. HAMBLETON. 1993. Basidiomycetous fungi from the roots of neotropical epiphytic Orchidaceae. Lindleyana 8: 127–137.

RODRIGUES K. F. AND G. J. SAMUELS. 1990. Preliminary studies of the endophytic fungi in a tropical palm. Mycol. Res. 94: 827–830.

ROGERS J. D. 1979. The Xylariaceae: systematic, biological and evolutionary aspects. Mycologia 71: 1–42.

——— B. E. CALLAN, A. Y. ROSSMAN AND G. J. SAMUELS. 1988. *Xylaria* (Sphaeriales, Xylariaceae) from Cerro de la Neblina, Venezuela. Mycotaxon 31: 103–153.

———, ——— AND G. J. SAMUELS. 1987. The Xylariaceae of the rain forests of North Sulawesi (Indonesia). Mycotaxon 29: 118–172.

ROLDÁN A., E. DESCALS AND M. HONRUBIA. 1989. Pure culture studies on *Tetracladium*. Mycol. Res. 93: 452–465.

ROSSMAN A. Y. 1983. The phragmosporous species of *Nectria* and related genera. Mycol. Pap. 150: 1–164.

SAMUELS G. J. 1976. A revision of the fungi formerly classified as *Nectria* subgenus *Hyphonectria*. Mem. New York Bot. Garden 26: 1–126.

———. 1989. *Nectria* and *Penicillifer*. Mycologia 81: 347–355.

———AND K. P. DUMONT. 1982. The genus *Nectria* (Hypocreaceae) in Panama. Caldasia 13: 372–423.

SAN MARTÍN-GONZALES F. AND J. D. ROGERS. 1989. A preliminary account of *Xylaria* of Mexico. Mycotaxon 34: 283–373.

SCHOL-SCHWARZ M. B. 1959. The genus *Epicoccum* Link. Trans. Br. mycol. Soc. 42: 149–173.

SIGLER L. AND J. W. CARMICHAEL. 1976. Taxonomy of *Malbranchea* and some other hyphomycetes with arthroconidia. Mycotaxon 4:349–488.

STEYAERT R. L. 1949. Contribution a l' étude monographique de *Pestalotia* de Not. et *Monochaetia* Sacc. Bull. Jard. Bot. Bruxelles 19: 285–354.

SUTTON B. C. 1980. The Coelomycetes. Commonwealth Mycological Institute, Kew, Surrey.

TZEAN S. S. AND R. H. ESTEY. 1992. *Geotrichopsis mycoparasitica* as a destructive mycoparasite. Mycol. Res. 96: 263–269.

WILCOX, H. E. AND C. J. K. WANG. 1987. Mycorrhizal and pathological associations of dematiaceous fungi in roots of 7-month old tree seedlings. Can. J. For. Res. 17: 884–899.