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MICROSCOPIC ASCOMYCETES ISOLATED FROM ROTTING WOOD IN THE BOREAL FOREST

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Abstract: During a survey of microfungi from rotting wood in northern Alberta forests, 49 species of ascomycetes, representing 24 genera, and 15 families in seven orders, were recovered. Twenty-eight species are new reports for Alberta, 15 of which are new for Canada, and seven are new for North America. Twenty species have not been reported previously from wood. The most frequently isolated species were *Microascus albonigrescens* and *Gelasinospora tetrasperma*. Diversity and abundance of ascomycete microfungi suggest that these fungi are a more significant component of wood decay fungus communities than previously recognized.

Keywords: biodiversity, decomposition, fungi, poplar, spruce, wood decay

Introduction

Woody material is a large reservoir of carbon in forest ecosystems, but relatively little is known about the communities of fungi that are responsible for the decomposition of this material. Most studies have concentrated on wood-decay basidiomycetes (e.g., Martin and Gilbertson 1978), or ascomycetes with superficial and macroscopic fruiting bodies (e.g., Abbott and Currah 1989), but the isolation of microscopic ascomycetes from wood has rarely been attempted. Studies of microfungi from wood have primarily reported hyphomycetes, and include only a few ascomycetes (e.g., Crawford et al. 1990; Duncan and Eslyn 1966).

During a survey of microfungi associated with decomposing wood in the boreal forest of Alberta, 298 fertile ascomycete cultures were recovered. Many of these are previously unknown from wood and some are known only from a few collections worldwide. It is our opinion that these hitherto overlooked organisms are not only playing an important role in the ecology of wood decay, but are important components of the biodiversity of boreal forest ecosystems. For these reasons, we provide an annotated list of ascomycetes recovered from rotting logs in undisturbed boreal forest of northern Alberta, as well as from logs of post-fire and post-harvest sites in the same region.

Materials and Methods

Study sites and sampling. Logs of diameter greater than 15 cm were sampled from undisturbed (1000 samples), post-fire (300 samples), and post-harvest (250 samples)

sites in north-central and northeastern Alberta, Canada during the summers of 1995-1997. Most samples were taken from sites in Elk Island National Park (53°40'N, 112°48'W), Mariana Lakes area (56°16'N, 111°40'W), near Slave (55°35'N, 114°42'W) and Calling (55°26'N, 113°33W) Lakes, but some samples were taken from several other sites. Most samples were from white spruce (*Picea glauca*) and aspen (*Populus tremuloides*), but some were from other species (*Abies balsamea, Alnus tenuifolia, Betula papyrifera, Larix laricina, Picea mariana, Pinus banksiana, Populus balsamifera, Salix discolor*). Stage of decomposition was determined for each log. Gymnosperm logs were characterized according to Sollins (1982). Stage I logs were newly fallen and supported above the ground by branches; bark was intact. Stage II were losing small branches, but wood was hard. Stage III had lost most branches and bark and were in contact with the ground along the entire length; wood was soft. At stage IV, bark and branches were gone and the wood was broken into large chunks, and by stage V, wood was becoming humified and visible as a hummock on the forest floor. Angiosperm logs decompose more quickly and less uniformly, with fewer consistent external indicators. Consequently, only three decomposition stages were recognized: early stage (stage I) logs still had bark and branches attached, intermediate stage (stage II) logs were noticeably softer, and had most bark and branches gone, and late stage (stage III) logs were mostly humified and visible as hummocks.

Media and plating. Logs were sampled in one of two ways. Early stage logs, with wood intact, were sampled by cutting cross-sectional "cookies" with a bow-saw and extracting samples (approximately $1cm^3$) using an ethanol-sterilized chisel. Late stage logs were sampled by extracting approximately 1 cm^3 of wood at various depths in the log. All samples were briefly flamed, and plated onto six media to encourage the growth of a broad spectrum of fungi. Media used were: tapwater agar (TWA, 1.5% agar w:v, which served primarily as a moist chamber), cornmeal agar (CMA, Difco, a non-specific medium), malt extract agar (MEA, 1.5% agar and malt extract w:v, a non-specific medium with a relatively high content of easily-assimilated carbon), MEA with benomyl (2 mg/L, primarily for the selection of resistant ascomycetes, such as Microascales), MEA with Rose Bengal (to retard the growth of all fungi, thus preventing rapid overgrowth and allowing isolation of slow-growing fungi), and Mycobiotic agar (MB, Difco, contains 400 mg/L cycloheximide which inhibits most fungi with the exception of certain ascomycetes, including some Onygenales and Microascales). Tetracycline (100 mg/L) was added to all media to inhibit the growth of bacteria.

Isolation and identification. Primary isolation plates were incubated at room temperature (19-24°C) and examined every 2-3 months, for 18-24 months. Species determinations were made either directly from primary isolation plates or from pure cultures grown on MEA, or on other diagnostic media, as required. Polyvinyl alcohol and lactofuchsin were used as mounting media (Sigler 1992). Ascospores were observed in squash mount preparations. Slide cultures used cereal agar (Sigler 1992). Representative isolates and specimens are maintained in the University of Alberta Microfungus Collection and Herbarium (UAMH).

Enzymatic abilities. Cellulolytic ability was determined for selected strains following the cellulose azure method of Smith (1977) using a basal salts medium. Molten basal salts medium (10 ml) was poured into 50 ml screw-cap test tubes and these were autoclaved for 12 minutes at 121°C. One millilitre of a molten 2% suspension (w:v) of cellulose azure (Difco) in basal salts medium was added to each of the cooled test tubes. Test tubes were inoculated with small (1 mm^3) cubes of agar taken

from the perimeter of colonies on MEA, and incubated in the dark at room temperature for eight weeks.

Results

Twenty-four genera, 15 families, and seven orders are represented. Twenty-eight species are new records for Alberta, eight of these are new records for Canada, and seven for North America. Twenty species have not been reported previously from wood. Isolation numbers are summarized for the eight most common genera (Fig. 1).

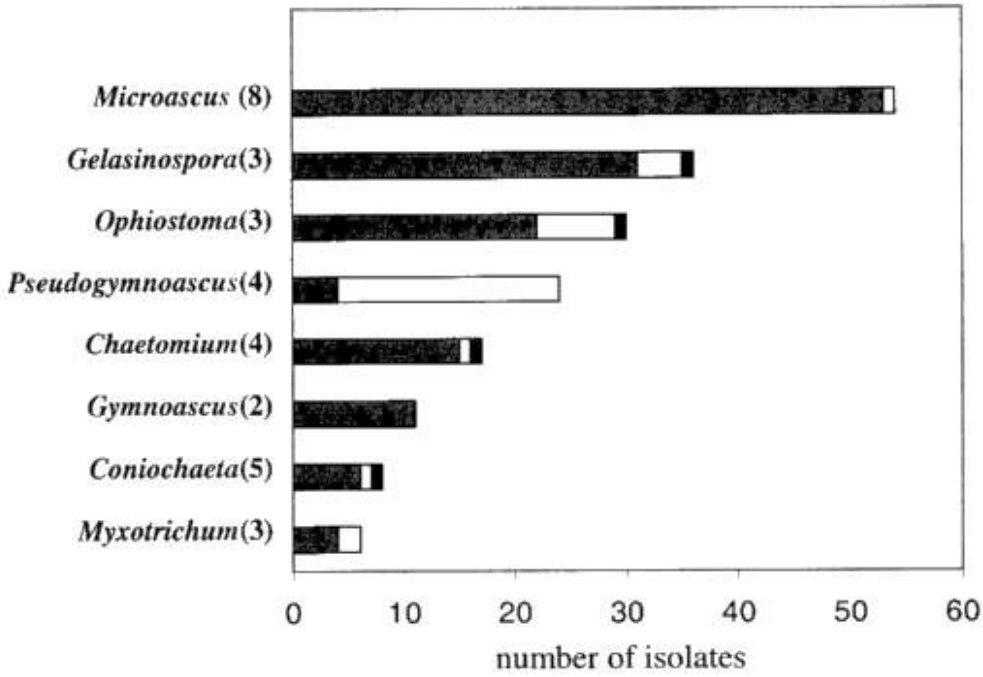

Figure 1. Number of isolates from the eight most common genera of ascomycetes isolated from rotting wood from undisturbed (gray), post-fire (white), and post-harvest (black) sites in the boreal forest of Alberta. Number of species is in parentheses.

