DISEASES OF CONIFER SEEDLINGS ASSOCIATED WITH CYLINDROCARPON SPECIES: A REVIEW

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INTRODUCTION

Species of Cylindrocarpon have commonly been isolated during investigations of conifer seedling diseases in the northern Rocky Mountains (James 1987a; James 1987b; James and Gilligan 1985).These organisms have been isolated from conifer seed (James and Genz 1982) and roots of diseased (James 1987a; James and Gilligan 1985) and nondiseased (James 1987b) seedlings. In some cases, they have accounted for the majority of fungal organisms isolated from seedlings (James and Gilligan 1985). Despite this common association with diseases of conifer seedlings, little is known of their importance as incitants of disease. Therefore, further work is planned to evaluate their importance as disease-causing organisms; such work will include pathogenicity tests to evaluate ability of several different isolates to elicit disease symptoms.

As an initial step in understanding Cylindrocarpon spp., a review was conducted of the genus concerning previously reported information about their association with conifers. Biological and ecological characteristics of these associations are included in this review.

Cylindrocarpon is a genus of hyphomycetes comprising 27 accepted species and 6 varieties (Booth 1966). Several species have Nectria perfect states (Samuels 1978). Generic characteristics and mycological descriptions of species associated with conifers are detailed in the Appendix. Photographs of characteristics of some isolates obtained from conifer seedlings are also included in the Appendix. This genus is subdivided into two ecological groups: (1). Ubiquitous soil-borne species with a particular affinity to plant roots and which rarely become pathogenic (these species usually produce resting structures called chlamydospores) and (2). facultative plant parasites mainly found on woody plants (Domsch, Gams and Anderson 1980). Cylindrocarpon spp. are quite similar to some species of Fusarium, included in the section Martiella (Domsch, Gams and Anderson 1980). Cylindrocarpon spp. can frequently be isolated on media selective for Fusarium, such as that described by Komada (1975). They also often occupy similar ecological niches as do Fusarium (Wilhelm 1959).

Seven species of Cylindrocarpon have either been implicated as causing diseases of conifer trees or isolated from diseased trees. Each of these species are discussed in detail below.

SPECIES CHARACTERISTICS

C. album (Sacc.) Wollenw. (teleomorph: Nectria punicea (Schmidt ex Fr.) Fr.)

This species has only rarely been reported on conifers. It has been found a few times on unidentified Pinus spp. in North America (Booth 1966). It has also commonly been reported on many other unrelated hosts. In pathogenicity tests, this species has been shown to be very weakly pathogenic (Matturi and Stenton 1964a). Cylindrocarpon album has not been isolated from or associated with conifer seedlings in the northern Rocky Mountains.

C. carneum Booth sp. nov. (teleomorph: unknown)

This species has only been reported as occurring on the galls of Pinus maximinoi in Honduras (Booth and Evans 1984). It produces bright pink spore tendrils which exude from sporodochia located on galls. It has not been reported in North America nor has it been associated with conifer seedling diseases.

C. cylindroides Wollenw. var. tenue Wollenw. (teleomorph: Nectria fuckeliana Booth).

This species has been rarely reported on conifers. It produces cankers on Abies spp. (Lang 1981) and is capable of causing mortality of A. concolor and several Abies hybrids.

C. destructans (Zinssm.) Schlolten. (=C. radicicola Wollenw.) (teleomorph: Nectria radicicola Ger. & Nils.)

This is by far the most common species of Cylindrocarpon (Domsch, Gams and Anderson 1980). It has frequently been reported from soil (Booth 1966; Domsch, Gams and Anderson 1980; Gams and Domsch 1969; Stenton 1953; Thornton 1958; Thornton 1960a) but is particularly common on roots and underground parts of a large variety of woody and herbaceous plants (Domsch, Gams and Anderson 1980; Kubikova 1963; Matturi and Stenton 1964a; Scholten 1964; Stenton 1958; Taylor and Parkinson 1961). Although this species is found commonly in temperate areas, reports of its occurrence in subtropical and tropical areas are relatively rare (Bolton 1984; Domsch, Gams and Anderson 1980).

