THE MONTESCLAROS DECLARATION

Prepared by a group of more than 70 forest pathologists (representing 17 nations) that attended an international IUFRO[1)]-meeting held at the Montesclaros Monastery in Cantabria, Spain during May 23th - 27th, 2011.

As scientists studying diseases of forest trees, we recognize that the international trade of plant material is increasing the risks to forest health worldwide. The evidence for this view is based on the recent, unprecedented rise in numbers of alien pathogens and pests emerging in natural and planted forest ecosystems in all parts of the globe. We thus propose a phasing out of all trade in plants and plant products determined to be of high risk to forested ecosystems but low overall economic benefit[2].

[1] IUFRO = International Union of Forest Research Organizations (www.iufro.org)

[2] We regard all international trade in containerized ornamental plant seedlings and trees intended as plants for instant landscape planting as low benefit in terms of overall economy but high risk to forest health. For instance, production of seedlings in low cost localities for outplanting in different and distant environments provides only a marginal net economic benefit to the whole area, but provides an efficient pathway for pathogen and pest dispersal. In addition, international trade in other plant materials (e.g., wood packaging, wood chips, etc.) should be scrutinized and more strictly regulated.

Supplement (pages 2-28)
Examples of severely damaging alien pathogens and pests of trees introduced by international trade of plants and plant products.

List of signers (page 29-30)

Version 18

Supplement to the Montesclaros Declaration

Examples of pathogens and pests introduced by international trade of plants and plant products

The pathogens and pests are presented here in reverse chronological order according to when they were first identified causing damage in a new area.

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Phytophthora lateralis in the UK

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Phytophthora lateralis is a fungus-like organism which attacks *Chamaecyparis lawsoniana*, known as Lawson cypress or Port Orford cedar. This pathogen was first reported killing *C. lawsoniana* in its native range of the Pacific Northwest of the USA in the 1920s, spreading rapidly throughout northern California and southern Oregon during the 1950s, and destroying commercial trade in American *C. lawsoniana*. The geographical origin of *P. lateralis* is thought to be south-east Asia, following its recent finding on old growth yellow cedar (*Chamaecyparis obtusa* var. *formosana*) in Taiwan, where it does not cause serious damage. In 2010, *P. lateralis* was reported for the first time in Britain, killing *C. lawsoniana* at a country park in Scotland (Figure 1). Since then the pathogen has been found causing mortality of *C. lawsoniana* in woodland or parkland settings at four locations in the Glasgow area and one location in Northern Ireland. Trees die rapidly from root infections (Figure 2), although *P. lateralis* has also been isolated from aerial lesions on a number of trees. **The pathogen has almost certainly been introduced in to Britain via the international plant trade**, and was isolated directly from young *Thuja occidentalis* and *C. lawsoniana* plants imported into Britain in 2010 and 2011 from Continental European nurseries. Attempts are currently underway to eradicate *P. lateralis* from Scottish and Northern Irish sites due to its potentially highly serious impact on amenity and garden landscapes across the UK.

Phytophthora lateralis killing *Chamaecyparis lawsoniana* in Scotland. (Photograph courtesy of The Forestry Commission)

Root infection of *Chamaecyparis lawsoniana* by *Phytophthora lateralis*. (Photographs courtesy of The Forestry Commission)

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Phytophthora ramorum in the UK

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Phytophthora ramorum is a fungus-like organism first described killing oaks in California, USA; hence it is commonly referred to as 'sudden oak death' or SOD (see also on page 9). The geographical origin of *P. ramorum* is unknown, although thought to be possibly Asia. The pathogen was first reported in the UK in 2002 on a viburnum plant in a garden centre, and until 2009 was found in the UK mainly on ornamental shrubs such as rhododendron, viburnum and camellia. **Its introduction into Britain is strongly associated with the international trade in ornamental shrubs**. In 2009, *P. ramorum* was found infecting and killing large numbers of Japanese larch (*Larix kaempferi*) in south-west England (Figure 1), and has since spread to cause large-scale mortality of Japanese larch in Wales and Northern Ireland, with a recent finding in Scotland. *Phytophthora ramorum* causes lethal stem cankers on Japanese larch and sporulates abundantly on needles, thus aiding aerial spread. This sudden and unexpected change in the pathogen's behaviour is the first finding, worldwide, of *P. ramorum* infecting and sporulating on large numbers of a commercially important conifer tree species.

Figure 1. Mortality of Japanese larch in south-west England due to lethal stem infections by *Phytophthora ramorum* (©Crown Copyright Forestry Commission)

Puccinia psidii: threatening native and commercially propagated *Myrtaceae*

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Puccinia psidii is a rust fungus with a large host range within the plant family Myrtaceae. The fungus is native to Central and South America and has been an important pathogen on commercially grown non-native *Eucalyptus* in various South American countries for many years. In 1977, *P. psidii* was found outside its native range in Florida and more recently in 2005 it was recorded in Hawaii where it has infected native *Meterosideros* and has devastated stands of non-native *Syzygium jambos*. **In April 2010, *P. psidii sensu lato* was detected for the first time in Australia** in New South Wales. While eradication attempts were made, the fungus has since spread rapidly and in December 2010 was detected in Queensland with the disease found to be widespread in northern New South Wales soon afterwards. The host range in Australia, while initially restricted, currently includes **106 species** across a wide range of genera. Many of the forests in Australia are dominated by Myrtaceae and *Puccinia psidii* has the potential to impact significantly on many plant communities, including associated fauna, and industries relying on species within this family. A few species already listed as rare and endangered appear highly susceptible to *P. psidii*. Other more common, but environmentally significant species such as *Melaleuca* spp., have also been recorded as being highly susceptible with infection likely to impact on growth, flower and seed production and regeneration following storm or fire events. The impact that the disease will have on commercially grown and native stands of eucalypts (*Eucalyptus* & *Corymbia* spp.) is still unknown.

Melaleuca leucadendra and *Xanthostemon oppostifolius – Photos G. Pegg*

Decline of European beech caused by invasive Phytophthora *species*

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During the past decade an increasing number of European beech stands in Bavaria, southern Germany, have been showing symptoms typical of *Phytophthora* diseases: increased transparency and crown dieback, small-sized and often yellowish foliage, root and collar rot and aerial bleeding cankers up to stem heights of >20m (Figs. 1-4). Between 2003 and 2007, 134 mature beech stands on a broad range of geological substrates were surveyed, and **root and collar rot and aerial bleeding cankers were found in 87% of the stands**. **Eleven *Phytophthora* species were recovered** from bark and soil samples from 81% of the sample trees in 93% of the stands. The most frequent species were ***Phytophthora plurivora, P. cambivora* and *P. cactorum***; all highly aggressive to roots and stems of beech in pathogenicity trials. None of these pathogens are considered to be native to Europe.

