Newsletter of the Asia-Pacific Forest Invasive Species Network (APFISN)
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The Asia-Pacific Forest Invasive Species Network (APFISN) has been established as a response to the immense costs and dangers posed by invasive species to the sustainable management of forests in the Asia-Pacific region. APFISN is a cooperative alliance of the 32 member countries in the Asia-Pacific Forestry Commission (APFC) - a statutory body of the Food and Agricultural Organization of the United Nations (FAO). The network focuses on inter-country cooperation that helps to detect, prevent, monitor, eradicate and/or control forest invasive species in the Asia-Pacific region. Specific objectives of the network are: 1) raise awareness of invasive species throughout the Asia-Pacific region; 2) define and develop organizational structures; 3) build capacity within member countries and 4) develop and share databases and information.

Pine tree affected by wilt disease

mid- to late-1980's. In addition to pine, the nematode has been isolated from trees such as larch, balsam, fir, spruce, deodar and atlas cedar.

Symptoms of pine wilt disease usually become evident in late spring or summer. The first symptoms are thinning of the crown and lack of resin exudation from bark wounds. The foliage turns pale green, then yellow, and finally reddish brown when the tree succumbs to the disease. The wood in affected trees appears dry and lacks resin. The nematode feeds on epithelial cells and resin ducts in the affected trees and can become distributed throughout the sapwood of the branches, trunk and roots, leading to vascular dysfunction and reduction in transpiration. It takes only two to three months from infection to death of the tree. Because death is so rapid, the tree retains its brown needles for a long period of time, often up to one year.

Sawyer beetle- adult

The pinewood nematode is transmitted to other trees by pine sawyer beetles (*Monochamus* spp.), also called long-horned beetles, either when the sawyer beetles feed on the bark and phloem of twigs of susceptible live trees (primary transmission), or when the female beetles lay eggs (oviposition) in freshly cut timber or dying trees. The nematodes are carried in the tracheae of the beetle's respiratory system. When the beetles feed on the branches of healthy trees, the nematode emerges and enters trees through feeding wounds created by beetles. Once introduced into a tree seedling, the nematodes migrate mainly via the cortical resin canals in branches. In mature trees, which lack cortical tissue, they spread through the xylem resin canals. When not feeding on plant cells, the nematode feeds on blue stain fungi (*Ceratocystis* spp., *Ophiostoma piceae*) carried by the beetles into trees, or on the fungi which inhabit the weakened or killed trees.

Larva of sawyer beetle

The pinewood nematode is a microscopic un-segmented worm, about 1 mm in length. It is one of 49 species of *Bursaphelenchus*, most of which have a symbiotic relationship with insects. *B. xylophilus* has the general characteristics of the genus, i.e. lips high and offset, weak stylet with small knobs, median bulb well developed and dorsal esophageal gland opening inside the median bulb. However, it can be distinguished by the simultaneous presence of three characteristics: 1) the spicules are flattened into a disc-like structure (the cucullus) at the distal end; 2) the anterior vulval lip is a distinct overlapping flap; and 3) the posterior end of the female body is rounded in nearly all individuals.

The life cycle of the pinewood nematode involves a propagative cycle and a dispersal cycle. The propagative cycle occurs in the sapwood and involves six life stages viz., The egg, four larval stages and the adult. The sequence of egg to adult takes only 4 to 5 days under favorable conditions. The third larval stage involves two forms: 1) larvae that change into fourth stage larvae and into adults that remain in infested trees; and 2) a non-feeding dispersal stage. The dispersal mode occurs in the late stage of tree infection after tree death, and only in the presence of sawyer beetle pupae within the wood. The larvae aggregate on the wall of the pupal chamber of the beetle in the xylem and then molt into dauerlarvae. This is a non-feeding larval stage that is specialized for survival during the transport phase of the lifecycle. These fourth-stage larvae enter into the respiratory system of the young adult beetle and are transferred to new hosts. The dauerlarvae can molt into adult nematodes within 48 hrs after transmission to a conifer host. The plant-feeding phase of the nematodes occurs when they are introduced into the branches of a susceptible host by adult sawyer beetles feeding on the young bark.

