The Honey Bee Sting

by JAMIE ELLIS
Gahan Endowed Associate Professor
of Entomology
Honey Bee Research and Extension Lab
Dept of Entomology and Nematology
University of Florida

jdellis@ufl.edu
www.ufhoneybee.com

Follow my lab on
Twitter and Instagram:
@ufhoneybeelab

Probably most people on the planet interact with honey bees at some point. Those of us who are beekeepers enjoy developed interactions with honey bees that arise out of a respect for and fascination of the bee. However, the interaction that many other individuals have with honey bees is quite negative, usually resulting from the person getting stung.

There are two common questions/comments that I receive from people when they find out that I work with honey bees. The first is "what is killing all the bees?". This question moved into first place about ten years ago when elevated colony loss rates put honey bees in the living rooms of people worldwide. Until that time, the second most common question I get asked now was the most common and it is "do you ever get stung?". This question is a bit humorous to me because it makes a couple of things immediately obvious. First, it tells me that stings are what many, maybe most, people equate with honey bees. That is quite sad if you think about it. Second, it reminds me how mortally terrified people are of getting stung, given the nature and prominence of the question (i.e. someone asks about it before they ask about the many other things one could want to know about honey bees). Finally, it tells me that the person suffers from a momentary lapse in understanding dangers associated with certain jobs. After all, carpenters hit their fingers with hammers, football players get concussions, electricians get shocked, and beekeepers get stung. It should be obvious. If you are considering getting into beekeeping and wonder if you can avoid getting stung – the answer is no. In fact, you ***will*** get stung, and you probably will be better off for it. ☺

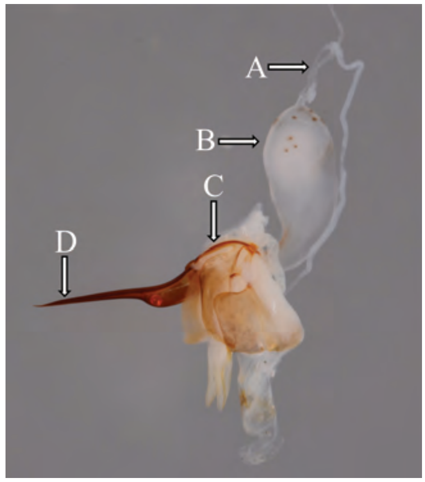
So, of course I get stung…a lot, probably tens of thousands of times over my beekeeping career. I am sure that I have been stung hundreds of times in one day, likely on multiple occasions. And yes, bee stings still hurt me. They hurt me as much as they hurt anyone. Yet, thousands of other beekeepers around the world and I continue to work with bees regardless of the risk and pain associated with getting stung. Are we crazy, naïve, tough or so captivated by our enjoyment of bees that we accept the stings? I suppose the answer to all of these is yes.

Humor aside, stings are a serious hazard of beekeeping. For most of us, stings are just a minor inconvenience, something that we do not like, but something that we permit given our insatiable desire to keep bees. We may get stung many times, most days, and we think nothing of it. However, for many people, stings pose a significant risk, even a fatal one. Worse yet, beekeepers can have kept bees for decades and suddenly develop an allergy to bee stings. Thus, it seems prudent that all would-be and seasoned beekeepers understand the science of a bee sting, what to do when stung, including how to recognize serious reactions to bee stings, and how to minimize the number of stings one receives.

What is a sting and why do bees have it?

Put simply, a sting is a honey bee's principal means of defense. The sting (Figure 1) is what bees use to tell the victim that their patience is waning. Bees sting when provoked, harmed, or are in danger. For most people, this means that they inadvertently stepped on a bee while walking barefoot in the yard (do people still do that?) or grabbed a bee when reaching for a flower. When this happens, the bee's natural instinct kicks in and she delivers her sting.

However, most bee specialists agree that a bee does not have a stinger for purposes of *self*-defense but rather for purposes of *colony* defense. Bee colonies are full of developing brood (protein), stored pollen (minerals, vitamins, protein), and honey (carbohydrates) and there are a number of organisms on the planet that want to exploit these stored resources. Given that colonies are full of food, they are a prime target for other insects, birds, mammals and various pests. Bees protect these resources and defend their colonies with their sting. The colony is so important to the individual bee that she will risk her life trying to defend it, altruism in the purest sense. Indeed, honey bees lose their stinger when stinging a tough-skinned invader such as mammals. This loss kills the bee. Thus, a bee's decision to deploy her sting comes at great cost to her. Interestingly enough, bees can sting organisms with soft tissues, such as other insects, repeatedly.



(l) **Figure 1. The sting shaft protruding from a worker honey bee's abdomen. Photograph by Mike Bentley. (r) Figure 2. A lateral (side) view of the major parts of a honey bee stinger. A – the tubular venom gland (sometimes called the acid gland); B – the venom (or poison) sac; C – the muscular bulb; D – the sting shaft. The venom gland produces venom that is stored in the venom sac until needed. When the sting is deployed, the venom flows through the sac, and into the bulb. The muscles on either side of the sting bulb contract alternately, causing the lancets to push deeper into the skin while pumping venom down the venom canal. Photograph by Lyle Buss, University of Florida.**

Honey bees are the only stinging insects that leave their sting in their tough-skinned victims. This is important to know because many people blame honey bees for stings they receive, though honey bees rarely are the culprit. The way to know is to look for a sting remaining at the sting site. If you consider wasps, for example, they can sting you over and over and over, as can many ants, and all other bees. This is a good defense but the full potential impact of the defense is not maximized. After all, you escape the sting once you kill the wasp or it flies away having accomplished its job of moving you away from its nest.

