

Hymenoptera of Afghanistan and the central command area of operations: Assessing the threat to deployed U.S. service members with insect venom hypersensitivity

Joseph C. Turbyville, M.D.,¹ James C. Dunford, Ph.D.,² and Michael R. Nelson, M.D., Ph.D.³

ABSTRACT

Insect venom hypersensitivity can pose a threat to personnel deployed to a combat zone but the exposure risk in Afghanistan is currently unknown. This study was designed to assess the threat of Hymenoptera stings and associated allergic reactions in Afghanistan. Hymenoptera species were collected during a deployment to southern Afghanistan from June 2010 through January 2011. The literature was also reviewed to determine species of medically important Hymenoptera recorded in the region. The U.S. Army theater electronic medical data system was mined for ICD-9 codes associated with insect stings to determine the number of theater medical clinic encounters addressing insect sting reactions. Three species of flying hymenoptera were commonly encountered during the study period: *Vespa orientalis* L., *Polistes wattii* Cameron, and *Vespula germanica* (F.). A literature review also confirms the presence of honeybees (Apidae), numerous velvet ant (Mutillidae) species, and various ant (Formicidae) species all capable of stinging. No evidence was identified to suggest that fire ants (*Solenopsis* spp.) are a threat in the region. Based on electronic medical records from the U.S. Central Command area of operations over a 2-year period, roughly 1 in 500 clinic visits involved a patient with a diagnosis of insect bite or sting. Cross-reactive members of all five flying Hymenoptera species commonly assessed for in Hymenoptera allergy evaluations are present in Afghanistan. The review of in-theater medical records confirms that insect stings pose an environmental threat to deployed service members.

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Injury from venoms produced by insects and other arthropods is a worldwide health hazard and insect venom hypersensitivity can pose a significant risk to individuals deployed to a combat zone. Deployed personnel often work in less-sheltered conditions, increasing their encounters with stinging insects by accidental exposure. If a service member on patrol has a serious allergic reaction to an insect sting, not only will his/her life be endangered, but other members of the unit can potentially be compromised by halting the patrol and arranging for evacuation. Members of the evacuating medical team also assume risk any time they transport a patient in a combat zone.

Because of this risk, the U.S. Army regulation governing induction into military service (AR 40–501) lists anaphylaxis to stinging insects as a disqualify-

ing medical condition.¹ The U.S. Army has also issued a stinging insect policy providing additional assessment and management guidance of soldiers with a possible allergy to stinging insects.² This policy lists “environmental likelihood of a sting” as a key factor directing management of these individuals.

In North America, testing for stinging insect sensitivity typically includes five winged Hymenoptera species. Standardized allergen extracts in the United States available for testing and treatment include honeybee (*Apis mellifera* F.), wasp (mixed *Polistes* spp.), yellow jacket (mixed *Vespula* spp.), white-faced hornet (*Dolichovespula maculata* [L.]), and yellow hornet (*Dolichovespula arenaria* [F.]). The medical literature contains very little information regarding Hymenoptera in Afghanistan, but entomological studies have confirmed the presence of bee, wasp, and hornet species.^{3–14} Although no studies have documented exactly which species of Hymenoptera present in North America are also found in the Middle East, members of all five flying Hymenoptera taxa commonly assessed in allergy evaluations have been reported in Afghanistan.^{4–8} Based on studies evaluating cross-reactivity of insect venoms, it can be assumed that taxonomically related species would likely pose a threat to an individual with previous exposure only to insects found in North America.^{15–18}

From the ¹Ireland Army Community Hospital, Fort Knox, Kentucky, ²Navy and Marine Corps Public Health Center Detachment, Centers for Disease Control and Prevention, Atlanta, Georgia, and ³Walter Reed National Military Medical Center, Washington, D.C.

