



The Formosan Subterranean Termite in Hawaii

The Formosan subterranean termite is one of the most economically significant pests in Hawaii. Preventing or repairing the damage it causes to wooden structures is estimated to cost over \$100 million each year. This immigrant insect probably arrived in Hawaii as a result of trade activity and has been on Oahu for over 100 years. From Oahu, it gradually spread to all of the major islands: Hawaii in 1925, Kauai in 1929, Lanai in 1932, Maui in 1933, and Molokai in 1975.

The pest moves from island to island in shipments of infested wood. Likely objects of transport include wooden skips (palettes), poles, wood recycled from old structures, and wooden packing crates. It has spread throughout most of Oahu and Kauai. Elsewhere in the state, it occurs near the seaports. On Hawaii it is found in Hilo, Honokaa, Kamuela, Kawaihae, Waikoloa along Highway 19, and Kona. On Maui it occurs in Kahului and Wailuku, and there are isolated infestations in Maalaea, Kihei, and Lahaina. It is found on Molokai in Kaunakakai and Kalaupapa and on Lanai at the Kaunapau Harbor.

Formosan subterranean termites are also called "ground termites" in Hawaii, because they live prima-

rily underground. They move up into structures and trees to feed, and they develop wings and fly around (swarm) to breed.

The Formosan subterranean termite's destructive power is great because its attack is both aggressive and secretive. There is often little or no external evidence of its presence until the damage is severe enough to cause sagging floors, a leaking roof, or warped walls. The first signs of infestation may be springy floors or steps, hollow-sounding beams, discolored or blistered paint, depressions or slits in wood surfaces, or moist areas of wood.

Much damage can be done in a relatively short time because the termites are usually present in large numbers. Their underground colonies have over two million individuals on average, and large ones exceed 10 million. Unprotected homes built over large existing colonies have been almost completely destroyed in two years.

The best defense is to prevent infestation, and if this is not possible, to detect infestations early. Both prevention and detection require detailed knowledge of the biology and habits of the termite. This publication is intended to help homeowners learn about the Formosan subterranean termite and be aware of signs of its presence. Numerous commercial termite inspection and control services are available in Hawaii, and homeowners are advised to seek professional advice if they believe they have a termite problem.

Swarming

The Formosan subterranean termite takes wing in large swarms during May and June, but small swarms can occur at any time of year. Swarming is the primary natural way this termite spreads after it has been transported to a new area. Spread by swarming is gradual, however, because the termite is a poor flier and cannot fly more than ¼ mile. Also, the swarmers are attracted to the closest light source which, when nearby, distracts them from ranging further.

Termite history

Known to entomologists as *Coptotermes formosanus* Shiraki, the Formosan subterranean termite was first officially recorded in Honolulu in 1913. An old newspaper article, however, indicates that it was present as early as 1869. The article described damage attributed to "white ants," but the description makes it obvious that the damage was caused by subterranean termites. This immigrant pest apparently was introduced from Formosa or South China during the period of extensive trade in sandalwood between the Kingdom of Hawaii and China. The initial infestations on Maui and Lanai in the 1930s were eradicated, but the termite was reintroduced to those islands sometime around 1950.

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A swarmer's life. Winged adult termite swarmer (left) emerge from "flight slits" made in the wood in which the colony is feeding (center). After flying around, they lose their wings and pair off in tandem (right), the first step in establishing a new colony. Later, the flight slits will be sealed with "carton material" to restore the gallery environment conditions that the workers prefer. The covered slits in boards and beams (center) are a clue to the presence of Formosan subterranean termites in a structure.

Swarmer (above, left) emerge just after sundown on warm, humid, nearly windless evenings. The primary environmental factor that determines whether the termites swarm is the wind speed at the locations from which they emerge to fly (above, center). If the wind exceeds 2 mph, swarming will not occur. If swarming starts and the wind increases to 2 mph or more, swarming stops. When conditions are right and large colonies are present, clouds of many thousands of winged termites can be seen around street lights and house lights.

On average, swarming lasts about 30 minutes. After a short flight, the termites land on the ground and drop their wings. The wings break off close to the termite's body when it folds them up and forward. It is only the adults that swarm, and not all of the swarmer in a colony will swarm on the same night.

