Invasive pathogens in Europe and Central Asia

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Invasive diseases species

Nightmare or reality?

Imagine the perfect tree…

If you could custom design a tree with all the best features, you would get the American chestnut.

- It is huge, majestic, graceful, and beautiful.
- It is abundant.
- Its fruit is a ready source of food and commerce for mountain families and a holiday treat for us all.
- It is also an important source of food for wild birds, squirrels, turkeys, deer, and bears.
- The wood is hard, straight-grained, easily worked and beautiful. The heartwood is almost magically resistant to decay.
- It is used for everything from fine furniture to utility poles. When the tree is harvested, it sprouts back vigorously from the roots. The tree grows fast so that the forest is readily renewed to provide its many benefits to future generations of people and wildlife.



It is an ideal tree.



Now imagine the perfect disease…

The perfect pathogen is brought to America and invades forests. Within 40 years, the American chestnut is virtually gone from the landscape.

- The pathogen grows fast and is highly virulent.
- It can infect anywhere on the stem or branches and quickly kill the bark in a spreading canker.
- It reproduces rapidly with huge numbers of spores. The spores can be shot into the air and carried by wind, can be splashed by raindrops, and can be carried by insects and birds to new trees.







It was in America, where perfect tree did not evolve with the pathogen and is helpless.

The perfect disease is chestnut blight

This is the story of invasive pathogen species.

We may never be able to bring back the American chestnut the way it was, but we can prevent future invasions that can decimate our forests, our crops, our waters and wildlands.

Outline



- Introduction to invasive disease: definitions, biological consecutive phases, framework, situation in reality
- Historical consequences of invasions
- Pathways of introduction
- Global pest movement with trade
- Invasive species on forest trees in Europe
- Social-economical Impact of alien invasions on woody plants
- Climate change and forest diseases
- Role of International organizations and databases
- Examples of Invasions

Introduction

The past two decades have seen an explosion of research interest on human-mediated invasions; that is, invasions by species that are not naturally present in a native assemblage, but have been moved beyond the limits of their normal geographic ranges by human actions.

The threat posed by invasive alien species on biodiversity is widely recognized (Williamson 1996; Wittenberg and Cock 2001; Pimentel 2002).

In plants, emerging infectious diseases (EIDs) are tightly linked to biological invasions. Fungal and fungal-like infections have always played a primary role amongst plant EIDs. Disease alerts for plant-infecting fungi in the Program for Monitoring Emerging Diseases (ProMED; http://www.promedmail.org) show a **13-fold increase from 1995 to 2010** (Fisher et al., 2012).

Definitions

Invasive alien species (IAS) are defined by the Convention on Biological Diversity (CBD) as "*species whose introduction and/or spread outside their natural past or present distribution threatens biodiversity*."

Pests and disease species become 'invasive' when they acquire a competitive advantage in a new area following the disappearance of natural obstacles to their proliferation including native antagonists or predators (parasitoids), and successfully adapt to new conditions (Valéry et al. 2008).

Alien species - A species that has been introduced either deliberately or accidentally by humans into a region where it is not native, including spread from such regions. Synonym with '**introduced**', '**exotic**', '**nonnative**' or '**nonindigenous**' species (Pysek et al., 2004)

Invasive species - An alien species that reproduces and is capable of, or has, spread over wide areas (Pysek et al., 2004)

Native species - A species that has originated/evolved in a given area or arrived there without human involvement from an area where it is native (Pysek et al., 2004)

Invasive forest pathogen (IFP)

Santini et al. (2013) slightly modified CBD version of the same definition to better fit forest pathogens.

An alien or invasive forest pathogen (IFP) is defined as a species, subspecies, race, or forma specialis which:

(1) is introduced into a country where it was previously unknown (for example, it can be either an alien species to Europe spreading in neighbouring countries or a European species extending its range)

(2) behaves as an agent of disease

(3) threatens the biological diversity of native or exotic forest trees and shrubs.

Consecutive phases

‘**Arrival**’ - single or multiple arrivals of a nonindigenous species at one or more points of entry into a new locale/environment (Prospero and Cleary, 2017)

‘**Establishment**’—whereby arriving populations start to reproduce in situ, surpassing barriers of initial extinction (geographic, environment, reproductive, antagonists)

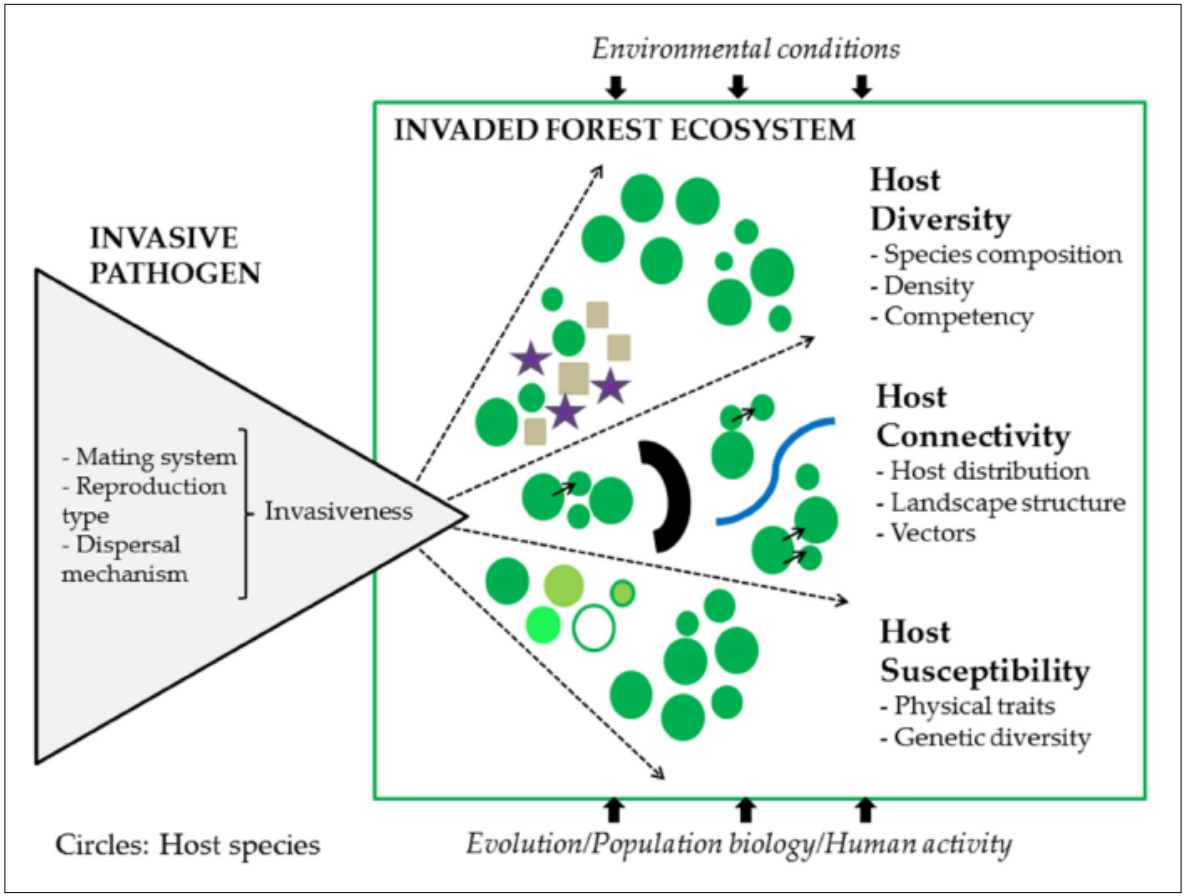
‘**Spread**’- expanding their range of occupied territory into new hospitable areas. Also synonymous with the terms ‘**dissemination’ and ‘dispersal’** refers to the movement of individuals either through random diffusion or directed dispersal such that they expand beyond the frontier of their geographic range (Hui et al. 2011).

Local, regional, and continental-scale factors governing the spread and impact of invasive forest pathogens post-introduction and establishment are affected by three factors: host diversity, host connectivity, and host susceptibility.

Host diversity is mainly affected by plant species richness (density/composition) creating a dilution effect of pathogen impacts on the ecosystem.

Host connectivity is largely influenced by the distribution of available host species; more or less aggregated.

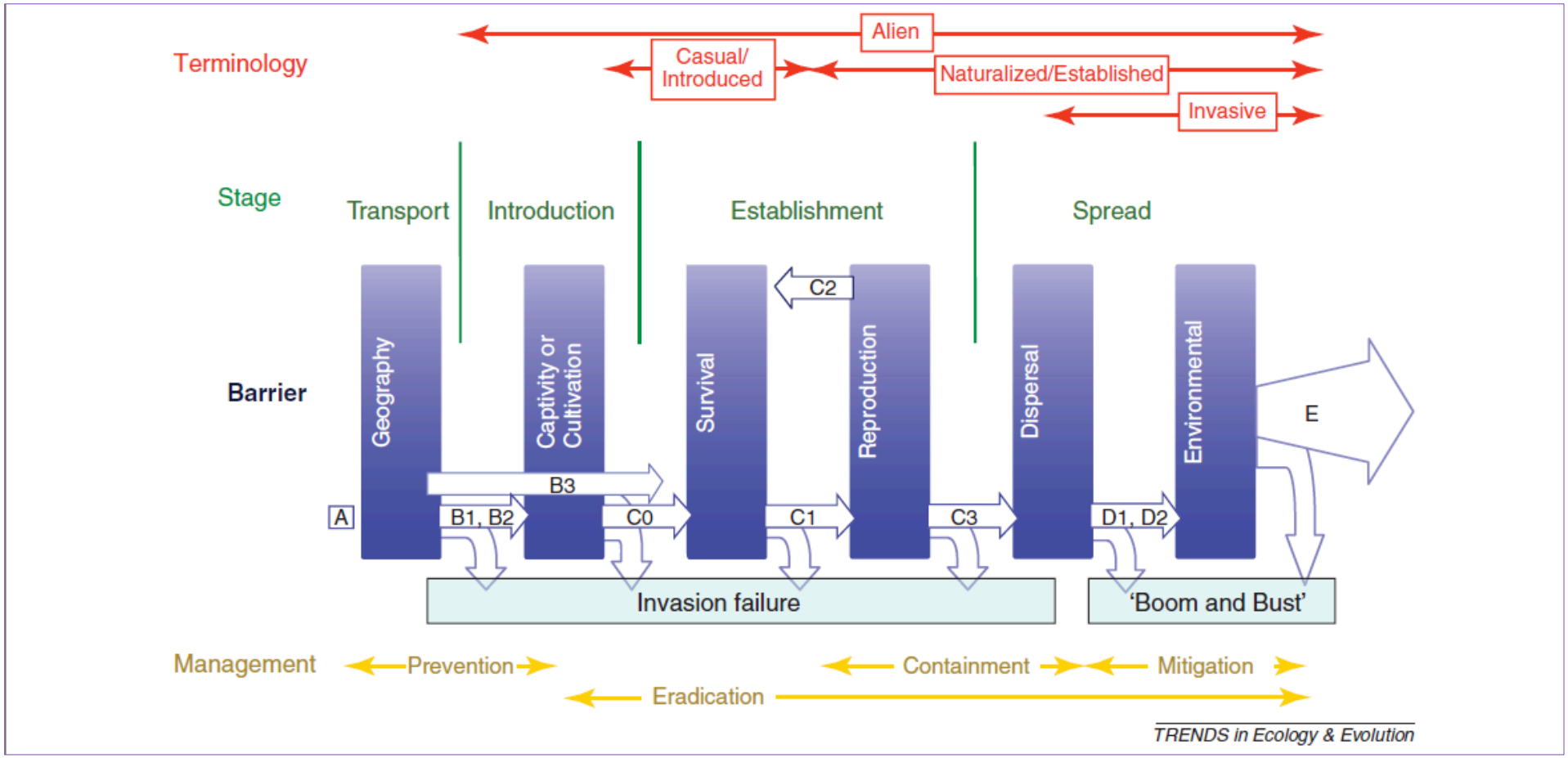
Host susceptibility to invasive pathogens is influenced by physical traits (size, age, morphology), the random presence of other (potentially antagonistic) organisms, environmental and site factors, and host genetic background.



