

## Emergence of the Introduced Ant *Pachycondyla chinensis* (Formicidae: Ponerinae) as a Public Health Threat in the Southeastern United States

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**ABSTRACT** *Pachycondyla chinensis* (Emery) (Formicidae: Ponerinae), a species introduced into North America >70 yr ago, is found throughout Southeast Asia. Stinging of zookeepers by *P. chinensis* at the Greenville Zoo (Greenville, SC) initiated an investigation of this exotic species and a survey of sting victims. Eighty percent of sting victims experienced local reactions, including swelling <5 cm in diameter around the sting site, recurring pain, skin redness, and mild-to-severe urticaria. These symptoms lasted 2 h to 5 d. Twelve percent of the sting victims reported minor reactions, including no swelling, localized redness, minor pain sensation at the time of sting, mild urticaria, and symptoms lasting <1 h. Eight percent of the sting victims reported significant local reactions, including swelling >5 cm in diameter around the sting site, recurring pain, skin redness, severe urticaria, and symptoms lasting 3–14 d. *P. chinensis* represents an emerging public health threat throughout its present range in the southeastern United States (i.e., Georgia, North Carolina, South Carolina, and Virginia). Because of reported adverse reactions to stings of *P. chinensis*, further studies on its ecology and medical and veterinary importance need to be undertaken.

**KEY WORDS** anaphylaxis, non-native species, ponerines, stinging, urticaria

The genus *Pachycondyla* (Formicidae: Ponerinae) comprises ≈200 species, primarily from tropical and subtropical regions of the world (Bolton 1995). Four species of *Pachycondyla* currently exist in North America. The known range of *Pachycondyla chinensis* (Emery) is Georgia, South Carolina, North Carolina, and Virginia (Smith 1934, Carter 1962, Hunter 1974, Hunter and Farrier 1975, Nuhn 1977, Smith 1979, MacKay and Vinson 1989, Peck et al. 1998, Ipser et al. 2004, Zettler et al. 2004). Likewise, the range of *Pachycondyla harpax* (F.) is Louisiana and Texas (Porter and Savignano 1990), *Pachycondyla stigma* (F.) is Alabama and Florida (Deyrup et al. 1989), and *Pachycondyla villosa* (F.) is in Texas (Smith 1979). Several species of *Pachycondyla* are specialized termite predators (Mill 1984) or are nectar feeders; however, most species are leaf litter inhabitants that are generalist scavengers or predators (Wild 2002). The latter is likely the case for *P. chinensis* in the United States (E.S.P., unpublished data), although it is reported as a termite predator in Japan (Teranishi 1929).

*P. chinensis* has been reported from China, Japan, New Zealand, South Korea, Taiwan, the United States, and Vietnam (Teranishi 1929, Smith 1979, Green 1992, Zhenghui 1994, Bae et al. 1999, Eguchi et al. 2005). However, its range is likely much more extensive be-

cause The Museum of Comparative Zoology (Harvard University, Cambridge, MA) contains *P. chinensis* specimens collected from Guam, India, Indonesia, Myanmar, Nepal, Papua New Guinea, Philippines, Solomon Islands, Sri Lanka, and Thailand (S. Cover, personal communication). The first record of *P. chinensis* in the continental United States was from Decatur, Dekalb County, Georgia. Although the exact mode and time of introduction into the United States is unknown, *P. chinensis* was likely introduced by accident sometime before 1932 (Smith 1934). Accidental introductions of ants are frequently reported in plant shipments. *P. chinensis*, for example, was intercepted during the early 20th century in Hamburg, Germany, in plant (*Prunus* spp.) shipments originating in Japan (Smith 1934).

