

A SURVEY OF THE URBAN PEST ANTS (HYMENOPTERA: FORMICIDAE) OF PENINSULAR FLORIDA

JOHN H. KLOTZ¹, JOHN R. MANGOLD², KAREN M. VAIL¹, LLOYD R. DAVIS, JR.¹
AND RICHARD S. PATTERSON¹

¹United States Department of Agriculture - Agriculture Research Service,
Household Insects & Imported Fire Ants Research Unit,
Gainesville, FL 32608

²The Terminix International Co. L.P., 25400 U.S. Highway 19 N., Suite 259
Clearwater, FL 34623

ABSTRACT

A one year survey was conducted with structural pest control employees of Florida to determine the kinds of ants and types of ant problems confronted in both commercial and household pest control. Eight species of ants were identified as key pests in Florida. Of these, the most common were *Solenopsis invicta* Buren - 14%, *Tapinoma melanocephalum* (F.) - 14%, *Paratrechina longicornis* (Latreille) - 14%, *Camponotus abdominalis floridanus* (Buckley) - 12%, *Monomorium pharaonis* (L.) - 11%, *Camponotus tortuganus* Emery - 8%, *Pheidole megacephala* (F.) - 7% and *Paratrechina bourbonica* (Forel) - 4%. More than twenty-five other species of ants which were occasional invaders were also collected in the survey. Customer complaints, nest locations, and treatment strategies for pest ants are also described.

Key Words: Urban pest control, house-infesting, treatment strategies, ant baits

RESUMEN

Una encuesta de un año fue llevada a cabo con empleados de control de plagas estructurales de la Florida para determinar los tipos de hormigas y de problemas causados por estas que eran confrontados por el control comercial y doméstico de plagas. Ocho especies de hormigas fueron identificadas como plagas claves en la Florida. De estas, las más comunes fueron *Solenopsis invicta* Buren-14%, *Tapinoma melanocephalum* (F.)-14%, *Paratrechina longicornis* (Latreille)-14%, *Camponotus abdominalis floridanus* (Buckley)-12%, *Monomorium pharaonis* (L)-11%, *Camponotus tortuganus* Emery-8%, *Pheidole megacephala* (F.)-7%, y *Paratrechina bourbonica* (Forel)-4%. También más de veinte y cinco especies de hormigas invasoras ocasionales fueron colectadas en la encuesta. Las quejas de los clientes, localizaciones de los nidos y estrategias de tratamiento para las hormigas plagas son también descritas.

Pest ants in the urban environment have a significant economic impact both on the pest control industry and the general public. In the National Home and Garden Pesticide Use Survey (Whitmore et al. 1992) ants were ranked as the number one pest problem of households, even surpassing cockroaches. However, their economic importance is overshadowed by our lack of information on both biology and control for many of these pest ants. A few species are well studied: fire ants because of their medical and agricultural impact (Banks 1990); Pharaoh ants, which are major household pests and can act as disease vectors in hospitals (Williams 1990); and carpenter ants, which are important wood-destroying organisms (Akre & Hansen 1990). We need to

learn more about numerous other pest species with the goal of designing more effective control programs.

Hedges (1992) and Thompson (1990) on a national scale and Smith (1965) for the eastern United States describe common structure-infesting ants. On a regional scale, a comprehensive list of the ants of Florida (Deyrup et al. 1989) reports geographic distribution of ant species by county, but only two small surveys report on structure-infesting ants in Florida (Bieman & Bloomcamp 1987; Bieman & Wojcik 1990).

Our goal in this study was to conduct a year-long survey of the structure-infesting pest ants of peninsular Florida to determine which species of ants pest control employees (PCEs) are being called upon to control, both in commercial accounts, such as hotels and apartment complexes, and private accounts, such as single-family dwellings.

We conducted a survey that consisted of identifying ants sent to us by PCEs (Terminix). The PCEs returned a questionnaire with each ant sample. We were able to determine the relative frequency of occurrence of urban pest ants, in addition to several key points about the infestations caused by these ants. More importantly the information gleaned from this study offers direction for future research with urban pest ants. Our findings indicate several species which are economically significant, but have not yet been studied.