Extensive Phytophthora damages of beech stands are also reported from Austria, Belgium, the Czech Republic, Denmark, northern Germany, Italy, Norway, Poland, Serbia, Romania, Slovenia, Sweden, Switzerland, Turkey, the UK and the USA.

Surveys of 40 nurseries in Germany, Austria, Poland and Serbia revealed regular ***Phytophthora* infections of young beech plants**. Among the nine *Phytophthora* species isolated, *P. plurivora*, *P. cambivora* and *P. cactorum* were most common. In a study of eleven beech afforestations in Germany severe root and collar rot damages, crown dieback, yellowing of leaves and mortality were found in all plantings, and *P. cambivora*, *P. plurivora* and *P. cactorum* were recovered from 73%, 37% and 27% of the plantings, demonstrating the **importance of the nursery pathway in the spread of these pathogens**.

The **widespread *Phytophthora* infestations of nursery stock will most likely prevent the success of current and future silvicultural projects** aiming on a large-scale replacement of non-natural conifer stands by beech-dominated mixed stands in several European countries.

Up until now, more than 15 invasive *Phytophthora* species, including *P.cactorum*, *P. cambivora*, *P. cinnamomi*, *P. kernoviae*, *P. multivora*, *P. pluvivora*, *P. quercina* and *P. ramorum,* have been **introduced into Europe** during the 19th and 20th centuries, **most likely within living plants**.

Mature declining beech in Bavaria with high crown transparency, brush- and claw-like leaf clustering, severe losses of lateral twigs, chlorosis and crown dieback due to root and collar rot caused by *Phytophthora plurivora*. (Photo by Thomas Jung)

Severe collar rot symptoms caused by *Phytophthora cambivora* on a mature beech growing in a mixed forest in the Bavarian Alps. (Photo by Thomas Jung)

Small woody root (diam 2-5mm) of a declining mature beech with dieback and severe losses of lateral roots and fine roots caused by *Phytophthora plurivora* and *P. cactorum*. (Photo by Thomas Jung)

Stem of mature declining beech in a mixed mountain forest with a series of active aerial bleeding cankers caused by *Phytophthora plurivora*. (Photo by Thomas Jung)

Pine wood nematode in Europe and North America

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The Pine wood nematode (PWN), *Bursaphelenchus xylophilus,* is a phytoparasitic nematode which feeds on fungi and parasitizes live pine trees. The PWN is native to North America where it inhabits dead pine trees.

This nematode is the causal agent of pine wilt disease, causing a sudden decline of pines and other conifers (like *Abies*, *Cedrus*, *Larix*, *Picea*, *Pinus*, *Pseudotsuga* and *Tsuga*). The most evident symptoms are a general decline and the yellowing of needles, and finally the death of the tree. *B. xylophilus* is transmitted by an insect vector from the genus *Monochamus* and can be found in wood and bark of susceptible species and in package materials like pallets, boxes, timber, etc made of conifers.

Nowadays the nematode appears in several countries: United States, Canada, Japan, China, Korea, Taiwan and Europe.

Studies in Japan, where over 46 million cubic meters of trees have been lost in the last 50 years as consequence of PWN, confirmed the pathogenicity of this nematode. From Japan the PWN spread to Eastern Asia (1982 and 1988). After the discovery of PWN in wood chips imported from Canada and USA, a strict ban was implemented in the importation of these products from countries where the PWN occurs.

In Europe, PWN was detected in Portugal in 1999 at the Setubal Peninsula and in 2008 it was declared to have spread across the whole country. The pathway of the first introduction of PWN to Portugal remains unknown although recent research indicates that it originated from Eastern Asia (Vieira et al., 2007).

World trade of wood products (timber, pallets, wooden crates, etc) is an important potential way for the dissemination of the PWN. Very strict regulatory measures, which try to control and eradicate the pine wood nematode, are being applied in Portugal but without obtaining the desired results.

In Spain the first detection of PWN was in Extremadura in 2008 with a second recent one in Galicia in 2010. Both detections were very close to the frontier with Portugal. In Extremadura the detection of a single pine affected with this nematode has led to the eradication of all susceptible trees in a radius of 3 km with a cost of about 3.000.000 €. Equally in Galicia the detection of PWD has led to the eradication of all the susceptible trees in a radius of 1,5 km with very high economic and ecological costs.

Pines killed by the pine wood nematode in Portugal. (Photo by Julio Diez)

Phytophthora ramorum in North America

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Two apparently unlinked events marked the beginning of **one of the most devastating forest diseases known to man in recent times**: Sudden Oak Death (SOD). In the mid 1990s, while a novel species of *Phytophthora* was being isolated from mildly diseased *Rhododendron* and *Viburnum* plants in German and Belgian nurseries, the first reports of inexplicable death of tanoaks (*Notholithocarpus densiflorus*) started to come in from concerned citizens on the coast of California. In 2000, red oaks such as Coast Live oak and black oak were also reported to be dying inexplicably, and in June of that year an undescribed *Phytophthora* species was isolated and quickly identified as the causal agent of the disease known as sudden oak death. As it turns out, the species from European nurseries and the one infecting California oaks and tanoaks turned out to be the same. This novel species was named *Phytophthora ramorum* a name that refers to the branch dieback it causes in rhododendron and other ornamental plants, but on oaks and tanoaks, the pathogenic activity of the organism is mostly concentrated on the cambial layer of the main trunk, which gets rapidly destroyed by the growth of the pathogen. *P. ramorum* was maybe the first aerial *Phytophthora* species described from temperate forests: the deciduous large sporangia become airborne and are responsible for the apparently aerial dispersal of the pathogen. The exotic nature of the pathogen was immediately postulated based on its limited geographic distribution around the San Francisco Bay Area, on the fact that both the disease and the causal agent had never been described before, and on the very high susceptibility of tanoaks and red oaks.