Isolates have been obtained from various forest soils, including nursery soils and within forest litter (Booth 1966; Domsch, Gams and Anderson 1980; Thornton 1960a; Thornton 1960b). Highest frequency from forest soil occurs in the lower half of the A horizon (Warcup 1951). It is easily recovered using standard soil dilution techniques (Griffin 1960; Thornton 1960b). It is most commonly found in neutral or slightly acidic soils (Peterson 1958; Taylor and Parkinson 1964; Warcup 1951) and moist soils are preferred (Taylor and Parkinson 1964; Warcup 1951). *Cylindrocarpon destructans* is a fast initial colonizer of forest soil following fire (Widden and Parkinson 1975). Soils undergoing seasonal desiccation are usually not preferred by this species (Taylor 1964; Thornton 1965).

Cylindrocarpon destructans has been isolated frequently from the root surfaces of numerous coniferous species including *Pinus strobus*, *Larix leptolepsis* (Fontana and Luppi 1966; Matturi and Stenton 1964a), *Pinus nigra* var. *laricio* (Parkinson and Crouch 1969), and several other species of *Abies*, *Picea* and *Pinus* (Booth 1966; Sierpinski 1981). Although this species is often considered a weak parasite on pine seedlings (Domsch, Gams and Anderson 1980), it has been reported as causing severe damage to *Pinus banksiana* seedlings (Vaartaja and Crum 1956) and *Pseutosuga menziesii* (Bloomberg and Sutherland 1971). This latter association is the "corky root" disease which includes damage caused by *Xiphinema bakeri* nematodes (Sluggett 1972). Tests on several conifer species indicated that pathogenic isolates may be common (Kluge 1966; Kowalski 1980; Manka and Gierczak 1971; Ouellette and Bard 1966). However, saprophytic isolates incapable of causing disease are also common (Booth 1966). The fungus is apparently active on root surfaces throughout the year (Kubikova 1963), usually in the form of hyphal strands that can quickly colonize root surfaces. However, it is not often recovered from roots at higher temperatures (Ross 1960; Rouatt et al. 1963). *Cylindrocarpon destructans* has been described as a "nonparasitic pathogen" on some plants because of its ability to produce toxic substances which penetrate host cells resulting in production of disease symptoms even though the fungus resides outside live cells (Evans, Cartwright and White 1967; Wilhelm 1959). It may also produce auxins and gibberellins which influence plant growth (Strzelczyk and Pokojska-Burdziej 1982). After plant death, the fungus persists in or on roots, probably as resistant mycelium and chlamydospores (Matturi and Stenton 1964a).

Several reports indicate that *C. destructans* does not display high saprophytic competitive ability within soil or on the surface of plant roots (Matturi and Stenton 1964a; Taylor 1964; Vaartaja and Salisbury 1965). The fungus exists in the soil as chlamydospores which germinate when stimulated by exudates from host plant roots (Matturi and Stenton 1964b). Tests have shown that isolates vary in their ability to exhibit antagonistic activity against other fungi (Domsch and Gams 1968; Kamoen 1959; White, Chilvers and Evans 1963). Actinomycetes have been shown to be more antagonistic toward this species than bacteria (Strzelczyk, Rozycki and Michniewicz 1986). *Cylindrocarpon destructans* is also inhibited by two common antagonistic fungi, Trichoderma viride (Vaartaja and Salisbury 1965) and Gliocladium roseum (Taylor 1964). Microorganisms from the rhizosphere may restrict spore germination of C. destructans (Strzelczyk, Rozycki and Michniewicz 1984). Occurrence of C. destructans seems to be inversely correlated with occurrence of Fusarium either within soils or on the surface of roots (Matturi and Stenton 1964a; Thorton 1960a).

Control of diseases caused by this fungus has been accomplished by steam treatment of potting soils and application of fungicides (Scholten 1964). Damage by this fungus may often be compensated for by improved fertilization which allows the host to produce new roots to replace those decayed (Scholten 1964). This common species may have been isolated frequently from seed and seedlings in northern Rocky Mountain nurseries (James 1987a; James 1987b; James and Genz 1982; James and Gilligan 1985), but labeled as a different species.

