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B735: Ectomycorrhizae of Maine 1: A Listing of Boletaceae with the Associated Hosts

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ECTOMYCORRHIZAE OF MAINE

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ECTOMYCORRHIZAE OF MAINE[1] 1. A LISTING OF BOLETACEAE WITH THE ASSOCIATED HOSTS.

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INTRODUCTION

Mycorrhizae are intimate associations of fungal hyphae and the roots of higher plants. The roots of most shrubs and many, if not all, trees form mycorrhizal associations.

There are two basic types of root-fungus associations: ectomycorrhizae and endomycorrhizae. Ectomycorrhizae are root-fungus associations where the fungal hyphae form compact mats covering the root's surface, but where the hyphae do not actually penetrate the root cells. The hyphae may penetrate the epidermis and cortex of the root, but always enter through intercellular spaces, never through the cells themselves. Roots participating in such associations are shorter and thicker than fungus-free roots and lack the root hairs typical of uninfected roots.

Endomycorrhizae are root-fungus associations where the fungal hyphae penetrate root hair cells and grow within the cells of the epidermis and cortex. Endomycorrhizae do not form the hyphal mats that cover ectomycorrhizal roots, and root morphology is unaffected by presence of the fungus.

The presence of fungal hyphae within or around roots might be expected to harm the host plant, but quite the contrary is true. The fungal hyphae in mycorrhizal roots have been shown to increase the roots' ability to absorb nutrients and thereby enhance plant growth and vigor (Hatch, 1937).

Although some species of fungi belonging to the Ascomycetes and Phycomycetes are known to form mycorrhizae with plant roots, the fungal components of most mycorrhizal associations involving tree roots are Basidiomycetes, especially members of the families Agaricaceae and Boletaceae, and the series Gasteromycetes. It has long been known that particular species of fungi tend to form mycorrhizae with particular tree species; however, the identity of the fungal component in many cases is not known with certainty. It is generally impossible to identify a fungus to species by examining its hyphae (the part associated with

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roots) since the hyphae of many fungi look essentially alike. Instead fungi are identified on the basis of sporocarp morphology: the appearance of the above-ground spore-producing structures, commonly called mushrooms, which develop from the underground hyphae when environmental conditions are appropriate. Thus, when a particular type of mushroom is consistently found growing in close proximity to a particular tree species, this is taken as evidence of a mycorrhizal association between those species.

Since forest products industries are a major component in the Maine economy and mycorrhizae are known to play an important role in the nutrition of our forest trees, it is important to understand these associations. The first step towards better understanding is to determine which species of fungi form mycorrhizae with the different tree species.

This report lists species of the family Boletaceae which are believed to participate in the formation of ectomycorrhizae, and the trees with which they are associated in Maine. Since most Maine forests are composed of several tree species, it is often difficult to be sure of the tree species with which a particular bolete is associated. In such doubtful cases, the proposed fungus-tree associations have been verified by comparison with the lists of mycorrhizal associates published by Trappe (1962) for the West Coast of the United States, and also by comparison with other studies of the Boleteceae (Smith and Thiers, 1971; Snell and Dick, 1970; and Jones, 1969).

The following format is followed in reporting hosts and their associated fungus species.

Host (Scientific Name: Common Name)

Fungus (Scientific Name; collector, and collection number identifying specimens in the University of Maine Herbarium at Orono. Figure number. Comments.)

Figure numbers refer to the color plates following the text. For convenience the listing is divided into two parts: conferous hosts and deciduous hosts.

MYCORRHIZAL LIST

CONIFEROUS HOST:

Abies balsamea (L.) Mill.: Balsam Fir.

Suillus punctipes (Peck) Singer; Homola 5009, A5696, 6123 (Fig. 20).

Larix laricina (Duroi) K. Koch: Tamarack; Eastern Larch.

Fuscoboletinus aeruginascens (Secretan) Pomerleau & Smith; Homola 3325, 3924, 5032 (Fig. 18).

Fuscoboletinus grisellus (Peck) Pomerleau & Smith; Homola 4053, 5044 (Fig. 16).

Fuscoboletinus paluster (Peck) Pomerleau; Homola 2746, 5045 (Fig. 17).

