One of the realities of beekeeping is that honey bees and their colonies are under constant attack from a number of biotic (living) stressors. These include bacteria, fungi, viruses, mites, other insects, spiders, birds, reptiles/amphibians, and mammals. As a result, beekeepers spend considerable time inspecting colonies for and remedying problems related to biotic stressors.

The truth is that all colonies have some sort of ailment at any given time. The majority of biotic colony stressors pose low to moderate threats to colonies. However, there are some biotic stressors that can kill bees or entire colonies if they are not addressed in a timely manner. Thus, beekeepers must adopt management practices that eliminate the presence, or mitigate the impact, of these stressors in honey bee colonies.

In this article, I will discuss the most common biotic stressors affecting honey bee colonies. This is *not* intended to be a thorough review of the biology and control of each stressor (I plan those articles for publication in future issues of the ABJ). Instead, consider this an introduction to the stressors that can kill bee colonies or severely limit their productivity. Every beekeeper, new or seasoned, must be aware of these stressors so that he/she can know how to manage their colonies appropriately. Additionally, every beekeeper must develop a control strategy that corresponds to his/her needs and those of the bees.

For each stressor, I briefly discuss its biology and control and include its scientific name, where appropriate, in parentheses. I also note the potential threat it poses to colonies (low, moderate, significant). It is important to realize that I ranked the stressors in Table 1 simply based on my views of how they impact colonies. In general, any stressor can have low, moderate, or significant impact on affected colonies and the level of the severity of the impact can vary widely by time of year or location. Consequently, my ranking of each stressor is only for reference purposes and not intended to be a static designation.

- Low threat – The stressor can kill bees or colonies, but usually does not. Thus, the beekeeper must be aware of its potential to cause harm and remedy the situation if necessary. Usually, stressors that present a low threat do not need to be managed actively and chemical control remedies usually are not necessary to bring the stressors under control. Stressors in this category usually only affect a small number of colonies in an apiary. In severe circumstances, low threat stressors can manifest as moderate threats and, correspondingly, would need to be controlled.
- Moderate threat – Stressors that present a moderate threat often are common (i.e. in/affect a high percentage of colonies) and can cause significant damage if not addressed appropriately. Often, moderate threat stressors can be managed via non-chemical control options, though intervention with chemical treatments can be necessary as a last resort. Moderate threat stressors can escalate into serious threats in some areas and in certain circumstances. Consequently, beekeepers must monitor for and actively manage moderate threat stressors to limit their overall impact on colonies.
- Significant threat – Significant threats are those threats that usually are widespread and typically kill colonies if the threat is not managed actively. In fact, these stressors must receive the full attention of beekeepers who may or may not have a viable list of control options available for the stressors (for the viruses, for example). This list includes a couple of stressors that are believed to harm colonies significantly, even if the level of threat they pose is not known with certainty.

Bacteria

1) American foulbrood, AFB (*Paenibacillus larvae*): American foulbrood is a ***significant*** bacterial disease that infects bee larvae that ingest the bacterial spores. It has a widespread distribution. American foulbrood kills capped stages of immature bee development, most notably the honey

Figure 1 - American foulbrood (AFB). A small metal wire was used to stir the contents (i.e. the dead bee) of the infected cell and perform the "rope test" for AFB. That the contents of the cell stuck to the metal wire when it was removed suggests that the dead bee was infected with AFB. *Photograph: University of Florida.*

bee prepupa and young pupae. The bees get infected as larvae and die as prepupae/young pupae (Figure 1). This is very important to know as it is one of the key differences between AFB and European foulbrood. One of the reasons that AFB is such a serious threat to honey bee colonies is that the bacterium that causes AFB forms a spore that is difficult to kill. In fact, it is so difficult to kill the spore that most bee inspection regulatory agencies require that infected colonies be burned. Once a colony has the disease, it cannot be saved. The best way to control AFB is to start with AFB-free equipment/bees, use AFB-resistant bee stock, and treat colonies prophylactically with an antibiotic to keep one's colonies from ever getting the disease.

2) European foulbrood (*Melissococcus plutonius*): European foulbrood (EFB) is bacterial disease affecting honey bee brood and caused by a non-spore forming bacterium. Like AFB, EFB has a widespread distribution. Unlike AFB, EFB poses a ***moderate*** threat to infected colonies. European foulbrood infects and kills honey bee larvae, or the uncapped stage of immature honey bees. Generally speaking, infected colonies recover from EFB during strong honey flows, by being requeened, or by being treated with an antibiotic. Because EFB is not caused by a spore-forming bacterium, it can be controlled after infection with an antibiotic.

