Major threats to forest ecosystems of Greece by exotic fungal pathogens

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Indigenous vs. exotic organisms

- **Indigenous pathogens usually cause little damage to natural forest ecosystems, because they have co-evolved with the trees and a natural balance has been developed.**
- **Major problems may arise if a pathogen or an insect pest is introduced into another region of the world where the native plants have little resistance.**

Introduction of exotic pathogens

- **Commercial movement of plants and plant products is a major pathway of exotic forest pathogen invasion.**

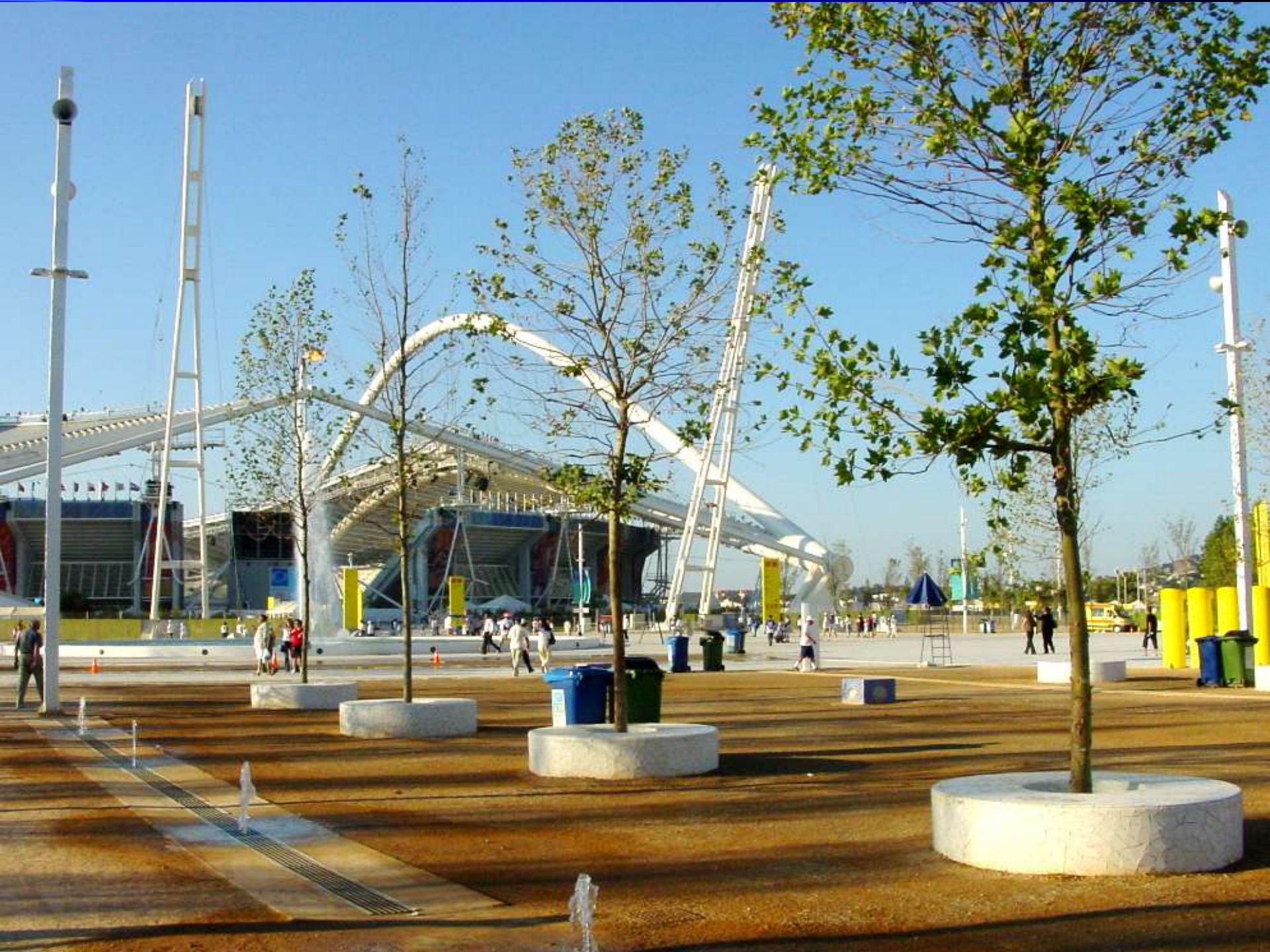
- **This includes international transportation of living plants, timber, contaminated seed etc.**