C. didymum (Hartig) Wollew. (teleomorph: unknown)

This rather uncommon species has probably been reported more frequently that it really occurs. The species name may have been misapplied several times (Booth 1966). This species occurs within forest soils in the United States (Christensen 1969; Gochenaur 1964; Gochenaur and Whittingham 1967; Wicklow and Whittingham 1974). Habitates also include nursery soils (Gochenaur 1964). The fungus has also been isolated from the roots of several host plants including forest trees (Booth 1966; Kuerbis 1937). It has been shown to be pathogenic to Pinus sylvestris seedlings (Houten 1939) and associated with decay of roots of containerized western white pine seedlings in northern Rocky Mountain nurseries (James 1987b). This species ranks as a very weak competitor compared with other Cylindrocarpon species (Matturi and Stenton 1958) and has displayed limited antibiotic activity against several test fungi (Domsch and Gams 1968).

C. magnusianum (Sacc.) Wollenw. (teleomorph: Nectria ramulariae (Wollenw.) E. Mull.)

This species has been found on numerous host plants and soils in the United States (Booth 1966). It is the second most common species of Cylindrocarpon found in soil after C. destructans (Cormack 1937; Domsch, Gams and Anderson 1980). Cylindrocarpon magnusianum has frequently been isolated from forest soils (Caldwell 1963; Morrall 1974) including those from nurseries (Domsch, Gams and Anderson 1980) and from the roots of Pinus maritima (Mickovski 1962). In comparison with other species of Cylindrocarpon, C. magnusianum has high competitive saprophytic ability in soil (Matturi and Stenton 1958; Matturi and Stenton 1964a). Its conidia rarely germinate in soil and tend to give rise to chlamydospores (Matturi and Stenton 1964b). Damage from this species has not been sufficient to warrant direct control measures. Cylindrocarpon magnusianum has not been reported on seedlings in the northern Rocky Mountains.

C. pineum Booth spec. nov.   (teleomorph: Nectria pinea Dingley)

This relatively uncommon species has been reported on members of the Pinaceae, including Abies, Larix, Pinus, and Pseudotsuga (Booth 1966). It occurs in North America, generally on old logs. However, there is no evidence of pathogenic associations with its hosts (Booth 1966) and it has not been associated with diseased conifer seedlings.

C. tenue Bugn.   (teleomorph: unknown)

This species is sometimes found within several different types of soils (Booth 1966). It has been associated with containerized Engelmann spruce seedling diseases (James and Gilligan 1985), although pathogenicity to conifer seedlings has not been confirmed. No other reports of its occurrence on conifers were found.

LITERATURE CITED

Bloomberg, W. J. and J. R. Sutherland. 1971. Phenology and fungus-nematode relations of corky root disease of Douglas-fir. Ann. Appl. Biol. 69:265-276.

Bolton, A. T. 1984. Root rot of Fiscus benjamina. Plant Disease 68:816-817.

Booth, C. 1966. The genus Cylindrocarpon. Commonwealth Mycological Inst. Mycological Papers, No. 104. 56 p.

Booth, C. and H. C. Evans. 1984. A new species of Cylindrocarpon associated with pine galls in Honduras. Trans. Brit. Mycol. Soc. 82(4):745-748.

Caldwell, R. 1963. Observations on the fungal flora of decomposing beech litter in soil. Trans. Brit. Mycol. Soc. 46:249-261.

Christensen, M. 1969. Soil microfungi of dry to mesic conifer-hardwood forests in northern Wisconsin. Ecology 50:9-27.

Cormack, M. W. 1937. Cylindrocarpon ehrenbergi and other species, as root parasites of alfalfa and sweet clover in Alberta. Can. J. Res., Sect. C. 15:403-424.

Domsch, K. H. and W. Gams. 1968. Die Bedeutung Vorfruchtabhaengiger Verschiebungen in Der Budenmikroflora. 2. Antagonistische Einfluesce Auf Pathogene Budenpilze. Phytopathologische Zietschrift 63:165-176.

Domsch, K. H., W. Gams and T. H. Anderson. 1980. Compendium of soil fungi. Academic Press, London. 859 p.

Evans, G., J. B. Cartwright and N. H. White. 1967. The production of a phytotoxin nectrolide by some root surface isolates of Cylindrocarpon radicicola Wr. Plant and Soil 26:253-260.

Fontana, A. and A.-M. Luppi. 1966. Funghi saprofiti isolati da ecto-micorrize. Allionia 12:38-46.

Gams, W. and K. H. Domsch. 1969. The spatial and seasonal distribution of microscopic fungi in arable soils. Trans. Brit. Mycol. Soc. 52(2):301-308.

