Diseases of trees II

Root rots

Tento projekt je spolufinancován Evropským sociálním fondem a Státním rozpočtem ČR InoBio – CZ.1.07/2.2.00/28.0018

Diseases of root system

- Root rots ON CONIFEROUS
  - *Armillaria ostoyae, A. gallica, A. borealis*
  - *Heterobasidion annosum*
  - *Phaeolus schweinitzii*
  - *Sparassis crispa*
  - *Rhizina undulata*
  - *….*
- Root rots on broadleaved
  - Ustulina deusta
  - Meripilus giganteus
  - Grifola frondosa
  - Phytophthora root rots


Honey mushrooms *Armillaria spp.*

Armillaria spp. in the World

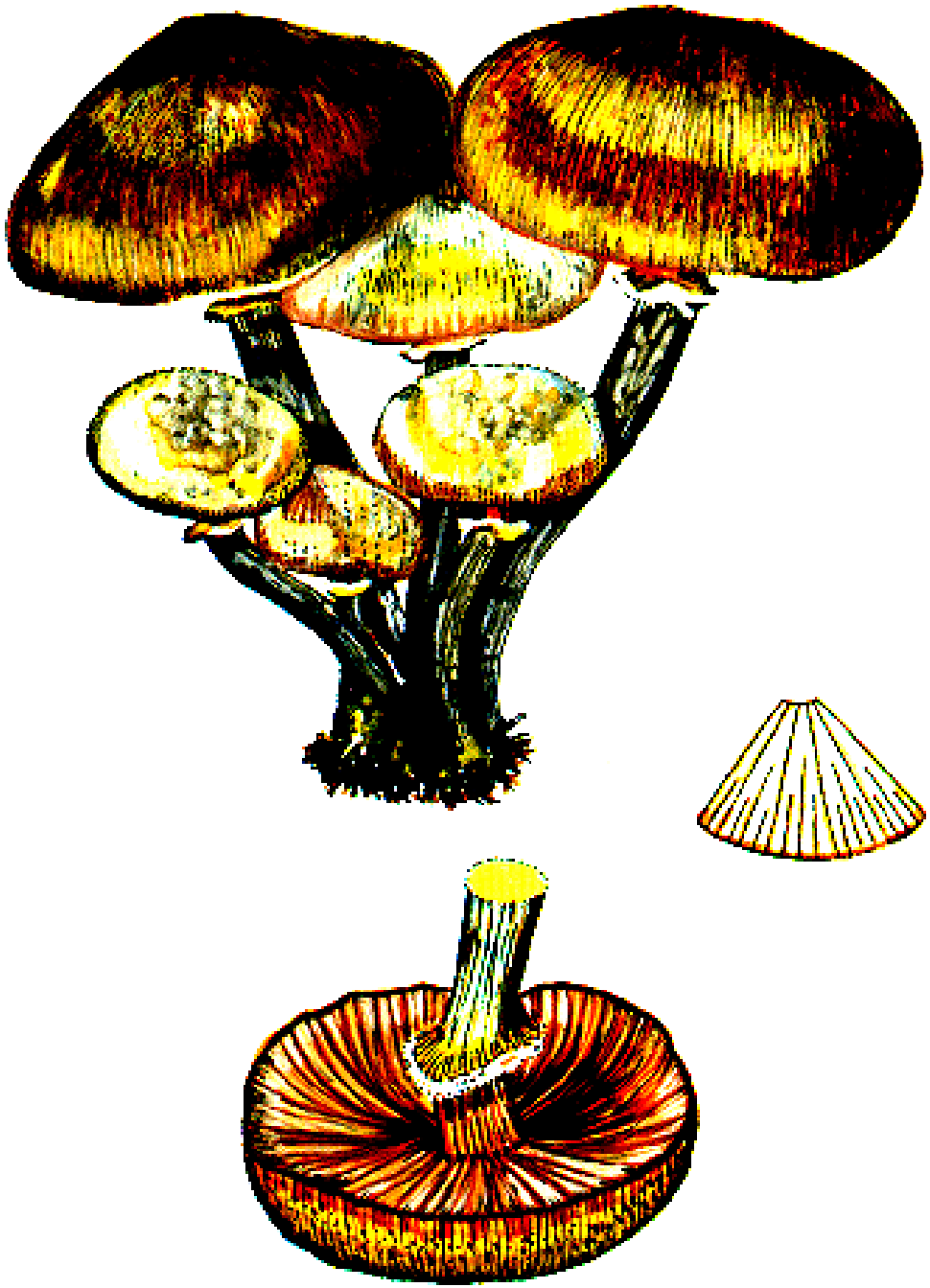
	Druh/ běžná synonyma	Rozšíření
1	*Armillaria affinis* (Singer) Volk et Burdsall (= *Armillariella* affinis Singer)	Střední Amerika, Karibská oblast
2	***Armillaria borealis* Marxmüller et Korhonen**	severní a střední Evropa, Rusko
3	*Armillaria calvescens* Bérubé et Dessureault	východ Severní Ameriky
4	*Armillaria camerunensis* (Henn.) Volk. et Burdsall	Afrika
5	***Armillaria cepistipes* Velenovský**	Evropa, Severní Amerika
6	*Armillaria duplicata* (Berk.) Sacc.	Indie
7	***Armillaria ectypa* (Fr.) Emel**	Evropa
8	*Armillaria fellea* (Hongo) Kille et Watling	Austrálie
9	*Armillaria fumosa* Kille et Watling	Austrálie
10	*Armillaria fuscipes* Petch. (= A.heimii Pegler)	Indie, Afrika
11	***Armillaria gallica* Marxmüller et Korhonen (=A.bulbosa (Barla) Velenovský, A. lutea Gillet)**	Evropa, Severní Amerika, Japonsko
12	*Armillaria gemina* Bérubé et Dessureault	východ Severní Ameriky
13	*Armillaria* griseo*mellea* (Singer) Kile et Watling (=A.*griseomellea* Singer)	Jižní Amerika
14	*Armillaria hinnulea* Kile et Watling	jihovýchodní Austrálie
15	*Armillaria jezoensis* Cha et Igarashi	Japonsko
16	*Armillaria limonea* (Stev.) Boesewinkel	Nový Zéland
17	*Armillaria luteobubalina* Watling et Kile	Austrálie
18	***Armillaria mellea* (Vahl.:Fr.) Kumm.**[1]	Evropa, Asie

