



Anaphylaxis to bull dog ant and jumper ant stings around Perth, Western Australia

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Abstract

Objective: To determine the main causative species, reaction characteristics and geographical locations of ant sting anaphylaxis around Perth, Western Australia (WA).

Methods: Structured interviews were performed on a cohort of 10 patients referred to our Anaphylaxis Clinic who were allergic to ant venom, followed by field trips to collect ant specimens. A descriptive analysis of clinical data was performed.

Results: Around Perth, *Myrmecia gratoria*, a bull dog ant, was the only species of stinging ant found around the locations where reactions had occurred (eight patients). To the south-west of Perth, species implicated were another bull dog ant *Myrmecia nigriscapa* (one patient), and a jumper ant *Myrmecia ludlowi* (one patient). Twelve reactions were documented as mild (one), moderate (seven) and severe with hypotension (four). In three bull dog ant venom allergic patients, specific IgE was analysed, demonstrating substantial cross-reactivity with other bull dog ant species. Clinical patterns of reaction severity and response to repeated stings were consistent with known features of insect sting allergy.

Conclusions: A single species of bull dog ant, *M. gratoria*, appears to be responsible for ant sting anaphylaxis around Perth. Further investigation is required for other regions of WA. The provision of effective immunotherapies for people allergic to native Australian ants might be simplified by the dominance of a limited number of ant species and IgE binding cross-reactivity between venoms, as was evident in this study.

Key words: allergy, anaphylaxis, ant venom, *Myrmecia*.

Introduction

Stings from ants of the genus *Myrmecia* are an important cause of IgE-mediated anaphylaxis in south-eastern Australia, causing systemic reactions in 2–3% of exposed populations.^{1–3} The *Myrmecia* appear to be

relatively unchanged descendants of an ancient group forming one of the two major lines of ant evolution that branched 80–100 million years ago and survived in Australia despite their extinction elsewhere.⁴ They are the sole living genus of the subfamily Myrmeciinae, consisting of 89 named species, 88 of which are endemic

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to Australia and one to New Caledonia.⁵ Phylogenetic relationships of the *Myrmecia* are outlined in Figure 1. Despite fearsome looking mandibles, the real danger to humans lies in the 'sting in the tail'; a venom delivery apparatus located at the tip of the abdomen. After firmly gripping their victim with their mandibles, the stinger delivers venom that contains pain-inducing substances and enzymes designed to kill insect prey, that are also potent allergens in humans.

Local knowledge of the insect species causing anaphylaxis is important for Emergency Physicians. This is because a detailed history obtained while the event is fresh in a patient's mind can be invaluable for later follow up when the correct venom extract(s) must be chosen for skin testing and immunotherapy. From a clinical perspective the important *Myrmecia* species are the smaller (10–12 mm) 'jumper ants' of the pilosula and nigrocincta species groups, and the larger (15–25 mm) 'bull dog ants' of the gulosa species group. The available data indicate that jumper ants, predominantly the 'jack jumper' (*Myrmecia pilosula* species complex) and to a much lesser extent *Myrmecia nigrocincta* are the most important causes of ant sting anaphylaxis from southern Queensland through New South Wales and Victoria to the Adelaide Hills of South Australia, and Tasmania.^{1,2,4,6–11} With regard to bull dog ants, *Myrmecia forficata* causes anaphylaxis in Tasmania,² and *Myrmecia pyriformis* appears to be important in rural Victoria although this has not been confirmed by formal insect species identification.¹ The species of bull dog ants causing anaphylaxis in South Australia, New

South Wales and Queensland have not been determined. Non-*Myrmecia*, predominantly the 'greenhead ant', *Rhytidoponera metallica*, also appear to cause anaphylaxis in Queensland.^{7,8,12}

Little is known about ant sting allergy in Western Australia (WA) apart from a passing reference in 1988 to the jumper ant *Myrmecia chasei*, having caused anaphylaxis 'near Perth'.⁴ Our local experience is that ant sting anaphylaxis does not present to metropolitan ED in Perth, but that anecdotally, occasional cases present to hospitals and general practices in the Darling Scarp region further inland. Our aim was to determine the likely causative species, reaction characteristics and geographical locations where ant sting allergy occurs in this area. These pieces of information are a prerequisite for developing diagnostic and therapeutic approaches to ant venom allergy.