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Address correspondence and reprint requests to Joseph C. Turbyville, M.D., Ireland Army Community Hospital, Department of Allergy–Immunology, 851 Ireland Loop, Fort Knox, KY 40121

E-mail address: jturbyville@familyallergy.com

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The aim of this study was to compile a preliminary list of medically important Hymenoptera species found in Afghanistan where ~97,000 U.S. personnel are currently deployed. A second aim was to estimate the prevalence of insect stings requiring medical care within the Central Command area of operations to get a general idea of the environmental threat of Hymenoptera in the region.

METHODS

Hymenoptera specimens were collected primarily by hand netting in southern Afghanistan from June 2010 through January 2011. During this study period the principal investigator was deployed as a general medical officer whose primary duty was to provide basic medical care to U.S. and Afghan soldiers. Both commercial and homemade “bee traps” were used with various baits but were found to be less effective than hand netting. Specimens were collected in the Kandahar province located in southern Afghanistan. Specimens were collected to maximize variety rather than quantity: when a few members of a given species were obtained, that species was no longer collected. Once collected, specimens were pinned and dried, and then photographed and examined by an entomologist for species confirmation. A review of the literature was also conducted to identify reports of Hymenoptera species in Afghanistan and to identify species common to both North America and Afghanistan.

The Joint Medical Workstation is an element of the U.S. Army’s electronic medical data system that can be mined for data based on set parameters. The Joint Medical Workstation was data mined for clinic visits containing ICD-9 codes potentially related to bee/wasp/hornet stings over a 2-year period (January 2009 through December 2010). Because multiple ICD-9 codes might have been used when a patient presented with a Hymenoptera sting, the data include codes with a range of specificity for true Hymenoptera stings (as opposed to bites from other arthropods). For this reason, the prevalence data are presented as a range and, likely, a rough estimate, of the true number of Hymenoptera stings.

Clinic visits throughout the U.S. Central Command area of operations were included in the search, and all patient data were de-identified. The majority of clinic visits were from Afghanistan and Iraq, but the data also encompassed service members evaluated in other Middle Eastern countries such as Kuwait, Kyrgyzstan, and Qatar. Because of the structure of the database and frequency of troop movement throughout the area, the authors were unable to extract data specific for Afghanistan. Similarly, limitations of this database did not permit classification of reactions by severity or

whether reports were local or systemic reactions. This study protocol was approved through the U.S. Army Medical Research and Materiel Command Institutional Review Board.

RESULTS

Three species of Hymenoptera were collected during the study period: *Vespa orientalis* L., *Polistes wattii* Cameron, and *Vespula germanica* (Fig. 1). *V. orientalis* was the most common species encountered during the summer months and *V. germanica* was more common in the fall. *P. wattii* was rarely seen at the primary study site but was common at a nearby combat outpost where multiple nests were located in the eaves of wooden buildings. Members of each of these species were collected and confirmed by an entomologist. These species are taxonomically related to other North American wasps⁶ and hornets and would be expected to show venom cross-reactivity. *V. germanica* is also found in North America, where it is well established in the northeastern parts of the United States.¹⁹ The Oriental hornet, *V. orientalis*, was recently reported in Cozumel Island, Mexico, representing the first known report of this Asian species in North or South America.²⁰

No honeybees were collected at the study site, but previous studies document the presence of *A. mellifera*, *Apis cerana* F., *Apis dorsata* F., and *Apis florea* F. in Afghanistan.^{3,7} Further evidence of Apidae in Afghanistan was found in a program run by U.S. Military entomologists that teaches Afghan women how to raise honeybee colonies for profit. Although some ant species were encountered and stinging species are reported in the literature,^{21–23} no imported fire ants (*Solenopsis* spp.) were collected. To the authors’ knowledge, there have been no bites or stings resembling those of imported fire ants reported from Afghanistan.

