Armillaria species: tree pathogens and edible mushrooms

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Outline

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- Predisposing agents
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- *Armillaria* as edible mushroom

Introduction

- Members of the genus *Armillaria* (honey mushrooms) are woodland fungi which occur usually in dense clusters, in groups but rarely solitarily

Photos (SW Eth.) credit: Dawit Abate

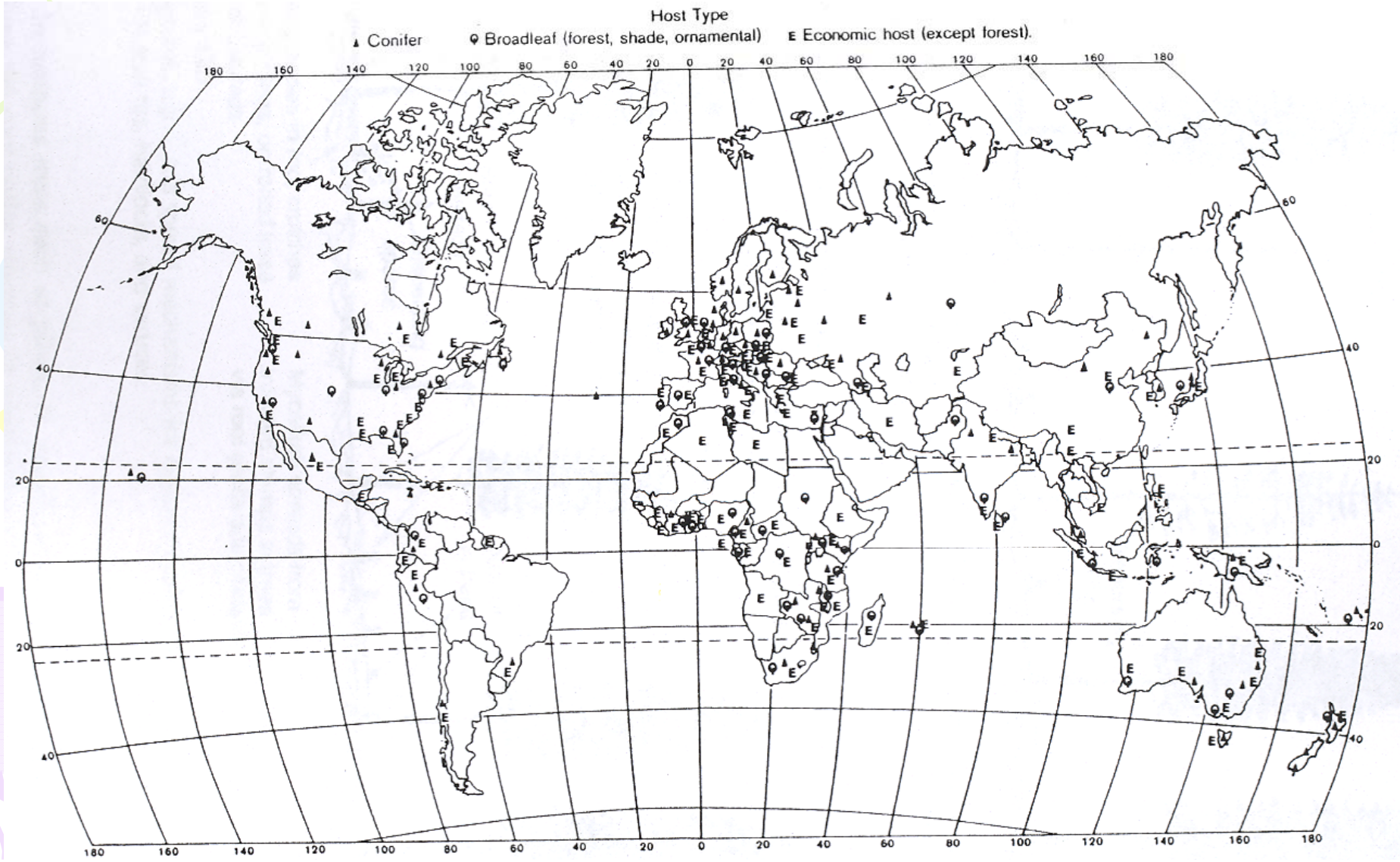
Introduction

- The genus contains about 40 species of important root rot fungi (Deacon, 1997)
- They cause root rot in forest trees and other perennial plantation crops.
- According to Shaw and Kile (1991), *Armillaria*:
  - occurs worldwide in temperate and tropical forests
  - attacks most woody plants including conifers, hardwoods, shrubs, and many horticultural plants such as citrus and grapes

