Adverse reactions to ants other than imported fire ants

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Objective: To identify ants other than *Solenopsis invicta* and *Solenopsis richteri* reported to cause adverse reactions in humans.

Data Sources: We conducted a literature review to identify reports of medical reactions to ants other than *S invicta* and *S richteri*. Our review of medical and entomological literature on stinging ants was generated from MEDLINE and FORMIS, respectively, using the key words *stinging ants* and *ant stings*. The search was limited to articles in English published from 1966 to 2004 on MEDLINE and all years on FORMIS. We also present 3 new case reports of severe reactions to stings by 2 different species of ants, *Pseudomyrmex ejectus* and *Hypoponera punctatissima*.

Study Selection: Articles that concerned anaphylactic (IgE-mediated) or anaphylactic-like (resembling anaphylaxis but mechanism unknown) immediate reactions to ant stings or bites were included in this review.

Results: Taken together, our data demonstrate that *S invicta* and *S richteri* are not alone in their capability to cause serious allergic or adverse reactions. A diverse array of ant species belonging to 6 different subfamilies (Formicinae, Myrmeciinae, Ponerinae, Ectatomminae, Myrmicinae, and Pseudomyrmecinae) and 10 genera (*Solenopsis*, *Formica, Myrmecia*, *Tetramorium*, *Pogonomyrmex*, *Pachycondyla, Odontomachus*, *Rhytidoponera*, *Pseudomyrmex,* and *Hypoponera*) have now been shown to have this capability.

Conclusion: Awareness that species other than imported fire ants may cause severe reactions should lead to more rapid evaluation and treatment and further investigation of the medical entomology of these ants.

Ann Allergy Asthma Immunol. 2005;95:418–425.

INTRODUCTION

The fire ants *Solenopsis invicta*, *Solenopsis richteri,* and the hybrid *S invicta x richteri* are notorious for their pugnacious behavior and sting both in their native South America and as imported fire ants in the United States. Fire ant venom contains piperidines, which cause a burning sensation in stung individuals, and proteins, which can cause anaphylaxis in a small percentage (<1%) of those stung.[1] Despite the low incidence of allergic reactions, imported fire ants are a growing public health risk in the southern United States, with up to 50% of inhabitants in fire ant endemic regions being stung per year.[1] Caplan et al[2] found that 17% of 200 randomly selected Georgians had specific IgE to the venom of *S invicta*. With an estimated 77,000,000 people living in areas of the United States infested with fire ants in the near future, an increasing number of individuals will be at risk of allergic reaction.[2] Reports of fire ant attacks on debilitated individuals indoors are increasing.[3]

Although most allergic reactions to ants occur following imported fire ant stings as previously described, there are also risks associated with stings from other species of ants. In addition to *Solenopsis*, other ant genera, including *Formica, Myrmecia*, *Tetramorium*, *Pogonomyrmex*, *Pachycondyla, Odontomachus*, *Rhytidoponera*, *Pseudomyrmex,* and *Hypoponera,* have episodically been reported to cause severe reactions. Therefore, we performed a comprehensive review to identify ants other than *S richteri* and *S invicta* reported to cause adverse reactions in humans. In addition, we add to this list 3 new case histories of severe reactions to stings by species of ants that have not been previously reported.

METHODS

Our review of medical and entomological literature on stinging ants was generated from MEDLINE and FORMIS,[4] respectively. FORMIS is a master bibliography of ant literature covering the years 1650 to 2000. We used a keyword search on MEDLINE and FORMIS using *stinging ants* and *ant stings*. The search was limited to articles in English from 1966 to 2004 on MEDLINE and all years on FORMIS. Articles that concerned anaphylactic (IgE-mediated) or anaphylactic-like (resembling anaphylaxis but mechanism unknown) immediate reactions to ant stings or bites were included in this review. Reports of adverse reactions to different species of ants were used to construct Table 1. Those reports with documented case histories were used to construct Table 2.

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Received for publication December 22, 2004.
Accepted for publication in revised form March 3, 2005.

Table 1. Ants Other Than Imported Fire Ants Reported to Cause Adverse Reactions in Humans

Subfamily and species of ant (common name)	Geographic location of stinging incident
Subfamily Formicinae	
Formica rufa (wood ant)	Europe
Subfamily Myrmeciinae	
Myrmecia pilosula (jack jumper ant)	Tasmania, Australia
Myrmecia pyriformis (bull-dog ant)	Tasmania, Australia
Myrmecia forficata (inchman ant)	Tasmania
Subfamily Ponerinae	
Pachycondyla sennaarensis (Samsum ant)	United Arab Emirates
Pachycondyla chinensis	Korea, Japan
Odontomachus bauri (trap-jaw ant)	Venezuela
Hypoponera punctatissima	Connecticut
Subfamily Ectatomminae	
Rhytidoponera metallica (greenhead ant)	Australia
Subfamily Myrmicinae	
Solenopsis xyloni (southern fire ant)	Mississippi, Arizona, California, Texas
Solenopsis aurea (desert fire ant)	California
Solenopsis geminata (tropical fire ant)	Okinawa, Guam, Oahu
Tetramorium spp.	South Carolina
Pogonomyrmex barbatus (red harvester ant)	Texas, Oklahoma
Pogonomyrmex maricopa (Maricopa harvester ant)	Arizona
Pogonomyrmex rugosus (rough harvester ant)	Arizona
Subfamily Pseudomyrmecinae	
Pseudomyrmex ejectus (twig or oak ant)	Georgia, Florida

Three new case reports were documented by 4 of the authors. Case 12 was documented by Dr Frishman, who was contacted as a pest control consultant. In case 22, Dr Suiter received an ant by mail from an extension agent in south Georgia, after its stings caused a severe reaction. Dr Klotz contacted the attending physician and patient to obtain the case history. Case 23 was a patient of Dr Price.