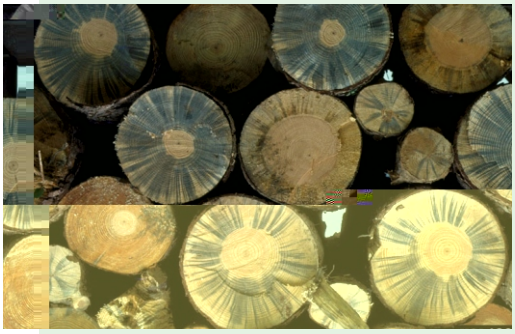
Pupa of sawyer beetle

Pine sawyer beetles are attracted to weakened trees or recently cut logs, where they mate and lay eggs. They will deposit eggs only on trees or logs with the bark attached. The larvae hatch within a week and feed on the phloem. The larvae also tunnel into the xylem to form an oval entrance hole and U-shaped galleries. The beetles overwinter as larvae and then pupate in an enlarged portion of the gallery. The pinewood nematode larvae, introduced by infested beetles along with their eggs, invade the thoracic spiracles and trachea of the beetle pupa in huge numbers (as high as 289,000). When the adult beetle emerges from the tree, it leaves a round, 0.5 cm diameter exit hole.

Log infested by sawyer beetle
with exit holes

Management of pine wilt disease is primarily limited to prevention by not planting non-native pines where the summer temperatures reach higher than 20° C. Where non-native trees already exist, alleviating drought stress can reduce the susceptibility of the trees. The pinewood nematode can be prevented from infesting softwoods by removing the bark at the time of felling, and by avoiding harvesting when sawyer

beetles lay their eggs (usually July-September). Controlling insect vectors by spraying the crowns of trees with insecticides and burning the infected trees are also practical methods. Trunk injection of nematicides has been used in Japan, but this needs to be done before any symptoms appear. Breeding resistant trees is another promising approach, since different species of pines vary in their resistance. Heat treatment (to a core temperature of 56° C or higher for 30 minutes), fumigation with aluminum phosphine or methyl bromide, kiln drying, irradiation or chemical dips have all been successfully used to eliminate pinewood nematodes from wood and wood chips.


Fungal blue staining on wood

The pinewood nematode has been found in shipments of conifer wood chips, in unseasoned lumber, and in packing case wood. Sawyer beetles have been found in wood pallets, crates and dunnage. Grub holes with blue staining fungi in crating materials indicate that sawyer beetles have been in the log. Young beetle grubs can survive very well in cut lumber, so, shipments of untreated coniferous wood, wood products and packing cases from nematode-infested countries to non-infested countries pose a great risk of transmitting the nematode. Extra quarantine measures need be taken to prevent accidental introductions. All packing cases and ship dunnage used to secure cargo in holds during sea voyages must be collected and destroyed portside as soon as possible. In 1985, the European Plant Protection Organization listed the pinewood nematode as a quarantine pest and recommended that Europe ban conifer products from countries that have the nematode unless the products have been kiln-dried. Several other countries have also adopted import restrictions on untreated softwood products.

Mile-a-minute weed (*Mikania micrantha*)

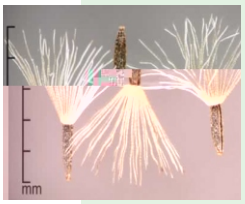
Mikania micrantha is a fast growing perennial creeper belonging to the family Asteraceae. It is commonly called "mile-a-minute weed" because of its exceptionally fast growth rate and spreading nature. The native range of *Mikania* lies in the tropical and sub-tropical zones of North, Central and South America. Although it is only of minor importance as a weed in its native habitats, once it is transported outside, *M. micrantha* is capable of rapidly producing a huge amount of biomass and even smothering large trees, causing significant losses in natural forests, plantations and agricultural systems. *Mikania* has now reached the status of a major weed in many countries within the moist tropical zones of South and Southeast Asia and the Pacific, and is still expanding its range.

Mikania infestation in natural forests in southern China

Mikania- habit

Mikania is a twining herb with the following characteristics: 5 ribbed branches, pubescent or glabrous; internodes 7.5-21.5 cm long; leaves opposite, ovate-deltoid, 6-15 x 3-9 cm, base cordate, apex acuminate, glabrous on both sides, 3-5 nerved from base; petiole 3 - 7 cm long; inflorescence axillary panicled corymbs; 4 flowers per capitula; 4 involucral bracts, oblong to obovate, acute, green, 1-3 mm long; corolla 5 lobed, white, often with a purple tinge, 4-5 mm long; achens 2-3 mm long, narrowly oblong, 4 - angled, black, glabrous; pappus capillary, uniseriate, connate at base, 3 mm long, white at first, becoming reddish-brown.