Pathways of spreading into USA

Because of its known association with ornamental plants in Europe, the presence of *P. ramourm* in California nurseries was rapidly ascertained, thus providing a potential pathway of introduction into California. Although it was later found out that populations of *P. ramorum* in Californian forests and European nurseries belong to evolutionary distinct lineages of the pathogen (thus negating a European source for the California forest infestation), both lineages and an additional third one were found to be **present in US nurseries**. A series of papers confirmed the genetic diversity of the pathogen in California forest is extremely limited, and convincingly showed that **nursery genotypes were ancestral to the entire pathogen population in the wild**, providing solid evidence that the SOD pathogen had been introduced from an unknown location through the nursery trade. These studies also showed that multiple independent introductions had occurred in California and southern Oregon. The repeated introductions from infected nursery stock at different locations explained more convincingly what on surface appeared to be an incredibly rapid spread of the pathogen.

SOD infects almost all native plant species in the coast California

By 2004 it was determined that 1 Oregon and 14 California counties were infested and that several hundreds of kms of coastal forests were being severely affected by the spread of the pathogen: **up to 100% of adult tanoaks and 60% of oaks are currently (2011) locally reported as dead as a result of infection by this pathogen**. The die-off of these keystone trees has been shown to alter the ecology of coastal forests (including the unique redwood forest) in more than one way, with long lasting proven implications for productivity, regeneration, fungal symbionts, and wildlife. *P. ramorum*, not unlike many other *Phytophthora spp*. is a generalist, and it was found to be able to infect almost all the native plant species on the coast California, including herbaceous and woody plants, monocots and dicots, ferns and trees. Not all infected plants respond to infection in the same way: while oaks and tanoaks are killed by girdling cambial lesions, many plants develop a disease that is similar to that of rhododendrons and is better described as a branch die-back, that may progressively kill the plant. Finally, some plants only develop foliar lesions with rather minimal impact on infected individuals. These two types of disease (die-back and foliar symptoms) are referred to as Ramorum blight and better describe the disease in the understory and in ornamental nurseries.

Spread of SOD by aerial spores

A further layer of complexity is added by the fact that lesions on infected oak and tanoak trunks rarely produce infectious sporangia, while large number of these infectious structures are produced on leaves of trees including California bay laurels, tanoaks, and redwoods. In particular bay laurel and tanoak leaves have both been demonstrated to be key drivers of the disease. Because oaks are mostly sympatric with bay laurels, this species is responsible for the vast majority of oak infections, thus creating a complex system in which density of one species (bay laurel) will affect disease incidence of the other (oaks).

Foliar infections progress rapidly and in the presence of rainfall and moderate temperatures sporulation can be attained within 48-64 hours from infection: it is this incredibly **rapid reproductive cycle** that allows the pathogen to spread even during short wet spells or after long droughts. Although the large sporangia were shown to be airborne mostly within 10 m from a source, evidence from field observations and from spatial autocorrelation studies based on genetic data, also indicate the occasional ability to move up to 5 km from a source, thus allowing the organism to cover the gaps frequently present in forest cover. Notwithstanding the occasional natural ability of the pathogen to move at distances of a few kms, **long distance dispersal is most likely linked to the movement of infected substrates by humans**. While infected plants are an obvious and proven pathways for long-distance dispersal of the pathogen, wood, soil and contaminated water may also act as infectious vectors of the disease. At present, **the disease is still spreading** and when rains occur between mid-April and mid-June, outbreaks are reported throughout the range of the pathogen.

Possibility to prevent further spread of SOD in USA

The scale of the problem in California is such that no single institution, whether the State and Federal Governments, or the US Forest Service has the means to tackle it. UC scientists are currently engaging private landowners as well as managers of county open spaces and regional parks to take charge and attempt to manage the disease, at least locally. Proven management tools to curtail the disease include preventive phosphonate treatments and selective thinning of infectious hosts such as bays and tanoaks.

Although a significant variability in susceptibility has been reported for bays, oaks, and tanoaks, it is unclear how much of this variation is environmentally driven vs. genetically acquired. A large common garden experiment is under way only for tanoaks, and preliminary results indicate an **absence of qualitative resistance**, while some quantitative tolerance to the disease has been detected both in laboratory tests and in plantings of seedlings n naturally infested sites.

Although nursery plants are highly regulated and periodically inspected for Ramorum blight, the fact that the disease **may remain asymptomatic for a significant amount of time** poses obvious challenges. The discovery of an oak recently infected by a nursery pathogen genotype in the Presidio National Park in San Francisco, and the infestation of rivers in Washington State and in the Southeastern USA, where only nursery infestations have been reported, show that, **in spite of regulations, a lot remains to be learned about this pathogen** in order to effectively prevent its movement and introduction. Because three evolutionary distinct lineages characterized by distinct genetic and phenotypic traits are present in US nurseries, while a single lineage is present in forests of California and Oregon, the potential escape of new genotypes is worrisome not only in other parts of the country but also in areas currently infested. The worry is that the release of genotypes belonging to the lineages currently absent in California and Oregon may intensify the outbreak.

Currently only about 10% of the habitat that could be colonized by *P. ramorum* has already been invaded, while the remaining 90% is obviously at risk. If indeed the pathogen will colonize its entire potential habitat, the damages it would cause would be orders of magnitude higher than the damages caused by the current infestation. SOD represents yet an additional current example of how human activities and natural plant communities are inextricably intertwined. One interesting fact: ***P. ramorum* was the first quarantined pathogen whose lack of detection had to be confirmed by DNA-based techniques in the USA**.

Bleeding tanoak (Photo by Matteo Garbelotto)

Tanoaks killed by *P. ramorum* (among green alive redwoods and Douglas firs) in California. (Photo by Janet Klein)

Mycosphaerella dearnessii in Austria

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Mycosphaerella dearnessii M. E. Barr (syn. *Scirrhia acicola*; anamorph: *Lecanosticta acicola* Thüm, syn. *Septoria acicola)* is an ascomycetous pine needle pathogen and the causal agent of brown spot needle blight. Potential hosts comprise various pine species and even *Picea glauca* can be infected when exposed to heavy spore loads. Heavily infested trees, suffering from intense needle losses for many years, show branch dieback extending upwards in the crown. Attacks over several years can kill the trees.

The disease is known from North, Central and South America, Asia, South Africa and Europe. Since it is widespread in North and Central America, it is assumed to be of Central American origin. The global **spread of the fungus is attributed to the expanded pine trade** in the last decades. In Europe *M. dearnessii* is mostly limited to local sites and often occur on *Pinus uncinata* in swamps and more rarely in *Pinus sylvestris* / *Pinus radiata* stands.