Armillaria spp. in the World

19	*Armillaria melleo-rubens* (Berk. et Curt.) Sacc.	Střední Amerika, Karibská oblast
20	*Armillaria montagnei* (Singer) Herink	Jižní Amerika
21	*Armillaria nabsnona* Volk et Burdsall 1995	západ Severní Ameriky
22	*Armillaria novae - zealandiae* (G.Stev.) Herink	Nový Zéland, Nová Guinea, Austrálie, Jižní Amerika
23	*Armillaria omnituens* (Berk.) Sacc.	Indie
24	***Armillaria ostoyae* (Romagn.) Herink** (= *A. obscura* (Schaeff.) Herink)	Evropa, Severní Amerika, Asie
25	*Armillaria pallidula* Kile et Watling	Austrálie
26	*Armillaria pelliculata* Beeli	Afrika
27	*Armillaria procera* Speg.	Jižní Amerika
28	*Armillaria puiggarii* Speg.	Jižní Amerika
29	*Armillaria sinapina* Bérubé et Dessureault	Severní Amerika, Japonsko
30	*Armillaria singula* Cha et Igarashi	Japonsko
31	*Armillaria solidipes* Peck.	Severní Amerika
32	*Armillaria sparrei* (Singer) Herink	Jižní Amerika
33	***Armillaria tabescens* (Scop.) Emel** (= *A. socialis* (DC.:Fr.) Herink)	Evropa, Severní Amerika
34	*Armillaria tigrensis* (Sing.) Volk. et Burdsall	Jižní Amerika
35	*Armillaria viridiflava* (Sing.) Volk. et Burdsall	Jižní Amerika
36	*Armillaria yungensis* (Singer) Herink	Jižní Amerika

Armillaria spp.

Biologický druh	Taxonomický druh	Synonyma
A	***Armillaria borealis* Marxmüller et Korhonen 1982**	**?*Armillaria praecox* Velenovskyý1920**
B	***Armillaria cepistipes* Velenovský 1920**	***Armillaria bulbosa* (Barla) Velenovský 1927** ***A. cepistipes* f. *pseudobulbosa* Romagn. et Marxmüller 1983**
C	***Armillaria ostoyae* (Romagn.) Herink 1973** **(**basionym: ***Armillariella ostoyae* Romagn. 1970)**	***A.obscura* (Schaeff.) Herink 1973** ***A. mellea var. obscura* Gillet 1874** ***Armillariella polymyces* (Pers.) Sing.&Clç.1972**
D	***Armillaria mellea* (Vahl.:Fr.) Kummer ss. stricto 1871** (basionym**: *Agaricus melleus* Vahl..:Fr. 1821**	***Armillariella mellea* (Vahl.:Fr.) P. Karst. 1881** ***Armillaria cerasi* Velen. 1920** ***Armillaria montagnei* (Sing.) Herink 1973**
E	***Armillaria gallica* Marxmüller et Romagnesi 1987**	***A. lutea* Gillet 1874[1]** ***A. bulbosa* (Barla) Kille et Watling** ***A. mellea var. bulbosa* (Barla)** ***Armilariella bulbosa* (Barla) Romagn.** ***Armillaria inflata* Velen. 1920**
bezprstenné	***Armillaria tabescens* (Scop.:Fr) Emel 1921** **(**basionym: ***Agaricus tabescens* Scop.:Fr.)**	***Armillaria socialis* (DC.:Fr.) Herink 1973** ***Clitocybe tabescens* (Scop.:Fr.) Bres** ***Armillariella tabescens* (Scop.:Fr.) Sing.**
bezprstenné	***Armillaria ectypa* (Fr.) Emel 1921** **(**basionym: ***Agaricus ectypus* Fr. 1821)**	***Clitocybe ectypa (Fr.) Bres.*** ***Armillariella ectypa (Fr.) Singer***

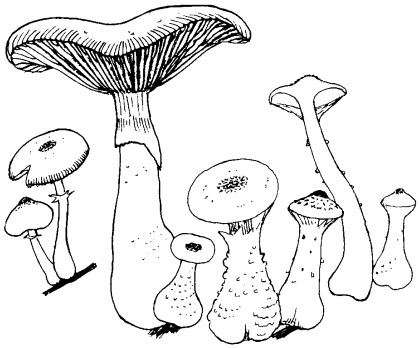


Armillaria mellea sensu lato.