Introduction

- *Armillaria* tends to be very common in areas with moderate temperatures
  - It occurs in the tropics in cooler higher-elevation forests, not in hot lowland tropical forests
  - It appears to be absent in regions with very cold climates

Worldwide distribution of recorded *Armillaria* attacks in conifer, broadleaf tree plantations and other economic hosts (after Shaw and Kile, 1991)



Introduction

- In Ethiopia, *Armillaria* root rot was the most common disease in a recent survey of plantation tree diseases (Gezahegne et al., 2003).
- Dagne Duguma (1998) estimated tree death in plantations due to *Armillaria* root-rot at 5 to 20%.
- Armillaria root-rot caused minor damage in coffee plantations (Eshetu et al., 2000).

- In Ethiopia, wood provides 85% of the energy requirements; it is used for construction purposes.

  Thus, *Armillaria* damage to plantations can have important effects
- *Armillaria* can also cause serious damage to orchard crops (e.g. peaches, citrus, avocado, coffee, etc.) whenever these are planted in sites where indigenous woodland or shrubland was cleared.
- However, little attention has been given to *Armillaria* root rot in Ethiopia.

Nature of *Armillaria* root-rot: symptoms

- Foliage loss (crowns thin and fade)
- Reduced leader growth
- Tree decline
- Excess cone crops (‘fruit’ set)
- Very young trees may die very rapidly with few decline symptoms
- Resin exudation near the base of the tree

Note: Crown symptoms are not reliable indicators

Signs of *Armillaria* infections

1. White mycelial fans, under the bark (beneath the bark of infected roots, root crowns and lower stems)

Source: Edwards et al. (2000)

Signs of *Armillaria* infections

Source: www.biology.ed.ac.uk/research/groups/jdeacon/microbes/armill.htm

2. Rhizomorphs

   These are black cord-like mycelial aggregates found between the bark and the wood, on bark surfaces below the soil line, and in the litter and soil around the roots and root crown

