A SIMPLE PAIN SCALE FOR FIELD COMPARISON OF HYMENOPTERAN STINGS

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ABSTRACT

A scale is described for reporting the painfulness of stings received from aculeate hymenoptera under uncontrolled conditions. The applicability and limitations of the scale are discussed, and examples are given of ranked stings. The usefulness of the pain scale in studying mimetic associations between stinging insects is discussed, with an example.

Key Words: Venom, sting, pain, Hymenoptera.

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INTRODUCTION

Venom injection (stinging) is an important defense tactic among various animal taxa, the most obvious of which is the aculeate Hymenoptera. It would be useful, then, to be able to compare the defensive power of stinging by different species or colonies. The components of such a comparison would be the number of potential defenders in the colony or aggregation, their readiness to attack, and the effectiveness of a single sting. The first of these is easily and often known. No standard measure has yet been derived for the second, but there is good reason to believe it correlates positively with the first, especially within species. That means that individuals of larger colonies appear to need less provocation to attack. This paper deals with the third component.

By "stinger" is meant here the venom-injection apparatus, while "sting" refers to the event. Research into the stinger and its venom has shown impressive progress along three lines: a) morphology of the stinger (Robertson 1968; Maschwitz and Kloft 1971; Kugler 1978; Bettini 1978; Hermann and Blum 1981; Hermann and Chao 1983), b) venom chemistry (Habermann 1971; Bettini 1978; Blum 1981; Schmidt 1982, in press), and c) the toxic effects of venom (Habermann 1971; Bettini 1978; Schmidt, in press).

At the same time, our knowledge of the pain caused by venom is still at the anecdotal stage. This is consistent with the fact that recent progress in the psychophysics of pain (Melzack 1973, 1976; Carregal 1975; Harcus et al. 1977) has been based on temperature, pressure, and electric shock, but not chemically-induced pain.

Yet in the evolution of defense against large, primarily vertebrate predators, pain must be the key factor in sting effectiveness, much more important than toxicity or paralyzing power. Given the extensive toxicological literature, it would be convenient if toxicity were a good index of painfulness. This appears not to be so. Schmidt and Blum (1979) and Schmidt et al. (1980, 1984) give examples of wasps with very painful stings yet only slightly toxic venoms. Even if we find that more toxic venoms are *usually* more painful, as appears reasonable, it will be the exceptions which are of special interest.

The Hymenoptera literature contains many brief descriptions of stings received in the course of field research. A common standard is lacking, though, so that it is often difficult to infer which of two species-stings mentioned in different reports is the more painful. The intention of this paper is to provide just such a standard, with the hope that over time a systematized body of comparative observations will accumulate.

THE PAIN SCALE

Pain is the body's alarm system in the face of injury, so that it is not surprising that its perception is graded into relatively few intensity levels. Humans can distinguish about 570 levels of light intensity, from barely perceptible to dazzling (Duke-Elder 1941) and about 90 levels of warmth below the pain threshold (Herget and Hardy 1942). But for pain induced by pressure or pricking, Hardy et al. (1947, 1952) put the number of distinguishable levels at just 22.

The complete fineness of discrimination is not commonly used in experimental pain studies. Chapman (1976) gives as the most common method of assessment a scale from 0 to 10, in which 1 represents the lower threshold of perception and 10 the upper threshold. The McGill Pain Questionnaire (Melzack 1975) has 6 levels over the same range, and that of Lutterbeck and Triay (1972) just 4. The scale described below has 5 levels, from 0 to 4. It is very close to the McGill scale, the only substantial difference being that McGill levels 4 and 5 are approximately equal to my level 4. Schmidt et al. (1984) use a pain scale of 1 - 4 for stinging hymenoptera, though without defining the levels. Inasmuch as all of the species they rank can penetrate human skin, and as their rankings agree very well with my own (Table 1) and with those given by Schmidt (in press) using the present scale, it seems that the rankings 1 - 4 of Schmidt et al. (1984) and this paper are virtually identical.

0. No pain
1. Pain so slight as to constitute no real deterrent.
2. Painful
3. Sharply and seriously painful.
4. Traumatically painful.

Rank 0 is common, as many species with a functional stinger are too small or weak to penetrate human skin. Rank 1 lies in that area in which the sting is clearly perceived (pain above threshold), yet most people would not say it "hurts." Stings of rank 4 are often medically serious events, producing strong physical reactions and durable pain even in persons without a history of acute reaction to stings (numerous pers. comm.), but attention is given here only to short-term pain, within a few seconds of the sting.

The distinction between ranks 2 and 3 may often be unclear. The intention is to distinguish between the great mass of painful stings (2) and those which stand out as clearly more painful than, for example, most honey bee stings, though not of traumatic intensity (3). One possibly useful characterization is that rank-3 stings, just from the pain itself and apart from any surprise or fear, produce loud cries, groans and/or long preoccupation. The examples in Table 1 will add to this distinction.

Table 1. Examples of ranked hymenoptera stings. Each of these is based on at least two stings, and as far as I know all follow the restrictions recommended in the text. Those marked with an asterisk are based on induced stings, explained in the text. Where a species has two rankings, this represents variation in stings, rather than uncertainty. Rankings of social species are all based on workers or the subcaste most commonly encountered outside the nest.

Family	Species	Rank	Source
Mutillidae	*Dasymutilla klugii*	3	d
	Dasymutilla lepeletierii	2	c,d
	Dasymutilla small sp.	1 - 2	d
	Pseudomethoca small sp.	2	e
Pompilidae	*Pepsis formosa pationii*	4	d
Scoliidae	*Trielis flammicoma*	1	e
Eumenkiae	*Monobia quadridens*	2*	a
Vespidae:			
Stenogastrince	*Eustenogaster luzonensis*	3	a
Vespidae:			
Polistinae	*Apoica pallens*	2	c,d
	Brachygastra bilineolata	2	c,d
	Brachygastra lecheguana	2	a
	Metapolybia docilis	0 - 1	a
	Mischocyttarus angulatus	1*	a
	Mischocyttaurs atrocyaneus	1*	a
	Mischocyttaurs costaricensis	1*	a
	Mischocyttaurs melanarius	low 2*	a
	Polistes annularis	3	a,c
	Polistes arizonensis	2 - 3	d
	Polistes comanchus navajoe	2 - 3	e
	Polistes dorsalis	2	a
	Polistes exclamens	2	a
	Polistes fuscatus	2	a,d
	Polistes infuscatus	3	c,d
	Polistes metricus	high 2 - 3	a
	Polybia diguetana	0 - 1	a
	Polybia occidentalis	1	a
	Polybia rejecta	2	a,d
	Polybia sericea	2	c,d
	Polybia simillima	2	a
	Ropalidia flavopicta	1	a
	Ropalidia sp.	1 - 2	d
	Stelopybia panamensis	3	a
	Synoeca septentrionalis	4	b
Vespidae:			
Vespinae	*Dolichovespula maculata*	2	c,d
	Vespa mandarinia	2	d
	Vespula flavopilosa	2	e
	Vespula maculiforns	2	a,c