Overall, *Microascus albonigrescens* was the most common (36 isolates), followed by *Gelasinospora tetrasperma* (32 isolates). *Pseudogymnoascus roseus* was also common (16 isolates) but was isolated almost exclusively from post-fire sites. Other examples of habitat specificity include *G. tetrasperma* almost exclusively from bark and *Gymnoascus uncinatus*, which was found only in Elk Island National Park. Only seven species were recovered from post-fire sites, including five from *Myxotrichaceae* (*Myxotrichum arcticum*, *Pseudogymnoascus alpinus*, *Pseudogymnoascus sp.*, *Pseudogymnoascus frigidus*, and *Pseudogymnoascus roseus*), and only four species were recovered from post-harvest sites (*Chaetomium funicola*, *Coniochaeta saccardoi*, *Gelasinospora tetrasperma*, and *Podospora tetraspora*).

Some species were strictly associated with one wood type. Twenty-one species were found only on gymnosperms and nine species were isolated exclusively from poplars. Species recovered from both log types were *Chaetomium funicola*, *Coniochaeta malacotricha*, *C. saccardoi*, *Emericella nidulans*, *Eupenicillium*

lapidosum, *G. tetrasperma*, *Microascus* cf. *nidicola*, *M. singularis*, and *Ophiostoma piluliferum*.

Discussion

Overall, most isolates came from wood sampled in undisturbed sites, where most of the samples were taken. Species of *Gymnoascus* came only from the undisturbed site in Elk Island National Park, and all but one isolate of *Microascus* spp. also came from this site. There was evidence of a great deal of animal activity, especially by ungulates, whose dung may have contributed to the relatively large number of isolations of these fungi. Species of *Chaetomium*, *Coniochaeta*, *Ophiostoma*, and *Gelasinospora* were isolated from all site types, and *Pseudogymnoascus* and *Myxotrichum* spp. (Myxotrichaceae) were isolated from undisturbed and post-fire sites only.

Direct examination of logs, branches, and twigs for superficially fruiting ascomycetes has been the traditional method for wood surveys, but the ascomycete flora detected in this manner (e.g., Ellis and Ellis 1985) is quite different from those isolated from the interior of decayed logs by plating the wood directly. Soft-rot fungi, including many *Chaetomium* spp., are vigorously cellulolytic and prevalent in wood (Rayner and Boddy, 1988) but only observable after isolation. In addition to cellulose, other substrata are also available to microfungi in rotting wood. These include lignin, xylan, insect frass and carcasses, keratinous animal remains, and other residual proteinaceous material and organic compounds deposited by the action of other organisms. The diversity of additional substrates may help explain the diversity of ascomycete species that have not previously been reported from rotting wood. Some of these ascomycetes, while not strongly cellulolytic, are able to utilize other substrata and may be an integral part of the decay process.

The Microascaceae (teleomorphs and anamorphs) are commonly reported from urban and agricultural areas, and are reported only infrequently from nature, with even fewer reports from the boreal forest. Collections of this group come mainly from dung, litter, soil, or as airborne spores (e.g., Morton and Smith 1963; von Arx et al. 1988), but *Microascus* species were the most commonly isolated in this study, and the genus *Microascus* accounted for the greatest number of species (Fig. 1). Most microascaceous fungi are cellulolytic and proteolytic, and presumably their role in the communities of fungi on herbivore dung is the degradation of residual cellulose and proteins. Cellulose-rich woody debris on the forest floor has not been extensively sampled for these fungi. Cellulolytic abilities for five of the *Microascus* species recovered (*Microascus albonigrescens*, *M. longirostris*, *M. manginii*, *M.* cf. *nidicola*, *M. singularis*) were tested using cellulose azure and by cellophane membrane degradation (Abbott and Lumley unpublished results). All species were moderately or weakly cellulolytic: *M. albonigrescens* was best able to degrade cellulose, while *M. longirostris*, *M. manginii*, *M.* cf. *nidicola*, and *M. singularis* degraded cellulose only to a limited extent after prolonged incubation. Interestingly, *M. albonigrescens* was the most frequently isolated species of *Microascus* (36 isolates) and the other species of *Microascus* were comparatively rare (18 isolates in total). Many anamorphic taxa allied to the Microascaceae were also recovered from decayed wood, including species of *Scopulariopsis*, *Cephalotrichum* and *Wardomyces*.

Ophiostoma species and their anamorphs (e.g., *Leptographium* spp.) are a common cause of bluestain (Dowding 1970; Wingfield et al. 1993), and are frequently found associated with beetle galleries. These fungi are frequently isolated from lumber

and logs, but very little is known about the ability of *Ophiostoma* species to compete with fungi during the latter stages of wood decomposition. Three species isolated produced perithecia in pure culture and, although anamorphic Ophiostomataceae were common during this study, teleomorphic strains were uncommon.

Chaetomium species are strongly cellulolytic, soft-rot fungi often isolated from soil (Gochenaur 1978), humus, litter, dung (Cain 1934), and wood (Duncan and Eslyn 1966). Many *Chaetomium* species are active at low water availability and their action can cause an accumulation of moisture. This is ecologically significant because it allows *Chaetomium* species to inhabit xeric environments where there is relatively little competition, but as water accumulates, they may be replaced by other, less xerotolerant, species. *Chaetomium* spp. were isolated from all site types and were among the few ascomycete species from post-harvest sites. These species were most frequent from early or intermediate stage logs, presumably correlated to low moisture levels.

The ecology of the Myxotrichaceae is virtually unknown, owing mainly to the inconspicuous nature of the ascomata and the relative difficulty with which they are cultured from natural substrata. Of the 16 accepted species, over half are known from three or fewer collections worldwide. Consequently, species distributions are uncertain and taxonomic circumscriptions at the species level are unreliable. Their ability to degrade cellulose is well-documented (Currah 1985) and, like *Microascus* species, were found to exhibit a broad range of cellulolytic abilities. *Pseudogymnoascus roseus* was the most efficient, followed by other *Pseudogymnoascus* species and *Myxotrichum arcticum*, which were only weakly cellulolytic, while isolates of *Myxotrichum ochraceum* and *Myxotrichum cancellatum* showed little or no cellulolytic ability. It is interesting that most isolates of *Pseudogymnoascus* spp. were recovered from post-fire sites, including from charred wood, although the reason for this is unknown.

Annotations

Species are listed alphabetically by genus and species with annotations concerning key diagnostic features and information on substrates and distribution. Annotations provide: Name and citation, taxonomic affiliation (Family, Order) following Eriksson and Hawksworth (1998), distinctive morphological features, taxonomic notes, substratum preference (stages I-V gymnosperm, stages I-III angiosperm) and any special adaptations (e.g., xerophily), and geographic distribution. "Collections examined" includes other specimens from Alberta and worldwide, including type material in some cases, used to confirm identity. Unless otherwise noted, material from Elk Island National Park, Mariana Lake, and Slave Lake was isolated by T. Lumley. To designate a taxon as a new record for Alberta, Canada, or North America, published works were searched, but herbarium records and unpublished lists were not.

Arthroderma curreyi Berkeley, 1860, Outlines of Brit. Fungology, p. 357.