In Austria, brown spot needle blight was identified originally from Mountain pine (*Pinus mugo)* in 1996 in the town of Hollenstein/Ybbs (Lower Austria). Annual surveys revealed a slowly increasing number of infested trees (*Pinus mugo, Pinus uncinata* and *Pinus sylvestris*) from 1996 to 2007, but infestation was still limited to urban sites in that town. In August 2008, however, the species was found for the first time in mixed forest stands on Scots pines (*Pinus sylvestris*) adjacent to the town of Hollenstein. In autumn 2009 newly infested trees were found at the border of the municipal area of Hollenstein close to further mixed pine forest stands. In autumn 2010 *M. dearnessii* was detected for the first time on urban trees in five other towns up to 40 km distant to Hollenstein. The findings indicate an ongoing spread of *M. dearnessii* in Austria.


Mycosphaerella dearnessii on *Pinus uncinata*: Solitary tree with severe infestation in the lower part of the crown in Lower Austria, June 2010. (Photo by Marion Kessler)

Pitch Canker of pines in Spain

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Fusarium circinatum Nirenberg & O'Donnell (Teleomorph: *Gibberella circinata* Nirenberg & O'Donnell) is a highly virulent pathogenic fungus causing Pitch Canker disease on *Pinus* species (mainly *Pinus radiata* D. Don, Monterey pine) in Spain. Classic symptoms of the disease include bleeding, resinous cankers on the trunk, large branches, or terminal shoots. Cankers are usually sunken and the bark is retained, while the wood beneath the canker is deeply pitch-soaked. The pathogen also causes damping off, shoot and tip dieback, and mortality of established pine seedlings. *Fusarium circinatum* was first detected in 1945 in the south-eastern United States; it was hypothesized to be endemic both there and in Mexico. During the last decades, *F. circinatum* has also been found in South Africa, Japan, Chile, Korea, Spain, Italy and Portugal.

Dispersion of *F. circinatum* to different countries has occurred mainly by way of contaminated seeds. Within individual countries, **seedling and wood trade** are the two main ways of *F. circinatum* spread. Insects are also involved in the spread of this fungus; in North America *Pityophthorus* species are considered the main vectors. Research on the presence of other vectors involved in disease transmission is underway in other parts of the world where Pitch Canker occurs.

In some countries where Pitch Canker has been recently introduced, the persistence of very susceptible species, such as Monterey pine, is endangered. In Spain the presence of *F. circinatum* in nurseries and plantations has resulted in crop and yield losses, high monitoring and control costs, exportation bans, and a shortage of both *Pinus radiata* seeds and seedlings in forest nurseries. In addition, the presence of *F. circinatum* is a potentially serious threat to pine species native to Europe (e.g., *Pinus pinaster, P. pinea, P. nigra, P. sylvestris, P. uncinata*); pathogenicity tests suggest that *P. halepensis* and *P. canariensis* are very susceptible to the disease. Other decline processes known to be present in Spain in species such as *P. pinaster* or *P. halepensis* might further increase the severity of forest damage caused by *F. circinatum*.

Pitch canker on *Pinus nigra*.
(Photo: Julio Diez).

Ceratocystis platani in Mediterranean countries

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Ceratocystis platani (J. M. Walter) Engelbr. & T. C. Harr. (≡*Endoconidiophora fimbriata* f. *platani*) is an Ascomycetous fungus responsible for a serious disease of *Platanus* spp. in Europe and North America. The pathogen causes staining of the xylem, interruption of water movement, cankers, and usually a rapid wilt death of young and mature trees. *Ceratocystis platani* has been associated with considerable mortality of *Platanus orientalis, P. occidentalis, and P. x acerifolia* in ornamental plantings and in natural stands along streams and rivers.

Based on research conducted by A. Panconesi, A. Santini (Italy), T.C. Harrington (USA) and P. Tsopelas (Greece), it is thought that ***C. platani*** **was introduced to Europe from the southeast of the USA and Mexico, on timber or wood used for packaging**. The pathogen spread initially in the Mediterranean region starting in Naples, Italy after World War II, then into southeastern France, and more recently into Greece. It is anticipated that *Platanus* species in eastern Turkey and western Spain will be the next to be affected by *C. platani.* Current, new introductions of the fungus in Europe also occur via the movement of infected rooted-cuttings as nursery stock. .

Ceratocystis platani is possibly vectored by wood-associated insects and by those visiting fresh wounds on trees. In Greece, spread of the fungus has been found to be associated with ambrosia beetles. In many cases, as reported from Italy, infection is associated with human-caused damage such as pruning wounds or similar injuries. The introduction of *C. platani* to the southern Mediterranean area is expected to have a dramatic impact on ornamental plantings and boulevards but also on riparian forests of the region. Along stream and river courses where the disease is currently present, stretches of streams of up 100 m have no surviving plane trees. The pathogen, which has been observed on naturalized, *P. orientalis* along waterways in Sicily, is now also affecting wild *P. orientalis* along river courses in Greece and appears capable of rapid spread throughout the natural environment.

Platanus X *acerifolia* (London plane) killed by *Ceratocystis platani*. (Photo by Paolo Capretti)

Dead trunk of *Platanus* X *acerifolia* (Photo by Paolo Capretti)

Symptoms of an infection by *Ceratocystis platani* in the inner bark of *Platanus X acerifolia* (Photo by Paolo Capretti)

Butternut canker in North America

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Caused by the ascomycetous fungus, *Ophiognomonia clavigignenti-juglandacearum* (formerly *Sirococcus clavigignenti-juglandacearum)*, butternut canker was first reported in Wisconsin, USA in 1967. The pathogen kills only butternut trees (*Juglans cinerea*) in North America, though other *Juglans* species and possibly other trees (*Quercus*, *Prunus*) are susceptible to infection. Where it originated and the pathway by which *Ophiognomonia clavigignenti-juglandacearum* was introduced is not known but its low level of genetic diversity and aggressive behaviour in North America support its treatment as a non-indigenous species. Butternut canker now occurs across the natural range of *J. cinerea* in the USA and it is also present in Canada in Ontario, Quebec, and New Brunswick. Spores of *Ophiognomonia clavigignenti-juglandacearum* are spread by insects, birds, rain splash, or on seeds. The fungus kills trees when multiple cankers girdle stems and/or branches. Due to the canker, butternut populations have experienced such serious reductions in the USA and Canada that butternut is considered to be 'endangered/a species of Federal Concern'. The loss of *J. cinerea* has impacted industries that used the good-quality wood for interior woodwork and furniture and as a source of nuts for humans and wildlife.

