Vzdělávací materiály projektu

Inovace biologických a lesnických disciplín pro vyšší konkurenceschopnost (InoBio)

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

History of Forest Pathology

An introduction

Th.L.Cech, Mendel University in Brno

Forest Pathology, definition

Forest pathology is the research of both biotic and abiotic maladies affecting the health of a forest or tree, primarily fungal pathogens and their insect vectors. It is a subfield of forestry and plant pathology (Wikipedia 2013)

The following research-fields fall into Forest Pathology

- Epidemiology
- Pathology sensu stricto
- Biology, here especially infection biology of the pathogens
- Research on management strategies as avoidance, exclusion, control, eradication, protection and even research on resistance.

Nowadays, forest pathology is **related to many other disciplines**, expressed by the fact, that "… many forest pathologists wear more than one hat" – many are molecular biologists, spatial statisticians, geographic information specialists, remote sensing experts, etc..

Forest Pathology, definition

Forest pathologists study the **interactions** of small, rapidly developing microorganisms within big, spatially heterogeneous, slow-developing forests. Spanning these vast scales makes forest pathology unique" (Forest Pathology – from Genes to Landscape, John E. Lundquist and Richard C. Hamelin, eds., APS press 2005).

Forest Pathology, history

History of Forest Pathology is both

history of epidemical tree diseases and

history of research on them

Thus, in this presentation, some **examples of major impacts of epidemical forest diseases** are briefly presented in a first part, followed by the development of Plant Pathology and Forest Pathology as a scientific subdiscipline of the latter.

History of epidemical tree diseases

Far the most common fungal, bacterial or viral (in a broad sense) caused disasters of forest trees have been and still are **related to invasive pathogens**.

Invasive species, short definition

Invasive species are introduced or naturally spread species which have not been native to the forest ecosystem of an area.

Some historical examples of epidemics

Spread of a disease caused by *Phytophthora cinnamomi* Rands in USA, affecting southern populations of American chestnut (*Castanea dentata*) as early as 1824 (Crandall et al. 1945)

Enhanced by the **increasing trade** between the continents, the **big catastrophies** happened to start around the end of the **19th century**.

History of epidemical tree diseases

Chestnut blight

Dutch elm disease

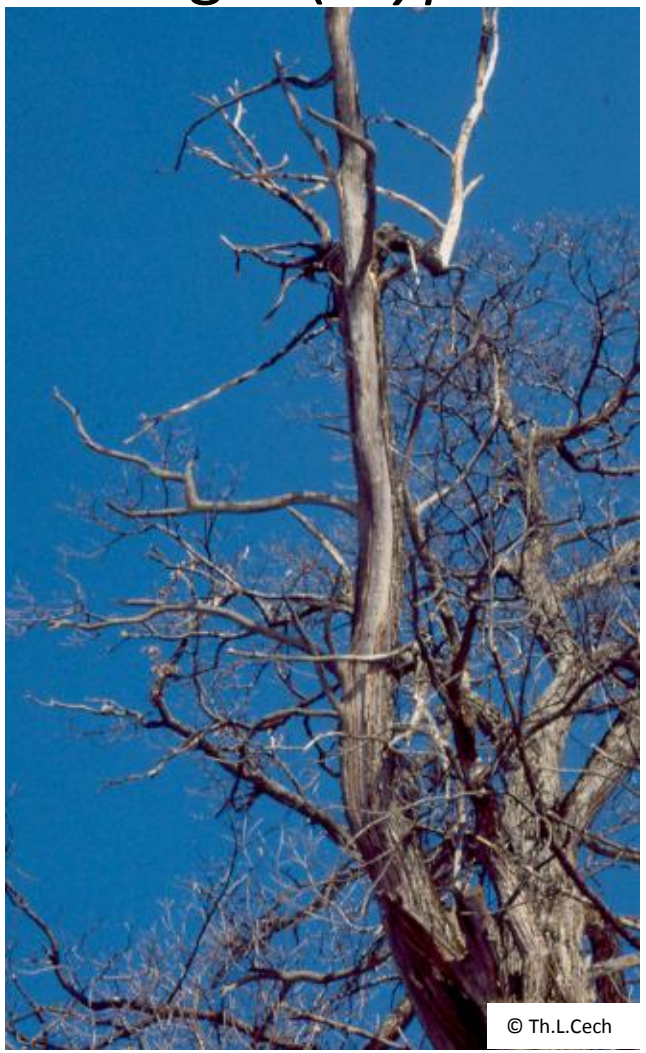
White pine blister rust

Platanus canker stain

History of epidemical tree diseases

Some historical examples of epidemics

Chestnut blight (*Cryphonectria parasitica*)