Armillaria borealis

Marxmüller et Korhonen

Armillaria cepistipes Velenovský

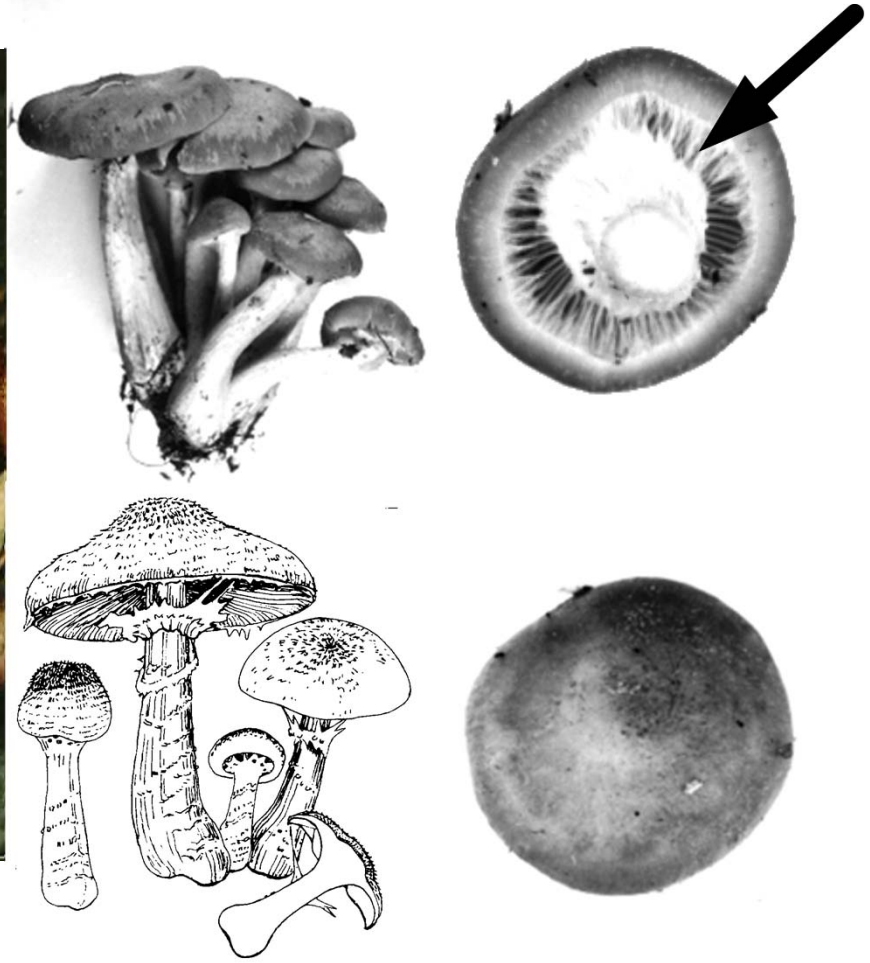


Armillaria ostoyae (Romagn.) Herink

Armillaria ostoyae (Romagn.) Herink

Armillaria mellea (Vahl:Fr.) Kummer

Armillaria gallica Marxmüller et Romagnesi

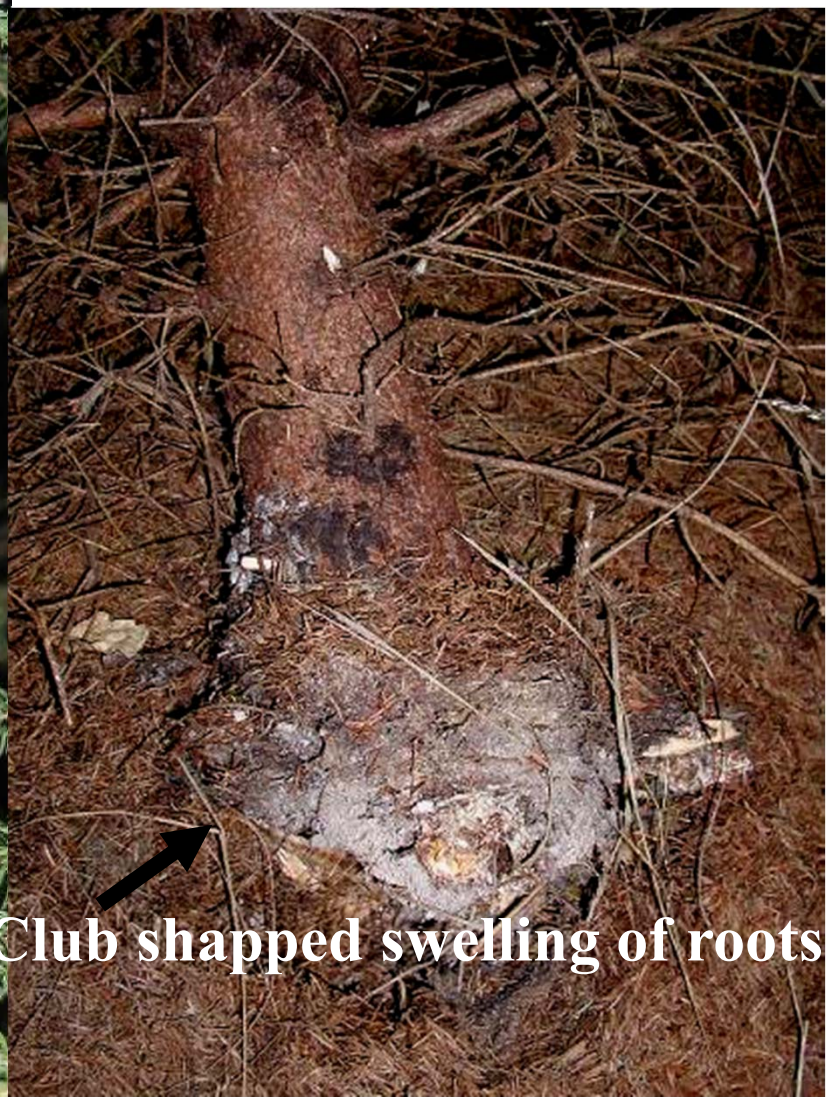


Diseases of Norway spruce I

- **The diseases of roots**
  - Primarilly parazitical wood destroying fungi
    - *Heterobasidion annosum*
    - *Armillaria ostoyae, A. borealis (A.bulbosa, A. cepistipes)*
  - Secondary parazite in roots
    - *Rhizina undulata*
    - *Phaeolus schweinitzii*
- **Vascular pathogens (pathogen of vascular tissues)**
    - *Erwinia cancerogena*
