Termite Damage and Detection: an American Perspective

by

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Abstract

Worldwide, there are more than 2,300 different species of termites now recognized. Much of this diversity can be lumped into four distinct ecological groups that include dampwood, drywood, subterranean, and arboreal/mound builders. Fortunately, less than 15% of this diversity poses any threat to landscapes managed by humans that include urban, agriculture, forest plantations, and wild lands. Global estimates of damage from termites are difficult to find in the published literature, but certainly are in the billions of dollars (US$) each year. However, their benefits to the world's ecosystems far exceed the damage they cause. In this paper I will review important termite pest groups by continent. I will also review methodologies and strategies currently used for termite detection and some new innovations planned for in the near future.

Key words: termites, Isoptera, detection, inspection, damage, global

Introduction

Americas. Termite diversity in North America (NA) is low, less than 50 species are currently recognized. For many hundreds of years, termite diversity in NA fell into three distinct ecological groups: dampwood, drywood, and subterranean. However, recently an arboreal species was recently introduced into Florida (Scheffrahn et al. 2002). Dampwood termites (genus *Zootermopsis*, Family Termopsidae) are very restricted in NA, confined primarily to the coniferous forests of the Pacific States and desert southwest. Drywood termites (important genera include *Incisitermes, Neotermes*, Family Kalotermitidae) occupy a narrow band from costal Northern California, through Arizona and New Mexico, including costal areas of five Gulf States, and finally costal areas for several Southeastern Atlantic States. In nature, they prefer hardwood forests and scrubs at elevations < 1,500 m. Subterranean termites (important genera include *Reticulitermes, Heterotermes*, *Amitermes*, and introduced species of *Coptotermes*, Family Rhinotermitidae) are the most diverse and widespread termites in NA. There are > 24 species and they occur from below sea level to ~ 3,000 m. These termites nest below ground and have large (tens of thousands or more) and diffuse colonies. In general, all termite species in NA prefers dead or decaying wood, rarely are tissues of living plants attacked. Estimates of damage attributed by termites to structures in NA exceed several billion (US$) annually (Su and Scheffrahn 2002).

In South America (SA), at least 400 termite species are recognized and many more yet to be described. Mound species and arboreal species are common in SA. Termites in SA occupy many ecological zones and habitats. Important termite genera include *Cryptotermes* and *Neotermes* (Family Kalotermitidae), *Coptotermes* and *Heterotermes* (Family Rhinotermitidae), and *Nasutitermes* (Family Termitidae). Not much has been reported estimating the damage caused to habitats by termites from SA. Unfortunately, not much is known on termite biology and ecology for the Caribbean. Similarly, for Central America and Mexico much of the termite diversity and ecology is poorly known.

European continent. Termite diversity in Europe is the least compared to other populated continents (Eggleton 2000). Fewer than 10 species naturally occur. The most important genus is *Reticulitermes*. This genus currently contains five species. Although native species of *Reticulitermes* exist in Europe, there are still questions about their origins and relatedness with species from eastern coastline of NA. In parts of France *Reticultermes* kills living trees, an unusual occurrence in NA. Damage to structures by termites is increasing in some European countries; enough so that France has mandated buildings inspections prior to sell. I also saw a severe drywood termite infestation (*C. brevis*) in a multi-unit living building while in Rome, Italy. Estimates of damage and costs exceed 500 million (Euros) annually (Clément 2000).

