Proceedings of the Sixth International Conference on Urban Pests
William H Robinson and Dániel Bajomi (editors), 2008
Printed by OOK-Press Kft., H-8200 Veszprém, Pápai út 37/a, Hungary

SEASONAL OCCURRENCE OF SWARMING ACTIVITY AND WORKER ABUNDANCE OF *PACHYCONDYLA CHINENSIS* (HYMENOPTERA: FORMICIDAE)

PATRICIA A. ZUNGOLI AND ERIC P. BENSON
Department of Entomology, Soils and Plant Sciences, Clemson University
Clemson, SC 29634-0315 USA

Abstract The introduced ant, *Pachycondyla chinensis* (Emery) (Hymenoptera: Formicidae) is a pest in northwestern South Carolina, and areas of North Carolina and Tennessee in the United States. First documented in the United States over 70 years ago, it only recently has achieved pest status. This exotic species originating from Asia, poses a health threat because of allergic reactions elicited by its sting. *Pachycondyla chinensis* also may pose a threat to ant communities in locations where it occurs. In the study reported here we assessed the seasonal occurrence of *P. chinensis* workers and alates in northwestern South Carolina USA. Pitfall traps were established in three locations in or near Clemson, SC USA to collect *P. chinensis* workers from January 2007 through March 2008. Worker activity was documented in January, but consistent activity was not recorded until late March. Ant worker activity began declining in September, was inconsistent in October, and by November, workers were no longer present in pitfall traps. Ground-dwelling colonies were not observed after this time. Light traps were operated in three locations in or near Clemson, SC USA from March through November 2007. We determined that *P. chinensis* began swarming in late May, peaked in mid-July and declined sharply by early August. Minimal swarming continued into September. Male alates were differentially captured in light traps by a mean ratio of 19♂:1♀.
Key Words Asian needle ant, ant abundance, pitfall trap, light trap

INTRODUCTION

The Asian needle ant, *Pachycondyla chinensis* (Emery) (Hymenoptera: Formicidae), is an adventive, stinging ant endemic to southeastern Asia. It is emerging as a public-health threat and a dominant species in the urban and forest habitats in which it is found (Nelder et al., 2006; Paysen, Zungoli, Nelder and Benson, unpublished data). Although abundant in some areas, it is rarely identified. *Pachycondyla chinensis* was first reported in the United States more than 70 years ago from Decatur, Dekalb County, Georgia, and simultaneously was reported in several locations in North Carolina and Virginia (Smith, 1934). The range of this species in North America is documented as Alabama, Georgia, North Carolina, South Carolina, Tennessee and Virginia (Carter, 1962; Nuhn, 1977; Smith, 1979; MacKay and Vinson, 1989; Ipser et al., 2004; Zettler et al., 2004; Paysen, Zungoli, Nelder, and Benson, unpublished data). The literature on the biology of this Ponerine ant is incomplete in North America, but it prefers nesting in dark, damp areas in soil beneath stones, logs, stumps, and debris (Smith, 1934; Creighton, 1950; Smith, 1979), which is consistent with literature from Japan (Gotoh and Ito, 2008). Where it occurs locally in northwestern South Carolina, we find *P. chinensis* in the previously identified habitats and under mulch, railroad ties, ornamental stones, concrete pavers, and other elements common in urban settings. Colony sizes previously were reported to range from approximately 20 to several hundred individuals often with several dealated females per nest (Creighton, 1950). However, recent collections indicate a range of colony sizes from a single nest site with 39 individuals to multiple, contiguous-nest sites with over 5,000 individuals (Paysen, Zungoli, Nelder and Benson, unpublished data). When present in urban and forest habitats in upstate South Carolina, *P. chinensis* is a dominant ant species (Paysen, Zungoli, Nelder and Benson, unpublished data). When established, *P. chinensis* may alter the ant community structure, and presumably the overall biodiversity.

In addition to its potential to displace native ants, *P. chinensis* also poses a threat to public health. The venom of *P. chinensis* is known to cause a broad range of allergic reactions from local urticaria to

anaphylaxis. Systemic allergic reactions have been reported in *P. chinensis* sting victims from Japan, South Korea, and recently, North Carolina and South Carolina where it has been documented as an emerging public-health threat (Yun et al., 1999; Kim et al., 2001; Cho et al., 2002; Fukuzawa et al., 2002; Leath et al., 2006; Nelder et al., 2006).

