Ips Engraver Beetles (Coleoptera: Curculionidae: Scolytinae)[1]

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INTRODUCTION: Pine bark beetles are frequent pests of stressed pines (*Pinus* spp.) in the southern United States. The five most common southern pine bark beetle species include three in the genus *Ips* (the six-spined engraver, *I. calligraphus* (Germar); the southern pine engraver, *I. grandicollis* (Eichhoff); and the small southern pine engraver, *I. avulsus* (Eichhoff)) (Fig. 1), and two species of *Dendroctonus* (the southern pine beetle, *D. frontalis* Zimmermann, and the black turpentine beetle, *D. terebrans* (Olivier)). Like other pine bark beetles, *Ips* pine engravers live predominantly in the inner bark, where they breed and feed on phloem tissue. Pines successfully colonized by *Ips* engravers, if not already dead, are killed by adult and larval feeding in the phloem (which can girdle the tree) and by colonization of the sapwood with blue-stain fungi that the beetles introduce. The blue-stain fungi spread into the xylem and block water flow, serving to hasten tree mortality (Connor and Wilkinson 1983, Kopper *et al.* 2004).

Ips beetles usually colonize only those trees that are already stressed, declining, or fallen due to other environmental or biotic factors. *Ips* also readily colonize cut logs and slash, and are attracted to fresh pine odors. Infestations may occur in response to drought, root injury or disease, timber management activities, lightning strikes, or other stresses, and sometimes occur in association with attacks by *D. frontalis* or *D. terebrans* (Anderson and Anderson 1968, Lovelady *et al.* 1991, Miller 1983). When populations of *Ips* beetles are sufficiently high, they can overcome the defenses of apparently healthy trees by attacking in large numbers. *Ips* outbreaks, however, are greatly limited in duration and spatial scale compared to outbreaks of the more aggressive *D. frontalis* (Anderson 1977).

DESCRIPTION: Adults are small (approx. 2-6 mm in length), cylindrical, reddish-brown to black, with the head generally concealed by the pronotum when viewed from above. The posterior portion of the elytra (wing covers) is distinctively hollowed-out, coarsely punctured, and bordered with multiple spines (Fig. 1). The three southern species can be distinguished by body length and number of spines along each side of the elytral declivity: *I. calligraphus*, 3.5 to 6.5 mm long, six spines per side (Fig. 1a); *I. grandicollis*, 2.8 to 4.7 mm long, five spines per side (Fig. 1b); and *I. avulsus*, 2.3 to 2.8 mm long, four spines per side (Fig. 1c). Dorsal comparisons of the elytral apices under magnification may also aid in distinguishing species (Fig. 2). Eggs are oblong (ca. 1.0 mm x 0.5 mm) and pearly white. Larvae are small, whitish, legless, and grublike with reddish colored heads that are $\leq$1 mm wide. Pupae are waxy-white and similar in size to adults (USDA Forest Service 1985, Connor and Wilkinson 1983).

DISTRIBUTION: All three *Ips* species can be found throughout Florida in areas where pines occur. *Ips calligraphus* has two recognized subspecies, *I. c. calligraphus*, found throughout much of the eastern US, north to southern Ontario, Canada, and *I. c. ponderosae*, a western US subspecies. The distributions of both *I. c. calligraphus* and *I. grandicollis* north of the southern pines coincide with the range of pitch pine (*Pinus rigida* Mill), although they will affect any pine species within that range. *I. avulsus* is restricted to the southeastern states, from southern Pennsylvania to Florida and Texas (USDA Forest Service 1985).

Fig. 1. Adult *Ips* beetles. A) *I. calligraphus* (Germar); B) *I. grandicollis* (Eichhoff); C) *I. avulsus* (Eichhoff). Photography credit: David T. Almquist, University of Florida.