MATERIALS AND METHODS

This survey was designed to last one year (January 1, 1993 -December 31, 1993). Thirty-one pest control offices of Terminix International Co. located throughout the state were notified by mail of the survey along with instructions for collecting specimens and completing survey questionnaires. Technicians were directed to collect specimens and complete questionnaires from each site of infestation when responding to a customer complaint for ants. Pest control offices were supplied with isopropyl alcohol, plastic whirl-pak bags, 7-dram, snap-top, plastic vials and preaddressed, padded envelopes for mailing specimens to us. One of us (LDJ) identified specimens with an Olympus binocular dissecting microscope, using the following taxonomic keys: Creighton (1950), Bolton (1979), Trager (1984, 1988), Deyrup et al. (1985), Naves (1985), Johnson (1988), Snelling (1988), and Hölldobler & Wilson (1990).

RESULTS AND DISCUSSION

The total number of samples identified was 810. Response was heaviest in four major metropolitan areas: Daytona/Orlando (Region I), Tampa Bay (Region II), Sarasota/Ft. Myers (Region III) and greater Miami (Region IV). Of this total, 80% consisted of eight common species (Table 1). Of these eight species within the four regions, carpenter ants (20%) were the most frequently encountered; however, they were represented predominantly by two different species [*Camponotus abdominalis floridanus* (Buckley), *C. tortuganus* Emery], while each of the other six common pest ants were represented by a single species. The red imported fire ant (14%), *Solenopsis invicta* Buren, which is a significant medical and agricultural pest, was common in our survey, indicating its importance in urban situations as well. Equally abundant was the ghost ant (14%), *Tapinoma melanocephalum* (F.), and crazy ant (14%), *Paratrechina longicornis* (Latreille). The Pharaoh ant (11%), *Monomorium pharaonis* (L.), was next in abundance and, along with the red imported fire ant, is probably the best studied of all eight species with respect to its control. A big-headed ant (7%),

TABLE 1. COMMON ANT SPECIES AND THEIR PERCENT FREQUENCY FOR EACH OF THE FOUR REGIONS SAMPLED AND FOR ALL REGIONS COMBINED (N = 667).

Species	Region I	Region II	Region III	Region IV	Overall
<i>Camponotus abdominalis</i>	15	14	10	12	12
<i>Camponotus tortuganus</i>	0	6	10	11	8
<i>Monomorium pharaonis</i>	9	13	12	8	11
<i>Paratrechina bourbonica</i>	6	4	4	2	4
<i>Paratrechina longicornis</i>	8	19	10	14	14
<i>Pheidole megacephala</i>	6	2	5	13	7
<i>Solenopsis invicta</i>	20	14	21	6	14
<i>Tapinoma melanocephalum</i>	8	14	10	21	14
Other species	28	14	18	13	16

Pheidole megacephala (F.), was next to the last in abundance. In several locations (Boynton Beach, Port Charlotte, Ft. Myers and Ft. Lauderdale) extensive infestations of *P. megacephala* were found around exterior building perimeters, ornamental plant bases, sidewalks and driveways. Deyrup (1991a) reports on a huge extended colony at one site on Key Largo. Owners of infested structures typically complained of finding hundreds of dead, dying and live ants inside daily. Finally, *Paratrechina bourbonica* (Forel) (4%) was the least abundant. Little is known about control for this last ant pest. Numerous other occasional ant pests made up the remaining 20% of the species, and consisted of many ants not commonly encountered in structural pest control (Table 2).

In a similar survey that we conducted in New Jersey (Klotz et al. 1994), carpenter ants were also the most common ant pest. Carpenter ants in the Pacific Northwest (Furniss & Carolin 1977) and in the northeastern part of the U.S. (Fowler 1983) are considered as important, if not more so, than termites as structural pests. In a survey of the urban ants of California, Knight & Rust (1990) ranked carpenter ants as fourth and the fire ant, *Solenopsis xyloni* McCook, second in frequency. Recognizing the limited amount of information on the extent of damage caused by carpenter ants, we feel they are making a significant economic impact on a national scale.