In addition to the 3 species collected, 244 other medically important Hymenoptera species representing 12 families were identified in Afghanistan in the literature search.^{4–14,21–25} Figure 2 lists these families and annotates (with asterisks) species occurring both in North America and in Afghanistan. Five medically relevant species (i.e., *A. mellifera*, *Diodontus minutus* [F.], *V. germanica*, *V. orientalis*, and *Polistes dominulus* [Christ]) occur in both regions. *Polistes olivaceus* (DeGeer), a social vespid species, is known to occur in Hawaii but it has not been reported in the continental United States.²⁶ A complete list of medically relevant Hymenoptera species in Afghanistan can be found in the online repository of this journal.

Over the 8-month study period, three individuals from the author’s brigade were evacuated by helicopter to a higher level of medical care after experiencing a systemic reaction to an insect sting. Two of these were unofficially confirmed as *V. orientalis* from the

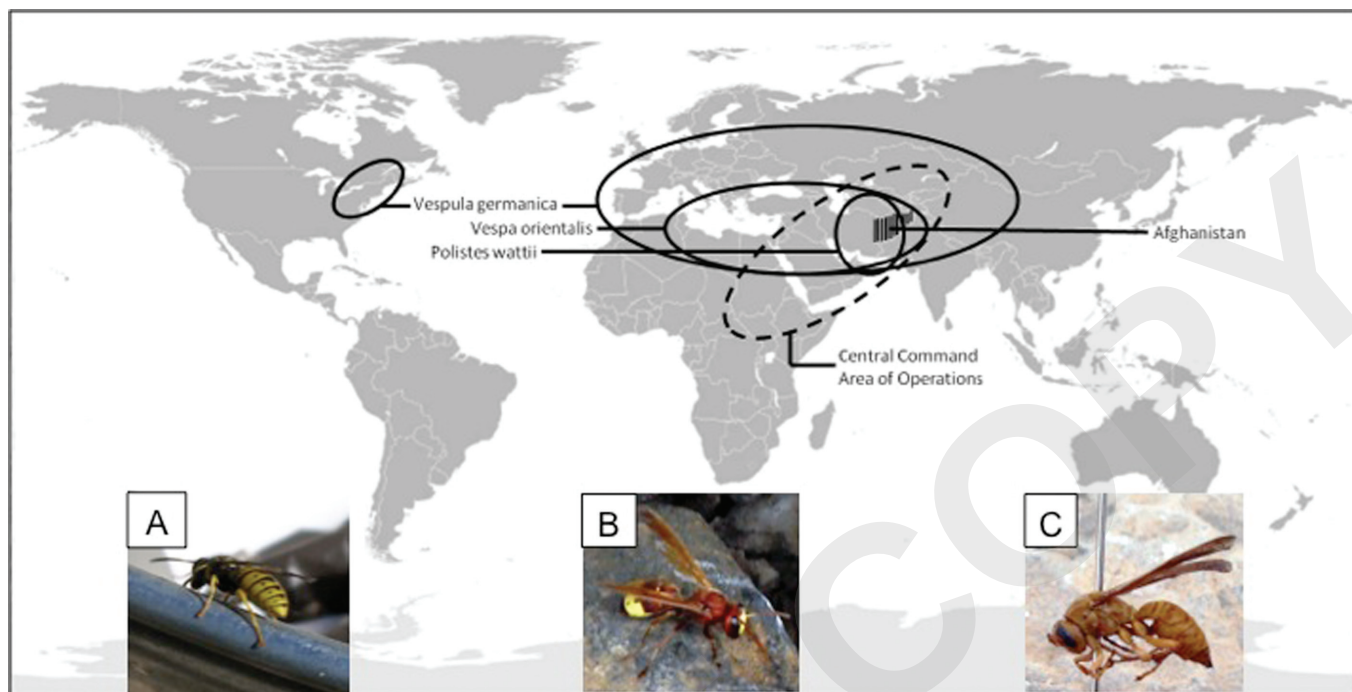


Figure 1. (A) *Vespa germanica*, (B) *Vespa orientalis*, and (C) *Polistes wattii*, were the three Hymenoptera species frequently encountered during the study period. Distribution of each species is shown in relation to Afghanistan and the Central Command area of operations. (Source: Refs. 5 and 6.)

patient's description of the insect, and neither patient reported a previous history of a reaction to an insect sting. In one case, the soldier said he believed the wasp was disturbed and provoked to sting because of a nearby explosion. In each case, the individual was treated with epinephrine and recovered uneventfully.

