MANAGING CARPENTER ANT POPULATIONS IN URBAN ENVIRONMENTS

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Abstract—Impact of carpenter ant infestations in structures ranges from nuisance pests to seriously damaging pests if structural timbers are attacked. Carpenter ants excavate wood to form galleries for their brood and tunnels for foragers. A mature colony consists of a parent or main colony with the queen, workers, winged reproductives, and young brood plus one or more satellite colonies with workers, winged reproductives, and mature brood.

Integration of chemical treatments and cultural controls was employed to manage structural carpenter ant infestations. Chemicals were applied directly to nests when parent and satellite colonies were located, and cultural controls were implemented to eliminate conducive conditions for carpenter ant infestations. When all aspects of the colony could not be located and conducive conditions could not be corrected, chemical treatments were employed. These included (1) the use of dusts in enclosed voids of a structure where ants were known to nest and travel, (2) the application of sprays to disrupt communication among parent and satellite colonies, (3) the application of chemicals to produce a barrier between the colonies and the foraging arena, and/or (4) the use of toxic baits to eliminate the parent and satellite colonies.

Successful management of carpenter ant infestations is possible when these factors are integrated: habitat modification, elimination of ants in nesting sites, proper placement of chemicals, disruption of foraging, and a thorough knowledge of the carpenter ant species involved in the infestation.

INTRODUCTION

Carpenter ants have long been recognized as structurally damaging in the northern United States, Canada, and northern Europe (Hansen and Akre, 1990; Wallin and Schroeder, 1994) (Fig. 1). In many other parts of North America and Europe, carpenter ants are classified as nuisance pests . The categorization of either nuisance or structurally damaging is dependent, in part, upon the species involved (Hansen and Akre, 1994; Hansen, 1995). A total of 23 species of Camponotus has been recorded in North America invading structures in one of these categories. Some of these species attack only decayed wood; others will attack sound wood. Nests are made in standing and downed timber, in stumps, and in wood used in structures. Tunneling by carpenter ants was reported in 75% of the ornamental trees in urban environments in the state of New Jersey where the tunneling weakened the trees physically and exposed them to other pests and pathogens (Fowler and Parrish, 1982). Due to these nesting activities, carpenter ants have become a major economic problem in urban environments.

Damaging species occurring in North America include *C. modoc* Wheeler, *C. vicinus* Mayr, *C. pennsylvanicus* (DeGeer), *C. herculeanus* (L.), *C. abdominalis* (Buckley). In Europe, the damaging species include *C. herculeanus* and *C. lignaperda* Latr. (Hansen and Akre, 1993). Management of these damaging species will be the primary focus in this paper.

Unlike termites, which have symbiotic microorganisms in their midgut to aid them in the digestion of cellulose, carpenter ants do not ingest wood. Instead, they remove wood with their mandibles to excavate brood chambers from the wood matrix and then deposit these wood chips away from their galleries and runways (Fig. 2).

Colony size varies with species, latitude, and queen number. Larger colonies are reported in the northern latitudes of North America. The largest colony sizes (100,000 workers) have been reported for *C. vicinus* which is polygynous. Colonies of *C. modoc* in the Pacific Northwest of the United States have been collected with 50,000 workers (Akre *et al.*, 1994a). Most species of carpenter ants are monogynous but may contain additional non inseminated queens that produce males.

Established carpenter ant colonies are partitioned into parent or main colonies and satellite colonies, which are extensions of the main colony (Hansen and Akre, 1985; Akre *et al.*, 1995a). The parent colony, which contains the queen and workers, is located in an area with high humidity. The presence of eggs, larvae, pupae, and winged reproductives is dependent on seasonal development

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Figure 1. Structural beam infested with *Camponotus modoc.*

