This is a Pre-Review Version of This Factsheet - An Update Will Be Available When Reviews Are Complete

The Asian Giant hornet (AGH) or Japanese giant hornet, *Vespa mandarinia*, recently found in British Columbia, Canada, and in Washington State, poses a significant threat to European honey bee (EHB), *Apis mellifera*, colonies and is a public health issue. The AGH is the world's largest species of hornet, native to temperate and tropical Eastern Asia low mountains and forests. The hornet is well adapted to conditions in the Pacific Northwest.

If this hornet becomes established, it will have a severe and damaging impact on the honey bee population, the beekeeping industry, the environment, public health, and the economy. It is critical that we identify, trap, and attempt to eliminate this new pest before it becomes established and widespread. Attempts to contain the spread and eradication of this invasive insect will be most effective in trapping queens during early spring before their nests become established.

It is critical these actions are taken before the fall reproductive and dispersal phase of the hornet. Beekeepers in the field are the most crucial line of defense in locating, identifying, and trapping the hornets. Yet, everyone should be on the lookout for the hornets and report any sightings to local authorities and the Washington Department of Agriculture.

Here we cover how the AGH will impact the honey bee, give the reader a better understanding of the hornet, and precautions and first aid if attacked by the hornet. For a complete explanation of the biology of the hornet developed by the USDA, click here.

The invasive hornet is a voracious predator of the European honey bees late in the season. Honey bee colonies provide a rich, plentiful, and easily attainable food source. The AGH also preys on other hornets and social wasps, yet its impact on honey bee colonies is the biggest concern. An easy target, European honey bees lack the defense mechanisms developed by Asian honey bees (*Apis cerana*), which co-evolved with the hornets. Honey bee brood is rich in protein and fat and is plentiful, the preferred food to feed the hornet's developing reproductives, the queens and drones.

To acquire the protein food base, the hornet attack on a honey bee colony occurs in three phases; hunting, slaughter, and occupation. Hornet scouts locate and mark a colony during the hunting phase. A food-site marking pheromone is produced in a gland located on the last abdominal segment of the hornet. The pheromone recruits additional hornet nest-mates, and the slaughter phase occurs. Several hornets will relentlessly attack and kill nearly all of the adult worker bees as they

Continued on Page 2 Main Column, Introduction

Vespa mandarinia japonica from Tarabagani - Wikimedia commons

What is a hornet?

A hornet is simply a large wasp. Generally, wasps of the class or genus know as Vespa are considered hornets. Interestingly, there are no true hornets (Vespa) native to North America. The European Hornet (Vespa crabro) is well established in much of the eastern half of the United States.

Hornets are part of a large order of insects known as hymenopterans that include bees, wasps, ants, and sawflies. Worldwide there are more than 115,000 species belonging to the order Hymenoptera. Most of this group of insects are beneficial and help us with pollination and pest control. There are two types of hornets, solitary and social. Solitary hornets hunt various insects and spiders. Their "stinger" is primarily used to paralyze their prey. They often lay an egg on the immobilized victim, when the egg hatches the larvae consume the still-living host. Solitary wasps generally do not sting humans and usually are not aggressive unless provoked.

Social wasps, on the other hand, do use their stingers to defend their nests and can be very aggressive and readily sting. The most common social wasp in the United States is the yellow-jacket. The recently introduced Giant Asian Hornet (AGH) is also a social wasp and has been described as one of the most intimidating

Continued on Page 2 Side Column, Hornet

If you see a AGH please report it!

Email: PestProgram@agr.wa.gov

Call: 1-800-443-6684

Reporting form: https://agr.wa.gov/departments/insects-pests-and-weeds/insects/hornets

Continued Fom Page 1 Main Column, Introduction

attempt to defend their colony. Within a few hours, a strong, healthy, and populous honey bee colony of 30,000 to 50,000 workers is slaughtered by a group of 15 to 30 hornets. The hornets go for the brood, the protein-rich pupae and larvae. To protect their food source, after eliminating the adult honey bees, the hornets occupy the colony and guard the entrance. During the occupation phase, their behavior changes and becomes very defensive, attacking nearby animals and humans. They harvest bee brood over the next ten to fourteen days, until rancid, transporting and feeding the hornet larvae back in their nest. Attacks are generally concentrated on a particular hive within a nearby apiary.

The hornets chew the bee brood into a paste and take this back to the nest. The adult hornets do not eat the paste; all is given to the developing larvae to promote their growth. After feeding and digesting the bee brood paste, the larvae drool a high energy mash, which the adult hornets consume from the larvae. The larvae secretion provides the adults with the nutrients needed for their survival.

