NOM-016-SEMARNAT-2013, QUE REGULA FITOSANITARIAMENTE LA IMPORTACIÓN DE MADERA ASERRADA NUEVA

ANÁLISIS DE RIESGO DE PLAGAS

ESPECIE DE INSECTO [(a)]	**DISTRIBUCIÓN**	**HOSPEDANTES**	**PRESENTE EN MEXICO**	**RIESGO**
Apate spp	Europa, Asia, África, Oceanía Norteamérica (Canada y USA)	*Abies, Cedrus, Acer,), Cedrus (c, Larix (, Picea (spruces), Picea, Pinus, Pseudotsuga (douglas-fir), Pseudotsuga, Thuja occidentalis, Tsuga sieboldii, Bambusa, Dendrocalamus y Phyllostachys*	No	Alto
Bostrichus capucinus	Europa, África, Asia y USA		No	Medio
Dinoderus spp (**excepto** *D. minutus*)	África, Oceanía, América Central y America del sur	*Bambusa*	No	Alto
Heterobostrychus spp	Europa, Asia, África, Oceanía y EUA.	*Bambusa, Cedrella, Casia, Mangifera, Quercus , Tectona*	No	Alto
Lichenophanes spp (**excepto** *Lichenophanes fasciculatus, L. pencilliatus, L. spectabilis, L. tuberosus, L. verrucosus*)	Amplia distribución; no todas las especies están presentes en México	*Diversos*	No	Medio
Lyctoxylon spp	Amplia distribución; no	*Diversos*	No	Alto

	todas las especies están presentes en México			
Lyctus spp (***excepto*** *Lyctus brunneus, L. caribeanus, L. carbonarius = L. planicollis, L. linearis, L. tomentosus y L. villosus)*	Europa, Asia, África, EUA, Australia	*Árboles forestales y Phoenix dactylifera*	Es un género muy amplio, existen especies no presentes en México.	Alto
Micrapate spp (**excepto** *Micrapate guatemalensis*, *M. labialis*, *M. mexicana*, *M. pinguis*, *M. scapularis*, *M. sericeicollis*, *M. unguiculata*)	Amplia distribución; no todas las especies están presentes en México	*Diversos*	No	Medio
Minthea spp (**excepto** *Minthea rugicollis*)	Europa y Asia	*Bambusa, Quercus, Fraxinus, Swietenia, Tectona, Cedrela, Ficus, Carya, Acacia albida*	No	Alto
Sinoxylon spp	Asia, Sudamérica (Venezuela y Brasil), Oceanía, Europa, África, Centroamérica y Norteamérica (USA y Canada)	*Acacia, Bambusa, Casuarina, Hevea brasiliensis, Manihot esculenta, Derris, Ficus*	No	Alto
Trogoxylon spp (**excepto** *Trogoxylon aequale*, *T. praeustum* y *T. punctatum*).	Europa, Asia	*Quercus*	No	Medio
Agrilus planipennis	Asia, USA y Canadá	*Fraxinus, Ulmus, Juglans*	No	Alto
Anophlophora spp	Asia, USA, Canadá	*Acer, Citrus, Malus plumila, Casuarina,*	No	Alto

		Populus, Sálix, Ulmus		
Euplatypus spp (Platypus spp) (**excepto** *Euplatypus compositus*, *E. longuis*, *E. longulus*, *E. otiosus*, *E. parallelus*, *E. pini*, *E. segnis*).	Asia, Europa, Norteamérica (Canadá), Oceanía. Amplia distribución; no todas las especies están presentes en México	*Castanopsis cuspidata, Cryptomeria japonica, Ilex chinensis, Lindera erythrocarpa, Lithocarpus, Prunus Quercus, Theobroma cacao*	No	Alto
Dendroctonus armandi, *D*. micans ,*D. murrayanae*, *D. punctatus*, *D. rufipennis*, *D. simplex* y *D. terebrans.*	Amplia distribución; no todas las especies están presentes en México	*Diversos*	No	Alto
Ips spp (**excepto** *Ips bonanseai, I. calligraphus*, *I. cribicollis*, *I. confusus*, *I. grandicollis*, *I. emarginatus*, *Ips hoopingi*, *Ips integer*, *I. latidens, I. lecontei*, *Ips mexicanus*, *Ips pini*)	Amplia distribución; no todas las especies están presentes en México	*Diversos*	No	Alto
Orthotomicus spp.	Europa, África, Asia, Sudáfrica, Estados Unidos (Ca)	*Pinus, Cupressus, Cedrus, Picea, Abies, Pseudotsuga.*	No	Alto
Xyleborus spp (**excepto** *X. affinis*, *X. catulus*, *X. discretus*, *X. ferrugineus*, *X. guatemalensis*, *X. horridus*, *X. imbelis, X. intrusus*, *X. macer*, *X. morulus*, *Xyleborus* (*Neoxyleborus*) *palatus*, *X. perebeae*, *X. posticus*, *X. pseudotenuis*, *X. rugicollis*, *X. sharpi*, *X. spathipennis*, *X.*	Amplia distribución; no todas las especies están presentes en México	*Diversos*	No	Alto

spinulosus, *X. squamalutus*, *X. subductus*, *X. tolimanus*, *X. vespatorius*, *X. visniae* y *X. volvulus*.)				
Xylosandrus spp (**excepto** *Xylosnadrus curtulus*, *X. morigerus* y *X. zimmermanni)*	Asia, África, Sudáfrica, Centro américa_Caribe, USA, Brasil, Oceanía	*Swietenia microphylla, Acacia, Cedrela, Pinus, Juglans, Ceiba, Hevea, Abies, Prunus, Coffea*	No	Alto
Hylastes ater	Europa, Asia, Australia, Chile, Nueva Zelanda y Sudáfrica.	*Pinus, Abies, Larix, Picea, Pseudotsuga, Araucaria, Thuja.*	No	Alto
Hylurgus ligniperda	Europa, Asia, África, Australia, Sudamérica (Brasil, Uruguay, Chile), Sudáfrica, USA.	*Pinus*	No	Alto
Tomicus spp	Europa, Asia, África (Argelia), USA (Illinois, Indiana, Michigan, Nueva York, Ohio, Pensylvania.	*Pinus, Picea, Larix, Abies*	No	Alto
Camponotus spp (**excepto** *Camponotus abdominalis, C. abdominalis transvectus, C. abscisus, C. atriceps, C. caryae, C.cereberulus, C. (Myrmentonia) clarithorax, C. (Myrmentonia) cuauhtemoc*, C. claviscapus, *C. (Myrmentonia) hyatti, C. linnael, C. mucronatus, C. novogranadensis, C. pellarius, C. picipes, C. planatus, C. rectangularis, C. rubrithorax, C.*	Amplia distribución; no todas las especies están presentes en México	*Diversos*	No	Alto

sanctafidel, C. senex, C. sericeiventris)				
Sirex noctilio	Europa, Sudáfrica, Norteamérica (USA y Canadá), Sudamérica (Argentina, Brasil, Chile, Uruguay), Oceanía.	*Pinus, Larix, Pseudotsuga, Picea, Abies*	No	Alto
Urocerus gigas	Asia, Europa, Norteamérica (USA y Canada), Chile, Argentina	*Pinus, Abies , Pseudotsuga, Larix y Picea*	No	Alto
Coptotermes spp (**excepto** *Coptotermes crassus*, *C. gestroi* , *C. niger* y *C. testaceus*)	Amplia distribución; no todas las especies están presentes en México	*Diversos*	No	Alto
Lymantria dispar	Europa, Norte de África, Asia, USA y Canadá.	*Populus, Quercus, Acer, Salix, Eucalyptus, Fraxinus, Pinus, Eucalypstus, Prunus y Pyrus.*	No	Alto

(a) Se anexan fichas técnicas

Fuente: Dirección General de Gestión Forestal y de Suelos. SEMARNAT.

Índice de Fichas Técnicas

Amphicerus bimaculatus

Names and taxonomy

Preferred scientific name

Amphicerus bimaculatus (Olivier)

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Bostrichidae

Other scientific names

Apate bimaculata Olivier

Apate bimaculatus (Ol.)

Bostrichus bimaculatus Ol.

Schistoceros bimaculatus (Ol.)

Host range

List of hosts plants

Hosts (source - data mining)

Punica , Vitis vinifera (grapevine)

Geographic distribution

Distribution List

Europe

Italy

unconfirmed record

CAB Abstracts, 1973-1998

Asia

Israel

unconfirmed record

CAB Abstracts, 1973-1998

Natural enemies

Natural enemy

Pest stage attacked

Associated plants

Biological control in:

Parasites/parasitoids:

Monolexis fuscicornis

Punica

Israel

References

CAB Abstracts, 1973-1998. Data mined from CAB Abstracts database, years 1973 to 1998. Wallingford, UK: CAB International

Trypodendron lineatum

Names and taxonomy

Preferred scientific name

Trypodendron lineatum (Olivier 1795)

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Scolytidae

Other scientific names

Bostrichus lineatus Olivier 1795

Xyloterus bivittatum (Kirby 1837)

Apate bivittata Kirby 1837

Trypodendron granulatum Eggers 1933

Trypodendron meridionale Eggers 1940
Ips lineatus (Olivier 1795)

Tomicus lineatus (Olivier 1795)
Xyloterus lineatus (Olivier 1795)
Xyloterus bivittatus (Kirby 1837)

Trypodendron bivittatum (Kirby 1837)
Bostrichus cavifrons Mannerheim 1843
Trypodendron vittiger Eichhoff 1881
Trypodendron borealis Swaine 1917

EPPO code

TRYDLI (Trypodendron
lineatum) Common names

English: striped
ambrosia beetle beetle,
striped ambrosia
timber, beetle, Spruce

timber, beetle, two-
striped Spanish:

barrenador o broca

French:

scolyte birayé
bostryche lisere
scolyte biraye

Russian:
drevesinnik polosatyy

Denmark:
stribet vedborer

Finland:
havupuun tikaskuoriainen

Germany:
Borkenkaefer, Gemeiner Nutzholz-
Borkenkaefer, Gestreifter Nutzholz-
Borkenkaefer, Liniierter Nutzholz-

Nutzholzborkenkafer

Norway:

stripet vedborer

Sweden:

randig vedborre

Notes on taxonomy and nomenclature

The genus Trypodendron Stephens 1830 was based on the type species Dermestes domesticus Linnaeus (Stephens, 1830). The genus Xyloterus Erichson 1836 was based on the type species Bostrichus lineatus Olivier (Erichson, 1836). Subsequently, Thomson (1859) and Eichhoff (1878) agreed that Xyloterus was a synonym of Trypodendron, which means that the formal name for the striped ambrosia beetle should be Trypodendron lineatum (Olivier) (Wood and Bright, 1992).

Host range

List of hosts plants

Major hosts

Abies (firs), Abies alba (silver fir), Abies balsamea (balsam fir), Abies lasiocarpa (rocky mountain fir), Acer macrophyllum (broadleaf maple), Cedrus (cedars), Larix (larches), Picea (spruces), Picea abies (common spruce), Picea engelmannii (Engelmann spruce), Picea sitchensis (Sitka spruce), Pinus (pines), Pinus sylvestris (Scots pine), Pseudotsuga (douglas-fir), Pseudotsuga menziesii (Douglas-fir), Thuja occidentalis (Eastern white cedar), Thuja plicata (western redcedar), Tsuga heterophylla (western hemlock), Tsuga sieboldii (Japanese hemlock)

Habitat

Winter-felled or naturally killed (e.g. fire, snow break, windfall) conifers are colonized as soon as flight temperatures of about 16°C occur in the spring. The beetles bore directly through the bark and excavate their galleries in the moist sapwood.

Geographic distribution

Notes on distribution

T. lineatum has a holarctic distribution and attacks most conifers in this range.

Distribution List

Please note: The distribution status for a country or province is based on all the information available. When several references are cited, they may give conflicting information on the pest status. In particular, citations of earlier presence of a pest are included even though there is an authoritative reference to indicate that the pest is now absent.

Europe

Austria

widespread

Wood & Bright, 1992

Belgium

widespread

Wood & Bright, 1992

Bosnia and Herzegovina

widespread

Gavrilovic & Korpic, 1992

Bulgaria

widespread

Wood & Bright, 1992

Croatia

widespread

CIE, 1982 Czech

Republic

widespread

Kula & Zabecki, 2000

Czechoslovakia (former)

widespread

Wood & Bright,

1992 Denmark

widespread

Wood & Bright, 1992

Estonia

widespread

CIE, 1982

Finland

widespread

Wood & Bright, 1992

Former Yugoslavia

widespread

Wood & Bright, 1992

<u>France</u>

widespread

Wood & Bright,

1992 <u>Germany</u>

widespread

Wood & Bright, 1992

<u>Greece</u>

widespread

Wood & Bright,

1992 <u>Hungary</u>

widespread

Wood & Bright, 1992

<u>Italy</u>

widespread

Wood & Bright, 1992

<u>Latvia</u>

widespread

Bichevskis et al., 1975

<u>Liechtenstein</u>

widespread

CIE, 1982

<u>Lithuania</u>

widespread

CIE, 1982

<u>Luxembourg</u>

widespread

Wood & Bright,

1992 <u>Netherlands</u>

widespread

Wood & Bright, 1992

<u>Norway</u>

widespread

Wood & Bright, 1992

Poland

widespread

Wood & Bright,

1992 Portugal

widespread

CIE, 1982

Romania

widespread

Wood & Bright,

1992 Central Russia

widespread

CIE, 1982

Eastern Siberia

widespread CIE,

1982 Northern

Russia

widespread CIE,

1982 Russian

Far East

widespread CIE,

1982 Southern

Russia

widespread CIE,

1982 Western

Siberia

widespread CIE,

1982 Serbia

widespread

Wood & Bright,

1992 Slovakia

widespread

Jakus, 1998

Slovenia

widespread

Babuder et al.,

1996 Spain

widespread

Wood & Bright, 1992

Sweden

widespread

Wood & Bright,

1992 Switzerland

widespread

Wood & Bright, 1992

Ukraine

widespread CIE,

1982 United

Kingdom

widespread

Wood & Bright, 1992

Asia

China

Gansu

widespread

Fu et al.,

1984 Japan

widespread

Wood & Bright,

1992 Hokkaido

widespread

CIE, 1982

Honshu

widespread

CIE, 1982

Korea, DPR

widespread

Wood & Bright,

1992 Kyrgyzstan

widespread

CIE, 1982

Turkey

widespread

Wood & Bright, 1992

Africa

Algeria

present

Wood & Bright, 1992

Egypt

present

Wood & Bright, 1992

Libya

present

Wood & Bright, 1992

Morocco

present

Wood & Bright, 1992

North America

Canada

Alberta

widespread

Wood & Bright, 1992

British Columbia

widespread

Wood & Bright,

1992 Manitoba

widespread

Wood & Bright, 1992

<u>New Brunswick</u>
widespread

Wood & Bright,
1992 <u>Newfoundland</u>
widespread

Wood & Bright,
1992 <u>Nova Scotia</u>
widespread

Wood & Bright, 1992

<u>Ontario</u>

widespread

Wood & Bright, 1992

<u>Quebec</u>

widespread

Wood & Bright,
1992 <u>Saskatchewan</u>
widespread

Wood & Bright, 1992

<u>USA</u>

<u>Alaska</u>
widespread

Wood & Bright,
1992 <u>California</u>
widespread

Wood & Bright,
1992 <u>Colorado</u>
widespread

Wood & Bright,
1992 <u>Connecticut</u>
widespread

Wood & Bright, 1992

<u>Idaho</u>

widespread

Wood & Bright, 1992

Maine

widespread

Wood & Bright,

1992 Michigan

widespread

Wood & Bright,

1992 Minnesota

widespread

Wood & Bright,

1992 Montana

widespread

Wood & Bright, 1992

Nevada

present

Wood & Bright, 1992

New Hampshire

widespread

Wood & Bright,

1992 New Mexico

widespread

Wood & Bright,

1992 New York

widespread

Wood & Bright,

1992 North Carolina

widespread

Wood & Bright, 1992

Oregon

widespread

Wood & Bright, 1992)

Pennsylvania

widespread

Wood & Bright,
1992 South Dakota
widespread

Wood & Bright,
1992 Tennessee
widespread

Wood & Bright, 1992
Utah
widespread

Wood & Bright,
1992 Washington
widespread

Wood & Bright,
1992 West Virginia
widespread

Wood & Bright,
1992 Wyoming
widespread

Wood & Bright, 1992
Oceania
New Zealand

absent, intercepted
only Bain, 1974, 1977

Biology and ecology

The first introduction a forestry worker might have to T. lineatum is the spectacular springtime 'swarming flight' that occurs as soon as temperatures rise above 16°C, especially on the first days to reach 20°C (Chapman and Kinghorn, 1958; Chapman and Nijholt, 1980). The previous late summer flights of the beetles to their overwintering locations at the base of stumps or in the forest floor go relatively unnoticed as the new brood adults leave infested logs over an extended period (McIntosh and McLean, 1992) and take flight to be passively transported to the forested areas they encounter while drifting downwind. Old parents leaving the logs after raising their brood may be trapped in pheromone-baited traps at this time but their numbers are generally low.

The spring swarm moves through the forested margins to clearcut areas, dry land sorting areas and over log booms. The fat store of the new brood is depleted by 25% during hibernation and by a further 25% during the spring dispersal (Nijholt, 1967). The beetles are arrested by the odour of suitable host logs (Bennett and Borden, 1971). The major primary attractant was identified as ethanol by Moeck (1970). Several researchers have noted that October-felled logs are the most attractive in Norway (Christiansen and Saether, 1968), Finland (Löyttyniemi and Uusvaara, 1977), western Oregon, USA (Daterman et al., 1965) and British Columbia, Canada (Prebble and Graham, 1957; Dyer and Chapman, 1965; Chapman and Nijholt, 1980). Recent studies by Kelsey and Joseph (1999) have shown that the ethanol contents of October-felled logs left in the field over the winter is 0.24-0.35 µmol/g fresh weight, more than 10 times that of dry logs. This ethanol accumulates from continued anaerobic respiration of the cambial tissues after the tree falls and the transpiration stream is broken (Kimmerer and Stringer, 1988).

Female T. lineatum initiate galleries into the host logs and soon a pile of white frass accumulates on the dark-coloured bark. If the forestry workers missed the main flight, they are now made very aware of the infestation in their saw logs. The females release a powerful aggregation pheromone, lineatin (3,3,7-trimethyl-2,9-dioxatricyclo[3.3.1.04,7]nonane) (Borden et al., 1979; Borden, 1988), which attracts both males and females to suitable host logs. Mating occurs on the surface of the logs, which are soon densely colonized. The male follows the female into the gallery and takes over the task of removing boring dust. The presence of the male increases the productivity of the gallery. Oviposition commences in the first 2 weeks of gallery construction. Unpaired females have been shown to produce 9.5 eggs per gallery, on average, whereas paired females produce an average of 17.0 eggs per gallery (Chapman, 1959). The female chews niches, 0.6-0.7 mm deep, in which to lay an egg. She then seals the egg in place with a protective layer of boring dust (Hadorn, 1933). The larva is responsible for deepening the niche as it feeds on the wood fibres and the hyphae of ambrosia fungi inoculated into the main gallery by the parent beetles. The main symbiotic ambrosia fungus is Monilia ferruginea (Fisher et al., 1953; Francke-Grosmann, 1963; Funk, 1965). The excrement of the larvae is extruded through the niche cap and the parent beetles remove this material from the gallery. During this gallery construction phase, the parent wing muscles are considerably reduced but return to normal size and function after the parent adults feed on the ambrosia fungi in the mature gallery (Chapman, 1956). A video clip of feeding larvae in a gallery may be seen at http://www.forestry.ubc.ca/fetch21/fetch21/tinybeetles.html. When the larva is mature, it pupates with its head towards the main gallery. The new brood chew through the niche cap, enter the main gallery, feed on ambrosia fungi and then emerge through the single entry hole to the gallery. The total development of T. lineatum has been estimated to be 265 degree-days above a threshold of 13°C (McIntosh and McLean, 1997). A life stage index has also been developed which shows the relative abundance of each life stage throughout the year. Eggs are found from early May, larvae from mid-May and pupae from early June. Teneral adults leave the logs by the end of July. The first brood of adults starts to emerge about 85 days after the first attack (McIntosh and McLean, 1992).

The new brood beetles emerge sporadically throughout the summer. Beetles show strong photopositive orientation in their first dispersal flight (Chapman, 1956) and photic reversal associated with air swallowing occurs after variable flight times (Graham, 1961). This results in beetles being displaced by the wind over and into the forest where they eventually settle to overwintering locations in the forest floor. This displacement has been measured to be more than 300 m around forest margins (Kinghorn and Chapman, 1959) and inferred to be more than 600 m as indicated by catches of spring-emerging beetles far from the nearest source of infested logs present in the previous autumn (McLean and Salom, 1989). All new brood beetles need to overwinter before they can become sexually mature and join the swarming flights of the next spring.

Morphology

Eggs

The white, translucent eggs, about 1.0 mm by 0.72 mm, are laid individually in niches cut into the end grain of the wood at intervals along the gallery. Hatching occurs after about 10 days.

Larvae

As the white, legless larvae grow, they enlarge the egg niches into larval cradles within which pupation occurs about 3 weeks after hatching (Prebble and Graham, 1957).

Adults

The adults are dark brown to black with two lighter longitudinal stripes on each elytron. The adults are 2.6-3.5 mm long and 1.7 mm wide (Wood, 1982). The head and thorax of the female are rounded in front. The head of the male is dished out and the thorax is straight across its front. Males are, on average, smaller than the females (Furniss and Carolin, 1977).

Means of movement and dispersal

Natural Dispersal

Assessment of beetle dispersal by capturing beetles, dusting them with fluorescent powders and releasing them in a second growth forest under gentle wind conditions showed strong upwind responses to pheromone-baited traps 5 m and 25 m from the release point. Catches were randomly distributed at 100 m, and at 500 m most catches were in the downwind traps (Salom and McLean, 1989). In a laboratory wind tunnel, percentages of catches to an upwind trap or log were shown to decrease with an increase of wind speed to 0.9 m/sec. Sustained flight was not maintained over 60 cm/sec (2.16 km/h). Catches to both pheromone-baited traps and logs was highest at 0.0 m/sec indicating arrestment in response to a known attractant (positive chemokinesis?). In a forested valley setting, higher catches were recorded within the forest as compared to adjacent clearcut areas. Pheromone-baited traps are far more effective in the quieter wind conditions within a forest than in adjacent clearcut areas or log boom storage areas (Lam and McLean, 1992) where breezes exceed flight capability and beetles are displaced downwind. Marked beetles released at noon were recaptured in pheromone-baited traps 2 km downwind (up valley) (Salom and McLean, 1991). In an industrial setting, marked T. lineatum were released in several locations by Shore and McLean (1988). Greatest catches were on traps less than 200 m from the release points; however, several beetles were also collected on traps 500 m away across a log boom storage area.

Movement in Trade/Transport

Winter-felled logs that are in the woods during the spring attack flight have the highest risk of attack. T. lineatum stays in the logs for a relatively short time and the brood population has generally emerged from the log by the autumn. Nevertheless, infested logs loaded out in the early summer complete with an active brood will release beetles from July onwards. These beetles go into forested margins to overwinter. By the time the log is sorted by grade at a dry land sorting area and made into a log boom for shipment to a sawmill, most of the beetles will have emerged. Beetles that overwinter in the forested margins around the log booming ground come out of hibernation the following spring and infest the fresh logs in storage areas. In this way the cycle of industrial infestation is compounded into a second year and soon infestations are rampant throughout the whole transportation system and in the sawmills. In the world of commerce, log movements from jurisdictions where transportation cannot start until the roads have hardened after snowmelt in the spring, are at greatest risk of an attack flight and the movement of T. lineatum to new areas. Unlike other ambrosia beetles, T. lineatum has not been known to attack and survive in green lumber. Boards showing dark stained pinholes from T. lineatum attack would probably not contain any live beetle life stages after September.

Plant parts liable to carry the pest in trade/transport

- Stems (above Ground)/Shoots/Trunks/Branches: Eggs, Larvae, Pupae, Adults; borne internally; visible to naked eye.
- Wood: Eggs, Larvae, Pupae, Adults; borne internally; visible to naked eye.

Plant parts not known to carry the pest in trade/transport

- Bark
- Bulbs/Tubers/Corms/Rhizomes
- Fruits (inc. Pods)
- Growing Medium Accompanying Plants
- Flowers/Inflorescences/Cones/Calyx
- Leaves
- Seedlings/Micropropagated Plants
- Roots
- True Seeds (inc. Grain).

Natural enemies

Surveys for hymenopteran parasites of T. lineatum showed two species, Perniphora robusta and Eurytoma spessivtsevi [Eurytoma polygraphi], to be present in Poland (Capecki, 1963), Switzerland (Eichorn and Graf, 1974) and Lithuania (Jakaitis, 1979). Mites, including Proctolaelaps xyloteri and velvet mites (Trombidiidae) (Strube and Benner, 1984) can heavily infest T. lineatum galleries. Tylenchid larvae have also been reported to parasitize T. lineatum adults (Thong and Webster, 1983).

Natural enemies listed in the database

The list of natural enemies has been reviewed by a biocontrol specialist and is limited to those that have a major impact on pest numbers or have been used in biological control attempts;

generalists and crop pests are excluded. For further information and reference sources, see About the data. Additional natural enemy records derived from data mining are presented as a separate list.

Natural enemies reviewed by biocontrol specialist

Natural enemy

Pest stage attacked

Biological control in:

Parasites/parasitoids:

Eurytoma polygraphi

Larvae, Pupae

Perniphora robusta

Larvae, Pupae

Additional natural enemies (source - data mining)

Natural enemy

Pest stage attacked

Biological control in:

Parasites/parasitoids:

Eurytoma spessivtsevi

Proctolaelaps xyloteri

Predators:

Thanasimus formicarius (ant beetle)

Germany

Pathogens:

Beauveria bassiana (white muscardine fungus)

Impact

Economic impact

When the winter snow and spring thaw make it impossible to load out logs that have already been felled in the forest, the spring flight of the striped ambrosia beetle is able to colonize a large proportion of the log inventory. Although the beetles most often complete their life cycle before the lumber milled from these logs reaches the market, their dark stained galleries cause considerable degradation of the normally high-value lumber milled from the outer regions of logs. Estimates of this degradation are as high as C$63 million in British Columbia (Canada) alone (McLean, 1985). Degrade values vary greatly according to log grade, ranging from nothing in small-diameter pulp grade logs to more than C$77.40/m³ for high grade Douglas-fir saw logs (Orbay et al., 1994). A year-long Ambrosia Beetle Task Force in coastal British Columbia in 1990/91 showed that one forest company lost $11 million dollars from lumber degrade on a 5 million m³ log inventory. Efficient log inventory management.

(http://www.forestry.ubc.ca/fetch21/fetch21/tinybeetles.html) is the best method for reducing these losses.

Environmental impact

Ambrosia beetles are one of nature's recycling agents for coarse woody debris. They have no adverse environmental impacts.

Phytosanitary significance

T. lineatum is of low phytosanitary risk. New broods of beetles leave the logs within 3 to 6 months. There are no records of the successful completion of life cycles in sawn lumber as has been noted for the sympatric ambrosia beetle Gnathotrichus sulcatus in British Columbia, Canada (McLean and Borden, 1975). Black-stained pinholes indicate that wood was once attacked but the impact of T. lineatum pinholes is mainly the lower value placed on such lumber.

Symptoms

Entrances to galleries on logs and stumps are marked by piles of fine, white, granular boring dust in the bark crevices in the early stages of attack (Furniss and Carolin, 1977). A major symptom of attack on wood products cut from infested logs is fine (1.8 mm diameter) black-stained 'pinholes'. The black stain is caused by the ambrosia fungi carried into the sapwood by the attacking adults.

Symptoms by affected plant part

Roots: internal feeding.

Stems: internal discoloration; internal feeding; visible frass.

Whole plant: internal feeding; frass visible.

Similarities to other species

Early records claim that T. lineatum has been recorded attacking hard woods. However, recent attention to the taxonomy of the genus may show these insects to be a closely related species. T. lineatum is generally the most abundant of the ambrosia beetles in conifers in the holarctic region.

Detection and inspection

Fresh attacks are indicated by piles of white boring dust that are readily visible against the dark-coloured bark. As the infestation continues, the frass darkens with the black stain of the ambrosia fungi. Where the bark has been sloughed off an infested log, dark pinholes are readily visible. Confirmation of attacking species is made by checking the diameter of the gallery. The T.

lineatum gallery is 1.68 mm in diameter whereas those of Gnathotrichus spp., which can also attack the same logs, are about 1.30 mm in diameter (Kinghorn, 1957). The dark staining of the T. lineatum galleries appears within 3 months of attack and helps to make them more visible.

Control

Cultural Control

Windfalls and broken trees caused by winter snow and ice storms provide a continuous source of host trees for T. lineatum. In an extensively forested area it is difficult to remove these trees quickly so operators should expect ambrosia beetles to be in all conifer forests. Stumps and logs need to 'ripen' for about 3 months to accumulate stimulation levels of ethanol that will encourage attack. This brief window is particularly important in the northern hemisphere in spring periods when roads are impassable until the snow has melted.

When a new road is cut into a forest, the time between the felling of the right of way and the construction of the road needs to be as short as possible. As soon as the roadbed has been constructed, self-loading trucks should be used to move the freshly cut logs to the sawmill to prevent ambrosia beetle attack on the logs. The residual stumps are attacked by T. lineatum, which means that a residual population is maintained in the forest.

The timing of the subsequent felling of the new setting, yarding of the logs to the roadside and their transportation to a sorting area should be completed before it snows in early winter. Logs trapped under snow have a very high probability of being heavily attacked before any loading out can be completed in the following spring. Large-diameter debris and stumps will be attacked by T. lineatum.

Logs are scaled in dry land sorting areas. Transit time in these areas in British Columbia (Canada) is usually short, often only a matter of hours, before bundles of similar grades of logs are either loaded on to logging trucks for transportation to a sawmill or are made up into a log boom for water transportation. Logs attacked in the forest are able to release new brood beetles throughout the summer as soon as they mature. These beetles fly to forested margins around the dry land sorting areas, log booming areas and sawmills. They overwinter and emerge during the first warm days of spring, when temperatures exceed 16°C, to attack any new logs that happen to be in the area. These forested margins can be clear felled to increase the dispersal distance for overwintered beetles. Pheromone-baited traps set in the forested margin intercept these spring flying beetles. In addition, pheromone-baited bundles of low grade saw logs or pulp logs can be set out around the margins of dry land sorting areas to intercept beetles flying in from forested margins. These trap bundles need to be processed before mid-summer in order to kill beetle broods developing therein.

A full sequence of log inventory controls including hot logging and rapid processing of logs plus the strategic use of mass trapping in areas where high value inventories are stored in dry land sorting areas and booming grounds has been detailed by Borden and McLean (1981) and McLean and Stokkink (1988).

Chemical Control

No chemicals are currently registered in Canada as sprays for use against ambrosia beetles although much spraying has been done in the past. In the past, benzene hexachloride [gamma-

HCH] and Methyl Trithion [S-[[(4-chlorophenyl)thio]methyl] O,O-dimethyl phosphorodithioate]have been sprayed on log inventories to prevent ambrosia beetle attack (Richmond, 1986).

IPM

There are IPM systems for minimising the impact of the striped ambrosia beetle. The best method for preventing attack by T. lineatum is to ensure that logs are removed from the forest before the beginning of the spring flight period. Large log inventories in dry land sorting areas can be protected by continuous water misting which deters beetles from landing on them (Richmond and Nijholt, 1972). The aggregation pheromone for T. lineatum has been identified, synthesized and is currently available for use as baits in traps such as the Lindgren multiple funnel traps (Lindgren, 1983). Pheromone-baited traps are very useful for mass trapping of the spring-emerging population. Individual traps can catch more than 100,000 beetles/week during the first swarming flight in a heavily infested area. In 1980, the first surveys for T. lineatum and attempts at mass-trapping were carried out in dry land sorting areas (Lindgren and Borden, 1983) and in a commercial sawmill (Shore and McLean, 1985). These early surveys identified seasonal trends in the abundance of ambrosia beetles and indicated high-hazard areas where high value products should not be stored and where trapping efforts could be intensified. In 1987, British Columbia forest industries contracted for an ambrosia beetle survey and suppression service at several dozen locations (Borden, 1988) and many locations maintain this service today.

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Apate monachus Fabricius

Names and taxonomy

Preferred scientific name

Apate monachus Fabricius, 1775

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Bostrichidae

Other scientific names

Apate monacha Fabricius, 1801

Apate carmelita Fabricius, 1801

Apate francisca Fabricius, 1801

Apate gibba Fabricius, 1798 Apate

mendica Olivier, 1790 Apate

semicostata Thomson, 1857 Apate

senii Stefani, 1911

Apate monachus var. rufiventris Lucas,

1843 EPPO code

APATMO (Apate monachus)

Common names

English:

black borer

twig borer

borer, black

borer, twig

date palm

bostrichid Spanish:

bostríquido monje

taladrador del tallo del cafeto

taladrador del cafeto French:

borer noir du cacaoyer

borer noir du caféier

Germany:

Bohrer, Schwarzer Kaffee-

Host range

Notes on host range

A. monachus has a wide host range and was recorded as a polyphagous species by Lesne (1901) and Chararas and Balachowsky (1962). Its development can be completed on a wide range of African trees and host crops. Adults have also been recorded attacking ornamental species, such as Syringa persica, Sophora japonica (pagoda tree) and Robinia pseudoacacia (false acacia).

Affected Plant Stages: Flowering stage, fruiting stage, post-harvest and vegetative growing stage.

Affected Plant Parts: Stems.

List of hosts plants

Major hosts

Azadirachta indica (neem tree), Cajanus cajan (pigeon pea), Casuarina equisetifolia (casuarina), Coffea arabica (arabica coffee), Coffea liberica (Liberian coffee tree), Elaeis guineensis (African oil palm), Mangifera indica (mango), Polyphagous (polyphagous), Psidium guajava (guava), Punica granatum (pomegranate), Swietenia (mahogany), Tamarindus indica (Indian tamarind), Theobroma cacao (cocoa)

Minor hosts

Annona cherimola (cherimoya), Calicotome spinosa (spiny broom (Australia)), Citrus , Citrus sinensis (navel orange), Gleditsia triacanthos (honey locust), Malus domestica (apple), Melia azedarach (Chinaberry), Morus alba (mora), Olea europaea subsp. europaea (olive), Phoenix dactylifera (date-palm), Prunus persica (peach), Pyrus communis (European pear), Robinia pseudoacacia (black locust), Styphnolobium japonicum (pagoda tree), Syringa pekinensis , Tamarix gallica (French tamarisk), Vitis vinifera (grapevine)

Wild hosts

Acacia (wattles)

Habitat

The natural habitat of A. monachus is tropical and subtropical African forest.

Geographic distribution

Notes on distribution

A. monachus is distributed mainly in tropical and subtropical regions and originates from African forests Lesne, 1901, 1924, 1938). It is present in the south Mediterranean and Middle East, including Sicily and Corsica (Chararas and Balachowsky, 1962). A. monachus is now well established and widely distributed in the Antilles, where it was accidentally introduced Lesne, 1901, 1938; Español, 1955; Chararas and Balachowsky, 1962; López-Colón, 1997). Chararas and Balachowsky (1962) recorded this species from USA (Florida), where it was also accidentally introduced. Specimens from Spain, Guinea and Morocco are located in the National Museum of Natural Sciences, Madrid, Spain. The distribution map incudes records based on specimens from the collection of the National History Museum (London, UK): dates of collection are noted in the List of countries (NHM, various dates).

Distribution List

Please note: The distribution status for a country or province is based on all the information available. When several references are cited, they may give conflicting information on the pest status. In particular, citations of earlier presence of a pest are included even though there is an authoritative reference to indicate that the pest is now absent.

Europe

France

Corsica

present

Lesne, 1901; Chararas & Balachowsky, 1962; Cymorec, 1969; Clavier, 1994

Germany

absent, intercepted only

Cymorec, 1969

Italy

Sardinia

present

Luciano, 1982

Sicily

restricted distribution

Chararas & Balachowsky, 1962; Cymorec, 1969

Spain

restricted distribution

Lucas, 1853; Lesne, 1901; Fuente, 1932; Espa¦ol, 1955; Chararas & Balachowsky, 1962; L¾pez-Col¾n, 1997

Asia

Israel

restricted distribution

Espa¦ol, 1955; Chararas & Balachowsky, 1962

Lebanon

restricted distribution

Lesne, 1901; Chararas & Balachowsky, 1962

Syria

restricted distribution

Lesne, 1901; Espa¦ol, 1955; Chararas & Balachowsky, 1962

Africa

Algeria

restricted distribution

Lesne, 1901; Espa¦ol, 1955; Chararas & Balachowsky, 1962

Cameroon

present

NHM, 1935

Congo

widespread

Lesne, 1938; Chararas & Balachowsky, 1962

Côte d'Ivoire

present

NHM, 1944

Egypt

restricted distribution

Lesne, 1938

Eritrea

present

NHM, 1950

Ethiopia

present

Chararas & Balachowsky, 1962

Ghana

present

NHM, 1912

Guinea

widespread

Chararas & Balachowsky, 1962

Morocco

present

Lesne, 1901; Martinez de la Escalera, 1914; Kocher, 1956; Chararas & Balachowsky, 1962

Niger

present

NHM, 1992

Nigeria

present

NHM, 1912

Sao Tome and
Principe present

NHM, 1919

Tanzania

present

Bohlen, 1973

Togo present

Chararas & Balachowsky, 1962

Tunisia

restricted distribution

Lesne, 1901, 1904; Chararas & Balachowsky, 1962

Uganda

present

NHM, 1936

Zambia

present

Loyttyniemi & Loyttyniemi, 1988

Central America & Caribbean

Cuba

present

Lesne, 1938; Cymorec, 1969

Dominican Republic

widespread

Lesne, 1901; Cymorec, 1969

Guadeloupe

present

Lesne, 1938

Jamaica

present

Cymorec, 1969

Martinique

present

Lesne, 1938

Puerto Rico

widespread

Lesne, 1938

Saint Kitts and Nevis

present

Lesne, 1938

North America

USA

Florida

absent, intercepted only

Chararas & Balachowsky, 1962

South America

Brazil

present

Lesne, 1938

Biology and ecology

A. monachus is a wood-boring beetle, often flying during the evening and night, when it may be attracted by lights. Adults usually first bore out one short gallery, the exterior of which is a hole approximately 8-12 mm in length and 5 to 7 mm wide. This perforation leads to a second gallery, a cylindrical chamber, about 10 cm in length and 15 mm in diameter. This in turn leads to a new tunnel, 20-60 cm in length and 10-20 mm in diameter. Other methods of tunnelling include small galleries (5 to 8 mm in diameter), without the first pre-chamber. Alternatively, adults make numerous short galleries for feeding, only 7 to 10 cm in length and 15 mm in diameter (Chararas and Balachowsky, 1962).

Females excavate galleries in dead wood, in which eggs are also laid. Larvae live in dead trees, excavating their own tunnels deep in the wood (Lesne, 1901, Español, 1955; Chararas and Balachowsky, 1962).

Morphology

Adults

A. monachus is a large boring beetle, measuring 10 to 20 mm. It is subcylindrical in shape, with parallel sides, chestnut brown to black in colour. The head of females has an anterior dense and long mass of bristles. Pronotum subquadrangular, forming a hood over the head. Antennae with the second segment elongate, cylindrical with three terminal segments forming a perfoliated club. Elytra posteriorly retuse, with four thin costae. Female with ovipositor very short and broad; no prothoracic-femoral stridulatory apparatus.

Natural enemies

The importance of the listed natural enemies is not known. Natural enemies would not normally be expected to be important in limiting numbers of wood borers, although another Teretriosoma species has been shown to be a promising biological control agent of the larger grain borer (Prostephanus truncatus).

Natural enemies listed in the database

The list of natural enemies has been reviewed by a biocontrol specialist and is limited to those that have a major impact on pest numbers or have been used in biological control attempts; generalists and crop pests are excluded. For further information and reference sources, see About the data. Additional natural enemy records derived from data mining are presented as a separate list.

Natural enemies reviewed by biocontrol specialist

Natural enemy

Pest stage attacked

Predators:

Teretriosoma flaviclava

Larvae, Pupae

Teretriosoma sanguineum

Larvae, Pupae

Impact

A. monachus is considered a pest with secondary economic impact and is not usually a serious pest of growing trees. It can be a destructive pest of coffee, but does not usually affect many trees. Crop losses caused by this species are difficult to assess, because damage is always localized, frequently occurring in several trees or a single plantation.

Chararas and Balachowsky (1962) reported that A. monachus is a localized pest of numerous crops in Central Africa (Congo, Guinea), the Antilles and south Mediterranean countries, but that no attempt had been made to estimate crop losses on coffee or cocoa due to a lack of reliable data.

Symptoms

Adults bore deeply into the wood of living host trees while feeding. Tunnelling into the stems of host plants produces galleries and external holes. Damage is usually most severe on young plantations and nursery trees. Stems may be completely excavated, resulting in the death of young trees, or reduced growth of older trees.

Larvae live in the wood of dead trees and do not usually cause economic damage. Reproduction, nidification, nesting behaviour, larvae development and behaviour of the larvae have not been well characterized (Chararas and Balachowsky, 1962).

Symptoms by affected plant part

Stems: internal feeding.

Similarities to other species

The genus Apate have elytra posteriorly retuse, and antennae with the second joint elongate, with the last three segments forming a perfoliated club. There are several other similar species from Africa and Madagascar, although A. monachus is the only one which causes economic damage. See Lesne (1924) for full descriptions and identification keys for African Bostrchidae.

Detection and inspection

Field infestations of A. monachus are detected mainly by examining stem damage in suitable hosts. White, cylindrical larvae with small legs can be observed in dead wood. Bored stems may be sampled for dissection and identification of adults.

Control

To reduce borer damage, the usual cultural methods may be used, such as planting pest-free young trees. Burning infested plants is sometimes proposed, although this can be sometimes avoided by killing larvae by pushing a flexible wire, such as a bicycle spoke, into the boring (LePelley, 1968; Entwistle, 1972). Chemical control is difficult due to targeting and access to internal pests, as is the case with other borers. These difficulties of application are frequently compounded by unjustifiable costs and risks of environmental pollution. Luciano (1982) described the use of permethrin on an infestation of A. monachus on fruit trees in Italy, but concluded that preventative control was preferred.

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Bostrichus capucinus

Names and taxonomy

Preferred scientific name

Bostrichus capucinus (Linnaeus, 1758)

14-Julio-2007.

Europa, España, Aragón, Zaragoza, Sestrica.
Leg: Isidro Martínez Det: Isidro Martínez.

Taxonomic position

Dominio: Eukaryota.
Reino: Animalia.
Filum: Arthropoda.
Clase: Insecta.
Orden: Coleoptera.
Suborden: Polyphaga.
Superfamilia: Anobioidea.
Familia: Bostrichidae.
Género: Bostrichus.
Especie: Bostrichus capucinus.

Se trata de un escarabajo bien repartido por Europa y Asia templada. Tiene un tamaño bastante grande entre los bostríquidos europeos, aunque es superado por Apate monachus y Lichenophanes numida. Su pronoto es giboso, cubriendo la cabeza, y está cubierto de tubérculos y protuberancias. Los élitros son rojos y el resto del cuerpo es negro, aunque en ocasiones se ven formas melánicas totalmente negras.

La larva se alimenta de madera muerta.

Country/region	**Genus *Bostrichus* Geoffroy 1762**
Albania	Absent
Andorra	Absent
Austria	Present
Azores	Absent
Balearic Is. Incl. Mallorca I., Menorca I., and Pityuses Is. (= Ibiza I. + Formentera I.)	Present
Belarus	Present
Belgium	Doubtful
Bosnia and Herzegovina	Absent
Britain I. Incl. Shetlands, Orkneys, Hebrides and Man Is.	Present
Bulgaria	Present
Canary Is.	Absent
Channel Is. Incl. Jersey, Guernsey, Alderney	Absent
Corsica	Present
Crete Incl. small adjacent islands like Gavdhos. Note that Andikithira I. although being closer to Kriti than to mainland, belongs to a	Present

mainland province	
Croatia	Present
Cyclades Is. Incl. Amorgos, Anafi, Anidros, Andros, Andiparos, Denousa, Folegandros, Ios, Iraklia, Karos, Kimolos, Kea, Kythnos, Milos, Mykonos, Naxos, Paros, Poliaigos, Serifos, Sifnos, Sikinos, Syros, Thira, Tinos, Yiaros and other smaller islands	Absent
Cyprus	Present
Czech Republic	Present
Danish mainland Incl. Borholm I.	Absent
Dodecanese Is. Incl. Alimnia, Arkoi, Astipalaia, Avgonisi, Ankathonisi, Farmakonisi, Ioinianisia, Kalimnos, Kalolimnos, Kandeliousa, Karpathos, Kasos, Khalki, Khamili, Kinaros, Kos, Leros, Levitha, Lipsoi, Meyisti, Nisiros, Ofidousa, Patmos, Rodhos, Saria, Simi, Sirina, Tilos, Tria Nisia, Yiali and other smaller islands	Absent
Estonia	Absent
European Turkey Incl. Imroz I. - Gokceada, but not those in the Sea of Marmara	Absent

Faroe Is.	Absent
Finland	Present
Franz Josef Land Not incl. Ushakova I. and Vize I.	Absent
French mainland	Present
Germany	Present
Gibraltar	Absent
Greek mainland Incl. Andikithira I., Evvia I., Ionian Is., Samothraki I., Northern Sporades Is., Thasos I.	Present
Hungary	Absent
Iceland	Absent
Ireland Not incl. Northern Ireland (GB-NI)	Absent
Italian mainland	Present
Kaliningrad Region	Absent
Latvia	Present
Liechtenstein	Absent
Lithuania	Absent
Luxembourg	Absent
Macedonia	Absent

Madeira	Absent
Malta	Present
Moldova, Republic of	Absent
Monaco	Absent
North Aegean Is. Incl. Andipsara, Ayios Evstratios, Fournoi, Ikaria, Khios, Lesvos, Limnos, Oinousa, Psara, Samos, Skopelos Kaloyeroi and other smaller islands	Absent
Northern Ireland	Absent
Norwegian mainland	Present
Novaya Zemlya	Absent
Poland	Present
Portuguese mainland	Present
Romania	Absent
Russia Central	Present
Russia East	Present
Russia North	Present
Russia Northwest	Absent
Russia South	Present
San Marino	Absent

Sardinia	Present
Selvagens Is.	Absent
Sicily Incl. adjacent Italian islands (Lipari Is., Ustica I., Egadi Is., Pantelleria I., Pelagie Is.)	Present
Slovakia	Present
Slovenia	Absent
Spanish mainland Incl. Alboran I.	Present
Svalbard & Jan Mayen Incl. Bear I.	Absent
Sweden Incl. Gotland I.	Present
Switzerland	Present
The Netherlands	Present
Ukraine	Absent
Vatican City	Absent
Yugoslavia Incl. Serbia, Kosovo, Voivodina, Montenegro	Absent
Worldwide	**Genus *Bostrichus* Geoffroy 1762**
Afro-tropical region	Absent
Australian region	Absent

East Palaearctic East of the border line here defined	Present
Near East Asian Turkey, Caucasian Russian republics, Georgia, Armenia, Azerbaidjan, Lebanon, Syria, Israel, Jordan, Sinai Peninsula (Egypt), Arabian peninsula, Iran, Iraq	Present
Nearctic region	Absent
Neotropical region	Absent
North Africa Not including Sinai Peninsula	Present
Oriental region	Absent

Dinoderus minutus

Names and taxonomy

Preferred scientific name

Dinoderus minutus (Fabricius)

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Bostrichidae

Other scientific names

Apate minutus Fabricius

Dinoderus siculus Baudi

Dinoderus substriatus Stephens

EPPO code

DINDMI (Dinoderus minutus)

Common names

Chinese:

zhu chang du

English:

bamboo borer

bamboo powder-post beetle

beetle, bamboo powder post

bamboo shot-hole, borer, smaller

caruncho do bambu

Germany:

Bohrer, Bambus-

India:

ghoon borer

Norway:

bambusborer, liten

Notes on taxonomy and nomenclature

D. minutus, the bamboo borer or bamboo powderpost beetle, belongs to Bostrichidae: Coleoptera. Bostrichidae is a small family with approximately 116 species in seven subfamilies and 34 genera. In China, there are 39 species in 18 genera; in North America, 93 species in 32 genera; and 17species in 11 genera in Japan (Liu Jingying, 1956, 1983; Chu Dong and Zhang Wei, 1997;Fisher, 1985, 1993). Dinonerinae, an important subfamily including many post-harvest insects, consists of 16 species in four genera. D. minutus was first named by Fabricius in 1775, according to records in the Bishop Museum, USA. On the basis of world literature concerning Dinoderus spp., five species were reported in China; in North America approximately four species are known; and in Asia, six species were studied, because they are all important insects damaging post-harvest bamboo (Chu Dong and Zhang Wei, 1997).

Host range

Notes on host range

D. minutus is an important borer that attacks felled culms and bamboo timber products. It also damages rice, cassava and sugarcane. In China and most south Asian countries, the main host plants are Bambusa bambos, Bambusa breviflora, Bambusa polymorpha, Bambusa textilis, Bambusa vulgaris, Bambusa pervariabilis, Dendrocalamus giganteus, Dendrocalamus hamiltonii, Dendrocalamus strictus, Phyllostachys pubescens [Phyllostachys edulis], Phyllostachys heterocycla, and Phyllostachys heteroclada (Wu et al., 1986; Mathew and Nair, 1990; Koehler, 2003). Moreover, D. minutus is also detected in the wood of some Pinus spp. (Gong Xiuze, 2003.). It can also feed on dry cassava (Mathew and Nair, 1984).

Affected Plant Stages: Post-harvest.

Affected Plant Parts: Stems.

List of hosts plants

Major hosts

Bambusa bambos (thorny bamboo), Bambusa breviflora , Bambusa pervariabilis , Bambusa polymorpha , Bambusa textilis , Bambusa vulgaris (common bamboo), Dendrocalamus giganteus (giant bamboo), Dendrocalamus hamiltonii , Dendrocalamus strictus (male bamboo), Phyllostachys heteroclada , Phyllostachys heterocycla , Phyllostachys pubescens

Minor hosts

Manihot esculenta (cassava), Oryza sativa (rice), Pinus (pines), Saccharum officinarum (sugarcane)

Geographic distribution

Notes on distribution

D. minutus has a worldwide distribution. It is native to Asia and has been reported in Israel, West Africa, South Africa, North America, Central America, South America, Germany and other European countries. It occurs in almost all the South Asia countries. In China, it can be detected in many cities, except a few cities in the north (Singh, 1974; Sandhu, 1975; Singh and Bhandhari, 1988; Xu Tiansen et al., 1993; Chang Yuzhen and Xue, 1994; Zhang Shimei and Zhao Yongxiang, 1996).

Distribution List

Please note: The distribution status for a country or province is based on all the information available. When several references are cited, they may give conflicting information on the pest status. In particular, citations of earlier presence of a pest are included even though there is an authoritative reference to indicate that the pest is now absent.

Europe

Germany

Present, introduced, not invasive

Wu et al., 1986

Asia

China

Anhui

Present, native, not invasive

Wu et al., 1986

Beijing

Present, native, not invasive

Wu et al., 1986; Chu & Zhang, 1997

Fujian

restricted distribution, native, not invasive

Liu, 1956a, b; Chu & Zhang, 1997

Guangdong

restricted distribution, native, not invasive

Liu, 1956a, b; Chu & Zhang, 1997

Guangxi

Present, native, not invasive

Chu & Zhang, 1997 Guizhou

Present, native, not invasive

Chu & Zhang, 1997

Hainan

Present, native, not invasive

Chu & Zhang, 1997

Henan

Present, native, not invasive

Wu et al., 1986

Hong Kong

Present, native, not invasive

APPPC, 1987

Hubei

Present, native, not invasive

Liu, 1956a, b; Xiao, 1991

Hunan

Present, native, not invasive
Liu, 1956a, b; Xiao, 1991

Shaanxi

Present, native, not invasive
Wu et al., 1986

Shandong

Present, native, not invasive
Wu et al., 1986

Shanxi

Present, native, not invasive
Wu et al., 1986

Sichuan

present, native, not
invasive Tan et al., 2000

Zhejiang

restricted distribution, native, not invasive
Xiao, 1991

India

Present, native, not invasive
Sandhu, 1975; Kumar et al.,
1985 Indonesia

Present, native, not invasive
Wu et al., 1986

Israel

Present, introduced, not invasive
Gerstmeier et al., 1999

Japan

Present, native, not invasive

Wu et al., 1986; Chu & Zhang, 1997

Malaysia

Present, native, not invasive

Wu et al., 1986; Chu & Zhang, 1997

Sarawak

present

NHM, 1978

Philippines

Present, native, not invasive

Wu et al., 1986

Sri Lanka

Present, native, not invasive

Wu et al., 1986

Vietnam

present

NHM, 1923

Africa

Congo Democratic
Republic present

NHM, 1927

Côte d'Ivoire

present

NHM, 1944

Mauritius

Present, not
invasive Wu et al.,
1986 Sierra Leone

present

NHM, 1915

Tanzania

Zanzibar

present

NHM, unda

Zambia

present

NHM, 1984

Zimbabwe

present

NHM, 1936

Central America & Caribbean

Cuba

Present, introduced, not invasive

Wu et al., 1986

Trinidad and Tobago

Present, introduced

Schotman, 1989

Windward Islands

present

NHM, 1893

North America

USA

California

Present, introduced, not invasive

Woodruff, 1967; Baker, 1972

Florida

restricted distribution, introduced, invasive Woodruff, 1967; Baker, 1972

South America

Brazil

Present, introduced, not invasive

Wu et al., 1986

Chile

Present, introduced, not invasive

Wu et al., 1986

Colombia

present

NHM, 1994

Oceania

Fiji

present

NHM, 2005

Papua New Guinea

present

NHM, 1934

Solomon Islands

present

NHM, 1963

Biology and ecology

The biology and ecology of D. minutus have been studied by a few entomologists worldwide (Van Dine, 1909; Whitney, 1927; Fullaway, 1930; Zimmerman, 1941; Krauss, 1945; Plank, 1948; Wu et al., 1986). The large amount of information relates to China and South Asia, the main areas of distribution of D. minutus.

D. minutus is polyvoltine. The life cycle is almost uniform irrespective of distribution. There are three generations in China and three to four in South Asia, per year, but the generations are heavily overlapped. In Changsha, Hunan Province, China, there are three generations per year and four to five generations in Guangzhou, China. The adults and larvae can be found at any given time of the year and overwintering is not distinct, although they are less active in cold winters. The first peak of adult emergence is in February, the second is in June, and the third is in October (Van Dine, 1909; Whitney, 1927; Zimmerman, 1941; Liu Jingying, 1956; Liu Yuan and Xu, 1982; Tan Zhongyi, 1984; Wu et al., 1986).

The females begin to deposit eggs individually, in tunnels mined by the adults in mid-April, and oviposition can last 4 months. The peak time for oviposition is in May and June. Temperature and humidity affect ovipositon. A female can lay approximately 20 eggs. The eggs hatch in 5 to 8 days. The larvae bore longitudinally in the culm, which can make a tunnel approximately 15 to 20 mm long and take about 40 days to develop. Pupation occurs in cocoons made at the terminal end of the larval tunnels. After approximately 4 days, the newly developed adult beetles may fly away or may explore other parts of the same bamboo. Some beetle holes are left on the bamboo and a great quantity of tunnels may be present at high densities of D. minutus (Singh, 1974; Sandhu, 1975; Tan Zhongyi, 1984; Singh and Bhandhari, 1988; Wu Jianfen et al., 1986).

Starch, soluble carbohydrates and proteins are nutritionally essential to D. minutus. The incidence of borer attacks has a strong correlation to the richness of nutrients in felled culms, and vary significantly with bamboo species, growing sites, timing and culm age at felling, and the method of transportation and storage. According to Xiao (1992), Bambusa textilis, Bambusa pervariabilis, Phyllostachys heterocycla and Phyllostachys heteroclada are more prone to attack by D. minutus than Pleioblastus amarus and Pseudosasa amabilis. The beetle shows a strong preference for newly-felled culms of some species, whereas others, such as P. amabilis and Pleioblastus spp., are hardly ever attacked. Culms from level sites are more susceptible to attack than those felled from sloping sites. Bamboos growing on plateaus are more seriously damaged than those growing in mountains, and those felled in spring and summer are more readily attacked than those felled in autumn and winter. Moreover, culms felled at a young age are more seriously damaged than those grown for 3 to 4 years. In general, culms felled at a young age and growing season, and those growing on shaded, wet sites are more susceptible to attack by D. minutus. Borgemeister et al. (1999) surmised that plant volatiles play an important role in the host-finding and damage behaviour of Dinoderus spp.

D. minutus has a strong ability for starvation tolerance. The adults have a strong ability for pesticide resistance and have no phototactic reaction toward light (Li Yanwen et al., 1996).

Outbreaks of D. minutus in large distribution areas have never been reported. There are records from factories or farms, which store bamboo in Asia (Singh, 1990; Chen Zhilin, 2000; Tan Sujin et al., 2000). The factors responsible for its outbreak are still unclear, so no monitoring system is built at present.

Morphology

Eggs

The eggs are spindle-shaped or elongate-oval, very small, milky-white, and nearly transparent. The eggs are individually laid in tunnels made by the adults.

Larvae

The larvae are approximately 3 to 4 mm long and milky-white. The body is 'C'-shaped. The head is round and the length is equal to the width. The mouthparts are black. The thorax is expanded and bears three legs, which decrease along its length. The spiracles are oval-round, which is longer than those in the sternum. Dense hair covers the tibia.

Pupae

The pupa is almost spindle-shaped, approximately 2.5 to 4 mm long, and milky-white. The compound eye and mandibles are black, and there is a pair of finger-like projections on the end of the sternum.

Adults

The adult is elongate-columnar, approximately 2.5 to 3 mm long and 0.9 to 1.5 mm wide, reddish or dark-brown and covered with dense puncta and hair, which is more obvious at the posterior of the wings. There are many tiny punctures on the head, which is small and black. The head is covered by the prothorax, so that it cannot be seen when viewed dorsally. The compound eyes are back and round. The antennae are ten-segmented and lamellate. The first segment is oval and twice as long as it is wide, the second is the same width as the first, and the three distal segments are swollen. The elytra are covered with dense and small punctures and bristles, which are more obvious at the posterior of the wings. The legs are reddish-brown. The tarsus consists of five segments; the first is no longer than the third or the fourth. The first abdominal segment is equal to the second in length (Xiao, 1991; Schäfer et al., 2000).

Means of movement and dispersal

Natural Dispersal

D. minutus adults disperse to nearby areas following emergence. There is a risk that the larvae, pupae and adults may stay in the tunnels of the bamboo culms, facilitating transport of D. minutus to new areas and providing the main way for long distance dispersal.

Movement in Trade

D. minutus is a post-harvest pest that damages bamboo and its products and in many countries it is an important plant-quarantine pest. It can be transported in the trade of domestic and imported bamboo woods and bamboo products, such as baskets and furniture; the principal way for its spread between countries. It has been detected and caught in many open ports (Xie Sen et al., 1998; Chen Zhilin et al., 1999, 2000; Liu Xiaodong, 2000; Gong Xiuze, 2003).

Plant parts liable to carry the pest in trade/transport

- Stems (above Ground)/Shoots/Trunks/Branches: Eggs, Larvae, Pupae, Adults; borne internally; visible to naked eye.
- Wood: Eggs, Larvae, Pupae, Adults; borne internally; visible to naked eye.

Plant parts not known to carry the pest in trade/transport

- Bark
- Bulbs/Tubers/Corms/Rhizomes
- Fruits (inc. Pods)
- Growing Medium Accompanying Plants
- Flowers/Inflorescences/Cones/Calyx
- Leaves
- Seedlings/Micropropagated Plants
- Roots
- True Seeds (inc. Grain).

Transport pathways for long distance movement

- Conveyances (transport Vehicles)
- Travellers And Baggage

Natural enemies

There are a few predators reported to attack D. minutus. Teretriosoma nigrescens (Rees, 1991), Denops albofasciata (Borgemeister et al., 1999; Gerstmeier et al., 1999) and Tillus notatus are known to prey on the eggs, larvae, pupae and adults (some species just prey on the eggs) in the boring tunnels. A clerid preys on the borer in the tunnels (Liu Yuan and Xu, 1982; Tan Zhongyi, 1984; Wu et al., 1986).

See Chatterjee and Misra (1974) for information on the parasitism of D. minutus.

Natural enemies listed in the database

The list of natural enemies has been reviewed by a biocontrol specialist and is limited to those that have a major impact on pest numbers or have been used in biological control attempts; generalists and crop pests are excluded. For further information and reference sources, see About the data. Additional natural enemy records derived from data mining are presented as a separate list.

Natural enemies reviewed by biocontrol specialist

Natural enemy

Pest stage attacked

Associated plants

Biological control in:

Parasites/parasitoids:

Platyspathius dinoderi

Eggs

Spathius vulnificus

Eggs

Predators:

Acarophenax lacunatus

Eggs

Denops albofasciata

Eggs

Teretriosoma nigrescens

Adults

Tillus notatus

Adults, Larvae, Pupae

Additional natural enemies (source - data mining)

Natural enemy

Pest stage attacked

Associated plants

Biological control in:

Parasites/parasitoids:

Cerocephala aquila

Cerocephala dinoderi

Cotesia ruficrus

Rhoptrocentrus piceus

Bambusa

Israel

Predators:

Nodele mu

Impact

Economic impact

Insects that cause damage to felled culm and finished products are probably the most common and serious pests in the Asian bamboo industry. Over 50 such insect species have been reported, and ghoon borers (Dinoderus spp.), found in most Asian countries, cause the most damage. Damages usually result in the loss of large amounts of raw materials or in the destruction of finished bamboo products.

Bamboo under storage, either as culms or as finished products, is very susceptible to damage by insects. Occasionally, subterranean termites cause severe damage. However, the most important pest of bamboo under storage conditions is the ghoon borer, D. minutus and other powderpost beetles, Dinoderus spp. Large quantities of culms are destroyed each year by insect borers, although the extent of loss has not yet been assessed. In storage yards, stacks with immature culms are the starting points for attack and the bamboo is often converted to dust. Approximately 40% of a bamboo stack may be lost within a period of 8 to10 months due to ghoon borer attack (Thapa et al., 1992).

Mathew and Nair (1990) reported that finished products made of reed or bamboo, such as mats, baskets, curtains, etc., are also damaged by D. minutus, but no data are available on the extent of the loss.

Impact descriptors

Negative impact on: trade / international relations

Phytosanitary significance

Considering the host range of D. minutus, its economic impact on bamboo and its ability to easily spread, there should be concern in the areas devoid of the pest, but with suitable hosts. In countries where D. minutus is present, some measures should be taken to define its dispersal.

Symptoms

The adult beetles burrow into felled culms through wounds, cracks and cut ends, and make horizontal tunnels along the fibrovascular tissues of the culms; the larvae make longitudinal tunnels. The damaged part of the culm becomes powdery, and the powder is sifted from the beetle hole. Large populations of borers will leave numerous tunnels in the culm, making it useless. Also a great quantity of beetle holes will be left on the surface of the culms.

The damaging habits of D. minutus are equivalent to other species belonging to Dinoterus spp. and the damage symptoms are so similar that it is difficult to distinguish species purely on the basis of symptoms.

Symptoms by affected plant part

Stems: internal feeding; visible frass; lodging; broken stems.

Similarities to other species

The morphology, way of feeding and symptoms of defoliation, are very similar to other bamboo borers, such as Dinoderus japonicus. For accurate identification to species, more work on the identification of eggs, larvae, pupae, and especially adults, should be undertaken (Schäfer et al., 2000).

Detection and inspection

The larvae and adults can be detected by the careful inspection of newly-felled culms or some bamboo products, such as houses and furniture. Also the symptoms of defoliation (wood powder ejected from the beetle hole is the most obvious) reveal larval feeding or adults. Pheromone traps for monitoring D. minutus have not been reported to date (2004).

Control

There are several options for the control of D. minutus, such as phytosanitary methods, biological control, physical methods and chemical control. Selecting the best option depends on a number of factors, such as the severity of infestation, the location of infestation, potential for reinfestation, and cost of treatment (Plank, 1950; Xu Tiansen, 1983; Kumar et al., 1985; Liu Yuan and Xu, 1985; Yang Guarong, 1991; Li Yanwen et al., 1996; Xu Changtang, 2003).

Phytosanitary Measures

D. minutus is a phytosanitary pest in many countries because it can be easily transported between countries in the international trade of bamboo wood and products. Therefore in many open ports, D. minutus is a dangerous pest that should be treated seriously and warrants careful inspections. All imported wood, containers and products are treated by government pest control operators using fumigation and heating, for example, if some symptoms of defoliation are detected (Xu Changtang, 2003).

Biological Control

There are a few predators reported that can be used to control D. minutus (Rees, 1991; Borgemeister et al., 1999). A clerid preys on the borer in boring tunnels (Liu Yuan and Xu, 1982; Tan Zhongyi, 1984; Wu et al., 1986). Spathius bisignatus [Platyspathius dinoderi] and Spathius vulnificus parasitize the eggs of D. minutus. Tillus notatus preys on the larvae, pupae and adults. These natural enemies cannot be relied upon as an effective control method, although they can cause high mortality of the borers. To date (2004), no literature concerning successful examples of biological control methods for the control of D. minutus is available.

Physical Control

After felling, the physical or chemical treatment of culms can significantly improve their resistance to borers as well as to fungi. The traditional and simplest method is to immerse felled culms in water. This method may only be effective in preventing damage from bostrychid beetles. It is also only suitable for those bamboos with a low starch content. This method takes a long time and culms treated in this way tend to blacken (Xu Tiansen, 1983). The heating of culms using fire, boiling water or exposure to direct sunlight in hot summers, can kill borers of D. minutus including the eggs, larvae, pupae and adults. Some advanced microwave and infrared techniques have recently been developed for killing the borers in bamboo culms (Yao Kang et al., 1986).

Chemical Control

Chemical treatment using various insecticides and preservatives has been the most widely used method in controlling post-harvest pests of bamboos, including D. minutus (Xin Jieliu, 1958). Various preservatives have been recommended and used in different countries: 5% water solution of copper-chrome-arsenic composition (CCA); 5-6% water solution of copper-potassium dichromate-borax (CCB); 5-6% water solution of boric acid-borax-sodium pentachlorophenate in 0.8:1:1 or 1:1:5 ratios (BBP); 2-3% water solution of borax: boric acid in a 5:1 ratio; and 10% or 20-25% water solution of copper sulphate. These are mostly applied by soaking under normal temperatures, cold or heated conditions, or under high pressure (Singh and Tewari 1979, 1980, 1981; Nair et al., 1983; Xu Tiansen, 1983; Kumar et al., 1985; Liu Yuan and Xu, 1985; Zhou Fanchun, 1985; Thapa et al., 1992).

Soaking in an aqueous solution of 2% boric acid, 0.5% pentachlorophenate and 5% alcohol can treat bamboo rind and similar semi-finished products. Sulthoni (1990) reported treating dried bamboo splits by immersing them in diesel oil as a simple and cheap method of bamboo preservation. Varma et al. (1988) tested the effectiveness of several commercial formulations of insecticides against D. minutus, and concluded that BHC and the two pyrethroids cypermethrin and permethrin, were effective. Mori and Hideo (1979) reported that the two low-toxicity organophosphorus insecticides prothiophos and phoxim, were more effective than organochlorine ones for the preservation of bamboo materials against fungi and boring pests. Treating culm splits by immersing them in 0.2% phoxim for 3 minutes can result in total mortality of D. minutus in the culm in 2 to 3 days, and can protect the treated split from attack for over 1 year (Zhou Huiming, 1987). Affected bamboo material can also be treated by fumigating in closed chambers or storehouses with sulphuryl fluoride at a rate of 30 to 50 g/m^3 of timber for 24 hours (Li Yanwen et al., 1996; Chen Zhilin et al., 1999, 2000).

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Dinoderus brevis

Names and taxonomy

Preferred scientific name

Dinoderus brevis Horn

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Bostrichidae

EPPO code

DINDBR (Dinoderus brevis)

Host range

List of hosts plants

Hosts (source - data mining)

Bambusa (bamboo)

Geographic distribution

Distribution List

Asia

Indonesia

unconfirmed record

CAB Abstracts, 1973-1998

References

CAB Abstracts, 1973-1998. Data mined from CAB Abstracts database, years 1973 to 1998. Wallingford, UK: CAB International

Rhyzopertha dominica

Names and taxonomy

Preferred scientific name

Rhyzopertha dominica (Fabricius)

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Bostrichidae

Other scientific names

Synodendron dominica Fabricius

Apate pusilla Fairmaire 1850

Apate rufa Hope 1845-47

Bostrychus moderatus Walk.

Dinoderus frumentarius Motschulsky 1857
Dinoderus pusillus Horn 1878

Ptinus fissicornis Marsham 1802 Ptinus picus Marsham 1802 Rhizopertha dominica Lesne 1896 Rhizopertha pusilla Stephens 1830 Rhizopertha rufa Waterhouse 1888 Synodendron dominicum Fabricius 1792 Synodendron pusillum Fabricius 1798 Rhizoperta dominica (F.)

Rhyzopertha pusilla
Fabricius EPPO code

RHITDO (Rhyzopertha dominica)

Common names

English:

lesser grain borer
American wheat weevil

weevil, Australian wheat
grain, borer, lesser
grain, borer, stored
grain, eater, small

Spanish:

capuchino de los granos
barrenador grande de los granos
escarabajo de los granos
gorgojo de los cereales taladrillo
de los granos pequeño
barrenador del trigo barrenador
menor de los granos gorgojo da
los creales

French:

perceur (petit) des céréales
bostryche des grains
perceur des cereales, petit
capucin des grains

petit perceur des céréales
besourinho do trigo armazenado
Czechoslovakia (former -):
korovník obilní

Germany:

Getreidekapuziner

Hungary:

Gabonaalszu

Indonesia:

Gabah-bubuk

Israel:

norer hatiras

Italy:

punteruolo dei cereali

Netherlands:

Graanboorder, kleine

Norway:

kornborer

Poland:

kapturnik zbozowiec

Serbia and Montenegro:

kapuciner

rizoperta

zitni kukuljicar

Turkey:

ekin kambur biti

Notes on taxonomy and nomenclature

See Gardner (1933) for a key separating full-grown larvae of the family Bostrichidae.

Host range

Notes on host range

Adults and larvae of R. dominica feed primarily on stored cereal seed including wheat, maize, rice, oats, barley, sorghum and millet. They are also found on a wide variety of foodstuffs including beans, dried chillies, turmeric, coriander, ginger, cassava chips, biscuits and wheat flour. There are several reports of the lesser grain borer being found in or attacking wood (Potter, 1935), as is typical of other Bostrichidae. R. dominica has been reported to produce progeny on the seeds of some trees and shrubs (acorns, hackberry [Celtis occidentalis] and buckbrush [Symphoricarpos orbiculatus]) (Wright et al., 1990).

Affected Plant Stages: Post-harvest.

Affected Plant Parts: Seeds.

List of hosts plants

Major hosts

Avena sativa (oats), Hordeum vulgare (barley), Oryza sativa (rice), Panicum (millets), Pennisetum (feather grass), Sorghum bicolor (sorghum), stored products (dried stored products), Triticum (wheat), Triticum aestivum (wheat), Triticum turgidum (durum wheat), Zea mays (maize)

Minor hosts

Capsicum frutescens (chilli), Coriandrum sativum (coriander), Curcuma longa (turmeric), Manihot esculenta (cassava), Phaseolus (beans), wheat flour , Zingiber officinale (ginger)

Hosts (source - data mining)

Arachis hypogaea (groundnut), Cicer arietinum (chickpea), Glycine max (soyabean), Lens culinaris ssp. culinaris (lentil), Pennisetum glaucum (pearl millet), Triticale , Triticum spelta (spelt), Vigna angularis (adzuki bean), Vigna mungo (black gram), Vigna radiata (mung bean), Zizania palustris (northern wild rice (USA))

Habitat

Rhyzopertha dominica is found mainly in cereal stores, and food and animal feed processing facilities. It has also been trapped using pheromone-baited flight traps several kilometres from any food storage or processing facility (Fields et al., 1993).

Geographic distribution

Notes on distribution

R. dominica is thought to originate from the Indian subcontinent, but now has a cosmopolitan distribution. It is a serious pest of stored products throughout the tropics, Australia and the USA. It is also found in temperate countries, either because of its ability for prolonged flight or as a result of the international trade in food products.

Distribution List

Please note: The distribution status for a country or province is based on all the information available. When several references are cited, they may give conflicting information on the pest status. In particular, citations of earlier presence of a pest are included even though there is an authoritative reference to indicate that the pest is now absent.