The protein portion of ponerine venom is delivered through a sting and acts as the major allergen responsible for allergic reactions in sting victims. Orivel and Dejean (2001) investigated the effects of venoms from *Pachycondyla* spp. on crickets, *Acheta domesticus* (L.) (Orthoptera: Gryllidae), and suggested that the genus *Pachycondyla* possesses venom containing several histolytic and neurotoxic peptides. Although not fully elucidated, *P. chinensis* venom likely contains amines, formic acid, histamines, hyaluronidase, phospholipases, and terpenes (Ohtaki et al. 1988). Systemic allergic reactions culminating in anaphylaxis (1–2% of

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victims studied) have been reported in *P. chinensis*-envenomed victims from Japan and South Korea (Ohtaki et al. 1988, Yun et al. 1999, Kim et al. 2001, Cho et al. 2002, Fukuzawa et al. 2002). In Pohang, South Korea, *P. chinensis* has been reported as the putative cause of a dermatosis epidemic in a factory where 12 of 73 workers experienced pruritic papules and urticaria (Bae et al. 1999).

Some of the more significant ant species in North America, in terms of medical and veterinary importance, include *Hypoponera punctatissima* (Roger) (Ponerinae), *Pseudomyrmex ejectus* (Smith) (Pseudomyrmecinae), *Solenopsis invicta* (Buren) (Myrmicinae), *Solenopsis xyloni* McCook (Myrmicinae), and *Tetramorium caespitum* (L.) (Myrmicinae) (Akre and Reed 2002, Klotz et al. 2005). *S. invicta* stings can cause painful, pustular lesions; anaphylaxis; seizures; and death in sting victims (deShazo et al. 1990, Candiotti and Lamas 1993, Kemp et al. 2000). Klotz et al. (2005) reported on severe allergic reactions to the sting of *Ps. ejectus* in Florida and Georgia, victims experienced anaphylactic shock accompanied by swollen tongues and respiratory distress, underscoring that ants other than *S. invicta* pose concerns for public health in the United States.

Complaints by zookeepers of the Greenville Zoo (Greenville, Greenville County, South Carolina; 34° 50.58' N, 82° 23.24' W) of painful and itchy ant stings during summer 2004 initiated our investigation. *P. chinensis* was not recognized as a problem at the zoo until 1997 when it was first reported during the building of a new exhibit. Landscaping materials, such as off-site potted plants or soil used in construction of the new exhibit, might have contained *P. chinensis*. Since 1997, zoo personnel have considered *P. chinensis* one of the most pestiferous insects in the zoo. Our objective is to expand the limited information regarding the medical importance of *P. chinensis* in the southeastern United States.

### Materials and Methods

Zookeepers ( $n = 9$ ) completed a survey summarizing their experiences with stinging ants at the zoo. Only surveys with accompanying *P. chinensis* specimens, associated with stings, were included in our results. Zookeepers collected stinging ants into vials containing 80% ethanol. All of the collected ants were later identified as *P. chinensis*. The survey consisted of five questions. 1) Where on the body did the sting occur? 2) What activity were you engaged in when the sting occurred? 3) What were the medical symptoms of the sting (i.e., description of swelling size, pain, urticaria, and redness)? 4) How long did the symptoms persist? and 5) Was medication required to alleviate the symptoms? Surveys made by a single individual that reported stinging on several occasions were treated as a single report in our results. Types of reactions were modified from those presented by Akre and Reed (2002). Minor reactions were characterized by a lack of swelling, localized redness, minor pain sensation at time of sting only, mild urticaria, and

**Table 1.** Summary of *P. chinensis* sting survey, categorized by reaction type and location of sting on victim's body, South Carolina (March–November 2005)

| Reaction type <sup>a</sup> | Location of sting on body <sup>a</sup> | Location of sting victims surveyed |                      | Total ( $n = 25$ ) |
|----------------------------|----------------------------------------|------------------------------------|----------------------|--------------------|
|                            |                                        | Greenville Zoo ( $n = 9$ )         | Clemson ( $n = 16$ ) |                    |
| Minor                      | Legs                                   | 1                                  | 0                    | 1                  |
|                            | Other                                  | 0                                  | 2                    | 2                  |
| Local                      | Legs                                   | 5                                  | 4                    | 9                  |
|                            | Other                                  | 2                                  | 9 <sup>b</sup>       | 11                 |
| Large-local                | Legs                                   | 0                                  | 1                    | 1                  |
|                            | Other                                  | 1 <sup>c</sup>                     | 0                    | 1                  |

<sup>a</sup> See text for explanations of reaction types and location of stings on body.

