Forest Insect
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Invasive Bark Beetles

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Banded elm bark beetle,
Scolytus schevyrewi Semenov

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Redhaired pine bark beetle,
Hylurgus ligniperda (F.)

A.G. Gutierrez

Mediterranean pine engraver,
Orthotomicus erosus
(Wollaston)

Pest & Disease
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Pine shoot beetle,
Tomicus piniperda (L.)

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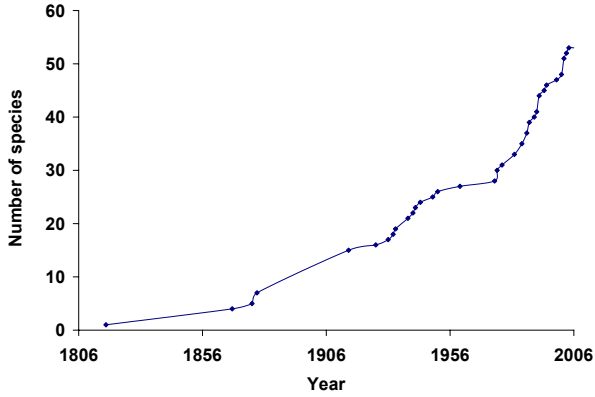
Bark beetles (Scolytidae) are among the most damaging insects in Northern Hemisphere forests, killing trees by direct feeding and by vectoring fungal pathogens. In addition to an already formidable native bark beetle complex, the number of exotic scolytids in U.S. forests has increased rapidly, with 53 known species



Cumulative number of established invasive scolytid species in the U.S.

established as of June 2007. Scolytids include 'true' bark beetles that breed and feed beneath the bark in the phloem and outer xylem, as well as ambrosia beetles that breed in the xylem and feed on fungi that grow in their galleries. Because of their close association with wood and other plant material, scolytids are moved easily and unwittingly to many places through trade. As a consequence, some species have become nearly cosmopolitan. Between 1985 and 2000, scolytids were intercepted at U.S. ports from imported cargo on 6,825 occasions by the United States Department of Agriculture – Animal and Plant Health Inspection Service (USDA-APHIS). Scolytids represented about 58% of all insects intercepted in solid wood packing material, most frequently in association with tile, marble, machinery, steel parts, ironware, granite, aluminum, and slate. Only a small portion of incoming cargo can be inspected, so most cargo containers are moved directly and quickly to inland distribution sites without inspection. Hence live bark beetles can enter the country undetected.

Special challenges posed by invasive bark beetles include:

1. Potential host affiliations and ultimate geographic distribution are difficult to predict in the varied new environments of the U.S.

2. The ecological niches of invasive bark beetles may overlap with native bark beetles and other insects. If the invasives are superior competitors, they may displace native species or affect relationships among native species and their natural enemies.

3. Invasive bark beetles may also introduce invasive pathogens, or may be efficient vectors of native or already established invasive pathogens, adding further obstacles to the health of U.S. tree populations.

4. In the absence of specific natural enemies from their native ranges, populations of invasive bark beetles may be poorly regulated.

Documented Impacts

Severe infestations of **banded elm bark beetle** (BEBB) have killed drought-stressed elms in Colorado and Wyoming. In 2004, 333 infested Siberian elms were removed from Newcastle, Wyoming.

Dead Siberian elm infested with BEBB

The **Mediterranean pine engraver** (MPE) and **redhaired pine bark beetle** (RPBB) have caused economic losses in Monterey pine plantations in the Southern Hemisphere by killing drought- and fire-stressed trees.

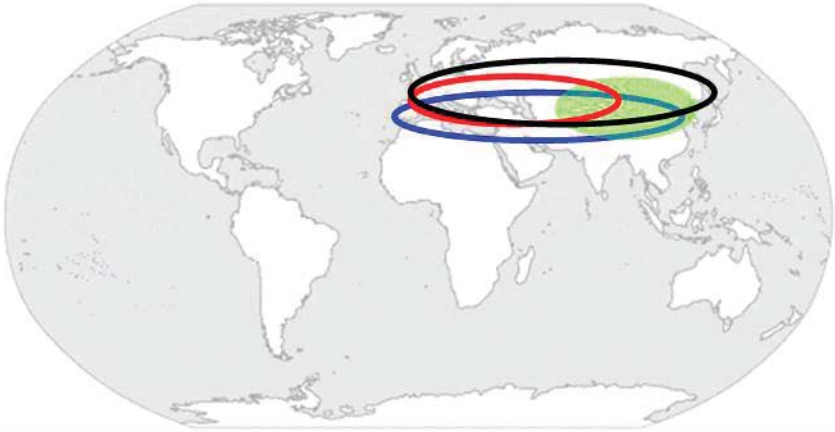
The **pine shoot beetle** (PSB) has caused severe shoot damage to pines in North America. Consecutive years of high density populations can reduce tree growth or affect the appearance of nursery or Christmas trees. A federal quarantine imposed in 1992 regulates transport of pine logs, Christmas trees, and nursery stock to areas not known to be infested.

