

# Prevalence of ectomycorrhizal fungi in Madhupur Sal forest of Bangladesh

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**Abstract:** Sal (*Shorea robusta*) grown in the upland terrace soils of Bangladesh were surveyed for ectomycorrhizal fungal association. Six different genera of ectomycorrhizal fungi namely *Russula sp.*, *Amanita sp.*, *Laccaria sp.*, *Lactarius sp.*, *Scleroderma sp.* and *Suillus sp.* were identified and described. Basidiocarps of different ectomycorrhizal fungi were found to be associated in different aged (below 5 years, 5-10 years, 10-15 years and above 15 years) Sal tree at Madhupur Sal forest of Bangladesh. *Russula sp.* was found as the most frequent occurring ectomycorrhizal fungi followed by *Amanita sp.*; while *Suillus sp.* was recorded as sparsely distributed fungi during survey. Variation in association was also seen in older and younger Sal plants. Association was higher in older plants. Therefore, *Russula sp.* and *Amanita sp.* were the most abundant ectomycorrhizal fungi associated with older Sal tree in a dipterocarpaceae forest at Madhupur of Bangladesh.

**Key words:** Ectomycorrhizal fungi, *Shorea robusta*, Ages, Abundance.

## Introduction

The tropical moist deciduous forests of Bangladesh locally known as Sal forest predominantly contain Sal (*Shorea robusta*) belongs to the family Dipterocarpaceae. Prain (1903) emphasized on the exploration of the Madhupur forest which occupy predominantly the Sal trees. *Shorea robusta*, locally known as 'Gojari' or 'Sal' is a commercially important timber species naturally grown in deep red-brown to shallow red brown and brown mottled terrace soil in Bangladesh. The timber is used for making poles, pillars, paneling, piling, furniture, lorry bodies and other important construction purposes. Mycorrhizas are the symbiotic association between specialized root inhabiting fungi and the roots of living plants (Lee, 1998). These fungi colonize trees and other plants to get the simple

carbohydrates or sugars they need. In return, the fungi extend their feeding tubes called mycelia far into the soil. Mycorrhizal fungi play a significant role in plant nutrition, growth improvement, successful afforestation, reforestation, bio-control of pathogens and land reclamation programs (Marx, 1977; Rawat, *et al.*, 2003). All members of the Dipterocarpaceae have been found to be associated with ectomycorrhizal fungi (ECM) (Singh, 1966; Bakshi, 1974; Hong, 1979; Ashton, 1982; Becker, 1983; Alexander and Hogberg, 1986; Smith, 1994; Aniwai, 1987; Hadi, *et al.*, 1991). They increase the tolerance of stress against drought, high soil temperature, organic and inorganic toxins and extreme soil acidity (Lee, 1998). Although a considerable amount of work had been done on ECM in different parts of the world (Becker, 1983;

Hadi and Santoso, 1988; Yasman, 1993; Zaratec, 1993), a few has been done in Bangladesh (Shayesta and Choudhury, 1985; Rahman and Mridha, 2004). The present study was undertaken to record the prevalence of ECM species associated with *Shorea robusta* tree at Madhupur Sal forest.

## Materials and Methods

The study was carried out in Madhupur Sal forest at Tangail district of Bangladesh during May-August, 2006. Geographically it is located at 23°50'-24°50' North latitude and 89°54'-90°50' East longitude. The soil belongs to the bio-ecological zone of Madhupur Sal Tract which is above normal flood level. The soils were moderately to strongly acidic in reaction (Richards and Hassan 1988) and the annual rainfall was 2030-2290 mm while the maximum temperature was 34°C and minimum 11°C.

During the study period frequent visits were made to collect the fungal basidiocarps from the main forest area nearby the Government Forest Office of Madhupur. Mycorrhizal fungi produce their basidiocarps during rainy season, when soil was wet or moist and temperature is high. Basidiocarps are the sexual production unit of higher fungi which are produced by fungus mycelium during the rainy season. The most diagnostic feature is the production of basidiocarps, on which sexual spores are produced, and from which the group takes its name (Buller, 1909; Ingold, 1991). Madhupur Sal forest is a naturally regenerated forest consists of Sal tree of all ages. In this study we have considered 15 circular plots and each plot radius is 15m which were selected randomly. The plots to plots distance were 100m in any directions. In each plots 30-45 different size and ages of Sal trees were found. The Sal trees selected for survey were classified into four categories i.e.

below 5 yr ages tree, 5-10 yr ages, 10-15 yr ages and above 15 yr ages tree. Fungal basidiocarps were first identified with their respective genus and at the same time data were recorded according to their frequency of association with different aged Sal tree. Every plot was marked and after 15 days data were recorded and collected according to their respective plot and Sal trees. Finally the data were calculated and transformed into the percentage to show the prevalence of the identified genus as regard to different aged Sal tree.

ECM prevalence was calculated by using the following formula:-

$$\text{ECM prevalence (\%)} = \frac{\text{Total no. of basidiocarps in each genus identified}}{\text{Total no. of basidiocarps identified}} \times 100$$

## Results

A total of six different genera of ECM were found to be associated with different aged Sal trees in the Madhupur Sal forest area. The genera were *Russula sp.*, *Amanita sp.*, *Laccaria sp.*, *Lactarius sp.*, *Scleroderma sp.* and *Suillus sp.*

***Russula*:** the genus *Russula* has always been difficult to identify systematically because of the great variety of species. The stem is rather short, thick and colors vary widely. The mature cap is concave or funnel shaped and has a purple or reddish cap (Figure 1: a). However, once they have reached the adult stage, they become dull, especially if they have subjected to rain. Their gills and stem are invariably white (Fig. 1: b and c). Moreover, *Russula* can be distinguishing by its larger size and by the jagged edge of the gill.