Methods

We analysed a cohort of 10 consecutive patients allergic to ant venom referred to a newly established Anaphylaxis Clinic at Fremantle Hospital, Fremantle, WA, Australia, during the first 6 months of 2004. These referrals related to reactions that had occurred up to 10 years previously, and came from around Perth because of our expertise in venom allergy. Between August and October 2004, telephone interviews using a structured datasheet recorded demographics, cardiovascular morbidity (hypertension, ischaemic heart disease, heart

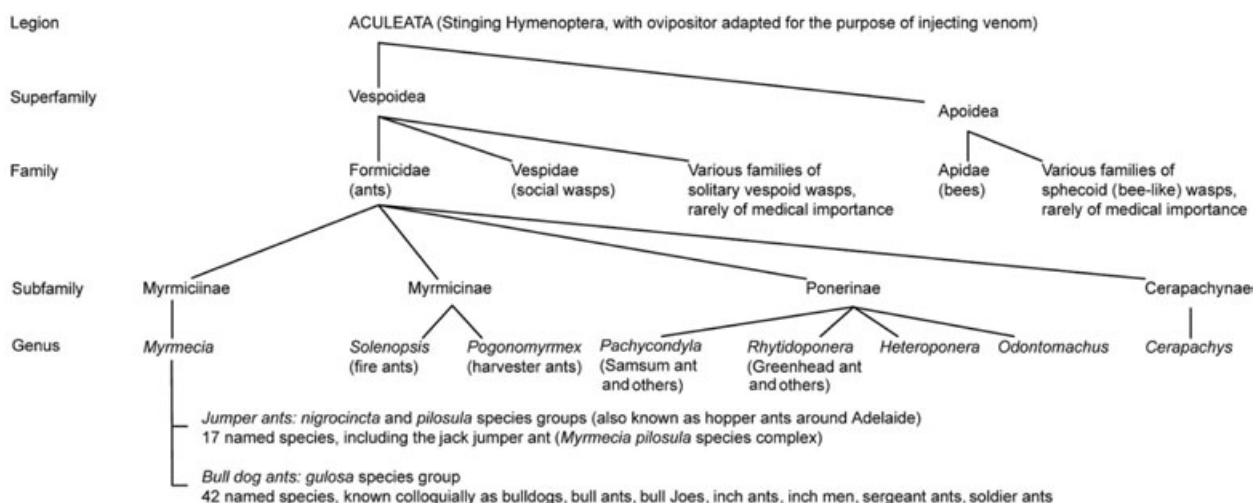


Figure 1. Phylogenetic relationships of the genus *Myrmecia* with other insect groups and ant genera that have been implicated in human anaphylaxis.

Table 1. Grading system for generalized hypersensitivity reactions, from Brown (2004)³

Grade†	Defined by
1. Mild (skin and subcutaneous tissues only)	Generalized erythema, urticaria, periorbital oedema, or angioedema
2. Moderate (features suggesting respiratory, cardiovascular or gastrointestinal involvement)	Dyspnoea, stridor, wheeze, nausea, vomiting, dizziness (pre syncope), diaphoresis, chest or throat tightness, or abdominal pain
3. Severe (hypoxia, hypotension, or neurological compromise)	Cyanosis or SpO ₂ ≤ 92% at any stage, hypotension (SBP < 90 mmHg in adults), confusion, collapse, LOC, or incontinence

†An episode of anaphylaxis is defined by a reaction classified into either the moderate or severe grades. LOC, level of consciousness; SBP, systolic blood pressure.

failure), airways disease (asthma, chronic airflow limitation), other history suggestive of atopy (eczema, hay fever), anaphylaxis to other insects, foods, medications and details of those allergies. Detailed information on geographical location of each sting and reaction features was collected for each sting and severity graded as mild, moderate or severe according to a recently developed classification system (Table 1).³ Written consent was obtained to access medical records from general practitioners, immunologists, and hospital medical records to verify the history obtained directly from patients. A simple descriptive analysis of clinical data, including the time to further accidental sting(s), was performed.