Understanding how host variability is affected by **host diversity, connectivity**, and **susceptibility** will improve our ability to predict disease spread on the landscape and potential consequences to ecosystem services.

Prospero and Cleary, 2017

Unified framework for biological invasions



Tim M. Blackburn et al. 2011

Situation in reality…



Invasive disease and pests **are ignored**…, while problem as invasive species is mentioned, **invasive plants and animals are considered only in spite of huge impact to nature and society**

Invasive disease increased exponentially in the last four decades and dramatically within past 10-15 years. This process will go on!

Countries with a wider range of environments, higher human impact or international trade hosted more invasive disease

Invasive tree diseases cause important environments, sociological and economical issues

Historical Consequences of Invasions



- The temporal trend of invasion in Europe reflects European history
- Until the beginning of the 1920s, most invasive pathogens in Europe were long-established species that simply extended their range across neighboring countries.
- After the 1920s, the most invasive pathogens were alien species arriving mainly from North America, Europe's main trading partner at that time.
- The end of World War I marked a major boundary of this expanding introduction and spread of alien species. In the last 30, the rate of forest pathogen invasions into Europe has escalated exponentially, similarly to that of invasive plants and animals.
- The origin of invasive species has also changed, with a great increase in the number of pathogens from Asia
- Political changes following 1989, when the Iron Curtain fell, opened the doors to globalization, leaving a world without strict borders and few, if any, areas sheltered from invasive species migrations.

(Santini et al 2013)

Globalization and the expanded transport of goods around the planet are together with climatic changes the main reasons for the increase in alien diseases introductions

Pathways of Introduction

Introduction of the pathogen into new territories and its adaptation to the new host (*Ophiostoma ulmi, O. novo-ulmi*)

Introduction of both pathogen and host to the new area (*Rhabdocline pseudotsugae, Phaeocryptopus gaemannii, Apiognomonia veneta*)

Introduction of the host and **adaptation** of indigenous pathogen to it (*Cronartium ribicola*)

Changing of the environmental conditions to those favoring the pathogen (*Dothistroma septosporum*)

Trade of plant material (powdery mildews. *D. septosporum, Calonectria pseudonaviculata, Bursaphalenchus xylophilus* est.)

Timber trade: woody chips, bark est (bark beetles, *Geosmithia morbida*)

Wood package material (*Anaplophora glabripenis, Heterobasidion irregular, Ophiostoma* spp.)

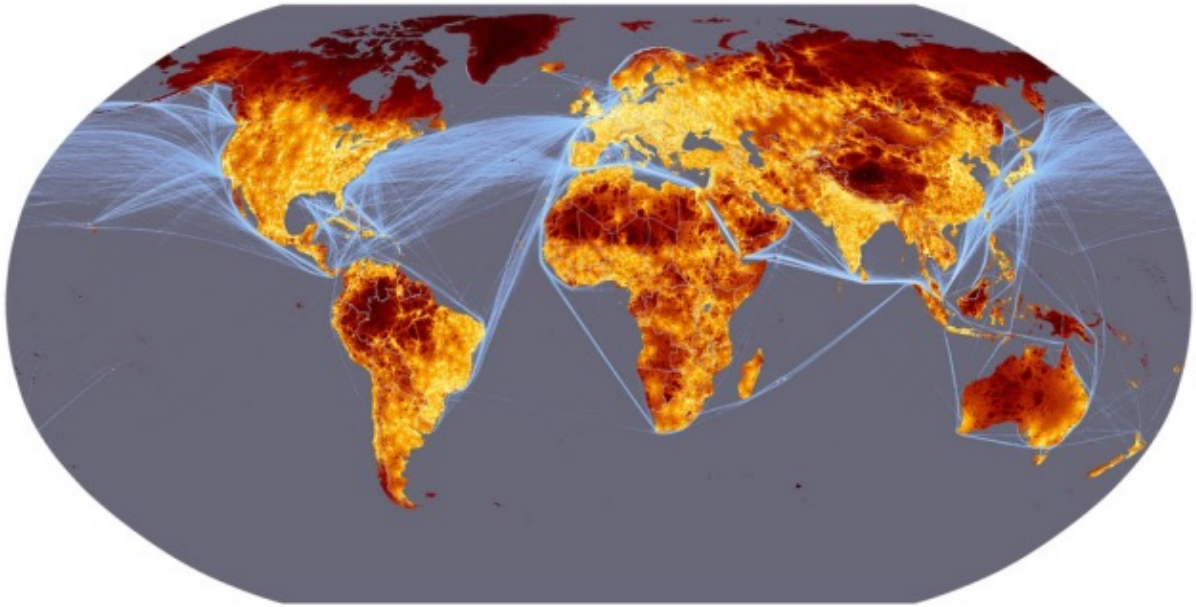
Scientific researches, incl. meetings (*Lumantria dispar, Cameraria ohridella, Lecanosticta acicola*?)

Transport: trucks, cars, railways, military invasions (*Ophiostoma ulmi, O. novo-ulmi*?)





Global Pest Movement with Trade



Economic and environmental impacts of forest pest invasions

Billions and billions of ….
€, £, ¥, $, ₹…



Ecological effects – "immense, insidious and usually irreversible"
(International Union for Conservation of Nature - IUCN 2000)

All of recent analyses indicate that most forest insect pests and diseases have arrived through one of two pathways: wood products and packaging, and live plant imports.

Trade of live plants around the world

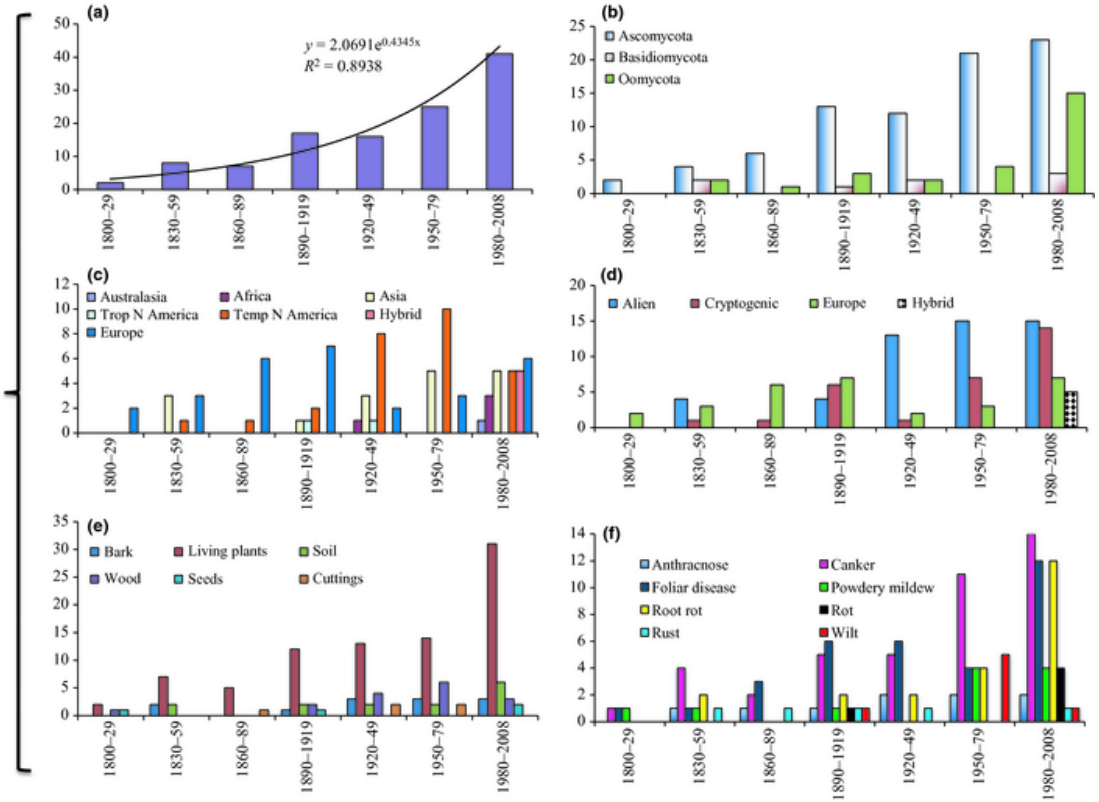
Live plants are the major pathway of introduction. In particular woody plants for outdoor use pose high risk





Forest pathogen species are expanding their geographical ranges through international trade at a rate that most pest specialists and ecologists find alarming.