Signs of *Armillaria* infections

3. Clusters of light brown to honey-colored mushrooms near the base of trees
(Photos credit: Dr. Dawit Abate)

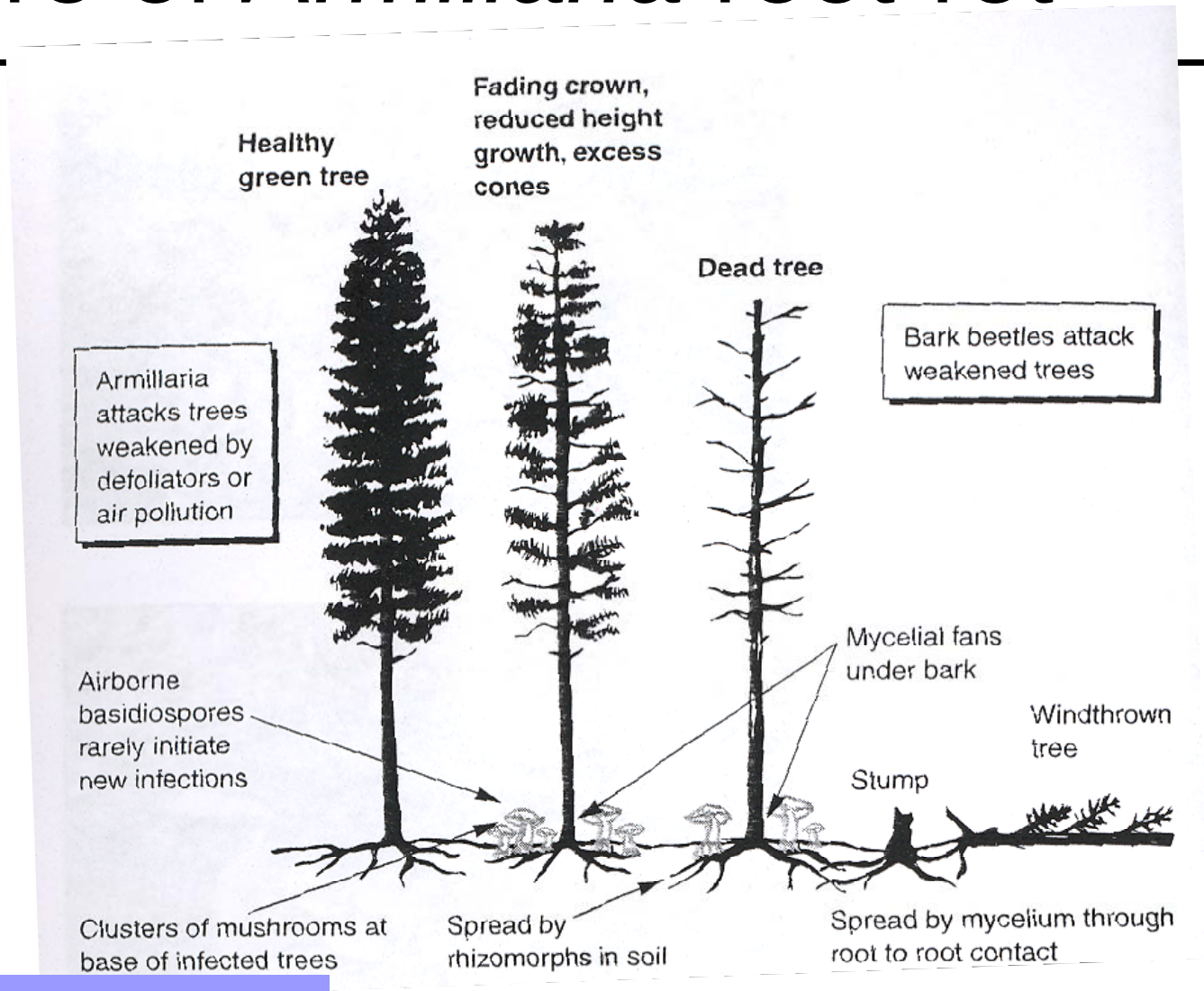
Mechanisms of spread

1. Rhizomorphs
2. Root contact (mycelial growth)
3. Basidiospores (limited role, perhaps only in initiation of new infection centers)

Rhizomorphs of Armillaria

Source: www.biology.ed.ac.uk/research/groups/jdeacon/microbes/armill.htm

Nature of *Armillaria* root-rot



Source: Edmonds et al., 2000)

Symptoms of Armillaria compared to other root diseases

Symptoms	Armillaria root disease	Annosus root and butt rot	Phytophthora root disease
Reduce height growth	x	x	
Yellow foliage	x	x	x
Slow loss of foliage	x	x	
Distress cones	x	x	
Slow crown decline	x	x	
Rapid tree death	x		x
Dead tree, no foliage loss	x		
Abundant basal resin flow	x		
Cinnamon stain in inner bark			x
Roots rotted	x	x	
Windthrown live trees	x		
Insect galleries under bark	x	x	x

Predisposing factors

- Stress reduces resistance to *Armillaria* attack :
  - Inadequate water, light, or soil nutrients
  - Exposure to temperature extremes
  - Pollution
  - Insect attack
  - Disturbances from partial cutting or other fungal diseases.
- Armillaria occurs more frequently in dry areas, on less productive sites, and on sites disturbed by human activities (including thinning and fire suppression).
- Tree age (young trees are more susceptible)

Role of *Armillaria* in natural forests

- *Armillaria* is widely distributed but may cause little disease in natural forests
- Stable balance exists between hosts and pathogens in natural forests
- Management of native forests, however, usually changes this balance.

Features of disease caused by *Armillaria* spp. in native forests

- Primary disease
  - Root lesions or root rot basal cankers
  - Killing of natural regeneration, mortality decreasing with stand age
  - Killing of trees of all ages and sizes, singly or in patches throughout the life of a stand
- Secondary disease
  - Killing of trees – weakened by stress, singly or on a standwide basis – by preexisting or new infections

Source: from Edmonds et al. (2000)

Armillaria root rot in plantations

- It is of particular importance in plantations
- It is widespread on planted hosts, both hardwoods and conifers, throughout temperate and tropical regions

  (particularly in areas with moderate temperatures)

Armillaria species record

- At one stage, all members of the genus were grouped as a single species *A. mellea*
- Now about 40 species are recognized on the basis of morphology, physiology, pathogenicity and geographical distribution

Armillaria studied

- Europe, N. America and Australesia have documented the species list, host range, virulence spectrum, interacting factors, etc.