<sup>b</sup> An individual used diphenhydramine HCl (for swelling and itching).

<sup>c</sup> Individual used diphenhydramine HCl (for swelling) and acetaminophen (for pain).

symptoms lasting <1 h. Local reactions were characterized by swelling <5 cm in diameter around sting site, recurring pain, redness of skin, mild-to-severe urticaria, and symptoms lasting 2 h to 5 d. Large-local reactions were characterized by swelling >5 cm in diameter around sting site, recurring pain, redness of skin, severe urticaria, and symptoms lasting 3–14 d.

To complement zoo data, *P. chinensis* sting victims ( $n = 16$ ) from the Clemson area (includes Anderson, Oconee, and Pickens counties of South Carolina) were surveyed using the protocol outlined above. These sting victims were identified from inquiries made by the public through the Clemson University Cooperative Extension Service. The survey was conducted between March and November 2005. Voucher specimens of *P. chinensis* were deposited in the Clemson University Arthropod Collection and the Museum of Comparative Zoology at Harvard University (Cambridge, MA).

### Results and Discussion

Stinging often occurred when an ant became trapped between the victim's clothing and skin. The most common stinging site (11/25) on victims was the legs and the remainder (14/25), in order of most prevalent to least prevalent, on the buttocks (6), torso (4), arms (2), and hands (2) (Table 1; Fig. 1). In the Greenville Zoo, stings occurred while zookeepers were replacing mulch in outdoor exhibits or indoors during educational programs. In the Clemson area, stings were associated with outdoor activity in wooded areas and in peridomestic situations. Medical manifestations of the stings were classified into three categories (minor, local, and large-local reactions) (Table 1; Fig. 2). Stings were often (17/25) described as an intense pain that faded away and returned frequently over several hours. The pain was frequently reported in areas not confined to the original sting site, a symptom diagnostic of *P. chinensis* stings in the victims we surveyed. Professional medical treatment was not sought for any of the cases reported here. Two



Fig. 1. Male worker of *P. chinensis* collected in Clemson, SC. Scale bar = 4.0 mm.

cases, however, required self-administration of antihistamines (diphenhydramine HCL) for itching/swelling (2/25) and analgesics (acetaminophen) for pain (1/25).

Anaphylactic reactions were reported in 2.1% of *P. chinensis* sting victims in a South Korean town (Cho et al. 2002). To our knowledge, no cases of anaphylaxis or other allergic reactions to *P. chinensis* stings have been reported in the literature for the United States.\* Several plausible reasons for the paucity of sting reaction reports in the United States exist. First, most stings have not been severe enough for victims to seek medical attention. Second, the causative agent (*P. chinensis* venom) in cases of severe reactions may have been identified by victims and medical practitioners as other ant or arthropod species. Ant stings and reactions caused by *P. chinensis* could have been attributed to other stinging ants in the region such as *S. invicta* or *T. caespitum* (Holldobler and Wilson 1990). Third, *P. chinensis* has only recently achieved population levels in the southeastern United States where people are likely to encounter and be stung by this ant. In terms of abundance and frequency of occurrence, *P. chinensis* is currently an ecologically dominant species of litter-dwelling ant in northwestern South Carolina (i.e., Anderson and Pickens counties) forests (E.S.P., unpublished data), emphasizing the importance of this exotic ant in the region.

The reactions from *P. chinensis* stings reported here do not include cases of anaphylaxis; nonetheless, the possibility of anaphylactic reactions after sensitization in certain individuals exists.\* Cross-reactivity between *P. chinensis* venom and honey bee (Hymenoptera: Apidae) or yellowjacket (Vespidae) venom has been demonstrated (Kim et al. 2001, Cho et al. 2002), posing a concern for individuals stung by *P. chinensis*, who are hypersensitive to other hymenopteran venoms. Victims surveyed during this study, who had been stung on multiple occasions (16/25), indicated that subsequent stinging by *P. chinensis* did not increase the severity of reaction (i.e., from a minor/local reaction to a systemic reaction). We cautiously interpret these findings as indication that hypersensitivity has not developed in the victims surveyed during this study.