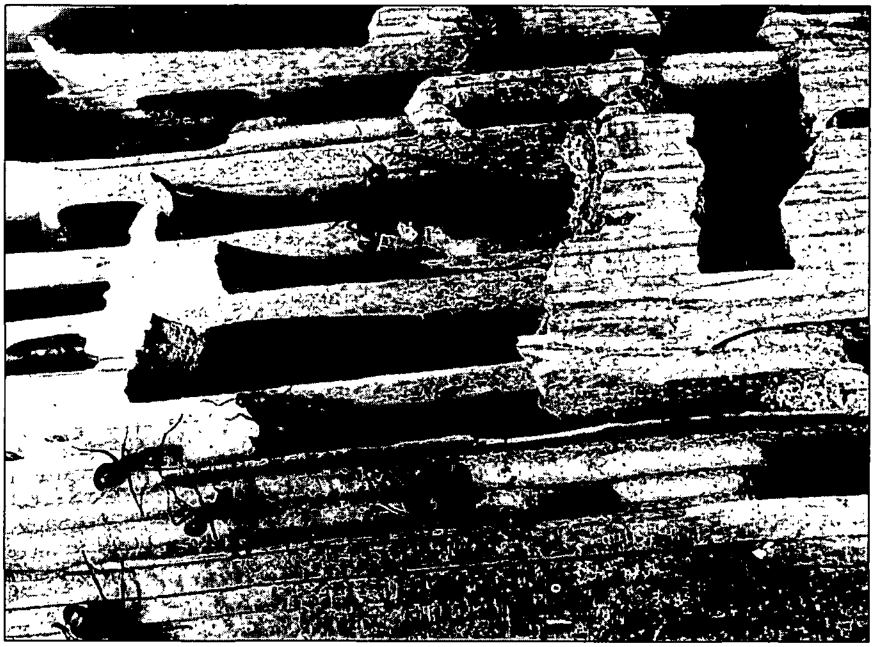

Figure 2. Carpenter ant infestation showing galleries and runways.

(Hansen and Akre, 1985; Hansen, 1993). The satellite colonies contain workers and depending upon seasonal development may contain mature larvae, pupae, and winged reproductives. Satellite colonies are found in warmer areas with less humidity than the parent colony. These conditions enhance larval and pupal development. Numbers of satellite colonies found within structures range from 2 to 25.

Most species of carpenter ants are chiefly nocturnal and rely on chemical trails for orientation to and from the nest (Hansen and Akre, 1985). Smaller numbers of foragers are present during the day. In California, *C. modoc* foragers were observed on the trail all day from May to October, but in July and August foragers were chiefly nocturnal (David and Wood, 1980). For *C. pennsylvanicus* in New Jersey, humidity and temperature were important parameters in June and August, whereas time of day was the dominant parameter in July (Fowler and Roberts, 1980). Trails are established between nesting sites and foraging arenas as well as between parent and satellite colonies. In addition to chemical trails, carpenter ants also use light compass orientation to the rays of the sun, to the moon, or even to streetlights at night (Klotz and Reid, 1993). Landmarks such as trees, shrubs, or rocks are also used in orientation. Within structures, carpenter ants orient to structural guidelines and follow artificial pathways formed by electrical wires and plumbing which make their lines of travel and infestation predictable (Klotz and Reid, 1992).

Carpenter ant infestations are ideally suited for the integration of management techniques involving cultural and chemical controls (Akre and Hansen, 1990). The integration of these control measures during six years of investigations is summarized in this paper.

MATERIALS AND METHODS

From 1990 through 1995, a total of 292 structures with carpenter ants infestations were investigated (Table 1). Many of these structures were included in research applications of perimeter spray programs, dust applications, and/or baiting. Structures were located in eastern Washington and northern Idaho. Homeowners with structural infestations requested assistance or were referred by pest control operators or by Washington State University Cooperative Extension personnel. Distribution of species found in these structures included: *C. modoc* 71.2%, *C. vicinus* 14.0%, *C. essigi* 10.3%, and miscellaneous species of *Camponotus* 4.5%.

Investigation of a carpenter ant infestation involved visiting the site, interviewing the homeowner, and inspecting the interior and exterior of the structure. The interior inspection included inspecting each room with emphasis on where carpenter ants had been observed and areas with plumbing such as kitchens, bathrooms, and laundry areas. In addition, the attic, basement, and crawl space were inspected. Exterior inspection included the exterior of the structure, roof, decks, porches, foundation, and gutters as well as all vegetation, other wooden materials used in landscaping, and stacked lumber or firewood.