The Japanese honeybees (*Apis cerana japonica*) forming a "bee ball" in which hornets are engulfed and being heated. Yokohama, Kanagawa prefecture, Honshu Island,Japan. Takahashi Wikimedia Commons

The intensity of attacks is dependent upon the distance of the food source. The shift from the hunting phase to the slaughter phase usually occurs when the hornet nest is close, within 0.5 to 1.5 miles, and hornet visits are constant. If more distance, up to 5 miles, the hunting phase can continue indefinitely; without an attack phase. The forging hornets wait and seize the bees near the entrance. A meaty ball is made from the thorax of the adult bees and carried back to the hornet's nest.

The European honey bee is easy and bountiful prey for the hornets, with no inherent defense mechanisms. As the bees rush out to defend their colony, they are slaughtered by the hornets, most of the adult workers are decapitated and discarded, the few remaining are ignored as the hornets collect and transport the bee brood back to their nest. The smaller Asian honey bee, *Apis cerana,* has co-evolved with wasp and hornet predators and has developed several behavioral defense mechanisms and counter-attack strategies against them.

The hornet's marking pheromone is recognized by *A. cerana* and stimulates defensive behaviors. The hornets mark a colony by rubbing the basal gland at the tip of the abdomen. European honey bees do not react and do not recognize the hornet marking pheromone. The Asian honey bee recognizes this pheromone and alerts the colony. No single bee attacks alone, the defense is collective. It is the opposite reaction of the European honey bees, which rush out and are slaughtered.

The Asian honey bees successfully repel hornets and eliminate the scouts before a mass attack can be started. When a hornet is detected, the *A. cerana* colony becomes very alert, with raised antennae, fanning heavily, and emits a warning sound that tends to repel the hornet. Bees at the entrance shimmer in a coordinated rapid shaking of their abdomens. Workers stop foraging and retreat into the colony, aggregating near the entrance.

Continued On Page 3 Main Column, Introduction

From Page 1 Side Column, Hornet

insects in the world. When foraging for food in spring, the AGH is not highly defensive – unless its nest is disturbed. Late summer and fall, with the high demand for protein, they become very aggressive when attacking or occupying a honey bee colony.

The Stinger

The stinger in bees and social wasps (including hornets) is a modified ovipositor or egg-laying device. Solitary wasps still use their ovipositor for egg-laying. The ovipositor gives certain types of solitary wasps the ability to deposit their eggs through wood or directly into their prey. With social bees and wasps – the ovipositor has evolved into a mechanism to attack, immobilize prey, defend their nest, and deliver venom that inflicts pain on the victim. Because the stinger is a modified egg-laying device, it only occurs in female bees, wasps, and hornets. The males or drones may look and sound intimidating, but they cannot deliver a sting. The males do not participate in food collection or defense of the nest. It can be challenging to distinguish between a male and female bee or wasp – so use caution and avoid any contact with AGH.

The stinger of hornet and wasps is different than that of the honey bee. Their sting is heavily barbed, with lancets that ride on rails on the main hollow shaft of the stinger. Their stinger is straight and can only sting under their bodies (ventrally). Muscular action work the lancets as they alternate their downward movement and tear into the flesh of the victim. As the stinger works its way into the victim, it alternates back and forth, digging deeper at the same time two diaphragms within the poison sac facilitate a pumping action delivering venom through the hollow main shaft into the victim. When the bee flies away, the barbs on the stinger keeps it lodged in the victim, leaving the stinger, poison sac, and some of the internal abdomen behind.

Hornets and wasps have curved stingers and have smaller and fewer barbs compared to the honey bee. The smaller barbs allow for the tearing of flesh, which helps the stinger puncture the skin of the victim and deliver venom. The fewer and smaller barbs of wasp and hornet stingers allow them to sting repeatedly. The curved stinger helps with the insertion of the stinger.

Continued on Page 3 Side Column, Stinger

Continued Fom Page 2 Main Column, Introduction

Upon detection of a hornet scout hovering near the hive entrance, a group of about 50 *A. cerana* guard bees display a warning behavior, lifting and shaking their abdomens simultaneously. Inside the colony, the nest bees collectively shake, causing a shimmer and emit a warning sound, and foraging activities decrease rapidly.

This shimmering behavior is often effective in driving away a hunting hornet. If a guard bee does grasp a hornet, several hundred bees, in an immediate synchronized rush, engulf the hornet in a ball, super-heating the hornet to a lethal temperature. The center of the heat ball reaches 47°C with high levels of carbon dioxide. The bees hold this position for about 20 minutes, tolerant within a few degrees of temperature of that lethal to the hornet.