Africa. Termite diversity in Africa reflects this continent's topological and climatological diversity. Termite diversity is tremendous, more than 1,000 of the > 2,300 recognized species occur on the African continent. Mound species of termites occur throughout most of the African landscape. Termite diversity for northern Africa is low, about 11 species, represented by subterranean and drywood termite groups. The important genera are *Anacanthotermes* (Family Hodotermitidae), *Psammotermes* and *Reticulitermes* (Family Rhinotermitidae), *Amitermes,* and *Microcerotermes* (Family Termitidae), and several species of Kalotermitidae. Termite diversity is great in eastern Africa, especially among the abundant Macrotermitidae. The important genera include *Macrotermes* (Family Termitidae), *Hodotermes* (Family Hodotermitidae), and *Schedorhinotermes* (Family Rhinotermitidae). Termite diversity in western Africa is similar to eastern Africa; mound species dominate the landscape, although subterranean and drywood species also occur. Important genera include *Ancistrotermes, Macrotermes, Odontotermes, Microtermes,* and *Cubitermes* (Termitidae). Termites have been transported over much of Africa over the millennia due to commerce and nomadic migrations. Little information is available on the tropical forests of central Africa and savanna and deserts of southern Africa. These areas also contain much termite diversity and ecology. Termite ecological groups for many African habitats include straw feeders, structure infesting, and agricultural pests; although monetary estimates of damage and crop loss are underreported.

Asia. Termite diversity in China is especially great, with more than 435 species described. Most termite ecological groups, subterranean, drywood, harvester, and mound builders, are found in China. Common and important genera include *Coptotermes, Reticulitermes* (Family Rhinotermitidae), *Macrotermes* and *Odontotermes* (Termitidae), as well as members of the *Cryptotermes* (Kalotermitidae) and Hodotermitidae. Termite species occur in many environmental habitats throughout the provinces of China; natural, forests, agricultural, dikes, and urban. There is much termite diversity and ecology yet to be discovered in China. During my travels through Asia that have included Japan, China, Singapore, and Pakistan, I have seen many examples of damage to structures by termites. Estimates of damage and crop loss caused by termites are few for most of Asia.

Australia. More than 360 species of termites have been described from Australia. All termite ecological groups (dampwood, subterranean, drywood, harvester, and mound builders) are represented in the Australian region. However, the Australian termite fauna is most known for its relict, primitive genera *Mastotermes, Porotemes,* and *Stolotemes*. In depth understanding of the biology and ecology of termites is restricted to 5 to 15% of the described species. Structural and agricultural pest species occur in Australia and severity is highly dependent on locality. Estimates of damage to structures and crops exceed 100 million (Aus$) annually (Lenz 2000).

Detection

There are at least seven detection devices and methods proposed as alternatives to visual searches. They include optical borescopes, dogs, electronic odor detectors, microwaves, acoustic emission devices, infrared, and X-ray. They all claim high levels of successful detection of termites; however, few have been scientifically tested (Lewis 1997, Lewis 2003a, Lewis et al. 2004, 2005).

Optical borescopes use visible light passing through a hollow tube as a means to view termites and damage hidden away behind walls. A small hole must be drilled into walls to allow viewing. Fire blocking, insulation, and viewing through a fish-eye lens may impede the inspector's view. Optical borescopes are currently marketed; however, their efficiency in the detection of termites has yet to be scientifically tested.

Canines. Several breeds of dogs have been trained, beagles being the mostly frequently used breed (Lewis et al. 1997). The mode-of-action used by dogs in finding termites, audition, olfaction, or both still needs further research (Lewis et al. 1997). For California, the effectiveness of beagles was mixed but only included subterranean termites. Drywood termites were not included in the laboratory investigations (Lewis et al. 1997). However, drywood termites were included in laboratory trials conducted in Florida and the success rate for dogs (beagle and German shepherd) in identifying plastic containers containing drywood termites (*Cryptotermes cavifrons* Banks and *Incisitermes snyderi* (Light)) was 88.8% (Brooks 2001). False positives, canines response to containers without drywood termites was < 1% (Brooks 2001). Currently, there are few commercial firms that train and provide dogs to assist with termite inspections.

Odor detection. Electronic odor detectors are another method of detection of termites. Their mode-of-action includes detecting methane gas, commonly produced by termites (Lewis et al. 1997). One device (Termitect II) was tested on subterranean termites and produce highly variable detection rates, 20 to 100% (Lewis et al. 1997). There have been no reports on the use of electronic odor detectors in successfully identifying drywood termites.

