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Data Sheets on Quarantine Pests

Dendroctonus frontalis

IDENTITY

Name: *Dendroctonus frontalis* Zimmermann
Synonyms: *Dendroctonus arizonicus* Hopkins
Taxonomic position: Insecta: Coleoptera: Scolytidae
Common names: Southern pine beetle (English)
Bayer computer code: DENCFR
EPPO A1 list: No. 264
EU Annex designation: II/A1 (under non-European Scolytidae)

HOSTS

D. frontalis attacks most of the *Pinus* spp. of southern USA, Central America and the Caribbean: in southeastern USA, especially *P. taeda*, and also *P. echinata*, *P. elliottii*, *P. virginiana*, *P. rigida*, *P. palustris*, *P. serotina*, *P. pungens* and the introduced *P. strobus*; in southwestern USA, *P. ponderosa*, *P. engelmannii*, *P. leiophylla*; in Central America, *P. caribaea*, *P. engelmannii*, *P. leiophylla*, *P. maximinoi* and *P. oocarpa*.

GEOGRAPHICAL DISTRIBUTION

EPPO region: Israel (intercepted only).
Asia: Israel (intercepted only).
North America: Mexico, USA (mainly in southeastern states: Alabama, Arkansas, Delaware, Florida, Georgia, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia; also Arizona, New Mexico).
Central America and Caribbean: Belize, El Salvador, Guatemala, Honduras.
EU: Absent.

BIOLOGY

The adults and larvae of *Dendroctonus* spp. are phloeophagous or bark-feeding. *D. frontalis* mainly overwinters as larvae but also as eggs and adults. Adults emerge from overwintering sites between February and June. Activity is resumed when subcortical temperatures become sufficiently high, about 7-10°C. The insects fly individually or in small groups, during the warmth of the day in spring or near nightfall in summer (at temperatures between 20 and 45°C), and infest further trees. Flight activity of *D. frontalis* is almost continuous from April to December in the USA, or even throughout the year in Honduras. Terpenes in the oleoresin are the primary source of attraction, guiding pioneer beetles in the selection of a new host. Pheromones are responsible for the secondary attraction of other members of the same species and are the means by which individuals communicate after colonization. Like other bark beetles, *D. frontalis* is associated with bluestain fungi, including *Ceratocystis minor*.

Dendroctonus spp. are monogamous. The female initiates the boring of a new gallery by constructing a radial entrance tunnel through the bark into the wood. After pairing has occurred, the female is generally responsible for boring egg galleries, the formation of egg niches, and care of eggs and larvae. The male keeps the nuptial chamber and entrance tunnel clean and expels the frass from the entrance hole. Oviposition commences about 7 days after attack and the eggs are deposited individually or in small clusters in niches, or in rows in long grooves. In *D. frontalis* (Miller & Keen, 1960), the egg niches are arranged alternately in the phloem on the sides of the egg gallery in contact with the cambium, about 3.5 mm apart with about 40 niches per gallery. One egg is deposited in each niche, which is then filled with specially prepared frass packed to the original level or contour of the gallery. The incubation period is 3-9 days in *D. frontalis* (Fronk, 1947).

The number of larval instars is four. The length of the larval period under optimum conditions is, as in other scolytids, about 30 to 90 days. The end of the larval mine is usually slightly enlarged and cleared of frass to form a pupal chamber or else the larva may bore into the wood or outer bark before forming the pupal cell. The pupal stage, as in other scolytids, requires between 3 and 30 days, but averages 6-9 days under ideal conditions. It may be extended if pupation begins in late autumn, but is rarely an overwintering stage except in areas where the winters are very mild.

Adult *Dendroctonus* may emerge from the host tree immediately or may require a period of maturation feeding before emerging. They usually emerge through separate exit holes. After completing one gallery system it is not uncommon for the parent beetles to re-emerge and construct a second, third or fourth system of tunnels to produce an equal number of broods. A few old adults may survive the winter and participate in the production of the spring brood. However, a majority of the adults die in their tunnels after producing one brood. *D. frontalis* has three annual generations in the northern part of its range (Thatcher *et al*., 1980), three to five in the eastern USA and sometimes more than five in Honduras. For further information on the biology of *D. frontalis*, see Waters *et al.* (1985).

DETECTION AND IDENTIFICATION

Symptoms

Pitch tubes on newly infested trees range in colour from dark reddish-orange to cream; they consist of resin and particles of bark expelled from the egg gallery by the beetles. Orange to cream-coloured particles of bark and wood in crevices and at the base indicate that the tree has been infested and killed by beetles.