    - *Ophiostoma polonicum, O. piceae, O. penicillatum, O. bicolor, O. ainoae, O. europhioides*
    - *Valsa sp., Cytospora sp.*
    - Others organisms of endophytic mycoflora
- **The decay of stem**

The main symptoms of infection in young growth and pole timber

The main symptoms of infection in premature and mature stands Acute development of Armillaria infection

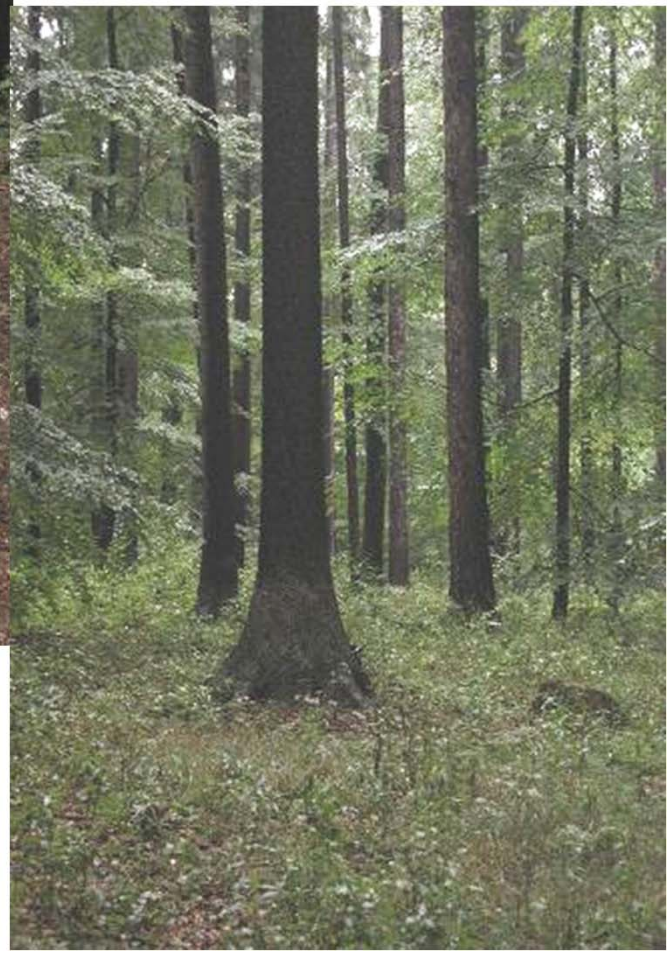


The main symptoms of infection in premature and mature stands. Acute development of Armillaria infection

The main symptoms of infection in premature and mature stands. Acute development of Armillaria infection

The main symptoms of infection in premature and mature stands. Acute development of Armillaria infection

