Subterranean Termites

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Scientific names of pests—Subterranean termites (Isoptera: Rhinotermitidae and Termitidae) in the genera *Schedorhinotermes* Silvestri [specifically *Schedorhinotermes intermedius intermedius* (Brauer), *S. i. actuosus* (Hill), *S. i. breinli* (Hill), *S. i. seclusus* (Hill), and *S. reticulatus* (Froggatt)], *Heterotermes* Froggatt [specifically *Heterotermes ferox* (Froggatt), and *H. paradoxus* (Froggatt)], *Coptotermes* Wasmann [specifically *Coptotermes acinaciformis* (Froggatt), *C. frenchi* Hill, *C. lacteus* (Froggatt), and *C. raffrayi* Wasmann], *Microcerotermes* Silvestri [specifically *Microcerotermes boreus* Hill, *M. distinctus* Silvestri, *M. implicadus* Hill, *M. nervosus* Hill, and *M. turneri* (Froggatt)], and *Nasutitermes* Dudley [specifically *Nasutitermes exitiosis* (Hill)]

Scientific names of hosts—Just about any hardwood or softwood could be infested.

Distribution—*Schedorhinotermes*, *Heterotermes*, *Coptotermes, Microcerotermes*, and *Nasutitermes* are all pantropical genera. Many of the individual taxa in these genera are difficult to identify. The taxonomy of several of the subterranean genera in Australia is in desperate need of revision (Gay and Calaby 1970, Watson and others 1989, Brown and others 1994). Light (1927) suggested that several factors make species determinations in termites difficult. First, termites are practically lacking in ornamentation and have few definite differences in position or number of parts that facilitate species diagnosis. Second, termite species are extremely plastic and exhibit a wide range of variation, from region to region and among colonies within the same region. Third, the characters that prove useful are differences in range of size of parts or of the entire individual or differences in size relations (that is, in the proportions of parts). Definitive species determinations of the Australian fauna will require the use of modern diagnostic techniques, such as characterization of cuticular hydrocarbons (Brown and others 1996) or cladistics (Miller 1997). Therefore, the distributions reported in the literature for a given species may, in fact, represent a combined distribution of sibling species with either sympatric, parapatric, or allopatric distributions.

In Australia *Schedorhinotermes* is represented by two species, one of which is made of up to four subspecies. *Schedorhinotermes intermedius intermedius* occurs from New South Wales into southern Queensland. *Schedorhinotermes intermedius actuosus* occurs in all of the mainland states except Victoria. *Schedorhinotermes intermedius breinli* is present in Queensland and the Northern Territory and is abundant in arid inland districts and areas of low rainfall near the coast. *Schedorhinotermes intermedius seclusus* extends from northern New South Wales to north Queensland. *Schedorhinotermes reticulatus* is widely distributed on the mainland but appears to be absent from the Northern Territory (Gay and Calaby 1970, French 1986).

Heterotermes ferox extends from southern Queensland through southeastern and southern areas of mainland Australia across to Western Australia. All four subspecies of *H. paradoxus* are distributed mainly in northern Australia (Gay and Calaby 1970, French 1986).

Coptotermes is represented by at least six species in Australia and is widely distributed throughout the mainland. With the exception of one species, the genus is largely dependent on eucalypts for food; *Coptotermes* species are found in abundance only in eucalypt communities. *Coptotermes acinaciformis* is widely distributed throughout Australia, but is absent from alpine areas of southeastern Australia and from Tasmania. It shows a wide tolerance of climatic conditions and has been collected from localities with annual rainfall ranging from as low as 20 cm (7.9 in.) up to more than 150 cm (59.1 in.). The putative subspecies *Coptotermes acinaciformis raffrayi* occurs only in southwestern Australia. *Coptotermes frenchi* extends from north Queensland to Western Australia in eucalypt communities. *Coptotermes lacteus* is very common in eastern Australia from Victoria to southern Queensland (Gay and Calaby 1970, French 1986).

