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Response by *Reticulitermes* (Isoptera: Rhinotermitidae) and *Cryptocercus punctulatus* (Blattaria: Cryptocercidae) to Wood Infected with the Green-Stain Ascomycete, *Chlorociboria aeruginascens aeruginascens*

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Response by *Reticulitermes* (Isoptera: Rhinotermitidae) and *Cryptocercus punctulatus* (Blattaria: Cryptocercidae) to Wood Infected with the Green-Stain Ascomycete, *Chlorociboria aeruginascens aeruginascens*

by

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ABSTRACT

Termites of the genus *Reticulitermes* Holmgren and the wood roaches *Cryptocercus punctulatus* Scudder were observed feeding on wood stained green by the ascomycete fungus, *Chlorociboria aeruginascens aeruginascens* (Leotiaceae), in a Virginia forest. However, in laboratory choice trials, both termites and wood roaches preferred unstained wood to stained wood. In no-choice feeding trials, *Reticulitermes* fed stained birch ate significantly less wood and weighed significantly less than termites fed unstained birch. These results indicate that natural host utilization patterns cannot be relied upon to indicate feeding preferences.

Key words: ascomycete, *Chlorociboria*, *Cryptocercus*, *Reticulitermes*

INTRODUCTION

Wood feeding insects and wood-decay fungi play central roles in forest nutrient cycles by degrading dead wood. Although insects and decay fungi frequently attack the same logs, the interactions between these taxa are complex and poorly understood. Subterranean termites and wood feeding cockroaches frequently eat decayed wood (Amburgey 1979, Gilbertson 1984, Nalepa 1984, Waller *et al.* 1987), perhaps to augment the nitrogen content of the diet (Collins 1983, Waller & La Fage 1987). Several fungi are phagostimulatory to termites (Gilbertson 1984), and extracts of some species induce positive orientation (Grace 1989) and trail following (Allen *et al.* 1964). Other fungal species inhibit termite feeding. For example, Amburgey & Beal (1977) found that *Reticulitermes* (Rhinotermitdae) avoided pine decayed by white rot fungi, although *Reticulitermes* and *Coptotermes* (Rhinotermitidae) often feed on white rotted wood in nature (Waller *et al.* 1987). The wood roach *Cryptocercus punctulatus* Scudder (Cryptocercidae) lives in decayed logs in family groups (Nalepa 1984), but the importance of fungi

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to *Cryptocercus* diets is uncertain. Investigations of the associations between wood feeding insects and decay fungi are important in understanding the roles of these organisms in forest ecology. Also, identification of phagostimulatory or antifeedant fungi may be useful in control programs for pest termites.

In the present study, I examined the responses of termites of the genus *Reticulitermes* and *Cryptocercus punctulatus* to wood stained green by the ascomycete fungus *Chlorociboria aeruginascens aeruginascens* (Leotiaceae). This fungus, a common wood-decay ascomycete in eastern woodlands, was formerly used to color wood green for the construction of boxes and toys (Dixon 1975). I had previously found both *Reticulitermes* and *Cryptocercus* feeding in fallen logs decayed by *C. aeruginascens aeruginascens* in Virginia. This study was performed to determine whether this fungus was phagostimulatory to the insects.

METHODS

Insects

Termites and wood roaches were collected from unstained logs in the George Washington National Forest in central Virginia. Insects were maintained in the laboratory in the original logs at 22-24°C until the experiments were performed.

Stained wood

Birch logs containing both unstained wood and wood stained by *C. aeruginascens aeruginascens* were collected from the George Washington National Forest. Wood pieces were dried, weighed on an analytical balance to 0.1mg and then presented to termites and cockroaches in feeding tests.

Termite choice tests

These experiments were conducted to determine whether termites preferred to eat wood stained with *C. aeruginascens aeruginascens* or unstained wood. Experimental units consisted of 480cc plastic containers with 70cc vermiculite and 35ml distilled water and one piece of stained birch and one piece of unstained birch. One hundred termites from the same colony were placed in each unit. Seven colonies of *Reticulitermes* were tested, and there were 2 replicate choice units per colony for 6 colonies and 1 choice unit for the 7th colony. Units were maintained at 22-24°C for 5 weeks, and then surviving termites were counted. Remaining wood pieces and 2 groups of 10 termites per unit were dried at 50°C for 48h and weighed to determine dry biomass.

Termite no-choice tests

This experiment was performed to determine if there was a difference in survivorship or individual termite biomass on stained versus unstained wood. Experimental units were similar to those described for termite choice tests, except that termites were confined with either stained wood alone or unstained wood alone. Seven colonies were tested. Two replicate units with stained wood and 2 units with unstained wood were assembled for each of 5 colonies and 1 replicate unit per treatment for each of the other 2 colonies.