Carpenter ants, ghost ants, and Pharaoh ants are primarily problems indoors, but a significant proportion of all three are found outdoors (Fig. 1). Of particular interest are Pharaoh ants, which in the past have been considered exclusively indoor pests. In addition to our survey, however, Knight & Rust (1990), Haack (1991) and Oi et al. (1994) showed them to be foraging outdoors, with the latter two authors effectively controlling them with outdoor baiting.

It is a well known fact that carpenter ants have cryptic nesting habits, making their nests very difficult to find. For the majority of the other ant species, except for fire ants which are primarily nesting outside, PCEs were unable to locate their nest sites (Fig. 2). These results indicate the importance of bait development, which would preclude the necessity of finding the nest in order to treat.

Most customers were calling PCEs for ant control because the ants were perceived as a nuisance (Fig. 3). This is true even for carpenter ants, which are considered to be wood-destroying organisms. There were a few cases of food infestation with ghost and Pharaoh ants, and several cases of biting and stinging by fire ants (Fig. 3).

TABLE 2. OCCURRENCE OF OCCASIONAL PEST ANTS, THE LOCATION WHERE THEY WERE COLLECTED AND THE COUNTIES WHERE THEY WERE COLLECTED.

Species (Samples)	Collection Location ¹		County
	No. Inside	No. Outside	
<i>Brachymyrmex</i> spp. (8) ²	5	3	Collier, Hillsborough, Palm Beach, Pinellas, Sarasota
<i>B. musculus</i> (2)	1	1	Duval, Polk
<i>B. obscurior</i> (5)	3	2	Broward, Collier, Lee, Orange
<i>Camponotus</i> spp. (5) ²	3	2	Palm Beach, Pinellas, Seminole, St. Lucie
<i>C. castaneus</i> (10)	6	9	Brevard, Flagler, Hernando, Hillsborough, Polk, Volusia
<i>C. decipiens</i> (2)	2	2	Hillsborough, Volusia
<i>C. planatus</i> (3)	2	3	Broward, Indian River, Lee
<i>C. socius</i> (1)	1	0	Bay
<i>Colobopsis impressus</i> (2)	-	1	Charlotte, Polk
<i>Crematogaster ashmeadi</i> (9)	6	3	Collier, Hillsborough, Palm Beach, Pinellas, Polk
<i>Dorymyrmex bureni</i> (14)	2	11	Bay, Charlotte, Collier, Escambia, Hernando, Jackson, Lee, Orange, Pasco, Pinellas, Seminole, Volusia
<i>Linepithema humile</i> (8)	3	6	Bay, Escambia, Hillsborough, Okaloosa, Pinellas, Walton
<i>Monomorium floricola</i> (8)	5	4	Brevard, Charlotte, Collier, Dade, Lee, Palm Beach, Pinellas
<i>M. trageri</i> (2)	2	1	Jackson, Volusia
<i>Odontomachus ruginodis</i> (7)	3	7	Broward, Charlotte, Collier, Orange, Palm Beach, Pinellas
<i>Paratrechina faisonensis</i> (1)	1	1	Okaloosa
<i>P. pubens</i> (1)	1	1	Palm Beach
<i>Pheidole</i> spp. (6) ²	4	3	Broward, Collier, Palm Beach, Polk, Volusia
<i>P. dentata</i> (4)	1	-	Lee, Palm Beach
<i>P. fallax obscurithorax</i> (2)	1	2	Escambia
<i>P. floridana</i> (2)	1	1	Collier, Orange
<i>P. metallescens</i> (1)	0	1	Hillsborough
<i>P. moerens</i> (5)	4	2	Lake, Pinellas, Seminole, Volusia
<i>P. morrisoni</i> (3)	2	2	Bay, Citrus, Volusia
<i>Platythyrea punctata</i> (1)	1	1	St. Lucie

¹Total may not add up to no. of samples because some samples were found both inside and outside or in the case of (-) were not recorded on the survey questionnaire.²Unidentified male ants.

TABLE 2. OCCURRENCE OF OCCASIONAL PEST ANTS, THE LOCATION WHERE THEY WERE COLLECTED AND THE COUNTIES WHERE THEY WERE COLLECTED.

