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Southwestern Pine Beetle

Introduction

The southwestern pine beetle, *Dendroctonus barberi* Hopkins (Coleoptera: Curculionidae: Scolytinae), is a significant pest of ponderosa pine *(Pinus ponderosa)* in the Southwestern United States (fig. 1). Pinyon pine *(Pinus edulis)* and Douglas-fir (*Pseudotsuga menziesii* var. *glauca*) have also been recorded as occasional hosts. The southwestern pine beetle occurs in Arizona, Colorado, New Mexico, Nevada, Utah, and Texas, and in the Mexican States of Chihuahua, Coahuila, Durango, Nuevo Leon, and Tamaulipas (fig. 2). Its largest impacts occur in Arizona, New Mexico, and Texas.

Southwestern pine beetles play a vital role in forest ecosystems by shaping the structure, composition, and function of these environments. They often contribute to tree mortality in forests that are overly dense, overmature, or both. Trees weakened by factors such as drought, fire, lightning, or mechanical

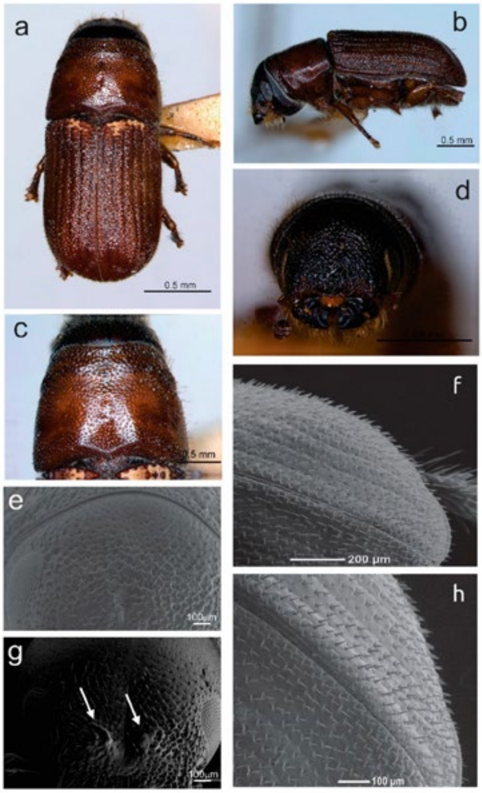

Figure 1—Southwestern pine beetle: (a) female, dorsal view, (b) female, lateral view, (c) female, pronotum, (d) female, frons sculpturing, (e) female, frons, (f, h) elytral declivity, (g) male, frons sculpturing with pair of frontal tubercles identified. From Valerio-Mendoza et al. (2019).

damage are particularly susceptible to infestation. At endemic (low) population levels, the southwestern pine beetle fulfills an essential ecological role by promoting forest health and renewal. At epidemic (outbreak) population levels, large numbers of trees may be killed, impacting many ecosystem services and causing severe economic losses. Dense stands of ponderosa pine, particularly those with 8- to 20-inch (20- to 50-cm) diameters at breast height (DBH), are especially susceptible to infestation.

Between 2011 and 2016, the ponderosa pine forests in the Davis Mountains of west Texas experienced a major tree mortality event caused, in part, by outbreaks of southwestern pine beetles. The Davis Mountains are one of three forested sky islands in a vast region of arid-lowland deserts. To date, more than 50 percent of ponderosa pines in the Davis Mountains have died, and the scarcity of natural tree regeneration poses a considerable challenge for the region.

Life History and Identification

Like other bark beetles, the life cycle of the southwestern pine beetle takes place within the bark of host trees—except for the adult stage when beetles disperse to locate new hosts. Southwestern pine beetles progress through four developmental stages (egg, larva, pupa, and adult) and generally have three generations per year. The beetles may be active from April to October, attacking primarily the lower bole of ponderosa pines. There are overlapping broods, with newly attacked trees occurring mostly

Figure 2—Gray area east of dotted line indicates the distribution of the southwestern pine beetle *(Dendroctonus barberi)*; gray area west of dotted line indicates distribution of the western pine beetle *(D. brevicomis)*. Adapted from Homicz et al. (2022).