The main symptoms of infection in premature and mature stands



The main symptoms of infection in premature and mature stands

The main symptoms of infection in premature and mature stands

The main symptoms of infection in premature and mature stands

The main symptoms of infection in premature and mature stands

Cull wood from the stem base

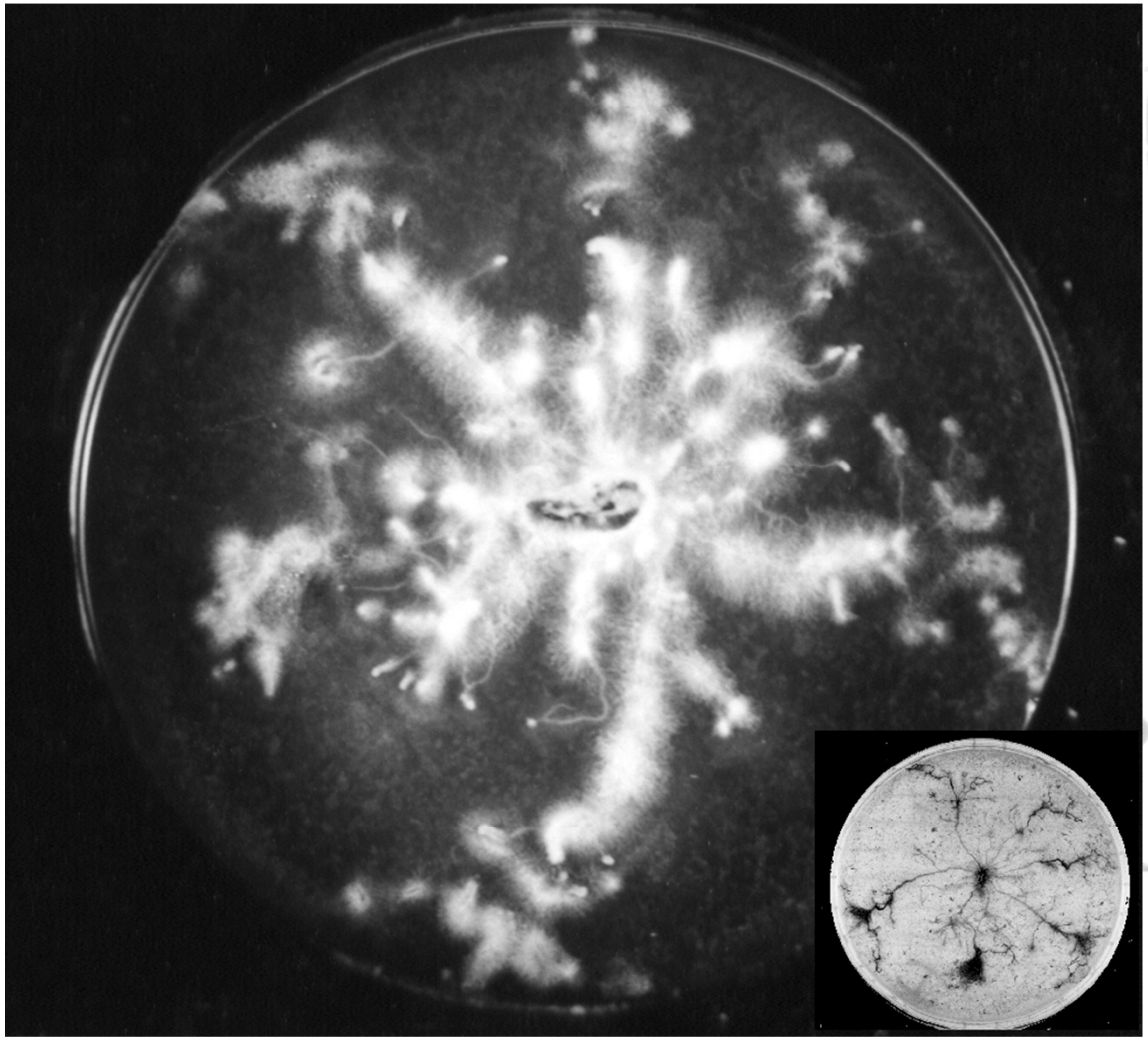
Armillaria rot

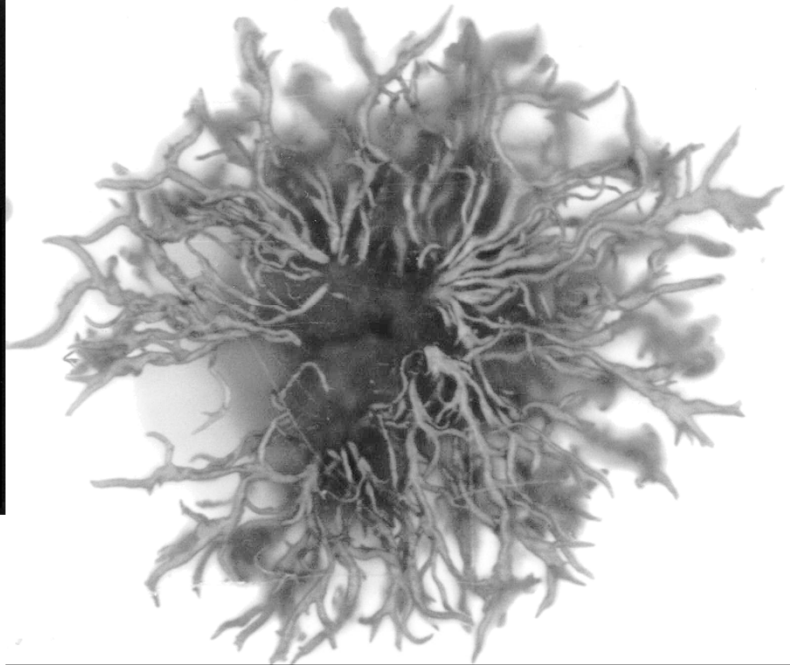
Mycelial fans - syrrocium

Mycelial fans - syrrocium

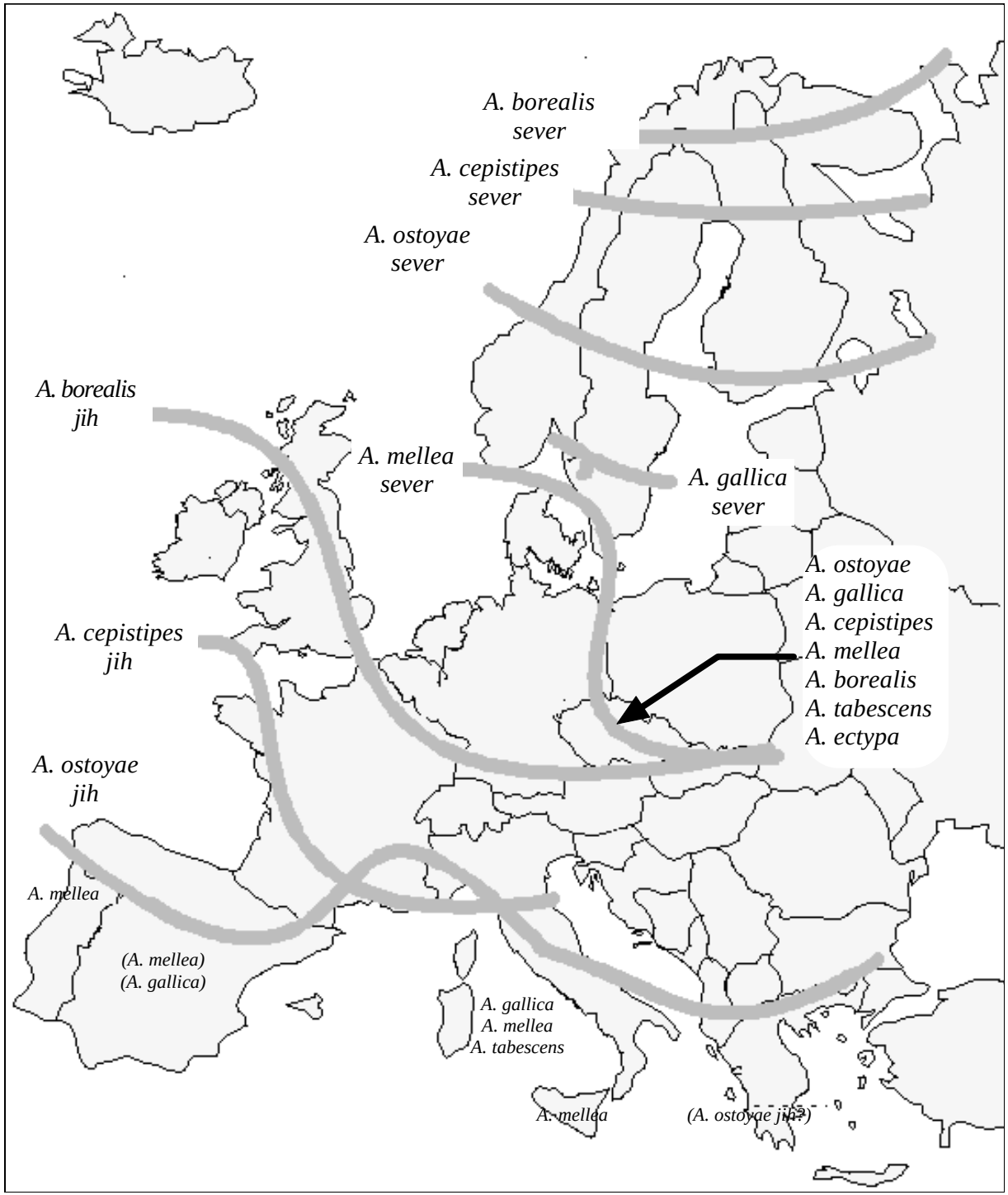
Rhizomorphs of Armillaria

Rhizomorphs of Armillaria





Armillaria spp. – mycelim in culture



Distribution of Armillaria in Europe

The risk of Armillaria root rot on forest stands under conditions of central Europe forests

- The most endangered stands are fertile stands in low and middle elevations
- Querceto – Fagetum
- Slt. 2B, 3B, 3H, 3S, 4B
- *Armillaria ostoyae as most common species*

The Armillaria control

- **The precaution of silviculture**
  - **The modification of stand composition close to natural**
  - **Support of maximal exploitation of water by individual trees**
- **The precaution of forest management**
  - **Low age of rotation (60 – 80 years)**
- **Chemical control**
  - fungicides (hexaconazol, flutriafol a fenpropidin, fundazol, cuprozan, derozal)
  - fumigants (metylbromid, chloropicrin, aj.)
  - Application of boric compounds (boric acid, boritans, diboráts, tetraboritans, oxids of bors and theirs mixtures)

The Armillaria control

- **Biological control**
  - **Bacterial agent**
    - » **Bacillus subtilis (Ibefungin)**
  - **Antagonistic wood destroying fungi**
    - *Trichoderma viride, Trichoderma harzianum*.
    - *Pythium oligandrum*