Gochenaur, S. E. 1964. The soil microfungi of willow-cottonwood forests in southern Wisconsin. University of Wisconsin. PhD Dissertation. 154 p.

Gochenaur, S. E. and W. F. Whittingham. 1967. Mycoecology of willow and cottonwood lowland communities in southern Wisconsin. 1. Soil microfungi in the willow-cottonwood forests. Mycopath. Mycol. Appl. 33:125-139.

Griffin, D. M. 1960. Fungal colonization of sterile hair in contact with soil. Trans. Brit. Mycol. Soc. 43:583-596.

Houten, J. G. 1939. Kiemplantenziekten van coniferen. Thesis, University of Utrecht. 125 p.

James, R. L. 1987a. Mortality of outplanted western larch seedlings - Plum Creek Nursery, Pablo, Montana. USDA Forest Service, Northern Region. Nursery Dis. Notes #55. 3 p.

James, R. L. 1987b. Root deterioration of containerized western white pine seedlings - Plum Creek Nursery, Pablo, Montana. USDA Forest Service, Northern Region, Nursery Dis. Notes #47. 5 p.

James, R. L. and D. Genz. 1982. Evaluation of fungal populations on ponderosa pine seed. USDA Forest Service, Northern Region. Rept. 82-22. 21 p.

James, R. L. and C. J. Gilligan. 1985. Containerized Engelmann spruce seedling diseases at the USDA Forest Service Nursery, Coeur d'Alene, Idaho. USDA Forest Service, Northern Region. Rept. 85-17. 15 p.

Kamoen, O. 1959. Physiologie Der Fructificatie. Onderzoekingen met Chaetomium globosum. Verh. Rijksstn Plziekt., Gent. 1. 40 p.

Kluge, E. 1966. Pathogenitat gegenuber Kiefernsamlingen und Toxinbildung bei Cylindrocarpon radicicola Wr. Phytopathology 55:368-371.

Komada, H. 1975. Development of a selective medium for quantitative isolation of Fusarium oxysporum from natural soil. Rev. Plant Protec. Res. 8:114-125.

Kowalski, S. 1980. Cylindrocarpon destructans (Zins.) Scholt., sprawca zamierania samusiewu jodly (Abies alba Mill.) w niektorych drzenostanach gorsckich polundniowej Polski. Acta. Agr. Silv. 19:57-73.

Kubikova, J. 1963. The surface mycoflora of ash roots. Trans. Brit. Mycol. Soc. 46(1):107-114.

Kuerbis, W. P. 1937. Mykologische untersuchungen veber den Wurzelbereich der Esche. Flora, Jena 131:129-175.

Lang, K. J. 1981. Cylindrocarpon cylindroides var. tenue als pathogen an Abies concolor und einigen Tannenbastarden. Eur. J. For. Path. 11:191-192.

Manka, K. and M. Gierczak. 1971. O czynnikach sprawczych zgorzeli siewek sosny zwyczajnej w woj. pozwanskim. Zesz. Probl. Post. Nauk Roln. 127:87-94.

Matturi, S. T. and H. Stenton. 1958. A technique for the investigation of the competitive saprophytic ability of soil fungi by the use of easily decomposed substrates. Nature 182:1248-1249.

Matturi, S. T. and H. Stenton. 1964a. Distribution and status in the soil of Cylindrocarpon species. Trans. Brit. Mycol. Soc. 47:577-587.

Matturi, S. T. and H. Stenton. 1964b. The behaviour in soil of spores of four species of Cylindrocarpon. Trans. Brit. Mycol. Soc. 47:589-599.

Mickovski, M. 1962. The fungus flora under Pinus maritima and its influence on the process of humus formation over the same. Annu. Fac. Agric. Skopje 15:241-246.

Morrall, R. A. A. 1974. Soil microfungi associated with aspen in Saskatachewan - synecology and quantitative analysis. Can. J. Bot. 52:1803-1817.

Ouellette, G. B. and G. Bard. 1966. A perennial canker of balsam fir on Anticosti Island. Plant Dis. Reptr. 50(10):722-724.

Parkinson, D. and R. Crouch. 1969. Studies of fungi in a pine-wood soil. 5. Root mycofloras of seedlings of Pinus nigra var. laricio. Revue Ecol. Biol. Soil. 6:263-275.