(Arthrodermataceae, Onygenales)

Ascomata sterile; *Chrysosporium* anamorph distinguishes this species from other heterothallic *Arthroderma* species. Keratinolytic (Currah 1985), found on bark in one undisturbed site, possibly from bird activity (Pugh 1964). Widespread (e.g., Europe, Australia, USA). The specimen reported from Alberta in Currah (1985) proved to be *A. cuniculi*.

Material examined: CANADA: Alberta: Elk Island National Park: *Picea glauca* bark, III, IV (UAMH 8728). **USA: Ohio:** soil, Kurup 1968 (UAMH 3171). **AUSTRALIA:** Melbourne: ex human arm (UAMH 7903).

Byssochlamys* cf. *fulva Oliver and Smith, 1933, J. Bot. Lond. 72: 197.
(Trichocomaceae, Eurotiales)

Cleistothecia pallid; ascospores hyaline, refractive, 6 x 4 µm; *Paecilomyces* state abundant. Several isolates were recovered on primary isolation plates after one-year incubation, but pure cultures were not obtained. Conidium size differed from the type of *B. fulva* (3-4.5 x 2-3 µm in UAMH 9624 versus 4.5-9 x 1.5-3.5 µm in UAMH 3094), and from the range reported in Stolk and Samson (1971)(4-8.5 x 1.5-5 µm).

Material examined: CANADA: Alberta: Mariana Lake: *Picea glauca* II, 2-year post-fire site (UAMH 9624); *Picea glauca* III; Elk Island National Park: *Populus tremuloides* II decomposition. **UK:** bottled fruit, Rendle 1933 (ex-type of *B. fulva*)(UAMH 3094).

Chaetomium funicola Cooke, 1873, Grevillea 1: 176.
(Chaetomiaceae, Sordariales)

Perithecia with distinctive two-tiered hairs, the first short, dichotomously-branched hairs, the second long and straight; ascospores limoniform, more acute at one end, 5.5-6.5 x 3.5-5.0 µm. Separated from the similar *C. dolichotrichum* Ames, which has dichotomously-branched hairs, by the presence of a second tier (Domsch et al. 1980), and from *C. elatum* Kunze : Fries by the smaller ascospores (10-13 x 8-10 µm in *C. elatum*). A cellulolytic, soft-rot fungus (Duncan and Eslyn 1966), possibly xerophilic. Worldwide, reported from pine litter (Hayes 1965), timber and paper, and forest soil (Hammill 1970). First report for Alberta.

Material examined: CANADA: Alberta: Elk Island National Park: *Populus tremuloides* II (UAMH 9370), *Picea glauca* I, IV; Slave Lake: 15-year post-harvest site, *Populus tremuloides* II. **USA:** Benjamin RSA 1683 (UAMH 3034). **COSTA RICA:** La Selva, Heredia Prov.: ex roots of epiphytic orchid *Pleurothallis* sp., Richardson 1991 (UAMH 7194).

Chaetomium globosum Kunze: Fries, 1829, Syst. Mycol. 3: 226.
(Chaetomiaceae, Sordariales)

Perithecia with wavy lateral hairs and undulate to loosely coiled terminal hairs; ascospores limoniform, 8.5-11.0 x 7.0-9.0 µm. Our isolates are probably var. *ochraceoides* Dreyfuss, because of the small ascospores and olive-green ascomata, but the delimitation among the five described varieties is not sharp (Dreyfuss 1976). *C. globosum* is common worldwide on most cellulosic substrata, including forest soil and litter (Hayes 1965), and wood (Mangenot 1952). Ascospores can survive drying for more than ten years (Page 1951). Reported from Alberta (Abbott et al. 1995; Sigler et al. 1996)

Material examined: CANADA: Alberta: Mariana Lake: *Populus tremuloides* I; Grimshaw: indoor air from *Apis mellifera* (honeybee) overwintering facility, Abbott 1994 (UAMH 7773); Devonian Botanic Garden near Devon: canvas in butterfly chrysalis incubation chamber, Abbott 1993 (UAMH 7407); Edmonton: indoor air, Sigler 1989 (UAMH 7142).

Chaetomium homopilatum Omrik, 1953, Mycologia 47: 749.
(Chaetomiaceae, Sordariales)

Perithecia elongate (subcylindric to ampulliform) with lateral and terminal, straight, unbranched hairs; ascospores limoniform with strongly apiculate apices, bilaterally flattened, 8.5-10 x 4.5 µm; *Botryotrichum* state present. First report from Canada.

Material examined: CANADA: Alberta: Elk Island National Park: *Populus tremuloides* II (UAMH 9453). **COSTA RICA: Heredia:** La Selva, roots of epiphytic orchid (*Dryadella pusiola*) Richardson 1991 (UAMH 7196).

Chaetomium piluliferum Daniels, 1961, Trans. Brit. Mycol. Soc. 44: 84.
(Chaetomiaceae, Sordariales)

Perithecia with uncinate hairs; ascospores ellipsoid, 13-16 x 7-8 µm; *Botryotrichum* state of large, globose, hyaline conidia from a hyaline, racemosely-branched conidiophore. Ascomata typically sterile, but two isolates examined from Alberta (UAMH 1086, 1387) form fertile ascomata in culture. *C. murorum* and *C. piluliferoides* are similar, but have narrower ascospores (Domsch et al. 1980). *Chaetomium piluliferum* is often found on dung, but also in soil and, less commonly, on wood. Cellulolytic (Daniels 1961), chitinolytic (Okafor 1967), and ligninolytic (Haider and Domsch 1969). Reported from Alberta by Sigler et al. (1996).

Material examined: CANADA: Alberta: Elk Island National Park: *Picea glauca* II, V, *Populus tremuloides* II (UAMH 9371); Mariana Lake: *Picea glauca* II; Grimshaw: indoor air from honeybee (*Apis mellifera*) overwintering facility, Abbott 1994 (UAMH 7718); Edmonton: lungs ex Richardson's ground squirrel (*Spermophilus richardsonii*), Carmichael 1962 (UAMH 1387); spleen of rodent, Carmichael 1960 (UAMH 1086); coyote (*Canis latrans*) dung, Currah (UAMH 5589).

Coniochaeta ellipsoidea Udagawa, 1967, Trans. Mycol. Soc. Japan 8: 51.
(Coniochaetaceae, Sordariales)

Perithecia sparsely setose; ascospores asymmetrical, 20-25 x 10-11.5 µm. A single strain of this species produced confluent ascomata on the primary isolation plate, but subsequent subcultures were not viable. Previously reported from soil in Japan and Spain (Udagawa and Takada 1967; Checa et al. 1988). First record for North America and from wood.

Material examined: CANADA: Alberta: Slave Lake: 30-year post-fire site *Picea glauca* III (UAMH 9502).

Coniochaeta ligniaria (Greville) Massee, 1887, Grevillea 16: 37.
(Coniochaetaceae, Sordariales)

Perithecia setose, black; ascospores discoidal, with longitudinal germ slit, 11-13 x 8.5-9.5 µm; *Lecythophora* anamorph. Reported from wood of *Alnus, Fagus, Pinus, Quercus, Ulex,* and *Ulmus*, including some from western Canada (Ellis and Ellis 1985; Ginns 1986).

Material examined: CANADA: Alberta: Rocky-Clearwater Forest: rotted *Populus* wood, Sigler 1986 (UAMH 5533).

Coniochaeta malacotricha (Auserwald) Traverso, 1907, Flora Italica Cryptogama 1: 473.
(Coniochaetaceae, Sordariales)

Perithecia setose, black; ascospores asymmetrical, broadly ellipsoid in face view, 10-12.5 x 5.5-7 µm; *Lecythophora* anamorph. Fertile ascomata abundant on cellophane membrane (Carmichael 1963). Previous reports only from conifer wood (Mahoney and LaFavre 1981; Rogers and Grand 1971), including *Pinus* in Ontario (Ginns 1986). First report on poplar; first reports for Alberta.

