

Direct Colony Baiting of Termite Colonies: A Tool for Ecological Studies¹

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Abstract: The benefits of direct colony baiting are described: bait substrates enclosed in polyvinyl chloride tubes are applied in direct contact with the galleries of the termite nest. Attention of researchers is drawn to the potential of this method for species other than the mound-building Coptotermes lacteus.

In the post-organochlorine era, knowledge of termite biology and behaviour is a precursor to effective control. This paper describes Australian experiences with termite baiting techniques and future directions for baiting research.

EXPERIENCE WITH BAITING IN AUSTRALIA

I first used baits to locate termites in 1979, after the method of La Fage and others (1973) as part of a study of the effects of removal of ground-wood by campers in Wyperfeld National Park in the desert of northwestern Victoria. By using rolls of toilet paper as baits and experimentally manipulating the wood supply it was possible to clearly show that fire-wood collection greatly diminished termite numbers (Ewart 1979).

Baiting for termites in Australia has a long history, mostly the work of the CSIRO³ Division of Entomology in Canberra (Gay and others 1957). One enduring technique is the use of wood dowels to detect termites in trees

(Greaves 1964). Dowel baits facilitate the detection of termites in living trees, without significant damage to the tree (Greaves and Florence 1966). The technique is simple: a hole is bored in the tree at about chest-height, and a snug-fitting dowel of a palatable eucalypt species is inserted to at least half the diameter. The dowel is likely to intercept termite galleries towards the center of the tree, where galleries are more abundant in the old heartwood. Within a few days, the dowel may be removed for inspection. The presence of termites may be determined by observing (i) fecal spotting on the bait, or (ii) cavities resulting from consumption of bait as food or excavation to re-open blocked galleries. If a suitable level of activity is detected, the dowel-hole may be treated with an insecticide, typically arsenic trioxide, although organochlorines and other termiticides have been used. The hole represents a potential entry point for other pests (Anon 1987), but this may be prevented by treatment with dieldrin (Greaves and Florence 1966).

Along the Great Dividing Range of eastern Australia and extending to Tasmania grow the tallest flowering plants in the world. These are eucalypts of the subgenus Monocalyptus, fast growing fire-climax trees which typically grow in single-species stands. Their timber, though non-durable, is prized for indoor use and for paper pulp. In the early 1980's I began to examine termite attack on one of these species, Eucalyptus regnans Mueller, the Mountain Ash.

In Victoria, vast even-aged forests of this species, which dated from a particularly bad cluster of wildfires in 1939, were just then becoming of merchantable age. Early logging suggested that the trees contained a higher than expected rate of defect due to termites. Attacks on the heartwood of living trees were by Coptotermes species and a dampwood, Porotermes adamsoni (Froggatt).

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Extraction of termites from mountain Ash is laborious and difficult and, unless you are prepared to sacrifice valuable sawlogs, involves coordination with commercial harvesting--following the fallers and collecting wherever possible. This is both extremely dangerous and unproductive.

Given my earlier desert experiences, I preferred to have the termites come to me. I tried a range of baiting techniques with the aim of monitoring foraging activity: transects of rolls of toilet paper, buried wood blocks and dowel baits in standing trees. In Mountain Ash forests, it soon became clear that these termites do not normally forage near the surface of the ground, but are almost entirely restricted to the bole of the tree. My study was stalled for lack of access to the animals and was shortly thereafter dealt a death blow by wildfire.

Wildfire did not necessarily affect the termites, but it drastically changed forest management and meant that the study sites would soon be clear-felled. It was at this rather low point that I first met Dr Jeffrey La Fage whilst he was visiting Dr John French. After some searching discussions and some particularly penetrating questions, I switched to baiting the termites where it was certain that they would be continually present--in their own mounds.

MOUNDS OF COPTOTERMES LACTEUS

Nests of Coptotermes lacteus (Froggatt) are typically formed in wood, usually within the center of a standing tree. The upper surfaces of the nest are always protected by a thick clay wall and, when the parent tree is lost, or the colony grows beyond the limits of the timber, an irregularly shaped mound is formed with the clay wall as the outermost surface (fig. 1). The outer wall is 20 to 60 cm thick and protects an extensive periecie. The spherical endoeicie (or nursery) is situated at or below ground level.

Direct baiting of mounds had been tried before without success; the experience then was that baits applied to the wall of the mound were soiled in place, but not attacked (Hunt and Snyder 1931, Gay and others 1955). With corrugated cardboard in a short length of polyvinyl chloride (PVC) tubing, termites can be drawn from the periecie to bait units on the mound surface (French and Robinson 1985).

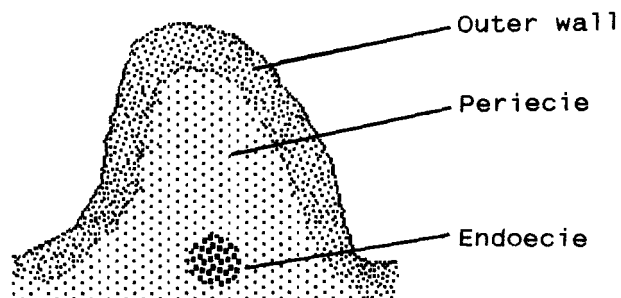


Figure 1--Schematic cross-section of a mound of Coptotermes lacteus.