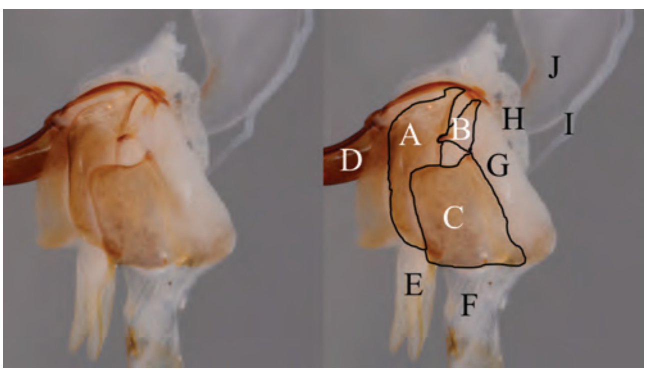
Honey bees, on the other hand, leave their sting, along with its venom sac, in their victims. The sting continues to inject venom long after the bee is gone, crushed, or killed. The honey bee sting is built to have maximum impact on the nest intruder. It is designed to remain in the victim and continue to do its job long after the stinging bee is gone. Of course, being stung hurts us. Yet, we usually are able to remove the sting from our bodies regardless of where the bee puts it. In contrast, think about other mammal or avian nest intruders. There are a lot of places they can be stung from which they cannot remove the sting. In these cases, the sting packs the maximum punch, delivering all of the venom it contains.

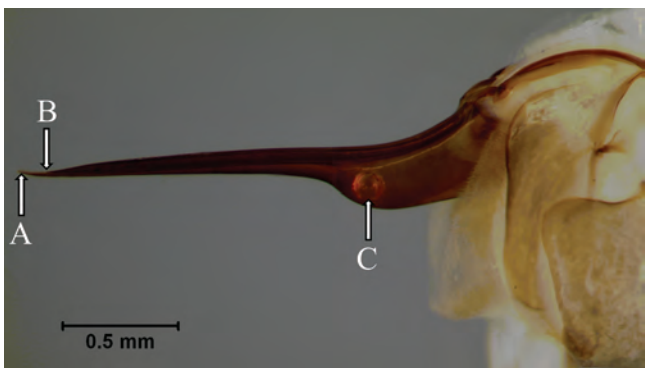
The anatomy of a sting

Honey bee stings are modified ovipositors. An ovipositor is an appendage that many female insects have and use to lay eggs. For example, there are many species of parasitic wasps whose females use their sting to lay an egg in or on its victim, in cracks, in the ground, in holes in trees, etc. Given that ovipositors can be possessed only by females, only females can sting.

There are three main parts of the honey bee sting and they include (1) the large, venom (some, incorrectly, say "poison") sac (Figure 2B) and accompanying venom gland (sometimes called the acid gland, Figure 2A), (2) the basal (or bulb) section which, essentially, is the motor apparatus of the sting (Figure 2C, Figure 3), and (3) the sting shaft (Figures 4 – 6, Snodgrass 1956). When they are not deployed, the three parts fold neatly in the sting chamber which is an internal space near the end of the bee's abdomen.

There are two main glands associated with the production of venom. The first is the venom gland (Figure 2A and 3J) and it is composed of a pair of long, slender tubules that end in a small glandular enlargement. The tubules unite to form a common duct that opens into the anterior end (or end closest to the head of the bee) of the venom sac (Figure 2B). The venom gland secretes at least 50 identified components of bee venom. It is possible that these different components affect various would-be nest invaders differently. Consequently, the venom





(l) Figure 3. A close up, lateral (side) view of the sting bulb. A – oblong plate; B – triangular plate; C – quadrat plate; D – bulb of the sting shaft; E – sting sheath or sheath lobe; F – connective tissue; G – muscle; H – Dufour's gland; I – venom gland; J – venom sac. I include both the original and modified images to facilitate seeing the respective parts. (r) Figure 4. A close up view of the honey bee sting shaft. The sting shaft is composed of a single stylet (A) on which the paired lancets (B) slide one after the other, digging deeper into the victim's tissue. Venom flows through the bulb, into the venom canal, and out the tip of the stinger into the victim. The arrow labeled C shows a bubble trapped at the beginning of the venom canal. The B labeled arrow indicates the point on the shaft where the lancets stop. Photograph by Lyle Buss, University of Florida.

gland appears to produce toxins affecting a range of threats. Female bees begin producing venom with this gland at the end of pupation and continue until they are about 30 day old, at which time the venom gland degenerates. The second gland, the Dufour's gland (sometimes called the alkaline gland, Figure 3H), empties its secretions near the top of the sting's lancets (more on the lancets later). The role of the Dufour's gland is not fully known, but its secretions mix with those of the venom gland, thus completing the venom cocktail that is injected into the victim's body.

The bulb section of the sting (Figure 3) contains three hard plates on both sides of the bulb (Figure 3A – C). The plates are attached to muscles (Figure 3G) that move the plates when the sting is deployed. The muscles also move the venom pump that is located inside a hollow area in the center of the sting bulb. The paired venom pumps can be thought of as upside-down umbrellas that push venom into the sting shaft when pumping. Venom flows from the venom sac into the bulb, where it is pumped into the sting shaft by the action of the pulsing muscles. The bulb also contains a pair of sting sheathes or sheath lobes (Figure 3E). The function of the lobes is not understood fully, though they are believed to secrete defensive compounds as well. They cover the sting shaft when the sting is folded inside the bee's body. Finally, the bulb is connected to the wall of the sting chamber via soft connective tissue (Figure 3F) that tears easily.

