Mycorrhizal mushroom and forest management

outline

1. **Mycorrhizas and their importance**
2. **Forest management and mycorrhizal mushroom:**
   - Natural forests
   - Plantation forests
   - Woodlands
3. **Managing mycorrhizal mushroom in agroforestry**
4. **Concluding remarks**

Mycorrhizal mushroom and forest management

1. **Mycorrhizas and their importance**

1.1. Mycorrhizal root types

Feature of root systems and high mycorrhizal dependency:

A. Root surface area

- low root system surface area
- few branching orders of lateral roots
- sparse branching frequency of roots
- few root hair and short length
- high abundance of fine roots

1.1. Mycorrhizal root types conted.

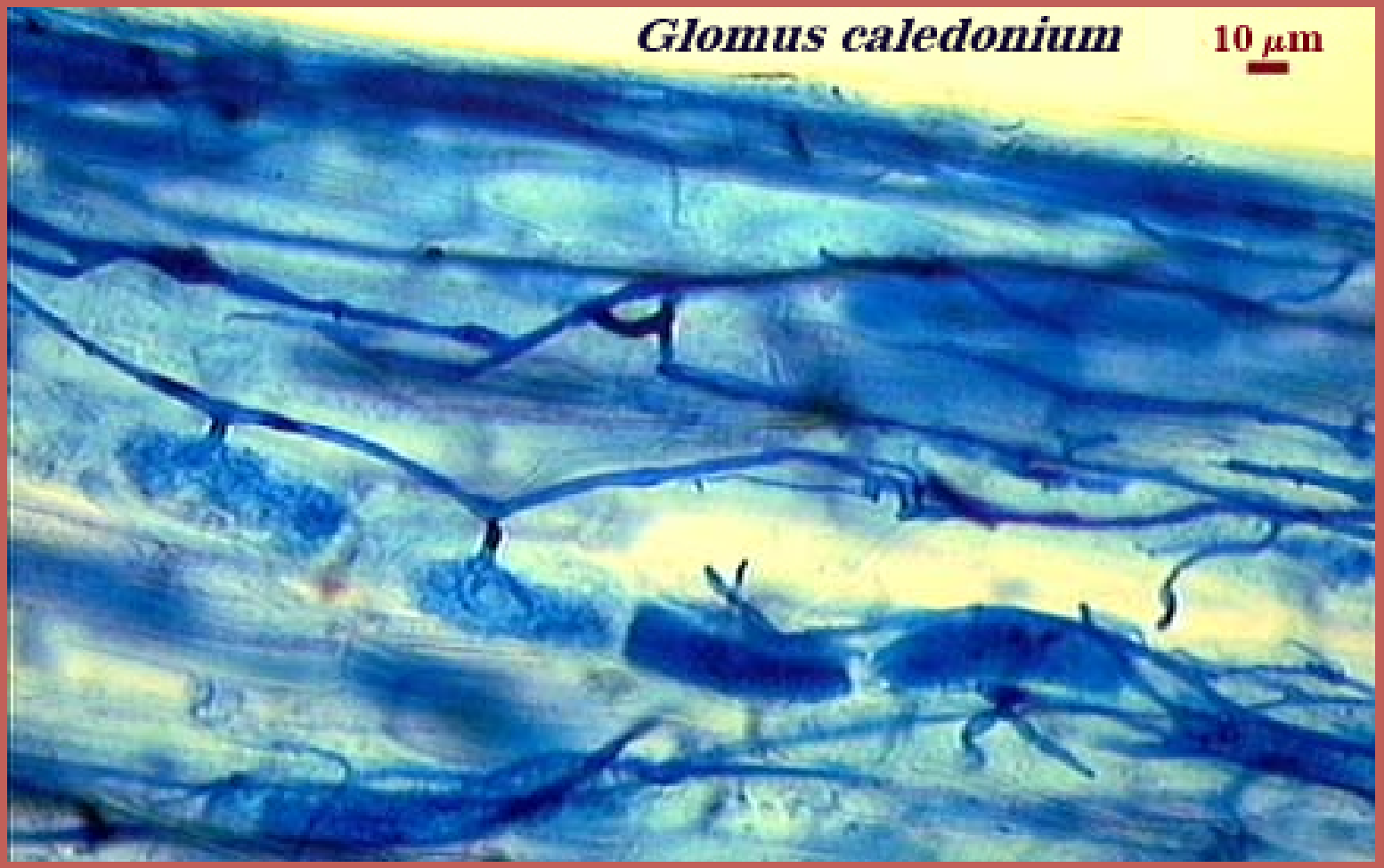
B. Root activity

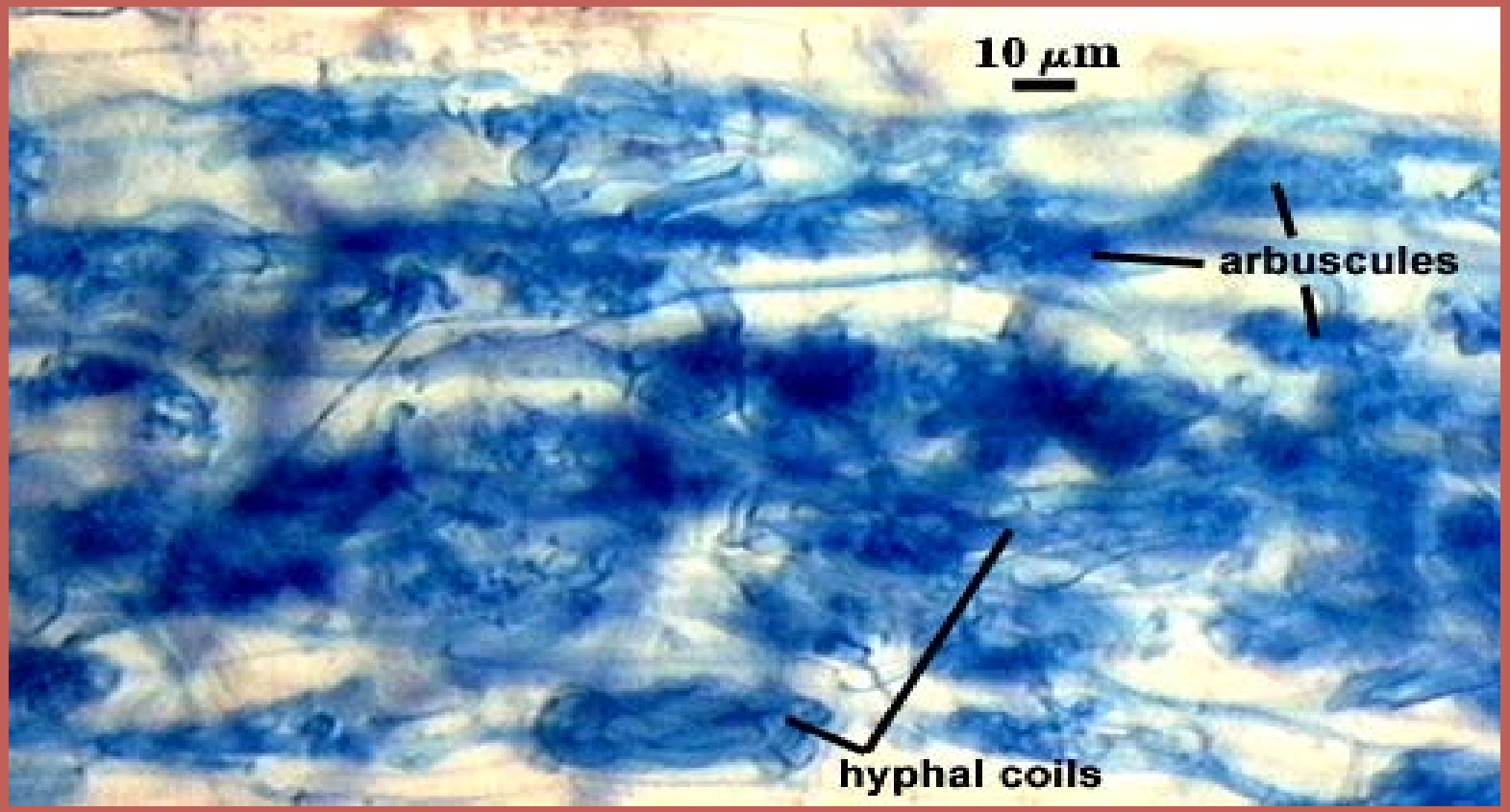
- slow growth rate
- strong protective structural features
- efficient mycorrhizal formation
- less exudation

