

Allergic Reactions to Insect Stings:

A Review of 180 Cases*

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Summertime is the time of the year for insect stings. At times these may present serious problems in prognosis and management. This offers timely reading.

THE MOST PRIMITIVE HYMENOPTERA first appeared in the fossil record around 200 million years ago.¹ Originally, the sting of these insects served for the taking of prey and in wasps the sting still serves this purpose—taking prey primarily to feed their larvae. It is of interest that some of these wasps also prey on other Hymenoptera.

I wish, in this paper, to discuss the insects which can and do sting man. It is usually the social bees and wasps which are prone to attack and sting humans.

Figure 1 shows some of the commonest bees and wasps in the United States. Most of these have produced serious reactions in humans, though some sting only when handled. Within a species of bee or social wasp (the hornets, yellow jackets, *Mischocyttarus*, *Polistes*) there is a considerable difference in size as between individual insects—the queens are larger than the workers.

I have been particularly interested in reactions to insect stings since 1955, and previously reported some of my experiences on the subject.²⁻⁴ A portion of this paper is to deal with a review of 180 patients having insect stings whom I have seen during the past eight years.

The problem of sensitivity to insect stings has gained much prominence in recent years. Mild allergic reactions are undoubtedly common, but there are an increasing number of reports of severe anaphylactic reactions, some fatal, appearing in the literature. Those of us interested in the subject have formed an Insect Committee of the American Academy of Allergy through which we can learn more about this subject and disseminate information to physicians.

Of my 180 patients having had generalized

reactions to insects, 175 were white and 5 were colored. Approximately 61%, or 110 were male. However, there was no comparable difference in reaction to stings relevant to the sex of the patient. Forty per cent of these patients had a past or present history of allergy, such as nasal allergy, asthma or eczema, while 62 or 34.4% had an associated history of drug allergy. Eosinophiles in the nasal smear were found in 112 or 62.2% (Table 1).

Age of Patients

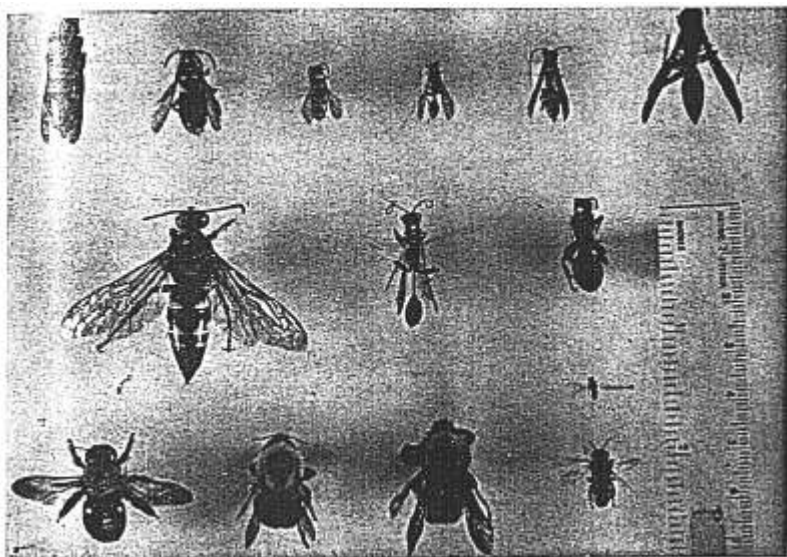
Dividing the patients into age groups of 3 to 4 years, we find reactions occurring most commonly in the following groups: 26% or 46 of the patients were children from 3 to 7 years of age; 14% or 25 of the patients were children from 8 to 12 years; 6% or 12 of the patients were teenagers from 13 to 16 years of age. Thirteen patients (7%) were 17 to 20 years of age; 11% or 19 patients were from 34 to 37 years of age. Twenty patients were in the 40 to 50 year group, 10 in the 50 to 60 year group and 12 in the 60 to 70 age group. The youngest patient was 2 years of age, the oldest was 77 years. The majority of reactions occurred in children from age 3 to 7 years (Table 2).

