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SOUTHERN PINE BARK BEETLES IN THE URBAN ENVIRONMENT¹

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Abstract. Five species of bark beetles attack pine trees in the South. The southern pine beetle, *Dendroctonus frontalis*, is the most notorious because of the extensive destruction it periodically causes to commercial pine forests. However, the three species of *Ips* engraver beetles and the black turpentine beetle, *Dendroctonus terebrans*, collectively may be more destructive than the southern pine beetle in urban situations. Several insecticides are registered for the prevention and control of southern pine bark beetles, but insecticide treatments are expensive and control is difficult. Most bark beetles kill pine trees very rapidly and symptoms of attack usually are not detected in time to save infested trees. The best way to prevent losses to bark beetles is to maintain healthy trees.

Résumé. Cinq espèces de scolytes attaquent les pins dans le Sud. Le dendroctone méridional du pin, *Dendroctonus frontalis*, est le plus notoire à cause de la destruction massive qu'il cause périodiquement aux forêts commerciales de pins. Cependant, les trois espèces de scolytes graveurs (*Ips*) et le dendroctone noir de l'épinette, *Dendroctonus terebrans*, peuvent être plus destructeurs collectivement en régions urbaines que le dendroctone méridional du pin. Plusieurs insecticides sont enregistrés pour la prévention et le contrôle du dendroctone méridional du pin, mais les traitements sont dispendieux et le contrôle difficile. La plupart des scolytes tuent les pins très rapidement et les symptômes d'attaque souvent ne sont pas détectés assez vite pour sauver les arbres infestés. La meilleure méthode pour prévenir les pertes dues aux scolytes est de maintenir les arbres en santé.

Pine trees are the predominant vegetation over much of the southeastern United States. Urban expansion in many southeastern cities such as Houston and Atlanta has taken place among the pines. Pine trees provide valuable shade and beauty to the urban setting (Fig. 1). Many pests plague southern pines, but bark beetles are by far the most destructive. The five principal species of pine bark beetles occurring in the South include: the southern pine beetle (SPB), *Dendroctonus frontalis*; the black turpentine beetle (BTB), *Den-*

droctonus terebrans; the six-spined ips, *Ips calligraphus*; the eastern five-spined ips, *Ips grandicollis*; and the small southern pine engraver, *Ips avulsus*. It has been estimated that, from 1973 to 1977, bark beetles collectively killed enough timber to build about 300,000 average-sized houses (15). Also, hundreds of thousands of pine trees are killed by bark beetles in urban areas each year resulting in additional incalculable dollar losses.

To effectively deal with pests, they must be identified, and control measures must be applied properly and in a timely manner. Numerous references are available providing general information on identification, biology, and control of *Ips* engraver beetles (6, 17), the southern pine beetle (11, 14), or all five bark beetle species (7, 10, 15, 16). This paper describes the behavior pat-



Figure 1. Southern pines provide a source of shade and beauty in the urban setting.

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terns for all five southern pine bark beetle species, how to distinguish the attacks of each, and methods available for their prevention and direct control.

Attack Process and Life Cycle

Adult bark beetles fly from one host tree to another. Pioneer beetles apparently are attracted by odors of damaged and weakened pines. Upon encountering a suitable host tree, SPB and *lps* beetles emit odors (pheromones) which attract more beetles to the tree. Thus, a chain reaction known as a mass attack is initiated. This process enables the bark beetles to overcome the tree's defense system - a persistent flow of toxic resin - and successfully colonize the tree in a matter of days. After one tree is completely colonized, excess beetles spread to other trees where they produce still more attractants, and continue the process (11). Southern pine beetles often spread from one tree to adjacent healthy ones, and often kill large groups of pines. However, *lps* beetles apparently are unable to successfully colonize healthy trees and therefore search out and attack scattered weakened, broken, or cut trees. The BTB can better tolerate the flow of toxic resins and does not require rapid mass attacks to successfully colonize pine trees. Black turpentine beetles are attracted to weakened or damaged pines, arriving a few at a time over a period of weeks or months.

Once inside the host tree, female beetles construct egg galleries of uniform width. Grubs, or larvae, feed on the inner bark creating larval mines which gradually increase in width as they radiate out from the egg galleries. Fully developed larvae transform into pupae and then to adult beetles, thus completing the life cycle. The SPB and the two larger *lps* beetles can complete as many as seven generations in a single year and the small southern pine engraver can have up to 12 overlapping generations per year (15).