    - *Phlebiopsis gigantea* (*Peniophora gigantea*) - Rotstop
    - *Hypholoma* (*Hypholoma fasciculare*, *H. capnoides*), *Gymnopilus*, *Pholiota* (*Gymnopilus sapineus* sensu lato, *Pholiota squarrosa* aj.), *Kuehneromyces mutabilis* etc.

The Armillaria control

- **The protective role of mycorrhiza**
  - The trees with well developed mycorhiza are more resistant towards to Armillaria infection
  - The growth of Armillaria is retarded by presence of ectomykorrhitic species in vitro conditions.
  - The relations of ectomykorrhitic species and primarily parasitical fungi is influenced by water stress and by presence of organic form of nitrogen
  - Ectomykorrhiza improve the providing by water during dry spell – from the origin of infection most critic season

Armillaria root rot on Pines

Heterobasidion

- The genus Heterobasidion (Stalpers 1979) is a global complex of woody plant pathogens and saprobes whose host range comprises
- over 200 plant taxa, the majority of which are conifers (Korhonen & Stenlid 1998). Heterobasidion has a worldwide
- negative impact on conifers, both ecologically and economically by reducing site productivity and the amount of harvestabletimber (Woodward et al. 1998).
- On the other hand, this organism is also responsible for creating forest conditions conducive to regeneration, nutrient cycling, and succession (Garbelotto 2004).
- In either case, it is a significant ecological force directly or indirectly affecting natural processes and anthropogenic activities.

(Otrosina, Garbelotto 2009)

Table 3 – Some diagnostic differences among the 5 taxa formerly included in the *Heterobasidion annosum* species complex that may be of use in the field where basidiocarps are found.

