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ROLE OF ANT LARVAE IN THE DIGESTION OF GEL AND GRANULAR BAITS IN MANAGEMENT OF *CAMPONOTUS MODOC* AND *TAPINOMA SESSILE* (HYMENOPTERA: FORMICIDAE)

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Abstract Solid food carried into nests of ants by foraging workers is reported to be fed to larvae for digestion before nutrients are transmitted back to workers. The role of the digestion of solid food by larvae for worker consumption was investigated in the use of gel and granular baits in the management of two species of ants: carpenter ants, *Camponotus modoc*, and odorous house ants, *Tapinoma sessile.* Nests were established in feeding trials with granular and gel baits with and without larvae. Ants in nests without larvae had a higher or equilivant mortality compared to ants in nests without larvae indicating that toxicants in baits were ingested without the aid of larval digestion. As only liquid materials can pass the infrabuccal filter in workers, digestion must occur in the infrabuccal pocket of the foraging ants.

Key words Carpenter ants, odorous house ants, trophallaxis,

INTRODUCTION

Tapinoma sessile, odorous house ants, and *Camponotus* spp., carpenter ants, are widely distributed throughout the United States and have become two of the most serious pests in structures, either as nuisance pests or structurally damaging organisms. Odorous house ants belong to the Subfamily Dolichoderinae and carpenter ants belong to Subfamily Formicinae. The industry considers these ants as the number one and two 'call-back' pests in the United States (NPMA 2012 Ant Industry Research Survey).

The complex food cycle within an ant colony varies with the species of ant. Foraging ants bring food or water back to the colony and distribute it to other workers and larvae by trophallaxis. A filtering mechanism (infrabuccal plate) in adult ants prevents solid food particles from entering the digestive tract (Eisner and Happ, 1962) (Hansen and Klotz, 2005). The feeding of larvae occurs most commonly when workers apply mouth parts to that of larvae and liquid food is regurgitated from the adult's crop (Wheeler 1928). Stomodeal trophallaxis by larvae has been observed in nearly all major ant families (Wheeler, 1928) except the Dolichodorinae (Holldobler and Wilson, 1990).

Wheeler (1994) states that larvae digest prey items externally, producing soluble proteins and are solicited from larvae by adults. The larvae then regurgitate the digested food back to the workers in a liquid form. The possibility that larvae serve as specialized digestive castes has been supported chiefly for some of the Myrmicinae that feed on seeds (Holldobler and Wilson, 1990).

The larval body shape of carpenter ants is pogonomyrmecoid and allows for a short ventrally curved neck that can feed from a praesaepium, a shallow ventral depression on the thoracic wall. This serves as an adaptation to feeding on insect fragments (Wheeler and Wheeler, 1976). Their simple mandible forms a round-pointed tooth with no medial teeth. Odorous house ant larval shape is designated

as dolichoderoid without a neck and with nearly vestigial mouth parts. These ants consume liquid food only (Wheeler and Wheeler, 1976).

Pest management professionals (PMPs) and homeowners employ a wide variety of management strategies with varying degrees of success. The recognition of the role that liquid foods play in the nutrition and colony cohesion has led to bait development, particularly liquids (Oi and Vail, 2011). Many bait formulations (granular, gels, liquids, and prepared stations) are available for both of these species.

The purpose of this study was to determine whether digestion by larvae is a factor in the consumption and distribution of the toxicants from the baits to worker ants. Understanding the mechanism that allows toxicants to enter the colony is fundamental for control. Application of baits is acceptable by homeowners as less toxicant is applied to their surroundings and to the environment compared to other application strategies.

MATERIALS AND METHODS

Two species were used in these trials: *Camponotus modoc* W.M.Wheeler and *Tapinoma sessile* (Say). The procedure was similar for both species. Carpenter ant colonies were collected in May near Moscow, Idaho and odorous house ant colonies were collected near Leavenworth, Washington in June. Colonies were transferred to the laboratory and maintained until trials were initiated.