Fungi

3) Chalkbrood disease (*Ascosphaera apis*): Chalkbrood disease is caused by a fungal pathogen that kills immature honey bees. It is a ***moderate*** threat to colonies. Chalkbrood-infected larvae (Figure 2) die and become overgrown with cotton-like mycelium. This mass dries, forms a hard corpse called a mummy, and usually is removed from colonies by adult bees. The fungus that causes chalkbrood is widespread. It usually can be controlled culturally, by using resistant stock, keeping colonies well ventilated, and locating colonies out of cool, damp areas. There are no chemical remedies for chalkbrood.

4) *Nosema apis*: *Nosema apis* (or *Nosema*) is a fungal disease caused by a group of single cell fungi called microsporidia. It is a ***moderate*** threat to honey bees. Adult honey bees ingest *N. apis*, thus passing the spore to its midgut where it infects the cells that line the midgut. *Nosema apis* causes, among other things, dysentery and reduced lifespans in infected bees. The true threat of *N. apis* to bees has been muddied somewhat by the discovery of another *Nosema* species believed to be a more serious threat than is *N. apis*. Regardless, *N. apis* tends to be a problem in late winter/early spring, is less common than it once was, and can be controlled reasonably well with a commercial product containing fumagillin.

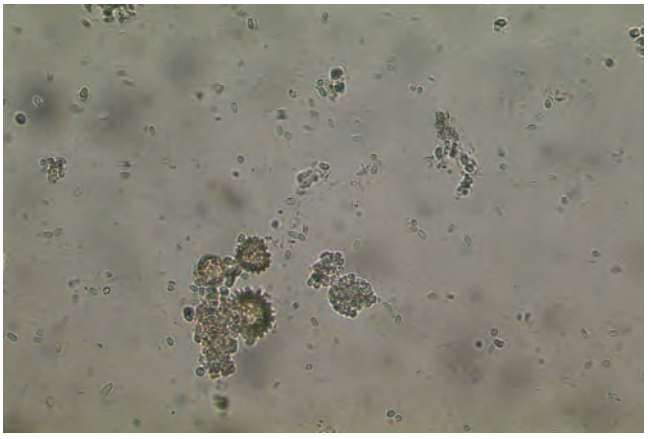
5) *Nosema ceranae*: *Nosema ceranae* (or *Nosema*) is similar to *N. apis* in many ways. It has a similar lifecycle in bees, is caused by a microspordian (Figure 3), and infects the cells that line the bee's midgut. *Nosema ceranae* is a newly recognized pathogen, having been discovered to be a separate species from *N. apis*, its less pathogenic relative. Though it is not known for sure, *N. ceranae* is believed to be a ***significant*** threat to infected bees. The growing mound of data suggest that this *Nosema* species is correlated with significant colony losses. It has a widespread distribution and in many situations can be controlled with fumagillin. That said, its control with the product is not guaranteed and there is little else that can be done to remedy it. Many colonies live with the disease and its true impact on those colonies remains unclear. This pathogen remains a subject of considerable investigation and speculation.

Viruses

Generally speaking, a number of viral pathogens affect honey bee colonies. The threat that most of these viruses pose to bees is unclear, but is believed to be moderate in many cases, and even severe in some. Some bee viruses have known associations with *Varroa destructor* (or *Varroa*), a parasitic mite that, itself, is a significant threat to bees. There are no true control remedies for any of the bee viruses at the moment. Most control recommendations concentrate on controlling the possible virus vector (*Varroa* in some instances) or requeening infected colonies in an effort to introduce more tolerant stock. Beyond that, colonies should be managed to remain strong and healthy, thus giving them the best chance to overcome virus infection on their own.

6) Acute bee paralysis virus or ABPV: The proposed threat ABPV poses to bees is believed to be ***moderate*** and comes mostly by way of reduced lifespan of infected bees. Infected bees also remain flightless, may lose their hair, and tremble. This virus may be associated with *Varroa*.