Between January 2009 and December 2010, there were 1,100,912 outpatient clinic visits documented in the U.S. Central Command area of operations. Table 1 lists the number of clinic visits with ICD-9 codes that might have been used when a patient was evaluated for an insect sting. Assuming all of these visits were actually for insect stings, ~1 in 420 clinic visits in theater was for an insect sting. Using only the most specific ICD-9 codes (E905.3 and 989.5), this rate becomes 1 in 7500. When less-specific codes such as 708.0 (urticaria) and 995.0 (anaphylaxis, not otherwise specified) are omitted, the number of clinic visits for an insect sting was ~1 in 500. Because no ICD-9 code is specific for Hymenoptera stings, these data include bites and stings from other arthropods and likely represent a rough estimate of the frequency of stings in theater.

DISCUSSION

This study confirms the presence of numerous Hymenoptera species in Afghanistan that are the same or likely to be cross-reactive with species in North

America. All five North American winged Hymenoptera species most commonly posing an allergenic threat are represented by similar species in Afghanistan. There is currently no evidence that fire ants (*Solenopsis* spp.) are present in the region, but other stinging ant species (e.g., *Myrmica* spp.) have been identified. Stings inflicted by members of the genus *Myrmica* have been reported to cause severe allergic reactions, including anaphylaxis.²⁷

Of the three primary species collected in the study, *V. orientalis* seemed to pose the greatest potential threat. These insects were plentiful throughout the summer and early fall and were unofficially identified as the culprit insect by two of the three patients who experienced systemic reactions. In the author's experience, they were generally nonaggressive unless disturbed. Unfortunately, combat operations provide many opportunities to disturb their in-ground nests.

As is the case with other Hymenoptera, it is likely that *V. orientalis* shares common allergens with other Vespidae and probably contains unique allergens that are species specific. Although there is no skin-testing reagent for *V. orientalis*, a study from Israel reported a case in which an individual with a systemic reaction to *V. orientalis* was skin test positive only to yellow jacket.¹⁵ Another study using protein electrophoresis to compare hymenoptera venoms found major lines of precipitation between *V. orien-*