Beetle Interactions and Activity Patterns

A pine tree may be killed by a single species of bark beetle, but more commonly, two or more species attack the same tree to bring about its death. Each of the five southern pine bark beetle species typically is found in certain portions of

pine trees (Fig. 2). However, beetles may occupy overlapping areas in the tree, particularly in the middle portion of the stem. Black turpentine beetles seldom attack much higher than 10 feet above the ground.

The behavior and abundance of bark beetles vary seasonally and from year to year. Southern pine beetles emerge and attack uninfested trees any time moderate temperatures prevail. They tend to be more dispersed in isolated trees during the cooler months and clumped in groups of trees (spots) during the warmer summer months. Southern pine beetle outbreaks are cyclic. Populations usually peak every 8-10 years and decline to low levels during the interim. The southern pine beetle is most active in late spring and early summer in the South and beetle development slows during periods of extreme heat. In contrast, *lps* and black turpentine beetles are usually most active during mid- to late summer when high temperatures prevail. Populations of BTB and *lps* beetles are more ubiquitous than SPB populations and often become particularly troublesome following disturbances, such as drought, storms, prolonged flooding, and man-caused damage to trees.

Urban Environment and Bark Beetles

The SPB has received considerable public attention because of the extensive destruction it periodically causes in commercial pine forests across the South. However, the three *lps* beetles and the BTB are more persistent and probably more important pests of pines in the urban and suburban areas. The occurrence and expansion of SPB infestations are favored by dense groups of large pine trees (1, 3), a situation rarely encountered in the urban environment. Most pine trees in urban areas are scattered remnants of pine forests left after urban expansion. These trees are subjected to an environment dramatically altered from that of the original forest. Disturbances encountered by urban pines include: 1) altered temperature and drainage patterns, 2) changes in amounts and kinds of nutrients and chemicals in the air and water, 3) sudden exposure of stems to direct sunlight, 4) damage to stems and crowns by equipment, and 5) damage to root systems by excavation, grade changes,