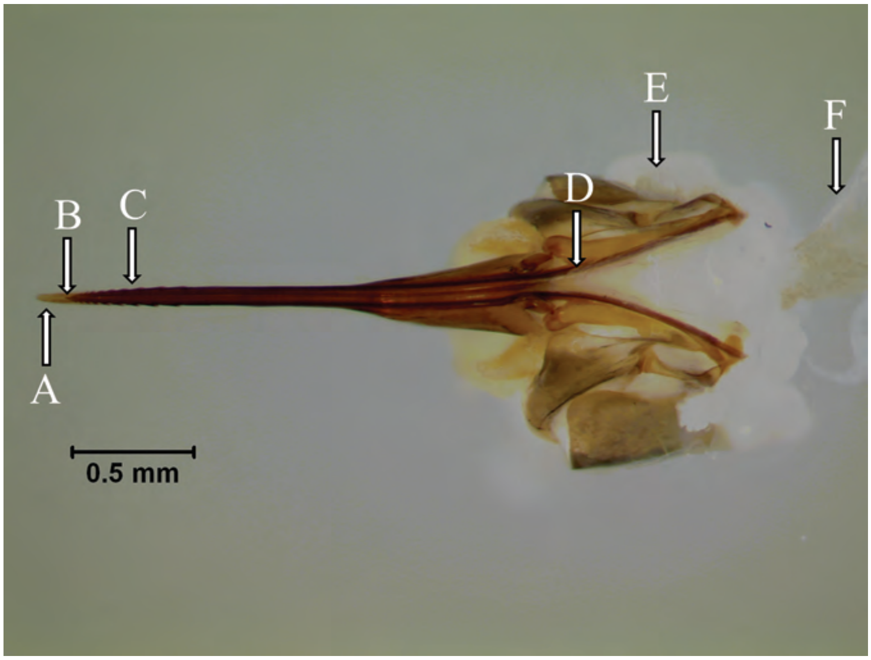
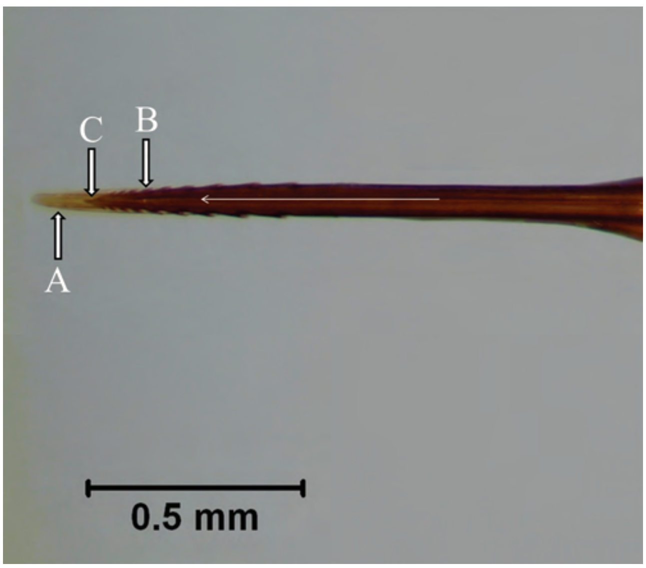


Figure 5. A ventral (underneath) view of the honey bee's sting. A – style; B – tip of paired lancets; C – barbs on lancet; D – arm of the upper lancet that attaches to the upper muscle (E); F – the venom sac. (Note: I say "upper" lancet and muscle because that is where both occur in this image. However, the sting in this image is viewed from the underside of the body and is turned on its side. Thus, the lancet noted is really the bee's right lancet when viewed from the bee's back.) The contraction of the muscle (E) pushes the lancet attached to it (C) past and beyond the other (lower in this image) lancet and deeper into the victim's tissue. The lower muscle then contracts, pushing its lancet beyond the upper one, and deeper still into the victim's tissue. Both lancets slide on the style (A). Photograph by Lyle Buss, University of Florida.

The sting shaft (Figures 4 – 6) is the part of the sting that most beekeepers know well. This is the pointed part of the sting. It actually is composed of three separate parts. The upper part is called the stylet (Figures 4A, 5A, 6A) and it provides the firm structure for the shaft. The remaining two parts are paired, pointed lancets (Figures 4B, 5C, 6B). The lancets are slender rods that are barbed near their tips (Figure 6B). The barbs point



(l) Figure 6. A close up, ventral (underneath) view of the honey bee's sting shaft. A – style; B – barbed lancet. The lancets contain 9 – 10 recurved barbs (this bee has nine per lancet) that allow them to hold the victim's tissue. They facilitate movement of the stinger deeper into the victim and are what cause the stinger to be ripped from the stinging bee's body. If you look at the tip of the lancets (C), you will notice that the lower lancet's tip lies beyond that of the upper lancet's tip. The thin, white arrow is drawn down the seam of the two lancets, thus showing where they fit together. The paired lancets and style are curved on their inner surfaces and together form the venom canal through which venom flows into the victim. Photograph by Lyle Buss, University of Florida. (r) Figure 7. A honey bee stinging the arm of the photographer. Photograph by Mike Bentley.

back toward the bee's body. The paired lancets are connected to one another and the stylet by fitted grooves and rods. The lancets slide back and forth on these grooves. The stylet and lancets are curved such that the union of the three forms a central venom canal that is larger on the end closest to the bulb of the sting (Figure 4C) and narrowest at its tip (Figure 4A).