Feeding damage by MPE under the bark of an Italian stone pine

Other economically-important exotic bark beetles that are not in the U.S. but have the potential to establish populations and assume pest status include *Dendroctonus armandii, Dendroctonus micans, Hylastes ater, Ips duplicatus, Ips sexdentatus, Ips typographus, Pityogenes chalcographus, Scolytus intricatus,* and *Scolytus scolytus* (major Eurasian pests); *Carphoborus minimus, Crypturgus mediterraneus, Hylastes linearis, Hylurgus micklitzi, Pityogenes calcaratus*, and *Tomicus destruens* (associated with MPE in the Mediterranean); and *Hylastes angustatus* (associated with RPBB in South Africa). Less prominent and even unobtrusive bark beetles from overseas are also of concern because they may become significant pests once established in the new environment afforded by the U.S.

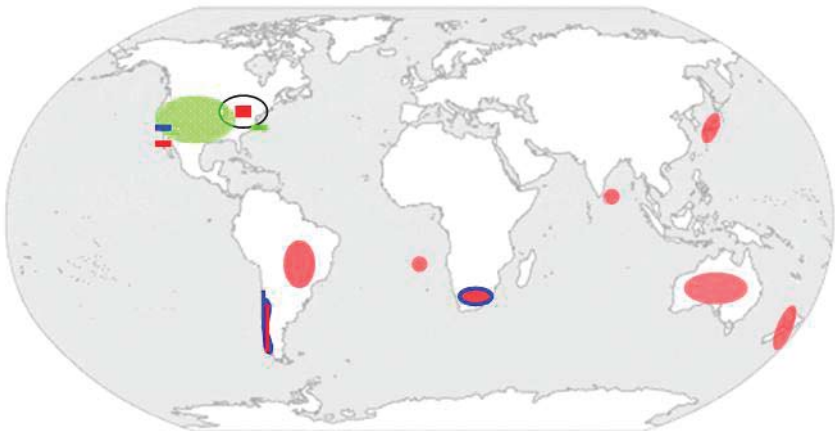
Christmas tree with shoot dieback from PSB feeding

Approximate Native Distributions



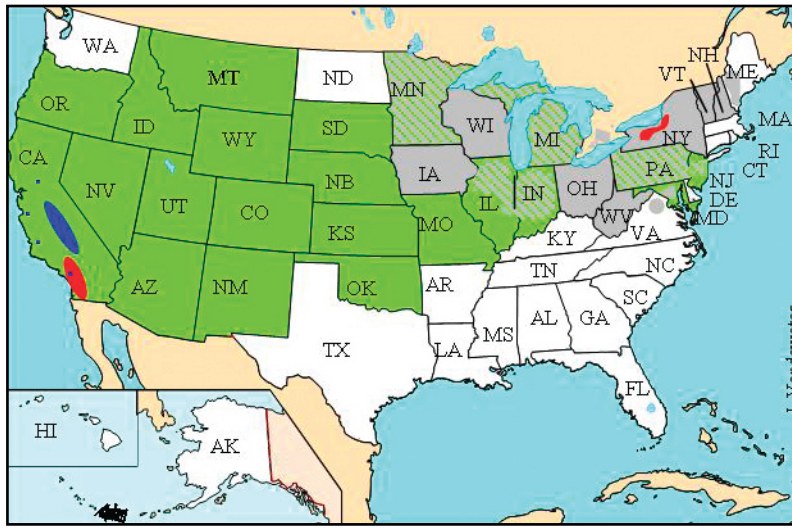
BEBB- central Asia, northern China, Korea, Mongolia, Russia, Siberia
MPE-central Asia, China, Mediterranean, Middle East
RPBB-Asia minor, central Europe, Mediterranean
PSB-Eurasia including Japan, Korea, Scandinavia

Introduced Distributions (as of June 2007)



BEBB-U.S.
MPE-Chile, South Africa, Swaziland, and U.S. (California); collected historically but likely not established in England, Finland, and Sweden
RPBB-Australia, Brazil, Chile, Japan, New Zealand, Saint Helena, South Africa, Sri Lanka, Swaziland, Uruguay, and U.S. (New York, California)
PSB-Canada, U.S.

