

## Reading the Lines Under Bark

If you have ever pulled the loose bark off of a stump, log, or dead tree in the forest, you probably noticed a rich community of organisms living there. If the tree had recently died or been cut, you may have even seen some of the early-colonizing creatures living within the bark. However, as time goes by and the tree begins to decay, a new community takes over from the primary attackers. To determine the identity of the bark's early inhabitants, you'll need to do some detective work. The tree invaders leave behind ample evidence of their activities. These clues and an understanding of the biology and habits of bark-dwelling insects can help solve the mystery.

### Importance and Natural Role of Bark Beetles

The most common insects in the dark world under tree bark are bark beetles. These insects belong to the family Scolytidae. The most destructive members of the Scolytidae can kill trees, but most bark beetles live and reproduce in weakened or dead trees. In the United States, tree-killing bark beetles are responsible for 60% of all tree deaths. In fact, insects kill more trees than fire, disease, wind, flooding, and drought combined. Bark beetles play a very important role in the natural succession of the forest landscape because they kill old, injured, or stressed trees. The resulting dead trees provide habitat for cavity nesting birds and other wildlife. Later the dead trees break down and thereby rejuvenate the forests by returning nutrients to the site and creating space for new healthy trees to grow.

There are more than 6,000 species of bark beetles worldwide. Most of the well-known bark beetles feed and reproduce in a single species of tree, or in closely related trees within a single genus. If you can determine the species of a dead tree (by examining the bark, wood, branches, foliage, and the surrounding forest community), you can narrow down the list of bark beetle suspects.

### Bark Beetle Life History and Gallery Production

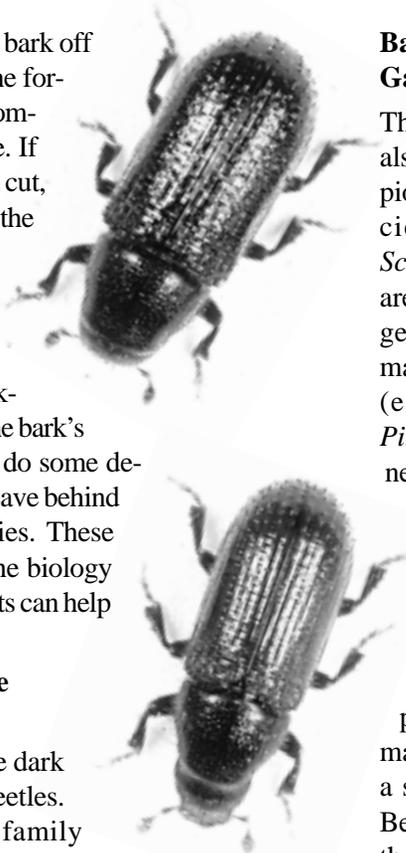
The first bark beetle individuals that attack a tree are called pioneer beetles. For some species (e.g., *Dendroctonus*, *Scolytus*, *Tomicus*), the females are the pioneers; each female is generally joined by only one male (Fig. 1). For other species (e.g., *Dryocoetes*, *Ips*, *Pityogenes*), the male is the pioneer sex. In these species, each male is usually joined by two to five females (Fig. 2).

Once a pioneer beetle has found a suitable host, it bores in and begins to release chemical attractants (i.e., pheromones) that attract both males and females. Each pioneer beetle enters the tree through a small, round entrance hole that it bores through the bark. Because the diameter of the entrance hole is about the same as the width of the beetle, the insects may use their bodies to block the entrance, permitting entry to mates but restricting access to parasites, predators, and competitors.

Once inside the tree, mating occurs in a mating or nuptial chamber (Figs. 1a, 2a), and the females chew through the inner bark making long tunnels called "galleries." Females construct their egg galleries (Figs. 1b, 2b) in the inner bark tissue of the tree. The inner bark, or phloem, is a thin layer of soft and nutritious tissue that is sandwiched between the outer bark and the hard sapwood. There are many types of bark beetle galleries that are often so characteristic of a species that it is possible to identify the bark beetle genus or species without seeing the beetles themselves.

### Bark Beetle Gallery Patterns

Some features of bark beetle galleries that aid in identification are the position of the galleries on the host tree; the number of egg galleries per gallery system; the orientation, shape, and size of the egg galleries; the type of egg niches; and the size and shape of larval feeding tunnels and pupal chambers.