Europe

Austria present

Faber, 1982

Croatia

present

Purrini, 1976

Cyprus present

Iordanou, 1976

Former USSR

present

Asanov, 1980

Former Yugoslavia

present

Pireva,

1992 <u>France</u>

present

ACTA, 1982

<u>Germany</u>

present

Bahr, 1975; Rassmann, 1978

<u>Greece</u>

present

Guerra, 1992

<u>Italy</u> present

Trematerra & Daolio, 1990; Suss et al., 1991

<u>Russian Federation</u>

present

Asanov, 1980; Zakladony, 1990

<u>Russia (Europe)</u>

present

Podobivskii,

1991 <u>Switzerland</u>

present

Hoppe, 1981; Buchi, 1993

<u>United Kingdom</u>

present

Dyte et al., 1975; Jacobson & Thomas,
1981 <u>Asia</u>

<u>Bangladesh</u>

widespread

Taylor & Halliday, 1986

<u>Bhutan</u>

present

Taylor & Halliday, 1986

<u>China</u>

present

Dunkel et al., 1982
<u>Taiwan</u>

present

Lin, 1981; Lo, 1986; Lin et al., 1990
<u>India</u>

widespread

Sinha & Sinha, 1990

<u>Bihar</u>

present

Sinha & Sinha, 1990

<u>Indian Punjab</u>

present

Dhaliwal, 1977

<u>Uttar Pradesh</u>

present

Girish et al.,

1974 <u>Indonesia</u>

present

Soegiarto et al., 1981; Sidik et al.,
1985 <u>Java</u>

present

Soegiarto et al., 1981
<u>Iraq</u>

present

Ismail et al., 1988
<u>Israel</u>

present

Carmi & Pater, 1989

<u>Japan</u>

present

Yoshida, 1983

<u>Korea, DPR</u>

present

Paik, 1976

Malaysia

present

Seth, 1975; Muda, 1985

Nepal

present

Taylor & Halliday, 1986

Pakistan

present

Tilton et al., 1983; Taylor & Halliday, 1986
Philippines

present

Caliboso et al., 1985; Sayaboc & Acda, 1990
Saudi Arabia

present

Mostafa et al., 1981; Rostom, 1993
Singapore

widespread

AVA, 2001

Sri Lanka

present

Ganesalingam, 1977; Taylor & Halliday, 1986

Syria

present

Teriaki & Verner, 1975

Thailand

widespread

Sukprakarn,

1985 Turkey

present

Aydin & Soran, 1987; Yucel, 1988

Uzbekistan

present

Asanov, 1980

<u>Vietnam</u>

present

Stusak et al., 1986

<u>Africa</u>

<u>Egypt</u>

present

El Nahal et al., 1984

<u>Guinea</u>

present

Potter, 1935

<u>Mali</u>

present

Taylor & Halliday, 1986

<u>Morocco</u>

present

Bartali et al., 1990

<u>Nigeria</u>

present

Ivbijaro, 1979; Ekundayo, 1988

<u>Rwanda</u>

present

Weaver et al., 1991

<u>Senegal</u>

present Seck,

1991 <u>Somalia</u>

present

Lavigne,

1987 <u>South</u>

<u>Africa</u>

present

Viljoen et al., 1984

Sudan present

Seifelnasr,

1992 Tanzania

present

Hodges et al., 1983

Central America & Caribbean

Cuba
present

Aviles & Guibert, 1986

Honduras

present

Hoppe, 1986

Nicaragua

present

Giles, 1977

Puerto Rico

present

Potter, 1935

North America

Canada
present

Fields et al., 1993

Alberta

present

Fields et al., 1993

British Columbia

present

Fields et al., 1993

Manitoba

restricted distribution

Fields et al., 1993

New Brunswick

present

Fields et al., 1993

Quebec

restricted distribution

Fields et al., 1993

Saskatchewan

present

Fields et al., 1993

Mexico

present

Rojas Leon, 1988; Corral et al., 1992

USA

widespread

Storey et al., 1982, 1983

Oregon

present

Cuperus et al., 1990

South America

Argentina

present

Trivelli,

1975 Brazil

present

Taylor & Halliday, 1986; Pacheco et al., 1990

Rio Grande do Sul

present

Oliveira et al., 1990

Sao Paulo

present

Pacheco et al., 1990

Chile

present

Trivelli, 1975

Peru

present

Fernandez Hermoza, 1972

Oceania

Australia

widespread

Sinclair & Haddrell, 1985; Collins et al., 1993

New South Wales

widespread

Greening, 1979

Queensland

widespread

Sinclair, 1982

Fiji

present

Potter, 1935

Biology and ecology

Females of R. dominica lay between 200 and 500 eggs in their lifetime. The eggs are laid loose in grain. The lowest temperature at which R. dominica can complete development is 20°C; at this temperature, the development from egg to adult takes 90 days. The fastest rate of development occurs at 34°C; at this temperature the egg takes 2 days, the larvae 17 days, and the pupae 3 days to complete development. R. dominica is unable to complete development between 38 and 40°C. Adults live for 4-8 months. Under optimal conditions of 34°C and 14% grain moisture content, there is a 20-fold increase in the population of R. dominica after 4 weeks. It can successfully infest grain at 9% moisture content, but has higher fecundity, a faster rate of development, and lower mortality on grain of a higher moisture content.

Adult males produce an aggregation pheromone in the frass that attracts both male and female adults. Adults are good flyers, and can be trapped in pheromone-baited flight traps placed several kilometres from grain stores. Adults can bore into intact kernels. The larvae of R. dominica are mobile.

Morphology

Potter (1935) provided a detailed description of all life stages of R. dominica. The egg is typically white when first laid, turning rose to brown before hatching. The egg is ovoid in shape, 0.6 mm in length, 0.2 mm in diameter. There are usually four larval instars. The larvae are scarabaeiform, the first two instars are not recurved, the third and fourth instars have the head and thorax recurved towards the abdomen. The widths of the head from the first to the fourth instar are 0.13, 0.17, 0.26 and 0.41 mm, and the lengths of the larvae are 0.78, 1.08, 2.04 and 3.07 mm, respectively. The pupae are 3.91 mm in length, with 0.7 mm between the eyes. At the end of the abdomen, the male pupae have a pair of 2-segmented papillae fused to the abdomen for their entire length, whereas female papillae are 3-segmented and project from the abdomen. Adults are 2-3 mm in length, reddish-brown and cylindrical. The elytra are parallel-sided, the head is not visible from above, and the pronotum has rasp-like teeth at the front.

Natural enemies

There are a few predators of R. dominica. Teretriosoma nigrescens is a histerid beetle that is found in Central America feeding on Prostephanus truncatus. It also feeds on R. dominica, though it produces more offspring on P. truncatus (Puschko, 1994). This predator was released into Africa in 1991 in an effort to control P. truncatus, and is now well established in Togo and Benin in West Africa, and in Kenya in East Africa. However, the ability of T. nigrescens to significantly reduce P. truncatus or R. dominica populations has yet to be determined (Markham et al., 1994). There is some concern regarding the use of T. nigrescens, as it also feeds on grain. The cadelle Tenebroides mauritanicus also feeds on grain, mites and stored-product insect eggs, including Rhyzopertha (Bousquet, 1990; Yoshida, 1975). The predatory mites, Cheyletus eruditus and Pyemotes ventricosus feed on a wide variety of stored product insect eggs (Asanov, 1980; Brower et al., 1991), but their effect on populations in the field has not been determined. The anthocorid bugs, Xylocoris flavipes and Lyctocoris campestris, are general predators that are known to attack R. dominica and are found in grain stores around the world (Parajukee and Phillips, 1993; Asanov, 1980).

Natural enemies listed in the database

The list of natural enemies has been reviewed by a biocontrol specialist and is limited to those that have a major impact on pest numbers or have been used in biological control attempts; generalists and crop pests are excluded. For further information and reference sources, see About the data. Additional natural enemy records derived from data mining are presented as a separate list.

Natural enemies reviewed by biocontrol specialist

Natural enemy

Pest stage attacked

Biological control in:

Parasites/parasitoids:

Anisopteromalus calandrae

Larvae

Steinernema feltiae

Pyemotes tritici (itch mite, straw (USA))

Eggs

Theocolax elegans

Larvae, Pupae

Predators:

Acaropsellina docta

Cheyletus eruditus

Eggs

Lyctocoris campestris
Eggs, Larvae

Tenebroides mauritanicus
(cadelle) Eggs

Teretriosoma nigrescens
Larvae

Tillus notatus

Eggs, Larvae, Nymphs, Pupae, Adults

Taiwan

Xylocoris flavipes

Eggs, Larvae, Nymphs, Pupae, Adults

Additional natural enemies (source - data mining)

Natural enemy

Pest stage attacked

Biological control in:

Parasites/parasitoids:

Acarophenax assanovi

Lariophagus

distinguendus Pteromalus

cerealellae Predators:

Tribolium castaneum (red flour beetle)

Pathogens:

Beauveria bassiana (white muscardine fungus)

Impact

R. dominica is pest of several stored products, see Host Range section. It is a major pest in wheat and rice. The larvae and adults consume the seed. There are three types of costs associated with infestations of R. dominica; loss in quantity of seed stored, loss in quality of seed stored (Sanchez-Marinez et al., 1997) and the cost to prevent or control infestations (Cuperus et al., 1990; Anon., 1998).

It is difficult to estimate the costs of R. dominica because it is found along with other stored-product insect pests that also cause damage, the most common and serious of these being: Sitophilus oryzae, Trogoderma granarium, Sitotroga cerealella and Prostephanus truncatus. These companion species change depending upon the region and crop. Fumigation with aluminum phosphide, the most common method of control, will also control all stored-product insects in the grain bulk. The value of grain varies from country to country, as do the costs of control measures. The penalties incurred for selling infested grain also vary from country to country: in Australia and Canada there is zero tolerance for insects in stored grain. In the USA, if there are two or more live weevils (Sitophilus sp. or R. dominica)/kg of any grain, the grain lot is labeled "Infested", and the grain is usually fumigated with aluminum phosphide. If wheat has 32 insect-damaged kernels/100 g or more, the lot is downgraded to the lowest grade of wheat "U.S. Sample grade"(Anon., 1997).

There are some estimates of the damage done by R. dominica. Storey et al. (1983) did extensive sampling of USA farm-stored wheat, maize and oats between 1976 and 1979. They estimate that R. dominica was present in 2.6% of wheat samples, 0.4% of maize samples and 0.5% of oat samples. They removed and counted all adults, incubated the samples so that all the immature stages could develop to the adult stage before sieving and counting adults a second time. For wheat they found 160 insects/kg of wheat, 7 insects/kg of maize and 23 insects/kg of oats. During these years the average production of wheat in the USA was 55 million metric tonnes (http://apps.fao.org/), given that 2.6% of the wheat was infested with an average of 160 R. dominica/kg, this gives a total of 2 million million R. dominica in the USA in wheat stored on the farm. Laboratory experiments have estimated that one R. dominica consumes 0.15 g of wheat (Campbell and Sinha, 1976) in it's life time (Birch, 1953). If each one of these R. dominica completed their life cycle, they would have consumed 300,000 metric tonnes of wheat annually from 1976 to 1979 in the USA, or 0.5% of the total of stored wheat. Similar calculations, assuming R. dominica eats 0.15 g during it's life, yield 8000 tonnes of maize (0.004% loss of total harvest) and 2000 tonnes of oats (0.02% loss) consumed annually by R. dominica. Sampling of grain at the export elevators showed that 5.6% of wheat samples were infested with 4.3 R. dominica/kg of wheat, and 0.3% of maize samples were infested with 0.7 R. dominica/kg of maize (Storey et al., 1982). Comparable field estimates of individual stored-grain insect populations have not been made in other countries or at other times in the USA.

The Environmental Protection Agency in the USA estimates that 730,000 kg of aluminum phosphide was used annually between 1987 and 1996, though they state that data for the amount of insecticide used on stored grain is lacking (Anon., 1998). Of this total, about 270 000 kg were used for wheat in storage. Aluminum phosphide retails for approximately US$50/kg so the cost of fumigating wheat would be about US$ 13.5 million per year, plus the cost of labour. As mentioned before, fumigations are carried out for all of the insects found in grain storage, not just for R. dominica.

Symptoms

Symptoms by affected plant part

Seeds: external feeding.

Similarities to other species

The Bostrichidae can be distinguished from most other Coleoptera found in stored foodstuffs by the presence of rasp-like teeth on the pronotum. Some Scolytidae found in stored products also have pronoted aspirities but but with a compact club not loose 3-segmented as in the Bostrichidae.

R. dominica can be distinguished from Prostephanus truncatus, the larger grain borer, by the shape of the abdomen and the elytra. The posterior end of the abdomen of Prostephanus is square with distinct corners, whereas Rhyzopertha has a tapered abdomen. When viewed from the side, the elytra declivity, where the elytra slopes towards the tip, is steep and flat for Prostephanus and tapered and rounded for Rhyzopertha. Less reliable indicators are adult size and colour. Prostephanus is black and 3-4 mm in length, whereas Rhyzopertha is brown and 2-3 mm in length.

In addition, the following characters may also be used to distinguish between these species.

R. dominica has pronotum with coarse asperities anteriorly, less coarse granules posteriorly, anterior margin strongly dentate in a regular curve. Elytra with regular rows of coarse punctures (finer at sides) covered with curved setae, fine anteriorly, thick posteriorly: declivity unarmed.

P. truncatus has pronotum with coarse asperities on front half (anterior - most ones forming inverted V which projects at middle of front margin), with fine granules on posterioir half which change to single punctures at sides. Elytra with coarse, partly linear punctation, covered with long, fine setae, curved anteriorly, erect posteriorly; declivity with lateral and preapical carina, and slightly raised suture.

Another bostrichid found in stored products, Dinoderus minutus, the bamboo powderpost beetle, can be distinguished from Rhyzopertha by its stout body and a pair of shallow, medial depressions near the base of the pronotum (Bousquet, 1990). Also, the elytra are irregularly punctate and declivity with ocellate punctures in Dinodermus. D. minutus is a pest of bamboo and cane which is occasionally found in stored grain, tobacco and fruit.

Detection and inspection

A variety of methods have been used to detect insect pests of stored products, including R. dominica. The simplest method is to sieve a 200-1000 g sample of the grain and look for adults. However, only a small sample of the grain is inspected using this method and larvae, pupae and adults inside the grain kernels are not detected. An inclined sieve enables 30 kg of grain to be sampled in 5 minutes, with the extraction of 90% of the adults (White, 1983). Berlese funnel extractions can be used to extract adults and larvae from inside the seed, by forcing the insects out of the grain into collection jars. This method does not detect non-mobile stages such as the pupae and eggs; it also takes several hours and requires specialized equipment.

An ELISA test which detects the presence of the insect muscle protein, myosin, can also be used (Quinn et al., 1992). The ELISA test is mainly intended for use in flour mills to ensure that the flour does not contain large numbers of insect fragments or whole insects, but it can also be used to detect insects in whole grain. The cost of the ELISA and the time involved make it unlikely to replace Berlese funnel extractions. However, rapid and inexpensive ELISA kits are being developed for use in the field and may become available in the near future.

Lesser grain borer can be detected by placing probe pitfall traps in the grain (White et al., 1990; Hagstrum, 2000). Insects fall into these traps, which resemble a torpedo with holes, as they move through the grain. The traps are left in the grain and inspected periodically. This method is more sensitive than the extraction of insects using either a sieve or Berlese funnel. However, the traps should be left in place for 2-7 days and are ineffective at temperatures below 10°C, when the insects stop moving. Placing the trap in the grain can also be impractical in many storage situations. To address this limitation, grain probe traps have been wired to electronic sensors that detect insects as they fall into the trap (Epsky and Shuman, 2001). Pheromone-baited flight traps are a highly sensitive tool for the detection of R. dominica (Leos Martinez et al., 1987; Fields et al., 1993). Like probe pitfall traps, flight trap catches are a relative measure and are temperature dependant, with few insects being caught at air temperatures below 20°C.

Near-infrared spectroscopy (NIRS) has been used for many years commercially to measure protein content in grain. In the laboratory, NIRS can be used to detect late instar larvae, pupae and adults of R. dominica and other internal feeders in grain (Dowell et al., 1998). This system can also be used to distinguish R. dominica from other insects (Dowell et al., 1999).

Temperature, carbon dioxide, sound and feeding damage can be used as indirect indicators of insect infestation. Insects release heat as they respire, and at high insect densities, 'hot spots' can be created. Thermometers, either attached to the end of a probe or wired permanently into a storage structure with a remote electronic readout, give a quick and accurate picture of grain temperature. However, hot spots can be very localized and difficult to detect, and insects can cause significant damage before they are detected.

Increased carbon dioxide concentration in the grain indicates the presence of insects in the storage bin at an earlier stage, during the development of the insect infestation. This method allows detection at lower insect densities, at the beginning of an infestation. Tubes are placed into the top of the grain mass, in the centre, and the intergranular air is sampled every 2 weeks (Sinha et al., 1986). Both of these methods also detect the growth of moulds.

Researchers have been listening to insects in stored grain for over 40 years (Shade et al., 1990; Hagstrum et al., 1990). Commercial units are now available to detect the sounds of insects moving and feeding. This technology is in its infancy and a number of improvements are needed before it can become an effective tool for the detection of insect infestations.

Feeding holes in grain and other commodities also indicate the presence of some insects, but sampling using sieves or traps is needed to identify which insects have caused the damage. All of these detection methods are not specific for R. dominica, and grain samples are required for verification of the insect species.

Control

Physical Control

Manipulation of the temperature, relative humidity, atmospheric composition, sanitation, ionizing radiation and the removal of adult insects from the grain, by seiving or air classification, can eliminate infestations of insects such as R. dominica, or reduce populations to a tolerable level (Banks and Fields, 1995).

Reducing temperatures to below 34°C reduces the rate at which the population of R. dominica increases, and it cannot complete its life cycle at temperatures below 20°C. All insects are controlled in 3-10 weeks at 9°C, and in 3-4 weeks at 4°C (Fields, 1992). In temperate countries, grain temperatures can be reduced by forcing air from outside through the grain, especially in winter. Grain can also be cooled by aeration using refrigerated air. Commercial units are available for both types of cooling. Increasing grain temperature to above 34°C also reduces the rate at which the population of R. dominica increases. Although R. dominica is one of the most heat tolerant of all stored grain insect pests, it can be controlled by heating the grain to 65°C in 4 minutes, and rapidly cooling it to below 30°C. Commercial units that can handle 150 t of grain/h have been developed in Australia and the running costs are comparable to those of chemical control. Care must be taken to ensure that the commodities in storage are only heated briefly so that the quality is not reduced. Manipulation of storage temperature is a new technology that may be used to a greater extent in the future.

Reducing grain moisture content also reduces insect populations, by reducing the number of eggs produced and the survival of offspring and adults. For R. dominica at 34°C; there are 109 adults produced per female per generation at 14% moisture content, 10 adults at 10%, 0.3 adults at 9%, and none at 8% moisture content (Birch, 1953).

The addition of inert dusts to the grain can reduce insect numbers by absorbing cuticular waxes and causing the insects to die from desiccation. This dust is more effective in drier grain. Inert dusts come in a variety of forms including ash, lime, clay, diatomaceous earth and silica aerogel. The most effective inert dusts are diatomaceous earth and silica aerogel. Silica aerogels are man-made powders with smaller and more uniform particle sizes than diatomaceous earth. Silicon dioxide is the major component of both inert dusts; this compound is registered as a food additive in several countries. R. dominica is relatively tolerant to diatomaceous earth, and concentrations between 500 and 1000 p.p.m. are required to control populations (Subramanyam et al., 1994). At these concentrations, diatomaceous earth reduces grain bulk density by 9% and flow rate by 39% (Jackson and Webley, 1994), levels that are unacceptable for much of the large-scale commercial trade but may be acceptable for households or subsistence farms. Diatomaceous earths from different geological sources have different efficacies, and the concentrations required to control infestations must be assessed before use.

The manipulation of gases (nitrogen, oxygen and carbon dioxide) within storage structures has been widely studied for the control of insect infestations. There are two main systems, high carbon dioxide and low oxygen. For control, oxygen levels must be maintained below 1% for 20 days; or carbon dioxide levels maintained at 80% for 9 days, 60% for 11 days or 40% for 17 days; or carbon dioxide levels initially above 70% must decline over at least 15 days to not less than 35%. Control is achieved faster at high temperatures; temperatures below 14°C are not practical because the gas levels must be maintained for over a month. Controlled atmospheres are more effective in drier grain. Structures should be sealed, joints caulked, and plastic placed over doors, windows and openings before the addition of gases (Annis and van Graver, 1990).

Other physical methods of controlling R. dominica include placing grain in airtight structures. These can range from well-sealed barrels holding several kilograms, to 100-t capacity metal bins. The structures should be pressure-tested to confirm airtightness. Removing insects by sieving does not control populations as many insects are not removed because they are inside the kernel. Impacting the grain, either by moving the grain using a pneumatic conveyer or dropping the grain onto a spinning, studded disc, can reduce R. dominica populations by over 90%. Good sanitation, removing spilt grain around storage facilities, reduces insect populations that can infest grain in storage.

Host-Plant Resistance

Although there are substantial differences in the resistance of host varieties to R. dominica (Kishore, 1993; Cortez Rocha et al., 1993, Sinha et al., 1988; Anuradha et al., 1988), the use of resistant varieties has not been exploited as a method of control. Resistant varieties often do not prevent insect infestations, but reduce the rate at which infestations develop, and increase mortalities. Host resistance would enable the crop to be stored for a longer period before extensive damage is caused by insect populations. However, caution is needed with regard to the introduction of resistant varieties as a method of control of R. dominica: the insect may overcome host plant resistance, as it has developed resistance to insecticides, and the development of resistance management strategies would be required.

Biological Control

The use of natural enemies to control R. dominica and other stored grain insects has been limited in developed countries because of the low tolerance (0-2 insects/kg grain) for insects in stored grain. However, because of the interest in controlling insect pests without the use of insecticides, there is renewed interest in predators and parasites (Brower et al., 1991). There have been many laboratory studies on the predators and parasites of R. dominica (Brower et al., 1991), and these insects have been caught in grain stores. There are, however, few studies that have looked at the predator-prey dynamics in the field. Studies in the USA have demonstrated that the inundative release of Theocolax elegans can control R. dominica in grain stores of a commercial scale (27 t) (Flinn et al., 1994). Another hymenopteran parasite, Anisopteromalus calandrae, is effective at reducing R. dominica populations in the laboratory (Battu and Dhaliwal, 1976) and is also found in the grain stores around the world (Asanov, 1980; Banks and Sharp, 1979; Dhaliwal, 1976).

There are a few predators of R. dominica. Teretriosoma nigrescens is a histerid beetle that is found in Central America feeding on Prostephanus truncatus. It also feeds on R. dominica, though it produces more offspring on P. truncatus. It was released into Africa in 1991 in an effort to control P. truncatus, and is now well established in Togo and Benin in West Africa, and in Kenya in East Africa. However, the ability of T. nigrescens to significantly reduce P. truncatus or R. dominica populations has yet to be determined (Markham et al., 1994). There is some concern regarding the use of T. nigrescens, as it also feeds on grain. The cadelle Tenebroides mauritanicus also feeds on grain, mites and stored-product insect eggs, including Rhyzopertha (Bousquet, 1990; Yoshida, 1975). The predatory mites, Cheyletus eruditus and Pyemotes ventricosus feed on a wide variety of stored product insect eggs (Asanov, 1980; Brower et al., 1991), but their effect on populations in the field has not been determined.

Bacillus thuringiensis var. tenebrionis (Keever, 1994; Mummigatti et al., 1994) has been investigated for the control of R. dominica. Most B. thuringiensis varieties are ineffective against beetles. R. dominica was one of the more susceptible beetles to B. thuringiensis var. tenebrionis with over 75% mortality in 17 days at 250 p.p.m. (Mummigatti et al., 1994).

Chemical Control

Insecticides are used around the world to control stored-grain insect pests, but the number of insecticides available for the protection of stored commodities against insect pests has declined recently as a result of concerns over worker and community safety, and the environment. Resistance to insecticides is also a growing problem, especially with residual insecticides such as malathion, chlorpyrifos-methyl and pirimiphos-methyl (Beeman and Wright, 1990), but also with fumigants (Taylor and Halliday, 1986; Taylor, 1994).

Chlorpyrifos-methyl and pirimiphos-methyl, although effective against most stored grain insect pests, are relatively ineffective against R. dominica. Insect growth regulators have low toxicity to mammals, but take longer to control insect populations and are more expensive than other insecticides. They can be sprayed or dusted directly onto the grain, and protect grain from infestation from 2 weeks to over a year. After treatment with an insecticide, grain often must be held for a certain period of time before it can be processed or used as animal feed. The period of protection is dependant upon the commodity treated, temperature, grain moisture content and the insecticide used. In general, temperatures must be over 15°C for effective control; higher temperatures cause more rapid control but also cause faster degradation of the insecticide. High moisture content also reduces the duration of protection. Many of these insecticides can be used as a structural treatment to eliminate residual insect populations from empty silos and buildings. The degradation of insecticides is faster on concrete than on wood or metal, because of the alkaline nature of concrete.

There are currently two fumigants in widespread use, phosphine and methyl bromide, to control insect infestations in stored commodities. These fumigants are effective, but commodities can become re-infested once the the fumigant has dissipated. Both fumigants are highly toxic to humans and should be handled with extreme care. Phosphine is usually applied to the grain as aluminium phosphide pellets or tablets, although magnesium phosphide is also available in some countries. Some countries allow phosphine to be delivered to the grain from compressed gas cylinders. Australia has developed a system in which phosphine mixed with carbon dioxide is delivered to the grain at low concentrations and continuous flow for several weeks. At high temperatures and humidities, phosphine is corrosive to copper and can cause damage to electrical systems. Methyl bromide is used mainly for empty structures and is delivered as a gas.

The Montreal Protocol on Substances that Deplete the Ozone Layer cited methyl bromide as an ozone-depleting substance. The 46 countries that are signatories of the Montreal Protocol have agreed to freeze their consumption of methyl bromide at 1991 levels by January 1995. There are exemptions for quarantine purposes and for developing countries. Some countries have stricter regulations calling for greater cuts or total elimination of methyl bromide in the near future (Taylor, 1994).

See Hill (1990), Snelson (1987) and Bond (1984) for more details on the insecticides used to control R. dominica.

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Dinoderus ocellaris

Names and taxonomy

Preferred scientific name

Dinoderus ocellaris Stephens

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Bostrichidae

Other scientific names

Dinoderus pilifrons Lesne

EPPO code

DINDOC (Dinoderus ocellaris)

Common names

English:

bamboo shot-hole, borer

bamboo shot-hole, borer

Prostephanus truncatus

Names and taxonomy

Preferred scientific name

Prostephanus truncatus (Horn)

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Bostrichidae

Other scientific names

Dinoderus truncatus Horn

EPPO code

PROETR (Prostephanus truncatus)

Common names

English:

larger grain borer

greater grain borer

scania beetle

grain, borer, larger

Spanish:

barrebador de los granos

barrenador del grano mayor

barrenador grande de los graneros

Germany:

Bohrer, grosser Korn-

Notes on taxonomy and nomenclature

Prostephanus truncatus was first described by Horn, 1878 as Dinoderus truncatus, and has been referred to as Stephanopachys truncatus by Back and Cotton (1938). The genus Prostephanus was erected by Lesne (1898) to accommodate this and three other species; P. truncatus is the only one of these species known to be associated with stored products.

The most commonly used English name for the species is larger grain borer (LGB) although some countries favour greater grain borer (GGB) which gives the correct semantic distinction from the lesser grain borer (Rhyzopertha dominica).

The adults may be identified using the keys of Fisher (1950), Kingsolver (1971) or Haines (1991). A key to both larvae and adults is given in Gorham (1991). The taxonomy, systematics and identification of P. truncatus have been reviewed recently by Farrell and Haines (2002).

Host range

Notes on host range

P. truncatus is a serious pest of stored maize and dried cassava roots, and will attack maize in the field just before harvest. Attempts to rear the species on cowpea, haricot beans [Phaseolus vulgaris], cocoa, coffee beans and rough rice in the laboratory have been unsuccessful, although development is possible on soft wheat varieties, and adult feeding may damage these other commodities (Shires, 1977).

P. truncatus behaves as a typical primary pest of farm-stored maize; whole grains are attacked, on the cob, both before and after harvest. P. truncatus is also a pest of farm-stored cassava, particularly cassava chips. The adults bore into a wide range of foodstuffs and other materials including wood, bamboo, plastic and soap. Extensive populations of P. truncatus occur in the natural environment, and it has been recorded from a number of tree species in Central America (Rees et al., 1990; Ramirez-Martinez et al., 1994) and Africa Nang'ayo et al., 1993, 2002; Nansen et al., 2004) in some cases associated with twig girdling by cerambycid beetles (Borgemeister et al., 1998).

Affected Plant Stages: Post-harvest.

Affected Plant Parts: Seeds.

List of hosts plants

Major hosts

Manihot esculenta (cassava), stored products (dried stored products), Zea mays (maize)

Minor hosts

Dioscorea (yam), Sorghum bicolor (sorghum), Triticale , Triticum aestivum (wheat)

Geographic distribution

Notes on distribution

P. truncatus is indigenous in Central America, tropical South America, and the extreme south of the USA as a major, but localized, pest of farm-stored maize. It was introduced into Tanzania, probably in the late 1970s, and has become a serious pest of stored maize and dried cassava in that part of East Africa; it has since spread into Kenya, Burundi, Rwanda, Malawi, Zambia, Mozambique, Namibia and South Africa, and is almost certainly present but unreported from several other countries in the region. It was first found in West Africa in Togo in 1984 and it has since spread to Benin, Nigeria, Ghana, Niger and Burkina Faso. A separate outbreak occurred in Guinea Conakry.

P. truncatus could potentially invade all maize and cassava growing areas of tropical and sub-tropical Africa, and it is the only recent example of a serious storage pest invading on a regional or continental scale. It remains a quarantine threat to other maize growing regions in the Old World.

There are several records of interceptions of P. truncatus, including Canada (Manitoba), the USA (Arizona, Montana, New York and New Jersey), Germany (interception from Guatemala), Israel and Iraq (IIE, 1995).

A record of P. truncatus in Thailand (EPPO, 2005), published in the 2005 edition of the CPC, is now known to be based on a misidentification (R. Hodges, Natural Resources Institute, UK, personal communication, 2006).

Distribution List

Please note: The distribution status for a country or province is based on all the information available. When several references are cited, they may give conflicting information on the pest status. In particular, citations of earlier presence of a pest are included even though there is an authoritative reference to indicate that the pest is now absent.

Show EPPO notes

EPPO notes may be available for records where the source is EPPO, 2006. PQR database (version 4.5). Paris, France: European and Mediterranean Plant Protection Organization. Further details may be available in the corresponding EPPO Reporting Service item (e.g. RS 2001/141), for details of this service visit http://archives.eppo.org/EPPOReporting/Reporting_Archives.htm, or contact the EPPO Secretariat hq@eppo.fr.

Europe

France

absent, intercepted only

IIE, 1995

Germany

absent, intercepted only

IIE, 1995; EPPO, 2006

Asia

China

absent, intercepted only

IIE, 1995; EPPO, 2006

Hong Kong

absent, intercepted only

IIE, 1995

India

absent, intercepted only

IIE, 1995; EPPO, 2006

Uttar Pradesh

absent, intercepted
only IIE, 1995; EPPO,
2006 Iraq

absent, intercepted
only IIE, 1995; EPPO,
2006 Israel

absent, intercepted
only IIE, 1995; EPPO,
2006 Philippines

absent, intercepted
only IIE, 1995

Africa

Benin

restricted distribution
introduced (1984)
invasive
Hodges, 1994; IIE, 1995; EPPO, 2006

Burkina Faso

restricted distribution
introduced (1991)
Hodges, 1994; IIE, 1995; EPPO, 2006

Burundi

restricted distribution
introduced (1984)
Hodges, 1994; IIE, 1995; EPPO, 2006

Ghana

restricted distribution
introduced (1989)
invasive
Hodges, 1994; IIE, 1995; EPPO, 2006

Guinea

restricted distribution

introduced (1987)

Hodges, 1994; IIE, 1995; EPPO, 2006

Kenya

present

introduced (1983)

invasive

Hodges, 1994; IIE, 1995; EPPO, 2006

Malawi

present

introduced (1992)

Hodges, 1994; IIE, 1995; EPPO, 2006

Mozambique

widespread

introduced (1999)

invasive

Anon., 2004

Namibia

restricted distribution

introduced

Rhodes, 1998

Niger

restricted distribution

introduced (1994)

IIE, 1995; Adda et al., 1996; EPPO, 2006 Nigeria

restricted distribution

introduced (1992)

Hodges, 1994; IIE, 1995; EPPO, 2006

Rwanda

present

introduced (1993)

Hodges, 1994; IIE, 1995; EPPO, 2006

South Africa

restricted distribution

introduced (1999)

EPPO, 2006

Tanzania

widespread

introduced (981)

invasive

Hodges, 1986; IIE, 1995; EPPO, 2006

Togo

present

introduced (1984)

invasive

Hodges, 1986; IIE, 1995; EPPO, 2006

Zambia

widespread

introduced (1993)

Hodges & Pike, 1995; EPPO, 2006

Central America & Caribbean

Costa Rica

present

native

Hodges, 1986; IIE, 1995; EPPO, 2006

El Salvador

present

native

Hodges, 1986; IIE, 1995; EPPO, 2006

Guatemala

present

native

Hodges, 1986; IIE, 1995; EPPO, 2006

Honduras

present

native

Hodges, 1986; IIE, 1995; EPPO, 2006

Nicaragua

present

native

invasive

Hodges, 1986; IIE, 1995; EPPO, 2006

Panama

present
native

Hodges, 1986; IIE, 1995; EPPO, 2006

North America

Canada

absent, intercepted
only EPPO 2006

Manitoba

absent, intercepted

only IIE, 1995; EPPO,

2006 Mexico

present

native

invasive

Hodges, 1986; IIE, 1995; EPPO, 2006

USA

restricted distribution
EPPO, 2006

Arizona

present

native

IIE, 1995; EPPO, 2006

California

present not
invasive

IIE, 1995; EPPO, 2006

District of Columbia

present introduced

(1878) not invasive

IIE, 1995

Montana

absent, intercepted

only IIE, 1995; EPPO,

2006 New Jersey

absent, intercepted

only IIE, 1995; EPPO,

2006 New York

absent, intercepted

only IIE, 1995; EPPO,

2006 Texas

present
native

IIE, 1995; EPPO, 2006

South America

Brazil

absent, formerly present
introduced (1993)

IIE, 1995; EPPO, 2006

Minas Gerais

absent, formerly present

introduced (1993) EPPO,

2006

Colombia

present

native

Hodges, 1986; IIE, 1995; EPPO, 2006

Peru

present

Hodges, 1986

History of introduction and spread

P. truncatus was probably introduced accidentally into Africa in the late 1970s, but was first recorded in 1981. It was introduced separately into East and West Africa and a summary of its spread into 11 African countries is provided by Hodges (1994). In Zambia, for example, it was first recorded near the Tanzanian border in 1993, but was subsequently spread throught the country in 1995 following the importation of infested maize (Sumani, 2000).

Biology and ecology

P. truncatus may be attracted to maize grain and dried cassava over short distances. However, field studies in both Mexico and Togo suggest that there is no long-range attraction of adult P. truncatus to maize grain or cobs, or dried cassava; this is not surprising because wood is the major host of this beetle. It has been shown in laboratory tests that upwind flight is mediated by a male-released aggregation pheromone and not by host volatiles (Fadamiro et al., 1998) and field studies provide strong evidence that host selection, in the case of maize and cassava, occurs by chance (Birkinshaw et al., 2002). Details of host selection can be found in Hodges (1994), Scholz et al. (1997) and Hodges et al. (1998).

Adults frequently initiate their attack on stored maize cobs with intact sheaths by boring into the base of the maize cob cores, although they eventually gain access to the grain via the apex of the cob by crawling between the sheathing leaves (Hodges and Meik, 1984). Adults bore into the maize grains, making neat round holes, and as they tunnel from grain to grain they generate large quantities of maize dust. Adult females lay eggs in chambers bored at right angles to the main tunnels. Egg-laying on stabilized grain, like that on the maize cob, is more productive than on loose-shelled grain as the oviposition period is longer, equal in length to the life of the female, and the eggs are laid at a greater rate.

Larvae hatch from the eggs after about three days at 27°C and seem to thrive on the dust produced by boring adults. For example, large numbers of larvae develop and pupate in dust at the base of dense laboratory cultures.

The life cycle of P. truncatus has been investigated at a range of temperatures and humidities Shires, 1979, 1980; Bell and Watters, 1982; Hodges and Meik, 1984). Development of the larva through to the adult stage at the optimum conditions of 32°C and 80% RH takes 27 days on a diet of maize grain. Humidity within the range 50-80% RH does not greatly affect the development period or mortality; at 32°C, a drop in RH from 80 to 50% (giving maize with an equilibrium moisture content of about 10.5%) extended the mean development period by just 6 days and increased the mean mortality by only 13.3%. This tolerance of dry conditions was confirmed during field studies in Nicaragua and Tanzania in which maize at 10.6 and 9% moisture content, respectively, was heavily infested.

The success of this pest may be partly due to its ability to develop in grain at low moisture. Many other storage pests are unable to increase in number under low moisture conditions. For example, Sitophilus oryzae, a species occurring in the same ecological niche, needs a grain moisture content of at least 10.5% for development. Thus, in dry conditions, P. truncatus probably benefits from the absence of any significant competition from other storage pests.

P. truncatus develops more rapidly on maize grain than on cassava; at 27°C and 70% RH, the respective development periods on maize grain and cassava were 32.5 and 40 days, respectively. Under ideal conditions of temperature and humidity on maize cobs or stabilized maize grain, estimates for the intrinsic rate of increase (r) of P. truncatus are in the order of 0.7-0.8 per week; this is similar to the rate of increase reported for Tribolium castaneum under comparable climatic conditions.

Details of flight performance and factors affecting flight and distribution behaviour have been investigated in the laboratory (Fadamiro and Wyatt, 1955, 1996; Fadamiro, 1997). A field study in Honduras showed flight activity of P. truncatus following a daily bimodal pattern with a major peak at 06.00-08.00 h and a minor peak at 18.00-20.00 h (Novillo, 1991). A similar pattern was observed by Tigar et al. (1993) in Central Mexico and Birkinshaw et al. (2004) in Ghana, but in both these cases the major peak was associated with dusk.

Adults may be sexed using a method described by Shires and McCarthy (1976).

For further detailed information on biology and ecology, consult reviews by Hodges (1986), Markham et al. (1991), Hodges (1994), Nansen and Meikle (2002) and Hill et al. (2002).

Morphology

Larva

The larvae are white, fleshy and sparsely covered with hairs. They are parallel-sided, i.e. they do not taper. The legs are short and the head capsule is small relative to the size of the body.

Adult

The adult has the typical cylindrical bostrichid shape. The declivity is flattened and steep and has many small tubercles over its surface. The limits of the declivity, apically and laterally, are marked by a carina. The antennae are 10-segmented and have a loose three-segmented club; the 'stem' of the antenna is slender and clothed with long hairs and the apical club segment is as wide as, or wider than, the preceding segments. The body is 3-4.5 mm long.

Means of movement and dispersal

P. truncatus is spread over longer distances almost entirely through the import and export of infested grain. Local dispersal is through the local movement of infested grain and by flight activity of the adult beetles themselves.

Plant parts liable to carry the pest in trade/transport

- Bulbs/Tubers/Corms/Rhizomes: .
- Roots: Eggs, Larvae, Pupae, Adults; borne internally; visible to naked eye.
- True Seeds (inc. Grain): Eggs, Larvae, Pupae, Adults; borne internally; visible to naked eye.
- Wood: Eggs, Larvae, Pupae, Adults; borne internally; visible to naked eye.

Plant parts not known to carry the pest in trade/transport

- Bark
- Fruits (inc. Pods)
- Growing Medium Accompanying Plants
- Flowers/Inflorescences/Cones/Calyx
- Leaves
- Seedlings/Micropropagated Plants
- Stems (above Ground)/Shoots/Trunks/Branches.

Transport pathways for long distance movement

- Conveyances (transport Vehicles): Carried By National And International Grain Trade (Hodges et al. 1996; Tyler & Hodges 2002)

Natural enemies

Only one predator, Teretrius (formerly Teretriosoma) nigrescens, has been associated with P. truncatus; this was in Central America. Laboratory studies by Rees (1985), using shelled maize grain (weighed down with glass beads) maintained at 8.5 or 14% moisture content, showed that 10 adult T. nigrescens were able to prevent populations of up to 100 adult P. truncatus from increasing. In the laboratory, T. nigrescens successfully suppressed the growth of populations of P. truncatus on maize cobs in the presence of Sitophilus zeamais and Tribolium castaneum (Rees, 1987). It is known that T. nigrescens in flight find P. truncatus by attraction to male-released aggregation pheromone. However, once the predator has landed it is no longer attracted by the pheromone but by material in the frass of P. truncatus Stewart-Jones et al., 2004, 2006).

Infestations of P. truncatus in Nicaragua were associated with high levels of parasitic Hymenoptera, accounting for 10% of the total number of insects present, while the P. truncatus population represented 56.5%; these Hymenoptera were not identified. In Tanzania, large numbers of Anisopteromalus calandrae were associated with P. truncatus when few other potential hosts were present (Hodges et al., 1983). The hemipteran Xylocoris flavipes has been observed as a predator of all three larval stages of P. truncatus in West Africa, however populations of the bug declined as pest numbers rose. It is believed that the conditions created by P. truncatus infestation are unfavourable to X. flavipes and hence this species probably does not play an important role in the control of the pest (Helbig, 1999).

Little is known about the relationship between P. truncatus and other organisms. Infestations of this beetle are found, together with those of other species, but P. truncatus is the predominant storage species in the dry conditions of Tanzania and Nicaragua. It has been demonstrated that P. truncatus is deterred from infesting grain in which the larvae of Sitophilus zeamais are developing and that this probably results from substances deposited on the grain surface by adult S. zeamais (Danho et al., 2000).

In a survey of the pest in Kenya, Odour et al. (2000) found that the entomopathogenic fungus Beauveria bassiana occurred on only 0.08 to 0.94% of the total insects collected. This is a low infection rate. Isolates of Beauveria, Metarhizium and Paecilomyces obtained in Ethiopia where all found to be virulent against P. truncatus although a total immersion bioassay was used so this result might have been anticipated (Kassa et al., 2002). The potential of Beauveria has been investigated in field trials designed to give a better understanding of how future research efforts can develop methods to make this fungus an effective means of control for P. truncatus (Meikle et al., 2001).

Natural enemies listed in the database

The list of natural enemies has been reviewed by a biocontrol specialist and is limited to those that have a major impact on pest numbers or have been used in biological control attempts; generalists and crop pests are excluded. For further information and reference sources, see About the data. Additional natural enemy records derived from data mining are presented as a separate list.

Natural enemies reviewed by biocontrol specialist

Natural enemy

Pest stage attacked

Biological control in:

Parasites/parasitoids:

Anisopteromalus calandrae

Theocolax elegans

Predators:

Teretriosoma nigrescens

Eggs, Larvae, Pupae

Africa; Togo

Xylocoris flavipes

Pathogens:

Beauveria bassiana (white muscardine fungus)

Metarhizium anisopliae (green muscardine fungus)

Additional natural enemies (source - data mining)

Natural enemy

Pest stage attacked

Biological control in:

Parasites/parasitoids:

Pteromalus cerealellae

Impact

Economic impact

P. truncatus is a pest of maize and dried cassava roots after harvest in sub-Saharan Africa and also from time to time in Central America.

Infestations in maize may start on the mature crop in the field, i.e. when moisture content is at or below 18%. Weight losses of up to 40% have been recorded in Nicaragua from maize cobs stored on the farm for 6 months (Giles and Leon, 1975). In Tanzania, up to 34% losses have been observed after 3 months storage on the farm, with an average loss of 8.7% (Hodges et al., 1983). P. truncatus is a much more damaging pest when compared to other storage insects including Sitophilus oryzae, S. zeamais and Sitotroga cerealella, under similar conditions; maize losses due to these other species were 2-6, 3-5 and 2-5%, during a storage season in Zambia, Kenya and Malawi, respectively.

Losses caused by P. truncatus in dried cassava roots can be very high; the dried roots are readily reduced to dust by boring adults and a loss of 70% has been recorded after only 4 months of farm storage (Hodges et al., 1985). A group of 25 farmers from five villages in Togo sustained average cumulative losses of 9.7% after 3 months storage, this figure rose to 19.5% after 7 months (Wright et al., 1993).

Not all problems with this pest are restricted to farmers' granaries. In the early days after the arrival of P. truncatus in East Africa, countries with the pest found their maize exports banned. For example in 1987-88, it is estimated that Tanzania lost US$634,000 in export earning. This situation improved following efforts to upgrade phytosanitary procedures in the region but such procedures, involving fumigation, have their own continuing costs (Boxall, 2002).

A grain injury model for P. truncatus infesting farm-stored maize in West Africa has been developed at the International Institute of Tropical Agriculture. It can be used in conjunction with predictive models of pest population dynamics to guide the development of integrated pest management strategies (Holst et al., 2000a). The models are conveniently displayed, together with information on sampling routines, on a web site (<http://www.agrsci.dk/plb/bembi/africa/project.htm>).

A detailed review of the damage and loss caused by P. truncatus has been prepared by Boxall (2002). He considers loss of value, nutrition as well as impact at the national level, effect on international trade and modern methods of rapid loss assessment. In the early days after the arrival of P. truncatus in East Africa, countries with the pest found their maize exports banned. For example, in 1987-1988, it is estimated that Tanzania lost US$634,000 in export earning. This situation improved following efforts to upgrade phytosanitary procedures in the region but such procedures, involving fumigation, have their own continuing costs.

Environmental impact

P. truncatus has no known environmental impacts.

Social impact

P. truncatus infests the granaries of subsistence farmers and in sub-Saharan Africa the losses that result can be twice that caused by other storage pests. Subsistence farmers typically rely on their stored maize as food until the next maize harvest. The depredation of P. truncatus results in farmers having to purchase maize, or those farmers with more extensive stock will have no maize to sell. The pest is thus a threat to food security and to the livelihoods of poor people.

Impact on biodiversity

P. truncatus has no known effects on biodiversity.

Impact descriptors

Negative impact on: trade / international relations

Phytosanitary significance

P. truncatus remains a quarantine threat to maize-growing regions in the Old World. The phytosanitary measures that should be taken against P. truncatus in international trade have been reviewed by Tyler and Hodges (2002).

Symptoms

Adults tunnel through stored maize grain or other starchy products, such as dried cassava chips, creating large quantities of dust. Larvae and pupae may be found in the tunnels made by the adults.

Symptoms by affected plant part

Seeds: internal feeding.

Detection and inspection

Methods for detection and monitoring of P. truncatus has been reviewed in detail by Hodges (2002).

Flight traps, such as funnel, delta or wing traps baited with the male-released aggregation pheromone of P. truncatus, are highly effective for monitoring this species. These traps should be placed at least 100 m from stores, which contain maize or dried cassava, or from the standing maize crop to avoid attracting the beetles to these food sources. A detailed leaflet giving recommendations on the use of pheromone traps to monitor P. truncatus has been prepared by Hodges and Pike (1995). For long-term, routine trapping programmes in both East and West Africa the Japanese beetle flight-trap baited with P. truncatus pheromone is now the method of choice while pheromone baited Delta traps, made from cardboard, are used in short-term programmes.

The risk of stores becoming infested by P. truncatus is known to be related to the number of P. truncatus that are flying (Birkinshaw et al., 2002). There are big variations both within and between years in the numbers of beetles taking flight. In many locations this difference between years is noticeable by the extent to which farmer's stores become infested, i.e. there are good and bad years. A computer-based model has been developed that uses climate data to predict P. truncatus flight activity and in this way it can predict the years when P. truncatus infestation will be bad (Hodges et al., 2003).

Monitoring for the presence of P. truncatus in farm maize stores themselves is difficult because the pest is not attracted to its pheromone when present on its food. A sequential sampling plan for inspecting stores in West Africa has been described by Meikle et al. (2000). Compton and Sherington (1999) have described a rapid method for estimating the weight losses caused by P. truncatus to maize cobs.

Control

Chemical Control

The most effective method of controlling P. truncatus in maize is to admix a dilute dust insecticide. P. truncatus is highly susceptible to synthetic pyrethroid insecticides such as permethrin and deltamethrin. However, these insecticides are relatively ineffective against other storage pests such as Sitophilus spp. and Tribolium castaneum, which occur in the same pest complex and are more susceptible to organophosphorus insecticides. Both types of insecticide are applied in order to control the whole complex (Golob et al., 1985; Golob and Hanks, 1990). Combinations such as pirimiphos-methyl and permethrin, deltamethrin and pirimiphos-methyl or fenitrothion and fenvalerate have been used successfully to protect farm-stored grain. Fumigation with phosphine or methyl bromide is very effective in large-scale stores.

Recent laboratory and field studies have shown that unless inert dusts are applied at very high rates, they are not particularly effective against P. truncatus. However, good control can be achieved when they are mixed with insecticides or soil bacteria metabolites such as Spindeba (Stathers, 2003).

For a detailed review of chemical, physical and cultural methods for the control of P. truncatus, see Golob (2002).

Biological Control

Detailed reviews on the control of P. trunctus by the predator Teretrius nigrescens have been published by Meikle et al. (2002) and Borgemeister et al. (2003). Initial releases of T. nigrescens were in Togo in 1991 and in Kenya in 1992. In both countries it became well established and spread. Subsequently, there have been predator releases in Benin, Ghana, Tanzania and Malawi. Only in the case of Tanzania does it appear that there has been any difficulty in the predator becoming quickly and easily established. However, despite the successful introductions, there are still regular outbreaks of P. truncatus and farmers still suffer losses. It has been concluded by Holst et al. (2000b) that T. nigrescens does not offer a good example of classical biological control but as the predator is able to reduce the density of the pest it is considered that it has, nevertheless, a role to play in integrated pest management.

Cultural Control and Sanitary Methods

Good store hygiene, especially the removal of infested residues and the selection of only sound material for storage, can play an important role in limiting infestation by P. truncatus. The use of resistant cultivars may also reduce the severity of an infestation, although much work remains to be done on the mechanisms of resistance.

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Heterobostrychus aequalis

Names and taxonomy

Preferred scientific name

Heterobostrychus aequalis (Waterhouse)

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Bostrichidae

EPPO code

HETBAE (Heterobostrychus aequalis)

Common names

English:

kapok borer

Host range

List of hosts plants

Major hosts

Camellia sinensis (tea), Ceiba pentandra (kapok), forest trees (woody plants)

Geographic distribution

Distribution List

Europe

Germany

unconfirmed record

CAB Abstracts, 1973-1998

Asia

Bangladesh

present

APPPC, 1987

China

restricted distribution

EPPO, 2006

Hainan

present

EPPO, 2006

India

present

EPPO, 2006

Kerala

unconfirmed record

CAB Abstracts, 1973-1998

Tamil Nadu

unconfirmed record

CAB Abstracts, 1973-1998

Indonesia

present

EPPO, 2006

Israel

unconfirmed record

CAB Abstracts, 1973-1998

Malaysia

present

EPPO, 2006

Philippines

present

EPPO, 2006

Sri Lanka

present

EPPO, 2006

Thailand

present

EPPO, 2006

Africa

Madagascar

present

EPPO, 2006

South Africa

unconfirmed record

CAB Abstracts, 1973-1998

North America

USA

present

EPPO, 2006

Oceania

Papua New Guinea

present

EPPO, 2006

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Heterobostrychus brunneus

Names and taxonomy

Preferred scientific name

Heterobostrychus brunneus (Murray)

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Bostrichidae

EPPO code

HETBBR (Heterobostrychus brunneus)

Host range

List of hosts plants

Major hosts

forest trees (woody plants)

Geographic distribution

Distribution List

Europe

Germany

unconfirmed record

CAB Abstracts, 1973-1998

Asia

Israel

unconfirmed record

CAB Abstracts, 1973-1998

Africa

Cape Verde

present

EPPO, 2006

Nigeria

present

CAB Abstracts, 1973-1998

Seychelles

present

EPPO, 2006

Zambia

unconfirmed record

CAB Abstracts, 1973-1998

References

CAB Abstracts, 1973-1998. Data mined from CAB Abstracts database, years 1973 to 1998. Wallingford, UK: CAB International

EPPO, 2006. PQR database (version 4.5). Paris, France: European and Mediterranean Plant Protection Organization. www.eppo.org.

Lichenophanes varius

BOSTRICHIDAE DE MÉXICO

especies presentes en México de la familia Bostrichidae (Bostrichidae species from México)

adaptación de: Borowski, J. & Wegrzynowicz, P. 2007 y Blackwelder, R.E., 1944

Especies presentes en México:
Lichenophanes penicillatus (Lesne, 1895)
Lichenophanes spectabilis (Lesne, 1895)
Lichenophanes tuberosus Lesne, 1934
Lichenophanes verrucosus (Gorham, 1883)

Lyctoxylon spp

Véase archivo anexo (sección VII.-ANEXOS, de la MIR)
Lyctoxylon

Lyctus africanus

Names and taxonomy

Preferred scientific name

Lyctus africanus Lesne

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Lyctidae

EPPO code

LYCTAF (Lyctus africanus)

Common names

English:

african powder-post beetle

Spanish:

licto africano

French:

licte africain

Germany:

Splintholzkaefer, Afrikanischer

Host range

List of hosts plants

Major hosts

forest trees (woody plants)

Hosts (source - data mining)

Phoenix dactylifera (date-palm)

Please note

Some hosts may be listed at the generic level: Lyctus

Geographic distribution

Distribution List

Europe

Germany

unconfirmed record

CAB Abstracts, 1973-1998

United Kingdom

present

EPPO, 2006

Asia

China

unconfirmed record

CAB Abstracts, 1973-1998

India

unconfirmed record

CAB Abstracts, 1973-1998

Africa

Egypt

present

EPPO, 2006

Sudan

present

EPPO, 2006

North America

USA

unconfirmed record

CAB Abstracts, 1973-1998

References

CAB Abstracts, 1973-1998. Data mined from CAB Abstracts database, years 1973 to 1998. Wallingford, UK: CAB International

EPPO, 2006. PQR database (version 4.5). Paris, France: European and Mediterranean Plant Protection Organization. www.eppo.org.

Micrapate spp

Se ofrecen las siguientes referencias en Internet:

Species	Micrapate albertiana Lesne, 1943
	Micrapate amplicollis (Lesne, 1899)
	Micrapate atra (Lesne, 1899)
	Micrapate bicostula Lesne, 1906
	Micrapate bilobata Fisher, 1950
	Micrapate brasiliensis (Lesne, 1899)
	Micrapate brevipes (Lesne, 1899)
	Micrapate bruchi Lesne, 1931
	Micrapate brunnipes (Fabricius, 1801)
	Micrapate catamarcana Lesne, 1931
	Micrapate cordobiana Lesne, 1931
	Micrapate cribripennis (Lesne, 1899)
	Micrapate cristicauda Casey, 1898
	Micrapate dinoderoides (Horn, 1878)
	Micrapate discrepans Lesne, 1939
	Micrapate exigua (Lesne, 1899)
	Micrapate foraminata Lesne, 1906
	Micrapate fusca (Lesne, 1899)
	Micrapate germaini (Lesne, 1899)
	Micrapate guatemalensis Lesne, 1906
	Micrapate horni (Lesne, 1899)
	Micrapate humeralis (Blanchard,1851)
	Micrapate kiangana Lesne, 1935
	Micrapate labialis Lesne, 1906
	Micrapate leechi Vrydagh, 1960
	Micrapate mexicana Fisher, 1950
	Micrapate neglecta Lesne, 1906
	Micrapate obesa (Lesne, 1899)
	Micrapate pinguis Lesne, 1939
	Micrapate puberula Lesne, 1906
	Micrapate pupulus Lesne, 1906
	Micrapate quadraticollis (Lesne, 1899)
	Micrapate scabrata (Erichson, 1847)
	Micrapate scapularis (Gorham, 1883)
	Micrapate schoutedeni Lesne, 1935
	Micrapate sericeicollis Lesne, 1906
	Micrapate simplicipennis (Lesne, 1895)
	Micrapate straeleni Vrydagh, 1954
	Micrapate unguiculata Lesne, 1906
	Micrapate wagneri Lesne, 1906
	Micrapate xyloperthoides (Jacquelin du Val, 1859)

Minthea spp

Datos generales

Nombre: Minthea spp

Posición taxonómica:

Orden: Coleoptera

Familia: Bostrichidae

Subfamilia: Lyctinae

Descripción

Las larvas tienen el cuerpo en forma de C y presentan tres pares de patas toráxicos, son blanquecinas y con la cápsula cefálica de color ámbar: Las larvas de Minthea al igual que el resto de los miembros de la subfamilia Lyctinae se caracterizan porque el octavo espiráculo abdominal es más grande que los demás.

Los adultos son escarabajos delgados de color café rojizo, con una longitud de 2.0 a 3.5 mm. El cuerpo y las antenas están cubiertos de setas amarillentas, escamiformes, gruesas y erectas. Los dos últimos artejos de las antenas son más gruesos.

Número de especies.

A nivel mundial se tienen registradas siete especies; para México solo esta reportada Minthea rugicollis Walker.

Distribución.

Se considera un género tropicolita, es decir se encuentra en los trópicos, según Gerber (1957) se distribuye en la región australiana, etiópica, neotropical y oriental.

Minthea rugicollis es una especie cosmopolita, y probablemente su hábitat natural es Asia, de donde pudo haber sido introducida a través del comercio a Europa y el resto del mundo.

Ciclo de vida y hábitos

Bajo condiciones favorables, el ciclo de vida requiere de 9-12 meses para completarse, pero si las condiciones son excepcionalmente favorables en cuanto temperaturas altas y alto contenido de almidón en la madera, puede reducirse a solo 6-7 meses o aún hasta 3-4 meses; pero bajo condiciones adversas de temperatura y nutrientes, el ciclo de vida puede prolongarse hasta 2.5, 4 ó más años.

Hospedantes.

Latifoliadas tanto de regiones templadas como tropicales, como por ejemplo: bambú, encinos (Quercus spp), nogales (Carya spp), fresnos (Fraxinus spp), caoba (Swietenia spp), teca (Tectona spp), cedro (Cedrela spp, Toonia spp), Ficus sp, Acacia albida, Kompitsia sp, Shorea sp, manioca o mandioca (Manhiot esculenta). En Malasia han comprobado que son susceptibles al ataque de este insecto las maderas de jelutong (Dyera costulata), ramin (Gonystylus spp), simpoh (Dillenia spp) y rubberwood (Hevea brasiliensis).

Hábitos

Los adultos son de hábitos nocturnos, pasan el día entre las hendiduras y orificios de la madera, son buenos voladores y son atraídos por la luz, mientras que en los interiores pueden encontrarse en los pisos, marcos de ventanas, muebles y otras superficies.

No obstante que las larvas solo barrenan la albura, si el adulto no tiene otro camino para emerger, barrena a través del duramen, maderas suaves, asbesto y otras superficies.

Factores que limitan el ataque

Diámetro de los poros de la madera (los poros deben permitir que el ovipositor pueda ser insertado).

Contenido de almidón en la madera (el mínimo es de 30%).

Contenido de humedad de la madera (el rango varía de 8-32%, presentándose mayor actividad en el rango de 10-20%).

Síntomas.

El ataque inicial (oviposición) pasa desapercibido, ya que frecuentemente la madera no presenta evidencias de ataque. El ataque de este insecto se detecta muy tarde.

Los síntomas para detectar a este insecto son:

Montículos de polvo con consistencia de talco debajo de los orificios de salida o en la madera.

Presencia en la superficie de la madera de numerosos orificios de salida redondos u ovales con un diámetro de 0.8 a 2.0 mm.

Control.

Existen varios métodos de control, entre ellos el tratamiento con calor seco o húmedo, fumigación y aplicación de productos químicos.

Importancia económica.

Minthea al igual que otros líctidos, ataca solo la albura de las latifoliadas, generalmente de menos de 10 años. Ataca tanto madera sin elaborar como productos terminados (como por ejemplo muebles, marcos de ventanas, entarimados, etc.), también ataca a la madera empleada en la construcción. La madera es atacada durante el proceso de secado o durante su almacenamiento. En Asia es una plaga muy importante ya que ataca la madera de hule. En ocasiones si el ataque es muy intenso la albura es reducida a una masa de polvo compacta que queda entre una capa de madera del grueso de una hoja de papel.

Bibliografía

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5. Kraus, E. J. 1911. II A revision of the powder-post beetles of the family Lyctidae of the United States and Europe. U.S. Bur. Ent. Tech. Serv. 20 Pp: 111-129.

6. Wagengühr, R. y Chr. Scheiber. 1989. Holzaltlas. 3 Auflage. VEB Fachbuchverlag Leipzig, Alemania.720 p.

Sinoxylon anale

Names and taxonomy

Preferred scientific name

Sinoxylon anale Lesne

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Bostrichidae

Other scientific names

Sinoxylon geminatum Schilsky

EPPO code

SINOAN (Sinoxylon anale)

Common names

English:

false powder-post beetle
feather-horned, borer

Host range

List of hosts plants

Major hosts

Albizia procera (white siris), Casuarina equisetifolia (casuarina), forest trees (woody plants)

Hosts (source - data mining)

Acacia auriculiformis (northern black wattle), Acacia mangium (brown salwood), Delonix regia (gold mohar)

Please note

Some hosts may be listed at the generic level: Sinoxylon

Geographic distribution

Distribution List

Asia

Asia (as a whole)

present

CAB Abstracts, 1973-1998

India

widespread

EPPO, 2006

Kerala

unconfirmed record

CAB Abstracts, 1973-1998

Indonesia

present

EPPO, 2006

Israel

unconfirmed record

CAB Abstracts, 1973-1998

Korea, Republic of

unconfirmed record

CAB Abstracts, 1973-1998

Pakistan

widespread

EPPO, 2006

Philippines

widespread

EPPO, 2006

Thailand

widespread

EPPO, 2006

South America

Venezuela

unconfirmed record

CAB Abstracts, 1973-1998

Oceania

Oceania (as a whole)

present

CAB Abstracts, 1973-1998

Australia

present

EPPO, 2006

New Zealand

present

EPPO, 2006

Sinoxylon conigerum

Names and taxonomy

Preferred scientific name

Sinoxylon conigerum Gerstaecker 1855

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Bostrichidae

EPPO code

SINOCO (Sinoxylon conigerum)

Common names

English:

conifer auger beetle

Notes on taxonomy and nomenclature

S. conigerum was first described by Gerstaecker (1855) and does not have any synonyms.

Host range

Notes on host range

Besides the hosts mentioned in the host table, S. conigerum has been recorded on unidentified climbers in India (Beeson, 1941). Mathur and Singh (1959, 1960, 1961), and Bhasin and Roonwal (1954) listed the host plants of S. conigerum recorded in India. Binda and Joly (1991) listed its host plants in Venezuela. In Madagascar, it is a serious pest of stored Manihot esculenta (cassava) tubers (Frappa, 1938; Andriantsileferintsoa, 1996). In India, it is reported to bore into dry roots of Derris species in storage (Mathur and Singh, 1959). It has been also observed to bore holes through the lead sheathing of telephone cables, permitting the entry of water and causing short circuits in Hawaii and infest Malvaceae besides other host plants (Zimmerman, 1941).

Affected Plant Stages: Post-harvest and vegetative growing stage.

Affected Plant Parts: Stems and whole plant.

List of hosts plants

Major hosts

Bambusa (bamboo), Hevea brasiliensis (rubber), Manihot esculenta (cassava)

Minor hosts

Acacia koaia , Albizia amara , Bombax ceiba (silk cotton tree), Cajanus cajan (pigeon pea), Ceratonia siliqua (locust bean), Delonix regia (gold mohar), Derris elliptica (Tuba root), Derris scandens , Erythrina variegata (Indian coral tree), Ficus altissima , Gossypium (cotton), Grewia tiliifolia , Haldina cordifolia (heart-leaf adina), Holoptelea integrifolia , Hura crepitans (sand box), Lagerstroemia microcarpa , Mangifera indica (mango), Myroxylon balsamum (Peru balsam), Persea americana (avocado), Shorea robusta (sal), Tephrosia candida (hoang pea), Terminalia bellirica (beleric myrobalan), Terminalia microcarpa

Please note

Some hosts may be listed at the generic level: Sinoxylon

Geographic distribution

Notes on distribution

In India, S. conigerum has a wide distribution, but is not generally common (Beeson, 1941); it is more prevalent in southern India and the tropics (Maxwell-Lefroy and Howlett, 1909; Stebbing, 1914). It has also been recorded from China (Chen, 1995), Malaysia (Ho and Hashim, 1997) and South-East Asia, Africa, Europe and the Americas (EPPO, 2003). Binda and Joly (1991) gave its distribution within Venezuela. Orlinskii et al. (1991) listed it as a potential quarantine pest in the former USSR, but there are unconfirmed reports of its occurrence in Russia. It has been accidentally introduced in several parts of the world such as the USA, South America, and Europe through trade.

Distribution List

Please note: The distribution status for a country or province is based on all the information available. When several references are cited, they may give conflicting information on the pest status. In particular, citations of earlier presence of a pest are included even though there is an authoritative reference to indicate that the pest is now absent.

Show EPPO notes

EPPO notes may be available for records where the source is EPPO, 2006. PQR database (version 4.5). Paris, France: European and Mediterranean Plant Protection Organization. Further details may be available in the corresponding EPPO Reporting Service item (e.g. RS 2001/141), for details of this service visit http://archives.eppo.org/EPPOReporting/Reporting_Archives.htm, or contact the EPPO Secretariat hq@eppo.fr.

Europe

Italy

widespread

EPPO, 2006

Italy [mainland]

widespread

EPPO, 2006

Spain

widespread

EPPO, 2006

United Kingdom

present

EPPO, 2006

Asia

China

widespread

Chen, 1995; EPPO, 2006

Hong Kong

widespread

EPPO, 2006

India

widespread

EPPO, 2006

Gujarat

present

Balasubramanya et al.,
1990 Kerala

present

Gnanaharan et al., 1983; Jose et al., 1989
Tamil Nadu

present

Stebbing, 1914

West Bengal

present

Beeson, 1941

Indonesia

widespread

EPPO, 2006

Israel

widespread

EPPO, 2006

Japan

widespread

EPPO, 2006

Malaysia

widespread

Ho & Hashim, 1997; EPPO, 2006

Pakistan

widespread

EPPO, 2006

Philippines

widespread

EPPO, 2006

Singapore

widespread

EPPO, 2006

Sri Lanka

widespread

Tisseverasinghe, 1970; EPPO, 2006

Thailand

widespread

EPPO, 2006

Vietnam

widespread

EPPO, 2006

Africa

Kenya

widespread

EPPO, 2006

Liberia

widespread EPPO,

2006 Madagascar

widespread

Frappa, 1938

Mauritius

widespread

Moutia, 1944

Somalia

widespread

Chiaromonte,

1933 Tanzania

widespread

EPPO, 2006

Central America & Caribbean

Barbados

present

Schotman,

1989 Costa Rica

widespread

EPPO, 2006

Haiti

widespread

EPPO, 2006

North America

Canada

absent, intercepted only

CFIA-ACIA, 1997, 1998

USA

widespread

EPPO, 2006

Florida

absent, intercepted only

FAO, 1959

Hawaii

present

Zimmerman, 1941; Swezey, 1954; EPPO, 2006

South America

Brazil

widespread

EPPO, 2006

Venezuela

widespread

Binda & Joly, 1991; Joly et al., 1994; EPPO, 2006

Oceania

American Samoa

widespread

EPPO, 2006

Australia

absent, intercepted only

AQIS, 1999, 2000

Biology and ecology

In India, Balasubramanya et al. (1990) gave a brief account of the life history of this pest. Stebbing (1914) described the detailed life history of the more serious Sinoxylon species in India, which in general holds good for all species of this genus.

To oviposit, the adult female bores through the bark and wood into the sapwood for a short distance of 0.6-1.2 cm and the end is scooped out and enlarged to form a mating chamber, from which the pest tunnels further into the wood. These tunnels serve as egg laying tunnels. In the case of S. crassum, it takes 4 to 8 days to construct the egg tunnel and the eggs hatch out within ca 48 hours.

After hatching, the larvae usually feed along the long axis of the tree, forming irregular tunnels, which coalesce and reduce the wood to powder. The larval period of Sinoxylon species lasts approximately 4 to 6 weeks 8 to 10 weeks in cooler climates). Mature larvae pupate in a slightly enlarged chamber at the end of their galleries. The pupation period is approximately two to three weeks. On maturity, the adults tunnel out of the tree or force their way through the mass of powdery material to a previously formed egg tunnel through which they crawl out (Stebbing, 1914; Beeson, 1941). The life cycle takes about three months to a maximum of four years. Smaller species of Sinoxylon, such as S. crassum, are known to make use of the entrance holes to enter the tree. Due to this and also the exit of emerging adults through the old entrance holes, the severity of the attack may be underestimated when observing the number of holes in the wood (Stebbing, 1914). Adults of Sinoxylon species are known to bore into young saplings for feeding, however, larvae can only develop in dead or dying wood.

In India, S. conigerum has been recorded only from the wet warm regions and isolated individuals have been collected in every month of the year except April (Beeson, 1941). In southern India, the life cycle of related species such as S. anale is short and takes about 2 months. Under favourable conditions, the generations are continuous and overlap causing heavy damage to stored wood (Gnanaharan et al., 1983). In northern India, Sinoxylon species are known to hibernate during the winter (Beeson, 1941). In the plains in Pakistan, species of Sinoxylon have three generations a year and development continues almost throughout the year, but adults are less active between November and January (Chaudhry et al., 1969).

Morphology

Descriptions of the immature stages of S. conigerum are not available, though the grubs of some species of Sinoxylon were described by Gardner (1933).

Stebbing (1914) described the adult beetle as follows: Short, squat and stout. Black, slightly reddish, moderately shiny. Prothorax convex, raised on disk; posterior portion finely rugose; anterior rugose-punctate, the rugosities coarsest anteriorly and laterally; four lateral teeth on anterior margin, the inner three large, sharp and more or less of equal size. Elytra one-third as long as prothorax, slightly wider apically; rugose-punctate, the punctures strongest apically, a short raised longitudinal stria on either side of suture in basal half; the two teeth on elytral declivity stout, pointed, placed at a distance from suture in upper portion of declivity and inclined outwards. Length 3.5 mm.

Binda and Joly (1991) gave a brief description of the adult based on the most important characteristics with illustrations.

Means of movement and dispersal

The common entry pathway for this pest is in or on dunnage or packing materials used to secure and crate cargo in the shipping industry and through trade in wood or wooden products CFIA-ACIA, 1997, 1998;AQIS, 1999, 2000). Timber used as dunnage is usually of a very low quality and can constitute a high quarantine risk. There are several reports of the interception of this pest in wooden articles and wood packing/crating materials, especially in low quality wood with bark attached. Even small pieces of wood and bark can carry adults and larvae.

Plant parts liable to carry the pest in trade/transport

- Bark: Larvae, Adults; borne internally; borne externally; visible to naked eye.
- Stems (above Ground)/Shoots/Trunks/Branches: Eggs, Larvae, Pupae, Adults; borne internally; borne externally; visible to naked eye.
- Wood: Eggs, Larvae, Pupae, Adults; borne internally; borne externally; visible to naked eye.

Plant parts not known to carry the pest in trade/transport

- Bulbs/Tubers/Corms/Rhizomes

- Fruits (inc. Pods)
- Growing Medium Accompanying Plants
- Flowers/Inflorescences/Cones/Calyx
- Leaves
- Seedlings/Micropropagated Plants
- Roots
- True Seeds (inc. Grain).

Transport pathways for long distance movement

- Containers And Packing: Dunnage, Wooden Crating, Pallets And Other Packing Material. (CFIA-ACIA 1997 1998; AQIS 1999 2000)

Natural enemies

Not many natural enemies of S. conigerum have been recorded. Only three parasitoids, one bethylid and two braconids, have been found to attack this species, though several parasitoids and predators have been recorded on other species of Sinoxylon. Histerids, carabids and other minor predatory species belonging to Colydidiidae or Trogositidae have been recorded on Sinoxylon species in India (Stebbing, 1914). Many species of Sinoxylon are known to be parasitized by the braconid, Spathius critolaus (Nixon, 1939).

Sclerodermus immigrans attacks the cocoons of this pest in Hawaii (Bridwell, 1920). Doryctes parvus is thought to attack the larvae in India (Balasubramanya et al., 1990).

Natural enemies listed in the database

The list of natural enemies has been reviewed by a biocontrol specialist and is limited to those that have a major impact on pest numbers or have been used in biological control attempts; generalists and crop pests are excluded. For further information and reference sources, see About the data. Additional natural enemy records derived from data mining are presented as a separate list.

Natural enemies reviewed by biocontrol specialist

Natural enemy

Pest stage attacked

Parasites/parasitoids:

Doryctes parvus

Sclerodermus immigrans

Larvae

Impact

The loss caused by S. conigerum has not been quantified. The timber loses weight and the market value is drastically reduced, and in severe cases of infestation may be completely reduced to a powder. In India, other species of Sinoxylon are the major destructive wood borers. In Sri Lanka, S. conigerum is the most destructive borer of Hevea brasiliensis (rubber) wood along with Heterobostrychus species (Tisseverasinghe, 1970). In Madagascar, S. conigerum along with other coleopterans such as Rhyzopertha dominica, is reported to cause 72% of the damage to stored (Manihot esculenta) cassava tubers (Andriantsileferintsoa, 1996).

Phytosanitary significance

S. conigerum poses a threat to the health of forests in many countries in North America, Europe and Australia, where it is currently not present. The pest has the potential to kill trees and modify or disrupt native forest ecosystems. It can travel around intact in wooden crating material. Dunnage and other wooden packing material CFIA-ACIA, 1997, 1998;AQIS, 1999, 2000) and cargoes of timber (Popova and Dubrovskii, 1974) are the major sources of spread into other countries and hence fumigation of such material at the countries of origin and phytosanitary certification and inspection should be strictly enforced.

Symptoms

There is no specific account of the nature of damage caused by S. conigerum. However, Sinoxylon species are known to tunnel into freshly or recently felled wood or sickly or dying standing green trees, and rarely dry timber (Stebbing, 1914; Beeson, 1941). Attacked trees/wood can be recognized by the presence of circular shot holes measuring 2.5-3.0 mm, with wood powder at or near their entrances. Small white grubs/pupae can be found in the sapwood behind the bark. Death, dieback, exudation of gummy sap or resin and early branching are the other symptoms of attack exhibited by Sinoxylon species infested trees, depending on the degree of resistance. Sometimes the branches may be severed by means of evident concave or conical cuts transverse to the axis and the branch below the cut remains green. The attack of these borers is an indication of reduced resistance on the part of the tree and is definitely secondary (Beeson, 1941). Severely affected logs look completely riddled and a network of tunnels can be seen in the interior. Sometimes complete death of a tree can happen due to S. conigerum attack (FAO, 1959).