Butternut trees infected with the butternut canker fungus *Ophiognomonia clavigignenti-juglandacearum*. Source: USDA Forest Service - Forest Health Protection - St. Paul Archive, USDA Forest Service, Bugwood.org

Dutch elm disease in the Europe and North America

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Two ascomycetous microfungi, *Ophiostoma ulmi* and *Ophiostoma novo-ulmi,* have caused Dutch Elm Disease (DED) globally. *Ophiostoma ulmi* appeared in Europe in 1910 and in North America in 1928. The second and considerably more virulent species, *O. novo-ulmi*, which was first described in Europe and North America in the 1940s, has devastated elms on both continents since the late 1960s. The origin of *O. novo-ulmi* remains unknown, but the species may have arisen as a hybrid between *O. ulmi* and *O. himal-ulmi*, a related species observed only in East Asia.

The major pathway by which DED has spread globally is through the international trade of timber and untreated logs. Such trade has resulted in the spread of both *O. ulmi* and *O. novo-ulmi* to distant geographical parts of continents and their movement across the Atlantic Ocean several times. In nature, these two species of *Ophiostoma* are vectored by bark beetles of the subfamily *Scolytinae*. First symptoms of DED include the withering and yellowing of leaves in the upper crowns of infected trees, which progressively spreads to the rest of the tree and results in the dieback of branches. Roots of infected trees ultimately die from starvation because of the loss of nutrients from leaves. Roots that survive infection often produce suckers, which can grow up to five meters in height before getting infected. DED has wiped out most of the mature Elm trees in Europe and North America, except in the northern regions of these continents, where the vector insects generally do not survive the harsh winter conditions.

Elm trees killed by *Ophiostoma novo-ulmi* (Photo by Julio Diez)

White pine blister rust in North America

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White pine blister rust is a disease of white pines and the causal agent is a fungus *Cronartium ribicola*. The fungus produces five different spore types and requires currants or goose berries (*Ribes*) as an alternate host. Basidiospores are formed on the underside of *Ribes* leaves from where they spread by wind to current year needles of pines. They infect the needles through stomata and grow into the cambial tissue of the branch and form a canker. After 2 to 3 years aeciospores are produced on the cankers and spread to *Ribes* to continue the cycle. Hence, the disease cycle takes three or more years to complete. Seedlings and young trees are very susceptible to this disease and die quickly while mature trees may survive for years. With time they frequently suffer from bark beetle attack with a result of subsequent mortality.

The rust originates probably in Asia where pines native to that area are rather resistant to it. In Europe this rust caused serious disease first on white pines that had been imported to Europe from North America. Eastern white pine seeds from America were planted as early as the 16th century throughout Europe where this pine is known as Weymouth pine. On *Ribes* spp. the fungus was first reported in Europe in the mid 1800s, and named *Cronartium ribicola*, but the connection of this fungus with the disease on white pines was not proven until 1889 by Heinrich Klebahn. To North America white pine blister rust was introduced between 1898 and 1908 when it appeared in eastern USA, where it probably came with seedlings from Europe. Later, in 1910 it arrived in Vancouver, British Columbia on a shipment of eastern white pine (*Pinus strobus*) **nursery stock that had been grown in and shipped from France**. The native *Ribes* became infected leading to permanent establishment of the disease. By 1929 the disease had spread 400 kilometres southward to the California border.

In North America this disease has caused widespread destruction of ecosystems in large forested areas where white pines were keystone species during the 20th century. Numbers of white pine stands have been entirely lost.

In USA the introduction of blister rust resulted in the Plant Quarantine Act in 1912. This was the first law which restricts import of plants. Later a so called Ribes Eradication Law authorized the destruction of cultivated and wild currants. During the Great Depression of 1933, when the US government provided work for the unemployed through the program of Civilian Conservation Corps, as many as 11000 workers were employed in a single year to eradicate *Ribes* from the national forests continent-wide. An estimated $150 million was spent on this programme, and *Ribes* plants were removed from over 8.1 million ha in the USA. This great effort to eradicate currants, however, failed and the programme was officially terminated in 1968 because after eradication there was only a low correlation between stand infection rates and residual *Ribes* density. This can be explained by recent observations that *Pedicularis* and *Castilleja* spp. act as uredinial hosts of *Cronartium ribicola*. This means that eradication of *Ribes* alone cannot lead to successful results in reducing blister rust. Also attempts to develop chemical control of blister rust have proven unsuccessful. Hence, emphasis shifted from direct control to genetic screening of planting stock for disease resistance.

Chestnut blight in North America

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Chestnut blight is caused by the ascomycetous fungus *Cryphonectria parasitica*. Introduced into North America from Asia in the early 1800s, it is thought that ***C. parasitica*** **arrived on nursery stock**. Chestnut blight was first observed in 1904 on American chestnut trees (*Castanea dentata*) in New York City and within the next three decades it killed most of the mature *C. dentata* (one source estimates four billion trees!) in the New England and mid Atlantic States of the USA. In Canada, chestnut blight has devastated *C. dentata* trees in southern Ontario. *Cryphonectria parasitica* spores are readily spread by wind, rain, and insects and their infection of stems results in lethal cankering. The fungus can also survive as a saprophyte on some oak species, red maple, and shagbark hickory. Ecological impacts of chestnut blight have been significant - American chestnut, once considered the 'Queen' of eastern American forests – has effectively been extirpated and replaced by other hardwood species in these forests. The economic impacts of chestnut blight add up to losses of billion of dollars through the loss of *C. dentata* as a source of lumber and other forest products, nuts, and tannic acid for tanning leather.

Figure 1. Giant American chestnut trees in North Carolina before the chestnut blight fungus was introduced. Source http://ctacf.org/page.cfm/ChestnutBlight

Figure 2. American chestnut trees devastated by *C. parasitica*.
Source: USDA Forest Service - Northeastern Area Archive, USDA Forest Service, Bugwood.org

Pests

Thaumastocoris peregrinus in Africa and South America

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Thaumastocoris peregrinus (Thaumastocoridae: Hemiptera) is a phytophagous sap feeding insect. It is native to Australia where it feeds on a wide range of *Eucalyptus* species. The insect has become a pest on *Eucalyptus* trees in Sydney where heavy infestations are found on street and garden trees. In 2003, *T. peregrinus* was first detected in South Africa and in 2005 in Argentina. It has since spread to Brazil, Uruguay, Malawi, Kenya and Zimbabwe. **It is believed that *T. peregrinus* was initially introduced to Africa and South America by infested plant material.** *Thaumastocoris peregrinus* feeds on the leaves of *Eucalyptus* causing yellowing and early senescence of the leaves and stunted growth. *Thaumastocoris peregrinus* has thrived in the non-native plantation environment of South America and Africa resulting in severe damage (Figure 1).

