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Red Turpentine Beetle

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The red turpentine beetle (RTB), *Dendroctonus valens* LeConte, is a common and widely distributed bark beetle that attacks all species of pine within its range. Like other bark beetles, the adults tunnel into the inner bark (phloem), where males and females mate, females lay eggs, and the larvae feed. RTB colonizes the lower bole and larger roots of stressed, injured, dying, and recently dead pine trees, whereas most other bark beetle species specialize in colonizing other portions of the tree. Aggressive species like the western and mountain pine beetles (*D. brevicomis* and *D. ponderosae*) may aggregate by the thousands on the main stem of an individual tree, but aggregations of RTB typically number in the single or double digits. Unlike the attacks of more aggressive beetles, attacks by RTB rarely cause tree mortality directly. However, attacks may indicate that a tree is weakened by injury or disease and in a state of decline. RTB readily colonizes freshly cut stumps, as well as trees infested by other bark beetles or damaged by wildfire. Occasionally RTB attacks apparently healthy pines, causing little if any damage.

The common name red turpentine beetle describes this insect well. Adults are reddish-brown beetles and are attracted by the odor of turpentine, a distillate of pine resin. Research has identified specific chemicals (monoterpenes) within the resin that account for this attraction. Monoterpenes serve as low-level attractants for many bark beetle species, but in the case of RTB, they appear to provide a more significant attraction that aids in locating injured and weakened hosts.

Distribution and Hosts

RTB's native range (Figure 1) includes most of North and Central America from the Northwest Territories in Canada south

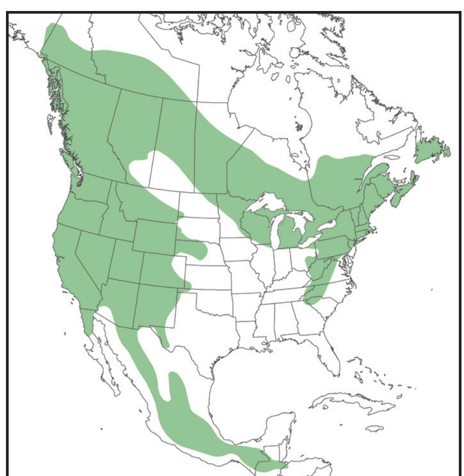

Figure 1. *Probable distribution of RTB.*

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to Honduras. It is not found in the southeastern U.S. (South Carolina to Texas), where the closely related black turpentine beetle, *D. terebrans,* occurs. The ranges of both beetles overlap along the eastern seaboard and southern Appalachia of the U.S. In parts of Mexico, RTB's range overlaps that of another closely related species, *D. rhizophagus,* which colonizes seedlings and small saplings.

In general, pole-size and larger trees are attacked, but trees as small as a few inches in diameter may be attacked when RTB is abundant. All pines (*Pinus* spp.) within its range may be colonized, including both native and introduced species. It is also reported to occasionally attack other genera of conifers, including Douglas-fir (*Pseudotsuga*), larch (*Larix*), spruce (*Picea*), and true fir (*Abies*). Throughout its native range, RTB is largely ranked as a tree pest of secondary importance. In the People's Republic of China, where RTB has been introduced, it has caused substantial mortality of native pines, particularly Chinese red pine, *Pinus tabuliformis.*

Life History and Identification

RTB is the largest bark beetle in North America. In most parts of its range, RTB and evidence of its attacks are readily identified by the following:

- Size and color of adults (Figure 2);
- Gallery pattern (tunnels made by adults and larvae) beneath the bark;
- Large pitch tubes (Figure 3) or other evidence of attack (Figures 4 & 5) on the lower bole and exposed roots of a tree.

RTB adults are cylindrical, reddish-brown beetles approximately 1/4 to 3/8 inches long with elbowed, clubbed antennae (Figure 2b). Males and females are similar in appearance, although a trained person can readily distinguish them by using a hand lens or dissecting microscope to observe differences in a sound-producing structure on the abdomen. Males often produce an audible chirp when handled.