Peterson, E. A. 1958. Observations on fungi associated with plant roots. Can. J. Microbiol. 4:257-265.

Ross, D. J. 1960. Physiological studies of some common fungi from grassland soils. New Zealand J. Science 3:219-257.

Rouatt, J. W., E. A. Peterson, H. Katznelson and V. E. Henderson. 1963. Microorganisms in the root zone in relation to temperature. Can. J. Microbiol. 9:227-236.

Samuels, G. J. 1978. Some species of Nectria having Cylindrocarpon imperfect states. New Zealand J. Bot. 16:73-82.

Scholten, G. 1964. Nectria radicicola en Thielaviopsis basicola als parasieten van Cyclamen persicum. Neth. J. Plant Path. 70 (Suppl. 2). 68p.

Sierpinski, Z. 1981. Ruckgang der Tanne (Abies alba Mill.) in Polen. Eur. J. For. Path. 11:153-162.

Sluggett, L. J. 1972. Corky root disease of Douglas-fir nursery seedlings. Can. For. Serv., Forest Insect & Disease Survey, Pest Leaflet No. 53. 5 p.

Stenton, H. 1953. The soil fungi of Wicker Fen. Trans. Brit. Mycol. Soc. 36:304-314.

Stenton, H. 1958. Colonization of roots of Pisum sativum L. by fungi. Trans. Brit. Mycol. Soc. 41:74-80.

Strzelczyk, E. and A. Pokojska-Burdziej. 1982. Production of auxins and gibberellin-like substances by Cylindrocarpon destructans (Zins.) Scholt. isolates pathogenic and non-pathogenic to fir (Abies alba Mill.). Phytopathologische Zietschrift 105:327-335.

Strzelczyk, E., H. Rozycki and M. Michniewicz. 1984. Effect of bacteria and actinomycetes on germination of conidia of Cylindrocarpon destructans isolates pathogenic to Abies alba and Pinus sylvestris. Eur. J. For. Path. 14:265-270.

Strzelczyk, E., H. Rozycki and M. Michniewicz. 1986. Growth and spore germination of Cylindrocarpon destructans in associative cultures with bacteria and actinomycetes. Eur. J. For. Path. 16:11-15.

Taylor, G. S. 1964. Fusarium oxysporum and Cylindrocarpon radicicola in relation to their association with plant roots. Trans. Brit. Mycol. Soc. 47:381-391.

Taylor, G. S. and D. Parkinson. 1961. The growth of saprophytic fungi on root surfaces. Plant and Soil. 15:261-267.

Taylor, G. S. and D. Parkinson. 1964. Studies on fungi in the root region. 2. The effect of certain environmental conditions on the development of root surface mycofloras of dwarf bean seedlings. Plant and Soil. 20:34-42.

Thornton, R. H. 1958. Biological studies of some tussock-grassland soils. II. Fungi. New Zealand J. Agr. Res. 1:922-938.

Thornton, R. H. 1960a. Fungi of some forest and pasture soils. New Zealand J. Agr. Res. 3:699-711.

Thornton, R. H. 1960b. Growth of fungi in some forest and grassland soils. In: Parkinson, d. and J. S. Waid (eds.). Ecology of Soil Fungi. Liverpool University Press. pp. 84-91.

Thornton, R. H. 1965. Studies of fungi in pasture soils. 1. Fungi associated with live roots. New Zealand J. Agric. Res. 8:417-447.

Vaartaja, O. and W. H. Cram. 1956. Damping-off pathogens of conifers and of Caragana in Saskatchewan. Phytopathology 46:391-397.

Vaartaja, O. and P. J. Salisbury. 1965. Mutual effects *in vitro* of micro-organisms isolated from tree seedlings, nursery soil, and forests. Forest Science 11:160-168.

Warcup, J. H. 1951. The ecology of soil fungi. Trans. Brit. Mycol. Soc. 34:376-399.

White, N. H., G. A. Chilvers and G. Evans. 1962. Antifungal activity of *Cylindrocarpon radicicola*. Nature 195:406-407.

Wicklow, D. T. and W. F. Whittingham. 1974. Soil microfungal changes among the profiles of disturbed conifer-hardwood forests. Ecology 55:3-16.

Widden, P. and D. Parkinson. 1975. The effects of a forest fire on soil microfungi. Soil Biol. Biochem. 7:125-138.