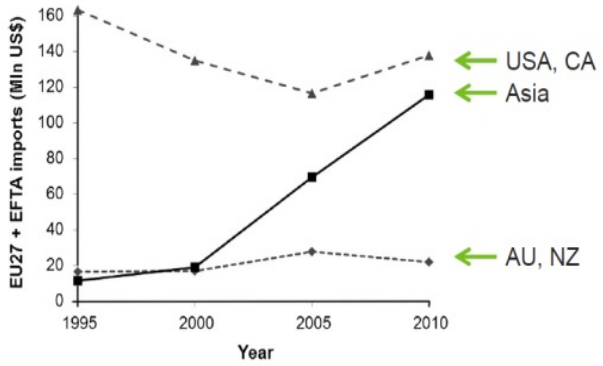
Long-term trend of invasive forest pathogens in Europe



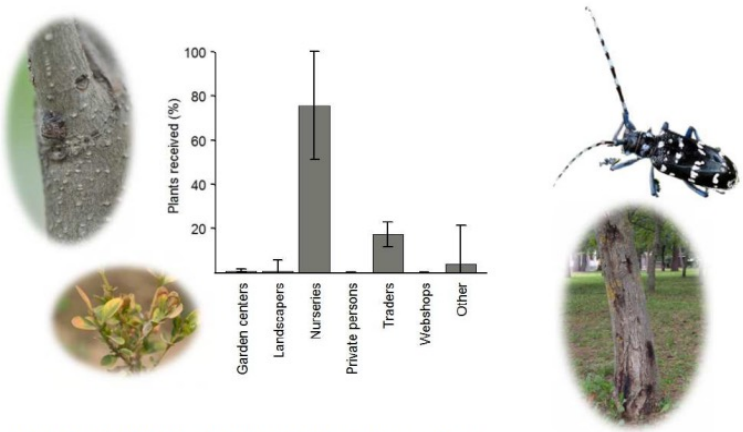
from: Santini et al. (2013)
New Phytologist

Pattern in further distribution unknown

Global trade in plants for planting is dynamic



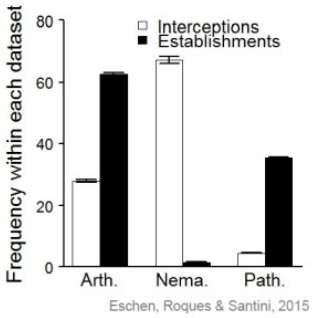
- Import from new sources may coincide with a heightened risk of importing harmful organisms



Shipped plants also vector for other pests



Most recently established harmful organisms were unknown and therefore not regulated

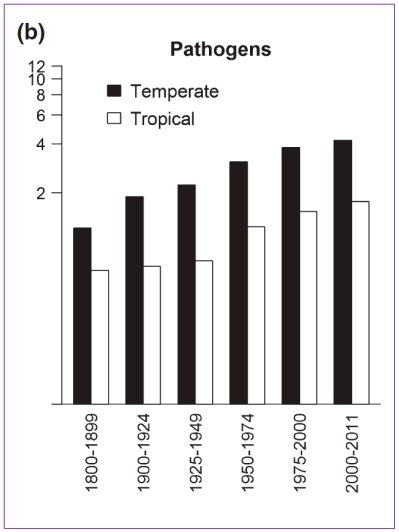


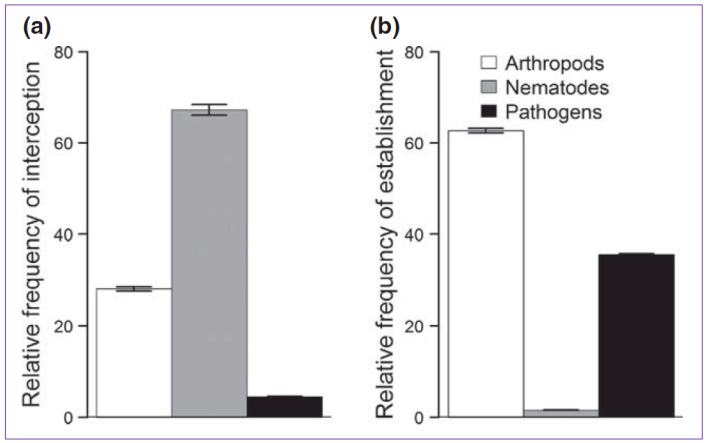
Eschen, Roques & Santini, 2015



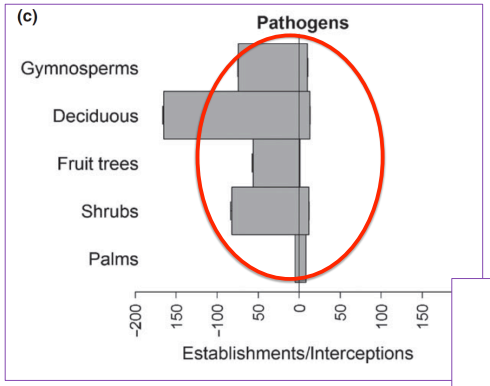
Taxonomic dissimilarity in patterns of interception and establishment of alien pathogens affecting woody plants in Europe Eschen et al. Diversity and Distributions, (2015) 21, 36–45

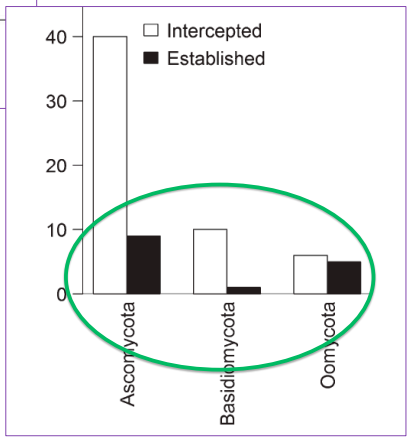
Establishment data were extracted from the DAISIE and FORTHREATS databases (**44 for pathogens, including 35 True fungi and 6 Oomycota**)
Interception records (1995–2010) were obtained from the European and Mediterranean Plant Protection Organization.





(a) The frequency of establishments (1800–2011) and (b) interceptions of arthropods, nematodes and pathogens (1995–2010) in the EU.





Invasive Species on Forest Trees in Europe

Santini et al (2103) processed analyses based on detailed database of IFPs in Europe, included **123 species of alien diseases** as a result of FP6 project Forthreats.

Invasive pathogens since 1800 were classified as **aliens (42%)**, species of **European origin (28%), cryptogenic species (26%)**, and **hybrids (4%).**

Trade and airborne were the most common putative pathways of arrival and diffusion.

At present, **70% of the species are established in Europe**, while **9% are spreading** and **19% have been recently recorded for the first time**. Only **1%** of them have been eradicated through sanitary measures (Gibberella *circinata* in Italy) or replaced by more aggressive species (*Ophiostoma ulmi* replaced by *O. novo-ulmi*).



New Phytologist — Research

Biogeographical patterns and determinants of invasion by forest pathogens in Europe

A. Santini[1], L. Ghelardini[1], C.De Pace[2], M. L. Desprez-Loustau[3], P. Capretti[4], A. Chandelier[5], T. Cech[6], D. Chira[7], S. Diamandis[8], T. Gaitniekis[9], J. Hantula[10], O. Holdenrieder[11], L. Jankovsky[12], T. Jung[13], D. Jurc[14], T. Kirisits[15], A. Kunca[16], V. Lygis[17], M. Malecka[18], B. Marcais[19], S. Schmitz[5], J. Schumacher[20], H. Solheim[21], A. Solla[22], I. Szabo[23], P. Tsopelas[24], A. Vannini[25], A. M. Vettraino[25], J. Webber[26], S. Woodward[27] and J. Stenlid[28]

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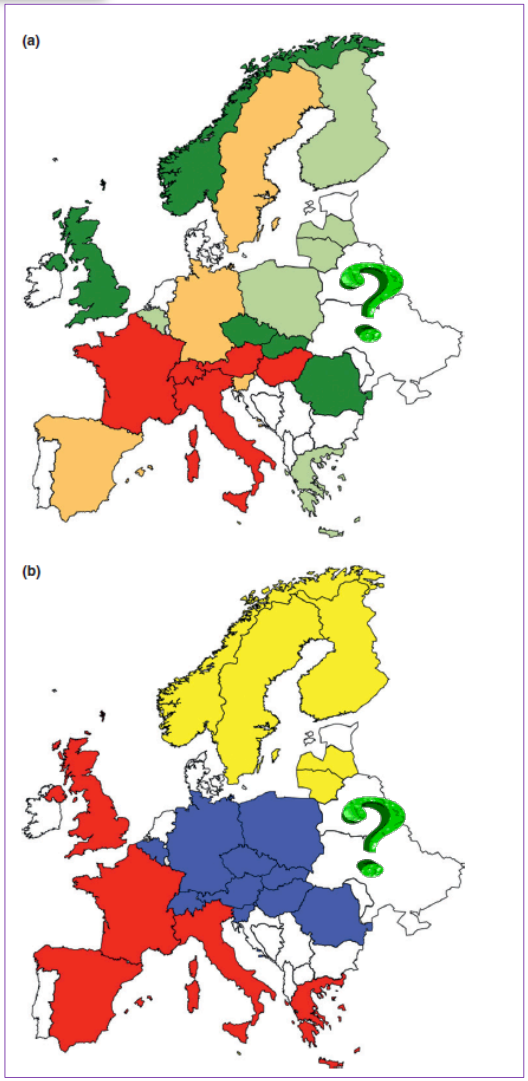
Key words: alien species, analysis of invasive species variance (ANISVA), biogeographical pattern of invasion, determinants of invasion, emerging infectious disease (EID), invasibility, invasive forest pathogens (IFPs), invasiveness

Summary

- A large database of invasive forest pathogens (IFPs) was developed to investigate the patterns and determinants of invasion in Europe.
- Detailed taxonomic and biological information on the invasive species was combined with country-specific data on land use, climate, and the time since invasion to identify the determinants of invasiveness, and to differentiate the class of environments which share territorial and climate features associated with a susceptibility to invasion.
- IFPs increased exponentially in the last four decades. Until 1919, IFPs already present moved across Europe. Then, new IFPs were introduced mainly from North America, and recently from Asia. Hybrid pathogens also appeared. Countries with a wider range of environments, higher human impact or international trade hosted more IFPs. Rainfall influenced the diffusion rates. Environmental conditions of the new and original ranges and systematic and ecological attributes affected invasiveness.
- Further spread of established IFPs is expected in countries that have experienced commercial isolation in the recent past. Densely populated countries with high environmental diversity may be the weakest links in attempts to prevent new arrivals. Tight coordination of actions against new arrivals is needed. Eradication seems impossible, and prevention seems the only reliable measure, although this will be difficult in the face of global mobility.