7) Black queen cell virus or BQCV: BQCV is believed to pose a ***moderate*** threat to colonies and is distributed globally. The virus affects developing queen pupae that die when infected and turn black



(l) Figure 2 – Chalkbrood mummies collected from an infected colony. (r) Figure 3 – Nosema spores as seen through a compound microscope. *Photographs: University of Florida.*

(l) Figure 4 – Adult worker honey bee infected with deformed wing virus. (r) Figure 5 - Tracheal mites. In this image, the bee's head has been removed from her thorax, and her thorax further dissected to reveal the two, upside-down, V-shaped trachea. The thoracic trachea on the left if infected with tracheal mites (notice the white matter in the trachea and the black scar tissue) while the one on the right is not. *Photographs: Tricia Toth, formerly of the University of Florida.*

in their cells. This virus may be associated with *Varroa*.

8) Chronic bee paralysis virus or CBPV: The proposed threat CBPV poses to bees is believed to be ***moderate***, principally by reducing the lifespan of infected bees. Infected bees also remain flightless, may lose their hair, and tremble, much like bees infected with ABPV do.

9) Deformed wing virus or DWV: DWV is a widespread virus with a documented association with *Varroa*. Increasingly, data suggest that DWV is a ***serious*** threat to honey bees, mostly when coupled with high colony *Varroa* infestations. As the name implies, DWV causes malformed wings in adult honey bees (Figure 4), a process that begins when they were infected with the virus as pupae. It also reduces infected bee lifespan and general body size. There are no known controls for DWV so controlling the vector, *Varroa*, helps limit the impact of this virus on bees.

10) Israeli acute paralysis virus or IAPV: IAPV is similar in presentation to ABPV, affecting bee longevity, causing bee trembling, infected bee hair loss, etc. It is believed to pose a ***moderate*** threat to honey bee colonies.

11) Kashmir bee virus of KBV: This virus is similar to ABPV in most ways, and can, in fact, be confused symptomatically for ABPV. It is vectored by *Varroa*, making vector control the best control method for KBV. Though extremely toxic to bees in the laboratory setting, KBV is believed to be a ***moderate*** threat to honey bee colonies.

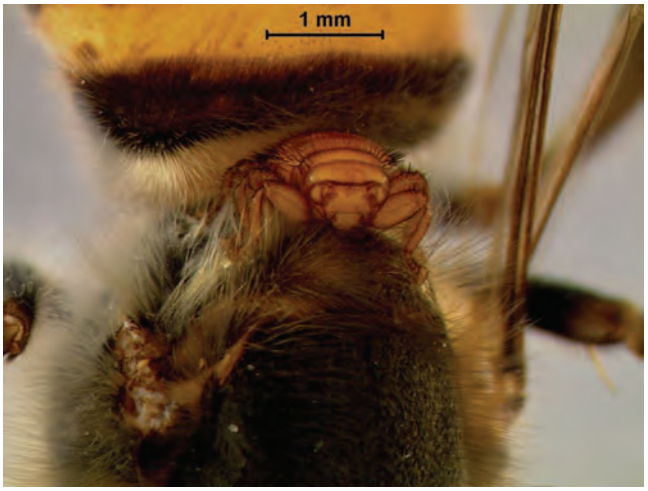
12) Sacbrood virus or SBV: SBV infects larval bees which ultimately fail to pupate when infected. Their bodies progressively darken and infected colonies express symptoms similar to those infected with American foulbrood. SBV is a ***moderate*** threat to honey bees and can infect adult bees who experience shorter lifespans when infected.

13) Other viruses: A number of other viral pathogens infect immature and adult honey bees. The true impacts of these viruses on bee and colony health are unclear, but may be moderate to significant in certain circumstances. Some of the known additional viruses include bee viruses X and Y, cloudy wing virus, iridescent virus, filamentous virus and slow paralysis virus.

Mites

14) Tracheal mites (*Acarapis woodi*): Tracheal mites are, as the name implies, mites that live in the thoracic tracheal system, or the breathing tubes in the thorax, of infected bees (Figure 5). Tracheal mites once were a major problem for bee colonies, but now are considered only a ***moderate*** threat to honey bees. These mites can reduce bee lifespan and kill colonies in severe circumstances. Tracheal mites probably are inadvertently controlled by beekeepers who use chemical treatments against *Varroa*. Regardless, the impacts of tracheal mites can be mitigated easily with resistant bee stock or sugar/vegetable oil patties.