Species (Samples)	Collection Location ¹		County
	No. Inside	No. Outside	
<i>Pogonomyrmex badius</i> (8)	1	8	Bay, Escambia, Pinellas, Walton
<i>Pseudomyrmex mexicanus</i> (8)	5	4	Broward, Collier, Hillsborough, Lee, Orange, Polk, Sarasota
<i>P. cubaensis</i> (1)	0	1	Palm Beach
<i>Solenopsis geminata</i> (2)	0	2	Collier, Lake
<i>Technomyrmex albipes</i> (8)	5	6	Dade, Palm Beach
<i>Tetramorium simillimum</i> (2)	-	-	Palm Beach
<i>Wasmannia auropunctata</i> (2)	0	1	Broward, Collier

¹Total may not add up to no. of samples because some samples were found both inside and outside or in the case of (-) were not recorded on the survey questionnaire.

²Unidentified male ants.

There were enough carpenter ant alates collected that a slight seasonal difference in swarming is suggested between *C. abdominalis* and *C. tortuganus*, with the former being more evident in late summer and the latter in spring and early summer.

Responses to the last part of the questionnaire on treatment strategy indicate that for ant control PCEs are relying heavily on sprays and dusts (Fig. 4). For Pharaoh and ghost ants there is a significant use of baits, mainly due to the availability of several effective baits for these ants. The lack of baits for the other common species again indicates the necessity for their development, due to their ease of application, efficacy, reduced pesticide use and the consequent environmental safety.

In the following section, the other occasional pest ants (Table 2) are listed in alphabetical order with a brief description of the results from this survey and previous findings.

Brachymyrmex spp.: Two species were collected, *B. obscurior* Forel and *B. musculus* Forel. Alates were collected in nearly half (47%) of the 15 samples, and the alates presence was sometimes the pest problem. For instance alates by the hundreds in screened swimming pools occurred twice. And for one of the authors, JRM, alates are a daily problem in his swimming pool every summer.

Camponotus spp.: Four species, *C. castaneus* (Latreille), *C. decipiens* Emery, *C. planatus* Roger and *C. socius* Roger were collected as occasional pests, in addition to the more common *C. abdominalis* and *C. tortuganus*. *C. castaneus* was the third most frequent carpenter ant (10 samples) with their alates being the typical pest caste found indoors (90% of samples were alates).

Crematogaster ashmeadi Mayr: Of the 6 (Johnson 1988) or 7 (Deyrup et al. 1989) known Florida species, this was the only *Crematogaster* collected as a pest. In several instances nests were located within buildings. Three of the eight samples consisted of alates. In the sample from Hillsborough Co., the bicolored morph (Johnson 1988) was collected.

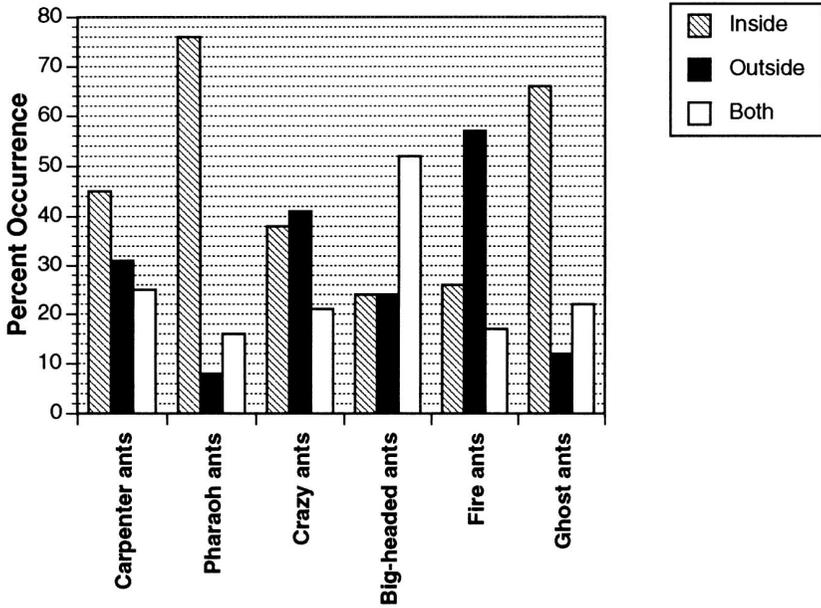


Fig. 1. Frequency of ants located by PCEs inspecting inside, outside, or both inside and outside of structures. Carpenter ants include all *Camponotus* species and crazy ants include *P. longicornis* and *P. bourbonica*.