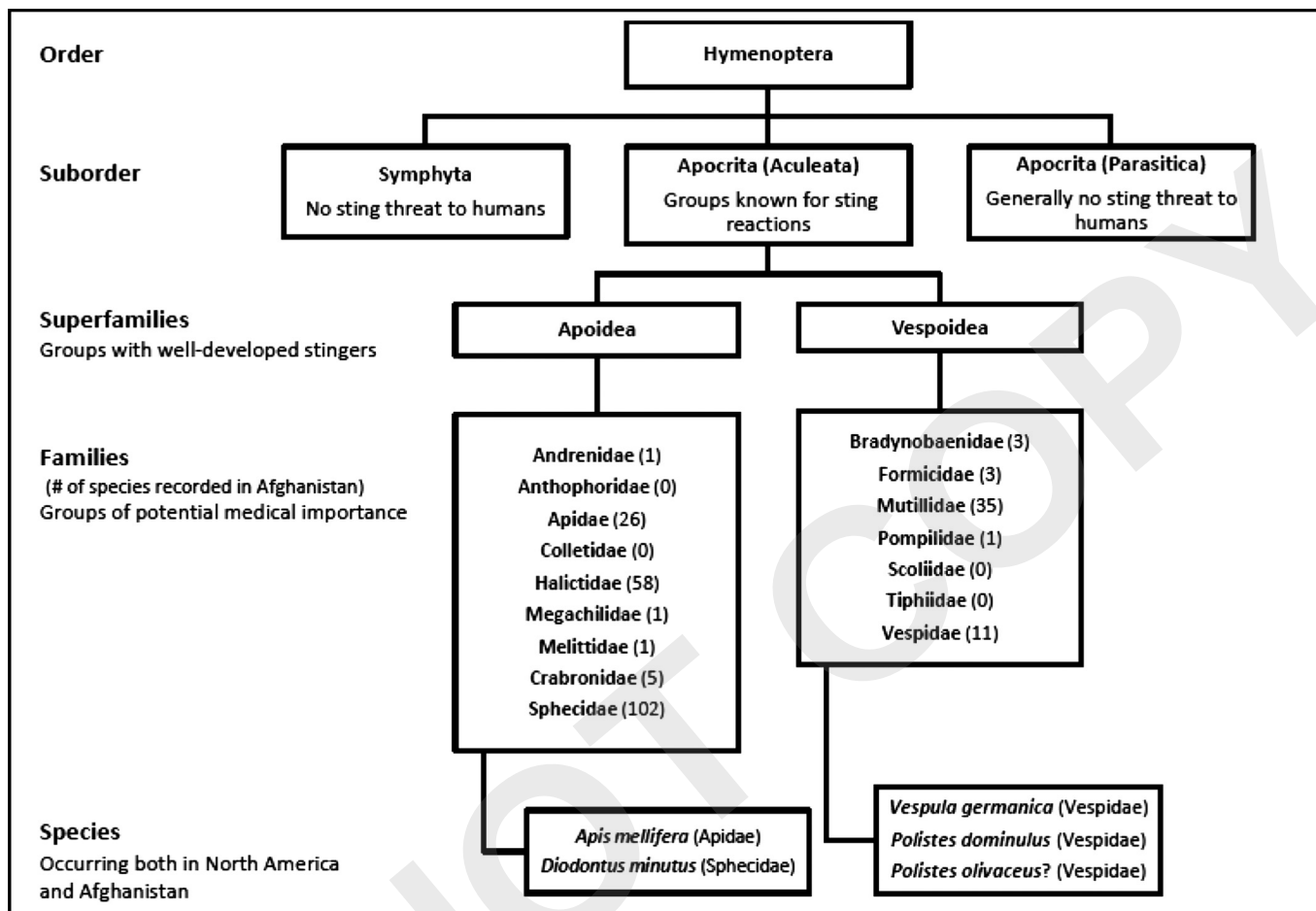


Figure 2. Classification of Hymenoptera showing common North American species and related species found in Afghanistan (? , reported in Hawaii but not the continental United States).

Table 1 Number of clinic visits in the Central Command area of operations related to insect stings over a 2-yr period

ICD-9	Description	No. of In-Theater Clinic Visits January 2009 to December 2010
E905.3	Sting of hornets/wasps/bees causing poisoning and toxic reaction	43
E906.4	Injury caused by nonvenomous arthropod	761
989.5	Toxic effect of venom (includes reactions to snakes, lizards, spiders, and ticks)	103
995.0	Anaphylactic shock not otherwise specified (excludes adverse food reactions and immunizations)	152
708.0	Urticaria	344
910.4–917.4	Superficial injury, insect bite, and nonvenomous of various body parts	1161
918.0	Superficial injury, insect bite, and periocular	50
All	Total number of in-theater clinic visits	1,100,912

Note. When less-specific ICD-9 codes such as those for urticaria and anaphylaxis are excluded, ~1 in 500 clinic visits involved a patient reporting an insect bite or sting reaction.

talis and honeybee, yellow jacket, and bald-faced hornet.¹⁷ A study using radioallergosorbent test to compare the venom of two American hornets to two Old World hornets found only weak cross-reactivity between the American hornets and *V. orientalis*.¹⁸ The authors concluded that currently available vespid extracts would not likely be sufficient to treat an individual primarily sensitive to *V. orientalis*.