History of epidemical tree diseases

Chestnut blight (*Cryphonectria parasitica*)

Origin: Asia: accidentally introduced to North America around 1900, probably on imported Japanese chestnut nursery stock

USA: 1904 in New York Zoo, killing American chestnut trees (*Castanea dentata*)

Description of the species and proof of pathogenicity: 1905

Spread over North America with speed of 80km/year, killing **EVERY** infected tree

Harm: By 1940, most mature American chestnuts wiped out (many millions of trees), now a few 1000 left!

regarded as the largest epidemics in history of tree diseases worldwide

History of epidemical tree diseases

Dutch elm disease (*Ophiostoma ulmi* and *Ophiostoma novo-ulmi*)

History of epidemical tree diseases

Dutch elm disease (*Ophiostoma ulmi* and *Ophiostoma novo-ulmi*)

Origin: probably Asia, arrived in Europe in 1910, in USA 1930

Name: initial description from the Netherlands in 1921

Impact: In Great Britain, for instance, around 30 million and in North America hundreds of millions of elm trees were killed by Dutch elm disease

Vectored by elm bark beetles

Indications for earlier epidemics:

Great Britain 1819-67: early and very precise symptom descriptions (Richard Jeffery, 1883, Nature near London)

History of epidemical tree diseases

Dutch elm disease (*Ophiostoma ulmi* and *Ophiostoma novo-ulmi*)

Indications for prehistoric epidemics:

fossil pollen in peat samples

Elms disappeared from northwestern Europe in mid-Holocene period (about 6000 years ago, and to a lesser extent 3000 years ago)

Synchronous and widespread, known as the 'Elm Decline'

Originally attributed to the impact of forest-clearance by Neolithic farmers, and of elm-coppicing for animal fodder

More recently: subfossil elm wood showing signs of the changes associated with the disease - an early form of Dutch elm disease?

Fossil finds from this period of elm bark beetles support this theory.

History of epidemical tree diseases

Some historical examples

White pine blister rust (*Cronartium ribicola*) - symptom fotos see internet (white pine blister rust)!

one of the most important diseases in the history of forest pathology in North America and one of the most famous forest diseases in the world

introduced to Europe from Asia in the early days of plant movements:

Into eastern North America on **seedlings** of *Pinus strobus* (eastern white pine) from Germany about **1898** and on eastern white pine seedlings from France into Vancouver in 1910: **Why?**

As a consequence of **over-exploiting its forests**, North America faced a need for large scale afforestations.

European nurseries produced plant stock from American seeds, with huge amounts of plants being sent back to the USA, some of them, however, infected.

History of epidemical tree diseases

Platanus canker stain (*Ceratocystis fimbriata* f.sp. *platani*)

History of epidemical tree diseases

Platanus canker stain (*Ceratocystis fimbriata* f.sp. *platani*)

Origin: probably south-eastern United States and Mexico, introduced to Italy in 1940`s, having probably arrived with military supplies during the World War 2 from the Philadelphia area

Impact: In many mediterranean countries, a big problem for city trees:

it has caused and still causes death of thousands of trees and high costs for sanitary felling for instance in Italian cities.

History of research on tree diseases

To understand the reasons and the development of this discipline, we have to follow the **history of plant pathology**, since people began to deal with diseases of crops as direct impacts to human nutrition much earlier than with tree problems.

Main literature source: standard publication on plant pathology by J.G. Horsfall and A.D.Dimond, Plant Pathology, an advanced treatise, Acad.Press, 1959 as well as the internet.

Reasons for plant pathology to develop as a research discipline

For thousands of years until the **beginning 19th century**, plant pathology was restricted to diffusely scattered, purely empiric knowledge on agents disturbing plant yield development or destroying plants and parts of plants.

Why did that change?

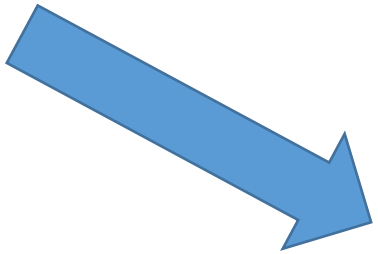
→ Two basic reasons:

- new research methods (microscopy and others) and

  artificial breeding of pathogens under controlled conditions
- Industrial revolution (steam power, urbanization, increase in need for nourishment)

Reasons for plant pathology to develop as a research discipline

increase in need for nourishment:
replacement of small sized production units by large acreages
replacement of diversity of crops by single crops, often single varieties



epidemics by plant pathogens increased in frequency and impact

increasing need for effective control measures

Reasons for plant pathology to develop as a research discipline

“War”for thruth

Rising of new ways of thinking,

referring both to the traditional way of observing and describing symptoms and disease-courses, which improved, beginning in the late 1700s, and the “war” for causal relations between plant diseases and pathogenic organisms, to place the observed processes in a network of causalities.

