Effects of Three Insect Growth Regulators, Feeding Substrates, and Colony Origin on Survival and Presoldier Production of the Formosan Subterranean Termite (Isoptera: Rhinotermitidae)

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ABSTRACT Effects of three insect growth regulators (IGR's)—methoprene, fenoxycarb (Ro13-5223), and 2-[p-m-(Flurophenoxy) phenoxy] ethyl ethylcarbamate (Ro16-1295)—at ca. 500, 1,000, and 1,500 ppm on three feeding substrates—filter paper, absorbent pure cellulose filter pads, and ponderosa pine (*Pinus ponderosa* Dougl. ex Laws) blocks—were evaluated on laboratory experimental groups of 150 *Coptotermes formosanus* Shiraki (130 workers and 20 soldiers) collected from three field colonies in Oahu, Hawaii. Ro16-1295 killed ca. 16% workers while only ca. 2% of workers died after 2-weeks exposure to methoprene and fenoxycarb. A considerably larger proportion of soldiers was killed as a result of exposure to these IGR's; ca. 25% were killed by methoprene and ca. 40% were killed by the other IGR's. All three IGR's induced presoldier formation. Approximately 12–22 presoldiers were found in treated groups after 2 weeks, while no presoldiers were observed in untreated controls. Feeding substrates did not affect worker mortality. However, IGR-impregnated pine blocks caused significantly lower soldier mortality and produced more presoldiers than the other two substrates. All three colonies were significantly different from each other in worker and soldier mortality and presoldier production in response to IGR's and feeding substrates.

REMEDIAL CONTROL of subterranean termites with baits or dust requires a control agent that is nonrepellent and slow-acting (Su et al. 1982). Mirex, which is one such compound, was used experimentally in a bait-toxicant system to suppress activity of *Reticulitermes* spp. colonies under field conditions (Esenther and Beal 1974, 1978). Amdro (Su et al. 1982) and fluorinated lipids (Prestwich et al. 1983) also appear to be slow-acting and nonrepellent compounds. In addition to these compounds, there is mounting evidence that insect growth regulators (IGR's) have potential as agents for remedial control of subterranean termites because of their delayed action, induction of presoldier development, defaunation with resulting starvation, and apparent nonrepellency (Howard and Haverty 1978, 1979a,b, Haverty and Howard 1979, Howard 1983, Jones 1984). Of the many effects of IGR's recorded on termites, induction of superfluous presoldiers, soldiers, and intercastes provides a promising new approach to termite control (Howard and Haverty 1979a). Because the termite worker is the only caste responsible for food intake in a colony, abnormally large proportions of dependent castes could lead to the disruption of the homeostasis of the termite society (Haverty 1977). Laboratory observations have shown that excess soldiers were usually starved or cannibalized by workers (Haverty 1979, Su and La Fage 1986).

Although effects of various IGR's have been tested on many termite species (Howard and Haverty 1979a), there is conflicting evidence concerning their effects on the Formosan subterranean termite, *Coptotermes formosanus* Shiraki. Hrdý et al. (1979) demonstrated soldier formation by *C. formosanus* and six other termite species under the influence of juvenile hormone (JH) and juvenile hormone analogs (JHA's). Haverty and Howard (1979), however, reported that neither methoprene nor hydroprene affected *C. formosanus*, although presoldier formation and elimination of symbiotic Protozoa were observed from *Reticulitermes flavipes* (Kollar) and *R. virginicus* (Banks). They suggested that the lack of presoldier development in *C. formosanus* might have resulted from an insufficient quantity of either chemical used in their test. Jones (1984), in tests of two experimental IGR's (phenoxycarb and Ro16-1295) against *R. virginicus* and *C. formosanus*, found that IGR-impregnated wood blocks produced more presoldiers than treated cellulose. She stated that food substrate significantly affects intercaste formation in *C. formosanus*.