Microcerotermes species are found all over mainland Australia with the exception of the southeastern portion of the continent. *Microcerotermes boreus* is confined to the northwest of Western Australia and the Northern Territory. *Microcerotermes distinctus* is widely distributed in all mainland states, more particularly in drier inland areas. *Microcerotermes implicadus* is distributed from southern Queensland through Victoria. *Microcerotermes nervosus* is common in the northern parts of Western Australia and the Northern Territory. *Microcerotermes turneri* is restricted to coastal districts from central New South Wales to north Queensland (Gay and Calaby 1970, French 1986).

Nasutitermes, which has 19 currently described species from Australia, is one of the most successful genera in Australia, and one of the few that has penetrated the cool temperate southeastern portion of the continent. *Nasutitermes exitiosus* is the best-known species of the genus. It extends from southern Queensland around the southeastern and southern regions of the continent across to Western Australia. Over most of its range, its northern limit of distribution coincides with the boundary of eucalypt communities. *Nasutitermes exitiosus* is absent from the wetter coastal country and from the colder higher parts of the southern highlands (Gay and Calaby 1970, French 1986).

Summary of natural history and biology of the pest—Subterranean termites must maintain a connection with the ground or soil, unless a supply of water is otherwise available. When free water is available or wood is saturated with water, species in these genera can maintain viable colonies or portions of colonies for extended periods and remain alive during transportation across vast stretches of land or water. They can also establish aerial colonies in buildings. To attack wood above the ground, shelter tubes composed of wood, soil, and termite excrement are constructed to connect the colony from the soil to the source of wood they are exploiting (Mampe 1990, Thorne 1998).

All species of subterranean termites are social insects and live in colonies. Some species of *Coptotermes* are found in discrete nest structures and can construct mounds. *Heterotermes* and *Schedorhinotermes*, as well as some species of *Coptotermes*, live in diffuse nests, a dispersed aggregation of subnests. These subnest units are mobile and allow the entire colony, including the reproductives, to move to areas with the most suitable environmental conditions (Thorne 1998). Generally there are five types of individuals in a colony: immatures or larvae, workers, soldiers, reproductives, and nymphs (Miller 1969). Nymphs will eventually metamorphose into adults with wings (alates) that serve to disperse and establish new colonies a significant distance from the natal colony. Colonies contain a large proportion of wingless workers whose role is the care of the immatures, feeding and foraging, and cleaning, whereas the soldiers defend the colony from predators. The workers are the individuals that damage the wood. Flights of the future reproductives (alates) generally occur during spring, summer, or fall after rain, but can occur anytime during the year in tropical environments.

Mature colonies contain several thousands to millions of individuals (Thorne 1998). Satellite colonies of the larger colonies can also be of a size that is equivalent to an immature or young colony. Workers and nymphs are capable of becoming replacement reproductives and assuming the reproductive role if their satellite colony or subunit is permanently separated from the main colony. It is primarily this capacity for establishing new colonies (by budding) from satellite colonies or subcolonies that makes subterranean termites a threat for introduction into nonendemic sites.

Coptotermes species generally occur in tropical or subtropical areas, and numerous species are known to infest buildings. *Coptotermes formosanus* Shiraki and *C. havilandi* (Sjöstedt) have most frequently been introduced to new localities (Edwards and Mill 1986). Where these species occur in exotic locations, they cause extensive damage to buildings. *Coptotermes formosanus* was first discovered in the Hawaiian Islands in 1907 (Bess 1970) and on the mainland of the United States in 1965 (Weesner 1970) but was likely established many years before both in Hawaii and on the mainland of the United States. *Coptotermes formosanus* has recently become successfully established in La Mesa near San Diego, California (Rust and others 1998), and *C. havilandi* has recently been reported to be established in Florida (Su and Scheffrahn 1997). *Coptotermes acinaciformis* and *C. frenchi* have become established in New Zealand, likely introduced from Australia in imported logs (Bain and Jenkin 1983). *Coptotermes formosanus*, *C. havilandi*, *C. acinaciformis*, and *C. frenchi* often feed on live trees and may eventually kill them or damage the root system and cause the trees to fall in heavy winds. *Coptotermes lacteus* feeds primarily on wood on the ground or wood in contact with the ground. *Schedorhinotermes, Heterotermes, Microcerotermes,* and *N. exitiosus* also feed on wood in contact with the ground but will bridge gaps with foraging tubes to reach wood above ground. For the purposes of this assessment, all species of *Heterotermes* and *Coptotermes* should be considered potentially severe pests if arriving at U.S. ports.