Reasons for plant pathology to develop as a research discipline

Microscopy

Discoverage of the multiplicating effect of the magnification of two optical lenses put together (**Zacharias Jansen**, Netherlands, 1608).

Antonie van Leeuwenhoek, Netherlands:

first constructor of **microscopes**, around

1674, discovering bacteria and other

microorganisms

Mycology

From early days on strong relation to mycology

What are spores?

Gianbattista della Porta, Italian philosopher, 1588

spore dust of mushrooms (truffles) ➡ “seed”, but he did not proof.

Mycology

What are spores?

Robert Hooke, 1675, first illustration of a fungal reproductive structure (teliospores of a ***Phragmidium-rust***).

Spontaneous rising of fungi but then spore production for further propagation

Malpighi 1675/1679 regarded spores as florets of an inflorescence, rather than as seeds. He already thought, but could not prove, that fungi grew from seeds or fragments of themselves rather than spontaneously.

Main belief in that time: Abiogenesis

emergence of organic life from anorganic material

Experiment by Johan Baptista **van Helmont**, a Belgian doctor of medicine and chemist, recommended the following **experiment** as proof:

*take a jar of potter`s clay, put moist wheat grains and **dirty female clothes** into it and wait for 21 days: then **mice** will have developed in the jar by a "**ferment**".*

Abiogenesis remained a subject of discussions and experiments until ***Louis Pasteur*** in 1862 proved, that results by some experiments

were the consequence of contaminations by airborne bacteria.

Josef Pitton de Tournefort (1705), a French botanist:

Fungi are

autonomous organisms

can incite plant diseases as the dangerous moldiness disease of plants in humid greenhauses in winter (=mildew)

and

reproduce by spores

Although: **no experimental proof**!

1st experimental proof of spores as "seeds" of fungi

Start of modern mycology

Pier Antonio Micheli, botanist to the grand duke of Tuscany, responsible for the public gardens in Florence

1729: *Nova plantarum genera*:

Microscopic investigation of many "seeds"

Careful experiments with agarics, *Mucor*,

Botrytis and *Aspergillus* to test the reproductive ability of their "seeds"

(tests, repetition, untreated controls etc.)- "**seeds" can produce crops by themselves**

Next step: certain diseases are contagious, but not yet proof for pathogenicity

Mathieu Tillet (1755) proved this for wheat bunt (*Tilleta tritici*) in brilliant experiments in Bordeaux.

However, he did not realize that the disease was caused by an organism, thinking of a “poisonous principle” in the back dust.

A.H. Tessier, a prominent French agriculturist, repeating **Tillet**`s experiment, but also not realizing the parasitic nature of the rust (1783).

Following a long period of ignorance and confusion

After these single “sunrising” experiments and observations a long period followed, where mycology dominantly focused on

1. observation
2. descriptions of fruiting structures on the natural substrate and
3. on a classification based on that as well as on speculations.

The belief in not changing, **fixed species** on the one hand and the still widely accepted **dogma of spontaneous generation** was a solid barrier against research progress.

Period of ignorance and confusion

In addition, there was a tendency to distort descriptions and classifications to be conform to the **theories** and the **terminology** of **medicine** of that time.

The result was a big **confusion** and the first right steps to the reality as mentioned above were nearly lost. This lasted from the **beginning of the 18th century** or even earlier to the **Seventies or early Eighties of the 19th century**.

Period of ignorance and confusion

Highlights of oddities of that time:

Michel Adanson, a French botanist, classified plant diseases into external and internal causes. He thought that **mildew**, **rust**, and **smut** diseases were caused by **impeded transpiration**, and regarded the **associated fungi as products of the plant sap**.

He thought, that the black dust of bunt was a secondary and perpetuating cause of this disease.

Period of ignorance and confusion

1766: severe grain rust epidemics in Italy, investigated by

Felice Fontana and **Giovanni Targioni-Tozzetti**:
disease caused by microscopic parasitic plants, but still no adequate experiments to proof that.

Period of ignorance and confusion

1773, ***Johann Baptist Zallinger***,

professor of natural history at Innsbruck, Austria, followed the medical concepts to an extreme extent, stating that **fungi associated with plant diseases** are **products of the diseased plants** rather than **causes of the disease**.