RESULTS

Adverse Reactions From Ants Other Than Imported Fire Ants

Stinging ants, bees, and many species of wasps are aculeate Hymenoptera. In Aculeata the ovipositor of females has been modified into a stinger. The stinger in numerous species of ants is vestigial or absent. However, these ants still possess potent defensive secretions. Ants belong to the family Formicidae, which is further divided into 21 subfamilies,[5] 296 genera,[6] and more than 11,000 described species. Adverse reactions to ants have been reported for 10 genera in 6 subfamilies (Table 1).

Subfamily Formicinae

These ants do not have a stinger but can spray venom, which contains formic acid and other nitrogenous constituents, into wounds inflicted with the mandibles.[7] We found 1 reported case of anaphylaxis associated with a bite from *Formica rufa*, a widespread species in central Europe (Table 2, case 1).[8] The patient's serum was positive for specific IgE against whole-body extract of *F rufa*. As in other subfamilies, the formicines are capable of secreting compounds from the mandibular and Dufour glands along with venom during an aggressive encounter.[7] The source of the allergen in case 1, however, was not identified.

Subfamily Myrmeciinae

Bull-dog ants belong to the primitive genus *Myrmecia,* which are characterized by their aggressive nature, powerful sting, fast movements, and keen vision.[9] There are approximately 120 species, and all are restricted to Australia except one in New Caledonia.[9] The jack jumper ant, in the *Myrmecia pilosula* species complex, is the most common cause of allergic reaction.[10] Suburban life has increased their contact with humans.[11] In Tasmania, allergic reactions to their stings occur in approximately 2.7% of the population, almost twice as often as those to honeybees (1.4%).[12] Other species that are allergenic include the inchman ant, *Myrmecia forficata*,[12] and the bull ant, *Myrmecia pyriformis*.[13] Another species that has been implicated is *Myrmecia nigrocincta*.[10] There appears to be immunologic cross-reactivity of the venom among different species of these ants.[14] Several deaths have been recorded (Table 2, cases 2 to 7).[15,16] In southeastern Australia, most stinging incidents occur in backyards.[13]

Subfamily Ponerinae

Another primitive group is the Ponerinae, which is primarily tropical in distribution. They typically form small colonies with a few hundred individuals.[17] The genus *Pachycondyla* is responsible for most cases of anaphylaxis. Four deaths during a 4-year period have been attributed to the Samsum ant, *Pachycondyla sennaarensis*, which is found in Africa and the Arabian Peninsula.[18,19] In the United Arab Emirates, allergic reactions are more common in women, presumably because they stay primarily at home where the ants are commonly found both indoors and outdoors in the garden.[19]

Another species, *Pachycondyla chinensis* (Table 2, cases 8 and 9),[20,21] causes adverse reactions in the Far East. The generic names, *Brachyponera* (Table 2, case 9)[21] and *Ectomomyrmex* (Table 2, case 10),[22] are synonymous with *Pachycondyla*.[23] Unfortunately, in the latter case the ant responsible was not identified as to species. In ant-infested areas of Korea there is a 2.1% incidence of systemic allergic reactions after stings by these ants.[24] This is similar to the anaphylactic risk to imported fire ants in the southern United States.[24] There is minimal cross-reactivity of *Pachycondyla* to the venom of imported fire ants.[25]

Table 2. Reports of Adverse Reactions to Ants Other Than Imported Fire Ants Where Clinical Data Were Provided