during the spring and summer when the life cycle (from egg to adult) takes about 50 to 60 days. During spring and summer, eggs hatch in 7 to 10 days. Larvae develop over 3 to 4 weeks, first in the phloem (the nutrient-transporting tissue located beneath the outer bark) and then within the outer bark. Mature larvae form a chamber in the outer bark in which to pupate. Pupation lasts about 1 week. Adult galleries are transversely winding (fig. 3). Newly molted (teneral) adults remain in the host tree for a few days, eventually boring individual emergence holes through the bark and flying in search of new hosts. Southwestern pine beetles overwinter in the host tree as larvae and pupae, during which time the life cycle extends to about 8 months.

Figure 3—Galleries of southwestern pine beetles on the bole of a ponderosa pine following bark removal. Photo by Christopher J. Fettig, USDA Forest Service.

Infestations begin when females are attracted to the host tree, likely by host odors and the tree's silhouette. As females bore through the tree's outer bark to the phloem, they release an aggregation pheromone, *endo*-brevicomin, which is augmented by an increased release of monoterpenes from the tree (due to the beetles boring into and wounding the tree). Males are attracted to the tree by the release of *endo*-brevicomin and monoterpenes. As the male enters the female's tunnel, he emits an aggregation pheromone, frontalin. This combination of host-released, female-released, and male-released semiochemicals (chemicals emitted by one organism that affect the behavior of another organism) attracts additional male and female southwestern pine beetles to the tree, helping to ensure the tree's defenses (pitch production, among others) are overwhelmed. Once males and females mate, they emit verbenone and *trans*-verbenol, anti-aggregation pheromones that elicit avoidance behaviors in the receiving beetles.

Attacks by southwestern pine beetles are most easily recognized by the presence of pitch tubes—masses of resin mixed with boring dust—that form around the beetles' entry holes on the outer bark surface (fig. 4). Pitch tubes are produced as a defensive response by the tree when female beetles bore into the tree. They measure about ¼ to ½ inch (6 to 12 mm) in diameter and range in color from creamy white to brownish red. Occasionally, only boring dust will be present on the outer bark, which occurs when a pine's ability to exude

Figure 4—Early attacks by southwestern pine beetles are most easily recognized by the presence of pitch tubes (noted by yellow circle)—masses of resin mixed with boring dust—that form around the beetle's entry hole. Photo by Demian F. Gomez, Texas A&M Forest Service.

resin is highly impaired. The presence of predominately creamy-white pitch tubes and the absence of boring dust suggest initial attacks were unsuccessful and that the tree will survive.

Following a mass attack—when sufficient numbers of beetles overwhelm a tree's defenses and kill the tree—the tree's foliage begins to change color within weeks to months. The needles first fade to a light yellow green, then progress to red or reddish brown before eventually dropping to the forest floor. The time it takes for needles to fade and fall from the tree's crown varies based on factors such as the timing (season) of attack, the tree's overall health, and environmental conditions. This process is accelerated during hot, dry weather. Trees die following mass attacks due to girdling of the phloem by larvae and adults and blockage of the xylem by beetle-vectored fungi.

Identification

Southwestern pine beetles are 2.5 to 4.7 mm long and dark brown to black (fig. 1a, b). The head varies slightly in size with a densely pubescent frons (fig. 1d, e). Elytra (wing covers) are 1.74 to 3.0 mm long, about 1.6 times longer than wide, with a convex declivity (fig. 1f). The setae (hairs) along the middle of the elytral declivity are very short (about the same length as distance between them or less) and typically highly uniform in length (fig. 1f, h).

Taxonomic History

The southwestern pine beetle and the closely related western pine beetle (*D. brevicomis* LeConte) were synonymous (considered the same species) from 1963 to 2019 but were recently separated through a combination of evidence from morphological, genetic, and chemical ecology studies. Currently, southwestern pine beetle is considered geographically isolated from western pine beetle by the Great Basin, Mojave, and Sonoran Deserts (fig. 2). Therefore, all publications on western pine beetle populations between 1963 and 2019 from east of the Great Basin are assumed to pertain to southwestern pine beetle.