Period of ignorance and confusion

Last of these many scientists disregarding the nature of plant pathogenic fungi:

Filippo Ré, professor at the University of Modena, Italy:

1807, after discussing the opinion of many famous scientists, he defined

"…cryptogamic plants, minute insects or the exudations, whether dry or not, as rather the **symptoms of the disease itself**, which is a result of **excessive vigour** or **over-repletion**".

The breakthrough – *Isaac Bénédict Prévost* and the first full experimental proof of a fungal pathogen as the cause of a disease

Born in Geneva, Switzerland, ***Isaac Bénédict Prévost*** (1755-1819) later became a professor at the académie du Lot at Montauban in France.

first recorded adequate experimental proof and interpretation of the role of a microorganism in the causation of a disease (1807)

experiments with wheat bunt (*Tilletia tritici*, *laevis) for* a decade

Isaac Bénédict Prévost: fundament of the whole later plant pathology:

detailed descriptions of all stages
interpretation of spore as germs
numerous inoculation experiments
- proof of the parasitic nature of the fungus
intense experiments with copper and other chemicals as control agents

Results widely accepted by practically working people as gardeners, agricalturists but not accepted by the scientists of that time who still stuck to the old believe in the spontaneous germination

It took until 1847, when the brothers **Tulasne** (***Louis-René*** (or ***Edmond***?) and ***Charles****)* referred to Prevost`s work fully proving it.

Protagonists of the germination theory

Franz Josef *Andreas Nicholas Unger*, Austrian Botanist, Book on plant pathology "Exantheme der Pflanzen", 1833:
fungi are abnormal changes in the plant juices of diseased plants
Franz Julius Ferdinand Meyen, German professor of Botany, Book on plant pathology "Pflanzen-Pathologie":
fungi associated to plant diseases are "pseudoorganisms" resulting from abnormal nutrition of the plants
Justus von Liebig, one of the most famous scientists of that time (founder of the science organic chemistry):
fermentation, putrefaction and contagious disease result from an active state of atoms, and that this state could be transferred from one body to another in contact with it.

The great famine of Ireland

More infos under
“great famine”
In the internet

1830 and 1840: **potato blight** (***Phytophthora infestans***) in Europe and the United States
1845 and 1846, **epidemics** destroyed the potato yield in Ireland totally
hundreds of thousands of Irish people died, further hundreds of thousands emigrated to USA
The majority of scientists still **did not** believe in a pathogen involved in potato blight, though:
In 1845 **Camille Montagne** in France described the pathogen first as ***Botrytis infestans.***
Official proof of the causal role in 1857 and by **Speerschneider** and **De Bary** in 1861 and 1863.
Control: only 40yrs later! - Bordeaux mixture (suspension of copper sulfate in CaO), already known and published by Prevost, but ignored!

Some historical aspects of controlling plant diseases

The ancient Greek ***Theophrastus of Eresus*** (370-286 b.C.) in his
“Historia plantarum”:
mixture of purely empiric and speculative basic approaches to treatment of seeds and plants (translated into Latin and amended by the Roman writer Pliny the Elder 23/79 a.d.)

Tillet (1755): wheat bunt can be (partly) prevented by seed treatment (saltpeter solution and lime)
But: standardized methods lacked until **Prevost`s** experiments with **copper sulfate**.

General acception only 1845 in viticulture in France and England.

Synthesis of urea: ***Woehler*** (1828).

Modern Mycology

Founders **Tulasne** brothers
main work on rusts, smut fungi and Ascomycetes (1847, 1854, 1861/1865).
Discovering polymorphism in fungi.

Big step in knowledge on morphology and natural relationships of fungi and on their potentialities as pathogens.
Crown work: “Selecta fungorum carpologia”.

Heinrich Anton De Bary (1831 born in Frankfurt am Main). Freiburg im Breisgau, following there the famous botanist ***Naegeli*** (the one, who in intense contact to ***Gregor Mendel*** did not accept ***Mendel***`s theories), furthermore in Halle an der Saale and Strasbourg. “Untersuchungen ueber die Brandpilze” (1853):
(“…smut and rust fungi do not originate from the host cell content or from the secretion of diseased cells and that they are not the result, but the causes of pathological processes”).