V. germanica also poses an increased threat because service members can be exposed to this species while working in other parts of the world. Its widespread distribution increases potential exposure and its sting may induce anaphylactic reactions to stings by other common Hymenoptera species.²⁸ Previous sting reactions induced by genetic congeners such as *Vespula maculifrons* (Buysson) can result in more serious subsequent reactions to a *V. germanica* sting.²⁹ These findings highlight the potential for clinical cross-reactivity and for immunotherapy treatment with commercially available Vespid extracts for at least some of the Hymenoptera present in Afghanistan.

Limitations to this study include the fact that insects were collected from a single area that is not likely representative of the entire ecologically diverse country. Even with this limitation, the data collected allow providers to determine that a patient with insect venom hypersensitivity could potentially encounter a similar insect in Afghanistan. The ICD-9 data are limited because there is no way to account for multiple visits for the same insect sting or to avoid the possibility of double or triple counting (a provider could enter more than one ICD-9 code for the same sting). Inclusion of ICD-9 data is meant to illustrate approximately how often individuals seek care for insect stings in theater, but is not adequate to determine the actual risk of being stung.

This study is the first comprehensive summary of medically important Hymenoptera species identified in Afghanistan. Findings from this study highlight the importance of careful screening and management measures for deploying U.S. military personnel. Providers evaluating personnel with insect sting hypersensitivity should be aware of potential cross-reactivity between endemic and North American species. Additional study is needed to expand the knowledge of insect species prevalent in deployment settings and to determine the efficacy of immunotherapy using current standardized extracts available in the United States to prevent sting reactions during deployments.