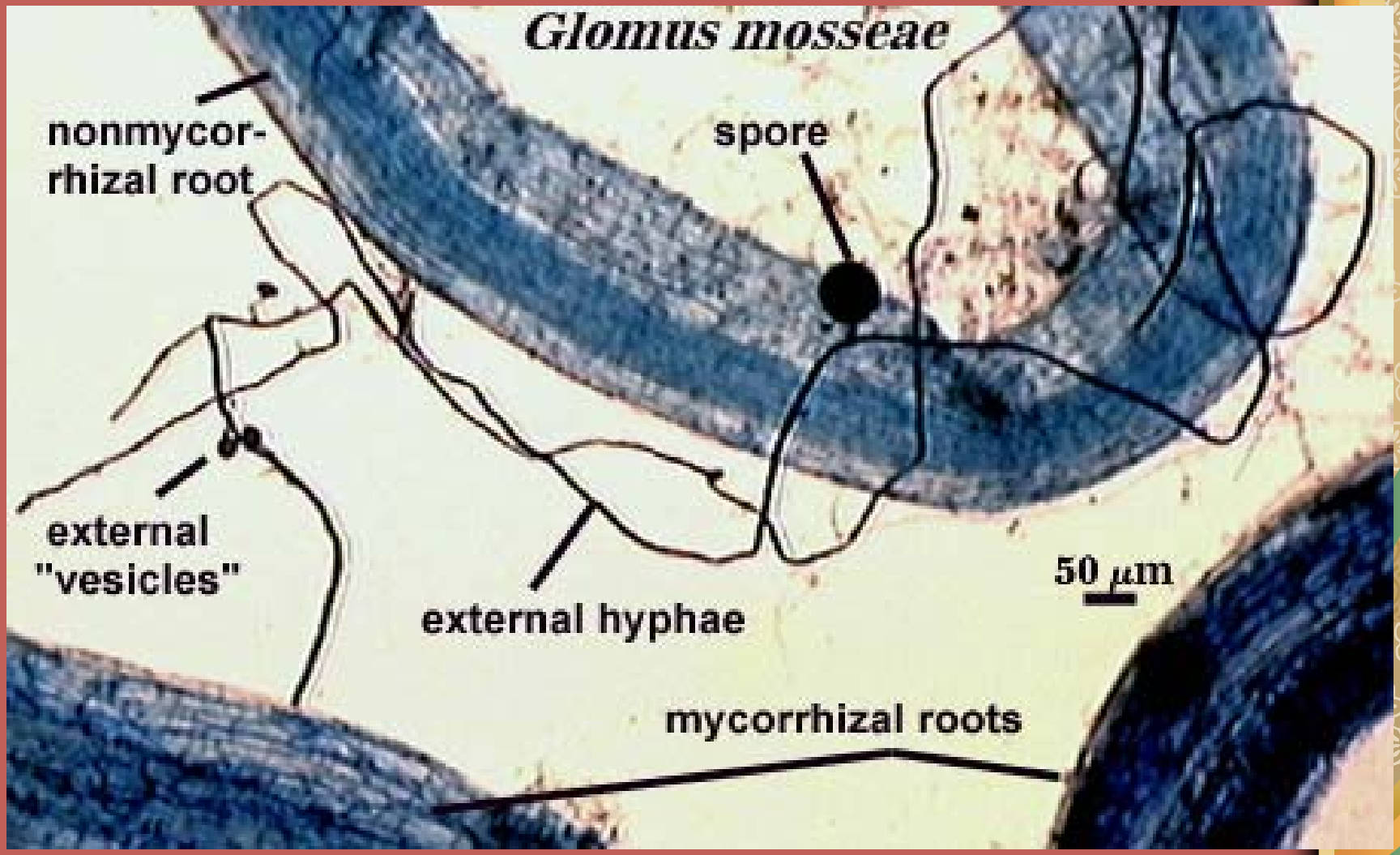
1.2. Mycorrhizal types

1.2.1.Arbuscular mycorrhizas

- Zygomycete fungi, about 150 spps
- Nutrient and carbon exchange takes place at arbuscular in the cortical cells
- Common agricultural crop and trees (coffee, citrus, avocado, mango, most legume trees)


Glomus caledonium
10 μm


10 μm
arbuscules
hyphal coils


Glomus mosseae
nonmycor-
rhizal root
spore
external
"vesicles"
external hyphae
50 μm
mycorrhizal roots

1.2. Mycorrhizal types conted

1.2.2. Ectomycorrhizas mycorrhizas

- Basidiomycetes, Ascomycetes, and a few Zygomycetes.
- currently estimated to be 5000-6000 species
- Mantle and hartig net
- Develop mushroom