The Formosan subterranean termite has been the most economically important insect pest in Hawaii for the last three decades and is becoming a potentially serious threat in many southern states

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(Thompson 1985). Because this species can exist above ground in situations that cannot be remedied by conventional subterranean termite treatments, we must find an acceptable and effective chemical for the remedial control of *C. formosanus*. Previous experimental results on the effects of IGR's on *C. formosanus* indicate that food source and colony origin are important factors that must be considered when testing IGR's (Haverty and Howard 1979, Howard and Haverty 1979a,b, Jones 1984). In the study reported here, we examined the effects of three IGR's—methoprene, fenoxycarb, and Ro16-1295 (2-[p-m-(Flurophenoxy) phenoxy] ethyl ethylcarbamate)—in conjunction with colony origin and feeding substrate on *C. formosanus* to clarify the previous conflicting results.

Materials and Methods

Three IGR's—methoprene, fenoxycarb (Ro13-5223), and Ro16-1295—were tested. The Formosan subterranean termites were collected from three field colonies on the University of Hawaii campus in Honolulu, Hawaii. Colony G was located and had been monitored for 8 months before testing; colonies H and P had been monitored for ca. 10 years by the method described by Tamashiro et al. (1973). Three substrates were tested, as follows: absorbant pure cellulose filter pads (4.7 cm diam, Gelman Instrument Co.), filter paper (5.5 cm diam, Whatman No. 1), and ponderosa pine (*Pinus ponderosa* Dougl. ex Laws) blocks (1.8 by 1.8 by 1.8 cm) cut from the sapwood of a single board; oven-dried at 80°C for 48 h; and weighed. The blocks were impregnated with acetone or acetone solutions of one of three IGR's at either 250, 500, or 750 ppm (Anonymous 1976). The resulting AI concentrations in the blocks were 465.8 ± 7.2 ppm, 987.3 ± 11.3 ppm, and 1,452.8 ± 11.8 ppm, respectively. All IGR's used were technical grade materials. Filter pads and filter papers containing 446 ppm, 987 ppm, and 1,453 ppm (AI) of each IGR were also prepared. Treated substrates were air-dried for 24 h before testing.

A total of 150 termites (130 workers, undifferentiated larvae of at least the third instar, and 20 soldiers) was introduced into a screw-top glass jar (5.5 cm diam by 6.5 cm height) containing the treated or untreated substrates covered with 50 ml of acetone-washed coral sand and moistened with 10 ml of deioinized water. Each treatment combination (compound × concentration × colony × substrate) was replicated four times; a total of 324 experimental units was used. All experimental units were stored at 29 ± 1°C for 2 weeks, then disassembled, and the number of surviving workers, soldiers, and presoldiers was counted.

The experimental design was a 3 × 3 × 3 × 3 factorial, with compound, concentration, colony origin, and substrate as the main effects. The response variables were percent worker mortality, percent soldier mortality, and number of presoldiers produced. Abbott's formula was used to correct for control mortality (Abbott 1925). Results were subjected to analysis of variance to evaluate the main effects and interactions among factors. Percentages were transformed to arcsine of the square root of the percentage before analysis. Significant differences were separated by Scheffé's test at the $\alpha = 0.05$ level (Scheffé 1959).

Results and Discussion

For all response variables (soldier and worker mortality and presoldier production), there were no significant differences among the three concentrations we tested; neither were there any concentration-related interactions. Thus, the results are presented as means of these three concentrations for each replicate of each substrate × IGR × colony combination. Obviously, all concentrations used in this test exceeded the effective threshold level for mortality and presoldier induction.

No significant differences in control mortality ($\bar{x} \pm$ SE) were observed among substrates or colonies. The grand mean control mortality at 14 days was 9.9 ± 1.7 and 9.6 ± 1.4% for workers and soldiers, respectively. Analysis of variance revealed significant interactions between main effects (IGR, substrate, and colony) with respect to mortality of both workers and soldiers (Table 1). Reasons for such interaction are not known. No significant differences were observed among overall mortalities of workers fed different substrates (Table 2). Ro16-1295 caused ca. 16% mortality and was apparently more toxic to *C. formosanus* workers than the other two compounds, which caused only ca. 2–3% mortality. The three colonies responded differently to Ro16-1295; colonies G and P suffered 27.6 and 18.0% worker mortality, respectively, whereas colony H suffered only 1.8% worker mortality. Significant differences in worker mortalities were observed among all three colonies. Workers collected from colonies P and G suffered overall mortality 10-fold that of colony H.