15) *Tropilaelaps* (*Tropilaelaps clarea*): *Tropilaelaps clarea* is the only stressor I include in this article that has yet to threaten honey bee colonies outside its endemic range. Regardless, many scientists and regulatory officials consider this mite a potentially ***significant*** threat and maintain



(l) Figure 6 – An adult, female *Varroa destructor*. Photograph: Tricia Toth, formerly of the University of Florida. (r) Figure 7 - Bee louse on the bee's thorax. Photograph: Tomas Bustamante, University of Florida.

Figure 8 – A tachinid fly larva inside the abdomen of a worker honey bee. This larva feeds and develops in the abdomen of the living bee, ultimately killing it as it emerges from the bee's body. The two black circles on the right end of the fly larva are its spiracles, or breathing ports. *Photograph: Joe Cicero, University of Florida.*

monitoring programs to search for and limit accidental importation of the mite.

16) *Varroa* (*Varroa destructor*): Many scientists and beekeepers suggest that *Varroa* (Figure 6) are the most ***significant*** threat to honey bee colonies globally. *Varroa* are ectoparasitic mites that are believed to feed on honey bee hemolymph and possibly fatty tissues. Adult female *Varroa* feed and reproduce on honey bee pupae developing in capped brood cells. Furthermore, they feed on adult bees while being transported through the colony in search of brood cells in which they can reproduce. *Varroa* are known vectors of several serious bee viruses. *Varroa* also enjoy a widespread distribution and infest many, likely most, colonies where they are present. Beekeepers managing colonies in areas where *Varroa* are present must manage colonies to minimize the impacts of *Varroa*. In fact, *Varroa* are said to have "domesticated" the honey bee in many places, given that most unmanaged/untreated colonies will succumb to *Varroa* infestations without proper management. Arguably, the spread of *Varroa* globally has had the most significant impact of any colony stressor on general honey bee management. Fortunately, there are a number of control strategies one can employ to limit the impact of *Varroa* on infested colonies. Unfortunately, many of the strategies are labor intensive and moderately efficacious at best. As a result, the commercial beekeeping industries in many areas where *Varroa* are present rely heavily on chemical remedies for *Varroa* control. In summary, if you keep bees, you almost certainly will have to address *Varroa*. They are unavoidable.

Insects

17) Ants: Numerous species of ants attack or live in honey bee colonies. Some species of ants in some areas and under certain circumstances can be significant problems for bees/bee colonies. However, generally speaking, ants typically pose a ***low*** threat to honey bee colonies. Almost all beekeepers will have to deal with an ant issue at some point during their beekeeping careers, but the issue usually is minor and can be controlled culturally or with chemical treatments.

18) Bee louse (*Braula coeca*): The bee louse (Figure 7) is a wingless fly that poses no or at most a ***low*** threat to honey bee colonies. The fly sits on the body of the infested bee and moves to the bee's mouthparts to feed on food passed between its bee host and another bee. The bee louse also can induce bees to regurgitate honey, on which the bee louse feeds. The only time the bee louse is perceived as a low threat is when many congregate on queen honey bees, presumably because the queens are fed so often, making it possible for the louse to obtain a reliable meal. I am not aware of any circumstances under which the bee louse should be controlled and they are not very common, likely owing to the widespread use of *Varroa* control products that probably kill the bee louse as well.

19) Flies: Flies, in general, pose a ***low*** threat to honey bee colonies. Flies can impact honey bee colonies in two main ways: as a parasite or as a predator. Some flies parasitize honey bees by laying eggs in or on them. The fly maggot will develop inside the living bee and ultimately kill its host (Figure 8). Other flies are predators of bees, capturing bees in mid-air and feasting on their internal organs (Figure 9). Though, conceivably, fly threats to honey bees can be severe, they usually are not and require no control efforts on behalf of the beekeeper.

Figure 9 - Robber fly feeding on an adult honey bee. *Photograph: University of Florida.*

20) Greater wax moth (*Galleria mellonella*): Greater wax moths (Figure 10) are the larger of the two wax moth species known to infest honey bee colonies. The caterpillars (or "wax moth larvae") of the moths tunnel through wax combs, reducing the wax to a webby mass of frass and debris. Generally speaking, greater wax moths pose a ***moderate*** threat to honey bee colonies, though many beekeepers might argue this point. However, greater wax moths largely are considered a secondary pest, meaning that they do not affect healthy colonies significantly and only cause colony collapse in colonies that were otherwise already stressed. The only remedy for greater wax moths in living colonies is to keep strong, healthy colonies that can address the moths themselves. Greater wax moths can be a problem in stored combs. Thus, many beekeepers use temperature (refrigeration or freezing), cultural, and chemical methods to control greater wax moths in stored equipment.