Introduction of exotic pathogens

- **Pathogens can be transferred with infected plants and also with contaminated potting media.**
- **The soil inside the pots it is not disinfected and maybe contaminated with pathogens.**
- **The problem is greater with the trade of large plants.**

  Trees 3-10 m high are transferred in huge pots, increasing the possibilities of pathogen transfer with the soil.

Plant transportation



Timber transportation

Exotic pathogens

- During the last century certain exotic fungal pathogens had serious impacts on native tree species in many forest ecosystems world-wide.

The presentation will focus on some of these pathogens that have affected forest trees in Greece.

Chestnut blight

- **The fungus *Cryphonectria parasitica* is native to East Asia.**
- **In the end of 19th century, the fungus was introduced into North America with the importation of the Japanese chestnut (*Castanea crenata*), which is resistant to this pathogen.**

Castanea crenata (Japanese chestnut)

Connecticut 1876

Chestnut blight

- **The disease was reported for first time in North America 1904.**
- **Within 50 years, chestnut blight had killed most American chestnut trees (*Castanea dentata*) within their natural range .**

A major forest tree had been reduced to a shrub.


UGA1396146

Invasion of *Cryphonectria parasitica* in Europe

- From N. America *C. parasitica* was introduced into Europe and affected native *Castanea sativa*
- It was recorded for first time in Italy in 1938.
- Chestnut blight was recorded in Greece in 1963 in natural chestnut stands of the Pelion region in central Greece.
- It is most likely that the pathogen was introduced there on chestnut timber by the Italian army during the Second World War.

Timber transportation

Chestnut blight in Greece

- **Until the early 1980's chestnut blight had been found only in natural stands of the Pelion region and the infection levels were relatively low.**
- **However, in the last two decades *Cryphonectria parasitica* was found all over Greece (even in some of the remote islands), in natural stands and chestnut plantations causing extensive tree mortality.**

Chestnut blight

Chestnut blight

Dutch elm disease

- **During the20th century, two pandemics of Dutch elm disease spread throughout three continents: North America, Europe and southwest Asia.**
- **Most of the elm trees (*Ulmus* spp.) in these regions have been destroyed.**

Pandemic #1 (*Ophiostoma ulmi*)

- **The first Dutch elm disease pandemic, caused by *Ophiostoma ulmi* (an indigenous species of East Asia), was initially observed in Europe around 1911 and was spread all over the continent and also in Asia.**
- **In the 1920's the pathogen was introduced into USA on diseased elm logs from Europe.**

Pandemic # 2 (*Ophiostoma novo-ulmi*)

- **A second pandemic started in North America and Europe in the 1940s by two novel, geographically distinct and highly virulent pathogens:**
  - **•*O. novo-ulmi* ssp. *nono-ulmi* in Europe and Asia (EAN).**
  - **•*O. novo-ulmi* ssp. *americana* in N. America (NAN), which was introduced into UK in the 1960's.**