Case No.	Species	Place	Patient age/sex	Medical history
1	*Formica rufa*	Central Europe	12 y/M	Hay fever, previous stings of other Hymenoptera with no reaction
2	*Myrmecia pilosula*	Southern Tasmania	49 y/M	Autopsy revealed pulmonary congestion; known allergy to jack jumper stings
3	*Myrmecia pilosula*	Southern Tasmania	62 y/M	Autopsy revealed severe edema of lips, tongue, upper airways, and lung congestion
4	*Myrmecia pilosula* or *forficata*	Southern Tasmania	40 y/M	Progressively worsening systemic allergic reactions to bull ants; autopsy revealed laryngeal edema
5	*Myrmecia pilosula*	Southern Tasmania	65 y/M	Past allergy to jack jumper ant with unconsciousness; hyposensitization was attempted with whole-ant preparation; autopsy revealed edema of larynx, aryepiglottis, and pharyngeal tissues
6	*Myrmecia pilosula*	Australia or Tasmania	>39 y/M	Mild asthma; autopsy revealed laryngeal edema and moderate coronary atherosclerosis
7	*Myrmecia pyriformis*	Australia or Tasmania	>39 y/M	History of systemic allergic reactions to ants; autopsy revealed laryngeal edema
8	*Pachycondyla chinensis*	Korea	44 y/F	Experienced systemic symptoms 5 to 6 times after ant stings the past 2 y
9	*Pachycondyla* (*Brachyponera*) *chinensis*	Japan	20 y/M	No prior history given
10	*Pachycondyla (Ectomomyrmex)*	Korea	40 y/F	Several anaphylactic reactions in past 3 y
11	*Odontomachus bauri*	Caracas, Venezuela	8 y/F	No history of ant stings
12	*Hypoponera punctatissima*	Storrington, CT	Adult/F	No prior history given
13	*Solenopsis xyloni*	Phoenix, AZ	3 mo/F	
14	*Solenopsis xyloni*	Riverside County, California	Older/F	Moderate local reaction to sting 3 wk before; no pustules developed
15	*Solenopsis xyloni*	Texas	4 y/M	No known history of prior ant stings; history of allergic rhinitis and urticaria with angioedema following a penicillin injection
16	Probable *Solenopsis xyloni*	San Luis Obispo County, California	33 y/F	No prior history given
17	*Solenopsis aurea*	Corona, CA	34 y/F	3 wk before stung 5 times in her home and had wheal-and-flare reactions about 2 cm in diameter at sting sites; no pustules developed
18	*Solenopsis geminata*	Barber's Point, Oahu, HI	32 y/M	One year previously he had been stung on the top of the foot and suffered similar but milder symptoms which lasted about an hour without treatment; never been stung by bees nor had any allergies
19	*Tetramorium*	South Carolina	25 y/F	Patient reported she was stung 6 mo prior with minimal reaction
20	*Pogonomyrmex maricopa*	Tucson, AZ	8 y/M	Received hyposensitization therapy with extract from *Formica*, and a stinging insect mixture but was not protected against a subsequent episode of anaphylaxis
21	*Pogonomyrmex barbatus*	Texas	9 y/F	History of asthma but had not had any wheezing for at least 1 y before sting; history of allergic rhinitis; no known previous sting to Hymenoptera
22	*Pseudomyrmex ejectus*	Thomas County, Georgia	35 y/M	Four episodes of severe reactions to stings by *Pseudomyrmex ejectus* during a 10-y period; during same period stung repeatedly by IFAs without adverse reactions
23	*Pseudomyrmex ejectus*	Lakeland, FL	47 y/F	Immunotherapy for perennial allergic rhinitis; history of anaphylaxis reaction to insect stings; desensitization for IFAs

Abbreviations: CPR, cardiopulmonary resuscitation; IFA, imported fire ant; RAST, radioallergosorbent test; WBE, whole-body extract.
* Extract coupled to activated disks and incubated with patient's serum.