Significant differences were also found in soldier mortality among colonies (Table 3). Again, colony G suffered the highest soldier mortality. More than 50% of soldiers collected from colony G died within 14 days, while only 17.0% of the soldiers in colony H died in that time. Similar trends among colonies were found between worker and soldier mortality; these compounds appeared to cause higher mortality in soldiers than in workers. Although the exact mode of action of IGR's on *C. formosanus* soldiers is unknown, the significantly lower soldier mortality in groups fed with pine blocks suggests that death of soldiers may have resulted from inability of the workers to provide adequate nutrition to the soldiers. Materials such as filter paper or filter pads that contain mainly cellulose are known to be nutritionally poor for termites (La Fage 1976). Under the influence of

Table 1. Analysis of variance for a factorial experiment to evaluate the effects of IGR's, feeding substrates, and colony origin on percent worker and soldier mortality and presoldier production after 2 weeks in laboratory experimental groups[a]

Source	df	Worker mortality (%)		Soldier mortality (%)		No. presoldiers produced	
		MS[b]	*F*	MS[b]	*F*	MS[b]	*F*
Colony (C)	2	3,406.5	28.3	35,279.9	48.4	1,348.5	19.7
Substrate (S)	2	65.7	0.6	52,406.5	71.9	431.0	6.3
IGR (I)	2	7,234.9	60.0	8,382.5	11.5	3,034.2	44.3
C × S	4	535.9	4.5	4,253.0	5.8	224.8	3.3
C × I	4	2,147.5	17.8	12,413.2	17.0	590.3	8.6
S × I	4	390.3	3.2	4,051.5	5.6	556.4	8.1
C × S × I	8	530.9	4.4	975.3	1.3	180.1	2.6
Error	297	120.5	—	728.9	—	68.4	—

[a] Each combination of treatments was replicated 12 times.
[b] Mean square.

IGR's, workers are subjected to the physiological stress of molting and elimination of their symbiotic Protozoa. As a result, soldiers probably starved to death because workers lacked the energy reserves to feed them. Soldier mortality also differed in response to the three IGR's. The overall soldier mortality was only 25.4% in groups exposed to methoprene, while fenoxycarb and Ro16-1295 caused ca. 40% soldier mortality. It is interesting, however, that Ro16-1295 caused the lowest mortality to soldiers in colony H.

No presoldiers were observed among groups fed untreated substrates after 14 days. Without the influence of IGR's, 3–5 weeks are generally required for this species to produce the first presoldier under laboratory conditions when no inhibiting soldiers are present (Haverty 1979, Su and La Fage 1984a). Compared to the control, the number of presoldiers found in treated groups was significant (Table 4). As with mortality, the interaction in presoldier production between main effects was significant (Table 1).

As expected, groups fed with a nutritionally superior food source, such as pine blocks, produced more presoldiers. Methoprene, which was less toxic to *C. formosanus*, produced significantly more presoldiers. The relationship between the effect of an IGR on mortality and presoldier production was inverse; compounds that caused lower mortality produced more presoldiers. A similar trend was also seen among the three colonies tested; colonies that produced more presoldiers exhibited lower mortality. Howard and Haverty (1978) reported that lower concentrations (32–1,000 ppm) of methoprene caused *R. flavipes* to starve from defaunation or presoldier production, while higher concentrations were toxic to these termites. Their conclusions may explain our finding of an inverse relationship between mortality and presoldier production.

Intercolony differences within a termite species have often been reported. Gay et al. (1955) found a great intraspecific difference in termite vigor among colonies of *Coptotermes acinaciformis*

Table 2. Effects of IGR's and feeding substrate on the worker mortality (%) of the Formosan subterranean termite collected from three field colonies ($\bar{x}$ ± SE)