Trends influencing Plant Pathology

Plant pathology, having overcome the initial problems discussed above, remained and still remains influenced by various trends (the most recent and actual being molecular biology)

Mycology
Physiology
Bacteriology
Virology

Mycology

Within mycology, several research centers or “schools” established, dealing with plant pathology

De Bary, Germany: dawny mildews (*Peronosporaceae*), rusts, physiology, infection mechanisms

Later on more experimental pathology

Julius Gotthelf Kuehn, Saxony, Germany***:*** smut diseases, rusts, root diseases and seedling treatment (Die Krankheiten der Kulturgewaechse, 1858)

Oskar Brefeld, Germany: leading in early development of techniques for **cultivating microorganisms** in pure culture and **inoculation techniques**. Life cycles of saprophytic fungi, then smut fungi

Pierre Marie Alexis Millardet, France, University of Bordeaux (1878):

Focus on **control measures** - eradication and exclusion (this research started more or less with the acceptance of fungi as organisms)

Mycology

Control measures

Resistance breeding – delay in systematic research until the **Mendel** laws (elaborated in Brno) were accepted (1881-1900), but: practical use of selection already in antique times

Resistance breeding: systematic studies onmly towards the end of the 19th century – blight resistant potatoes, grapes resistant to downy mildew

First researchers: ***Rowland Biffen***, Cambridge University, stripe rust of wheat (*Puccinia glumarum*)

C.R.Orton, USA, resistance of cotton, watermelon and cowpea against *Fusarium*

Physiology

Highly concerning Forest Pathology
Famous protagonists:

Paul Karl Moritz Sorauer
Botanist and director of the “Imperial Cider Institute” in Proskau, Germany (now Poland).
Father of serious research on physiogenic diseases (i.e. diseases by physiological factors and/or environmental influences): “Handbuch der Pflanzenkrankheiten”, 1874

Prévost, ***De Bary*** (discoverage of **toxins** from pathogens killing host cells advancing the mycelium), **Harry Marshall Ward**, Cambridge

Bacteriology

This trend started with ***Louis Pasteur*** and **Robert Koch**, the latter pioneer of Bacteriology, (Anthrax). This work can be regarded as the foundation work for Bacteriology, revolutionizing animal pathology and medicine and had great influence on plant pathology. Interestingly, there was a phase of ignorance of bacteria as pathogens in the late 19th century (even **De Bary**!)!

Pioneers:

Thomas Jonathan Burrill,
University of Illinois, Fire blight (1877/1883),
First experimental proof of bacterial pathogenicity

J.H.Wakker, Amsterdam, Netherlands, same for yellow disease of hyacinth (1883 and 1889)

Luigi Savastano, Italy, olive knot = bacterial disease
(1887)

Bacteriology

The modern bacteriological trend in plant pathology was initiated by **Erwin Frink Smith**, educated at the Michigan University and working for a long time in the **USDA** (United States Department of Agriculture) with the development of **modern techniques of Bacteriology** for plant disease research.

He started will studies on **wilt of Cucurbits**, **brown rot of solanaceous plants**, **black rot of cruciferous plants** and **crown gall**. His work culminated with his “Bacteria in relation to Plant diseases” (1905-1914).

Virology

Descriptions of virus symptoms were made long before detection of viruses. In plant pathology, even the **pathological causality** was proven before the identification of viruses: **Adolf Mayer** , Agricultural Experimental Station at Wageningen, Holland, tobacco mosaic disease.
Disease incitation by injection of sap from diseased leaves into healthy ones (ca. 1880). Similar work: **Smith** with peach yellows in US about the same time. Both, naturally, believed in a bacterial cause.

Next step: something smaller than bacteria ….
Dimitrii Ivankovski, Russia: use of Chamberland filters - disease incitation with TMV (1892)

Virology

One before final step:
Existence of viruses as causal agents of plant diseases: **Martinus Willem Beijerinck**, a Dutch biologist, assumed a “contagium vivum fluidum” as the cause for the mosaic and not a microbe or a corpuscular organism (1898).

Final step: viruses **optically** detected (electrone microscopy, 1940s, **Helmut Ruska**)

Forest Pathology

dates back in its origin +- to the the **19th century**. Why?

1. **Need for fire wood** and **timber** increased in that time - exploitation of forests for

- **melting of iron**, which needed high amounts of firewood before the discover of the big coal deposits and adequate transport-facilities.
- To a lesser extent the same referred to **salt exploitation** (for instance in Austria).

Consequences: deforestation and beginning of artificial stand regeneration with disease epidemics by planting mistakes, mal adapted plant stock, and invasive pathogens.

2. disorders/diseases of woody plants are usually more complex in their interacting causes than those of herbaceous plants.

The anticipation “one symptom=one causal agent” normally does not apply to tree diseases.

Thus diagnostics of tree diseases is still nowadays one of the research fields with an urgent need of **interdisciplinary** research approaches, which was **nearly impossible** during the 19th century up to two thirds of the past century!

Forest Pathology

Founder and therefore "**father**" of Forest Pathology was
Heinrich Julius Adolph Robert Hartig
Born in **Braunschweig**, Germany, in 1839, he studied at the Universities of Berlin & Marburg, obtaining his doctor`s degree at Marburg in 1867. Later he was professor of Botany and director of the Royal Forestry Experiment Station at Munich.