Factors Affecting Outbreaks

All bark beetle outbreaks fundamentally require two components: (1) an abundance of susceptible host trees, and (2) weather conditions favorable to beetle development. Several biotic and abiotic factors affect population growth and incite outbreaks. High densities of suitable hosts (ponderosa pines at least 8 inches (20.3 cm) DBH) positively affect southwestern pine beetle populations by increasing host availability and reducing host resistance through increased competition among hosts. High tree densities also reduce airflow and the vertical movement of air within a stand, increasing the concentration of aggregation pheromone plumes that facilitate mass attacks.

Associated Bark Beetles

Ponderosa pines that are top-killed by engraver beetles (*Ips* spp.) are more susceptible to colonization by southwestern pine beetle. These weakened trees provide viable host material for populations of southwestern pine beetle to grow, potentially breaching the threshold from endemic to outbreak levels. As such, factors that influence engraver beetle populations indirectly affect southwestern pine beetle populations. For instance, engraver beetles readily colonize slash (fine to coarse woody debris generated by logging activities, wind, snow, or other disturbances), which acts as a population reservoir. When slash is no longer suitable for colonization, engraver beetles often transition to colonizing the tops of live trees.

Mountain pine beetles (*D. ponderosae* Hopkins) and roundheaded pine beetles (*D. adjunctus* Blandford) are also common associates of southwestern pine beetles. Population growth of these species may result in increased competition with southwestern pine beetles and under some circumstances can negatively affect populations of southwestern pine beetle.

Predators and Parasites

Southwestern pine beetles are prey for several predators and parasites. Woodpeckers are important predators that peck off the outer bark of infested trees to feed on larvae, pupae, and adults. *Temnoscheila virescens* Mann. is an important insect predator. A parasitoid wasp, *Roptrocerus xylophagorum* (Ratz.), and nematode, *Contortylenchus brevicomi* (Massey), are noted parasites.

Drought, Warming, and Wildfire

Drought is likely the most important factor inciting outbreaks of southwestern pine beetle. Water stress inhibits tree defenses, which reduces the number of southwestern pine beetles required to successfully mass attack a tree and reproduce. The climate of the Southwest is projected to get drier and hotter, resulting in increased levels of host tree stress and the susceptibility of ponderosa pine to colonization by southwestern pine beetles. Wildfire activity is also projected to increase. Fire-damaged ponderosa pines are often colonized by southwestern pine beetles and associated bark beetles. Moderately injured trees are most susceptible. Increased incidences of fire-damaged trees will likely positively affect southwestern pine beetle populations in these areas.

Management Options

There are two strategies for managing bark beetles: direct control and indirect control. Direct control is designed to treat current infestations by manipulating beetle populations with chemicals (semiochemicals and insecticides) and sanitation (removal or treatment of infested trees). Indirect control is designed to decrease the probability and severity of future infestations by reducing tree densities, increasing host tree vigor, and encouraging variability in tree species composition and forest structure. Limited literature is available on strategies for managing southwestern pine beetle. Given similarities in the ecologies of southwestern pine beetle and western pine beetle, strategies for managing western pine beetle—which have been the target of extensive research in California and Oregon dating to the early 1900s—may have applicability to southwestern pine beetle. However, consult a professional before extrapolating management strategies for western pine beetle to southwestern pine beetle.

Semiochemicals (Attractants and Repellants)

Commercial lures and baits are available for southwestern pine beetle. Lures consist of the female aggregation pheromone (*endo*-brevicomin), the male aggregation pheromone (frontalin), and α-pinene, a host volatile emitted by ponderosa pine. Lures are used in trapping for a variety of purposes, including survey and detection and monitoring of diurnal and seasonal flight. Baits are used for inducing colonization of individual ponderosa pines and typically exclude α-pinene, which is naturally emitted by the host. Baits can be used for a variety of purposes, including inducing aggregation and attacks on trees to test the efficacy of repellants and insecticides.