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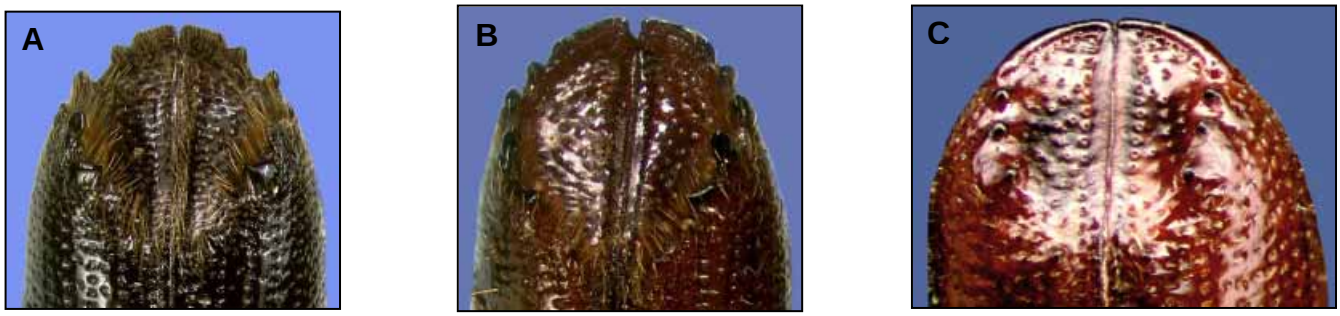

Fig. 2. Dorsal view of the elytral apices. A) *I. calligraphus*; B) *I. grandicollis*; C) *I. avulsus*. Photography credit: David T. Almquist, University of Florida.

HOSTS: All three southern *Ips* species can infest any pine species within their range, and occasionally other conifers such as spruce, hemlock, and fir. Common hosts in Florida include loblolly pine (*Pinus taeda* L.), longleaf pine (*P. palustris* Mill.), pond pine (*P. serotina* Michx.), sand pine (*P. clausa* (Chapm. *ex* Engelm.) Vasey *ex* Sarg.), shortleaf pine (*P. echinata* Mill.), slash pine (*P. elliottii* Engelm.), and spruce pine (*P. glabra* Walt.).

BIOLOGY: Adult male *Ips* beetles are responsible for host selection, principally attacking trees that are stressed, damaged, or recently killed (Coulson and Witter 1984). Males release two primary types of aggregation pheromones, one produced when successfully feeding and the other in response to the presence of defensive resin produced by the tree. These pheromones attract both females and males in numbers that can overwhelm a tree's defense mechanisms. The highest rates of aggregation occur when both pheromone types are produced, indicating that the tree is susceptible to colonization yet still capable of activating its defenses (Vité *et al.* 1972). The adult male bores into the phloem and excavates a nuptial chamber, where it mates with one to five (commonly three) females. After mating, each female excavates an egg gallery that extends away from the nuptial chamber and usually parallel to the wood grain, resulting in an overall I-, H- or Y-shaped gallery pattern (Fig. 3).

Eggs are deposited in niches along the sides of the egg galleries. Larvae tunnel in the phloem perpendicular to the egg galleries and eventually pupate in individual cells excavated in the inner bark. After pupation, the adult will feed for a short time in the phloem before emerging through the bark, leaving small scattered emergence holes (USDA Forest Service 1985). Newly-emerged adults can fly as far as four miles in their first dispersal flight to find a new host tree (Kinn 1986). Development is slower in cool temperatures and the time required to complete the life cycle varies from a few weeks in the summer to several months through the winter. *Ips calligraphus* and *I. grandicollis* can complete their life cycles within 25 days during the summer and can produce eight generations per year in Florida (Dixon 1984), while the *I. avulsus* life cycle can take as little as 18 days, producing 10 generations per year. Generations commonly overlap and all life stages may overwinter in the tree (Connor and Wilkinson 1983).

The three species of *Ips* tend to colonize different parts of the tree, although there is considerable overlap between these territories (Coulson and Witter 1984). *I. calligraphus* usually attacks the lower bole or portions of stumps, trunks, and large limbs greater than 10 cm (4") in diameter (Connor and Wilkinson 1983). *I. grandicollis* prefers to infest recently felled trees and slash, but also can be found infesting weakened living trees, most heavily on large limbs and the mid to upper bole of the host. *I. avulsus* prefers small-diameter slash, but will attack groups of young trees and the crowns of large trees (USDA Forest Service 1985). *I. avulsus* shows a higher degree of aggregation behavior than some other *Ips* species (Mason 1970).