Valuable contributions to **many aspects** of forestry, Botany, and entomology.

Two outstanding books confirm his **pioneer role** in Forest Pathology:

"**Wichtige Krankheiten der Waldbaeume**" (1876) and
"**Lehrbuch der Baumkrankheiten**" (1882), the latter representing the first comprehensive book on Forest tree diseases.

Forest Pathology

Carl FH v.Tubeuf, 1862-1941
Forest pathologist
University of Munich, Germany, Berlin, Dahlem, Institute of Biology
University of Munich again

Introduced the term “biological control”:

Discoverage of insect parasitic fungi 1914 biological control of fungus diseases of plants 1895, plant diseases caused by cryptogamic parasites
1923, monography of mistletoes

Broad interests in numerous fields of Biology

Forest Pathology

Frederick Georg Emil Rostrup, 1831-1907
Plant pathologist
Denmark, University of Copenhagen
Described many species of fungi

USA: Forest pathology started in the USDA in St. Louis in 1899. In 1907 the Division of Forest Pathology was established in Washington, D.C. and in 1953 the responsibility shifted to the US Forest Service.

John Shaw Boyce 1899-1971, born in Ireland, pioneered studies in the western U.S. in the 1920's and 30's.

Forest Pathology

History 1918 to 1945

The two catastrophes in the first half of the 20th century severly affected development of research, including Forest Pathology.
In addition, **world war 1**, leading to the destruction of two powerful monarchies in Europe, was followed by a **world economic crisis**. From the second half of the 30s on, much research was directed into **war industry**. During **world war 2**, **banishment** and **holocaust** additionally threw back development.

Forest Pathology

Valuable references:

By James J.Worall, USDA Forest Service, Rocky Mountain Region, Colorado, 2013

Virus diseases of trees:
Atanasoff D. 1935: old and new viruses of deciduous trees and shrubs, Phytopath.Z.8, 197-223.
University of Sofia, Faculty of Agriculture: **plum pox virus**

Subikova V.: Department of Microbiology and Virology, Faculty of Science, Comenius University, 842 15 Bratislava, Slovakia.

Institute of Experimental Botany AS CR, Czechoslovakian Academy of Sciences, Prague and Oloumoc

Nienhaus, Franz: Rheinische Friedrich-Wilhelms-Universität Bonn,
Institut für Pflanzenkrankheiten Bonn / Abteilung Virologie
Buettner, Carmen: Humboldt-Uni zu Berlin, division of phytomedicine

Phytoplasma diseases:
Many plant diseases, earlier described as virus diseases, have been recognized as phytoplasma or spiroplasma diseases during the past 44 years.
Breakthrough discovery in 1967: detection of mycoplasma-resembling microorganisms in diseased plants and insect vectors by Japanese plant pathologists and entomologists .
Karl Maramorosch, Rutgers-The State University of New Jersey, School of Environmental and Biological Sciences, Department of Entomology, Blake Hall, New Brunswick, USA.

1972 **Biljana Plavsic** recognized phytoplasmas in inflorescences of **coconut palms** affected by **lethal yellowing disease**. The devastation caused by it on several **Caribbean islands** and in southern **Florida** was of great concern. Plavsic later switched to policy and was involved in war crimes in the Yugoslavian war, later on sentenced to prison in The Hague and then released a few years ago.

Bacterial diseases:

From the high number of known bacteria only very few are directly or indirectly associated with forest tree diseases (**Griffiths, H.M.** 2013):

Research predominantly in the USA:

W.A. Sinclair, Department of Plant Pathology, Cornell University, Ithaca, New York: **elm phloem necrosis**

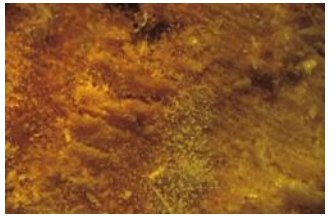
Bacterial canker of ash:
Pseudomonas syringae* ssp. *savastanoi* pv.*fraxini

Pinewood nematodes:

The most aggressive species of the pine wood nematodes, ***Bursaphelenchus xylophilus***, was identified as the cause of **pine wilt** in **1971** by **Kiyohara and Tokushige** in Japan, being the first known nematode killing woody plants. It had been, however, described already in 1934.
Meanwhile there is intense research, not only in North America, but also in Europe, since the pathogen entered Portugal a couple of years ago.