1.2. Mycorrhizal types conted

1.2.3. other mycorrhizal types

- Orchid
- Ericoid
- Arbutoid
- Monotropoid
- Endecto-mycorrhizas

1.3. The role of mycorrhizas

1.3.1. Benefits to plants

- Biofertilizer: Plant nutrient supply through mycorrhizal root e.p. The ratio of length of hyphae to root length 300 to 8,000 and 16 to 2,000 m hyphae/cm3 (Read and Boyd, 1986);
- Biocontrol- antagonism of parasitic organism: fungus, bacteria, nematodes
- water relation


Symbiosis
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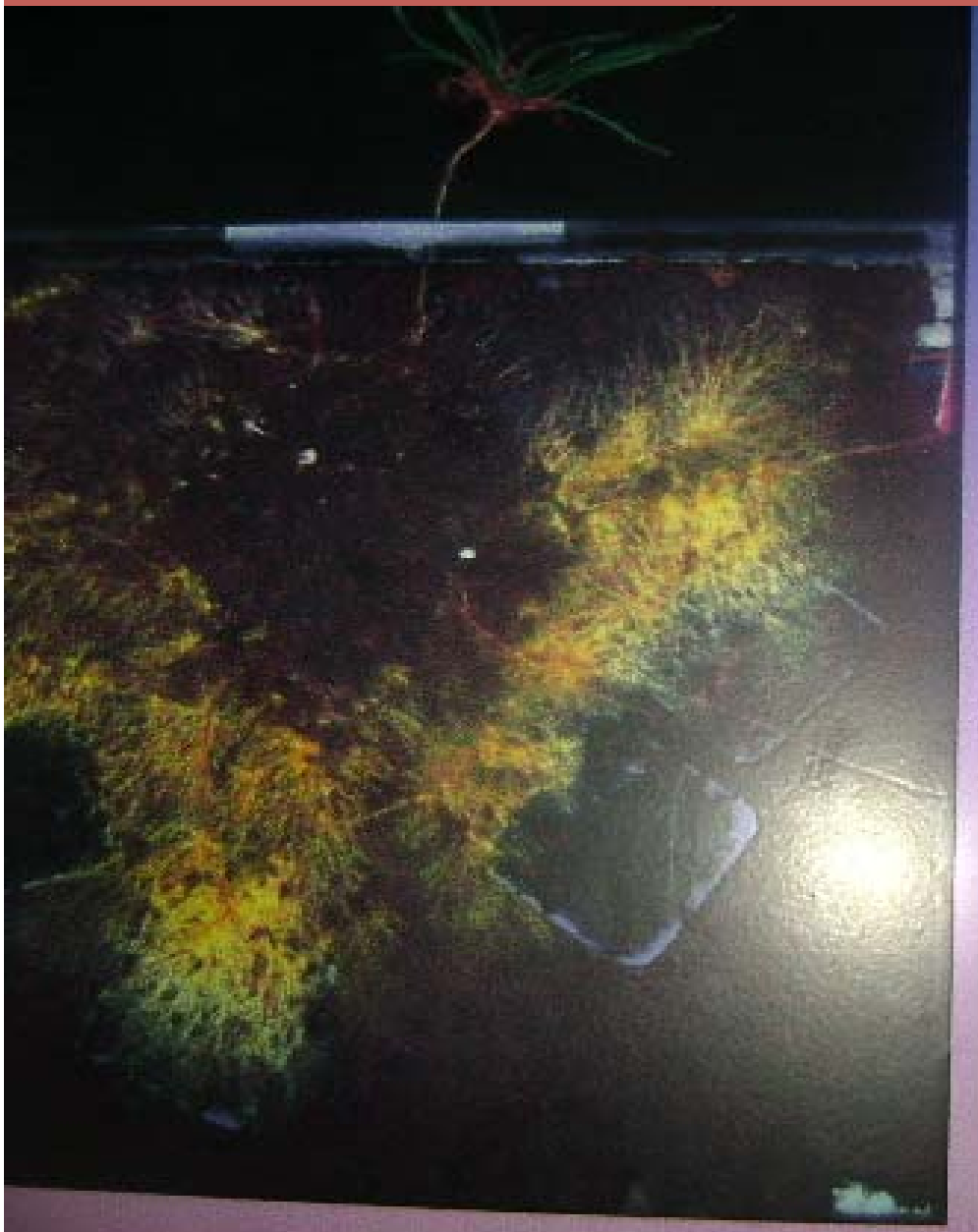