Material examined: CANADA: Alberta: Mariana Lake: *Picea glauca* II (UAMH 9375); Elk Island National Park: *Populus tremuloides* II; Slave Lake; *Picea glauca* III (UAMH 9503).

Coniochaeta saccardoi (Marchal) Cain, 1968, Bibl. Mycol. 9: 65.
(Coniochaetaceae, Sordariales)

Perithecia densely setose, black; ascospores narrowly ellipsoid, 13-17 x 6-8 µm. Typically dung or soil inhabiting (Mahoney and LaFavre 1981), known previously in the boreal forest from rabbit dung in Saskatchewan (Cain 1934) and from caribou dung

in arctic Alaska (Kobayasi et al. 1969). First report from wood and first report for Alberta.

Material examined: CANADA: Alberta: Elk Island National Park: *Picea glauca* IV, V; Mariana Lake: *Populus tremuloides* III (UAMH 9504, 9505).

***Coniochaeta* sp.**

(Coniochaetaceae, Sordariales)

Perithecia pyriform to ovoid, black, moderately setose; asci cylindric with 8 uniseriate ascospores; ascospores black, smooth, with longitudinal germ slit, lacking gelatinous sheath, 11.5-14 x 4.5-5.5 µm; *Lecythophora* anamorph with allantoid conidia. Overlaps with *C. saccardoi*, but distinguished by consistently smaller ascospores and darker colonies. Possibly a new taxon.

Material examined: CANADA: Alberta: Mariana Lake: *Picea glauca* I (UAMH 9506).

Cryptendoxyla hypophloia Malloch and Cain, 1970, Can. J. Bot. 48: 1816.

(Pseudeurotiaceae, Eurotiales)

Ascomata black, non-ostiolate, peridium "cephalothecoid" (Malloch and Cain 1970); asci evanescent, pyriform, short-stipitate, 8-spored; ascospores dark-brown, long-cylindrical, 4.5-5.5 x 2-3 µm; *Chalara* anamorph common in most isolates, rarely sparse. Species originally described beneath the bark of standing, dead ("snag") deciduous trees (Malloch and Cain 1970). Our isolate came from an aspen snag and is the first record from outside Ontario. Possibly arthropod dispersed (Malloch and Cain 1970).

Material examined: CANADA: Alberta: Elk Island National Park: standing (snag) *Populus tremuloides* (UAMH 9468). **Ontario:** Ottawa: nails of human male, 1995 (UAMH 8816); ex human hand, 1991 (UAMH 7049).

Emericella nidulans (Eidam) Vuillemin, 1927, Compt. Rend. Hebd. Séances Acad. Sci., Paris 184: 137.

(Trichocomaceae, Eurotiales)

Cleistothecia reddish, surrounded by a layer of yellow hülle cells; ascospores with two ribbed equatorial crests, or "flanges", 4-6 x 3-4 µm; *Aspergillus* state (*A. nidulans* (Eidam) Winter), conidiophores pigmented, with biseriate aspergilla and rough-walled, globose conidia. Distinguished from the similar *Emericella rugulosa* by smooth, convex ascospore walls, and rapid growth rate (Klich and Pitt 1988). *E. nidulans* is most frequently isolated from soil in warm regions (Domsch et al. 1980), but reports also include Canada and Alberta (Bisby et al. 1935; Sigler et al. 1996). Cellulolytic (Marsh et al. 1949; Reese and Downing 1951; Reese and Levinson 1952) and possibly ligninolytic (Bull and Carter 1973). First report from wood.

Material examined: CANADA: Alberta: Elk Island National Park: *Picea glauca* IV; Wagner Natural Area near Spruce Grove: *Populus balsamifera* II, Abbott 1996 (UAMH 9373), rotted wood of willow (*Salix discolor*), Abbott 1996 (SA-M280); Grimshaw: indoor air from *Apis mellifera* (honeybee) overwintering facility, Abbott 1994 (UAMH 7677).

Eremomyces bilateralis Malloch and Cain, 1971, Can. J. Bot. 49: 849-850.

(Eremomycetaceae, Dothideales)

Cleistothecia globose, black; ascospores hyaline, plano-convex, 3.5-5.5 x 2-3.5 µm; anamorph lacking. Although ascomata and ascospores are reminiscent of Microascaceae, this species is readily distinguished by cleistothecia that split at maturity to release a hyaline spore mass, and by the pseudoparenchymatous ascoma initials. Found previously on herbivore dung in North America and Africa (Malloch and Cain

1971a; Malloch and Sigler 1988). Our isolates are the most northerly collections known and the first report for Alberta and from wood.
Material examined: CANADA: Alberta: Elk Island National Park: *Populus tremuloides*, III (UAMH 8972, 8973). **USA: California:** Crystal Spring Reservoir, San Mateo Co.: pack rat dung, Malloch 1969 (paratype) (UAMH 5516).

Eupenicillium lapidosum Scott and Stolk, 1967, Antonie Leeuwenhoek J. Microbiol. 33: 298.
(Trichocomaceae, Eurotiales)
Cleistothecia with large refractive peridial cells; ascospores echinate, with 2 prominent, thin, equatorial crests; 6-6.5 x 4-4.5 µm; *Penicillium* anamorph. Uncommon, but primarily from soil. First report for Alberta and from wood.
Material examined: CANADA: Alberta: Red Earth: *Populus tremuloides* III, *Picea glauca* III; Mariana Lake: *Picea glauca* V, *Populus tremuloides* III (UAMH 9493).

Eurotium chevalieri Mangin, 1901, Ann. Sci. Nat. Botan., Ser. 9, 10: 361.
(Trichocomaceae, Eurotiales)
Cleistothecia bright yellow, subglobose; ascospores smooth, with 2 distinct equatorial flanges, mostly 4.5 µm diameter; anamorph in the *Aspergillus glaucus* group. Xerophilic, previously reported mainly as an airborne contaminant from Alberta (Sigler et al. 1996). First report from wood.
Material examined: CANADA: Alberta: Mariana Lake: *Picea glauca* V; Fairview: indoor air from *Apis mellifera* (honeybee) overwintering facility, Abbott 1994 (UAMH 7682). **USA:** ex coffee beans, Thom 1916 (authentic strain of *Eurotium chevalieri*) (UAMH 6583).

Gelasinospora endodonta (Malloch and Cain) von Arx, 1973, Kon. Ned. Akad. van Weten. Amsterdam Ser. C 76: 290.
(Sordariaceae, Sordariales)
Perithecia pyriform, ascospores broadly ellipsoid, black, surface with small, conical pits, 18.5-22 x 14.5-17 µm. Reported from soil in Australia (Malloch and Cain 1971b as *Anixiella endodonta*). First report for North America and from wood.
Material examined: CANADA: Alberta: Slave Lake: 15-year post-fire site *Picea glauca* III (UAMH 9501).

Gelasinospora retispora Cain, 1950, Can. J. Res. 28: 573.
(Sordariaceae, Sordariales)
Perithecia pyriform, black; asci 8-spored; ascospores, ellipsoid to broadly ellipsoid, with large, angular pits, 28-32 x 14-16 µm. Known from soil, litter, seeds, apple twigs and *Nothofagus* wood (Cain 1950; Domsch et al. 1980). Our single collection matches the ex-type culture (UAMH 484), and is the first report from Alberta.
Material examined: CANADA: Alberta: Slave Lake: *Picea glauca* V (UAMH 9495). **NETHERLANDS:** seeds of *Beta vulgaris*, 23 Dec 1955 (ex-type of *Gelasinospora retispora*) (UAMH 484).