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Invasive Species on Forest Trees in Europe



Since 1800, **> 40 of invasive diseases** on forest species were found in the countries of central-sourthen region of Europe (Italy, France, Switzerland, Austria, Hungary)

31-40 invasive diseases were recorded in Spain, Germany, Slovenia, Sweden, Romania, Slovakia, CZ

21-30 invasive diseases were recorded in UK, Norway

< 29 species were found in Latvia, Lithuania, Poland, Belgium, Greece (Santini et al. 2013)

Social-economical Impact of Alien Invasions on woody plants

- Dieback of trees and economical lose of timber production (Ash dieback, Dothistroma needle blight on Pines, *Sphaeropsis sapinea* on Pines, Pitch cancer on Pines, Pine Wood Nematode....)
- Damage of environment (Ash dieback, Pine Wood Nematode, Pitch cancer, Chestnut blight...)
- Impact to urban plantations, including safety risks (Ash dieback, *Ceratocystis platani* on planes, *Massaria platani*...)
- Lost of production in nurseries (DNB, powdery mildews...)
- Deficiency of some tree products as some kind of timber (Ash dieback and ashes, Dutch elm diseases and elms), tannin (Chestnut blight ....), fruits (Chestnut blight , Thousand Cancer Disease on Walnuts), vanishing of some crafts
- Injury of landscape due to changes in forest composition, resp. Absence of some tree species

Climate change and forest diseases

It is probably safe to say that there is a high level of uncertainty about how to profile fungal tree pathogens into a 'climate-changed future' because

1) generally less is known about their occurrence, incidence, and impact compared with other disturbance agents such as fire and insects and
2) many have complicated life cycles (e.g., rusts with four types of spores), exhibit pleomorphy (Tubby and Webber, 2010),
3) or little is known about their life history and epidemiology.

Whether climate '**alone'** causes tree mortality is difficult to evaluate, yet the number of reports of forest dieback, decline and mortality attributed to climatic drivers **is increasing**.

Climate change is likely to have a deep impact on plant–pathogen interactions, and it will probably represent one of the biggest challenge for the ecological and functional stability of the forests in the coming years.

We cant really predict behaving of invasive and native pathogens in the future!

Sturrock R.N. Forest Systems 2012 21(2), 329-336

Climate change and invasive forest diseases

Invasive pathogens directly affected by climate	
Dothistroma needle blight ~ *Dothistroma septosporum* & *D. pini*	It is expected to continue or increase wherever it currently occurs and where springs &/or summers become warmer and moister and suitable host species are present. Disease intensity may decrease if summer rainfall decreases.
Chestnut blight ~ *Cryphonectria parasitica*	Warmer temperatures in Europe may enhance 1) exchange of dsRNA (cause of hypovirulence in this fungus) and 2) activity of chestnut endophytes antagonistic to *C. parasitica* and therefore may contribute to decrease in disease. Epidemic of chestnut blight expected to continue in North America to extent that suitable host is available and temperatures not lethal to *C. parasitica*.
Phytophthora root rot ~ *Phytophthora cinnamomi*	Increased incidence and/or range expansion of *P. cinnamomi* and other Phytophthora spp. causing root rots is expected in temperate world forests where seasonal temperatures and precipitation increase whereas a reduction is predicted across the tropics and subtropics.
Pathogens indirectly affected by climate	
Armillaria root disease ~ *Armillaria ostoyae*	Incidence of root disease and butt rot caused by *A. ostoyae* is likely to increase as temperatures increase and precipitation decreases, resulting in increased direct and indirect tree mortality and larger impacts on tree growth.
Cytospora canker ~ *Valsa melanodiscus*	Projected increases in temperature where the disease currently occurs will likely cause it to continue and increase in severity.

Sturrock R.N. Forest Systems 2012 21(2), 329-336

Invasive Species - Role of International organizations and databases

- **Center for invasive species and ecosystem health** (www.invasive.org)
- **IUCN - Global Invasive Species Database** (www.issg.org)
- **European and Mediterranean Plant Protection Organisation** – EPPO (www.eppo.org)
- **North American Plant Protection Organization** (www.nappo.org).
- **Biological Invasion Centre** (www.zin.ru)
- **NEOBIOTA** (http://www2.tu-berlin.de/~neobiota/), Technical University Berlin
- **European Strategy on Invasive Alien Species** (Genovesiet Shine 2003) http://www.coe.int/t/e/Cultural_Co-operation/Environment/Nature_and_biological diversity/Nature_protection/sc23_tpvs07erev.pdf?L=E)
- **National lists of invasive species**: eg. Lithuania(http://www.ku.lt/lisd/), Poland(http://www.iop.krakow.pl/ias/).

Most databaces of invasive species include animals and plants; mushrooms, diseases and pests of plants are included exceptionally

Invasive Species - Role of International organizations and databases

European and Mediterranean Plant Protection Organization (EPPO)

European Food Safety Authority (EFSA)

Food and Agriculture Organization of the United Nations

Core values and authority of these organizations

- Scientific excellence
- Independence
- Openness
- Transparency
- Responsiveness
- Produce Pest Risk Assessment (PRA) for the EU territory
- Develop harmonised PRA methodology (Guidance)
- Evaluate supporting documents

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Delivering Alien Invasive Species Inventories for Europe



» **Threskiornis aethiopicus**
one of the 100 worst alien species in Europe, click **here** to see the full list.

Delivering Alien Invasive Species Inventories for Europe

Biological invasions by non-native or 'alien' species are one of the greatest threats to the ecological and economic well-being of the planet. Alien species can act as vectors for new diseases, alter ecosystem processes, change biodiversity, disrupt cultural landscapes, reduce the value of land and water for human activities and cause other socio-economic consequences for man.

To help those tackling the invasive species challenge, this website provides a 'one-stop-shop' for information on biological invasions in Europe. Please note that the DAISIE database behind this website is continually being updated. Read more about DAISIE.

DAISIE Handbook of alien species in Europe available



Search Species

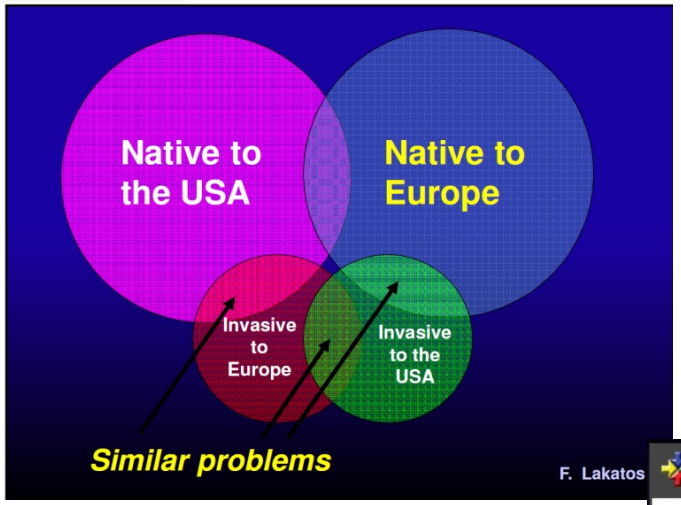


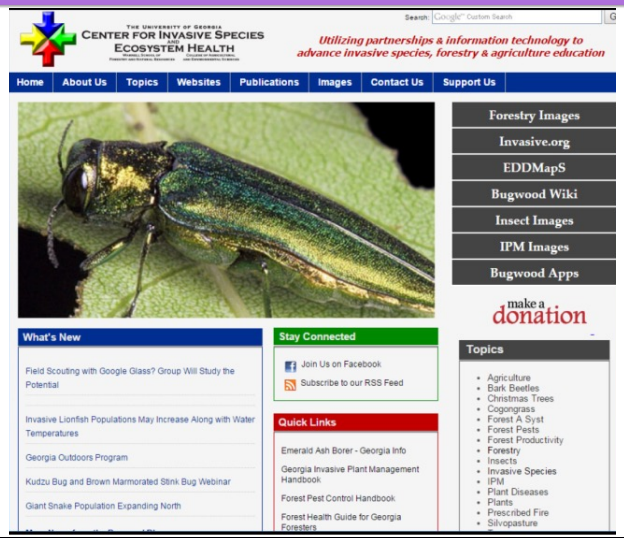
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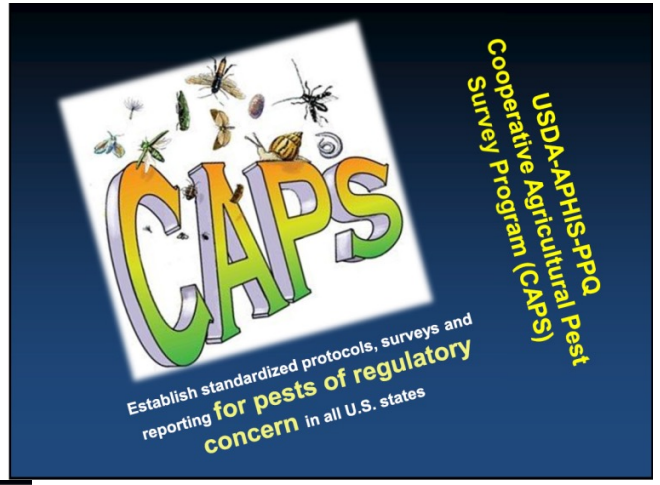


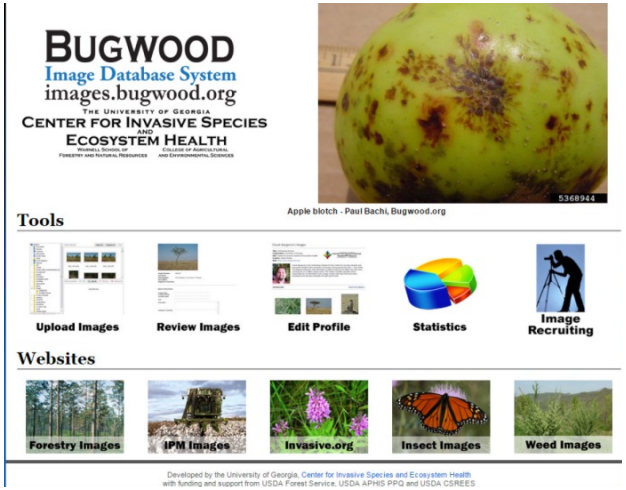
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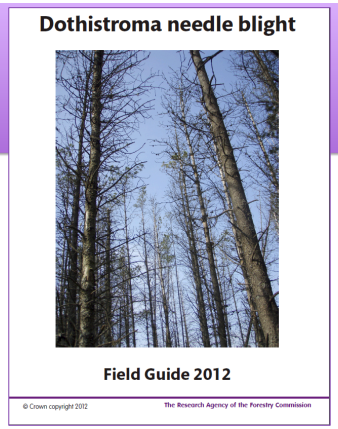