Adults of some Sinoxylon species sometimes bore into green shoots and twigs for feeding or hibernation marking axial tunnels; as a result, the stems of seedlings or young saplings may be girdled or killed (Beeson, 1941).

Symptoms by affected plant part

Stems: abnormal exudates; dieback; internal feeding.

Whole plant: internal feeding.

Similarities to other species

Among Indian species, S. atratum is a close relative of S. conigerum, from which S. conigerum can be distinguished by its much broader and squat appearance (Stebbing, 1914).

Binda and Joly (1991) gave a key to distinguish S. conigerum from other bostrichids recorded from Venezuela and illustrated the diagnostic characteristics. Joly et al. (1994) provided a modified key to differentiate S. conigerum from S. anale with illustrations. Zimmerman (1941) also included S. conigerum in the key to identify Hawaiian bostrichids.

Detection and inspection

Infestation in standing trees can be detected by the presence of circular shot holes (adult emergence/entrance holes) of 2.5-3.0 mm diameter in the bark with particles of sawdust at or near their entrances. When a strip of bark is removed and the sapwood is examined, small white larvae/pupae can be found. Stored and felled wood should be periodically checked for the presence of bore holes and life stages of this pest. Routine inspection and treatment of timber packaging is necessary as it is a high quarantine risk pest in many countries.

Control

Cultural Control

Field sanitation measures such as immediate removal of fresh cut wood from forests and plantations, and removal and burning of infested standing trees can minimize borer attack. Primary or epidemic attacks on relatively healthy trees may develop in the vicinity of an unhealthy crop if local infestation is allowed to continue unchecked (Beeson, 1941). Standing sick trees may also be used as traps for egg laying and later can be destroyed (Stebbing, 1914).

Physical Control

Seasoning to practically air dryness is a very effective way of minimizing or preventing borer incidence, although S. conigerum may also attack seasoned wood. Rapid drying to reduce the exposure time during seasoning by barking, storage in the sun in open rows and kiln seasoning will considerably reduce borer attack. Water seasoning or ponding (submersion in water ponds/tanks for up to 10 days) is also helpful. Immersion in water for 6-12 months can give protection for 6-32 months and subsequent infestation is also not severe (Roonwal et al., 1961). Logs which are already infested can be sterilized by immersion in cold or hot water (Beeson, 1941).

Chemical Control

If rapid drying is not possible, the logs may be treated with preservatives after felling, barking and immersing. Impregnating the sapwood and heartwood of susceptible softwood is also effective (Beeson, 1941). Treatment of wood with insecticides during storage is very effective at preventing and minimizing the damage. Synthetic pyrethroids (Gul and Chaudhry, 1991; Garcia et al., 1999; Gul and Bajwa, 1999), borax/boric acid (Gnanaharan et al., 1983; Jose et al., 1989), monocrotophos, phosphamidon (Jose et al., 1989), dieldrin (Chaudhry et al., 1969; Balasubramanya et al., 1990) are reported to give varying degrees of protection against various species of Sinoxylon.

Quarantine Control

Since the most common entryway for S. conigerum is in or on dunnage, wooden crating, pallets, waste wood and other packing material, utmost vigilance is required on the part of quarantine officials. The interception frequencies can be quantified and a risk level can be attached to certain commodities imported from specific countries. Targeted import inspection of high risk commodities should be undertaken.

CFIA-ACIA (1997, 1998) has identified and targeted specific high risk commodities including sheet metal, tile, granite/stone/marble, wire cables (wooden spools), heavy machinery and steel or iron products such as pipes, because they are often associated with larger dimension wooden crating. As these commodities are non-agricultural, the consignments are identified by reviewing shipping manifests in advance and then inspected on arrival.

Asia, particularly South and South-East Asia, is the greatest packaging-related source of risk from contamination and incursion of exotic wood borers, evident from the frequent interception of wood borers in import consignments from this area CFIA-ACIA, 1997, 1998;AQIS, 1999, 2000). Phytosanitary certification and fumigation of the dunnage originating from countries of risk should be strictly enforced to avoid the entry of this pest and other wood borers.

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Sinoxylon perforans

Names and taxonomy

Preferred scientific name

Sinoxylon perforans (Schrank)

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Bostrichidae

Other scientific names

Sinoxylon muricatum Fabricius

Bostrichus perforans Schrank

EPPO code

SINOPE (Sinoxylon perforans)

Common names

Germany:

Rebendreher

Italy:

Apate della vite

Host range

List of hosts plants

Hosts (source - data mining)

Vitis vinifera (grapevine)

Please note

Some hosts may be listed at the generic level: Sinoxylon

Geographic distribution

Distribution List

Europe

Former USSR

unconfirmed record

CAB Abstracts, 1973-1998

Romania

unconfirmed record

CAB Abstracts, 1973-1998

References

CAB Abstracts, 1973-1998. Data mined from CAB Abstracts database, years 1973 to 1998. Wallingford, UK: CAB International.

Trogoxylon impressum

Names and taxonomy

Preferred scientific name

Trogoxylon impressum (Comolli)

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Lyctidae

Other scientific names

Lyctus impressus Comolli

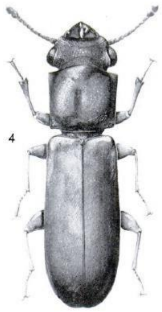
EPPO code

TROXIM (Trogoxylon impressum)

Common names

Germany:

Kaefer, Gepraegter Splintholz-



Host range

List of hosts plants

Hosts (source - data mining)

Quercus robur (common oak)

Geographic distribution

Distribution List

<u>Europe</u>

<u>Norway</u>

unconfirmed record

CAB Abstracts, 1973-1998

<u>Switzerland</u>

unconfirmed record

CAB Abstracts, 1973-1998

<u>Asia</u>

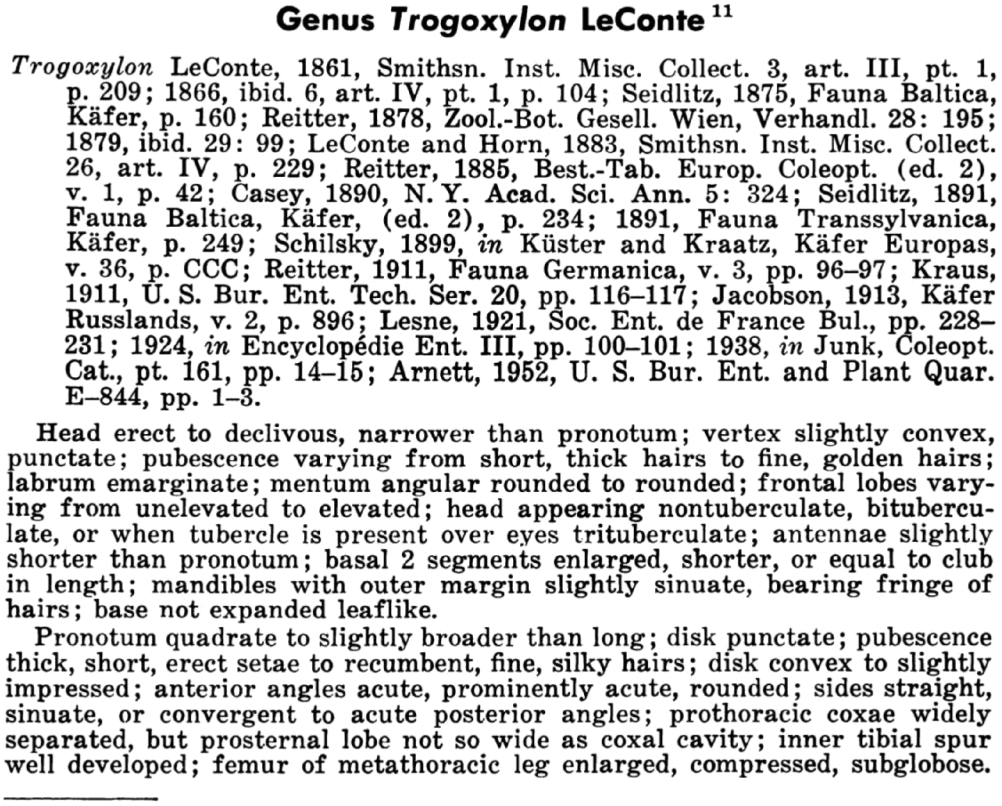
<u>China</u>

unconfirmed record

CAB Abstracts, 1973-1998

References

CAB Abstracts, 1973-1998. Data mined from CAB Abstracts database, years 1973 to 1998. Wallingford, UK: CAB International

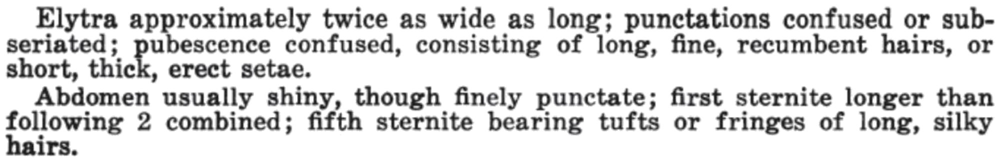


Genus *Trogoxylon* LeConte[11]

Trogoxylon LeConte, 1861, Smithsn. Inst. Misc. Collect. 3, art. III, pt. 1, p. 209; 1866, ibid. 6, art. IV, pt. 1, p. 104; Seidlitz, 1875, Fauna Baltica, Käfer, p. 160; Reitter, 1878, Zool.-Bot. Gesell. Wien, Verhandl. 28: 195; 1879, ibid. 29: 99; LeConte and Horn, 1883, Smithsn. Inst. Misc. Collect. 26, art. IV, p. 229; Reitter, 1885, Best.-Tab. Europ. Coleopt. (ed. 2), v. 1, p. 42; Casey, 1890, N. Y. Acad. Sci. Ann. 5: 324; Seidlitz, 1891, Fauna Baltica, Käfer, (ed. 2), p. 234; 1891, Fauna Transsylvanica, Käfer, p. 249; Schilsky, 1899, *in* Küster and Kraatz, Käfer Europas, v. 36, p. CCC; Reitter, 1911, Fauna Germanica, v. 3, pp. 96–97; Kraus, 1911, U. S. Bur. Ent. Tech. Ser. 20, pp. 116–117; Jacobson, 1913, Käfer Russlands, v. 2, p. 896; Lesne, 1921, Soc. Ent. de France Bul., pp. 228–231; 1924, *in* Encyclopédie Ent. III, pp. 100–101; 1938, *in* Junk, Coleopt. Cat., pt. 161, pp. 14–15; Arnett, 1952, U. S. Bur. Ent. and Plant Quar. E–844, pp. 1–3.

Head erect to declivous, narrower than pronotum; vertex slightly convex, punctate; pubescence varying from short, thick hairs to fine, golden hairs; labrum emarginate; mentum angular rounded to rounded; frontal lobes varying from unelevated to elevated; head appearing nontuberculate, bituberculate, or when tubercle is present over eyes trituberculate; antennae slightly shorter than pronotum; basal 2 segments enlarged, shorter, or equal to club in length; mandibles with outer margin slightly sinuate, bearing fringe of hairs; base not expanded leaflike.

Pronotum quadrate to slightly broader than long; disk punctate; pubescence thick, short, erect setae to recumbent, fine, silky hairs; disk convex to slightly impressed; anterior angles acute, prominently acute, rounded; sides straight, sinuate, or convergent to acute posterior angles; prothoracic coxae widely separated, but prosternal lobe not so wide as coxal cavity; inner tibial spur well developed; femur of metathoracic leg enlarged, compressed, subglobose.



Elytra approximately twice as wide as long; punctations confused or subseriated; pubescence confused, consisting of long, fine, recumbent hairs, or short, thick, erect setae.

Abdomen usually shiny, though finely punctate; first sternite longer than following 2 combined; fifth sternite bearing tufts or fringes of long, silky hairs.

Agrilus planipennis

Names and taxonomy

Preferred scientific name

Agrilus planipennis Fairmaire

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Buprestidae

EPPO code

AGRLPL (Agrilus plannipenis)

Common names

English:

emerald ash borer

Host range

Notes on host range

A. planipennis essentially attacks Fraxinus spp. In eastern Asia, several native species are recorded as hosts (Fraxinus chinensis, Fraxinus lanuginosa and Fraxinus mandshurica), but the pest has not attracted particular attention. In North America, where it is introduced, A. planipennis damages native American species, especially Fraxinus americana, Fraxinus pennsylvanica and Fraxinus nigra. There is no information on how it might behave on other Fraxinus spp., such as the European Fraxinus excelsior and Fraxinus angustifolia. In Asia, it is said to also occur on Juglans ailanthifolia, Pterocarya rhoifolia and Ulmus japonica [Ulmus davidiana var. japonica], but there is no indication that it occurs on species of these genera elsewhere.

Affected Plant Stages: Vegetative growing stage.

Affected Plant Parts: Leaves, stems and whole plant.

List of hosts plants

Major hosts

Fraxinus americana (white ash), Fraxinus nigra (black ash), Fraxinus pennsylvanica (downy ash)

Minor hosts

Fraxinus chinensis (chinese ash), Fraxinus lanuginosa , Fraxinus mandshurica (Manchurian ash), Juglans mandshurica (Manchurian walnut), Pterocarya rhoifolia (japanese wing nut), Ulmus davidiana (japanese elm), Ulmus parvifolia (lacebark elm)

Wild hosts

Fraxinus rhynchophylla

Geographic distribution

Notes on distribution

A. planipennis is native to eastern Asia, where it has attracted little attention. In 2002, it was introduced into North America, probably through the port of Detroit, and now occurs locally in the states of Maryland (Prince George's county), Michigan (Livingston, Macomb, Oakland, Monroe, Washtenaw and Wayne counties), Ohio (Lucas county) and Virginia (Fairfax county), and in the province of Ontario (Essex county).

Distribution List

Please note: The distribution status for a country or province is based on all the information available. When several references are cited, they may give conflicting information on the pest status. In particular, citations of earlier presence of a pest are included even though there is an authoritative reference to indicate that the pest is now absent.

Show EPPO notes

EPPO notes may be available for records where the source is EPPO, 2006. PQR database (version 4.5). Paris, France: European and Mediterranean Plant Protection Organization. Further details may be available in the corresponding EPPO Reporting Service item (e.g. RS 2001/141), for details of this service visit http://archives.eppo.org/EPPOReporting/Reporting_Archives.htm, or contact the EPPO Secretariat hq@eppo.fr.

Biology and ecology

Agrilus is a large genus of flat-headed woodborers with species found in Asia, Australia, Europe and North America (Browne, 1968). The larvae typically feed in the cambium of trees or in the stems of vines and small woody plants. The adults are attractive insects with striking metallic colours and are often referred to as jewel beetles. In China, A. planipennis typically has one generation per year, though some individuals may require 2 years to complete a generation. The adults are active between mid-May and July. After emergence, they walk to the crown of their host tree and feed on small amounts of foliage, continuing to feed throughout their life. Initial flight begins 3-4 h after first feeding. The adults are active from 06.00 to 17.00 h, especially on warm sunny days. On cloudy or rainy days, the adults rest in bark cracks or on foliage. They remain on foliage at night. The eggs are laid individually on the bark surface, inside bark cracks and crevasses. Each female lays 68-90 eggs. The adult males typically live for 2 weeks and females for 3 weeks. The eggs hatch in about 1 week. First-instar larvae tunnel through the bark to the cambium, where they feed from mid-June to mid-October. The larvae make long serpentine galleries (up to 26-32 mm long) into the sapwood, which enlarge as they grow and are filled with brownish sawdust and frass. The mature larvae overwinter in pupal cells. Pupation occurs in April and May at the end of a tunnel near the surface. Individual larvae that are not full grown by autumn, overwinter in the cambium, resume feeding in April and complete development in late summer. The adults remain under the bark for 1-2 weeks and then emerge through 'D'-shaped exit holes that are about 3-4 mm wide (Haack et al., 2002).

Morphology

Eggs

The eggs are light-yellow, turning to brownish-yellow before hatching. They are oval-shaped and 1 x 0.6 mm. The centre of each egg is slightly convex.

Larvae

The mature larvae are 26-32 mm long and creamy-white. The body is flat and broad. The head is small and brown and retracted into the prothorax, exposing only the mouthparts. The prothorax is enlarged and the meso- and meta-thorax are slightly narrower. The mesothorax bears spiracles.

The abdomen is ten-segmented. Segments one to eight have one pair of spiracles each and the last segment bears one pair of brownish serrated styles.

Pupae

The pupae are 10-14 mm long and creamy-white. The antennae stretch back to the base of the elytra and the last few segments of the abdomen bend slightly ventrally.

Adults

The adults are 8.5-14.0 mm long and 3.1-3.4 mm wide. The body is narrow and elongate, cuneiform and metallic blue-green. The species is glabrous, and is characterized by dense but fine sculpture. The head is flat and the vertex is shield-shaped. The compound eyes are kidney-shaped and somewhat bronze-coloured. The prothorax is transversely rectangular and slightly wider than the head, but is the same width as the anterior margin of the elytra. This anterior margin is raised, forming a transverse ridge, the surface of which is covered with punctures. The posterior margins of the elytra are round and obtuse with small tooth-like knobby projections on the edge.

Means of movement and dispersal

Research in China and Japan indicates that A. planipennis adults are strong fliers and typically fly in 8-12 m bursts. Long-distance flights of more than 1 km are also possible (Haack et al., 2002). The adults are small and subject to dispersal by air currents. A. planipennis can also be transported in plants and wood products (including wood, wood packing, wood chips and firewood) containing bark strips, moving in international trade. To date, at least six exotic species of Agrilus have established in the USA. Between 1985 and 2000, 38 confirmed detections of Agrilus spp. were made at US points of entry, 28 from dunnage, four from crating, four from grapevine leaves, one from a cutting and one in a ship's hold (Haack et al., 2002).

Plant parts liable to carry the pest in trade/transport

- Stems (above Ground)/Shoots/Trunks/Branches: Eggs, Larvae, Pupae; borne internally; borne externally; visible to naked eye.
- Wood: Larvae, Pupae; borne internally; visible to naked eye.

Natural enemies

It seems probable that A. planipennis is attacked by natural enemies in eastern Asia, and that its populations are regulated by them. However, no specific information is available on this.

Impact

Economic impact

Trees attacked by A. planipennis are ultimately killed. In China, A. planipennis typically attacks ash trees that grow in open areas or at the edge of closed forests. However, entire stands can be killed during outbreaks. Attack densities are highest in the lower bole of host trees (Yu, 1992). Whereas in North America, A. planipennis has infested and killed trees in both open settings and closed forests and the attacks begin in the upper bole and main branches of host trees. In Michigan, it is estimated that A. planipennis has killed millions of trees over the past few years (Fraxinus pennsylvanica, Fraxinus americana and Fraxinus nigra, as well as several horticultural varieties of ash). In Ontario, it is estimated that it has killed 9000 to 10,000 ash trees. A. planipennis can kill trees of various size and condition (small trees of 5 cm trunk diameter to large mature trees). Tree death usually occurs within 3 years following initial attack although heavier infestations can kill trees within 1 to 2 years (Haack et al., 2002).

Ashes are important park, garden and street trees and A. planipennis is presently causing extensive mortality of such trees in south-eastern Michigan. These trees have to be replaced and there are now fewer viable choices for their replacement. Ash wood is a high-quality material for various special uses. However, it is not produced on a plantation scale, and it is not clear that its availability has been significantly reduced by the invasion of A. planipennis.

Environmental impact

Various species of ash are important components of many broadleaf forest communities in the northern hemisphere. In the native range of A. planipennis in eastern Asia, there is no particular indication that A. planipennis has a significant impact on native forests. However, in North America ashes are being attacked in open situations and in forests, and millions of trees are killed. The long-term environmental impact of this mortality remains to be seen. Forests are likely to show an altered tree species composition and reduced biodiversity.

Phytosanitary significance

A. planipennis has a high risk of further spread in North America, where restrictions have been imposed on the movement of ash trees, firewood, branches and logs from infested to uninfested areas (Haack et al., 2002; Ohio Department of Agriculture, 2003). The species is featured on the Alert List of NAPPO (see http://www.pestalert.org). In Europe, where Fraxinus spp. are commonly grown in forests and for amenity purposes, there is also a considerable risk. In the light of its area of origin and the area where it has been introduced, and of the considerable damage in North America, it seems likely that A. planipennis would be able to survive and have economic impact in many parts of the EPPO region. Control (containment and suppression) would be very difficult to achieve. On this basis, A. planipennis also features on the EPPO Alert List and is currently a candidate for the EPPO A1 list.

Symptoms

The larvae make long serpentine galleries (up to 26-32 mm long) into the sapwood, which enlarge as they grow and are filled with brownish sawdust and frass. Callus tissue produced by the tree in response to larval feeding may cause vertical splits 5-10 cm long in the bark above a gallery. Newly emerged adults bore 'D'-shaped (3-4 mm diameter) exit holes on trunks and branches. As the larvae damage the vascular system, attacks cause general yellowing and thinning of the foliage, dying of branches, crown dieback and eventually death of the tree after 2 to 3 years of infestation. Basal sprouting and also the presence of woodpeckers may indicate wood-boring beetle activity. After 1 to 2 years of infestation, the bark often falls off in pieces from damaged trees, exposing the insect galleries.

Symptoms by affected plant part

Leaves: abnormal colours.

Stems: dieback; internal feeding.

Whole plant: plant dead; dieback; internal feeding.

Detection and inspection

See Symptoms. The larval galleries and exit holes are characteristic, and are not normally seen in Fraxinus spp. outside Asia.

Control

Control

No effective control methods are currently available. Research is under way on the evaluation of systemic insecticides, natural enemies, survival rates in cut trees, etc. Infested trees containing larvae and pupae should be felled and chipped.

Phytosanitary Measures

Phytosanitary measures should cover the import of host plants of A. planipennis, and especially their untreated wood (including wood, wood packing material, wood chips and firewood from the infested areas). Restrictions on the movements of these commodities are also important in the containment of established infestations.

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Anoplophora chinensis

Names and taxonomy

Preferred scientific name

Anoplophora chinensis (Forster, 1771)

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Cerambycidae

Other scientific names

Melanauster chinensis (Forster)

Anoplophora chinensis Breuning 1944

Anoplophora malasiaca malasiaca Samuelson
1965 Anoplophora perroudi Pic 1953

Anoplophora sepulchralis Breuning 1944

Callophora afflicta Thomson 1865

Callophora luctuosa Thomson 1865

Calloplophora abbreviata Thomson 1865

Calloplophora malasiaca Thomson 1865

Calloplophora sepulcralis Thomson 1865

Cerambyx chinensis Forster 1771

Cerambyx farinosus Houttuyn 1766

Cerambyx sinensis Gmelin 1790

Cerambyx pulchricornis Voet 1778

Lamia punctator Fabricius 1777

Melanauster chinensis Matsumura 1908

Melanauster chinensis macularius Kojima 1950

Melanauster chinensis var. macularia Bates 1873

Melanauster chinensis var. macularis Matsushita 1933

Melanauster chinensis var. Sekimacularius Seki 1946

Melanauster macularius Kolbe 1886

Melanauster malasiacus Aurivillius 1922

Melanauster perroudi Pic 1953

Anoplophora malasiaca (Thomson)

EPPO code

ANOLCN (Anoplophora chinensis)

ANOLMA (Anoplophora malasiaca)

Common names

English:

black and white citrus longhorn

citrus root cerambycid

mulberry white spotted longicorn

citrus longhorned beetle

white-spotted longicorn beetle

citrus longhorn beetle

French:

capricorne á points blancs

Japan:

gomadara-kamikiri

hosi-kamikiri

Notes on taxonomy and nomenclature

After many years of confusion, the Genus Anoplophora was revised by Lingafelter and Hoebeke (2002). Earlier uncertainty resulted from some workers using colour variation between features to distinguish specimens from different regions of China, Japan and South-East Asia and to split them into separate species. For example, Gressitt (1951) recognized A. chinensis and A. malasiaca as two distinct species on the basis of A. malasiaca having pale pubescence on the pronotum but Duffy (1968) considered them a single species. A. malasiaca has been treated as synonymous with, or as a variation of, A. chinensis or A. macularia for over 100 years (Bates, 1873; Matsushita, 1933;Breuning, 1949, 1961). Most recently Lingafelter and Hoebeke (2002) synonymised A. malasiaca with A. chinensis because they share so many characteristic features. They argued that A. chinensis and A. malasiaca could not be separated on the basis of the colour and size of elytral macula and the presence or absence of hair on the pronotum because the variation of such features is considerable and overlaps in specimens from the same locality.

Host range

Notes on host range

A. chinensis is a polyphagous xylophile i.e. a species that attacks many species of living tree. Over 100 species in at least 26 families can be attacked (Kojima and Nakamura, 1986; EPPO, 1997b;

Lingafelter and Hoebeke, 2002) especially in orchards where it is regarded as a serious pest of Citrus (Yamaguchi and Ohtake, 1986; Mitomi et al., 1990). Malus, Pylus, Alnus and Platanus also suffer serious damage (Research Group of Alder-tree-pests, 1972; Aono and Murakoshi, 1980; Ito et al., 1980; Yamaguchi and Ohtake, 1986; Ohga et al., 1995).

Affected Plant Stages: Vegetative growing stage.

Affected Plant Parts: Leaves, roots, stems and whole plant.

List of hosts plants

Major hosts

Casuarina equisetifolia (casuarina), Citrus , Citrus aurantiifolia (lime), Citrus aurantium (sour orange), Citrus deliciosa (mediterranean mandarin), Citrus limonia (mandarin lime), Citrus maxima (pummelo), Citrus natsudaidai (natsudaidai), Citrus nobilis (tangor), Citrus reticulata (mandarin), Citrus sinensis (navel orange), Citrus unshiu (satsuma), Malus domestica (apple), Poncirus trifoliata (Trifoliate orange), Populus (poplars), Populus alba (silver-leaf poplar), Populus maximowiczii (Japanese poplar), Populus nigra (black poplar), Populus sieboldii (japanese aspen), Populus tomentosa (Chinese white poplar), Salix babylonica (weeping willow), Salix gracilistyla (big catkin willow), Salix integra , Salix jessoensis , Salix laevigata (red willow), Salix sachalinensis

Minor hosts

Acer negundo (box elder), Acer palmatum (Japanese maple), Acer pictum (painted maple), Betula platyphylla (Manchurian birch), Broussonetia papyrifera (paper mulberry), Cajanus cajan (pigeon pea), Carpinus laxiflora , Castanea crenata (Japanese chestnut), Cryptomeria japonica (Japanese cedar), Elaeagnus umbellata (autumn elaeagnus), Fagus crenata (Siebold's beech), Ficus carica (fig), Fortunella margarita (oval kumquat), Hedera rhombea (japanese ivy), Hibiscus mutabilis (cottonrose), Juglans (walnuts), Lagerstroemia indica (indian crape myrtle), Litchi sinensis , Mallotus japonicus , Melia azedarach (Chinaberry), Morus alba (mora), Persea thunbergii , Pinus massoniana (masson pine), Platanus acerifolia (London planetree), Platanus orientalis (plane), Prunus armeniaca (apricot), Prunus mume (Japanese apricot tree), Prunus pseudocerasus (chinese fruiting cherry), Prunus yedoensis , Pyracantha angustifolia (Narrow-leaf firethorn), Pyrus communis (European pear), Pyrus pyrifolia (Oriental pear tree), Rosa multiflora (Multiflora rose), Rubus microphyllus , Ulmus davidiana (japanese elm), Ulmus pumila (dwarf elm), Ziziphus mauritiana (jujube)

Wild hosts

Acacia decurrens (green wattle), Acacia mearnsii (black wattle), Albizia julibrissin (silk tree), Alnus (alders), Alnus firma , Alnus hirsuta (Siberian alder), Alnus pendula , Alnus viridis (green alder), Aralia cordata (spikenard), Atalantia , Carya illinoinensis (pecan), Castanopsis cuspidata (chinkapin), Casuarina stricta (coast she-oak), Eriobotrya japonica (loquat), Lindera praecox , Psidium guajava (guava), Quercus acutissima (sawtooth oak), Quercus glauca (ring-cup oak), Quercus petraea (durmast oak), Quercus serrata (glandbearing oak), Rhus javanica , Rhus verniciflua , Robinia pseudoacacia (black locust), Sapium sebiferum (Chinese tallow tree), Sophora , Styrax japonica , Vernicia fordii (central China wood oil tree)

Habitat

In China, A. chinensis is extremely abundant in all lowland orchards (Duffy, 1968).

Geographic distribution

Notes on distribution

The distribution of A. chinensis has been confused with other Anoplophora species for many years because of taxonomic confusion (Kojima and Hayashi, 1969; Kusama and Takakuwa, 1984; Saito and Ohbayashi, 1989; Adachi, 1994; Carvey et al., 1998; Fukaya et al., 2000). Since Lingafelter and Hoebke (2002) synonymised A. malasiaca with A. chinensis, it is considered to occur primarily in China, Japan and Korea. Within China it is found in all but the most northern prefectures (CABI/EPPO 1999a). In Japan it is found from the southern part of Hokkaido to Okinawa Island in the Ryukyu Archipelago, in the south (Azuma, 1975; Kiyosawa et al., 1981; Hayashi, 1985). It is widespread in the southern part of the Democratic People's Republic of Korea and the Republic of Korea including Cheju Island (Lee, 1982).

CABI/EPPO (1999a) report A. chinensis as present with restricted distribution in the USA on the basis of interceptions from plants said to originate in Hawaii (Sorauer, 1954). Hua (1982) recorded A. chinensis from North America but did not provide further details. Although the species has been intercepted at ports or found in association with plants recently imported from Asia, it is not presently known to be established in the USA or Canada (Lingafelter and Hoebeke, 2002). Reports of A. chinensis establishing in the UK (Cooter, 1998) have subsequently been found to be erroneous (Cooter, 2000).

The first published record of A. chinensis occuring on natural vegetation in Europe, as opposed to on imported plant material, was in 2001 (Colombo and Limonta, 2001) although it is suggested that the pest may have been present since 1997. Eradication efforts are underway in Italy (EPPO 2002a).

Distribution List

Please note: The distribution status for a country or province is based on all the information available. When several references are cited, they may give conflicting information on the pest status. In particular, citations of earlier presence of a pest are included even though there is an authoritative reference to indicate that the pest is now absent.

Show EPPO notes

EPPO notes may be available for records where the source is EPPO, 2006. PQR database (version 4.5). Paris, France: European and Mediterranean Plant Protection Organization. Further details may be available in the corresponding EPPO Reporting Service item (e.g. RS 2001/141), for details of this service visit http://archives.eppo.org/EPPOReporting/Reporting_Archives.htm, or contact the EPPO Secretariat hq@eppo.fr.

Europe

France

present, few occurrences

EPPO, 2006

Italy

restricted distribution

Colombo & Limonta, 2001; EPPO, 2002a

Netherlands

eradicated

EPPO, 2001; EPPO, 2006

United Kingdom absent,

intercepted only ADAS,

1986

Asia

China Widespread,

native

APPPC, 1987; EPPO, 2006

Anhui

present

CABI/EPPO, 1999a; Lingafelter & Hoebeke, 2002; EPPO, 2006

Fujian

present

Gressitt, 1951; Duffy, 1968; CABI/EPPO, 1999a; Lingafelter & Hoebeke, 2002; EPPO, 2006

Gansu

present

Gressitt, 1951; CABI/EPPO, 1999a; Lingafelter & Hoebeke, 2002; EPPO, 2006

Guangdong

widespread

Gressitt, 1951; Duffy, 1968; CABI/EPPO, 1999a; Lingafelter & Hoebeke, 2002; EPPO, 2006

Guangxi

present

Gressitt, 1951; CABI/EPPO, 1999a; Lingafelter & Hoebeke, 2002; EPPO, 2006

Guizhou

present

CABI/EPPO, 1999a; Lingafelter & Hoebeke, 2002; EPPO, 2006

Hainan

present

Gressitt,1942, 1951; Duffy, 1968; CABI/EPPO, 1999a; Lingafelter & Hoebeke, 2002; EPPO, 2006 Hebei

present

Gressitt, 1951; CABI/EPPO, 1999a; Lingafelter & Hoebeke, 2002; EPPO, 2006
Hong Kong

present

Gressitt, 1951; Duffy, 1968; APPPC, 1987; CABI/EPPO, 1999a; Lingafelter & Hoebeke, 2002; EPPO, 2006

Hubei
present

Gressitt, 1951; CABI/EPPO, 1999a; Lingafelter & Hoebeke, 2002; EPPO, 2006
Hunan

present

CABI/EPPO, 1999a; Lingafelter & Hoebeke, 2002; EPPO, 2006

Jiangsu

present

Gressitt, 1951; Duffy, 1968; CABI/EPPO, 1999a; Lingafelter & Hoebeke, 2002; EPPO, 2006
Jiangxi

present

Gressitt, 1951; CABI/EPPO, 1999a; Lingafelter & Hoebeke, 2002; EPPO, 2006
Liaoning

present

Duffy, 1968; CABI/EPPO, 1999a; Lingafelter & Hoebeke, 2002; EPPO, 2006 Macao

present

EPPO. 1997a; CABI/EPPO, 1999a; Lingafelter & Hoebeke, 2002; EPPO, 2006 Shaanxi

present

Gressitt, 1951; CABI/EPPO, 1999a; Lingafelter & Hoebeke, 2002; EPPO, 2006
Sichuan

widespread

Gressitt, 1951; Duffy, 1968; CABI/EPPO, 1999a; Lingafelter & Hoebeke, 2002; EPPO, 2006
Taiwan

Present, native

Gressitt, 1951; Duffy, 1968; CABI/EPPO, 1999; Lingafelter & Hoebeke, 2002
Xizhang

present

Gressitt, 1951; CABI/EPPO, 1999a; Lingafelter & Hoebeke, 2002; EPPO, 2006
Yunnan

present

CABI/EPPO, 1999a; Lingafelter & Hoebeke, 2002; EPPO, 2006

Zhejiang

present

Gressitt, 1951; Duffy, 1968; CABI/EPPO, 1999a; Lingafelter & Hoebeke, 2002; EPPO, 2006
Indonesia

present

Lingafelter & Hoebeke, 2002

Sumatra

present

Lingafelter & Hoebeke, 2002

Japan

Widespread, native

Gressitt, 1951; Duffy, 1968; Lee, 1982; CABI/EPPO, 1999b; Lingafelter & Hoebeke, 2002 Hokkaido

widespread

Hayashi, 1985; Saito & Ohbayashi, 1989; CABI/EPPO, 1999b; Lingafelter & Hoebeke, 2002
Honshu

widespread

Hayashi, 1985; Saito & Ohbayashi, 1989; CABI/EPPO, 1999b; Lingafelter & Hoebeke, 2002 Kyushu

widespread

Hayashi, 1985; Saito & Ohbayashi, 1989; CABI/EPPO, 1999b; Lingafelter & Hoebeke, 2002 Ryukyu Archipelago

widespread

Gressitt, 1951; Duffy, 1968; Hayashi, 1985; Saito & Ohbayashi, 1989; CABI/EPPO, 1999b; Lingafelter & Hoebeke, 2002

Shikoku

widespread

Hayashi, 1985; Saito & Ohbayashi, 1989; CABI/EPPO, 1999b; Lingafelter & Hoebeke, 2002 Korea, DPR

present

Lee, 1982; Kusama & Takakuwa, 1984; CABI/EPPO, 1999b; Lingafelter & Hoebeke, 2002 Korea, Republic of

widespread

Gressitt, 1951; Duffy, 1968; Lee, 1982; Kusama & Takakuwa, 1984; CABI/EPPO, 1999b; Lingafelter & Hoebeke, 2002; EPPO, 2006

Malaysia

Present, native

CABI/EPPO, 1999b; Lingafelter & Hoebeke, 2002; EPPO, 2006

Peninsular Malaysia

present

Lingafelter & Hoebeke, 2002

Myanmar

present

Gressitt, 1951; Duffy, 1968; CABI/EPPO, 1999; EPPO, 2006

Philippines

present

Lingafelter & Hoebeke, 2002

Vietnam

restricted distribution

Waterhouse, 1993; CABI/EPPO, 1999b; Lingafelter & Hoebeke, 2002; EPPO, 2006 North America

USA

restricted distribution

CABI/EPPO, 1999; Lingafelter & Hoebeke, 2002; EPPO, 2006

California

absent, intercepted only

Lingafelter & Hoebeke, 2002

Georgia (USA)

eradicated

CABI/EPPO, 1999; USDA-APHIS, 1999; EPPO, 2002a; EPPO, 2006

Hawaii

present

CABI/EPPO, 1999; Lingafelter & Hoebeke, 2002; EPPO, 2006

Washington

present, few occurrences

EPPO, 2002a; EPPO, 2006

Wisconsin

eradicated

EPPO, 2002a; EPPO, 2006

Biology and ecology

Adults live for about 30 days in China and can be found from April to August, but are most abundant from May to July. In Japan adults live about 70 days between June and August. Adults are active during the daytime feeding on leaves, petioles and the young bark of host trees. Sexual maturation occurs around 10 days after emergence (Adachi, 1988). Adults fly readily and the rate of tree-to-tree movement tends to be higher in males (Adachi, 1990b) presumably due to mate searching behaviour. When a male encounters a female, the male has to touch the female with his antennae and/or tarsi to detect a sex pheromone on the body surface of the female which stimulates mounting and copulation Fukaya et al., 1999, 2000). Adults mate polygamously. There are two peaks of mating activity, from 08.00 to 12.00 h and from 15.00 to 17.00 h. Mating occurs on the trunks and main branches at least 0.6 m from the ground. Egg deposition begins a week after copulation. Females use their mandibles to cut a T-shaped slit in the bark of a living tree, several centimetres from the ground. Eggs are laid singly under the bark of the trunk through the ovipositional cut. Females may also oviposit on exposed roots (Wang et al. 1996). In Japan females lay around 190 eggs with the peak rate of egg laying around 30 days after emergence (Adachi, 1988). At 20-30°C, eggs hatch about 10 days after oviposition. The feeding larva tunnels into the trunk just under the bark and later enters and destroys the pith and vascular systems of the lower trunk and root. If a tree is small, a single larva can remove much of the heart wood. During this feeding process, large amounts of frass are ejected through holes in the bark. Larvae spend several months without feeding before pupation (Adachi, 1994). Pupation takes place in the wood, often in the upper part of the feeding area. Four to eight days after adult eclosion, they exit through emergence holes approximately 10-20 mm diameter about 25 cm above the oviposition site (Xu, 1997).

Adachi (1994) studied the development of A. chinensis under fluctuating seasonal temperatures and at three constant temperatures of 20, 25 and 30°C. With fluctuating temperatures, more than 70% of the larvae survived and required 1 or 2 years to complete their life cycle (from egg to adult eclosion). Adults emerged simultaneously in June although there had been three different oviposition dates. At 20°C, 57% of the individuals completed their development 306 to 704 days after oviposition. All larvae died at 25 and 30°C. Adachi (1994) estimated that the lower developmental threshold temperatures for eggs and young larvae were 6.7 and 11.6°C, respectively. A total accumulated temperature of 1200°C was needed after overwintering to develop from larvae into adults (Xu, 1997).

In tropical and subtropical regions there is one generation per year although further north there may be one generation every 2 years. Xu (1997) reported that even where A. chinensis had, on average, one generation per year, 15% had two generations in 3 years.

Chang (1975), Aono and Murakoshi (1980), Kawamura (1985), Adachi (1988, 1994) and Mitomi et al. (1990) provide more details on the life cycle.

Morphology

Eggs

The egg is elongate, subcylindrical, white and about 6 mm long (Gressitt, 1942). The chorion is off-white, turning yellowish-brown closer to hatching (Lieu, 1945).

Larvae

The larva is elongate, cylindrical, up to 56 mm long and 10 mm at its broadest point across the prothorax; it lacks obvious legs. It tapers gradually behind the prothorax towards the end of the abdomen, but is then slightly broadened apically. It is pale yellowish-white, with the anterior part of the head pitchy-black. There are some yellow, chitinized patterns on the prothorax. The pronotum has a narrow orange transverse band near the anterior margin and a large, orange, raised area posteriorly. The ocelli, one on each side, are slightly chitinized on the surface and are ventro-lateral to the antennae. The antennae are very short, three-segmented (Lieu, 1945; Nakamura and Kojima, 1981). An illustrated description of the larva was provided by Gressitt (1942) and by Duffy (1968). Duffy also keyed out all the known Oriental cerambycid larvae, including A. chinensis.

Pupae

The pupa is light yellow, 24 to 35 mm long, with legs and long, coiled antennae (Kawada, 1975).

Adults

Typically cerambycid in shape, adults are black and shiny, 21 (male) to 37 (female) mm long, with long antennae, 1.7-2 times body length in males; 1.2 times body length in females. The head, antennae, legs and underside are covered with very fine pale-blue to white pubescence. The head is held vertically downwards, with maxillary palpi tapering apically. Antennae are inserted on distinct prominences forming a strong V on the top of the head. The basal segment of the antennae has a distinct apical scar-like region. Antennal joints are black with a blue-grey base. The pronotum is transverse, with a stout lateral spine at each side and a raised area medially in the basal half. The legs appear to have four segments excluding the claws, but with the third segment strongly bilobed and almost concealing the very small fourth segment at the base of the true fifth, claw-bearing segment. Male fore tarsi are larger than those of the female. Elytral pubescence form several irregular, white to blue spots and usually covering the scutellum. The male has the elytra narrowed distally. The sides of the female elytra are parallel and rounded distally. On mainland China, most A. chinensis have white rather than blue pubescence, which is usually seen in

Japanese specimens although rarely some have neither white or blue patches on the elytra, and resemble A. leechi (Duffy, 1968; Kusama and Takakuwa, 1984; EPPO, 1997b).

For a detailed description and colour photographs, see Lingafelter and Hoebeke (2002).

Means of movement and dispersal

A. chinensis can move via international trade. It is most likely to be moved as eggs, larvae or pupae in woody planting material or finished minature plants (bonsai or penjing). Individuals (larvae and adults) have entered Europe and the USA on bonsai plants of Acer buergeranum, A. palmatum, Celastrus, Cydonia sinensis, Malus micromalus and Sageretia from China and Japan Anon., 1986, 1988;EPPO, 2001, 2002a).

Plant parts liable to carry the pest in trade/transport

- Stems (above Ground)/Shoots/Trunks/Branches: Eggs, Larvae, Pupae; borne internally; visible to naked eye.

Plant parts not known to carry the pest in trade/transport

- Bark
- Bulbs/Tubers/Corms/Rhizomes
- Fruits (inc. Pods)
- Growing Medium Accompanying Plants
- Flowers/Inflorescences/Cones/Calyx
- Leaves
- Seedlings/Micropropagated Plants
- Roots
- True Seeds (inc. Grain)
- Wood.

Natural enemies

Aprostocetus fukutai was the only natural enemy listed by Duffy (1968). Ontsira anoplophorae was described as the first parasitoid of Anoplophora spp. in Japan (Kusigemati and Hashimoto, 1993) although Tetrastichus (=Aprostocetus) sp. was also found to be a parasitoid of A. chinensis from Japan (Japan Plant Protection Society, 1997). In China, Oecophylla smaragdina preys on A. chinensis and when present in Citrus orchards, it can be so effective as to significantly reduce, or remove, the need for insecticides (Yang, 1984).

Natural enemies listed in the database

The list of natural enemies has been reviewed by a biocontrol specialist and is limited to those that have a major impact on pest numbers or have been used in biological control attempts; generalists and crop pests are excluded. For further information and reference sources, see About the data. Additional natural enemy records derived from data mining are presented as a separate list.

Natural enemies reviewed by biocontrol specialist

Natural enemy

Pest stage attacked

Associated plants

Biological control in:

Parasites/parasitoids:

Aprostocetus fukutai

Eggs

Ontsira anoplophorae

Larvae

Predators:

Oecophylla smaragdina (weaver ant)

Adults, Larvae

Citrus

China; Fujian

Additional natural enemies (source - data mining)

Natural enemy

Pest stage attacked

Associated plants

Biological control in:

Parasites/parasitoids:

Steinernema carpocapsae

Citrus

Japan

Pathogens:

Beauveria bassiana (white muscardine fungus)

Beauveria brongniartii (biocontrol: cockchafer larvae)

Japan

Impact

A. chinensis is regarded as one of the most destructive cerambycid pests of fruit trees, especially Citrus, in lowland areas of China where economic loss can be substantial (Gressitt, 1942; Duffy, 1968; Wang et al., 1996). In a survey of Citrus orchards in six regions of Japan, 66% of trees were found to have adult emergence holes. Across all regions, there was a mean of 3.8 holes per tree although means between regions varied from 2.2 to 5.9 holes per tree (Mitomi et al., 1990). Trees are weakened by larval attack and are readily susceptible to diseases and wind damage. Serious infestation causes tree decay and a decrease of fruit yield in orchards. Damage to small young trees is most serious (Lieu, 1945; Kojima and Hayashi, 1974). Adult damage to the fruiting shoots of fruit trees results in particular economic loss.

Phytosanitary significance

A. chinensis is a quarantine pest for the European Union and EPPO. The species presents a significant risk to Citrus-growing countries around the Mediterranean. A. chinensis is also a quarantine pest in Canada (EPPO, 2002b).

Symptoms

A female will use her mandibles to cut a T-shaped slit in the bark of the tree trunk close to ground level or on an exposed root, in which to lay an egg. Upon hatching the larva bores into the stem and destroys the pith and vascular system of the host (Adachi, 1989; Mitomi et al., 1990) but later enters the heart wood, tunnelling up and down. Considerable amounts of frass (small cylindrical pellets of sawdust) and woodpulp are ejected through holes in the bark (Gressitt, 1942). The piles of frass accumulating at the base of an attacked tree are usually conspicuous when a tree is undisturbed and give a good indication of infestation. Adults eat young leaves, branches and bark of the tree (Kajiwara et al., 1986).

Symptoms by affected plant part

Leaves: external feeding.

Roots: internal feeding.

Stems: abnormal exudates; internal feeding; visible frass.

Whole plant: plant dead; dieback; frass visible.

Similarities to other species

Following the taxonomic revision by Lingafelter and Hoebeke (2002) A. chinensis is most similar to A. davidis and A. macularia. Mature larvae are extremely similar to those of Monochamus species (Duffy, 1968).

Detection and inspection

Bark around the base of trees should be examined for an ovipositional scar (3-4 mm wide, 1-2 mm long) (Kojima and Hayashi, 1969). Trees should be inspected, especially at the base of trunks, and any exposed roots, for signs of larval tunnels. Frass and wood pulp extruding from holes are signs of infestation (Kajiwara et al., 1986).

Control

Insecticide treatments are used in Citrus orchards in China and Japan. The insecticides are sprayed on the tree canopy to kill adults, and at the base of the trunk to kill eggs and larvae (Komazaki et al., 1989). Omethoate, '851' [of unstated composition] and monocrotophos, were 91-100% effective at controlling A. chinensis in Casuarina equisetifolia forests in Zhejiang Province, China (Dai, 1994). 96-100% control of larvae was obtained when omethoate 40EC was injected into each larval channel of infested Populus nigra (Wu et al., 2000). Infested branches can also be cut and burnt and a mixture of dieldrin and kerosene can be inserted into the frass holes to kill the larvae (Hill, 1983).

Biological control has been used in Japan with the nematode Steinernema feltiae Kashio, 1982, 1986), and with the pathogenic fungi Beauveria bassiana and B. brongniartii (Kashio and Ujiye, 1988; Japan Plant Protection Society, 1997). Application of a formulation of B. brongniartii drastically decreased emergence of the pest in a Citrus orchard (Kobayashi et al., 1999). The fungi was reported to kill 43-100% of adults when it was impregnated on polyurethane forms and hung from the trunk, or wrapped along the trunks of Citrus trees (Kashio and Tsutsumi, 1990; Tsutsumi et al., 1990). In China, chemical control of A. chinensis was found to be unnecessary when colonies of the ant Oecophylla smaragdina are present in Citrus orchards (Yang, 1984).

Physical methods can also be used. For example, covering the bottom of trunks with netting (6 holes/cm), sticky cardboard or 2-cm fishing net can prevent oviposition and capture adults (Adachi and Korenaga, 1989). Wire netting and piling soil around the trunk base proved to be effective at preventing oviposition in Citrus groves (Adachi, 1990a).

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Anoplophora glabripennis

Names and taxonomy

Preferred scientific name

Anoplophora glabripennis (Motschulsky)

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Cerambycidae

EPPO code

ANOLGL (Anoplophora glabripennis)

Common names

English:

Asian longhorned beetle

basicosta white-spotted longicorn beetle

starry sky beetle

Asian long-horn beetle

French:

longicorne asiatique

Germany:

Asiatischer Laubholzkäfer

Notes on taxonomy and nomenclature

The taxonomy of this genus is in some confusion. Anoplophora glabripennis is part of the glabripennis complex, comprising A. glabripennis, A. freyi, A. flavomaculata and A. coeruleoantennatus (the latter being doubtful, taxonomically) (Wu and Jiang, 1998). Wu and Jiang (1998) considered the members of the glabripennis complex on a geographical basis within China, possibly pointing to different races of A. glabripennis in various parts of the country. For example, there is debate in China whether A. glabripennis from northern China and A. glabripennis from southern China are actually two separate species (Chen, 1989).

Host range

Notes on host range

In China, A. glabripennis has mainly been recorded on Populus and Salix. The major hosts are species and hybrids of section Aegeiros of the genus Populus: P. nigra, P. deltoides, P. x canadensis and the Chinese hybrid P. dakhuanensis. Some poplars of the other sections of the genus (Alba and Tacamahaca) are also attacked, but are only slightly susceptible (Li and Wu, 1993). There are also records on Acer, Alnus, Malus, Morus, Platanus, Prunus, Pyrus, Robinia, Rosa, Sophora and Ulmus. In USA, Acer spp. are the main hosts, with occasional records on Aesculus hippocastanum, Liriodendron tulipifera, Morus alba, Robinia pseudacacia, and species of Betula, Fraxinus, Populus, Salix and Ulmus. The insect seems to be widely polyphagous on hardwoods, but has never been found on conifers, nor apparently on such important forest genera as Fagus and Quercus.

It should also be noted that the host range has two elements: the species on which larvae can develop to maturity and the species on which adults do their maturation feeding. In China, the main hosts given are larval hosts. In North America, however, as the outbreak areas are recent, and subject to containment and eradication measures, it is not quite clear what is the natural host status of the various trees on which A. glabripennis has been recorded, as larvae or adults. Research is currently evaluating which species are most at risk from larval feeding. Bancroft et al. (2002), rearing larvae in freshly cut logs, ranked eight tree species in the following order for larval weight gain (from largest to smallest): Ulmus chinensis, Acer platanoides, Ulmus americana, Gleditsia triacaenthos, Acer saccharum, Quercus rubra, Fraxinus americana, Fraxinus pennsylvanica. Smith et al. (2002) found that adult survival and reproductive capacity were highest on Acer platanoides, than in turn on Acer rubrum and on Salix nigra. Ludwig et al. (2002) investigated oviposition under caged conditions, and insertion of first-instar larvae into potted trees as experimental methods for determining host potential; they showed that eggs are laid on, and larvae develop in, species which are not yet known to be hosts (e.g. Quercus rubra).

Affected Plant Stages: Vegetative growing stage.

Affected Plant Parts: Stems and whole plant.

List of hosts plants

Major hosts

Acer (maples), Acer negundo (box elder), Aesculus hippocastanum (buckeye), Populus (poplars), Populus canadensis (hybrid black poplar), Populus dakuanensis , Populus deltoides (poplar), Populus nigra (black poplar), Robinia pseudoacacia (black locust), Salix (willows), Salix babylonica (weeping willow), Salix matsudana (Peking willow), Ulmus (elms)

Minor hosts

Acer platanoides (Norway maple), Acer pseudoplatanus (sycamore), Acer rubrum (red maple), Acer saccharinum (soft maple), Acer saccharum (sugar maple), Alnus (alders), Betula (birches), Fraxinus (ashes), Liriodendron tulipifera (tuliptree), Malus (ornamental species apple), Morus alba (mora), Platanus (planes), Prunus (stone fruit), Pyrus (pears), Rosa (roses), Sophora

Geographic distribution

Notes on distribution

A. glabripennis is indigenous to China. Its prevalence and range has increased as a result of widespread planting of susceptible poplar hybrids (see Economic Impact). Yan (1985) provided a map showing the beetle to be most damaging in a zone of eastern China extending from Liaoning to Jiangsu and inland to Shanxi, Henan and Hubei. It was also present, but at lower levels, further west (to Neimenggu, Gansu, Sichuan and Yunnan) and further south (but not in the south-east). Li and Wu (1993) record the pest practically throughout the country (absent only from the Central Asian provinces in the west (Qinghai, Xinjiang and Xizang)). This implies that the pest, in the interval between these publications, was found in Jilin and Heilongjiang in the north, and in Zhejiang, Fujian and Hainan in the south-east.

A. glabripennis has invaded small areas in North America: USA (New York (New York city), discovered in 1996, although probably present for the previous 3 years; Illinois (Chicago), discovered in 1998 although probably present since at least 1993). Measures aimed at eradicating the pest are being implemented (USDA/APHIS, 1996; Haack et al., 1997; USDA, 1998).

Distribution List

Please note: The distribution status for a country or province is based on all the information available. When several references are cited, they may give conflicting information on the pest status. In particular, citations of earlier presence of a pest are included even though there is an authoritative reference to indicate that the pest is now absent.

Show EPPO notes

EPPO notes may be available for records where the source is EPPO, 2006. PQR database (version 4.5). Paris, France: European and Mediterranean Plant Protection Organization. Further details may be available in the corresponding EPPO Reporting Service item (e.g. RS 2001/141), for details of this service visit http://archives.eppo.org/EPPOReporting/Reporting_Archives.htm, or contact the EPPO Secretariat hq@eppo.fr.

Europe

Austria

present, few occurrences

EPPO, 2006

France

present, few occurrences

EPPO, 2006

Germany

present, few occurrences

EPPO, 2006

Poland

present, few occurrences

EPPO, 2006

United Kingdom

absent, intercepted only

introduced

CABI/EPPO, 1999; EPPO, 2006

Asia

China

Present, native, invasive

CABI/EPPO, 1999; EPPO, 2006

Anhui

present

EPPO, 2006

Fujian

present

CABI/EPPO, 1999; EPPO, 2006

Gansu

present

EPPO, 2006

Guangdong

present

CABI/EPPO, 1999; EPPO, 2006

Guangxi

present

EPPO, 2006

Guizhou

present

EPPO, 2006

Hainan

absent, reported but not confirmed CABI/EPPO, 1999

Hebei

present

CABI/EPPO, 1999; EPPO, 2006

Heilongjiang

present

CABI/EPPO, 1999; EPPO, 2006

Henan

present

CABI/EPPO, 1999; EPPO, 2006

Hubei

present

CABI/EPPO, 1999; EPPO, 2006

Hunan

present

CABI/EPPO, 1999; EPPO, 2006

Jiangsu

present

CABI/EPPO, 1999; EPPO, 2006

Jiangxi

present

CABI/EPPO, 1999; EPPO, 2006

Jilin

present

EPPO, 2006

Liaoning

present

EPPO, 2006

Nei Menggu

present

EPPO, 2006

Ningxia

present

EPPO, 2006

Qinghai

present

EPPO, 2006

Shaanxi

present

CABI/EPPO, 1999; EPPO, 2006

Shandong

present

CABI/EPPO, 1999; EPPO, 2006

Shanxi

present

CABI/EPPO, 1999; EPPO, 2006

Sichuan

present

CABI/EPPO, 1999; EPPO, 2006

Taiwan

present

EPPO, 2006

Yunnan

present

EPPO, 2006

Zhejiang

present

CABI/EPPO, 1999; EPPO, 2006

Japan

absent, formerly present, introduced, not invasive CABI/EPPO, 1999; EPPO, 2006

Honshu

absent, formerly present

CABI/EPPO, 1999; EPPO, 2006

Korea, DPR

present

CABI/EPPO, 1999; EPPO, 2006

Korea, Republic of

present

CABI/EPPO, 1999; EPPO, 2006

North America

Canada

present, few occurrences, introduced, invasive CABI/EPPO, 1999; EPPO, 2006

Ontario

present, few occurrences

EPPO, 2006

USA

restricted distribution, introduced, invasive

CABI/EPPO, 1999; EPPO, 2006

California

present, few occurrences

EPPO, 2006

Illinois

present

introduced (1998)

CABI/EPPO, 1999; EPPO, 2006

New Jersey

present

EPPO, 2006

New York

present

introduced (1996)

CABI/EPPO, 1999; EPPO, 2006

Biology and ecology

In China, the number of annual generations varies with climate and latitude. The further north A. glabripennis is found, the longer it takes for a generation to develop. In Taiwan, there is one generation per year. In eastern China, a generation may take 1 or 2 years to develop, whereas in northern China (Neimenggu), a single generation takes 2 years to develop. Thus, there can be one or two overlapping generations per year, depending upon the climate and feeding conditions. Adults emerge between May and October and live for about a month. The most active period for adult activity is late June to early July (Li and Wu, 1993). The adults usually remain on the tree from which they emerged, or fly short distances to nearby trees, and feed there on leaves, petioles and young bark. Egg deposition begins a week after copulation. The eggs, about 32 per female (Wong and Mong, 1986), are laid one by one under the bark, in oviposition slits chewed out by the female. Slits are generally cut on the eastern side of the trunk or of branches greater than 5 cm in diameter (Li and Wu, 1993). Eggs hatch after about 2 weeks. The larva feeds in the cambial layer of bark in the branches and trunk and later enters the woody tissues. Pupation takes place in chambers in the heartwood, accompanied by the presence of characteristic wood 'shavings' that are packed into the chamber. Adults emerge from circular holes, 10 mm across, above the sites where the eggs were laid.

Unlike many cerambycid species, A. glabripennis can attack healthy trees as well as trees under stress. Several generations can develop within an individual tree, leading eventually to its death.

Morphology

Eggs

About 5-7 mm, off-white, oblong. The ends of the eggs are slightly concave (Peng and Liu, 1992). Just before hatching, the eggs turn yellowish-brown.

Larva

The larva is a legless grub up to 50 mm long when fully grown. It is creamy white, with a chitinized brown mark on the prothorax.

Adult

Typically cerambycid in shape, 25 mm (male) to 35 mm (female) long. Antennae 2.5 times body length in males; 1.3 times body length in females. The beetle is black with about 20 irregular, white spots on the elytra. The antennae have 11 segments, each with a whitish blue base.

Means of movement and dispersal

Without transport of infested material by man, infestations spread slowly, e.g. rates of 300 m/year in poplar groves in Beijing, China, have been quoted by RW Thier (USDA Forest Service, personal communication, 1997). Although it is reported that adults can fly weakly 30 to 225 m in a single flight on a clear day, short-distance flight is typical of many cerambycids. More recent results from China (Smith et al., 2001) show greater dispersal distances within a season (1029 and 1442 m, respectively, for males and gravid females).

In international trade, A. glabripennis is most likely to move as eggs, larvae or pupae in packing or dunnage made of the wood of host species. Individual larvae and adults have been detected in several European countries (Austria, France, Germany, Sweden, UK) in wood packaging accompanying consignments from China (OEPP/EPPO, 2003). Such packaging is typically of relatively low grade, used for building materials (e.g. tiles).

Plant parts liable to carry the pest in trade/transport

- Wood: Eggs, Larvae, Pupae; borne internally; visible to naked eye.

Natural enemies

Shimazu et al. (2002) and Zhang et al. (2003) describe fungal and microsporidian pathogens of A. glabripennis, but there is no indication that these have been applied in practice. Luo et al. (2003) briefly review possibilities for biological control of the pest.

Natural enemies listed in the database

The list of natural enemies has been reviewed by a biocontrol specialist and is limited to those that have a major impact on pest numbers or have been used in biological control attempts; generalists and crop pests are excluded. For further information and reference sources, see About the data. Additional natural enemy records derived from data mining are presented as a separate list.

Natural enemies reviewed by biocontrol specialist

Natural enemy

Pest stage attacked

Pathogens:

Bacillus thuringiensis wenguanensis

Impact

Economic impact

Over the past 30-40 years (i.e. since the 1960s), there has been a policy in China to plant hybrid poplars in plantations, along roads, around farm buildings, etc. This started in Henan and Shandong provinces, but was eventually applied in most of the country. Initially, rather few hybrids were used, on a vast scale. Some of these hybrids were imported from other continents, whereas others were bred in China. Certain of them, but not all, proved to be very susceptible to A. glabripennis and suffered serious damage. A. glabripennis has proliferated on these susceptible hosts, becoming a common pest in many parts of China, also attacking a range of other hardwood hosts, especially Salix spp. These hosts appear to be mainly fruit, ornamental and amenity trees. Since the 1980s, hybrids resistant to the pest have been used for new plantations of poplar, and there has been a corresponding decline in the importance of A. glabripennis. There is no indication that A. glabripennis is a pest of natural forests in China. Recently (Taketani, 2001), a project to plant a vast forest shelter belt (the 'Great Green Wall') across north-west China to protect from incoming sandstorms is said to be threatened by A. glabripennis.

Poplar wood damaged by A. glabripennis larvae can be downgraded and lose value by up to 46% (Gao et al., 1993). Severe damage is caused between 21° and 43°N and 100° and 127°E in China (Yan, 1985). The boring larvae damage the phloem and xylem vessels, resulting in heavy sap flow from wounds which are then liable to attack by secondary pests and infection. Infested trees lose turgor pressure, and leaves become yellow and droop. Structural weakening of trees by the larvae in urban regions poses a danger to pedestrians and vehicles from falling branches. The adults can also cause damage by feeding on leaves, petioles and bark. Damage to the fruiting shoots of fruit trees results in particular economic loss.

In the USA, suppressing a 1996 infestation in New York State cost more than 4 million USD (USDA, 1998). Nowak et al. (2001) have estimated that the maximum potential national urban impact of A. glabripennis would be a loss of 34.9% of total canopy cover, 30.3% tree mortality (1.2 billion trees) and value loss of 669 billion USD.

Environmental impact

Existing problems with A. glabripennis mainly concern plantations in China and urban trees in North America. It is not clear how damaging this pest could be to its host trees in natural or managed forests.

Phytosanitary significance

Attention was drawn to A. glabripennis by its introduction into the USA, where a major eradication programme is underway, and strong measures have been taken to reduce the risk of further introduction with wood packing from China. The same international trade from China presents a risk of introducing the pest into Europe, and a detailed pest risk analysis has been done by MacLeod et al. (2002). Using the climate-matching system CLIMEX (Skarratt et al. 1995) and the EPPO Standard for pest risk assessment (OEPP/EPPO, 1997), areas in southern Europe have been identified as those where the pest is most likely to establish and cause economic damage. A. glabripennis is regulated by the European Union and is on the EPPO A1 list.

It should also be noted that there are currently few or no active measures to manage cerambycid beetles in broad-leaved trees. This favours establishment and increases the risk of serious losses, at least until suitable management practices can be put in place.

Symptoms

Resin bleeds from oviposition holes and larval tunnels in the bark. Larval activity is recognized by the presence of galleries under the bark and, later, tunnels in the wood. Masses of wood shavings extruding from round exit holes are also signs that adults have emerged from infested wood. Piles of wood shavings also collect at the base of infested trees.

Symptoms by affected plant part

Stems: internal feeding.

Whole plant: internal feeding.

Similarities to other species

Details of similar species in China are given by Wu and Chen (2003): A. nobilis from north-western China and A. freyi from south-western China. Luo et al. (2000) indicate that A. glabripennis occurs in mixed populations with A. nobilis in Ningxia province, and provide microscopic characters to distinguish the two species.

A. chinensis is another Far Eastern Anoplophora spp. that has been categorized as a quarantine pest by European countries (EPPO/CABI, 1997).

Diagnosis

Kethidi et al. (2003) describe DNA markers for the molecular identification of all development stages, and frass, of A. glabripennis, as distinct from related species.

Control

In China, control measures include the direct application of insecticides (Chen et al., 1990; Liang et al., 1997), trap trees combined with insecticide treatments (Sun et al., 1990) or the use of insect-pathogenic nematodes (providing up to 94% mortality; Liu et al., 1992). As certain poplar hybrids are relatively resistant (Qin et al., 1996), the planting of such hybrids is now preferred, and the use of very susceptible hybrids is avoided. Control strategies in China have recently been reviewed by Luo et al. (2003).

In the USA (Haack, 2003; Lance, 2003), control measures aim to contain and eradicate the outbreaks in urban areas. However, the cryptic life style and tendency of the beetle to lay small numbers of eggs on several trees combine to make it difficult to define the limits of the outbreak and thus eradicate the beetle without destroying large numbers of trees. In most situations, wholesale felling of infested trees is unlikely to be a viable option, unless the infestation is very localized.

Phytosanitary Measures

In the USA and in Europe, strong measures have been taken for wood packing materials from China. This includes packing cases and dunnage. Unger (2003) has reviewed the measures needed to exclude the pest from Germany. The case of A. glabripennis has been the main stimulus for the development by the FAO Interim Commission on Phytosanitary Measures of an international standard 'Guidelines for regulating wood packaging material in international trade' (ICPM, 2002). Such packaging should be treated by methods recognized to have adequate efficacy against all wood pests. These currently include heat treatment (to an internal temperature of 56°C for 30 min) or fumigation with methyl bromide. Once treated, packing wood is unlikely to be re-infested, so such wood (especially crates and pallets) can continue to be used in trade. An internationally recognized mark is stamped to the treated wood. The international standard was approved in 2002 and is now progressively being implemented worldwide.

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Anoplophora nobilis

Names and taxonomy

Preferred scientific name

Anoplophora nobilis (Ganglbauer)

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Cerambycidae

EPPO code

ANOLNO (Anoplophora nobilis)

Common names

English:

yellow spotted cerambycid

Host range

List of hosts plants

Major hosts

Populus (poplars)

Geographic distribution

Distribution List

Asia

China

present

CAB Abstracts, 1973-1998

Gansu

widespread

CABABSTRACT

Ningxia

widespread

CABABSTRACT

Qinghai

present

CABABSTRACT

Shaanxi

widespread

CABABSTRACT

Sichuan

widespread

CABABSTRACT

Natural enemies

Natural enemies listed in the database

Natural enemy

Pest stage attacked

Predators:

Dendrocopos major beicki

Pathogens:

Beauveria bassiana (white muscardine fungus)

References

CAB Abstracts, 1973-1998. Data mined from CAB Abstracts database, years 1973 to 1998. Wallingford, UK: CAB International

Platypus apicalis

Names and taxonomy

Preferred scientific name

Platypus apicalis White

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Platypodidae

Host range

List of hosts plants

Hosts (source - data mining)

Nothofagus

Please note

Some hosts may be listed at the generic level: Platypus

Geographic distribution

Distribution List

Oceania

New Zealand

unconfirmed record

CAB Abstracts, 1973-1998

References

CAB Abstracts, 1973-1998. Data mined from CAB Abstracts database, years 1973 to 1998. Wallingford, UK: CAB International

Platypus compositus

Names and taxonomy

Preferred scientific name

Platypus compositus

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Platypodidae

Host range

List of hosts plants

Major hosts

Carya illinoinensis (pecan)

Please note

Some hosts may be listed at the generic level: Platypus

Platypus cylindrus

Names and taxonomy

Preferred scientific name

Platypus cylindrus (Fabricius)

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Platypodidae

Other scientific names

Platypus cylindriformis Reitter

EPPO code

PLTPCS (Platypus cylindrus)

Common names

English:

oak pinhole, borer

pinhole, bore

Germany:

Kernholzkaefer, Eichen-

Host range

List of hosts plants

Hosts (source - data

mining) Quercus suber

(cork oak) Please note

Some hosts may be listed at the generic level: Platypus

Geographic distribution

Distribution List

Europe

Former USSR

unconfirmed record

CAB Abstracts, 1973-1998

Portugal

present

CAB Abstracts, 1973-1998

Spain

present

CAB Abstracts, 1973-1998

Natural enemies

Natural enemies listed in the database

Natural enemy

Pest stage attacked

Predators:

Colydium elongatum

References

CAB Abstracts, 1973-1998. Data mined from CAB Abstracts database, years 1973 to 1998. Wallingford, UK: CAB International

Platypus jansoni

Names and taxonomy

Preferred scientific name

Platypus jansoni Chapuis

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Platypodidae

EPPO code

PLTPJA (Platypus jansoni)

Host range

List of hosts plants

Hosts (source - data mining)

Theobroma cacao (cocoa)

Please note

Some hosts may be listed at the generic level: Platypus

Geographic distribution

Distribution List

Asia

Indonesia

present

APPPC, 1987

Oceania

Papua New Guinea

unconfirmed record

CAB Abstracts, 1973-1998

References

APPPC, 1987. Insect pests of economic significance affecting major crops of the countries in Asia and the Pacific region. Technical Document No. 135. Bangkok, Thailand: Regional FAO Office for Asia and the Pacific (RAPA), 56 pp.

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Platypus parallelus

Names and taxonomy

Preferred scientific name

Platypus parallelus Fabricius

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Platypodidae

Other scientific names

Bostrichus parallelus Fabricius

Host range

List of hosts plants

Major hosts

forest trees (woody plants)

Please note

Some hosts may be listed at the generic level: Platypus

Geographic distribution

Distribution List

Central America & Caribbean

Barbados

present

Schotman,

1989 Cayman

Islands present

Schotman,

1989 Costa Rica

present

Schotman,

1989 Cuba

present

Schotman, 1989

Dominica

present

Schotman, 1989

Guatemala

present

Schotman, 1989

Honduras

present

Schotman, 1989

Panama present

Schotman, 1989

Trinidad and Tobago
present

Schotman, 1989

North America

Mexico present
Schotman,
1989

USA

unconfirmed record

CAB Abstracts, 1973-1998

Florida

unconfirmed record

CAB Abstracts, 1973-1998

South America

Argentina

present

Schotman,

1989 Brazil

present

Schotman, 1989

Colombia

present

Schotman, 1989

French Guiana

present

Schotman, 1989

Guyana present

Schotman, 1989

Suriname

present

Schotman, 1989

Venezuela

present

Schotman, 1989

References

CAB Abstracts, 1973-1998. Data mined from CAB Abstracts database, years 1973 to 1998. Wallingford, UK: CAB International

Schotman CYL, 1989. Plant pests of quarantine importance to the Caribbean. RLAC-PROVEG, No. 21:80 pp. View Abstract

Platypus quercivorus

Names and taxonomy

Preferred scientific name

Platypus quercivorus (Murayama, 1925)

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Platypodidae

Other scientific names

Crossotarsus quercivorus Murayama, 1925

Crossotarsus sexfenestratus Beeson, 1937

Common names

English:

oak ambrosia beetle

Notes on taxonomy and nomenclature

P. quercivorus was first described from specimens collected in Taiwan (Formosa) by Murayama in 1925 and placed in the genus Crossotarsus. In 1937, Beeson described this species as Crossotarsus sexfenestratus from material collected in India. It was assigned to the genus Platypus by Schedl in 1972 (Beaver and Hsien-Tzung Shih, 2003).

Host range

Notes on host range

P. quercivorus has a wide host range. It attacks many species of the family Fagaceae but it is also known to attack trees from other families including Aquifoliaceae, Lauraceae, Rosaceae and Cupressaceae (Wood and Bright, 1992).

Affected Plant Stages: Vegetative growing stage.

Affected Plant Parts: Leaves, stems and whole plant.

List of hosts plants

Major hosts

Castanopsis cuspidata (chinkapin), Cryptomeria japonica (Japanese cedar), Ilex chinensis , Lindera erythrocarpa , Lithocarpus edulis , Lithocarpus glaber , Prunus (stone fruit), Quercus acuta (japanese evergreen oak), Quercus acutissima (sawtooth oak), Quercus gilva , Quercus glauca (ring-cup oak), Quercus mongolica (Mongolian oak), Quercus phillyraeoides (ubame oak), Quercus salicina , Quercus serrata (glandbearing oak), Quercus sessilifolia

Please note

Some hosts may be listed at the generic level: Platypus

Habitat

P. quercivorus can be found in temperate, subtropical and tropical forests. It is presently

a pest of mixed oak forests in parts of Japan.

Geographic distribution

Notes on distribution

P. quercivorus is widely distributed in Asia, including temperate, subtropical and tropical ecosystems in India, Indonesia (Java), Japan, Papua New Guinea and Taiwan (Beaver and Hsien-Tzung Shih, 2003). In Japan, this insect is found from the island of Ishigaki Shima to Honshu (Hamaguchi and Goto, 2003).

Distribution List

Please note: The distribution status for a country or province is based on all the information available. When several references are cited, they may give conflicting information on the pest status. In particular, citations of earlier presence of a pest are included even though there is an authoritative reference to indicate that the pest is now absent.

Asia

China

Taiwan

present

native

not invasive

Beaver & Hsien-Tzung Shih, 2003

India

present

native

not invasive

Beaver & Hsien-Tzung Shih, 2003

Indonesia

present

native

not invasive

Beaver & Hsien-Tzung Shih, 2003

Java

present

native

not invasive

Beaver & Hsien-Tzung Shih, 2003

Japan

Hokkaido

widespread

native

invasive

Hamaguchi & Goto, 2003

Honshu

widespread

native

invasive

Hamaguchi & Goto, 2003

Kyushu

widespread

native

invasive

Hamaguchi & Goto, 2003

Ryukyu Archipelago

widespread

native

invasive

Hamaguchi & Goto, 2003

Oceania

Papua New Guinea

present

native

not invasive

Beaver & Hsien-Tzung Shih, 2003

Biology and ecology

The genus Platypus is exceptionally large within the Platypodidae, with several hundred recognized species. These are distributed throughout the world's temperate and tropical forests, and attack both broadleaf and coniferous trees (Bright and Skidmore, 2002). Eight species are known to occur in North America (Furniss and Carolin, 1977; Drooz, 1985; Cibrián Tovar et al., 1995). These include Platypus flavicornis [Myoplatypus flavicornis], which invades the basal portions of pines in large numbers in south-eastern USA following attacks by bark beetles, and

Platypus parallelus [Euplatypus parallelus], a tropical species present in southern USA and Mexico, which is regarded as the most destructive ambrosia beetle in the world (Drooz, 1985).