Mycelium of the ectomycorrhizal fungus *Piloderma croceum* (yellow) extending from the root system of the host seedling

1.3.3. Value to people

- Valuable food resource e.g.chanterelles, pine mushrooms,morels, king, boletus, desert truffle (*Terfezia ssp*.)
- Economic gain e.g. $40-60 million, world maket $ 3 billion (Yun et al., 1997)
- Medicinal uses
- Aesthetic values fungi diversity as a bio-indicator of environmental quality

Craterelles & Chanterelles

1.3.2. Other roles in ecosystems

Minimize plant competition and maintaining abundance and diversity

- Plants hosting the same linked by mycelia share nutrients (Simard et al., 1997);
- mycorrhizal association maintain plant of diversity in TNF (Janos, 1996);

1.3.2. Other roles in ecosystems conted

Ecosystem rehabilitation:

- Absence of native mycorrhizas
- heavy metals (such as Zn, Cu, Mn, Ni, Cr) is enhanced by their colonisation by mycorrhizal fungi (Galli et al., 1994; Hartley et al., 1997; Leyval et al., 1997).
- EM plants in alkaline soils access limiting nutrients such as P and Zn (Lapeyrie et al., 1991);
- M fungi can protect some non-halophytic plants against yield losses in moderately saline soils (Ruiz-Lozano and Azcon, 2000)

1.3.2. Other roles in ecosystems conted

Nutrient cycling:

- Mycorrhizas transport, store, release and cycle nutrients;
- 18-58 % more N was added to the soil as ectomycorrhizae than was contributed by litterfall (Vogt et al., 1986);
- EMs account for 43% of the annual turnover of N in a *Pseudotsuga menziesii* forest in Oregon (Fogel, 1980) .

1.3.2. Other roles in ecosystems conted

Improve soil structure:

- EM mycelial mats, 16 to 2,000 m hyphae/cm3 that mycorrhizal fungi have a big impact on soil structure;
- AM fungi increase the formation of soil aggregates (Bethlenfalvay et al., 1999)

1.3.2. Other roles in ecosystems conted

Carbon transport from plant roots to soil organism:

- movement of carbon from the plant to the fungus, and for movement between plants linked by mycelia (Simard et al., 1997);
- Carbon economy of shaded understorey plants (plants like coffee) can may be subsidized by fully illuminated overstorey trees, through pathways provided by their fungal symbionts.

2. Forest management and mycorrhizal mushroom

2.1. Natural forest

- shelter wood silvicultural systems
- selection systems or gap preferring spps
- secondary forests
- Enrichment plants

2.2. Plantation forests

A. Mgt with positive influence

- Tree selection and mixed species stands
- Nursery inoculation
- Vegetation management
- Thinning
- Pruning
- Harvesting