Event	Adverse reaction	Allergy tests	Treatment	Outcome
Forest walk in Sep	Minutes after bite, facial flushing, urticarial exanthema, wheezing, severe dyspnea	Positive skin prick test result and IgE antibody-binding* to WBE	Bronchodilators, corticosteroids	Recovered
Stung on forearm while wood-cutting	Dyspneic and unresponsive within 20 min	Tests not performed	Two antihistamine tablets	Death; left alone for 15–20 min; found dead
Stung while fishing	Tongue and lip swelling and breathlessness	Positive IgE antibody-binding* to venom; elevated serum tryptase level	Resuscitation was unsuccessful	Death; paramedic arrived 20–30 min after sting, patient in cardiac arrest
Stung on foot while in the garden; inebriated	Became increasingly drowsy and was put to bed	Positive IgE antibody-binding* to venom; elevated serum tryptase level	He injected himself with promethazine (50 mg)	Found dead in bed several hours later
Stung on the knee by jack jumper ant while gardening	Immediately felt unwell, itchy, and short of breath; ambulance was called and he collapsed	Positive IgE antibody-binding* to venom; elevated serum tryptase level	Paramedics administered CPR with 13 mg of adrenaline	Intubation on arrival at hospital; resuscitation attempts ceased shortly thereafter
Stung on hand while in garden	Became unresponsive within 5 min	Tests not performed		Death
Stung on hand while gardening	Died within 5 min	Positive IgE antibody-binding* to venom; elevated serum tryptase level		Death
Ants collected in her yard and house	Urticaria on whole body, conjunctival injection, angioedema of her hands and feet; lost consciousness	Positive skin test and ELISA results to abdominal extract of *Pachycondyla chinensis*	Epinephrine, diphenhydramine, and intravenous hydrocortisone	Recovered
Stung repeatedly on the buttock	Hypotension, extensive urticaria without any signs of anaphylaxis; infusion of prednisolone	No venom specific tests performed; positive reaction to *Polistes* venom	Prednisolone administered	Recovered
Stung while working in garden	Urticaria, dizziness, abdominal cramps, shortness of breath, and hypotension	Positive skin test and ELISA results to venom of *Pachycondyla*	Emergency care, specifics not given	Recovered
Stung on middle finger by flying ant while playing in garden	About a minute after sting she complained of burning and itchiness, followed by erythematous, pruriginous lesions; 6 h later with erythematous, papular, pruriginous lesions on arm, hands, posterior trunk, pectoral region, and foot that lasted for 1 wk; developed eosinophilia	Tests not performed	Systemic antihistamine loratadine	Recovered
Nurse stung on duty at health care facility	Shortness of breath, dysphonia, and wheezing	Tests not performed	Treated for anaphylaxis	Recovered
Napping in crib, found covered in ants; received hundreds of stings	Severe respiratory distress	Positive RAST result to WBE of IFA; elevated serum tryptase level	Taken by helicopter to local hospital	Death
Stung outside her home	Anaphylactic reaction complicated by use of β-blockers	Positive skin test and RAST result to IFA WBE and venom, respectively		Recovered
Stung on his right foot by several ants	Within 10 min of sting, he developed diffuse urticaria and pruritus with severe, continuous coughing	Skin tests performed but results not reported (missing from table in publication)	Diphen-hydramine intramuscularly	Recovered; generalized urticaria persisted for 24 h, right foot became severely swollen
Stung inside her house	Generalized urticaria, dyspnea, throat swelling; 24 h later 3 welts on thigh; no pustules developed	Positive RAST result to IFA venom	Treated in emergency department	Recovered
Stung on the leg	Generalized urticaria and swelling of the entire lower leg, which persisted for 3 days; no pustule developed	Tests not performed		Recovered
Stung on the foot by 5 small ants while at the beach	Immediately, intense itching of the foot and tearing; diffuse flushing and tightness in the throat, followed by hives and angioedema of the face; wheezing	Positive skin test result to IFA WBE	Injections of diphenhydramine and adrenalin	Recovered
Stung by a small black ant	Generalized itching, puffy eyes, erythema, initial tachycardia due to fright and respiratory difficulty	Positive skin test result to ant extract (specifics of extract not given)	Two antihistamines orally; arrived at emergency department with respiratory distress, urticaria and hypotension; treated with epinephrine and corticosteroids.	Symptoms subsided, however, patient reported a hard, nonnecrotic nodule remained at the site of sting for approximately 2 wk
History of numerous stings by red ants	Generalized urticaria, laryngeal edema, wheezing	Positive specific skin test	Epinephrine; required hospitalization because of persistent wheezing	Recovered
Stung on the hand by 2 large red ants	During the next 30 min she developed moderately severe asthma and lethargy, which lasted approximately 12 h and not relieved by bronchodilators	Positive skin test results to *Pogonomyrmex rugosus* and IFA (specifics of extracts not given)	Bronchodilators	Sting sites were swollen to about the size of a quarter but resolved over 24 h
Stung on neck by ants that swarmed out of a gatepost	Difficulty breathing, cyanotic, dizzy, swollen tongue, and feeling of "doom"	Tests not performed	Treated with epinephrine and steroids at emergency department	Recovered
Stung by ants that dropped from tree	Tingling all over; felt "funny" and noticed hands and feet were red and itchy; developed generalized pruritus, urticaria, and erythema on entire body; some swelling in mouth, throat, and eyes; large local reaction	Positive skin test result to IFA WBE	Self-administered Benadryl	Recovered

A severe reaction to a sting by *Odontomachus bauri* (Table 2, case 11)[26] was reported in Venezuela, where it is found in gardens.[26]

Members of the genus *Hypoponera* have a vast geographic range and are prevalent on a global scale.[27] Colonies are small (<100 individuals) and nest in soil or rotten wood.[17] They are considered occasional pests because female winged reproductives may sting during their mating flights.[28] *Hypoponera punctatissima* (Fig 1) is an exotic species, possibly originating from Europe, and is now widely established in Florida,[28] and in buildings in New England.[29]

New Case Report: Hypoponera punctatissima

In December 1992, ants identified as *Hypoponera punctatissima* were noted to be swarming from the foundation slab of a health care facility in Storrington, CT. The residents in one wing had to be evacuated in an attempt to control the ants emerging from soil beneath the slab. Patients and one of the nurses were stung. The nurse (Table 2, case 12) developed shortness of breath, dysphonia, and wheezing and was successfully treated for anaphylaxis. In the summer of 1993 at a hospital on Roosevelt Island in New York City, employees in the laundry area reported reactions to stings of *Hypoponera punctatissima*. The ants were noted to be emerging from beneath the slab foundation. They were also present at least 200 ft away in a food storage area in another section of the hospital. The swarming continued into the fall months. In a third location at a hospital in Nassau County, New York, swarms of winged *H punctatissima* were discovered in summer 1993 in 2 patient rooms, but no one was reported stung. Some of the swarmers were discovered in a dresser drawer.

Figure 1. Female winged reproductive of *Hypoponera punctatissima*. Females are approximately 2.7 to 2.9 mm in length.