The galleries formed by the adults and larvae are diagnostic. Within the gallery system, the entrance tunnel, mother or egg galleries and larval galleries can usually be distinguished. The entrance tunnel is usually short, more or less perpendicular to the tree axis and found at the base of simple galleries (in *Dendroctonus* spp., which are monogamous). This tunnel serves for the evacuation of frass and other debris which accumulates. The entrance hole is closed by tightly packed frass in *Dendroctonus*.

The mother or egg galleries are the same diameter along their length and sometimes possess perforations (aeration or ventilation holes) to the exterior. These galleries are constantly cleared of boring frass in most species. In *D. frontalis*, the egg galleries, in the soft inner tissues of the phloem, are generally 30-35 cm long (up to 89 cm), sinuous and always extending upwards from the entrance hole. They cross or anastomose abundantly, giving a maze-like appearance. The diameter of the individual egg galleries is slightly greater than the width of a beetle. The ventilation holes are usually placed at irregular intervals and may be absent, especially in trees with relatively thin bark.

The larval galleries commence more or less parallel to or divergent from the egg gallery, penetrating the bark or wood to varying depths and progressively widening away from it. These galleries are usually full of debris. The gallery terminates in a small chamber, where pupation occurs and the adult emerges through a hole from this chamber. In most *Dendroctonus* spp., the galleries are individual and radiate from the parental mine, or the larvae may feed in congress for part or all of their development. The mines usually extend for 1-4 cm along a straight or winding route without increasing in diameter, and then abruptly expand into an oval to irregular feeding chamber approximately 0.5-1.0 cm wide by 1 or 2 cm long.

Morphology

Eggs

Smooth, oval, white, translucent. Eggs are laid separately but packed in niches and covered with frass.

Larva

In general, *Dendroctonus* larvae are white, legless, with lightly sclerotized head; head usually as broad as long with evenly curved sides, protracted or slightly retracted. Body at most only slightly curved; abdominal segments each with two or three tergal folds; pleuron not longitudinally divided. Larvae do not change appreciably in form as they grow. Identification requires the assistance of a specialist. For generic keys to the larvae of *Dendroctonus* and other bark beetles, see Peterson (1951) and Thomas (1957, 1965).

Pupa

The pupae of scolytids are less well known than the larva: exarate; usually whitish; sometimes with paired abdominal urogomphi; elytra rugose or smooth; head and thoracic tubercles sometimes prominent. See in particular Thomas (1965).

Adult

In general, *Dendroctonus* adults are relatively large bark beetles, 3-8 mm in length; *D. frontalis* is 3 mm long, cylindrical, dark-brown. Antennae geniculate, funicle five-segmented, with abrupt three-segmented club; subcircular. Head visible from above, not prolonged into distinct rostrum, narrower than pronotum, with mouthparts directed downwards. Eyes flat, usually elongate, entire. Pronotum scarcely declivous in anterior half, usually without crenulations except sometimes anterolaterally. Scutellum small and rounded or depressed. Elytra entire, concealing pygidium, with basal margin usually procurved and with crenulations. Elytra terminate in a rounded or blunt slope (the declivity) which may be fringed by a row of spines or tubercles. Tibiae unguiculate. Tarsal segment 1 not longer than 2 or 3, pseudotetramerous with third tarsal segment bilobed. *D. frontalis* much resembles *D. brevicomis*, except that the hairs on the elytral declivity are sparse and much longer than the width on an interspace. For generic and specific keys to *Dendroctonus* and other genera, see Wood (1982), Duncan (1987) and Lanier *et al*. (1988).

MEANS OF MOVEMENT AND DISPERSAL

Some bark beetles are strong fliers with the ability to migrate long distances. *D. frontalis* has a tendency to migrate considerable distances from the brood tree to begin a new attack (Hopkins, 1909). The most common mode of introduction into new areas is unseasoned sawn wood and wooden crates with bark on them. If wood is barked, there is no possibility of introducing bark beetles. Dunnage is also a high-hazard category of material, on which most of the scolytids intercepted in the USA are found. It is particularly difficult to monitor properly. An adult of *D. frontalis* was intercepted in Canadian sawn wood at Dublin Docks, Ireland, in 1981 (O'Connor *et al.*, 1983). *D. frontalis* has also been caught in pheromone traps in Israel, without any tree infestations being found (Mendel & Argaman, 1986); the source was probably imported American pine logs.