Sites of Sting

The most frequent site to be stung was the head and neck (in 45 instances). This is to be expected since it is an exposed area; the next most common site was the feet (below the ankle) in 32 instances. You might think we all go barefoot in North Carolina, but all but two of these stings were in children. It would seem then, that one good preventive measure would be to keep one's shoes on. The hand was the next most common site with 26, the arm with 21, and the leg with 19. Other sites are shown in table 3.

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FIG. 1



Top row (left to right), European hornet (*Vespa crabro germana*) builds paper nests in hollow trees or sidings of houses; found mostly along eastern seaboard; Bald-faced hornet (*Vespa maculata*) builds paper nests, more or less football-shaped, commonly in shrubbery or trees; Yellow jacket (*Vespa maculifrons*) builds subterranean paper nests, often under shrubs and sidewalks; No common name (*Mischocyttarus cubensis*) builds small, open comb paper nests, often on palm fronds, and under porch roofs in extreme southeast—a larger, related species occurs in the southwest; Paper wasp (*Polistes exclamans*) builds an elongated, open comb with cells arranged in horizontal rows; Paper wasp (*Polistes annularis*) builds an umbrella-shaped, open comb paper nest; Middle Row. Cicada killer (*Sphex speciosus*) a solitary, gregarious, ground-nesting wasp which paralyzes cicadas and carries them to its nest; Common mud-dauber (*Sceliphron caementarium*) builds a clump of clay cells under eaves, porches and so forth;—other species, colored differently, build differently shaped nests; Velvet ant (*Dermatillus occidentalis*) also called cow killer, is wingless (female) solitary wasp, found in sandy, open places—there are many other species, those in southwest have a shaggier appearance. Below middle row, (right) Sweat bee (*Lesioglossum inaequalis*) of hundreds of species in the United States, mostly dull green or blue or brown in coloration. They are attracted to perspiration on the arms and often appear inside automobile windshields while driving. Bottom row. Carpenter bee (*Cylloceria virgata*) nests in tunnels bored in wood, as at ends of rafters—often confused with bumble bees; Bumble bee (*Bombus impatiens*) of many species, nest mainly on the surface of the ground or just under the surface; Bumble bee (*Bombus americanorum*) another species of bumble bee illustrates different coloration and size; Honeybee (*Apis mellifera*) is the only bee in the United States which leaves its stinger in the wound.

Types of Insects

In this series, yellow jackets were responsible for 56 of the reactions, wasps for 43, honeybees for 35, hornets for 9, bumble bees for 3, sweat bees for 1, and unknown for 32 (Table 4).

It was believed, after studying the severity

of the reactions, that all of these insects had equivalent capabilities of inducing severe reactions.

Bees and wasps belong to the class Hexapoda, order Hymenoptera.^{5,6} The bees belong to the Apid family and the wasps to the Vespid family. While there are many species of both,

TABLE 1

Total number of patients	180
White	175
Colored	5
Sex	
Male	110
Female	70
Personal history of atopy	92%

TABLE 2
AGE OF PATIENTS

Age	Number of Patients	Per Cent
5-7	46	26
8-12	25	14
13-17	19	11
18-20	13	7
21-30	12	6

TABLE 3
SITES OF STING

Site	Number of Patients	Per Cent
Head and neck	45	25
Feet	32	17
Hand	26	14
Arm	21	11
Leg	19	11
Body	9	5
Ankle	7	4
Wrist	6	3

it is usually the social bees and the wasps which are so prone to attack and sting humans. The mud-dauber, potter and blue mud-dauber wasps are commonly encountered solitary wasps and usually cause no trouble. The social Apids consist of the honeybees (family Bombidae). The commonest species of honeybee is *Apis mellifica* and was introduced into this country from Europe. The local social Vespids constitute about a dozen species whose members are more diverse in appearance, but only three species are of importance to the present problem. Honeybee hives may contain as many as 50,000 inhabitants and the worker bees will attack promptly if disturbed and will attack in groups if the colony is apparently threatened. Bumble bees make small nests underground with fewer inhabitants and seem to attack individually and then only after being repeatedly disturbed.