Fuscoboletinus spectabilis (Peck) Pomerleau & Smith; Homola 4052 (Fig. 7).

Suillus cavipes (Opat.) Smith & Thiers; Homola 2804, 5042 (Fig. 8).

Suillus grevillei (Klotzch) Singer; Homola 3324, 5043, 5762 (Fig. 6).

In agreement with Smith and Thiers (1971), Snell and Dick (1970), Trappe (1962) and Jones (1969) *F. aeruginascens, F. grisellus, F. paluster, F. spectabilis, S. cavipes,* and *S. grevillei* were found associated with tamarack. In Maine, *F. grisellus, F. paluster, F. spectabilis, S. cavipes* and *S. grevillei* are commonly found fruiting in the fall along the edge of the Bangor Bog under a very thick growth of tamarack. *F. aeruginascens* is the only species mentioned here which was not found with the other boletes in the Bangor Bog. However, *F. aeruginascens* was collected under tamarack along Interstate-95 near LaGrange.

Picea rubens Sarg.: Red Spruce.

Suillus punctipes (Peck) Singer; Homola 5009, A5696, 6123 (Fig. 20).

Pinus resinosa Ait.: Red Pine.

Suillus brevipes var. *subgracilis* Smith & Thiers; Homola 3389. Smith and Thiers (1971) reported *S. brevipes* var. *subgracilis* under 2-needle pine. *S. brevipes* var. *subgracilis* was found in a red pine plantation of the University of Maine. It has not been collected to date in any other area of Maine. The pine stock seedlings were gathered from a nursery in Orono.

Suillus luteus (Fries) S.F. Gray; Homola 5046 (Fig. 22). *S. luteus* is rather common in conifer plantations as reported by Smith and Thiers (1971) and under Scots pine and red pine by Snell and Dick (1970). *S. luteus* has been found in a red pine plantation at the University of Maine. The pine stock was grown at a nursery in Orono. The seed was gathered from the Great Lakes area.

Pinus strobus L.: Eastern White Pine; Pumpkin Pine; Soft Pine.

Suillus americanus (Peck) Snell ex Slipp & Snell; Homola 2273, 3935, 4944, 5415 (Fig. 21).

Suillus granulatus (Fries) Kuntze; Homola 3340, 3932, A5659, 6124 (Fig. 5).

Suillus pictus (Peck) Smith & Thiers; Homola 5008, A5677 (Fig. 19).

Suillus placidus (Bonorden) Singer; Homola 3933 (Fig. 25).

Pulveroboletus ravenelii (Berkeley & Curtis) Murrill; Homola 2402, 5300, 5567, 5643 (Fig. 9). Snell and Dick (1970) reported *P. ravenelii* in mixed pine-hemlock-hardwood stands. In Maine, *P. ravenelii,* a rare bolete, was found in hemlock woods with an occasional white pine and white birch. However, whenever *P. ravenelii* was collected, white pine was nearby and therefore it is considered the mycorrhizal associate.

Smith and Thiers (1971), Snell and Dick (1970) and Trappe (1962) reported *S. americanus, S. granulatus, S. pictus* and *S. placidus* under white pine. In Maine, white pine is usually scattered throughout mixed conifer and conifer-deciduous stands. When the *Suillus* species were collected there was always a white pine in the vicinity. Therefore, we are in agreement that white pine is the mycorrhizal associates' host for *S. americanus, S. granulatus, S. pictus* and *S. placidus*.

Thuja occidentalis L.: Northern White Cedar; Eastern Arbor-vitae.

Leccinum holopus (Rostkovius) Watling var. *holopus;* Homola 5317 (Fig. 4). Snell and Dick (1970) reported *L. holopus* under birch in low wet woods. Smith and Thiers (1971) reported it in cold bogs and cedar swamps. In Maine, *L. holopus* is scattered but rather common in our cedar swamps on *Sphagnum* hummocks.

Tsuga canadensis (L.) Carr.: Eastern Hemlock.

Boletus edulis Bull. ex Fries var. *edulis;* Homola 5388, 6376 (Fig. 11). Smith and Thiers (1971) reported *B. edulis* var. *edulis* under conifers, especially pine. In Maine, we found it attached to young roots of hemlock.