After collecting structured clinical data, field trips were made to meet patients and visit the sites where major reactions had occurred. Specimens of stinging ants were collected from nests present in the immediate vicinity, and locations recorded using a global positioning system (GPS) device. Specimens were sent to the Commonwealth Scientific and Industrial Research Organization (CSIRO) Entomology National Insect Collection in Canberra (Dr Steve Shattuck) for identification.

The collection and analysis of confidential patient data was approved by the South Metropolitan Area Health Service Human Research and Ethics Committee as part of a larger prospective study of anaphylaxis.

Results

A summary of clinical characteristics for each patient is presented in Table 2 and a map indicating where reactions occurred is presented in Figure 2. All ant specimens were identified as belonging to the genus *Myrmecia*. Five patients were children (ages 2–7 years), all of whom had experienced moderate reactions. Five were adults (ages 39–62 years), of whom three had experienced severe reactions, one a moderate reaction and one a mild reaction. Most reactions occurred on the outskirts

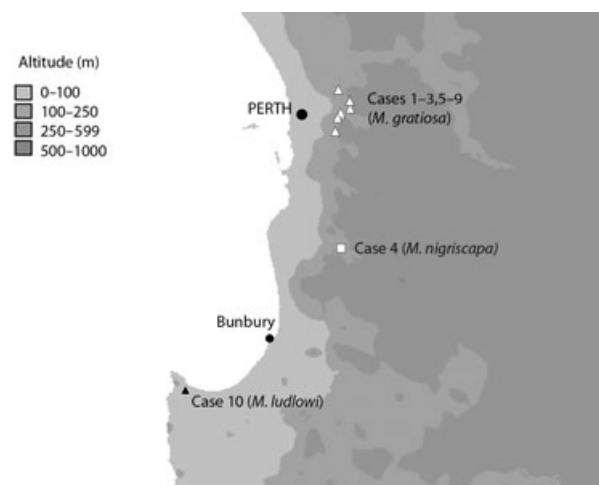


Figure 2. Geographical location where reactions occurred, with case numbers. (Δ) Attributed to *Myrmecia gratiosa*; (□) Attributed to *Myrmecia nigriscapa*; (▲) Attributed to *Myrmecia ludlowi*.

of Perth around the Darling Scarp, where only one species of stinging ant, the large bull dog ant *Myrmecia gratiosa*, was found during field trips. Two other species, the bull dog ant *Myrmecia nigriscapa* and the jumper ant *Myrmecia ludlowi* were linked to reactions in one patient each in rural areas south of Perth. All reactions occurred in native bushland or on properties with a substantial amount of native bush nearby. The three species are shown in Figure 3.

All except one of the reactions occurred following stings in the afternoon between 13.00 and 18.00 hours. Case 3 reacted to a sting in bed at 3.00 hours. The ants responsible for reactions were clearly seen and recognized at the time of the stings in eight people. Estimates of time from sting to onset of systemic symptoms ranged from 1 to 15 min, with four cases developing a systemic response within 1 min. All reactions were treated with antihistamines and three with