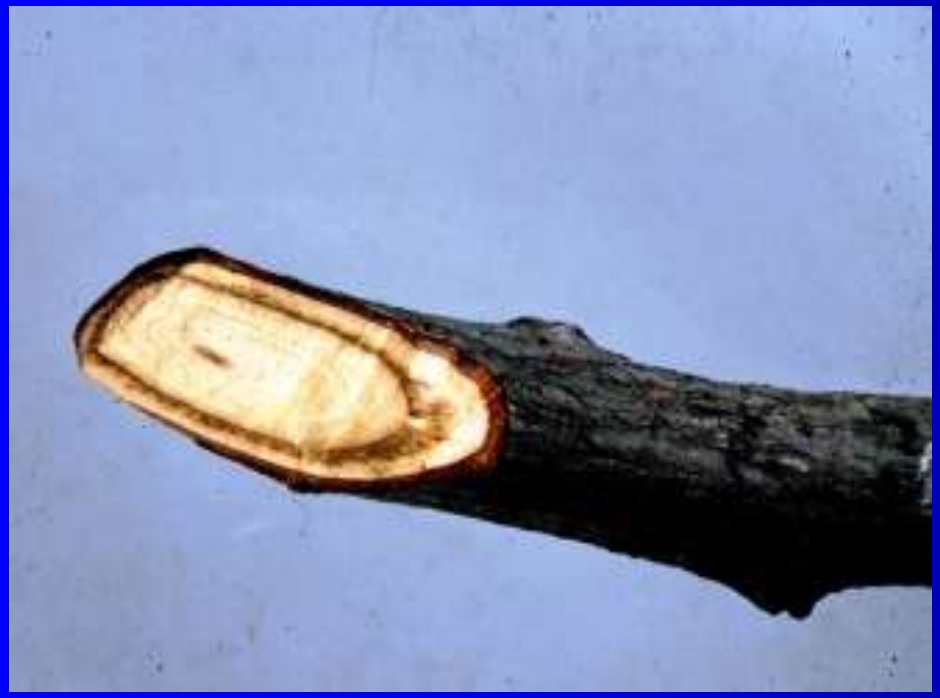
Dutch elm disease impact

The second epidemic was more catastrophic than the first one:

- **Most mature European elm trees have died because of the disease.**
- **Only in UK the number of dead trees is estimated between 30 and 50 million.**
- **In North America, the destructive impact of the pathogen was greater; the losses have amounted to hundreds of millions of elm trees.**

Dutch elm disease

Symptoms



Insect vectors

Dutch elm disease in Greece

- **Dutch elm disease was recorded for first time in Greece in 1968 in some localities of Macedonia, in northern Greece.**
- **Since then the pathogen has spread all over the country eliminating the elm trees growing in natural ecosystems as well as those that had been planted as ornamentals.**

Cypress canker disease

- **The invasion in Europe of the fungus *Seiridium cardinale*, that causes the cypress canker disease, is a great threat to cypress trees and other species of the Cupressaceae family.**
- **The pathogen is considered to be of North American origin and has spread to all five continents.**
- **In certain areas of the Mediterranean region, including Greece, the disease has taken epidemic proportions.**

Cypress canker disease

Cypress canker disease

- **The fungus *Seiridium cardinale* was recorded for first time in Greece in 1961; Since then it has spread all over the country.**
- **The Mediterranean cypress (*Cupressus sempervirens*) has been severely affected in many areas of Greece, especially in areas with wet climatic conditions.**
- **However, the most susceptible host is *Cupressus macrocarpa,* which has played a major role in the spread of the disease in many areas of Europe including Greece.**