Boletus piperatus Fries; Homola 6296, 6304, 3942 (Fig. 13). Smith and Thiers (1971) reported *B. piperatus* under conifers. Snell and Dick (1970) reported it under several types of conifers including hemlock. In Maine, *B. piperatus* has been collected from a woods predominately hemlock.

Boletus rubinellus Peck; Homola 4964 (Fig. 14). Snell and Dick (1970) reported *B. rubinellus* under spruce and hemlock. We have collected it under hemlock.

Boletus radicans Pers *ex* Fr. *sensu* Kallenbach or *Boletus inedulis* (Murrill) Murrill *sensu* A.H. Smith; Homola 5159 (Fig. 30). Snell and Dick (1970) reported *B. radicans* under oak, beech, spruce, hemlock and arbor vitae. We have collected it in a woods predominately hemlock. It is not common in Maine.

Boletus subvelutipes Peck; Homola 6523 (Fig. 31). Snell and Dick (1970) reported *B. subvelutipes* under hardwood or mixed hemlock-hardwood. Collection (Homola 6523) was found under hemlock.

Suillus intermedius (Smith and Thiers) Smith and Thiers; Homola 3343, 3951, 5416, 5660 (Fig. 23). Smith and Thiers (1970) reported *S. intermedius* under pine, mostly *Pinus resinosa*. In Maine, *S. intermedius* is abundant under hemlock. *P. resinosa* was not present.

Tylopilus eximius (Peck) Singer; Homola 2379, 3242, 5625 (Fig. 37). Snell and Dick (1970) reported *T. eximius* under spruce, balsam fir and hemlock. In Maine, *T. eximius* was found under hemlock.

DECIDUOUS HOSTS:

Acer negundo L.: Box-Elder; Ash-Leafed Maple.

Boletinellus meruliodes (Schw.) Murrill; Homola 2508, 6507 (Fig. 3). *B. merulioides* was reported associated with *Pinus strobus* (Trappe, 1962) and *Fraxinus* sp. (Trappe, 1962) (Smith and Thiers, 1971) (Snell and Dick, 1970). In Maine, *B. merulioides* was found near a box elder stump. No other trees were in close proximity to this stump.

Betula papyrifera Marsh.: White Birch; Paper Birch; Canoe Birch.

Boletus subglabripes Peck; Homola 5931 (Fig. 28). *B. subglabripes* was reported associated with hardwoods or mixed woods (Smith and Thiers, 1971) (Snell and Dick, 1970). We have found *B. subglabripes* in a birch-poplar woods. Paper birch was rather common with scattered grey birch present. We also found it under birch in a predominantly hemlock woods.

Boletus edulis var. *clavipes* Peck; Homola 5038. Smith and Thiers (1971) reported *B. edulis* var. *clavipes* under birch and aspen. We found it under paper birch.

Leccinum atrostipitatum Smith, Thiers, and Watling; Homola 2185, 2382. Smith and Thiers (1971) reported *L. atrostipitatum* under birch. In Maine, *L. atrostipitatum* was found in a birch-poplar woods.

Leccinum insigne Smith, Thiers and Watling; Homola (No collection cited).

Leccinum scabrum (Fries) S.F. Gray; Homola 6305 (Fig. 32). *L. scabrum* was reported under birch by Smith and Thiers (1971). We found it under birch also.

Fagus grandifolia Ehrh.: American Beech.

Boletus sensibilis Peck var. *sensibilis;* Homola 6257 (Fig. 10). *B. sensibilis* reported under trees of maple, aspen and birch with scattered beech by Smith and Thiers (1971).

Boletus badius Fries; Homola 2221, 2343, 3199 (Fig. 35).

Boletus ornatipes Peck; Homola 5641, 5724, 6256, 6555 (Fig. 29). Smith and Thiers (1971) reported it under hardwoods. Snell and

Dick (1970) reported it (as *Pulveroboletus retipes*) under hardwoods (oak, beech and birch) with occasional spruce. We generally find it in open areas near beech and oak.

Boletus affinis Peck var. *affinis;* Homola 6258. (See below var. *maculosus*).