Subfamily Ectatomminae

The old subfamily Ponerinae has been split up so that *Rhytidoponera* is now in the Ectatomminae.[5] During an 8.5-year period in Queensland, Australia, there were 17 reported allergic reactions to greenhead ants, *Rhytidoponera metallica*.[30]

Subfamily Myrmicinae

In the United States, most adverse reactions to ant stings are caused by species belonging to the Myrmicinae subfamily. Foremost is the genus *Solenopsis*, with more than 80 deaths attributed to imported fire ants.[31] Two fatalities have been recorded for native fire ants, both due to an adverse reaction to stings by the southern fire ant, *Solenopsis xyloni*. One was an 8-month-old child in Keownville, MS,[32] and the other a 3-month-old child in Phoenix, AZ (Table 2, case 13).[33] In the latter case, a positive postmortem radioallergosorbent test result to whole-body extract of imported fire ant and an elevated serum tryptase level confirmed an anaphylactic reaction. Nonfatal allergic reactions to *S xyloni* (Table 2, cases 14 and 15)[34–36] and probable *S xyloni* have also been reported (Table 2, case 16).[34] Less aggressive than its exotic sister species, *S xyloni* nest in the open, under objects such as boards and stones, and sometimes in woodwork or masonry.[37] The mounds of *S xyloni* are irregular craters that consist of scattered soil with multiple obscure entrances. In contrast, mounds of imported fire ants are frequently shaped like domes.

Stings of 2 other native fire ants, *Solenopsis aurea* (Table 2, case 17)[34,38] and *Solenopsis geminata* (Table 2, case 18),[39] have also caused adverse reactions. The former is limited to the Colorado Desert in California and north along the eastern Mojave into southern Nevada.[40] The latter has been largely displaced within its prior native southeastern US area by imported fire ants but has spread to other parts of the world, including many Pacific islands.[41] Two US servicemen stationed in Guam and Okinawa experienced near fatal reactions to stings by *S geminata*.[34] Before their deployment, both men were sensitized to imported fire ant venom, which is highly cross-reactive with other native fire ant venoms.[34]

In addition to *Solenopsis*, stings by ants in the genera *Tetramorium* (Table 2, case 19)[42] and *Pogonomyrmex* (Table 2, cases 20 and 21)[36,43] in the subfamily Myrmicinae have caused generalized allergic reactions in various regions of the United States. Unfortunately, the species of *Tetramorium* was not identified in the case cited.[42]

Harvester ants in the genus *Pogonomyrmex* are common in the arid grasslands and deserts of the western United States. The red harvester ant, *Pogonomyrmex barbatus*, is found from Kansas through Texas and into Arizona. The stings of harvester ants are considered to be the most persistently painful of all North American ants[44] and the most toxic of all insect venoms based on median lethal doses to mice.[45]

At least 2 deaths have been attributed to stings by this ant in Oklahoma.[46,47] The Florida harvester ant, *Pogonomyrmex badius*, is the only eastern species and is found from Louisi-

ana to North Carolina. Although docile, when disturbed they can sting with severely painful consequences.[48]

During a 1-year period in Tucson, AZ, 8 patients were treated for stings by the Maricopa harvester ant, *Pogonomyrmex maricopa,* and rough harvester ant, *Pogonomyrmex rugosus*.[43] Four of these patients had systemic allergic reactions and the other 4 were large, local reactions. Immunologic tests indicated cross-sensitivity of patients to various species of *Pogonomyrmex*.[43,49] Thus, an individual sensitized to one species of *Pogonomyrmex* would be expected to react again to a sting from another species.

Subfamily Pseudomyrmecinae

Commonly known as twig or oak ants, *Pseudomyrmex* species frequently nest in hollow plant cavities. For example, *Pseudomyrmex ejectus* is a common species in the South and lives in hollow twigs on hardwood trees such as live oak. Colonies of *P ejectus* have multiple queens and nests with an average worker population of fewer than 100.[50] The workers of *Pseudomyrmex* are unusually long and slender and are often not recognized as ants[51] but mistaken for wasps. Species are tropical and subtropical and in the United States are primarily found in the Southeast. Their venom is unique, containing highly pharmacologically active polysaccharides.[52] These compounds inactivate complement[53] and have been used to treat rheumatoid arthritis.[54] In Florida, *Pseudomyrmex cubaensis* and *P ejectus* (Fig 2) are considered occasional pests because of their stings.[28]

Two New Case Reports: Pseudomyrmex ejectus

In case 22 (Table 2), a 35-year-old cattle farmer from Thomas County, Georgia, experienced 4 episodes of anaphylactic shock during a 10-year period, secondary to stings of the twig ant, *Pseudomyrmex ejectus*. The first episode occurred after a sting at the hairline in the back of the neck. The ants had swarmed on a gatepost that he came into contact with while opening the gate. He immediately had difficulty breathing, "turned blue," and became dizzy; his tongue became swollen, and he experienced a feeling of "doom." He drove immediately to a nearby emergency department. He was successfully treated with epinephrine and steroids for 3 additional episodes of anaphylaxis. In the most recent incident, in September 2002, the patient was hospitalized with a generalized allergic reaction. A specimen of the stinging ant was sent to Dr Suiter and was identified as *P ejectus*. During the same period, the patient experienced multiple stings from *S invicta,* resulting in aseptic pustules at the sting site but no systemic symptoms.