A bee ready to sting curves her abdomen down and pushes the shaft into the victim with a single thrust (Figure 7). When the sting is engaged, the alternating pulsating motion of the muscles on either side of the bulb causes the lancets to move counter to one another. This motion drives the stinger deeper and deeper into the victim, while pumping venom from the bulb, through the venom canal, and into the wound. This is all made possible by the barbed teeth located at the end of the lancets (Figure 6B). How? One lancet (lancet A) is pushed into the skin when the muscle to which it is attached (muscle A) contracts. Once it has been pushed as far as it can via the contraction of muscle A, the teeth on this lancet catch the skin while muscle A begins to relax, thus keeping the lancet from sliding back out of the victim. While this is happening, the other lancet (lancet B) slides past lancet A when the muscle to which it is attached (muscle B) contracts, sending the sting even deeper into the skin. This process is repeated over and over, with the sting shaft pulling its way into the body. There are two great videos online that show this process really well. I recommend that everyone reading this article visit the following websites to see great animations of a working stinger: **http://goo.gl/L0NnYx** and **http://goo.gl/YMbG4k**. Watch both videos to get a better appreciation for all that happens during a sting event.

The sting is only delicately and loosely connected to the walls of the sting chamber via soft connective tissue (Figure 3F). It only takes a slight pull to tear the associated tissues, thus leaving the stinger in the victim's body as the bee attempts to get away. As an aside, queen bees also have a stinger. However, their stinger has fewer and smaller barbs than does a worker's stinger, has well developed venom glands, and a large poison sac. She does not lose her sting when she uses it, and it mainly is used on rival queens. I have handled thousands of queens in my lifetime and I have been stung by only 5 or so queens.

Table 1. The composition of honey bee venom.[1] Over 50 compounds have been isolated from honey bee venom. The function of many of the compounds is not known. The % of total composition of venom varies and the data here are only approximations. The contributions of some of the compounds to the sting's overall impact are not known. However, I list the contributions of each compound, when known, in the final column. Notably, only a few of the compounds are known to have allergenic importance and this, too, is noted in the final column.

Component	% of total composition of venom	Allergenic importance (bold font in parentheses) and function in venom, when important/known
Enzymes		
1) Acid phosphatase	1) 1	1) **(Moderate-to-Major)**
2) Alkaline phosphatase	2) trace	
3) Esterase	3) trace	
4) Hyaluronidase	4) 1-2	4) **(Moderate-to-Major):** Dilates capillaries, causing spread of inflammation
5) Phospholipase A2	5) 10 - 12	5) **(Major):** Degrades phospholipids in the cell membrane, decreases blood pressure, inhibits blood coagulation, promotes disintegration of red blood cells
6) Phospholipase B	6) 1	6) Degrades phospholipids in cell membrane
Peptides		
1) Adolapine	1) 0.5 - 1	1) Anti-inflammatory and analgesic
2) Apamin	2) 2 - 3	2) Increases cortisol production in adrenal gland, causes release of histamine from mast cells
3) Mast Cell Degranulating Peptide	3) 2 - 3	3) Stimulates mast cell degranulation (which releases histamines), anti-inflammatory
4) Melittin	4) 40 - 50	4) **(Minor):** Stimulator of Phospholipase A2, aids in breaking of cell membrane, causes release of histamine from mast cells, ruptures red blood corpuscles
5) Minimine	5) 2	
6) Pamine	6) 1 - 3	
7) Procamine A, B	7) 1 - 2	
8) Protease inhibitor	8) 0.1 - 0.8	8) Anti-inflammatory agents and stops bleeding
9) Secapine	9) 0.5 - 2	
10) Tertiapin	10) 0.1 - 2	
Biogenic Amines		
1) Dopamine	1) 0.1 - 1	1) Increases pulse rate
2) Histamine	2) 0.7 - 1.6	2) Involved in allergic response
3) Noradrenalin (or Norepinephrine)	3) 0.1 - 0.2	3) Increases pulse rate
Phospholipids (six)	1 - 3	
Amino Acids (Aminobutyric acid, α-amino acids, at least 19 free amino acids)	1	
Sugars (Glucose, Fructose)	2 - 4	
Volatiles (complex pheromones, possibly 13 compounds, including isoamyl acetate)	4 - 8	Isoamyl acetate is a component of alarm pheromone. It marks the victim, telling other bees where to sting.
Minerals (P, Ca, Mg)	3 - 4	

[1]From:
1) Bogdanov, S. 2015. Bee venom: composition, health, medicine: a review. Self-published, www.bee-hexagon.net. 20 pp.
2) O'Connor, R., Peck, M.L. 1978. Venoms of Apidae. In Bettini, S. (editor) Arthropod Venoms. Springer-Verlag, Berlin/Heidelberg, Germany, pp. 613 – 660.
3) Schmidt, J.O. 1992. Allergy to venomous insects. In Graham, J.M. (editor) The Hive and the Honey Bee. Dadant and Sons, Hamilton, IL, USA. 1209-1269.
4) Collison, C. 2015. A closer look: venom/venom glands. Bee Culture, May: http://www.beeculture.com/a-closer-look-venomvenom-glands/.

The composition and function of bee venom

Bee venom is composed of over 50 compounds, though the contribution of most to the overall impact of the sting is minor. Generally speaking, bee venom contains mainly peptides, enzymes, and biogenic amines (Table 1). These are the compounds that cause most of the issues related to bee stings. I list the major components of bee venom in Table 1. This table also includes the known function of the components, if the function is considered to be a major contributor to the impact of the sting. I will not review each component here, but only mention those that cause the biggest impact.