Gelasinospora tetrasperma Dowding, 1933, Can. J. Res. 9: 294.
(Sordariaceae, Sordariales)
Perithecia pyriform, black; asci 4-spored; ascospores ellipsoid, surface finely pitted, 23-27 x 13-16 µm. Common from herbivore dung, especially in North America (Cain 1950; Kobyasi et al. 1969). Homothallic or secondarily homothallic (Sanni 1982). A first report from Alberta, but common from wood, especially burn sites in this study. Also reported from *Vaccinium* in Quebec (Ginns 1986). Ascospores may germinate

only after heating (Cain 1950). First report from wood.
Material examined: CANADA: Alberta: Mariana Lake: *Picea glauca* I-V, *Populus tremuloides* I- III, burned rotted (stage IV) wood of jack pine (*Pinus banksiana*) in 1-year-old fire site, Abbott 1996 (UAMH 9372); Elk Island National Park: *Picea glauca* IV, V. **Ontario:** Muskoka District: coniferous duff in mixed forest, Khan 1990 (UAMH 7729); from Cain to Keeping 1955 (authentic material) (UAMH 480).

Gymnoascus reessii Baranetzky, 1872, Botanische Zeitung 30:158.
(Gymnoascaceae, Onygenales)
Cleistothecia small, deep orange to dull rust, peridium of interwoven, modified hyphae with numerous bifurcate and trifurcate appendages; ascospores oblate, red-brown, smooth, 3.0-4.0 x 1.5-2.5 µm. *G. reessii* is common from soil (Wicklow and Wittingham 1974) and dung of herbivores (Currah 1985) and carnivores (Sigler and Flis, 1998). Neither keratinolytic nor cellulolytic. First report from wood.
Material examined: CANADA: Alberta: Elk Island National Park: *Picea glauca* IV (UAMH 8531), V; Lost River Canyon: coyote (*Canis latrans*) dung, Sigler 1983 (UAMH 4809); Red Deer: leg scrapings ex human female, Brown 1981 (UAMH 4416). **USA: California:** Coolinga, Fresno Co.: soil, Orr (UAMH 3158).

Gymnoascus uncinatus Eidam, 1880, Cohn Beitr. Biol. Pfl. 3:292.
(Gymnoascaceae, Onygenales)
Cleistothecia yellow-brown when mature, with long, uncinate peridial appendages; ascospores oblate, scattered pits barely visible under oil immersion, 4.5-5.5 x 1.5-3 µm; anamorph resembles *Chrysosporium merdarium*, with large yellow, asperulate conidia. *G. uncinatus* previously known only from dung (Samson 1972). Weakly cellulolytic, reports of keratinolytic ability (Currah 1985; von Arx 1987) not corroborated here. Previously reported from rotting wood in Alberta (Lumley and Currah 1995).
Material examined: CANADA: Alberta: Elk Island National Park: *Picea glauca* II, IV, V (UAMH 8530, 9421). **USA: California:** dung, Benjamin (ex-type of *Gymnoascus uncinatus*) (UAMH 3913).

Gymnostellatospora frigida Uchiyama, Kamiya, and Udagawa, 1995, Mycoscience 36: 214.
(Myxotrichaceae, Onygenales)
Cleistothecia orange-brown, peridium of thin-walled, little-differentiated hyphae; ascospores with coarse, longitudinal ridges, some of which appear sigmoid under oil immersion, 4-5 x 3-4 µm. Type based on one isolate from forest soil in Japan (Uchiyama et al. 1995b). Differentiated from *Pseudogymnoascus japonicus*, which has ascospores with a more distinct sigmoid crest, and by the olive-green ascomata in *P. japonicus*. First report for North America and the first from wood.
Material examined: CANADA: Alberta: Mariana Lake: *Picea glauca* V (UAMH 9239), 2-year post-fire site, *Picea glauca* V (UAMH 9240).

Kernia retardata Udagawa and Muroi, 1981, Trans. Mycol. Soc. Japan 22: 18.
(Microascaceae, Microascales)
Cleistothecia black, globose; asci evanescent; ascospores ellipsoid, light red-brown, with a single germ pore, 6-8 x 4.5-5.5 µm; *Scopulariopsis* anamorph. Isolates from well rotted spruce wood were morphologically consistent with three other isolates from Alberta collected on decomposing leaves and dung. Many produced cleistothecia only on natural substrata and primary isolation plates, but also produced conidia sparsely in pure culture. Ascospore size varies more than described for the type specimen, both

within and among collections. Previously known only from the type from soil in Japan (Udagawa and Muroi 1981). First report for North America and from wood.

Material examined: CANADA: Alberta: Slave Lake: *Picea glauca* III, 30 year post-fire site (UAMH 9500); Elk Island National Park: *Picea glauca* IV, V (UAMH 9420, 9454), leaf litter under *Corylus cornuta* and *Populus tremuloides*, Abbott 1997 (UAMH 9455); Devonian Botanic Garden near Devon: leaves of aspen (*Populus tremuloides*) on lawn with snow mold, Abbott 1997 (UAMH 9026); south of Leduc: dung of skunk (*Mephitis mephitis*) on ground in farm yard, Abbott 1997 (UAMH 9027). **JAPAN:** Nishinasuno-machi, Nasu-gun, Tochigi: rice (*Oryza sativa*) field soil, Muroi 1978 (ex-type of *Kernia retardata*) (UAMH 9134).

Leptosphaerulina argentinensis (Spegazzini) Graham and Luttrell, 1961, Phytopathol. 51: 687.

(Pleosporaceae, Dothideales)

Pseudothecia black; ascospores muriform, typically with 5 longitudinal and 3 transverse septa, 34 x 12.5 µm. Known mainly as a leaf saprophyte. First report from rotting wood. Our isolates are the only reports for Canada, and are the most northerly collections known.

Material examined: CANADA: Alberta: Elk Island National Park: *Picea glauca* IV (UAMH 9507); Edmonton: soil under coniferous tree, Carmichael 1962 (UAMH 1333).

Microascus albonigrescens (Sopp) Curzi, 1931, Boll. Staz. Patol. Veg. Roma 11: 60.

(Microascaceae, Microascales)

Ascocarps black, papillate to short-necked, ostiolate; asci evanescent; ascospores allantoid-reniform (concavo-convex), 4.5-5 x 3-3.5 µm, orange in mass, cirrhi especially well developed as medium dehydrates; *Scopulariopsis* anamorph, conidia narrowly ellipsoid or narrow ovoidal, with a truncate base, white in mass, abundant in some isolates. Originally described from Scandinavia (Sopp 1912), and reported from North America by Barron et al. (1961a). It has also been isolated from wood in Sweden (CBS catalogue) and litter in Japan (UAMH 8851). The most frequently isolated ascomycete during this study. Abundant in well-decayed conifer wood. First reports from Canada. Unlike other species of *Microascus*, which are common on dung and in soil, this species is found primarily on wood and litter.

Material examined: CANADA: Alberta: Elk Island National Park: *Picea glauca* II, IV, V (UAMH 8487, 8490, 9148), *Populus tremuloides* III; Slave Lake: 15-year post- fire site: *Populus tremuloides* III (UAMH 9529); North Buck Lake near Lac La Biche: debris of red squirrel (*Tamiasciurus hudsonicus*) midden under jack pine (*Pinus banksiana*), Abbott 1996 (UAMH 8753). **USA: Massachusetts:** R. Thaxter, Harvard University (UAMH 9322). **JAPAN:** litter, K. Tubaki 1968 (UAMH 8851).

Microascus brevicaulis S.P. Abbott, 1998, Mycologia 90: 298.

(Microascaceae, Microascales)

Perithecia subglobose, papillate, black; asci evanescent, ascospores broadly reniform, 5-6 x 3.5-4.5 µm; *Scopulariopsis brevicaulis* anamorph (Abbott et al. 1998). All fertile isolates described have come from Alberta. A single ascocarpic isolate came from well decayed spruce wood, but many anamorphic strains from rotted white spruce wood (UAMH 9145), burned wood of *Picea mariana* (UAMH 8628), aspen twigs (UAMH 9253), soil, litter, and dung in the boreal forest (e.g., UAMH 8746-8751) were collected.