A list of questions pertaining to the infestation and the structure became evident early in the investigations. These were directed to the homeowner either in the initial telephone contact or during the inspection process. This list of questions was modified during investigations.

In management of carpenter ant infestations, homeowners were requested to correct problems that would modify carpenter ant habitat or foraging patterns and to remove conducive conditions for carpenter ant nesting sites to prevent reinfestation or movement of an existing population. Information on the biology of carpenter ants and the reasons these modifications were required were explained to homeowners (Akre et al., 1992).

Chemical applications including baits were applied to 77% of the structures inspected. From prior and current research involving tests for chemical efficacy and residual activity, compounds were selected which modify habitat, disrupt foraging, and control carpenter ant populations existing within structures. Chemicals used in perimeter spray treatments included cyfluthrin, cypermethrin, chlorpyrifos, tralomethrin, and deltamethrin, in either a wettable powder, microencapsulated, or suspended concentrate formulation. Perimeter sprays were applied with a 4 L compressed air sprayer. Chemicals used as dusts included borates, cyfluthrin, deltamethrin, and bendiocarb. Dusts were applied with bulb dusters or power dusters. Baits were experimental products which are not commercially available with the exception of a granular formulation with

Table 1. Inspections and treatments of carpenter ant infestations from 1990–1995. (m=*Camponotus modoc*, v=*C. vicinus*, e=*C. essigi*, os= other species of *Camponotus*). Numbers in parentheses represent retreats.

Investigation	1990	1991	1992	1993	1994	1995
Inspections only	4m	6m	6m	12m	4m	3m
	4v	4v	5v	2v	—	2v
	—	—	—	—	—	3e
	1os	2os	2os	3os	3os	2os
Perimeter Spray	5m	—	6m(1)	9m	8m(1)	13m
	3v	—	2v	1v	—	3v
	—	3e(1)	3e(2)	5e(3)	5e(1)	3e
Bait only	25m(9)	30m(3)	16m(2)	2m	5m(2)	3m
	4v(1)	4v	—	—	1v	1v
	2e(2)	1e	—	—	—	—
Bait and Perimeter Spray	3m	9m(1)	—	5m(2)	—	—
	—	2v(1)	—	—	—	—
	—	2e(2)	—	—	—	1e
Dust and Perimeter Spray	6m	—	3m	6m	9m(2)	5m
	1v(1)	—	1v	—	1v	—
	2e(2)	—	—	—	—	—
Bait, dust, and Perimeter Spray	1m	3m(1)	—	1m	—	—
Total Investigations per species	44m	48m	31m	35m	26m	24m
	12v	10v	8v	3v	2v	6v
	4e	6e	3e	5e	5e	7e
	1os	2os	2os	3os	3os	2os
Total Investigations	61	66	44	46	36	39

boric acid. The granular formulation was dusted into wall voids. Other baits were placed in 6–8 stations near foraging trails and were monitored weekly. Bait was replaced in stations at weekly intervals and relocated if the bait had not been consumed.

RESULTS

Results of the investigations were divided into four major areas: interviewing the homeowner, inspection of the infestation site, treatment of the problem, and follow-up on management procedures (Hansen, 1993).

The Interview

A structural history of the building and of the current infestation was obtained by questioning the homeowner. This list of questions was modified to include specific areas encountered on previous inspections (Table 2). Many of these questions were answered with the initial telephone contact which assisted in the preparation and planning for the inspection. These questions related directly to the location of nesting sites. Children frequently provided information as they were often more aware of ant activity, particularly outside the structure.

The Inspection

The second phase included the inspection. This was the most important and time consuming phase of carpenter ant management. The goals of the inspection were to determine if there was a

Table 2. Interview questions asked to homeowners for the purpose of obtaining a history of the structure and of the carpenter ant infestation.