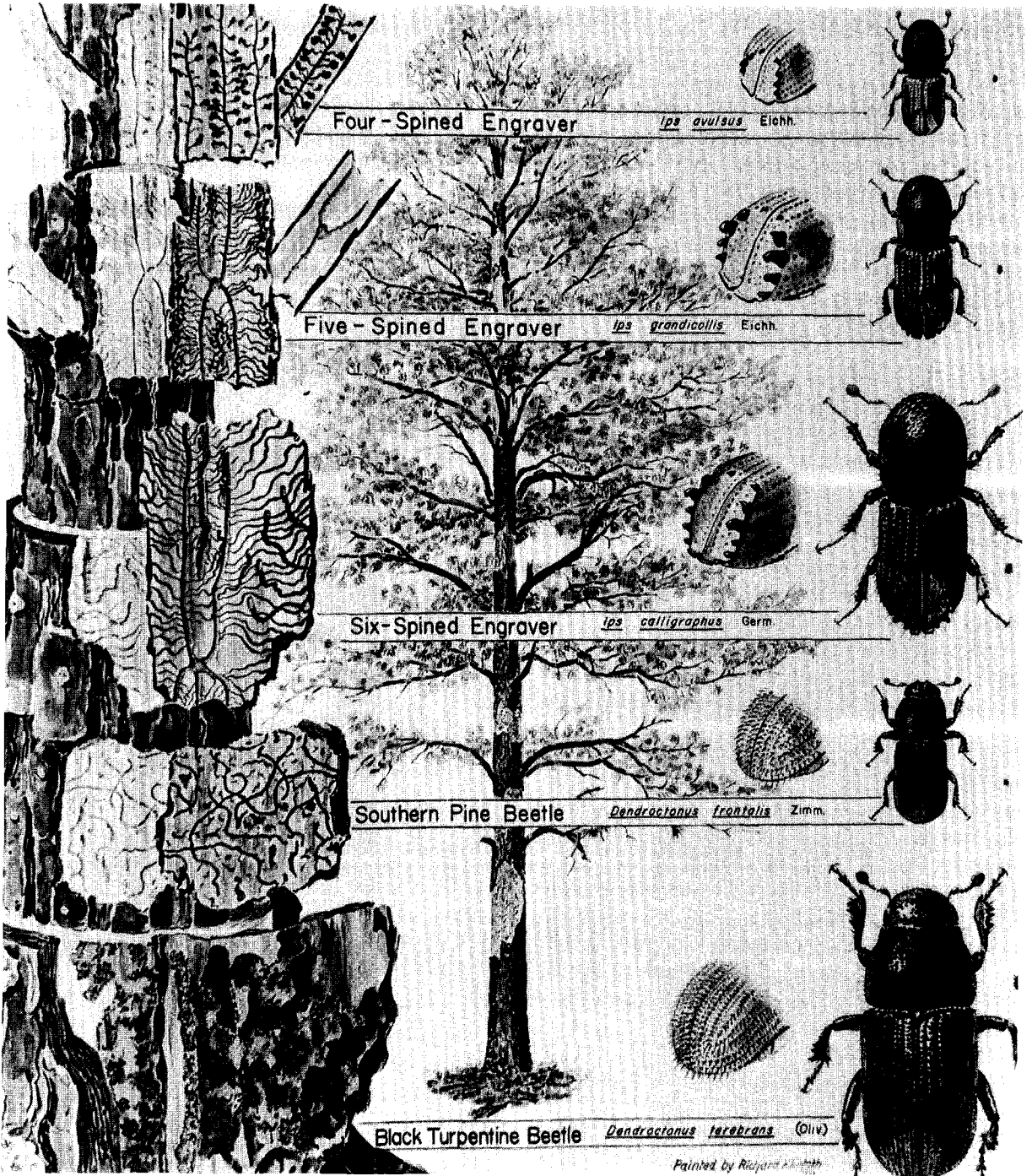


Figure 2. Diagram of the five southern pine bark beetles, illustrating gallery patterns, the portion of the tree preferred, and adult beetle characteristics (Courtesy of Boyce Thompson Institute). The four-spined engraver, five-spined engraver, and six-spined engraver listed in this figure are referred to in the text as the small southern pine engraver, eastern five-spined ips, and six-spined ips, respectively.

and soil compaction.

Environmental changes and damage often cause heavy stress, reduced vigor, and weakened defense systems in pine trees. Since BTB and *Ips* beetles are particularly adept at locating and colonizing weakened pines, their populations often reach epidemic proportions for several years following urban expansion in areas with large numbers of pine trees. These epidemics may be magnified if the urban development coincides with weather-related stress (wind storms, drought, or flooding).

Symptoms of attack

Early detection and prompt action are essential to minimize pine bark beetle damage (5). The detection of scattered bark beetle attacks in suburban areas is mostly the responsibility of individual property owners. Periodic tree inspections by homeowners focusing on early symptoms of pine bark beetle attacks would assure more timely detection of bark beetle infestations in these areas (Fig. 3).

The symptoms of bark beetle attacks have been thoroughly described and color illustrated elsewhere (4, 15). Brief descriptions of the distinguishing characteristics of bark beetle attacked trees follow. *Boring material* is the first external symptom of bark beetle attack (Figure 3B). As bark beetles bore into pine trees, they eject tiny pieces of ground bark and hardened resin which accumulate in bark crevices, on spider webs, and on understory plants. *Pitch tubes* (masses of resin) the size of popped corn on the bark surface often mark the entry points of SPB and *Ips* beetles (Figure 3A-B). Black turpentine beetle attacks are marked by large thumb-sized pitch tubes.

Discolored foliage is usually the first symptom noticed by homeowners following bark beetle attack. The needles of attacked pine trees fade from green to yellow-green, then to red or brown, and eventually fall from the tree. Fading of foliage to the red stage may take up to 4 months in the cooler seasons but only about 1 month in mid-summer. In most cases, by the time the foliage turns red, the new beetles have already emerged and gone on to other trees. Rapid discoloration of the entire crown is typical of trees killed by all the

southern pine bark beetles except the smaller southern pine engraver which sometimes kills only the top of the crown or individual branches.