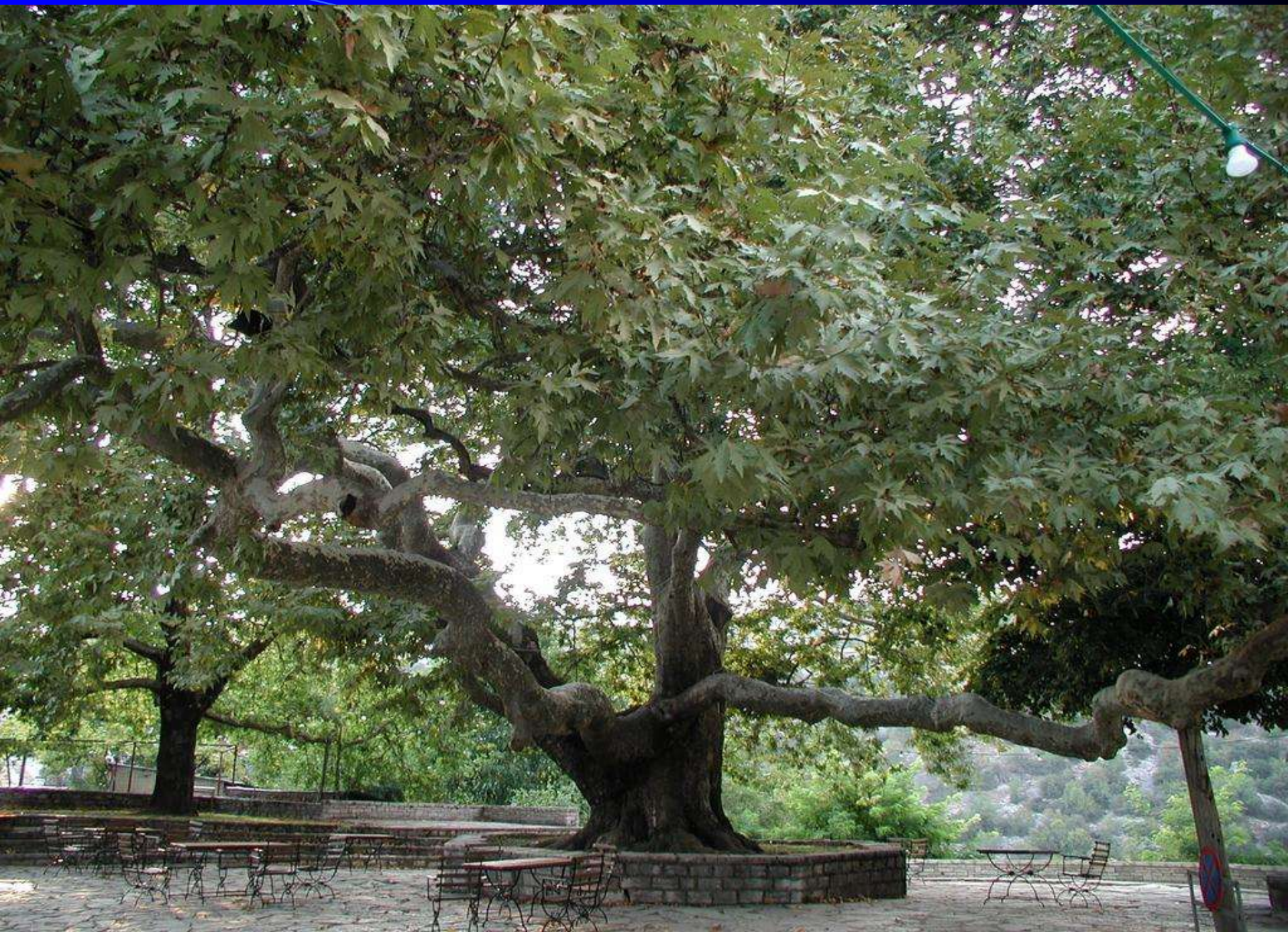
Cupressus macrocarpa "Goldcrest"

Cupressus macrocarpa

Canker stain disease of plane trees

- **Pathogen:** ***Ceratocystis platani*** **(≡*Ceratocystis fimbriata* f. sp. *platani*)**
- **The disease is fatal**
- **It is one of the most destructive diseases of forest trees, very similar to the Dutch elm disease, but much more significant for Greece.**
- **It threatens one of the most valuable forest trees:**

Oriental Plane (*Platanus orientalis*)



Oriental plane

- **Oriental plane (*Platanus orientalis* L.) is native in the Balkan Peninsula growing all over Greece (0-1200m) from Crete in the south to the northern borders of the country.**
- **It occurs naturally in a large part of Greece, mainly on moist sites along streams and rivers**

Oriental plane

- Oriental plane is a long-living tree attaining large dimensions, among the largest tree species in the country.

- In many areas of Greece there are centuries-old plane trees of historic value, and some of them have been declared as “Protected Monuments of Nature”

The disease in Europe

- ***Ceratocystis platani*** **was introduced into Europe from the United States during World War II .**
- **The disease though was detected in the early 1970's in Italy and France.**
- **Late detection in Italy and France had as a result the spread of *C. platani* into many areas.**
- **On the other hand, early detection of the pathogen in Switzerland (Canton Ticino) in 1986 had as a result disease containment.**

Introduction of *C. platani* in Greece

- **Canker stain of plane trees, has been detected in Greece in the autumn of 2003 and up to the present has only been found in western Peloponnese.**
- ***Ceratocystis platani* was introduced into Greece most likely on planting stock from Italy, because it is the main exporting country of plane trees to Greece.**

The disease in Greece

- **The pathogen may have been in Greece for many years before its detection in 2003. Plane tree mortality due to unknown causes had been observed in the Messinia prefecture for more than a decade before the detection of the disease.**
- **This late detection of *C. platani* had as a result the spread of the disease in to many areas.**
- **Also, the lack of action in the following Six (6) years resulted in further spread of the disease in to many areas of south-western Peloponnese .**

Disease symptoms

***C. platani causes tracheomycosis*, growing into the vessels of the sapwood and the medullary rays.**

Disease symptoms

It also causes necrosis of the cambium and inner bark forming cankers.