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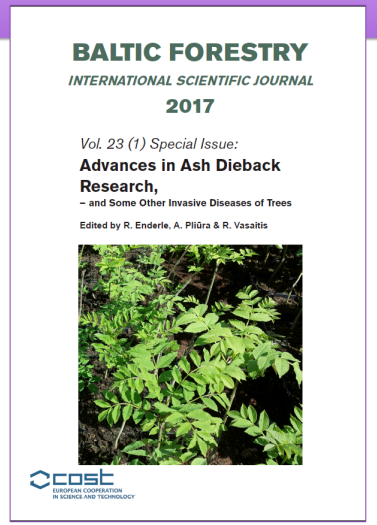

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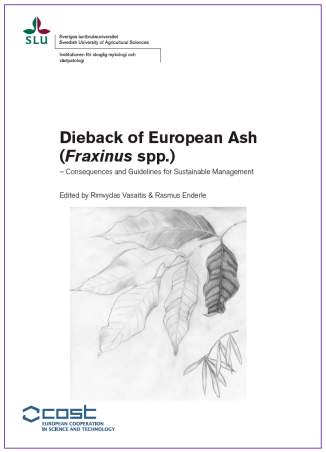

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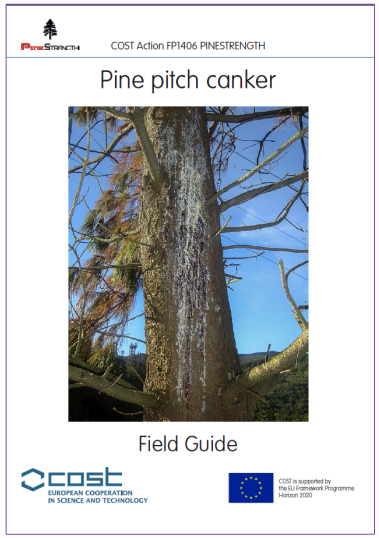
Contribution of Scientists

- Forthreats, project of FP6, output Santini (2013), 2006-2007
- **FPS COST Action FP1102** Determining Invasiveness And Risk Of Dothistroma (DIAROD)- http://www.forestry.gov.uk/fr/diarod
- **FPS COST Action FP1103** Fraxinus dieback in Europe: elaborating guidelines and strategies for sustainable management (FRAXBACK) http://www.fraxback.eu
- **FPS COST Action FP1401** A global network of nurseries as early warning system against alien tree pests (Global Warning) | 02 December 2014 - 01 December 2018 http://www.ibles.pl/en/web/cost/globalwarning
- **FPS COST Action FP1406** Pine pitch canker - strategies for management of Gibberella circinata in greenhouses and forests (PINESTRENGTH) http://www.pinestrength.eu/
- H2020 program EMPHASIS
- National research projects **MANY**

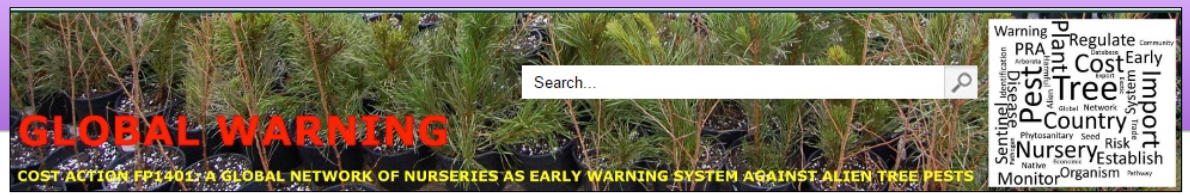












6
Damage to leaves of broadleaf woody plants

N. Kirichenko, S. Augustin, E. Barham, T. Cech, R. Drenkhan, C. Morales-Rodríguez, I. Matsiakh, A. Roques, V. Talgø, A.M. Vettraino and J. Witzell

6.1. Skeletonisation

Description: Soft leaf tissue eaten, leaving leaf veins intact. Sometimes the lower or upper epidermis remains untouched (if feeding is on the upper side of the leaf in the first case and is on the lower side of the leaf in the second).

Possible damaging agents: Insects: Larvae and adults of some Coleoptera (Fig. 6.1.1). Larvae of some Hymenoptera (Figs. 6.1.2 – 6.1.4) and Lepidoptera (Fig. 6.1.5).

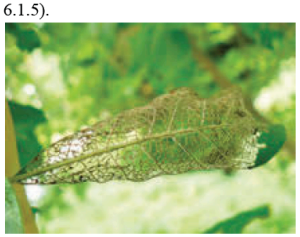


Fig. 6.1.1. Leaf of pussy willow (*Salix caprea*) skeletonised by larvae of a leaf beetle (Coleoptera, Chrysomelidae: *Phratora* sp.). Novosibirsk, Russia, NK.



Fig. 6.1.2. Leaf of pedunculate oak (*Quercus robur*) partially skeletonised on lower side by sawfly larvae (Hymenoptera, Tenthredinidae). Sentinel tree plantations, Fuyang, China, AR.

11
Damage to foliage of coniferous woody plants

I. Matsiakh, D.N. Avtzis, K. Adamson, S. Augustin, R.C. Beram, T. Cech, R. Drenkhan, N. Kirichenko, G. Maresi, C. Morales-Rodríguez, L. Poljaković-Pajnik, A. Roques, V. Talgø, A.M. Vettraino and J. Witzell

11.1. Needle nibbling

Description: Needles are laterally and irregularly nibbled, all layers being consumed in the damaged parts.

Possible damaging agents: Insects: Adults of Coleoptera (Figs. 11.1.1 – 11.1.4), larvae of Hymenoptera (sawflies) and Lepidoptera.



Fig. 11.1.1. Needle of black pine (*Pinus nigra*) damaged by weevils (Coleoptera, Curculionidae: *Pachyrhinus mustela*). Viskyar Mt., Bulgaria, DD.



Fig. 11.1.2. Needle of creeping pine (*Pinus mugo*) with weevil feeding damage (Coleoptera, Curculionidae: *Otiorrhynchus parreyssi*). Rila Mt., Bulgaria, DD.



Field Guide for the Identification of Damage on Woody Sentinel Plants

Edited by Alain Roques, Michelle Cleary, Iryna Matsiakh and René Eschen





One world, many pests and pathogens!

Potential, emerging or establishing diseases problems in Europe

Examples of Invasions

	Hosts	Asia	Europe	North America
Cronartium ribicolaq **White pine blister rust**	*Pinus (5 needle)/ Ribes*		1854 *(P. strobus)* →	→ 1898/1910 (1909)
Ophiostoma ulmi **Duthch elm disease**	*Ulmus spp.*	→	→ 1916 → (1958) 1960-1963 ← *(Ophiostoma novo - ulmi)*	→ 1930/1944 ←
Cryphonectria parasitica **Chestnut blight**	*Castanea spp.. (Quercus spp.)*	→	→ 1938 ←	→ 1900 (?) 1934 (Oregon) ←
Phytophthora cambivora ***Ink disease***	*Castanea sativa. C.. dentata*	? →	→ 1860 ←	← ?
Miscrosphaera alphitoides **Powdery mildew**	*Quercus spp..*	1930 ←	← 1877/1907 (?)	
Trichoscyphella willkommii **Larch Cancer**	*Larix spp..*		→	→ 1927
Hymenoscyphus fraxineus ***Ash dieback***	*Fraxinus spp.*		90`s	



Important Alien Diseases of Woody Plants in Europe

Oak mildew (*Erisyphe flexuosa*)	Oak (*Quercus* spp.), Horse chestnut (*A. hippocastanum*)
Plane mildew (*Erisyphe platani*)	Plane (*Platanus hybrida*)
Cricket bat willow disease (*Brenneria salicis*)	Willow (*Salix* spp.)
Dutch elm disease (*Ophistoma ulmi* and *O. novo-ulmi*)	Elm (*Ulmus* spp.)
Rhabdocline needle cast (*Rhabdocline pseudotsugae*)	Douglas fir (*Pseudotsuga menziesii*)
Swiss needle cast (*Phaeocryptopus gaeumannii*)	Douglas fir (*P. menziesii*)
Dothistroma needle blight (*Dothistroma septosporum* and *D. pini*) Brown spot needle blight (*Lecanosticta asicola*) Pitch canker (*Gibberella circinata)*	Pine (*Pinus* spp.)
Coryneum canker (*Seiridium cardinale*)	Cypress (*Cupressus* spp.)
Box blight (*Cylindrocladium buxicola*)	Box tree (*Buxus* spp.)
Ash dieback (*Hymenoscyphus fraxineus*)	Ash (*Fraxinus excelsior*)
Chestnut blight (*Cryphonectria parasitica*) and ink disease (*Phytophthora cambivora and Phytophthora cryptogea)*	Sweet chestnut (*Castanea sativa*)
Juniper Phomopsis canker (*Phomopsis juniperovora*)	Juniper (*Juniperus* spp.)
Sirococus tsugae	Cedar (*Cedrus atlantica*)