This insect is easily dispersed and has spread rapidly between and within countries. It is likely that *T. peregrinus* will quickly spread to other *Eucalyptus* growing countries in South America, Africa and the rest of the world. Systemic insecticides have been found to be an effective tool for the control of *T. peregrinus*, but this approach is generally not feasible for large scale application such as plantations. The parasitic wasp *Cleruchoides noackae* (Mymaridae: Hymenoptera) has been identified as a potential biological control agent, but its effectiveness to control *T. peregrinus* must still be determined.

Figure 1. Severe infestation of *T. peregrinus* in Mpumulanga, South Africa.

Emerald Ash Borer in the USA

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The emerald ash borer*, Agrilus planipennis,,* is a phloem-feeding beetle in the family bupréstidae native to Asia and was discovered near Detroit, Michigan and Windsor, Ontario in the summer of 2002. **It is believed that this species arrived inadvertently in solid wood packaging in cargo.** Subsequently, the species has spread outward through much of the eastern USA and Canada. Domestic spread of this species most often occurs via accidental transport in infested firewood or nursery stock.

None of the N. American ash species exhibit any resistance to this insect and it has already caused vast amounts of tree mortality. Much of this mortality has occurred in naturally regenerating forests but extensive mortality has also been in urban areas as well. Many of the cities where mortality is heavy are locations where street trees were killed 30-40 years ago by invading Dutch elm disease and were replanted with ash. Costs associated with removal of dead street trees are typically high and represent a financial hardship for municipal governments. As this species continues to expand its range, these impacts in urban areas will be very large. Impacts in naturally regenerated forests are more poorly understood, but the expected extirpation of ash as a component of these forests may have cascading impacts on associated species.

Figure 1. Ash trees in Michigan recently killed by the emerald ash borer (photo by Daniel Herms, Forestry Images 5171038).

The Citrus longhorn beetle in Europe and North America

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The Citrus longhorn beetle, *Anoplophora chinensis* (Forster, 1771), is a large 25 to 35 mm long and highly polyphagous xylophage Cerambycid beetle. It can feed on hundreds of different broadleaved species of trees and shrubs from more than 70 plant taxa that belong to over 20 different families (e.g. *Acacia, Acer, Aesculus, Alnus, Betula, Castanea, Citrus, Corylus, Juglans, Prunus, Citrus, Malus, Populus* and *Salix*). Adult beetles feed mostly on twigs of the trees. The most damaging effects are caused by larvae which bore into living host trees making them susceptible to diseases, secondary pests and wind damage - if the trees are not killed directly by this pest.

The Citrus longhorn beetle originates from Eastern/South Eastern Asia (China, Taiwan, Korea, Japan, Myamar, Vietnam) and has had outbreaks in several European countries like Italy (2000), France (2003), Netherlands (2007) and Croatia (2007). It has been introduced to new areas via import of **solid wood packaging and plants for planting**. Almost all of the **introductions to Europe are from live plant material; bonsai trees brought** from Eastern Asia.

Anophora chinensis. (Photo by Kari Heliövaara)

The pest causes devastation on fruit tree farms and especially on citrus plantations and it has been ranked as a high-risk quarantine pest in Canada, Europe and USA. So far its ecological damage on newly introduced areas has been minor. However, it is proposed that it could cause immense economic damage by killing live and healthy amenity trees in urban areas, as well as in natural forests.

The Asian longhorn beetle in Europe and North-America

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The Asian longhorn beetle, *Anoplophora glabripennis* (Motschulsky 1853), is a large 25 to 35mm long xylophagous Cerambycid beetle that mainly attacks trees belonging to genuses *Acer* and *Populus*. The species is highly polyphagous and besides *Acer* and *Populus* it can feed on families e.g. *Alnus, Aesculus, Betula, Fraxinus, Liriodendron, Malus, Morus, Prunus, Platanus, Pyrus, Robinia, Rosa, Sophora, Ulmus and Salix*. Adult beetles feed mostly on twigs of the trees. The most damaging effects come from the larvae which bore into living host trees making them susceptible to diseases, secondary pests and wind damage - if the trees are not killed directly by the pest.

The pest originates from China and has had outbreaks in several European countries: Austria (2001), Germany (2004), Italy (2007), France (2003) and Netherlands (2010). In USA it was first discovered in 1996, and in Canada in 1998. The pest´s **main pathway to new areas is via solid wood packing material from Asia**, but it can also be introduced via plants for planting. The Asian longhorn beetle causes vast damage on urban trees. It has been ranked as a high-risk quarantine pest in Canada, Europe and USA. In China the Asian longhorn beetle has prevented the starting of wood and syrup production from North American maples by repeatedly killing the trees. Its biggest damaging impact in China is on *Populus*. In USA the pest is estimated to potentially cause in bigger cities an economical damage worth up to $669 billion. APHIS´s eradication program estimates the eradication costs in USA to vary from $30 to $48 million a year. The potential economic and ecological impact of the pest is thus high.

Anoplophora glabripennis (Photo by Kari Heliövaara)