Plants show phenotypic plasticity in high altitude areas where the stems turn dark violet and more pubescent. The lamina and petiole develop a dark violet tinge and the margins are deeply toothed or serrate. *Mikania* has vigorous vegetative and sexual reproductive capacity, but cannot tolerate dense shade. Seeds are dispersed over long distances by wind and the plants can grow vegetatively from the nodes and from very small segments of the stem. Growth of young plants is extremely fast (8-9 cm in 24 hours) and, using trees as support, the weed rapidly forms a dense cover over entangled leafy stems. Areas formerly free from the weed can be colonized within a few days. *Mikania* starts to flower in August and continues up to February. Fruit setting occurs from September to February. Seed dispersal occurs during October to April. Wind, water and animals are the common agents for the dispersal of seeds. The seeds are minute and bear papus.



Mikania seeds

A literature search shows that *Mikania* currently occurs as a weed in Australia, Bangladesh, Myanmar, Nepal, Borneo, Dominican Republic, Indonesia, Jamaica, Mauritius, Melanesia, West Polynesia, Thailand, Philippines, West Indies, Fiji, Solomon Islands, Samoa and American Samoa,

Sri Lanka, India, Hong Kong, Malaysia, Vietnam and Japan. *Mikania* is reported to have been deliberately introduced into northeastern (NE) India during the second world war as a ground cover for tea plantations. Thereafter it dramatically increased its range within India, causing damage to tree crops and agroforestry/multipurpose trees in the moist tropical zones of southwest and northeast India. As the weed can penetrate crowns, smother, choke and pull over plants, the damage caused to crop plants is significant. It also successfully competes with trees and other crop plants for soil nutrients and sunlight. The weed often covers the canopy of trees, reducing light penetration. Damage due to *Mikania* is reported to be higher in young (0-4 year-old) plantations when compared to older ones.

Reduced yields due to *Mikania* infestation in rubber, oil palm and cacao plantations are reported from Malaysia. The girth of rubber trees in the infested plantations was 27% smaller than in non-infested plantations. In oil palm, the weed caused a 20% reduction of the palm yield during the initial five years of production. In Indonesia, *Mikania* poses a threat to coconut rubber, teak and *Pinus merkusii* plantations. The annual cost of controlling *Mikania* in plantations in Malaysia is estimated to be 8-10 million Malaysian ringgits. Besides the effect on crop yield, *Mikania* makes harvesting cumbersome due to its twining and creeping habit. The weed renders collection of non-wood products (e.g., reed extraction) from natural forests in Kerala (India), less profitable, since only small quantities can be collected in a day due to the heavy overgrowth of the weed.

Attempts to control *Mikania* have been carried out from time to time using cultural, mechanical, biological and chemical methods. Sickle weeding, uprooting and digging were some of the mechanical methods used. These were, however, labor intensive, expensive and not effective in the longer term. Application of the herbicides such as glyphosate (@ 2.5 l/ha) or diuron (@ 1 kg/ha) provides temporary control of *Mikania* infestation, provided spraying is carried out before the initiation of flowering/seed setting. Repeated yearly applications may be required for long-term control. Biological control of *Mikania* using a natural insect enemy viz., *Liothrips mikaniae* from Trinidad was attempted in the Solomon Islands and Malaysia. However, successful establishment of the insect was not achieved due to various reasons. Recent studies proved that a highly damaging, microcyclic rust viz., *Puccinia spegazzinii*, which occurs naturally in the neotropics, has great potential as a biocontrol agent against *Mikania*. The fungus has recently been released in northeast and southwest India and preliminary reports from the release sites have been encouraging.