Anti-aggregation pheromones and other repellants (nonhost volatiles) may be useful to protect individual ponderosa pines or groups of ponderosa pines. Expanding on research on western pine beetles in California, Idaho, Oregon, and British Columbia, Canada, ongoing efforts in west Texas have demonstrated that verbenone (a female and male anti-aggregation pheromone) in combination with nonhost volatiles (Verbenone Plus) is an effective repellant for southwestern pine beetles (fig. 5). Verbenone Plus is being evaluated for protecting ponderosa pines from southwestern pine beetles (fig. 6) but is not currently registered for operational use.

Insecticides

While very limited research has focused on the southwestern pine beetle, several insecticides are registered to protect pines from bark beetles. These include contact insecticides sprayed directly on the tree bole (bole sprays) and systemic insecticides injected directly into the tree (bole injections). In each case, insecticide treatments are applied in advance of the tree being colonized by bark beetles. Sprays of bifenthrin, carbaryl, and permethrin (active ingredients) are most common. Recent advances in tree injection, especially with formulations of

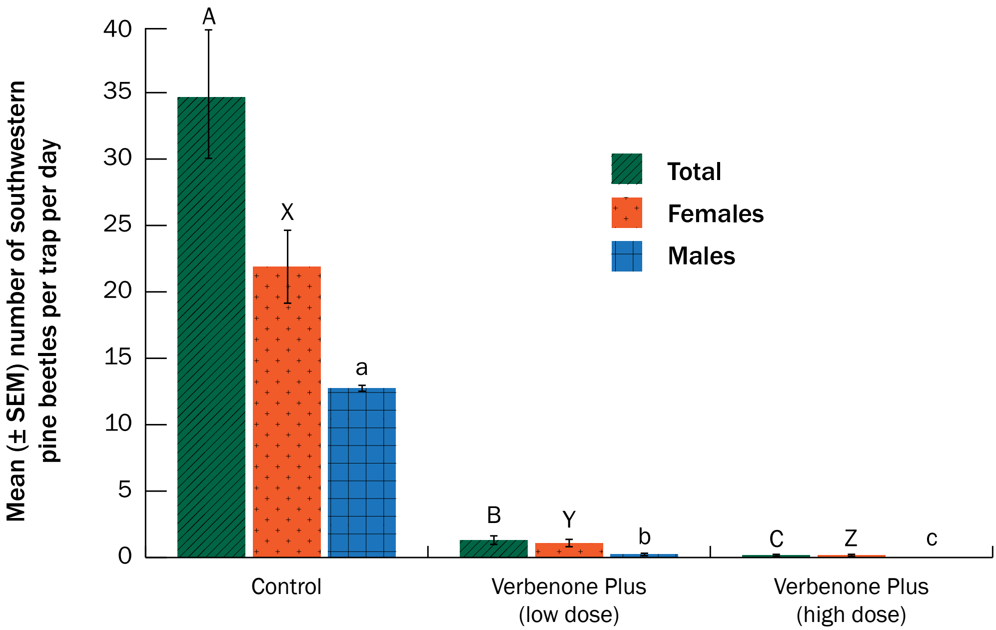

Figure 5—Demonstration of the repellent effect of Verbenone Plus against southwestern pine beetles in west Texas, 2024. Verbenone Plus consisted of SPLAT® Verb (ISCA Inc., Riverside, CA) applied at 35 grams (low dose) or 70 grams (high dose) per trap in combination with pouches of acetophenone and green leaf volatiles [(*E*)-2-hexen-1-ol and (*Z*)-2-hexen-1-ol]. All traps were baited with a southwestern pine beetle lure. Treatment means (± SEM) followed by different letters for total (green bars), females (orange bars), and males (blue bars) are significantly different (i.e., the probability of obtaining the difference by chance is very small).

emamectin benzoate (active ingredient), offer an alternative to bole sprays. Residual activity varies with active ingredient, abiotic factors, and other factors, but generally one to three field seasons of protection are provided with a single application. Lists of insecticide products registered for protecting pines from bark beetles can be obtained online from State regulatory agencies.

Sanitation

Sanitation treatments that remove or destroy (e.g., by removing or damaging the bark) infested trees may be effective for limiting levels of tree mortality at small spatial scales (e.g., several acres) if most of the infested trees are sanitized. The intent is to reduce localized populations of beetles. It is important to remove or destroy infested trees before beetles emerge from these trees and fly in search of new hosts.