Leptocybe invasa in the Middle East and Europe

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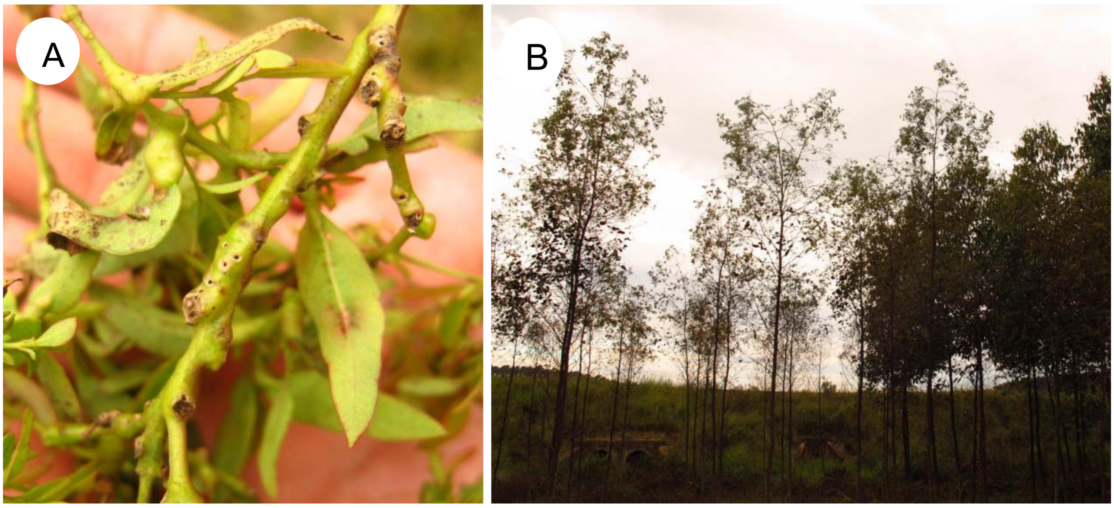
The gall wasp *Leptocybe invasa* is native to Australia where it causes malformations (galls) on the stems, petioles and leaves of *Eucalyptus* species (Figure 1). This insect was unknown in its native range before it was detected in the Middle East and Meditteranean region in 2000. It has since spread to southern Europe, southern Asia, Brazil, and northern, eastern and southern Africa. **It is believed that the original introduction of *L. invasa* in to the Middle East was by means of infested plant material.** In areas where *L. invasa* has invaded, it has become a serious pest of *Eucalyptus*. Heavy infestations result in malformed trees, stunted growth and in severe cases tree death. Biological control agents have been sought in its native and introduced ranges, resulting in the release of a number of parasitic wasps (mainly in the family Eulophidae) for the management of *L. invasa*. The success of these biological control agents still needs to be fully assessed. Differences in susceptibility to *L. invasa* between *Eucalyptus* species, hybrids and clones has been found, making planting of resistant or less susceptible material a viable tactic to use alongside biological control. The effectiveness of insecticides to manage *L. invasa* is still being investigated. If effective, insecticides could possibly be used to manage *L. invasa* in the nursery environment.

Figure 1. A. *Leptocybe invasa* induced galls on *Eucalyptus* sp. B. *Eucalyptus* clone highly susceptible to *L. invasa* (left) showing loss of leaves from severe galling, next to a less susceptible clone (right).



Hemlock Wooly Adelgid in the USA

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The hemlock woolly adelgid*, Adelges tsugae,,* is a aphid-like insect in the family adelgidae that is an exotic invader in eastern N. America. This species is native to East Asia and western N. America and was first noticed in eastern N. America in the 1950s. **The invading population arrived on live plants that were imported from Japan.** Since then, it has slowly expanded its range; in areas where populations have established, they often reach high densities, causing widespread defoliation and sometimes mortality of host trees. Ecosystem impacts of damage can be high because hemlocks typically grow in riparian habitats and hemlock mortality may result in pronounced changes in stream water temperature and chemistry.

Attempts are being made at biological control of this species via importation of natural enemies however this effort is greatly limited by the fact that no member of the family Adelgidae is known to host any parasitoid species.

Figure 1. Heavy population of the hemlock woolly adelgid (photo by Daniel Herms, Forestry Images 1523054).

Sirex noctilio in New Zealand, Australia, America and in South Africa

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The woodwasp *Sirex noctilio* (Siricidae: Hymenoptera) is native to Europe, parts of Asia and North Africa, where it infests conifer trees particularly in the genus *Pinus*. *Sirex noctilio* has an obligatory symbiotic association with the Basidiomycete fungus *Amylostereum areolatum*. The *S. noctilio* female inserts toxic mucus and the fungus into the host tree at the time of oviposition, and in combination the mucus and fungus result in tree death. *Sirex noctilio* larvae feed on the fungus and emerging *S. noctilio* wasps move the fungus to new hosts.

Sirex noctilio was first detected outside its native environment around 1900 when it was detected in New Zealand. It has since been accidentally introduced to Australia, Argentina, Brazil, Chile, Uruguay, South Africa, and more recently to the USA and Canada. **It is believed that *S. noctilio* spread to the various continents by solid wood packaging.**

In the non-native plantation environment of the southern hemisphere, *S. noctilio* has caused severe losses in stands of *Pinus* species (Figure 1). The pest status of *S. noctilio* in the USA and Canada, where *Pinus* species exist in natural forests and plantations and where native siricids and their natural enemies occur, has yet to be determined. Silvicultural practices and biological control have been used to manage populations of *S. noctilio*. These tactics have shown much success, but the use of silvicultural practices are constrained by economic considerations and success of biological control has not been consistent across different environments.

Figure 1. Mortality of *Pinus patula* in KwaZulu-Natal, South Africa, caused by *S. noctilio* and its fungal symbiont *A. areolatum*.

Gypsy Moth in the USA

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The gypsy moth, *Lymnatria dispar,* is a highly polyphagous foliage–feeding Lepidoptera native to temperate regions of Europe, Asia and Northern Africa. It was accidentally introduced to N. America near Boston in 1869 by an amateur entomologist. Subsequent to its introduction, it has been slowly expanding its range, and now is established in an area over 1000 km^2 in northeastern US and eastern Canada. In areas where the species has become established, populations periodically build to very high levels, causing high levels of defoliation over large areas (Fig. 1). Outbreaks recur indefinitely, sometimes causing mortality of host trees and in urban areas, tree defoliation and mortality is a considerable nuisance to homeowners. Large areas are aerially sprayed with pesticides as part of efforts to suppress outbreaks.

Invading populations established in N. America are believed to have originated from Europe and females from these populations are incapable of flight. Populations originating from various parts of Asia are typically larger and females are capable of flight. Gypsy moth egg masses are often laid on ships, containers, autos and other objects and inadvertently introduced to new areas. **There is considerable concern that Asian populations may be inadvertently transported in cargo and invade uninfested portions of the world where they may become serious pests.**

Figure 1. Extensive defoliation of broadleaf forests in Pennsylvania, USA caused by the gypsy moth in 2007 (photo Karl Mierzejewski).