Interior-Infestation

1. How long have you been seeing ants in the house?
2. In what rooms are you seeing the ants?
3. Are the ants winged or wingless?
4. How many ants are you seeing a 24 hour period?
5. Have the ants been attracted to any particular food products?
6. Have you observed "sawdust" anywhere in the house that may have been excavated by the ants?
7. Have you heard any rustling noises in the walls?
8. Have your children observed the ants or heard rustling noises?

History of the structure

1. How old is the house?
2. How long have you lived in the house?
3. Do you know of any remodeling or additions that have been done to the house?
4. Have your recently replaced a roof or siding to the house?
5. Have you had any problems with leaks in the roof?
6. Have you had any plumbing leaks or plumbing repairs?
7. Have you had any other water leaks or damage?
8. Have you noticed water vapor or frost on the inside of your windows at any time?
9. Do you have a crawl space, full basement, or is the house on a slab?
10. If there is a basement, is it finished?
11. Where is the access to the crawl space?
12. Where is the access to the attic?
13. Do you have an open beam or cathedral ceiling?
14. Do you know what kind of insulation is in the walls? the attic? the subfloor?
15. Is the roof flat, gently sloped, or steeply sloped?
16. Have you had any leaks from the gutter? When were the gutters last cleaned?
17. How many bathrooms, kitchens, and laundry rooms are in the house?

Exterior

1. Do you remember seeing ants outside the structure?
2. Have you noticed any ant trails? Have children noticed ant trails?
3. Have you recently added decorative bark to your landscaping? If so, how deep is the bark?
4. Are there trees or shrubs in the landscaping around the house?
5. Do any trees or shrubs have contact with the walls or roof of the house?
6. What kinds of trees are in the yard?
7. How far are the trees located from the house?
8. Does your yard contain timbers, railroad ties, or wood in the landscaping?
9. Have there been any large excavations in your yard for landscaping or for bringing in new water, sewer, or electrical lines?
10. Have any trees been removed from your yard? If so, was the stump removed or covered?
11. Is there any stacked firewood inside the structure? Outside? If so, how long has it been stacked in its present location?
12. Is there any stacked lumber or siding near the structure? If so, how long has it been stacked in its present location?
13. Is there a wooden fence around the yard?
14. Is there a deck or hot tub? Are these covered? Is there access under these areas?
15. Is the exterior brick or siding? Is siding wood, vinyl, or aluminum?

carpenter ant infestation in the structure, to determine which species of carpenter ant was involved, to locate the nest, or nests of the colony, and to locate all conducive conditions for carpenter ants.

On the interior of the structure, infestation clues such as excavated wood, presence of foragers, sounds in walls, and foraging trails were examined. The number of ants the homeowner was seeing on a daily or weekly basis was important when it was related to the biology of the ant. If carpenter ants were found in the structure during the winter, or winged forms emerged in the house during the winter or spring months, the conclusion was that the structure was infested with at least one nest. An occasional stray ant during the summer or a wingless female following the mating flight usually reflected an outside nest. Excavated wood from carpenter ant activity was found in attic areas, crawl spaces, unfinished basement areas, beneath electrical switch plates, in closet corners, under sinks, behind cabinets, under insulation, or between the carpeting and the carpet tacking strip. Sounds in wall voids were heard only when ants were particularly active. Introduction of an aerosol or compressed air into a void excited the ants and they responded by striking their mandibles or gasters on the wood in an alarm response. A similar response occurred by striking the wall with a series of taps such as drumming of finger tips. Listening devices were not employed.

Important aspects of the investigation included an inspection of attics and crawl spaces with fiberglass insulation and under tacked carpeting. Edges of insulation were pulled away from joists to inspect for the presence of excavated wood fragments, dead ants and ant parts, and live ants. Carpeting was lifted at the corners and along the edges to determine presence of ants and wood fragments along the tacking strip.