Beetles fly, potentially for many miles, in search of suitable trees to colonize. Females initiate attack by tunneling individually into the inner bark where they begin constructing an egg gallery. Each is joined by a single male with which she mates. The volatile chemical frontalin has been identified as a component of the female-produced sex pheromone. The first attacks often occur on the bole near ground level and typically are marked by a resinous, granular boring material that may be hidden by needles and other forest litter at the base of the tree (Figure 4). Subsequent attacks occur both above and below ground, usually not extending up the bole more than 8 feet. Large pitch tubes (up to 2 inches across) on the lower bole of a pine tree (Figure 3) are a distinctive feature of RTB attacks. Attacks below ground initially occur around the root collar, but can extend well below this over time. Beetles have been found in roots as far as 15 feet from the bole. Root colonization is due, at least in part, to females that establish mul-

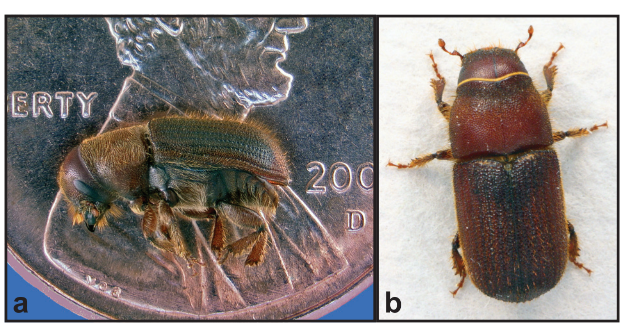

Figure 2. *Lateral (a) and dorsal (b) views of adult.*

Figure 3. RTB pitch tubes on the bark surface of a pine.

Figure 4. Resinous granular boring material at the base of a pine.

tiple egg galleries, with successive galleries initiated farther out on the root system.

Egg galleries are roughly linear, packed with frass (material that remains as the beetles tunnel through the inner bark), and oriented longitudinally, i.e., following the grain of the tree bole and roots. Occasionally they are branched or widely lobed. Linear portions are typically 1/2 to slightly more than 1 inch wide, which is considerably wider than the galleries of other bark beetles found in pines. Gallery length varies, with most ranging between 6 inches and 2 feet. Egg galleries initiated above ground may start upward and then loop downward, whereas those initiated below ground usually continue downward. The female lays eggs in loose groups along the sides of the gallery (Figure 6). One to a few groups is common, with one group usually containing the majority of eggs. Although more than 100 eggs have been observed in a single gallery, typically fewer eggs are present. Eggs are oblong, less than 1/16 inch in length, opaque white, and hatch in 1 to 3 weeks. When attacks are abundant, individual galleries may run together and be difficult to distinguish.

Figure 5. RTB boring dust at the base of a pine.

Figure 6. RTB eggs in a gallery.

Larvae (Figure 7) eat the phloem, feeding side by side and producing a fan-like pattern as they mine away from the egg gallery. Larvae are cream-colored, legless grubs, with a reddish-brown head. At the tip of the abdomen, they have a sclerotized (hardened) brown spot that bears minute spines, a feature that distinguishes them from the larvae of other bark beetles and weevils that might be found beneath the bark. When fully grown, they are about the same length or slightly longer than an adult beetle. The larval stage can last from a few months to over a year, depending on temperature. Pupation is brief and takes place in individual cells within or just beyond the larval feeding area. Pupae are cream-colored and show evidence of developing adult features like wings, eyes, legs, and antennae (Figure 8). New adults are referred to as teneral or callow adults and initially are a lighter, more yellowish-brown color than the reddish-brown of older beetles.

The entire life cycle, from egg to adult, can be completed in less than a year in the warmest parts of the beetle's range, or may take from one to two years in colder areas. Adults and larvae are the life stages that typically overwinter. In areas with cold winters, new adults that develop in the fall overwinter beneath the bark and emerge the following year. A distinctive feature of the life history, even in areas with a one-year life cycle, is overlapping generations. The ability of females to establish multiple broods in the same tree or stump, or potentially in different trees, apparently contributes to this. In areas where the life cycle is completed in one year, a dramatic peak flight of adults occurs in the spring, but adults can be captured and attacks may occur throughout the summer and into early fall. In warmer areas, beetle flight and attacks may occur during much of the year.

