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Identification of Ectomycorrhizal Fungi in a *Pinus rigida-rigida* × *taeda* Stand*

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리기다-리기테다 소나무林分內에 共生하는 外生菌根菌의 同定*

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Abstract: Ectomycorrhizal fungi in a pine stand were identified by collecting mushrooms from forest floor of a 24-year-old *Pinus rigida-rigida*×*taeda* stand in Suweon from late June to early November of 1981. Of over 70 different mushrooms collected, 26 were identified by species names and 20 were classified into genus categories. A total of 17 different fungal genera were represented in this pine stand. Most commonly observed mushrooms belonged to the genera of *Russula, Lactarius, Boletus* and *Amanita*. The genus *Hebeloma* and following four species are listed as new genus and species, respectively, which have not been reported previously in Korea: *Inocybe fastigiata, Phylloporus bellus, Lactarius glaucescens*, and *Lactarius subvellereus*. The *Phylloporus bellus* has been incorrectly identified in Korea as *Phylloporus rhodoxanthus*.

Introduction

Mycorrhizal association between higher plants and soil fungi and its benefit to plant growth have received much attention during the last two decades. Foresters have shown interest particularly in ectomycorrhizae, because they are mostly associated with woody plants. Most mushrooms found on forest floor are generally considered ectomycorrhizal fungi. Trappe (1962) listed over 500 species of fungi which formed ectomycorrhizae with over 280 tree species. According to Marx (1977), there are more than 2,100 ectomycorrhizal fungi in North America alone, suggesting existence of much larger number of ectomycorrhizal fungi in the world.

Single tree species may form ectomycorrhizae with large number of different fungi. For example, Zak (1973) stated that *Pseudotsuga menziesii* in the Pacific Northwest of United States bore over 100 different ectomycorrhizal fungi. In Japan Ogawa (1977a) listed 13 fungi as mycorrhizal in a *Pinus densifiora* stand. Sixty-two different mycorrhizal fungi were reported to inhabit in a mixed stand of *Tsuga-Betula-Abies* (Ogawa, 1977b).

The authors estimate that about 630 mushrooms have been identified in Korea. However, there are no papers describing specifically on mycorrhizal nature of these fungi. Most of the mushrooms reported in Korea were collected from large areas of povarious geographic locations, with no statement of association of these fungi with specific host. In this

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paper we report a list of mushrooms collected from forest floor of a single pine stand near Suweon from June to November. These mushrooms are potential ectomycorrhizal fungi in *Pinus rigida.*

Materials and Methods

The study area was a 24-year-old pine stand (a mixture of *Pinus rigida* and *P. rigida*×*taeda* covering 0.5ha) near the Institute of Forest Genetics in Suweon. The two pines were planted in alternate rows initially to test growth performance of the hybrid pine. The ground vegetations included *Plantago* sp., *Eragrostis* sp., *Festuca* sp., *Trifolium* sp., *Eularia* sp., *Commelina* sp., *Hemerocallis* sp., and occasionally small trees of *Alnus japonica*, *Lespedeza* sp., *Quercus* sp., *Rhododendron* sp., and *Robinia pseudoacacia* (the bushes were cut down annually).

Starting late June,1981, the study area was visited daily and fruiting bodies of fungi appearing on the forest floor were collected until early November. Mushrooms found on the tree trunk or apparently on the dead plant bodies on the forest floor were not collected. The following characteristics of mushrooms necessary for identification were recorded; color, smell, taste, lactation, spore prints,morphology of pileus, warts, stalk, gill, ring, volva, and cystidia. Following books were used for identification; Cooke (1888), Coker and Beers (1974), Imazeki and Hongo (1957, 1965), Imazeki *et al.* (1970), Ito (1959), McIlvaine aed Macadam (1973), and Pegler and Young (1971).