Gotoh and Ito (2008) reported on the seasonality of colony structure in western Japan. However, no data are available for North America. We anticipate an increased need for pest management information as *P. chinensis* is documented in more locations especially in light of the health threat it poses. The fundamental starting point for designing an integrated management program for any pest species is its life history. The objective of the research reported here was to determine the seasonal activity of *P. chinensis* workers and alates in South Carolina.

MATERIALS AND METHODS

Ten pitfall traps were placed at each of three locations in or near Clemson, SC USA January 2007 through March 2008 to monitor the seasonal activity of *P. chinensis* workers. Trap placement was determined based on proximity to habitats characteristic of typical colony sites for *P. chinensis* such as near mulched patches under trees, near stones and rocks in protected areas, and by stumps where ants were spotted. Traps consisted of a test tube (2 cm x 15 cm) inserted into a tight-fitting outer PVC sleeve of equal length. The sleeved test tube was inserted into the soil with the top lip flush with the soil surface. Test tubes were half filled with propylene glycol (Camco Mfg., Greensboro, NC USA). The opening was covered by a 10 cm square of vinyl tile to prevent rain from flooding the test tube. A nail, approximately 7.5 cm in length was pushed through the vinyl into the ground to anchor it over the test tube. Test tubes were removed to collect the contents weekly and the sample was returned to the lab for sorting and counting. Fresh propylene glycol was added to test tubes each week and returned to the PVC sleeve and covered.

New Jersey light traps (Bioquip Products Inc., Rancho Dominguez, CA USA) were operated in three locations in or near Clemson, SC USA from March to November 2007 to monitor seasonal flight activity of *P. chinensis* alates. Light trap catch jars were half filled with 80% ethyl alcohol. Each day, lights were turned on by a timer from 1900 hr until 700 hr the following morning. Light trap catches were collected weekly and returned to the laboratory where ant gender and number were evaluated.

Temperature data were obtained from almanac.com. Data were generated from the Clemson-Oconee Weather Tower located at the Clemson Oconee County Airport (34°40.18 N, 82°53.11 W).

RESULTS AND DISCUSSION

Pachycondyla chinensis workers were active from January 2007 through October 2007 (Figure 1). Although worker activity was documented in January 2007, mean trap catches were <1 worker/trap until March and did not begin to increase substantially until April (Table 1). Pitfall trap catches peaked in July/August and maintained a high level through mid-September. A sharp decline in activity as documented by pitfall trap catches began at that point until all activity ceased at the end of October. Worker inactivity also was marked by the disappearance of ground colonies, although colonies could still be located in stumps and logs in December. Presumably colonies move further beneath the soil surface. There were no trap catches in 2008 until March. Mean temperature in January-March 2007 was higher than January-March 2008 (Figure 1). Higher temperature may explain why workers were active in January through March 2007, but not for the same time period in 2008. Activity was documented when the mean weekly temperature was approximately at or above 15°C.

Table 1. Mean (±SD) weekly pitfall trap catches of *Pachycondyla chinensis* workers in Clemson, South Carolina USA from January 2007 to March 2008 and total standard deviations for each week. Date reported is the date on which traps were collected and refreshed. Numbers are rounded to nearest whole number.