Boletus affinis var. *maculosus* Peck; Homola 5222, 5692, (Fig. 34). Snell and Dick (1970) and Smith and Thiers (1971) report *B. affinis* and its variety under hardwoods without naming any specific tree. We found it in predominately beech woods.

Boletus chrysenteron Fries; Homola 6528. Smith and Thiers (1971) reported *B. chrysenteron* in hardwoods. We found it associated with beech in a predominately beech-maple woods.

Boletus subtomentosus Fries; Homola 5050, 5654. Snell and Dick (1970) reported *B. subtomentosus* (as *Xerocomus subtomentosus*) in both deciduous or coniferous woods. We have found *B. subtomentosus* in predominately beech-maple woods.

Boletus subvelutipes Peck; Homola 5693 (Fig. 31). *B. subvelutipes* was found associated with deciduous trees as reported by Smith and Thiers (1971). Snell and Dick (1970) reported it under hardwoods or hemlock-hardwoods. Collection (Homola 5693) was found in a woods predominantly beech.

Gyroporus castaneus (Fries) Quélet; Homola 3032, 5205, 5720 (Fig. 12). Smith and Thiers (1970) reported *G. castaneus* in open oak woods and in mixed conifer and hardwoods. In Maine, *G. castaneus* was found in disturbed sandy soil near a predominately beech woods.

Gyroporus cyanescens (Fries) Quélet var. *violaceotinctus* Watling; Homola 2238, 3161, 6564 (Fig. 15). Smith and Thiers (1971) reported *G. cyanescens* var. *violaceotinctus* on exposed soil near or in open hardwood stands. We have found it on exposed soil near beech in a predominantly beech-maple woods.

Populus grandidentata Michx.: Big-Toothed Aspen.

Boletus subglabripes Peck; Homola 5391 (Fig. 28). Smith and Thiers (1971) reported *B. subglabripes* in hardwoods. Snell and Dick (1970) reported it under various trees in mixed woods. In Maine, *B. subglabripes* has been found under big-toothed aspen in birch-aspen woods.

Suillus subaureus (Peck) Snell; Homola 5580 (Fig. 24). Smith and Thiers (1971) associated *S. subaureus* with aspen and scrub oak. Snell and Dick (1970) reported it under white pine and occasionally red pine, or hemlock and quaking aspen. In Maine, *S. subaureus* was found in poplar-birch woods.

Tylopilus chromapes (Frost) Smith & Thiers; Homola 4925, 5227, (Fig. 26). Smith and Thiers (1971) reported *T. chromapes* abundant under aspen. Snell andd Dick (1970) reported it in various forest and frondose woods, hemlock-hardwoods, white-pine and oak, hemlock-spruce, balsam fir and under white pine. In Maine, *T. chromapes* is found in poplar-birch forest with an occasional white pine. *Populus grandidentata* is the predominant tree.

Quercus rubra L.: Red Oak.

Boletus bicolor Peck var. *bicolor;* Homola 3252, A5635.

Leccinum rugosiceps (Peck) Singer; Homola A5638 (Fig. 33). Smith and Thiers (1971) reported *L. rugosiceps* in grassy oak woods. Snell and Dick (1970) reported it under oak and possibly under members of the beech group. In Maine, *L. rugosiceps* is very rare. It was found in a woods predominately beech with an occasional red oak.

Tylopilus rubrobrunneus Mazzer and Smith; Homola 4975 (Fig. 27). Mazzer of Kent State identified our material as belonging to the *T. rubrobrunneus* complex.

Boletus griseus Frost; Homola 2253.

Boletus russellii (Frost) Gilbert; Homola 2393, 3253, 5627 (Fig. 2). In Maine, *B. russellii* has been found in a deciduous woods under oak. Smith and Thiers (1971) and Snell and Dick (1970) substantiated this host relationship for *B. russellii.*

Strobilomyces floccopus (Fries) Karsten; Homola 3254, A5628 (Fig 1). Snell and Dick (1970) reported *S. floccopus* from hardwoods and pine-hardwood mixture, and in pine barrens. It has been collected in an oak woods from the Lewiston area.