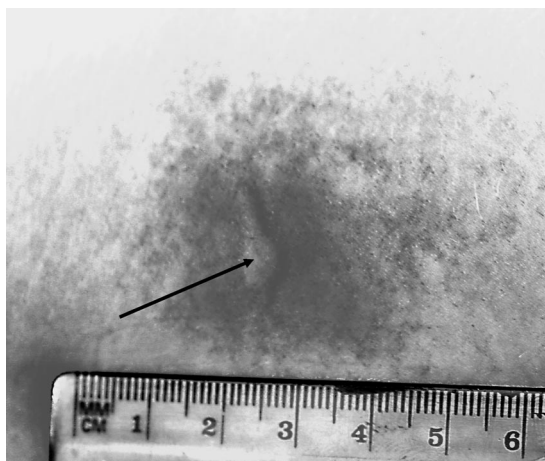


Fig. 2. Typical local reaction to a recent (30-min) *P. chinensis* sting on a victim's upper arm showing inflammation around the sting site (arrow).

There are no reports of *P. chinensis* stinging animals other than humans; however, veterinary concerns could exist. *P. chinensis* has been found in animal bedding at the Greenville Zoo and therefore might have inflicted stings when animals rested on bedding materials. Although not recorded in the United States as a mechanical vector of animal pathogens, *P. chinensis* is an intermediate host for the chicken tapeworm, *Raillietina kashiwarensis* Sawada (Cestoidea: Davaineidae), in Japan (Sawada 1953, 1959).

In conclusion, *P. chinensis* is present throughout northwestern South Carolina and its sting poses a public health threat. In our study, we have shown that *P. chinensis* stings cause local reactions in most victims (80%) and minor reactions (12%) or large-local reactions (8%) in the remainder of victims. The likelihood of systemic reactions is a legitimate concern in South Carolina because *P. chinensis* populations seem to be increasing in abundance and systemic reactions in victims have been demonstrated in Japan

\*Addendum: After this manuscript was typeset, we were contacted through the Clemson University Cooperative Extension Service (Clemson University, Clemson, SC) by an individual who suffered a severe allergic reaction to multiple stings from a single ant (Anderson, Anderson Co., SC; 28 May 2006). After two stings on the thigh and two on the hand, the victim experienced intense pain and itching at the sting sites, and became overheated and nauseous. The victim developed a systemic reaction (anaphylaxis) with hives over her entire body, chest pain, respiratory distress, and swelling of the tongue and face. Three caplets of over-the-counter diphenhydramine HCL (75 mg, Benadryl, Pfizer Inc., New York) were self-administered immediately. The victim was taken to an emergency room where she was treated for anaphylaxis (i.e., administered albuterol sulfate, diphenhydramine HCL, epinephrine, methylprednisolone sodium succinate, and ranitidine HCL). Two days after release from the hospital, the victim brought the dried specimen responsible for the stings to the Clemson University Arthropod Collection for identification. Patricia A. Zungoli (Urban Entomology Laboratory, Clemson University) identified the ant as *P. chinensis*. We inspected the area around the victim's home and found multiple locations in the yard and adjacent forest containing colonies of thousands of *P. chinensis* workers. This is the first report of anaphylaxis caused by *P. chinensis* outside of Japan and South Korea, further underscoring the medical importance of this ant in the United States.

and South Korea. Throughout its range in the United States, *P. chinensis* venom should be considered a causative agent of dermatoses and allergic reactions in cases where an ant sting is suspected. Measures to restrict the further spread of *P. chinensis* should be undertaken in the United States and worldwide; however, further information on its basic biology and ecology is urgently needed before effective quarantine and control can be feasible. A federal quarantine was enacted in 1958 to prevent the spread of *S. invicta* within the United States. The U.S. Department of Agriculture quarantine prevents the movement of hay, sod, soils, used soil-moving equipment, potted plants, and plants with attached soil from infested areas to those that are uninfested (Dowell et al. 1997). A quarantine requiring inspection of nursery stock or other potentially infested materials might be successful in slowing the spread of *P. chinensis* in the United States. Control strategies for Ponerine ants are not documented because they are not typically considered pest species. Until further research is completed, control recommendations for *P. chinensis* are only speculative.

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