***Amanita*:** the most important features of *Amanita* of its volva at the base of the foot and the stalk carries

ring on its upper parts. At the young stages the volva looks like an egg shell. Moreover it has well developed long stalk and the umbrella like large cap (Fig. 1: h and i). Below this cap radiate numerous gills covered by the fertile hymenium. The color of the cap and stalk is more or less white to yellowish white and the size of the basidiocarps is large.

**Laccaria:** The *Laccaria* are remarkable for the variety of their colors, which embrace the whole range of violet, red and pink. Both the cap and stalk are reddish color and the cap is look like small umbrella shape (Fig. 1: e). The surface of the cap is covered with a characterized down and dark color. The size of the basidiocarps is small.

**Lactarius:** The very distinctive *Lactarius* is characterized by the milk which flows from their skin when it is broken. The cap is pale pink in color and characterized by the hollow which decorate its stem and more or less concave (Fug. 1: d). The stalk is white, stout and forms very close gills.

**Suillus:** The most identifying features of the *Suillus* of their white color and both the stalk and cap remains white in color (Fig. 1: g). The stem much more cylinder and bases are swollen to form of a bulb or top. The basidiocarps have no volva or ring and the total structure is look like a typical umbrella shape.

**Scleroderma:** The *Scleroderma* species are rounded, with no gills or stem but they have a thick, hard skin and are poisonous (Fig. 1: f). The young basidiocarps are closed and its gnarled surface is covered with flattened warts. Mature specimens are split open at the top, revealing the spores. The colors of the species are grayish to yellowish grey and large size.

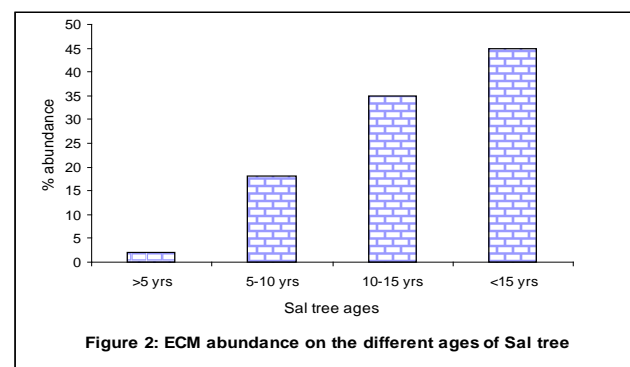
As regard to the prevalence of the ECM genera, *Russula* constitute the highest abundance (36%) followed by *Amanita* (26%); while *Suillus*

(08%) were recorded as the least abundance genera (Table 1)

**Table 1.** Abundance of ECM associated with *Shorea robusta* tree at Madhupir Sal Forest

Ectomycorrhizal (ECM) fungi	Abundance (%)
<b>Family: Russulaceae</b> ▪ <i>Russula sp.</i>	<b>36</b>
<b>Family: Amanitaceae</b> ▪ <i>Amanita sp.</i>	<b>26</b>
<b>Family: Sclerodermataceae</b> ▪ <i>Scleroderma verrucosum.</i>	<b>12</b>
<b>Family: Tricholomataceae</b> ▪ <i>Laccaria sp.</i> ▪ <i>Lactarius sp.</i>	<b>10</b> <b>08</b>
<b>Family: Boletaceae</b> ▪ <i>Suillus sp.</i>	<b>08</b>

Different ages of Sal tree varied in their association with ECM at Madhupur Sal forest (Figure 2). The survey revealed that above 15 years aged tree showed the highest (45%) ECM association and the lowest was (02%) found on below 5 years aged Sal tree. The figures also indicated that ECM association increased consistently as the increase of Sal tree ages.



## Discussion

Forest plant species belonging to the dipterocarpaceae have reported to be associated with ECM all over the world. In the present investigation Sal plants of dipterocarpaceae family are associated with six different ECM genera in Bangladesh. *Russula sp.* and *Aminata sp.* were the predominant genera and others genera were also found in

association with Sal forest though their abundance were low. Species belonging to the genera *Amanita* and the families Russulaceae, Boletaceae and Sclerodermataceae have also been reported as mycorrhizal association of dipterocarps in Malaysia (Hong 1979; Becker 1983; Lee 1992). The similar genera were also found to be associated with dipterocarps in Indonesia (Ogawa 1992; Smiths 1994). Similarly, many ectomycorrhizal fungal species associated with dipterocarps have been reported from Philippines (Zarate 1993), Thailand (Aniwat 1987), Srilanka (de Alwis 1980). Becker (1983) reported that among the 28 species of ECM fruiting bodies collected, 15 species belongs to Russulaceae. The study also showed that there was variation of ECM association in the young (below 5 years) and old (above 15 years) Sal trees. Number of ECM association was increased with the increase of Sal tree ages. Similar type of result was found in *Dipterocapus turbinatus* plantation by Huda *et al.* (2006).

Mycorrhization of forest species has been attracted considerable attention over the last few years because of their role as biofertilizers (Mridha 2002), improving host growth as well as contributing of diseases suppression (Marx 1972). Hence, the appropriate association of ectomycorrhizal fungi with *Shorea robusta* is of considerable significance and needs further study and successful exploitation for a sustainable afforestation program.

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a) *Russula sp.*



b) *Russula sp.*



c) *Russula sp.*



d) *Lactarius sp.*



e) *Laccaria laccata*



f) *Scleroderma verrucosum*



g) *Suillus sp.*



h) *Amanita sp.*



i) *Amanita sp.*

**Figure 1 (a-i): Photographs showing the different basidiocarps of ectomycorrhizal fungi at Madhupur Sal forest of Bangladesh**