Egg galleries engraved on the underside of bark on attacked pines are reliable characteristics for identifying the species of bark beetle causing the

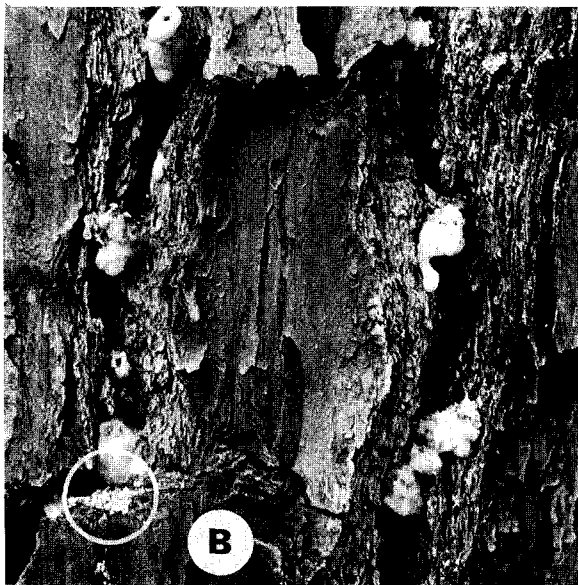
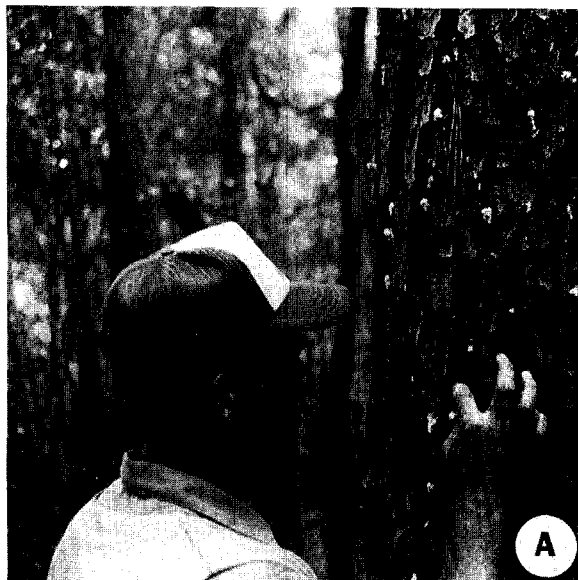


Figure 3. Inspecting a loblolly pine tree for symptoms of pine bark beetle attack. Note the numerous white SPB pitch tubes in the bark crevices (A and B) and boring material accumulated on the bark scale below the pitch tubes (circle in B).

damage (Fig. 2 and Fig. 4A-D). Attacking adults of the southern pine beetle leave interwoven S-shaped trails in the inner bark. *Ips* engraver beetles hollow out a central chamber beneath the bark from which two to four egg galleries radiate up and down the trunk of the tree. Black turpentine beetle egg galleries have no distinctive pattern, but are large and often filled with pitch.

Sawyer beetles are common among the many secondary insects associated with bark beetles in pine trees. Immature sawyer larvae tunnel beneath the bark in dying pine trees leaving large winding galleries packed with fibrous boring material. Sometimes these galleries are so numerous that they obliterate the bark beetle galleries (Fig. 4D). The presence of sawyers in infested pines often can be detected by the characteristic rasping noise made by the larvae as they feed beneath the bark. Ambrosia beetles also bore into dying pine trees. These beetles bore straight into the wood, ejecting boring dust consisting of fine slivers of wood which accumulate in fluffy white piles around the base of the pine tree.

Prevention

Once bark beetles have mass attacked and successfully colonized a pine tree, there is no reasonable way to save it. Therefore, the best approach for dealing with bark beetle problems is to promote good tree health, thereby minimizing the probability of bark beetle attack and subsequent spread to other trees. Much of the tree mortality which occurs in suburban areas could be avoided by carefully following well designed plans to minimize disturbances and encourage vigorous growth among selected "leave" trees (13).

Minimizing stress and encouraging vigor. Trees to be left at building and landscaping sites should be carefully selected and protected during construction. Healthy young trees with full crowns should be favored over old diseased, or severely suppressed trees when selecting leave trees in suburban planning. A mixture of ages and species, particularly those which can adapt to harsh urban environments, should be encouraged. Thinning dense stands of trees is a recommended procedure for reducing stress due to competition, provided the thinning operation can

be carried out without severely disturbing the residual trees. Harris (8) provides an excellent discussion on protecting existing trees and preparing sites for planting. If trees cannot be adequately protected and cared for during and after construction, it is better to remove them before construction begins, rather than later when tree removal is far more costly.