Some of the *Armillaria* species recorded in Europe, N. America and Australia

A. ostoyae
A. mellea
*A. gallica**
A. cepistipes
*A. borealis**
*A. sinapina**
A. tabascens
A. calvescens
A. gemina
A. luteobubalina
A. hinnulea
A. novae-zelandie
A. fumosa

There are variations among the species in the main hosts, degree of virulence and distribution

E.g. * are weakly virulent

Armillaria species in Africa

- Härkönen et al. (2003):
  - Acknowledged that African species are poorly known
  - Described only *A. mellea* sensu laro among Tanzanian mushrooms
- Pegler (1977) recognized two east African species – *A. heimii* and *A. mellea*

Armillaria species in Ethiopia

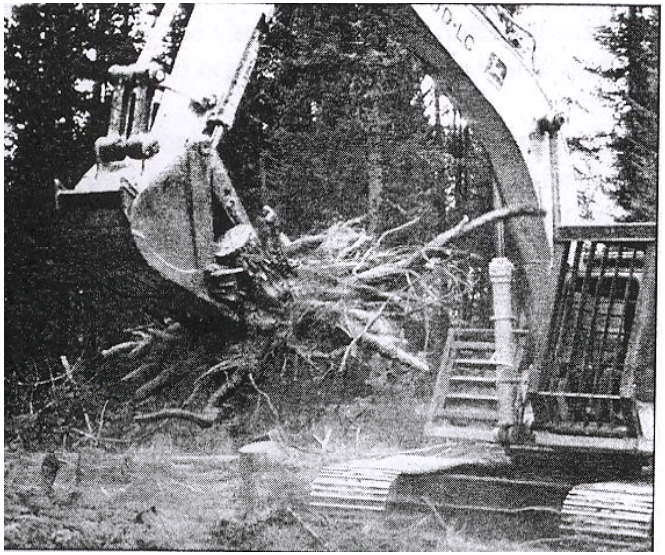
- The tree pathogenic species of *Armillaria* were generally considered as *A. mellea* (Hulluka, 1982; Derso et al., 2000).
- A recent report indicated that *A. fuscipes* is the most widespread species (Gezahegn et al., 2004).
- There is a need for further studies (more extensive sampling of basidiocarps and possibly molecular analysis of isolates)

Armillaria root-rot in Ethiopia

- Armillaria root rot was the most common disease in a recent survey of plantation tree diseases
- It mainly affected *Pinus patula* in Wodo Genet, Belete (Jimma) and Bedele.
- It also occcured on:
  - *Acacia abyssinica*
  - *Cordia alliodora*
  - *Cedrela odorata*

Management of *Armillaria* root-rot in plantations: pre-planting measures

- Inoculum reduction:
  - Stump removal (expensive!)
  - Fumigation (mostly in ornamental situations)
- Re-planting root-rot centers with resistant/tolerant tree species suited to the site



Backhoe removing stumps to reduce *Armillaria*; source: Arnolds et al. (2000)

Management of *Armillaria* root-rot in plantations: post-planting measures

- The most important control measure is to manage for reduced tree stress

- Use of silvicultural practices to regulate species composition, maintain biological diversity, reduce chances for insect pest buildup and increase host vigor.

Are *Armillaria* mushrooms edible?

- Fruit bodies of *Armillaria* are usually considered edible
- However, only young caps are tasty (tough stipes and old caps are useless)
- *Armillaria* is eaten in some localities (e.g. western Ethiopia)
- Wood-inhabiting fungi generally cause suspicion

Notes on recognizing edible *Armillaria* mushrooms

- There are many other fungi growing in clusters around decaying trees
- Many of them are inedible (bitter or even poisonous)
- To be sure of *Armillaria*, check:
  - The presence of annulus (ring)
  - The spore print which is white

Conclusions

- Available information indicates that *Armillaria* root-rot could be important in Ethiopian plantation trees (e.g., *P. patula*).
- There is a need to study:
  - The pathogenic *Armillaria* species
  - Variations in host range and virulence
  - Influencing factors: When/where is *Armillaria* root rot severe?
  - What are the relative susceptibility of important trees?
  - What happens in horticultural crops planted after clearing native woodland/shrubland?
  - How important is *Armillaria* problem in forest coffee?

- What are the relationships of *Armillaria* with insects and other diseases?

Bark beetle damage to *Acacia* sp.

(Photos: Dr. Amare Ayalew)

THANK YOU