Boletellus chrysenteroides (Snell) Singer; Homola 5581 (Fig. 36). Smith and Thiers (1971) and Snell and Dick (1970) associated *B. chrysenteroides* with oak. In Maine, we have found *B. chrysenteroides* often on decaying wood, possibly oak.

SUMMARY

Forty-nine boletes have been collected and identified with their possible ectomycorrhizal associates for Maine. Most of the boletes are new reports for Maine. *Acer negundo* is a new host report for *Boletinellus merulioides.* Most of the ectomycorrhizal relationships reported here for Maine are confirmed by the work of others. Colored photos of thirty-seven Maine boletes are included.

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Fig. 1 *Strobilomyces floccopus* (Homola 5628).

Fig. 2 *Bolletellus russellii* (Homola 5627).

Fig. 3 *Boletinellus merulioides* (Homola 6057).

Fig. 4 *Leccinum holopus* (Homola 5317).

Fig. 5 *Suillus granulatus* (Homola 6124).

Fig. 6 *Suillus grevillei* (Homola 5043).

Fig. 7 *Fuscoboletinus spectabilis* (Homola 4052).

Fig. 8 *Suillus cavipes* (Homola 5092).

Fig. 9 *Pulveroboletus ravenelii* (Homola 5643)

Fig. 10 *Boletus sensibilis* var. *sensibilis* (Homola 6257).

Fig. 11 *Boletus edulis* var. *edulis* (Homola 6376).

Fig. 12 *Gyroporus castaneus* (Homola 5720).

Fig. 13 *Boletus piperatus* (Homola 6304).

Fig. 14 *Boletus rubinellus* (Homola 4964).

Fig. 15 *Gyroporus cyanescens* var. *violaceotinctus* (Homola 6564).

Fig. 16 *Fuscoboletinus grisellus* (Homola 5044).

Fig. 17 *Fuscoboletinus paluster* (Homola 5045).

Fig. 18 *Fuscoboletinus aeruginascens* (Homola 5032).

Fig. 19 *Suillus pictus* (Homola 5677).

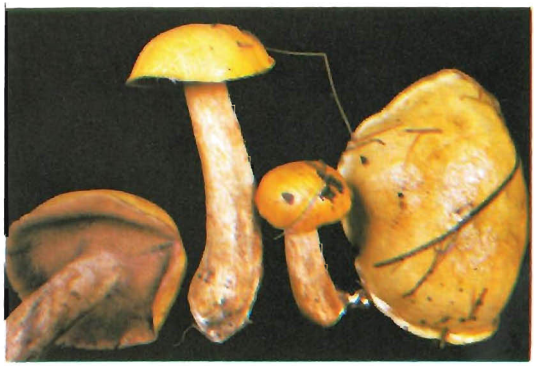

Fig. 20 *Suillus punctipes* (Homola 5696).

Fig. 21 *Suillus americanus* (Homola 6550).

Fig. 22 *Suillus luteus* (Homola 6616).

Fig. 23 *Suillus intermedius* (Homola 5416).

Fig. 24 *Suillus subaureus* (Homola 5580).

Fig. 25 *Suillus placidus* (Homola 3933).

Fig. 26 *Tylopilus chromapes* (Homola 4925).

Fig. 27 *Tylopilus rubrobrunneus* complex (Homola 4975).

Fig. 28 *Boletus subglabripes* (Homola 6556).

Fig. 29 *Boletus ornatipes* (Homola 5641).

Fig. 30 *Boletus radicans* (Homola 6535).

Fig. 31 *Boletus subvelutipes* (6523).

Fig. 32 *Leccinum scabrum* (Homola 3999).

Fig. 33 *Leccinum rugosiceps* (Homola A5638). A drop of KOH on the one cap and stipe shows red color reaction.

Fig. 34 *Boletus affinis* var. *maculosus* (Homola 5692).

Fig. 35 *Boletus badius* (Homola 6555).

Fig. 36 *Boletellus chrysenteroides* (Homola 5581).

Fig. 37 *Tylopilus eximius* (Homola 6573).

Fig. 4 *Leccinum holopus* (Homola 5317).

Fig. 5 *Suillus granulatus* (Homola 6124).

Fig. 6 *Suillus grevillei* (Homola 5043).