University of Florida Book of Insect Records
Chapter 23 *Most Toxic Insect Venom*

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Insects in the order Hymenoptera were recorded as early as the 26th century BC as possessing a venom toxic to vertebrates. Harvester ants in the genus Pogonomyrmex *have the most toxic venom based on mice LD_{50} values, with* P. maricopa *venom being the most toxic. The LD_{50} value for this species is 0.12 mg/kg injected intravenously in mice, equivalent to 12 stings killing a 2 kg (4.4 lb) rat. A* Pogonomyrmex *sp. sting produces intense pain in humans that lasts up to 4 hours.*

Adult worker of Pogonomyrmex sp. Photo courtesty of J.O. Schmidt

A venom is a toxin that is injected into another organism using a specialized apparatus attached to a venom-producing gland. It may be used to immobilize or kill prey and/or to defend the delivering organism against attack by predators. Venomous insects are known from the orders Lepidoptera, Hemiptera, and Hymenoptera (Blum 1981). The method of delivery may be active, such as the sting apparatus of Hymenoptera (bees and wasps), and the mouthparts of Hemiptera (stylets), or passive such as the modified setae in some lepidopteran larvae (caterpillars) that are broken on contact and pierce the outer surface of the receiving organism. Schmidt (1982) proposed that some insects in the orders Diptera, Neuroptera, and Coleoptera also possess oral venoms, but there is a problem with whether this constitutes a true venom or is a digestive fluid that is ejected. The biological activity of the venom can be classified as neurotoxic, hemolytic, digestive, hemorrhagic and algogenic (pain-producing). Venoms are chemically described as consisting of alkaloids, terpenes, polysaccharides, biogenic amines (such as histamine), organic acids (formic acid), and amino acids, but the majority are peptides and proteins (Schmidt 1986a; Blum 1981). The first record of human death attributed to envenomation by a wasp or hornet was that of King Menes of Egypt in the 26th century B.C. (Waddell 1930). Toxicity of venoms is difficult to quantify in an unbiased manner and will vary among target species. It is also confounded by responses to the venom that are due to immune system disorders (such as hypersensitivity and allergies). For this reason, morbidity and mortality data may not be the best comparative method to classify venom toxicity (Schmidt 1986b). I will base my selection of the species of insect with the most toxic venom to vertebrates based on LD_{50} values using mice as the test organism.

Methods

Subscribing to the ENTOMO-L bulletin board and posting a general inquiry about insect venoms was the most profitable first step in obtaining information about venomous insect species. Personal interviews with University of Florida and USDA-ARS staff provided often colorful information on people's 'favorite' stinging bug. A wire story ("Killer Caterpillars," *Gainesville Sun*, 16 January 1996) apparently was widely distributed in newspapers and generated some discussion on the bulletin board. Searches on LUIS for information on literature in the University of Florida libraries retrieved some secondary literature such as the book by Blum (1981). Primary literature was identified using references obtained through ENTOMO-L replies and also by searching the AGRICOLA, *Current Contents*, and MED-LINE data bases available at University of Florida.

Results

There were numerous insects suggested for the most toxic insect from personal interviews and the ENTOMO-L bulletin board replies, many of which were based on personal experience and descriptions of the reaction to being envenomed. Insects suggested included harvester ants (*Pogonomyrmex*; Hymenoptera: Formicidae), bees (Hymenoptera: Apidae), yellowjackets and hornets (*Vespula*, *Dolichovespula*; Hymenoptera: Vespidae), velvet ants (Hymenoptera: Mutillidae), puss caterpillars (*Megalopyge opercularis*; Lepidoptera: Megalopygidae), slug caterpillars (*Sibene stimulea*; Lepidoptera: Limacodidae), giant silkworm moth caterpillars (*Lonomia* sp. and *Automeris io*; Lepidoptera: Saturniidae) and assassin bugs (*Rasahus* sp.; Hemiptera: Reduviidae). However unpleasant the experience of being "stung" by ants, bees, wasps, and assassin bugs is, it is difficult to quantify pain responses objectively. Likewise, the perception of the toxicity or danger may be artificially inflated when death of humans or other verte-brates is the result of envenomation (Schmidt 1986b). LD_{50} values provide an unbiased method of comparing insect venoms.

Hymenopteran insects possess the most toxic venoms that have been characterized (Schmidt 1990; J.O. Schmidt personal communication). Table 1 lists the LD_{50} values for some of these insects that are known to most people, such as the honey bee, paper wasp, yellowjacket, velvet ant and harvester ants. The most toxic venom is found in a species of harvester ant, *Pogonomyrmex maricopa* with a mouse LD_{50} value of 0.12 mg/kg (Schmidt et al. 1989; J.O. Schmidt personal communication). Schmidt (1986a) states that for a 2 kg mammal only 12 stings are required to reach the LD_{50} dose. Other species of *Pogonomyrmex* also produce venoms with low LD_{50} values when compared with other Hymenoptera (Table 1).

Discussion

Comparing LD_{50} values of a test organism (in this case, mice) can be a useful tool to objectively assess the toxicity of insect venoms; however, this method has its limitations. The values obtained in mice reveal a relative toxicity scale for different toxins in mice only. They do not reflect how the same toxins would rank for another species (such as humans). For example, the LD_{50} value of *P. maricopa* venom against a lizard, *Phrynosoma cornutum*, which is a predator of *P. maricopa*, was much higher than in mice (162 mg/kg). When one other lizard, *Sceloporus jarrovii*, was tested, the venom had an LD_{50} value of 28 mg/kg. These results suggest that *P. cornutum* has evolved resistance to the harvester ant venoms and can exploit the ants as a food resource (Schmidt et al. 1989). In another species of harvester ant, *P. badius*, there were high levels of an enzyme, phospholipase A_2, which is also present in honey bee and wasp venoms (Schmidt & Blum 1978a). Although cross-reactivity to honey bee and wasp venoms may be involved in the response of humans to *Pogonomyrmex* envenomation, in those cases

Table 1. LD_{50} values in mice for toxins found in Hymenoptera.

Family	Species	Common name	LD_{50} (mg/kg)	Reference
Apidae	*Apis mellifera*	honey bee	2.8	Schmidt 1990
Mutillidae	*Dasymutilla klugii*	velvet ant	71	Schmidt et al. 1980
Vespidae	*Polistes canadensis*	paper wasp	2.4	Schmidt 1990
Vespidae	*Vespula squamosa*	yellowjacket	3.5	Schmidt et al. 1980
Formicidae	*Pogonomyrmex spp.*[1]	harvester ants	0.66	Schmidt 1990
Formicidae	*P. maricopa*	harvester ant	0.12	Schmidt et al. 1989

[1] Average of 20 species tested.

that have been studied cross-reactions to vespid and formicid venoms have not been found (Schmidt 1986b). Interestingly, the venom of *P. badius* is not particularly lethal against larval insects (Schmidt & Blum 1978b). Since harvester ants are non-predatory, it suggests that their venom has evolved from being used in prey capture as in other ant species (Schmidt 1986a), to defense against vertebrates; hence their power against humans and other vertebrates.

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