From the collected colonies, nest boxes of ants for trials were established with 45 worker ants per box or 45 worker ants plus larvae per box. Each nest box was supplied with a food source (honey) and water. Estimates were made of the number of larvae: 10-12 larvae (all sizes) for carpenter ants and 20-25 larvae (all sizes) for odorous house ants. Attempts to determine what larval instars were present were not made. Nest boxes were maintained for 24 hours before feeding trials were initiated. After 24 hours exposure to bait, honey was added to provide an alternate food choice. Controls were offered honey as a food source and no bait. Five reps were made for each treatment. Mortality of workers (and larvae) was monitored and recorded every two days for four weeks. Percent mortality for each nest box at each time interval was computed and the five reps were averaged for each bait.

Granular Baits with five different active ingredients were selected: Advion Insect Granules (0.22% Indoxacarb), Maxforce Granular Insect Bait (1.0% Hydramethylnon), InVict Xpress (granules) (0.5% Imidacloprid), Niban FG (5% Orthoboric acid), and Advance Select Granular Ant Bait (0.011% Abamectin). For comparison three gel baits were selected: Advion Ant Gel (0.05% Indoxacarb), Optigard Ant Gel Bait (0.010% Thiamethoxam), and InTice Sweet Ant Bait (5.0% Orthoboric Acid).

RESULTS

Carpenter ants: At the end of four weeks, mortality of ants in nest boxes without larvae was similar or higher than ants in nest boxes with larvae for all the baits (Table 1). A higher rate of mortality was shown in nest boxes without larvae for three granular baits and for two gel baits. None of the nest boxes contained larvae after four weeks. The larvae did not increase in size or pupate. The larvae darkened in color and shriveled in size before dying. In the control boxes 50% of the larvae remained but did not increase in size or develop to pupae.

Odorous house ants: At the end of four weeks, mortality of ants in nest boxes without larvae was similar or higher than ants in nest boxes with larvae for all the baits (Table 2). A higher rate of mortality was shown without larvae for three granular baits and for two gel baits. None of the odorous house ant nest boxes contained larvae after 4 weeks. The larvae did not increase in size or pupate but larvae darkened in color and shriveled in size. In the control boxe,s approximately 30% of the larvae remained but did not increase in size or develop to pupae.

DISCUSSION

Management training materials (Hedges, 2010) (Bennett et al., 2010) state that solid pieces of food are carried back to the colony and are fed to larvae that eat and digest them. The larvae then regurgitate the digested food back to the workers in a liquid form. Carpenter ants in the Subfamily Formicinae have this capability; however, the odorous house ants (Subfamily Dolichodorinae) lack this ability.

Table l. Average percent mortality of *Camponotus modoc* workers in nest boxes with and without larvae supplied with granular and gel baits through four weeks.

Bait	Days	2	4	8	16	22	28
ADVION G	No larvae	21.1	46.2	85.5	100.0		
	With larvae	2.4	16.2	53.9	86.1	97.9	100.0
MAXFORCE G	No larvae	2.5	4.6	5.4	22.5	49.2	57.1
	With larvae	1.1	3.8	7.8	40.8	47.6	55.4
INVICT EXPRESS	No larvae	21.4	30.3	67.3	98.7	100.0	
	With larvae	2.7	22.1	57.7	97.2	99.2	100.0
NIBAN G	No larvae	1.7	3.3	7.1	35.9	65.8	85.4
	with larvae	1.3	1.3	3.8	35.9	55.8	70.8
ADVANCE	No larvae	1.2	2.4	15.2	65.9	81.3	89.2
	With larvae	4.4	6.3	12.6	46.5	86.4	99.2
ADVION GEL	No larvae	1.2	7.3	21.6	82.8	96.0	100.0
	With larvae	1.3	5.0	11.7	37.5	51.7	67.1
OPTIGARD GEL	No larvae	9.9	63.7	93.4	100.0		
	With larvae	8.6	48.0	73.2	89.8	98.8	100.0
INTICE BAIT	No larvae	2.9	11.2	33.2	73.8	90.8	93.3
	With larvae	1.1	7.6	45.1	77.5	92.1	98.7
CONTROL	No larvae	1.3	2.2	3.8	5.8	6.9	6.9
	With larvae	0.4	2.1	2.9	2.9	2.9	4.2

Table 2. Average percent mortality of *Tapinoma sessile* workers in nest boxes with and without larvae supplied with granular and gel baits.