Material examined: CANADA: Alberta: Elk Island National Park: *Picea glauca* V (UAMH 9387); Scandia: indoor air from *Apis mellifera* (honeybee) overwintering facility, Abbott 1994 (holotype of *Microascus brevicaulis*) (UAMH 7770); Calgary: indoor air of basement of home, Abbott 1995 (UAMH 7880); Edmonton: straw ex birdhouse roosts, Carmichael 1961 (UAMH 1197); Barrhead: outside air ex RCS strip, Abbott 1996 (UAMH 8627); Lethbridge: dead housefly larva, Bell (UAMH 3753).

Microascus cinereus (Emile-Weil and Gaudin) Curzi, 1931, Boll. Staz. Patol. Veg. Roma 11: 60.
(Microascaceae, Microascales)

Perithecia papillate to short-necked; asci evanescent; ascospores narrowly reniform, typically 5.5 x 3 µm, orange in mass, forming a long cirrhus at maturity; dematiaceous *Scopulariopsis* anamorph. Widespread and common in soil and on dung, and from clinical sources (Barron et al. 1961a; Morton and Smith 1963). First reports for Canada and the first from wood.

Material examined: CANADA: Alberta: Muskeg Road SW of Boyle: wood from dead branches of *Salix discolor* II, Abbott 1996 (UAMH 9486); Maqua Lake near Fort McMurray: dung of grouse under black spruce (*Picea mariana*), Abbott 1996 (UAMH 9366); Edmonton: toe nail, 1993 (UAMH 8681). **USA: California:** lung of man, Orr (UAMH 9390). **England:** soil, Mendy 1958 (UAMH 8889).

Microascus longirostris Zukal, 1885, Verh. Zool.-Bot. Ges. Wien 35: 339.
(Microascaceae, Microascales)

Perithecia black, neck long; asci evanescent; ascospores reniform, 3-4 x 2.5 µm, orange in mass and forming a cirrhus. The type and most commonly reported species of *Microascus*. Originally from dung and wood in contact with dung (Barron et al. 1961a), it has been isolated from seeds, plant remains, and a wasp nest (Barron et al. 1961a; Morton and Smith 1963). A single isolate made from wood in this study.

Material examined: CANADA: Alberta: Elk Island National Park: *Picea glauca* V, *Populus tremuloides* III (UAMH 9151); Slave Lake: dung of coyote (*Canis latrans*), Sigler 1983 (UAMH 4833); north of Lac La Biche: lung of northern flying squirrel (*Glaucomys sabrina*), Csotonyi 1997 (UAMH 9042). **Saskatchewan:** Prince Albert: indoor air of mill woodroom, Abbott 1995 (UAMH 8354). **USA: Maine:** Kittery Point: wasp nest, Harvard University (UAMH 9329).

Microascus manginii (Loubière) Curzi, 1931, Boll. Staz. Patol. Veg. Roma 11: 60.
(Microascaceae, Microascales)

Perithecia black, papillate; asci evanescent; ascospores broadly reniform, 4-6 x 5 µm, orange in mass; *Scopulariopsis candida* anamorph is often the only state present. Perithecia in some isolates (e.g., UAMH 9174) sterile, a feature common in isolates of *S. candida* (Abbott et al. 1998). Fertile isolates not previously reported from wood, although *Scopulariopsis candida* was isolated from a wooden cheese barrel (Morton and Smith 1963).

Material examined: CANADA: Alberta: Elk Island National Park: *Picea glauca* II (UAMH 9147, 9174), IV; Red Deer: outside air, Abbott 1995 (UAMH 7921). **USA: Arizona:** dung, Orr 1958 (UAMH 8977). **FRANCE:** Mangin, (ex-type of *Microascus manginii*) (UAMH 9135). **UK:** buckwheat chaff, Donnelly 1974 (UAMH 8797).

Microascus* cf. *nidicola Massee and Salmon, 1901, Ann. Bot. 15: 313-357.
(Microascaceae, Microascales)

Perithecia black, papillate; asci evanescent; ascospores narrow falcate-reniform, 7-8 x 2 µm, cirrhi inconspicuous or absent; *Scopulariopsis* anamorph. Ascospores consistent with the extralimital specimens, but colonial morphology and the *Scopulariopsis* anamorph are unique. Few reports since the original collection on dung (Massee and Salmon 1901). Barron et al. (1961a), Morton and Smith (1963), and von Arx et al. (1988) base their descriptions on material from desert regions of the USA (UAMH 8979, 8980). Only a few of our isolates produce fertile ascocarps (e.g., UAMH 9169), but several others produce sterile sclerotium-like structures (e.g., UAMH 9168) (see notes under *Microascus manginii*)(Abbott et al. 1998).

Material examined: CANADA: Alberta: Elk Island National Park: *Picea glauca* II (UAMH 9167, 9168), *Populus tremuloides* III (UAMH 9169). **USA: Utah:** kangaroo rat (*Dipodomys merriami*), Emmons Oct 1956 (UAMH 8979), soil, Emmons Oct 1956 (UAMH 8980).

Microascus singularis (Saccardo) Malloch and Cain, 1971, Can. J. Bot. 49: 859.
(Microascaceae, Microascales)

Perithecia black, often covered with flexuous hairs, short-necked; asci evanescent; ascospores broadly reniform to heart-shaped, 3-4.5 x 2-3 µm, orange in mass; anamorph *Wardomycopsis*, conidia dark brown, ellipsoid, truncate at base, with germ slit, conidiophores compact and branched. The conidial state is the most prominent feature in some isolates, but sparsely produced in others. Ascomata mature slowly (8 weeks to 6 months) and are sparse in most isolates. Widely distributed, but infrequent. First reports for Canada.

Material examined: CANADA: Alberta: Elk Island National Park: *Picea glauca* II (UAMH 8618, 9152), *Populus tremuloides* III (UAMH 9175). **USA: Massachusetts:** Cambridge: barrel bottom, Thaxter 1904 (UAMH 2637). **JAPAN:** Tokyo: laboratory contaminant, Udagawa 1962 (UAMH 9330).

Myxotrichum arcticum Udagawa, Uchiyama and Kamiya, 1994, Mycotaxon 52: 197-205.
(Myxotrichaceae, Onygenales)

Cleistothecia black with short, curved appendages; ascospores fusiform, with longitudinal ridges, 4-6 x 1.5-2.0 µm; *Oidiodendron* anamorph, some parts of conidiophores geniculate, giving rise to short, fertile branches which develop into conidia that appear blastic, otherwise resembling *Oidiodendron griseum*. The peridial cells resemble *Myxotrichum bicolor*. This is the second report of this species, and the first report for Canada and from wood.

Material examined: CANADA: Alberta: Mariana Lake: *Picea glauca* III (UAMH 9243), 2-year post-fire site, *Picea glauca* III (UAMH 9244); Slave Lake: 29-year post-fire site, *Picea glauca* V (UAMH 9337). **USA: Alaska:** Willow north of Wasilla: forest soil, Udagawa 1992 (ex-type of *Myxotrichum arcticum*) (UAMH 7565).

Myxotrichum cancellatum Phillips, 1884, Grevillea 13: 51.
(Myxotrichaceae, Onygenales)

Cleistothecia black, confluent in a dense mat, appendages long and spine-like; ascospores fusiform, smooth, 3-4 x 1-2 µm; anamorph reported as an *Oidiodendron*-state (Orr and Kuehn 1964a), our isolate *Geomyces*-like. Ascomata larger than type (200-500 µm vs. 100-250 µm), and appendages longer (100-500 µm vs. 50-300 µm). *M. cancellatum* has been found on dead *Fraxinus* branches, frozen blueberry pastries, a pineapple pericarp stored at 5°C, and soil (Orr and Kuehn 1964). The first isolation in Canada, and the first from wood. Enzymatic abilities unknown; our cellulose assay was negative.

