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The Formosan subterranean termite — Harmon R. Johnston — read by S. R. Morris

The Formosan subterranean termite, *Coptotermes formosanus* Shiraki, is one of the most aggressive and destructive species of termites. It is native to China, Formosa, and Japan, and has been introduced into Ceylon, Hawaï and other Pacific Islands, and the continental United States.

The possibility of this destructive species of termite becoming established in the continental United States has been recognized for many years. in 1934 Kofoid (1) discussed this probability and pointed out that climatic conditions in certain areas of this country are satisfactory for the successful establishment of this species.

The first established colony of this termite in the continental United States was found in Houston, Texas in 1965. In the spring of 1966 well established, large, reproducing colonies were discovered in New Orleans and Lake Charles, Louisiana and Galveston, Texas.

Upon the discovery of this highly destructive species, the U.S. Department of Agriculture, Forest Service, recognized the threat and started limited research aimed at learning its biology and testing methods of control. Tests were established in 1966 at Lake Charles, Louisiana, to determine the effectiveness against *C. formosanus* of the soil insecticides that are used successfully against native subterranean termites. The Forest Service has made available funds to Louisiana State University under a cooperative aid agreement to study certain phases of the biology of the insect. In addition, the Forest Service has approved a grant to University to support other biological studies for a period of three years. The Forest Service plans to appreciably expand research on the biology and control of this insect as soon as funds are made available.

Biology and Habits

Details of the biology of the Formosan termite in its native habitat are incomplete and sketchy, and essentially nothing is known concerning details of its biology in the United States. Broad generalities concerning its biology and habits can be made from observations and limited research studies.

Like other species of subterranean termites, the Formosan termite depends for its survival on a food source, cellulose usually obtained from wood, and on moisture, ordinarily obtained from the ground. The primary nests are usually in the ground in posts, poles, tree stumps, or other wood in contact with the soil. In their foraging for food they make extensive underground passages or tunnels, so infested buildings may be considerable distances away from the nest.

They gain access to the woodwork of buildings through cracks or joints in concrete slabs, hollow tile foundations, or earthern shelter tubes which they construct over the surface of impervious foundations. They often build secondary nests within the walls of buildings, packing crates, hollow trees, etc. Like other species of subterranean termites

they are capable of establishing and maintaining colonies without contact with the soil provided they have a source of moisture such as leaky water pipes, etc., but they die when the source of moisture is removed.

Large colonies may contain many thousands of individuals consisting of reproductives, soldiers, and workers in all stages of development. Swarming of the winged reproductives, the primary kings and queens, occurs after sundown, usually in late May or early June depending somewhat on climate conditions. Warm, humid conditions are favourable for these flights.

If a pair of these swarming reproductives find a source of food and suitable moisture they can start a new colony. Reproduction is slow during the first year, but it increases as the egg producing capacity of the queen increases. Reportedly, a queen in large, well established colony may lay a thousand eggs per day. Under some circumstances numerous supplementary reproductives develop in established colonies and may start new colonies by branching off from their parent colony. The presence of numerous supplementary queens in a single colony probably accounts for the very large colonies of this species.

Damage

As mentioned before, the primary food of the Formosan termite is cellulose which it usually obtains from wood. If a source of food is not available in the soil it readily attacks and damages the woodwork of buildings. As it feeds on the inside of the wood and may leave only a thin outer shell, it may cause severe damage before being detected.

This termite has been recognized as a serious pest of wooden structures for many years. In 1919 Oshima (2) listed four species of termites in Formosa and Japan as known pests of wooden structures. He states, "*Coptotermes formosanus*, which is distributed in Formosa, Riu Kiu Islands, and in the southern parts of Japan Proper, is especially formidable to buildings". He mentioned the *bitter experience* during the previous twenty years as a result of the severe damage caused by this species, and he recommended an elaborate method of construction to prevent or reduce attack.

Weesner (3) states that the Formosan termite is very active and destructive and constitutes a severe economic problem in Hawaii where it was well established by 1904. Kofoid (1) states, "*Coptotermes formosanus* was introduced into Honolulu, presumably by transshipment in soil of potted plants or in wood, from an Asiatic port". It is now reported that no other insect in Hawaii causes as much damage to wooden structures as the Formosan termite, which causes an estimated annual loss of 2 to 3 million dollars in Honolulu alone.

Checks of several infested buildings in New Orleans showed extensive damage with secondary nests within the walls of the buildings. They were found investing shade trees and shrubs also. An estimated loss of $79,000 has been caused already in New Orleans.