Thinning

Thinning reduces the risk of infestation by southwestern pine beetles as thinned trees are more vigorous and resistant to colonization. Practices that reduce average stand density to <80 ft^2 of basal area per acre (18.4 m^2 per hectare) will be most effective, but data are limited for the southwestern pine beetle, and thinning guidelines specific to southwestern pine beetles do not exist. Prescribed fire may also be used to reduce stand

Figure 6—Verbenone Plus (indicated by yellow circles on tree in foreground) applied to evaluate efficacy for protecting ponderosa pines from southwestern pine beetles in west Texas, 2024. Photo by Demian F. Gomez, Texas A&M Forest Service.

density, however, shortly after prescribed fire, surviving ponderosa pines may be weakened and more susceptible to colonization by southwestern pine beetles and other bark beetles. Recent research in ponderosa pine forests indicates that maintaining low stand densities to increase resistance to bark beetle infestations may be more important in contemporary forests—compared to historic forests—due to increases in tree stress associated with warmer, drier conditions.

Assistance

Forest landowners can obtain more information on the southwestern pine beetle from university cooperative extension offices, county agricultural commissioner's offices, State natural resource agencies, and the U.S. Department of Agriculture (USDA), Forest Service, Forest Health Protection program (https://www.fs.usda.gov/science-technology/forest-health-protection). This publication and other Forest Insect and Disease Leaflets are available online (https://www.fs.usda.gov/science-technology/forest-health-protection/publications-reports/forest-insect-disease-leaflets).

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Author Credits

Demian F. Gomez, Regional Forest Health Coordinator, Texas A&M Forest Service, Austin, TX.

Jackson P. Audley, Assistant Project Scientist, University of California, Davis, CA.

Christopher J. Fettig, Research Entomologist, USDA Forest Service, Vallejo, CA.

References

DeGomez, T.; Fettig, C.J.; McMillin, J.D.; Anhold, J.A.; Hayes, C.J. 2008. Managing slash to minimize colonization of residual leave trees by *Ips* and other bark beetle species following thinning in southwestern ponderosa pine. AZ1448. Tucson, AZ: University of Arizona, College of Agriculture and Life Sciences. 12 p.

Fettig, C.J.; Egan, J.M.; Delb, H.; Hilszczański, J.; Kautz, M.; Munson, A.S.; Nowak, J.T.; Negrón, J.F. 2021. Management strategies to reduce bark beetle impacts in North America and Europe under altered forest and climatic conditions. In: Gandhi, K.; Hofstetter, R.W., eds. Bark beetle management, ecology, and climate change. New York: Elsevier Publishing: 345–394. https://doi.org/10.1016/B978-0-12-822145-7.00006-4.

Fettig, C.J.; Grosman, D.M.; Munson, A.S.; Moan, J.E. 2025. Protecting conifers from bark beetles with insecticides in the western United States. Journal of Entomological Science. 60(2): 157–185. https://doi.org/10.18474/JES24-31.

Fettig, C.J.; McKelvey, S.R.; Dabney, C.P.; Huber, D.P.W.; Lait, C.G.; Fowler, D.L.; Borden, J.H. 2012. Efficacy of “Verbenone Plus” for protecting ponderosa pine trees and stands from *Dendroctonus brevicomis* (Coleoptera: Curculionidae) attack in British Columbia and California. Journal of Economic Entomology. 105(5): 1668–1680. https://doi.org/10.1603/EC12184.

Gaylord, M.L.; Hofstetter, R.W.; Wagner, M.R. 2010. Impacts of silvicultural thinning treatments on beetle trap captures and tree attacks during low bark beetle populations in ponderosa pine forests of northern Arizona. Journal of Economic Entomology. 103(5): 1693–1703. https://doi.org/10.1603/EC10082.

Hansen, E.M.; Bentz, B.J.; Vandygriff, J.C.; Garza, C. 2023. Factors associated with bark beetle infestations of Colorado Plateau ponderosa pine using repeatedly-measured field plots. Forest Ecology and Management. 545: 121307. https://doi.org/10.1016/j.foreco.2023.121307.