Some bark beetle species prefer to attack the lower trunk of their host trees while others attack smaller diameter sections of the upper trunk or in the branches. On felled or fallen trees, some bark beetles attack the shaded underside of the tree while others prefer the exposed upper surface of the bark. For monogamous species (1 male + 1 female), each gallery system consists of a single tunnel that generally appears as a relatively straight line (Fig. 1). For polygamous species (1 male + 2 or more females), the gallery system consists of a central mating or nuptial chamber constructed by the male with 2 or more egg galleries radiating from it. Each of these egg galleries is constructed by an individual female (Fig. 2). Egg galleries are generally oriented longitudinally (i.e., with the grain of the tree) (Fig. 2); however, some species bore across the wood grain (Fig. 1). Egg galleries are as wide as the width of the female beetles that make them.

Fig. 1  
*Scolytus* gallery

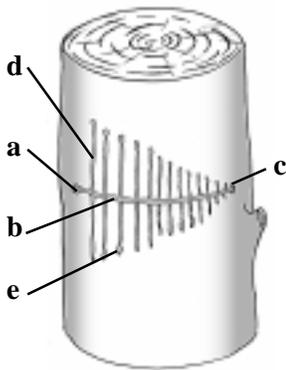
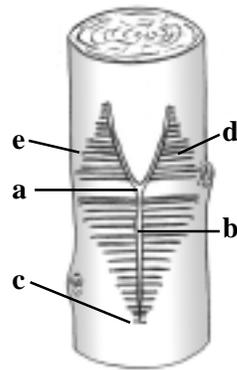


Fig. 2  
*Ips* gallery



After mating, females begin excavating egg galleries. In most species, the females cut tiny egg niches (Figs. 1c, 2c) along the sides of the egg galleries as they proceed. The eggs are placed individually in the specially prepared niches that the parent female constructs by chewing. After laying a single egg in each niche, the female covers the egg with a mixture of boring dust and adhesive secretions. Eggs are laid sequentially along the length of the egg gallery with the first eggs laid being those nearest the nuptial chamber. Egg niches are usually placed on both sides of the egg gallery. However, if the female detects a nearby neighbor, she'll often construct egg niches on only the side furthest from her neighbor (Fig. 2). The eggs usually require an incubation period of one or more weeks before the larvae hatch. Since the larvae hatch from eggs in the order in which they were laid, the oldest larvae in each gallery are those from eggs laid nearest the nuptial chamber.

After hatching, the larvae generally mine individual larval feeding galleries (Figs. 1d, 2d) that at first tend to be perpendicular to the egg gallery. Initially, the larval galleries are very tiny; they are only as wide as the tiny legless grubs that hatch from the eggs. The spacing of the larval galleries is determined initially by the spacing of egg niches, but feeding tunnels elongate and fan out as the larvae mine. The larval galleries get wider

as the larvae molt and grow. The longest and widest larval galleries are usually those that originated closest to the nuptial chamber. Larvae usually try to avoid each other as they tunnel, but sometimes they intersect, especially if populations are high. After completing larval development, each larva excavates a small pupation chamber (Figs. 1e, 2e) at the end of its feeding gallery. The first larvae to reach the pupal stage usually are from eggs laid closest to the nuptial chamber. The larvae of some bark beetle species construct their pupal chambers in the inner bark while others pupate in the outer bark. After pupation, new adults of some species emerge immediately through the bark while others remain under the bark for several days before they emerge. During this period of "maturation feeding," the new adults become sexually mature.

### Examining Bark Beetle Galleries

Examining bark beetle galleries is easy. You can look for galleries on logs, stumps, or branches in any forest, park, or your own backyard. If bark is remaining, examine the bark for small circular holes on the bark surface. Depending on the stage of attack, these holes could be entrance or exit holes. If the tree is still under attack, look for piles of boring dust (or frass) coming out of some of the holes. To see the galleries, you will have to carefully cut away the outer bark with an axe, pocket knife, or similar object. As you cut through the bark, pry up the bark and examine the phloem and galleries underneath. If the log is fresh enough, you will see the bark beetles themselves!

To follow the construction of a bark beetle gallery system, you can set out some fresh logs as "traps." In early spring or summer, cut a fresh tree or a branch into logs about 50 cm (20 in.) long and place them in a forest, a woodlot, or a shady area with trees nearby. You may have to get permission from a woodlot owner to cut down a tree. Good tree species to start with are pine, spruce, hickory, and ash. Every few weeks, go back and examine your trap logs. First look for entrance holes and boring dust. You may even see some adult beetles tunneling into the log. Debark a log, or part of a log every few weeks and you will be able to follow the development of the bark beetles and their galleries over time. Besides bark beetles, you may find other bark and wood-boring insects such as predatory and parasitic insects and even mites and nematodes.

As you read the lines under the bark, a story unfolds about the life of the fascinating creatures that make their home there. The more you explore, the more the mystery unravels, revealing the identities of the species, their habits, and interactions. Solving the mystery will help us understand insects better and help us better appreciate and manage the forest environment.

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