The three commonly encountered species of social wasps are the paper wasp (*Polistes pallipes*), the yellow jacket (Vespine wasp or hornet, *Vespa Maculifrons*) and the common white-faced hornet (*Vespa maculata*). The paper wasp is the largest and builds small, open-bottomed, comb-type nests under eaves and in other open but protected areas. He stings on provocation only but can be troublesome when irritated. The white-faced hornet builds the large, gray, football-shaped nest often seen hanging from the branches of trees or shrubs. These nests contain as many as 10,000 citizens who pour out in large droves

TABLE 4
TYPE OF INSECT

Type	Number of Reactions	Per Cent
Yellow jacket	56	51
Wasp	43	26
Honeybee	35	19
Unknown	32	17
Hornet	9	5
Sweet bee	1	

at the slightest threat to their colony. The yellow jacket, so-called because of the yellow bands on its body, is the smallest of the three, but is probably the most frequently encountered, since its nests, although small, are just under the ground or on the ground near old logs. They are, therefore, easily disturbed when mowing a lawn or when planting, and they attack promptly when provoked.⁷

The solitary wasps are hunters.¹ Each species tends to specialize, hunting down a particular prey and disregarding others of similar size. Many formidable stingers—such as ants, bees and other wasps, as well as grasshoppers and crickets are among the prey of solitary wasps, the insects are paralyzed and taken to the larvae. When these wasps sting a cricket, they give a single sting in the region of the nerve ganglia which controls the hindlegs and prevents jumping. This specialization of behavior is not surprising, a difference in strategy and tactics being required for capturing a caterpillar as compared to capturing a fly. Wasps take prey mainly for feeding their larvae. The solitary wasps foreshadows the social Hymenopters.

The solitary wasps have received a great deal of attention from zoologists and are esteemed by entomologists, not only as subjects, but as colleagues of a sort. One species of wasps collected three new species of bees. In the Congo, one scientist trained several assistants to collect flies being brought to their nests by these wasps. More than 200 species of flies were brought in by these wasps—many of which were new to science and several not re-discovered since.

What makes bees behave the way they do? It is interesting and helpful to patients to know a little about the behavior of bees. For example, they are more likely to sting on bright, warm days if interfered with while they are busy gathering nectar. They are angry, disappointed and in a stinging mood after a heavy rain has washed the nectar from the flowers. Stinging insects are attracted to gaily colored, dark and rough clothing, but take less offense to white clothing with a hard finish. Highly scented hair dressings, perfumes and other cosmetics should not be used, since they attract stinging insects.

It would be nice if these stinging insects did not go around using their stingers. Some recent work has been done by animal behaviorists

and organic chemists working together in an attempt to determine why insects behave as they do. It has been found that chemical systems may provide the dominant means of communication in many animal species.⁸ Attempts have been made to decipher these systems. For example, pheromone has been found to be a substance secreted by animal that influences the behavior of other animals of the same species. The mode of influence can take either of two general forms. The pheromone may produce an immediate and reversible change by acting directly on the recipient's nervous system, or the pheromone may trigger a chain of physiologic events in the recipient and act as a primer so the organism has a new behavior repertory, the components of which are thenceforth invoked by appropriate stimuli.

In honeybees, chemical signals play various roles. For example, the mother queen bee secretes a pheromone which, when ingested by a worker bee, inhibits development of its ovaries and its ability to manufacture the royal cells in which new queens are reared.

When a new food is found, the insect may do a "waggle dance" and also secrete a substance which diffuses through the air. This substance and the dance attracts bees to the food. When a worker bee stings an intruder, it discharges, in addition to the venom, a secretion from clusters of unicellular glands located next to the basal plates of the sting. This secretion has been thought to be responsible for the tendency, well known to bee keepers, of an angry swarm of bees to sting at the same spot. One component which acts as a simple attractant has been identified as isoamyl acetate, a compound that has a banana-like odor. It is possible that the stinging response might be evoked by an alarm substance secreted with the attractant.