21) Large hive beetles (Scarabidae): The term "large hive beetle" is a term used to describe any "large" beetle found

Figure 10 - Greater wax moth adult (a) male and (b) female. *Photographs: Lyle Buss, University of Florida.*

Figure 11 - Lesser wax moth adult (a) male and (b) female. ***Photographs: Lyle Buss, University of Florida.***

in a honey bee colony. Usually, the term denotes beetles from the family Scarabidae, or scarab beetles. Scarab beetles can enter some colonies and consume pollen stores and possibly honey stores. That said, they pose only a ***low*** threat to strong colonies and require no control.

22) Lesser wax moth (*Achroia grisella*): Like their larger cousins (the greater wax moth), lesser wax moths (Figure 11) pose a ***moderate*** threat to honey bee colonies. They are smaller than greater wax moths and tend to tunnel under the cappings of the wax comb. They can cause problems in weak colonies and stored equipment. They are managed much the same way greater wax moths are managed, given that they have similar biologies and life cycles.

23) Small hive beetles (*Aethina tumida*): Like wax moths, small hive beetles (Figure 12) are largely considered a ***moderate***, secondary threat to honey bee colonies. Certainly, they can have high enough populations in some climates and in certain circumstances to kill colonies routinely, elevating their threat status in those areas to significant. Despite this, small hive beetles are only moderate threats to colonies in most locations. Small hive beetles damage colonies by virtue of the feeding habits of their larvae which eat honey bee brood, stored pollen, and stored nectar/honey. Many beekeepers find that they can control small hive beetles culturally through improved management techniques. In some instances, chemical intervention may be needed and is available to bring small hive beetle populations down to manageable levels.

Figure 12 – Adult female small hive beetle. ***Photograph: Josephine Ratikan, formerly of the University of Florida.***

24) Assassin bugs (insects from the Order Hemiptera, Family Reduviidae): Assassin bugs are a type of "true bug" (i.e. from the Order of insects actually called "bugs") that can be quite large and feed on other soft-bodied insects. Assassin bugs are considered only a ***low*** threat to honey bees. Sometimes, they can be seen sitting on the outside of a honey bee colony with a dead or dying bee positioned at the tip of their piercing/sucking mouthparts. Assassin bugs do not need to be controlled, unless you just cannot stand the sight of your bees being eaten alive, in which case you can simply squash the bug.

25) Wasps: Wasps are the most significant stressor in the ***low*** threat category. I placed them in the low threat category because, in most cases, honey bees and wasps live harmoniously with little to no negative interactions. However, wasps (hornets and yellow jackets specifically) can be moderate to significant problems for honey bee colonies during certain times of the year and under certain circumstances. Wasps, by nature, are carnivores. The adults hunt, sting, and catch prey (usually soft-bodied insects and other arthropods) to feed to their young. For most of the wasp-year, there is ample prey available for wasps to hunt. However, prey availability tends to decrease in late summer/early fall, when wasp populations remain high. Thus, honey bees become the favored prey during this season. Despite the fact that wasps can be a significant problem, even for entire apiaries, they usually are not and do not warrant control. The best control option is hunting down and destroying the problem wasp nest(s). Otherwise, bee colony problems with wasps can be controlled culturally or by moving the colonies away from the threat.

26) Spiders: There are many species of spiders that prey upon wasps. I am not aware of any spider species that eat honey bees exclusively. However, I have seen many types of spiders preying on honey bees that inadvertently got caught in their webs or were ambushed by the spiders. In general, spiders pose a ***low*** threat to honey bees and do not need to be controlled.

Figure 13 – An apiary destroyed by a bear. ***Photograph: University of Florida.***