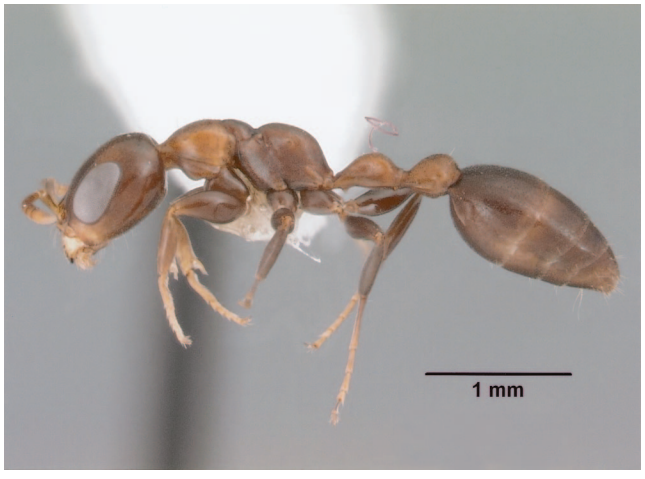

Figure 2. Worker of *Pseudomyrmex ejectus*.

In case 23, a 47-year-old woman with a history of perennial allergic rhinitis experienced several anaphylactic reactions to stings by oak ants in Lakeland, FL. The first episode occurred in February 1983 with 6 to 8 stings over her left leg from a suspected ant that was inside her clothing. At the emergency department, she complained of visual changes, swollen tongue, difficulty breathing, and generalized urticaria. She was treated with epinephrine and was prescribed epinephrine-chlorpheniramine (Ana-Kit). She had no further episodes until late summer 1999, when she was sitting under an oak tree and stated that an "oak ant" fell on her left leg and stung her twice. She shortly developed tingling all over her body, and she took 50 mg of diphenhydramine. Then she developed generalized pruritus, urticaria, and erythema that involved her entire body and swelling in her mouth, throat, and eyes for which she took 25 mg more of diphenhydramine. The sting left a large local reaction on her left upper thigh. In 2001 she was sitting under a tree when an oak ant fell on her chest and stung her. Localized tingling occurred within 30 seconds but resolved with 50 mg of diphenhydramine.

DISCUSSION

The incidence of stings by ants is likely to increase with the accelerating rate of urbanization. In addition, increased trade and travel provide invasion pathways for exotic ants. Urban development and sprawl disrupt natural ecosystems, bringing humans in contact with native and exotic species that thrive in disturbed habitats.

McGlynn[41] reported 147 species of ants that have been collected in nonnative habitats in various parts of the world. Several of these exotic species have become major economic pests in urban, agricultural, and wildlife environments. Some are invasive species that spread aggressively into the environment, outcompeting and displacing native ants. The imported fire ant, *S invicta*, is probably the most infamous of these, but the tropical fire ant, *S geminata*, is another example. Its native locality is the Neotropics, but it has been transferred to various Pacific islands, Australia, southern Africa, India, Madagascar, and the Caribbean Islands.[41]

Other exotics, such as *Hypoponera punctatissima* and *Tetramorium caespitum,* are considered tramp species, because they are readily transferred through commerce. Unlike invasive species, tramp species do not spread rapidly or dominate new environments but are tied to human activities. An example is *H punctatissima*, which moves with commerce and has become established worldwide. This species prefers disturbed

habitats in close association with humans. Another transferred ponerine is *Pachycondyla chinensis*. Its native locality is China, but it has been collected in New Zealand, Japan, Taiwan, and neighboring islands.[41]

In the United States, ants are considered by urban pest management professionals to be the top economic pest[55] and by homeowners to be more serious than cockroaches.[56] Some of the most common of these structural ant pests are exotic species. The more adaptive native species, such as *S xyloni* and *P rugosus,* also thrive in disturbed habitats, becoming house or yard pests, respectively. These 2 species flourish alongside roadways peripheral to asphalt surfaces, which retain moisture and may soften the soil for nesting and promote growth of grasses.[40]

Information regarding cross-sensitivity among these ants is limited. Studies have demonstrated antigenic cross-reactivity for species within the genera *Solenopsis*[57] and *Pogonomyrmex*.[43] A surprising degree of cross-reactivity was shown between *Solenopsis* and the common striped scorpion, *Centruroides vittatus*,[58] but the significance of this finding remains unclear. As these ants expand their habitat, more individuals can be expected to have medical consequences of stings. Further information about the biology of their venom and human clinical reactions to it will be necessary.

ACKNOWLEDGMENTS

We thank Lloyd Davis, Jr, recently retired from the US Department of Agriculture, Agricultural Research Service, in Gainesville, FL, and the late William L. Brown of Cornell University for ant identifications. We also thank Gary Alpert of Harvard University and Phil Ward of the University of California, Davis, for providing the photographs of ants. We also thank Lloyd Davis, Jr, and Phil Ward for taxonomic advice.