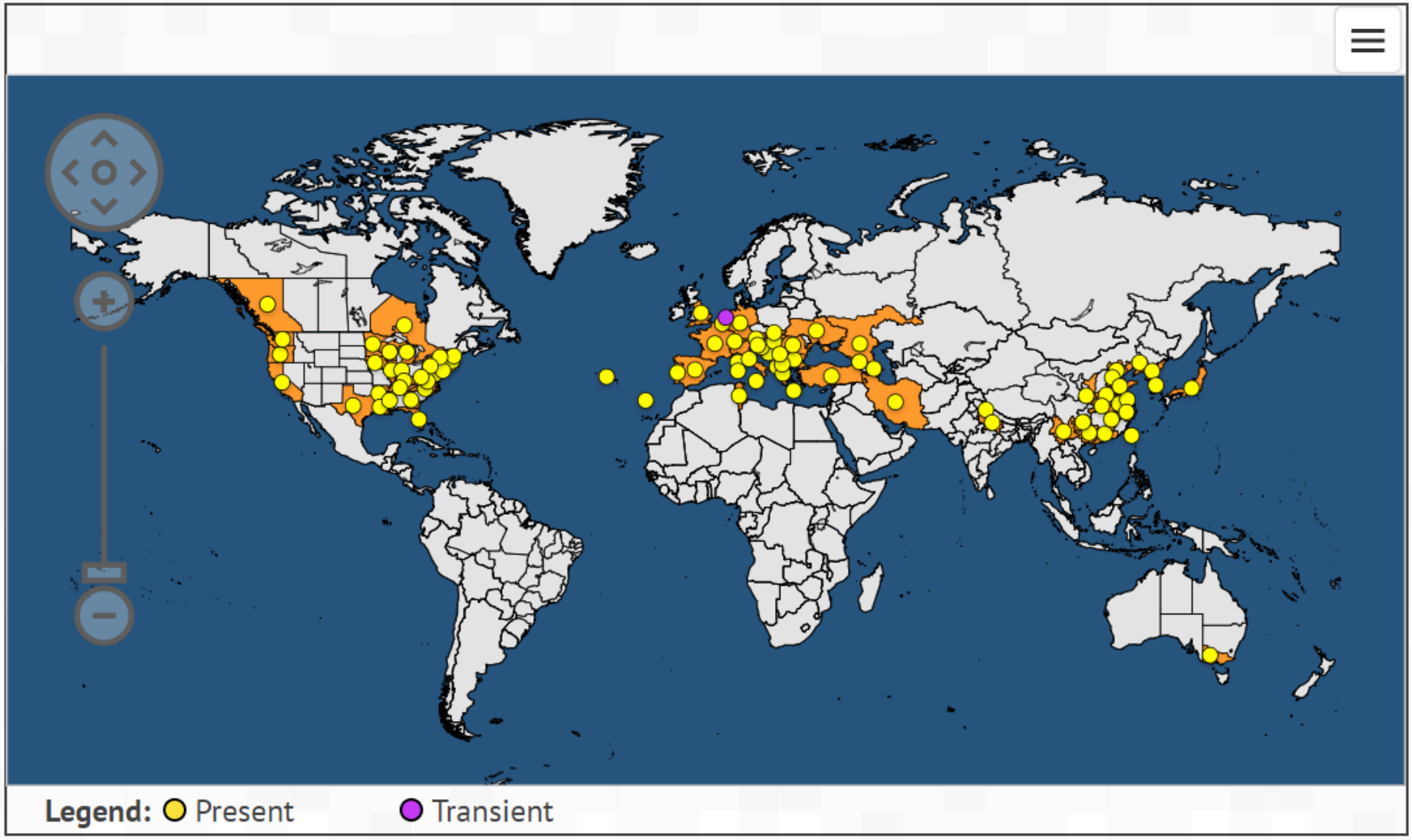
Important Alien Diseases of Woody Plants in Europe

Canker stain of plane (*Ceratocystis platani*)	Plane trees (*Platanus* spp.)
Plane mildew (*Erisyphe platani*)	Plane (*Platanus hybrida*)
Root rot (*Heterobasidion irregulare*)	Pine (*Pinus* spp.), *Calocedrus decurrens, Juniperus virginiana*
Sudden oak death (*Phytophthora ramorum*)	*Abies alba, Abies grandis, Acer pseudoplatanus, Aesculus hippocastanum, Betula pubescans, Castanea sativa, Cinnamomum camphora, Fagus sylvatica, Nothofagus obliqua, Quercus acuta, Quercus cerris, Quercus falcata, Quercus petraea, Schima argentia, Quercus robur, Pseudotsuga mensiesii, Larix* spp.
Holly blight (*Phytophthora ilicis*)	Holly (*Ilex aquifolium*)
Phytophthora quercina	Native oaks (*Quercus* spp.)
Phytophthora kernoviae	Beech (*Fagus sylvatica*), bilberry (*Vaccinium* spp.)
Phytophthora pseudosyringae	Beech (*Fagus sylvatica*), hornbeam (*Carpinus betulus*), bilberry (*Vaccinium* spp.), *Nothofagus* spp.
Phytophthora lateralis	Lawson cypress (*Chamaecyparis lawsoniana*), *Juniperus communis, Thuja occidentales*
Phytophthora austrocedri	Juniper (*Juniperus communis*)
Phytophthora cinnamomi	300 host plant species
Phytophthora alni and *Phytophthora siskiyouensis*	Alder (*Alnus* spp.)

More about *Phytophthora* in next presentation

Distribution

Last updated: 2018-06-11



Ash dieback *Hymenoscyphus fraxineus* (*Chalara fraxinea*)

Within the nearly 20 years since damage was first reported in Lithuania and Poland, the pathogen has spread throughout most of western and eastern Europe where native *Fraxinus* spp. are growing including **Ukraine (Matsiakh *et al.* 2016, 2017)**.















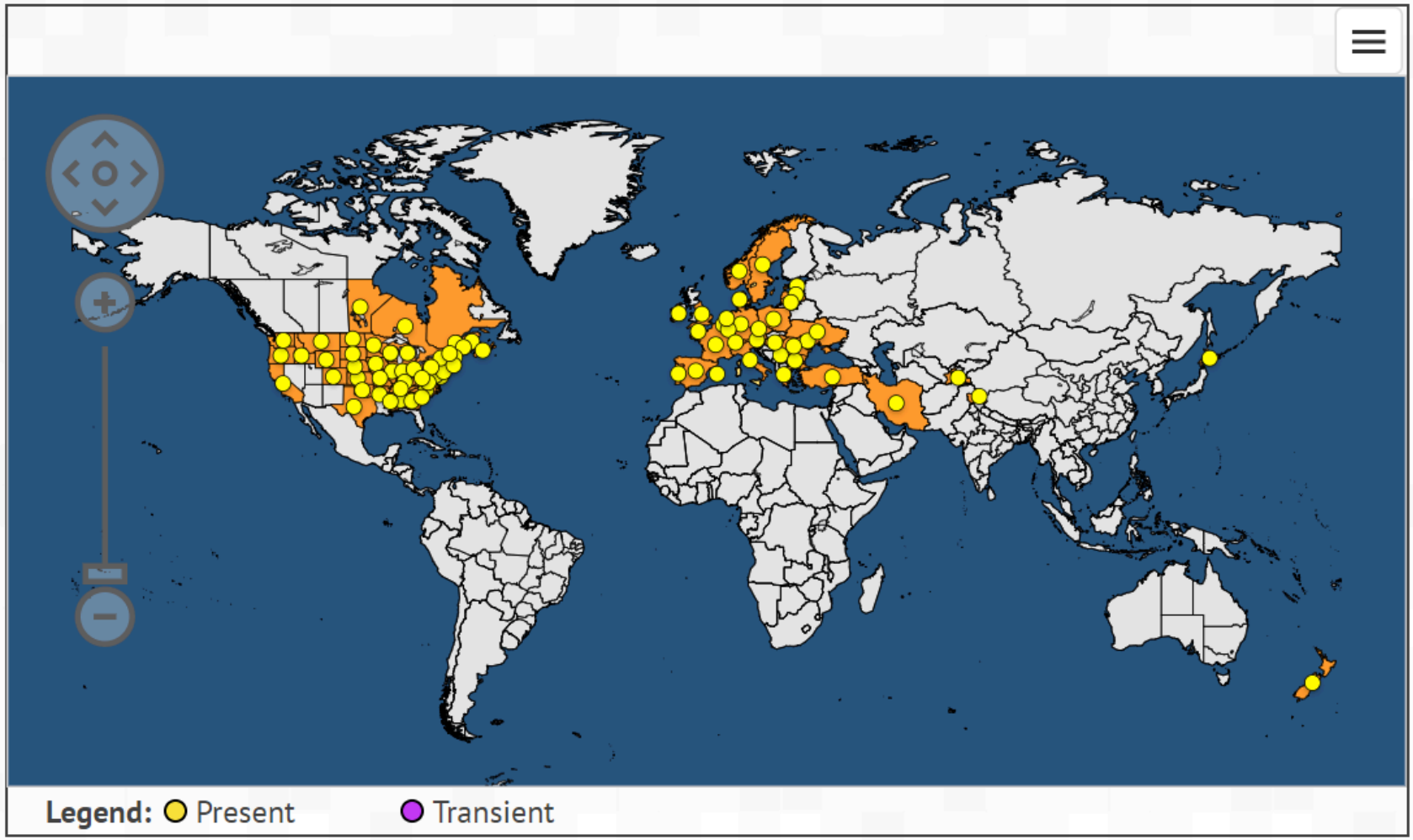


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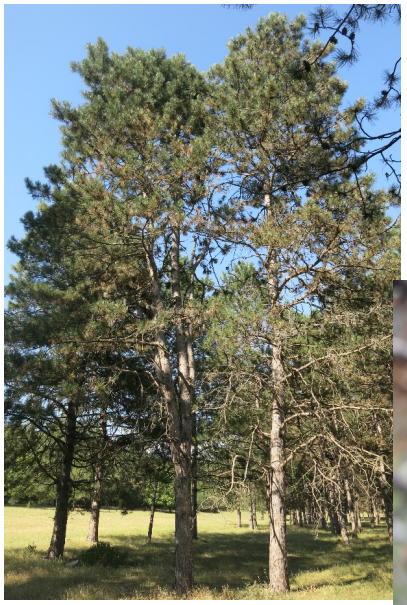
Distribution

Last updated: 2013-07-19





Dothistroma needle blight (DNB) - red band disease
Dothistroma pini







D. pini is currently known on two continents in 13 countries with a host range including 12 *Pinus* species (Drenkhan et al., 2016).
Other conifers reported as susceptible are five spruce species, including Sitka spruce (*Picea sitchensis*) and Norway spruce (*Picea abies*), European larch (*Larix decidua*) and Douglas fir (*Pseudotsuga menziesii*). However, they are all thought to be of low susceptibility, only becoming infected under high inoculum pressure.

Matsiakh et al. 2018. *Dothistroma* spp. in western Ukraine and Georgia. Forest Pathology, 2018;e12409. https://doi.org/10.1111/efp.12409



Two new hosts for *Dothistroma* spp. were recorded in western Ukraine: *D. septosporum* on *Pinus nigra* var. *australica* and *D. pini* on *P. nigra* var. *mollet*. *D. septosporum* was found on 15-year-old *P. strobus* trees. **New hosts for *D. septosporum* were recorded in Georgia** on 5-to 10-year-old naturally regenerated *P. sylvestris* var. *hamata* and on 40-to 50-year- old *P. ponderosa* trees. *D. pini* was found for the first time in Georgia on 30-to 40-year- old *P. nigra* trees.