	IGR's[ab]			Colony origin[ab]			
	Methoprene	Ro13-5223	Ro16-1295	G	H	P	
Substrate							Substrate[c]
Filter pad	2.6 ± 1.2aA	1.0 ± 0.4aA	21.2 ± 4.9aB	16.4 ± 4.9aA	0.0 ± 0.0aB	7.8 ± 1.8aAB	8.0 ± 1.8a
Filter paper	2.9 ± 1.0aA	3.6 ± 0.7bA	15.9 ± 3.6aB	7.6 ± 3.0aAB	2.3 ± 0.8bA	13.5 ± 2.7aB	7.7 ± 1.4a
Pine block	3.4 ± 0.8aA	2.0 ± 0.5abA	13.6 ± 2.2aB	11.0 ± 2.3aA	0.8 ± 0.3abB	7.9 ± 1.0aA	6.9 ± 1.0a
Colony							Colony[c]
G	1.3 ± 0.6aA	1.8 ± 0.5aA	27.6 ± 4.2aB				11.5 ± 2.0a
H	0.5 ± 0.2aA	0.9 ± 0.4aA	1.8 ± 0.7bA				1.1 ± 0.3b
P	7.2 ± 1.4bA	3.9 ± 0.7bA	18.0 ± 2.4aB				9.7 ± 1.1c
IGR's[c]							
	2.9 ± 0.6a	2.2 ± 0.3a	16.6 ± 2.0b				

[a] Means for each combination of treatment (substrate × IGR, substrate × colony, IGR × colony) followed by the same lowercase letters within a column or means followed by the same capital letter within a row are not significantly different at the $\alpha = 0.05$ level (Scheffé's test).
[b] Values for each combination (substrate × IGR, substrate × colony, and IGR × colony) of treatments are means of 36 observations.
[c] Values for each main treatment effect (substrate, IGR, colony) are means of 108 observations. Means followed by the same letter are not significantly different at the $\alpha = 0.05$ level (Scheffé's test).

Table 3. Effects of IGR's and feeding substrate on the soldier mortality (%) of the Formosan subterranean termite collected from three field colonies ($\bar{x} \pm SE$)

	IGR's[ab]			Colony origin[ab]			
	Methoprene	Ro13-5223	Ro16-1295	G	H	P	
Substrate							Substrate[c]
Filter pad	43.7 ± 5.4aA	58.1 ± 6.7aA	50.0 ± 7.3aA	71.5 ± 5.4aA	33.2 ± 6.0aB	47.5 ± 6.5aB	50.6 ± 3.7a
Filter paper	28.8 ± 4.8aA	61.2 ± 5.9aB	47.2 ± 7.1aAB	62.9 ± 6.2aA	15.6 ± 3.9bB	59.5 ± 5.8aA	46.1 ± 3.7a
Pine block	2.7 ± 0.8bA	1.8 ± 0.6bA	27.8 ± 6.1aB	27.7 ± 6.2bA	1.7 ± 0.8bB	3.4 ± 0.8bB	11.9 ± 2.6b
Colony							Colony[c]
G	25.6 ± 5.1aA	52.7 ± 6.8aB	74.2 ± 5.8aC				52.7 ± 3.9a
H	21.0 ± 4.7aAB	24.1 ± 6.0bA	6.0 ± 1.8bB				17.0 ± 2.7b
P	29.7 ± 5.5aA	44.1 ± 7.0abA	34.6 ± 6.5cA				36.3 ± 3.7c
IGR's[c]							
	25.4 ± 3.0a	40.3 ± 4.0b	40.8 ± 4.0b				

See footnotes to Table 2.

(Froggatt) and *Nasutitermes exitiosus* (Hill). Shimizu (1965) suggested that intrinsic factors such as colony age, caste composition, or worker weight may affect the vitality of *C. formosanus*. Carter et al. (1972) reported that colonies of *R. flavipes* responded differently to unfavorable foods. Su and La Fage (1984b) also showed that there can be considerable differences in survival and wood consumption among colonies of *C. formosanus* in laboratory tests. Many authors have been aware of the intraspecific variation and suggested that colony origin should be incorporated into the experimental design whenever possible (Gay et al. 1955, Haverty 1979, Haverty and Howard 1981, Su and La Fage 1984b).