Members of the genus Platypus are ambrosia beetles and breed in the wood of host trees. White splinters are produced during gallery construction as opposed to fine sawdust, which is produced by other ambrosia beetles. Also, unlike other ambrosia beetles, the galleries of Platypus spp. often penetrate into the heartwood. The larvae and adults feed on ambrosia fungi, which are stored and disseminated by the adult female. The fungal associates of several species of Platypus are members of the genus Raffaelea. In western North America, the ambrosia fungus associated with Platypus wilsoni is Raffaelea canadensis (Furniss and Carolin, 1977). In Argentina, Raffaelea santoroi is associated with Platypus mutatus (Giménez and Etiennot, 2003). In Europe, Raffaelea ambrosiae is associated with the oak ambrosia beetle, Platypus cylindrus (Babuder and Pohleven, 1995).

Adult ambrosia beetles vector their associated ambrosia fungi via structures known as mycangia, which store fungal spores. In the family Platypodidae, if mycangia are present, they are simple; usually small pits or notches in the integument. These structures are often present only on the females although the males typically initiate the attacks. For example, in the case of Platypus hintzi the mycangia consist of a pair of small hollows on the pronotum. In contrast, P. wilsoni has numerous small punctures on the pronotum (Cook, 1977). Ito et al. (2004) suggested that P. quercivorus has mycangia similar to P. hintzi.

Male P. quercivorus initiate the attacks on the boles of host trees and excavate galleries for mating from June to October (Soné et al., 2000). Apparently the first entry holes bored by male beetles trigger a mass attack (Kobayashi and Ueda, 2003). The attacks generally occur near ground level (Hijii et al., 1991). A single female joins the male and constructs the oviposition gallery after mating. This is kept clean by the male who expels the residues to the outside of the tree. During gallery construction, the females inoculate the gallery surface with spores of the ambrosia fungus, which the larvae feed on. The adult females begin to deposit eggs at the terminal parts of the tunnels, 2 to 3 weeks after gallery construction begins. The eggs are deposited in individual niches. An average of 50 to 60 larvae develop in a single gallery system but the number of larvae can be as high as 161. The larvae feed on the ambrosia fungus that develops on the walls of the galleries. Pupation occurs in the larval galleries. The majority of new adults leave their maternal galleries in September and October but some adults remain in the galleries until the spring and then die. In other cases the larvae reach the fifth-instar by late November and overwinter in pupal chambers. Pupation begins in the following May and the adults emerge in June and July. They emerge through entry holes made by the parents (Soné et al., 1998).

In Japan, Quercus mongolica and Quercus serrata that are mass-attacked by P. quercivorus, are usually killed later in the summer. Two fungi have been recovered from trees attacked by this insect and described as new species. Ophiostoma longicollum was described from Q. mongolica infested by P. quercivorus in 1998 (Masuya et al., 1998). The fungus, Raffaelea quercivora was isolated from discoloured sapwood, necrotic inner bark, the body surfaces of beetles, female beetle's mycangia and beetle galleries of symptomatic trees in 2002. Inoculation tests indicated that R. quercivora is the causal agent of Japanese oak disease and P. quercivorus is its vector. This is the first known occurrence of mass-mortality of trees in the family Fagaceae, caused by a species of Platypus and an associated ambrosia fungus of the genus Raffaelea (Ito et al., unda).

Morphology

Eggs

The eggs are elongated and cylindrical.

Larvae

The larvae are variable in size and range from 2-6 mm long when mature. They are legless and creamy-white, with an amber to light-brown head capsule. The last abdominal segment ends in a flat to slightly concave declivity.

Pupae

The pupae are creamy-white and have partially developed wings and appendages.

Adults

The adults of the genus Platypus are reddish-brown to dark-brown with a cylindrical, elongated body that averages 5 mm long. These insects have a concave elytral declivity armed with spines. The front (prothoracic) legs are adapted for excavation.

Means of movement and dispersal

Plant parts liable to carry the pest in trade/transport

- Stems (above Ground)/Shoots/Trunks/Branches: Eggs, Larvae, Nymphs, Pupae, Adults; borne internally; visible to naked eye.

Plant parts not known to carry the pest in trade/transport

- Bark
- Bulbs/Tubers/Corms/Rhizomes
- Fruits (inc. Pods)
- Growing Medium Accompanying Plants
- Flowers/Inflorescences/Cones/Calyx
- Leaves
- Seedlings/Micropropagated Plants
- Roots
- True Seeds (inc. Grain)
- Wood.

Natural enemies

No natural enemies have been reported.

Impact

Economic impact

Direct damage caused by P. quercivorus is associated with galleries constructed in the wood of host trees during breeding attacks. This can result in the loss of structural integrity in the wood and loss of lumber quality.

Since the early 1980s, extensive mortality of oak forests has been reported from western Japan (Kaneko, 1995). This condition, referred to as Japanese oak disease, is now attributed to the fungus Raffaelea quercivora, an anamorphic Ascomycete, which is a fungal associate of P. quercivorus (Ito et al., unda). The mortality of oak trees, at a rate of more than 200,000 per year, has been observed in the western coastal areas of Honshu, Japan (EPPO, 2003). The deciduous species of oaks, Quercus serrata and Quercus mongolica are susceptible to the disease. Other trees of the family Fagaceae that are present in the area, e.g. Quercus acutissima, Quercus acuta, Quercus phillyraeoides and Castanopsis sieboldii, are apparently not affected by the fungus (Ito et al., unda). To date, the most severe tree mortality has occurred on the west coast of Honshu (Hamaguchi and Goto, 2003).

It has been postulated that oaks, which are resistant or tolerant to Raffaelea quercivora, co-evolved under a stable relationship between the tree, fungus and beetle during a long evolutionary process. Q. mongolica may not have been part of this co-evolution. This hypothesis is supported by the fact that P. quercivorus has the least preference for Q. mongolica but exhibits the highest reproductive success in this species. Therefore, P. quercivorus could spread more rapidly in stands with a high composition of Q. mongolica. The present oak dieback epidemic in Japan may have resulted from the warmer climate that began in the late 1980s. This facilitated the encounter of P. quercivorus and Q. mongolica, by allowing the beetle to extend its range to more northerly latitudes and higher altitudes (Kamata et al., 2002).

Environmental impact

P. quercivorus, in combination with its associated ambrosia fungus, Raffaelea quercivora is capable of causing extensive tree mortality in oak forests dominated by Quercus mongolica and Quercus serrata. This could result in major environmental impacts such as the loss of biodiversity, changes in the species composition of forests, reduced acorn crops and the resultant adverse impacts on wildlife species that depend on these crops for food.

Phytosanitary significance

The adults are capable of sustained flight for at least 1 km and may also be dispersed on air currents. All life stages are subjected to human-assisted dispersal. The use of oak crating, pallets or dunnage in international trade could result in the inter-continental spread of all the life stages of P. quercivorus. The localized spread of newly established infestations could be facilitated via the transport of logs and firewood.

Symptoms

The external symptoms of infestation include copious amounts of white, splinter-like boring dust near the base of infested oaks, and late summer wilting of the foliage of attacked trees. Examination of the wood will reveal a brown discoloration in the sapwood surrounding the galleries of P. quercivorus. Fungal hyphae can be found in the vessels near the beetle galleries (Kuroda and Yamada, 1996).

Symptoms by affected plant part

Leaves: wilting; yellowed or dead.

Stems: internal discoloration; visible frass.

Whole plant: plant dead; dieback; frass visible.

Similarities to other species

Most species of Platypus are similar in appearance. Species identification of ambrosia beetles (families Platypodidae and Scolytidae) must be carried out on the adults. A taxonomist, with expertise in the family Platypodidae, should identify specimens suspected of being exotic species of Platypus.

Detection and inspection

Lumber, crating, pallets and dunnage made from oak should be inspected for ambrosia beetle galleries and an associated brown discoloration caused by Raffaelea quercivora. Infestations in standing trees can be detected by the presence of white boring dust near the root collar and late summer tree mortality.

Control

The management of Platypus spp. beetles includes the application of contact insecticide sprays to the bark of high value trees to prevent attack. Systemic insecticides can be applied to the soil or bark of infested trees. Attacks in harvested logs can be prevented by the timely removal of them from forested areas and rapid processing or debarking at the sawmill (Cibrián Tovar et al., 1995).

Pest management methods that are designed to reduce the rate of oak mortality caused by the combination of P. quercivorus and Raffaelea quercivora are being developed in Japan. Recent studies indicated that both P. quercivorus and its associated fungus can be controlled by the injection of NCS [metam-ammonium] (N-methyldithiocarbamate) into holes bored in the stems of host trees (Weng PuJin et al., 2000).

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Platypus wilsoni

Names and taxonomy

Preferred scientific name

Platypus wilsoni Sw.

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Platypodidae

EPPO code

PLTPWI (Platypus wilsoni)

Common names

English:

wilson's white-headed ambrosia beetle

ambrosia beetle, wilson`s wide headed

Host range

List of hosts plants

Major hosts

forest trees (woody plants)

Please note

Some hosts may be listed at the generic level: Platypus

Geographic distribution

Distribution List

North America

Canada

unconfirmed record

CAB Abstracts, 1973-1998

References

CAB Abstracts, 1973-1998. Data mined from CAB Abstracts database, years 1973 to 1998. Wallingford, UK: CAB International.

Dendroctonus armandi

Names and taxonomy

Preferred scientific name

Dendroctonus armandi Tsai & Li

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Scolytidae

Common names

Chinese:

huashansong daxiaodu

da ningzhi xiaodu

Notes on taxonomy and nomenclature

The genus Dendroctonus consists of 19 species worldwide. Most of these occur on conifers in North and Central America but D. armandi is native to China (Wood, 1982).

Host range

List of hosts plants

Major hosts

Pinus armandii (armand's pine)

Geographic distribution

Notes on distribution

This species is restricted to China. The host Pinus armandii is mostly distributed in the Qinling and Qilian mountains.

Distribution List

Please note: The distribution status for a country or province is based on all the information available. When several references are cited, they may give conflicting information on the pest status. In particular, citations of earlier presence of a pest are included even though there is an authoritative reference to indicate that the pest is now absent.

Asia

China

present

Li & Zhou, 1992

Gansu

restricted distribution

Li & Zhou, 1992

Henan

restricted distribution

Li & Zhou, 1992

Hubei

restricted distribution

Li & Zhou, 1992

Shaanxi

restricted distribution

Li & Zhou, 1992

Sichuan

restricted distribution

Li & Zhou, 1992

Biology and ecology

Life History and Habits

The number of generations of D. armandi are closely related to altitude: in the Qinling forest region (Shaanxi, China) it has two generations per year below 1700 m and one generation above 2150 m; between 1700 m and 2150 m it has three generations over two years. The effective cumulative temperature for each generation is 495.5 degree-days. The threshold temperature of D. armandi is 9.6°C. Generally, the over-wintering stage of this borer is the larva, but sometimes also pupae and adults.

Female and male adults inhabit each mother gallery. First they drill into the bark to make a shoe-shaped mating room. Eggs are not laid until the mother gallery is formed. The number of eggs is 20-100 (average 50) spaced about 8 mm apart. With the development of the larvae, the larval gallery is widened to reach the sapwood. Galleries are packed with dust-coloured fine frass. The milk-white larvae pupate at the end of the larval gallery in a pupal chamber which is approximately oval or irregular in shape.

When they emerge, adults are straw yellow in colour and gradually turn sandy beige, dusky brown and, finally, black. Adults that have just emerged feed on the phloem around pupal chambers and larval galleries which can destroy the tree's transport tissues. Emergence holes are then made in the bark and peak emergence occurs around 6.00-13.00 hours.

D. armandi is inclined to infect healthy Pinus armandii trees over 30 years old. This selectivity results from chemotaxis towards volatile compounds (including terpene compounds). Females secrete an aggregation pheromone which is vented with frass and can attract large quantities of bark beetles to a single tree. The distributional density of adults in the trunk varies with height - with a peak at 20-30% of the height; occasionally, beetles have been found at 70% of the height. The spatial distribution of D. armandi has been studied by Li et al. (1997).

Physiology and Phenology

Polyacrylamide gel electrophoresis has been used to study esterase isoenzymes of D. armandi larvae in different growth periods (Xie et al., 2002).

Associations

D. armandi attack often facilitates infestation by other pest beetles and up to 20 species have been associated with trees damaged by D. armandi. A number of fungi are also found with D. armandi, including blue-stain fungi such as Leptographium spp. (Zhu et al., 2003). L. terebrantis and Ophiostoma minus [Ceratocystis minor] were the main spores carried by the mycangia of D. armandi into the xylem (Chen and Feng, 2000). Studies on L. terebrantis showed that this fungus quickly blocks resin ducts of the xylem, upsets resin metabolism and expands among the tracheid cells inhibiting water conduction (Chen and Ming, 2002).

Morphology

Eggs

Eggs are oval, milk white, about 1 x 0.5 mm.

Larvae

Larvae are around 6 mm long and milk white with a yellow head and brown mouthparts.

Pupae

Pupae are about 4-6 mm long and milk white. There is a rank of tiny setae on every node of the abdomen and a pair of spiny maculae at the end.

Adults

Adults are 4.4-6.5 mm long, black or dark brown. The top of the antenna looks like a flat hammer, and its width is greater than the length; antennae have three clear transverse joints. The surface of the frons is granulate and has a coarse prosternal process. There is a vertical sulcus like a line in the middle of head; sometimes the sulcus can reach the frons. The width of the pronotum is greater than the length, and gradually shrinks from the bottom to the top. The costal margin of the elytron has saw-tooth dentation. On the back of elytron there are many distinct dots.

Means of movement and dispersal

Natural Dispersal

Adults do not generally fly very fast (in forests natural spread is about 20-30 m), although wind-assisted spread can reach 1000 m.

Movement in Trade

All life stages of D. armandi may be easily transported with wood commodities that include bark.

Plant parts liable to carry the pest in trade/transport

- Bark: Eggs, Larvae, Nymphs, Pupae, Adults; borne internally; visible to naked eye.

- Stems (above Ground)/Shoots/Trunks/Branches: Eggs, Larvae, Nymphs, Pupae, Adults; borne internally; visible to naked eye.

Plant parts not known to carry the pest in trade/transport

- Fruits (inc. Pods)
- Growing Medium Accompanying Plants
- Flowers/Inflorescences/Cones/Calyx
- Leaves
- Seedlings/Micropropagated Plants
- Roots
- True Seeds (inc. Grain)
- Wood.

Natural enemies

In general, natural enemies of bark beetles are unable to prevent outbreaks.

Natural enemies listed in the database

The list of natural enemies has been reviewed by a biocontrol specialist and is limited to those that have a major impact on pest numbers or have been used in biological control attempts; generalists and crop pests are excluded. For further information and reference sources, see About the data. Additional natural enemy records derived from data mining are presented as a separate list.

Natural enemies reviewed by biocontrol specialist

Natural enemy

Pest stage attacked

Parasites/parasitoids:

Aprostocetus dendroctoni

Eggs, Larvae

Calosota longigasteris

Coeloides qinlingensis

Eggs, Larvae

Dinotiscus armandi

Eggs, Larvae

Eurytoma longicauda

Metapelma zhangi

Rhopalicus tutela

Roptrocerus mirus

Eggs, Larvae

Roptrocerus qinlingensis

Eggs, Larvae

Roptrocerus xylophagorum

Eggs, Larvae

Spathius

Eggs, Larvae

Tomicobia liaoi

Eggs, Larvae

Additional natural enemies (source - data mining)

Natural enemy

Pest stage attacked

Parasites/parasitoids:

Coeloides qinlinensis

Impact

Economic impact

Pinus armandii is a fast-growing high-quality conifer species in China. It is mostly distributed in the Qinling and Qilian mountains at 1600-2200 m altitude, usually asociated with birch (Betula) or Quercus robur. However, since 1954 Pinus armandii has suffered from severe bark beetle damage, with D. armandi and its associated fungi being the main species resulting in the death of healthy trees over 30 years old.

Impact descriptors

Negative impact on: forestry production

Phytosanitary significance

D. armandi is not known to be listed as a quarantine pest. It is very likely to be transported with any untreated wood commodities that carry bark. It would be unlikely to be transported in planting material because any infested material would certainly show symptoms and would be rejected for sale.

The natural range of D. armandi includes mountain regions in central Asia whose climate would be similar to many parts of north and central Europe. It is, therefore likely to find suitable conditions and susceptible hosts in other areas. It is considered as a serious forest pest in the area where it occurs.

Symptoms

When infected Pinus armandii trees begin to decline, D. armandi cannot easily be detected. This beetle mainly inhabits the middle and bottom halves of trees. Mahogany or dust-coloured curdled colophony [rosin] appears as a cone-shape of 10-20 mm diameter at the openings of tunnels bored by adults. Removal of the bark from infested portions of trees will reveal characteristic galleries, larvae, pupae and adults. The mother gallery is a single vertical tunnel, usually 30-40 long (but can be only 10 cm or up to 60 cm) and 2-3 mm wide. Larval galleries extend from two sides of the mother gallery and are usually 2-3 cm long (up to 5 cm). Death results from destruction of the tree's conductive tissues either directly by D. armandi, by other beetles or by associated fungi.

Symptoms by affected plant part

Stems: abnormal exudates.

Whole plant: plant dead; dieback; internal feeding.

Control

An integrated control strategy is recommended to include monitoring D. armandi levels, removal of infested trees and trees blown down by wind, promoting tree health and conducive conditions for natural enemies, and chemical control.

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Dendroctonus micans

Names and taxonomy

Preferred scientific name

Dendroctonus micans (Kugelann, 1794)

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Scolytidae

Other scientific names

Bostrichus micans Kugelann, 1794

Hylesinus ligniperda Gyllenhal, 1813

EPPO code

DENCMI (Dendroctonus micans)

Common names

English:

great spruce bark beetle

beetle, European spruce

French:

le dendroctonus geant de l'epicea

le hylesine geant de l'epicea

hylesine geant

Denmark:

kjemperbarkbille

Finland:

ukkoniluri

Germany:

Riesenbastkaefer

Riesenbastkäfer

Netherlands:

Sparrebastkever

Norway:

kjemperbarkbille

Sweden:

jättebastborre

Notes on taxonomy and nomenclature

D. micans was originally described as Bostrichus micans by Kugelann in 1794 and as Hylesinus ligniperda by Gyllenhal in 1813 (Grüne, 1979). This insect was designated as the type species of the genus Dendroctonus, when Erichson described the genus in 1836 (Wood, 1982).

Host range

Notes on host range

D. micans primarily breeds in spruce (Picea spp.), especially Picea abies (Norway spruce), Picea sitchensis (Sitka spruce) and Picea orientalis (Oriental spruce) (Grégoire, 1988). It also breeds in other Eurasian spruce species such as Picea asperata (dragon spruce), Picea crassifolia (Qinghai spruce), Picea ajanensis [Picea jezoensis] (ezo spruce), Picea obovata (Siberian spruce) and Picea omorika (Serbian spruce), as well as in several North American spruce species that have been introduced into its geographic range. These include Picea breweriana (Brewer spruce), Picea engelmannii (Engelman spruce), Picea glauca (white spruce), Picea mariana (black spruce) and Picea pungens (blue spruce) (Grégoire, 1988; Evans and King, 1989). Pines (Pinus spp.), especially Pinus sylvestris (Scotch pine), have also been attacked, especially in Estonia, Poland, Scandinavia and Siberia (Kolomiets and Isaev, 1981; Markov, 1985; Voolma, 1993).

D. micans is also known to attack several other pines, including Pinus contorta (lodgepole pine), Pinus nigra (black pine), Pinus sylvestris var. hamata, Pinus strobus (white pine) and Pinus uncinata (mountain pine). It also attacks fir trees; Abies alba (silver fir), Abies nordmanniana (Nordmann fir), Abies sibirica (Siberian fir) and Pseudotsuga menziesii (Douglas fir); and larch, Larix decidua (European larch) (Grégoire, 1988; Smith et al., 1992; Wood and Bright, 1992; Wainhouse and Beech-Garwood, 1994).

Affected Plant Stages: Vegetative growing stage.

Affected Plant Parts: Leaves, stems and whole plant.

List of hosts plants

Major hosts

Picea abies (common spruce), Picea asperata (dragon spruce), Picea breweriana (brewer's spruce), Picea crassifolia , Picea engelmannii (Engelmann spruce), Picea glauca (white spruce), Picea jezoensis (Yeddo spruce), Picea mariana (black spruce), Picea obovata (Siberian spruce), Picea omorika (Pancic spruce), Picea orientalis (oriental spruce), Picea pungens (blue spruce), Picea sitchensis (Sitka spruce)

Minor hosts

Abies alba (silver fir), Abies nordmanniana (Nordmann fir), Abies sibirica (Siberian fir), Larix decidua (common larch), Pinus contorta (lodgepole pine), Pinus nigra (black pine), Pinus strobus (eastern white pine), Pinus sylvestris (Scots pine), Pinus sylvestris var. hamata (caucasian pine), Pinus uncinata (mountain pine), Pseudotsuga menziesii (Douglas-fir)

Habitat

D. micans normally occurs in mature spruce forests. Within its natural range, this insect typically causes low levels of tree mortality and is not considered to be a major pest.

Geographic distribution

Notes on distribution

D. micans is believed to have originated in the conifer forests of Asia. When determining the geographic distribution of this insect it is difficult to establish whether it is native or introduced because of its unique history.

It has steadily spread westward over the past 100 years, undoubtedly aided by the increased trade in unprocessed logs. At present, it is found throughout Eurasia and has adapted to a wide range of forest conditions. This insect is now established across most of western Europe from European Russia, west to Belgium and France, south to Turkey, and north to Finland and Sweden. It was discovered in the British Isles in 1982.

Distribution List

Please note: The distribution status for a country or province is based on all the information available. When several references are cited, they may give conflicting information on the pest status. In particular, citations of earlier presence of a pest are included even though there is an authoritative reference to indicate that the pest is now absent.

Show EPPO notes

EPPO notes may be available for records where the source is EPPO, 2006. PQR database (version 4.5). Paris, France: European and Mediterranean Plant Protection Organization. Further details may be available in the corresponding EPPO Reporting Service item (e.g. RS 2001/141), for details of this service visit http://archives.eppo.org/EPPOReporting/Reporting_Archives.htm, or contact the EPPO Secretariat hq@eppo.fr.

Europe

Austria

present

Wood & Bright, 1992; EPPO, 2006

Belgium

Present, introduced, invasive

Wood & Bright, 1992; EPPO, 2006

Bosnia and Herzegovina

present

EPPO, 2006

Bulgaria

Widespread, introduced

Wood & Bright, 1992; EPPO, 2006

Croatia

restricted distribution

EPPO, 2006

Czech Republic

Widespread, introduced

Wood & Bright, 1992; EPPO, 2006

Denmark

restricted distribution

Wood & Bright, 1992; EPPO, 2006

Estonia

restricted distribution

Bright & Skidmore, 2002; EPPO, 2006

Finland

restricted distribution

Bright & Skidmore, 2002; EPPO, 2006

France

restricted distribution, introduced, invasive

GrÚgoire, 1988; GrÚgoire et al., 1989; EPPO, 2006

France [mainland]

restricted distribution

EPPO, 2006 Germany

present, few occurrences, introduced (1930's)

Wood & Bright, 1992; EPPO, 2006

Greece

absent, never occurred

Wood & Bright, 1992; EPPO, 2006

Hungary

restricted distribution,

introduced Wood & Bright, 1992;

EPPO, 2006 Ireland

absent, never occurred

EPPO, 2006

Italy

restricted distribution, introduced

Battisti, 1984; Wood & Bright, 1992; EPPO, 2006
Italy [mainland]

restricted distribution
EPPO, 2006

Latvia
present

Bright & Skidmore, 2002

Lithuania

present, few occurrences

EPPO, 2006 Luxembourg

present

Wood & Bright, 1992; EPPO, 2006

Netherlands

restricted distribution

Wood & Bright, 1992; EPPO, 2006

Norway

Widespread, introduced

Wood & Bright, 1992; EPPO, 2006

Poland

restricted distribution,
introduced Wood & Bright, 1992;
EPPO, 2006 Portugal

absent, never occurred
EPPO, 2006

Romania, restricted distribution

Wood & Bright, 1992; EPPO,
2006 Russian Federation

restricted distribution, native

Wood & Bright, 1992; EPPO,
2006 Central Russia

Present, native

Wood & Bright, 1992; EPPO, 2006

Eastern Siberia

Present, native

Wood & Bright, 1992; EPPO, 2006

Northern Russia

Present, native

Wood & Bright, 1992; EPPO, 2006

Russian Far East

Present, native

Wood & Bright, 1992; EPPO, 2006

Southern Russia

Present, native

Wood & Bright, 1992; EPPO, 2006

Western Siberia

Present, native

Wood & Bright, 1992; EPPO, 2006

Serbia and Montenegro

present

Wood & Bright, 1992; EPPO, 2006

Slovakia

restricted distribution, introduced EPPO, 2006

Spain

absent, never occurred

Wood & Bright, 1992; EPPO, 2006

Sweden

Widespread, introduced

Wood & Bright, 1992; EPPO, 2006

Switzerland

restricted distribution, introduced Wood & Bright, 1992; EPPO, 2006 Ukraine

restricted distribution

EPPO, 2006

United Kingdom

restricted distribution, introduced (1973)

EPPO, 2006

England and Wales

restricted distribution, introduced, invasive

Bevan & King, 1983; Evans & King, 1989; EPPO, 2006

Northern Ireland

absent, never occurred

EPPO, 2006

Scotland

absent, never occurred

EPPO, 2006

Asia

China

present

EPPO, 2006

Heilongjiang

present

EPPO, 2006

Liaoning

present

EPPO, 2006

Qinghai

present

EPPO, 2006

Sichuan

present

EPPO, 2006

Georgia (Republic)

Present, introduced, invasive

Kobakhidze, 1965; EPPO, 2006

Japan

restricted distribution

EPPO, 2006

Hokkaido

present

EPPO, 2006

Turkey

restricted distribution, introduced, invasive

DKOA, 2001; EPPO, 2006

Biology and ecology

Life History and Habits

The genus Dendroctonus consists of 19 species, worldwide. Most occur on conifers in North and Central America. Dendroctonus armandi (native to China) and D. micans are found in Palearctic conifer forests (Wood, 1982). Several species are important forest pests, capable of reaching epidemic levels and killing thousands of trees. The genus Dendroctonus contains some of the most destructive forest insects in North and Central America, including the southern pine beetle (Dendroctonus frontalis), mountain pine beetle (Dendroctonus ponderosae), Douglas-fir beetle (Dendroctonus pseudotsugae) and the spruce beetle (Dendroctonus rufipennis).

D. micans exhibits a number of life cycle characteristics that make it unique among Dendroctonus species. Mating takes place under the bark prior to emergence and before the adult beetles are fully chitinized. Sibling males normally mate the females (incestuous mating). The ratio of males to females is low. Typically the sex ratio is one male per 10 females but can be as low as one male per 45 females. The phenomenon of pre-emergence mating precludes the need for females to attract males. Therefore, there is no adult aggregation pheromone.

The adult beetles can remain underneath the bark of the trees in which they developed for long periods, if the conditions for emergence are not suitable. They often mine in large groups, among their original larval galleries, chewing the larval frass and sometimes forming 'nose to tail' columns within the brood excavations. When emergence does occur, the adults cut round emergence holes through the thin bark that covers the brood system. The emergence holes can be constructed well ahead of the actual emergence and large quantities of powdery frass are ejected. Emergence can occur over a protracted period, with many beetles using the same emergence hole.

The mated females emerge to attack either new trees or unattacked portions of the host tree from which they emerged. Adult flight and, more commonly, walking, play an important part in adult dispersal. This typically leads to small groups of attacked trees. Sometimes no adult emergence occurs and new brood areas are established in the same tree, along the margins of existing galleries.

D. micans is different from the more aggressive North American Dendroctonus species in that it usually attacks its hosts in low numbers, killing the bark in patches. Successive attacks, over a period of 5 to 8 years, may be necessary to kill a tree, except during outbreaks.

The temperature threshold for adult flight is reported to be 21-23°C. However, in Britain, initial flight at 20°C with sustained flight at 14°C has been observed.

Beetle attacks often occur around areas of damage on a tree, which may have been caused by lightning or logging. Attacks are often associated with decreased resin pressure and commonly occur in forked or multi-stemmed trees, just below the branch nodes. In some countries, there appears to be an association between beetle attack and the occurrence of root disease caused by fungi such as Heterobasidium annosum or Armellaria sp.. However, apparently healthy trees are also commonly attacked.

The female bores through the bark and establishes a brood chamber. She clears the resin that accumulates during the attack process by mixing it with frass and expelling it through the entrance hole. The expelled resin mixed with frass is purplish-brown and gives rise to resin tubes, which are characteristic of D. micans. These can be seen on the bark surface of infested trees. When the female reaches the cambium, she bores upwards for approximately 2 cm, constructs an egg chamber and deposits a cluster of between 100 and 150 eggs. These are covered with frass and wood dust. Then she may produce additional egg chambers, leading to a mix of several larval instars in the same family group, or she may attack other portions of the tree or adjacent trees.

Newly hatched larvae feed gregariously, side by side, in a brood gallery that becomes larger as the larvae feed. The size of the brood gallery varies according to the number of larvae present. A large brood of larvae can construct a gallery that is 30-60 cm long and 10-20 cm wide. When several females oviposit close to each other, the individual galleries coalesce. This can cause extensive injury to the tree.

The larval colony feeds upwards and outwards from its origin. The frass and dead bodies of siblings are tightly packed into the area behind the feeding front. The larvae produce an aggregation pheromone; a mixture of trans- and cis-verbenol, verbenone and myrtenol, which sustains larval aggregation. There are five larval instars. When feeding is completed, they move back into the islands of tightly packed frass and construct single pupal chambers.

The time required for D. micans to complete one generation in the field ranges from 1 to 3 years, depending on local temperatures. In Great Britain, the time to complete a generation ranges from 10 to 18 months (Fielding and Evans, 1997). In Turkey and the Former Soviet Republic of Georgia, 12 to 15 months are required to complete a generation and in the Nordic countries, 2 to 3 years may be required (Grégoire, 1988).

D. micans does not appear to be associated with any major pathogenic fungi (Serez, 1979; Kolomiets and Isaev, 1981; Grégoire, 1988; King and Fielding, 1989).

Morphology

Eggs

Scolytidae eggs are smooth, ovoid, white and translucent. They are 1.2 mm long and deposited in clusters of 100-150 in the egg gallery.

Larvae

All Scolytidae larvae are similar in appearance and difficult to separate. They are white, 'C'-shaped and legless. The head capsule is lightly sclerotized and amber with dark, well-developed mouthparts. Each abdominal segment has two to three tergal folds and the pleuron is not longitudinally divided. The larvae do not change as they grow. Spruce beetle larvae have four larval instars and are 4-6 mm long when mature (Holsten et al., 1989).

Pupae

Scolytid pupae are white and mummy-like. They are exarate, with legs and wings free from the body. Some species have paired abdominal urogomphi. The elytra are either rugose or smooth, sometimes with a prominent head and thoracic tubercles.

Adults

The adults are 6-9 mm long, dark-brown and cylindrical. The legs and antennae are yellow-brown. The head is visible when viewed dorsally and the elytral declivity is smooth and rounded.

Means of movement and dispersal

Plant parts liable to carry the pest in trade/transport

- Bark: Eggs, Larvae, Nymphs, Pupae, Adults; borne internally; visible to naked eye.
- Stems (above Ground)/Shoots/Trunks/Branches: Eggs, Larvae, Nymphs, Pupae, Adults; borne internally; visible to naked eye.

Plant parts not known to carry the pest in trade/transport

- Bulbs/Tubers/Corms/Rhizomes
- Fruits (inc. Pods)
- Growing Medium Accompanying Plants
- Flowers/Inflorescences/Cones/Calyx
- Leaves
- Seedlings/Micropropagated Plants
- Roots
- True Seeds (inc. Grain)
- Wood.

Natural enemies

D. micans has few natural enemies. This may be due to its unique biology, which seems to protect it from competitors and generalist natural enemies (Everaerts et al., 1988). One specific predator, Rhizophagus grandis, is abundant in areas where D. micans has been present for long periods of time. This beetle is believed to be responsible for maintaining a low and stable D. micans population in these areas (Kobakhidzi, 1965; Moeck and Safranyik, 1983). Woodpeckers (Picoides major) prey on the larvae and pupae.

Natural enemies listed in the database

The list of natural enemies has been reviewed by a biocontrol specialist and is limited to those that have a major impact on pest numbers or have been used in biological control attempts; generalists and crop pests are excluded. For further information and reference sources, see About the data. Additional natural enemy records derived from data mining are presented as a separate list.

Natural enemies reviewed by biocontrol specialist

Natural enemy

Pest stage attacked

Associated plants

Biological control in:

Parasites/parasitoids:

Dolichomitus terebrans

Pupae

Picea abies; Pinus sylvestris

Estonia

Predators:

Rhizophagus grandis

Larvae

Picea; Picea abies; Pinus sylvestris

Estonia; Italy; Republic of Georgia; UK

Additional natural enemies (source - data mining)

Natural enemy

Pest stage attacked

Associated plants

Biological control in:

Parasites/parasitoids:

Bracon hylobii

Picea abies; Pinus sylvestris

Estonia

Dolichomitus tenebrans

Lonchaea collini

Picea abies; Pinus sylvestris

Estonia

Predators:

Dromius quadrimaculatus

Picea abies; Pinus sylvestris

Estonia

Melanotus villosus

Picea abies; Pinus sylvestris

Estonia

Nudobius lentus

Picea abies; Pinus sylvestris

Estonia

Placusa depressa

Picea abies; Pinus sylvestris

Estonia

Raphidia ophiopsis

Picea abies; Pinus sylvestris

Estonia

Raphidia xanthostigma

Picea abies; Pinus sylvestris

Estonia

Scoloposcelis pulchella

Picea abies; Pinus sylvestris

Estonia

Thanasimus dubius (bark beetle, destroyer, American)

USSR

Thanasimus femoralis

Picea abies; Pinus sylvestris

Estonia

Thanasimus formicarius (ant beetle) Picea abies; Pinus sylvestris

Estonia

Pathogens:

Bacillus thuringiensis thuringiensis

Beauveria bassiana (white muscardine fungus)

Impact

Economic impact

Within most of its natural range, D. micans normally occurs at low levels and causes little tree mortality. However, occasionally outbreaks do occur and result in widespread tree mortality. Most outbreaks occur along the leading edge of the geographic range of D. micans and not within the interior portion of the range. Trees are killed as a result of the girdling action of larval feeding. This can take place over a period of several years. As D. micans extended its range westward into Europe (France and the UK) and southwestern Asia (Georgia and Turkey) during the late 1900s, outbreaks occurred on more than 200,000 ha of spruce forests (Grégoire, 1988; Vouland and Schvester, 1994; Konca, 1995). In some cases, older trees were preferentially attacked (Carle et al., 1979) while in other instances, all age classes of spruce trees were attacked (Battisti, 1984; Benz, 1984; Evans et al., 1984). Similarly, when D. micans attacked Pinus sylvestris in Estonia (Voolma, 1978) and Siberia (Kolomiets and Bogdanova, 1976), both young and old trees were infested. Normally, D. micans only colonizes green standing trees, but it will attack trees that are stressed as a result of logging damage, frost, snow, wind, lightning, poor soil nutrition and drought (Chararas 1960; Bejer-Petersen, 1976; Novak, 1976; Voolma, 1978; Battisti, 1984; Shavliashvili and Zharkov, 1985; Gabeev and Gnat, 1986; Grégoire, 1988).

Environmental impact

Sustained attack on individual trees can result in tree mortality. Widespread outbreaks are common, especially along the leading edge of the D. micans range. Outbreaks have occurred in spruce forests and, to a lesser extent, in Scotch pine forests. In some cases more than 50% tree mortality has occurred. Outbreaks are often more common in forests that are stressed by drought, poor soil nutrition and logging damage, for example.

Phytosanitary significance

The adults can fly at least 2 to 3 km in search of new hosts but prefer to attack either the same trees in which they developed or immediately adjacent trees. The adults can disperse on air currents. Other life stages are confined to the cambium layer and inner bark, and do not naturally disperse.

Pathways for human-assisted dispersal include the transport of unprocessed pine logs or lumber, crates, pallets and dunnage, containing bark strips. It is conceivable that larvae, pupae and overwintering adults could survive an ocean voyage and be introduced into a new location. Should this new location contain forests with a component of spruce, D. micans could become established and cause severe damage. The related North American red turpentine beetle, Dendroctonus valens, has recently been introduced to and established in, China, and has killed more than 6 million pines in recent years (Sun et al., 2003).

Most Eurasian conifer forests now have populations of D. micans. However, this insect is not present in North America. Therefore, North American conifer forests are at risk from the introduction and establishment of this insect.

Symptoms

Heavily infested trees have large numbers of conspicuous purplish-brown pitch tubes on the bark surface of the lower boles. Lightly infested trees usually survive beetle attack. Therefore, several generations of beetles could emerge from a tree that still has green foliage. The bark often easily peels away in areas where the larvae have consumed the inner bark. Removal of the bark from infested portions of trees will reveal characteristic galleries, larvae, pupae and adults (Bevan and King, 1983; Grégoire, 1988).

Symptoms by affected plant part

Leaves: yellowed or dead.

Stems: external discoloration; abnormal exudates; internal feeding.

Whole plant: plant dead; dieback; internal feeding; frass visible.

Similarities to other species

Morphologically, D. micans is difficult to distinguish from the North American species, Dendroctonus punctatus and the two species were thought to be conspecific. However, it has now been established that they are distinct species (Furniss, 1996; Kegley et al., 1997). The communal larval galleries of D. micans resemble the galleries of the North American black turpentine beetle, Dendroctonus terebrans, the red turpentine beetle, Dendroctonus valens and the Mexican species, Dendroctonus rhizophagus. However, all of the latter species confine their attacks to Pinus spp.. To ensure positive identification, a taxonomist, with expertise in the family Scolytidae, should examine bark beetles believed to be a new introduction.

Detection and inspection

The bark surface should be inspected for pitch tubes and/or boring dust. The cambium and inner bark of unprocessed logs, or dunnage, crates or pallets, containing bark strips, should be inspected for the presence of galleries and insect life stages.

Control

Cultural Control

The felling, removal and rapid processing of infested trees to destroy broods is a widely used control method for D. micans. The thinning of overstocked forests will help to reduce their susceptibility to attack.

Biological Control

Classical biological control, involving the mass rearing and release of the predaceous beetle, Rhizophagus grandis, has been used in France (Grégoire et al., 1989, 1992; van Averbeke and Grégoire, 1995), the Former Soviet Republic of Georgia (Tvaradze, 1984; Evans, 1987), Turkey (Alkan and Aksu, 1990) and the UK (King and Evans, 1984; Fielding et al., 1991; Evans and Fielding, 1996; Fielding and Evans, 1997).

Chemical Control

Insecticide application to infested portions of the lower boles of trees has been undertaken but with questionable success. For example, extensive chemical control operations were undertaken in Turkey between 1967 and 1985. However, treatments were not successful, except for a slight decrease in the populations of the pest (DKOA, 2001).

Pheromonal Control

Since this insect does not produce an aggregating pheromone, pheromonal control is not a viable control method.

Field Monitoring

In the UK, surveys designed for the early detection of new infestations or for general forest health monitoring have failed to detect infestations until the beetle has been present for approximately 3 years and has become well-established. However, ground surveys, especially near areas of old infestations, can be conducted to detect infested trees that should be removed from stands.

D. micans does not produce an aggregating pheromone, therefore the use of pheromones for the early detection of infestations is not feasible.

Integrated Pest Management

Integrated pest management (IPM) of this insect consists of the timely detection of infestations, the rapid removal and processing of infested trees, thinning of overstocked stands to reduce their susceptibility to attack and the release of the predator, Rhizophagus grandis, into areas where this insect has recently spread.

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Dendroctonus murrayanae

Hopkins (Wood 1963)

Posición taxonómica:

Orden: Coleoptera

Familia: Curculionidae

Subfamilia: Scolytinae

Sinonimia

Dendroctonus shoshone Hopkins, *Dendroctonus rufipennis* Hopkins

Nombres comunes

Dendroctone du pin tordu, lodgepole pine beetle

Descripción

El macho mide de 5.0 a 7.3 mm (promedio de 6 mm), 2.3 veces más largo que ancho, el cuerpo es de color café obscuro con élitros cafés rojizos. Pronoto 1.35 veces más ancho que largo con superficie lisa y brillante. La hembra es muy similar al macho.

Hospedantes

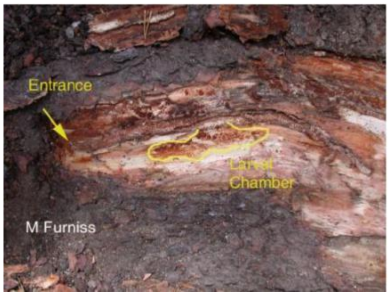
Pinus banksianna, P. contorta y *P. strobus*

Distribución

Los Grandes Lagos en el área de Alberta hasta el sur hacia Utah y Colorado.

Biología y hábitos.

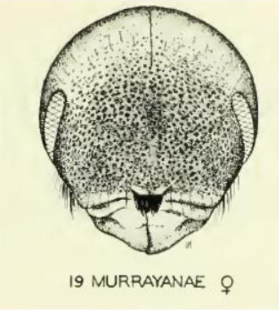
De forma ordinaria esta es una especie no agresiva. Pero se sugiere según la información disponible que ha matado arboles de pino Lodgepole saludables y vigorosos. Sin embargo, debido a la estrecha cercanía con *Dendroctonus obesus* algunas de las pérdidas causadas por esta especie han sido atribuidas a *D. murrayanae*. En todos los casos donde los especímenes fueron preservados para el estudio de *D. obesus* infestando pinos LodgepoleLas larvas y los adultos jóvenes de la generación invernal en todos los estados de desarrollo se vuelven más activos cuando la temperatura de primavera es suficientemente alta, probablemente cercana entre los 45º y 50º F. La actividad de vuelo probablemente no comience antes de Junio a grandes altitudes.

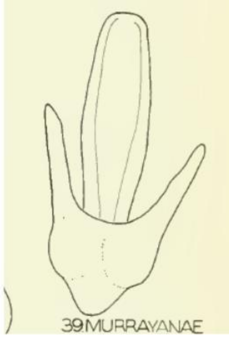


Daños

Por lo visto, el ataque comienza en o cerca del nivel del suelo por un lado de manera ascendente, descendente o alrededor desde ese punto. Al mismo tiempo dos o más generaciones sucesivas pueden estar involucradas en rodear el árbol vivo. Normalmente solo un par de escarabajos están involucrados en el ataque de un árbol particular.

Los soldados miden 5 mm de longitud, sus antenas están formadas por 14 artejos, el tercero un poco más corto que el segundo.





Cabeza de *D. murrayanae*. Bastón seminal de *D. murrayanae*

Información adicional

Véase archivos anexos (sección VII.-ANEXOS, de la MIR): Principales lineas de estudio en la biología evolutiva Dendroctonus y Biology of Dendroctonus murrayanae.

Dendroctonus punctatus

Names and taxonomy

Preferred scientific name

Dendroctonus punctatus Leconte

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Scolytidae

Other scientific names

Dendroctonus johanseni Swaine

EPPO code

DENCPU (Dendroctonus punctatus)

Common names

English:

allegheny spruce beetle

beetle, allegheny spruce

beetle, arctic spruce

French:

dendroctone de l'Allegheny

Host range

List of hosts plants

Hosts (source - data mining)

Picea glauca (white spruce)

Geographic distribution

Distribution List

North America

North America (as a whole) present

CAB Abstracts, 1973-1998

Canada

unconfirmed record

CAB Abstracts, 1973-1998

British Columbia

unconfirmed record

CAB Abstracts, 1973-1998

USA

unconfirmed record

CAB Abstracts, 1973-1998

Montana

unconfirmed record

CAB Abstracts, 1973-1998

References

CAB Abstracts, 1973-1998. Data mined from CAB Abstracts database, years 1973 to 1998. Wallingford, UK: CAB International

Dendroctonus rufipennis

Names and taxonomy

Preferred scientific name

Dendroctonus rufipennis (Kirby, 1837)

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Scolytidae

Other scientific names

Dendroctonus borealis Hopkins, 1909

Hylurgus rufipennis Kirby, 1837

Hylurgus obesus Mannerheim, 1843

Dendroctonus obesus (Mannerheim, 1843)

Dendroctonus piceaperda Hopkins, 1901

Dendroctonus engelmanni Hopkins, 1909

Dendroctonus similis LeConte, 1857

EPPO code

DENCRU (Dendroctonus rufipennis)

Common names

English:

spruce beetle

beetle, spruce

beetle, Alaska spruce

beetle, eastern spruce

beetle, Engelmann spruce

beetle, red-winged pine

beetle, sitka-spruce

Alaska spruce beetle

eastern spruce beetle

Engelmann spruce beetle

spruce bark beetle

French:

dendroctone de l'épinette

dendroctone de l'epinette sitka

dendroctone d' Engelmann

Germany:

Riesenbastkaefer, Sitkafichten-

Sitkafichten Riesenbastkäfer

Notes on taxonomy and nomenclature

This insect was originally described as Hylurgus rufipennis by Kirby in 1837. J.L. LeConte placed it in the genus Dendroctonus in 1868. Prior to 1963, six species of spruce inhabiting Dendroctonus were recognized in North America. Wood (1963) synonymized these species under the name D. obesus. However, D. rufipennis (Kirby) was an older name and had priority. Wood corrected this oversight in 1969 and established D. rufipennis as the proper name (Schmid and Frye, 1977).

Host range

Notes on host range

D. rufipennis attacks all species of spruce (Picea spp.) within its geographic range (Holsten et al., 1989). In eastern North America, red spruce (Picea rubens) is attacked. Across the transcontinental boreal forests, white spruce (Picea glauca) is attacked. In the Rocky Mountains, Engelmann spruce (Picea engelmannii) is the primary host. In the Pacific Northwest and coastal regions of Alaska, Sitka spruce (Picea sitchensis) and Lutz spruce (Picea x lutzii [Picea lutzii]), a naturally occurring hybrid of P. glauca and P. sitchensis, are attacked.

Normally D. rufipennis does not attack Picea mariana (black spruce). However, in outbreak situations, black spruce trees as small as 2 inches in diameter at breast height have been successfully attacked (Holsten E, USDA Forest Service, Alaska, personal communication, 2004).

Affected Plant Stages: Vegetative growing stage.

Affected Plant Parts: Leaves, stems and whole plant.

List of hosts plants

Major hosts

Picea (spruces), Picea engelmannii (Engelmann spruce), Picea glauca (white spruce), Picea lutzii , Picea mariana (black spruce), Picea rubens (red spruce), Picea sitchensis (Sitka spruce)

Habitat

Populations of D. rufipennis typically develop in windthrown trees and large numbers of emerging brood adults attack standing trees. Outbreaks typically occur in mature spruce forests.

Geographic distribution

Notes on distribution

D. rufipennis is found throughout the range of spruce in North America, from eastern Canada, south along the Appalachian Mountains, west across the boreal forests of Canada and Alaska and south along crests of the Rocky Mountains and Cascades to northern California, Arizona and New Mexico (see map in Holsten et al., 1989).

See also CABI/EPPO (1998, No. 61).

Distribution List

Please note: The distribution status for a country or province is based on all the information available. When several references are cited, they may give conflicting information on the pest status. In particular, citations of earlier presence of a pest are included even though there is an authoritative reference to indicate that the pest is now absent.

Show EPPO notes

EPPO notes may be available for records where the source is EPPO, 2006. PQR database (version 4.5). Paris, France: European and Mediterranean Plant Protection Organization. Further details may be available in the corresponding EPPO Reporting Service item (e.g. RS 2001/141), for details of this service visit http://archives.eppo.org/EPPOReporting/Reporting_Archives.htm, or contact the EPPO Secretariat hq@eppo.fr.

Africa

South Africa

absent, invalid record

CABI/EPPO, 2004; EPPO, 2006

North America

Canada

widespread

CABI/EPPO, 2004; EPPO, 2006

Alberta

widespread native invasive

Wood, 1982; CABI/EPPO, 2004; EPPO, 2006

British Columbia

widespread native invasive

Schmid & Frye, 1977; Wood, 1982; CABI/EPPO, 2004; EPPO, 2006 Manitoba

widespread native invasive

Wood, 1982; CABI/EPPO, 2004; EPPO, 2006

New Brunswick

widespread native invasive

Wood, 1982; CABI/EPPO, 2004; EPPO, 2006

Newfoundland

widespread

CABI/EPPO, 2004; EPPO, 2006

Northwest Territories

widespread native invasive

Wood, 1982; CABI/EPPO, 2004; EPPO, 2006

Nova Scotia

widespread native invasive

Wood, 1982; CABI/EPPO, 2004; EPPO, 2006

Nunavut

widespread native invasive

Wood, 1982; CABI/EPPO, 2004

Ontario

widespread native invasive

Wood, 1982; CABI/EPPO, 2004; EPPO, 2006

Quebec

widespread

CABI/EPPO, 2004; EPPO, 2006

Saskatchewan

widespread

CABI/EPPO, 2004; EPPO, 2006

Yukon Territory

widespread native invasive

Wood, 1982; CABI/EPPO, 2004; EPPO, 2006

Mexico

absent, unreliable record
CABI/EPPO, 2004; EPPO, 2006

USA
widespread

CABI/EPPO, 2004; EPPO, 2006

Alaska

widespread native invasive

Wood, 1982; Ciesla & Coulston, 2002; CABI/EPPO, 2004; EPPO, 2006
Arizona

widespread native invasive

Schmid & Frye, 1977; Wood, 1982; CABI/EPPO, 2004; EPPO,
2006 California

widespread native invasive

Wood, 1982; CABI/EPPO, 2004; EPPO, 2006

Colorado

widespread native invasive

Schmid & Frye, 1977; Wood, 1982; Ciesla & Coulston, 2002; CABI/EPPO, 2004; EPPO,
2006 Idaho

widespread native invasive

Wood, 1982; CABI/EPPO, 2004; EPPO, 2006

Maine

widespread native invasive

Wood, 1982; Weiss et al., 1985; CABI/EPPO, 2004; EPPO, 2006
Michigan

widespread native invasive

Wood, 1982; CABI/EPPO, 2004; EPPO, 2006

Minnesota

widespread native invasive

Wood, 1982; CABI/EPPO, 2004; EPPO, 2006

Montana

widespread native invasive

Wood, 1982; CABI/EPPO, 2004; EPPO, 2006

Nevada

widespread native invasive

Wood, 1982; Weiss et al., 1985; CABI/EPPO, 2004; EPPO, 2006
New Hampshire

widespread

CABI/EPPO, 2004; EPPO, 2006

New Mexico

widespread native invasive

Schmid & Frye, 1977; Wood, 1982; CABI/EPPO, 2004; EPPO, 2006
New York

widespread native invasive

Schmid & Frye, 1977; Wood, 1982; CABI/EPPO, 2004; EPPO,
2006 Oregon

widespread native invasive

Wood, 1982; Ciesla & Coulston 2002; CABI/EPPO, 2004; EPPO,
2006 Pennsylvania

widespread native not invasive

Wood, 1982; CABI/EPPO, 2004; EPPO, 2006

South Dakota

widespread

CABI/EPPO, 2004; EPPO, 2006

Utah

widespread native invasive

Schmid & Frye, 1977; Wood, 1982; CABI/EPPO, 2004; EPPO,
2006 Vermont

Widespread, native, invasive

Wood, 1982; Weiss et al., 1985; CABI/EPPO, 2004; EPPO, 2006
Washington

Widespread, native, invasive

Wood, 1982; Ciesla & Coulston 2002; CABI/EPPO, 2004; EPPO,
2006 Wisconsin

widespread

CABI/EPPO, 2004; EPPO, 2006

Wyoming

Widespread. Native, invasive

Schmid & Frye, 1977; Wood, 1982; Ciesla & Coulston 2002; CABI/EPPO, 2004; EPPO, 2006

Biology and ecology

Life History and Habits

The genus Dendroctonus consists of 19 species worldwide. Most occur on conifers in North and Central America. Two species: Dendroctonus armandi, native to China, and D. micans are found in Palearctic conifer forests (Wood, 1982). Several species are important forest pests, capable of reaching epidemic levels and killing thousand of trees. The genus Dendroctonus contains some of the most destructive forest insects in North and Central America.

In the Rocky Mountains, a generation of spruce beetle typically requires 2 years to complete. However, they can complete a generation in 1 year on warm sites at low altitudes or may require 3 years in cool, shaded locations on north-facing slopes. Two-year cycle spruce beetles may emerge between May and October, depending on local temperature. They attack soon after emergence. Adults emerging from August to October may represent a re-emergence of parent adults or the movement of maturing brood adults to overwintering sites.

Females bore through the outer bark and, after attracting a male and mating, construct egg galleries in the cambium layer and inner bark. Egg galleries are slightly wider than the adults and are tightly packed with frass and boring dust except for the terminal portion of the gallery. Total gallery length is about 13 cm. Eggs are deposited in short rows along both sides of the egg gallery at the rate of between 4 and 14 eggs per centimetre of gallery.

Larvae bore outward from the egg gallery, and feed communally for the first two instars. The third and fourth instars feed in individual galleries. The larval stage is the predominant life stage during the first winter, although some parent adults and eggs may also be present. Two-year cycle spruce beetles pupate about 1 year after attack by the parent adults. Pupation generally lasts 10-15 days and takes place in cells at the end of the larval galleries.

The second winter is passed in the adult stage, either in pupal sites or at the base of infested trees. During the following summer, the brood adults emerge from their overwintering sites and attack new host material.

In Alaska, 2 years are required to complete a generation. In eastern North America and in the coastal areas of the Northwest, a 1-year cycle may be more common. Adults emerge and attack from June to August and the brood overwinters as larvae. They resume development the following spring and emerge as adults in June (Holsten et al., 1989).

Morphology

Eggs

Eggs of beetles of the family Scolytidae are smooth, ovoid, white and translucent. Spruce beetle eggs (1-2 mm long) are deposited in short rows along both sides of the egg gallery at a rate of between 4 and 14 eggs per centimetre of gallery (Holsten et al., 1989).

Larvae

The larval stages of insects of the family Scolytidae are all similar in appearance and difficult to separate. They are white, 'c'-shaped, legless grubs. The head capsule is lightly sclerotized, amber in colour with dark, well-developed mouthparts. The abdominal segments each have two or three tergal folds and the pleuron is not longitudinally divided. The larvae do not change as they grow. Spruce beetle beetle larvae pass through four larval instars and are 4-6 mm long when mature (Holsten et al., 1989).

Pupae

Scolytid pupae are white and mummy-like. They are exarate, with legs and wings free from the body. Some species have paired abdominal urogomphi. The elytra are either rugose or smooth, sometimes with prominent head and thoracic tubercles.

Adults

Adults are blackish-brown to black with reddish-brown or black elytra. They are cylindrical and range in length from 3.4 to 5.0 mm (average 4.2 mm) long and about 3 mm wide. The elytra are 2.5 times the length of the pronontum (Wood, 1982; Holsten et al., 1989).

Means of movement and dispersal

Plant parts liable to carry the pest in trade/transport

- Stems (above Ground)/Shoots/Trunks/Branches: Eggs, Larvae, Nymphs, Pupae, Adults; borne internally; visible to naked eye.

Natural enemies

The natural enemy complex of the spruce beetle has been studied extensively and consists of a complex of parasitoids, invertebrate and vertebrate predators and nematodes. Three species of woodpeckers are known predators. The northern three-toed woodpecker (Picoides tridactylus) is the most effective because it feeds exclusively on the boles of trees. The effects of insect parasitoids and predators on spruce beetle populations can be quite variable. In some cases they can kill large numbers of spruce beetle life stages but have a minimal effect on the overall population (Schmid and Frye, 1977).

For further information on the natural enemies of D. rufipennis, see Bellows et al. (1998) and Schmid and Frye (1977).

Natural enemies listed in the database

The list of natural enemies has been reviewed by a biocontrol specialist and is limited to those that have a major impact on pest numbers or have been used in biological control attempts; generalists and crop pests are excluded. For further information and reference sources, see About the data. Additional natural enemy records derived from data mining are presented as a separate list.

Natural enemies reviewed by biocontrol specialist

Natural enemy

Pest stage attacked

Associated plants

Biological control in:

Parasites/parasitoids:

Coeloides dendroctoni

Larvae

Dinotiscus dendroctoni

Larvae

Roptrocerus xylophagorum

Larvae

Predators:

Enoclerus lecontei (clerid, blackbellied)

Adults, Larvae, Pupae

Medetera aldrichii

Larvae

Thanasimus undatulus

Adults, Larvae, Pupae

Additional natural enemies (source - data mining)

Natural enemy

Pest stage attacked

Associated plants

Biological control in:

Parasites/parasitoids:

Rhopalicus tutele

Picea

Canada

Pathogens:

Beauveria bassiana (white muscardine fungus)

Impact

Economic impact

The spruce beetle is considered the most destructive insect pest of spruce forests in North America. This insect is normally present in small numbers in weakened or windthrown trees, large pieces of logging residues or fresh stumps. However, under favourable conditions, outbreaks can develop and kill extensive forests over large areas. Spruce beetle populations typically increase following severe storms that result in extensive windthrow. Large numbers of beetles emerging from the windthrow can attack standing trees. Other factors that can trigger outbreaks include large volumes of spruce logging debris, cutting of seismic lines for oil and gas exploration and road construction. When outbreaks develop in mature spruce forests, larger diameter trees are usually attacked first but spruces of all diameter classes can be killed. Stands that are slow growing are especially susceptible to prolonged outbreaks (Furniss and Carolin, 1977; Schmid and Frye, 1977; Holsten et al., 1989).

North American spruce forests have a long history of spruce beetle outbreaks. According to early records, spruce beetle was first recognized as a pest of spruce in the north-eastern USA in the early 1800s, when several outbreaks killed large numbers of trees (Hopkins, 1901). These outbreaks continued until the beginning of the twentieth century but have since dwindled to smaller outbreaks covering several thousand acres, presumably due to a reduction in the area of mature spruce forests (Weiss et al., 1985). This insect has also been a serious pest in the Rocky Mountains and in portions of Oregon and Washington (Furniss and Carolin, 1977). Historical records summarized by Schmid and Frye (1977) report on outbreaks in western Colorado in the mid 1870s. During this same period an outbreak killed more than 90% of the spruce on more than 5300 ha in southern New Mexico. Another massive outbreak occurred in western Colorado between 1942 and 1948 following a severe storm resulting in extensive windthrow. Spruce beetle has been a continuing problem in portions of Alaska since the early 1970s. This outbreak began to increase significantly in 1992 and peaked in 1996 when nearly 460,000 ha were infested (Ciesla and Coulston, 2002).

Environmental impact

During outbreaks, widespread tree mortality alters the character of forests with a significant spruce component. Outbreaks modify stand structure by lowering tree diameter, height and stand density. In some cases spruce forests have been replaced by less desirable species, such as subalpine fir (Abies lasiocarpa) or paper birch (Betula papyrifera). Large outbreaks significantly reduce aboveground water loss by transpiration due to loss of spruce foliage. Extensive spruce mortality also increases water yield, resulting in increased amounts of water in rivers, lakes and streams. As the dominant spruce trees are killed, increased forage develops, which benefits some wildlife species. However, outbreaks adversely affect those species dependent on mature spruce forests for habitat (Holsten et al., 1989).

Phytosanitary significance

Adult spruce beetles are relatively strong fliers and can fly at least 2-3 km in search of new hosts. In addition, their small size makes them subject to dispersal by air currents. Other life stages are confined to the cambium layer and inner bark and are not subject to natural dispersal.

Pathways for human-assisted dispersal include transport of unprocessed pine logs or lumber, crates, pallets and dunnage containing bark strips. It is conceivable that larvae, pupae and overwintering adults could survive an ocean voyage and be introduced into a new location. Should this new location have spruce forests, it could become established and cause severe damage. A related North American species of Dendroctonus, the red turpentine beetle (D. valens) has recently been introduced and established in China and has killed more than 6 million pines in recent years (Sun et al., 2003).

Symptoms

Trees attacked by spruce beetle are killed. However, the needles of spruces do not fade or discolour during the first year of attack. During the second summer following attack, most needles turn a yellowish colour. The needles on different branches of the same tree may discolour at different times. Needles are readily washed from dead trees by thunderstorms, leaving the upper crowns of exposed twigs with a yellow-orange to reddish hue.

On standing trees, the most conspicuous evidence of attack is the presence of reddish-brown sawdust in the bark crevices on the bole and around the base of infested trees. Less noticeable evidence of attack includes entrance holes without sawdust and sawdust-clogged entrance holes. Masses of resin may accumulate around the entrance holes. These symptoms are most visible in the summer following attack and become less noticeable later in the year.

Sawdust in bark crevices and on the ground directly below the stems is a sign of infestation on windthrown trees and residual trees from harvesting operations. Spruce beetles are most common on the lower surfaces of fallen trees.

During the first autumn and winter following attack, trees are typically debarked by woodpeckers in search of larvae.

The removal of the bark of infested trees should reveal egg and larval galleries and life stages of the spruce beetle (Holsten et al., 1989).

Symptoms by affected plant part

Leaves: yellowed or dead.

Stems: external discoloration; abnormal exudates; visible frass.

Whole plant: plant dead; dieback; frass visible.

Similarities to other species

Dendroctonus rufipennis is distinguished from the closely related D. murrayanae with great difficulty. Morphological characteristics that separate the two species include a more coarsely granulated frons on D. rufipennis. The male genitalia of the two species are also different. Field characteristics that can be used to separate these two species include host differences (D. murrayanae infests Pinus contorta) and gallery structure (Wood, 1982).

In Alaska, Canada and the north-eastern USA, the Allegheny spruce beetle (Dendroctonus punctatus) also attacks spruce. This insect may be distinguished from spruce beetle by its uniformly brown colour (Holsten et al., 1989). D. rufipennis also resembles to some extent the Douglas-fir beetle (D. pseudotsugae). However, D. pseudotsugae is found on Pseudotsuga menziesii (Furniss and Carolin, 1977).

To ensure positive identification, bark beetles believed to be a new introduction, should be examined by a taxonomist with expertise in the family Scolytidae.

Detection and inspection

Look for pitch tubes and/or boring dust on the bark surface and the presence of galleries and insect life stages in the cambium and inner bark on unprocessed logs or dunnage, crating or pallets containing bark strips.

Control

Cultural Control

A number of cultural tactics, designed to modify forest conditions, are available to manage spruce beetle infestations. Infested and susceptible spruce can be removed from the overstorey to encourage regeneration of a new, healthy, vigorous forest. Partial cuts can be used to remove infested and susceptible trees to improve the growth of the residual stand. Trap trees, green trees of large diameter (>46 cm), can be felled before adult flight to attract flying beetles. Trap trees must be removed from forests before the brood completes development and emerges (Holsten et al., 1989).

Biological Control

No biological control programme has been developed for spruce beetle. Unless large volumes of favourable host material exist, this insect is kept at low levels by a combination of factors including a complex of natural enemies (Bellows et al., 1998).

Chemical Control

Several tactics involving chemicals have been used. The application of chemicals to the boles of infested trees to kill broods and emerging adults has been used. However, as is the case with other bark beetles, this procedure is expensive and of marginal effectiveness as long as forest conditions are favourable for the development of spruce beetle outbreaks. The boles of high value, uninfested trees in recreation sites or homesites can be sprayed with a residual insecticide to prevent attack. This treatment can protect trees for up to 2 years (Holsten et al., 1989).

Pheromonal Control

Aggregating pheromones can increase the effectiveness of trap trees. The anti-attractant pheromone methylcyclohexenone shows promise as a repellent but is not yet an operational pest management tactic (Holsten et al., 1989).

Mechanical Methods

Infested logging debris or windthrow can be exposed to direct sunlight to kill spruce beetle broods. Infested material is cut into 1.5-2 m lengths and rotated at 2-week intervals to expose the bark surface to the sun. This technique is effective in the Rocky Mountains but not in Alaska (Holsten et al., 1989).

Infested material can be piled and burned to destroy broods. Only the bark has to be burned (Holsten et al., 1989).

Field Monitoring

Monitoring of spruce beetle consists of aerial and ground surveys designed to locate groups of dead and dying trees and confirm the presence of infestations. In areas where this insect has a history of causing damage, these surveys are conducted on an annual basis. Attractant pheromones can also be used to monitor the relative abundance of adult beetles.

Integrated Pest Management

Integrated pest management of spruce beetle consists of monitoring of forests for the presence of infestations and management to keep forests in a healthy growing condition. Guidelines are available to rate the hazard of spruce forests for susceptibility to spruce beetle attack (Alexander, 1986). The removal of infested and high-risk trees, treatment of logging debris and windthrow, and the judicious use of trap trees are effective pest management tactics. Attacks in high value trees can be prevented by the application of insecticides. Many forests with a heavy spruce component and susceptible to outbreaks of spruce beetle occur at high altitudes (e.g. the Rocky Mountains) or remote, inaccessible areas (e.g. Alaska) where it is logistically difficult to implement pest management programmes. Therefore, this insect remains a major threat to North American spruce forests.

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Dendroctonus simplex

Names and taxonomy

Preferred scientific name

Dendroctonus simplex Leconte

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Scolytidae

EPPO code

DENCSI (Dendroctonus simplex)

Common names

English:

eastern larch beetle
beetle, eastern
larch French:

dendroctone du mélèze
dendroctone du meleze

Host range

List of hosts plants

Hosts (source - data mining)

Larix laricina (American larch)

Geographic distribution

Distribution List

North America

North America (as a whole) present

CAB Abstracts, 1973-1998

Canada

present

CAB Abstracts, 1973-1998

British Columbia

unconfirmed record

CAB Abstracts, 1973-1998

Newfoundland

present

CAB Abstracts, 1973-1998

USA

unconfirmed record

CAB Abstracts, 1973-1998

Alaska

unconfirmed record

CAB Abstracts, 1973-1998

Idaho

unconfirmed record

CAB Abstracts, 1973-1998

New York

unconfirmed record

CAB Abstracts, 1973-1998

Natural enemies

Natural enemies listed in the database

Natural enemy

Pest stage attacked

Parasites/parasitoids:

Rhopalicus tutela

Roptrocerus xylophagorum

Spathius canadensis

References

CAB Abstracts, 1973-1998. Data mined from CAB Abstracts database, years 1973 to 1998. Wallingford, UK: CAB International

Dendroctonus terebrans

Names and taxonomy

Preferred scientific name

Dendroctonus terebrans (Olivier)

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Scolytidae

EPPO code

DENCTE (Dendroctonus terebrans)

Common names

English:

beetle, black
turpentine French:

dendroctone noir de l'epinette

Host range

List of hosts plants

Hosts (source - data mining)

Pinus (pines), Pinus echinata (shortleaf pine), Pinus elliottii (slash pine), Pinus patula (Mexican weeping pine), Pinus rigida (pitch pine), Pinus taeda (loblolly pine), Pinus thunbergii (Japanese black pine), Pinus virginiana (scrub pine)

Ips acuminatus

Names and taxonomy

Preferred scientific name

Ips acuminatus Gyllenhal

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Curculionidae

Other scientific names

Bostrichus acuminatus Gyllenhal

Ips acuminatus var. heydeni Eichhoff

Tomicus acuminatus Gyllenhal

EPPO code

IPSXAC (Ips acuminatus)

Common names

English:

bark beetle, sharp-dentated

Finland:

okakaarnakuoriainen

Germany:

Borkenkaefer, Sechszaehniger Kiefern-

Norway:

skarptannet barkbille

Sweden:

skarptandad barkborre

Host range

List of hosts plants

Hosts (source - data mining)

Pinus sylvestris (Scots pine)

Geographic distribution

Distribution List

Europe

Europe (as a whole)

present

CAB Abstracts, 1973-1998

Austria

present

CAB Abstracts, 1973-1998

Czech Republic

present

CAB Abstracts, 1973-1998

Finland

unconfirmed record

CAB Abstracts, 1973-1998

France

present

CAB Abstracts, 1973-1998

Norway

unconfirmed record

CAB Abstracts, 1973-1998

Poland

present

CAB Abstracts, 1973-1998

Spain

unconfirmed record

CAB Abstracts, 1973-1998

Asia

China

unconfirmed record

CAB Abstracts, 1973-1998

Georgia (Republic)

unconfirmed record

CAB Abstracts, 1973-1998

Natural enemies

Natural enemies listed in the database

Natural enemy

Pest stage attacked

Parasites/parasitoids:

Coeloides melanostigma

Dendrosoter middendorffii

Eurytoma

Larvae, Pupae

Eurytoma arctica

Larvae, Pupae

Rhopalicus brevicornis

Rhopalicus tutela

References

CAB Abstracts, 1973-1998. Data mined from CAB Abstracts database, years 1973 to 1998. Wallingford, UK: CAB International

Ips amitinus

Names and taxonomy

Preferred scientific name

Ips amitinus (Eichhoff, 1872)

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Curculionidae

Other scientific names

Tomicus amitinus Eichhoff, 1872

Ips montanus Fuchs, 1913

EPPO code

IPSXAM (Ips amitinus)

IPSXVA (Ips montanus)

Common names

English:

small spruce bark beetle

French:

bostryche amitinus

petit bostryche du pin

Czech Republic:

lýkozrout mensi

Germany:

Achtzähnigen Fichtenborkenkäfer

Borkenkaefer, Achtzaehniger Kleiner

Fichten-kleiner Buchdrucker

Poland:

kornik drukarczyk

Slovakia:

lýkozrút smrecinový

Host range

Notes on host range

The main host tree of I. amitinus is the Norway spruce, Picea abies. Infestations on some pine species, especially the arolla pinetree, Pinus cembra (high mountains) and eastern white pine, Pinus strobus, have been recorded. I. amitinus has been found to breed in Abies and Larix spp. (Burakowski et al., 1992). This insect is frequently found in spruce stands, which also contain fir (Abies spp.) and beech (Fagus spp.) admixtures (Zumr, 1984).

Affected Plant Stages: Vegetative growing stage.

Affected Plant Parts: Leaves, stems and whole plant.

List of hosts plants

Major hosts

Picea abies (common spruce)

Minor hosts

Abies alba (silver fir), Larix decidua (common larch), Pinus cembra (arolla pine), Pinus heldreichii (heldreich's pine), Pinus mugo (mountain pine), Pinus strobus (eastern white pine)

Habitat

I. amitinus occurs more frequently in conifer, mainly spruce, forests in the mountains (up to the timber line) than in the lowlands. Pure spruce stands are most endangered by the pest. Trees stressed by abiotic (drought, wind, snow) or biotic (defoliating insects, fungal diseases) factors are predisposed for the attacks.

Geographic distribution

Notes on distribution

I. amitinus is more frequent in the montane regions (Alps, Carpathians and Sudeten, Europe), including high altitudes up to the upper timber line, as well as in the northern parts of Eurasia. The pest is absent in Lithuania although it has been reported in the past. The occurrence of I. amitinus in some parts of Europe is changing.

Distribution List

Please note: The distribution status for a country or province is based on all the information available. When several references are cited, they may give conflicting information on the pest status. In particular, citations of earlier presence of a pest are included even though there is an authoritative reference to indicate that the pest is now absent.

Show EPPO notes

EPPO notes may be available for records where the source is EPPO, 2006. PQR database (version 4.5). Paris, France: European and Mediterranean Plant Protection Organization. Further details may be available in the corresponding EPPO Reporting Service item (e.g. RS 2001/141), for details of this service visit http://archives.eppo.org/EPPOReporting/Reporting_Archives.htm, or contact the EPPO Secretariat hq@eppo.fr.

Europe

Austria

restricted distribution

native

Haidler & Wegensteiner, 2001; BAWBILT, 2002; EPPO, 2006

Belgium

restricted distribution

EPPO, 2006

Bosnia and Herzegovina

present

EPPO, 2006

Bulgaria

widespread

introduced

Tsankov & Rosnev, 1978; EPPO, 2006

Croatia

restricted distribution

EPPO, 2006

Czech Republic

widespread

introduced

Jelinek, 1993; BAWBILT, 2002; EPPO, 2006

Czechoslovakia (former -)

widespread

native

Zumr, 1986; Jelinek, 1993

Estonia

restricted distribution

native

Luik, 1986; BAWBILT, 2002; EPPO, 2006

Finland

widespread

native

Koponen, 1980; EPPO, 2006

France

restricted distribution
native

Balachowsky, 1949; EPPO, 2006

Corsica

absent, never occurred
EPPO, 2006

France [mainland]
restricted distribution

EPPO, 2006 Germany

widespread

introduced

Francke et al., 1980; Richter, 1989; BAWBILT, 2002; EPPO, 2006
Greece

absent, never occurred
EPPO, 2006

Hungary

restricted distribution
introduced

EPPO, 2006

Ireland

absent, never occurred
introduced

BAWBILT, 2002; EPPO, 2006

Italy

restricted distribution
native

Coslop & Masutti, 1978; Hellrigl, 1985; BAWBILT, 2002; EPPO, 2006
Italy [mainland]

restricted distribution

EPPO, 2006 Lithuania

absent, formerly present

EPPO, 2006

Macedonia

present

native

Karaman et al., 1973; EPPO,

2006 Netherlands

absent, formerly present

EPPO, 2006

Poland

widespread

introduced

Burakowski et al., 1992; BAWBILT, 2002; EPPO, 2006

Portugal

absent, never occurred

EPPO, 2006

Romania

widespread

native

Simionescu et al., 1998; BAWBILT, 2002; EPPO, 2006

Russian Federation

restricted distribution

EPPO, 2006

Central Russia

present EPPO,

2006 Northern

Russia present

native

Mandelshtam, 1999

Serbia and Montenegro

restricted distribution

EPPO, 2006

Slovakia

restricted distribution

introduced

Jelinek, 1993; BAWBILT, 2002; EPPO, 2006

Slovenia

restricted distribution

EPPO, 2006

Spain

absent, invalid record

EPPO, 2006

Switzerland

restricted distribution

introduced

Nierhaus-Wunderwald, 1992; Stauffer & Zuber, 1998; BAWBILT, 2002; EPPO, 2006

Ukraine

restricted distribution

native

Vasechko, 1971; Grodzki et al., 2002; EPPO, 2006

United Kingdom

absent, intercepted only

introduced

BAWBILT, 2002; EPPO, 2006

Africa

Tunisia

restricted distribution

EPPO, 2006

Biology and ecology

The life cycles of I. amitinus and Ips typographus are similar. Swarming in the spring is strongly dependent on the temperature. The beetles start to fly in April/May (or May/June in the Nordic countries). In the mountains, spring swarming is dependent on the altitude and exposition of the slopes, which affect the thermal conditions. The flight starts earlier on sunny slopes and at lower altitudes. I. amitinus beetles start to fly slightly later than I. typographus.