REFERENCES

1. deShazo RD, Butcher BT, Banks WA. Reactions to the stings of the imported fire ant. *N Engl J Med*. 1990;323:462–466.
2. Caplan EL, Ford JL, Young PF, Ownby DR. Fire ants represent an important risk for anaphylaxis among residents of an endemic region. *J Allergy Clin Immunol*. 2003;111:1274–1277.
3. deShazo RD, Kemp SF, deShazo MD, Goddard J. Fire ant attacks on patients in nursing homes: an increasing problem. *Am J Med*. 2004;116:843–846.
4. FORMIS: A Master Bibliography of Ant Literature, 1650–2000. Available at: http://cmave.usda.ufl.edu/~formis/. Accessed October 10, 2004.
5. Bolton B. Synopsis and classification of Formicidae. *Mem Am Entomol Inst*. 2003;71:1–370.
6. Bolton B. *Identification Guide to the Ant Genera of the World*. Cambridge, MA: Harvard University Press; 1994.
7. Blum MS, Hermann HR. Venoms and venom apparatuses of the Formicidae: Myrmicinae, Ponerinae, Dorylinae, Pseudomyrmecinae, Myrmicinae, and Formicinae. In: Bettini S, ed. *Arthropod Venoms*. Berlin, Germany: Springer; 1978:801–869.
8. Schmid-Grendelmeier P, Lundberg M, Wüthrich B. Anaphylaxis due to a red harvest ant bite. *Allergy*. 1997;52:230–231.
9. Wilson EO. *The Insect Societies*. Cambridge, MA: Belknap Press; 1971.
10. Trinca JC. Insect allergy in Australia: results of a five-year survey. *Med J Aust*. 1964;51:659–663.
11. Clarke PS. The natural history of sensitivity to jack jumper ants (Hymenoptera formicidae *Myrmecia pilosula*) in Tasmania. *Med J Aust*. 1986;145:564–566.
12. Brown SGA, Franks RW, Baldo BA, Heddle RJ. Prevalence, severity, and natural history of jack jumper ant venom allergy in Tasmania. *J Allergy Clin Immunol*. 2003;111:187–192.
13. Douglas RG, Weiner JM, Abramson MJ, O'Hehir RE. Prevalence of severe ant-venom allergy in southeastern Australia. *J Allergy Clin Immunol*. 1998;101:129–131.
14. Street MD, Donovan GR, Baldo BA, Sutherland S. Immediate allergic reactions to *Myrmecia* ant stings: immunochemical analysis of *Myrmecia* venoms. *Clin Exper Allergy*. 1994;24:590–597.
15. Brown SGA, Wu Q, Kelsall GRH, et al. Fatal anaphylaxis following jack jumper ant sting in southern Tasmania. *Med J Aust*. 2001;175:644–647.
16. McGain F, Winkel KD. Ant sting mortality in Australia. *Toxicon*. 2002;40:1095–1100.
17. Wheeler GC, Wheeler JN. *The Ants of Nevada*. Los Angeles, CA: Natural History Museum; 1986.
18. Dib G, Ferguson RK, Sljivic V. Hypersensitivity to Samsum ant. *Lancet*. 1992;339:552–553.
19. Dib G, Guerin B, Banks WA, Leynadier F. Systemic reactions to the Samsum ant: an IgE-mediated hypersensitivity. *J Allergy Clin Immunol*. 1995;96:465–472.
20. Yun YY, Ko SH, Park JW, Hong CS. Anaphylaxis to venom of the *Pachycondyla* species ant. *J Allergy Clin Immunol*. 1999;104:879–882.
21. Fukuzawa M, Arakura F, Yamazaki Y, et al. Urticaria and anaphylaxis due to sting by an ant (*Brachyponera chinensis*). *Acta Derm Venereol*. 2002;82:59.
22. Kim S, Hong C. A case of anaphylaxis by ant (*Ectomomyrmex* spp.) venom and measurements of specific IgE and IgG subclasses. *Yonsei Med J*. 1992;33:281–287.
23. Bolton B. *A New General Catalogue of the Ants of the World.* Cambridge, MA: Harvard University Press; 1995.
24. Cho YS, Lee Y, Lee C, et al. Prevalence of *Pachycondyla chinensis* venom allergy in an ant-infested area in Korea. *J Allergy Clin Immunol*. 2002;110:54–57.
25. Kim SS, Park HS, Kim HY, et al. Anaphylaxis caused by the new ant, *Pachycondyla chinensis*: demonstration of specific IgE and IgE-binding components. *J Allergy Clin Immunol*. 2001;107:1095–1099.
26. Rodriquez-Acosta A, Reyes-Lugo M. Severe human urticaria produced by ant (*Odontomachus bauri*, Emery 1892) (Hymenoptera: Formicidae) venom. *Int J Dermatol*. 2002;41:801–803.
27. Wilson EO. Which are the most prevalent ant genera? *Stud Entomol*. 1976;19:187–200.
28. Vail K, Davis L, Wojcik D, et al. Structure-invading ants of Florida. *Florida Coop Ext Serv Univ Fla Bull*. 1994:164.
29. Alpert G. Harvard University's guide to New England household pests. 2002. Available at: http://www.massinsects.com/default.htm. Accessed November 21, 2004.
30. Solley GO. Allergy to stinging and biting insects in Queensland. *Med J Aust*. 1990;153:650–654.
31. Kemp SF, de Shazo RD, Moffitt JE, et al. Expanding habitat of the imported fire ant (*Solenopsis invicta*): a public health concern. *J Allergy Clin Immunol*. 2000;105:683–691.