Peptides make up the bulk of bee venom and they cause a range of effects in the stung victim's body. The peptide melittin is the most common constituent of bee venom, composing 40-50% of the total dry weight of venom. Melittin is only a minor allergen but it is a major stimulator of Phospholipase A2, an enzyme that, itself, is a major allergen. Melittin is a very powerful anti-inflammatory agent. It also ruptures red blood corpuscles. Phospholipase A2 breaks down cell walls, impends various biochemical reactions, and is the possible cause of the pain associated with stings. Melittin and phospholipase A2 together cause most of the injury associated with stings. They do this by rupturing cell walls, especially walls of mast cells. Mast cells carry histamine. Thus, the release of histamine into the blood triggers the body's "anti-sting" response. As a result, the sting site swells, itches, turns red, etc. A third compound, the enzyme hyaluronidase, contributes to the overall impact of the sting by dilating capillaries and breaking down cell components, thus allowing the venom to spread.

Bee venom also contains some biogenic amines, though in small amounts. These include dopamine, histamine, and noradrenalin (or norepinephrine, Table 1). Dopamine and noradrenalin increase the pulse rate of the victim. Histamine can cause a significant allergic response. Overall, bee venom has three toxic effects on the human body. It acts as a neurotoxic, causing paralysis of the local nervous stems. It is hemorrhagic because it increases the permeability of blood capillaries. Finally, it is hemolytic because it destroys red blood cells. I think you will agree that venom is designed well to achieve the desired effect. The stung victim usually flees the nest or leaves the bee alone.

The human body's reaction to bee stings

One of the things I like to do when giving lectures on bees is to ask the audience how many people are allergic to bees. Invariably, many hands fly into the air when I ask this question. In fact, it is common to see 10-20% of the audience claim that they are allergic to bees. Of course, they are wrong. The vast majority of people are not allergic to bee stings. However, many have been stung and experienced a reaction that they incorrectly determined to be an allergic one.

Undeniably, some people are allergic to bee stings. In all the research that I did to write this article, I found that about 0.5 – 4% of people have a true allergy to bee stings. The data also suggest that the number is lower in Europe and North America where about 0.5 – 2% of the population is allergic to bees. Thus, in a crowd of 100 people, only a maximum of two likely exhibit a true allergy to stings. In this section, I will review what the possible reactions to bee stings are and the appropriate response to the sting by the victim.

Justin Schmidt, world expert on honey bee stings, wrote a good chapter on the topic for the 1992 edition of *The Hive and the Honey Bee* (Schmidt, 1992). He has a number of notable quotes on the topic of bee venom allergies that I include in this article. The first quote follows:.

"Allergy is a general term that describes a variety of human symptoms and reactions to a diversity of materials including pollen, animal dander, foods, drugs, dust mites (house dust), stinging insects and others. Stinging insect allergy refers to sting-induced systemic reactions of the body that occur at body locations *distant* from the sting site. Allergic reactions *do not include* the immediate pain caused by the sting itself or to the burning, redness, itching and swelling that might occur at the sting site. Such reactions include very large local swelling are referred to as "local reactions."" (I added the emphasis on "distant" and "do not include".)

He also notes that people's normal and allergic reactions to stings can vary enormously from person to person and even from sting to sting.

Interestingly, allergic reactions to bee stings do not usually occur after the first sting. Instead, a second sting separated by space and time usually is required to trigger an allergic reaction. Schmidt (1992) notes:

"An allergic reaction typically occurs after the second or subsequent stinging event by the same or closely related species. The first sting, (or stings), induces the production of the allergy causing antibody, immunoglobulin E (IgE), by the body resulting in the sensitization of the individual to the venom. Later when the now hypersensitive individual is stung again, the venom causes an IgE-mediated allergic reaction."

Schmidt (1992) recognizes six categories

Table 2. Normal and allergic reactions to honey bee stings.[1] Categories 1-3 are considered "normal/local" reactions while categories 5 and 6 are "systemic or allergic" reactions. Category 4 shows allergic reactions of the skin. Typically, people experiencing symptoms in categories 5 and 6 are told to seek medical help immediately.

1. Normal, non-allergic reactions at the time of the sting (symptoms virtually everyone experiences)	• Pain, sometimes sharp and piercing • Burning, or itching burn • Redness (erythema) around the sting site • A white area (wheal) immediately surrounding the sting puncture mark • Swelling (edema) • Tenderness to touch
2. Normal, non-allergic reactions hours or days after the sting (symptoms virtually everyone experiences)	• Itching (pruritus) • Residual redness (erythema) • A small brown or red damage spot at the puncture site • Swelling (edema) at the sting site
3. Large local reactions (typically nothing to be feared as this usually does not progress to systemic reactions, though many people seek medical help at this stage)	• Rapid or massive swelling (angioedema) around the sting site extending over an area of 10 cm (about 4 inches) or more and frequently increasing in size for 24 to 72 hours, sometimes lasting for a week in duration
4. Cutaneous allergic reactions (not life threatening, but usually worrisome to the sting victim)	• Hives/nettle rash (urticaria) anywhere on skin • Massive swelling (angioedema) remote from the sting site • Generalized itching (pruritus) of the skin • Generalized redness (erythema) of the skin remote from the sting site
5. Non life-threatening systemic allergic reactions	• Allergic inflammation inside nose (rhinitis) or eye (conjunctivitis) • Minor respiratory symptoms • Abdominal cramps • Severe gastrointestinal upset (nausea, vomiting, diarrhea) • Weakness • Fear or other subjective feelings
6. Life-threatening systemic allergic reactions	• Shock • Unconsciousness • Abnormally low blood pressure (hypotension) or fainting • Respiratory distress (difficulty breathing) • Laryngeal blockage (massive swelling in the throat, face, tongue or mouth tissue) • Rapid pulse
	• Dizziness