The males of I. amitinus produce pheromones: ipsdienol (2-methyl-6-methylene-2,7-octadien-4-ol), ipsenol (2-methyl-6-methylene-7-octen-4-ol) and trans-2-methyl-6-methylene-3,7-octadien-2-ol, known as 'amitinol' (Francke et al., 1980). The males attract three to seven females to the nuptial chamber and after mating, the females start to bore the maternal galleries and lay eggs in niches. The duration of the larval stage is shorter than in I. typographus, and depends on the thermal conditions. I. amitinus has two generations in the lowlands, but in the mountains the number of generations may be reduced to one. I. amitinus overwinters as an adult and hibernates in decaying plants or litter.

I. amitinus usually accompanies I. typographus, but infests the upper parts of stems of the same trees, where it co-exists with the bark beetle, Pityogenes chalcographus (Grodzki, 1997). In lowlands, I. amitinus can compete against Ips duplicatus and they occupy the same ecological niche (part of the stem). In individual cases, I. amitinus can infest lone stand trees and is a main agent of tree mortality.

Morphology

Adult

The adults are 3.5-4.5 mm long, cylindrical, dark-brown, shiny and hairy. The antennae are clavate. The frontal part of the pronotum is rounded, dentate and squamate, and the hind part is stippled. The posterior edges of the elytra form a characteristic collar shape with dents on both sides. There are rows of depressed points on the glossy elytra, with spaces in between them. The elytral declivity has four spines on each side, the third spine is the largest and capitate. The rear side of the elytral declivity is shiny (when the insect is viewed from the rear).

Egg

The eggs are whitish-grey, ovate and mm long. The eggs are individually laid in niches along both sides of the maternal gallery. Each female lays an average of 60 eggs.

Larva

The larvae are similar in size to the adults. They are 4.5-5.5 mm long, white, cylindrical and legless. They have small, brown, chitinous heads and brown mandibles.

Pupa

The pupa has many free segments (pupa libera). It is white and similar in size to the adult (up to 5 mm).

Means of movement and dispersal

Natural Dispersal (Non-Biotic)

The beetles are able to fly over long distances. Wind and air movements can be additional factors enabling dispersion.

Movement in Trade

The pupae and young beetles can be transported inside the bark of logs that have not been debarked.

Plant parts liable to carry the pest in trade/transport

- Bark: Pupae, Adults; borne internally; visible to naked eye.

- Stems (above Ground)/Shoots/Trunks/Branches: Eggs, Larvae, Pupae, Adults; borne internally; visible to naked eye.

Plant parts not known to carry the pest in trade/transport

- Bulbs/Tubers/Corms/Rhizomes
- Fruits (inc. Pods)
- Growing Medium Accompanying Plants
- Flowers/Inflorescences/Cones/Calyx
- Leaves
- Seedlings/Micropropagated Plants
- Roots
- True Seeds (inc. Grain)
- Wood.

Natural enemies

The complex of natural enemies of I. amitinus is relatively well recognised and similar to that of Ips typographus. Hymenopteran parasitoids, mostly from the families Braconidae and Pteromalidae, are the most effective. The main predators are beetles from the families Cleridae, Staphylinidae, Histeridae and Rhizophagidae, but the larvae of Medetera sp. are also effective. Entomopathogenic fungi, mainly Beauveria bassiana, are important mortality factors. However, the impact of natural enemies is very variable, and dependent on environmental conditions, population density and the phase of the outbreak (maximum impact occurs in the retrogradation phase).

Natural enemies listed in the database

The list of natural enemies has been reviewed by a biocontrol specialist and is limited to those that have a major impact on pest numbers or have been used in biological control attempts; generalists and crop pests are excluded. For further information and reference sources, see About the data. Additional natural enemy records derived from data mining are presented as a separate list.

Natural enemies reviewed by biocontrol specialist

Natural enemy

Pest stage attacked

Parasites/parasitoids:

Coeloides bostrychorum

Larvae

Dendrosoter middendorffii

Larvae

Eurytoma arctica

Larvae, Pupae

Rhopalicus tutela

Larvae

Roptrocerus xylophagorum

Larvae

Tomicobia seitneri

Adults

Pathogens:

Beauveria bassiana (white muscardine fungus)

Larvae, Pupae

Impact

Economic impact

I. amitinus is a member of the complex of bark beetles on Norway spruce, Picea abies, and this usually also includes Ips typographus and Pityogenes chalcographus. The impact of the association with I. typographus, as a major agent responsible for tree mortality, should be taken into consideration. Outbreaks of I. amitinus alone are exceptional. However, in favourable environmental conditions, the role of this species can increase significantly. The insect's association is an important factor that may cause the severe mortality of spruces and related economic losses (see data sheet on I. typographus).

Environmental impact

Usually I. amitinus inhabits montane forests. Local outbreaks that cause tree or stand mortality can result in the deforestation of mountain slopes and related disturbances in the water regime of large areas. In the case of total forest decline on large mountain areas, the reforestation of such damaged areas can be very problematic, as well as work- and time-consuming (Grodzki, 1997).

Phytosanitary significance

I. Amitinus was the only european ips species considered to be an a2 quarantine pest by EPPO, but it has recently been deleted from this list, because too few countries attach any importance to it (EPPO, 2003). However, it is a quarantine pest in Sweden (Schlyter F, Swedish University of

Agricultural Sciences, personal communication, 2003) and was recently intercepted in USA entry ports (Haack, 2001).

Symptoms

Trees that are attacked or infested by I. amitinus have discoloured crowns. The needles turn lighter in colour, form mats and often fall to the ground. They are green and thus visible under the tree. The frass (light-brown sawdust) can be found on the bark in the basal part of the stems of standing trees. Woodpeckers, in search of developing larvae, often break off the bark on the attacked part of the stem. A complex of bark beetle species usually attacks the trees and Ips typographus is a dominant species. Attacks by I. amitinus usually occur in the upper part of the stem and in the crown. The gallery systems under the bark extend vertically on the tree. They extend from a nuptial chamber with four to seven irregular and wavy maternal galleries.

Symptoms by affected plant part

Leaves: abnormal colours; abnormal leaf fall; yellowed or dead.

Stems: abnormal exudates; internal feeding.

Whole plant: plant dead; dieback; internal feeding; frass visible.

Similarities to other species

I. amitinus is similar in all stages of development to Ips typographus. The adults of I. typographus are bigger (4.2-5.5 mm) and thicker than I. amitinus, and the frontal part of the pronotum is obliquely cut. The rear side of the elytral declivity is greasy and shiny. The gallery systems of I. typographus are shorter, with one to three (or four) regular and vertical maternal galleries extending from the nuptial chamber.

I. amitinus is also similar in all stages of development to Ips duplicatus. The adults of I. duplicatus are smaller (2.8-4.0 mm) than I. amitinus, and the frontal part of the pronotum is rounded. The second and third teeth on the rear elytral edge are joined and the rear side of the elytral declivity is shiny. I. duplicatus has shorter gallery systems than I. amitinus, with one to five regular and vertical maternal galleries extending from the nuptial chamber.

Detection and inspection

The discoloration of infested trees, due to the abnormal colour of the needles, is visible. Another obvious symptom of infestation is the bark that has been broken off by woodpeckers.

When looking under the bark of felled trees, the nuptial chambers, maternal galleries, eggs, larvae and pupae (depending on the extent of development) are easy to find in the upper part of the stem, including the crown zone, and on the branches.

The attacked trees are usually localized at the edges of stands and grouped. However, individually attacked trees also occur.

A complex of species, in which I. amitinus accompanies Ips typographus, usually attacks the trees. The early symptoms of infestation are not very evident; the discoloration of foliage and the broken bark (removed by woodpeckers) are more obvious.

Control

Cultural Control

The main control method used against I. amitinus (co-occurring with the other bark beetle species) is the removal of infested trees from stands before the emergence of a new generation of beetles. If the identification of infested trees is late (advanced development of insects inside the bark), debarking and bark-destroying (processing and composting) are effective. Trap logs are usually infested by I. amitinus and can be used as a control method against the complex of bark beetles. Spraying logs with insecticides (where prohibited) is also an applicable control method. Synthetic pheromones have not been effective.

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Dryocoetes autographus

Names and taxonomy

Preferred scientific name

Dryocoetes autographus Ratzeburg

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Scolytidae

Other scientific names

Dryocoetes americanus Hopkins

Ips autographus

Tomicus autographus

Dryocoetes pseudotsugae Swaine

Dryocoetes hectographus REITTER

EPPO code

DRYOAU (Dryocoetes autographus)

Common names

Finland:

huhtikirjaajat, kannon

Germany:

Borkenkaefer, Zotten-

Borkenkaefer, Zottiger nordischer Fichten-

Sweden:

barkborra, harig

Host range

List of hosts plants

Hosts (source - data mining)

Abies (firs), Larix (larches), Picea (spruces), Picea abies (common spruce), Picea mariana (black spruce), Pinus strobus (eastern white pine), Pinus sylvestris (Scots pine), Pseudotsuga (douglas-fir)

Geographic distribution

Distribution List

Europe

Czechoslovakia (former -)

unconfirmed record

CAB Abstracts, 1973-1998

Finland

present

CAB Abstracts, 1973-1998

Germany

unconfirmed record

CAB Abstracts, 1973-1998

Norway

unconfirmed record

CAB Abstracts, 1973-1998

Poland

unconfirmed record

CAB Abstracts, 1973-1998

Sweden

unconfirmed record

CAB Abstracts, 1973-1998

North America

Canada

Manitoba
unconfirmed record

CAB Abstracts, 1973-1998

Ontario

unconfirmed record

CAB Abstracts, 1973-1998

Natural enemies

Natural enemies listed in the database

Natural enemy

Pest stage attacked

Parasites/parasitoids:

Eurytoma arctica

Larvae, Pupae

Eurytoma morio

Larvae, Pupae

Parasitorhabditis autographi

Pathogens:

Malamoeba scolyti

References

CAB Abstracts, 1973-1998. Data mined from CAB Abstracts database, years 1973 to 1998. Wallingford, UK: CAB International

Ips avulsus

Names and taxonomy

Preferred scientific name

Ips avulsus Eichhoff

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Curculionidae

EPPO code

IPSXAV (Ips avulsus)

Common names

English:

pine, engraver, small southern

Host range

List of hosts plants

Hosts (source - data mining)

Pinus (pines), Pinus echinata (shortleaf pine), Pinus elliottii (slash pine), Pinus taeda (loblolly pine), Pinus virginiana (scrub pine)

Geographic distribution

Distribution List

North America

SA

present

CAB Abstracts, 1973-1998

Florida

present

CAB Abstracts, 1973-1998

Georgia (USA)

unconfirmed record

CAB Abstracts, 1973-1998

Louisiana

present

CAB Abstracts, 1973-1998

Oklahoma

unconfirmed record

CAB Abstracts, 1973-1998

Texas

present

CAB Abstracts, 1973-1998

Natural enemies

Natural enemies listed in the database

Natural enemy

Pest stage attacked

Parasites/parasitoids:

Neoparasitylenchus avulsi

Rhopalicus pulchripennis

Predators:

Scoloposcelis flavicornis

References

CAB Abstracts, 1973-1998. Data mined from CAB Abstracts database, years 1973 to 1998. Wallingford, UK: CAB International

Pityokteines sparsus

Names and taxonomy

Preferred scientific name

Pityokteines sparsus (Leconte)

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Scolytidae

Other scientific names

Ips balsameus Leconte

Tomicus balsameus

Ips sparsus (Lec.)

Pityokteines balsameus LECONTE

Pityokteines punctipennis LECONTE

EPPO code

PITKSA (Pityokteines sparsus)

Common names

English:

balsam fir bark beetle

bark beetle, balsam

bark beetle, balsam

fir French:

scolyte du sapin baumier

Host range

List of hosts plants

Hosts (source - data mining)

Abies balsamea (balsam fir)

Geographic distribution

Distribution List

North America

North America (as a whole) present

CAB Abstracts, 1973-1998

Canada

present

CAB Abstracts, 1973-1998

Manitoba

unconfirmed record

CAB Abstracts, 1973-1998

Nova Scotia

unconfirmed record

CAB Abstracts, 1973-1998

Ontario

unconfirmed record

CAB Abstracts, 1973-1998

USA

unconfirmed record

CAB Abstracts, 1973-1998

Minnesota

unconfirmed record

CAB Abstracts, 1973-1998

Natural enemies

Natural enemies listed in the database

Natural enemy

Pest stage attacked

Parasites/parasitoids:

Aphelenchoides pityokteini

Sulphuretylenchus nopimingi

References

CAB Abstracts, 1973-1998. Data mined from CAB Abstracts database, years 1973 to 1998. Wallingford, UK: CAB International

Pityogenes bidentatus

Names and taxonomy

Preferred scientific name

Pityogenes bidentatus Herbst

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Scolytidae

Other scientific names

Ips herbellae (Strohm.)

Bostrichus bidentatus

Ips bidentatus

Pityogenes bidens

Tomicus bidens

Tomicus bidentatus

Pityogenes herbellae Strohmeyer

Pityogenes obtusus EGGERS

EPPO code

PITYBD (Pityogenes bidentatus)

Common names

English:

beetle, two-toothed pine

Denmark:

totandet barkbille

Finland:

tähtikirjaaja kaksihampainen

Germany:

Borkenkaefer, Zweizaehniger Kiefern-

Netherlands:

Denneschorskever, tweetandige

Norway:

totannet barkbille

Sweden:

tvatandad barkborre

Host range

List of hosts plants

Hosts (source - data mining)

Picea (spruces), Picea abies (common spruce), Pinus sylvestris (Scots pine)

Geographic distribution

Distribution List

Europe

Europe (as a whole)

present

CAB Abstracts, 1973-1998

Former USSR

unconfirmed record

CAB Abstracts, 1973-1998

Norway

unconfirmed record

CAB Abstracts, 1973-1998

Poland

unconfirmed record

CAB Abstracts, 1973-1998

Russian Federation

present

CAB Abstracts, 1973-1998

Sweden

unconfirmed record

CAB Abstracts, 1973-1998

United Kingdom

unconfirmed record

CAB Abstracts, 1973-1998

North America

USA

unconfirmed record

CAB Abstracts, 1973-1998

New York

unconfirmed record

CAB Abstracts, 1973-1998

Natural enemies

Natural enemies listed in the database

Natural enemy

Pest stage attacked

Parasites/parasitoids:

Eurytoma morio

Larvae, Pupae

References

CAB Abstracts, 1973-1998. Data mined from CAB Abstracts database, years 1973 to 1998. Wallingford, UK: CAB International

Pityogenes bistridentatus

Names and taxonomy

Preferred scientific name

Pityogenes bistridentatus (Eichhoff)

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Scolytidae

Other scientific names

Ips bistridentatus (Eichhoff)

Pityogenes pilidens Reitter

Tomicus bistridentatus Eichh.

EPPO code

PITYBS (Pityogenes bistridentatus)

Common names

French:

petit, bostryche, du pin cembro

Germany:

Borkenkaefer, Kleiner Arven-

Host range

List of hosts plants

Hosts (source - data mining)

Pinus (pines), Pinus nigra (black pine)

Geographic distribution

Distribution List

Europe

Austria

present

CAB Abstracts, 1973-1998

Italy

unconfirmed record

CAB Abstracts, 1973-1998

References

CAB Abstracts, 1973-1998. Data mined from CAB Abstracts database, years 1973 to 1998. Wallingford, UK: CAB International

Ips cembrae

Names and taxonomy

Preferred scientific name

Ips cembrae (Heer, 1836)

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Curculionidae

Other scientific names

Bostrichus cembrae Heer, 1836

Tomicus cembrae (Heer, 1836)

Ips cembrae var. engadinensis Fuchs, 1913

Ips shinanoensis Yono, 1924

Ips fallax Eggers, 1915

EPPO code

IPSXCE (Ips cembrae)

Common names

English:

large larch bark beetle

scolytid, larger pine

French:

bostryche du meleze, grand

scolyte du cembrot

Germany:

Borkenkaefer, Achtzaehniger Laerchen-

Borkenkaefer, Grosser Laerchen-

Grosser Lärchenborkenkäfer

Italy:

Bostrico del pino cembro

Japan:

matu-no-o-kikuimusi

Norway:

Lerkebarkbille

Notes on taxonomy and nomenclature

In Russia and the Far East, a similar species Ips subelongatus occurs on Larix sibirica and other hosts. Many authors regard this as subsp. subelongatus of I. cembrae. With respect to the whole Eurasian region covered by EPPO, these two taxa are regarded as presenting distinct phytosanitary risks (whether considered as two distinct species, or as subspecies of a single species). With respect to other continents, they can be considered together. The molecular relationships of seven European Ips species, including I. cembrae, have been analysed by Stauffer et al. (1997).

Host range

Notes on host range

Larix decidua is the main host. Exotic Larix species planted in Europe may also be affected (L. leptolepis). The beetle may also occasionally breed in species of the genera Pinus and Picea.

Affected Plant Stages: Vegetative growing stage.

Affected Plant Parts: Stems.

List of hosts plants

Major hosts

Larix decidua (common larch)

Minor hosts

Larix kaempferi (Japanese larch), Picea (spruces), Pinus (pines), Pinus cembra (arolla pine)

Geographic distribution

Notes on distribution

I. cembrae is distributed throughout the Larix forests of the Alps and Carpathians in central Europe. It has also spread to Larix plantations in the Netherlands (Luitjes, 1974), Scotland, UK, and other countries.

Distribution List

Please note: The distribution status for a country or province is based on all the information available. When several references are cited, they may give conflicting information on the pest status. In particular, citations of earlier presence of a pest are included even though there is an authoritative reference to indicate that the pest is now absent.

Show EPPO notes

EPPO notes may be available for records where the source is EPPO, 2006. PQR database (version 4.5). Paris, France: European and Mediterranean Plant Protection Organization. Further details may be available in the corresponding EPPO Reporting Service item (e.g. RS 2001/141), for details of this service visit http://archives.eppo.org/EPPOReporting/Reporting_Archives.htm, or contact the EPPO Secretariat hq@eppo.fr.

Europe

Austria

present

native

not invasive

EPPO/CABI, 1997; EPPO, 2006

Croatia

restricted distribution

native

not invasive

EPPO/CABI, 1997; EPPO, 2006

Czech Republic

widespread

introduced

not invasive

EPPO/CABI, 1997; EPPO, 2006

Finland

absent, formerly present

EPPO, 2006

France

restricted distribution

native

not invasive

EPPO/CABI, 1997; EPPO, 2006

France [mainland]

restricted distribution

EPPO, 2006 Germany

widespread

introduced

not invasive

EPPO/CABI, 1997; EPPO, 2006

Greece

absent, never occurred

EPPO, 2006

Hungary

restricted distribution

introduced

not invasive

EPPO/CABI, 1997; EPPO, 2006

Ireland

absent, never occurred

EPPO, 2006

Italy

restricted distribution

introduced

not invasive

EPPO/CABI, 1997; EPPO, 2006

Italy [mainland]

restricted distribution

EPPO, 2006

Netherlands

restricted distribution

native

not invasive

EPPO/CABI, 1997; EPPO, 2006

Poland

restricted distribution

introduced

not invasive

EPPO/CABI, 1997; EPPO, 2006

Portugal

absent, never occurred

EPPO, 2006

Romania

present

native

not invasive

EPPO/CABI, 1997; EPPO, 2006

Russian Federation restricted

distribution

EPPO, 2006

Central Russia

restricted distribution

native

not invasive

EPPO/CABI, 1997; Mandel'shtam and Popovichev, 2000; EPPO, 2006

Serbia and Montenegro

present

native

not invasive

EPPO/CABI, 1997; EPPO, 2006

Serbia

present

native

not invasive

EPPO/CABI, 1997

Slovakia

restricted distribution

introduced

not invasive

EPPO/CABI, 1997; EPPO, 2006

Slovenia

widespread

native

not invasive

EPPO/CABI, 1997; EPPO, 2006

Spain

absent, never occurred

EPPO, 2006

Switzerland

restricted distribution

introduced

not invasive

EPPO/CABI, 1997; EPPO, 2006

Ukraine

widespread

native

not invasive

EPPO/CABI, 1997; EPPO, 2006

United Kingdom

restricted distribution

introduced (1950's)

not invasive

EPPO/CABI, 1997; EPPO, 2006

England and Wales

restricted distribution

EPPO, 2006

Northern Ireland

absent, never occurred

EPPO, 2006

Scotland

restricted distribution

introduced (1955)

EPPO, 2006

Biology and ecology

Adults emerge from hibernation sites in May. Main flight takes place on warm days in late May/early June. Males initiate boring and release a pheromone consisting of ipsdienol, ipsenol and 3-methyl-3-buten-1-ol (Stoakely et al., 1978; Rebenstorff and Francke, 1982). There may be one or two annual generations depending on the length of the summer season. The second generation may fly in August/September. There may also be a sister brood of the first generation, flying in June.

The new generation adults have a maturation feed in late summer, either in branches of younger trees or near to the brood gallery, if there is still fresh bark present. Adults aggregate in response to terpenoid pheromones (Kohnle et al., 1988). Adults hibernate in tunnels resulting from maturation feeding under thicker bark of trunks lying on the ground or, more commonly, in the forest litter (Schneider, 1977).

Morphology

Adult beetles are blackish, 4-6 mm long. There are four spines on each side of the elytral declivity. The third is the largest and is strongly capitate (Balachowsky, 1949; Grüne, 1979). The larva has been described by Kalina (1969).

Means of movement and dispersal

Laboratory experiments have shown that adult Ips species can fly continuously for several hours. In the field, however, flight has only been observed to take place over limited distances and then usually downwind. Beetles have been found in the stomach of trout in lakes 35 km from the nearest spruce forest, probably carried by the wind (Nilssen, 1978). Dispersal over longer distances depends on transportation under the bark of logs. I. cembrae has been intercepted on wood from central Europe imported into Sweden. There is little risk of movement with plants for planting.

Plant parts not known to carry the pest in trade/transport

- Bark
- Bulbs/Tubers/Corms/Rhizomes
- Fruits (inc. Pods)
- Growing Medium Accompanying Plants
- Flowers/Inflorescences/Cones/Calyx
- Leaves
- Seedlings/Micropropagated Plants
- Roots
- Stems (above Ground)/Shoots/Trunks/Branches
- True Seeds (inc. Grain)
- Wood.

Natural enemies

Natural enemies listed in the database

The list of natural enemies has been reviewed by a biocontrol specialist and is limited to those that have a major impact on pest numbers or have been used in biological control attempts; generalists and crop pests are excluded. For further information and reference sources, see About the data. Additional natural enemy records derived from data mining are presented as a separate list.

Natural enemies reviewed by biocontrol specialist

Natural enemy

Pest stage attacked

Parasites/parasitoids:

Dinotiscus eupterus

Larvae

Rhopalicus tutela

Larvae

Roptrocerus barbatus

Larvae

Roptrocerus xylophagorum

Larvae

Impact

This species is a secondary pest in native European Larix plantations, breeding in logs, wind-blown stems and dying trees. In Germany, timber from the April felling of larch is rapidly attacked and severely invaded (Elsner, 1997). Drought conditions on drier sites may promote attack on green trees. The introduced population in the UK is able to attack live trees suffering from drought stress (Bevan, 1987). The introduced population in the Netherlands developed on storm-damaged trees (Luitjes, 1974). As in the case of other conifer bark beetles, I. cembrae acts as a vector for a bluestain fungus (Ceratocystis laricicola) which also damages the tree (Redfern et al., 1987).

Phytosanitary significance

I. cembrae is regulated by the European Union (EU, 2000). A protected zone covering Greece, Ireland and parts of UK (Northern Ireland, Isle of Man) is designated. In the Irish/Northern Irish zone, no Ips species occur naturally, and many plantations of exotic conifers have been established, including Larix decidua and other Larix species. It is intended to maintain this zone free from other European and non-European bark beetles. Elsewhere in Europe, I. cembrae is an indigenous species presenting no particular risk.

I. cembrae may present a risk to other continents where Larix plantations are exploited, particularly North America and eastern Asia.

Appropriate phytosanitary measures would be to require treatment (debarking or kiln-drying) or "pest-free area" for wood, and treatment or "pest-free area" for bark. For plants for planting, which present little risk, only very large plants (above 3 m) might be considered ("pest-free place of production"). It may be appropriate to extend the requirement to other, less important hosts (Picea, Pinus).

Symptoms

Breeding occurs under the thick bark of Larix. Most commonly, three female galleries diverge longitudinally from the nuptial chamber, two in one direction and one in the opposite direction. Galleries with one, two or four female galleries are also found. Female galleries are rarely longer than 25 cm, usually 13-17 cm.

Symptoms by affected plant part

Stems: internal feeding.

Detection and inspection

Pheromone trapping can be used to detect Ips cembrae in the field (Niemeyer, 1989; Pavlin, 1997).

Control

Control measures are not used against this species, except to protect logs (Stoakely, 1975). According to Watzek and Niemeyer (1996), larch harvested by modern harvesters is readily colonized by I. cembrae, so control is needed. When thinnings are left unbarked in the stand, infestations may become severe, so spatial or temporal gaps should be left between harvesting and thinning.

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Orthotomicus erosus

Datos generales

Nombre científico

Orthotomicus erosus Wollaston

Sinonimias: Tomicus erosus, Ips erosus

Posición taxonómica

Orden: Coleoptera

Familia: Curculionidae

Subfamilia: Scolytinae

Nombres comunes:

südeuropäischer Kiefernborkenkäfer (alemán), European bark beetle, Mediterranean pine engraver (ingles), perforador de pinos, escarabajo de corteza, falso Ips del pino (español)

Descripción del insecto

Larvas

Son apodas, blanquecinas, encorvadas y con la cápsula cefálica ámbar.

Pupas

Son de blancas y ya son visibles los apéndices (antenas y patas). Miden aproximadamente 3 mm de longitud.

Los adultos miden entre 2.8 y 3,5 mm de longitud y son de color café, casi negro y élitros con estrías.

Huevos

Son esféricos, de medio milímetro de diámetro, aspecto gelatinoso y blanquecino.

Jim Stimmel, Pennsylvania Department of Agriculture, Bugwood.org

Distribución

Europa: Centro, sur y suroeste, islas del Mediterráneo (Francia, Portugal, España, Suiza, Italia, Bulgaria, Rumania y Grecia, hay reportes de su presencia en Lativia, Alemania, Austria, Polonia y en los Países Nórdicos). África: Norte (Marruecos, Túnez). Asia: China, Irán, Chipre, Israel, Jordania, Siria y Turquía. Introducido en: Sudáfrica, Fidji, Inglaterra, Suecia, Chile, Tajikastán y Estados Unidos (California, 2004)

Hospedantes: Primarios: Pinos (Pinus), secundarios: Cupressus spp, Cedrus libani, Picea orientalis, Cedrus atlantica, C. deodara, C. libani, Abies pinsapo, A. alba, A. normandianna, A. bornmülleriana Picea spp y Pseudotsuga menziesii

Ciclo de vida

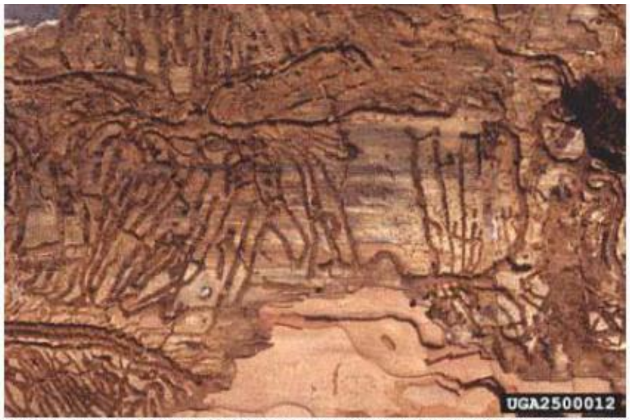
Esta especie es polígama, razón por la cual las galerías de oviposición presentan forma de estrella con 2, 3 o 4 ramas longitudinales ; cuando se presentan dos galerías opuestas, el sistema de galerías tiene la apariencia de una galería longitudinal simple; miden 1,2-1,4 mm de anchura y 2-8 cm de longitud.

Dependiendo de la temperatura puede tener de dos a cuatro generaciones al año; aunque en las Islas Baleares se presentan cinco generaciones. La oviposición se lleva a cabo durante varios períodos consecutivos originando cuatro generaciones hermanas. Los ataques se producen desde marzo hasta octubre; siendo los meses de primavera y verano la época de mayor actividad.

Una semana después de la oviposición emergen las larvas, las cuales alcanzan la madurez normalmente 20 días después y una semana como de pupas, por lo que se requieren de 35 días para que se formen los adultos, aunque en condiciones óptimas puede tardar sólo 15. Inverna como pupa o adulto bajo la corteza.

Daños

Es una plaga secundaria ya que atacan el fuste o las ramas gruesas de árboles en pié debilitados o moribundos (debido a la sequía, incendios, podas o al ataque de otros insectos o patógenos) o de árboles derribados (se asocia a trozas recién cortadas y restos de explotación), por lo que constituye uno de los principales elementos de selección natural, sin embargo cuando las poblaciones son numerosas, los ataques masivos pueden desencadenar la muerte de los árboles sanos; además son vectores de hongos que provocan el azulado de la madera (Ophiostoma ips, Verticadiella alaricis). En España es vector del nematodo Bursaphelenchus fungivorus



William M. Ciesla, Forest Health Management International, Bugwood.org

Formas de movimiento y dispersión

Los adultos son capaces de volar distancias considerables buscando sus hospederos, también pueden ser dispersados por el viento. Todos los estados de desarrollo pueden ser transportados debido al comercio en el embalaje o plataformas que contengas trozos de corteza.

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Xyleborus fallax Eichhoff

Names and taxonomy

Preferred scientific name

Xyleborus fallax Eichhoff

Taxonomic position

Phylum: Arthropoda
Class: Insecta
Order: Coleoptera
Family: Scolytidae

Other scientific names

Xyleborus amphicranulus Eggers

Notes on taxonomy and nomenclature

A number of species within the Xyleborini, the tribe in which Xyleborus and related genera are placed, could be considered potential pests to agriculture and forestry. X. fallax is one of a group of closely related species which also includes Xyleborus emarginatus. Synonymy follows Wood and Bright (1992), who give many references to the species. Further references can be found in Bright and Skidmore (1997, 2002).

Host range

Notes on host range

Members of Xyleborus and the related genera Ambrosiodmus, Euwallacea, Xyleborinus and Xylosandrus are all ambrosia beetles that feed and breed in a variety of forest trees and shrubs. Depending on the species, they may be found in small branches and seedlings to large logs. All are potentially damaging to agriculture and/or forestry under suitable conditions. Many species, previously considered of only minor importance, may become important pests in agriculture and forestry as a result of the continuing destruction of natural forests and the expansion of forest and tree crop plantations, agroforestry and agriculture.

X. fallax is a very common pin-hole borer of felled trees. There are numerous records from Dipterocarpaceae, and the species may perhaps show a slight preference for this family, but it is not very selective in its host requirements having been reported on hosts from more than 20 plant families (Browne, 1961;Ohno et al., 1986, 1987, 1988; Ohno, 1990). Only a selection for hosts is given. It is basically a forest species, and has only occasionally been recorded from crop trees. It could become a problem in reforestation projects or in plantations because of its large host range and its abundance.

Affected Plant Stages: Flowering stage, fruiting stage, post-harvest and vegetative growing stage.

List of hosts plants

Minor hosts

Durio zibethinus (durian), Manilkara zapota
(sapodilla) Wild hosts

Agathis , Anisoptera , Artocarpus elasticus , Canarium , Castanopsis tribuloides , Dialium , Dipterocarpus , Dipterocarpus baudii , Dryobalanops , Dyera , Eugenia , Euodia latifolia , Ficus padana , Intsia palembanica (ironwood), Koompassia excelsa , Octomeles sumatrana , Pometia pinnata (fijian longan), Shorea , Shorea leprosula , Shorea macroptera , Terminalia , Vatica

Distribution

Notes on distribution

There are unpublished records from Brunei Darussalam (RA Beaver, Chiangmai, Thailand, personal communication, 2004).

Distribution List

Please note: The distribution status for a country or province is based on all the information available. When several references are cited, they may give conflicting information on the pest status. In particular, citations of earlier presence of a pest are included even though there is an authoritative reference to indicate that the pest is now absent.

Asia				
India	present	native	not invasive	Wood & Bright, 1992
Assam	present	native	not invasive	Beeson, 1930
Indonesia	present	native	not invasive	Wood & Bright, 1992

Java	present	native	not invasive	Wood & Bright, 1992
Kalimantan	present	native	not invasive	Wood & Bright, 1992
Moluccas	present	native	not invasive	Ohno et al., 1987
Sulawesi	present	native	not invasive	Browne, 1980; Ohno et al., 1986
Sumatra	present	native	not invasive	Wood & Bright, 1992
Japan	absent, intercepted only	introduced		Ohno et al., 1986, 1987, 1988; Ohno, 1990
Malaysia	present	native	not invasive	Wood & Bright, 1992
Peninsular Malaysia	present	native	not invasive	Browne, 1961
Sabah	present	native	not invasive	Browne, 1985
Sarawak	present	native	not invasive	Eggers, 1927; Parsons, 1963
Myanmar	present	native	not invasive	Wood & Bright, 1992
Nepal	present	native	not invasive	Wood & Bright, 1992
Philippines	present	native	not invasive	Wood & Bright, 1992
Thailand	present	native	not invasive	Beaver, 1999
Vietnam	present			Wood & Bright, 1992
Oceania				

Australia	absent, intercepted only	introduced		Schedl, 1979
Papua New Guinea	present			Wood & Bright, 1992
Solomon Islands	present	native	not invasive	Ohno et al., 1988

History of introduction and spread

This species seems to be native in the region from Nepal to the Solomon Islands. As yet, it has not become established outside that area, although intercepted many times in Japan and Australia.

Biology and ecology

The important pest species in the genus Xyleborus and the related genera Ambrosiodmus, Euwallacea, Xyleborinus and Xylosandrus are all ambrosia beetles in the Xyleborini, a tribe with a social organization of extreme polygamy. The sexual dimorphism is strongly developed, and the ratio of females to males is high. The biology of this species is similar to Xyleborus emarginatus, and the two species often occur together in the same stems. The female of X. fallax flies mostly between dusk and dawn, and is attracted to light. It attacks dying or cut trees of all sizes down to about 8 cm diameter, though it is more common in larger logs. It will also attack newly sawn but unseasoned timber, but is not known to attack healthy trees (Browne, 1961). In unbarked stems, the female almost always makes a transverse gallery between bark and wood. Part of this is enlarged as a brood chamber, and most of the brood develops between bark and wood. However, other tunnels enter the wood where they form a branched sytem in one transverse plane. Brood chambers are also constructed in the wood. If the bark has been removed, surface galleries are absent, and the whole system lies in the wood (Browne, 1961). Development from attack to young adults takes about 1 month (Browne, 1961). Kalshoven (1959) notes one case of successful breeding in an acorn of Quercus sp., but this is most unusual.

All species of Xyleborus and the related genera are closely associated with ambrosial fungi. Some of these fungi are phytopathogenic and all species of Xyleborus and related genera should be considered to be possible vectors of plant disease.

Morphology

The following diagnostic notes refer to females only and include only the minimum characters required to differentiate these species from other pest species. Adult Female

Length about 2.5-2.8 mm. Frons convex, with deep punctures except on a median raised area. Antennal club with one suture on posterior surface. Pronotum 1.2 times longer than wide; sides weakly curved in basal two-thirds; anterior margin broadly rounded, without serrations. Elytra 1.8 times longer than wide; apex strongly emarginate in a 'U'-shape. Elytral declivity commencing on posterior third, shallowly excavate, lateral margin of excavated area elevated, armed with two distinct spines on each elytron, and a small spine at lateral angle of apical emargination. Immature Stages

The immature stages have not been described.

Means of movement and dispersal

Natural Dispersal

The adult females fly readily and flight is one the main means of movement and dispersal to previously uninfected areas. Of more importance, however, is the movement of infested woody material in timber, ship dunnage and crating. Numerous species of Xyleborus and related genera have been taken in port cities from raw logs destined for saw mills, from discarded ship dunnage, and in similar circumstances. Vector Transmission

X. fallax, like other members of the Xyleborini is dependent for food on a symbiotic ambrosia fungus or fungi. The fungus is transmitted by the female in a mycangial pouch. The position of this is not known in X. fallax. Both adult and larvae are dependent on the growth of the fungus on the walls of the gallery system in the wood for their food (Beaver, 1989). No studies of the ambrosia fungus have been made in X. fallax, but the typical staining of the wood around the galleries can easily be observed. Some ambrosia fungi are pathogenic to the host tree. This can be particularly important if live trees are attacked.

Movement in Trade

The species has frequently been intercepted in logs imported from tropical countries from Malaysia to Papua New Guinea (e.g. Ohno et al., 1986, 1987, 1988; Ohno, 1990).

Plant parts liable to carry the pest in trade/transport
- Bark: Adults; borne internally; visible to naked eye.
- Stems (above Ground)/Shoots/Trunks/Branches: Eggs, Larvae, Pupae, Adults; borne internally; visible under light microscope.
- Wood: Eggs, Larvae, Pupae, Adults; borne internally; visible under light microscope.

Plant parts not known to carry the pest in trade/transport
- Bulbs/Tubers/Corms/Rhizomes
- Fruits (inc. Pods)
- Growing Medium Accompanying Plants
- Flowers/Inflorescences/Cones/Calyx
- Leaves
- Seedlings/Micropropagated Plants
- Roots
- True Seeds (inc. Grain).

Natural enemies

No specific information is available for X. fallax. The immature stages of xyleborines have few natural enemies. The female parent normally remains in the gallery entrance whilst the immature stages are developing, preventing the entry of potential predators and parasitoids. Provided that the female remains alive and the growth of the ambrosia fungus on which the larvae feed is satisfactory, mortality of the immature stages is likely to be very low. Most mortality is probably during the dispersal of the adults, and during gallery establishment. The adults of ambrosia beetles are predated by lizards, clerid beetles and ants as they attempt to bore into the host tree. The adults will also fail to oviposit if the ambrosia fungus fails to establish in the gallery.

Impact

Economic impact

Species of Xyleborus are known pests of various forest and agricultural plants. Attacks by X. fallax usually only occur on very unhealthy trees. However, the species could become a pest in reforestation projects or in plantations. X. fallax is one of the commonest ambrosia beetles found in felled timber in the region from Southeast Asia to Papua New Guinea. As such, it must be partly responsible for the degrade of timber as a result of its galleries in the wood, and the staining of the surrounding wood by the associated ambrosia fungus. X. fallax and other ambrosia beetle species have the potential to transmit phytopathogenic fungi to their hosts.

Impact descriptors
Negative impact on: forestry production

Phytosanitary significance

Several other species of Xyleborus with similar habits to X. fallax have been imported to tropical and subtropical areas around the world. A few have become important pests, either because they may attack living or stressed trees, or because of their abundance in disturbed forest areas, and their very wide host range. X. fallax seems to be solely a secondary borer, but it can be very abundant in felled timber. An increased tendency for secondary species of ambrosia beetle to attack living trees in recent years has been noted (Kühnholz et al., 2003). The risk of introduction outside its present geographic range must be considered high. X. fallax is not specifically listed as a quarantine pest, but Xyleborus spp. are included in the APHIS Regulated Pest List in the USA, and as quarantine pests in New Zealand.

Symptoms

Attacked plants may show signs of wilting, branch die-back, shoot breakage, chronic debilitation, sun-scorch or a general decline in vigour.

Similarities to other species

The adult females of X. fallax are very similar to those of Xyleborus emarginatus, except in length; X. fallax is 2.8 mm and X. emarginatus is 3.5-3.7 mm. The emargination at the apex of the elytra is 'U'-shaped in X. fallax, but forms less than a semicircle in X. emarginatus. There are a number of other closely related species.

Detection and inspection

Some success has been obtained by using traps baited with ethanol placed in and around port facilities where infested material may be stored. Simple types of trap are described by Bambara et al. (2002) and Grégoire et al. (2003). X. fallax may also be collected at light. Visual inspection of suspected infested material is required to detect the presence of ambrosia beetles. Infestations are most easily detected by the presence of entry holes made by the attacking beetles, and the presence of frass produced during gallery construction.

Control

When Xyleborus species are detected in imported plant material, all of the infested material should immediately be destroyed. When they are detected in traps, plant material in the vicinity of the trap should be actively inspected, with special attention directed towards imported woody products such as timber, crating, dunnage and lumber milling scraps. If an active infestation is detected, control using insecticides is possible but is of limited effectiveness. Chemical control is not generally effective since the adult beetles bore deep into the host material. The following insecticides were effective against a species of Euwallacea destructive to tea: fenvalerate, deltamethrin, quinalphos, cypermethrin and dichlorvos (Muraleedharan, 1995); these insecticides may also be effective against other ambrosia beetles. The concealed habitats in which these species feed and reproduce, the difficulties and high costs of insecticide application, and environmental concerns all limit the effectiveness of chemical control. In logging areas, fast removal of the felled timber from the area will reduce attacks, and rapid conversion to sawn timber will reduce the depth of such attacks as have occurred. Attacks on sawn timber are much less frequent, and can be further reduced if the timber is seasoned and its moisture content falls (Roberts, 1987).

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Xyleborus emarginatus Eichhoff

Names and taxonomy

Preferred scientific name
Xyleborus emarginatus Eichhoff

Taxonomic position
Phylum: Arthropoda
Class: Insecta Order:
Coleoptera Family:
Scolytidae

Other scientific names
Xyleborus cinchonae (Veen)
Xyleborus cordatus Hagedorn
Xyleborus emarginatus semicircularis Schedl
Ips cinchonae Veen

Notes on taxonomy and nomenclature

A number of species within the Xyleborini, the tribe in which Xyleborus and related genera are placed, can be considered potential pests to agriculture and forestry; X. emarginatus is one of the more important species. Synonymy follows Wood and Bright (1992), who give many references to the species. Further references can be found in Bright and Skidmore (1997, 2002). The species forms part of a complex of closely related species, which are not always easily separated. Xyleborus fallax is another species in this complex.

Host range

Notes on host range

Members of Xyleborus and the related genera Ambrosiodmus, Euwallacea, Xyleborinus and Xylosandrus are all ambrosia beetles that feed and breed in a variety of forest trees and shrubs. Depending on the species, they may be found in small branches and seedlings to large logs. All are potentially damaging to agriculture and/or forestry under suitable conditions. Many species, previously considered of only minor importance, may become important pests in agriculture and forestry as a result of the continuing destruction of natural forests and the expansion of forest and tree crop plantations, agroforestry and agriculture.

X. emarginatus perhaps shows some preference for Dipterocarpaceae (Browne, 1961; Ohno, 1990), but it has been recorded from at least 19 families of plants (Browne, 1961), and is clearly not very host selective. There are few records from crop trees; most are from native forest trees.

Affected Plant Stages

Flowering stage, fruiting stage, post-harvest and vegetative growing stage.
List of hosts plants
Minor hosts
Cinchona , Cinnamomum camphora (camphor laurel), Durio zibethinus (durian)

Wild hosts

Agathis , Anisoptera , Artocarpus elastica , Canarium , Castanopsis javanica , Copaifera palustris (swamp sepetir), Dipterocarpus , Fagraea fragrans (Ironwood), Ficus , Gonystylus bancanus , Intsia palembanica (ironwood), Koompassia malaccensis , Pinus taiwanensis (Taiwan pine), Pinus yunnanensis (Yunnan pine), Podocarpus imbricata , Shorea , Terminalia

Geographic distribution

Notes on distribution

There are unpublished records from Malaysia (Sabah) and Brunei Darussalam (RA Beaver, Chiangmai, Thailand, personal communication, 2004).

Distribution List

Please note: The distribution status for a country or province is based on all the information available. When several references are cited, they may give conflicting information on the pest status. In particular, citations of earlier presence of a pest are included even though there is an authoritative reference to indicate that the pest is now absent.

Asia				
China	present	native	not invasive	Yin etq al., 1984; Wood & Bright, 1992
Fujian	present	native	not invasive	Yin et al., 1984; Wood & Bright, 1992
Shaanxi	present	native	not invasive	Yin et al., 1984; Wood & Bright, 1992
Sichuan	present	native	not invasive	Yin et al., 1984; Wood & Bright, 1992
Xizhang	present	native	not invasive	Yin et al., 1984; Wood & Bright, 1992
India	present	native	not invasive	Wood & Bright, 1992
Indonesia	present	native	not invasive	Wood & Bright, 1992
Java	present	native	not invasive	Wood & Bright, 1992
Kalimantan	present	native	not invasive	Wood & Bright, 1992
Moluccas	present	native	not invasive	Wood & Bright, 1992
Papua Barat	present	native	not invasive	Schedl, 1964
Sulawesi	present	native	not invasive	Ohno et al., 1986
Sumatra	present	native	not invasive	Wood & Bright, 1992
Japan	absent, intercepted only	introduced		Schedl, 1966; Ohno, 1990

Korea, Republic of	absent, intercepted only	introduced		Choo & Woo, 1983
Laos	present	native	not invasive	Wood & Bright, 1992
Malaysia	present	native	not invasive	Wood & Bright, 1992
Peninsular Malaysia	present	native	not invasive	Browne, 1961
Sarawak	present	native	not invasive	Browne, 1961
Myanmar	present	native	not invasive	Wood & Bright, 1992
Philippines	present	native	not invasive	Wood & Bright, 1992
Sri Lanka	present	native	not invasive	Wood & Bright, 1992
Thailand	present	native	not invasive	Beaver, 1999
Vietnam	present	native	not invasive	Wood & Bright, 1992
Oceania				
Australia	present	native	not invasive	Wood & Bright, 1992
Papua New Guinea	present	native	not invasive	Wood & Bright, 1992
Solomon Islands	present	native	not invasive	Bigger, 1988

History of introduction and spread

The species has been intercepted in timber imported to Japan and Korea on numerous occasions (e.g. Schedl, 1966, 1969; Choo and Woo, 1983; Ohno et al. 1986, 1987, 1988, 1989; Ohno, 1990) but has not established there.

Biology and ecology

The important pest species in the genus Xyleborus and the related genera Ambrosiodmus, Euwallacea, Xyleborinus and Xylosandrus are all ambrosia beetles in the Xyleborini, a tribe with a social organization of extreme polygamy. The sexual dimorphism is strongly developed, and the ratio of females to males is high. X. emarginatus usually attacks large logs, but will infest stems down to a diameter of about 15 cm (Browne, 1961). It is a secondary borer in unhealthy, dead or recently cut trees, and has also been found in newly sawn, unseasoned timber. It is not known to attack healthy trees (Kalshoven, 1959). When the bark has not been removed, the female makes a transverse gallery at the surface between the bark and the wood. Part of this is enlarged to form a brood chamber in which many of the larvae develop. There are also galleries penetrating the wood and branching within it. There may be more brood chambers within the wood, lying in the longitudinal plane (Kalshoven, 1959; Browne, 1961). The adults are nocturnal and attracted to light. In China (Tibet), the species occurs up to an altitude of 1600 m (Yin and Huang, 1988).

Morphology

The following diagnostic notes refer to females only and include only the minimum characters required to differentiate these species from other pest species.

Adult Female

Length about 3.5-3.6 mm. Frons convex, with deep punctures except on a median raised area. Antennal club with 1 suture on posterior surface. Pronotum 1.2 times longer than wide; sides parallel in basal two-thirds; anterior margin broadly rounded, without serrations. Elytra 1.5 times longer than wide; apex strongly emarginate. Elytral declivity commencing on posterior third, shallowly excavate, lateral margin of excavated area elevated, armed with two distinct spines on each elytron, and a small spine at lateral angle of apical emargination.

Immature Stages

The immature stages have not been described.

Means of movement and dispersal

Natural Dispersal

The adult females fly readily and flight is one the main means of movement and dispersal to previously uninfected areas. Of more importance, however, is the movement of infested woody material in timber, ship dunnage and crating. Numerous species of Xyleborus and related genera have been taken in port cities from raw logs destined for saw mills, from discarded ship dunnage, and in similar circumstances.

Vector Transmission

X. emarginatus, like other members of the Xyleborini is dependent for food on a symbiotic ambrosia fungus or fungi. The fungus is transmitted by the female in a mycangial pouch. The position of this is not known in X. emarginatus. Both the adults and larvae are dependent on the growth of the fungus on the walls of the gallery system in the wood for their food (Beaver, 1989). No studies of the ambrosia fungus have been made in X. emarginatus, but the typical staining of the wood around the galleries can easily be observed. Some ambrosia fungi are pathogenic to the host tree. This can be particularly important if live trees are attacked.

Movement in Trade

The species has frequently been intercepted in logs imported from tropical countries from Malaysia to Papua New Guinea (e.g. Ohno et al., 1987, 1988; Ohno, 1990).

Plant parts liable to carry the pest in trade/transport

- Bark: Adults; borne internally; visible to naked eye.
- Stems (above Ground)/Shoots/Trunks/Branches: Eggs, Larvae, Pupae, Adults; borne internally; visible under light microscope.
- Wood: Eggs, Larvae, Pupae, Adults; borne internally; visible under light microscope. Plant parts not known to carry the pest in trade/transport
- Bulbs/Tubers/Corms/Rhizomes
- Fruits (inc. Pods)
- Growing Medium Accompanying Plants
- Flowers/Inflorescences/Cones/Calyx
- Leaves
- Seedlings/Micropropagated Plants
- Roots
- True Seeds (inc. Grain).

Natural enemies

No specific information is available for X. emarginatus. The immature stages of xyleborines have few natural enemies. The female parent normally remains in the gallery entrance whilst the immature stages are developing, preventing the entry of potential predators and parasitoids. Provided that the female remains alive and the growth of the ambrosia fungus on which the larvae feed is satisfactory, mortality of the immature stages is likely to be very low. Most mortality is probably during the dispersal of the adults, and during gallery establishment. Adults of ambrosia beetles are predated by lizards, clerid beetles and ants as they attempt to bore into the host tree. Adults will also fail to oviposit if the ambrosia fungus fails to establish in the gallery.

Impact

Economic impact

Species of Xyleborus are known pests of various forest and agricultural plants. Attacks by X. emarginatus usually follow more serious causes of plant disease. However, the species could become a pest in reforestation projects or in plantations. X. emarginatus is one of the commonest ambrosia beetles found in felled timber in the region from South-East Asia to Papua New Guinea. As such, it must be partly responsible for the degrade of timber as a result of its galleries in the wood, and the staining of the surrounding wood by the associated ambrosia fungus. X. emarginatus and other ambrosia beetle species have the potential to transmit phytopathogenic fungi to their hosts.

Impact descriptors

Negative impact on: forestry production

Phytosanitary significance

Several other species of Xyleborus with similar habits to X. emarginatus have been imported to tropical and subtropical areas around the world. A few have become important pests, either because they may attack living or stressed trees, or because of their abundance in disturbed forest areas, and their very wide host range. X. emarginatus seems to be solely a secondary borer, but it can be very abundant in felled timber. The risk of introduction outside its present geographic range must be considered high. X. emarginatus is not specifically listed as a quarantine pest, but Xyleborus spp. are included in the APHIS Regulated Pest List in the USA, and as quarantine pests in New Zealand.

Symptoms

Attacked plants may show signs of wilting, branch die-back, shoot breakage, chronic debilitation, sun-scorch or a general decline in vigour.

Similarities to other species

Adult females of X. emarginatus are very similar to those of Xyleborus fallax, except in length; X. emarginatus is 3.5-3.6 mm long and X. fallax is 2.6 mm long. There are a number of other closely related species.

Detection and inspection

Some success has been obtained by using traps baited with ethanol placed in and around port facilities where infested material may be stored. Simple types of trap are described by Bambara et al. (2002) and Grégoire et al. (2003). Visual inspection of suspected infested material is required to detect the presence of ambrosia beetles. Infestations are most easily detected by the presence of entry holes made by the attacking beetles, and the presence of frass produced during gallery construction.

Control

When Xyleborus species are detected in imported plant material, all of the infested material should immediately be destroyed. When they are detected in traps, plant material in the vicinity of the trap should be actively inspected, with special attention directed towards imported woody products such as timber, crating, dunnage and lumber milling scraps. If an active infestation is detected, control using insecticides is possible but is of limited effectiveness. Chemical control is not generally effective since the adult beetles bore deep into the host material. The following insecticides were effective against a species of Euwallacea destructive to tea: fenvalerate, deltamethrin, quinalphos, cypermethrin and dichlorvos (Muraleedharan, 1995); these insecticides may also be effective against other ambrosia beetles.

The concealed habitats in which these species feed and reproduce, the difficulties and high costs of insecticide application, and environmental concerns all limit the effectiveness of chemical control. In logging areas, fast removal of the felled timber from the area will reduce attacks, and rapid conversion to sawn timber will reduce the depth of such attacks as have occurred. Attacks on sawn timber are much less frequent, and can be further reduced if the timber is seasoned and its moisture content falls (Roberts, 1987).

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Xyleborus perforans

Preferred scientific name
Xyleborus perforans

(Wollaston)
Taxonomic position

Phylum: Arthropoda
Class: Insecta Order:
Coleoptera Family:
Scolytidae

Other scientific names Tomicus
perforans (Wollaston)
Bostrichus testaceus Walker
Xyleborus duponti Montrouzier
Anodius tuberculatus Motschulsky
Anodius denticulus Motschulsky
Xyleborus kraatzi Eichhoff
Xyleborus kraatzi philippinensis Eichhoff
Xyleborus immaturus Blackburn
Xylopertha hirsutus Lea
Xyleborus whitteni
Beeson Xyleborus criticus
Schedl Xyleborus apertus
Schedl Xyleborus cylindrus
Schedl Xyleborus minimus
Schedl Common names
English:
island pinhole borer
sugarcane ambrosia beetle

Notes on taxonomy and nomenclature

This species is doubtfully distinct from Xyleborus volvulus (F.), with which it appears to intergrade in some areas (Wood and Bright, 1992; Bright and Skidmore, 2002). Molecular studies are needed on populations from different areas to determine intraspecific and interspecific relationships. Many references to the species are given by Wood and Bright (1992), and by Bright and Skidmore (1997, 2002). The synonymy given follows these authors.

Host range

Notes on host range

Members of Xyleborus and the related genera Ambrosiodmus, Euwallacea, Xyleborinus and Xylosandrus are all ambrosia beetles that feed and breed in a variety of forest trees and shrubs. Depending on the species, they may be found in small branches and seedlings to large logs. All are potentially damaging to agriculture and/or forestry under suitable conditions. Many species, previously considered of only minor importance, may become important pests in agriculture and forestry as a result of the continuing destruction of natural forests and the expansion of forest and tree crop plantations, agroforestry and agriculture.

X. perforans is widely distributed and very common. It attacks hundreds of host plant species in many plant families in forests and plantations(Browne, 1961; Schedl, 1963; Gray and Wylie, 1974), and has been intercepted in Japan and elsewhere from imported timber of many species and families (e.g. Ohno et al., 1987, 1988, 1989; Ohno, 1990). Its wide host range, coupled with its tolerance of a considerable range of climatic conditions, makes it a potential pest in forest plantations. It is normally found in dying, dead and newly-felled trees, and usually infests material of a moderate to large size. Given the great range of host trees attacked, and the differences between geographical areas, it is not possible to distinguish 'main host' trees from 'other host' trees. It may be expected that almost any crop, plantation or ornamental tree in a particular area can be attacked. The list that is given here is a small selection of hosts only.

Affected Plant Parts

Whole plant.

List of hosts plants

Minor hosts

Acacia mangium (brown salwood), Anacardium occidentale (cashew nut), Annona squamosa (sugarapple), Artocarpus heterophyllus (jackfruit), Bombax ceiba (silk cotton tree), Carica papaya (papaw), Cinnamomum verum (cinnamon), Citrus , Cocos nucifera (coconut), Hevea brasiliensis (rubber), Leucaena leucocephala (leucaena), Macadamia integrifolia (macadamia nut), Mangifera indica (mango), Persea americana (avocado), Saccharum officinarum (sugarcane), Theobroma cacao (cocoa)

Wild hosts

Agathis macrophylla (kauri), Albizia , Araucaria cunninghamii (colonial pine), Bauhinia variegata (mountain ebony), Boswellia serrata (Indian olibanum tree), Dryobalanops aromatica (Borneo camphorwood), Eucalyptus (Eucalyptus tree), Ficus , Gonystylus bancanus , Rhizophora mucronata (true mangrove), Shorea robusta (sal), Toona ciliata (toon).

Geographic distribution

Notes on distribution

It should be noted that Wood and Bright (1992) refer all records of the species from Central and South America which appear in CIE (1973) to the closely related species Xyleborus. Within Africa, both species are believed to occur (Wood and Bright, 1992), sometimes within the same country. Schedl (1963) refers nearly all the African records to Xyleborus volvulus (as its synonym X. torquatus). Because the two species may intergrade (Wood and Bright, 1992), and biological and other information in this datasheet is equally valid to both species, the African records in CIE (1973) have been retained here.

Distribution List

Please note: The distribution status for a country or province is based on all the

information available. When several references are cited, they may give conflicting information on the pest status. In particular, citations of earlier presence of a pest are included even though there is an authoritative reference to indicate that the pest is now absent.

Europe				
Germany	absent, intercepted only	introduced		Cola, 1971
Italy	absent, intercepted only	introduced		Cola, 1971, 1973
Poland	absent, intercepted only	introduced		Bright and Skidmore, 1997
[Portugal]				
Azores	present	introduced	invasive	Wood & Bright, 1992
Madeira	present	introduced	invasive	CIE, 1973; Wood & Bright, 1992
[Spain]				
Canary Islands	present	introduced	invasive	Wood & Bright, 1992
Asia				
Bangladesh	present	native	not invasive	Beeson, 1930
Cambodia	present	native	not invasive	CIE, 1973
China	present	native	not invasive	Wood & Bright, 1992
Guangxi	present	native	not invasive	Wood & Bright, 1992
Taiwan	present	native	not invasive	CIE, 1973; Wood & Bright, 1992

Yunnan	present	native	not invasive	Wood & Bright, 1992
Christmas Island (Indian Ocean)	present	introduced		CIE, 1973
Cocos Islands	present	introduced	invasive	CIE, 1973
India	present	native	not invasive	CIE, 1973
Andaman and Nicobar Islands	present	native	not invasive	CIE, 1973; Wood & Bright, 1992
Assam	present	native	not invasive	CIE, 1973
Bihar	present	native	not invasive	CIE, 1973
Indian Punjab	present	native	not invasive	CIE, 1973
Karnataka	present	native	not invasive	Beeson, 1930
Kerala	present	native	not invasive	CIE, 1973
Madhya Pradesh	present	native	not invasive	CIE, 1973
Maharashtra	present	native	not invasive	CIE, 1973
Orissa	present	native	not invasive	CIE, 1973
Tamil Nadu	present	native	not invasive	CIE, 1973
Uttar Pradesh	present	native	not invasive	CIE, 1973
West Bengal	present	native	not invasive	CIE, 1973

Indonesia	present	native	not invasive	CIE, 1973; Kalshoven LGE, Laan PA van der (Reviser translator), 1981
Java	present	native	not invasive	CIE, 1973; Wood & Bright, 1992
Kalimantan	present	native	not invasive	Wood & Bright, 1992
Moluccas	present	native	not invasive	Ohno et al., 1987
Nusa Tenggara	present	native	not invasive	CIE, 1973; Wood & Bright, 1992
Sulawesi	present	native	not invasive	CIE, 1973; Wood & Bright, 1992
Sumatra	present	native	not invasive	CMI, 1973; Wood & Bright, 1992
Japan	absent, intercepted only	introduced		Ohno et al., 1987, 1988, 1989; Ohno, 1990
Bonin Island	present	introduced	invasive	CIE, 1973; Nobuchi, 1985
Ryukyu Archipelago	present	introduced	invasive	Nobuchi, 1985
Laos	present	native	not invasive	CIE, 1973
Malaysia	present	native	not invasive	CIE, 1973; Wood & Bright, 1992
Peninsular Malaysia	present	native	not invasive	Browne, 1961
Sarawak	present	native	not invasive	CIE, 1973
Maldives	present	introduced	invasive	CIE, 1973
Myanmar	present	native	not	CIE, 1973; Wood & Bright,

			invasive	1992
Nepal	present	native	not invasive	Schedl, 1973
Pakistan	present	native	not invasive	CIE, 1973
Philippines	present	native	not invasive	CIE, 1973; Wood & Bright, 1992
Singapore	present	native	not invasive	CIE, 1973
Sri Lanka	present	native	not invasive	CIE, 1973; Wood & Bright, 1992
Thailand	present	native	not invasive	CIE, 1973; Wood & Bright, 1992
Vietnam	present	native	not invasive	CIE, 1973; Wood & Bright, 1992
Africa				
Burundi	present	introduced	invasive	CIE, 1973
Cameroon	present	introduced	invasive	CIE, 1973; Wood & Bright, 1992
Cape Verde	present	introduced	invasive	CIE, 1973; Wood & Bright, 1992
Comoros	present	introduced	invasive	CIE, 1973; Wood & Bright, 1992
Congo Democratic Republic	present	introduced	invasive	CIE, 1973; Wood & Bright, 1992
Congo	present	introduced	invasive	CIE, 1973
Côte d'Ivoire	present	introduced	invasive	Wood & Bright, 1992
Gabon	present	introduced	invasive	Wood & Bright, 1992
Ghana	present	introduced	invasive	CIE, 1973; Schedl, 1977

Kenya	present	introduced	invasive	CIE, 1973; Wood & Bright, 1992
Madagascar	present	introduced	invasive	CIE, 1973; Wood & Bright, 1992
Malawi	present	introduced	invasive	CIE, 1973; Wood & Bright, 1992
Mauritius	present	introduced	invasive	CIE, 1973; Wood & Bright, 1992
Nigeria	present	introduced	invasive	CIE, 1973; Wood & Bright, 1992
Rwanda	present	introduced	invasive	CIE, 1973
Réunion	present	introduced	invasive	CIE, 1973; Wood & Bright, 1992
Sao Tome and Principe	present	introduced	invasive	Schedl, 1963; CIE, 1973
Seychelles	present	introduced	invasive	CIE, 1973; Wood & Bright, 1992
Sierra Leone	present	introduced	invasive	Wood & Bright, 1992
Somalia	present	introduced	invasive	CIE, 1973; Wood & Bright, 1992
Tanzania	present	introduced	invasive	CIE, 1973; Wood & Bright, 1992
Uganda	present	introduced	invasive	CIE, 1973; Wood & Bright, 1992
North America				
Canada	present	introduced	invasive	Krcmar-Nozic et al., 2000; Bright & Skidmore, 2002
British Columbia	present	introduced	invasive	Bright & Skidmore, 2002
Oceania				

American Samoa	present	introduced	invasive	CIE, 1973
Australia	present	native	not invasive	CIE, 1973; Wood & Bright, 1992
New South Wales	present	native	not invasive	CIE, 1973
Queensland	present	native	not invasive	CIE, 1973
Belau	present	introduced	invasive	Wood & Bright, 1992
Cook Islands	present	introduced	invasive	Wood & Bright, 1992
Federated states of Micronesia	present	introduced	invasive	CIE, 1973; Wood & Bright, 1992
QCaroline Islands	present	introduced	invasive	CIE, 1973
Fiji	present	introduced	invasive	CIE, 1973; Wood & Bright, 1992
French Polynesia	present	introduced	invasive	CIE, 1973; Wood & Bright, 1992
Marquesas (Iles Marquises)	present	introduced	invasive	CIE, 1973
Tahiti	present	introduced	invasive	Beeson, 1935
Guam	present		invasive	Wood & Bright, 1992
Kiribati	present	introduced	invasive	Wood & Bright, 1992
Line Islands	present	introduced	invasive	CIE, 1973
Marshall Islands	present	introduced	invasive	CIE, 1973
New Caledonia	present	introduced	invasive	CIE, 1973; Wood & Bright, 1992
New Zealand	absent, intercepted only	introduced		Bain, 1974, 1977
Niue	present	introduced	invasive	Wood & Bright, 1992

Northern Mariana Islands	present	introduced	invasive	CIE, 1973; Wood & Bright, 1992
Papua New Guinea	present	native	not invasive	CIE, 1973; Wood & Bright, 1992
Samoa	present	introduced	invasive	CIE, 1973
Solomon Islands	present	introduced	invasive	CIE, 1973; Wood & Bright, 1992
Tonga	present	introduced	invasive	APPPC, 1987
Vanuatu	present	introduced	invasive	CIE, 1973; Wood & Bright, 1992

History of introduction and spread

As with a number of other widespread species of Xyleborus and related genera, it is difficult to be certain of the extent of the native distribution. This species appears to be native in the Oriental region through to Australia. It was probably introduced into Africa hundreds of years ago through commerce, and has undoubtedly been introduced to many of the Pacific islands through human agency many years ago. The species has frequently been intercepted in timber imported to Japan from countries in the region from Cambodia, the Philippines and Indonesia to the Solomon Islands Ohno et al., 1987, 1988, 1989; Ohno, 1990), but has not become established on the main islands of Japan. It has also been intercepted in imported timber in Australia and India (where it also native) (Schedl, 1964; Krishnasamy et al., 1991), New Zealand Bain, 1974, 1977; Brockerhoff et al., 2003), and in Germany, Italy and Poland Cola, 1971, 1973; Bright and Skidmore, 1997), but is not established in New Zealand or in Europe.

Biology and ecology

The important pest species in the genus Xyleborus and the related genera Ambrosiodmus, Euwallacea, Xyleborinus and Xylosandrus, are all ambrosia beetles in the Xyleborini, a tribe with a social organization of extreme polygamy. The sexual dimorphism is strongly developed, and the ratio of females to males is high. The biology of X. perforans has been studied by Beeson (1930), Browne (1961), Schedl (1963) and Kalshoven (1964). The species is particularly common in disturbed areas. It flies mainly around dusk, and may be attracted to light in large numbers. It normally attacks stressed or recently felled trees, but also readily attacks newly sawn timber (Browne, 1961). It also attacks fire-damaged trees, and salvaged logs (Wylie and Shanahan, 1976; Wylie et al., 1999). Living trees are normally only attacked through injuries or diseased areas (Browne, 1961). It is not very size-selective, and attacks stems from about 5 cm diameter to the largest logs, but is not found in small shoots and twigs (Browne, 1961). The gallery system consists of branching tunnels, without enlargements, and penetrate deeply into the wood. When there are dense attacks, the tunnels from different broods may intersect (Beeson, 1930). The tunnels are usually in one transverse plane, but Kalshoven (1964) notes that some galleries have more than one transverse level, the levels connected by vertical galleries, and that side branches may connect to the outside, forming additional openings to the exterior. Sometimes there may be a surface gallery, at the cambial level, before the beetle penetrates the wood (Browne, 1961). The first eggs appear when the tunnel length is from 3-8 cm (Kalshoven, 1964), and the larvae develop and pupate within the gallery system. The parent female and the larvae feed on the ambrosia fungus growing on the walls of the galleries. Kalshoven (1964, quoting Zehnter, 1900) gives the duration of the egg stage as 4 days, the larval stage as 7-9 days, and the pupal stage as 4 days, giving a total of only 16-18 days from egg to teneral adult. These are likely to be optimal figures, and in most conditions a generation would be expected to take 4-6 weeks. The total brood size is difficult to estimate because of the intricacies of the tunnel system. Kalshoven (1964) gives figures of 56 to 112 for advanced gallery systems, and total broods may be even higher in favourable conditions. After mating with their brother(s), the new generation of females emerges through the original entrance hole (or presumably also through any additional openings from the gallery system to the exterior). Kalshoven (1964, quoting Zehnter, 1900) suggests that the first females of the new generation extend the gallery system, and begin to lay eggs before the parental female has died, so that there may be overlapping generations within a single cane stem. In most countries where it occurs, breeding is continuous throughout the year (Browne, 1968), although Beeson (1930) notes that there may be marked seasonal fluctuations in populations.

Morphology

The following diagnostic notes refer to females only and include only the minimum characters required to differentiate this species from other pest species.

Adult Female

Length 2.1-2.5 mm. Frons convex, entire surface minutely reticulate, with faint, shallow punctures. Antennal club solid on posterior face. Pronotum 1.2 times longer than wide; sides moderately arcuate; anterior margin broadly rounded, without serrations. Elytra 1.7 times longer than wide; apex narrowly rounded. Elytral declivity steep, convex, commencing on posterior third of elytra; face of each elytron with a row of 4 to 5 small, acute granules in interspaces 1 and 3; several smaller granules are present in interspaces 4, 5 and 6; interspace 7 rounded, with small, acute granules.

Immature Stages

The immature stages have not been described.

Means of movement and dispersal

Adult females fly readily and flight is one the main means of movement and dispersal to previously uninfected areas. Of more importance however, is the movement of infested woody material in timber, dunnage and crating. Numerous species of Xyleborus and related genera have been taken in port cities from raw logs destined for saw mills, from discarded ship dunnage, and in similar circumstances.

Both adults and larvae of X. perforans are dependent on the growth of the fungus on the walls of the gallery system in the wood for their food. The fungus is transmitted by the female in a mycangium. In X. perforans, this most probably consists of mandibular pouches, as in related species, including X. volvulus (Francke-Grosmann, 1966; Beaver, 1989). 'Contamination ' of the mycangia by the spores of pathogenic fungi is possible. Spores of pathogenic fungi can also be transported on the cuticle of the beetle, although their chance of survival there is much less than in the mycangial pouch. No specific studies have been made on fungi associated with X. perforans.

Plant parts liable to carry the pest in trade/transport

- Bark: Adults; borne internally; visible to naked eye.
- Stems (above Ground)/Shoots/Trunks/Branches: Eggs, Larvae, Pupae, Adults; borne internally; visible under light microscope.
- Wood: Eggs, Larvae, Pupae, Adults; borne internally; visible under light microscope. Plant parts not known to carry the pest in trade/transport
- Bulbs/Tubers/Corms/Rhizomes
- Fruits (inc. Pods)
- Growing Medium Accompanying Plants
- Flowers/Inflorescences/Cones/Calyx
- Leaves
- Seedlings/Micropropagated Plants
- Roots
- True Seeds (inc. Grain).

Natural enemies

The immature stages of xyleborines have few natural enemies. The female parent normally remains in the gallery entrance whilst the immature stages are developing, preventing the entry of potential predators and parasitoids. Provided that the female remains alive and the growth of the ambrosia fungus on which the larvae feed is satisfactory, mortality of the immature stages is likely to be very low. Most mortality is probably during the dispersal of the adults, and during gallery establishment. Adult ambrosia beetles are predated by lizards, clerid beetles and ants as they attempt to bore into the host tree. Adults will also fail to oviposit if the ambrosia fungus fails to establish in the gallery. One species of hymenopteran parasitoid (Eulophidae) has been bred from adults of X. perforans attacking macadamia trees in Hawaii (LaSalle, 1995). It oviposits in the adult, and the immature stages of X. perforans are not attacked.

Natural enemies listed in the database

The list of natural enemies has been reviewed by a biocontrol specialist and is limited to those that have a major impact on pest numbers or have been used in biological control attempts; generalists and crop pests are excluded. For further information and reference sources, see About the data. Additional natural enemy records derived from data mining are presented as a separate list.

Natural enemies reviewed by biocontrol specialist	
Natural enemy	**Pest stage attacked**
Parasites/parasitoids:	
Phymastichus xylebori	Adults

Impact

Economic impact

X. perforans has been recorded as a minor pest of sugarcane and coconut trees in Indonesia (Kalshoven, 1964; Browne, 1968), and in the days of wooden beer, wine and rum barrels, was known to bore into casks and cause leakage (Blandford, 1893; Schedl, 1963). It has been known to cause minor damage by its attacks on the tapped panels of rubber trees in Guyana and Sri Lanka (Browne, 1968), and on coffee and coffee shade trees in Suriname (LePelley, 1968). However, it is more important in many areas because of its heavy attacks on newly felled trees and recently sawn, unseasoned timber. The attacks result in numerous pinholes in the wood and fungal staining around them (Browne, 1961), and can render the timber unusable for furniture or veneer.

Impact descriptors

Negative impact on: crop production; forestry production

Phytosanitary significance

Several other species of Xyleborus with similar habits to X. perforans have been imported to tropical and subtropical areas around the world. A few have become important pests, either because they may attack living or stressed trees, or because of their abundance in disturbed forest areas, and their very wide host range. X. perforans is a secondary borer, but it can attack injured trees, and is often very abundant in recently felled timber.

Kühnholz et al. (2003) note that a number of secondary borers have started to attack living trees, and discuss the possible reasons for this change of habit. The risk of introduction outside its present geographic range must be considered high. X. perforans is not specifically listed as a quarantine pest, but Xyleborus spp. are included in the APHIS Regulated Pest List in the USA, and as quarantine pests in New Zealand.

Symptoms

Attacked plants may show signs of wilting, branch die-back, shoot breakage, chronic debilitation, sun-scorch or a general decline in vigour.

Symptoms by affected plant part

Whole plant: plant dead; dieback; internal feeding; wilt.

Detection and inspection

Some success has been obtained by using traps baited with ethanol placed in and around port facilities where infested material may be stored. Simple types of trap are described by Bambara et al. (2002) and Gregoire et al. (2003). Visual inspection of suspected infested material is required to detect the presence of ambrosia beetles. Infestations are most easily detected by the presence of entry holes made by the attacking beetles, and the presence of frass produced during gallery construction.