Fungal diseases:

According to the high number of research activities worldwide I limit the younger history to **examples** for research on some famous and harmful fungal pathogens in forests:

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Annosum root rot (***Heterobasidion annosum*** s.l.):
General: J.W.Greig, Derek B.Redfern, 1974: *Fomes annosus*, Forestry Commission, UK
Biology: Siegfried Schoenhar, Baden-Wuerttembergische Forstliche Versuchs- und Forschungsanstalt in Wittental.
Spread, infection biology
Control: Claude Delatour, Unite de Recherches sur les Ecosystemes forestiere, laboratoire de pathologie forestale, INRA Centre Nancy, France
Jim Pratt: Forestry Commission, UK
Othmar Holdenrieder, TU Zuerich, Switzerland

Fungal diseases:
Armillaria root rot: **Armillaria species**
Probably noted already by **Michelis** in 1729

1956: *Armillaria* is **a single and polymorphic species** (**Singer** 1956) – confusion

From the 70ies on again more intense research – f.i. **K**. **Korhonen** 1978 (Finnish Forest Research Institute), several species.
Biology, Pathogenicity: initial work on sexual reproduction by **Hintikka** 1973, Finland

Derek B.Redfern
Steve Gregory, UK
Garrett, S.D., 1956, biology of root infecting fungi, ***Armillaria***
etc.

Chestnut blight:
Anagnostakis, S.L.1987, Chestnut blight: the classical problem of an introduced pathogen. Mycologia 79, 23-37.
Sandra L. Anagnostakis, Connecticut Agricultural Experimental Station. America`s number one in historical research on *Cryphonectria parasitica*

Europe:
Research predominantly in Switzerland,
Ursula Heiniger,
WSL, **hypovirulence**,
as well as before **G.Bazzigher**, WSL, **resistance**

and in Italy,
Tullio Turchetti, Florence University, **hypovirulence**

Cypress canker – ***Seiridium cardinale***:

Appeared in 1928 on Monterey Cypress in California (Wagener W.W., 1939), destroying quickly numerous stands 1974 research by **Funk, A**. in British Columbia. Spread over all continents, occurring now in New Zealand, France, Chile, Italy, Argentina, Greece, Canada, North and South Africa,
Australia

Research predominantly done in Italy:
Moriondo, F., 1972
Panconesi, A. & Parrini C., 1979

Larch canker – ***Lachnellula willkommii***

Regarded as the major disease of larches (***Larix*** sp.), larch canker was detected early and, according to its widespread impacts, investigated from the 19th century on, already by Hartig in 1880. In the 20th century, Hahn (G.G.) and Ayers (T.T.) studied the pathogen in North America (1934, 1943). Further studies were done in Europe:

E.Muench - larch canker as a phenomenon of provenance in 1933

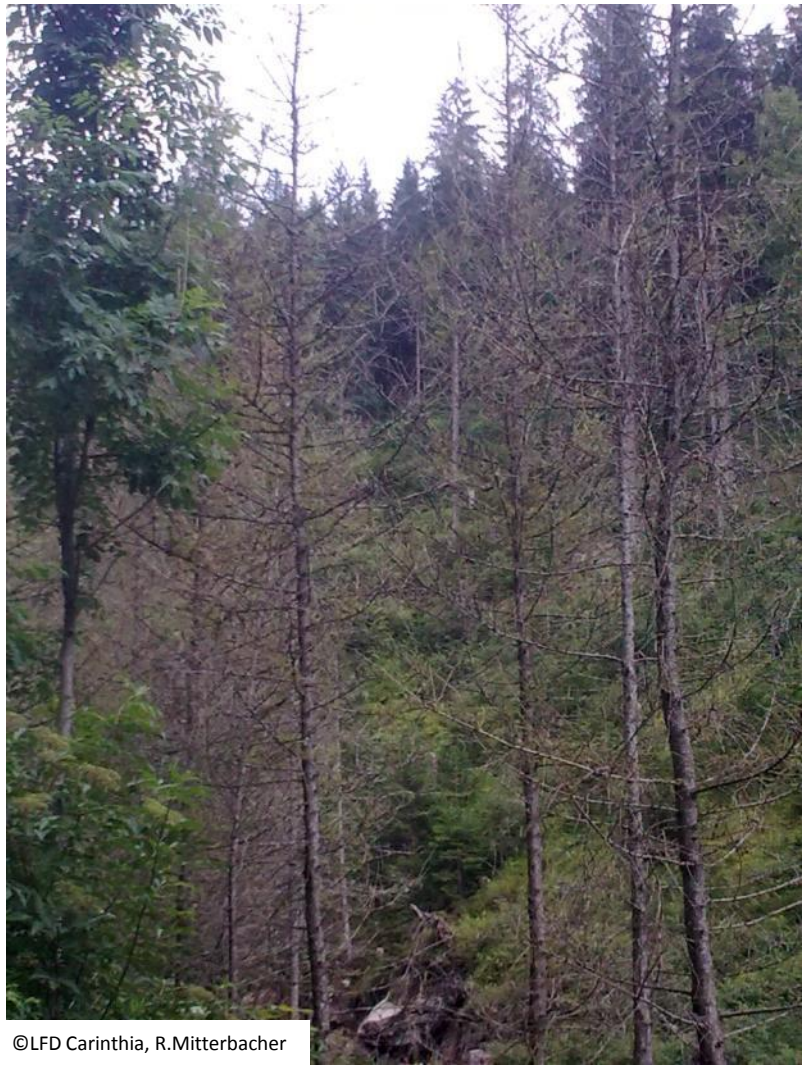
Scandinavia - **A. Yde-Andersen** (The Danish Forest Experiment Station, Springforbi, Klampenborg, Denmark),