On the exterior of the structure attempts were made to locate trails between nests and foraging arenas. If ants were not observed trailing near a structure, inspections were made of possible foraging arenas and foragers could be traced to their entrances into the structure. Baiting for carpenter ants with freshly killed crickets or other insect material was also very successful. This procedure involved baiting in several locations and allowing 2–3 hours for the ants to find the bait (Akre *et al.*, 1994b). The ants with bait were tracked to parent or satellite nesting sites. The determination of a parent or a satellite nesting site was made by observing conditions of the nesting habitat. A nest in a warm, dry area was assumed to be a satellite colony (Fig. 3); a nest in an area with high humidity was assumed to be a parent colony

The exterior of the structure was inspected for wood in contact with soil (Fig. 4) and other areas with moisture problems. Common problems occurred with gutters, roofs, and exterior framing of windows and doors. Tree branches or shrubs touching the exterior of the structure or the roof provided foraging trails for the ants. Wood timbers and other wooden structures used for decoration or landscaping were carefully inspected by listening for hollow sounds when the timber was tapped. Timbers that sounded hollow were removed. In infested timbers, carpenter ants were tunneling underground away from the timber, lining their tunnel with wood fragments from the timber, and emerging at a distance of 1–4 m.

Stacked lumber or firewood required particular attention as the surface inspection often did not reveal ants or wood fragments. Inspection of these areas involved restacking the wood. Usually, only one or two pieces of the firewood were infested.

Figure 3. Satellite nest of *Camponotus modoc* in an attic.

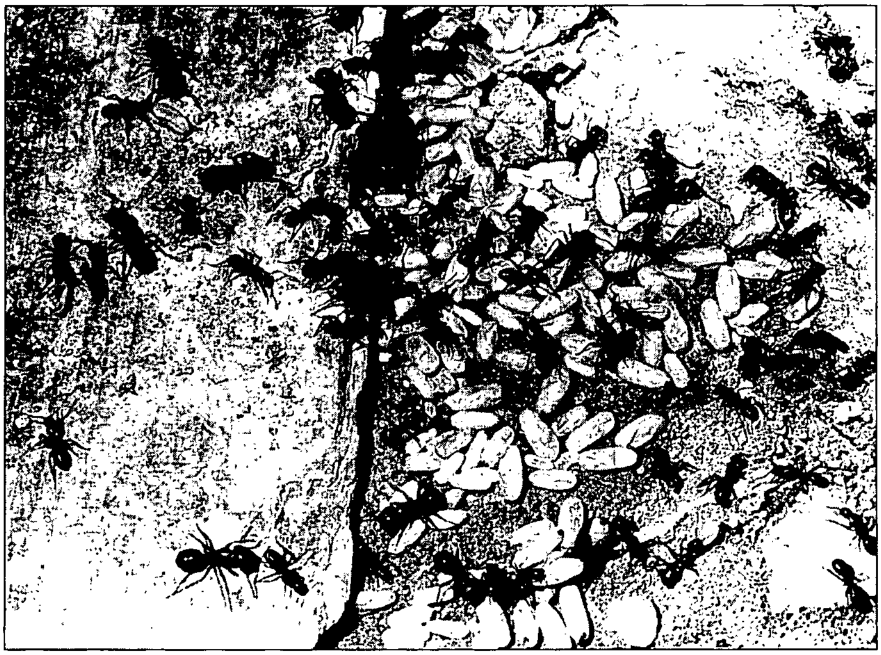

Figure 4. Satellite nesting site of *Camponotus modoc* under a piece of wood used in landscaping.

Live trees often were the source of a parent colony. Inspections were made of tree trunks for entrances to the heartwood of the tree through an injury, broken or cut branch, or through an area of wood decay. Entrances were found in deciduous trees where the junctures of branches were large enough for water to accumulate and wood decay to begin.

As a satellite colony may live for several years without a parent colony, a complete inspection was important to locate all the nesting sites. Careful examination and answers to questions to the homeowners provided clues which usually revealed the nesting sites and extent of the infestation (Table 3).

Table 3. Locations of main colonies of *Camponotus* spp. infesting structures.