Control

When Xyleborus species are detected in plant material in areas outside the present range of the species, it is necessary to immediately destroy all of the infested material. When they are detected in traps, plant material in the vicinity of the trap should be actively inspected, with special attention directed towards imported woody products such as crating, dunnage and lumber milling scraps. If an active infestation is detected, control using insecticides is possible but is of limited effectiveness. Chemical control is not generally effective because the adult beetles bore deep into the host material. The following insecticides were used against the ambrosia beetle, Euwallacea fornicatus, which is destructive to tea: fenvalerate, deltamethrin, quinalphos, cypermethrin and dichlorvos (Muraleedhaan, 1995). Selvasundaram et al. (2001) found that lambda-cyhalothrin 2.5 EC was more effective in reducing E. fornicatus populations than fenvalerate. Jose et al. (1989) suggest the use of solutions of boric acid and borax, which have both fungicidal and some insecticidal action, to protect stored wood. These insecticides may also be effective against other ambrosia beetles, but the concealed habitats in which these species feed and reproduce, the difficulties and high costs of insecticide application, and environmental concerns all limit the effectiveness of chemical control.

The use of the parasitoid, Phymastichus xylebori, which attacks the adult beetle, has been suggested by LaSalle (1995). However, it seems unlikely that this would be practical or effective.

In logging areas, prompt removal of the felled timber from the area will reduce attacks, and rapid conversion to seasoned, sawn timber will reduce the depth of such attacks as have occurred (Roberts, 1987). It should be noted that debarking may increase the susceptibility to attack (Supriana et al., 1978). X. perforans normally forms part of a complex of bark and ambrosia beetle species attacking felled trees, and control measures need to be directed against all species at the same time (Beaver, 2000).

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Xyleborus similis

Names and taxonomy

Preferred scientific name
Xyleborus similis Ferrari
Taxonomic position
Phylum: Arthropoda
Class: Insecta
Order: Coleoptera
Family: Scolytidae
Other scientific names
Xyleborus parvulus Eichhoff
Xyleborus dilatatus Eichhoff
Xyleborus bucco Schaufuss
Xyleborus capito Schaufuss
Xyleborus novaguineanus Schedl
Xyleborus dilatatulus Schedl
Xyleborus submarginatus
Blandford EPPO code
XYLBSI (Xyleborus similis)
Notes on taxonomy and nomenclature

Xyleborus novaguineanus was synonymised with X. similis by Wood (1989). The majority of the specimens of the two species are clearly morphologically distinct, but in the region of New Guinea and Australia, some intermediate specimens occur which are difficult to assign to one or other species. Because the biology of both is the same, X. novaguineanus is considered here as a synonym of X. similis. The catalogue of Wood and Bright (1992) gives many references to the taxonomy, distribution and biology of the species. More recent references are given by Bright and Skidmore (1997, 2002).

Host range

Notes on host range

Members of Xyleborus and the related genera Ambrosiodmus, Euwallacea, Xyleborinus and Xylosandrus are all ambrosia beetles that feed and breed in a variety of forest trees and shrubs. Depending on the species, they may be found in small branches and seedlings to large logs. All are potentially damaging to agriculture and/or forestry under suitable conditions. Many species, previously considered of only minor importance, may become important pests in agriculture and forestry as a result of the continuing destruction of natural forests and the expansion of forest and tree crop plantations, agroforestry and agriculture.

The species is strongly polyphagous, the range of its hosts determined primarily by the variety of trees in which the associated ambrosia fungus will grow. Browne (1961) recorded X. similis (and its synonym Xyleborus parvulus) from 33 host plant families, and more than twice that number of species. Schedl (1963) recorded the species from 32 families and about 80 species. Further hosts in Java are listed by Kalshoven (1964). Many more host genera in which the species has been intercepted in Japan are listed in papers from the Nagoya Plant Protection Station, e.g. Ohno et al. (1987, 1988, 1989); Ohno (1990). Given the great range of host trees attacked, and the differences between geographical areas, it is not possible to distinguish 'main host' trees from 'other host' trees (see Host table). It may be expected that almost any crop, plantation or ornamental tree in a particular area can be attacked. The host list in this datasheet is only a selection of hosts.

Affected Plant Stages

Flowering stage, fruiting stage and vegetative growing stage.

Affected Plant Parts

Stems.

List of hosts plants

Minor hosts

Artocarpus integer (champedak), Camellia sinensis (tea), Durio zibethinus (durian), Erythrina subumbrans (December tree), Falcataria moluccana (batai wood), Ficus religiosa (botree), Hevea brasiliensis (rubber), Mangifera indica (mango), Manihot glaziovii (ceara rubber), Syzygium cumini (black plum), Tectona grandis (teak), Theobroma cacao (cocoa) Wild hosts

Agathis , Boswellia serrata (Indian olibanum tree), Bruguiera parvifolia , Dipterocarpus baudii , Dryobalanops aromatica (Borneo camphorwood), Intsia palembanica (ironwood), Pometia pinnata (fijian longan), Pterocarpus indicus (red sandalwood), Rhizophora mucronata (true mangrove), Shorea leprosula , Styrax benzoin (gum Benjamin), Terminalia bellirica (beleric myrobalan)

Geographic distribution

Notes on distribution

Wood and Bright (1992) include Hawaii in the distribution, but the Hawaiian Terrestrial Arthropod Database of the Bernice P. Bishop Museum indicates that the species was adventive and not established in the state. Samuelson (1981) suggests that the record is doubtful. Although Madagascar is included in the distribution by Wood and Bright (1992), Schedl (1977) states that there are no records from that country. The distribution map includes records based on specimens of X. similis from the collection in the Natural History

Museum (London, UK): dates of collection are noted in the List of countries (NHM, various dates). There are unpublished records from Laos and Reunion (RA Beaver, Chiangmai, Thailand, personal communication, 2004).

Distribution List

Please note: The distribution status for a country or province is based on all the information available. When several references are cited, they may give conflicting information on the pest status. In particular, citations of earlier presence of a pest are included even though there is an authoritative reference to indicate that the pest is now absent.

Show EPPO notes

EPPO notes may be available for records where the source is **EPPO, 2006. PQR database (version 4.5). Paris, France: European and Mediterranean Plant Protection Organization.**

Further details may be available in the corresponding EPPO Reporting Service item (e.g. RS 2001/141), for details of this service visit http://archives.eppo.org/EPPOReporting/Reporting_Archives.htm, or contact the EPPO Secretariat hq@eppo.fr.

Asia				
Bangladesh	present	native	not invasive	Beeson, 1930
Bhutan	present	native	not invasive	NHM, 1986
Cambodia	present	native	not invasive	Schedl, 1966
China	present	native	not invasive	Wood & Bright, 1992
Guangdong	present	native	not invasive	Wood & Bright, 1992
Hong Kong	present	native	not invasive	NHM, 1892
Taiwan	present	native	not invasive	Wood & Bright, 1992
Christmas Island (Indian Ocean)	present	introduced	invasive	Wood & Bright, 1992
Cocos Islands	present	introduced	invasive	Wood & Bright, 1992
India	present	native	not invasive	Wood & Bright, 1992
Andaman and Nicobar Islands	present	native	not invasive	Wood & Bright, 1992
Assam	present	native	not invasive	Beeson, 1930; Schedl, 1969
Bihar	present	native	not	Beeson, 1930

			invasive	
Karnataka	present	native	not invasive	Beeson, 1930
Madhya Pradesh	present	native	not invasive	Beeson, 1930; Schedl, 1975a
Sikkim	present	native	not invasive	Saha & Maiti, 1984
Tamil Nadu	present	native	not invasive	Beeson, 1930; Schedl, 1975a
Uttar Pradesh	present	native	not invasive	Beeson, 1930; Schedl, 1969
West Bengal	present	native	not invasive	Beeson, 1930
Indonesia	present	native	not invasive	Wood & Bright, 1992
Java	present	native	not invasive	Wood & Bright, 1992
Kalimantan	present	native	not invasive	Wood & Bright, 1992
Moluccas	present	native	not invasive	Eggers, 1926; Ohno et al., 1987
Sulawesi	present	native	not invasive	Wood & Bright, 1992
Sumatra	present	native	not invasive	Wood & Bright, 1992
Japan	absent, intercepted only	introduced	not invasive	Ohno et al., 1987, 1988, 1989
Bonin Island	present	introduced	not invasive	Wood & Bright, 1992
Jordan	present	introduced	invasive	Wood & Bright, 1992
Korea, Republic of	absent, intercepted only	introduced	not invasive	Choo et al., 1981
Malaysia	present	native	not invasive	Wood & Bright, 1992
Peninsular Malaysia	present	native	not invasive	Browne, 1961
Sabah	present	native	not invasive	Browne, 1968
Sarawak	present	native	not invasive	Browne, 1961
Myanmar	present	native	not	Wood & Bright, 1992

			invasive	
Nepal	present	native	not invasive	Wood & Bright, 1992
Pakistan	present	native	not invasive	Browne, 1968
Philippines	present	native	not invasive	Wood & Bright, 1992
Singapore	present	native	not invasive	NHM, 1984; Murphy & Meepol, 1990
Sri Lanka	present	native	not invasive	Wood & Bright, 1992
Thailand	present	native	not invasive	Wood & Bright, 1992
Vietnam	present	native	not invasive	Wood & Bright, 1992
Africa				
Cameroon	present	introduced	invasive	Wood & Bright, 1992
Egypt	present	introduced	invasive	NHM, 1995
Kenya	present	introduced	invasive	Wood & Bright, 1992
Mauritania	present	introduced	invasive	Wood & Bright, 1992
Mauritius	present	introduced	invasive	Wood & Bright, 1992
Seychelles	present	introduced	invasive	Wood & Bright, 1992
South Africa	present	introduced	invasive	Schedl, 1975b
Tanzania	present	introduced	invasive	Wood & Bright, 1992
North America				
USA	present, few occurrences			EPPO, 2006
Hawaii	absent, formerly present	introduced		Wood & Bright, 1992
Texas	present, few occurrences	introduced	invasive	Haack, 2003; EPPO, 2006
Oceania				
Australia	present	native	not invasive	Wood & Bright, 1992
Belau	present	introduced	invasive	Wood & Bright, 1992
Federated states of Micronesia	present	introduced	invasive	Wood & Bright, 1992
Fiji	present	introduced	invasive	Wood & Bright, 1992
QFrench Polynesia	present	introduced	invasive	Wood & Bright, 1992
Guam	present	introduced	invasive	Wood & Bright, 1992
Kiribati	present	introduced	invasive	Beaver, 1990

Marshall Islands	present	introduced	invasive	Wood & Bright, 1992
QNew Caledonia	present	introduced	invasive	Wood & Bright, 1992
Northern Mariana Islands	present	introduced	invasive	Wood, 1960
Papua New Guinea	present	native	not invasive	Wood & Bright, 1992
Bismarck Archipelago	present	native	not invasive	Wqood & Bright, 1992
Samoa	present	introduced	invasive	Beqeson, 1929; Beaver, 1976
Solomon Islands	present	native	not invasive	Wood & Bright, 1992

History of introduction and spread

As with a number of other widespread species of Xyleborus and related genera, it is difficult to be certain of the extent of the native distribution. It seems likely that it can be considered native in the area from Pakistan to the Solomon Islands, but that it has been introduced accidentally to parts of Africa and offshore islands, and to many of the island groups in the Pacific Ocean. The recent (2002) introduction of the species to mainland USA (Texas) should be noted. It seems likely that the species is established there, although it has not yet spread beyond the original area of discovery. The species has frequently been intercepted in timber imported to Japan from countries in the region from Cambodia, the Philippines and Indonesia to the Solomon Islands (e.g. Ohno et al., 1987, 1988, 1989; Ohno, 1990), but has not become established on the main islands of Japan. It has also been intercepted in Korea (Choo et al., 1981).

Biology and ecology

The important pest species in the genus Xyleborus and the related genera Ambrosiodmus, Euwallacea, Xyleborinus and Xylosandrus are all ambrosia beetles in the Xyleborini, a tribe with a social organization of extreme polygamy. The sexual dimorphism is strongly developed, and the ratio of females to males is high. The biology of X. similis has been studied by Beeson (1930, 1961), Browne (1961) and Kalshoven (1964). The species is common both in open, disturbed areas and in densely forested areas. It tends to fly around dusk, and is attracted to light. It is most frequently found in stems from about 8 to 25 cm diameter. The lower limit of host size is about 4 cm (Browne, 1961). X. similis is a secondary species attacking stressed, dying, dead or felled trees. It is not known to attack healthy trees. Mahindapala and Subasinghe (1976) report attacks on the bases of living coconut palms, but it is not clear whether the trees were completely healthy. The gallery system consists of branching tunnels in one transverse plane. Beeson (1961) notes that in smaller diameter stems, the side branches are short and soon bifurcate towards the centre of the stem. In larger stems, the side branches may run for several centimetres parallel to the cicrcumference before branching. No brood chambers are constructed either at the cambial level or within the wood. Kalshoven (1964) notes that in mature galleries, a few side branches may penetrate the outer bark and form additional openings to the exterior. The eggs are laid, and the larvae develop and pupate within the gallery system. After mating with their brother(s), the new generation of females emerges through the original entrance hole (or presumably also through any addition openings from the gallery system to the exterior). Kalshoven (1964) found from 10 to 37 offspring in the gallery systems that he investigated, but it is likely that broods can be considerably larger than this. Browne (1961) found young adults 5 weeks after a host tree had been cut, but Beeson (1961) gives a minimum period to emergence of 3 months, and notes that an individual host tree may continue to produce new adults over a much longer period (up to 10 months). It is not known whether this represents a series of broods in the same stem (Beeson, 1930), or a prolonged development period due, for example, to poor growth of the ambrosia fungus that forms the only food of the developing larvae. It is possible that the ambrosia fungus associated with X. similis is Fusarium solani (Balasundaran and Sankaran, 1991). Breeding is continuous throughout the year, with overlapping generations, so that the species is active at all times, and in all stages of development (Browne, 1968).

Morphology

The following diagnostic notes refer to females only and include only the minimum characters required to differentiate this species from other pest species.

Adult Female

Length about 2.2-2.7 mm. Frons convex, entire surface minutely reticulate, with faint, shallow punctures. Antennal club with one obscure suture on posterior face. Pronotum 1.1 times longer than wide; sides nearly straight; anterior margin broadly rounded, without serrations. Elytra 1.7-1.8 times longer than wide; apex narrowly rounded. Elytral declivity sloping, convex, commencing on posterior third to posterior fourth of elytra; face of each elytron with a large, distinct tubercle on lower third in interspace 1, which is outwardly curved around the tubercle sometimes with a few much smaller tubercles near declivital base; several small tubercles in other interspaces; interspace 7 acutely elevated, very weakly crenulate.

Immature Stages

The immature stages have not been described.

Means of movement and dispersal

Natural Dispersal

The adult females fly readily and flight is one of the main means of movement and dispersal to previously uninfected areas. Of more importance, however, is the movement of infested woody material in timber, ship dunnage and crating. Numerous species of Xyleborus and related genera have been taken in port cities from raw logs destined for saw mills, from discarded ship dunnage, and in similar circumstances.

Vector Transmission

X. similis, like other members of the Xyleborini is dependent for food on a symbiotic ambrosia fungus or fungi. The fungus is transmitted by the female in a mycangial pouch. The position of this is not known for certain in X. similis, but in many species of Xyleborus it consists of paired mandibular pouches (Beaver, 1989). Both adult and larvae are dependent on the growth of the fungus on the walls of the gallery system in the wood for their food (Beaver, 1989). Balasundaran and Sankaran (1991) report the association of X. similis with the phytopathogen Fusarium solani, and implicate the beetle in the spread of a disease producing cankers and die-back of teak trees in Kerala, India.

Movement in Trade

The species has frequently been intercepted in East Asia in timber imported from countries from Indonesia and the Philippines to the Solomon Islands.

Plant parts liable to carry the pest in trade/transport

- Bark: Adults; borne internally; visible to naked eye.
- Stems (above Ground)/Shoots/Trunks/Branches: Eggs, Larvae, Pupae, Adults; borne internally; visible under light microscope.
- Wood: Eggs, Larvae, Pupae, Adults; borne internally; visible under light microscope.

Plant parts not known to carry the pest in trade/transport

- Bulbs/Tubers/Corms/Rhizomes
- Fruits (inc. Pods)
- Growing Medium Accompanying Plants
- Flowers/Inflorescences/Cones/Calyx
- Leaves
- Seedlings/Micropropagated Plants
- Roots
- True Seeds (inc. Grain).

Natural enemies

No specific information is available for X. similis. The immature stages of xyleborines have few natural enemies. The female parent normally remains in the gallery entrance whilst the immature stages are developing, preventing the entry of potential predators and parasitoids. Provided that the female remains alive and the growth of the ambrosia fungus on which the larvae feed is satisfactory, mortality of the immature stages is likely to be very low. Most mortality probably occurs during the dispersal of the adults, and during gallery establishment. Adults of ambrosia beetles are predated by lizards, clerid beetles and ants as they attempt to bore into the host tree. The adults will also fail to oviposit if the ambrosia fungus fails to establish in the gallery.

Impact

Economic impact

Some species of Xyleborus are known pests of various forest and crop trees. Attacks by X. similis are normally secondary on stressed, dying or dead trees. However, the species could become a pest in reforestation projects or in plantations. X. similis is one of the commonest ambrosia beetles found in felled timber in the region from India to the Solomon Islands, although it is more usually found in stems less than about 25 cm diameter. As such, it must be partly responsible for the degrade of timber as a result of its galleries in the wood, and the staining of the surrounding wood by the associated ambrosia fungus. X. similis and other ambrosia beetle species have the potential to transmit phytopathogenic fungi to their hosts, and X. similis has been implicated in the spread of Fusarium solani to teak trees in southern India (Balasundaran and Sankaran, 1991). However, the number of trees involved (16 after 2 years) was small.

Impact descriptors

Negative impact on: crop production; forestry production

Phytosanitary significance

Several other species of Xyleborus with similar habits to X. similis have been imported to tropical and subtropical areas around the world. A few have become important pests, either because they may attack living or stressed trees, or because of their abundance in disturbed forest areas, and their very wide host range. X. similis seems to be solely a secondary borer, but it can be very abundant in felled timber. The risk of introduction outside its present geographic range must be considered high. X. similis is not specifically listed as a quarantine pest, but Xyleborus spp. are included in the APHIS Regulated Pest List in the USA, and as quarantine pests in New Zealand.

Symptoms

Attacked plants may show signs of wilting, branch die-back, shoot breakage, chronic debilitation, sun-scorch or a general decline in vigour.

Symptoms by affected plant part

Stems

DETECTION AND INSPECTION

Some success has been obtained by using traps baited with ethanol placed in and around port facilities where infested material may be stored. Simple types of trap are described by Bambara et al. (2002) and Grégoire et al. (2003). Visual inspection of suspected infested material is required to detect the presence of ambrosia beetles. Infestations are most easily detected by the presence of entry holes made by the attacking beetles, and the presence of frass produced during gallery construction.

Control

When Xyleborus species are detected in plant material, all of the infested material should immediately be destroyed. When they are detected in traps, plant material in the vicinity of the trap should be actively inspected, with special attention directed towards imported woody products such as crating, dunnage and lumber milling scraps. If an active infestation is detected, control using insecticides is possible but of limited effectiveness. Chemical control is not generally effective since the adult beetles bore deep into the host material. The following insecticides were effective against Euwallacea fornicatus, which is destructive to tea: fenvalerate, deltamethrin, quinalphos, cypermethrin and dichlorvos (Muraleedharan, 1995). Selvasundaram et al. (2001) found that Lambda-cyhalothrin 2.5 EC was more effective in reducing E. fornicatus populations than fenvalerate. Gnanaharan et al. (1982, 1983) suggest the use of solutions of boric acid and borax, which have both fungicidal and some insecticidal action, to protect stored wood. These insecticides may also be effective against other ambrosia beetles, but the concealed habitats in which these species feed and reproduce, the difficulties and high costs of insecticide application, and environmental concerns all limit the effectiveness of chemical control. Das and Gope (1985) protected tea chest panels against the development of wood-boring insects, including X. similis, by heating the panels to 93°C for 10-20 minutes, sufficient to kill the insects without distorting the panels.

In logging areas, fast removal of the felled timber from the area will reduce attacks, and rapid conversion to sawn timber will reduce the depth of such attacks as have occurred. Debarking can also reduce attacks (Gnanaharan et al., 1985). X. similis normally forms part of a complex of bark and ambrosia beetle species attacking felled trees, and control measures need to be directed against all species at the same time (Beaver, 2000).

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Xylosandrus ater

Names and taxonomy

Xylosandrus ater (Eggers)

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Scolytidae

Other scientific names

Xyleborus retusiformis Schedl

Notes on taxonomy and nomenclature

Many species previously classified in the genus Xyleborus have now been transferred into other genera such as Ambrosiodmus, Euwallacea, Xyleborinus and Xylosandrus, including X. ater. A number of species within the Xyleborini, the tribe in which Xyleborus and related genera are placed, could be considered potential pests to agriculture and forestry.

Host range

Notes on host range

Members of Xyleborus and the related genera Ambrosiodmus, Euwallacea, Xyleborinus and Xylosandrus are all ambrosia beetles that feed and breed in a variety of forest trees and shrubs. Depending on the species, they may be found in small branches and seedlings to large logs. All are potentially damaging to agriculture and/or forestry under suitable conditions. Many species, previously considered of only minor importance, may become important pests in agriculture and forestry as a result of the continuing destruction of natural forests and the expansion of forest and tree crop plantations, agroforestry and agriculture.

X. ater has been recorded from hosts in at least nine different plant families (Browne, 1961). The adults infest shoots, twigs and small poles, and have also been found in cut rattan stems. The species could become a pest in plantations or other similar areas where small seedlings or transplants are found, although it has not yet been found as a primary borer (Browne, 1961).

Affected Plant Stages: Flowering stage, fruiting stage, seedling stage and vegetative growing stage.

List of hosts plants

Minor hosts

Swietenia macrophylla (big leaved mahogany)

Wild hosts

Adenanthera pavonina (red-bead tree), Artocarpus (breadfruit trees), Calamus , Cinnamomum , Dehaasia cuneata , Dryobalanops oblongifolia , Grewia latifolia , Palaquium stellatum , Pometia pinnata (fijian longan), Shorea , Vitex pinnata

Geographic distribution

Notes on distribution

The record of X. ater from Fujian, China requires confirmation. The record only appears in Wood and Bright (1992), and the location does not appear in any of the references cited there. If correct, the species may have been introduced from South-East Asia. There are also unpublished records from Brunei Darussalam, and Sabah, Malaysia (RA Beaver, Chiangmai, Thailand, personal communication, 2004).

Distribution List

Please note: The distribution status for a country or province is based on all the information available. When several references are cited, they may give conflicting information on the pest status. In particular, citations of earlier presence of a pest are included even though there is an authoritative reference to indicate that the pest is now absent.

Asia

China

present

Wood & Bright, 1992

Fujian

present

Wood & Bright, 1992

Indonesia

present

native

not invasive

Wood & Bright, 1992

Kalimantan

present

native

not invasive

Kalshoven, 1960; Wood & Bright, 1992

Sumatra

present

native

not invasive

Eggers, 1923

Malaysia

present

native

not invasive

Wood & Bright,

1992 Peninsular

Malaysia present

native

not invasive

Kalshoven,

1960 Sarawak

present

native

not invasive

Kalshoven, 1960

History of introduction and spread

With the exception of the doubtful record from China (see Distribution notes), the species does not seem to have been introduced outside its native range.

Biology and ecology

The important pest species in the genus Xyleborus and the related genera Ambrosiodmus, Euwallacea, Xyleborinus and Xylosandrus are all ambrosia beetles in the Xyleborini, a tribe with a social organization of extreme polygamy. The sexual dimorphism is strongly developed, and the ratio of females to males is high. Some species infest small twigs and shoots, others are found in larger branches and poles, while others are found in large timber; others may breed in material of almost any size. In general, most species bore through the bark and into the wood where an enlarged chamber of varying size and shape is constructed. The tunnels into the wood are highly variable in depth and shape, depending on the species involved in the construction. Generally only unhealthy or newly fallen material is infested, but some species are capable of attacking host plants following only a slight set-back, for example, transplanting or temporarily unfavourable conditions such as drought or mechanical injury. A few species have become aggressive under certain conditions, and have thereby attained the status of important pests.

All species of Xyleborus and the related genera are closely associated with ambrosial fungi. Some of these fungi are phytopathogenic and all species of Xyleborus and related genera should be considered to be possible vectors of plant disease.

Some details of the biology of the species are given by Browne (1961). He notes that a gallery system may contain from 8 to 29 brood in various stages of development, and that there are from 8 to 10 females for each male. A generation takes about 4 weeks.

Morphology

The following diagnostic notes refer to females only and include only the minimum characters required to differentiate this species from other pest species. The species was redescribed and figured by Nunberg (1978).

Adult Female

Length 3.2 mm. Frons convex, surface densely reticulate, with small, close, deep punctures. Antennal club solid on posterior face, no sutures present. Pronotum very large, globose, very slightly wider than long; sides weakly arcuate, anterior margin broadly rounded, with 2 large, distinct serrations. Elytra much shorter than pronotum, 1.6 times wider than long, apex broadly rounded. Elytral declivity commencing at middle of elytra, steep; surface weakly convex, dull, with numerous, small, rounded granules and abundant, short, yellowish setae.

Immature Stages

The immature stages have not been described.

Means of movement and dispersal

Natural Dispersal

The adult females fly readily, and flight is one of the main means of movement and dispersal to previously uninfected areas. Of more importance for long distance movement, however, is the transport of infested seedlings, saplings or cut branches. X. ater is unlikely to occur in wood packing or crates and similar material, because it normally attacks stems of small diameter (not more than 5 cm diameter).

Vector Transmission

The female has a mycangium, a pouch used to carry spores of the ambrosia fungus on which both adult and larvae feed, opening between the pronotum and mesonotum, and extending below the pronotum (Beaver, 1989). 'Contamination ' of the mycangia by the spores of pathogenic fungi is possible, and the ambrosia fungus itself may be pathogenic in some cases, although there is currently no evidence for this in X. ater. Spores of pathogenic fungi could also be transported on the cuticle of the beetle, although their chance of survival there is much less than in the mycangial pouch.

Plant parts liable to carry the pest in trade/transport

- Bark: Adults; borne internally; visible to naked eye.

- Seedlings/Micropropagated Plants: Eggs, Larvae, Pupae, Adults; borne internally; visible under light microscope.

- Stems (above Ground)/Shoots/Trunks/Branches: Eggs, Larvae, Pupae, Adults; borne internally; visible under light microscope.

- Wood: Eggs, Larvae, Pupae, Adults; borne internally; visible under light microscope.

Plant parts not known to carry the pest in trade/transport

- Bulbs/Tubers/Corms/Rhizomes
- Fruits (inc. Pods)
- Growing Medium Accompanying Plants
- Flowers/Inflorescences/Cones/Calyx
- Leaves
- Roots
- True Seeds (inc. Grain).

Natural enemies

The immature stages of xyleborine beetles have few natural enemies. None have been recorded for X. ater. The female parent normally remains in the gallery entrance whilst the immature stages are developing, preventing the entry of potential predators and parasitoids. Provided that the female remains alive and the growth of the ambrosia fungus on which the larvae feed is satisfactory, mortality of the immature stages is likely to be very low. Most mortality is probably during the dispersal of the adults, and during gallery establishment. Adults of ambrosia beetles are predated by lizards, clerid beetles and ants as they attempt to bore into the host tree. Adults will also fail to oviposit if the ambrosia fungus fails to establish in the gallery.

Impact

At present, X. ater is not known to have any economic, environmental or social impact, nor any impact on biodiversity. It might potentially adversely affect forest production in tropical and subtropical countries as a result of its wide host range.

Phytosanitary significance

Three other species of Xylosandrus, Xylosandrus compactus, Xylosandrus crassiusculus and Xylosandrus morigerus, with similar habits to X. ater, have become important pests of tree crops, ornamental and native trees in tropical and subtropical areas where they have been introduced. The risk of introduction of X. ater must be considered high, most probably in small branches of imported plants, although other pathways are also possible. Once established, such species are difficult to eradicate, and are likely to spread with the movement of infested plants, as well as by normal dispersal of the adults. X. ater is not currently known to be specifically listed as a quarantine pest.

Symptoms

Attacked plants may show signs of wilting, branch die-back, shoot breakage, chronic debilitation, sun-scorch or a general decline in vigour.

Detection and inspection

Some success in the detection of Xylosandrus species has been obtained by using traps baited with ethanol placed in and around port facilities where infested material may be stored, and around nurseries with plants susceptible to attack. A simple type of trap is described by Bambara et al. (2002). Visual inspection of suspected infested material is required to detect the presence of ambrosia beetles. Infestations are most easily detected by the presence of entry holes made by the attacking beetles, and the presence of frass thrown out during gallery construction.

Control

When Xylosandrus species are detected in plant material, it is necessary to immediately destroy all of the infested material. When they are detected in traps, plant material in the vicinity of the trap should be actively inspected, with special attention directed towards imported woody plants and plant products, especially the smaller branches of plants, and canes, but also including dunnage, etc. If an active infestation is detected, chemical control using insecticides are not generally effective since the adult beetles bore deep into the host material. The following insecticides were found to be effective against a species of Euwallacea destructive to tea: fenvalerate, deltamethrin, quinalphos, cypermethrin and dichlorvos (Muraleedharan, 1995); these insecticides may also be effective against other ambrosia beetles. Bambara and Casey (2002) suggest the use of permethrin, but multiple treatments may be required during a season. They also suggest the use of some attacked trees as trap trees, which need to be removed and burned before the life cycle of the beetle is completed. The concealed habitats in which these species feed and reproduce, the difficulties and high costs of insecticide application, and environmental concerns all limit the effectiveness of chemical control.

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Xylosandrus compactus

Names and taxonomy

Preferred scientific name

Xylosandrus compactus (Eichhoff, 1875)

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Scolytidae

Other scientific names

Xyleborus morstatti Hagedorn,

1912 Xyleborus compactus Eichhoff

Xylosandrus morstatti (Hagedorn)

Common names

English: shot-

hole borer tea

stem borer

black coffee twig borer

black coffee borer

black twig borer

French:

scolyte noir du caféier

scolyte des rameaux du

caféier scolyte noir des

rameaux Germany:

Bohrer, Schwarzer Kaffeezweig-

Schwarzer Zweigbohrer an Kaffee

Netherlands:

takkenboeboek

zwarte takkenboeboek

Notes on taxonomy and nomenclature

Xylosandrus compactus was described by Eichhoff in 1875 in the genus Xyleborus. Xylosandrus was described by Reitter in 1913, and X. compactus was transferred to Xylosandrus by Nunberg (1959) and Browne (1963). Xyleborus morstatti was recognized as a synonym of X. compactus by Murayama and Kalshoven (1962). No other synonyms have been recognized.

Host range

Notes on host range

Over 225 species of plants, belonging to 62 families, are susceptible to X. compactus (Ngoan et al., 1976). Browne (1961) remarked that X. compactus does not appear to be highly host specific in its natural mixed-forest habitat, and it is only when it finds special conditions of concentrated cultivation that it tends to be a pest. Only a selection of the recorded hosts is given here. Further host lists can be found in Schedl (1963), Brader (1964), Hara and Beardsley (1979) and Wood and Bright (1992).

The main economic host of X. compactus is coffee (especially Coffea canephora robusta, also Coffea arabica). In Japan, X. compactus is a pest of tea (Kaneko et al., 1965). X. compactus is also a pest of avocado and cocoa in South-East Asia and elsewhere (Kalshoven, 1958; Browne, 1961; Beaver, 1976; Waterhouse, 1997; Nair, 2000; Matsumoto, 2002). In India, X. compactus is reported as infesting and killing the seedlings and saplings of Khaya grandifoliola, and Khaya senegalensis, shade trees in coffee plantations (Meshram et al., 1993); in Africa, Erythrina sp. and Melia azedarach (Le Pelley, 1968). Attacks on seedlings and young plantations of a variety of forest trees can be severe (Browne, 1968; Intachat and Kirton, 1997). In addition to the large range of dicotyledonous trees and shrubs, it will sometimes attack both monocotyledonous plants, such as orchids and gingers, and conifers (Hara and Beardsley, 1979). Its attacks can also endanger rare native trees Ziegler, 2001, 2002).

Affected Plant Stages: Flowering stage, fruiting stage, seedling stage and vegetative growing stage.

Affected Plant Parts: Leaves, stems and whole plant.

List of hosts plants

Major hosts

Camellia sinensis (tea), Coffea arabica (arabica coffee), Coffea canephora (robusta coffee), Swietenia macrophylla (big leaved mahogany)

Minor hosts

Acacia auriculiformis (northern black wattle), Acacia mangium (brown salwood), Annona , Aucoumea klaineana (okoume), Castanea (chestnuts), Cedrela odorata (Spanish cedar), Cinnamomum verum (cinnamon), Dendrobium , Entandrophragma utile (ogipogo-mahogany), Erythrina abyssinica (red hot poker tree), Hevea brasiliensis (rubber), Khaya grandifoliola (big-leaf mahogany), Khaya ivorensis (African mahogany), Khaya senegalensis (dry zone mahogany), Leucaena leucocephala (leucaena), Macadamia integrifolia (macadamia nut), Mangifera indica (mango), Melia azedarach (Chinaberry), Myrciaria dubia , Ochroma pyramidale (balsa), Persea americana (avocado), Pinus (pines), Pometia pinnata (fijian longan), Swertia , Swietenia mahagoni (Cuban mahogany), Theobroma cacao (cocoa), Toona ciliata (toon)

Wild hosts

Caesalpinia kavaiensis , Colubrina oppositifolia , Dalbergia (rosewoods), Eusideroxylon zwageri (billian), Shorea

Geographic distribution

Notes on distribution

In addition to the records given here, there are unpublished records from Brunei Darussalam, Christmas Island and Malaysia (Sarawak) (RA Beaver, Chiangmai, Thailand, personal communication, 2004). The record of X. compactus from New Zealand (Wood and Bright, 1992; CABI/EPPO, 1997) must refer to intercepted specimens not seen by the New Zealand Quarantine Service, or be incorrect. Brockerhoff et al. (2003) noted that there is no breeding population in New Zealand and they do not include X. compactus in their list of Scolytidae intercepted in the country.

Distribution List

Please note: The distribution status for a country or province is based on all the information available. When several references are cited, they may give conflicting information on the pest status. In particular, citations of earlier presence of a pest are included even though there is an authoritative reference to indicate that the pest is now absent.

Cambodia

present

native

not invasive

Waterhouse, 1993; CABI/EPPO, 1997

China

present

native

not invasive

CABI/EPPO, 1997

Guangdong

present

native

not invasive

CABI/EPPO, 1997

Guizhou present

native

not invasive

CABI/EPPO, 1997

Hainan

present

native

not invasive

CABI/EPPO, 1997

Hunan

present

native

not invasive

CABI/EPPO, 1997

<u>Taiwan</u>

present

native

not invasive

Wood & Bright, 1992; CABI/EPPO, 1997

<u>India</u>

present

native

not invasive

CABI/EPPO, 1997

<u>Gujarat</u>

present

native

not invasive

CABI/EPPO, 1997

<u>Karnataka</u>

present

native

not invasive

CABI/EPPO, 1997

<u>Kerala</u>

present

native

not invasive

CABI/EPPO, 1997

Madhya Pradesh

present

native

not invasive

CABI/EPPO, 1997

Maharashtra

present

native

not invasive

CABI/EPPO, 1997

Tamil Nadu

present

native

not invasive

CABI/EPPO, 1997

Indonesia

present

native

not invasive

Waterhouse, 1993; CABI/EPPO, 1997

Java

present

native

not invasive

CABI/EPPO, 1997

Kalimantan

present

native

not invasive

CABI/EPPO, 1997

Papua Barat

present

native

not invasive

CABI/EPPO, 1997

Sulawesi present

native

not invasive

CABI/EPPO, 1997

Sumatra present

native

not invasive

CABI/EPPO, 1997

Japan

present

native

not invasive

CABI/EPPO, 1997

Hokkaido

present

native

not invasive

CABI/EPPO, 1997

Honshu

present

native

not invasive

CABI/EPPO, 1997

Kyushu

present

native

not invasive

CABI/EPPO, 1997

Ryukyu Archipelago

present

native

not invasive

CABI/EPPO, 1997

Shikoku

present

native

not invasive

CABI/EPPO, 1997

Laos

present

native

not invasive

CABI/EPPO, 1997

Malaysia present

native

not invasive

Waterhouse, 1993; CABI/EPPO, 1997

Peninsular Malaysia

present

native

not invasive

CABI/EPPO, 1997

Sabah

present

native

not invasive

CABI/EPPO, 1997

Myanmar

present

native

not invasive

Waterhouse, 1993; CABI/EPPO, 1997

Philippines

present

native

not invasive

Wood & Bright, 1992; CABI/EPPO, 1997

Singapore

present

native

not invasive

CABI/EPPO, 1997

Sri Lanka present

native

not invasive

CABI/EPPO, 1997

Thailand present

native

not invasive

Wood & Bright, 1992; CABI/EPPO, 1997

Vietnam

present

native

not invasive

Waterhouse, 1993; CABI/EPPO, 1997

<u>Africa</u>

<u>Benin</u>

present

introduced

invasive

CABI/EPPO, 1997

<u>Cameroon</u>

present

introduced

invasive

CABI/EPPO, 1997

<u>Central African Republic</u>

present

introduced

invasive

CABI/EPPO, 1997

<u>Comoros</u>

present

introduced

invasive

Wood & Bright, 1992; CABI/EPPO, 1997

Congo

present

introduced

invasive

CABI/EPPO, 1997

Côte d'Ivoire

present

introduced

invasive

CABI/EPPO, 1997

Gabon

present

introduced

invasive

CABI/EPPO, 1997

Ghana

present

introduced

invasive

CABI/EPPO, 1997

Guinea-Bissau

present

introduced

invasive

CABI/EPPO, 1997

Guinea present

introduced

invasive

CABI/EPPO, 1997

Kenya

present

introduced

invasive

CABI/EPPO, 1997

Liberia

present

introduced

invasive

CABI/EPPO, 1997

Madagascar

present

introduced

invasive

CABI/EPPO, 1997

Mauritania

present

introduced

invasive

Wood & Bright, 1992; CABI/EPPO, 1997

Mauritius

present

introduced

invasive

CABI/EPPO, 1997

Nigeria

present

introduced

invasive

CABI/EPPO, 1997

Réunion present

introduced

invasive

CABI/EPPO, 1997

Senegal

present

introduced

invasive

Wood & Bright, 1992; CABI/EPPO, 1997

Seychelles

present

introduced

invasive

CABI/EPPO, 1997

<u>Sierra Leone</u>

present

introduced

invasive

CABI/EPPO, 1997

<u>South Africa</u>

present

introduced

invasive

Wood & Bright, 1992

<u>Tanzania</u>

present

introduced

invasive

CABI/EPPO, 1997

<u>Togo</u>

present

introduced

invasive

CABI/EPPO, 1997

<u>Uganda</u>

present

introduced

invasive

CABI/EPPO, 1997

Zimbabwe

present

introduced

invasive

CABI/EPPO, 1997

Central America & Caribbean

British Virgin Islands

present

introduced

invasive

CABI/EPPO, 1997

Cuba

present

introduced

invasive

Wood, 1977; Bright, 1985; CABI/EPPO, 1997

Curaçao

present

introduced

invasive

Vazquez & Monteagudo, 1988

Netherlands Antilles

present

introduced

invasive

CABI/EPPO, 1997

Puerto Rico

present

introduced

invasive

Franqui, 1991; CABI/EPPO, 1997

United States Virgin Islands

present

introduced

invasive

Bright, 1985; CABI/EPPO, 1997

North America

USA

Alabama

present

introduced

invasive

CABI/EPPO, 1997

Florida

present

introduced

invasive

Wood, 1977; CABI/EPPO, 1997

Georgia (USA)

present

introduced

invasive

Wood, 1977; CABI/EPPO, 1997

<u>Hawaii</u>

present

introduced

invasive

CABI/EPPO, 1997

<u>Louisiana</u>

present

introduced

invasive

CABI/EPPO, 1997

<u>Mississippi</u>

present

introduced

invasive

Wood, 1977; Wood & Bright, 1992; CABI/EPPO, 1997

<u>South Carolina</u>

present

introduced

invasive

CABI/EPPO, 1997

<u>Texas</u>

present

introduced

invasive

Wood & Bright, 1992; CABI/EPPO, 1997

South America

Brazil

present

introduced

invasive

Wood, 1980; CABI/EPPO, 1997

Amazonas

present

introduced

invasive

Wood, 1980; Abreu et al., 2001

Oceania

Fiji present

introduced

invasive

CABI/EPPO, 1997

New Zealand

absent, unreliable record

Wood & Bright, 1992; CABI/EPPO, 1997; Brockerhoff et al., 2003

Papua New Guinea

present

introduced

invasive

CABI/EPPO, 1997

Samoa

present

introduced

invasive

CABI/EPPO, 1997

Solomon Islands

present

introduced

invasive

Bigger, 1985

History of introduction and spread

X. compactus was probably unintentionally introduced to the Afrotropical region from the Oriental region hundreds of years ago by early traders, and is now widespread. It was accidentally introduced into the Americas before the middle of the twentieth century. Wood (1977) indicated that X. compactus was present in Florida in 1941, in Cuba in 1958, in Mississippi in 1968 and in Georgia ca 1975. Since then it has spread further in the USA and has been accidentally introduced to other Caribbean countries. It was collected in Brazil (Amazonas) in 1979 (Wood, 1980) and again in the same province more recently (Abreu et al., 2001), but has apparently not yet spread to other countries of South America. It was intercepted in Hawaii in 1931, but not found again until 1961 in Oahu, by which time it was established and spreading (Samuelson, 1981). According to Samuelson (1981), it spread to the islands of Kauai by 1962, Hawaii by 1966, Maui by 1968, Molokai by 1974 and Lanai by 1975.

Biology and ecology

Several studies of the biology of X. compactus have been made. Browne (1961) reviewed the biology of X. compactus in South-East Asia, under the name Xylosandrus morstatti. Brader (1964) studied the biology of the pest when attacking coffee in West Africa, with particular reference to the effects of climatic factors, and relationships to the associated ambrosia fungus, and to the host plant. Kaneko (1965) and Kaneko et al. (1965) studied the biology of X. compactus in tea plants in Japan. Entwistle (1972) gives a detailed review of earlier work. Dixon and Woodruff (1982) summarized the biology and ecology of X. compactus in Florida, USA. Hara and Beardsley (1979) reported on the biology of X. compactus in Hawaii, USA. Beaver (1988) studied the biology and host associations of X. compactus in the Seychelles. Wood and Bright (1992) give several hundred references relating to the biology, habits, taxonomy and control of X. compactus. Bright and Skidmore (1997, 2002) give more recent references.

Only the adult females initiate the attack on the host plants. X. compactus is mainly a borer of seedlings, shoots and small twigs, but it will also breed in cut branches and poles up to a diameter of about 6 cm, rarely in larger material (Browne, 1961). Attacks in the tap root of seedlings have been noted in West Africa (Entwistle, 1972), but such attacks are more likely to be caused by the related species, Xylosandrus morigerus. On cocoa seedlings in Nigeria, attacks were most abundant 20-40 cm above ground level, and on stems of 6-10 mm diameter (Entwistle, 1972). The female constructs an entrance tunnel into the pith or wood of the host to a depth of 1-3 cm. The tunnel system consists of a simple or bifurcated entrance tunnel, and a longitudinal chamber or irregular tunnel where a loose cluster of eggs is deposited (Browne, 1961; Entwistle, 1972). One or more females may occupy a twig or branch. Generally, there is only one female if the twig diameter is less than 7 mm, but up to 20 females may be found on branches of diameter 8-22 mm.

Entwistle (1964) and Takenouchi and Tagaki (1967) report arrhenotokous parthenogenesis in X. compactus. Unmated females produce an all-male brood, but such broods are rare (Brader, 1964; Entwistle, 1972). Hara and Beardsley (1979) found seven all-male broods out of 416 examined.

The size of the brood varies considerably. Browne (1961) found that in peninsular Malaysia, broods rarely exceeded 10 individuals, and in the Seychelles, the largest brood that was observed by Brown (1954) included two eggs and seven larvae. Chevalier (1931) reported broods of 30-50 individuals in tropical Africa. In one gallery system in Fiji, 26 individuals of all instars were found (Lever, 1938). Entwistle (1972) found a mean of 12.3 offspring in field-collected galleries, but the number could occasionally exceed 60. The larvae feed on an ambrosia fungus growing on the walls of the gallery.

The pupation and mating of brood adults occurs in the infested material; the (usually) single male in each gallery mating with his sisters. The brood adults emerge through the entrance holes made by the parent beetles. In tropical Africa, Lavabre (1958, 1959) found that oviposition began 7-8 days after the parent female began her gallery. The egg stage lasted 4-5 days, larval development took 11 days, 7 days were spent in the pupal stage and the teneral adults remained in the gallery system for another 6 days before emerging. Thus about 37 days were required from the time the female first began boring into the branch until sexual maturity of the next generation. Ngoan et al. (1976) found that approximately 28 days (at 25°C) were required for development from egg to adult. According to Ngoan et al. (1976) and Hara and Beardsley (1979), there are two larval instars. The ratio of females to males varies, but is usually approximately 9:1 (Entwistle, 1972; Hara and Beardsley, 1979).

In Japan, there are normally two generations per year, and adult females overwinter, but in most parts of the range, breeding is continuous, with overlapping generations, so that the species is active at all times, and in all stages of development (Browne, 1968).

Morphology

Eggs

The egg of X. compactus is about 0.3 mm wide and 0.5 mm long. It is white and ovoid with a smooth surface (Hara and Beardsley, 1979). The incubation period varies from 3 to 5 days with over 80% of eggs hatching after 4 days (Hara and Beardsley, 1979).

Larvae

The mature larva is about 2.0 mm long. The body is creamy white with a pale-brown head. It has no legs. The mean head width of final-instar larvae is about 0.36 mm (Ngoan et al., 1976). A detailed description of the larva has not been published.

Pupae

The pupae are illustrated by Hara and Beardsley (1979). The body of the pupa is creamy white and exarate. It is about the same length as the adult.

Adults

Bright (1968) provided a brief description of the female and male of X. compactus. The adult females are dark brown to almost black, 1.4-1.9 mm long and about two times longer than wide. The front of the head is convex, with a weak transverse impression just above the mouthparts. The antennal funicle is five-segmented, and the antennal club is obliquely truncate, about 1.2 times longer than wide. The pronotum, viewed from above, is subcircular. The anterior margin of the pronotum is broadly rounded, with 6-8 (sometimes 10) distinct, equal-sized serrations. The anterior half of the pronotum is finely asperate whereas the posterior portion is smooth with distinct, shallow punctures. The elytra are 1.1 times longer than wide, convex and steeply declivitous posteriorly. The strial punctures on the elytra are distinctly impressed, about equal in size to those between the striae. Each interstria bears a row of long setae, these are about two times longer than the interstrial width. The steeply convex, posterior portion of the elytra is similar to the remaining portion of the elytra.

The small, wingless males are about 0.8-1.1 mm long and two times longer than wide. The pronotum is narrowly rounded in front without serrations. The anterior portion of the pronotum is flattened and slightly concave in the median portion and the asperities are very low, almost obsolete.The elytral striae and interstrial are irregularly punctured.

A partial list of illustrations of the adult is given in Wood and Bright (1992) and Bright and Skidmore (1997).

Wood (1982) provided a key to species of Xylosandrus found in North and Central America, including X. compactus.

Means of movement and dispersal

Natural Dispersal

The adult females fly readily, and flight is one the main means of movement and dispersal to previously uninfected areas. Entwistle (1972) found that adult females dispersed at least 200 m, and it is likely that dispersal over several kilometres is possible, especially if wind-aided. However, of more importance for long distance movement is the transport of infested seedlings, saplings or cut branches.

Vector Transmission

The female has a mycangium, a pouch used to carry spores of the ambrosia fungus on which both adult and larvae feed, opening between the pronotum and mesonotum, and extending below the pronotum (Beaver, 1989). The ambrosia fungus of X. compactus has been variously identified by different researchers. Brader (1964) described it as Ambrosiella xylebori in Côte d'Ivoire. Bhat and Sreedharan (1988) agreed, but Muthappa and Venkatasubbaiah (1981) suggested that in India, the ambrosia fungus is Ambrosiella macrospora. In North America, the fungus has been identified as Fusarium solani (Ngoan et al., 1976; Hara and Beardsley, 1979). It is possible that A. xylebori is a pleomorphic form of F. solani (Hara and Beardsley, 1979). The records of Cladosporium cladosporioides and Penicillium pallidum [Geosmithia putterillii] (Brown, 1954) from X. compactus galleries in the Seychelles are of secondary saprophytic fungi (Schedl, 1963). Ambrosiella spp. are not known to be pathogenic, although they do cause staining of the wood around the gallery systems. However, F. solani is well known as a plant pathogen, and its pathogenicity to host plants of X. compactus has been confirmed (Hara and Beardsley, 1979; Dixon and Woodruff, 1983). Entwistle (1972) noted that fungal attack always follows gallery formation. In West Africa, the fungi Botryodiplodia theobromae [Lasiodiplodia theobromae] and Calonectria rigidiuscula [Nectria rigidiuscula] (the perfect stage of Fusarium decemcellulare), both of which are wound parasites of weak pathogenicity, are involved (Entwistle, 1972).

Plant parts liable to carry the pest in trade/transport

- Bark: Adults; borne internally; visible to naked eye.

- Seedlings/Micropropagated Plants: Eggs, Larvae, Pupae, Adults; borne internally; visible under light microscope.

- Stems (above Ground)/Shoots/Trunks/Branches: Eggs, Larvae, Pupae, Adults; borne internally; visible under light microscope.

- Wood: Eggs, Larvae, Pupae, Adults; borne internally; visible under light microscope.

Plant parts not known to carry the pest in trade/transport

- Bulbs/Tubers/Corms/Rhizomes
- Fruits (inc. Pods)
- Growing Medium Accompanying Plants
- Flowers/Inflorescences/Cones/Calyx
- Leaves
- Roots
- True Seeds (inc. Grain).

Natural enemies

The immature stages have few natural enemies. The female parent normally remains in the gallery entrance whilst the immature stages are developing, preventing the entry of potential predators and parasitoids. Provided that the female remains alive and the growth of the ambrosia fungus on which the larvae feed is satisfactory, mortality of the immature stages is likely to be very low. Most mortality is probably during the dispersal of the adults and during gallery establishment.

Several studies of the natural enemies of X. compactus have been made in India. Sreedharan et al. (1992) reported that larvae of the clerid coleopteran Callimerus sp. were found in over 4% of the gallery systems of X. compactus. Although the predator feeds on all stages of the scolytid, it prefers feeding on the larvae. In India, Eupelmus sp. was found in nearly 8% of the branches of robusta coffee examined (Balakrishnan et al., 1989). The larvae of this eupelmid act as predators when several ambrosia beetle larvae are available. The incidence of parasitism ranged from 1.3%

in January to nearly 21% in September. In Java, the eulophid Tetrastichus xylebororum parasitizes both this species and Xylosandrus morigerus (Le Pelley, 1968), a related species recorded from India (Dhanam et al., 1992), and a further species of Tetrastichus from Hawaii (Tenbrink and Hara, 1994). Le Pelley (1968) mentioned an undescribed bethylid ectoparasitoid of X. compactus larvae, and the bethylid, Prorops nasuta, a well-known parasite of the coffee berry borer, Hypothenemus hampei, has been recorded attacking X. compactus in West Africa (Brader, 1964). However, parasitism is not normally an important cause of mortality in Xylosandrus species.

One species of entomopathogenic fungus, Beauveria bassiana, was found infecting X. compactus in India (Balakrishnan et al., 1994) and has also been recorded in West Africa (Brader, 1964).

During gallery establishment, the adults are frequently attacked by ants (Lavabre, 1962; Brader, 1964). Brader (1964) noted attacks by Oecophylla longinoda in Côte d'Ivoire, and similar attacks by Oecophylla smaragdina occur in South-East Asia. Lizards and clerid beetles prey on the adults of ambrosia beetles, such as Xylosandrus as the latter attempt to bore into the host tree.

Natural enemies listed in the database

The list of natural enemies has been reviewed by a biocontrol specialist and is limited to those that have a major impact on pest numbers or have been used in biological control attempts; generalists and crop pests are excluded. For further information and reference sources, see About the data. Additional natural enemy records derived from data mining are presented as a separate list.

Natural enemies reviewed by biocontrol specialist

Natural enemy

Pest stage attacked

Biological control in:

Parasites/parasitoids:

Tetrastichus sp. nr. xylebororum

Larvae

Predators:

Callimerus

Eggs, Larvae, Nymphs, Pupae, Adults

Pathogens:

Beauveria bassiana (white muscardine fungus)

Adults

Additional natural enemies (source - data mining)

Natural enemy

Pest stage attacked

Biological control in:

Parasites/parasitoids:

Dendrosoter enervatus

Hawaii

Dendrosoter protuberans

Hawaii

Tetrastichus xylebororum

Tetrastichus xylebororum

Impact

Economic impact

X. compactus is a serious pest of shrubs and trees. It causes extensive damage to coffee and cocoa throughout tropical Africa, Indonesia, southern India and the West Indies. There is no recent objective assessment of crop losses caused by X. compactus. In India, Ramesh (1987) observed that losses due to X. compactus were 21% on 45-year-old coffee plants and 23.5% on young plants. Infestation rates of 60-70% in African mahogany were reported by Meshram et al. (1993) in India. Lavabre (1958, 1959) reported losses of about 20% of the coffee crop in Cameroon. In Japan, X. compactus is a major pest of tea causing extensive dieback (Kaneko et al., 1965). In China, Yan et al. (2001) recorded an attack rate of 78% on the main stems of young chesnut trees.

Impact on biodiversity

In Hawaii, X. compactus attacks several rare and threatened native trees, including Colubrina oppositifolia (Ziegler, 2001) and Caesalpinia kavaiensis (Ziegler, 2002), providing an additional threat to their survival. Similar threats to rare native trees may occur elsewhere in the range of the beetle as a result of its very wide host range.

Impact descriptors

Negative impact on: crop production; forestry production; rare / protected species

Phytosanitary significance

Two other species of Xylosandrus, Xylosandrus crassiusculus and Xylosandrus morigerus, with similar habits to X. compactus, have become important pests of tree crops, ornamental and native trees in tropical and subtropical areas where they have been introduced. The risk of introduction for X. compactus must be considered high, most probably in the twigs and small branches of imported plants. Once established, such species are difficult to eradicate and are likely to spread with the movement of infested plants, as well as by normal dispersal of the adults. X. compactus is listed as a quarantine pest in New Zealand, but apparently not elsewhere.

Symptoms

X. compactus bores into the current year's twigs, killing them in a few weeks or causing them to break from the weight of the crop. The pest weakens and retards the fruiting of young plants and makes the replacement of trees very difficult. The typical host symptoms that characterize X. compactus infestation are necrosis of the leaves and stem extending from the entrance hole distally to the end of the branch. Flagging of branches occurs about 5-7 days after initial tunnelling and gallery formation. Wilting of twigs and branches usually becomes evident within weeks of infestation. The entrance holes are small (0.8 mm diameter) and are located on the underside of branches. Cankers, 10-210 mm long, are commonly seen around the attacked areas of larger twigs and branches (Dixon and Woodruff, 1982). A whitish pile of dust from boring may be seen at each hole.

X. compactus is one of the few species of ambrosia beetles that can attack and kill live twigs and branches. Most of the other species of ambrosia beetles primarily attack newly felled, stressed, dead or dying trees and shrubs. Apparently, the pathogenic action of the ambrosia fungus, Fusarium solani to the host plant enables X. compactus to attack live plants. The pathogenic action of F. solani to woody host plants has been proven by pure culture isolates of F. solani from discoloured vascular tissues of a large number of host species (Dixon and Woodruff, 1982).

Symptoms by affected plant part

Leaves: lesions; wilting.

Stems: external discoloration; internal feeding.

Whole plant: plant dead; dieback.

Control

Chemical Control

The decision to use chemical control is influenced by environmental concerns and the difficulties of applying chemicals to the concealed habitats in which X. compactus feeds. Meshram et al. (1993) reported that spraying with monocrotophos in October-November gave effective control of X. compactus in African mahogany in India. Mangold et al. (1977) reported that when chlorpyrifos was applied with a hand sprayer to individual twigs of flowering dogwood in Florida, USA, there was 77% mortality of all stages of the beetle. In subsequent field studies, hydraulic sprays of chlorpyrifos killed 83-92% of all beetle stages per infested twig. Bambara (2003) suggested the use of chlorpyrifos, permethrin or bifenthrin. Yan et al. (2001) used quinalphos or chlorypyrifos plus cypermethrin mixed with yellow soil and painted it on the main stem of young chestnut trees, and reported good control.

Cultural Control

Material that is infested with X. compactus should be pruned and destroyed. Where practicable, this is perhaps the most effective method of control, but it may not be economic (Le Pelley, 1968). Practices that promote tree vigour and health will aid recovery from beetle damage (Dixon and Woodruff, 1982; Bambara, 2003). Entwistle (1972) noted the attraction of X. compactus to cocoa seedlings with overhead shade, and with a growing ground cover, but he pointed out that shade may be essential for seedling establishment, and that its removal may also render the plant more susceptible to other pests. In Malaysia, Anuar (1986) found that when growing robusta and Liberian coffee under shaded and unshaded conditions, only robusta showed damage caused by X. compactus. The frequency and severity of damage was significantly higher on shaded than on unshaded trees.

Biological Control

X. compactus is "singularly free from attack by parasites and predators" (Entwistle, 1972). In Africa, there are no effective parasites of X. compactus (Brader, 1964). Parasites are known in Indonesia and Le Pelley (1968) suggested that they have "an appreciable effect from time to time". The entomopathogenic fungus, Beauveria bassiana, causes some mortality in X. compactus and its potential usefulness is being investigated (Balakrishnan et al., 1994). However, biological control methods seem unlikely to be effective for X. compactus.

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Xylosandrus crassiusculus

Names and taxonomy

Preferred scientific name

Xylosandrus crassiusculus (Motschulsky)

Taxonomic position

Phylum: Arthropoda
Class: Insecta
Order: Coleoptera
Family: Scolytidae

Other scientific names

Xyleborus bengalensis Stebbing
Xyleborus crassiusculus (Motschulsky)
Xyleborus semigranosus Blandford

Xyleborus semiopacus Eichhoff
Xyleborus ebriosus Niisima
Dryocoetes bengalensis Stebbing
Xyleborus mascarenus Hagedorn
Xyleborus okoumeensis Schedl
Xyleborus declivigranulatus Schedl
Xylosandrus semigranosus (Blandford)
Xylosandrus semiopacus (Eichhoff)

EPPO code

XYLBCR (Xyleborus crassiusculus)
XYLBEB (Xyleborus ebriosus)

Common names

English:

Asian ambrosia beetle
granulate ambrosia beetle

Notes on taxonomy and nomenclature

Many species previously classified in the genus Xyleborus have now been transferred into other genera such as Ambrosiodmus, Euwallacea, Xylosandrus and Xyleborinus, including X. crassiusculus. These species are all ambrosia beetles. A number of species within the Xyleborini, the tribe in which Xyleborus and related genera are placed, can be considered potential pests to agriculture and forestry; X. crassiusculus is one of the more important species.

Host range

Notes on host range

Members of Xyleborus and the related genera Ambrosiodmus, Euwallacea, Xyleborinus and Xylosandrus are all ambrosia beetles that feed and breed in a variety of forest trees and shrubs. Depending on the species, they may be found in small branches and seedlings to large logs. All are potentially damaging to agriculture and/or forestry under suitable conditions. Many species, previously considered of only minor importance, may become important pests in agriculture and forestry as a result of the continuing destruction of natural forests and the expansion of forest and tree crop plantations, agroforestry and agriculture.

X. crassiusculus occurs in a very wide variety of host plants (e.g. Kalshoven, 1959; Browne, 1961; Schedl, 1963; Beaver, 1976; Samuelson, 1981). Schedl (1963) lists 94 species in 28 families in Africa, and 63 species in 34 families outside Africa, and many more species have since been added to this list (Wood and Bright, 1992). It is evident that almost any broad-leaved tree or sapling can be attacked, although the species has not been recorded from conifers. It is particularly important as a pest of crop and ornamental trees. Its attacks are sometimes primary on apparently healthy hosts. It has been recorded killing saplings of forest trees shortly after transplanting. Given the great range of host trees attacked, and the differences between geographical areas, it is not possible to distinguish 'main host' trees from 'other host' trees (see List of hosts). It may be expected that almost any non-coniferous crop, plantation or ornamental tree in a particular area can be attacked. The Host list in this datasheet contains a selection of hosts only.

Affected Plant Stages

Flowering stage, fruiting stage, post-harvest, seedling stage and vegetative growing stage. List of hosts plants

Minor hosts

Acacia mangium (brown salwood), *Albizia* , *Artocarpus integer* (champedak), *Aucoumea klaineana* (okoume), *Calamus* , *Carya illinoinensis* (pecan), *Castanea mollissima* (hairy chestnut), *Ceiba pentandra* (kapok), *Cercis canadensis* (eastern redbud), *Cinchona* , *Cinnamomum camphora* (camphor laurel), *Cinnamomum verum* (cinnamon), *Coffea* (coffee), *Diospyros kaki* (persimmon), *Elaeis guineensis* (African oil palm), *Eucalyptus robusta* (swamp mahogany), *Grevillea robusta* (silky oak), *Hevea brasiliensis* (rubber), *Khaya ivorensis* (African mahogany), *Laburnum* , *Leucaena leucocephala* (leucaena), *Liquidambar styraciflua* (Sweet gum), *Litchi sinensis* , *Macadamia ternifolia* (Queensland nut), *Magnolia* , *Mangifera indica* (mango), *Milicia excelsa* (rock-elm), *Persea americana* (avocado), *Prunus* (stone fruit), *Prunus persica* (peach), *Saccharum officinarum* (sugarcane), *Syzygium cumini* (black plum), *Theobroma cacao* (cocoa), *Toona ciliata* (toon)

Wild hosts

Acacia koa (koa), *Deckenia nobilis* , *Metrosideros collina* , *Shorea* , *Ulmus* (elms)

Geographic distribution

Notes on distribution

There are unpublished records from Brunei Darussalam, Christmas Island (Indian Ocean), Reunion, South Africa (RA Beaver, Chiangmai, Thailand, personal communication, 2004). Browne (1968) reported this species from Fiji, however, this record is incorrect and this species has not yet been recorded from the Fiji islands.

Distribution List

Please note: The distribution status for a country or province is based on all the information available. When several references are cited, they may give conflicting information on the pest status. In particular, citations of earlier presence of a pest are included even though there is an authoritative reference to indicate that the pest is now absent.

Asia				
Bhutan	present	native	not	Wood & Bright, 1992

			invasive	
China	present	native	not invasive	Wood & Bright, 1992
Fujian	present	native	not invasive	Wood & Bright, 1992
Hong Kong	present	native	not invasive	Wood & Bright, 1992
Hunan	present	native	not invasive	Wood & Bright, 1992
Sichuan	present	native	not invasive	Wood & Bright, 1992
Taiwan	present	native	not invasive	Murayama, 1934; Eggers, 1939
Xizhang	present	native	not invasive	Wood & Bright, 1992
Yunnan	present	native	not invasive	Yin et al., 1984
India	present	native	not invasive	Wood & Bright, 1992
Andaman and Nicobar Islands	present	native	not invasive	Wood & Bright, 1992
Assam	present	native	not invasive	Wood & Bright, 1992
Himachal Pradesh	present	native	not invasive	Wood & Bright, 1992
Karnataka	present	native	not invasive	Sreedharan et al., 1991
Madhya Pradesh	present	native	not invasive	Wood & Bright, 1992
Maharashtra	present	native	not invasive	Wood & Bright, 1992
Tamil Nadu	present	native	not invasive	Wood & Bright, 1992

Uttar Pradesh	present	native	not invasive	Wood & Bright, 1992
West Bengal	present	native	not invasive	Wood & Bright, 1992
Indonesia	present	native	not invasive	Wood & Bright, 1992
Java	present	native	not invasive	Wood & Bright, 1992
Kalimantan	present	native	not invasive	Wood & Bright, 1992
Moluccas	present	native	not invasive	Wood & Bright, 1992
Nusa Tenggara	present	native	not invasive	Browne, 1961
Papua Barat	present	native	not invasive	Schedl, 1940
Sulawesi	present	native	not invasive	Kalshoven, 1959
Sumatra	present	native	not invasive	Wood & Bright, 1992
Japan	present	native	not invasive	Wood & Bright, 1992
Bonin Island	present	native	not invasive	Wood & Bright, 1992
Hokkaido	present	native	not invasive	Murayama, 1953
Honshu	present	native	not invasive	Murayama, 1953
Kyushu	present	native	not invasive	Murayama, 1953
Shikoku	present	native	not invasive	Murayama, 1953
Korea, DPR	present	native	not	Wood & Bright, 1992

			invasive	
Korea, Republic of	present	native	not invasive	Murayama, 1931; Choo et al., 1983
Malaysia	present	native	not invasive	Wood & Bright, 1992
Peninsular Malaysia	present	native	not invasive	Browne, 1961
Sabah	present	native	not invasive	Chey VunKhen, 2002
Sarawak	present	native	not invasive	Schedl, 1964
Myanmar	present	native	not invasive	Wood & Bright, 1992
Nepal	present	native	not invasive	Wood & Bright, 1992
Philippines	present	native	not invasive	Wood & Bright, 1992
Sri Lanka	present	native	not invasive	Wood & Bright, 1992
Thailand	present	native	not invasive	Beaver & Browne, 1975
Vietnam	present	native	not invasive	Wood & Bright, 1992
Africa				
Cameroon	present	introduced	not invasive	Wood & Bright, 1992
Congo Democratic Republic	present	introduced	not invasive	Wood & Bright, 1992
Côte d'Ivoire	present	introduced	not invasive	Wood & Bright, 1992
Equatorial Guinea	present	introduced	not invasive	Wood & Bright, 1992

Ghana	present	introduced	not invasive	Wood & Bright, 1992
Kenya	present	introduced	not invasive	Wood & Bright, 1992
Madagascar	present	introduced	not invasive	Wood & Bright, 1992
Mauritania	present	introduced	not invasive	Wood & Bright, 1992
Mauritius	present	introduced	not invasive	Wood & Bright, 1992
Nigeria	present	introduced	not invasive	Wood & Bright, 1992
Seychelles	present	introduced	not invasive	Wood & Bright, 1992
Sierra Leone	present	introduced	not invasive	Wood & Bright, 1992
Tanzania	present	introduced	not invasive	Wood & Bright, 1992
North America				
USA	present	introduced	invasive	Wood & Bright, 1992
Florida	present	introduced	invasive	Wood & Bright, 1992
Georgia (USA)	present	introduced	invasive	Wood & Bright, 1992
Hawaii	present	introduced	invasive	Wood & Bright, 1992
Louisiana	present	introduced	invasive	Wood & Bright, 1992
Maryland	present	introduced	invasive	Bambara & Casey, 2003
Mississippi	present	introduced	invasive	Wood & Bright, 1992
North Carolina	present	introduced	invasive	Wood & Bright, 1992; Bambara & Casey, 2003
Oklahoma	present	introduced	invasive	Bambara & Casey, 2003
South Carolina	present	introduced	invasive	Wood & Bright, 1992;

				Bambara & Casey, 2003
Tennessee	present	introduced	invasive	Oliver & Mannion, 2001; Bright & Skidmore, 2002
Texas	present	introduced	invasive	Wood & Bright, 1992; Bambara & Casey, 2003
Virginia	present	introduced	invasive	Bambara & Casey, 2003
Oceania				
Belau	present	introduced		Wood & Bright, 1992
New Caledonia	present	introduced		Wood & Bright, 1992
New Zealand	absent, intercepted only	introduced		Brockerhoff et al., 2003
Papua New Guinea	present	native	not invasive	Wood & Bright, 1992
Samoa	present	introduced	invasive	Beeson, 1929; Beaver, 1976

History of introduction and spread

X. crassiusculus was probably introduced to the Afrotropical region from the Oriental region hundreds of years ago by early traders. It has become one of the commonest ambrosia beetles in the rain forest (Schedl, 1963) in both East and West Africa. In North America, it was first discovered near Charleston, South Carolina in 1974 (Anderson, 1974). From there it spread to North Carolina (Hunt, 1979), Louisiana and Florida (Chapin and Oliver, 1986; Deyrup and Atkinson, 1987), and to Mississippi and Texas (Atkinson et al., 1991). Most recently, it has been reported from Tennessee (Oliver and Mannion, 2001). The species is now well-established in south-eastern USA, and may be expected to spread further where climatic conditions are suitable. X.crassiusculus was intercepted in Canada in 1997, but has not established there (Krcmar-Nozic et al., 2000). It seems likely that climatic conditions are too harsh there for the species. In the Hawaiian islands, the species was first found on Hawaii in 1950, and became established on most of the windward islands during the 1950s (Samuelson, 1981). There is no information on when it was introduced to other Pacific Islands. In all cases, the introduction has been accidental.

Biology and ecology

The important pest species in the genus Xyleborus and the related genera Xylosandrus, Xyleborinus and Euwallacea are all ambrosia beetles in the Xyleborini, a tribe with a social organization of extreme polygamy. The sexual dimorphism is strongly developed, and the ratio of females to males is high. Some species infest small twigs and shoots, others are found in larger branches and poles, while others are found in large timber; others may breed in material of almost any size. In general, most species bore through the bark and into the wood where an enlarged chamber of varying size and shape is constructed. The tunnels into the wood are highly variable in depth and shape, depending on the species involved in the construction. Generally only unhealthy or newly fallen material is infested, but some species are capable of attacking host plants following only a slight set-back, for example, transplanting or temporarily unfavourable conditions such as drought or mechanical injury. A few species have become aggressive under certain conditions, and have thereby attained the status of important pests.

All species of Xyleborus and the related genera are closely associated with ambrosial fungi. Some of these fungi are phytopathogenic and all species of Xyleborus and related genera should be considered to be possible vectors of plant disease.

Some details of the biology of X. crassiusculus are given by Beeson (1930), Browne (1961), Schedl (1963) and Beaver (1976, 1988). The species is known to prefer fresh, moist wood (Beeson, 1930; Beaver, 1988), and attack-densities are usually higher on wood in the shade than in the sun, and higher on the lower side of logs. Stems of fairly small diameter (2.5 - 8 cm) are usually attacked, but sometimes larger logs. The gallery sytem is somewhat variable depending on the size of the stem. In large stems, it branches several times in one transverse plane, and may penetrate 5 cm or more. In small stems, there are fewer branches and one or more may extend along the axis of the stem. In the palm rachis, the galleries run more irregularly through the fibrous tissues. Brood sizes up to 65 have been recorded in the Congo, and up to 100 in Ghana (Schedl, 1963), but usually range between about 10 and 40 (Beaver, 1988). In the tropics, breeding is continuous throughout the year, with overlapping generations, so that the species is present at all times and in all stages of development (Browne, 1968). In south-eastern USA, beetles are active from the beginning of March until autumn, and the life cycle takes about 55 days (Bambara and Casey, 2003).

Morphology

Adult Female

Length 2.2-2.5 mm. Frons weakly convex, with a distinct median line, surface coarsely granulate, sparsely punctate. Antennal club solid on posterior face, no sutures present. Pronotum about as long as wide; sides weakly arcuate, anterior margin narrowly rounded, with 8 or 9 weak serrations. Elytra 1.2-1.3 times longer than wide, apex broadly rounded. Elytral declivity abrupt, convex, surface opaque with dense, confused granules and rows of long stout setae.

Immature Stages

The egg and pupa have not been described. The larvae of X. crassiusculus and Xylosandrus discolor are briefly described and keyed by Gardner (1934). Gardner (1934) describes the mature larva (as Xyleborus semigranosus) as follows: length about 3.5 mm. Head pale, slightly wider than long. Labrum with strong posterior extension. Epipharyngeal setae very small. Maxillary palp with apical segment only slightly longer than wide. Labial palps separated by about width of a basal segment, apical segment globular, not longer than wide. Abdominal terga with two distinct folds separated by an extremely narrow subdivision. Spiracles with combined width of air-tubes equal to diameter of atrium. Skin rather densely covered with micro-asperities.

Too little is known of the larvae of other species of Xylosandrus to be sure whether the description is adequate to separate X. crassiusculus larvae from those of related species. Gardner (1934) distinguishes the species from Xylosandrus discolor by the micro-asperate (versus smooth) skin.

Means of movement and dispersal

Natural Dispersal

Adult females fly readily, and flight is one of the main means of movement and dispersal to previously uninfected areas. Of more importance for long distance movement, however, is the transport of infested seedlings, saplings or cut branches. X. crassiusculus usually attacks stems of small diameter (not more than 5 cm diameter), but is sometimes found in larger timber, especially if fresh. Hence it may also be transported in crates or other packing material.

Vector Transmission

The female has a mycangium, a pouch used to carry spores of the ambrosia fungus on which both adult and larvae feed, opening between the pronotum and mesonotum, and extending below the pronotum (Beaver, 1989). The ambrosia fungus of X. crassiusculus is a species of Ambrosiella (Kinuura, 1995; Dute et al., 2002). Ambrosiella spp. are not pathogenic, although they do cause staining of the wood around the gallery systems. 'Contamination ' of the mycangia by the spores of pathogenic fungi is possible. Spores of pathogenic fungi can also be transported on the cuticle of the beetle, although their chance of survival there is much less than in the mycangial pouch. There is some evidence for the transmission of wilt fungi by X. crassiusculus (Davis and Dute, 1997). The species has been reported to vector the sap-stain fungus, Botryodiplodia theobromae, into shade trees (Grevillea robusta) in coffee plantations in India (Sreedharan et al., 1991).

Plant parts liable to carry the pest in trade/transport

- Bark: Adults; borne internally; visible to naked eye.
- Seedlings/Micropropagated Plants: Eggs, Larvae, Pupae, Adults; borne internally; visible under light microscope.
- Stems (above Ground)/Shoots/Trunks/Branches: Eggs, Larvae, Pupae, Adults; borne internally; visible under light microscope.
- Wood: Eggs, Larvae, Pupae, Adults; borne internally; visible under light microscope.