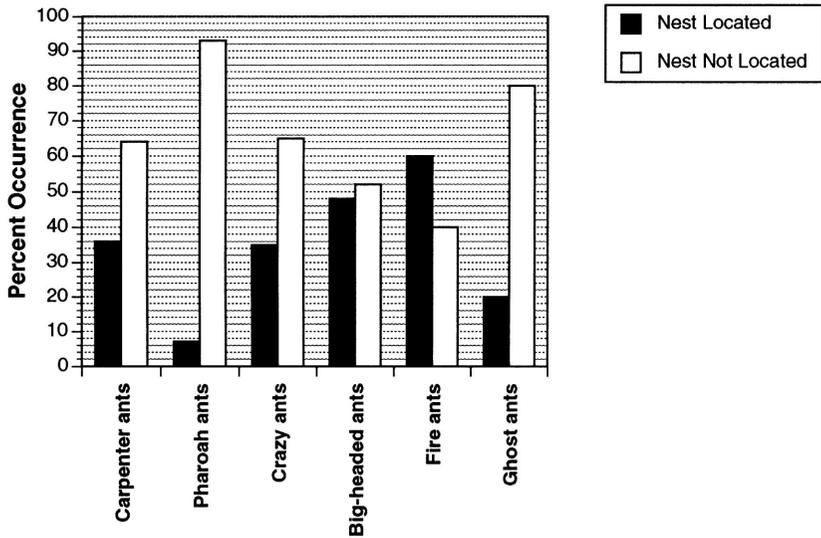


Fig. 2. Frequency of ant nests which were located or not located by PCEs doing inspections. Carpenter ants include all *Camponotus* species and crazy ants include *P. longicornis* and *P. bourbonica*.

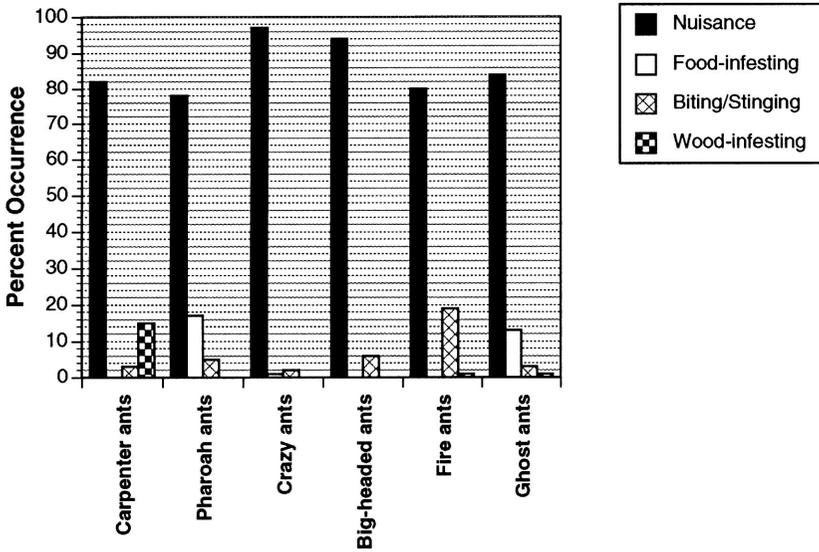


Fig. 3. Frequency of different complaints reported to PCEs from customers with pest ants. Carpenter ants include all *Camponotus* species and crazy ants include *P. longicornis* and *P. bourbonica*.