The following participants of the IUFRO meeting on foliage, shoot and stem diseases at Montesclaros Monastery in Cantabria (Spain) during May 23-28th 2011, signed the declaration (followed with a list of later signers):

1. Müller, Michael. M.	Finland	(preparation group)
2. Green, Sarah	United Kingdom	(preparation group)
3. Hantula, Jarkko	Finland	(preparation group)
4. Wingfield, Michael	South-Africa	(preparation group)
5. Diez, Julio	Spain	(preparation group)
6. Adai, Gylden.	Turkey	
7. Akilli, S.	Turkey	
8. Álvarez Baz, G.	Spain	
9. Alves-Santos, F. M.	Spain	
10. Bezos, D.	Spain	
11. Blanco, J.	Spain	
12. Botella, Leticia	Spain	
13. Capretti, Paolo	Italy	
14. Černý, K.	Czech Republic	
15. Colinas, C.	Spain	
16. Davydenko, K.	Sweden	
17. de Vallejo, M.	Spain	
18. Doğmus-Lehtijärvi, Tugba	Turkey	
19. Dvořák, M.	Czech Republic	
20. Elvira-Recuenco, M.	Spain	
21. Fernández, M. M.	Spain	
22. Haque, M. M.	Spain	
23. Horne, B.	Canada	
24. Hsiang, Tom	Canada	
25. Jankovsky, Libor	Czech Republic	
26. Janoušek, J.	Czech Republic	
27. Kaitera, Juha	Finland	
28. Keßler, Marion	Austria	
29. Kirisits, Tomas	Austria	
30. Koltay, A.	Hungary	
31. Kovács, J	Hungary	
32. Kräutler, K.	Austria	
33. Kujundzic, C.	Canada	
34. Kuroda, K.	Japan	
35. Laflamme, Gaston	Canada	
36. Lehtijärvi, Asko	Turkey	
37. Lilja, Arja	Finland	
38. Machado, Helena, N.	Portugal	
39. Maden, S.	Turkey	
40. Májek, T.	Czech Republik	
41. Martín, J. A.	Spain	
42. Martínez-Álvarez, P.	Spain	
43. Martín-García, J.	Spain	
44. Misik, T.	Hungary	
45. Munck, I. A.	USA	
46. Nagy, L.	Hungary	
47. Oliva, Jonas	Sweden	
48. Orazio, C.	France	
49. Oskay, Funda	Turkey	
50. Pajares, J. A.	Spain	
51. Prieto-Recio, C.	Spain	
52. Raposo, R.	Spain	

53. Romeralo, C.	Spain
54. Rytkönen, Anna	Finland
55. Sánchez, G.	Spain
56. Santamaría, O.	Spain
57. Sanz-Ros, A. V.	Spain
58. Serrano, Y.	Spain
59. Silva, M. C.	Portugal
60. Smith, D. R.	USA
61. Solla, A.	Spain
62. Stanosz, Glen R.	USA
63. Stenström, Elna	Sweden
64. Strnadová, V.	Czech Republic
65. Sturrock, Rona	Canada
66. Talgo, V.	Norway
67. Tomešová, Vera	Czech Republic
68. Uotila, Antti	Finland
69. Vivas, M.	Spain
70. Vuorinen, Martti	Finland
71. Witzell, Johanna	Sweden
72. Zamora, Paula	Spain

Other pathologists and entomologists signing the declaration

(updated on April 28th, 2014)

73.	András, Koltany	Hungary
74.	Bakonyi, Jósef	Czech republic
75.	Battisti Andrea	Italy
76.	Cech, Thomas	Austria
77.	Chandelier, Anne	Belgium
78.	Cleary, Michelle	Sweden
79.	Corcobado Sánchez, Tamara	Spain
80.	Cravador, Alfredo	Portugal
81.	Drenkhan, Rein	Estonia
82.	Garbelotto, Matteo	USA
83.	Glen, Morag	Australia
84.	Grégoire, Jean-Claude	Belgium
85.	Greyling, Izette	South Africa
86.	Grigaliunas, Kestutis	Lithuania
87.	Gunulf, Anna	Sweden
88.	Hansen, Everett	USA
89.	Heyman, Fredrik	Sweden
90.	Hietala, Ari	Norway
91.	Holdenrieder, Ottmar	Switzerland
92.	Horta, Marilia	Portugal
93.	Hyder, Rafiqul	Bangladesh
94.	Iturritxa, Eugenia	Spain
95.	Jaber, Emad	Palestine
96.	Jiménez-Díaz, Rafael M.	Spain
97.	Kalicz, Péter	Hungary
98.	Kasanen, Risto	Finland
99.	Keca, Nenad	Serbia
100.	Kohli, R.K.	India
101.	Korhonen, Kari	Finland
102.	Kurkela, Timo	Finland
103.	Lakatos Ferenc	Hungary
104.	LaPorta, Nicola	Italy
105.	Lertxundi, Dioni Berra	Spain
106.	Liebhold, Andrew	USA
107.	Lombardero, Maria J.	Spain

108.	Lourenço Costa, Rita	Portugal
109.	Lovett, Gary M.	USA
110.	Maresi, Giorgio	Italy
111.	Mirtchev, Stefan	Bulgaria
112.	Muñoz, Carmen	Spain
113.	Nagy, Zoltán	Hungary
114.	Nakabonge, Grace	Uganda
115.	Nechwatal, Jan,	Germany
116.	Nevalainen, Seppo	Finland
117.	Nuorteva, Heikki	Finland
118.	O'Hara, Kevin L.	USA
119.	Ota, Yuko	Japan
120.	Pavlov, Igor	Russia
121.	Pennanen, Taina	Finland
122.	Pratt, Jim	UK
123.	Rajala, Tiina	Finland
124.	Roberts, Joanne	
125.	Roux, Jolanda	South Africa
126.	Sánchez, Esperanza	Spain
127.	Shamoun, Simon Francis	Canada
128.	Skovsgaard, Jens Peter	Sweden
129.	Smith, Amy	Australia
130.	Solla, Alejandro	Spain
131.	Soulioti, Nikoleta G.	Greece
132.	Stenlid, Jan	Sweden
133.	Thinggaard, Kirsten	Denmark
134.	Trzewik, Aleksandra	Poland
135.	Tsvetkov, Ivaylo	Bulgaria
136.	Tuomivirta, Tero	Finland
137.	Vainio, Eeva	Finland
138.	Valkonen, Jari	Finland
139.	Valtonen, Teppo	Finland
140.	Vanhanen, Henri	Finland
141.	Von Weissenberg, Kim	Finland
142.	Woodward, Stephen	UK
143.	Zas Arregui, Rafael	Spain