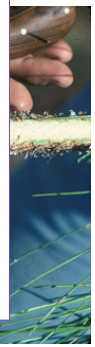
Pitch canker *Gibberella circinata (Fusarium circinatum)*

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УДК 632.4:632.7

ФИТОПАТОГЕННЫЙ ГРИБ *FUSARIUM CIRCINATUM* И ВОЗМОЖНОСТИ ЕГО РАСПРОСТРАНЕНИЯ НАСЕКОМЫМИ В РОССИИ

© 2018 Селиховкин А.В.[a, b, *], Марковская С.[c, **], Васайтис Р.[d, ***], Мартынов А.Н.[a, ****], Мусолин Д.Л.[a, *****]

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Поступила в редакцию 15.10.2017

Появление в Европе возбудителя язвенного рака сосны – аскомицета *Fusarium circinatum* Nirenberg & O'Donnell (телеоморфа *Gibberella circinata*) – тревожный сигнал для России. В кратком обзоре проанализированы биология *F. circinatum* и векторы его распространения. Воротами инфекции для этого фитопатогена являются открытые раны на коре стволов и ветвей, куда фузариум попадает с капельной влагой или по воздуху. Заражение сопровождается образованием обширных язв, интенсивным смолоотделением и отмиранием кроны. В России этот патоген может появиться и распространиться на побережье Чёрного моря (с наибольшей вероятностью юго-восточнее Краснодара) в питомниках и посадках сосны. Однако в настоящее время не ясно, в полной ли мере подойдут климатические условия этого региона для *F. circinatum* и насколько патоген окажется конкурентоспособным в новой для него обстановке. Связанные с соснами насекомые являются важным фактором распространения *F. circinatum*, поскольку могут быть как непосредственными переносчиками пропагул гриба (то есть векторами распространения возбудителя), так и наносить на побеги, ветви и стволы сосен повреждения, которые становятся воротами инфекции. Закончив развитие на заражённом *F. circinatum* дереве, взрослое насекомое перелетает на другое, возможно, здоровое дерево, перенося на своих покровах и оставляя на новом дереве прилипшие споры гриба. В обзоре рассматриваются насекомые, повреждающие сосны рода *Pinus*, и обсуждается их роль в распространении *F. circinatum*. Показано, что в России обитает немало видов насекомых, потенциально способных обеспечить быстрое распространение язвенного рака сосны, если *F. circinatum* появится на территории страны.

Ключевые слова: инвазии, насекомые, патоген, сосна, фузариум, язвенный рак сосны, *Fusarium circinatum*, *Gibberella circinata*.

Введение

Инвазионные фитопатогенные грибы, как правило, становятся проблемами не отдельных стран, а целых континентов. Хорошо известна ситуация с голландской болезнью вязов, пришедшей в Россию из Европы и вызываемой аскомицетами *Ophiostoma ulmi* (Buisman) Nannf. и *O. novo-ulmi* Brasier. В частности, в Санкт-Петербурге за последние 20 лет погибли или были вырублены практически все вязы, ещё недавно являвшиеся одним из красивейших элементов зелёного убранства города. Вектором распространения голландской болезни (то есть организмами, которые не только связаны с больным растением, но и способны переносить патогена от одного растения к другому и заражать его, распространяя патогена и болезнь [Brockerhoff et al., 2016]) были короеды-заболонники (Coleoptera: Curculionidae: Scolytinae): *Scolytus multistriatus*

forests

MDPI

Article

A Comparative Study of the Pathogenicity of *Fusarium circinatum* and other *Fusarium* Species in Polish Provenances of *P. sylvestris* L.

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9 Forest Research Institute, Department of Forest Protection, 05090 Sękocin Stary, Poland; t.oszako@ibles.waw.pl
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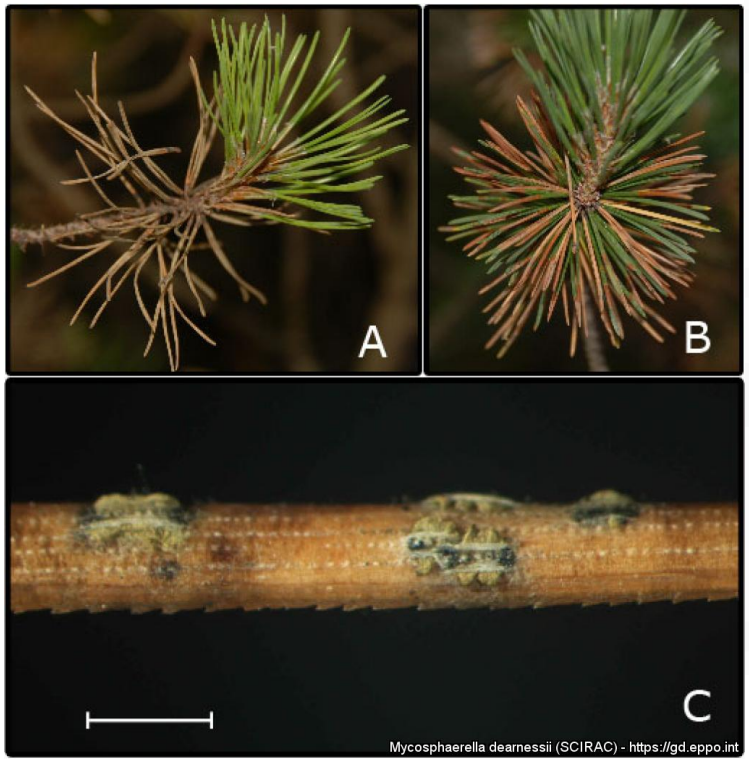
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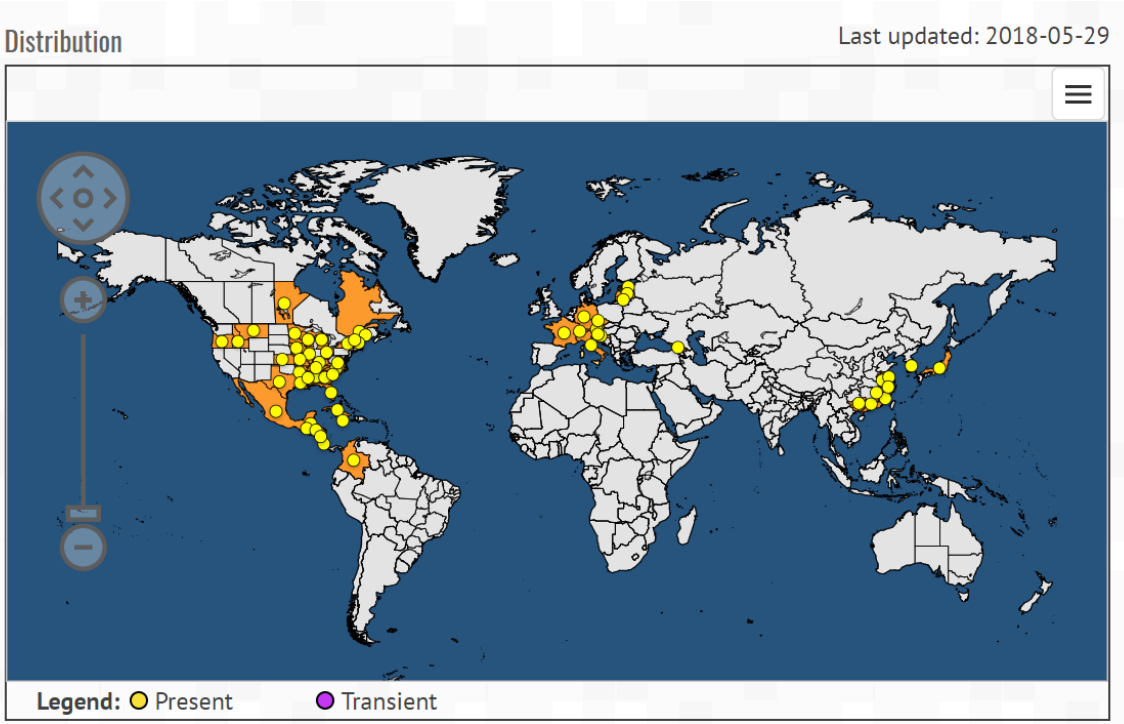
Abstract: The fungal pathogen *Fusarium circinatum* is the causal agent of Pine Pitch Canker (PPC), a disease which seriously affects different species of pine in forests and nurseries worldwide. In Europe, the fungus affects pines in northern Spain and Portugal, and it has also been detected in France and Italy. Here, we report the findings of the first trial investigating the susceptibility of Polish provenances of Scots pine, *Pinus sylvestris* L., to infection by *F. circinatum*. In a greenhouse experiment, 16 Polish provenances of Scots pine were artificially inoculated with *F. circinatum* and with six other *Fusarium* species known to infect pine seedlings in nurseries. All pines proved highly susceptible to PPC and displayed different levels of susceptibility to the other *Fusarium* spp. tested. The findings obtained indicate the potentially strong threat of establishment of an invasive pathogen such as *F. circinatum* following unintentional introduction into Poland.

Keywords: *Pinus sylvestris*; pitch canker; *Fusarium circinatum*; damping-off; disease spread

Brown spot of pine *Lecanosticta acicola*

Lecanosticta acicola is the causal agent of brown spot needle blight on pines, though mainly known from North America, has also been found spreading in Europe colonizing *Pinus mugo, P. nigra, P. ponderosa, P. rotundata, P. sylvestris, P. uncinata* (Luttrell 1949; Holdenrieder & Sieber 1995; La Porta & Capretti 2000; Diekmann et al. 2002; Jankovský et al. 2009).