Wilhelm, S. 1959. Parasitism and pathogenesis of root-disease fungi. *In*: Plant Pathology: Problems and Progress 1908-1958. Univ. of Wisconsin Press, pp. 356-366.

APPENDIX

Mycological descriptions of selected species of *Cylindrocarpon* that are associated with conifer trees.

C. album (Sacc.) Wollenw. (teleomorph: *Nectria punicea* (Schmidt ex Fr.)Fr.)

-relatively slow growing, forming a colony of 10 mm in diameter on potato dextrose agar (PDA) after 7 days at about 20°C.
-agar becomes pale reddish-brown from below and tinged with yellow.
-aerial mycelium white, floccose to felted.
-mycelium septate with occasional swollen cells.
-microconidia formed; they are oval, cylindrical to broadly fusoid.
-condiophores penicillately branched with branches terminating in phialides.
-macrocondia curved, 3-9 septate, cylindrical and narrowing slightly towards each end.
-no chlamydospores described.

C. carneum Booth sp. nov. (teleomorph: unknown).

-colonies salmon pink, powdery, and orange in reverse.
-aerial mycelium hyaline and floccose.
-microconidia abundant, aseptate, hyaline, oval to obovoid.
-macroconidia on palmate condiophores, each branch terminating in one or more phialides.
-macroconidia highly variable, oval to cylindrical, curved with rounded ends, 1-8 septate.
-chlamydospores absent.

C. _cylindroides_ Wollenw. var. _tenue_ Wollenw. (teleomorph: _Nectria fuckeliana_ Booth)

-colonies white and floccose.
-agar yellow becoming beige to light brown.
-microconidia abundant; colonies assume a powdery appearance due to production of masses of microconidia.
-macroconidia mostly cylindrical, 1-3 septate, produced on branching subulate phialides.
chlamydospores absent.

C. _destructans_ (Zinssm.) Schlolten. (teleomorph: _Nectria radicicola_ Ger. & Nils.)

-colonies fast growing, reaching 10-12 cm diameter in 7 days on PDA at 20°C.
-aerial mycelium floccose to felted, whitish, beige to pale brown or reddish brown; reverse beige to deep reddish brown (sometimes with the odor of soap).
-condiophores repeatedly branched and bearing subulate phialides (slender, tapering at their ends).
-sporodochia with cream to beige conidial slime commonly produced.
-macroconidia cylindrical in the central part, straight or slightly curved, the apical cell symmetrically rounded in sporodochial conidia but in others slightly asymmetrical, mostly 1-3 septate.
-microconidia little differentiated from macroconidia.
-chlamydospores abundantly produced, intercalary or terminal, singly or in chains, smooth or warted, mostly pigmented.

C. _didymum_ (Hartig) Wollenw. (teleomorph: unknown)

-colonies slow growing, reaching 4 cm diameter in 7 days on PDA at about 20°C.
-colonies whitish, beige to coffee-brown.
-conidiophores initially long and slender becoming shorter, broader and more strongly branched.
-phialides almost cylindrical.
-conidia hardly separable into macro-and micro-conidial types, 0-1 (rarely 2) septate, oval to ellipsoidal or cylindrical, straight or slighly curved; the apical cell is characteristically bent to one side and slightly beaked.
-chlamydospores terminal or intercalary, single or in chains, globose, smooth, hyaline at first but later becoming brown.

C. _magnusianum_ (Sacc.) Wollenw. (teleomorph: _Nectria ramulariae_ (Wollenw.) E. Mull.)

-relatively slow growing, colonies reaching 4.4 cm diameter in 7 days at about 20°C on PDA.
-aerial mycelium whitish to cream, floccose, some isolates producing numerous reddish sclerotial bodies.
-reverse pale beige or sometimes becoming reddish brown.
-conidiophores sometimes branched or consisting of solitary phialides.
-some isolates produce discrete cream colored sporodochia.

-phialides mostly cylindrical.
-conidia rather uniform in shape and size, slightly curved, the apical cell obliquely tapered, 1-3 septate.
-chlamydospores intercalary or terminal, hyaline at first, but later becoming brownish, smooth-walled or warted, more or less globose.
-this species has narrower conidia than the other soil-borne Cylindrocarpon species and is easily recognized by the oblique apical cell of the conidia.