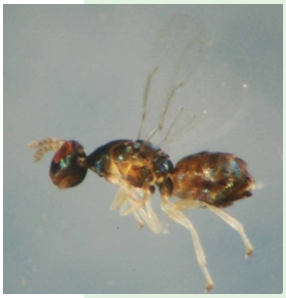
Mikania smothering banana in Kerala, India

Outbreak of the invasive gall-inducing wasp *Leptocybe invasa* on eucalypts in India

Leptocybe invasa (Hymenoptera: Eulophidae), or blue gum chalcid, is a gall-inducing wasp (apparently originating from Australia) which is curently spreading throughout many countries in the Mediterranean basin, Africa and Asia, causing damage to eucalypt nurseries and plantations. Ocurrence of the wasp was reported from Algeria, France, Israel, Italy, Jordan, Morocco, Spain, Turkey, Kenya, Syria, Tanzania, Uganda, Iran and Vietnam. In Uganda, where the incidence of the wasp was first noticed in 2002, it is reported to take a heavy toll on eucalypt plantations. This article reports, for the first time, the outbreak of the wasp in India. Its occurrence was recorded in plantations and nurseries of *Eucalyptus camaldulensis* and *E. tereticornis* at several locations in Tamil Nadu, Karnataka, Andhra Pradesh and Pudusserry.

Eucalypt seedling with galls

Seedlings in nurseries and 6-8 month-old saplings in plantations are susceptible to *L. invasa*, which produces galls in young shoot terminals, petioles, and midribs. In mature trees, the galls occur only on leaf midribs. Adult females of *L. invasa* oviposit on young shoot tips and midribs of juvenile leaves. Scars due to the laying of eggs are visible on both sides of the midrib, particularly on tender leaves. After the eggs hatch, the larvae develop inside characteristic cylindrical galls produced on the midrib, petiole or stem axis. Mature galls are usually deep pink or red in color. Pupation occurs within the gall and adult wasps emerge by cutting exit holes (about 2.7 mm wide) on the gall wall. Thelytokous reproduction has been reported in *L. invasa*. The duration of the life cycle of the wasp is around 4 months. Several galls on a single leaf may usually give rise to about 24 adult wasps although the



Adult female of L.invasa

occurrence of 35 adults has also been noticed. Gall formation by *L. invasa* damages growing shoot tips and leaves of eucalypts, resulting in quicker abscission of leaves and drying up of shoots. Infested shoot terminals and leaves appear deformed. A heavy infestation of the wasp results in loss of vigor and growth retardation in clones and seedlings. In Iran, Israel and Turkey, two to three overlapping generations of the wasp per year have been observed.

Exit holes of adult wasps on galls

Eucalypts occupy 8 million ha in India (25% of the plantation estate of the country) and spread of the gall wasp is of huge economic concern to the country. The young shoots of seedlings and coppice crops form an ideal breeding site for the wasp and heavy infestations can damage an entire plantation if timely control measures are not adopted. If the galls are few in number, selective pruning or plucking of leaves or shoots containing galls may be done and the affected plant parts burned. In severe infestations, spraying of the plants with of 0.06% dimethoate (2 ml per liter of water) or 0.02% imidacloprid a.i. 17.80% (1 ml per liter of water) may help to contain the problem. A second spraying may be given after 15-20 days of the first application if fresh infestations appear. Constant monitoring and removal of plant parts with young galls will reduce the damage and spread of the pest.

L. invasa is reported to attack several other eucalypt species such as *E. botryoides*, *E. bridgesiana*, *E. globulus*, *E. gunii*, *E. grandis*, *E. saligna*, *E. maidenii*, *E. robusta* and *E. viminalis*. The movement of young plants can transmit the pest over long distances. Strict quarantine measures need to be adopted to check the further spread of the wasp.

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New publications

Palmer, W. A. and A. McLennan. 2006. The host range of *Isturgia deerreria*, an insect considered for the biological control of *Acacia nilotica* in Australia. African Entomology, 14: 141-145.

Gosper, C. R., Whelan, R. J. and K. French. 2006. The effect of invasive plant management on the rate of removal of vertebrate-dispersed fruits. Plant Ecology, 184: 351-363.

White, E. M., Wilson, J. C. and A.R. Clarke. 2006. Biotic indirect effects: A neglected concept in invasion biology. Diversity & Distributions, 12: 443-455.