	H. annosum	*H. irregulare*	*H. parviporum*	*H. abietinum*	*H. occidentale*
Natural range	Eurasia	North America	Europe	Central, Southern, & Eastern Europe	Western North America
Exotic range	na	Central Italy	na	na	na
Major hosts	*Pinus* spp.	*Pinus* spp, *Libocedrus*, *Juniperus* spp	*Picea* spp. or Abies in Eastern Russia	*Abies* spp.	*Abies* spp., *Tsuga* spp., *Pseudotsuga* spp. & *Sequoiadendron*
Secondary significant hosts	Stumps of *Picea*	na	Saplings of *Pinus* spp.	na	Stumps of *Juniperus* and *Pinus* spp.
Location of sporocarps	Root collar and primary roots of dead trees	Root collar (Eastern North America, Italy), underbark of buttress and under intact stump surface (Western USA)	Root collar and decay pockets within boles	Root collar, along roots, and in decay pockets	Decay pockets in stumps and fallen trees, under intact surface of pine stumps
Length of sporocarps	Up to 30 cm	Up to 30 cm in North America. In Central Italy sporocarps can be 30–40 cm, and larger than *H. annosum*	Up to 30 cm	In colder areas (Central-Eastern Europe) up to 30 cm, in mesic warm areas up to 40–45 cm	Up to 40 cm
Mean pore density in mm^2 (SD) and % of irregular pores	8 (0.3) (no data available)	7.3 (0.12) 11 %	13.4 (0.4) (no data available)	12.5 (0.3) (no data available)	8.6 (0.07) 6 %

na – not applicable.

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Heterobasidon annosum s.l. in Europe

- *Heterobasidion parviporum*
  - S-form
- *Heterobasidion annosum*
  - P-form
- *Heterobasidion abietinum*
  - F-form

Heterobasidion annosum sl.

Heterobasidion annosum

Heterobasidion annosum

Heterobasidion annosum

Heterobasidion annosum

- On the pseudoglej soils and on the afforested areas in the first rotation
- The exterior root system like main predisposal factor
- Cause red rot
- Spreading in the coalescence of roots; in the stands in first rotation by cutting area in stumps
- Infection start from the pole timber
- Stumps a roots are infected by conidia and basidiospores germinated on cutting area of stumps

Heterobasidion annosum

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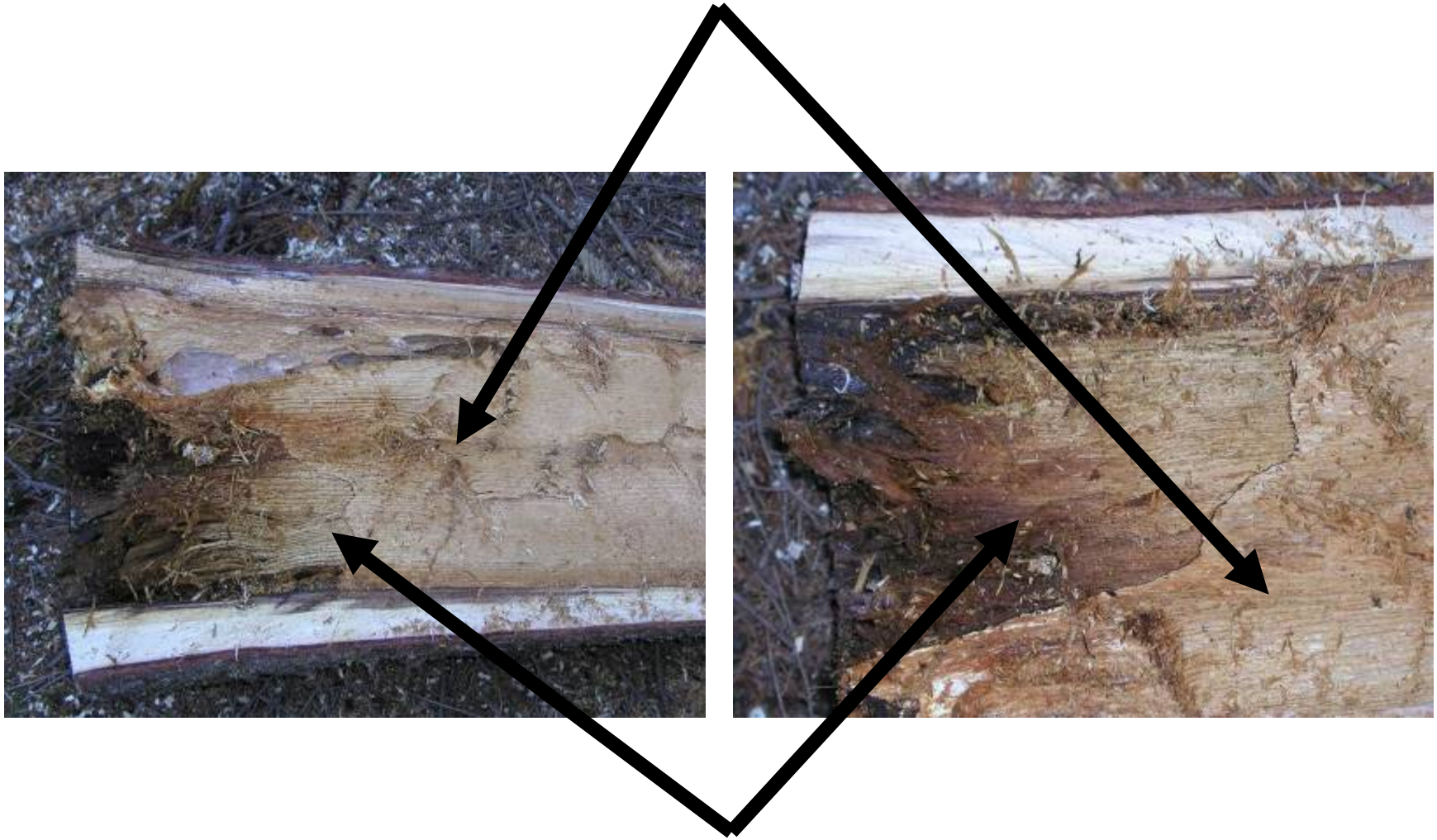