DETECTION: Often the first noticeable indication of an *Ips* infestation is the fading of foliage from green to yellow to reddish brown (Fig. 4c) as the host tree wilts due to plugging of the xylem by blue-stain fungi (Fig 4d). These color changes can occur in 2 to 4 weeks in warm weather, but may take several months in the winter. In cooler weather, the beetles have frequently vacated the tree by the time the needles fade. Early signs of attack include the accumulation of reddish-brown boring dust on the bark, nearby cobwebs, or understory foliage (Fig. 4a).

If there is sufficient resin pressure within the host, attacked trees will exhibit dime-sized, whitish or reddish-brown globs of resin and boring dust called "pitch tubes" on the bark at each point of beetle attack (Fig. 4b). Unlike those of the southern pine beetle, *Ips* pitch tubes are more commonly seen on the surface of bark plates than in bark crevices. After beetles emerge from the tree, scattered circular emergence holes (1-3 mm diameter) can be observed on the outer bark. By removing a section of the outer bark, the characteristic Y-, I- or H-shaped galleries may be observed in the phloem or engraved on the outer sapwood (Connor and Wilkinson 1983) (Fig. 3). These gallery patterns are sometimes obscured by larval galleries of other phloem borers in the families Cerambycidae (roundheaded borers) and Buprestidae (flatheaded borers) that readily colonize dead pines.

Fig. 3. Galleries in the inner bark characteristic of A) *I. calligraphus*; B) *I. grandicollis*; C) *I. avulsus*. Photography credits: Ronald F. Billings, Texas Forest Service (A,C); Jeffrey M. Eickwort, Florida DOACS (B). Images A, C accessible at http://www.forestryimages.org