Deep watering during dry periods and proper fertilization (9, 16) will reduce stress and improve vigor among residual trees. Ideally, fertilization prescriptions should be based on soil analyses. Reducing crown volume by pruning will help reduce drought stress for trees with damaged root systems.

Attending to damaged trees. Unlike SPB and BTB, engraver beetles will breed in downed pine trees and branches. New broods emerging from this material can invade weakened standing pines in the area. Therefore, pine trees that are damaged, uprooted, or broken by storms or other causes need to be disposed of promptly to avoid a buildup of *Ips* engraver beetle populations. Pine trees struck by lightning may be attacked by bark beetles within hours, particularly during warm weather. But quick action can sometimes save lightning struck pines. Bark tracing to remove damaged bark should be followed by thorough coverage of the entire stem with a preventive insecticide spray. Pine trees immediately adjacent to the damaged tree should also be treated with a preventive spray.

Using insecticides for prevention. Certain formulations of lindane, chlorpyrifos, and fenitrothion are currently registered by the Environmental Protection Agency for the prevention and control of southern pine bark beetles. Spray coverage required for the prevention of each of the southern pine bark beetles is illustrated in Figure 5. Insecticide sprays need to be repeated at 4- to 6-month intervals until the threat of bark beetle attack has subsided. Spraying large standing trees with an insecticide requires special equipment (a high pressure hydraulic sprayer) and the trees must be accessible to this equipment. Insecticide sprays should be limited to special situations involving high value trees in imminent danger of bark beetle attack.

Control

If a bark beetle infestation is detected, prompt action is needed to prevent further spread to other pine trees in the area (12). The first step is to determine which trees are attacked, which still have bark beetles in them, and which beetle species are involved. If the bark beetles have already vacated the attacked trees and left the area, no immediate action is needed, but dead trees should be removed when convenient for aesthetic and safety reasons.

Black turpentine beetles attacking alone at the

bases of green trees generally can be controlled and the trees saved by applying an insecticide spray to the basal portion of the tree. However, trees already colonized by SPB or *Ips* cannot be saved. Recommended control procedures are designed to stop the spread of the infestation and remove the beetles from the area. Trees with fresh attacks and developing brood should be cut down, limbed, and cut into workable lengths. Tree sections should be burned or sprayed with an insecticide on site, or hauled away for disposal before new beetles emerge and spread to nearby