Plant parts not known to carry the pest in trade/transport
- Bulbs/Tubers/Corms/Rhizomes
- Fruits (inc. Pods)
- Growing Medium Accompanying Plants
- Flowers/Inflorescences/Cones/Calyx
- Leaves
- Roots
- True Seeds (inc. Grain).

Natural enemies

The immature stages have few natural enemies. The female parent normally remains in the gallery entrance whilst the immature stages are developing, preventing the entry of potential predators and parasitoids. Provided that the female remains alive and the growth of the ambrosia fungus on which the larvae feed is satisfactory, mortality of the immature stages is likely to be very low. Schedl (1962) records a species of the curculionid genus Scolytoproctus (Scolytoproctus schaumi) which acts as a nest parasite of X. crassiusculus in the Congo. The female Scolytoproctus forces its way into the beetle gallery, and lays its eggs near the gallery entrance. It is unclear, however, whether the ambrosia beetle is killed by the invader, and whether the ambrosia beetle brood continues to develop normally. Most mortality is probably during the dispersal of the adults, and during gallery establishment. The adults of ambrosia beetles are predated by lizards, clerid beetles and ants as they attempt to bore into the host tree. The adults will also fail to oviposit if the ambrosia fungus fails to establish in the gallery.

IMPACT

Economic impact

Xylosandrus species are known pests of various forest and agricultural plants, and have the potential to transmit pathogenic fungi to their host plants. X. crassiusculus has been recorded killing saplings of forest trees shortly after transplanting. Browne (1968) notes 'devastating' attacks on newly formed plantations of Aucoumea klaineana and Khaya ivoriensis in Ghana. It has also been found in apparently healthy Cinchona trees in Java, Indonesia (Kalshoven, 1959). No known stress factors could be associated with primary attacks on peach orchards in South Carolina, USA (Kovach and Gorsuch, 1985). Atkinson et al. (2000) note large numbers of attacks in Florida, USA on Shumard oak saplings which showed no other symptoms of stress, disease or attack by other insects, and consider that the beetles caused the death of the trees. Atkinson et al.

(2000) also noted isolated attacks on large Drake elm saplings. The attacks did not kill the tree directly, but large cankers developed at the site of the attacks, and these sometimes resulted in the death of the trees by girdling. The species can breed successfully in newly sawn timber (Browne, 1961).

Impact on biodiversity

Samuelson (1981) notes that in Hawaii, X. crassiusculus has spread into native forest environments, where its hosts include the important endemic trees, Acacia koa and Metrosideros collina. Maeto et al. (1999) noted a large influx of the species from oil palm plantations, where it breeds in fallen palm leaf stalks, into lowland rain forest in Peninsular Malaysia.

Impact descriptors

Negative impact on: crop production; forestry production; rare / protected species; native flora; animal / plant collections

Phytosanitary significance

Two other species of Xylosandrus, Xylosandrus compactus and Xylosandrus morigerus, with similar habits to X. crassiusculus, have become important pests of tree crops, ornamental and native trees in tropical and subtropical areas where they have been introduced. The risk of introduction for X. crassiusculus must be considered high, most probably in the twigs and small branches of imported plants, although, because it can also breed in fresh timber, other pathways are also possible. Once established, such species are difficult to eradicate, and are likely to spread with the movement of infested plants, as well as by normal dispersal of the adults. X. crassiusculus is listed as a quarantine pest in New Zealand, but apparently not elsewhere. This should be remedied.

Symptoms

Attacked plants may show signs of wilting, branch die-back, shoot breakage, chronic debilitation, sun-scorch or a general decline in vigour.

Detection and inspection

Some success in the detection of the beetle has been obtained by using traps baited with ethanol placed in and around port facilities where infested material may be stored, and around nurseries with plants susceptible to attack. A simple type of trap is described by Bambara et al. (2002). Visual inspection of suspected infested material is required to detect the presence of ambrosia beetles. Infestations are most easily detected by the presence of entry holes made by the attacking beetles, and the presence of frass produced during gallery construction. In X. crassiusculus, the frass is pushed out in the form of a compact cylinder, which may reach a length of 3 to 4 cm before it breaks off, and forms a useful recognition character for the presence of attacks.

Control

When Xylosandrus species are detected in plant material, it is necessary to immediately destroy all of the infested material. When they are detected in traps, plant material in the vicinity of the trap should be inspected, with special attention directed towards imported woody products such as crating, dunnage and lumber milling scraps. If an active infestation is detected, chemical control using insecticides is not generally effective since the adult beetles bore deep into the host material. The following insecticides were found to be effective against a species of Euwallacea, destructive to tea: fenvalerate, deltamethrin, quinalphos, cypermethrin and dichlorvos (Muraleedharan, 1995); these insecticides may also be effective against other ambrosia beetles. Bambara and Casey (2003) suggest the use of permethrin, but multiple treatments may be required during a season. They note that lindane and dursban are ineffective. They also suggest the use of some attacked trees as trap trees, which need to be removed and burned before the life cycle of the beetle (about 55 days in North Carolina, USA) is completed. The concealed habitats in which these species feed and reproduce, the difficulties and high costs of insecticide application, and environmental concerns, all limit the effectiveness of chemical control. The use of radiation to kill, sterilize or inhibit the emergence of beetles in cut timber (Yoshida et al., 1975), is unlikely to be practical.

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Xylosandrus discolor

Names and taxonomy

Xylosandrus discolor (Blandford, 1898)

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Scolytidae

Other scientific names

Xyleborus discolor Blandford

Xyleborus posticestriatus Eggers

Xylosandrus posticestriatus (Eggers)

EPPO code

XYLBDC (Xyleborus discolor)

Common names

French:

scolyte brun et noir

Notes on taxonomy and nomenclature

Many species previously classified in the genus Xyleborus have now been transferred into other genera such as Ambrosiodmus, Euwallacea, Xyleborinus and Xylosandrus, including X. discolor. Xylosandrus posticestriatus has been considered a synonym of X. discolor by Schedl (1958), Browne (1963) and Nobuchi (1967). It is listed as a distinct species by Wood and Bright (1992) without any reason given for the change. As Schedl (1962) noted, it really differs only in its smaller size from X. discolor, and its recorded distribution is very similar. Several species of Xylosandrus have forms which differ from each other only in their size. X. posticestriatus is considered here as a synonym of X. discolor. A number of species within the Xyleborini, the tribe in which Xyleborus and related genera are placed, could be considered potential pests to agriculture and forestry; X. discolor is one of the more important species.

Host range

Notes on host range

Members of Xyleborus and the related genera Ambrosiodmus, Euwallacea, Xyleborinus and Xylosandrus are all ambrosia beetles that feed and breed in a variety of forest trees and shrubs. Depending on the species, they may be found in small branches and seedlings to large logs. All are potentially damaging to agriculture and/or forestry under suitable conditions. Many species, previously considered of only minor importance, may become important pests in agriculture and forestry as a result of the continuing destruction of natural forests and the expansion of forest and tree crop plantations, agroforestry and agriculture.

X. discolor has been recorded from a number of other host tress (Beeson, 1930; Kalshoven, 1959;Browne, 1961, 1968). It seems to attack non-indigenous trees especially (Beeson, 1930). It has the potential to become an important shoot borer. It is usually a secondary species, but attacks are sometimes primary on living twigs and small branches of crop and plantation trees (Browne, 1968).

Affected Plant Stages: Flowering stage, fruiting stage, seedling stage and vegetative growing stage.

Affected Plant Parts: Stems.

List of hosts plants

Major hosts

Coffea arabica (arabica coffee), Coffea canephora (robusta coffee), Theobroma cacao (cocoa)

Minor hosts

Ailanthus altissima (tree-of-heaven), Albizia , Camellia sinensis (tea), Chloroxylon swietenia (satinwood), Cinchona , Cinnamomum camphora (camphor laurel), Grevillea robusta (silky oak), Hevea brasiliensis (rubber), Juglans nigra (black walnut), Mangifera indica (mango), Mesua ferrea (Ceylon iron wood), Rhus chinensis (nutgal sumac), Styphnolobium japonicum (pagoda tree), Swietenia mahagoni (Cuban mahogany), Toona ciliata (toon)

Geographic distribution

Notes on distribution

There is an unpublished record from Sarawak, Malaysia (RA Beaver, Chiangmai, Thailand, personal communication, 2004).

Distribution List

Please note: The distribution status for a country or province is based on all the information available. When several references are cited, they may give conflicting information on the pest status. In particular, citations of earlier presence of a pest are included even though there is an authoritative reference to indicate that the pest is now absent.

Asia

China

present

native

not invasive

Yin et al., 1984; Wood & Bright, 1992

Fujian

present

native

not invasive

Yin et al., 1984; Wood & Bright, 1992

Guangdong

present

native

not invasive

Yin et al., 1984; Wood & Bright, 1992

Sichuan

present

native

not invasive

Yin et al., 1984; Wood & Bright, 1992

Taiwan

present

native

not invasive

Nobuchi, 1967; Beaver & Browne, 1975

Yunnan

present

native

not invasive

Yin et al., 1984; Wood & Bright, 1992

India

present

native

not invasive

Beeson, 1930, 1961; Wood & Bright, 1992

Andaman and Nicobar Islands

present

native

not invasive

Maiti & Saha, 1986; Wood & Bright, 1992

Assam

present

native

not invasive

Beeson, 1930; Wood & Bright, 1992

Sikkim

present

native

not invasive

Saha & Maiti, 1984

Tamil Nadu

present

native

not invasive

Beeson, 1930; Wood & Bright, 1992

Uttar Pradesh

present

native

not invasive

Beeson, 1930; Wood & Bright, 1992

West Bengal

present

native

not invasive

Beeson, 1930

Indonesia

present

native

not invasive

Wood & Bright, 1992

<u>Java</u>

present

native

not invasive

Kalshoven, 1959; Wood & Bright, 1992

<u>Nusa Tenggara</u>

present

native

not invasive

Schedl, 1961

<u>Papua Barat</u>

present

native

not invasive

Entwhistle, 1972

<u>Sumatra</u> present

native

not invasive

Kalshoven, 1959, 1981

<u>Malaysia</u>

present

native

not invasive

Wood & Bright, 1992

Peninsular Malaysia

present

native

not invasive

Browne, 1961

Myanmar

present native

not invasive

Beeson, 1930; Wood & Bright, 1992

Pakistan

present

native

not invasive

Browne, 1968

Sri Lanka

present native

not invasive

Blandford, 1898; Speyer, 1923; Wood & Bright, 1992

Thailand

present

native

not invasive

Beaver & Browne, 1975

Vietnam

present

native

not invasive

Le Pelley, 1968

History of introduction and spread

As yet, this species does not seem to have been introduced outside its native range.

Biology and ecology

The important pest species in the genus Xyleborus and the related genera Ambrosiodmus, Euwallacea, Xyleborinus and Xylosandrus are all ambrosia beetles in the Xyleborini, a tribe with a social organization of extreme polygamy. The sexual dimorphism is strongly developed, and the ratio of females to males is high. Some species infest small twigs and shoots, others are found in larger branches and poles, while others are found in large timber; others may breed in material of almost any size. In general, most species bore through the bark and into the wood where an enlarged chamber of varying size and shape is constructed. The tunnels into the wood are highly variable in depth and shape, depending on the species involved in the construction. Generally only unhealthy or newly fallen material is infested, but some species are capable of attacking host plants following only a slight set-back, for example, transplanting or temporarily unfavourable conditions such as drought or mechanical injury. A few species have become aggressive under certain conditions, and have thereby attained the status of important pests.

All species of Xyleborus and the related genera are closely associated with ambrosial fungi. Some of these fungi are phytopathogenic and all species of Xyleborus and related genera should be considered to be possible vectors of plant disease.

Some details of the biology of X. discolor are given by Beeson (1961), Browne (1961) and Kalshoven (1959). The species usually breeds in stems from about 0.8 to 3.0 cm diameter, but occasionally up to about 7.5 cm diameter. There is a short radial gallery penetrating the stem, and one or more longitudinal galleries, which may be irregularly enlarged, and in which the brood develop. Brood size is usually small (six to ten), but development is rapid. In most parts of the range, there will be numerous overlapping generations during the year.

Morphology

The species was redescribed and figured by Maiti and Saha (1986).

Adult Female

Length 1.9-2.0 mm. Frons broadly convex, surface shining, reticulate, with sparse, small and large punctures. Antennal club solid on posterior face, no sutures visible. Pronotum slightly wider than long, sides strongly arcuate, anterior margin broadly rounded, with 8 coarse serrations. Elytra equal in length to pronotum, about as long as wide, apex broadly rounded. Elytral declivity commencing at posterior third, very steep, convex; strial punctures obsolete, replaced by close granules and very small setae; interstrial punctures also obsolete, with irregular small granules and a single row of erect scales and small setae over entire surface.

Immatue Stages

The egg and pupa have not been described.

Gardner (1934) describes the mature larva (as Xyleborus discolor) as follows: length about 4 mm. Head pale, slightly wider than long. Labrum with moderate posterior extension. Epipharyngeal setae normal, short and very fine; the two pairs of setae between the rods rather close, the setae of each pair widely separated. Maxillary palp with apical segment slightly longer than wide. Labial palps widely separated; apical segment globular, slightly transverse. Abdominal terga with two distinct folds and an extremely narrow intermediate strip. Spiracles with atrium not wider than air tubes together. Skin smooth.

Too little is known of the larvae of other species of Xylosandrus to be sure whether the description is adequate to separate X. discolor larvae from those of related species. Gardner (1934) distinguishes the species from X. crassiusculus by the smooth (versus micro-asperate) skin.

Means of movement and dispersal

Natural Dispersal

The adult females fly readily, and flight is one of the main means of movement and dispersal to previously uninfected areas. Of more importance for long distance movement, however, is the transport of infested seedlings, saplings or cut branches. X. discolor is unlikely to occur in wood packing or crates and similar material, because it normally attacks stems of small diameter (not more than 5 cm diameter).

Vector Transmission

The female has a mycangium, a pouch used to carry spores of the ambrosia fungus on which both adult and larvae feed, opening between the pronotum and mesonotum, and extending below the pronotum (Beaver, 1989). 'Contamination ' of the mycangia by the spores of pathogenic fungi is possible, and the ambrosia fungus itself may be pathogenic in some cases, although there is currently no evidence for this in X. discolor. The spores of pathogenic fungi could also be transported on the cuticle of the beetle, although their chance of survival there is much less than in the mycangial pouch.

Plant parts liable to carry the pest in trade/transport

- Bark: Adults; borne internally; visible to naked eye.

- Seedlings/Micropropagated Plants: Eggs, Larvae, Pupae, Adults; borne internally; visible under light microscope.

- Stems (above Ground)/Shoots/Trunks/Branches: Eggs, Larvae, Pupae, Adults; borne internally; visible under light microscope.

- Wood: Eggs, Larvae, Pupae, Adults; borne internally; visible under light microscope.

Plant parts not known to carry the pest in trade/transport

- Bulbs/Tubers/Corms/Rhizomes
- Fruits (inc. Pods)
- Growing Medium Accompanying Plants
- Flowers/Inflorescences/Cones/Calyx
- Leaves
- Roots
- True Seeds (inc. Grain).

Natural enemies

The immature stages have few natural enemies. None have been recorded for X. discolor. The female parent normally remains in the gallery entrance whilst the immature stages are developing, preventing the entry of potential predators and parasitoids. Provided that the female remains alive and the growth of the ambrosia fungus on which the larvae feed is satisfactory, mortality of the immature stages is likely to be very low. Most mortality is probably during the dispersal of the adults, and during gallery establishment. Adults of ambrosia beetles are predated by lizards, clerid beetles and ants as they attempt to bore into the host tree.

Impact

Economic impact

Species of Xylosandrus and related genera are known pests of various forest and agricultural plants. X. discolor could become an important shoot borer if imported outside its native range. Its apparent preference for non-indigenous trees should be noted.

X. discolor and other ambrosia beetles have the potential to transmit pathogenic fungi to their hosts.

LePelley (1968) records the species as a primary, though not an important pest of coffee in Java, Sri Lanka and Vietnam. Entwhistle (1972) also records the species as a primary borer of twigs and shoots, but notes that its occurrence in cocoa in West Irian was sporadic and in not entirely healthy trees. Speyer (1923) found the species only in diseased branches of rubber trees. Browne (1968) notes minor injury to Mesua ferrea in Pakistan, and its occurrence in unhealthy crowns of several forest plantation trees in India and Sri Lanka. It is clear that the economic impact of the species to date has been small.

Impact descriptors

Negative impact on: crop production; forestry production

Phytosanitary significance

Three other species of Xylosandrus, Xylosandrus compactus, Xylosandrus crassiusculus and Xylosandrus morigerus, with similar habits to X. discolor, have become important pests of tree crops, ornamental and native trees in tropical and subtropical areas where they have been introduced. The risk of introduction for X. discolor must be considered high, most probably in the twigs and small branches of imported plants, although other pathways are also possible. Once established, such species are difficult to eradicate, and are likely to spread with the movement of infested plants, as well as by normal dispersal of the adults. X. discolor is not currently known to be specifically listed as a quarantine pest.

Symptoms

Attacked plants may show signs of wilting, branch die-back, shoot breakage, chronic debilitation, sun-scorch or a general decline in vigour.

Symptoms by affected plant part

Stems:

Detection and inspection

Some success in the detection of the beetle has been obtained by using traps baited with ethanol placed in and around port facilities where infested material may be stored, and around nurseries with plants susceptible to attack. A simple type of trap is described by Bambara et al. (2002). Visual inspection of suspected infested material is required to detect the presence of ambrosia beetles. Infestations are most easily detected by the presence of entry holes made by the attacking beetles, and the presence of frass thrown out during gallery construction.

Control

When Xylosandrus species are detected in plant material, it is necessary to immediately destroy all of the infested material. When they are detected in traps, plant material in the vicinity of the trap should be actively inspected, with special attention directed towards imported woody products such as crating, dunnage and lumber milling scraps. If an active infestation is detected, control using insecticides is possible but of limited effectiveness. Chemical control is not generally effective since the adult beetles bore deep into the host material. The following insecticides were found to be effective against a species of Euwallacea destructive to tea: fenvalerate, deltamethrin, quinalphos, cypermethrin and dichlorvos (Muraleedharan, 1995); these insecticides may also be effective against other ambrosia beetles. Bambara and Casey (2003) suggest the use of permethrin for the related species, Xylosandrus crassiusculus, but multiple treatments may be required during a season. They also suggest the use of some attacked trees as trap trees, which need to be removed and burned before the life cycle of the beetle is completed.

The concealed habitats in which these species feed and reproduce, the difficulties and high costs of insecticide application, and environmental concerns all limit the effectiveness of chemical control.

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Xylosandrus germanus

Names and taxonomy

Xylosandrus germanus (Blandford)

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Scolytidae

Other scientific names

Xyleborus germanus Blandford

Xyleborus orbatus Blandford

EPPO code

XYLBGE (Xylosandrus germanus)

Common names

English:

black timber bark beetle

smaller alnus bark beetle

tea root borer

French:

xylebore japonique

petit scolyte noir du Japon

xylebore germanique

Germany:

Borkenkaefer, Japanischer Nutzholz-

Borkenkaefer, Schwarzer Nutzholz-

Japanischer Nutzholzborkenkäfer

Schwarzer Nutzholzborkenkäfer

Japan:

Han-no-kikuimusi

hannoki-kikuimushi

Notes on taxonomy and nomenclature

The female of the species was described from Japan by Blandford (1894) in the genus Xyleborus Eichhoff. It was transferred to Xylosandrus by Hoffmann (1941), but has often been referred to in later literature as Xyleborus germanus. The male was described by Eggers (1926). The only synonym, Xyleborus orbatus Blandford (1894), was recognized as the male of the species by Nobuchi (1981). Further references to the species are given by Wood and Bright (1992), and Bright and Skidmore (1997, 2002). It should be noted that the Scolytidae are now usually treated not as a separate family, but as a subfamily (Scolytinae) of Curculionidae (e.g. Kuschel, 1995; Lawrence and Newton, 1995; Marvaldi et al., 2002).

Host range

Notes on host range

Like many other related ambrosia beetles, X. germanus attacks a very wide range of host plants, including both deciduous and coniferous trees. Weber and McPherson (1983a) list over 200 host species belonging to 51 plant families. X. germanus is not strongly size-selective, and will breed both in small branches and in large logs and stumps, although there may be some preference for stems of less than 10 cm diameter (Henin and Versteirt, 2004). It is clear that it will attack almost any woody plant stem which is in a suitable condition. Given the great range of host trees attacked, and the differences between geographical areas, it is not possible to distinguish 'main host' trees from 'other host' trees. It may be expected that almost any crop, plantation or ornamental tree in a particular area can be attacked. The list of hosts is only a small selection.

Affected Plant Stages: Flowering stage, fruiting stage, post-harvest and vegetative growing stage.

Affected Plant Parts: Leaves, roots, stems and whole plant.

List of hosts plants

Major hosts

Abies alba (silver fir), Acer pseudoplatanus (sycamore), Alnus glutinosa (European alder), Betula pendula (common silver birch), Camellia sinensis (tea), Carpinus laxiflora , Carya illinoinensis (pecan), Castanea mollissima (hairy chestnut), Castanopsis cuspidata (chinkapin), Cinnamomum camphora (camphor laurel), Diospyros kaki (persimmon), Fagus sylvatica (common beech), Juglans nigra (black walnut), Juglans regia (walnut), Malus domestica (apple), Morus alba (mora), Picea abies (common spruce), Pinus sylvestris (Scots pine), Prunus armeniaca (apricot), Prunus serrulata (Japanese flowering cherry), Quercus petraea (durmast oak), Quercus robur (common oak), Rhus sylvestris , Styrax japonica , Ulmus americana (American elm), Vitis vinifera (grapevine)

Habitat

X. germanus can be found in temperate zone deciduous and coniferous forests, both in natural forests and in plantations (e.g. Nobuchi, 1981; Weber and McPherson, 1984; Grégoire et al., 2001; Iwai et al., 2001; Büssler and Müller, 2004; Bouget and Noblecourt, 2005). It also occurs in orchards, vineyards and tree nurseries (e.g. Yoon et al., 1982; Osumi and Mizuno, 1992; Oliver and Mannion, 2001; Boll et al., 2005).

Geographic distribution

Notes on distribution

Unlike many species in the tribe Xyleborini (Xylosandrus and related genera), the distribution of X. germanus lies outside the tropical zone. (There is a single record from Vietnam (Browne, 1968.) Its distribution is confined to more temperate climates, both in its native habitats, and in areas where it has been introduced.

Distribution List

Please note: The distribution status for a country or province is based on all the information available. When several references are cited, they may give conflicting information on the pest status. In particular, citations of earlier presence of a pest are included even though there is an authoritative reference to indicate that the pest is now absent.

Europe

Austria

present

introduced (1992)

invasive

Holzschuh, 1993; Geiser & Geiser, 2000

Belgium

present

introduced (1994)

invasive

Bruge, 1995; Henin & Versteirt, 2004

Former Yugoslavia

present

introduced

invasive

Wood & Bright, 1992

France

present

introduced

invasive

Wood & Bright, 1992

Germany

present

introduced (1952)

invasive

Groschke, 1952; Wood & Bright, 1992; Wichmann, 1995, 1957

Italy

present

introduced (1998)

invasive

Stergulc et al., 1999; Faccoli, 2000

Russian Federation

Russian Far East

present

introduced (1998)

not invasive

Krivolutskaya, 1973; Nobuchi, 1981

Southern Russia

present

introduced (1939-

1941) invasive

Mandelshtam, 2001

Switzerland

present

introduced (1986)

invasive

Maksymov, 1987; Graf & Manser, 1996

Asia

China

Anhui

present

native

not invasive

Yin et al., 1984; Wood & Bright, 1992

Fujian

present

native

not invasive

Yin et al., 1984; Wood & Bright, 1992

Shanxi

present

native

not invasive

Yin et al., 1984; Wood & Bright, 1992

Sichuan

present

native

not invasive

Yin et al., 1984

Taiwan

present native

not invasive

Nobuchi, 1967; Wood & Bright, 1992

Xinjiang

present

native

not invasive

Yin et al., 1984; Wood & Bright, 1992

Yunnan

present

native

not invasive

Yin et al., 1984; Wood & Bright, 1992

Japan

present

Murayama, 1954; Nobuchi, 1981

Hokkaido

present

native

not invasive

Murayama, 1954; Nobuchi, 1981

Honshu

present, few occurrences

native

not invasive

Murayama, 1954; Nobuchi, 1981

<u>Kyushu</u>

present

native

not invasive

Murayama, 1954; Nobuchi, 1981

<u>Ryukyu Archipelago</u>

present

native

not invasive

Nobuchi, 1981; Wood & Bright, 1992

<u>Shikoku</u>

present

native

not invasive

Murayama, 1954; Nobuchi, 1981

<u>Korea, Republic of</u>

present

native

not invasive

Murayama, 1930; Choo et al., 1983; APPPC, 1987; Wood & Bright, 1992

<u>Vietnam</u>

present

native

not invasive

Browne, 1968; Wood & Bright, 1992

North America

Canada

present

Wood & Bright,

1992 British

Columbia present

introduced (1995-

1998) invasive

Krcmar-Nozic et al.,

2000 Nova Scotia

present

introduced

invasive

Canadian Food Inspection Agency, 2005

Ontario

present

introduced

invasive

Wood & Bright, 1992; Bright et al., 1994

Quebec

present

introduced (2000)

invasive

Bright & Skidmore, 2002

USA

present

introduced (pre-1932)

invasive

Felt, 1932; Wood, 1977, 1982; Weber & McPherson, 1982

California

absent, intercepted only

Weber & McPherson,

1982 Connecticut

present

introduced

invasive

Bright, 1968; Wood & Bright, 1992

Delaware

present

introduced

invasive

Rabaglia & Valenti, 2003

Georgia (USA)

present

introduced

invasive

Weber & McPherson, 1982

Illinois

present

introduced

invasive

Weber & McPherson, 1982; Wood & Bright, 1992

Indiana

present

introduced (1975)

invasive

USDA, 1975; Weber & McPherson, 1982; Wood & Bright, 1992

Kansas

unconfirmed record

CAB Abstracts, 1973-1998

Kentucky

present

introduced

invasive

Weber & McPherson, 1982; Wood & Bright, 1992

Louisiana

present

introduced (1978)

invasive

USDA, 1978; Weber & McPherson, 1982

Maine

present

introduced (2004)

invasive

Crowe, 2005

<u>Maryland</u>

present

introduced (pre-1971)

invasive

Staines, 1984

<u>Michigan</u>

present

introduced

invasive

Weber & McPherson, 1982

<u>Missouri</u>

present

introduced (1968)

invasive

USDA, 1968, 1969; Weber & McPherson, 1982

<u>New Jersey</u>

present

introduced (pre-1941)

invasive

Hoffmann, 1941; Wood & Bright, 1992

<u>New York</u>

present

introduced (1932)

invasive

Felt, 1932; Hoffman, 1941; Wood & Bright, 1992

<u>North Carolina</u>

present

introduced (1963)

invasive

Schneider & Farrier, 1969; Wood & Bright, 1992

<u>Ohio</u>

present

introduced (pre-1941)

invasive

Hoffmann, 1941; Wood & Bright, 1992

<u>Oregon</u>

present

introduced (1999)

invasive

LaBonte et al., 2005

<u>Pennsylvania</u>

present introduced

invasive

Weber & McPherson, 1982; Wood & Bright, 1992

<u>South Carolina</u>

present

introduced

invasive

Weber & McPherson, 1982

<u>Tennessee</u>

present

introduced

invasive

Weber & McPherson, 1982; Oliver & Mannion, 2001

<u>Virginia</u>

present

introduced (1971)

invasive

USDA, 1972; Weber & McPherson, 1982

<u>West Virginia</u>

present

introduced (pre-1941)

invasive

Hoffmann, 1941; Wood & Bright, 1992

<u>Oceania</u>

<u>New Zealand</u>

absent, intercepted only

Brockerhoff et al., 2003

History of introduction and spread

X. germanus is native to East Asia, from the Kuril Islands to Vietnam, but has been accidentally introduced to North America, Europe and the Caucasus region (Mandelshtam, 2001). In the USA, its spread can be followed in the literature. It was first detected in the USA in New York in 1932 (Felt, 1932). Hoffmann (1941) recorded the species from three further states: New Jersey, Ohio and West Virginia. It was present in North Carolina in 1963 (Schneider and Farrier, 1969), in Missouri in 1968 (USDA, 1968) and in Maryland prior to 1971 (Staines, 1984). It was first recorded from Virginia in 1971 (USDA, 1972), Indiana in 1975 (USDA, 1975) and Louisiana in 1978 (USDA, 1978). Weber and McPherson (1982) add seven further states in the eastern half of the USA. In many of these areas, it is regarded as a pest species. More recently, it has been found for the first time (1999) in the western half of the USA in Oregon (LaBonte et al., 2005) and in 2004 in Maine (Crowe, 2005). In southern Canada, it has been recorded in Ontario (Wood and Bright, 1992) and more recently in Quebec (Bright and Skidmore 2002). The first record in Europe is from Germany (Groschke, 1952), but it has also spread to neighbouring countries. It is recorded from France (Wood and Bright, 1992), and for the first time in Switzerland in 1986 (Maksymov, 1987), Austria in 1992 (Holzschuh, 1993), Belgium in 1994 (Bruge, 1995) and Italy in 1998 (Stergulc et al., 1999; Faccoli, 2000). In the Caucasus region of Russia, it is believed to have been introduced from China in 1939-1941 (Mandelshtam, 2001). In almost all these countries, it has attained pest status, at least locally. It can be expected to spread further on both North American and Eurasian continents where conditions are suitable.

Biology and ecology

Life Cycle

The important pest species in the genus Xylosandrus and the related genera Euwallacea, Xyleborinus and Xyleborus are all ambrosia beetles in the Xyleborini, a tribe with a social organization of extreme polygamy. The sexual dimorphism is strongly developed, and the ratio of females to males is high. All are closely associated with symbiotic ambrosia fungi, which are transported by the female, and form the sole food for both adult and larvae.

Studies of the biology and life cycle of X. germanus have been made by Kaneko et al. (1965), Kaneko et al. (1965) and Kaneko and Takagi (1966) in Japan, Hoffmann (1941), Schneider and Farrier (1969), Weber and McPherson (1983c), and Oliver and Mannion (2001) in the USA, and in Europe by Groschke (1953), Gauss (1960), Heidenreich (1960, 1964) and Peer and Taborsky (2004, 2005).

The species is not strongly size-selective, and breeds both in small branches and in large logs and stumps. There may be some preference for stems of less than 10 cm diameter (Henin and Versteirt, 2004). In Japan, X. germanus also attacks the roots of tea (Kaneko et al., 1965). In small stems, an entrance tunnel cut into the pith or wood is extended into a longitudinal tunnel or an irregular chamber. In larger stems, the gallery may branch once or twice in the transverse plane, with a brood chamber in the longitudinal plane, but not penetrating far into the wood. The female feeds on the ambrosia fungus, Ambrosiella hartigii, which she has introduced into the gallery system before oviposition begins. The eggs are laid loosely in the gallery over some days, and the larvae feed on the ambrosia fungus on the walls of the gallery.

The size of the brood varies considerably. Broods from 1 to 54 individuals have been found, with an average of about 16 (Kaneko and Takagi, 1966; Weber and McPherson, 1983c). Pupation and mating of brood adults occurs within the gallery system, the (usually) single male in each gallery mating with his sisters. The new generation of females emerges through the entrance hole made by the parent. It is usually considered that the males of xyleborine ambrosia beetles do not emerge from the gallery system (e.g. Kirkendall, 1993), but Peer and Taborsky (2004) have shown that some males of X. germanus do disperse locally (by walking because they are flightless) to seek additional matings. Total development time from egg to adult is about 25 days at 24°C in the laboratory (Weber and McPherson, 1983c), but in the field in the temperate zone summer, about 55-60 days is required from gallery initiation to emergence of a new generation (Oliver and Mannion, 2001).

Genetics

X. germanus, like other xyleborines (Jordal et al., 2000), has diploid females and haploid males (Takagi and Kaneko, 1966). The diploid number of chromsomes is 16, the haploid number 8 (Takagi and Kaneko, 1966). Unmated females produce only haploid male offspring; mated females lay eggs with a sex ratio of about 9 females: 1 male, and produce adults with the same sex ratio (Takagi and Kaneko, 1966).

Phenology

The number of generations per year depends primarily on environmental temperatures. In its native range in Japan, there are one or two generations per year (Kaneko et al., 1965), in central Europe one generation (Bruge, 1995; Henin and Versteirt, 2004), but in Italy usually two (Faccoli, 2000), and in the USA (North Carolina to Illinois) two generations per year (Weber and McPherson, 1983). The optimum range of temperature for development is 21-23°C (Kaneko et al., 1965). The flight period of the adults is usually between April and August, but may extend into March and September (Kaneko and Takagi, 1966; Weber and McPherson, 1991). Adults overwinter in the host plants, often clustering in galleries (Hoffmann, 1941; Kaneko and Takagi, 1966; Weber and McPherson, 1983).

Environmental Requirements

The biotic and abiotic factors that could affect the distribution of the species are discussed by Henin and Versteirt (2004), and it is concluded that climatic conditions, particularly winter temperatures, play a crucial role - at least in limiting its northward spread. The reasons for the absence of the species from more tropical regions are unknown.

Associations

X. germanus is often found together with other species of scolytid ambrosia beetles in the same trees, e.g. together with Xylosandrus compactus on tea (Kaneko and Takagi, 1966); Xylosandrus crassiusculus on black walnut (Oliver and Mannion, 2001); Ambrosiodmus apicalis on apple (National Horticultural Research Institute, 2002); Xyleborus (Anisandrus) dispar on grapevine (Boll et al., 2005). The distributions of the species on the host tree may differ, for example, in Japan, X. germanus attacks mainly the roots of tea, X. compactus the stems (Kaneko and Takagi, 1966). These additional attacks add to the detrimental effect on the host plants.

Morphology

Small, black beetles, antennae geniculate with an obliquely truncate club, pronotum rounded, elytra about a half longer than the pronotum and with a broadly convex declivity.

Adult female: 2.0-2.3 mm long, 2.3 times as long as wide. Frons broadly convex, minutely reticulate, sparsely punctured, the punctures with fine, moderately long hairs. Pronotum subcircular, as long as wide, anterior margin with 8-10 low asperities, summit slightly behind middle, anterior slope coarsely asperate, posterior areas smooth, with a few minute punctures, a tuft of fine hairs at the median basal margin, remaining vestiture sparse. Scutellum large, flat, filling sutural notch, flush with surface. Elytra 1.3 times longer than wide, 1.4 times as long as pronotum, shining, sides almost straight and parallel on basal three-fourths, broadly rounded behind; striae not impressed, punctures small, rather shallow, without setae; interstriae smooth, shining, punctures uniseriate, more widely spaced, granulate; declivity commencing slightly behind middle, rather steep, broadly convex, the ventrolateral margin acutely elevated from apex to interstriae 7, interstrial setae longer than on disc.

Adult male: Males are rare, and very occasionally found outside the gallery system. Generally resembling female, but much smaller and more weakly sclerotised, 1.3-1.8 mm long, 2.0 times as wide as long. Frons shining, with weak, scattered punctures, median longitudinal line weakly elevated. Pronotum broadly rounded anteriorly, lacking asperities on the margin, anterior slope with numerous small asperities, shining posteriorly and impunctate. Elytra 1.5 times as long as wide, striae and interstriae seriate-punctate, the punctures larger on the disc than at the sides; declivity less convex, impressed along apico-lateral margins.

Egg: White, translucent, shiny, ellipsoidal, about 0.67 mm long and 0.38 mm wide (Hoffmann, 1941).

Larva: The larva is described by Weber (1982; see Weber and McPherson, 1982). There is a photograph of a larva in Hoffmann (1941). There are three larval instars (Weber and McPherson, 1983c).

Pupa: The pupa has not been described. There is a photograph of a pupa in Hoffmann (1941).

Means of movement and dispersal

Natural dispersal

The male adults of X. germanus are flightless, but the females can disperse by flight over relatively long distances. Grégoire et al. (2003) suggest that adults can fly at least 2 km. Longer distances may be covered by a few beetles, especially if they are caught by wind currents. In the USA, X. germanus spread at a rate of several tens of kilometres per year, and its initial rate of spread in Europe seems to have been similar (Henin and Versteirt, 2004).

Movement in trade

Long distance spread may also be the result of human transport of infested wood. This is the most likely route by which X. germanus has become established in Europe and North America. LaBonte et al. (2005) suggest that the recent spread of X. germanus from the eastern states of the USA, to Oregon in the West, is probably due to the intracontinental movement of untreated domestic solid wood packing material and other raw timber.

Vector Transmission

It was shown many years ago Buchanan, 1940, 1941) that X. germanus can transmit the Dutch elm disease fungus (Ophiostoma ulmi), but it is not an important vector (Carter, 1973). It is more often associated with Fusarium spp., which cause dieback, sprouting and stem cankers on affected trees. Such associations have been noted in walnut (Juglans nigra, J. regia) (Kessler, 1974;Weber and McPherson, 1984b, 1985; Stergulc et al., 1999; Faccoli, 2000); sycamore (Acer pseudoplatanus) (Gauss, 1960); and tulip poplar (Liriodendron tulipifera) (Anderson and Hoffard, 1978; Weber, 1980). It is likely that in some cases, spores of Fusarium spp. are carried on the cuticle of the dispersing adult beetles. The ambrosia fungus of the beetle, Ambrosiella hartigii (Batra, 1967), is not pathogenic, although it does cause staining of the wood around the galleries.

Plant parts liable to carry the pest in trade/transport

- Roots: Eggs, Larvae, Pupae, Adults; borne internally; visible to naked eye.

- Stems (above Ground)/Shoots/Trunks/Branches: Eggs, Larvae, Pupae, Adults; borne internally; visible to naked eye.

- Wood: Eggs, Larvae, Pupae, Adults; borne internally; visible to naked eye.

Natural enemies

No natural enemies appear to have been specifically recorded from X. germanus. Gauss (1960) recorded the parasitoid Tetrastichus sp. from galleries of X. germanus in Germany, but provided no evidence of its relationship to the species. Weber and McPherson (1983c) record one instance of predation by a hemipteran, possibly a reduviid. Fungivorous mites have also been recorded from the galleries (Gauss, 1960; Weber and McPherson, 1983c). A recent, thorough survey of the parasitoids and predators of European scolytids (Kenis et al., 2004) found no records of parasites or predators on X. germanus. In general, the immature stages of ambrosia beetles have few natural enemies. The female parent normally remains in the gallery entrance while the immature stages are developing, preventing the entry of potential predators and parasitoids. Adults will fail to oviposit if the ambrosia fungus fails to establish in the gallery. Provided that the female remains alive and the growth of the ambrosia fungus on which the larvae feed is satisfactory, mortality of the immature stages is likely to be very low. Adults of ambrosia beetles are likely to be predated by lizards, clerid beetles and ants as they attempt to bore into the host tree. Most mortality is probably during the dispersal of the adults and during gallery establishment.

Impact

Economic impact

The economic impact of X. germanus results both from its attacks on trees per se, and through its association with its ambrosia fungus, Ambrosiella hartigii, and with pathogenic fungi, primarily Fusarium spp. The tunnels, although not usually penetrating far into the wood, are accompanied by staining of the wood caused by the ambrosia fungus. This can cause degradation of affected timber. In Switzerland, Graf and Manser (1996, 2000) consider X. germanus an important pest of stored spruce and pine (Pinus sylvestris) logs. The tunnels also provide sites where pathogenic fungi can become established (Kessler, 1974;Weber, 1979, 1980; Katovich, 2004). These fungi may cause dieback, sprouting and stem cankers (e.g. Weber and McPherson, 1985; Stergulc et al., 1999; Faccoli, 2000) and may eventually result in the death of affected trees (Anderson and Hoffard, 1978; Weber, 1980). Attacks sometimes occur on healthy trees, especially walnut trees in plantations (Katovich, 2004). However, Weber (1984) suggests that the long-term effects of attacks by X. germanus on black walnut are minimal both biologically and economically. In China and Japan, X. germanus can be locally important as a pest of tea, attacking especially the roots of living plants (Kaneko and Takagi, 1966; Nobuchi, 1981).

Impact on biodiversity

In areas of Europe that have been invaded by X. germanus, it can become the dominant species in the forests (e.g. Haase et al., 1998; Grégoire et al., 2001; Büssler and Müller, 2004; Bouget and Noblecourt, 2005). This presumably results in a decline in abundance of the native species as a result of the occupation of potential breeding sites by X. germanus. However, there appear to be no quantitative studies of this presumed effect.

Impact descriptors

Negative impact on: biodiversity; forestry production; native fauna; trade / international relations

Phytosanitary significance

X. germanus should be considered a high-risk quarantine pest. In the tribe Xyleborini (Xylosandrus plus related genera), sib-mating occurs in the gallery system before the new generation of mated females emerges. Thus the introduction of only a few individuals (females) may lead to the establishment of an active population if suitable host plants can be found and environmental conditions are satisfactory. Specific host plants may not be a limiting factor because the adult beetle does not actually feed on the plant material, but uses it as a medium for growing the fungus which is the larval food. Any woody material of suitable moisture content and density may be all that is required. A very wide range of host plants have been recorded for many species of Xylosandrus, including X. germanus. The risk of establishment of species of Xylosandrus should be considered very high.

Symptoms

Symptoms by affected plant part

Leaves: wilting; yellowed or dead.

Roots: rot; internal feeding.

Stems: internal discoloration; external discoloration; canker; abnormal growth; abnormal exudates; dieback; internal feeding; visible frass; wilt; lodging; broken stems.

Whole plant: plant dead; dieback; early senescence; internal feeding; frass visible; discoloration; wilt.

Similarities to other species

In Europe, X. germanus might be confused with Xyleborus (Anisandrus) dispar but is smaller (2.0-2.3 mm relative to 3.2-3.6 mm long), the elytra are not strongly punctured, and the anterior coxae are widely separated not contiguous. In North America (USA), X. germanus might be confused with Xylosandrus crassiusculus or Xylosandrus compactus. X. crassiusculus can be distinguished by the elytral declivity, which is matt, not shiny, lacks striae and is densely covered by minute granules. X. compactus is smaller (1.7 mm or less), the declivital striae are not impressed, and clearly bear setae which are about one-third as long as the interstrial setae.

Detection and inspection

Visual inspection of suspected infested material is required to detect the presence of ambrosia beetles. Infestations are most easily detected by the presence of entry holes made by the attacking beetles, and the presence of frass produced during gallery construction. In X. germanus, the frass is pushed out in the form of a compact cylinder, which may reach a length of 3-4 cm before it breaks off, and forms a useful recognition character for the presence of attacks by this species or the related species, Xylosandrus crassiusculus. Ethanol-baited traps have been used to detect and monitor the presence of X. germanus in Europe, Asia and North America (Klimetzek et al., 1986; Grégoire et al., 2001; Oliver and Mannion, 2001; National Horticultural Research Institute, 2002;Boll et al., 2004, 2005). Both Oliver and Mannion (2001) and Boll et al. (2005) note that the traps are significantly less attractive to X. germanus than to other ambrosia beetles, and are only suited to monitor the presence of the species, not its abundance. Many types of traps are available, both commercial and non-commercial. One simple, cheap design is described by Bambara et al. (2002). Oliver et al. (2004) compare the efficiency of ambrosia beetle collection, and problems associated with the use of a number of different types of trap.

Control

Cultural Control

The removal of infested trees, branches and logs, and their destruction can help to reduce the level of attacks, at least locally. Weber and McPherson (1984a) showed that black walnut (Juglans nigra) trees from different provenances were not equally susceptible to attack. Selection of resistant strains may help to reduce the level of attacks.

Biological Control

Given the apparent absence of pathogens, parasitoids and predators, biological control measures are unlikely to be effective.

Chemical Control

Some studies have been carried out in Japan on the susceptibility of both adults and immature stages of X. germanus to fumigation with various chemicals (methyl bromide, methyl iodide, methyl isocyanate, sulfuryl fluoride) (Mizobuti et al., 1996; Soma et al., 1997; Oogita et al., 1998; Naito et al., 1999; Soma et al., 1999; Naito et al., 2003). The results suggest that methyl iodide has high potential as a fumigant of imported logs (Naito et al., 2003) and that mixtures of low concentrations of methyl bromide (providing high efficacy against eggs) and sulfuryl fluoride (providing high efficacy against larval and pupal stages) could also be used (Oogita et al., 1998). Attempts to control X. germanus and related species of Xylosandrus using insecticides have had rather limited success (Kaneko, 1967; Hudson and Mizell, 1999). Ambrosia beetles are difficult to control with insecticides because the host tree forms a barrier between the insecticide and the beetle. To be effective, insecticides must either be closely timed with beetle attacks, be applied repeatedly, or have long residual activity (Oliver and Mannion, 2001).

Physical Control

A study in Japan of the effects of irradiation on X. germanus in cut timber (Yoshida et al., 1975) indicated that treatment could prevent progeny surviving to the adult stage, and also further boring damage.

Monitoring

Oliver and Mannion (2001) have pointed out that the catch of X. germanus in ethanol-baited traps may not reflect the actual abundance and frequency of attacks on trees in the neighbourhood. Nevertheless, such traps can be used as an indicator of attacks, as with the related species, Xylosandrus crassiusculus (Mizzell et al., 1998; Oliver et al., 2005). It has been shown that the response of the beetles increases with the concentration of ethanol (Klimetzek et al., 1986; National Horticultural Research Institute, 2002), so the concentration needs to be kept high for effective monitoring.

IPM Programmes

No detailed IPM programmes have been developed for X. germanus. However, general recommendations (Katovich, 2004) would include monitoring for the presence of the pest, and reducing stress on recently-planted, nursery, or plantation trees. Heavily attacked branches or trees should be removed and destroyed to prevent infestations of nearby stressed trees. Insecticides appropriately labelled as bark treatments may be employed against new attacks, but systemic insecticides are not effective.

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Hylastes ater

Names and taxonomy

Preferred scientific name

Hylastes ater (Paykull, 1800)

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Curculionidae

Other scientific names

Bostrichus ater Paykull, 1800 Hylesinus chloropus Duftschmidt, 1825 Tomicus pinicola Bedel, 1888

EPPO code

HYASAR (Hylastes ater)

Common names

English:

black pine bark beetle
bark beetle, black
pine French:

hylesine noir du pin
Denmark:

rodbille,
fyrrens Finland:
ruskoniluri
Germany:
Bastkaefer, Schwarzer Kiefern-
Schwarzer Kiefernbastkär
Italy:

ilaste nero dei pini Japan:
matsuno-kuro-kikuimushi

Netherlands:

Dennebastkever, zwarte

zwarte dennebastkever

Norway:

fururotbille

Sweden:

tallbastborre, Svart

Notes on taxonomy and nomenclature

There has been some disagreement as to whether H. ater and Hylastes brunneus are distinct species. Blair (1949), Duffy (1953), Hansen (1955) and Lekander (1965) stated that they are distinct but Schedl (1968) considered that H. brunneus was only a form of H. ater. Beaver (1970) presented evidence of both adult and larval characters that demonstrate they are distinct species.

Host range

Notes on host range

The main hosts of H. ater are Pinus spp. but other conifers are utilized to a lesser extent.

Affected Plant Stages: Post-harvest and seedling stage.

Affected Plant Parts: Growing points, roots, stems and whole plant.

List of hosts plants

Major hosts

Abies alba (silver fir), Araucaria cunninghamii (colonial pine), Chamaecyparis lawsoniana (Port Orford cedar), Larix decidua (common larch), Picea sitchensis (Sitka spruce), Pinus cembra (arolla pine), Pinus densiflora (Japanese umbrella pine), Pinus muricata (bishop pine), Pinus nigra (black pine), Pinus pinaster (maritime pine), Pinus pinea (stone pine), Pinus pumila (Dwarf Siberian pine), Pinus radiata (radiata pine), Pinus strobus (eastern white pine), Pinus sylvestris (Scots pine), Pinus taeda (loblolly pine), Pinus uncinata (mountain pine), Pseudotsuga menziesii (Douglas-fir), Sequoia sempervirens (coast redwood), Thuja sp. (thuja)

Geographic distribution

Notes on distribution

H. ater is indigenous to virtually the whole of the Palearctic region and is present as an introduced species in Australia, Chile and New Zealand.

Distribution List

Please note: The distribution status for a country or province is based on all the information available. When several references are cited, they may give conflicting information on the pest status. In particular, citations of earlier presence of a pest are included even though there is an authoritative reference to indicate that the pest is now absent.

Biology and ecology

H. ater primarily breeds in the inner bark and cambium of pine roots and fresh stumps, the bases of dead and dying trees, and in recently felled logs, particularly those in contact with the ground (Milligan, 1978; Pasek, 1998). The adults also feed on the bark around the root collars, and the roots of pines and other conifers. Broods are mainly reared in pines (Clark, 1932; Milligan, 1978).

The brood galleries may be initiated in any month of the year. Each gallery that is initiated by the female consists of a short entrance tunnel leading to an oblique nuptial chamber from which issues a single egg gallery. This is 80-130 mm long and usually parallel with the grain of the wood. These brood galleries reach, but do not engrave, the surface of the sapwood. The male is usually in the nuptial chamber, close to the entrance and the female is further in towards the egg gallery, but in some chambers the male may be absent. Approximately 100 eggs are laid in individual notches that the female cuts in the lateral walls of the egg gallery. The females may sometimes leave the first egg gallery and start a second one elsewhere. The males may assist with the gallery construction, at least by pushing out frass from the entrance and sometimes making short feeding tunnels that extend from the nuptial chamber. The success of brood galleries in the absence of the males suggests that their part in establishing the galleries is only minor. The larvae initially make feeding tunnels at right angles to the maternal gallery, but these are later randomly directed and eventually obliterate both the early larval tunnels and those made by the parent adults. There are four larval instars and the rate of development of the feeding larvae appears to depend on seasonal temperatures. Emergence does not immediately follow eclosion of the adults but the length of the delay has not been investigated. Some adults feed in the material in which they were reared but the majority emerge and feed in fresh material where groups of approximately 40 feeding adults are found in communal galleries (Milligan, 1978).

In Canterbury, New Zealand the development from egg to adult can take from 60 to 300 days. The duration of development is least when the eggs are laid at the end of January and the beginning of February, and greatest when they are laid in approximately the second week of March. These later broods overwinter as mature larvae and appear to be subject to diapause so that they do not pupate until late December. Variations in the rate of development of both feeding and non-feeding larvae cause the adults from both the fast-developing and slow-developing broods to appear in January (Milligan, 1978).

There are two or three overlapping broods of H. ater per year in New Zealand (Clark, 1932) and Munro (1917) reported two in Scotland. Milligan (1978) noted that in September to October and in April to May swarming flights of H. ater occur in New Zealand. These do not coincide with the times when the greatest numbers reach the adult stage and probably involve many beetles that have been feeding for some time. What initiates this swarming, or what purpose it serves, is not understood. It has been suggested that it is associated with the local depletion of host material but this would not seem to apply in those forests where felling continues throughout the year (Milligan, 1978).

Reay and Walsh (2001) discuss the results of a trapping programme, which indicate that H. ater is now univoltine in New Zealand. They hypothesize that this has happened since Hylurgus ligniperda (another northern hemisphere scolytine) established in New Zealand in 1974. The trapping programme used raw turpentine in Lindgren funnel traps as the attractant and this must make the results of the programme open to question because Reay and Walsh (2002a) reported that raw turpentine performed no better as an attractant than a control.

Morphology

The eggs are ovoid, pearly-white, 0.9 mm long and 0.5 mm wide (Clark, 1932).

The larvae are of a typical scolytine form. For a detailed description see Lekander (1968) and Beaver (1970).

The pupa is soft, yellowish-white and exarate, with two conspicuous caudal processes on the ninth abdominal segment. Spines are conspicuous on the head, pronotum and abdomen (Clark, 1932).

There are about 30 species of Hylastes that are native to the Holarctic region and they are all superficially quite similar. See Wood (1982) for a generic description of the adults. Hylastes is closely related to Hylurgops but can be distinguished by having narrower, emarginated third tarsal segments. In Hylurgops these segments are broader and bilobed, and the pronotum is usually anteriorly constricted.

H. ater adults are 3.5-4.5 mm long and black (light-brown when teneral). The pronotum is strongly elongate and parallel-sided for the basal half with a median, impunctate, conspicuous ridge. The elytral interstices are dull and microscopically reticulate between the punctures.

Means of movement and dispersal

H. ater is a strong flier that disperses readily and responds to host volatiles.

Plant parts liable to carry the pest in trade/transport

- Seedlings/Micropropagated Plants: Adults; borne externally; visible to naked eye.
- Roots: Eggs, Larvae, Pupae, Adults; borne internally; visible to naked eye.
- Stems (above Ground)/Shoots/Trunks/Branches: Eggs, Larvae, Pupae, Adults; borne internally; visible to naked eye.

Natural enemies

Herting (1973) lists 11 species (in the families Staphylinidae, Histeridae, Nitidulidae, Cleridae, Raphididae and Asilidae) as predators but it is not clear whether these have been specifically recorded from H. ater or from other species of bark beetles in similar niches.

In 1976, the adults and larvae of Thanasimus formicarius were imported into New Zealand from Austria. The adults were successfully reared, and between 1977 and 1987 over 12,000 adults were released in numerous pine plantations. The first recoveries were made in 1984 (Faulds, 1989).

Rhopalicus tutele and Dinotiscus eupterus may be parasitic on H. ater in Europe. In 1975, numbers of both of these species were shipped to New Zealand from Austria as potential biological control agents. They were reared from logs from which H. ater constituted less than 1.7% of emerging bark beetles compared with over 90% for Hylurgops palliatus (Faulds, 1989).

Ten species of nematodes (Allantonema morosa, Parasitylenchus kleini, Contortylenchus cunicularii, Neoditylenchus panurgus, Cryptaphelenchus koerneri, Ektaphelenchus hylastophilus, Parasitaphelenchus uncinatus, Parasitylenchus hylastis, Micoletzkya thalenhorsti and Parasitorhabditis ateri) are associated with H. ater in Europe. Except for P. hylastis, the nature of the relationships with H. ater is unknown and it may be just phoretic. Three of these species: P. hylastis, M. thalenhorsti and P. ateri have also been found in New Zealand as has Bursaphelenchus eggersi which is not associated with H. ater in Europe but is found with Hylurgops palliatus. Anguilluloides zondagi has also been found associated with H. ater in New Zealand (Dale, 1967).

Natural enemies listed in the database

The list of natural enemies has been reviewed by a biocontrol specialist and is limited to those that have a major impact on pest numbers or have been used in biological control attempts; generalists and crop pests are excluded. For further information and reference sources, see About the data. Additional natural enemy records derived from data mining are presented as a separate list.

Natural enemies reviewed by biocontrol specialist

Natural enemy

Pest stage attacked

Associated plants

Biological control in:

Parasites/parasitoids:

Parasitylenchus hylastis

Adults, Larvae, Pupae

Predators:

Thanasimus formicarius (ant beetle)

Adults, Larvae

Pinus

New Zealand

Additional natural enemies (source - data mining)

Natural enemy

Pest stage attacked

Associated plants

Biological control in:

Parasites/parasitoids:

Rhopalicus tutele

Pinus

New Zealand

Predators:

Rhizophagus bipustulatus

Pinus

New Zealand

Rhizophagus dispar

Pinus

New Zealand

Rhizophagus ferrugineus

Pinus

New Zealand

Impact

Economic impact

Bevan (1987) stated that the damage caused by H. ater in Britain is severe and noted that over the years it has played a major role in causing planting losses, particularly of pine. Bevan also noted that it has proved to be rather more aggressive under British conditions than in many other parts of Europe. Munro (1917) recorded 45% mortality of newly planted Pinus sylvestris in a plantation in Britain.

Neumann (1979) stated that the damage is sometimes severe on nursery stock and young plantings in Australia but Elliott et al. (1998) noted that it is a relatively minor pest of Pinus spp., particularly Pinus radiata. However, Elliott also noted that in the early 1990s, 770 ha of second rotation P. radiata in Tasmania sustained numerous deaths of young seedlings.

Ciesla (1988) reported that up to 70% of pine seedlings in some areas of Chile have died as a result of H. ater attack.

Zondag (1965) reported that H. ater was the most troublesome insect in P. radiata regeneration in New Zealand and recorded over 50% mortality but with the qualification that it was only significant in poorly stocked areas. This implies that he was referring to natural regeneration and not planted areas. Clark (1932) reported that it caused severe loss in a young pine stand that had been re-established after logging operations.

Reay et al. (2001) discussed seedling mortality surveys that had been conducted within 1 year following planting in the central North Island of New Zealand. Seedling mortality in most forest compartments was less than 5% but was as high as 30% in a few compartments. The destructive sampling of seedlings showed that there was a high level of sub-lethal attack on seedlings, it was greater than 50% in two-thirds of the compartments sampled. Similar results were reported from a trial in the South Island of New Zealand much earlier, where 82% of seedlings had superficial resin-encrusted wounds on the stem base and larger roots (New Zealand Forest Service, 1970).

Obviously the sub-lethal or abortive attack on seedlings is very common and it would seem that the presence of feeding damage or the beetles themselves on dead seedlings is not conclusive evidence of cause and effect. Milligan (1978) suggested that in general healthy seedlings do not succumb to adult feeding and that those seedlings that do die are in some way debilitated or weakened by environmental factors such as extreme climatic conditions and poorly aerated soils. Several writers have observed that the quality of nursery stock and its treatment prior to and during planting, affect its susceptibility to damage by H. ater (e.g. Munro, 1917; Clark, 1932).

Reay et al. (2001) suggested that there might be ramifications from the adult feeding on seedlings on future wood quality because it is known that the beetles can carry sapstain fungi to seedlings. The following species of sapstain fungi have been isolated from H. ater in New Zealand: Ophiostoma ips, Ophiostoma setosum, Ophiostoma querci, Ophiostoma huntii, Ophiostoma galeiformis, Ophiostoma pluriannulatum, Leptographium truncatum and Leptographium procerum. The following fungi have been isolated from surface-sterilized seedlings following attack by H. ater: O. galeiformis, O. huntii, O. setosum, O. querci, Ophiostoma floccosum, Ophiostoma piceae, L. procerum and L. truncatum (MacKenzie, 1992; Reay et al., 2001). It would be of interest to know what species of fungi could be isolated from seedlings that have not been attacked by H. ater. Clearly more work is warranted.

Pasek (1998) suggested that there is the potential for H. ater to vector root diseases associated with intensive management. In England, several species of sapstain fungi can be consistently isolated from brood galleries of H. ater. These include Ophiostoma coerulescens, Ophiostoma penicillata (Dowding, 1973), Leptographium serpens and Leptographium sp. (Wingfield and Gibbs, 1991).

In New Zealand, infested logs are either refused for export or must be treated (usually by fumigation) immediately before shipping. Green sawn timber for export may also have to be treated (fumigation or kiln sterilization) if the adults that have been attracted to the freshly sawn wood are present. Sapstain fungi are transmitted by the beetles to the outer sapwood of logs but rarely significantly penetrate unless there is abnormal delay between felling and sawing (Milligan, 1978).

Environmental impact

Although the possible economic damage caused by this insect would not cause environmental problems, control measures using pesticides, if warranted, would raise environmental concerns.

Phytosanitary significance

H. ater is readily transported around the world in logs with bark on, in dunnage and casewood that has bark strips. However, a thorough inspection should reveal its presence in such material.

Symptoms

Symptoms by affected plant part

Growing points: dead heart; discoloration.

Roots: external feeding.

Stems: abnormal exudates; external feeding.

Whole plant: plant dead; dieback; external feeding.

Similarities to other species

H. ater is most closely related to Hylastes brunneus and they are difficult to distinguish. In H. brunneus the pronotum is less elongate and broadest behind the middle. See Beaver (1970) for further details.

Detection and inspection

Adult feeding on seedlings can be detected by a close examination of the root collar. This is greatly facilitated by removing the seedlings from the ground.

Removal of the bark from stumps, larger roots, logs and sawn timber will reveal the presence of insects under the bark.

Reay and Walsh (2002a) have shown that H. ater is attracted to raw turpentine and beta-pinene with the addition of ethanol but was not attracted to alpha-pinene, either in combination with ethanol or alone. Eight-funnel traps (Lindgren, 1983) were used.

Control

Infestations in logs may be minimized by:

- The rapid turnover of stockpiles in the forest.
- A selection of unshaded skid sites.
- The stacking of logs on skids rather than on the ground (Milligan, 1978).

Logs for export can be mechanically debarked and treated with an insecticide (USDA, 1992).

Green sawn timber that is intended for export can either be kiln sterilized just prior to shipping or treated with an insecticidal dip (Milligan, 1978).

Seedlings can be protected from adult feeding damage by the use of controlled release granular insecticides (Reay and Walsh, 2002b). However, this measure is not usually necessary.

Biological control agents were imported into New Zealand, but only Thanasimus formicarius established. Because the larvae of H. ater are principally below ground, they are protected from natural enemies and T. formicarius is ineffective (Faulds, 1989).

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Hylurgus ligniperda

Names and taxonomy

Preferred scientific name

Hylurgus ligniperda (Fabricius, 1787)

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Scolytidae

Other scientific names

Bostrichus ligniperda Fabricius, 1787

Bostrichus elongatus Herbst, 1793
Hylesinus flavipes Panzer, 1795
Hylesinus ligniperda (Fabricius, 1792)
Hylurgus elongatus (Herbst, 1793)
Hylurgus flavipes (Panzer, 1795)
Hylurgus longulus Kolenati, 1846

EPPO code

HYLGLI (Hylurgus ligniperda)

Common names

English:

red-haired pine bark beetle
golden haired bark beetle
bark beetle, golden haired

Russian:

volosatyi luboed

Estonia:

karusürask

Germany:

Bastkaefer, Holzzerstoerender Kiefern-
Bastkaefer, Rothaariger Kiefern-
Holzzerstörender Kiefernbastkäfer
Rothaariger Kiefernbastkäfer

Latvia:

matainais priezu luksngrauzis

Lithuania:

plaukuotasis karnagrauzis

Notes on taxonomy and nomenclature

Fabricius described Hylurgus ligniperda in 1787 as Bostrichus ligniperda. The following synonyms were used: Hylesinus ligniperda, Bostrichus elongatus, Hylesinus flavipes, Hylurgus elongatus, Hylurgus flavipes and Hylurgus longulus (Postner, 1974; Grüne, 1979;Pfeffer, 1989, 1995).

Host range

Notes on host range

This beetle has been found exclusively in pines (Family Pinaceae) (Browne, 1968).

As far as we know, the beetle breeds exclusively in the bark of unhealthy Pinus, usually in the thick bark near the base of the stem or in large exposed roots (Brown and Laurie, 1968). Fresh stumps, slash and logging debris are also used for breeding.

List of hosts plants

Major hosts

Pinus sylvestris (Scots pine)

Minor hosts

Pinus armena , Pinus brutia (brutian pine), Pinus canariensis (Canary pine), Pinus elliottii (slash pine), Pinus halepensis (Aleppo pine), Pinus montezumae (montezuma pine), Pinus nigra (black pine), Pinus nigra var. pallasiana , Pinus patula (Mexican weeping pine), Pinus pinaster (maritime pine), Pinus pinea (stone pine), Pinus radiata (radiata pine), Pinus strobus (eastern white pine)

Geographic distribution

Notes on distribution

H. ligniperda is present in a wide range of climates throughout the world. It is native to central and southern Europe, Crimea (Ukraine), Caucasus, Asia Minor and Algeria (Pfeffer, 1995). It has been introduced to South Africa, Asia (Japan and Sri Lanka), Australasia, the South Pacific (Australia and New Zealand), North America (infestation in New York, USA) and South America (Brazil and Chile). It could potentially survive in all regions of the USA.

Distribution List

Please note: The distribution status for a country or province is based on all the information available. When several references are cited, they may give conflicting information on the pest status. In particular, citations of earlier presence of a pest are included even though there is an authoritative reference to indicate that the pest is now absent.

Europe

Austria

present

native

not invasive

Eichhoff, 1881

Belarus

present

native

not invasive

Rudnev & Vasechko, 1988

Belgium

present

native

not invasive

Wood & Bright, 1992

Czechoslovakia (former -)

present

native

not invasive

Wood & Bright, 1992

Denmark

present

native

not invasive

Lekander et al., 1977

Estonia

present

native

not invasive

Voolma & iunap, 1994

Former Yugoslavia

present

native

not invasive

Wood & Bright, 1992

France

present

native

not invasive

Wood & Bright, 1992

Corsica

present

native

not invasive

Wood & Bright, 1992

Germany

present

native

not invasive

Wood & Bright, 1992

Greece

present

native

not invasive

Wood & Bright, 1992

Hungary

present

native

not invasive

Wood & Bright, 1992

Italy

present

native

not invasive

Russo, 1946

Latvia

present

native

not invasive

Ozols, 1985

Lithuania

present

native

not invasive

Pileckis & Monsevicius, 1997

Moldova

present

native

not invasive

Rudnev & Vasechko, 1988

Netherlands

present

native

not invasive

Wood & Bright, 1992

Poland

present

native

not invasive

Burakowski et al., 1992

Portugal

present

native

not invasive

Wood & Bright, 1992

Azores

present

native

not invasive

Wood & Bright, 1992

Madeira

present

native

not invasive

Schedl, 1959

Russian Federation

Central Russia

present

native

not invasive

Petrov & Nikitskii, 2001

Southern Russia

present

native

not invasive

Stark, 1952

Western Siberia

present

native

not invasive

Krivolutskaja, 1983; Yanovskij, 1999

Spain

present

native

not invasive

Garcia de Viedma, 1964

Canary Islands

present

native

not invasive

Schedl, 1959

Sweden

present

native

not invasive

Lekander et al., 1977

Switzerland

present

native

not invasive

Wood & Bright, 1992

Ukraine

present

native

not invasive

Rudnev & Vasechko, 1988

United Kingdom

present

native

not invasive

Wood & Bright, 1992

Asia

China

present

native

not invasive

Wood & Bright, 1992

Japan

present

introduced

invasive

Wood & Bright, 1992

Honshu

present

introduced

invasive

Schedl, 1959

Sri Lanka

present

introduced

invasive

Brown, 1968

Turkey

present

native

not invasive

Serez, 1987

<u>Africa</u>

<u>Morocco</u>

present

native

not invasive

Wood & Bright,

1992 <u>Saint Helena</u>

present

introduced

invasive

Schedl, 1959; Wood & Bright, 1992

<u>South Africa</u>

present

introduced

invasive

Tribe, 1991a, b, 1992

<u>Tunisia</u>

present

native

not invasive

Wood & Bright, 1992

<u>South America</u>

<u>Brazil</u>

present

introduced

invasive

Wood & Bright, 1992

<u>Chile</u>

present

introduced

invasive

Schedl, 1959; Wood & Bright, 1992

Uruguay

present

introduced

invasive

Wood & Bright, 1992

Oceania

Australia

present

introduced

invasive

Wood & Bright,

1992 New Zealand

present

introduced

invasive

Hosking, 1979

History of introduction and spread

H. ligniperda is occasionally intercepted at USA ports in association with solid wood packing materials from Europe.

It was initially detected and intercepted in the USA at Newcomb Estate, Monroe County, and 3.5 miles from the port of Rochester, New York, on 31 May 1994. This was by a Lindgren funnel (CAPS [Cooperative Agricultural Pest Survey] Pheromone Trap Survey) with alpha-pinene, located near 75 acres of conifers (Picea abies, Larix decidua, Pinus resinosa, Pinus sylvestris and Pinus strobus). It was collected by C Conrow, New York Department of Agriculture and Marketing.

An overwintering colony of adult H. ligniperda was discovered in November 2000 near Rochester, New York, USA. These European beetles were found during an evaluation of white pine root decline in a Christmas tree plantation (Hoebeke, 2001).

H. ligniperda was intercepted 217 times at ports of entry in the USA between 1985 and 2000 (Haack, 2002). Excluding these interceptions, individual beetles had only been caught in detection traps in 1994 and 1995 approximately 15 miles west of the current infestation. The positive trap catch in 1994 occurred in a pine stand damaged by a winter storm in 1991. The lag time between the first detections and the discovery of an overwintering colony may reflect how long it takes a recent introduction to reach a damage-detectable threshold. The surveys conducted in the spring and summer of 2001, detected small numbers of adult H. ligniperda at single locations in two adjacent counties (Wayne and Ontario), as well as two locations in Monroe County. Surveys in five other adjacent counties were negative.

In recent years, this European beetle has successfully established itself in South Africa Tribe, 1991a, b, Japan, Australia (Neumann, 1987), New Zealand, Brazil, Uruguay and Chile (Ciesla, 1988). Much of this recent spread is attributed to the increased global trade in conifer logs.

In New Zealand, H. ligniperda was found for the first time near Whitford, South Auckland, in April 1974 (New Zealand Forest Service, 1974). It has since been found in plantations of pine at five other places in the Auckland district. It is suggested that it may have been introduced in sawn timber from South Australia.

Biology and ecology

Physiology and Phenology

The biology and ecology of H. ligniperda is briefly described by Eichhoff (1881), Stark (1952) and Postner (1974). It usually has one generation per year and up to three generations in southern Europe (Postner, 1974).

The flight time for the adults occurs from March to April in southern Europe (Grüne, 1979). Adult H. ligniperda are good fliers and can disperse over several kilometres in response to host volatiles. In south-eastern France, where two generations occur, the major activity peak is in the spring followed by a shorter peak in the autumn. The peak in the autumn coincides with the second generation and the adult beetles then enter winter hibernation.

Tribe (1991a) studied the phenology of Orthotomicus erosus, Hylastes angustatus and H. ligniperda colonizing Pinus radiata logs in South Africa. Weekly log trapping in 1981-1986 showed that the activity peak occurred in April and May. Although H. ligniperda was present in every month of the year, it was mainly active in the cooler months, with the fewest captured in the summer. H. ligniperda was said to be the most variable and found in every month of the year, although an autumn peak occurred in April/May. Beetle activity was lowest in mid-winter.

In 2001, H. ligniperda appeared to complete two generations in New York, USA, with the first developing from May to mid-July and the second from mid-July to September. The adult flight activity was highest from September to November, corresponding with the second generation's emergence. However, there was no similar increase in July, suggesting that the brood adults continued to breed in the same stumps in which they developed (Phytosanitary Alert System, 2002).

Reproductive Biology

Fabre and Carle (1975) described the morphology, biology, life history and oviposition of H. ligniperda in south-eastern France. H. ligniperda attacks trees that are already very weak and develops in the root collar, main roots and large logs. Adult H. ligniperda are attracted to fresh stumps, slash and logging debris for breeding. In unhealthy Pinus spp., the beetle usually breeds in thick bark near the base of the stem or in large exposed roots.

H. ligniperda is monogamous. The sex ratio of H. ligniperda in Chile was analysed using baited funnel traps located at four sample points. At all localities the male: female ratio was 1:1 (Lanfranco et al., 2001).

The female beetle enters the bark and constructs a short entrance tunnel and an oblique nuptial chamber cut in the phloem. After mating in this chamber, the female constructs a single, long egg gallery. The gallery may wander and even double-back on itself, but generally follows the wood grain and may be over a metre long. The eggs are laid in individual notches along the single gallery. After laying the first batch of eggs, the female may extend the gallery for another 10 to 20 cm and lay a second batch of eggs. The larval galleries, initially at right angles to the egg gallery, soon become random and thus do not create a distinctive gallery pattern. There are four larval stages. When the larvae are fully grown, they pupate at the end of their tunnels.

A fully developed nest is comprised of a single, longitudinal or more often oblique egg gallery and long, individual larval feeding tunnels that end in pupal cells (Brown and Laurie, 1968).

Modifications in the shape of the egg galleries made by the bark beetles are determined not only by the need to facilitate the ejection of bore dust, but also by the degree of unthriftiness of the tree and by such factors as temperature, humidity and population density. Occasionally H. ligniperda has to make galleries that extend vertically downwards and clear them of debris. In such circumstances, the females may bore extra holes while members of other species may alter the pattern of the galleries. When mass-breeding occurs, the bark beetles can extend their usual range. In general, in narrow stems with thin bark, the galleries are closely associated with the sapwood and the larvae pupate in the wood. However, in thick bark the pupation takes place between the bark and the wood, or in the bark itself (Rudnev and Kozak, 1974).

The newly emerged adults may attack seedlings and stressed, pole-sized trees. Usually, the emerging adults feed on the root collars and roots of 1- to 2-year-old seedlings and can cause seedling mortality (Ciesla, 1993). The adult beetles often overwinter gregariously in tunnels in the bark of the root collars or larger roots (Brown and Laurie, 1968). For example, a piece of a white pine stump from Rochester, New York, USA, which was 7.62 cm long by 8.89 cm diameter yielded 83 overwintering adult beetles.

There has been one report of overwintering adults girdling and killing young trees in Spain and another from Chile (Anon., 2002). However, in most countries where this beetle has established itself, there has been no tree mortality attributed to it.

H. ligniperda usually has one generation per year in Europe, although up to three generations may occur in the southern regions. In the Mediterranean region of France, H. ligniperda has two generations a year; the first generation has two successive periods of oviposition and the second generation has two periods of oviposition that only occur in ideal conditions (Fabre and Carle, 1975). In New Zealand, the development from initiation of the brood galleries to the first appearance of recently moulted adults takes 10 to 11 weeks. At 25°C in southern France, the beetle requires 45 days to develop from egg to adult (Tribe, 1991a).

Environmental Requirements

The adults invade freshly cut stumps, logs and slash following timber harvesting; the adults use this material for breeding sites Ciesla, 1988, 1993). Infestations of dead, dying and fallen trees are often heavy and conspicuous (Brown and Laurie, 1968). Attacks along the root zone of residual trees occur locally, generally in trees weakened by nutrient deficiencies, mechanical injury, disease or insect attack. Of particular interest are the localized secondary attacks in the root zone of trees infected with a root pathogen, Verticicladiella sp. (Ciesla, 1988).