Acoustic emissions. Termites produce vibrations in wood while feeding and by alarm calls from the head banging of soldiers. These sounds are produced during feeding (Matsuoka et al. 1996) and by vibratory movements of workers (Leis et al. 1992, Maistrello and Sbrenna 1996). The earliest commercial audible listening device for termite feeding was an INSECTA-SCOPE. However, no data are available on its performance. Newer technology that amplifies and records termite-feeding vibrations is acoustic emission (AE). Surface and subsurface probes are available and successfully detection of termites in laboratory settings is at least 80% (Fujii et al. 1989, Fujii et al. 1990, Scheffrahn et al. 1993, 1997, Lewis and Haverty 1996, Lewis et al. 2004, 2005). Wall covering can impede sensor and AE performance. Distance in detection is limited to ≈80 cm along the length of a board and < 8 cm across the grain (Scheffrahn et al. 1993). Excessive background noise can also result in false positive results for active termites. AE detection equipment is commercially available now on several continents, although availability locally is very limited.

Microwaves. Recently, portable microwave detection devices have been marketed in North America and Australia (Lewis 1997, Evans 2002, Peters and Creffield 2002). Published papers using microwaves have been reported for several species of termites (Peters and Creffield 2002, Evans 2002). Success in detection of drywood termites (*Cryptotermes brevis* (Walker)) using microwaves (TERM_A_TRAC™) was 86% based on laboratory studies (Peters and Creffield 2002). Detection distance was 35 mm along the long axis of test boards and 25 mm deep below the surface. However, water in wood, wall coverings, and excessive wind and motion can lead to false positives results for live termites.

Infrared. This portion of the electromagnetic spectrum is nearest red in the visible range. Although invisible to eye, infrared energy has a penetrating heating effect and is easily felt when encountered. Most objects, living or not, give off infrared heat, whether internally generated or reflected. There are many uses for infrared and include measurement devices, binoculars, night viewing for hunting, etc. In structures, infrared devices have been used to find faulty electrical connections and heat and water leaks in walls and roofs (Tobiasson 1994, Maldague and Moore 2001). A more recent use includes termite detection (Lewis 2003a). Commercial termite detection models are available. Some testimonials and demonstrations on the termite detection ability of infrared exist (Anon. 2000); however, the effectiveness in finding termite infestations has not been scientifically tested.

X-ray. These penetrating rays are part of the electromagnetic spectrum that is nearest ultraviolet rays. There are many commercial applications for X-rays and include dental, medical, military, security, and nondestructive evaluation of materials (Martz et al. 2002). These penetrating rays have also been used to nondestructively view insects in hidden locations (Fisher and Tasker 1939; Berryman and Stark 1962a,b; Berryman 1964; Davies et al. 1988; Kim and Schatzki 2001), and internal structures of insects (Westneat et al. 2003). For viewing insects hidden in wood, X-rays have been used for at least seven decades (Fischer and Tasker 1939, Kim and Schatzki 2001). X-rays have also been used to view several structural infesting beetle pests (Fisher and Tasker 1939, Suomi and Akre 1992). Only recently has the potential use of X-ray in detecting drywood termite infestations been explored (Lewis et al. 2005).

Concluding remarks. Because of proceedings paper format, I will not be reviewing control/management for termites. The topic is too vast for the space allotted. For more comprehensive regional and global reviews on termite management, see Su and Scheffrahn 2000; Pearce 1997; and Lewis 2003b. Excellent reviews on termite diversity and management are also contained in a United Nations website at http://www.chem.unep.ch/pops/termites/termite_toc.htm.

Lastly, recent excellent reviews on the positive contributions of termites to global ecologies of soils, air, carbon cycles, as well as invertebrates and vertebrates can be found Abe et al. 2000 and the United Nations Environmental Program (UNEP) and Food and Agriculture Organization (FAO) at http://www.chem.unep.ch/pops/newlayout/repdocs.html.

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