Date 01/07 thru 06/07	Mean (±SD) Workers	Date 07/07 thru 08/07	Mean (±SD) Workers	Date 09/07 thru 03/08	Mean (±SD) Workers
01/05/07	<1±<1	05/04/07	11±24	09/07/07	106±218
01/12/07	<1±<1	05/11/07	8±21	09/14/07	94±164
01/19/07	<1±<1	05/18/07	21±42	09/21/07	26±41
01/26/07	0±0	05/25/07	15±20	09/28/07	36±47
02/02/07	0±0	06/01/07	9.±10	10/05/07	26±31
02/09/07	<1±<1	06/08/07	18±23	10/12/07	11±24
02/16/07	<1±<1	06/15/07	18±23	10/19/07	4±8
02/23/07	0±0	06/22/07	26±37	10/26/07	3±8
03/02/07	<1±<1	06/29/07	21±28	11/02/07	<1±1
03/09/07	<1±12	07/06/07	14±33	11/09/07	<1±1
03/16/07	1±5	07/13/07	14±19	11/16/07	<1±1
03/23/07	<1±1	07/20/07	25±52	11/23/07	<1±1
03/30/07	3±7	07/29/07	68±180	11/30/07	<1±<1
04/06/07	2±4	08/03/07	32±93	12/07/07	<1±<1
04/13/07	<1±1	08/10/07	99±228	12/14/07	<1±1.11
04/20/07	1±4	08/17/07	80±165	12/21/07 - 03/07/08	0±0
04/27/07	6±23	08/24/07	117±187	03/14/08	<1±<1
		08/31/07	112±306		

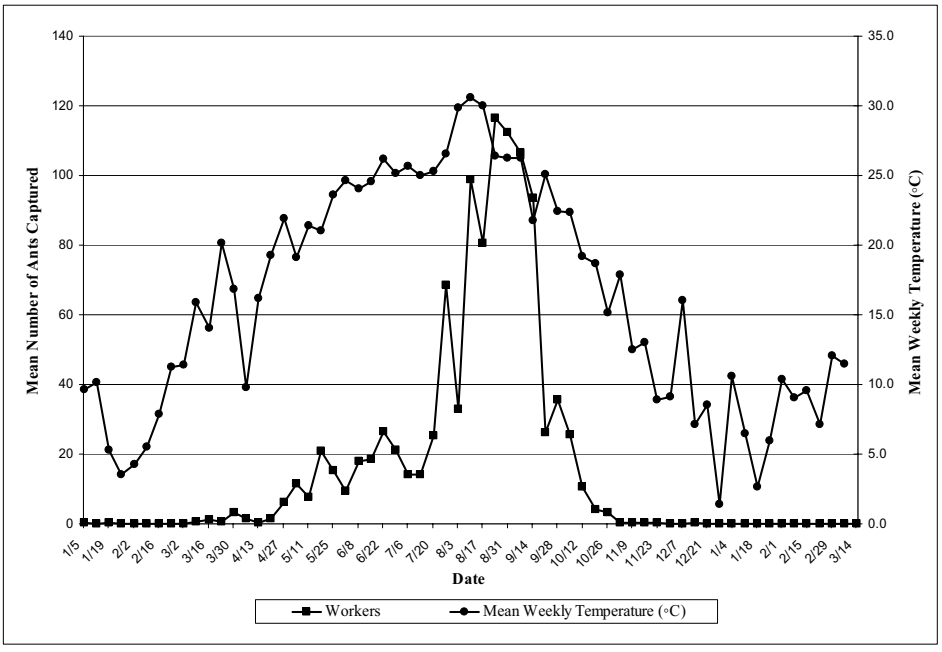

Figure 1. Mean weekly temperature (°C) compared to mean number of *Pachycondyla chinensis* workers captured in 10 pitfall traps at each of three locations in or near Clemson, South Carolina USA from January 2007 to March 2008.

Variability in *P. chinensis* worker trap catches was high as indicted by the standard deviations reported (Table 1). This was particularly notable during July, August and September when worker numbers were experiencing the largest increases and decreases in activity. Traps with highest trap counts were in proximity to what appeared to be polydomous colonies with multiple brood areas. In most cases, colony location was predictable based on the surrounding habitat.

Few other invertebrates were captured and no other ants were collected in pitfall traps indicating that *P. chinensis* was the dominant terrestrial ant competitor to the exclusion of other species in the habitats in which pitfall traps were placed. The primary invertebrates collected with *P. chinensis* were sowbugs and millipedes. Other ants, not collected in pitfall traps, but observed in the terrestrial environment, were *Camponotus* spp. and *Crematogaster* spp. However, in Clemson, species in these genera tend to nest in arboreal habitats and may avoid prolonged terrestrial interactions with *P. chinensis* which we have never found above ground-level.