Evidence of Attack and Infestation

In most situations, RTB attack densities (numbers of pitch tubes per tree) are relatively low. Large-diameter trees may occasionally have up to 100 pitch tubes when RTB are abundant. Pitch tubes (Figure 3) can remain on a tree for several years. Newly formed pitch tubes are soft to the touch and vary in color from white to pink to reddish-brown to dark brown. This variation is largely due to the amount of outer bark or oxidized phloem fragments embedded in the pitch. The freshest tubes are shiny and sticky. As they age, they become opaque with a light yellow to gray color. Eventually they harden and crumble.

Although the appearance of RTB pitch tubes may be disconcerting, their formation indicates that the tree is defending itself from beetle attack. The attacks may

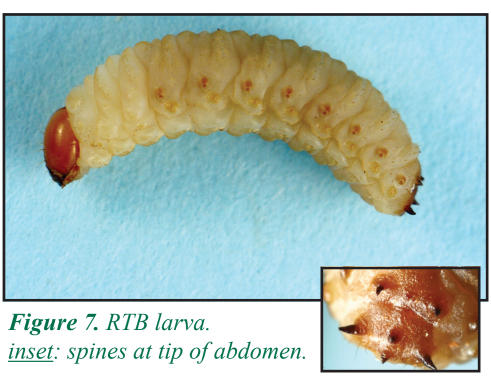

Figure 7. *RTB larva.*
inset: spines at tip of abdomen.

Figure 8. *RTB pupa in a cell in the phloem.*

have occurred in response to the condition of the tree (an injury or disease) or they may relate to something that happened to trees nearby. Any factor that contributes to an increase in local RTB populations may increase the likelihood of attacks on trees, even those with no evidence of injury or disease. Attacks on an apparently healthy tree are generally of little concern.

If a tree is unable to defend itself from beetle attack, little or no resin will be released and pitch tubes will not form. It is fairly common to see pitch tubes produced by the first beetle attacks, whereas later attacks produce only non-resinous boring dust (Figure 5) as the tree's defenses fail. In addition to being attacked by RTB, a dying tree may be under attack by other bark beetle or woodborer species. If attacks by either the red turpentine beetle or other bark beetle species are producing non-resinous dust that encircles the bole, the tree is likely already dead. This can be confirmed by removing small portions of bark and checking the condition of beetle galleries. In a dying tree, at least some of the galleries will be well-developed and have live adults, eggs, or feeding larvae. If the tree is successfully defending itself, galleries will be short, have substantial amounts of resin, and may contain dead beetles.

Ecology and Impacts

As one of the initial colonizers of a dying pine tree, RTB interacts with other beetles and microorganisms that seek the same or similar tissues upon which to feed. As a generalist, RTB functions in many different pine ecosystems. To be successful, it must locate suitable trees to attack and be the first colonizer of the phloem on the lower bole and larger roots of a dying pine. The timing and location of attacks define RTB's niche on the tree. The niches of other beetles may overlap with that of RTB. These beetles include species of bark beetles in the genera *Dendroctonus, Ips, Hylastes, and Hylurgops*, as well as roundheaded and flatheaded borers and weevils.

The contribution of RTB attacks to tree decline and eventual mortality is poorly understood. RTB can attack a tree in advance of mass attack by other, more aggressive beetles, but tree mortality is typically attributed to the more aggressive beetles. RTB may play a more apparent role in tree mortality for pines that are rarely attacked by an aggressive bark beetle species (e.g., bishop, knobcone, Monterey, or pinyon pines in the western U.S.). On trees injured by fire, RTB may establish broods on individual roots in advance of tree death. A fire-injured tree with RTB attacks will have a higher probability of mortality than will a similar tree without attacks. In most situations, RTB is seen as an opportunist and the impact of its attacks are not easily separated from the impacts of injury, disease, and other beetles.

In parts of the western U.S., RTB has killed pole-size, drought-stressed ponderosa pine following thinning or thinning plus soil ripping (deep, mechanical breakup of hardened soil layers) conducted in the spring of the year, i.e., just prior to or during peak RTB flight. Trees were killed in the same year that treatments occurred, but also during the following year, apparently due to RTB population build-up in stumps. RTB population size subsequently declined because of poor brood production in the killed trees. Even though RTB readily breeds in fresh pine stumps, rarely does this lead to lethal attacks on trees that are free of stress, injury, or disease.