U.S. Distributions (as of June 2007)



Banded elm bark beetle
Mediterranean pine engraver
Pine shoot beetle
Redhaired pine bark beetle

BEBB-22 states, mostly western and midwestern region
MPE- six Central Valley counties of California, occasionally in coastal areas
RPBB-Lake Ontario region of New York, six southern California counties
PSB-16 eastern and midwestern states (MA, CT, RI quarantined but not infested)

First Detections

The **banded elm bark beetle** was first detected in April 2003 in Aurora, Colorado, and Ogden, Utah, in baited Lindgren funnel traps placed around pallet recycling sites, as part of a USDA Forest Service and APHIS-PPQ Early Detection and Rapid Response Pilot Project. Inspection of museum specimens confirmed that it was captured earlier; one beetle was collected in 1994 in Denver, Colorado. **Mediterranean pine engraver** was detected in May 2004 at the Fresno Zoo, Fresno, California, in funnel traps during a survey by the California Department of Food and Agriculture (CDFA). Established populations of the **redhaired pine bark beetle** were first detected in November 2000 near Rochester, New York while evaluating white pine root decline in a Christmas tree plantation. RPBB was also detected in July 2003 in a flight survey trap in Los Angeles, California by CDFA. The **pine shoot beetle** was discovered in July 1992 near Cleveland, Ohio, in a Christmas tree plantation. A museum specimen was found from 1991 in Michigan.

Banded elm bark beetle (BEBB)

Mediterranean pine engraver (MPE)

Redhaired pine bark beetle (RPBB)

Pine shoot beetle (PSB)

Reported Hosts

Elms (*Ulmus* spp.): **American**, big fruit, chalked bark, **English**, European white, field, Japanese, **rock**, **Siberian**, **smooth-leaved**, winged

Rose (Rosaceae): almond, apricot, cherry[no], paradise apple, peach, pear, other *Prunus* spp.[no]

Other: Oleaster, Russian olive[no] (Elaeagnaceae), pea shrub[no] (Fabaceae), weeping willow (Salicaceae)

Pines (*Pinus* spp.): **Aleppo**, Austrian, **Brutia**, **Canary Island**, Caribbean, Chinese hard, Chinese red, Coulter, David, eastern white[lab], **grey**, khasia, **Italian stone**, jack[lab], Jeffrey[lab], loblolly[lab], lodgepole[lab], maritime, Mexican weeping, **Monterey**, pinyon[lab], ponderosa[lab], red[lab], **Scots**, shortleaf, slash, sugar[lab], Yunnan

Other: **Cedar** (*Cedrus*), Douglas-fir[lab] (*Pseudotsuga menziesii*), fir[no] (*Abies*), spruce[lab] (*Picea*), tamarack[lab] (*Larix*)

Pines (*Pinus* spp.): **Aleppo**, Austrian, Brutia, **Canary Island, eastern white**, Italian stone, maritime, Mexican weeping, Monterey, Montezuma, Scots, slash

Pines (*Pinus* spp.): **Austrian, eastern white, jack, loblolly, lodgepole, longleaf, red, Scots, shortleaf, slash, ponderosa, Virginia** *(cut logs of southern and western pines were tested in PSB-infested plantations in Ohio and Michigan)*

Other: Spruce (*Picea*), fir (*Abies*), Douglas-fir (*P. menziesii*), and tamarack (*Larix*) in rare cases

bold - recorded as a host in the field in the U.S.

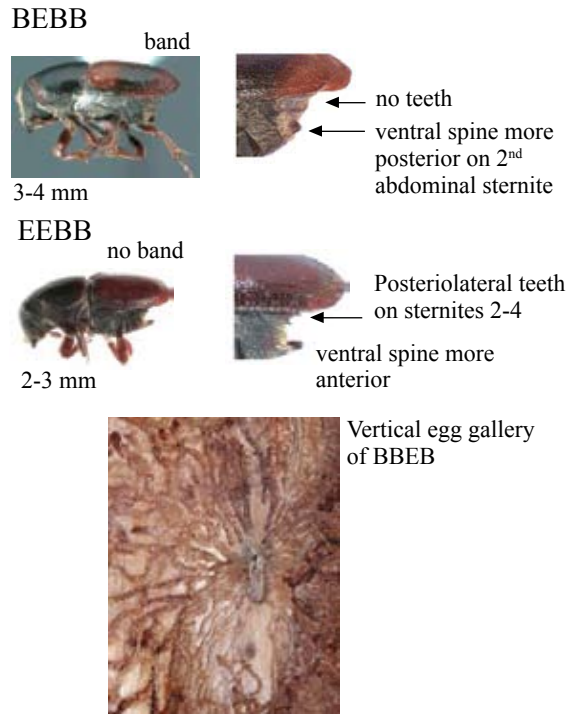
[lab] recorded as a host in the laboratory, although not yet observed in the field in the U.S.