Bait	Days	2	4	8	16	22	28
ADVION G	No larvae	23.2	52.7	79.3	96.9	100.0	
	With larvae	13.4	32.6	57.4	83.6	90.1	90.1
MAXFORCE G	No larvae	12.8	27.5	42.5	83.5	95.1	98.7
	With larvae	5.3	7.5	16.0	36.7	44.1	65.2
INVICT EXPRESS	No larvae	20.6	28.0	35.3	48.6	62.6	77.6
	With larvae	4.0	8.2	15.1	19.4	21.4	31.4
NIBAN G	No larvae	17.1	21.7	23.7	27.3	39.4	59.4
	With larvae	6.5	13.7	19.5	32.7	39.8	54.2
ADVANCE	No larvae	13.5	38.3	55.8	74.3	76.5	77.6
	With larvae	14.2	34.3	55.5	68.6	79.3	80.2
ADVION GEL	No larvae	3.0	9.1	15.4	45.4	58.4	81.5
	With larvae	14.5	16.6	20.5	26.2	29.7	39.4
OPTIGARD GEL	No larvae	25.5	55.9	94.1	98.1	100.0	
	With larvae	14.4	28.9	66.9	79.6	83.5	87.8
INTICE BAIT	No larvae	2.2	4.8	7.0	17.7	52.8	44.8
	With larvae	11.1	17.0	19.6	28.7	32.9	39.0
CONTROL	No larvae	2.7	4.6	8.4	9.1	11.0	12.6
	With larvae	1.5	2.6	2.6	5.3	6.2	9.9

In the feeding trials with larvae, granular baits were not dependent on larval digestion to affect mortality of worker carpenter ants or odorous house ants. Both granular and gel formulations produced similar results in trials with both species. Differences in the mortality of carpenter ants compared to odorous house ants with different baits demonstrate that these two ants do not respond equally to the same baits.

The toxic effect of baits to worker ants may occur through the exoskeleton or through the mouth parts where food enters the cibarium. This chamber opens into a second chamber, the infrabuccal pocket that is a collection site for particles of food and debris. Ducts from the propharyngeal, postpharyngeal, maxillary, labial, and mandibular glands empty into the cibarium and infrabuccal pocket (Hansen and Klotz, 2005). Materials including baits stored in the infrabuccal pocket would come into contact with glandular secretions that would release the toxicants. Through trophallaxis among workers, the toxicants spread rapidly through nestmates without the aid of digestion by larvae.

REFERENCES CITED

Bennett, G.W., J.M. Owens, and R.M. Corrigan. 2010. Truman's scientific guide to pest management operations. 7th ed. Questex Media Group, Cleveland, OH

Eisner, T. and G.J. Happ. 1962. The infrabuccal pocket of a formicine ant: a social filtration device. Psyche 69: 107-116.

Hansen, L.D. and J.H. Klotz. 2005. Carpenter ants of North America and Canada. Ithaca, NY: Cornell University Press.

Holldobler, B. and E.O. Wilson. 1990. The ants. Cambridge, MA: Harvard University Press.

Hedges, S.A. 2010. Field guide for the management of structure-infesting ants. Richfield, OH: G.I.E. Media.

NPMA. 2012. Ant Industry Research Survey. Pest Management Foundation.

Oi, D. and K. Vail. 2011. Ants, Chapter 11. *In* Handbook of pest control. 10th ed. Mallis Handbook LLC

Wheeler, D.E., 1994. Nourishment in ants: patterns in individual and societies. *In* J.H. Hunt and C.A. Nalepa (eds.). Nourishment and evolution in insect societies. Boulder: Westview Press.

Wheeler, W.M. 1928. The social insects: their origin and evolution. London: Kegan Paul, Treanch, Trubner and Co.

Wheeler, G.C., and J. Wheele. 1976. Ant larvae: review and synthesis. Memoirs Entomol. Soc. Washington, No. 7. Washington, D.C.: Entomological Society.