Like all bark beetles, RTB carries an array of microorganisms that enter the tree along with the beetle. Notable among these are fungi that colonize the sapwood, producing a blue stain (Figure 9) and disrupting the flow of water in the stem. Two of these fungi, *Leptographium terebrantis* and *L. procerum*, have been implicated in the decline of living pines. *L. terebrantis* has been isolated from RTB throughout its range in the U.S., whereas *L. procerum* has been isolated from RTB in the eastern half of the U.S. and China. Other beetles carry these fungi as well.

Figure 9. *Pine stump (bark removed) with fungal stain and RTB galleries.*

Management

When RTB attacks occur, the land manager should try to determine what factors have precipitated the attacks and whether these factors are currently having an impact on the tree. Look for evidence of injury or disease on the attacked tree, but also consider the condition of nearby trees and whether any activities may have attracted RTB into the area. If there are no obvious reasons why RTB attacks have occurred, the manager should monitor trees for additional attacks since the interaction between beetle attack and tree defense is dynamic.

Wounding of tree boles or roots, or placing freshly cut or chipped pine material next to the boles of standing trees often leads to attacks. Attacks on healthy trees are unlikely to be damaging. Attacks on young, pole-size pines, however, may result in mortality if the trees are under stress. To reduce this risk, avoid activities such as thinning, pruning, chipping, and soil ripping when trees are drought stressed. If this is impractical, schedule the activities for late summer or autumn when the numbers of dispersing adult beetles are lower. Monitor for RTB activity following prescribed burning. RTB attacks likely indicate that a tree's roots or root collar have been injured by fire. As a preventive step, remove duff and other flammable materials from around the base of trees prior to conducting a burn.

The presence of fresh RTB attacks may be a sign that the tree's health is failing or that it is dying or already dead. Boring dust encircling the bole often indicates that the tree has been girdled by successful bark beetle attacks, even if the tree's foliage is still green. When a tree dies, its needles will transition (fade) to yellow-green to sorrel to red-brown in color. No treatments are available to save a tree that has been successfully mass-attacked by bark beetles.

Maintaining tree health is the most important means of preventing beetle attack. Even so, the combination of high beetle populations and temporary stress (e.g., drought) can expose even relatively healthy trees to the threat of beetle-caused mortality. Preventive insecticide treatments are available to protect individual trees. When applied directly to the tree bole with a high pressure sprayer, insecticide treatments are very effective at preventing successful bark beetle attacks. Bole surfaces missed or not treated effectively can be successfully attacked. Flowable formulations of carbaryl and pyrethroids such as permethrin or bifenthrin are effective preventive treatments for RTB. Ensure that the insecticide used is registered within the state and is labeled for use against the target beetle. Follow all label directions to ensure safe use and treatment efficacy. Certain insecticide formulations can only be applied by a licensed pesticide applicator.

Acknowledgements

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Figure credits: The distribution map (Figure 1) was prepared by Meghan Woods, Sanborn Map Company, Davis, CA, and is based on a map by S.L. Wood (1963), with modification to include more recent records. Figure 2a was provided by Erich Vallery, USDA Forest Service, Southern Research Station, Pineville, LA. Figure 4 was provided by Mike Albers, Minnesota Dept. of Natural Resources, Grand Rapids, MN. All other photos (Figures 2b, 3, and 5-9) were taken by D.R. Owen.

Additional Information

Private landowners can get more information from County Extension Agents, State Forestry Departments, or State Agriculture Departments. Federal resource managers should contact USFS Forest Health Protection (www.fs.fed.us/foresthealth/). This publication and other Forest Insect and Disease Leaflets can be found at www.fs.fed.us/r6/nr/fid/wo-fidls/.

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Pesticides used improperly can be injurious to humans, animals, and plants. Follow the directions and heed all precautions on the labels. Store pesticides in original containers under lock and key--out of the reach of children and animals--and away from food and feed. Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues. Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container. If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first-aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly. Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides. Dispose of empty pesticide containers promptly. Have them buried at a sanitary land-fill dump, or crush and bury them in a level, isolated place.

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