In bees and wasps, the stinging mechanism is similar and represents an adaptation of the egg-laying apparatus.^{5,9} It consists of an acid gland, a poison sac and an alkaline gland. The venom produced by the mixture of the contents of these glands is generally acid and is injected into the victim through a hollow double lancet. In the instance of the worker bee, barbs are placed on the shaft of the lancet to cause it and the poison gland to remain in the subject. The lancet should therefore be gently removed without squeezing the poison sac to avoid the inadvertent but additional injection

of venom. The lancet of the queen bee, the bumble bee and the hornet have no barbs, and that of the wasp has short barbs so these lancets can be withdrawn and each can, therefore, inflict multiple stings.

Types of Reactions

My patients had generalized reactions to insect stings which included one or more of the following symptoms: shock, unconsciousness, dyspnea, angioedema, nausea, vomiting, urticaria, wheezing, chills and fever, generalized itching and loss of vision in one patient.

It is believed that these systemic symptoms are not due to toxic effects of the venom, but are manifestations of allergic sensitization to substances in the venom. In an attempt to determine if there were any antigenic relationships between the different Hymenoptera, gel diffusion studies indicated that extracts of bees, wasps, yellow hornets, and yellow jackets contained from four to six antigenic fractions. Probably two of these are immunologically identical in all of these insects. However, the remaining two to four antigenic fractions are specifically characteristic of the individual insect species and are not shared with other species.¹⁰

In August of 1963, I corresponded with Dr. John Pisano of the National Institute of Health, and in his letter he said, "Our work with wasps began only two months ago. We have confirmed the presence of histamine and an acetylcholine-like material in the venom, as well as the peptide. Of interest is the fact that quantitatively, it is the peptide which is present in the highest amount (about twice the amount of histamine) and it must play a major role not only in pain production but in causing vasodilation and increasing capillary permeability."*

Below is a summary of 3 case reports:

Case 1. A 45 year old Negro, was seen on July 16, 1956, for the first time. He was stung by a yellow jacket on the left arm, followed by a loss of vision of the left eye within two hours after being stung. He still had some loss of vision in this eye several days later. An ophthalmologist found some edema of the retina of the left eye. He was treated with an antihistamine and nicotinic acid with gradual improvement of vision.

Case 2. A 52 year old man was seen in September of 1956 with a history of having been stung many times as a child. Whenever he was stung by a bee, it was followed by "swelling" so severe he had to stay in bed. These reactions gradually became worse. About

*Personal correspondence with Dr. John J. Pisano.

five years before he had a wasp sting on his left knee followed by "swelling" of his left leg, abdomen and chest in about 15 minutes. One year ago he developed urticaria after a yellow jacket sting and had to stay in bed for two days. He had the unhappy experience of being stung again in a few days, followed immediately by urticaria, nausea, vomiting and loss of consciousness. He feels very warm after each sting and also feels as if he were chilling.

Case 3. A 44 year old man was brought into an emergency room in Miami, Florida, following a wasp sting. Immediately following the sting he attempted to walk to the bathroom and lost consciousness; his "eyes turned back in his head" and for a few seconds he had a generalized convulsion. He became bluish and received mouth to mouth resuscitation for 5 to 10 minutes by his son. He remained unconscious for about an hour; he was given oxygen in the ambulance enroute to the hospital. On arrival at the hospital the B.P. was 60/30, P. 120, R. 18 and T. 100° rectally. The patient was somewhat responsive but somnolent; he would answer questions but at times rather poorly. In the emergency room he was given epinephrine intravenously and 10 mg. of mephentermine (Wyamine) intramuscularly, oxygen by mask; 200 mg. of hydrocortisone (Solu-Cortef) intravenously, and promethazine HCl (Phenargen) 45 mg. intramuscularly. The patient's blood pressure improved. He subsequently developed severe, intense pain in the thighs and upper legs which required meperidine HCl (Demerol). Following admission, the patient improved gradually. He had considerable indigestion, gaseous sensations in the abdomen, and some substernal burning which he stated was similar to that which he had had in the past at home. A myocardial infarction was suspected because of one electrocardiographic tracing but later the changes were thought to be most likely the result of tissue anoxia rather than myocardial damage.