Table 1: Ranking the biotic stressors of honey bee colonies by the threat they pose to the bees. Within the threat level (significant, moderate or low), the stressors are ranked from most significant (higher on the list) to least significant (lower on the list) based on their distribution and impact on colonies when present in an area. A given stressor's impact on a colony can vary according to many factors, meaning that most listed stressors are capable of being low, moderate, or significant threats at certain times or under certain circumstances. Thus, the ranking system that follows is general and somewhat fluid.	
Significant threat - when present, you *must* address the issue and sometimes this is best done prophylactically	
Varroa	likely the most significant threat to honey bees, must be addressed in managed colonies
American foulbrood	very contagious brood disease, cannot be remedied once colony contracts the disease
Deformed wing virus	increasingly considered a significant threat to honey bees, intimately linked to *Varroa*
Nosema ceranae	true colony impacts unknown, believed to be a significant problem for colonies
Moderate threat - can be a stressor, sometimes even serious, in certain areas and under certain circumstances	
Small hive beetles	can decimate entire apiaries in certain circumstances, but usually manageable in most situations
Bears	when present in an area, will find and damage/destroy colonies in an apiary, must protect colonies when bears are in the area
Other viruses (BQCV, SBV, IAPV, KBV, ABPV, CBPV)*	virus synergisms possibly significantly damaging to already stressed colonies
European foulbrood	may have widespread distribution and affect colonies chronically
Greater wax moth	present in many colonies, waiting to overrun stressed colonies
Nosema apis	causes bee dysentery and may impact colonies in other ways
Tracheal mites	no longer considered a major problem, mainly an issue in late winter/early spring
Lesser wax moth	in many colonies, but rarely overrunning them
Chalkbrood	brood disease that manifests in certain colony conditions
Low threat - rarely a major problem, but can significantly stress a colony when conditions are right	
Wasps	can overrun colonies in late summer when natural prey is scarce
Ants	can destroy colonies and sometimes difficult to control
Flies	can parasitize bees
Skunks	eat bees at night, but rarely truly damage colonies
Birds	eat bees, but not usually at damaging levels
Assassin bugs	eat bees, but not usually enough to damage colonies
Mice	mainly a problem during winter months
Toads	only a minor problem in the U.S., but major elsewhere
Lizards	eat low numbers of bees
Large hive beetle	scarab beetles that cause minor colony damage
Bee louse	a wingless fly that can be present in colonies but is not known to stress colonies in any way
Emerging threat	
Tropilaelaps	the biggest potential threat on the beekeeper's horizon
*BQCV (Black queen cell virus), SBV (Sacbrood virus), IAPV (Israeli acute paralysis virus), KBV (Kashmir bee virus), ABPV (Acute bee paralysis virus), CBPV (Chronic bee paralysis virus.	

27) Birds: Some birds will prey upon honey bees and can be significant threats to colonies in limited areas around the world. However, generally speaking, birds pose a ***low*** threat to honey bees and do not need to be controlled. That said, birds can damage some colonies if they happen to prey upon queen honey bees on the queens' mating flights. However, I suspect that this is not so common, meaning that most beekeepers have little to worry about when it comes to birds.

Reptiles/Amphibians

28) Lizards: Lizards pose a ***low*** threat to honey bee colonies. They may be seen sitting near the nest entrance, feeding on bees outside of the nest. However, I am not aware of any instances of lizards posing a significant threat to honey bee colonies. Consequently, no control for lizards is necessary.

29) Toads: In some parts of the world, toads, which can be predators of bees, can cause significant damage to honey bee colonies. In Australia, for example, cane toads can reduce a bee colony's population significantly in a single night's feeding. In most areas, however, toads pose only a ***low*** threat to colonies and control is not necessary.

Mammals

30) Bears: Where present, bears are a ***moderate*** threat to honey bee colonies. In fact, I tell people that the way to know if bears are in your area is to place a colony of bees nearby. If bears are present, they will find the bees! Contrary to popular myth, most bears do not destroy bee colonies to access the honey contained within it. Instead, the bears are interested in eating the protein/nutrient rich brood. Bears usually attack at night, sometimes carrying entire colonies away from the apiary so that they can snack at their leisure. The end result is a destroyed colony, and a decimated apiary if the problem is not noticed soon enough (Figure 14). People keeping bees in areas where bears are present should bear proof their apiary with an electric fence to reduce the threat that bears pose to their bees.

31) Mice: Mice pose only a ***low*** threat to bee colonies. They do not eat bees, but instead can build their nests in bee hives, especially in late fall/winter. I have worked many colonies in late winter, only to find that mice have moved into the bee nest and constructed a nest of their own. Mice, correspondingly, can cause significant comb damage. Despite this, they are an infrequent problem and can be controlled culturally through good husbandry practices.

32) Skunks: Skunks and other similar mammals pose a ***low*** threat to honey bee colonies. Skunks sometimes develop a palate for bees, attacking the colonies at night time and eating the bees that respond. Generally speaking, most beekeepers will never have a problem with skunks. When they do, the skunks usually can be controlled culturally.