[1]Modified from:
Schmidt, J.O. 1992. Allergy to venomous insects. In Graham, J.M. (editor) The Hive and the Honey Bee. Dadant and Sons, Hamilton, IL, USA. 1209-1269.
With additions from:
WebMD, 2014. Allergies to Insect Stings. http://www.webmd.com/allergies/guide/insect-stings

of the body's response to stings. I list the categories in Table 2, a modified version of a table Schmidt included in his 1992 chapter. I think this table summarizes well what one can expect when stung and when to seek emergency medical attention. I modified the table to include recommendations from medically-supported websites maintained by *e*Medicine*health*, *Web*MD, the Mayo Clinic, and the American Academy of Allergy Asthma & Immunology (see the references section). It is important to note that I am *not* a medical doctor. Thus, I stop short of personally making medical recommendations. Rather, I note the medical recommendations made by medical doctors who developed the literature I used when writing this article.

Categories of reactions to honey bee stings:

1) Normal, non-allergic reactions at the time of the sting (Table 2) – These symptoms can vary tremendously from individual to individual. That said, these are the symptoms that most people stung by a honey bee experience. These include the sharp pain/burning at the sting site that intensifies for minutes after the sting and then slowly decreases over time. There usually is some redness or swelling associated with this response. The sting site can be tender to the touch. Medical intervention usually is not needed for these reactions.

2) Normal, non-allergic reactions hours or days after the sting (Table 2) – As for category 1, these symptoms can vary from individual to individual. In this category, the victim may itch, experience redness, swell, etc. for a number of hours or days after the sting. It is common for the sting site to contain a small brown or red damage spot at the puncture site. This happens to me a lot, especially on my fingertips – they look almost like small freckles. Medical intervention usually is not needed for these reactions.

3) Large local reactions (Table 2) – These reactions usually are not to be feared as they rarely progress to systemic reactions. However, many sting victims consider these symptoms to be significant and end up seeking medical attention, though the medical attention usually is not necessary. The primary symptom associated with this category is the rapid or massive swelling around the sting site, with the swelling extending considerably farther than the sting site. For example, it is relatively common (the literature suggests nearly 20% of all cases) for people to be stung somewhere such as on the hand and the swelling to progress up the arm to the shoulder, or be stung on the leg, causing the entire leg to swell. Admittedly, this reaction is visually disturbing. The swellings can be enormous, occuring anywhere on the body, including the face. The swelling can be painful and otherwise be a nuisance since it can restrict the movement of a given body part, worry the friends/family/coworkers of the victim (after all, this can be quite a temporarily disfiguring body response), etc. However, these symptoms are rarely cause for alarm. Despite this, many sting victims experiencing this response end up going to the doctor, who, then, prescribes medicine to help control the symptoms. It *is*, however, recommended that people experiencing a large local reaction go to the doctor if the reaction is occurring in the mouth or neck area, especially if the swollen area is beginning to restrict airflow. Many people try to relieve the symptoms of a large local reaction with an over-the-counter pain killer (Tylenol/Aspirin) and antihistamines (such as Benadryl).

4) Cutaneous allergic reactions (Table 2) – These reactions are not believed to be life threatening, though they often are quite worrisome to the victim. Schmidt (1992) calls these reactions a "gray area" given that the medical community tends to debate the seriousness of this reaction. It is important to note that this only affects the skin. Admittedly, the skin is the visible part of the body, hence the alarm it causes the victim who has to see it. People experiencing this reaction have hives, swelling, itching, or redness remote from the sting site. Usually this reaction does not imply that the victim will progress into one of the final two reaction categories. However, a good general recommendation is that when in doubt, seek medical advice.

5) Non life-treatening systemic allergic reactions (Table 2) – As the name implies, this reaction to bee stings *is* a systemic, allergic reaction meaning that it causes problems away from the sting site. It is the "catch-all" category for systemic responses that are rarely life-threatening,but not occurring on the skin. Even though typically not life-threatening (Schmidt 1992), every medical site I visited recommended seeking medical attention immediately if experiencing any of the symptoms in this category. Without question, the symptoms are unpleasant and frightening, hence providing a good reason to see a medical doctor the moment they occur. The symptoms include allergic inflammation inside the nose or around the eyes, some minor respiratory symptoms, abdominal cramps and associated gastrointestinal problems (nausea, vomiting, and diarrhea), general weakness, etc.

6) Life-threatening systemic allergic reactions (Table 2) – This is a comparatively less common response to bee stings. This reaction affects the body's life support systems, the circulatory and respiratory systems, and can lead to death. People experiencing these symptoms following a sting *must seek medical attention immediately*. Otherwise, the response can led to shock, cardiac arrest, and unconsciousness in ten or fewer minutes. This can be a fatal response unless addressed by medical doctors quickly. Essentially, the body is eliciting a life-threatening response called anaphylaxis or is entering anaphylactic shock. The symptoms associated with this category include shock, unconsciousness, abnormally low blood pressure, respiratory distress, laryngeal blockage, rapid pulse, and dizziness. People who are allergic to bees often know that they are and carry an epinephrine shot with them. Epinephrine (usually sold in an EpiPen) is the only treatment capable of arresting the systemic reactions. If you notice these symptoms in yourself or anyone stung by a bee, call 911 immediately.