P. x acerifolia

P. orientalis

Fungal spores
Sexual spores

Perithecia

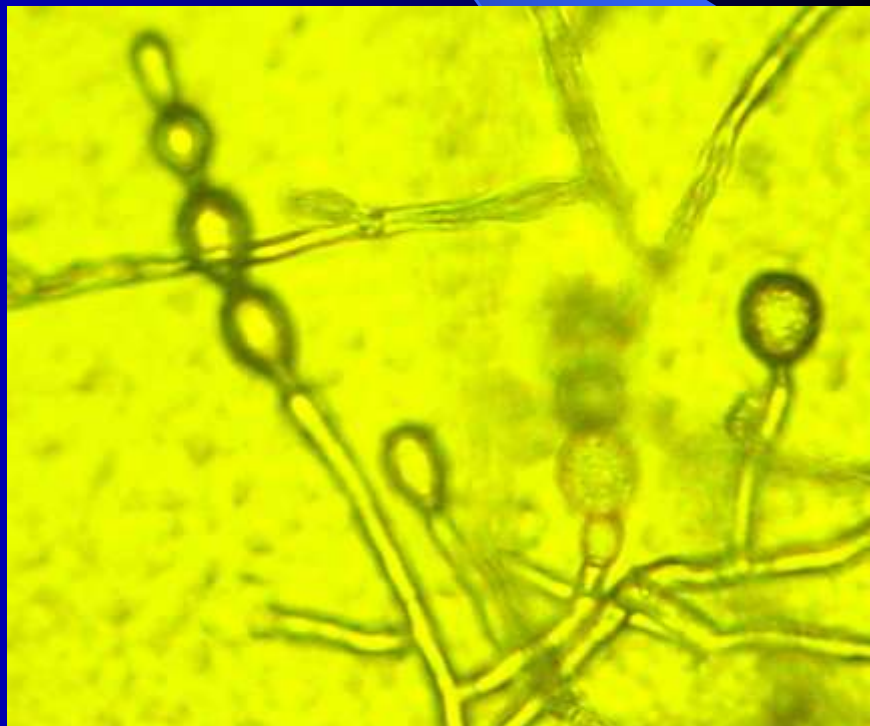
Ascospores

Fungal spores

Asexual spores

Cylindrical endoconidia

Thick-walled aleurioconidia (chlamydospores)



Tree infection

- ***Ceratocystis platani*** **is primarily a wound parasite; infections can only occur through wounds in the branches, the trunk, or the roots.**

Tree wounding

Tree wounding

In each new infection focus the fungus spreads to neighbouring trees through root grafting.

Terracing machinery seem to play an important role in the spread of the disease in Greece by carrying infested soil and/or infected wood pieces from diseased to healthy areas.