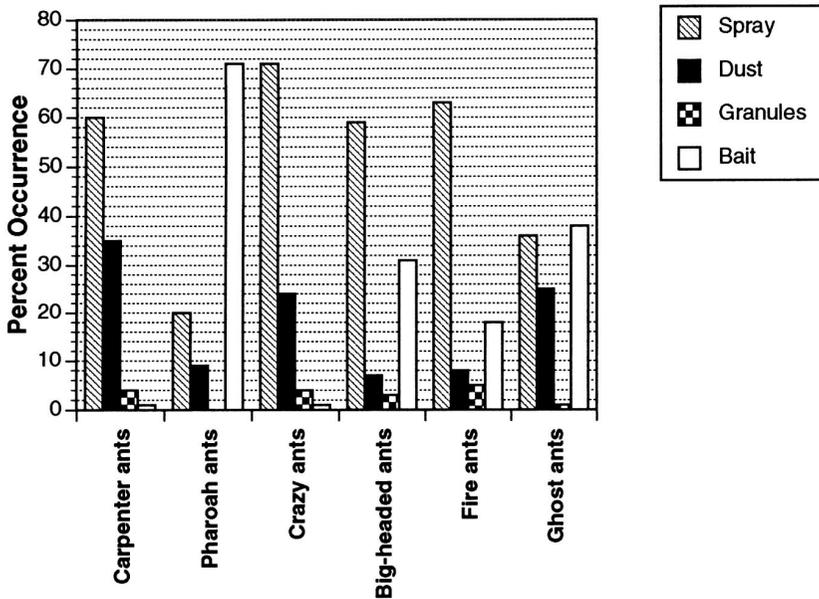


Fig. 4. Frequency of different treatments used by PCEs for control of pest ants. Carpenter ants include all *Camponotus* species and crazy ants include *P. longicornis* and *P. bourbonica*.

- Dorymyrmex bureni* (Trager): This ant is sometimes considered a pest by homeowners, probably due to the conspicuous nest craters it creates in sandy lawns, although 2 of the 12 samples were reported from indoors.
- Linepithema humile* (Mayr): The Argentine ant is widespread, but highly localized in Florida (Deyrup 1991a), possibly due to its displacement by *S. invicta* (Porter et al. 1988). In some areas it is a significant pest invading buildings in large numbers.
- Monomorium floricola* (Jerdon): Smith (1965) stated that it is unknown whether this ant nests inside homes. Five of the 7 samples in this survey were collected inside structures.
- Odontomachus ruginodus* Wheeler: Five of the 7 samples were collected from the outside of structures. The two collections inside were associated with door and window frames. Nests of this ant are often seen in expansion joints in concrete around malls and, in this survey, a sample was collected from a sidewalk and a driveway.
- Paratrechina pubens* (Forel): A home in Boca Raton had numerous ants both inside and outside. The following observations were made prior to the survey by one of the authors (JRM). In 1990, hundreds of these ants were found on the second floor of a large Miami hospital (approximately 712 beds) and around a commercial building near Homestead. Previously they have been collected within USDA greenhouses in Washington D.C. (Trager 1984).
- Pheidole* spp.: In addition to *P. megacephala*, 6 species of *Pheidole* were collected: *P. dentata* Mayr, *P. fallax obscurithorax* Santschi, *P. moerens* Wheeler, *P. floridana* Emery, *P. metallescens* Emery and *P. morrisoni* Forel. None of these six were very numerous indoors or presented any difficulty with control. Smith (1965) includes *P. dentata* and *P. floridana* as structural ant pests.
- Platythyrea punctata* (F. Smith): One sample was collected indoors where they had entered a home and stung the occupants.
- Pogonomyrmex badius* (Latreille): This ant was collected 8 times. Seven of the samples were collected outside, where its nests are large and conspicuous.
- Pseudomyrmex* spp.: Two species were found as pests, *P. mexicanus* (Roger) and *P. cubaensis* (Forel). Of the 5 inside pest collections of *P. mexicanus*, 3 were from nests associated with doors and 2 were from the kitchen. Only a few workers were found. The one sample of *P. cubaensis* was taken from a patio, following a homeowner's complaint about allergic reaction to stings.
- Solenopsis geminata* (Fabricius): Only 2 samples were collected in this survey and this might reflect this ant's absence from coastal areas and preference for coarse, excessively drained soil (Deyrup 1991a).
- Technomyrmex albipes* (F. Smith): Perhaps Florida's newest exotic pest ant, it was collected from 8 homes in Palm Beach and Dade Co.. Deyrup (1991b) reviewed the status of this ant in Florida, mentioning 1986 and 1990 collections from Dade Co. Two of the 8 infested homes had large multiple invasions of worker ants for several years, with colonies established in exterior walls and attics. Alates inside two of the homes were also a nuisance. Based on reports of Yamauchi et. al (1991) of huge polydomous colonies with several million workers and its house pest status in South Africa (Prins et al. 1990), it may have tremendous potential as

a widespread pest ant in Florida. It is also known to enter switches of relays (Little 1984) and were responsible for disabling a light switch in one Palm Beach Co. home.