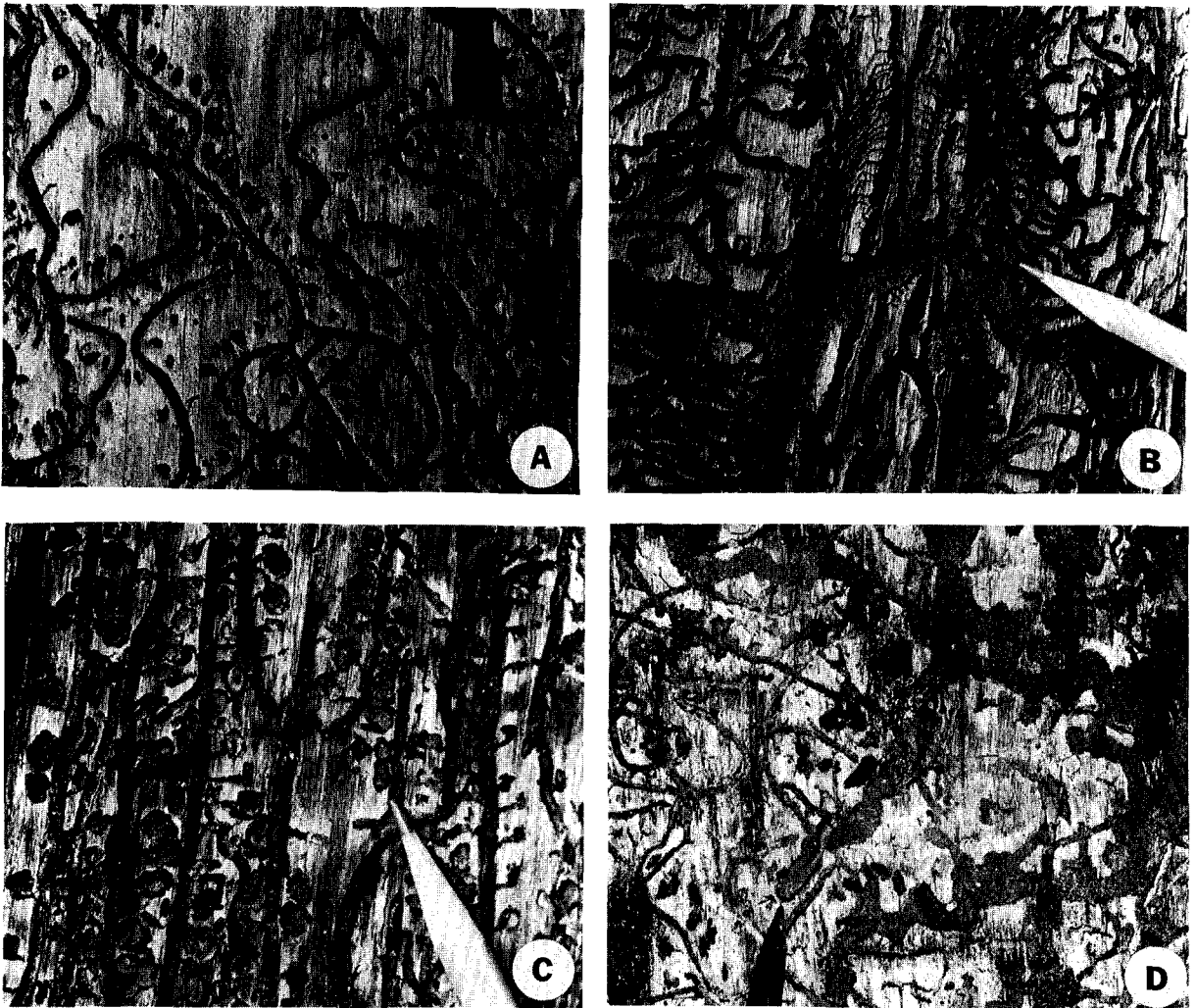


Figure 4. Egg gallery patterns on the inside surface of bark sections removed from bark beetle-attacked pines. (A) southern pine beetle. (B) six-spined ips. (C) small southern pine engraver. (D) sawyer beetle galleries beginning to obliterate older southern pine beetle galleries.

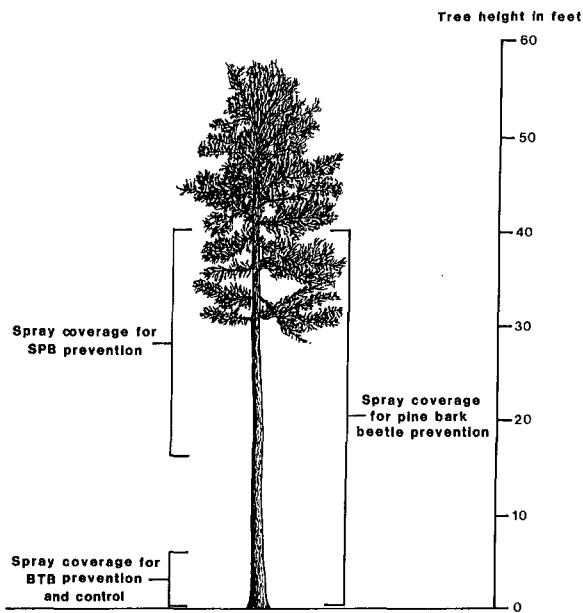


Figure 5. Diagram indicating portions of a pine stem requiring spray coverage to prevent attacks by the southern pine beetle (SPB), black turpentine beetle (BTB), and all southern pine bark beetles. Treatment of the entire stem may be necessary to prevent attacks by the small southern pine engraver in the tops of pine trees (Modified from Berisford and others (2)).

pine trees.

If insecticides are used, one of the products registered for prevention and control of southern pine bark beetles should be applied to the infested tree sections with a low pressure sprayer. Check the remaining pine trees in the area carefully to assure that all fresh attacked trees are detected and removed. As a precautionary measure, a preventive insecticide spray can be applied to uninfested pine trees remaining in the area. It is advisable to revisit the site a week or two after treatment to check for and treat additional attacks.

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