Armillaria ostoyae

Heterobasidion annosum

- On the pseudoglej soils and on the afforested areas in the first rotation
- The exterior root system like main predisposal factor
- Cause red rot
- Spreading in the coalescence of roots; in the stands in first rotation by cutting area in stumps
- Infection start from the pole timber
- Stumps a roots are infected by conidia and basidiospores germinated on cutting area of stumps

Control of *Heterobasidion annosum*

- Spraying of cutting area by
  - Urea
  - Creozot
  - Spores of *Peniophora gigantea* (Rotstop)
- Silvicultural precautions

Rhizina undulata

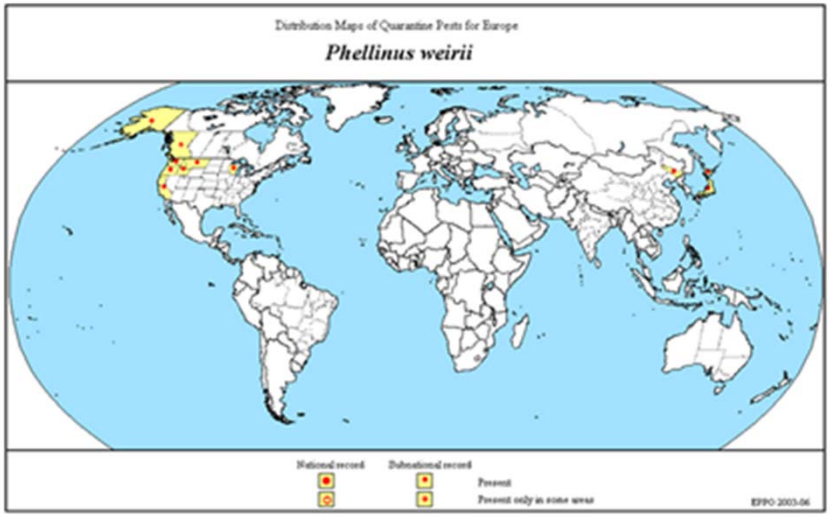
Rhizina und

Phaeolus schweinitzii

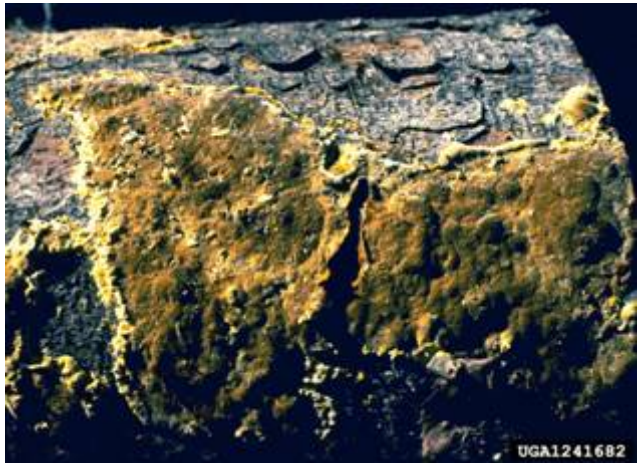
Phaeolus schweinitzii

Sparassis crispa

Phellinus weirii



Phellinus weirii



Ustulina deusta

Ustulina deusta

Xylaria polymorpha

Xylaria polymorpha

Anamorph

Teleomorph

Daldinia concentrica

Saprofyte in the wood of broadleaved

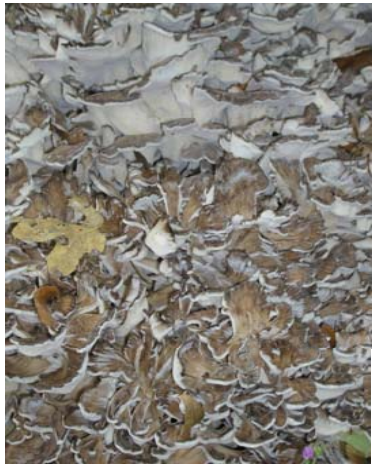
Armillaria spp.

Pholiota squarrosa

Meripilus giganteus

Meripilus giganteus

Grifola frondosa



Grifola frondosa

Perenniporia fraxinea

Perenniporia fraxinea

Coprinus disseminatus

Coprinus sp.

Phytophthora

- Phytophthora alni
- Phytopthora cambivora
- Phytopthora citricola
- P. kernoviae
- P. ramorum (Suden Oak Death)

http://www.baumkrankheiten.com

Alder dieback *Phytophthora alni, P. multiformis*

Alder dieback *Phytophthora alni, P. multiformis*

Oomycota

Phytopthora beech dieback

P. citricola, P. kernoviae

Phytopthora beech dieback
P. citricola, P. kernoviae

Decline of beech in Bile Karpaty Mts.

Phytophthora necrosis

Phytopthora beech necroses
P. cambivora

P. cambivora

P. cambivora

P. citricola, P. cambivora

Pictures by T. Jung http://www.baumkrankheiten.com

P.cambivora

Pictures by T. Jung http://www.baumkrankheiten.com

P.citricola
Aesculus hippocastaneum

Pictures by T. Jung http://www.baumkrankheiten.com

Oaks

P. citricola, P. roboris

Suden oak death

P. ramorum

Suden oak death

P. ramorum

Leaf spots caused by *Phytophthora ramorum* on rhododendron. Leaf spot margins caused by this *Phytophthora* are often fuzzy, rather than sharply defined.

Black zone lines under diseased bark in oak.

P.ramorum