Tetramorium simillimum (F. Smith): Both samples of this ant from Palm Beach Co. were alates causing a nuisance problem.

Wasmannia auropunctata (Roger): Only two samples were collected. The low incidence of this ant is surprising given its widespread occurrence in 15 Florida counties (Deyrup et al. 1989) and common occurrence around structures in south Florida (JRM unpublished). Ulloa-Chacon & Cherix (1990) classify it as both an agricultural and structural pest.

This study presents a snapshot of Florida pest ants in 1993. Many of the exotic pest ants in Florida are well known invaders (Deyrup 1991a; Porter et al. 1988) including *S. invicta*, *P. megacephala*, *L. humile* and *W. auropunctata*. Other exotic common and occasional Florida pest ants such as *T. melanocephalum* and *T. albipes* appear to be extending their range.

ACKNOWLEDGMENTS

We thank the pest control employees of Terminix International Co. L.P. for their careful and diligent collection of ant specimens and completion of survey questionnaires. We also thank Mark Deyrup, Archbold Biological Station, Lake Placid, Florida; Stefan P. Cover, Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts; Phil Ward, University of California, Davis; and Roy Snelling, Los Angeles County Museum for help with identification.

REFERENCES CITED

- AKRE, R. D., AND L. D. HANSEN. 1990. Management of carpenter ants, pp. 693-700 in R. K. Vander Meer et al. [eds.], Applied myrmecology, a world perspective. Westview Press, Boulder, Colorado.
- BANKS, W. A. 1990. Chemical control of the imported fire ants, pp. 596-603 in R. K. Vander Meer et al. [eds.], Applied myrmecology, a world perspective. Westview Press, Boulder, Colorado.
- BIEMAN, D. N., AND L. BLOOMCAMP. 1987. Ant key for over-the-phone identification. Pest Management 6: 25,27.
- BIEMAN, D. N., AND D. P. WOJCIK. 1990. Tracking ants in Florida. PCO. Florida Pest Control Association service magazine April: 11-13.
- BOLTON, B. 1979. The ant tribe Tetramoriini (Hymenoptera: Formicidae). The genus *Tetramorium* Mayr in the Malagasy region and in the New World. Bull. British Museum (Natural History) Entomol. Series 38: 129-181.
- CREIGHTON, W. S. 1950. The Ants of North America. Bull. Mus. Comp. Zool. Harvard 104: 1-585.
- DEYRUP, M. 1991a. Exotic ants of the Florida Keys. Proceedings of the 4th Symposium on the Natural History of the Bahamas, p. 15-22.
- DEYRUP, M. 1991b. *Technomyrmex albipes*, a new exotic ant in Florida (Hymenoptera: Formicidae). Florida Entomol. 74: 147-148.
- DEYRUP, M., C. JOHNSON, G. C. WHEELER, AND J. WHEELER. 1989. A preliminary list of the ants of Florida. Florida Entomol. 72: 91-101.
- DEYRUP, M., J. TRAGER, AND N. CARLIN. 1985. The genus *Odontomachus* in the southeastern United States (Hymenoptera: Formicidae). Entomol. News 96: 188-195.
- FOWLER, H. 1983. Urban structural pests: carpenter ants (Hymenoptera: Formicidae) displacing subterranean termites (Isoptera: Rhinotermitidae) in public concern. Environmental Entomol. 12: 997-1002.