[no] not recorded as a host in the laboratory, but reported as a host in the literature from its indigenous distribution.

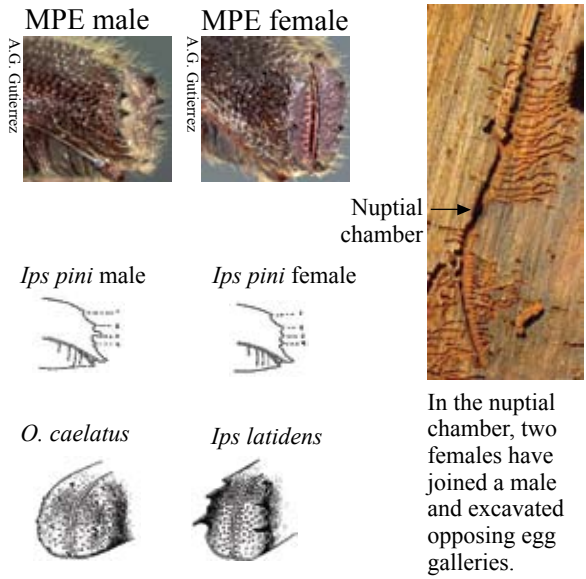
Areas of Concern	Fungal Associations
Populations of **BEBB** are damaging stressed elms in the arid Rocky Mountain and Intermountain regions where Siberian elm is a primary shade tree. The ultimate impact of BEBB on American elm populations across the U.S. is uncertain.	Beetles emerging from diseased American elm logs carried spores of *Ophiostoma novo-ulmi*, the causative agent of Dutch elm disease. Before mating, BEBB feeds in twig crotches; this may enable beetles to transmit the pathogen to living trees.
The broad host range of **MPE** could facilitate its spread throughout California to coastal Monterey pines, native pines in the mountain ranges, and to distant warm regions such as the Southeast where loblolly, shortleaf, and slash pine are present.	*Ophiostoma (Ceratocystis) ips, Leptographium lundbergii, L. serpens*, and *Graphium pseudormiticum* have been isolated from adults infesting various pines overseas. In California, *O. ips* was the most frequently isolated fungus from beetles infesting cut pine logs.
RPBB may affect Aleppo, Canary Island, and Monterey pines frequently grown as shade trees in southern California. Its potential to vector procera root pathogen may affect Christmas tree plantations in the East and the unexposed Northwest.	*Leptographium lundbergii, L. procerum, L. serpens, O. ips, O. galeiformis,* and *Ceratocystiopsis minuta* have been isolated from adults and galleries in pines overseas. RPBB could vector black stain root disease, *L. wageneri*, a native pathogen that already threatens western pines.
Throughout the Northeast and Lake States, **PSB** may cause damage in poorly managed Christmas tree or nursery plantations. A federal quarantine was enacted to retard the southern and western spread of PSB.	PSB vectors *Leptographium wingfieldii*, causing blue-stain of the xylem of Scots pines. Beetles and infested trees have also been associated with *L. lundbergii, L. huntii, L. procerum,* and *Graphium* sp.

Identification

The **banded elm bark beetle** generally has a light-to-dark band across its wing covers (elytra). It resembles the smaller European elm bark beetle (EEBB), *Scolytus multistriatus*, another exotic that was established in the U.S. a century ago and is a vector of Dutch elm disease. The two species can be distinguished by size, ventral spine placement, presence/absence of elytral band, and posteriolateral teeth along the edges of the underside. Females excavate a single vertical egg gallery in the phloem.



The **Mediterranean pine engraver** is 2-3 mm long, dark brown, and has four spines on its end (declivity). The second spine is largest and very pronounced in males. It may be confused with the native species, *Ips pini*, whose males have a large third spine and whose females have four equally sized spines. Other native species, *Orthotomicus caelatus* and *Ips latidens*, have only three declivital spines.



In the nuptial chamber, two females have joined a male and excavated opposing egg galleries.

Drawings Wood 1982

The **redhaired pine bark beetle** is 5-6 mm long and black. RPBB is distinguished from PSB by RPBB's abundant setae (hairs) that point in various directions on the elytral declivity. Under the microscope, numerous reddish or yellowish hairs cover the beetle. A native species, *Hylastes porculus*, appears similar, but is nearly hairless. RPBB has a raised longitudinal tubercle on the frons, the front part of the head behind the mouthparts.