Specific information relating to risk elements

A. Likelihood of introduction

1. Pest with host-commodity at origin potential:
   Logs—*High* (VC) (Applicable risk criteria, from Ch. 1: a, b, c, d, e, f, g, h)
   Chips—*Low* (RC) (Applicable risk criteria, from Ch. 1: b)

   Just about any of the commercial eucalypt species could supply harborage for subterranean termites. The likelihood of association of subterranean termites with freshly cut logs is much greater in natural forests in which silvicultural practices include precommercial thinning and use of prescribed fire. Mature trees with a hollow center are often occupied by subterranean termites. During our visit to logging operations and sawmills in New South Wales, we often saw logs with evidence of live termites inside. Throughout much of the range of *Eucalyptus* harvested for wood chips one species of subterranean termite or another can be found. However, the damage done by these termites is easily detected in logs and should result in redirecting logs to a local chip mill rather than being shipped overseas as whole logs. Termite colonies or subcolonies would not survive the chipping process or the process of moving the chips from the mill to the ship or the ship to the processing plant.

2. Entry potential:
   Logs—*High* (RC) (Applicable risk criteria, from Ch. 1: a, b, c)
   Chips—*Low* (RC) (Applicable risk criteria, from Ch. 1: none)

   Viable colonies of various subterranean termite species would likely survive the 14-day journey to port cities in the United States, although they should be detectable within the moist cavity in the log or by the presence of the packed fecal material, friable carton, or an extensive gallery system. Recently cut logs and the moist fecal material would provide conditions suitable to subterranean termites during transit. The greatest risk exists if logs are shipped from Australia with subterranean species present then remain in storage at the import site, in a suitable habitat such as Hawaii or Puerto

Rico, for extended periods of time. This is how *C. acinaciformis* and *C. frenchi* became established in New Zealand. Wood chips are not likely to harbor viable groups of termites.

3. Colonization potential: *High* (RC) (Applicable risk criteria, from Ch. 1: a, b, c, d, e)

   Coptotermes acinaciformis and *C. frenchi* have become established in New Zealand, and *C. formosanus*, *C. havilandi*, and *C. vastator* Light have become established in exotic locations (Gay 1969, Su and Scheffrahn 1998a). *Nasutitermes* species have been intercepted upon introduction but not yet established (Gay 1969). Not one of the subterranean termites examined in this report is restricted by host. *Coptotermes* can infest numerous species of live trees. Even partial colonies can contain many individuals capable of differentiating into a reproductive caste. If a colony contains alates and they were to fly after arriving in the United States, incipient colonies could easily be established. Because these subterranean termites can infest numerous tree species and wood in service, the presence of an acceptable host is not the critical factor. Rather, a suitable environment with an adequate supply of wood and appropriate temperature and moisture conditions are the key factors. The initiation of a colony is a slow process, but wood in ground contact, moist wood in structures, and suitable host trees with scars or wounds at ports and storage facilities may provide an infestation site. The adults (alates) fly only about 100 m (328 ft) but are capable of moving up to 1 km (0.62 miles), depending on wind conditions and weather. Long-range [>10 km (>6.2 miles)] establishment of colonies from alates has a very low probability. Colonization potential would depend on the genus; warm, moist conditions would be conducive to *Heterotermes, Coptotermes*, and *Schedorhinotermes*, and cool, moist conditions would likely favor *N. exitiosus*.