C. pineum Booth sp. nov. (teleomorph: Nectria pinea Dingley)

-colonies very slow growing, becoming 4-5 mm in diameter on PDA after 14 days.
-after 2 weeks, a purple-brown discoloration of the agar is generally present.
-aerial mycelium hyaline to reddish-brown.
-conidiophores penicillately-branched, each branch terminating in one or more phialides.
-in older cultures, condiophores borne in sporodochia.
-macroconidia cylindrical, curved, rounded at both ends, 3-5 septate at maturity.
-globose, thick-walled chlamydospores occasionally form in cells of macroconidia.
-no mycelial chlamydospores or microconidia observed.

C. tenue Bugn. (teleomorph: unknown)

-colonies slow growing, reaching 2-2.5 cm diameter after 7 dayes at about 20°C.
-aerial mycelium hyaline, floccose to felted.
-agar surface pale brown to deep reddish-brown.
-the intensity of the pigment varies with different isolates, but in some with deep pigmentation of the media the pigment appears to pass into the aerial mycelium.
-no microcondia produced.
-condiophores penicillately-branched, each branch terminating in one or more simple cylindrical phialides.
-condia very straight or very slightly curved, 0-1 septate, cylindrical or tapering slightly towards the base.
-chlamydospores globose, solitary or in chains, terminal or intercalary, hyaline becoming brown.

FIGURES

Figure 1. Colony of Cylindrocarpon (isolate 84-65) on PDA after growing for 14 days.

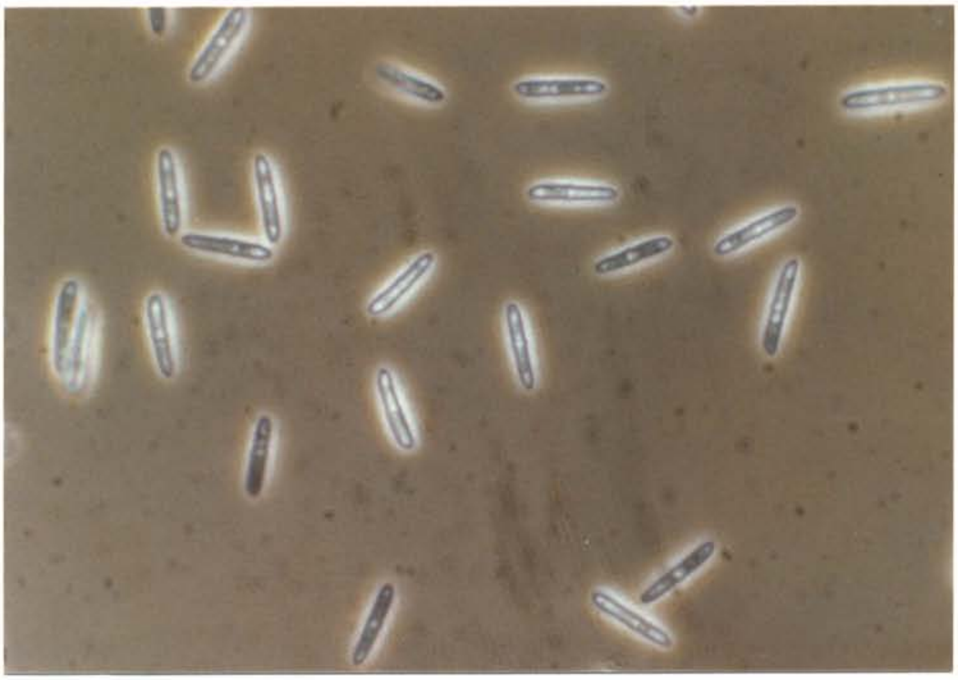

Figure 2. Macroconidia of Cylindrocarpon (isolate 84-63)(x450).