Table 2. Case details

Case	Comorbidities	Age at first SR (years)	Preventive and response measures	Further stings since first reaction: N stings (N of SR)	Worst reaction:		Grade	Clinical features	Myrmecia species
					Age (years)	Activity			
1. 12 years M ⁺	Hay fever	3	Poisons nests, EpiPen	1 (0)	3	At home outside	Moderate	URT, AE, cough, wheeze [‡]	<i>M. gratioiosa</i> §
2. 12 years M ⁺	Nil	4	Poisons nests, EpiPen	0 (0)	4	At home outside	Moderate	Cough, wheeze [‡]	<i>M. gratioiosa</i> §
3. 68 years F	HT, HB sting allergy treated with VIT	62	EpiPen	1 (0)	62	At home inside	Moderate	URT, blocked nose, anxiety, dizziness	<i>M. gratioiosa</i>
4. 15 years M	Nil	7	Clothing, restricted activities, EpiPen	0 (0)	7	Camping	Moderate	URT, AE, throat tightness, cough, wheeze [‡]	<i>M. nigricapab</i> §
5. 57 years F	HT, HB sting allergy	57	Poisons nests, clothing, EpiPen	0 (0)	57	Working on property	Severe	URT, vomiting, dizziness, throat tightness, visual loss, confusion, hypotension [‡]	<i>M. gratioiosa</i>
6. 17 years F	Asthma, hay fever	7	Poisons nests, EpiPen	1 (0)	7	Picnic	Moderate	URT, AE, throat tightness	<i>M. gratioiosa</i>
7. 51 years F	Eczema	51	Poisons nests, clothing, EpiPen	0 (0)	51	At home outside	Mild	URT, AE	<i>M. gratioiosa</i>
8. 50 years M	Paroxysmal AF, Asthma	48	EpiPen	0 (0)	48	Picnic	Severe	URT, AE, SOB, throat tightness, SpO ₂ < 92%, hypotension, loss of consciousness [‡]	<i>M. gratioiosa</i>
9. 3 years F	Nil	2	Poisons nests, EpiPen	0 (0)	2	At home outside	Moderate	URT, stridor, cough [‡]	<i>M. gratioiosa</i>
10. 40 years F	Hay fever, mild seafood allergy	39	Poisons nests, clothing, EpiPen	2 (2)	39	At home outside	Severe	URT, AE, SOB, stridor, nausea, vomiting, dizziness, throat tightness, abdominal pain, confusion, hypotension [‡]	<i>M. ludlowi</i>

⁺Cases 1 and 2 – identical twins. [‡]Medical notes available to confirm severity of reaction. [§]Serum analysed for IgE to *M. pilosula*, and *M. gulosa* group venoms (see text and Table 3). AE, angioedema; HB, honeybee; HT, hypertension; N, number; SOB, shortness of breath; SR, systemic reaction; URT, urticaria/erythema; VIT, venom immunotherapy.

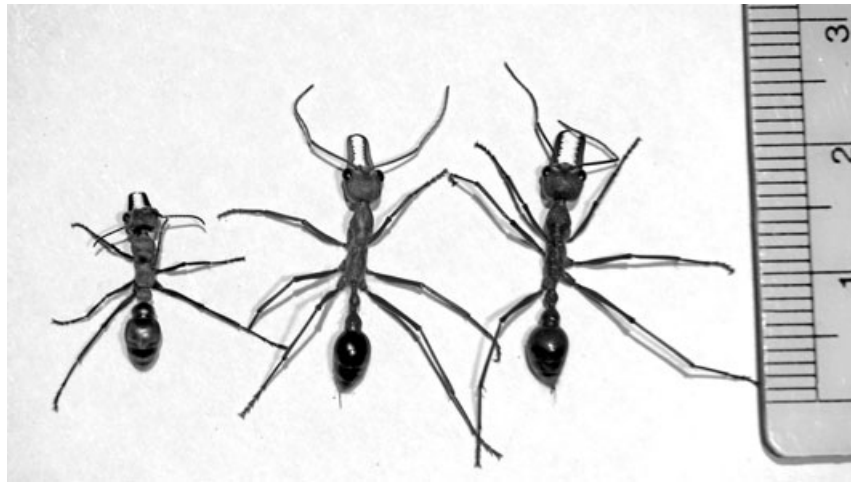


Figure 3. From left to right, the jumper ant *Myrmecia ludlowi*, and the bull dog ants *Myrmecia gratiosa* and *Myrmecia nigriscapa* – the abdominal stinger is visible in the tail of the specimen of *M. gratiosa*.

corticosteroids. Four reactions (three severe and one moderate) were treated with adrenaline. One severe reaction was not treated with adrenaline despite there being respiratory distress (dyspnoea and stridor), and hypotension with an altered mental state.