This is not an entirely unnatural way of presenting food. Mounds initially form after tree-fall or premature cutting, and C. lacteus readily forage on branches or debris that either contact the exposed periecie or lie on the outer wall. Breaching of the wall or the accumulation of woody debris on the surface of the mound, or both, are not unusual circumstances. The PVC "fistula" bait units (French and Robinson 1985) merely standardize this food source.

BAIT SUBSTRATES

During trials to identify potential bait substrates, cork (bark of Quercus suber L.) was serendipitously discovered to be highly susceptible to attack (French and others 1986). Indigenous eucalypt timber and exotic softwood (Pinus radiata D. Don), although taken by termites in laboratory colonies (Gay and others 1955, Lenz and Barrett 1984), suffered only minor, erratic attack in the bait units, whereas with cork, a high proportion of baits were reliably attacked (fig. 2).

BENEFITS OF DIRECT COLONY BAITING

As a tool for the study of the ecology and biology of termites, direct baiting of termite colonies has many advantages over baits dispersed throughout their foraging territories. Response by the termites is obligatory--the bait substrate (or feeder strip) is applied in direct contact with freshly severed termite galleries. This security of response allows for the use of smaller sample sizes, with consequent economies of effort and expenditure.

Variation in response to baits due to the (mostly seasonal) fluctuations in the

effective size of foraging territories is minimized. Termites (*C. lacteus* at least) will forage close to the nest at times of climatic extremes.

There can be absolute certainty as to which species and colony are responding to individual baits (and replicates). A major problem with area baitings that use rolls of toilet paper or graveyard stakes is that considerable uncertainties regularly arise as to the identity of species/colonies responsible for a fair proportion of the attack (Ewart 1979, Ferrar 1982, French and Robinson 1980, Usher 1975).

With direct colony baiting, there is no need to employ large-footprint baits to attract termites (Akhtar and Jabeen 1981, French and Robinson 1980, Usher and Ocloo 1974) or for baits large enough to sustain attack for the long exposures typically required to sustain significant attack (Howick and Creffield 1983). Baits may be small, and the tube to the periecie need only be of sufficient diameter to accommodate the expected number of foragers. Thus there are savings to be had from the use of smaller baits, and time savings as a turnover of baits from 7 to 28 days becomes effective.

Wood blocks, stakes and rolls of toilet paper all suffer from the errors as they become cemented to the surface of the soil. Withdrawal of stakes often leaves many termites lost or crushed because of scraping, and inspection of toilet paper may cause the rolls to disintegrate, leaving many termites in

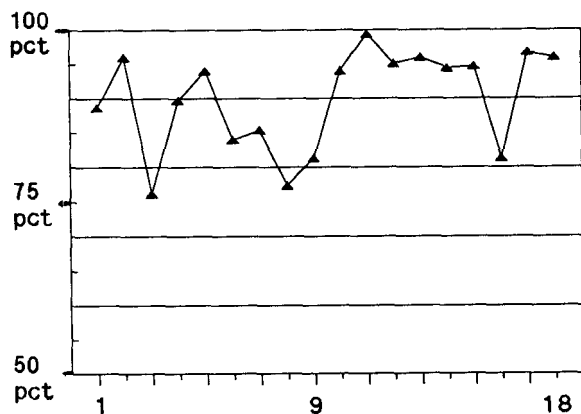


Figure 2--Success rate of cork baits: Percentage of baits with termites present ($n=80$, 20 mounds, 4 baits per mound) at 18 consecutive monthly samples.

fractured galleries on the soil surface. By enclosing the bait in a close-fitting PVC tube, these errors are avoided.

Inspection of the bait creates a clean break of galleries across a small surface area--and the tube may be replaced in exactly the same position, so that the integrity of the galleries is restored. Thus inspection of baits can occur with almost no disruption to the activity of the termites. Swapping of baits takes only a few seconds--one PVC tube is replaced by another containing a new bait block. Thus there is no need to wait for termites to discover the new block, as there has effectively been no interruption of exposure. This is a substantial improvement over the use of stakes, buried blocks, or rolls of toilet paper, because swapping of these baits causes significant damage to galleries and often requires the experimenter to re-excavate or level the surface.

For all but a few species, when it is possible for the experimenter to directly observe foraging termites, it is likely that their normal behaviour has been disrupted by the conditions necessary for observation. The use of direct colony baiting and PVC fistulas enables instantaneous sampling of foraging groups. The bait unit can be removed and replaced before the termites have time to respond. Thus the termites collected by this system represent an instantaneous sample, delimited by an arbitrarily defined, but regularly replicable, break in the galleries at the end of the removable bait unit. The problems of galleries adhering to the bait are overcome by regulating these additions to a constant volume surrounding the bait block. The experimenter may transport the bait tube in a large vial, contents intact, for later dissection in the laboratory.

OPPORTUNITIES FOR OTHER SPECIES.

The system I have described is clearly well suited to sampling *C. lacteus* in mound populations, but just as it has its roots in the early toilet paper roll studies of the Sonoran Desert (La Fage and others 1973) and *C. formosanus* in Cypress stumps (La Fage and others 1973, 1975, 1976), and *C. formosanus* in Cypress stumps (La Fage and others 1983), it too can be modified for application to non-mound colonies. Tree-based colonies are an obvious opportunity, as are some entirely subterranean species. The method is proven, the opportunities remain.

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