PEST SIGNIFICANCE

Economic impact

Like other scolytids, *Dendroctonus* spp. periodically cause loss of wood (cut wood or standing trees) over extensive areas. Their galleries do not affect the structural properties of the wood significantly, but may render it useless for veneer or furniture making. In general, compared with other genera such as *Ips*, they tend to be more aggressive and more host-specific. They mostly breed in coniferous hosts larger than 15 cm in diameter.

D. frontalis is a member of the so-called "southern pine bark-beetle guild", found on *Pinus* in southeastern USA, and including also *Ips calligraphus* and *I. grandicollis* (EPPO/CABI, 1996a). It mainly attacks disturbed trees (Flamm *et al*., 1993). In the USA, its populations and economic impact fluctuate considerably, probably because of climatic variation (e.g. drought), although the underlying causes are still under investigation (Turchin *et al*., 1991). Outbreaks of *D. frontalis*, especially in southeastern Texas, have been reported since 1882. They usually last only 2-3 years, but one which started in 1957 on 24 000 ha of *P. taeda* had spread to 3 200 000 ha by 1974. Heavy economic losses were experienced from 1974 to 1980 in Texas, and again in the 1980s (Carter *et al*., 1991). In a massive outbreak on pines (*Pinus caribaea* var. *hondurensis*, *P. oocarpa*, *P. maximinoi*) in Honduras, in 1963-1966, about 77 000 trees were killed each day, resulting in a 25% mortality of pines in the affected area. During outbreaks, trees selected for attack are normally living, standing, and larger than 15 cm DBH. The attack is usually concentrated on the upper half of the bole but may reach ground level. In southwestern USA, *D. frontalis* occurs but is not reported to be damaging. A blue-stain fungus, *Ceratocystis minor*, occurs symbiotically with *D. frontalis*, helping the beetle to infest a tree (Furniss & Carolin, 1977) and reducing the value of the wood. An annotated bibliography of this species was provided by Kulhavy & Johnson (1983).

Control

Broadly, the same control methods are available for all bark beetles. A tree that has been attacked usually cannot be saved, so preventive rather than curative control is best. Since scolytid populations are probably always present in a forest, breeding on unthrifty, injured, broken, wind-thrown or felled material, damage can be reduced or avoided by maintaining the health and vigour of the stand; especially by thinning stagnated young stands or removal of overmature trees in older stands.

Losses caused by bark beetles usually involve individual trees or irregularly distributed groups of trees. Insect surveys are made to locate and appraise infestations in their early stages. If endemic conditions prevail, natural control factors (climate, weather, predators, parasites, disease) will hold the population at a steady level at which damage is within normal limits (losses less than annual tree growth). If epidemic conditions exist, damage exceeds normal limits (losses exceed annual growth). Such surveys determine the need for direct control. The available methods have been reviewed in EPPO/CABI (1992). Treatment with insecticides is used, if at all, for logs rather than for trees. Belanger *et al*. (1993) discuss management strategies for *D. frontalis* in the USA.

Phytosanitary risk

D. frontalis is an A1 quarantine pest for EPPO, within the category "non-European Scolytidae" (EPPO/CABI, 1992). Since it makes primary attacks on *Pinus* spp., it presents a definite risk to the EPPO region, where pines are important forest trees. This risk can, however, be assessed as relatively moderate because the geographical range of *D. frontalis* in North America, and particularly the range in which it causes damage, is essentially southern (its range extends into tropical Central America) and the *Pinus* species concerned in North America are not grown in the EPPO region. The only exception is *P. ponderosa*,

but *D. frontalis* is not reported to be particularly damaging on this species in southwestern USA. There are apparently no records of attacks of *D. frontalis* on European pine species. Thus, *D. frontalis* mostly presents a risk to the southern part of the EPPO region, but direct evidence is lacking that the Mediterranean pine species would be attacked (*D. frontalis* has been trapped in Israel, probably coming from imported logs; no attacks were found on *P. halepensis*).

D. micans and other indigenous bark beetles (*Ips* spp.) already occur on conifers throughout most of the EPPO region, so the risk arising from introduced species is uncertain. However, those areas of the EPPO region which lack indigenous bark beetles and and protect themselves from species already present elsewhere in Europe have evident reason to protect themselves also from North American bark beetles.

PHYTOSANITARY MEASURES

If measures are needed against *D. frontalis*, those recommended for *D. ponderosae* (EPPO/CABI, 1996b), suitably adapted, should exclude it.

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