Although light traps were operated beginning in March, *P. chinensis* alates were captured only from late May until September (Figure 2). Peak activity occurred in late July/early August, declined sharply by late August, and ceased by the last trapping date for September. Increases in temperature and alate number did not coincide before or after the large flush of alates were detected with light trap catches (Figure 2). However, if alates do not overwinter in the colony, as is suspected, but are produced when colony activity begins in the spring, there would be a natural lag in their appearance at light traps.

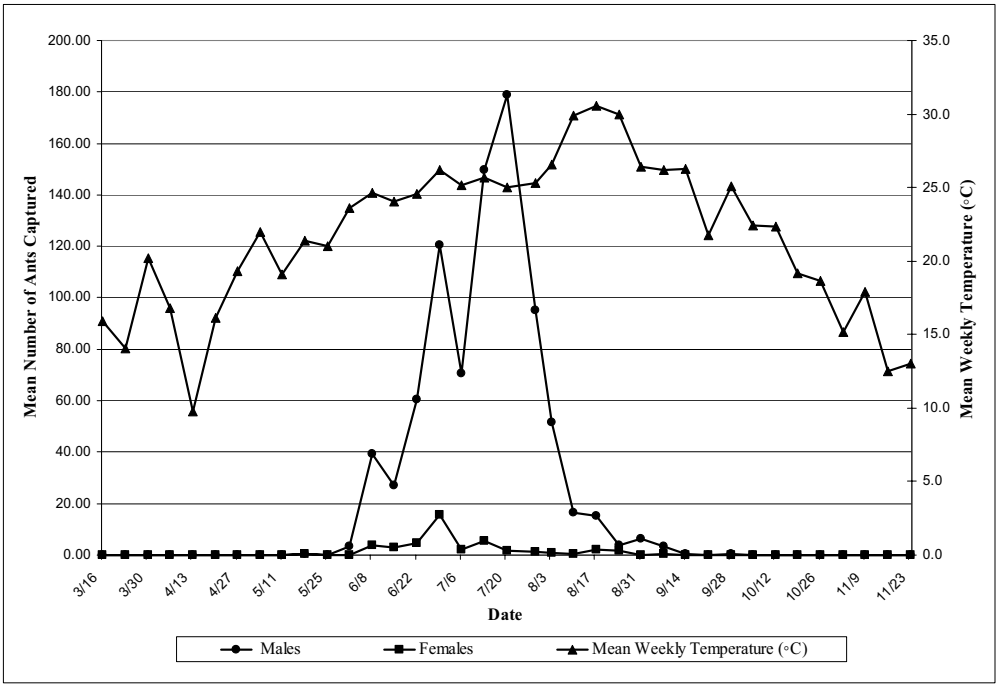

Figure 2. Mean weekly temperature (°C) compared to *Pachycondyla chinensis* alates captured by New Jersey light traps at three locations in or near Clemson, South Carolina USA from March 2007 to November 2007.

Other weather related parameters may influence swarming behavior. However, peak light trap collections dates were closely aligned with peak pitfall trap catches with similar high variability (Tables 1 and 2).

Males were captured more frequently than females at a rate of 19♂:1♀ (3,330:172) overall (Table 2). At the peak of alate activity at light traps the ratio increased to approximately 102♂: 1 ♀ (715:7). Male alates also were observed in higher numbers than female alates within colonies during this period (Zungoli, unpublished data). We cannot determine if the difference in male and female trap catches is an artifact of the light trap design or if male numbers are indicative of the mating strategy for this Ponerine species.

Female workers often were observed carrying male alates to the edges of the colonies, whereby males would take flight. Males, alone, also would position themselves at an edge or "high" spot in the colony to take off. Hölldobler and Wilson (1990) discussed adult transport behavior, but in the context of colony emigration. The behavior we observed was not emigration behavior. Other carrying behavior between female workers also was observed, but the purpose was not discernible.

Table 2. Mean ±SD weekly New Jersey light trap catches of *Pachycondyla chinensis* male and female alates in Clemson, South Carolina USA from May to October 2007 and sex ratio for each week. Date reported is the date on which traps were collected and refreshed. Numbers are rounded to nearest whole number.