4. Spread potential: *High* (RC) (Applicable risk criteria, from Ch. 1: b, c, d, e, f, g)

   Termites spread slowly [15 to 300 m (49 to 984 ft) per year], and less than 1% of the alates eventually establish a new colony. However, an important factor concerning subterranean termites is that infested wood (or plants in soil) moved by humans in commerce spreads termites at a much faster rate than their natural spread. Also, once established at the receiving seaport or inland destinations, subterranean termites are often not detected because of their cryptic habits; colonies can be large before the first evidence of their activities is apparent. By this time multiple colonies will already be established adjacent to the invading colony, and additional wood or plants could become infested and distributed within the continental United States or its possessions. Furthermore, exotic subterranean termites could be misdiagnosed or confused with endemic species.

B. Consequences of introduction

5. Economic damage potential: *High* (VC) (Applicable risk criteria, from Ch. 1: a, b, c, f)

   Of the 2,300 species of termites known to exist in the world, only 183 are known to cause damage to structures, and of these, 83 have a significant economic impact. Subterranean termites account for about 80% of the economically important species (Gay 1969, Su and Scheffrahn 1990), and the genus *Coptotermes* contains the largest number of economically important species (Su and Scheffrahn 1998a). Of the 183 species noted for their potential for economic damage, only 17 occur in the United States (Su and Scheffrahn 1990). Control of subterranean termites and repair of their damage in the United States results in a total economic impact of about \$6.0 billion (billion = 10^9) per year (\$1.5 to 2.0 billion for control of subterranean termites and \$4 billion for repair of damage) (Nan-Yao Su, 1999, personal communication, University of Florida, Ft. Lauderdale, Florida).

   Subterranean termites will attack untreated wood and some will attack live trees. None of these termites discussed here would do well in extremely cold climates but could be a problem in moist, warm climates along the western, southern, and southeastern coasts of the continental United States, and subtropical and tropical locations of the United States and its protectorates and possessions. They could pose a significant hazard to the numerous eucalypt trees planted as ornamentals, as windbreaks, or for fiber. Control methods for subterranean termites are available but can be expensive and could be a risk to environmental quality through increased pesticide use. The exotic *Coptotermes formosanus* Shiraki is out-of-control in New Orleans, Louisiana. In some situations it can be controlled or managed with baits, but in the French Quarter it has proven very difficult to control. Given that some of the species of *Coptotermes* in Australia occur in temperate climates, they could easily become established in the United States and perhaps confused with *C. formosanus*.

6. Environmental damage potential: *Moderate* (MC) (Applicable risk criterion from Ch. 1: d)

   These termites would not likely cause large outbreaks or kill an excessive number of trees. Trees at greatest risk would be street trees, such as the ones injured by *C. formosanus* in Honolulu and New Orleans. They could conceivably compete with native termites that degrade and decompose wood in use. In fact, where *C. formosanus* is established in Florida and New Orleans, they successfully compete with the native termite fauna.

7. Social and political considerations: *Moderate* (RC) (Applicable risk criterion from Ch. 1: a)

   These termites generally do not cause aesthetic damage in forests, although most *Coptotermes* species will consume the heartwood of live trees. However, damage to wood in use would cause significant consumer concerns, adding to concerns about other exotic termites species already established in the United States.

C. Pest risk potential:
   Logs—*High* (Likelihood of introduction = *High*; Consequences of introduction = *High*)
   Chips—*Low* (Likelihood of introduction = *Low*; Consequences of introduction = *High*)

   Termite colonies or subcolonies would not survive the chipping process.

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Reviewers' comments—"Termites are obvious organisms of concern. Australia has a rich fauna, including *Coptotermes lacteus*, a very destructive species. While not ordinarily a problem with chips, importing raw logs is a different matter. We already have introduced species of termites in North America, we do not need others." (Lattin)

Response to comments—Given the success of *Coptotermes formosanus* in the United States and the fact that *C. formosanus* is out-of-control in New Orleans, element "f" was included, which elevates the economic consequences to "*High*", but the pest risk potential for chips remains "*Low*".