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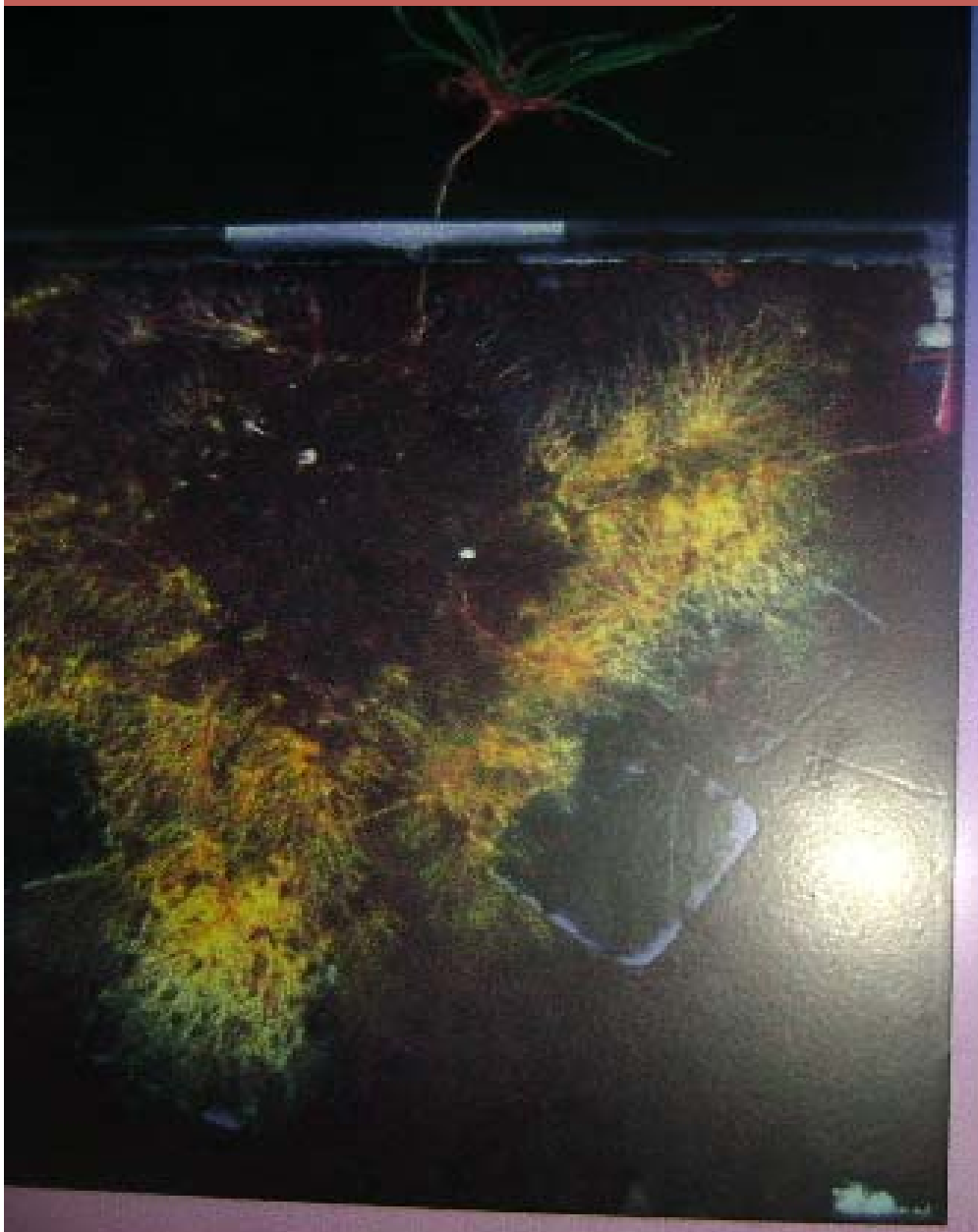

Mycelium of the ectomycorrhizal fungus *Piloderma croceum* (yellow) extending from the root system of the host seedling

2.2. Plantation forests conted.

B. Mgt with Negative influence

- The felling of trees with no economic value to foresters
- The clearance of large areas for agriculture
- monoculture plantations which are too dense, have no undergrowth and allow very little light/precipitation to reach the soil;
- the introduction of exotic, non-native species,
- the failure to mow fields on the edge of forest plantations in silvopastoral agroforestry;
- the use of chemical fertilizers; the use of pesticides;
- the removal of dead trees in plantation and natural forest;
- the use of heavy machinery for forest harvest and other operations;
- the fall in the life expectancy of trees, reduced rotations

3. Managing mycorrhizal mushroom in agroforestry land use

3.1. Agroforests

3.2. Multipurpose woodlots

3.3. Treerows

3.4. Silvopastoral agroforestry practice

Podo treerow agroforestry in Sidama

2.3. Woodlands

- EM species types -With contribution by Alexander and Högberg (1986), Newbery et al. (1988), Thoen and Ba (1989) and Lock (1989) the number of general reach more than 51 fungal species with corresponding 287 tree species in Africa.
- Culture
- Access to the woodlands
- Coppice silvicultural system

Mushroom fro Miombo woodland

Mycorrhizal mushroom in the agroforestry land use

3.1. Agroforests (homegardens, village forest gardens, agroforestry for buffer zones)

3.2. Multipurpose woodlots

3.3. Treerows or trees for soil and waterconservation

3.4. Silvopastural agroforestry practices

4. Concluding remarks

- Unless forest mgt issues are addressed at ecosystem scales, it is possible that many harvesting operations within forests will not be sustainable in the long term. ecosystem management will necessitate the inclusion of all microorganisms into forest management guidelines

4. Concluding remarks

- In the unmanaged forest ecosystem most mycorrhizal mushrooms are associated with diverse tree species;
- Due to creation of skid trails, landings and forest roads, selective logging had a very large negative impact on both EMand AM

4. Concluding remarks conted.

- In the natural ecosystems, diversity of mycorrhizal mushroom communities can be related to diversity of plant communities (Smith and Read, 1997);
- There is ample opportunities to produce mycorrhizal mushroom in forestry and agroforestry land use in Ethiopia but requires extensive surveys for the resource base and **participatory extension;**