Recent Books

Invasion ecology: By Julie Lockwood, Martha Hoopes, and Michael Marchetti, published by Blackwell Publishing Professional, 2006. The book focuses on ecological patterns and mechanisms of invasion biology and targets upper-division undergraduates and beginning graduate students. While covering many basic ecological theories, the book purposefully discusses these within the unique context of the multi-stage invasion process, starting with the transport and release of non-native organisms and moving through the establishment, spread, and impacts of invasive species.

Weed biology and management (Bioelectric engineering). Ed. Inderjit, published by Springer, 2004. This book offers a global perspective on weed science by presenting contributions from an outstanding group of researchers in 12 countries, reviewed by over 50 experts. It discusses technologies which could relieve the negative impacts of weeds on crop production in a way that allows growers to optimize profits and preserve human health and the environment. These technologies represent the science of weed management. The aim of the book is to provide insight and recent progress in the science of weed research.

Dynamics of weed populations: By Roger Cousens and Martin Mortimer, published by Cambridge University Press, 2004. The authors place weed management within an ecological context, with the focus on the manipulation of population size. They consider the dynamics of abundance and spatial distribution at both geographic and local scales, and consider the basic processes of dispersal, reproduction and mortality, together with the factors that influence them. The authors show how management modifies patterns of behavior that are intrinsic to populations, and note the evolution and management of resistance to herbicides.

Forthcoming Symposia / Workshops

8 - 10 May 2007. Developing Invasive Species Management Plans. Kuala Lumpur, Malaysia. This workshop is organized by the Asia-Pacific Forest Invasive Species Network (APFISN). The main objectives of the workshop are to: 1) identify key components of an overall forest invasive species (FIS) biosecurity strategy to mitigate the risk of entry, establishment and spread of FIS in the Asia-Pacific region, 2) identify effective methods for prevention of new incursions through implementing effective quarantine measures and various appropriate codes of practice and 'best practice' procedures, 3) develop an action plan for early detection of invasive species and rapid response and 4) identify and develop key elements and activities to enhance capacity and capability for early detection and rapid response to mitigate impact of FIS in the region. The workshop will be particularly relevant to senior forestry officials, policy makers, forest researchers and quarantine personnel. Contact: Mr. Patrick Durst, Senior Forestry Officer, FAO Regional Office for Asia and Pacific, 39 Phra Atit Road, Bangkok (patrick.durst@fao.org)

10 - 12 May 2007. Best Practice in Disease, Pest and Weed Management, Berlin, Germany. The symposium focuses on 'Best Management Practices (BMP)' established in plant protection reflecting the ongoing public and scientific debate about benchmarking of existing practices in integrated plant protection and the development of alternative or innovative approaches. The symposium provides the stage for experts from various related fields such as extension services, chemical or biotechnological companies, retailers, universities, research institutions, non-governmental organisations and public authorities in order to synthesize a critical evaluation of the state of BMPs in crop protection, based on which a projection of future demands and developments should be derived. Contact: www.dpg-bcpc-symposium.de

21 - 24 May 2007. Fifth International Conference on Marine Bioinvasions, Massachusetts Institute of Technology, Massachusetts, USA. The National Sea Grant College Program, the International Council for the Exploration of the Seas (ICES) and the North Pacific Marine Science Organization (PICES) are jointly sponsoring this Conference. The purpose is to examine marine bioinvasion vectors, patterns, distribution, ecological and evolutionary consequences, economic impacts, biosecurity approaches, and natural and invasion impacts on biodiversity. Contact: Lynne Lenker (llenker@mit.edu)

7-9 August 2007. Managing Vertebrate Invasive Species, Fort Collins, Colorado, U.S.A. The symposium will highlight research and management and public education associated with vertebrate invasive species (e.g., mammals, birds, reptiles and amphibians). Speakers will discuss early detection and rapid response, prevention, management or eradication, invasions and impacts, economics, resource recovery, public education and support, research needs and global initiatives. Contact: Dr. Kathleen Fagerstone (Kathleen.a.fagerstone@aphis.usda.gov)

Compiled and edited by Dr. K. V. Sankaran, APFISN Co-ordinator on behalf of the Asia-Pacific Forest Invasive Species Network. For more information on the APFISN, please contact your national focal point or the APFISN Co-ordinator or Mr. Patrick Durst, Senior Forestry Officer, FAO Regional Office for Asia and the Pacific, 39 Phra Atit Road, Bangkok. Email: patrick.durst@fao.org