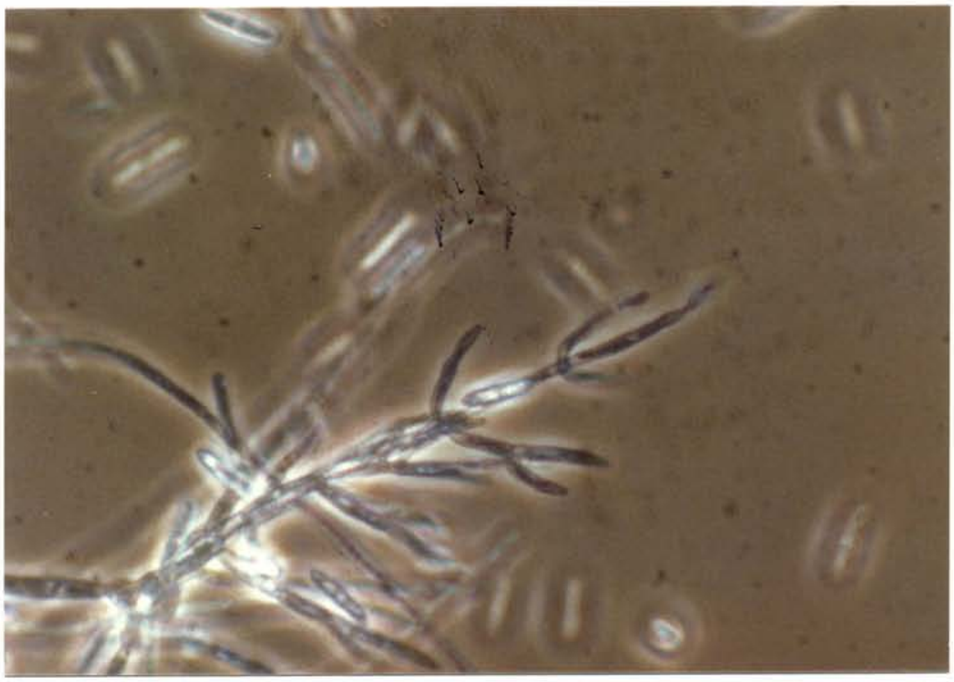

Figure 3. Branched conidiophore of <u>Cylindrocarpon</u> (isolate 84-62)(x450).

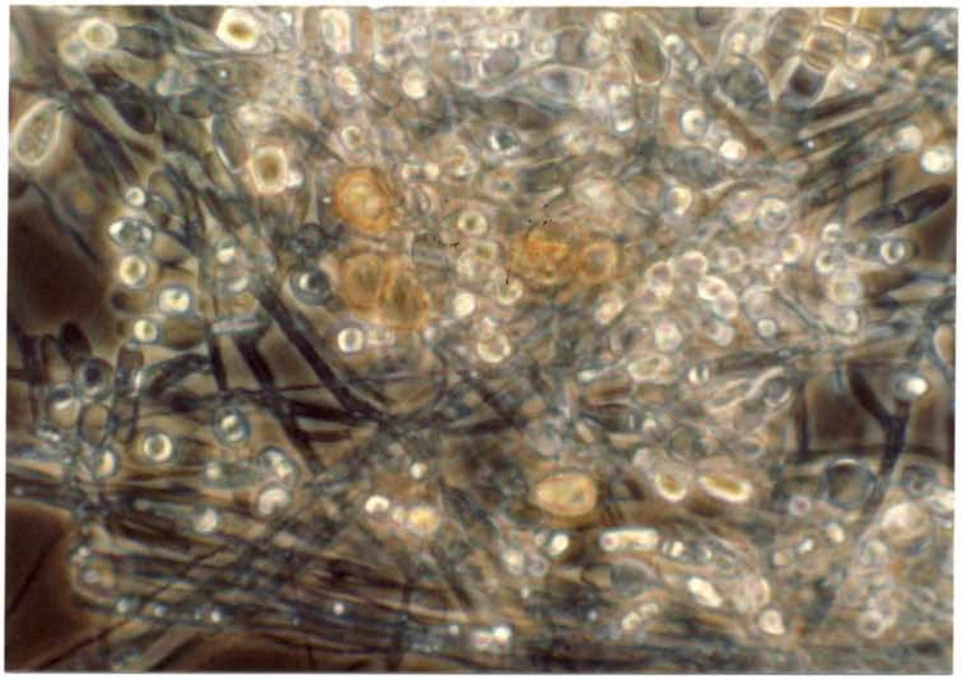

Figure 4. Chlamydospores of <u>Cylindrocarpon</u> (isolate 87-1)(x450).

Figure 5. Cylindrocarpon growing on Komada's medium (selective for Fusarium) after 10 days' incubation. Note profuse sporodochial production.