The patient subsequently returned to his home in Asheville and desensitization was started. After he had received about nine injections of the extract he was again stung by a wasp early one morning. Naturally terrified, he rushed to the office, but as we observed him in the office he had no reaction to the sting.

Reactions to an insect sting generally occur within a few minutes after the event, though it has been reported that delayed reactions can occur 24 hours later and even four to ten days later. In the latter instances, the mechanism is considered to be similar to that of serum sickness, the symptoms occurring after the first sting and only after an incubation period. Unequivocal cases of this type, however, are rare.

The reactions following insect stings may consist simply of an unusual amount and/or duration of local swelling.^{11,12} Generalized papular urticaria has been reported but urticaria of the usual variety is a frequently observed symptom.¹³ Marked regional adenopathy consistently follows stings in some

sensitive individuals. Petechial hemorrhages, locally, generalized, subcutaneous or distributed throughout many organs and even in the central nervous system, have been observed.

The more severe reactions consist of one or more of the following symptoms: constriction of throat and chest, dyspnea, asthma, cyanosis, abdominal cramps, diarrhea, nausea, vomiting, chills and fever, vertigo, laryngeal stridor, shock, loss of consciousness, involuntary action of the bowel and bladder, and bloody frothing sputum. In a few instances, the reaction has consisted of exfoliative dermatitis and recurrent neuritis¹⁴ (Table 5).

Numerous fatalities have been reported—many of them in the public press. The fatalities reported in the literature were reviewed by Williams¹⁵ and those fatalities studied by autopsy were summarized by Schenkin, Tamis and Winter.¹⁶ The necropsy findings in the ten cases reviewed by Schenkin and associates showed the following changes, in the order of the frequency of occurrence, pulmonary emphysema, cerebral edema, fatty metamorphosis of the liver, dilatation of the heart, epicardial hemorrhage, cerebral intraventricular hemorrhage, fluid blood, congestion of nasal sinuses, cutaneous petechiae, cerebral petechiae, meningeal hyperemia, fatty degeneration of the heart, cardiac hypertrophy and lobar pneumonia.

Preceding Stings and Their Frequency

Previous stings were known in 142 patients; 48 of these patients were stung by the same insect which resulted in the severe reaction; 94 were stung by different insects than the one causing the reaction; 38 patients could not recall being stung prior to the sting causing the reaction (Table 6).

The patients were thoroughly questioned as to approximately how often they had been

TABLE 5
SYMPTOMS OF INSECT STING REACTIONS

Urticaria	Nausea and vomiting
Regional adenopathy	Chills and fever
Petechial hemorrhages	Vertigo
Constriction of throat and chest	Laryngeal stridor
Dyspnea	Shock
Asthma	Loss of consciousness
Cyanosis	Involuntary evacuation of bowel and bladder
Abdominal cramps	Bloody frothy sputum
Diarrhea	Exfoliative dermatitis
	Recurrent neuritis

TABLE 6

PRECEDING STINGS IN 142 PATIENTS

Number of Patients	Type of Insect
48	Same
94	Different
38	Couldn't recall being stung before

stung in the past, considering the possibility that repeated stings at frequent intervals may have induced hypersensitivity. This had to be an approximation since they could not remember the exact number of times they had been stung during the year. However, 111 patients had a history of about one sting a year; 14 had a history of one to two stings a year; 3 patients had a history of about three to four stings a year; and 2 patients had a history of four to six stings a year. Twelve patients had a history of not remembering more than two to four stings in their lifetime. Most of the patients had a history of infrequent stings, that is, not being stung more than once a year (Table 7).

An attempt was made to determine how much time had elapsed between the last previous sting and the sting causing the severe reaction. In 115 patients there was a time lapse of one to five years before having the severe reaction; in 11 of the patients there was a time interval of two to six months; in 8 of the patients there was a time interval of one to two months; and only 8 were stung less than a month before having a severe reaction (Table 8). The time interval nor the frequency of stings did not seem to be related to the severity of the reaction.