Venom-specific IgE analysis

Three children had serum sent for *Myrmecia* venom-specific IgE analysis soon after their reactions. This test, performed at the Kolling Institute, Royal North Shore Hospital, Sydney, Australia, ceased to be available after 1999. Except for *M. pilosula*, the venoms against which sera were tested were from species not found in WA. In these cases, sera were positive for specific IgE to *Myrmecia gulosa* and related species in the gulosa group, but not to either species of jumper ant (Table 3). The three children had been resident in WA since birth and had not travelled to areas where these other gulosa group ants are found.

Sting episodes prior to the first systemic reaction

Except for the parents of two children, all patients reported stings on multiple occasions with only local reactions prior to the first systemic reaction. These were small (<5 cm diameter), except Case 3 who had experienced a severe local reaction with oedema of the entire upper arm from elbow to shoulder. Case 8 had been stung more than 100 times before he had his first systemic reaction, which included hypotensive collapse.

Table 3. Serum venom-specific IgE analysis for Cases 1, 2 and 4

Species	Case 1	Case 2	Case 4
Jumper ant venoms			
<i>M. pilosula</i> ('jack jumper')	–ve	–ve	–ve
<i>M. nigrocincta</i>	–ve	–ve	–ve
Bull dog ant (gulosa group) venoms†			
<i>M. gulosa</i>	+ve	+ve	+ve
<i>M. pyriformis</i>	+ve	–ve	–ve
<i>M. tarsata</i>	+ve	–ve	+ve
<i>M. simillima</i>	+ve	+ve	–ve

†All gulosa group venoms tested against are found only in the eastern states of Australia. Of the jumper ant species tested, only *M. pilosula* has been found in Western Australia. M., *Myrmecia*.

Sting episodes after the first systemic reaction

Nine patients had experienced only one systemic reaction; three of these had been stung again once, and did not have a further systemic reaction. One patient (case 10) had experienced three reactions (two severe with documented hypotension with one intervening moderate reaction) to three successive stings from *M. ludlowi* over a 12 month period. The number of years elapsed between the first reaction and our assessment ranged from 0 to 10 years (mean 4.5 years), during which a total of five accidental stings occurred in four people (40%, 95% confidence interval [CI] 12–74%). The mean time from initial reaction to another sting was 2.7 years (95% CI 0–6.3) in those who were stung again. Because only one patient had more than one systemic reaction, we did

not undertake a similar analysis for the risk of repeated systemic reactions. At the time of our review, all except one person with nests near their home had embarked on a nest-poisoning strategy for nests in the area, and all patients had been prescribed an EpiPen.

Discussion

We found that the bull dog ant *M. gratio*sa is the main cause of ant sting anaphylaxis around Perth, WA, in the Darling Scarp region in or near to native bushland. In three young children where venom-specific IgE had been measured soon after their reactions, the results confirmed our clinical assessment and demonstrated a substantial cross reactivity between bull ant venoms, a characteristic that has been noted previously.⁹ Other species were implicated in the south-west of WA, namely the bull dog ant *M. nigriscapa*, and the jumper ant *M. ludlowi*. Systemic reactions ranged in severity from mild through to severe and clearly life-threatening anaphylaxis. A number of people received further stings within a few years of an initial reaction, suggesting that stings are difficult to avoid where the ants are prevalent.