Date	Mean±SD ♂	Mean±SD ♀	Total±SD ♂+♀	Sex ratio ♂ : ♀
05/11/07	0±0	0±0	0±0	0 : 0
05/18/07	1±1	1±1	2±1	1:1
05/25/07	0±0	0±0	0±0	0:0
06/01/07	14±7	0±0	14±5	14: 0
08/08/07	158±74	16±6	174±52	10:1
06/15/07	109±51	19±5	128±36	6:1
06/22/07	242±120	63±8	305±84	4:1
06/29/07	482±226	8±23	490±159	61:1
07/06/07	283±130	22±3	305±93	13:1
07/13/07	598±285	22±3	620±202	27:1
07/20/07	715±357	7±3	722±252	102: 1
07/29/07	380±158	5±2	385±115	77 : 1
08/03/07	206±84	3±1	209±61	69:1
08/10/07	66±33	2±1	68±23	33:1
08/17/07	61±29	9±2	70±20	8:1
08/24/07	15±4	6±2	21±3	3:1
08/31/07	26±13	0±0	26±9	26:1
09/07/07	13±5	2±1	15±3	7:1
09/14/07	2±1	2±0	2±1	2:0
09/21/07	0±0	2±0	0±0	0:0
09/28/07	2±1	0±0	2±1	2:0
10/05/07	0±0	1±0	0±0	0:0

CONCLUSIONS

These results indicate that in South Carolina, *P. chinensis* worker activity begins in early spring when mean weekly temperature is approximately 15°C. Worker activity increases slowly until it peaks in late July/ early August and declines sharply until it ceases in October. Temperature and alate activity do not appear as closely linked as temperature and worker activity, but peaks occur in both measures within one to two weeks of each other.

Using these data, we would recommend early intervention for the most efficient reduction in *P. chinensis* colonies. Pest management professionals should target *P. chinensis* habitats in the spring or early summer when the mean weekly temperature is above 15°C and after workers have moved from winter retreats, but before the population peaks. Because nest sites for *P. chinensis* are predicable, a combination of habitat alteration and targeted treatments should be effective.

ACKNOWLEDGEMENTS

The authors thank Antwan Eady, Tammy Edlund, Theresa Pizzuto, Coker Prosser, Sarah Stellwagen, Jessee Wagner and Sherri Wegner for technical support with special thanks to Sonya Prosser for technical support, data entry, and preparation of graphs.

REFERENCES CITED

Bae, G.-R., H.-S. Lim, and B.-J. Kim. 1999. Epidemiologic survey on outbreak of dermatosis associated with ants, *Pachycondyla chinensis.* Korean J. Prev. Med. 3: 421-426.

Carter, W.G. 1962. Ant distribution in North Carolina. J. Elisha Mitchell Sci. Soc. 78: 150-204.

Cho YS., Y-M. Lee, C-K. Lee, B. Yoo, H-S. Park, and H-B. Moon. 2002. Prevalence of *Pachycondyla chinensis* venom allergy in an ant-infested area in Korea. J. Allergy Clin. Immunol. 110:.54-57.

Creighton, W.S. 1950. The Ants of North America. Bull. Mus. Comp. Zool. 104: 1-585.

Eguchi, K., T.V. Bui, S.K. Yamane, H. Okido, and K. Ogata. 2005. Ant faunas of Ba Vi and Tam Dao, North Vietnam (Insecta: Hymenoptera: Formicidae). Bull. Inst. Trop. Agric. Kyushu Univ. 27: 77-98.

Fukuzawa M., F. Arakura, Y. Yamazaki, H. Uhara, and T. Saida. 2002. Urticaria and anaphylaxis due to sting of an ant (*Brachyponera chinensis*). Acta Derm-Venereol. 82: 59.

Green, O.R. 1992. New Zealand ants (Hymenoptera: Formicidae). Distribution and effects, pp. 67-72. *In* Symposium: Social and Harmful Insects. Proc. 41st Ann.Conf. Entomol. Soc. New Zealand, Heretavnga, Hutt Valley, NZ.