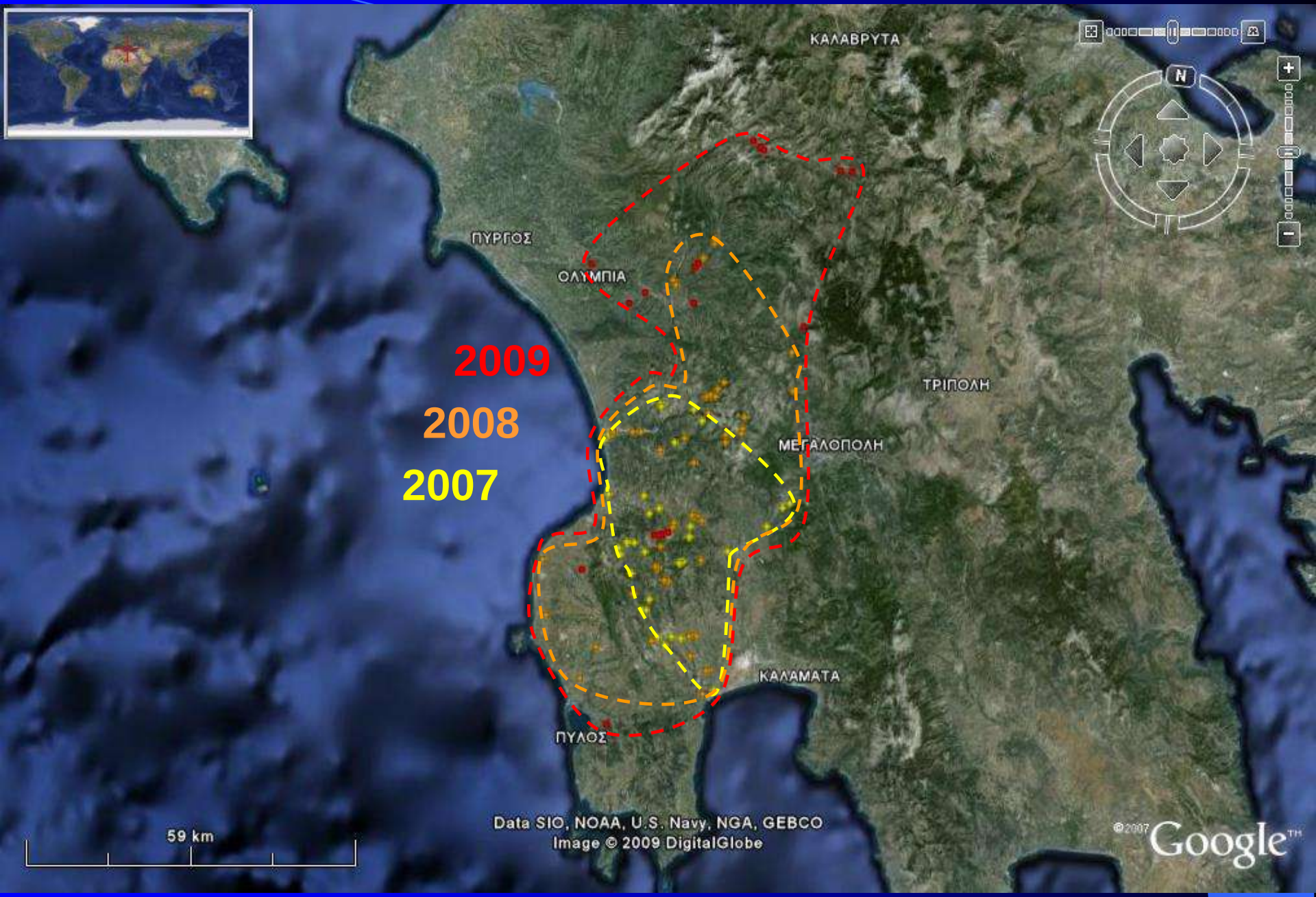
The disease in Greece

- **The disease has killed ornamental trees of different ages and sizes in residential areas and recreation sites.**
- **Some of them are centuries old with very large dimensions.**

The disease in Greece

- However, most of the trees affected by the disease have been in natural stands along streams and rivers.
- Dead and dying oriental planes have been observed in many of the streams and rivers of south-western Peloponnese.
- In some cases diseased trees have been found along streams for many km.

Dead logs and pieces of branches from killed trees may be carried by the water downstream, creating new infection foci.


ΚΑΛΑΒΡΥΤΑ
ΠΥΡΓΟΣ
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2009
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ΤΡΙΠΟΛΗ
ΜΕΓΑΛΟΠΟΛΗ
ΚΑΛΑΜΑΤΑ
ΠΥΛΟΣ
59 km
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
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Emerging diseases

- **In the last two decades a number of new pathogens appeared in Europe and other regions of the world, causing some emerging diseases in forest ecosystems.**

Emerging pathogens in Europe

Pathogen	Pathways	Possible origin
Phytophthora ramorum	Nursery stock 1990's	Eastern Asia ?
Phytophthora kernoviae	Nursery stock 1990's	New Zealand ?
Phytophthora alni	Nursery stock 1970-1990	Hybrid
Fusarium circinatum	Seeds/ nursery stock 1980's	Mexico