A.G. Gutierrez

Declivity with dense, but variable red and yellow hairs

W.M. Ciesla

Females construct a long egg gallery

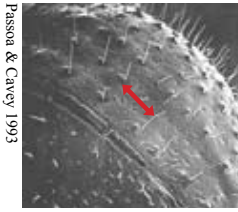
S. Passoa

UGA 1669028

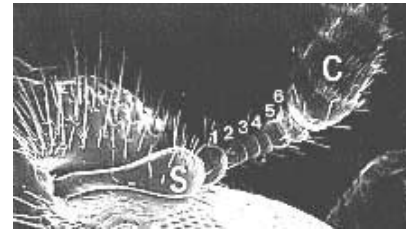
The **pine shoot beetle** is 3-5 mm long and brown to black. PSB is distinguished from other species of *Tomicus* by its smooth elytral intervals on its declivity (arrow). PSB may resemble *Dendroctonus* spp. (e.g., southern pine beetle), but its antennal stalk (funicle) has six short segments rather than five/seven as in *Dendroctonus*. The egg gallery is vertical with a bend or hook at the end.

S. Kinelski

Passoa & Cavey 1993



Declivity with single rows of erect hairs, and smooth interval



Antennal funicle with segments numbered

Life Cycles

Banded elm bark beetle females construct single vertical egg galleries about 4-6 cm long that lack a nuptial chamber. Males move about the bark surface searching for entrance holes and mate with multiple females at these entrances. Between 20 and 120 eggs are laid and females guard the egg gallery until death. Larvae develop through four or five instars and migrate to the outer bark to pupate. There are two to three generations in the U.S. Larvae, pupae, and adults overwinter, and the adults start emerging in early spring.

Mediterranean pine engraver males construct a nuptial chamber and emit an aggregation pheromone. Two or three females mate with each male, and each female excavates an egg gallery in opposite directions laying 26-75 eggs. Adults may start a new gallery in another location. In California, MPE overwinters as larvae, pupae, and adults beneath the bark; adults fly during all months except late December and January; and the beetle has three to four generations per year. Newly laid eggs have been observed as early as the first week of March and as late as the last week of November.

Redhaired pine bark beetle females construct a nuptial chamber, and one RPBB male mates with one female. A female lays up to 500 eggs in a vertical gallery that is sometimes one meter long. Galleries are often found on the undersides of logs in contact with moist soil. In California, RPBB adults fly all year, and the beetle completes two to three generations per year.

J. Cavey

RPBB adults overwinter beneath the bark

Pine shoot beetle adults mate and construct single vertical egg galleries in dying, cut, or severely stressed pines. New adults emerge in early summer and feed primarily in current-year shoots during the summer. Each beetle can damage one to six shoots. PSB completes one generation per year in the U.S. Adults overwinter in the bark at the base of stems and rarely in the shoot. Overwintering adults emerge in early spring when temperatures exceed 10-12°C (50-54°F).

Hollowed-out shoot fed on by PSB

Management

Managing invasive bark beetle populations begins with prevention tactics, early detection, and occasionally quarantine. Semiochemicals, which are often based on the beetle's aggregation pheromone or host attractants, are used as lures in monitoring traps. Traps are typically cardboard flat panel traps, or plastic funnel traps that present a dark, cylindrical silhouette to the flying beetles. Infested material should be removed and burned, debarked, or chipped to prevent build up and spread of the populations. Live trees should be adequately watered to prevent stress and reduce susceptibility to bark beetle attacks. Registered insecticides (e.g., carbamates, pyrethroids) are available as preventive treatments and should be applied before high value trees are attacked. Consult your State Department of Agriculture or County Extension office for a list of registered products.

Funnel trap

Semiochemicals for monitoring invasive bark beetles and additional recommendations	
BEBB	Multilure™ (Pherotech), which was developed for the smaller European elm bark beetle, is also moderately attractive to BEBB. 2-Methyl-3-buten-2-ol is weakly attractive.
MPE	(–)-Ipsdienol, 2-methyl-3-buten-2-ol, and α-pinene in combination are attractive synergistically. (+)-Ipsdienol can be used to interrupt MPE flight to otherwise attractive materials.
RPBB	α-Pinene and ethanol are attractive synergistically. RPBB burrows into host material that is in contact with wet soil. Therefore, elevating cut logs aboveground can decrease the level of infestation in cut pine logs.
PSB	α-Pinene and *trans*-verbenol are attractive.

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