Results and Discussion

More than 70 different mushrooms were collected from forest floor of a *Pinus rigida-rigida*×*taeda* stand from June to November. Of these mushrooms, 26 were identified by species names, and 20 were classified into genus categories (Table I). A total of 17 different fungal genera were represented in this pine stand. The fungi most frequently observed during the study period included Russulaceae (*Russula, Lactarius*) and Boletaceae (*Boletus, Gyroporus, Phylloporus*). In addition, following genera were collected; *Laccaria, Amanita, Lepiota, Coprinus, Inocybe, Hebeloma, Rhodophyllus, Cantharellus, Thelephora, Scleroderma, Pisolithus,* and *Rhizopogon.*

The genus *Hebeloma* has not been reported in Korea, but we observed two different species of *Hebeloma* in this study. Unfortunately, we were unable to identify them by species names. Of the 26 mushrooms identified, four mushrooms have not been reported in Korea and should be listed as new species. They are *Inocybe fastigiata, Phylloporus bellus, Lactarius glaucescens,* and *Lactarius subvellereus.* The *Phylloporus bellus* has been incorrectly identified in Korea as *Phylloporus rhodoxanthus.* Taxonomic descriptions of these fungi will be reported later.

In the present study, we collected the mushrooms found on the forest floor of a pine stand, and report here that these mushrooms might be ectomycorrhizal fungi. We should admit that not all the fungi listed in this report are necessarily ectomycorrhizal. The authentic claim of these fungi to be mycorrhizal should be supported by confirmation of mycorrhizal formation of these fungi with host plants under axenic culture (Zak, 1973). In natural environments of complex forest ecosystems, saprophytic and saprophytic-mycorrhizal fungi are found in large number as observed by Ogawa(1977b), who identified 57 saprophytic fungi out of 121 total number of fungi in a mixed coniferous stand. However, his collection included all the mushrooms found in the forests, rather than selective collection from forest floor as the case of presentstudy reported here.

There are very few papers on mycorrhizae published in Korea. Survey of ectomycorrhizae in woody plants was performed by Lee *et al.* (1981a). They confirmed common ectomycorrhizal formation in Pinaceae, Betulaceae, Salicaceae, Fagaceae, Tiliaceae, and Ulmaceae. Present study identified mycorrhizal fungi in a pine stand only. Further studies are necessary to characterize mycorrhizal association and identify fungal symbionts in other types of forests. Readers are recommended to refer to a paper by Lee *et al.* (1981b) for discussion on mycorrhizal formation in relation to soil fertility and to a paper

Table I. List of mushrooms (potential ectomycorrhizal fungi) collected from the forest floor of a 24-year-old *Pinus rigida*—*rigida*×*taeda* stand in Suweon from late June to early November, 1981.