Conditions for colony formation

After swarming, landing, and shedding their wings, the adults pair off and move about in tandem, with the male following the female (photo above, right), searching for a place to live. Fortunately, very few of these pairs survive to start new colonies. Most are soon eaten by geckos, spiders, chameleons, toads, ants, or other predators. Those that escape being eaten still have to find the right conditions to survive. The appropriate niche must include food, moisture, and shelter.

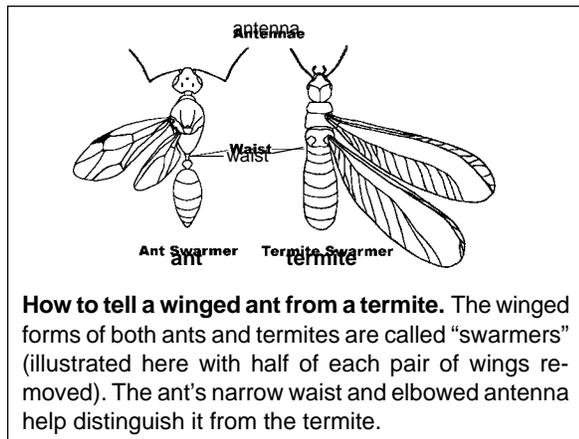
Food. The termite's food is cellulose, the building material of plant cell walls. Termites can live on any plant material, including paper, cane, fruits, nuts, cork, and living plants, but their primary food is wood. Although cellulose is their food, termites actually lack the ability to digest cellulose themselves. Protozoa living in the termite's gut provide the enzymes to break down cellulose to metabolites the termite can absorb and use.

Moisture. Unlike drywood termites, which obtain water from the digestion of wood, subterranean termites must have an external source of moisture. This need for moisture can be fulfilled by high humidity—free water is not necessary. They usually use the moisture naturally held in the soil around their underground colonies. They are very sensitive to desiccation (drying), and they build tunnel-like extensions of their humid underground environment when they forage for food above ground. Subterranean termites occasionally form aboveground ("aerial") colonies when their aboveground habitat provides a source of water—an aerial colony supported by water from a leaky roof is a common example of this. Other man-made moisture sources include leaking plumbing, condensation from air conditioners or pipes, water collected on poorly designed decks and roofs, and irrigation systems. Although they can survive on very small amounts of moisture, the need for *some* moisture is critical, which is one reason that they swarm only when the weather is windless and humid.

Shelter. The termite pairs are particular about finding an appropriate physical niche. They cannot start on bare, smooth surfaces but need a hole, crack, joint, or similar crevice that they can enter and seal to form a mating chamber.

Starting a new colony

If food, moisture, and an appropriate niche are found, the pair can mate within their sealed chamber. About five days after mating, the female (queen) lays a batch of 15–25 eggs; these hatch in 21–30 days. The newly hatched young need semiliquid food because their jaws are not yet hardened, so the parents feed them predigested food. This also serves to pass on the symbiotic protozoa they will need to digest their own food. The



young remain in the nursery until they go through two molts. Then they become functional workers in the colony and can leave the nursery to forage, continue to molt, and grow.

The queen then lays another batch of eggs. The second group and all subsequent offspring are first fed by the workers in the colony, rather than the parents. This process continues until a major colony, made up of two million or more termites, is produced. This will take at least seven years.

The "royal pair" may live 20 years or more, but they are seldom seen unless the colony is disturbed. Both of them become large and rather gross. The mature queen is about 1 inch long and ¼ inch in diameter and weighs more than 100 times her original weight, with most of the growth in her abdomen, due to the expansion of her ovaries. She can now lay about 2000 eggs each day. Her legs can no longer carry her, so she lives in a special "queen's chamber" and is fed, groomed, and moved about by the workers. The king also becomes enlarged, although not as much as the queen, to produce the sperm needed to fertilize the large number of eggs laid by the queen.



Queen

Specialization within the colony

Termites of different castes are produced from immature workers. Caste determination is based on pheromone level, which is controlled by the queen. At certain pheromone concentrations, either workers, soldiers, or winged adults are formed. When and how many mem-



Soldier

Worker

bers of the various castes are produced is based on the need for a particular caste in the colony.