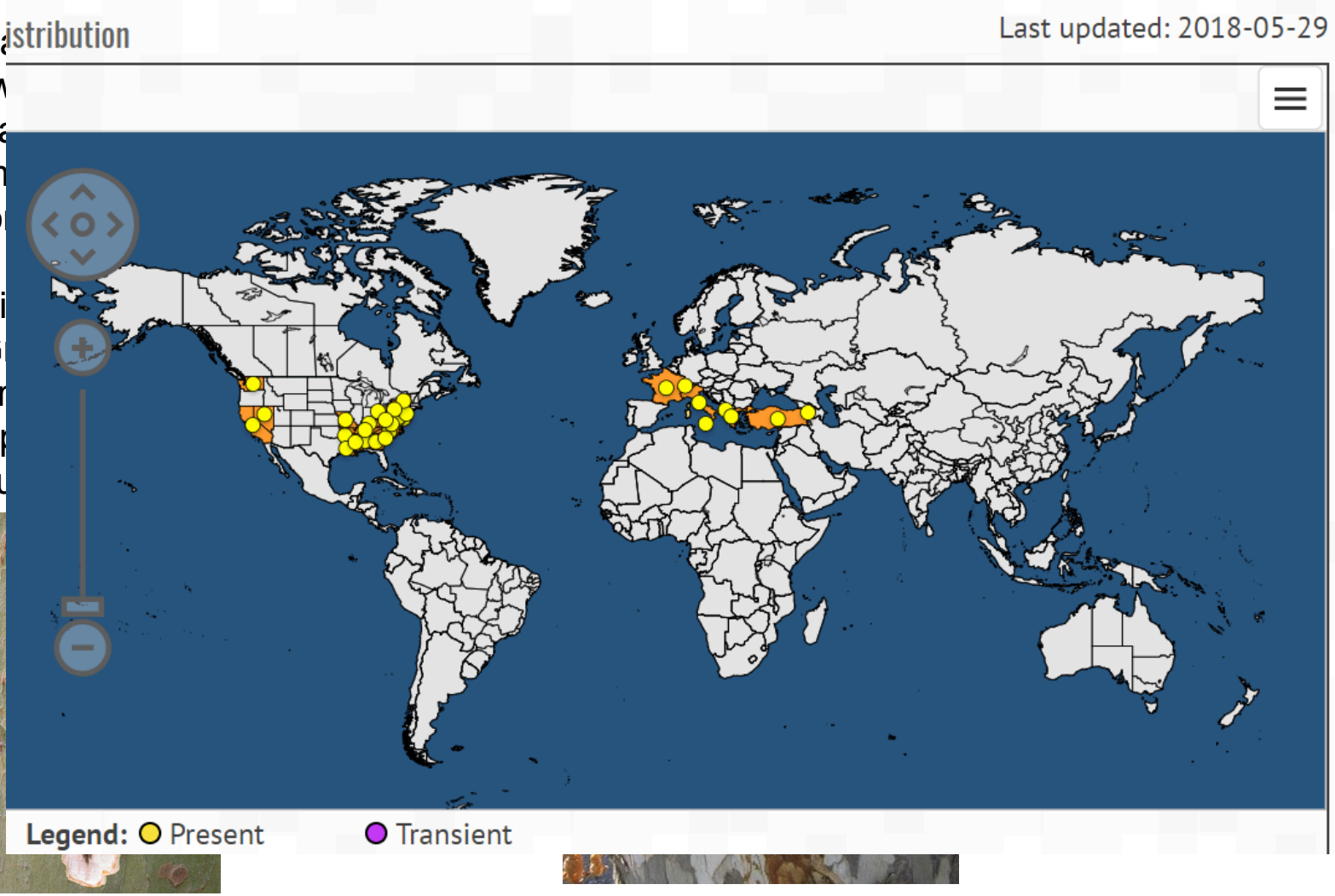


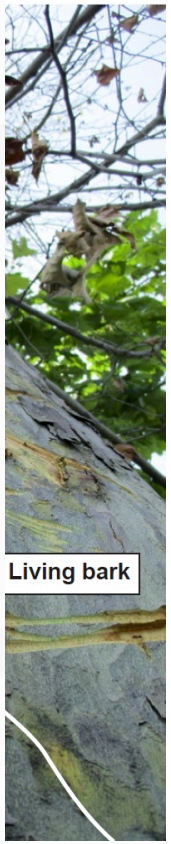
2015 – in Estonia (Adamson et al. 2015)

Canker stain of plane (*Ceratocystis platani*)

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Root and butt rots *Heterobasidion irregulare*

Heterobasidion annosum sensu lato includes 5 species:
- 3 occurring in Europe: *H. annosum* sensu stricto, *H. parviporum* and *H. abietinum*.
- 2 occurring in North America: *H. irregulare* and *H. occidentale*.

- *H. irregulare* was introduced into Lazio region in Italy, most probably during World War II by US troops via infected wood material.
- It has spread from its initial introduction site (Castelporziano) and is currently causing extensive mortality in several *Pinus pinea* stands.
- It was recently added to the EPPO Alert List because of the risk it may present to pine trees in the EPPO region.



What does this have to do with forest pathology?

A lot.

Some of invasive pests and diseases have practically eliminated the dominant native species from some of our major forest ecosystems.

At best, they have made forest management more complex and expensive.

Gaps, Needs, Hopes

• Absence of broad knowledge on potentially dangerous disease for European species woody plants in Asia, especially in China; identification od spectrum of potential invasive pathogens of woody plants

• Absence of information system on invasive species on woody plants, weak cooperation of some institutions

• Intensive survey for presence of invasive alien species of woody plants in forests, woodlands, urban greeneries, especially in vicinity of entry points

Gaps, Needs, Hopes

- Quick diagnostic tools
- Identification of risk pathways as containers, packing materials etc.
- Quick reaction in the case of findings of Invasive alien species, not only quarantine ones, which are under quarantine measures
- Enthusiasm of mycologist a plant pathologists – Cost Actions, Mycological Network, Diagnostic system of Phytosanitary Authority, Forest Protection Service etc.



What is the solution?

We need to **be much more aggressive about controlling imports (and exports!)** and insisting that items that carry invaders in international trade and travel be treated to kill pathogens. This conflicts with trade, of course, and is a very complex issue. But this is the number one solution and deserves the greatest emphasis.

We also **need to be better organized and more aggressive in finding, attacking and eradicating invaders as soon as possible after their establishment on a new continent**. In many cases, eradication will not be feasible, **but early detection and rapid response** will result in successful eradication of some.

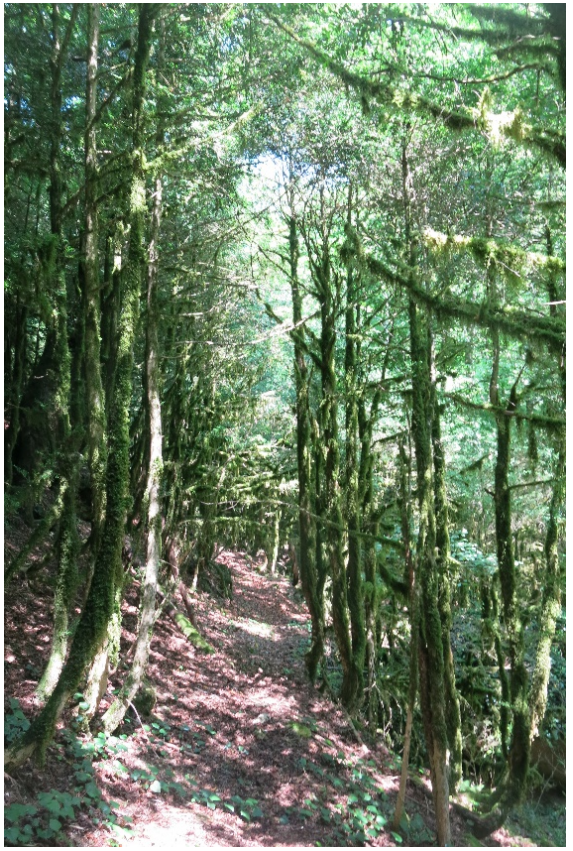
Finally, **continued action to suppress and contain established invaders is needed even when eradication is no longer feasible.** Limiting their damage and spread will save money, protect uninvaded ecosystems, and buy time, during which more effective measures may be found.

My experience with biological invasions in Georgia



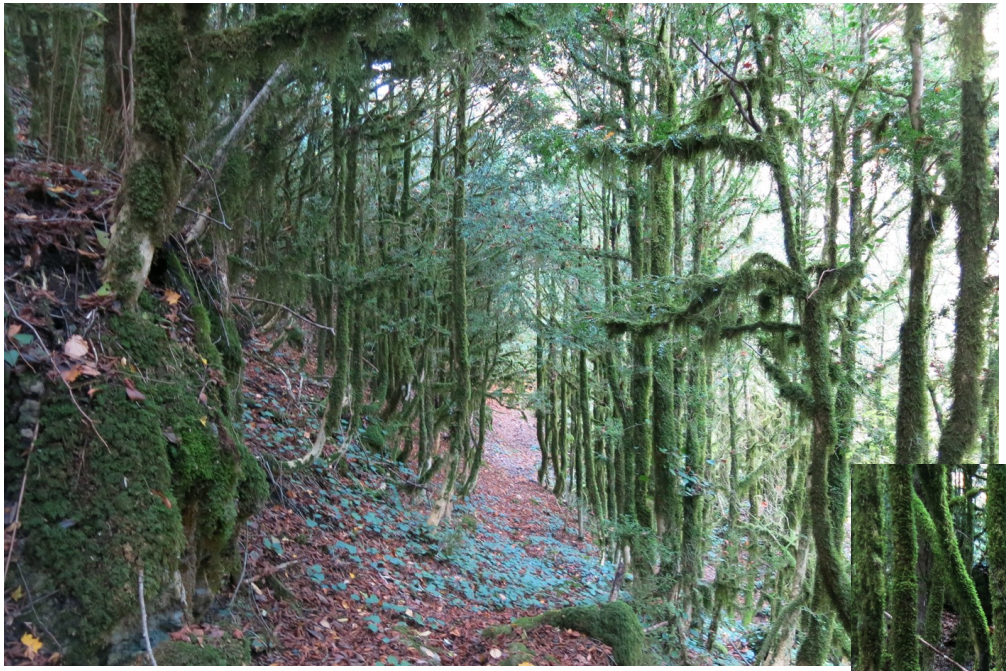
Buxus colchica forests







Racha-Lechkhumi (Lower Svaneti) Forest Service







The first signs of *B. colchica* damage were found in 2009.

In 2011, a new disease (box blight) caused by invasive species *Calonectria pseudonaviculata* (anamorph *Cylindrocladium buxicola*) was found in boxwood natural population in the protected areas in Caucasus (Gorgiladze *et. al.* 2011; Meparishvili, 2013).





Boxwood blight symptoms in Georgian boxwood forests









Box tree moth *Cydalima perspectalis*







Box tree moth *Cydalima perspectalis*



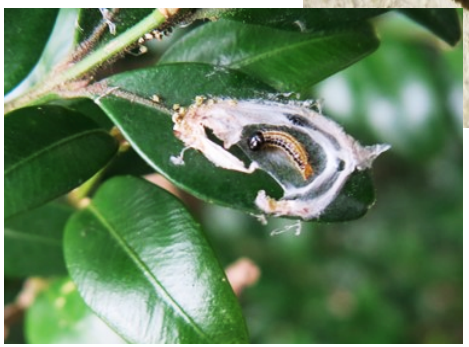












Green areas of the Zugdidi city

Zugdidi Botanical Garden











Thank you very much for attention!