In many of my patients there was no advance warning before the occurrence of the systemic reaction. Forty-five or 25% reported no local reaction from previous stings.

Desensitization

Skin tests with extracts of whole insects are done by scratch and intradermal methods to aid in determining cross-sensitivity and a starting point for treatment. All of my patients

TABLE 8

PRECEDING STINGS

When Was Last Sting Prior To The Reaction?	Number of Patients
over 1 year	115
2-6 mos. ago	11
1-2 mos. ago	8
0-1 mo. ago	8

received desensitization with extracts of whole insects. There has been some discussion as to whether extracts from venom-sac or whole-insect is the most satisfactory for desensitization. The arguments for using contents of venom-sac versus whole-insect extracts, as raised by Lowell and Fackler¹⁷ seem, with present knowledge, to have been satisfactorily answered by the reports of Benson,^{11,12} Rockwell,¹⁸ Ellis and Ahrens,¹⁹ and others. From our experience, as well as others, I still favor the whole-insect extract. The different studies would indicate that the antigen causing reactions is present throughout the insect's body, independent of venom, but that the venom contains a small amount of this antigen.²⁰ Reactions to desensitization have been very infrequent and mild in the patients I have treated. There has been, usually, some itching at the site of the injection which lasts only a few minutes. I can recall only two generalized reactions, but none of the reactions were so severe as to require discontinuing the desensitization. I usually begin desensitization at the strength giving a slight reaction to the skin test. The patient should be kept in the office for 30 minutes after an injection for observation. If there is any sneezing, generalized itching, coughing, urticaria or wheezing after an injection, treatment of the reaction is indicated. These systemic reactions are usually controlled by: (a) a tourniquet above the site of the injection, which may be loosened momentarily for comfort; and (b) injections of five minims of epinephrine 1:1,000 in the arm above the tourniquet every ten minutes until comfortable or symptoms of too much epinephrine appear. If the reaction is mild, (usually occurring after two hours) an antihistamine will usually relieve it. If such a reaction occurs, one should drop the dosage back one half and be very cautious about continuing hyposensitization. It is also a good idea to give the patient an antihistaminic and isoproterenol (Isuprel) to carry with him in case he has a reaction after leaving the office.

TABLE 7

FREQUENCY OF STINGS IN PAST OF 142 PATIENTS

Number of Patients	Approximate Number of Stings a Year
111	1
14	1-2
3	3-4
2	4-6
12	2-4 in lifetime

TABLE 9
EFFECT OF DESENSITIZATION

Reactions After Sting	
Worse	2
Less	39

Effect of Desensitization. Forty-one of the patients were stung after desensitization had been started; and 39 of these had much less reaction than prior to immunization and 18 had no reaction. Only two patients showed a slightly worse reaction. There can no longer be any question of the efficacy of desensitization for allergy to insect sting (Table 9).

Treatment

At the present time, the treatment of choice of an acute reaction to a sting seems to be prompt administration of epinephrine 1:1,000 subcutaneously and, in extreme instance, intravenously. A tourniquet should be placed proximal to the site of the sting whenever possible and the epinephrine should be given above the tourniquet. An antihistamine can be given by mouth parenterally. Steroids should be given if the severity of the reaction warrants it. Epinephrine should be repeated at intervals depending upon the response of the patient. For shock, hospitalization may be necessary, as well as the use of intravenous fluids for treatment of shock. Tracheotomy may prove necessary.

An insect sting kit has been prepared which I described recently.⁴ This kit contains, among other things, (a) isoproterenol (Isuprel), a 15 mg. tablet; (b) epinephrine HCl aerosol for inhalation; (c) instructions on the use of the tourniquet, tweezers and antiseptic towelette.

Summary

In summary, I have tried to describe some of the stinging insects, their behavior and

certain of the reactions to these insects. I believe that most stinging insects are capable of causing allergic reactions in humans. There seems to be no difference in these reactions as to type of insect, sex or color of the patient, or frequency of stings. The majority of reactions occurred in children from three to seven years of age.

I believe desensitization is effective in preventing these severe reactions.

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