Consistent with the observations of Jones (1984), all three IGR's used in this study caused mortality and induced presoldier formation in *C. formosanus*. Haverty and Howard (1979) observed neither presoldier induction nor significant mortality in *C. formosanus* in preliminary tests in which workers were exposed to methoprene and hydroprene concentrations as high as 5,000 ppm. Thus, the contradiction between the findings reported in our study and the findings of Haverty and Howard (1979) apparently results not from an insufficient quantity of chemicals, as they suggested, but rather from differences in susceptibility or receptivity of the colonies to methoprene. Haverty and Howard (1979) noted that their results were not conclusive, as only one colony was used in the test. The single colony of *C. formosanus* used by Haverty and Howard (1979) had been collected from an infected cypress snag at Lake Charles, La., and maintained in culture for at least 2 years. *C. formosanus* collected in this manner does not always contain a complete caste composition. Indeed, in a recent sample of five infested cypress snags in Lake Charles, La., when the trees were disassembled, only two contained reproductives, eggs, and first-instar larvae (J. P. La Fage and N.Y.S., unpublished data). If a colony is collected without reproductives and stored in culture for 2 years, the tested workers may have become too mature to

Table 4. Number of presoldiers of the Formosan subterranean termite produced after 2-weeks exposure to three IGR's and three feeding substrates ($\bar{x} \pm SE$)

	IGR's[ab]			Colony origin[ab]			
	Methoprene	Ro13-5223	Ro16-1295	G	H	P	
Substrate							Substrate[c]
Filter pad	26.1 ± 1.8aA	12.4 ± 1.1aB	9.2 ± 1.3aB	11.6 ± 1.7aA	18.0 ± 2.1aAB	18.3 ± 1.6aB	16.0 ± 1.1ab
Filter paper	19.6 ± 2.1aA	16.4 ± 1.2aAB	11.2 ± 1.2abB	14.3 ± 1.4aA	18.6 ± 1.7aA	13.8 ± 1.7aA	15.6 ± 0.9b
Pine block	21.4 ± 1.9aA	22.4 ± 1.5bA	14.3 ± 1.6bB	14.4 ± 1.7aA	25.1 ± 1.4bB	18.4 ± 1.6aA	19.0 ± 1.0a
Colony							Colony[c]
G	16.5 ± 1.7aA	17.2 ± 1.4aA	8.3 ± 1.5aB				13.6 ± 0.9a
H	29.3 ± 1.8bA	15.4 ± 1.6aB	17.2 ± 1.1bB				20.5 ± 1.1b
P	21.6 ± 1.8aA	18.6 ± 1.4aA	10.6 ± 1.2aB				16.9 ± 1.0c
IGR's[c]							
	22.4 ± 1.1a	17.1 ± 0.8b	11.8 ± 0.8c				

See footnotes to Table 2.

respond to IGR's. This is probably what occurred with the workers used by Haverty and Howard (1979). Further study is needed, however, to test this hypothesis.

Our results also demonstrate that feeding substrate affected the results; groups fed with pine blocks generally survived better and produced more presoldiers. The difference between pine blocks and the other two substrates containing mostly α-cellulose, however, was not as substantial as that suggested by Jones (1984), who stated that IGR-impregnated α-cellulose produced no presoldiers in *C. formosanus*. The differences reported here should be considered in future bioassays, since using a single substrate and a single colony, or both, could significantly skew the results.

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References Cited

Abbott, W. S. 1925. A method for computing the effectiveness of an insecticide. J. Econ. Entomol. 18: 265–267.

Anonymous. 1976. Standard method of testing wood preservatives by laboratory soil block cultures, pp. 424–433. *In* Annual book of ASTM standards. Part 22. Wood: adhesives. American Society for Testing and Materials, Pa.

Carter, F. L., C. A. Stringer, and R. V. Smythe. 1972. Survival of six colonies of *Reticulitermes flavipes* on unfavorable woods. Ann. Entomol. Soc. Am. 65: 984–985.

Esenther, G. R., and R. H. Beal. 1974. Attractant-mirex bait suppresses activity of *Reticulitermes* spp. J. Econ. Entomol. 67: 85–88.

1978. Insecticidal baits on field plot perimeters suppress *Reticulitermes*. J. Econ. Entomol. 71: 604–607.

Gay, F. J., T. Greaves, F. G. Holdaway, and A. H. Wetherly. 1955. Standard laboratory colonies of termites for evaluating the resistance of timber, timber preservatives, and other materials to termite attack. Aust. C.S.I.R.O. Div. For. Prod. Bull.