In South Africa, H. ligniperda is predominately a root-dwelling species that tunnels directly through the soil to its food source. The colonization sites of O. erosus, H. ligniperda and H. angustatus were determined in South Africa in 1983-1984, 1986 and 1990 using buried and partially buried Pinus radiata logs placed vertically in the soil (Tribe, 1992). Almost all (98%) O. erosus were found in the protruding part of the log, whereas 86 and 64% of H. ligniperda and H. angustatus, respectively, occurred below soil level. Both of the latter species were able to detect and colonize logs buried horizontally at depths of down to 400 mm. Where the logs are in contact with the soil, the beetles may colonize the immediate aerial parts, but only infrequently and in small numbers. The beetles were evenly distributed in all buried sections of the vertically and horizontally buried logs. Because the beetles are active throughout the year in South Africa and because they require high moisture levels, they are confined to subterranean habitats where there is adequate moisture and the environmental conditions are more stable (Tribe, 1992).

In trapping experiments in Poland, the smoke from small bonfires of thin shoots and needles was slightly attractive to Hylobius abietis and some bark beetles, including H. ligniperda, were also attracted to smoke (Dominik and Litwiniak, 1983).

Associations

The adult beetles are efficient vectors of Leptographium spp. fungi, which have been implicated in pine root decline diseases. Two species of the forest pathogen, Leptographium, have previously been associated with this bark beetle. Both Leptographium truncatum and Leptographium procerum have been isolated from New Zealand populations of H. ligniperda. L. procerum is the cause of procera root disease, found in white pines (Pinus strobus) in the eastern USA. L. truncatum has been reported from Canada and L. procerum has been implicated in white pine root decline in the USA. Inoculation studies indicate that both of these fungi are not particularly virulent pathogens. However, in combination with an attacking bark beetle, these fungi could cause significant tree decline. These fungi should be described as weak pathogens that have the potential to be destructive if linked with a suitable bark beetle attacking stressed conifers. The frequency with which Leptographium spp. have been recovered from H. ligniperda beetles would suggest that in other countries at least, such a partnership has already developed. Initial isolations from the recently discovered Hylurgus population have yielded Leptographium sp. The adults overwintering gregariously in tunnels in the bark of the root collars or larger roots could easily cross contaminate each other with fungal spores.

In a survey of fungi associated with H. ligniperda, 106 of 112 flying beetles were found to carry Leptographium [Ophiostoma] when they landed on freshly-peeled pine logs (Anon., 1994). A few beetles may transmit fungi such as Ceratocystis spp. and Leptographium spp. (Wingfield et al., 1985).

Ophiostoma wageneri is a virulent American pathogen, which causes black stain root disease, and is currently present in the western USA. There is concern that H. ligniperda could be an efficient vector of this fungus if the range of the beetle and the fungus were ever to overlap. If H. ligniperda reached the conifer forests of western North America and began to vector O. wageneri, the forest disease dynamics would shift dramatically and a bark beetle seen as a tolerable nuisance in the east, could become a serious pest in the west.

Ophiostomatoid fungi associated with H. ligniperda in pine plantations (Pinus patula and Pinus elliottii) were studied in South Africa (Zhou XuDong et al., 2001). Nine different ophiostomatoid fungi species were identified. Among these, Leptographium serpens [Ophiostoma serpens], Leptographium lundbergii and Ophiostoma ips, were most frequently encountered. Ophiostoma galeiformis [Ophiostoma galeiforme], Ophiostoma piceae and L. procerum are newly recorded from South Africa.

Pine pitch canker caused by Fusarium subglutinans f.sp. pini [Gibberella circinata] is a serious disease of many species of pine and has severely affected Pinus radiata in California, USA, since its discovery in 1986. Hylastes ater, H. ligniperda and Pineus laevis would be the most likely vectors of the disease (Dick, 1998).

Morphology

H. ligniperda is a small beetle about 2 mm wide by 4-6 mm long, black and covered with rather long reddish hairs. The hairs are particularly noticeable on the posterior slope of the wing covers (elytra). The distinctive, dense hairs are quite thick and they appear notched at magnifications under x80. The elytral apex is convex with a slight indentation and has no teeth or other armature (Cavey et al., 1994).

Means of movement and dispersal

Natural Dispersal

Adult H. ligniperda are good fliers and can disperse over several kilometres.

Movement in Trade

All stages of H. ligniperda would be transported with infested timber. Much of the recent spread is attributed to the increased global trade in conifer logs.

Plant parts liable to carry the pest in trade/transport

- Bark: Eggs, Larvae, Pupae, Adults; borne internally; visible to naked eye.
- Roots: Eggs, Larvae, Pupae, Adults; borne internally; visible to naked eye.
- Stems (above Ground)/Shoots/Trunks/Branches: Eggs, Larvae, Pupae, Adults; borne internally; visible to naked eye.

Plant parts not known to carry the pest in trade/transport

- Bulbs/Tubers/Corms/Rhizomes
- Fruits (inc. Pods)
- Growing Medium Accompanying Plants
- Flowers/Inflorescences/Cones/Calyx
- Leaves
- Seedlings/Micropropagated Plants
- True Seeds (inc. Grain)

- Wood.

Natural enemies

H. ligniperda has natural enemies. However, the natural enemies may affect too few bark beetles to prevent loss (Tribe, 1991b). Some species of native parasitoids and predators of H. ligniperda are listed in Eichhoff (1881), Nikitski (1980) and Michalski and Mazur (1999).

Natural enemies listed in the database

The list of natural enemies has been reviewed by a biocontrol specialist and is limited to those that have a major impact on pest numbers or have been used in biological control attempts; generalists and crop pests are excluded. For further information and reference sources, see About the data. Additional natural enemy records derived from data mining are presented as a separate list.

Natural enemies reviewed by biocontrol specialist

Natural enemy

Pest stage attacked

Associated plants

Biological control in:

Predators:

Platysoma oblongum

Eggs, Larvae, Pupae

Lonchaea collini

Eggs, Larvae, Pupae

Pityophagus ferrugineus

Eggs, Larvae, Pupae

Platysoma lineare

Eggs, Larvae, Pupae

Rhizophagus dispar

Eggs, Larvae, Pupae

Pinus

New Zealand

Thanasimus formicarius (ant beetle)

Eggs, Larvae, Pupae

Pinus

New Zealand

Additional natural enemies (source - data mining)

Natural enemy

Pest stage attacked

Associated plants

Biological control in:

Parasites/parasitoids:

Rhopalicus tutele

Pinus

New Zealand

Predators:

Rhizophagus bipustulatus

Pinus

New Zealand

Rhizophagus ferrugineus

Pinus

New Zealand

Impact

Economic impact

In Chile, there was great concern that the presence of this and other bark beetles could adversely affect the establishment of new Monterey pine (Pinus radiata) plantations. However, the levels of damage have remained low.

In Chile, H. ligniperda has been observed feeding on the root collars of 1- to 2-year-old seedlings. The damage tends to be more severe in natural regeneration, although planted trees are also damaged. Most planted trees that have been killed thus far have either malformed roots caused by poor planting or bark injury caused by other insects or small mammals (Ciesla, 1988).

H. ligniperda is a minor pest of Pinus in South Africa (Tribe, 1991a). It introduces blue stain fungi, Ceratocystis spp. to wood via its tunnels and transmits the root pathogens Leptographium spp. Tribe, 1991a, b.

Three exotic bark beetles (Ips grandicollis, Hylastes ater and H. ligniperda) are present in the plantations of P. radiata and other exotic conifers in Australia but have not yet caused economically important damage (Neumann and Marks, 1990).

Impact on biodiversity

H. ligniperda in included as a rare species in the Red List of Swedish Species (Gärdenfors, 2000).

Impact descriptors

Negative impact on: forestry production

Positive impact on: rare / protected species

Phytosanitary significance

Many forest managers consider bark beetles to be the most economically important group of forest insects (Ciesla, 1993). Interceptions of H. ligniperda are common. Pine cargo crates containing strips of bark, which harbour small numbers of adults, pupae or larvae have spread the beetle to various countries of the world Ciesla, 1988, 1993). Infested logs have also spread the beetle (Sato, 1975).

Similarities to other species

The genus Hylurgus is most similar to Hylastes, Dendroctonus and Tomicus. H. ligniperda is superficially similar to Hylastes porculus (Cavey et al., 1994). By comparison, H. ligniperda is significantly hairier than the European pine shoot beetle, Tomicus piniperda and lacks the teeth/spines/bumps that line the margins of the posterior abdominal concavity of Ips spp.

Detection and inspection

The placement of trap logs and survey of pine cull trees, slash piles and stumps are survey methods that may be of use. Tools should be used for prying open pine wood, branches and stumps.

A recent study by the USDA Forest Service found Lindgren funnel traps with high release alpha-pinene (625 mg/day = 5 standard lures) plus high release ethanol (1000 mg/day) to be the most effective of the trap-lure combinations tested. Intercept panel traps and Theysohn traps may be used in conjunction with high release alpha-pinene plus high release ethanol. Lindgren funnel traps should be hung from a trap rod with the top of the trap approximately 1.83 m from the ground, with the ethanol attractant hung from the top funnel down through the inside of the funnels below. The alpha-pinene should be attached below the ethanol and these attractants should not touch each other.

In Estonia, H. ligniperda was attracted to ground traps baited with turpentine and ethanol in clear-cuttings of a Pinus sylvestris forest (Voolma et al., 2001).

Traps containing 1500 mg Ipslure (a mixture of ipsdienol, 2-methyl-3-buten-2-ol and cis-verbenol), which were used for the control of Orthotomicus erosus, a pest of Pinus brutia in the Mediterranean, Aegean and Marmara regions of Turkey, also caught H. ligniperda (Serez, 1987).

Control

Cultural Control and Sanitary Methods

The removal of dead and dying hosts for certain bark beetles is a standard silvicultural practice. Silvicultural techniques, such as sanitation and slash disposal, have been recommended to reduce the number of breeding sites (Ciesla, 1993). However, even if the aerial parts of dead and dying hosts are removed, the beetle could still colonize the subterranean roots. However, the eggs, larvae and pupae of H. ligniperda have been reported in 2- to 3-year-old seedlings in Chile. Delaying the replanting of pine plantations for a year following harvest can reduce damage.

Biological Control

Biological control (e.g. using predatory clerid beetles) may be of some use in light infestations. Experiments to rear the imported clerid beetle, Thanasimus formicarius, were made in New Zealand (Zondag, 1979). In September 1976, 214 adults and 165 larvae of T. formicarius were received in New Zealand from Austria. A successful breeding and rearing technique was developed using Hylastes ater and H. ligniperda as prey in logs of pine (mainly Pinus nigra). By July 1977, 364 adult clerids had been reared and by June 1978 a further 1081. Liberations were made in several forests in the North Island, New Zealand for the biological control of the scolytids (Zondag, 1979).

An improved method of rearing T. formicarius for use in the control of H. ater and H. ligniperda is described by Faulds (1988) in New Zealand and involves the transfer of larvae hatched from eggs laid in vitro in glass jars by adults fed on the two prey species. The technique is particularly useful in quarantine conditions. The efficiency of rearing programmes can be improved by cool storage of T. formicarius adults. This is possible by feeding freshly emerged adults with bark beetles and keeping them individually in 50 x 25 mm glass tubes with ventilated stoppers at 4°C, and removing them every 3 months for feeding. The beetle remains were removed after feeding to prevent fungal growth. Mortality in storage from late March to early December was 4.2%, and no adverse effects on fecundity were apparent. The cold storage of breeding adults has now become routine.

Temnochila virescens [Temnoscheila virescens], a predator of the five-spined engraver beetle (Ips grandicollis) from the south-eastern USA, was imported into Australia in 1981 as part of a biological control programme for I. grandicollis on Pinus spp. In tests of prey acceptability, T. virescens accepted H. ligniperda as prey (Lawson and Morgan, 1993).

Chemical Control

Treatment of the stems and boles of seedlings by chemicals is possible. However, this will not affect the beetles, which dig directly through the soil to the roots, although the treatment will protect the stems close to the soil surface. It is recommended that insecticide should be applied to both the stems and roots of young Pinus radiata (Tribe, 1992). Because of the expense and environmental concerns, treatment by chemicals may not be carried out in a field situation.

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Tomicus piniperda

Nombre científico:

Tomicus piniperda L

Sinonímias:Blastophagus piniperda, Dermestes piniperda, Myelophilus piniperda

Pest and Diseases Image Library, , Bugwood.org

Posición taxonómica :

Orden : Coleoptera

Familia: Curculionidae

Subfamilia: Scolytinae

Nombres comunes:

pine shoot beetle, escarabajo de los brotes del pino

Descripción del insecto.

Adulto. Es un escarabajo cilíndrico de 3-5 mm de longitud. La coloración varía de café-rojizo a café oscuro casi negro.

Huevo. Es oval, liso de color blanco brillante y mide un milímetro de longitud.

Larva. Tiene forma de C, es apoda, de color blanquecino con la cabeza ámbar. Cuando madura puede llegar a medir 5 mm de longitud.

Steve Passoa, USDA APHIS PPQ, Bugwood.org

Distribución:

Es una especie eurasiática que se distribuye en toda la región paléartica, se presenta en donde se encuentra el pino escoses (Pinus sylvestris) su principal hospedero.

Alemania, Argelia, Austria, Bélgica, Bulgaria, Corea, China, Chipre, España, Francia, Finlandia, Gran Bretaña, Grecia, Holanda, Finlandia, Hungría, Islas Canarias, Italia, Japón, Madeira, Noruega, Polonia, República Checa, República Eslovaca, Rumania, Rusia, Suecia, Suiza y Turquía. Introducido en Estados Unidos de América (Illinois, Indiana, Michigan, Nueva York, Ohio y Pennsylvania).

Hospedantes.

Primarios: pinos (Pinus sylvestris, Pinus halepensis, Pinus strobus y otras especies) y secundarios piceas (Picea abies, Picea obovata y otras), alerces o lárices (Larix decidua, Larix europa y otras) y abetos (Abies spp)

Ciclo de vida.

Presenta una generación al año. Es una especie monógama. Normalmente este insecto ataca pinos caídos y derribados por el viento que tienen cortezas gruesas, así como trozas y árboles en pie debilitados. Normalmente los escarabajos pasan el invierno dentro de la corteza gruesa de la base de pinos vivos o entre la hojarrasca, aunque en los lugares donde el invierno no es muy riguroso (sur de Europa y Estados Unidos) pueden hacerlo en los brotes.

Los escarabajos se vuelven activos cuando la temperatura del aire es de 10-12 oC e inician el periodo de vuelo que varía según la localidad, siendo lo más común que se presenté entre marzo y abril. La oviposición se lleva a cabo en árboles muertos, marchitos y en troncos recientemente cortados, en un sistema de galerías que se encuentran en el floema y miden de 10-25 cm de longitud. El estado larval se presenta desde abril hasta junio, al alcanzar la madurez las larvas se transforman en pupas y permanecen dentro de la corteza. La emergencia de los adultos de la nueva generación se puede presentar a mediados de junio y julio (en Europa Central), durante agosto (en los países escandinavos) o de julio a octubre (en Estados Unidos). Los adultos vuelan hacia los brotes de árboles sanos para alimentarse y poder madurar sexualmente; barrean el centro de estos brotes y allí se alimentan y maduran, haciendo unos túneles de 2.5-10 cm de longitud, hasta finales de otoño, preparándose para invernar.

Daños

Los brotes afectados de árboles sanos de todos los tamaños se debilitan, se amarillean y se caen durante el verano y el otoño. Cuando el daño es severo, se reduce el crecimiento en diámetro y en altura del árbol atacado.

También daña a los troncos de árboles débiles y moribundos, así como a la corteza de las trozas, al hacer sus galerías de oviposición lo que acelera el establecimiento de hongos en la madera, aunque en general esto se traduce en poco daño económico; sin embargo en China y en Polonia este escarabajo ha atacado y causado la muerte de pinos aparentemente sanos.

Síntomas

1.- Brotes moribundos, amarillentos, marchitos o puntas de los brotes amarillentas.

2. Al examinar los brotes se observan orificios de barrenación a los lados de los mismos y presencia de tubos de resina de color claro

3. Brotes doblados o rotos o caídos.

4. Brotes que se caen del árbol cuando éste se limpia ligeramente.

5. Dentro de los brotes dañados se pueden encontrar a los adultos.

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Noväk; V., F. Hrozinka & B. Stary. 1976. Atlas of insects harmful to forest trees. Vol.I. Elsevier Scientific Company. Printed in Czechoslovakia. 125p.

USDA. El escarabajo de los brotes USDA. 1993. El escarabajo de los brotes de pino. Factsheet. Plant Protection & Quarantine. Animal and Plant Health Inspection Service. 2p

http://www.forestryimages.org. Pino con brotes muertos: Robert A. Haack, USDA Forest Service, Bugwood.org. Adulto en brote: Indiana Department of Natural Resources Archive, Indiana Department of Natural Resources, Bugwood.org. Rama con brote dañado: Bruce Smith, USDA APHIS PPQ, Bugwood.org y acercamiento del brote: Gyorgy Csoka, Hungary Forest Research Institute, Bugwood.org

Camponotus pensilvanicus

Names and taxonomy

Nombre común

Hormiga del carpintero

Nombre científico

Camponotus pensilvanicus

Clase/orden/familia

Insecta/Hymenoptera/Formicidae

Metamorfosis:

Completo

Introducción.

La hormiga negra del carpintero, *Camponotus pennsylvanicus* (DeGreer), es una especie nativa y la especie común en el este. Estas hormigas consiguen su nombre común de su hábito de ahuecar áreas en pedazos de madera para los propósitos del hormiguero. Este hábito del hormiguero puede dar lugar a daño estructural. Las hormigas se encuentran a través de los Estados Unidos.

Como reconocerlas.

Las obreras polimórficos, grande (1/8-1/2 " o 3,5-13 milímetros) pero varían grandemente de tamaño; reinas cerca de 112-518 " (13-17 milímetros) de largo. Color negro, combinaciones de rojo y de negro, o totalmente rojo o marrón. Antena 12-segmentada, sin un club. El tórax falta las espinas dorsales, perfil d uniformemente redondeada en cara superior. Cáscara 1-segmented. Gassier con la apertura anal redonda, rodeado por el anillo de pelos. Aguijón ausente. Obreras capaces de emitir un olor fuerte del ácido fórmico.

Camponotus pennsylvanicus. Las obreras cerca de 1/4-1/2 " (6-13 milímetros) de largo y totalmente negro excepto una capa a través de su superficie, con pelos amarillentos pálidos pegados contra su cuerpo.

Distribución.

North America		
North America (as a whole)	present	CAB Abstracts, 1973-1998
USA	present	CAB Abstracts, 1973-1998
Connecticut	present	CAB Abstracts, 1973-1998
Florida	present	CAB Abstracts, 1973-1998
Maryland	present	CAB Abstracts, 1973-1998
Massachusetts	present	CAB Abstracts, 1973-1998
New Jersey	present	CAB Abstracts, 1973-1998

Daños.

La única indicación externa de la infestación con excepción de la presencia de obreras

y/o de swarmers es el aspecto de aperturas pequeñas o de agujeros en la superficie de la madera. Con éstos, los obreras sacan los escombros que consiste en aserrín-como virutas y/o los fragmentos de las piezas del cuerpo del aislante y del insecto. La acumulación de tales escombros debajo de tales agujeros es una buena indicación de una infestación.

Dentro de, las galerías siguen la madera más suave del resorte con las conexiones numerosas a través de la madera del verano de harder/dark. Las paredes de la galería son lisas, con un aspecto arena-empapelado. Las galerías activas se mantienen limpias de los escombros.

Prefieren atacar la madera ablandada por el hongo y se asocian a menudo a problemas de la humedad.

Biología.

Las colonias de la hormiga son de tamaño moderado, generalmente conteniendo 3.000 obreras (hasta 10-15.000 incluyendo jerarquías basadas en los satélites) cuando la madurez se alcanza en cerca de 3 a 6 años.

Hábitos.

La mayoría de las especies de la hormiga del carpintero establecen su primera jerarquía en madera podrida y más adelante amplían o agrandan esto en la madera sana. Interiores, las jerarquías están situadas en la madera (ablandada preferiblemente por la putrefacción fungosa), en el aislante, y/o en vacíos de la pared. Los obreras son un fastidio cuando salen a buscar alimento pero sea destructivo a las maderas utilizadas para las actividades del hormiguero. Afuera, las jerarquías se establecen típicamente en los postes de la cerca de la descomposición, tocones, vieja leña, porciones muertas de árboles derechos, y bajo piedras o registros caídos.

La presencia de una jerarquía de la hormiga del carpintero es indicada a veces por un sonido que cruje que viene de vacíos de la pared o de la madera donde localizan a la colonia. Si no, la aparición de swarmers dentro puede ser la primera indicación de una colonia de interior.

Las hormigas del carpintero se alimentan sobre todo en ligamaza del insecto, zumos de la planta y de fruta, insectos, y otros artrópodos. Adentro también alimentarán en los dulces, los huevos, las carnes, las tortas, y la grasa.

Los obreras forrajean para las distancias de hasta 300 pies (los 91.4m) de la jerarquía. Entran en típicamente edificios alrededor de marcos de la puerta y del ventana, de aleros, de líneas de la plomería y del cableado electrico, y de ramas del arbusto y del árbol en contacto con el edificio. Aunque algunos obreras son activos durante el día, la mayoría de la actividad es en la oscuridad hasta amanecer, con actividad máxima entre 10 P.M. y 2A. M. El rastro entre el padre y la jerarquía del satélite es generalmente cerca de 1/4-13/16 " (6-20 milímetros) de par en par y se guarda claramente de la vegetación y los escombros. Sigue generalmente contornos pero cortará típicamente a través de pastos.

Sirex noctilio

Hymenoptera: Siricidae

Identification

Adult wasps have four clear yellow membranous wings. Both sexes also have a stout, cylindrical body measuring 9 to 36 mm and a pointed abdomen. Males have thickened, black hind legs and orange-yellow middle segments on the abdomen. Females have reddishbrown legs and a steel-blue body. Females also have a spike-like projection on their abdomen, which protects the ovipositor.

Host trees

Pinus (main host), *Abies* and *Picea*.

Location of infestation within the tree

Along the lower or middle portion of the bole, larvae feed on a symbiotic fungus within the sapwood and heartwood.

Host condition

Healthy and stressed trees (e.g. logging damage, drought, fire) or dead stems.

Distribution

Europe, northern Africa, Mongolia, Siberia and Turkey. Introduced to Australia, New Zealand, South Africa, Argentina, Brazil, Uruguay and eastern North America.

Signs and symptoms

Females use their saw-like ovipositor to cut oviposition holes 12 mm into the wood of the host tree. Up to 5 holes are drilled into the outer sapwood. The spores of a symbiotic white rot fungus (*Amylostereum areolatum*), which are fed upon by the larvae, and a toxic mucus are injected into the sapwood by ovipositing females. Up to three eggs are laid per oviposition hole. The fungus and the mucus act together to kill the tree and create a suitable environment for developing larvae. When the bark is removed, a dark fungal stain can be seen extending vertically from each oviposition site.

Larval galleries, 5 to 20 cm long, are packed with chewed wood and a fine powdery frass. These galleries occur at all depths in the sapwood and heartwood, even to the centre of large trees. The length of the gallery and the size of the developing wasps are dependent upon the moisture content of the wood. If the wood is dry, the galleries will be short, the smaller larvae will pupate earlier and become adults at a smaller size. Mature larvae pupate close to the bark surface.Adults emerge through circular emergence holes 3 to 8 mm in diameter.

Symptoms of attack also include beads of resin flowing from oviposition holes.4Needles on attacked trees wilt and turn from green to yellow and finally to reddishbrown. Stem growth is drastically reduced as a result of attack. Mortality occurs in heavily infested trees.

Urocerus gigas

Names and taxonomy

Scientific name
Urocerus gigas (Linnaeus)
Taxonomic position
Phylum: Arthropoda
Class: Insecta
Order: Hymenoptera
Family: Siricidae
Other scientific
names Sirex gigas
Xanthosirex gigas
Common names
English:
horntail, sawfly, banded
wood wasp, giant
pine, wood wasp
Spanish:
sirice gigante
French: sirex
geant
urocere a cornes jaunes
Denmark:
kaempetraehveps
Finland:
jaettilaeispuupistiaeinen

Germany:
Holzwespe, Riesen-
Italy:
Sirice gigante
Norway:
kjempetreveps
Sweden:
vedstekel, gul

Host range

List of hosts plants

Major hosts**:** *Pinus radiata* (radiata pine)

Hosts (source - data mining): *Abies alba* (silver fir), *Larix* (larches), *Picea abies* (common spruce), *Pinus nigra* (black pine), *Pinus sylvestris* (Scots pine)

Geographic distribution

Distribution List

Europe		
Finland	unconfirmed record	CAB Abstracts, 1973-1998
Former USSR	unconfirmed record	CAB Abstracts, 1973-1998
Ireland	unconfirmed record	CAB Abstracts, 1973-1998
Poland	unconfirmed record	CAB Abstracts, 1973-1998
[Russian Federation]		
Siberia	unconfirmed record	CAB Abstracts, 1973-1998
United Kingdom	present	CAB Abstracts, 1973-1998
Northern Ireland	unconfirmed record	CABq Abstracts, 1973-1998

Natural enemies

Natural enemies listed in the database

Natural enemy	Pest stage attacked
Parasites/parasitoids:	
Ibalia drewseni	
Ibalia leucospoides	
Rhyssa amoena	
Rhyssa persuasoria	
Predators:	
Dendrocopos major	
Dryocopus martius	

References

CAB Abstracts, 1973-1998. Data mined from CAB Abstracts database, years 1973 to 1998. Wallingford, UK: CAB International

Coptotermes spp

Datos generales

Nombre: Coptotermes spp

Posición taxonómica

Orden: Isoptera

Familia: Rhinotermitidae

Subfamilia: Coptotermitinae

Descripción

Adulto alado: Cabeza oval o casi circular; fontanela casi no visible. Antenas con 16-21 artejos. Pronoto grande, plano, generalmente más angosto que la cabeza, con el margen anterior ligeramente cóncavo. Alas generalmente cubiertas con numerosas setas; la vena media de las alas anteriores corre libremente desde la base

Hospedantes

Todo tipo de madera, muebles, cultivos (caña de azúcar, arroz, algodón), árboles frutales (cítricos, litchi, cerezo negro), pinos, maples, nogales, encinos, cedros, sauces, olmos chinos, encino blanco, liquidámbar, eucalipto, cipreses, pinoabeto, nueces, libros, periódicos, cocoteros, cafetales, árbol del hule, árboles muertos, trozas, tocones.

Obrera: Mandíbulas iguales a las de los adultos alados (mandíbula izquierda con cuatro dientes y la derecha con dos).

Soldado: cabeza generalmente piriforme; tubo frontal corto y ancho. Muy rara vez con ojos facetados, Mandíbulas largas y delgadas, en forma de sable, la derecha sin dientes, la izquierda con varios dientecillos anteriores a un diente basal prominente. Antenas con 13-17 artejos.

Número de especies

A nivel mundial se tienen registradas 48 especies; 23 de las cuales son orientales. Para México están reportadas cuatro especies, de las cuales una es nativa (C. crassus) y las otras (C. testaceus, C. gestroi y C. niger) son introducidas

Factores que favorecen el ataque

Las termitas son más abundantes en suelos húmedos y calientes, que contengan una gran cantidad de alimento en forma de madera o de otro tipo de material celulósico. Estas condiciones de presentan en las construcciones.

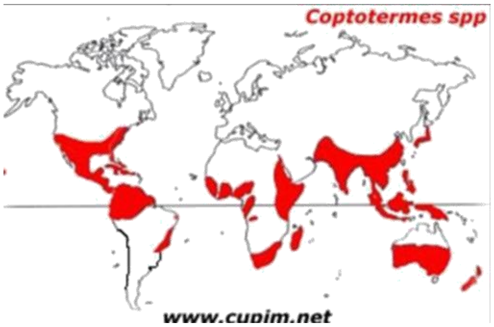
Hábitos.

La actividad de las termitas aumenta y se prolonga aún en las áreas más al norte, en donde el suelo dentro o cerca de los cimientos con calefacción se mantiene caliente durante la mayor parte del año.

Otra característica importante es que las termitas que se localizan en las edificaciones, pueden perder el contacto con el suelo y sobrevivir, siempre que puedan obtener la humedad dentro de las construcciones.

Distribución:

Es un género pantropical y muchas de las especies han sido dispersadas por el hombre por todo el mundo. Hay mas de 45 especies en el mundo, en América existen 5 especies, dos de ellas introducidas.



Síntomas

La madera muy dañada puede tener un sonido seco cuando se golpea.

La madera atacada se reconoce por las largas galerías que corren paralelas al grano, que frecuentemente están cubiertas de una mezcla de excremento y tierra de color ámbar o gris. Ocasionalmente las termitas construyen sus galerías en toda la madera, teniendo la apariencia de un panal, dejando únicamente una delgada capa.

Importancia económica

El mayor impacto económico es sobre la madera empleada en la construcción, aunque también daña a postes y a cualquier producto elaborado con madera, prefiriendo la que se encuentra en proceso de descomposición.

En su búsqueda de alimento y humedad, las termitas pueden dañar muchos materiales que no contienen celulosa tales como: placas delgadas de metales suaves (aluminio y cobre), asfalto, creosota, hule, yeso, argamasa, plástico, cableado eléctrico y fibras sintéticas.

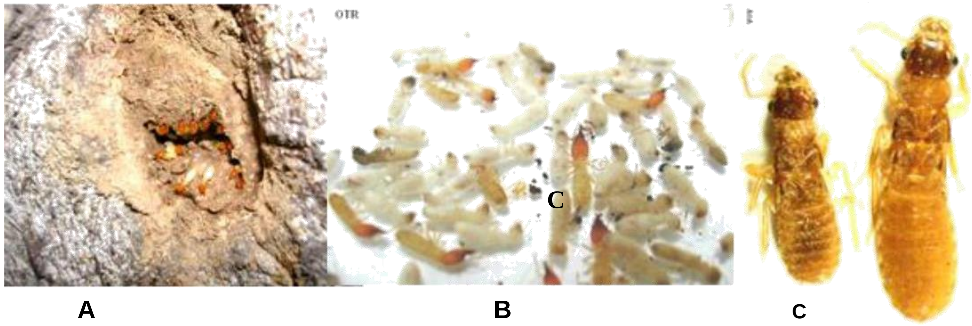
Control

Los tratamientos existentes para el control de esta termita son principalmente para proteger las construcciones: aplicación de productos químicos al suelo, a la madera empleada en la construcción y a las diferentes estructuras antes y después de la construcción.

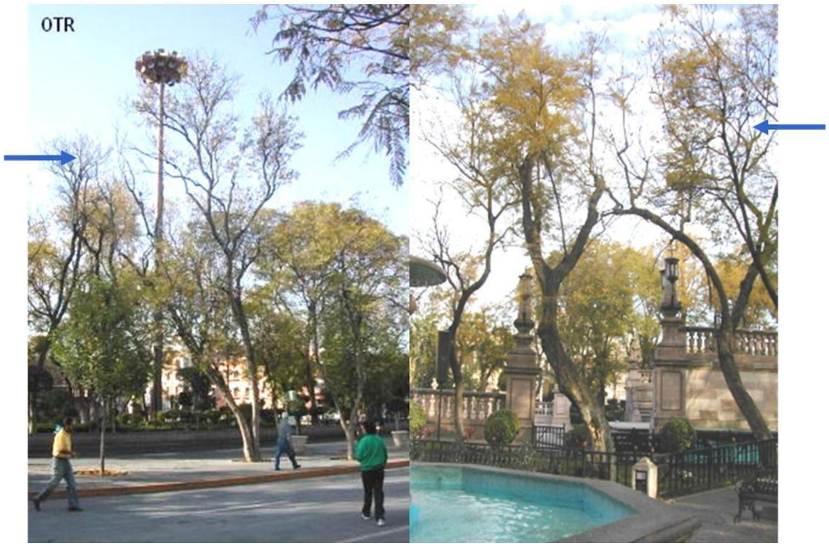
Cómo detectar a la Térmita Subterránea Coptotermes gestroi

¿Qué buscar en los árboles?

1. A y B) soldados, B) obreras y C) reproductores



2. Follaje amarillento y ramas muertas



3. Ramas con desgarramientos y partes muertas con oficios

4. Caminos de tierra

5. Acumulación de tierra en el tronco

6. Ramas y troncos con síntomas de pudrición y centro de los árboles huecos.

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Constantino, R. 1999. Catalog of the termites of the new world.

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Holmgreen, 1913. Termitenstudien. IV. Versuch einer systematischen Monographie der Termiten der orientalischen Region. Kungl. Svenska Vetenskpsakademiens Handlingar. Band. 50 No. 2. 276pp.

Krishna, F. y F.W. Wessner (Eds.). 1969. Biology of termites. Vol. I. Academic Press, New York. 598pp.

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Termitas en: www.cupim.net

Lymantria dispar

Names and taxonomy

Preferred scientific name

Lymantria dispar Linnaeus

Taxonomic position

Phylum: Arthropoda

Class: Insecta

Order: Lepidoptera

Family: Lymantriidae

Other scientific names

Porthetria dispar Linnaeus

Ocneria dispar Linnaeus

Bombyx dispar Linnaeus

Hypogymna dispar Linnaeus

Liparis dispar Linnaeus

Phalaena dispar Linnaeus

Porthesia dispar Linnaeus

EPPO code

LYMADI (Lymantria dispar)

Common names

English:

gypsy moth

Spanish:

lagarta peluda de los encinares

French:

spongieuse

bombyx

disparate zig-zag

Denmark:

lovskovnonne

Finland:

lehtinunna

Germany:

Grossdickkopf

Schwammspinner, Gemeiner

Schwammspinner, Grosser

Israel:

tavai haalon

hasayir Italy:

bombice dispari

farfala dispari

limantria dispari

Japan:

maimaiga

Netherlands:

Plakker

Stamuil

Zigzag

Norway:

lauvskognonne

Sweden:

loevskogsnunna

traedgardsnunna

Turkey:

kir tirtili

Notes on taxonomy and nomenclature

The species has been placed in various genera before being assigned to the genus Lymantria, but the name Porthetria dispar is still commonly used.

Host range

Notes on host range

L. dispar has an exceptionally broad host range. Only genera of the main hosts are listed. Kurir (1953) provided a literature review on the host range in Eurasia with a list of several hundred hosts. Forbush and Fernald (1896) listed 458 plants on which it fed in Massachusetts, USA, alone. Over 150 host species have been recorded in Japan (Schaefer et al., 1988). Oak species (Quercus spp.) are considered the preferred host tree but heavy defoliation is also observed on several other tree genera such as Carpinus, Castanea, Fagus, Populus and Salix. Larix is a very susceptible host in Asia, but not in Europe or North America. Damage may also be observed on orchard trees such as Malus (apple), Pyrus (pear) and Prunus (stone fruit). Outbreaks usually start on a preferred host, such as oak, but as the population density increases other species are subsequently attacked. Gypsy moth stages differ in their host preference, early instars being more host specific than later instars.

Affected Plant Stages: Flowering stage and vegetative growing stage.

Affected Plant Parts: Inflorescence and leaves.

List of hosts plants

Major hosts

Acer saccharum (sugar maple), Betula papyrifera (paper birch), Quercus alba (white oak), Quercus coccinea (scarlet oak), Quercus ellipsoidalis (Northern pin oak), Quercus garryana (Garry oak), Quercus ilex (holm oak), Quercus lobata (California white oak), Quercus montana (basket oak), Quercus muehlenbergii (Chinquapin oak), Quercus palustris (pin oak), Quercus petraea (durmast oak), Quercus robur (common oak), Quercus rubra (northern red oak), Quercus suber (cork oak), Quercus velutina (black oak), Salix fragilis (crack willow)

Minor hosts

Acer (maples), Acer negundo (box elder), Acer platanoides (Norway maple), Acer rubrum (red maple), Acer saccharinum (soft maple), Alnus (alders), Alnus rhombifolia (white alder), Betula (birches), Betula alleghaniensis (yellow birch), Betula lenta (sweet birch), Betula populifolia (gray birch), Carpinus (hornbeams), Carya (hickories), Castanea sativa (chestnut), Corylus , Eucalyptus camaldulensis (red gum), Fagus (beeches), Fagus grandifolia (American beech), Fagus sylvatica (common beech), Fraxinus americana (white ash), Fraxinus pennsylvanica (downy ash), Glycine max (soyabean), Hamamelis virginiana (Virginian witch-hazel), Larix (larches), Larix kaempferi (Japanese larch), Larix occidentalis (western larch), Liquidambar styraciflua (Sweet gum), Litchi chinensis (lichi), Lithocarpus edulis , Malus (ornamental species apple), Malus domestica (apple), Ostrya virginiana (American hophornbeam), Picea abies (common spruce), Picea jezoensis (Yeddo spruce), Pinus (pines), Pinus contorta (lodgepole pine), Pinus echinata (shortleaf pine), Pinus resinosa (red pine), Pinus rigida (pitch pine), Pinus strobus (eastern white pine), Pinus sylvestris (Scots pine), Pinus taeda (loblolly pine), Pistacia vera (pistachio), Platanus acerifolia (London planetree), Populus (poplars), Populus grandidentata (Bigtooth aspen), Populus nigra (black poplar), Populus tremuloides (trembling aspen), Prunus (stone fruit), Prunus armeniaca (apricot), Prunus domestica (plum), Prunus salicina (Japanese plum), Prunus serotina (black cherry), Prunus serrulata (Japanese flowering cherry), Pseudotsuga menziesii (Douglas-fir), Pyrus (pears), Quercus ilicifolia (bear oak), Robinia (locust), Robinia pseudoacacia (black locust), Salix (willows), Salix babylonica (weeping willow), Taxodium distichum (bald cypress), Tilia americana (basswood), Tilia cordata (small-leaf lime), Vaccinium (blueberries), Zea mays (maize)

Geographic distribution

Notes on distribution

L. dispar is of Eurasian origin. It is widespread from Portugal to Japan and from Finland to North Africa. In altitude it is limited to the growth zone of oaks. Moths of Asian and European origins are morphologically similar but differ in their ecological and behavioural characteristics, for example, in their flying capacity, host preferences, etc. Important genetic differences have been found (Bogdanowicz et al., 1993). The European strain was accidentally introduced from France into Massachusetts, USA, in 1869. It gradually spread south, north and west to reach Canada in 1924. Today it is considered permanently established in all New England states to North Carolina, West Virginia, Ohio and Wisconsin, and in the Canadian Provinces Ontario, Quebec, New Brunswick and Nova Scotia. Males are regularly caught in most other US states and Canadian Provinces where eradication programmes are conducted to prevent establishment of this pest (USDA Forest Service, 1996, 1997). Eradication programmes are also focused on the Asian form of the gypsy moth that has been recently caught in several regions in North America.

Distribution List

Please note: The distribution status for a country or province is based on all the information available. When several references are cited, they may give conflicting information on the pest status. In particular, citations of earlier presence of a pest are included even though there is an authoritative reference to indicate that the pest is now absent.

Show EPPO notes

EPPO notes may be available for records where the source is EPPO, 2006. PQR database (version 4.5). Paris, France: European and Mediterranean Plant Protection Organization. Further details may be available in the corresponding EPPO Reporting Service item (e.g. RS 2001/141), for details of this service visit http://archives.eppo.org/EPPOReporting/Reporting_Archives.htm, or contact the EPPO Secretariat hq@eppo.fr.

Europe

Austria

widespread

introduced

Giese & Schneider, 1979; EPPO, 2006

Belarus

present

EPPO, 2006

Belgium

present

EPPO, 2006

Bulgaria

widespread

introduced

EPPO, 2006

Croatia

widespread

Giese & Schneider, 1979; EPPO, 2006

Cyprus

widespread

EPPO, 2006

Czech Republic

widespread

introduced

EPPO, 2006

Denmark

present

EPPO, 2006

Finland

present

EPPO, 2006

France

widespread

Giese & Schneider, 1979; EPPO, 2006

Corsica

present

EPPO, 2006

France [mainland]

restricted distribution

EPPO, 2006 Germany

widespread

introduced

EPPO, 2006

Greece

present

EPPO, 2006

Greece [mainland]

present

EPPO, 2006

Hungary

widespread

introduced

EPPO, 2006

Italy

widespread

Giese & Schneider, 1979; EPPO, 2006

Italy [mainland]

present

EPPO, 2006

Sardinia

widespread

Giese & Schneider, 1979; EPPO, 2006

Sicily

present

EPPO, 2006

Lithuania

widespread

Giese & Schneider, 1979; EPPO, 2006

Macedonia

present

EPPO, 2006

Moldova

present

EPPO, 2006

Netherlands

restricted distribution

EPPO, 2006

Poland

widespread

Giese & Schneider, 1979; EPPO, 2006

Portugal

widespread EPPO,

2006 Portugal

[mainland]

widespread

EPPO, 2006

Romania

widespread

Giese & Schneider, 1979; EPPO, 2006

Russian Federation

widespread

Giese & Schneider, 1979; EPPO, 2006

Russian Far East

widespread

Giese & Schneider, 1979; EPPO, 2006

Siberia

widespread

Giese & Schneider, 1979; EPPO, 2006

Serbia and Montenegro

widespread

Giese & Schneider, 1979; EPPO, 2006

Slovakia

widespread

Novotny et al., 1998; EPPO, 2006

Spain

widespread

Giese & Schneider, 1979; EPPO, 2006

Balearic Islands

present

EPPO, 2006

Spain [mainland]

present

EPPO, 2006

Sweden

restricted distribution

introduced

EPPO, 2006

Switzerland

widespread

introduced

EPPO, 2006

Ukraine

widespread

Giese & Schneider, 1979; EPPO, 2006

United Kingdom

present, few occurrences

Nettleton, 1996

Asia

Afghanistan

present

EPPO, 2006

Azerbaijan

present

EPPO, 2006

China

present

EPPO, 2006

Hebei

present

EPPO, 2006

Heilongjiang

present

EPPO, 2006

Jiangsu

present

EPPO, 2006

Jiangxi

present

EPPO, 2006

Jilin present

EPPO, 2006

Liaoning

present

EPPO, 2006

Shandong

present

EPPO, 2006

Taiwan

present

EPPO, 2006

Xizhang

present

EPPO, 2006

India

restricted distribution

EPPO, 2006

Indian Punjab

present EPPO,

2006 Iran

present

EPPO, 2006

Iraq present

EPPO, 2006

Israel

present

EPPO, 2006

Japan

present

EPPO, 2006

Hokkaido

widespread

Giese & Schneider, 1979; EPPO, 2006

Honshu

widespread

Giese & Schneider, 1979; EPPO, 2006

Kyushu

widespread

Giese & Schneider, 1979; EPPO, 2006

Ryukyu Archipelago

present

EPPO, 2006

Kazakhstan

present

EPPO, 2006

Korea, DPR

present

EPPO, 2006

Korea, Republic of

present

APPPC, 1987; EPPO, 2006

Kyrgyzstan

widespread

Giese & Schneider, 1979; EPPO, 2006

Lebanon

present

EPPO, 2006

Syria

present

EPPO, 2006

Tajikistan

present

EPPO, 2006

Turkey

widespread

Giese & Schneider, 1979; EPPO, 2006

Turkmenistan

present

EPPO, 2006

Uzbekistan

present

EPPO, 2006

Africa

Algeria

present

EPPO, 2006

Morocco

present

EPPO, 2006

Tunisia

present

EPPO, 2006

North America

Canada

restricted distribution

EPPO, 2006

<u>British Columbia</u>

eradicated

introduced (1993)

USDA-APHIS, 2004; EPPO, 2006

<u>New Brunswick</u>

restricted distribution USDA-APHIS, 2004; EPPO, 2006

<u>Newfoundland</u>

present

EPPO, 2006

<u>Nova Scotia</u>

restricted distribution USDA-APHIS, 2004; EPPO, 2006

<u>Ontario</u>

widespread

USDA-APHIS, 2004; EPPO, 2006

<u>Prince Edward Island</u>

present

EPPO, 2006

<u>Quebec</u>

restricted distribution USDA-APHIS, 2004; EPPO, 2006

<u>USA</u>

restricted distribution

EPPO, 2006

<u>Arkansas</u>

absent, intercepted only

USDA Forest Service, 1996, 1997

<u>California</u>

eradicated

USDA-APHIS, 2004; EPPO, 2006

<u>Colorado</u>

absent, intercepted only

USDA Forest Service, 1996, 1997

Connecticut

widespread

USDA Forest Service, 1996, 1997; USDA-APHIS, 2004; EPPO, 2006

Delaware

widespread

USDA Forest Service, 1996, 1997; USDA-APHIS, 2004; EPPO, 2006

Florida

eradicated

CIE, 1981; USDA-APHIS, 2004; EPPO, 2006

Georgia (USA)

absent, intercepted only

USDA Forest Service, 1996, 1997

Idaho

absent, intercepted only

USDA Forest Service, 1996, 1997

Illinois

restricted distribution

USDA Forest Service, 1996, 1997; USDA-APHIS, 2004; EPPO, 2006

Indiana

restricted distribution

CIE, 1981; USDA-APHIS, 2004; EPPO, 2006

Iowa

eradicated

USDA-APHIS, 2004; EPPO, 2006

Kentucky

restricted distribution

CIE, 1981; USDA-APHIS, 2004; EPPO, 2006

Maine

widespread

USDA Forest Service, 1996, 1997; USDA-APHIS, 2004; EPPO, 2006

Maryland

widespread

USDA Forest Service, 1996, 1997; USDA-APHIS, 2004; EPPO, 2006

Massachusetts

widespread

USDA Forest Service, 1996, 1997; USDA-APHIS, 2004; EPPO, 2006

Michigan

widespread

USDA Forest Service, 1996, 1997; USDA-APHIS, 2004; EPPO, 2006

Montana

absent, intercepted only

USDA Forest Service, 1996, 1997

Nebraska

absent, intercepted only

USDA Forest Service, 1996, 1997

New Hampshire

widespread

USDA Forest Service, 1996, 1997; USDA-APHIS, 2004; EPPO, 2006

New Jersey

widespread

USDA Forest Service, 1996, 1997; USDA-APHIS, 2004; EPPO, 2006

New Mexico

absent, intercepted only

USDA Forest Service, 1996, 1997

New York

widespread

USDA Forest Service, 1996, 1997; USDA-APHIS, 2004; EPPO, 2006

North Carolina

restricted distribution

USDA Forest Service, 1996, 1997; USDA-APHIS, 2004; EPPO, 2006

Ohio

restricted distribution

USDA Forest Service, 1996, 1997; USDA-APHIS, 2004; EPPO, 2006

Oregon

eradicated

USDA Forest Service, 1996, 1997; USDA-APHIS, 2004; EPPO, 2006

Pennsylvania

widespread

USDA Forest Service, 1996, 1997; USDA-APHIS, 2004; EPPO, 2006

Rhode Island

widespread

USDA Forest Service, 1996, 1997; USDA-APHIS, 2004; EPPO, 2006

South Carolina

eradicated

USDA Forest Service, 1996, 1997; USDA-APHIS, 2004; EPPO, 2006

South Dakota

absent, intercepted only

USDA Forest Service, 1996, 1997

Tennessee

absent, intercepted only

USDA Forest Service, 1996, 1997

Utah

absent, intercepted only

USDA Forest Service, 1996, 1997

Vermont

widespread

USDA Forest Service, 1996, 1997; USDA-APHIS, 2004; EPPO, 2006

Virginia

widespread

USDA Forest Service, 1996, 1997; USDA-APHIS, 2004; EPPO, 2006

Washington

eradicated

USDA Forest Service, 1996, 1997; USDA-APHIS, 2004; EPPO, 2006

West Virginia

widespread

USDA Forest Service, 1996, 1997; USDA-APHIS, 2004; EPPO, 2006

Wisconsin

restricted distribution

USDA Forest Service, 1996, 1997; USDA-APHIS, 2004; EPPO, 2006

Wyoming

absent, intercepted only

USDA Forest Service, 1996, 1997

Biology and ecology

Doane and McManus (1981) extensively reviewed most aspects of the biology, ecology and population dynamics of L. dispar. Other reviews include von Wellenstein and Schwenke (1978), Leonard (1974), Montgomery and Wallner (1988) and Elkinton and Liebhold (1990). The life cycle of the gypsy moth is as follows. The gypsy moth has one generation per year. Overwintering eggs hatch when host trees produce new leaves, from late March to late May, depending on the climatic situation. Newly hatched larvae can remain on the egg masses for several days before climbing the trees to the branch tips and starting to feed on buds and new leaves. The first-instar larva is the main natural dispersal stage. As larvae move upwards, they spin a thread of silk and suspend themselves from the threads that eventually fracture. The young larva is then carried by the wind. While most larvae will not move more than 200 m, some are reported to travel several kilometres. During the first three instars, feeding occurs by daylight. From the fourth instar onwards, larvae mainly feed at night and leave the foliage during daylight to seek resting sites in the litter or on the trunk. However, at outbreak density, feeding continues during the day. Males usually have five instars and females six. The final-instar larvae are by far the most voracious feeders. On average, during its entire life a single larva consumes a total of about 1m² of foliage.

The larval stage lasts around 6-8 weeks. At the end of this period, larvae find a resting site, usually on a trunk, on a rock or in the litter, and surround themselves with a silken nest in which they will pupate. Pupal development is complete within 2-3 weeks. Males emerge 1 or 2 days before females and at emergence both sexes are sexually mature. Males are good flyers, but in Europe and North America, females remain flightless, although their wings are fully formed. In Asia, however, females are capable of flight. After emergence, females crawl to an elevated place, usually the tree trunk, and begin releasing a pheromone to attract males. Mating lasts up to 1 hour, and although males are capable of mating several times, females usually only mate once. Immediately after mating oviposition of a single egg mass begins. All adults are short-lived, surviving for about 1 week where no feeding occurs. Embryogenesis commences soon after oviposition and fully formed larvae are complete in the eggs about 1 month after their oviposition. Eggs undergo obligatory diapause. It is not uncommon to find a small number of larvae hatching in late summer but these never develop.

Morphology

Eggs

Grey, pellet-like eggs (ca 1 mm diam.) are laid in single clusters, or masses, from 80 to 1200 individuals. Egg masses are ca 2-5 mm long, 0.5-2 mm wide, and are covered by a dense, yellowish coating of hair sloughed off from the female abdomen. Egg masses are found mainly on trunks or lower branches, but also on rocks, walls, fences, etc.

Larvae

Males and females usually go through five and six larval instars, respectively, but additional instars are often observed. Larval instars can be determined by the width of the head capsule (von Wellenstein and Schwenke, 1978). First-instar larvae are about 3 mm long. Mature male larvae reach a length of about 40-50 mm and female larvae about 60-70 mm. All larval instars are hairy but show considerable variation in their coloration. First-instar larvae are grey-black. Later instars are more colourful with black, yellow, blue and red patterns. The head is predominantly dark in the first three and yellow in the last three instars. The main characteristics of the gypsy moth larvae are, on the dorsum, two rows of blue tubercles on the first five segments and two rows of red tubercles on the following six segments.

Late-instar larvae can often be found resting on tree trunks or in other cryptic resting sites. Bands of burlap or other fabric can be placed around tree trunks to facilitate finding resting larvae.

Pupae

Pupae are dark brown and matted with reddish hairs, and are attached to trunks, stones or other objects by silken threads. Male and female pupae are 2-3 cm and 3-4 cm long, respectively. Pupae are also commonly found in bark crevices or other cryptic locations (including under burlap bands).

Adults

Sexes show a strong sexual dimorphism. The male has a slender body and is grey-brown in colour, with dark wing markings. The wingspan is about 3-4 cm. Antennae are plumose and much longer than in the female. The female has a larger wingspan (4-7 cm) and body. Her wing colours are nearly all white with wavy, black bands across the forewing. Her abdomen is distended with an egg mass, and is white with yellowish hairs. Females produce a pheromone that attracts males for mating. Even though males are very sensitive in their ability to locate females, the inability of males to locate females apparently limits the viability of isolated low-density populations (Liebhold and Bascompte, 2003).

Means of movement and dispersal

Natural dispersal of European strain gypsy moths is primarily by wind-borne dispersal of first-instar larvae. For Asian strains, females are capapble of flight and this would be the primary mode of dispersal.

Plant parts liable to carry the pest in trade/transport

- Bark: Eggs; borne externally; visible to naked eye.
- Stems (above Ground)/Shoots/Trunks/Branches: Eggs, Larvae, Pupae; borne externally; visible to naked eye.
- Wood: Eggs; borne externally; visible to naked eye.

Plant parts not known to carry the pest in trade/transport

- Bulbs/Tubers/Corms/Rhizomes
- Fruits (inc. Pods)

- Growing Medium Accompanying Plants
- Flowers/Inflorescences/Cones/Calyx
- Leaves
- Seedlings/Micropropagated Plants
- Roots
- True Seeds (inc. Grain).

Transport pathways for long distance movement

- Conveyances (transport Vehicles)
- Containers And Packing

Natural enemies

Natural enemies of L. dispar have been extensively studied in all regions where the pest occurs, mainly as part of biological control programmes (see Doane and McManus, 1981, for review). Over 100 species of parasitoids have been reported to attack the gypsy moth in Eurasia. Only the most abundant and fequently reared parasitoids are listed in the table. Braconid parasitoids of the gypsy moth have been reviewed by Marsh (1979); ichneumonids by Gupta (1983) and tachinids by Sabrosky and Reardon (1976). More than 50 parasitoid species were introduced into North America, but only 11 have established (Kenis and Lopez Vaamonde, 1998). The most abundant and frequent parasitoids on both continents are the tachinid larval parasitoids: Compsilura concinnata, Parasetigena silvestris and Blepharipa pratensis; the braconid larval parasitoid Cotesia melanoscelus; the egg parasitoid Ooencyrtus kuvanae (Encyrtidae) and the pupal parasitoid Brachymeria intermedia (Chalcididae). Other important parasitoids in Eurasia include the braconid larval parasitoids Glyptapanteles porthetriae, G. liparidis and Meteorus pulchricornis; the tachinid larval parasitoids Blepharipa schineri and Exorista spp. and the eupelmid egg parasitoid, Anastatus japonicus. Birds, small mammals (e.g. mice and shrews) and invertebrate predators (e.g. the carabid beetle Calosoma sycophanta) are also known to be important mortality factors, especially at low prey density. Spatial and temporal variation in abundance of small mammal predators is closely tied with the onset of gypsy moth outbreaks (Elkinton and Liebhold, 1990; Jones et al., 1998; Liebhold et al., 2000). Dermestid beetles have been reported as major natural enemies in Morocco (Herard, 1979). In dense outbreak populations diseases are important sources of mortality. A nuclear polyhedrosis virus specific to L. dispar is present all over Eurasia and was apparently introduced into North America in the initial, founding gypsy moth population in 1869. The fungal pathogen, Entomophaga maimaiga, often decimates outbreak populations of gypsy moth in Japan and, more recently, in North America (Hajek et al., 1993). In Russia, microsporidia are known to be an important mortality factor for gypsy moth populations (Zelinskaya, 1980).

Natural enemies listed in the database

The list of natural enemies has been reviewed by a biocontrol specialist and is limited to those that have a major impact on pest numbers or have been used in biological control attempts; generalists and crop pests are excluded. For further information and reference sources, see About the data. Additional natural enemy records derived from data mining are presented as a separate list.

Natural enemies reviewed by biocontrol specialist

Natural enemy

Pest stage attacked

Associated plants

Biological control in:

Parasites/parasitoids:

Anastatus japonicus

Eggs

ornamental woody plants;
Salix Canada; USA

Blepharipa pratensis

Larvae

ornamental woody plants; Quercus
suber Italy; Sardinia; North America; USA

Blepharipa schineri

Larvae

ornamental woody plants

USA

Brachymeria tibialis

Pupae

ornamental woody plants; Quercus suber

Connecticut; Italy; Sardinia; Morocco; Pennsylvania; USA

Brachymeria lasus

ornamental woody plants

Connecticut; USA

Ceranthia samarensis

Larvae

Pimpla disparis

Pupae

ornamental woody plants
Connecticut; USA

Compsilura
concinnata Larvae

ornamental woody plants

Pennsylvania; Quebec;

USA Cotesia melanoscela

Larvae

ornamental woody plants; Quercus suber

USA

Eurytoma goidanichi

Larvae, Pupae

Eurytoma verticillata

Larvae, Pupae

Exorista larvarum

Larvae

ornamental woody plants; Quercus
suber Italy; Sardinia; Massachusetts; USA

Glyptapanteles liparidis

Larvae

ornamental woody plants

USA

Glyptapanteles
porthetriae Larvae

ornamental woody plants; Quercus
suber Italy; Sardinia; USA

Meteorus
pulchricornis Larvae

ornamental woody plants

USA

Meteorus versicolor
Larvae

ornamental woody plants

USA

Ooencyrtus kuvanae

Eggs

deciduous forests; ornamental woody plants; Quercus; Quercus suber; Salix; trees

Bulgaria; Canada; Czechoslovakia; Morocco; Pennsylvania; Portugal; Russia; Spain; USA; USSR; Yugoslavia

Parasetigena silvestris

Larvae

ornamental woody plants

USA

Phobocampe disparis

Larvae

Pennsylvania

Trichogramma dendrolimi

Predators:

Calosoma sycophanta (European Calosoma beetle)

Larvae, Pupae

ornamental woody plants; Quercus; Quercus suber

Italy; Sardinia; Pennsylvania; USA; USA; Connecticut

Carabidae (ground beetles)

Larvae, Pupae

Pathogens:

Beauveria bassiana (white muscardine fungus)

Entomophaga maimaiga

Larvae

Lithocarpus edulis

Japan; Virginia; Pennsylvania; Michigan; Maryland; West Virginia

Nucleopolyhedrosis virus

Larvae

Ontario; Maryland

Additional natural enemies (source - data mining)

Natural enemy

Pest stage attacked

Associated plants

Biological control in:

Parasites/parasitoids:

Actia jocularis

Larvae

Agria affinis

Anastatus japonicus

ornamental woody plants;

Salix Anastatus kashmirensis

Apechthis compunctor

ornamental woody plants

USA

Bessa parallela

Larvae

Blepharipa flavoscutellata

Larvae

USA

Blepharipa sericariae

Larvae

USA

Blepharipa tibialis

Larvae

Blondelia nigripes

Larvae

ornamental woody plants

USA

Blondelia nigripes

Larvae

ornamental woody plants

USA

Carcelia beijingensis

Larvae

Carcelia gnava

Larvae

Carcelia laxifrons

Larvae

ornamental woody plants

USA

Carcelia lymantriae

Larvae

Carcelia rasa

Larvae

Carcelia separata

Larvae

ornamental woody plants

USA

Casinaria arjuna

ornamental woody plants

USA

Casinaria tenuiventris

Ceromasia rubrifrons

Larvae

Coccygomimus morgauesi

ornamental woody plants

USA

Cotesia callimone

Larvae

Cotesia laeviceps

Larvae

Cotesia schaferi

Larvae

ornamental woody plants

USA

Drino inconspicua

Larvae

ornamental woody plants

USA

Euceros superbus

Exorista fasciata

Larvae

Massachusetts

Exorista japonica

Larvae

ornamental woody plants

USA

Exorista rossica

Larvae

ornamental woody plants

Massachusetts; USA

Exorista segregata Larvae

ornamental woody plants

USA

Apanteles flavicoxis

Larvae

ornamental woody plants

USA

Glyptapanteles fulvipes

Larvae

Glyptapanteles indiensis

Larvae

ornamental woody plants

USA

Goniocera versicolor

Larvae

Gregopimpla inquisitor

Gregopimpla malacosomae

Gryon hungaricus

Hexamermis albicans

Hyposoter lymantriae

ornamental woody plants

USA

Hyposoter tricoloripes
ornamental woody plants

USA

Itoplectis enslini

Lymantrichneumon disparis

Marietta leopardina

Masicera sphingivora

Larvae

Masicera sylvatica

Larvae

ornamental woody plants

USA

Mermis albicans

Mesocomys albitarsis

Monodontomerus aeneus

Monodontomerus aereus

ornamental woody plants

USA

Steinernema carpocapsae

Steinernema feltiae

Pales pavida

Larvae

Salix

USA

Pales processioneae

Larvae

Palexorista disparis

Larvae

ornamental woody plants

USA

Parasetigena agilis

Larvae

USA

Peribaea tibialis

Larvae

Phanerotoma atra

Larvae

Phobocampe lymantriae

ornamental woody plants

USA

Phobocampe unicincta

ornamental woody plants

USA

Phryxe magnicornis

Larvae

ornamental woody plants

USA

Phryxe

prima Larvae

Phryxe vulgaris

Larvae

Pimpla contemplator

ornamental woody plants

USA

Pimpla hypochondriaca (ichneumon, red legged)

ornamental woody plants; Quercus suber

Italy; Sardinia; USA

Rogas indiscretus

Larvae

ornamental woody plants

Pennsylvania; Massachusetts; New Jersey; Connecticut; USA

Rogas lymantriae

Larvae Sarcophaga

harpax

Sarcophaga portschinskyi

Sarcophaga uliginosa

Senometopia excisa

Larvae

Senometopia separata
Larvae

Siphona samarensis
Larvae

Tachina grossa
Larvae

Telenomus phalaenarum

USA

Thelymorpha marmorata
Larvae

Theronia atalantae

ornamental woody plants; Quercus
suber Italy; Sardinia; USA

Trichogramma buluti
Eggs

Trichogramma kilinceri
Eggs

Trichomalopsis peregrinus
ornamental woody plants

USA

Tyndarichus

navae Zenillia

libatrix Larvae

Salix

USA Predators:

Anatis labiculata

Anthrenus vladimiri

Aplocnemus jejunus

Blarina brevicauda

Calosoma calidum (fiery hunter)
Larvae

Calosoma chinense
Larvae

ornamental woody plants

USA

Calosoma frigidum
Larvae

Calosoma inquisitor
Larvae

ornamental woody plants

USA

Calosoma
reticulatum Larvae

ornamental woody plants

USA

Camponotus ferrugineus (red carpenter ant)
Carabus arcensis

Larvae

ornamental woody plants

USA

Carabus auratus
Larvae

ornamental woody plants

USA

Carabus
glabratus Larvae

ornamental woody plants

USA

Carabus nemoralis
Larvae

Carabus nemoratus
Larvae

ornamental woody plants

USA

Carabus violaceus (ground beetle,
violet) Larvae

ornamental woody plants

USA

Cryptorhopalum
ruficorne Cuculus canorus

Dermestes ater (black larder beetle)
Dermestes erichsoni

Dermestes lardarius (larder beetle)
Dinorhynchus dybowskyi
ornamental woody plants

USA

Dolichovespula maculata (baldfaced hornet)
Ficedula zanthopygia

Formica neogagates
Formica polyctena
Formica subsericea
Glischrochilus quadripunctatus
USA

Haplodrassus cornis
Megatoma conspersa
Muscina pabulorum
Parus atricapillus
Parus caeruleus
Parus major

Passer domesticus (house, sparrow)
Passer montanus (eurasian tree
sparrow) Peromyscus leucopus

Phoenicurus auroreus
Polistes jadwigae
Procrustes coriaceus

Larvae

USA

Sitta europaea

Vespula maculifrons (eastern yellowjacket)
Zhantievus lymantriae

Pathogens:
Bacillus cereus
Larvae

Bacillus thuringiensis
aizawai Larvae

Bacillus thuringiensis alesti
Larvae

Bacillus thuringiensis
caucasicus Larvae

Bacillus thuringiensis subsp. dendrolimus
Larvae

Bacillus thuringiensis entomocidus
Larvae

Bacillus thuringiensis
galleriae Larvae

Bacillus thuringiensis kenyae
Larvae

Bacillus thuringiensis kurstaki
Larvae

Italy

Bacillus thuringiensis
morrisoni Larvae

Bacillus thuringiensis
sotto Larvae

Bacillus thuringiensis subtoxicus
Larvae

Bacillus thuringiensis thuringiensis
Larvae

Bacillus thuringiensis wenguanensis
Larvae

Borrelinavirus reprimens

Conidiobolus thromboides (parasite of
aphids) Cordyceps militaris

cytoplasmic polyhedrosis viruses
Larvae

Densonucleosis virus
Larvae Entomophaga
aulicae

Entomophaga grylli (parasite of
locusts) Furia pieris

Fusarium polyphialidicum

Gibberella pulicaris (basal canker of
hop) Hirsutella thompsonii (parasite:
insects) Levinea amalonica

Metarhizium anisopliae (green muscardine fungus)
Nomuraea rileyi (parasite of Anticarsia on
soybean) Nosema furnacalis

Nosema infuscatellus
Nosema lymantriae
Czechoslovakia
Nosema medinalis
Nosema serbica
Paecilomyces farinosus

Paecilomyces fumosoroseus
Pleistophora schubergi

Pseudomonas aeruginosa (opportunistic pathogen of insects)
Serratia marcescens

Spicaria coccospora
Streptococcus faecalis
Thelohania similis
Tolypocladium niveum

Lecanicillium lecanii (mycoparasite of aphids, whitefly and Puc)

Impact

Economic impact

In the gypsy moth's native range in Eurasia, outbreaks sometimes occur, but they tend to be localized and of short duration. Severe defoliation results in reduced growth increment, crown dieback, but tree mortality is only occasionally observed. This is in contrast to North America, where outbreaks tend to be more frequent and of longer duration. Two to three years of complete defoliation often results in significant tree mortality, particularly during drought conditions. This difference may be due in part to the absence of certain natural enemies.

L. dispar is considered the most important forest pest in north-eastern USA. Over the last 25 years over 26 million hectares were defoliated. In Pennsylvania in 1981 alone, timber loss was estimated to be more than US$ 72 million (Montgomery and Wallner, 1988). As the range of the gypsy moth continues to expand, these impacts are also likely to increase (Liebhold et al., 1997). The most significantly impacted economic resource has been oak timber.

Environmental impact

The environmental impact of the gypsy moth in its introduced range in North America appears to exceed that in its native range in Eurasia. Oaks are more susceptible to defoliation, thus repeated gypsy moth outbreaks have contributed to a regional decline in the component of oak in eastern North American forests (Morin et al., 2001). By doing so, it exacerbates an existing problem of inadequate oak regeneration in this region.

Over 1 million ha of forests have been aerial sprayed with pesticides for gypsy moth control and this may have serious impacts on both terrestrial and aquatic non-target organisms.

Social impact

Gypsy moth is a serious nuisance in urban environments. Ornamental trees and shrubs in gardens and recreation areas are often defoliated and massive numbers of larvae sometimes crawl into houses, climb on fences, vehicles and people. Caterpillar hairs provoke allergenic reactions and the larvae contaminate water with their frass, etc. In eastern North America it is a common practice to locate homes in forested areas, and this often leads to severe impacts on homeowners. A recent economic evaluation of gypsy moth impacts determined that these types of impacts on homeowners vastly exceeded other impacts (e.g., timber) and that homowners were willing to pay vast sums of money to control populations (Leuschner et al., 1996).

Impact on biodiversity

Little information exists about the impact of large-scale defoliation caused by the gypsy moth on native insect and herbacious plant populations; however, extensive defoliation is thought to negatively impact lepidoptera species that depend upon the availability of oak foliage. An even greater concern is that aerial spraying of pesticides for the control or eradication of gypsy moth populations may negatively impact native lepidoptera and this is of particular concern for endangered species.

Recent evidence suggests that at least one parasitoid species (Compsilura concinnata) has had a delitorious impact on native Lepidoptera (Boettner et al., 2001). This is a generalist parasitoid that was introduced from Eurasia, which parasitizes gypsy moth larvae, but also attacks many other species of lepidoptera. There is good evidence that parasitism has contributed to the decline and endangerment of native silkworm (Cecropia spp.) populations.

Impact descriptors

Negative impact on: biodiversity; environment; forestry production; rare / protected species; native fauna; native flora; tourism

Phytosanitary significance

Natural dispersal of European strains of gypsy moth is limited to short-distance, wind-borne movement of first instars. However, females of the Asian strain are capable of flying distances of >1 km. Range expansion of invading populations is primarily facilitated by long-range movement by humans. Egg masses are often laid on cars, trucks, trains or boats, on logs, or containers that are inadvertenly moved by humans. The accidental introduction of L. dispar represents a risk in all temperate countries where it is not yet present, for example, the UK, New Zealand and Australia. The USA and Canada have extensive quarantine and eradication programmes to prevent establishment of new isolated populations beyond the current range. The USA currently has a large barrier zone project designed to delay the permanent establishment in states and provinces where the pest is not yet firmly established. New Zealand imports many used cars from Japan and this is a known pathway of gypsy moth introduction (egg masses). In 2003 an Asian gypsy moth male was detected in a pheromone trap in Hamilton, New Zealand (presumably the progeny of an egg mass introduced on a used car) and this detection was followed up by an aerial application of Bacillus thuringiensis for eradication purposes.

Symptoms

Hatching larvae usually start feeding on flushing buds and later on leaves and flowers. High populations often result in total tree defoliation.

Symptoms by affected plant part

Inflorescence: external feeding.

Leaves: external feeding.

Detection and inspection

Pheromone baited traps are the primary method for detecting and delimiting new isolated gypsy moth populations in previously uninfested areas. Pheromone traps are a very sensitive tool that can be used to detect very low density populations that could not be detected using any other method. Every year, over 300,000 traps are deployed in the USA for detection/delimitation alone. When a new population is detected using pheromone traps, it is a common practice to make a search for gypsy moth life stages in order to confirm the presence of a reproducing population. However, given the difficulty of detecting low-density populations in this way, life stages cannot always be found in all populations.

Larvae on foliage are easily distinguishable from other defoliators. Late in the year, host pupae and egg masses on tree trunks indicate gypsy moth infestation. Egg mass counting is a common practice for monitoring infested areas to estimate population density and predict future outbreaks. In North America, the detection of gypsy moth outbreaks is also based on aerial defoliation surveys.

Control

Cultural Control

Silvicultural manipulations are often proposed to manage gypsy moth populations in North America (Gottschalk 1993). All are based on thinning strategies. Thinning to reduce host species preferred by the gypsy moth would theoretically reduce stand susceptibility, but is not very satisfactory because the most susceptible tree species, such as oak species, are also usually considered the most valuable timber species. Gottschalk (1993) also suggested presalvage thinning to remove low-vigour trees to lower stand vulnerability. Effects of silvicultural manipulations on gypsy moth populations and tree mortality are discussed by Muzika et al. (1998) and Liebhold et al. (1998).

Biological Control

Since its introduction into North America in the 19th century, L. dispar has been the target of several extensive biological control programmes. About 80 species of natural enemies, parasitoids, predators and pathogens were introduced from 1906 to the present but most have failed to establish, probably due to the lack of alternate hosts (Hoy, 1976). Only 11 parasitoids, one predator and two pathogens became firmly established on the gypsy moth, some of which have become important mortality factors in North America. Of major interest is the fungal pathogen Entomophaga maimaiga, probably introduced accidentally from eastern Asia. This pathogen has regularly decimated gypsy moth populations since 1989 (Hajek et al., 1993). However, problems still remain, especially in newly infested regions and biological control programmes are still carried out. Kenis and Lopez Vaamonde (1998) review current biological control programmes and new strategies.

Classical biological control programmes have also been implemented in Morocco, where the gypsy moth lacks several of its major natural enemies. The egg parasitoid Ooencyrtus kuvanae and the nuclear polyhedrosis virus were introduced from Europe (Fraval and Villemant, 1995).

Other biological control strategies have been experimented with. Mass releases of O. kuvanae were made in Bulgaria (Chernov, 1976) that resulted in 60% higher egg parasitism. Maksimovic and Sivcev (1984) released gypsy moth eggs to sparse populations in order to maintain a low density of hosts and sustain parasitoids, which increased parasitism and prevented defoliation in subsequent years.

Recent biological control efforts have concentrated on the introduction into North America of parasitoids that are common on low density populations, notably Ceranthia samarensis, which is currently being bred and released (Kenis and Lopez Vaamonde, 1998).

Chemical Control

The control of gypsy moth outbreaks mainly relies on aerial chemical applications. More recently, biochemical insecticides have replaced broad-spectrum, chemical insecticides. The most favoured bioinsecticide to control the gypsy moth is the bacteria Bacillus thuringiensis (Bt). The insect growth regulator diflubenzuron and the nuclear polyhedrosis virus are also commonly used.

Pheromonal Control

The synthetic pheromone of L. dispar, disparlure, is a very efficient attractant for males and in recent years has been widely used to treat low-density, isolated populations along the expanding front. In 2003 over 100,000 acres were aerially treated with a slow-release formulation of disparlure in plastic flakes with a sticker. Treatment of low-density populations appears to be as effective as Bt (Sharov et al., 2002). Trials to use the pheromone for mass trapping or mating disruption have not been conclusive.

Mechanical Control

Before chemical insecticides were available, the destruction of egg masses was a common, yet time consuming, control method. Egg mass removal may still be used in high value stands such as gardens or recreation areas.

Field Monitoring

Three monitoring methods are commonly used to assess the level of gypsy moth populations: pheromone trapping is used in regions that lack established populations to detect and delimit new infestations; in higher density populations counting egg masses is the most appropriate method to predict damage in the following year; and aerial defoliation surveying is used in North America to detect new outbreaks. Monitoring procedures are described in detail in Doane and McManus (1981) and Novotny et al. (1998). A model for predicting gypsy moth defoliation in Connecticut, USA, is proposed by Weseloh (1996).

Integrated Pest Management

In countries that are most affected by the gypsy moth problem, such as the USA and some regions of central Europe including Slovakia and Romania, the general control strategy is largely based on well defined IPM programmes that combine various monitoring methods, biological control, biochemical control, silvicultural methods and environmental considerations (Doane and McManus, 1981; Novotny et al., 1998).

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Información adicional

Para mayor información sobre las plagas que aparecen en el listado, véase archivos anexos (sección VII.-ANEXOS, de la MIR): A revision of the New World species to the family Lyctidae, Heteropterus_Rev_Entomol_1_25-40[1] y Heteropterus_Rev_Entomol_7(2)_147-227[1].