32. Coarsey JM. Southern fire ant, *Solenopsis xyloni* (death of a child in Mississippi). *Coop Econ Insect Rep.* September 19, 1952:301.
33. Klotz S, Schmidt J, Kohlmeier R, et al. Stinging ants: case histories of three native North American species. *Proc Natl Conf Urban Entomol*. 2004:108–109.
34. Hoffman DR. Reactions to less common species of fire ants. *J Allergy Clin Immunol*. 1997;100:679–683.
35. Weiss SJ, Hoffman DR, Stafford CT. Allergy to the native fire ant, *Solenopsis xyloni* [abstract]. *J Allergy Clin Immunol*. 1990; 85:212.
36. Lockey RF. Systemic reactions to stinging ants. *J Allergy Clin Immunol*. 1974;54:132–146.
37. Smith MR. House-infesting ants of the eastern United States. *US Dept Agric Tech Bull*. 1965;No. 1326.
38. Ellis MH, Jacobson RS, Hoffman DR. Allergy to *Solenopsis aurea*, an uncommon native fire ant [abstract]. *J Allergy Clin Immunol*. 1992;89:293.
39. Helmly RB. Anaphylactic reaction to fire ant. *Hawaii Med J*. 1970;29:368–369.
40. Snelling RR, George CD. *The Taxonomy, Distribution and Ecology of California Desert Ants (Hymenoptera: Formicidae): Report to CA Desert Plan Program of Bureau of Land Management, US Department of Interior*. 1979.
41. McGlynn TP. The worldwide transfer of ants: geographical distribution and ecological invasions. *J Biogeography*. 1999;26: 535–548.
42. Majeski JA, Durst GG, McKee KT. Acute systemic anaphylaxis associated with an ant sting. *South Med J*. 1974;67:365–366.
43. Pinnas JL, Strunk RC, Wang TM, Thompson HC. Harvester ant sensitivity: in vitro and in vivo studies using whole body extracts and venom. *J Allergy Clin Immunol*. 1977;59:10–16.
44. Schmidt JO, Blum MS. Pharmacological and toxicological properties of harvester ant, *Pogonomyrmex badius*, *venom Toxicon*. 1978;16:645–651.
45. Schmidt JO. Venom. In: Resh VH, Carde RT, eds. *Encyclopedia of Insects*. Orlando, FL: Academic Press; 2003:1160–1163.
46. Brett CH. The Texas harvester ant. *Okla Agr Exp Stat Bull*. July 1950; No. B-353.
47. Young J, Howell DE. Ants of Oklahoma. *Okla Agr Exp Stat Misc Pub*. January 1964; No. MP-71.
48. Creighton WS. The ants of North America. *Bull Mus Comp Zool Harv Coll*. 1950;104:1–585.
49. Schmidt JO, Meinke GC, Chen TM, Pinnas JL. Demonstration of cross-allergenicity among harvester ant venoms using RAST and RAST inhibition [abstract]. *J Allergy Clin Immunol*. 1984; 73:158.
50. Klein RW. Colony structures of three species of *Pseudomyrmex* (Hymenoptera: Formicidae: Pseudomyrmecinae) in Florida. In: Eder J, Rembold H, eds. *Chemistry and Biology of Social Insects*. Munchen, Germany: Verlag J Peperny; 1987:107–108.
51. Wheeler GC, Wheeler JN. *Ants of Deep Canyon, Colorado Desert, California.* Riverside, CA: Philip L. Boyd Deep Canyon Desert Research Center, University of California, Riverside; 1973.
52. Schmidt JO. Chemistry, pharmacology, and chemical ecology of ant venoms. In: Piek T, ed. *Venoms of the Hymenoptera: Biochemical, Pharmacological and Behavioural Aspects*. Orlando, FL: Academic Press; 1986:425–508.
53. Schmidt JO. Biochemistry of insect venoms. *Ann Rev Entomol*. 1982;27:339–368.
54. Schultz DR, Byrnes JJ, Brown HE. Response of mixed cryoglobulinemia to treatment with ant venom [abstract]. *Clin Res*. 1978;26:58A.
55. Jenkins M. Battling a common enemy. *Pest Control*. 2001;69: S10–S12, S16, S27.
56. Whitmore RW, Kelly JE, Reading PL. *National Home and Garden Pesticide Use Survey, Final Report, Volume 1: Executive Summary, Results, and Recommendations*. Washington, DC: US Environmental Protection Agency; 1992.
57. Hoffman DR, Smith AM, Schmidt M, et al. Allergens in Hymenoptera venom, XXII: comparisons of venoms from two species of imported fire ants, *Solenopsis invicta* and *richteri. J Allergy Clin Immunol*. 1990;85:988–996.
58. Nugent JS, More DR, Hagan LL, et al. Cross-reactivity between allergens in the venom of the common striped scorpion and the imported fire ant. *J Allergy Clin Immunol*. 2004;114:383–386.

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