How does this allergic response happen? As noted, a bee's venom contains substances that destroy cells. The peptides and enzymes (Table 1) break through cell walls, including the walls of the skin's mast cells. Mast cells contain histamine. Their destruction releases histamine into the blood stream, causing blood vessels to dilate. For people with allergies, too much histamine is released. The blood vessel dilation is too extreme and the person loses the ability to regulate blood pressure, which then drops significantly. This leads to the starvation of cells for oxygen, swelling, spasms, and eventually death. This is why it is so important the people experiencing the symptoms in categories 5 and especially 6 seek medical attention immediately.

As bad as the symptoms in the final category sound, there is hope for people who are very allergic to honey bee stings. Such individuals can try venom immunotherapy, where a medical doctor specializing in allergies gives the individual a series of venom injections over time, with the amount of venom in the injection increasing each time. This is done until the person is no longer hyper-responsive to bee stings. It is worthwhile to discuss this with your allergist if you develop a life-threatening allergy to bees.

The body also can suffer from mass envenomation if too many stings are received, leading to a second way that bee stings can kill. Generally speaking, humans can take about 5 – 10 stings per lb of body weight before they die from venom toxicity. This means that a 100 lb adult can receive 500 – 1,000 stings before they die. A 200 lb adult can withstand 1,000 – 2,000 stings. The following symptoms begin to appear when a person has been stung too many times: nausea, fever, swelling at the site of the sting, fainting, seizures, shock and even death. Generally speaking, non-beekeepers are recommended to seek medical advice anytime they receive 100+ stings in a single stinging event or if any of the symptoms listed above are expressed. Incidentally, this is why African-derived honey bees are so dangerous. It usually takes a significant stimulus to cause European-derived honey bees (those we keep) to elicit a defense response. Even when they do, they respond with a few to a couple dozen bees. African bees, on the other hand, are hyper-sensitive to even small stimuli. They respond in significantly greater numbers, leading the victim to be stung more than their body can withstand. The venom of African bees is no more toxic than that of European bees. They are problematic simply because more of them attack, causing the victim to receive too many stings.

Appropriate response to bee stings

The first thing that a non-beekeeper sting victim should do is get away from the area as quickly as possible. Being stung, especially if stung multiple times, is an indication that you are too close to the bees' nest and that they want you gone. The best thing non-beekeepers can do is accommodate the bees' clear request. The general recommendation for non-beekeepers who find themselves being attacked by bees is to pull their shirt over their head/neck to minimize stings to this area and run away from the site as quickly as possible. Do not jump into the water. If possible, get indoors, inside an enclosed area such as a vehicle, shed, or house. Beekeepers, of course, take a different response if they are getting stung at a level under what they perceive to be the "danger threshold." They usually just stay and stick it out unless dangerous symptoms are exhibited.

Once safely away from the area where you are stung, remove the sting(s) from your skin. The longer the sting remains in the body, the more venom the victim receives. The more venom the victim receives, the bigger the potential reaction. As noted, honey bees leave their stinger behind in tough-skinned threats. If you look closely at the sting (if you are willing to leave it in your body long enough to notice☺), you will notice that the muscles of the bulb are contracting, causing it to beat like a heart, pumping venom into the sting site. Conventional wisdom, then, suggests that you should scrape the stinger out of your skin rather than grabbing it and pulling it out. After all, it seems intuitive that grabbing the bulb simply pushes more venom into the sting site. Look up "how to remove a honey bee stinger" online and you will see all types of advice on how to scrape out the stinger, from using your fingernail to using a credit card or even a knife. Interesting enough though, three investigators conducted a research project on how best to remove a sting from the body, i.e. they attempted to settle the "scrape vs. pinch" debate (Visscher et al. 1996). They found that it does not matter which way the sting is removed. It only matters how quickly it is removed. The resulting recommendation, then, is to get the stinger out of the body as quickly as possible, regardless of whether you scrape or pinch it.

Once stung, you can note the body's response (Table 2) and develop an appropriate treatment plan. Most medical doctors recommend washing the sting site with soap and water to lessen the chance of bacterial infection. This they usually suggest following with wound icing, taking an antihistamine such as Benadryl, and applying a topical sting aid to alleviate pain. You can apply soothing ointment on the sting site and take pain relief medicine to help with the pain associated with a sting. Of course, beekeepers would never get any work done if they took the time to do this every time they were stung. Most of us just live with the results. As an aside, medical doctors also recommend seeking medical attention if stung on the eyeball. Finally, as I have stated already, it is always best to consult with a physician if you are worried about your body's reaction to a given sting.

How to protect yourself from stings

To borrow a line from football, the best offense against a sting is a good defense. By this I mean, you should take defensive precautions to avoid getting stung and know what to do in the event you are stung.

Some people, perhaps you, reading this article are not yet beekeepers and have never been stung. Consequently, these readers will not know if they are going to develop an allergy to bee stings. The good news is that local medical allergists/immunologists can help. There are sting sensitivity tests that allergists can perform to determine if someone is going to have a problem with stings. I recommend scheduling a consultation with an allergist/immunologist if you want to keep bees, but are worried about developing an allergy or if you keep bees and fear that you suddenly are developing an allergy.

Many new and seasoned beekeepers elect to carry an EpiPen with them into the apiary. EpiPens are injectors (shots) that contain epinephrine. They are a prescription controlled product. Thus, every individual wanting to carry an EpiPen has to consult with his/her own doctor and convince him/her to prescribe the product. EpiPens are not for everyone. There are certain risks associated with using EpiPens given certain existing preconditions. It is important to consult your medical specialist before electing to carry one.