In addition to several infested buildings at Lake Charles, the heartwood

of hundreds of dead cypress snags is heavily damaged or destroyed. This wood is somewhat resistant to native termites.

The presence of these large reproducing colonies is proof that climatic conditions in these localities are favourable for this species. Since somewhat similar climatic conditions exist in southern California, the Gulf Coast, and the South Atlantic States, this termit could probably flourish and cause extensive damage to wooden structures throughout these sections of the United States. The northern extent of the termites range in China and Japan would indicate that it would survive and cause damage along the west coast to Tacoma, Washington and on the east coast to Philadelphia, Pennsylvania. Indeed, it conceivably can become established over much of this country, when heated buildings under which it may thrive are considered. The loss caused by our native termites is variously estimated at 3 to 4 hundred million dollars annually. If the Formosan termite becomes widely distributed it may rival or even surpass native species in destructiveness.

Prevention and Control

Since the Formosan termite is a subterranean species the same principles of prevention and control are suggested for it as those used for native subterranean termites.

Construction which discourages attack and the treatment of soil around or under the foundation of buildings are the primary means of control of subterranean termites. This is discussed fully in the U. S. Department of Agriculture Home and Garden Bulletin No. 64, "Subterranean Termites, Their Prevention and Control in Buildings".

Water emulsions containing concentrations of 1.0 percent chlordane or 0:5 percent aldrin, dieldrin, or heptachlor correctly applied to the soil around foundations or under buildings give many years of protection against native species of termites. The treated soil forms a barrier that the insects do not penetrate. The termites that may be trapped in a building when the soil is treated die because they cannot penetrate the treated soil to obtain essential moisture.

Tests were established at Lake Charles, Louisiana, in September 1966 in an area heavily infested with the Formosan termite to determine the effectiveness of these chemicals against this termite. In one series of tests, water emulsions containing 1/32 and 1/2 percent dieldrin and 1/32 and 1 percent chlordane were applied at the rate of 4 gallons per 10 cubic feet of soil. Each concentration was applied in sand in the area and in topsoil typical of pine forests in nearby areas. After a period of eight months attack occurred in both soil types treated with the 1/32 percent concentrations of chlordane and dieldrin. These same concentrations were effective against our native termites for over two years in tests in Mississippi. No attack occurred in eight months with treatmens of 1/2 percent dieldrin and 1 percent chlordane. Eighty percent attack occurred in the untreated controls.

Although the studies have not been in progress long enough to fully evaluate the effectiveness of these treatments, these early results indicate that (1) concentrations used for control of native species will

give some protection against the Formosan termite (eight monhts in these studies) an (2) higher concentrations of these chemicals are required to prevent penetration by the Formosan termite than by native species.

The Department of Defense has reported effective control of the Formosan termite in buildings in Hawaii and Guam by treating the soil with a water emulsion containing a concentration of 2.0 percent chlordane, which is double the concentration recommended and used successfully for prevention and control of native termites. Hence, concentrations of 2.0 percent chlordane, 1.0 percent aldrin, 1.0 percent dieldrin, and 1.0 percent heptachlor are suggested at present for control of the Formosan termite.

Reportedly in Asia, individual colonies of *C. formosanus* may be controlled by injecting a small quantity of arsenical dust such as Paris green into the tunnels. The insects pick up the dust on their bodies and carry it back to their nests. Their social habits of grooming and feeding each other and eating the dead start a chain reaction that may destroy the colony. No research has been done on this method of control in this country to confirm its value.

To aid in preventing the spread of this pest, materials that may harbor the insects should not be moved from localized infested areas unless the materials are treaetd or inspected to insure that they are free of living termites. Materials that could harbor the insects may include used lumber, untreated soil, and also wooden or cardboard packing boxes, lumber, plywood, rolls of paper, and similar products that have been in storage.

Detections

The winged form of the Formosan termite can be distinguished readily from native species. In fact, the shed wings alone can be used to differentiate between it and native termites. Since this species flies at night and is attracted to lights, its presence can be detected easiest by the use of light traps and by collections at street lights. This method of detection is useful, however, only during the swarming period, usually in May and June.
The presence of the entire insects or of only their wings entrapped in cobwebs, etc., indicates the presence of a nearby colony.

The soldier caste is easily distinguished from the soldiers of other subterranean species, but they cannot be collected without first locating the infestation. This would require the probing and inspection of buildings and all woods in contact with the ground, which is impractical over widespread areas. Encouraging commercial pest control operators and others engaged in termite control to submit specimens collected during control operations offers a good means of detecting infestations of these termites.

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