Cockroach choice tests

The objective of this experiment was to determine whether *Cryptocercus* preferred stained or unstained wood in a choice situation. Experimental units were similar to those prepared for the termite choice tests, except that wood pieces were each soaked in 2ml deionized water and then placed individually in 35ml plastic vials. Each unit therefore contained a pair of vials, 1 with stained wood and the other with unstained wood. Preliminary experiments indicated that *Cryptocercus* survivorship was higher using this method. One *Cryptocercus* individual, a brown nymph

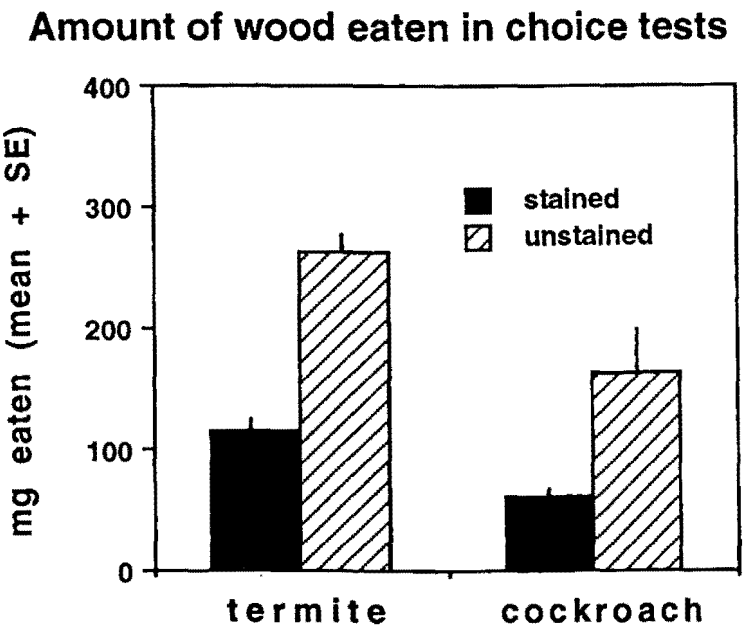

Fig. 1. Mean (+SE) amount of unstained and stained wood eaten by *Reticulitermes* and *Cryptocercus* under choice conditions.

approximately 2-3 years old, was placed in each of 9 units. Units were maintained at 22-24°C for 11 days, and then the remaining wood was dried and weighed to determine consumption.

RESULTS

Termite choice tests

Termites ate significantly more unstained birch wood than stained wood in choice tests (2-tailed paired T-test, $T = -5.98$, $DF = 12$, $p < 0.001$) (Fig. 1). Survivorship in choice units was 64.4±17.4% (n = 13), and the remaining termites had an average dry biomass of 5.8±1.9 mg per group of ten (n = 25 groups).

Termite no-choice tests

Termites also ate significantly more unstained than stained birch wood in no-choice tests (unstained wood: 341.8±61.2 SD mg, n = 11; stained wood: 237.1±47.3 SD mg, n = 12) (ANOVA, $F = 30.593$, $p = 0.0004$). Survivorship was higher in units with stained wood (70.0±20.4% SD) than in those with unstained wood (47.3±32.6% SD), but this may have resulted because termites ran out of food in some of the units with unstained wood. Termite dry biomass was significantly lower in units with stained wood (5.2±1.5 SD mg per 10 termites, n = 23 groups) than in those with unstained wood (5.8±1.6 SD mg per 10 termites, n = 16 groups) (ANOVA, $F = 7.414$, $p = 0.0114$), indicating that stained wood was a poor quality food source for termites.

Cockroach choice tests

As in the choice tests with termites, *Cryptocercus* nymphs ate significantly more unstained birch than stained wood (2-tailed paired T-test, $T = -2.43$, $D.F.=8$, $p < 0.05$) (Fig. 1).

DISCUSSION

In this study unstained birch wood was preferred over wood stained green by *Chlorociboria aeruginascens aeruginascens* by both *Reticulitermes* and *Cryptocercus*. Termites ate greater amounts of unstained wood under both choice and no-choice conditions, and termites confined with stained wood had lower individual biomasses than those fed unstained wood. *Cryptocercus* also preferred unstained wood in choice tests.

Termites and wood roaches had previously been observed feeding on wood stained by *C. aeruginascens* in nature (Waller, unpublished). It is possible that the insects were forced to feed on stained wood due to the absence of more suitable foods in that particular habitat. Sometimes

many or most of the fallen logs in a given area in Virginia woodlands are infected by *C. aeruginascens aeruginascens* (Waller, unpublished).

Some insects have very complex associations with stain producing ascomycetes. For example, southern pine beetles, *Dendroctonus frontalis* Zimm., introduce the blue-stain fungus, *Ceratocystis minor* (Hedge.) Hunt, to the southern pine trees that the insects infest. Infection by the fungus results in the death of the trees, in part by reducing stem water conductivity (Hemmingway *et al.* 1977). Although the life histories of *Dendroctonus* and *Ceratocystis* are intimately linked, laboratory trials indicate that blue-stained wood is toxic and repellant to both adult and larval beetles (Franklin 1970). The agents that render blue-stained wood unsuitable for the beetles have not been identified, but *C. minor* is known to produce isocourmarins and to reduce the water content of infected pines (Franklin 1970).

Numerous fungal species have been found to be antifeedant to termites (Amburgey 1979, Gilbertson 1984). Unpalatability in wood-decay fungi might be a defense against wood feeding insects that act as competitors or fungal predators in forest habitats. A comprehensive survey of termite and wood roach response to different species of decay fungi would be valuable in understanding decomposition patterns in forest habitats. Phagostimulatory or antifeedant fungi could be further examined to isolate compounds useful in termite control.

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