Species Name	Korean Name	References indicating ectomycorrhizal
Laccaria laccata(Fr.) Cooke	졸각버섯	Brown and Sinclair(1981), Marx and Daniel(1976), Ogawa(1977b)
Amanita farinosa Schw.	애우산광대버섯	Bryan and Zak(1961), Marks and Kozlowski(1973), Ogawa(1977b), Ogawa *et al.*(1981)
Amanita vaginata(Fr.) Vitt.	우산버섯	〃
Amanita melleiceps Hongo	파리버섯	〃
Amanita spissacea Imai	뱀껍질광대버섯	〃
Amanita sp.: 1 kind	광대버섯속	
Lepiota luteus(Secr.) Locquin	노란각시버섯	Marx and Daniel(1976)-*L. nuda* mycorrhizal
Lepiota spp.: 4 kinds	갓버섯속	
Coprinus comatus(Fr.) S.F. Gray	먹물버섯	Imazeki and Hongo(1957)-saprophytic
**Inocybe fastigiata*(Fr.) Quel	New species	Marks and Kozlowski(1973), Ogawa(1977b), Ogawa *et al.*(1981).
**Hebeloma* spp.: 2 kinds	New genus	Debaud *et al.*(1981), Marks and Kozlowski(1973).
Rhodophyllus sp.: 1 kind	외대버섯속	Ogawa(1977b), Ogawa *et al.*(1981)-saprophytic
Gyroporus castaneus(Fr.) Quel	흰돌레그물버섯	Imazeki and Hongo(1957, 1965)-potential mycorrhizal
**Phylloporus bellus*(Mass.) Corner	New species	Imazeki and Hongo(1957, 1965)-potential mycorrhizal
Boletus rubellus Kromba	붉은그물버섯	Marks and Kozlowski(1973), Ogawa(1977b), Trappe (1962).
Boletus sp.: 1 kind	그물버섯속	
Russula nigricans(Bull.) Fr.	절구버섯	Marks and Kozlowski(1973), Ogawa(1977b), Ogawa *et al.*(1981), Trappe (1962).
Russula pseudodelica Lange	흰무당버섯아재비	〃
Russula lepida Fr.	졸각무당버섯	〃
Russula virescens(Zanted.) Fr.	기와버섯	〃
Russula foetens(Fr.) Fr.	깔때기무당버섯	〃
Russula spp.: 8 kinds	무당버섯속	
Lactarius volemus(Fr.) Fr.	젖버섯	Bryan and Zak(1961), Hacskaylo(1965), Marks and Kozlowski(1973), Ogawa *et al.*(1981).
**Lactarius glaucescens* Crossl	New species	〃
**Lactarius subvellereus* Peck	New species	〃
Lactarius gerardii Pk	애기젖버섯	〃
Lactarius subzonarius Hongo	당나귀젖버섯	〃
Lactarius spp.: 2 kinds	젖버섯속	
Cantharellus cibarius Fr.	꾀꼬리버섯	Ogawa(1977b), Ogawa *et al.*(1981).
Cantharellus sp.: 1 kind	꾀꼬리버섯속	
Thelephora terrestris Fr.	사마귀버섯	Hacskaylo(1965), Marks and Kozlowski(1973), Marx and Daniel(1976).
Scleroderma lycoperdoides Schw.	점박이어리알버섯	Marks and Kozlowski(1973), Marx and Daniel(1976)
Pisolithus tinctorius(Pers.) Coker *et* Couch	모래밭버섯	Bryan andZak (1961), Marx and Daniel(1976).
Rhizopogon rubescens(Tul.) Tul	알버섯	Hacskaylo(1965), Marx and Daniel(1976).

Four species and a genus with asterisks are new species or genus reported first in Korea by the authors.

by Lee *et al.*(1981c) on defense mechanism of mycorrhiza against soil pathogens. Stimulation of pine growth in nursery by artificial inoculation with mycorrhizal fungi will be published shortly in Journal of Korean Forestry Society.

要 約

水原近處에 있는 24年生 리기다-리기테다 소나무林의 林床으로부터 1981年 6月末부터 11月初까지 버섯을 採取하여, 소나무林에 共生하는 外生菌根菌의 分布를 究明하였다.

이 期間동안 70種類 以上의 버섯을 採取하였으며, 그 中 26種類는 種名을 究明하였고, 20種類는 屬名까지 硏明하는데 그쳤다. 이들 46種類의 버섯은 모두 17個의 屬에 包含되어 있었으며, 가장 흔하게 觀察된 버섯은 *Russula*, *Lactarius*, *Boletus*, *Amanita*에 속해 있었다.

이번 調査에서 一屬의 韓國未記錄屬과 四種의 未記錄種을 發見하였다. 未記錄屬인 *Hebeloma*에 속하는 버섯을 두 種類를 採取하였으나 種名을 究明하지 못했으며, 네가지 未記錄種은 *Inocybe fastigiata*, *Phylloporus bellus*, *Lactarius glaucescens*와 *Lactarius subvellereus*이었다. 그 中 *Phylloporus bellus*는 終前에 *Phylloporus rhodoxanthus*로 잘못 命名되었음을 發見하였다.

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