New beekeepers should wear personal protective equipment (PPE: bee suits, veils, gloves, etc.) until they are comfortable with stings and know what their bodies are going to do in response to a sting. It is OK if beekeepers elect to wear PPE their entire beekeeping careers. For some reason, some beekeepers think it is macho not to wear any PPE. Of course, this is a personal choice, but it should not influence ones decision regarding the use of PPE. Personally, I wear a veil, but no suit or gloves. I simply do not like getting stung on the face and I do not want to risk getting stung on the eyeball. I tolerate stings on my legs, feet, hands, arms, and torso just fine. Many beekeepers end up wearing only veils.

Use smokers. Beekeepers use smokers as the smoke produced by the smoker masks alarm pheromones produced by the bees. Smoke has a calming effect on colonies. Like for PPE, there are many beekeepers who forgo the use of smokers saying that it violates their goals as natural beekeepers. Personally, I feel that everyone should use smokers when working colonies. It minimizes the number of stings the beekeeper will receive, thus keeping more bees alive.

I also tell beekeepers to approach colonies only when properly prepared to work the colonies. I, once, was trying to show off in front of my then-girlfriend (who became my wife) by walking to a stack of supers being robbed by bees. After all, experience tells me that bees robbing supers stacked away from colonies are not all that defensive. I walked into the cloud of bees and then out of the cloud with about 15 stings to the face and neck. I did not feel so macho. When you are not working colonies, it is better to maintain a safe distance from the nests or other areas where bees are congregating.

There are other ways that beekeepers can lessen their likelihood of stings. Do not mow or use loud, vibration-generating power equipment close to hives. Do not be heavily scented (perfumes, colognes, hairsprays, etc.) when working bees. Wear light-colored clothing (bees sting dark colors). Do not swat at bees and move slowly and purposefully when working colonies.

I also tell beekeepers that they need to be aware that their bees can sting other people. With that in mind, beekeepers should locate their colonies away from property lines, places where people and animals frequent, swimming pools, public areas, confined animals, roadways, etc. Beekeepers with small apiary sites should consider keeping their colonies at least 25 feet from a property line. Furthermore, they can establish a flyway barrier that is at least 6 feet high near the colony. This barrier, a solid wall/fence/dense vegetation/etc., will force the bees to fly up quickly, thus keeping them above head level during flight. Consider fencing your apiaries to limit unwanted people/animal access to the bees. Provide the bees a source of water if they do not have one. Otherwise, they will visit the neighbor's pool, water taps, etc. Requeen defensive colonies. Do not take unprotected friends/family close to hives or hive equipment that bees are visiting/inhabiting. It is important to note that while beekeepers may not be allergic to bees, their friends, family, or neighbors may be. Beekeepers are not only bringing bees into their own lives, but also into the lives of those people with whom they interact daily.

Finally, it is important to know that beekeepers can develop allergies to bee stings over time. While most beekeepers experience reduced reactions to bees over time, some beekeepers may experience the reverse trend. I occasionally hear of beekeepers who have kept bees for 50+ years getting a single sting that sends them into an allergic response. Consequently, it is very important that beekeepers, all beekeepers, know the symptoms associated with the various categories of bodily response to stings so that they can respond appropriately in the event of an emergency.

The good news is that the vast majority of beekeepers and people wanting to keep bees will be able to do so safely for the rest of their lives. Of course, they will have to put up with the pain and minor inconvenience of the occasional sting. Yet, I will end with a thought that a mentor of mine shared regarding this. Bee stings build character. We all could use a bit more character.

References

*Note about linked references: I realize that it is difficult to see and reproduce the web addresses listed below correctly in a web browser. In most cases, you can find the site simply by searching the author and name of the document.

1. **American Academy of Allergy Asthma & Immunology. 2015.** Stinging Insect Allergy. **http://www.aaaai.org/conditions-and-treatments/allergies/stinging-insect-allergy.aspx**
2. **Bee Spotter Project. 2015.** Bee Stings. Department of Entomology, University of Illinois at Urbana-Champaign. **http://beespotter.org/topics/stings/**
3. **Bogdanov, S. 2015.** Bee venom: composition, health, medicine: a review. Self published, **www.bee-hexagon.net**. 20 pp.
4. **Collison, C. 2015.** A closer look: venom/venom glands. Bee Culture, May: **http://www.beeculture.com/a-closer-look-venomvenom-glands/**.
5. **Emedicinehealth, 2014.** Bee and Wasp Stings. **http://www.emedicinehealth.com/bee_and_wasp_stings/article_em.htm**
6. **Mayo Clinic, 2014.** Bee Stings. **http://www.mayoclinic.org/diseases-conditions/bee-stings/basics/symptoms/con-20034120**
7. **O'Connor, R., Peck, M.L. 1978.** Venoms of Apidae. In Bettini, S. (editor) Arthropod Venoms. Springer-Verlag, Berlin/Heidelberg, Germany, pp. 613 – 660.
8. **Schmidt, J.O. 1992.** Allergy to venomous insects. In Graham, J.M. (editor) *The Hive and the Honey Bee*. Dadant and Sons, Hamilton, IL, USA. 1209-1269.
9. **Snodgrass, R.E. 1956.** *Anatomy of the Honey Bee*. Cornell University Press, published by Northern Bee Books, Mytholmroyd, Hebden Bridge, West Yorkshire, UK. 334 pp.
10. **USDA/ARS, 2012.** Bee stings/safety. **http://www.ars.usda.gov/Research/docs.htm?docid=11067&page=1**
11. **Visscher, P.K., Vetter, R.S., Camazine, S. 1996.** Removing bee stings. The Lancet, 348: 301- 302.
12. **WebMD, 2014.** Allergies to Insect Stings. **http://www.webmd.com/allergies/guide/insect-stings**