Haverty, M. I. 1977. The proportion of soldiers in termite colonies: a list and a bibliography (Isoptera). Sociobiology 2: 199–216.

1979. Soldier production and maintenance of soldier proportions in laboratory experimental groups of *Coptotermes formosanus* Shiraki. Insectes Soc. 26: 69–84.

Haverty, M. I., and R. W. Howard. 1979. Effects of insect growth regulators on subterranean termites: induction of differentiation, defaunation, and starvation. Ann. Entomol. Soc. Am. 72: 503–508.

1981. Production of soldiers and maintenance of soldier proportions by laboratory experimental groups of *Reticulitermes flavipes* (Kollar) and *Reticulitermes virginicus* (Banks) (Isoptera: Rhinotermitidae). Insectes Soc. 28: 32–39.

Howard, R. W. 1983. Effects of methoprene on binary caste groups of *Reticulitermes flavipes* (Kollar) (Isoptera: Rhinotermitidae). Environ. Entomol. 12: 1059–1063.

Howard, R. W., and M. I. Haverty. 1978. Defaunation, mortality and soldier differentiation: concentration effects of methoprene in a termite. Sociobiology 3: 73–78.

1979a. Termites and juvenile hormone analogues: a review of methodology and observed effects. Sociobiology 4: 269–278.

1979b. Comparison of feeding substrates for evaluating effects of insect growth regulators on subterranean termites. J. Ga. Entomol. Soc. 14: 3–7.

Hrdý, I., J. Krěček, and Z. Zusková. 1979. Juvenile hormone analogues: effects on the soldier caste differentiation in termites (Isoptera). Vestn. Cesk. Spol. Zool. 43: 260–269.

Jones, S. C. 1984. Evaluation of two insect growth regulators for the bait-block method of subterranean termite (Isoptera: Rhinotermitidae) control. J. Econ. Entomol. 77: 1086–1091.

La Fage, J. P. 1976. Nutritional biochemistry, bioenergetics, and nutritive value of the dry-wood termite *Marginitermes hubbardi* (Banks). Ph.D. dissertation, University of Arizona, Tucson.

Prestwich, G. D., J. K. Mauldin, J. B. Engstrom, J. F. Carvalho, and D. Y. Cupo. 1983. Comparative toxicity of fluorinated lipids and their evaluation as bait-block toxicants for the control of *Reticulitermes* spp. (Isoptera: Rhinotermitidae). J. Econ. Entomol. 76: 690–695.

Scheffé, H. 1959. The analysis of variance. Wiley, New York.

Shimizu, K. 1965. Analytical studies on the vitality of colonies of the Formosan termite, *Coptotermes formosanus* Shiraki. I. Analysis of the strength of vitality. Bull. Fac. Agric. Univ. Miyazaki 8: 106–110.

Su, N. Y., and J. P. La Fage. 1984a. Comparison of laboratory mehods for estimating wood-consumption rates by *Coptotermes formosanus* (Isoptera: Rhinotermididae). Ann. Entomol. Soc. Am. 77: 125–129.

1984b. Differences in survival and feeding activity among colonies of the Formosan subterranean termite (Isoptera: Rhinotermitidae). Z. Angew. Entomol. 97: 134–138.

1986. Effects of starvation on survival and maintenance of soldier proportion in laboratory groups of the Formosan subterranean termite, *Coptotermes formosanus* Shiraki (Isoptera: Rhinotermitidae). Ann. Entomol. Soc. Am. 79: (in press).

Su, N. Y., M. Tamashiro, J. R. Yates, and M. I. Haverty. 1982. Effect of behavior on the evaluation of insecticides for prevention of or remedial control of the Formosan subterranean termite. J. Econ. Entomol. 75: 188–193.

Tamashiro, M., J. K. Fujii, and P. Y. Lai. 1973. A simple method to observe, trap, and prepare large numbers of subterranean termites for laboratory and field experiments. Environ. Entomol. 2: 721–722.

Thompson, C. R. 1985. Detection and distribution of Formosan termite (Isoptera: Rhinotermitidae) in southeastern Florida. J. Econ. Entomol. 78: 528–530.

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