Location	*C. modoc*	%	*C. vicinus*	%	*C. essigi*	%
Living tree	30	14.4	5	12.2	—	—
Landscaping*	44	21.2	2	4.9	—	—
Stump	10	4.8	—	—	—	—
Neighbor's yard	18	8.6	2	4.9	—	—
Landscaping Timbers	26	12.5	9	22.0	—	—
Roof	5	2.4	1	2.4	—	—
Porch Floor	5	2.4	—	—	—	—
Construction**	23	11.1	1	2.4	—	—
Stacked wood	9	4.3	—	—	—	—
Wood/soil contact	7	3.4	—	—	—	—
Unknown	31	14.9	21	51.2	30	100
Totals	208	100	41	100	30	100

*Included homes in wooded areas where main colony was traced into the woods.
**Faults in construction: gaps in siding, unfinished areas around window frames and door frames, gaps in log homes, etc.

The Treatment

Treatment of nesting sites involved habitat modification, disruption of foraging, and elimination of ants from the structure. Correction of structural problems; elimination of vegetation in contact with the structure; removal of infested timbers, landscaping materials, and stacked wood were the first steps in carpenter ant management. The homeowner was involved in making these corrections. If satellite colonies had not been established within the structure, these steps were often sufficient to manage the carpenter ant infestation.

If a nesting site could not be located within the structure, and the number of ants indicated an infestation, a dust was applied through existing openings around plumbing and electrical outlets into void areas. Effective control was achieved with 50 g of formulation per 100 square meters of structure applied with a power duster or 100 g of formulation per 100 square meters of structure applied with a hand-held duster (Akre *et al.*, 1995b). The number of main colonies that could not be located included: *C. modoc* 14.9%, *C. vicinus* 51.2%, and *C. essigi* 100% (Table 3). Perimeter sprays were exclusively employed in management of *C. essigi*, where little information was available on their biology.

A perimeter spray application of 1 litre per 15 m was applied under the lower edges of siding to control ants. This procedure controlled ants trailing in this area and was repellent to ants seeking satellite nesting sites. Perimeter sprays applied to areas receiving no direct sunlight or rainfall remained active in carpenter ant control throughout the foraging season. This application was also used as a maintenance technique when a main colony was located in a tree or if the main colony could not be located. In addition, trails were sprayed to disrupt foraging patterns and communication between a parent and satellite colony.

Baiting was a useful tool but demonstrated the limitations to a baiting program for carpenter ants. First, baits were only effective during the five month foraging season of carpenter ants found in the northern U. S. Second, the bait must be competitive with the natural foods that carpenter ants consume such as insect larvae and aphids. The toxicant must be slow acting so that the foragers can carry the bait home and distribute the bait to other ants in the nest. In baiting large colonies in the laboratory, carpenter ants were observed to be carnivorous on their brood during periods of stress. Baiting drastically reduced the numbers of foragers, but the queen and a nucleus of workers remained. At this time no commercial bait has proven to be consistently effective in carpenter ant control.

The Follow-Up

The success of a management program was assessed throughout the season by contact with the homeowner and documentation of the number of ants observed within the structure. Homeowners were asked to collect the ants in small containers to determine if the same species was present. This also provided information on sizes and numbers of the ants collected. The final assessment of a treatment procedure was made the following spring (May-June, following the mating flight). At that time the homeowner was contacted and asked if ants had been observed within the structure. A second inspection was made if ants were reported within the structure and management techniques were assessed. Numbers of retreats are indicated on Table 1.

DISCUSSION

Carpenter ant management is challenging in that carpenter ants are very adaptable to the environment of man where wood is used in home construction. Nesting sites have been found in a number of materials including insulation, cardboard, paper, decorative bark, and treated timbers used in landscaping. Trails have been located on fences, wires entering the structure, underground structures such as sprinkler systems or cables, and tree roots.

Successful management of carpenter ant infestations was possible when a number of factors were considered. These included habitat modification, elimination of nesting sites through proper placement of chemicals, disruption of foraging, and a thorough knowledge of the carpenter ant species involved in the infestation.

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