Workers

As the colony grows, specialized castes are produced for the different tasks required. The first caste produced is the workers, which are small, white, blind, and quick-moving. The great majority of the individuals in a colony are workers, who maintain the colony. They forage for food, take care of the eggs, maintain the nursery, feed the king, queen, soldiers, and young, build tunnels and carton nests, open and close the flight slits for swarming, and bury or cannibalize abnormal or injured colony members. Workers are very susceptible to drying, so they always work within tunnels and galleries. They can live for four years or more, and they are the ones that do the damage caused by termite colonies.

Soldiers

The second caste produced is the soldiers, who defend the colony against enemies. They have hard, brown heads with jaws that look like pincers. These jaws are strictly for fighting and are so specialized that they cannot be used to chew food, so the soldiers must be fed by the workers.

Whenever there is a break in a tunnel, an alarm signal causes the soldiers to congregate around the break and bite any invader that tries to enter. When they bite, a white, sticky liquid is ejected through a pore at the top of their heads, which hinders the movement of enemies. The soldiers guard the exposed area until the workers repair the break. During swarming, soldiers guard areas around open flight slits.

Reproductives

The third caste to appear is the reproductives, of which there are two types. Primary reproductives, also called alates or swarmers, swarm and start new colonies. They are brown and have wings (see photo on p. 2, left) and functional eyes. The skin of the primary is thick, enabling it to survive for many days in dry environments outside the colony. Thousands of primary reproductives are produced each year, and they all leave the nest during swarms. Primaries cannot become reproductive if they remain in their colony of origin. In a Formosan colony, the only primaries that reproduce are the original king and queen that started the colony.

Supplementary reproductives, on the other hand, can become reproductive only in the colonies in which they were born. Supplementaries are wingless, blind, and lighter in color than the primaries. They never leave the colony. They take over reproduction when the primary king or queen dies or becomes separated from the main colony. It takes many supplementaries to equal the productivity of a pair of primaries.

Controlling infestations

The keys to controlling Formosan subterranean termites are based on their need for a suitable physical niche to start a colony and for access to sources of food and moisture to maintain it. The goal is to make it hard for the termite to find these conditions in the first place. Once they become established, the goal is to interfere with their necessities of life.

The first step to control an established infestation of Formosan subterranean termites is to disrupt the connection between the ground colony and the termites that are feeding in the structure. Any wooden parts of the structure that touch the ground and allow the termites direct access must be found and removed. The termites' mud tubes that bridge over non-wood foundations must be located and destroyed. Sometimes these connections to the ground nest are difficult to find, as when they are through narrow cracks within foundations. It is often necessary to thoroughly treat the soil with an appropriate insecticide (termiticide) at all possible points of connection.

The second step is to prevent the termites from re-establishing the connection. This is commonly done by treating the soil around the foundations with insecticide, a process referred to as "ground treatment," which is

effective as long as the termiticide remains active and the treated soil is not disturbed.

Even when the points of access to the structure have been found and disrupted, the workers remaining in the structure can live for a long time and continue their damage. And, the termites stranded in the structure will do their best to establish a new colony. This is readily done by the supplementary reproductives if a source of moisture to support the aerial colony can be found, and it often can. The third step, therefore, is to eradicate the infestation within the structure to prevent it from forming an aerial colony. This is done by either spot-treatment with insecticide or tenting and fumigating the structure.

An alternative to chemical spot treatments and prevention treatments is termite baiting systems, which can minimize the need for applications of insecticides to the inside and outside of structures. Baiting systems can be highly effective in controlling subterranean termite infestations and termite colonies.

Preventing infestations

As with control of infestations of Formosan subterranean termites, preventing them from getting started requires a careful, concerted attack. Here are a few simple things the homeowner can do:

- When swarming starts, turn off lights.
- Attract and kill swarmers with a light source placed above a pan containing water and a few drops of dish soap.
- If there are many swarmers inside the house, look for flight slits within the structure.
- Kill any tandem pairs you find. They can be seen running around after the swarming has stopped.
- Periodically inspect within and around your home for signs of infestation.
- Keep the area immediately adjacent to your house clear of plants, so you can see the base of the foundation slab or piers. Plants in the area not only screen the tunnels but also set up ideal conditions for the termites. The plants provide the food, and you provide the moisture when you water them.
- Avoid having any wood or wooden part of the house touching the ground.
- If you live in an uninfested area, do not transport material that may harbor the termites from infested areas without being sure that it is termite-free.