- FURNISS, R., AND V. M. CAROLIN. 1977. Western forest insects. USDA FS Misc. Publ. No. 1339, 654 pp.
- HAACK, K. D. 1991. Elimination of Pharaoh ants, an analysis of field trials with Pro-Control and Maxforce ant baits. *Pest Control Technology* 19: 32-33,36,38,42.
- HEDGES, S. A. 1992. Field guide for the management of structure-infesting ants. *Pest Control Technology* series, Franzak & Foster Co., Cleveland. 155 pp.
- HÖLLDOBLER, B., AND E. O. WILSON. 1990. *The Ants*. Belknap Press, Cambridge, Mass. 732 pp.
- JOHNSON, C. 1988. Species identification in the Eastern *Crematogaster* (Hymenoptera: Formicidae). *J. Entomol. Sci.* 23: 314-332.
- KLOTZ, J. H., G. GOVEIA, L. DAVIS, AND B. L. REID. 1994. Surgical strikes. *Pest Control Technology* 22: 32-33,36,38,42.
- KNIGHT, R. L., AND M. K. RUST. 1990. The urban ants of California with distribution notes of imported species. *Southwestern Entomol.* 15: 167-178.
- LITTLE, E. 1984. Ants in electric switches: a note. *New Zealand Entomol.* 8: 47.
- NAVES, M. A. 1985. A monograph of the genus *Pheidole* in Florida (Hymenoptera: Formicidae). *Insecta Mundi* 1: 53-90.
- OI, D. H., K. M. VAIL, D. F. WILLIAMS, AND D. N. BIEMAN. 1994. Indoor and outdoor foraging locations of Pharaoh ants (Hymenoptera: Formicidae) and control strategies using bait stations. *Florida Entomol.* 77: 85-91.
- PORTER, S. D., B. V. EIMEREN, AND L. E. GILBERT. 1988. Invasion of red imported fire ants (Hymenoptera: Formicidae): microgeography of competitive replacement. *Ann. Entomol. Soc. America* 81: 913-918.
- PRINS, A. J., H. G. ROBERTSON, AND A. PRINS. 1990. Pest ants in urban and agricultural areas of Southern Africa, pp. 25-33 in R. K. Vander Meer et. al [eds.], *Applied myrmecology, a world perspective*. Westview Press, Boulder, Colorado.
- SMITH, M. R. 1965. House-infesting ants of the eastern United States. *USDA, Technical Bull.* 1326: 105 pp.
- SNELLING, R. R. 1988. Taxonomic notes on nearctic species of *Camponotus*, sub-genus *Mymentoma* (Hymenoptera: Formicidae), pp. 55-78 in J. C. Trager [ed.], *Advances in Myrmecology*. E. J. Brill, Leiden.
- THOMPSON, C. R. 1990. Ants that have pest status in the United States, pp. 51-67 in R. K. Vander Meer et. al [eds.], *Applied myrmecology, a world perspective*. Westview Press, Boulder, Colorado.
- TRAGER, J. 1984. A revision of the genus *Paratrechina* (Hymenoptera: Formicidae) of the continental United States. *Sociobiology* 9: 49-162.
- TRAGER, J. 1988. A revision of *Conomyrma* (Hymenoptera: Formicidae) from the southeastern United States, especially Florida, with keys to the species. *Florida Entomol.* 71: 11-29.
- ULLOA-CHACON, P., AND D. CHERIX. 1990. The little fire ant *Wasmannia auropunctata* (R.) (Hymenoptera: Formicidae), pp. 281-289 in R. K. Vander Meer et. al [eds.], *Applied myrmecology, a world perspective*. Westview Press, Boulder, Colorado.
- WILLIAMS, D. F. 1990. Effects of fenoxycarb baits on laboratory colonies of the Pharaoh's ant, *Monomorium pharaonis*, pp. 676-683 in R. K. Vander Meer et al. [eds.], *Applied myrmecology, a world perspective*. Westview Press, Boulder, Colorado.
- WHITMORE, R. W., J. E. KELLY, AND P. L. READING. 1992. National home and garden pesticide use survey, final report, Volume 1: executive summary, results, and recommendations. U.S. Environmental Protection Agency
- YAMAUCHI, K. T., T. FURUKAWA, K. KINOMURA, H. TAKAMINE, AND K. TSUJI. 1991. Secondary polygyny by inbred wingless sexuals in the dolichoderine ant *Techonomyrmex albipes*. *Behav. Ecol. Sociobiol.* 29: 313-319.