various aspects of the biology of the pathogen.

In the Eighties, **G. Sylvestre-Guinot**

(INRA Centre Nancy, France) published a series of paper on larch canker (ecology, infection biology, resistance).

Larch canker – *Lachnellula willkommii*



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Diseases of poplars (***Populus*** spp.)

Poplars gained enormous interest in the Sixties last century, as this genus was "detected" as apt to short time rotation – energy plantations.

Subsequenty disease-problems rose, triggering the establishment of research groups in several European countries with hotspots in Italy*, France, Austria, the Netherlands, Czechoslovakia, Poland, but also in North America.

Marssonina-diseases, **poplar rusts** and **dieback fungi**

Chemical control, later on resistance breeding:

J.Pinon, INRA Centre Champenoux, France

***E. Castellani**, **G.P. Cellerino**, **N.Anselmi** (Italy)

R. Leontovič (Czechoslovakia, 1968)

H.Pagony (Hungary, 1972), **K.Przybył** (Poland, 1990)

*Foundation of an research institute only dealing with cultivated poplars (Istituto di sperimentazione per la pioppicoltura di Casale Monferrato)

Diseases of poplars (*Populus* spp.)

Marssonina brunnea
poplar rusts

Melampsora larici-populina

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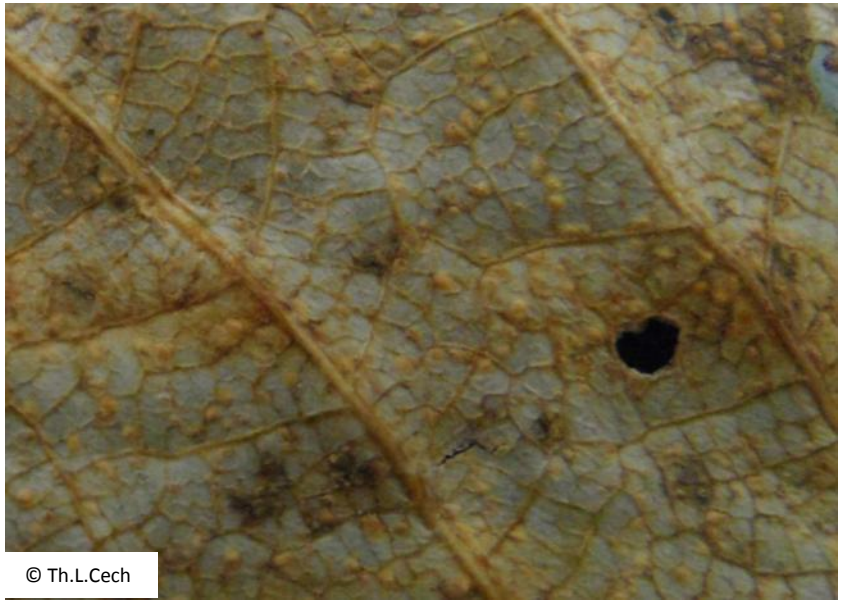

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Dothichiza-dieback

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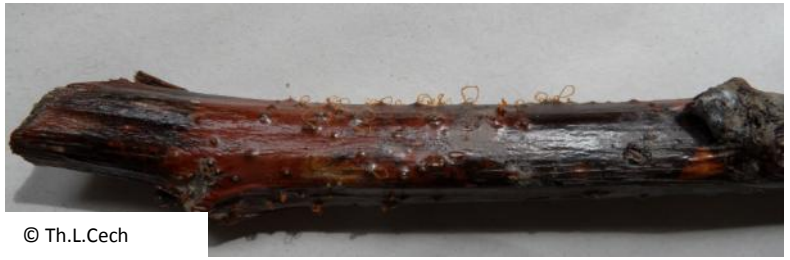
Cytospora



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