Joan Webber (2009)

Phytophthora ramorum

- **The pathogen *Phytophthora ramorum* causes the disease with the common name "Sudden Oak Death" (SOD).**
- **The disease has had devastating effects on oak (*Lithocarpus densiflorus* και *Quercus agrifolia*) and other tree species in California and Oregon, USA.**
- **The pathogen infects many other plant species; it has been reported on 75 plant genera and more than 130 plant species, but mostly causing non-lethal foliar infections.**

Sudden oak death - SOD

Sudden oak death - SOD

Phytophthora ramorum in Europe

- ***Phytophthora ramorum*** **was known to cause dieback of *Rhododendron* and *Viburnum* species in nurseries of Europe since the 1990's.**
- **In recent years though it has been reported to infect some forest tree species (*Quercus* spp., *Fagus sylvatica*, *Castanea sativa* etc.) in UK and Netherlands.**

Phytophthora ramorum in Europe

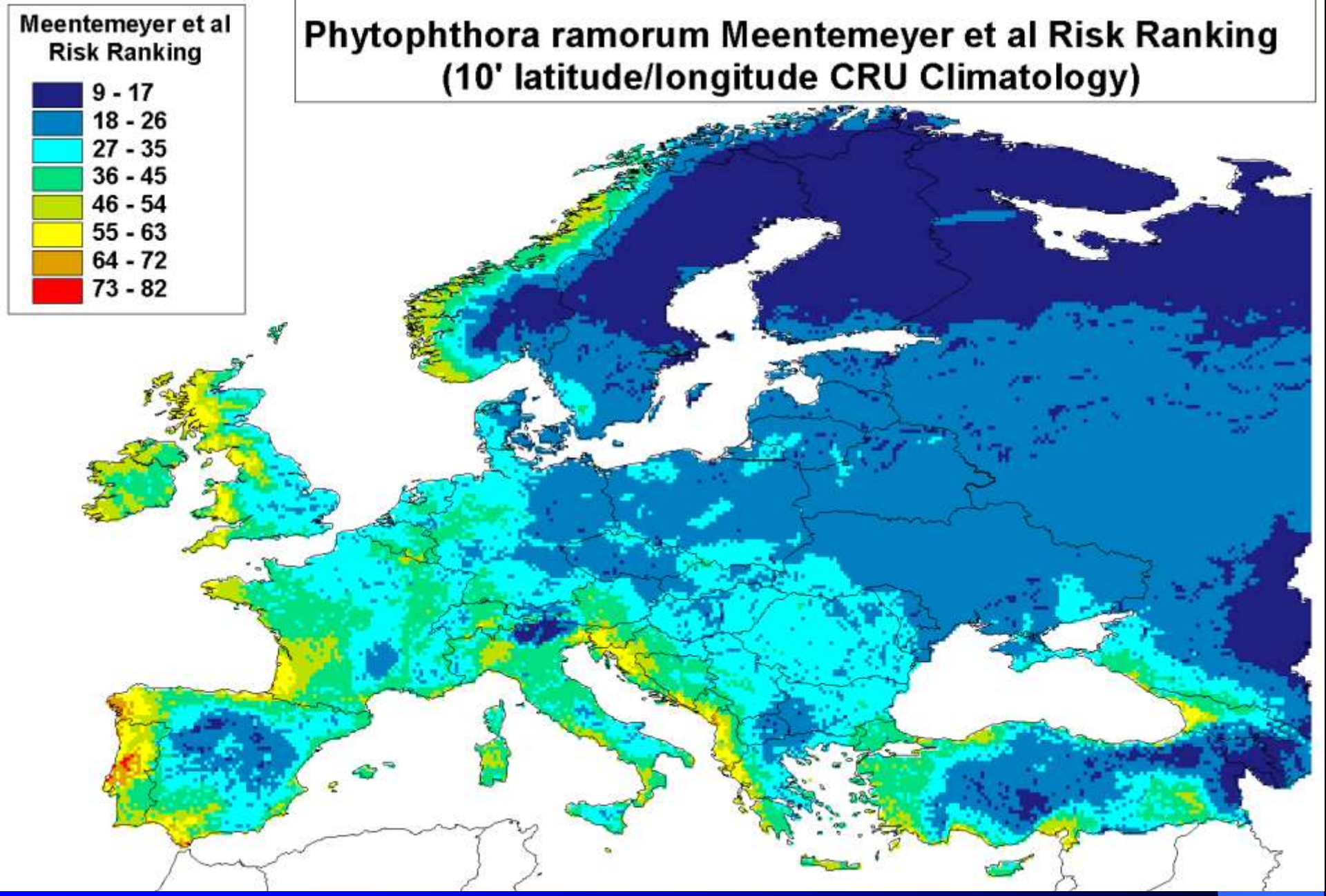
impact *of Phytophthora ramorum*

- **From the mid-1990s that the disease was noticed in California, it is estimated that over a million oak trees have been killed.**
- **In Europe, on the other hand, the number of trees that have been killed by *Phytophthora ramorum* is very limited.**
- **The pathogen has been detected in 21 European countries (19 EU Member States plus Norway and Switzerland) but it is mostly confined in nurseries.**

impact *of Phytophthora ramorum*

- ***Phytophthora ramorum*** **is moving in trade with nursery plants in both Europe and North America; some of the most susceptible hosts are species of *Rhododendron, Viburnum* and *Camelia*.**
- **The pathogen in Europe has the potential to spread in parks and natural ecosystems of susceptible hosts in climatic habitats that most favour the disease.**

Phytophthora ramorum Meentemeyer et al Risk Ranking (10' latitude/longitude CRU Climatology)



Surveys in Greece

- **In 2009 surveys have been conducted for first time in Greece by the Forest Service for the detection of quarantine pathogens and insect pests.**
- **The fungal pathogens included in these surveys are:**
  - ***Ceratocystis platani***
  - ***Phytophthora ramorum***
  - ***Fusarium circinatum* (*Giberella circinata*)**

Control of *Ceratocystis platani*

- **The most important pathogen at this moment is *Ceratocystis platani,* which is spreading in many areas of Peloponnesse.**
- **The control measures taken so far are not sufficient to contain the disease.**

Control of *Ceratocystis platani*