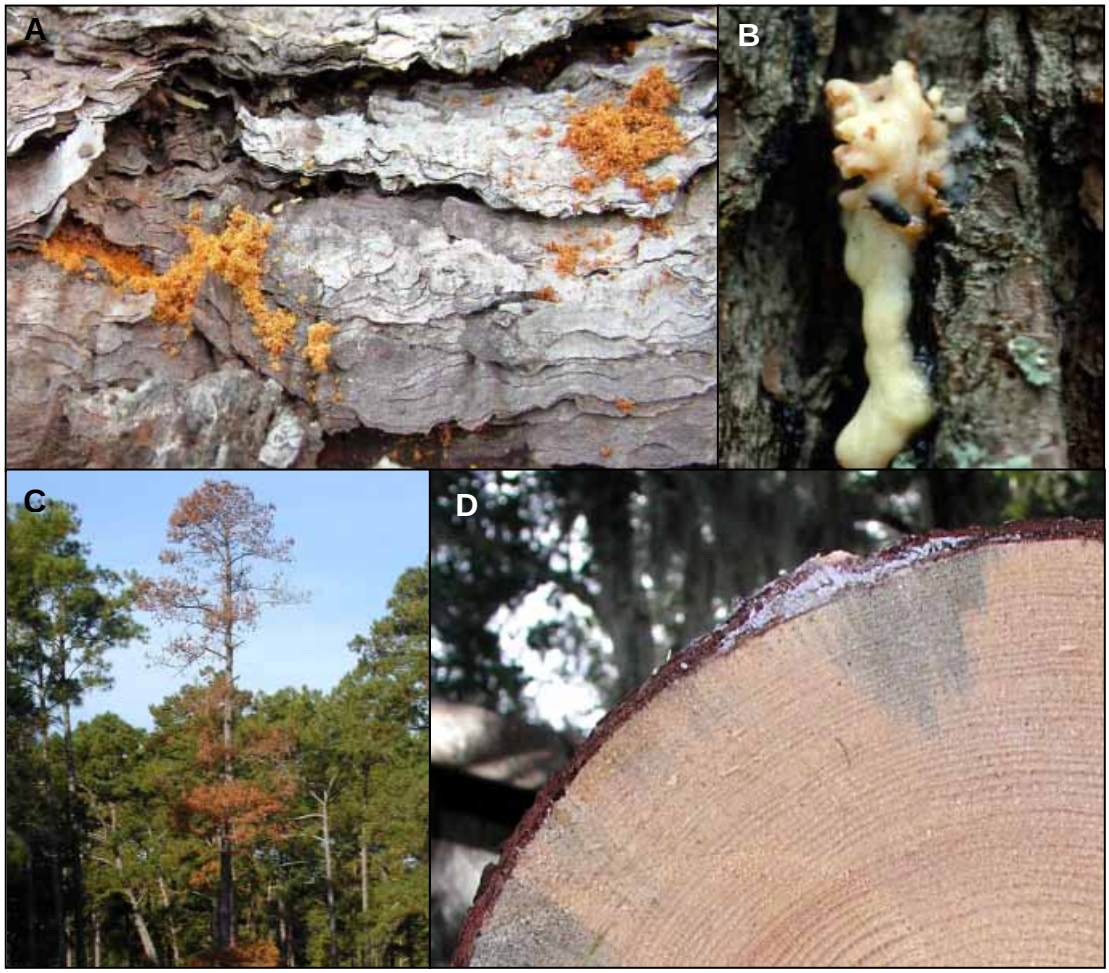

Fig. 4. Possible signs of an *Ips* engraver beetle infestation. A) Boring dust; B) Pitch tube; C) Fading crown; D) Blue-stain fungi in the sapwood, emanating from an *Ips* gallery in the phloem. Photography credits: Albert E. Mayfield III, Florida DOACS (A); Wayne N. Dixon, Florida DOACS (B); John L. Foltz, University of Florida (C,D).

PREVENTION AND CONTROL: The strategies for preventing damage and controlling the spread of *Ips* beetles essentially involve promoting tree vigor and reducing the amount of vulnerable host material within the stand. Preventative strategies in forest stands include: 1) planting species that are appropriate to the site, 2) thinning dense, overstocked stands, 3) conducting prescribed burns or other treatments to control competing understory vegetation, 4) removing and/or salvaging damaged,

declining, or recently-dead trees, 5) avoiding damage to residual stand when conducting management operations, and 6) lopping and scattering or removing logging slash (Connor and Wilkinson 1983, Dixon 1984, Thatcher and Barry 1982).

As for control, when *Ips* infestations are small and/or sparsely scattered throughout a stand, the best course of action is often to let them die out on their own. Cutting and removal of isolated infested trees or small "spot" infestations with buffer strips (as is done to control *D. frontalis* infestations) is not recommended. Observations in Florida suggest that such selective removals may increase the likelihood of *Ips* problems by producing fresh host odors, logging slash, and additional stress or injury to the residual stand. If scattered mortality is progressing to unacceptable levels, a stand-level clearcut or a contiguous block removal of a generally infested area may be preferable to selection harvests.

For urban and residential landscape trees, preventative strategies include the following: 1) avoiding compaction of, physical damage to, or pavement over the root zones of pines, 2) providing adequate spacing (15-20 ft) between trees, 3) minimizing competing vegetation beneath pines, 4) maintaining proper soil nutrient and pH status by employing an acidic needle or pine bark mulch over the root zone in place of turf grasses that require frequent irrigation, and 5) providing supplemental deep watering during extended drought periods. In some cases, the application of an approved insecticide that coats the entire tree bole may be warranted to protect high-value landscape trees from infestation; contact your local county agricultural extension office for current insecticide recommendations. When infested trees are removed, care should be taken to avoid injury to surrounding pines. There is no effective way to save an individual tree once it has been successfully colonized by *Ips* beetles (Connor and Wilkinson 1983, Dixon 1984, Thatcher *et al.* 1978).

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