Material examined: CANADA: British Columbia: near Mount Robson: well-rotted conifer wood under orchid (*Calypso bulbosa*), Lumley 1996 (UAMH 8727). **USA: New Jersey:** Camden: frozen blueberry pastry, Kuehn 1961 (UAMH 1911). **JAPAN:** Tokyo: soil, Udagawa 1959 (UAMH 1996).

Myxotrichum ochraceum Berkeley and Broome, 1875, Ann. Nat. Hist. IV. 15: 37.
(Myxotrichaceae, Onygenales)

Cleistothecia black, interspersed among bright yellow mycelium, peridial appendages long (up to 150 µm) and straight, with reflexed branching in the lower half; ascospores fusiform, with longitudinal ridges, 3.5-5 x 1.5-3 µm; *Malbranchea*-like anamorph. Differed in several respects from the type: appendages occurring at one level (vs. two,

Apinis 1964; Currah 1985) and pale yellow centrum (vs. bright orange-yellow, Apinis 1964). *M. ochraceum* has been isolated from wood shavings, twine and straw (Orr et al. 1963), rotten wood, bark, and cardboard (Currah 1985). *Myxotrichum ochraceum* var. *frigidum*, from forest soil in Japan, grows better at 15°C (Uchiyama et al. 1995a).
Material examined: CANADA: Alberta: Elk Island National Park: *Populus tremuloides* II (UAMH 8532). **ENGLAND:** rotten cardboard (UAMH 1904).

Ophiostoma piliferum (Fries) H. and P. Sydow, 1919, Ann. Mycol. 17: 43.
(Ophiostomataceae, Ophiostomatales)
Perithecia black, long-necked, ostiolate; asci evanescent; ascospores hyaline, allantoid to falcate (concavo-convex), 3-4.5 x 1.5-2 µm; *Sporothrix* anamorph (see Benade et al. 1998). Widely distributed in North America; including from aspen wood in Alberta and British Columbia (UAMH 7233, 7459) and white spruce in Manitoba (Olchowecki and Reid 1974). Frequent on *Pinus*, but also on *Abies, Betula, Picea, Populus, Quercus, Thuja, Liquidambar* and *Platanus* (Olchowecki and Reid 1974; Ginns 1986; Griffin 1968; Upadhyay 1981, as *Ceratocystis pilifera*).
Material examined: CANADA: Alberta: Mariana Lake: *Picea glauca* II (UAMH 9374); Whitecourt: *Populus tremuloides* wood, Crane 1989 (UAMH 7233). **British Columbia:** Fort Nelson: *Populus tremuloides* wood, Hutchison 1991 (UAMH 7459).

Ophiostoma stenoceras (Robak) C. Moreau, 1952, Rev. Mycol. (Paris) Suppl. Colon. 17: 22.
(Ophiostomataceae, Ophiostomatales)
Perithecia black, long-necked, ostiolar hairs pointed and divergent; ascospores hyaline, reniform or orange-section shaped, concavo-convex, 2-4 x 1-1.5 µm, forming a droplet at ostiole; *Sporothrix* anamorph (see Upadhyay 1981). Perithecia abundantly produced on OAT. Widely distributed in North America, reported from *Pinus* and *Picea* in Ontario (Ginns 1986 as *Ceratocystis stenoceras*) and from air in Alberta (Sigler et al. 1996).
Material examined: CANADA: Alberta: Elk Island National Park: *Picea glauca* I (UAMH 9530); St. Lina: indoor air of honeybee (*Apis mellifera*) overwintering facility, Abbott 1995 (UAMH 7953). **British Columbia:** Lynn Creek Road: bark of *Pinus contorta* attacked by *Dendroctonus* beetles, Sigler 1982 (UAMH 4590).

***Ophiostoma* sp.**
(Ophiostomataceae, Ophiostomatales)
Perithecia black, long-necked, ostiolar hairs pointed and divergent; ascospores ellipsoid, 2 x 1.5 µm, forming a clear droplet at the ostiole; synanamorphs *Sporothrix*, conidia 3.5-4 x 1.5 µm, consistent in all collections, and *Leptographium*, conidiophores 45-65 x 3 µm, conidia 3 x 1.5 µm. Slow growing, fertile perithecia forming on primary isolation plates after 1 year, but not in axenic culture. This was the most abundant *Ophiostoma* species and was found exclusively on intermediate to late stage decay spruce logs in undisturbed sites.
Material examined: CANADA: Alberta: Elk Island National Park: *Picea glauca* III, V (UAMH 9531); Mariana Lake : *Picea glauca* II, III, IV.

Petriella sordida (Zukal) Barron and Gilman, 1961, Can. J. Bot. 39: 839.
(Microascaceae, Microascales)
Perithecia black, subglobose with distinct neck; asci evanescent; ascospores red-brown, asymmetrically ellipsoid to fusoid (plano-convex), smooth, 9-10 x 5 µm; synanamorphs

Graphium and *Scedosporium*. Known from soil, plant debris, and dung (Barron et al. 1961b). First report for Alberta.
Material examined: CANADA: Alberta: Wizard Lake near Calmar: wood of *Populus* II, Abbott 1997 (UAMH). **Nova Scotia:** Kentville: twigs of apple (*Malus* sp.) wood, Gourley (UAMH 8695). **Ontario:** Algonquin Provincial Park: porcupine (*Erythizon dorsatum*) dung, Scott 1991 (UAMH 7493). **ITALY:** dry branch of pear (*Pyrus communis*), Curzi (ex-type of *Petriella asymmetrica*)(UAMH 3983); Cyprus: bark of poplar (*Populus nigra*), Nattrass (ex-type of *Petriella asymmetrica* var. *cypria*)(UAMH 8893).

Podospora tetraspora (Winter) Cain, 1962, Can. J. Bot. 40: 460.
(Sordariaceae, Sordariales)
Perithecia with small tufts of agglutinated hairs; asci 4-spored; ascospores black, ellipsoid, with cylindrical apical appendage, approximately 10 µm long. Typically found on dung (Mirza and Cain 1969), not previously reported from rotting wood. Widespread, known from Ontario and Quebec (Mirza and Cain 1969) and Alaska (Kobayasi et al. 1969). First report for Alberta.
Material examined: CANADA: Alberta: Calling Lake: *Populus tremuloides* I (UAMH 9496), 15-year post-harvest site.

Pseudogymnoascus alpinus Müller and von Arx, 1982, Sydowia 35: 135.
(Myxotrichaceae, Onygenales)
Cleistothecia often confluent, white or bright yellow, without distinct peridial hyphae; ascospores fusoid, with a longitudinal ridge or ridges, 3-5 x 3-4 µm. Previously known only from the type, from the rhizosphere of *Erica carnea* (Müller and von Arx 1982). Our isolates differ from the type in having large, yellow ascomata, while those of the type are small and white or brownish. First report for North America and from wood.
Material examined: CANADA: Alberta: Mariana Lake: *Picea glauca* III (UAMH 9242), V (UAMH 9241). **SWITZERLAND:** Graubünden: rhizosphere of *Erica carnea*, Müller 1978 (UAMH 9430) (ex-type of *P. alpinus*).

***Pseudogymnoascus* sp.**
(Myxotrichaceae, Onygenales)
Cleistothecia yellow when young, olive-green when mature, with thin-walled, asperulate, clavate appendages; ascospores fusoid, with a longitudinal, sigmoid crest, 4-5 x 3-4 µm; *Ovadendron*-like anamorph resembles the *Geomyces* anamorph of *Pseudogymnoascus roseus* and the arthroconidial anamorph of *Pseudogymnoascus dendroideus* Locquin-Linard. Probably a new species. Weakly cellulolytic.
Material examined: CANADA: Alberta: Mariana Lake: *Picea glauca* V (UAMH 9238), 25-year post-fire site, *Picea glauca* III with some charring (UAMH 8899).