Two are the key factors to avoid spread of an introduced pathogen:

- **Early detection**
- **Rapid response**

In the case of *Ceratocystis platani* in Greece we had:

- **Late detection**
- **(almost) No response**

What went wrong

According to the Greek law, which is an adaptation of EU Regulations:

- **Demarked areas should be delimited around the infection centers, in order to apply quarantine measures.**
  - **Terracing or agricultural machinery should not be allowed in the quarantine zone, and if they are used they should be cleaned and disinfected before leaving the site.**
  - **Movement of wood from these areas should be prohibited.**
- **However, no such zones have been determined six (6) years after the detection of the disease!...**

What went wrong

According to a regulation signed by the Minister of Agriculture, local Forest authorities were supposed to apply control measures.

HOWEVER

- **Regional Forest Departments do not have trained personnel for this type of work.**
- **Foresters did not have a previous experience to control a quarantine organism.**
- **NO FINANCIAL SUPPORT**

Control of *Ceratocystis platani*

- In some areas of Messinia prefecture the disease appears to have already reached unmanageable levels.
- It is important, however, to avoid further spread of the disease into new areas.
- Because the disease is mainly spread by human activity, it is feasible to limit the spread by phytosanitary measures.

Control of *Ceratocystis platani*

- **Efforts should be made to avoid anthropogenic spread of the pathogen into new localities with terracing machinery and cutting tools.**
- **It should also be avoided the dissemination of *C. platani* with infected planting stock or infected wood.**

Control of *Ceratocystis platani*

- **Active surveillance all over Greece is needed, especially in the vicinity of infected areas.**
- **A key factor in applying effective control measures is the early detection of new disease foci.**
- **In areas of limited infestation, the application of disease suppression treatments will be more effective and the cost relatively low.**

Impact of *Ceratocystis platani*

- **The presence of the disease in Greece is particularly alarming because the pathogen is now present in natural stands of a highly susceptible species and has the capacity to eliminate its host.**

- **Oriental plane has tremendous historical, aesthetic and ecological importance, and all efforts should be taken to limit the spread of the pathogen throughout the natural range of this host.**