Weaknesses of this study include its small numbers because of the rarity of this problem in WA, convenience sampling with potential for selection bias, retrospective design causing recollection bias, and that we were unable to perform venom-specific IgE analysis for local *Myrmecia* species. The latter two impact on species identification. However, these weaknesses were limited because the responsible insects were clearly seen in eight of 10 cases, contemporary medical notes were available to confirm reaction characteristics in seven of 10 cases including all severe reactions, and field trips were performed to make an assessment of stinging ant species in each area. Our field trips included a search for stinging ants at the location and in surrounding bushland. The species identified here were the only stinging ants that we could find over a wide area in the Darling Scarp region, and they also matched the descriptions given to us by our patients. Thus, despite the small number of patients, our finding regarding the main species responsible for ant sting anaphylaxis around Perth is likely to be accurate.

A significant referral bias is likely because of an absence of specialist allergy services in regional WA and because specialists in the Perth region are more likely to be aware of recent progress towards providing venom immunotherapy (VIT) for ant sting allergy.^{13,14} As ants of the *Myrmecia* genus are common in the

south-west region,^{5,15} further study may reveal a larger number of cases involving *M. nigriscapa*, *M. ludlowi* and perhaps other species including *M. pilosula*.

The finding that four out of 10 people had a sting soon after the first reaction is consistent with data collected in Tasmania from 368 allergic volunteers where 87 people (23%) received accidental stings during a mean prospective follow-up period of 2.3 years.² Although the number of cases reported here was too small to justify any statistical analysis beyond a rough estimate of accidental sting risk, a number of clinical patterns were consistent with other known features of insect sting allergy:

1. The four severe reactions occurred in adults more than 38 years old. Both older age and high annual rates increase the risk of developing sting allergy of any severity.^{2,3} Previous studies have identified a threefold greater risk of severe sting anaphylaxis in those aged 35 and older,² which is also the age group in which most deaths occur.^{16,17} Cardiovascular comorbidities do not appear to have a major effect on reaction severity although the presence of respiratory disease increases the risk of bronchospasm and hypoxia.^{2,3}
2. After an initial systemic reaction three of four patients did not react to subsequent stings. This is consistent with observations from larger studies that only 25–70% (depending on the species being studied) will react to a second sting.^{2,14,18,19} However, people who do not react to the first subsequent sting might react again, sometimes with lethal results, to later stings.^{17,20,21} Thus, reaction severity fluctuates from sting to sting, probably because of variations in the amount of venom delivered. The worst previous reaction rather than the most recent reaction is of most importance in assessing future reaction risk.^{2,19}
3. Stings occurred around the home or place of work in six of 10 cases. A recent Asian study also found that most ant sting anaphylaxis occurs around the home.²² This suggests the importance of destroying nests around the houses of affected persons, although such a strategy has not been proven to be useful. It is notable that despite patient's attempts to destroy them, we were able to find nests re-establishing around their homes.

Venom immunotherapy has been shown to be highly effective in preventing anaphylaxis to *Myrmecia* stings.¹⁴ However, treatment requires accurate diagnosis of the species involved. In our area, a single locally prepared ant venom extract from *M. gratio*sa will be

sufficient for diagnosis and immunotherapy. Considerable antigenic cross-reactivity between gulosa group ('bull dog ant') species means that the *M. pilosula* immunotherapy preparation already developed,¹⁴ plus a standardized mixture of bull dog ant venoms might be sufficient to provide VIT to the majority of Australians who are allergic to *Myrmecia* stings.

A collaborative study of ant sting allergy employing the methodology used here and supplemented by venom-specific IgE analysis is required to guide the further development of diagnostic and therapeutic strategies at a national level. In the meantime, ant venom allergic patients should be advised of appropriate avoidance strategies including nest poisoning around the home, and receive careful education with written action plans to guide their response to stings including correct use of their EpiPen.

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Author contributions

Y Gilhotra carried out structured interviews of allergic patients and reviewed medical records. S Brown carried out GPS mapping, designed graphics and performed the photography. Both investigators were responsible for study design and data analysis, made field trips to collect insect specimens, and wrote the final manuscript.

Competing interests

None identified.

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