REFERENCES

1. Army Regulation 40-501. Standards of medical fitness. Rapid Action Revision Issue Date August 4, 2011. Available online at www.apd.army.mil/pdffiles/r40_501.pdf; accessed March 25, 2012.
2. U.S. Army Office of the Surgeon General (OTSG)/Medical Command (MEDCOM) Policy Memo 07-037. Stinging insect policy. Available online at www.afpmb.org/sites/default/files/contingency/Stinging_Insects_Policy.pdf; accessed March 31, 2012.
3. Woyke J. Survival and prophylactic control of *Tropilaelaps clareae* infesting *Apis mellifera* colonies in Afghanistan. *Apidologie* 15:421–434, 1984.
4. Lelej AS, and Kabakov ON. On Bradynobaenidae and Mutillidae (Hymenoptera) of Afghanistan [in Russian]. *Entomol Obozrenie* 59:181–196, 1980. (Transl. in *Entomol Rev* 59:141–156, 1981.)
5. Archer ME. A key to the world species of the Vespinae (Hymenoptera). Part 1. Keys, checklist, and distribution. Research Monograph, York, U.K.: University College of Ripon and York St. John, 89, 1989.
6. Carpenter JM. Distributional checklist of species of the genus *Polistes* (Hymenoptera: Vespidae: Polistinae, Polistini). *Am Museum Novitates* 3188:30, 1996.
7. Williams PH, and Gupta RK. An annotated catalogue of the bee species of the Indian Region. Available online at www.beesind.com/beesind2/apis.htm; accessed October 31, 2011.
8. Rasmont P, and Haubruge E. Atlas Hymenoptera. Available online at www.atlashymenoptera.net/; accessed November 1, 2011.
9. Pulawski, W. Catalog of Sphecidae. Available online at www.research.calacademy.org/ent/catalog_sphecidae; accessed November 1, 2011.
10. Dikmen F, and Aytakin AM. Notes on the *Halictus* Latreille (Hymenoptera: Halictidae) fauna of Turkey. *Turk J Zool* 35:537–550, 2011.
11. Bagriacik N, and Samin N. A checklist of Iranian Vespinae (Hymenoptera: Vespoidea: Vespidae). *Arch Biol Sci Belgrade* 63:487–492, 2011.
12. Ebrahimi E, Schmid-Egger C, and Wahis R. New records of Pompilidae (Hymenoptera) from Iran. *Linzer Biol Beiträge* 40: 1435–1442, 2008.
13. Maria Ban C, and Tomozei B. New data on the Apoid Hymenopterans (Hymenoptera: Andrenidae, Anthophoridae, Apidae) from Dobrogea (Romania). *Travaux du Muséum National d'Histoire Naturelle* 49:307–318, 2006.
14. Thi Phuong Lien N, and Carpenter JM. Vespidae of Vietnam (Insecta: Hymenoptera) 1. Vespinae. *J N Y Entomol Soc* 110: 199–211, 2002.
15. Goldberg A, Confino-Cohen R, and Mekori YA. Deliberate Hymenoptera sting challenge as a diagnostic tool in highly selected venom-allergic patients. *Ann Allergy* 75:30–32, 1995.
16. Reisman RE, Wypych J, Mueller U, et al. Comparison of the allergenicity and antigenicity of *Polistes* venom and other vespid venoms. *J Allergy Clin Immunol* 70:281, 1982.
17. Reisman RE, Müller UR, Wypych JI, and Lazell MI. Studies of coexisting honeybee and vespid-venom sensitivity. *J Allergy Clin Immunol* 73:246–252, 1984.
18. Mueller U, Elliott W, Reisman R, et al. Comparison of biochemical and immunologic properties of the four hornet species. *J Allergy Clin Immunol* 67:290, 1981.
19. Menke AS, and Snelling R. *Vespula germanica* (Fabricius), an adventive yellow jacket in the northeastern United State (Hymenoptera: Vespidae). *USDA Coop Econ Insect Rep* 25:193–200, 1975.
20. Dvořák L. Oriental hornet *Vespa orientalis* Linnaeus, 1771 found in Mexico (Hymenoptera, Vespidae, Vespinae). *Entomol Prob* 36:80, 2006.
21. Paknia O, Radchenko A, and Pfeiffer M. New records of ants (Hymenoptera: Formicidae) from Iran. *Asian Myrmecol* 3:29–38, 2010.

22. Bharti H. Altitudinal diversity of ants in Himalayan regions (Hymenoptera: Formicidae). *Sociobiology* 52:305–322, 2008.
23. Radchenko A, and Elmes GW. *Myrmica afghanica* (Hymenoptera: Formicidae), a new ant species from Afghanistan. *Zootaxa* 375:1–8, 2003.
24. Radloff SE, Hepburn R, and Fuchs S. The morphometric affinities of *Apis cerana* of the Hindu Kush and Himalayan regions of western Asia. *Apidologie* 36:25–30, 2005.
25. Goulet H, and Huber JT. Hymenoptera of the World: An identification guide to families. Agric Can Res Branch Monogr. 1894E:668, 1993.
26. Carpenter JM. Review of Hawaiian Vespidae (Hymenoptera). Bishop Museum Occasional Pap 99:1–18, 2008. Available online at www.hbs.bishopmuseum.org/pubs-online/pdf/op99c.pdf; accessed March 31, 2012.
27. Arevalo HA, and Groden E. European fire ant, red ant (suggested common names), *Myrmica rubra* Linnaeus (Insecta: Hymenoptera: Formicidae: Myrmicinae). University of Florida, Institute of Food and Agricultural Sciences, Florida Cooperative Extension Publication EENY-410, 1–5, 2007.
28. Košnik M, Korošec P, Šilar M, et al. Wasp venom is appropriate for immunotherapy of patients with allergic reaction to European hornet sting. *Croatian Med J* 43:25–27, 2002.
29. Golden DB, Breisch NL, Hamilton RG, et al. Clinical and entomological factors influence the outcome of sting challenge studies. *J Allergy Clin Immunol* 117:670–675, 2006. □

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