Pseudogymnoascus roseus Raillo, 1929, Zentralbl. Bakteriol. Parasitenkde Infektionskr Abt. I 78:515.
(Myxotrichaceae, Onygenales)
Cleistothecia red-brown, peridium of loosely interwoven, thick-walled hyphae, appendages short (up to 20 µm long), straight, thin-walled, and asperulate; ascospores fusoid, smooth, 3-4.5 x 2-2.5 µm; *Geomyces* anamorph. *Geomyces* state and red-brown ascomata set this species apart from others in the genus. Worldwide distribution (Domsch et al. 1980). Isolated mainly from soil, including alpine and boreal forest soil in Alberta (Bissett and Parkinson 1979), forest and grassland soil (Morrall and Vanterpool 1968; Samson 1972; Orr 1979), and wood (Currah 1985). Most frequent from wood in post-fire sites. Vigorously cellulolytic.

Material examined: CANADA: Alberta: Mariana Lake: *Populus tremuloides* III, 30-year post-fire site, *Picea glauca* V (UAMH 9222); F951-03, F953-02, 2-year post-fire site *Picea glauca* V, 2-year post-fire site *Populus tremuloides* III; Slave Lake: 15-year post-fire site *Populus tremuloides* III; Gregoire Lake Provincial Park: soil, aspen (*Populus tremuloides*) forest under alder (*Alnus crispa*), Abbott 1996 (UAMH 8835); Kananaskis: soil under *Pinus contorta*, Widden 1967 (UAMH 2879); Cadomin: mycorrhizal roots of *Abies lasiocarpa*, Fernando (UAMH 9163). **Saskatchewan**: Grasslands National Park: bottom layer of ungrazed grassland soil, Abbott 1996 (UAMH 8834); Morrall (UAMH 3002). **ITALY:** Torino: wood of larch (*Larix decidua*), Dal Vesco (UAMH 1644).

Rosellinia aquila (Fries) de Notaris, 1844, Giorn. Bot. Ital. 1: 334.
(Xylariaceae, Xylariales)

Perithecia black, papillate, discrete and subglobose; ascospores inequilateral-ellipsoid to bean-shaped, with germ slit and small, hyaline appendages at the apices, 17-20 x 7-8 µm; *Geniculosporium* anamorph. Common on angiosperm wood (Ellis and Ellis 1988). Widely distributed (Dennis 1977; Martin 1967; Dargan and Thind 1979). First report for Canada.

Material examined: CANADA: Alberta: Sherwood Natural Area near Sherwood Park: standing *Populus tremuloides*, II, Abbott 1996 (UAMH 9465); **USA: New York:** Nyack Village, Rockland Co.: Martin 1963 (UAMH 1832). **MEXICO:** San Cristobal, Chiapes: cow dung, Martin 1962 (UAMH 2164).

Sordaria fimicola (Roberge) Cesati and De Notaris, 1863, Comm. Soc. Crit. Ital. 1: 226.
(Sordariaceae, Sordariales)

Perithecia pyriform, black; ascospores ellipsoid, smooth, black, with a narrow gelatinous sheath and a single prominent germ pore, 23-25 x 11-15 µm. Previously isolated from dung, herbaceous plants and seeds in Canada (Cain 1934; Cain and Groves 1948; Ginns 1986). Our isolates are the first known from wood and the first reports for Alberta.

Material examined: CANADA: Alberta: Elk Island National Park: *Picea glauca* V (UAMH 9497); Lesser Slave Lake: carnivore dung, Sigler 1982 (UAMH 4575); Perryvale: living sphagnum moss (*Sphagnum fuscum*), Thormann 1997 (UAMH 9475).

Sphaerodes fimicola (Hansen) D. Hawksworth, 1982, Bot. J. Linn. Soc. 84: 146.
(Melanosporaceae, Sordariales)

Perithecia pyriform, with a translucent peridium; ascospores dark, limoniform, reticulate, 16-18 x 11-14 µm. Typically coprophilous, this is the first report from rotted wood and the first reports for Alberta.

Material examined: CANADA: Alberta: Elk Island National Park: *Picea glauca* IV (UAMH 9369); ex roots of orchid (*Platanthera hyperborea*), Zelmer 1994 (UAMH 7777).

Strattonia carbonaria (Phillips and Plowright) Lundquist, 1972, Symb. Bot. Upsal. 20: 269.
(Lasiosphaeriaceae, Sordariales)

Perithecia ovoid; ascospores with a hyaline, triangular, apical appendage and appearing two-celled, 18-23 x 9-10 µm. It is generally found on burnt ground or charcoal (Dennis 1977; Ellis and Ellis 1988), and was found only once from a post-fire site in the boreal forest. First report for North America.

Material examined: CANADA: Alberta: F681-03, *Picea glauca* V, 30-year post-fire site (UAMH 9498).

Talaromyces retardatus Udagawa, Kamiya, and Osada, 1993, Trans. Mycol. Soc. Japan 34: 9.

(Trichocomaceae, Eurotiales)

Cleistothecia yellow to pink; ascospores ellipsoid, covered with blunt warts, pallid yellowish, 3.5-4.5 x 2.5-3 µm; *Penicillium* subgenus *Biverticillium* anamorph, well developed biverticillate conidiophores up to 300 µm long, conidia smooth to finely roughened, 3 x 2 µm; mycelium white to yellow, slow growing (8 mm in 7 days), producing a red diffusing pigment. Isolates produced ascomata after one year on primary isolation plates. These isolates faster growing than the ex-type culture (Udagawa et al. 1993), but slower than other species in *Talaromyces* section *Lutei* (Pitt 1979). Type material from decaying wood in Japan (Udagawa et al. 1993). First report for North America.

Material examined: CANADA: Alberta: Elk Island National Park: *Picea glauca* IV, V (UAMH 9494); Mariana Lake: *Picea glauca* III.

Talaromyces udagawae Stolk and Samson, 1972, Stud. Mycol. 2: 36.

(Trichocomaceae, Eurotiales)

Cleistothecia large (often over 1 mm on MEA after 6 months), bright yellow, peridium of loosely-interwoven, occasionally encrusted hyphae, including some radiating elements; ascospores with distinct lateral or spiral bands or crests, 3-4.5 x 2-3 µm; biverticillate *Penicillium* anamorph often sparse. Similar to *Talaromyces luteus* (Zukal) C.R. Benjamin, considered distinct by Stolk and Samson (1972) on the basis of larger ascospores and spiral ornamentation. *T. udagawae* was previously known only from the type, from soil, Misugimura, Japan. First report for North America and from wood.

Material examined: CANADA: Alberta: Elk Island National Park: *Picea glauca* V (UAMH 9338).

Thielavia terrestris (Apinis) Malloch and Cain, 1972, Can. J. Bot. 50: 61.

(Chaetomiaceae, Sordariales)

Perithecia black, non-ostiolate, smooth or with hypha-like setoid appendages, 100-200 µm diameter; ascospores ovoid, dark brown, 4-6 x 3-4 µm; *Acremonium* anamorph, conidia borne in short chains or in slimy heads. Heterothallic; most isolates produce only the conidial state and sterile ascomata in culture. Previously isolated from soil and plant debris, including wood (von Arx 1975; Wacha and Tiffany 1979). First report for Alberta.

Material examined: CANADA: Alberta: Elk Island National Park: *Picea glauca* IV, V, *Populus tremuloides* III (UAMH 8975); Edmonton: soil by hair bait, Blondell-Hill 1990 (UAMH 6818); human toe nail, Sand 1995 (UAMH 8112). **British Columbia:** Vancouver: spruce and pine wood, Forest Products Lab (UAMH 3264-3268). **ENGLAND:** pasture soil, Apinis (ex-type of *Allescheria terrestris*)(UAMH 3988).

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