Gotoh, A. and F. Ito. 2008. Seasonal cyle of colony structure in the Ponerine ant *Pachycondyla chinensis* in western Japan (Hymenoptera: Formicidae). Insect Soc. 55: 1-7.

Hölldobler, B. and E.O. Wilson. 1990 The Ants. Belknap, Cambridge, MA

Hunter, J.E. 1974. Mites of the genus *Oplitis* Berlese (Acarina: Uropodidae) associated with ants (Hymenoptera: Formicidae) in the southeastern United States. M.S. thesis, North Carolina State University, Raleigh, NC.

Hunter, J.E., and M.H. Farrier. 1975. Mites of the genus *Oplitis* Berlese (Acarina: Uropodidae) associated with ants (Hymenoptera: Formicidae) in the southeastern United States. Part I. Acarologia 17: 595-623.

Ipser, R.M., M.A. Brinkman, W.A. Gardner, and H.B. Peeler. 2004. A survey of ground-dwelling ants (Hymenoptera: Formicidae) in Georgia. Fla. Entomol. 87: 253-260.

Kim S-S., H-S. Park, H-Y. Kim, S-K. Lee, and D-O. Nahm. 2001. Anaphylaxis caused by the new ant, *Pachycondyla chinensis*: demonstration of specific IgE and IgE-binding components. J. Allergy Clin. Immunol. 107: 109-1099.

Leath, T.M., T.J. Greier, R.S. Jacobson, M.E. Fontana-Penn. 2006. Anaphylaxis to *Pachycondyla chinensis*. J. Allery Clin. Immunol. 117 Supplement 1: Abstracts S129.

MacKay, W.P., and S.B. Vinson. 1989. A guide to species identification of New World ants (Hymenoptera: Formicidae). Sociobiology 16: 3-47.

Nelder, M.P., E.S. Paysen, P.A. Zungoli, and E.P. Benson. 2006. Emergence of the introduced ant *Pachycondyla chinensis* (Formicidae: Ponerinae) as a public health threat in the southeastern United States. J. Med. Entomol. 43(5): 1094-1098.

Nuhn, T.P. 1977. A survey of the ants (Hymenoptera: Formicidae) on the campus of North Carolina State University at Raleigh. M.S. thesis, North Carolina State University, Raleigh, NC.

Paysen, E.S., P. A. Zungoli, and E.P. Benson. 2007. Packing a punch. Pest Control Technology. 35 (4): 55, 56, 58, 60.

Peck, S. L., B. McQuaid, and C. L. Campbell. 1998. Using ant species (Hymenoptera: Formicidae) as a biological indicator of agroecosystem condition. Environ. Entomol. 27: 1102-1110.

Smith, M.R. 1934. Ponerine ants of the genus *Euponera* in the United States. Ann. Entomol. Soc. Am. 27: 558-564.

Smith, D.R. 1979. Formicoidea, pp. 1323-1467. *In* K. V. Krombein, P. D. Hurd, Jr., D. R. Smith, and B. D. Burks [eds.], Catalog of Hymenoptera in North America north of Mexico. Vol. 2. Apocrita (Aculeata). Smithsonian Institution Press, Washington, D.C.

Teranishi, Y. 1929. Habits and distributions of Japanese ants II. Zool. Mag. 41: 312-332.

Yun Y-Y, S-H. Ko, J-W. Park, and C.S. Hong. 1999. Anaphylaxis to venom of the *Pachycondyla* species ant. J. Allergy Clin. Immunol. 104: 879-882.

Zettler, J.A., M.D. Taylor, C.R. Allen, and T.P. Spira. 2004. Consequences of forest clear-cuts for native and nonindigenous ants (Hymenoptera: Formicidae). Ann. Entomol. Soc. Am. 97: 513-518.

Zhenghui, X. 1994. A taxonomic study of the ant genus *Brachyponera* Emery in southwestern China (Hymenoptera: Formicidae: Ponerinae). J. Southwest. For. Coll. 4: 181-184.

Zungoli, P.A., E. S. Paysen, E.P. Benson, and J.S. Nauman. 2005. Colony and habitat characteristics of *Pachycondyla chinensis* (Emery) (Hymenoptera: Formicidae). Proc. 4th International Conf. Urban Pests Singapore.