Hofstetter, R.W.; Chen, Z.; Gaylord, M.L.; McMillin, J.D.; Wagner, M.R. 2008. Synergistic effects of α-pinene and *exo*-brevicomin on pine bark beetles and associated insects in Arizona. Journal of Applied Entomology. 132(5): 387–397. https://doi.org/10.1111/j.1439-0418.2007.01263.x.

Homicz, C.S.; Fettig, C.J.; Munson, A.S.; Cluck, D.R. 2022. Western pine beetle, forest insect and disease leaflet 1. FS-1192. Washington, DC: U.S. Department of Agriculture, Forest Service. 15 p.

Kolb, T.E.; Fettig, C.J.; Ayres, M.P.; Bentz, B.J.; Hicke, J.A.; Mathiasen, R.; Stewart, J.E.; Weed, A.S. 2016. Observed and anticipated impacts of drought on forest insects and diseases in the United States. Forest Ecology and Management. 380: 321–334. https://doi.org/10.1016/j.foreco.2016.04.051.

Kolb, T.; Keefover-Ring, K.; Burr, S.J.; Hofstetter, R.; Gaylord, M.; Raffa, K.F. 2019. Drought-mediated changes in tree physiological processes weaken tree defenses to bark beetle attack. Journal of Chemical Ecology. 45: 888–900. https://doi.org/10.1007/s10886-019-01105-0.

Massey, C.L. 1961. Biology of the southwestern pine beetle, *Dendroctonus barberi.* Annals of the Entomological Society of America. 54(3): 354–359. https://doi.org/10.1093/aesa/54.3.354.

McHugh, C.W.; Kolb, T.E.; Wilson, J.L. 2003. Bark beetle attacks on ponderosa pine following fire in northern Arizona. Environmental Entomology. 32(3): 510–522. https://doi.org/10.1603/0046-225X-32.3.510.

Negrón, J.F.; McMillin, J.D.; Anhold, J.A.; Coulson, D. 2009. Bark beetle-caused mortality in a drought-affected ponderosa pine landscape in Arizona, USA. Forest Ecology and Management. 257(4): 1353–1362. https://doi.org/10.1016/j.foreco.2008.12.002.

Sullivan, B.T.; Grady, A.M.; Hofstetter, R.W.; Pureswaran, D.S.; Brownie, C.; Cluck, D.R.; Coleman, T.W. [et al]. 2021. Evidence for semiochemical divergence between sibling bark beetle species: *Dendroctonus brevicomis* and *Dendroctonus barberi.* Journal of Chemical Ecology. 47: 10–27. https://doi.org/10.1007/s10886-020-01233-y.

Valerio-Mendoza, O.; Armendáriz-Toledano, F.; Cuéllar-Rodríguez, G.; Negrón, J.F.; Zúñiga, G. 2017. The current status of the distribution range of the western pine beetle, *Dendroctonus brevicomis* (Curculionidae: Scolytinae) in northern Mexico. Journal of Insect Science. 17(5): 92. https://doi.org/10.1093/jisesa/iex070.

Valerio-Mendoza, O.; García-Román, J.; Becerril, M.; Armendáriz-Toledano, F.; Cuéllar-Rodríguez, G.; Negrón, J.F.; Sullivan, B.T.; Zúñiga, G. 2019. Cryptic species discrimination in western pine beetle, *Dendroctonus brevicomis* LeConte (Curculionidae: Scolytinae), based on morphological characters and geometric morphometrics. Insects. 10(11): 377. https://doi.org/10.3390/insects10110377.

Vega, F.E.; Hofstetter, R.W. 2015. Bark beetles: Biology and ecology of native and invasive species. London: Academic Press. 620 p.

Wallin, K.F.; Kolb, T.E.; Skov, K.R.; Wagner, M. 2008. Forest management treatments, tree resistance, and bark beetle resource utilization in ponderosa pine forests of northern Arizona. Forest Ecology and Management. 255(8–9): 3263–3269. https://doi.org/10.1016/j.foreco.2008.01.075.

Pesticide Precautionary Statement

This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

Caution: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.

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