This colony defense is highly effective in interrupting the initial hunting phase of the hornet, eliminating the scout hornet, preventing recruitment and mass attack. The defensive heat ball temperature extremes can kill 25% of the honey bees and shorten the longevity of those exposed, though the colony survives. However, the importation of *A. cerana* is NOT an option to counter the AGH.

Public Health Issue

The AGH tends not to be aggressive toward people, though it will attack when their nest or food source is threatened. Stumbling upon or disturbing a nest can be dangerous, especially for the unaware. Hornets patrol the nest entrance, day and night, and are highly defensive when protecting their nest or food source. The hornet sting is excruciating, and they can repeatedly sting, unlike honey bees that loose their sting in the process. Dr. Justin Schmidt, in his book the Sting of the Wild, refers to the AGH as, " the most intimidating insect on earth." In some areas of Asia, they are known as the yak-killer hornet. The sting is also longer, about a quarter-inch, and can penetrate through a standard beekeeper's suit or coveralls. When eliminating nests, double layers of smooth, slippery fabrics should be worn. A protective face mask is also recommended as the hornets can spray venom. If allergic, stings can cause anaphylactic shock but can also be lethal to people who are not allergic if a sufficient dose received

Vespa mandarinia – what beekeepers need to know

Beekeepers in the Pacific Northwest should be very concerned with the hornet's discovery in British Columbia and northwest Washington State. The Washington Department of Agriculture is distributing sap baited sticky boards aimed at attracting inseminated queens coming out of hibernation. Queens come out of hibernation in late March or early April and begin seeking a suitable site for developing a new nest. During this time, she has a high carbohydrate diet – with oak sap being one of their preferred sources. Sticky traps are an excellent way to capture these AGH queens and prevent their establishment of new nests.

Sticky boards can be used throughout the season to reduce the number of hornets. One trick that Japanese beekeepers use it to "bait" the sticky board with a dead AGH. The pheromone they release attracts additional hornets who, in turn, attract more hornets. Individual hornets can often be seen in honey bee apiaries in areas heavily infested with the AGH. In Japan, beekeepers use sticks or badminton rackets to knock them out of the air. Care should be taken whenever coming into direct contact with hornets, but they are not overly aggressive away from their nest or when they are not "occupying" a honey bee hive harvesting the pupae or larvae. The Japanese beekeepers have also developed a couple of hive attachments to control the AGH. One is a trap that allows the hornet into a chamber containing bait, from the bottom of the trap. A second opening at the top of the bait chamber leads into a capture trap opening. They are taking advantage of the hornet's tendency to fly up and away once it has taken the bait. These traps do work, but hornets can escape and eventually learn to avoid the trap and wait outside to catch the bees. Another is to attach a screen loosely over the full front of the hive that allows honey bees to come and go, but inhibits the hornet's approach to the colony. These two methods are often used in tandem at a ratio of 1:5 screens to traps to keep costs down while still disrupting the hornets.

Continued On Page 4 Main Column, Beekeepers Need to Know

From Page 2 Side Column, Stinger

Wasps are able to deliver the stinger at a force that is 40 to 225 percent greater than that of the honey bee. In addition, wasps are able to sting both above (dorsally) and below (ventrally), giving them much greater flexibility in delivering a sting. Given this greater flexibility and force of the sting, extra precaution is warranted.

Venom

The primary purpose of venom is defense against predators by inflicting pain and damage. *Vespa mandarinia* is one of the two most poisonous known insects in the world.. The amount of venom each wasp delivers (4.1 µl/wasp) has designation *V. mandarinia* as the most venomous insect. In comparison, the honey bee has about 0.6µl/bee.

Bee and wasp venom contains a cocktail of substances; most of these are primarily proteins, but the type of proteins differ between bees, wasps, and hornets. Milligram to milligram the honey bee is more toxic than that of the AGH, but given that they deliver a bigger dose and can sting multiple times , they are far more dangerous than the honey bee. Histamine is a common ingredient in bee, wasp and hornet venom, which causes dilatation of blood vessels , responsible for localized swelling, redness and itching. However, histamine does not cause pain, but acetylcholine found only in hornet venom does cause a sharp pain. Most beekeepers are very aware of this difference and can readily tell the difference between a honey bee sting and that of a wasp or hornet, as more intense and longer lasting pain compared to the honey bee sting.

Stinger of *V. mandarinia* by kobunny Flickr

Continued From Page 3 Main Column, Beekeepers Need to Know

The USDA suggests some sample traps that may also work to capture queens and workers in the spring and fall. For a list of traps that may work, see the USDA's "New Pest Response Guidelines: *Vespa mandarinia* - Asian Giant Hornet."

Finding the nests can be a bit of a challenge. Their nests are typically in the ground though they can also be found under overhangs and within wall voids. The AGH is a strong flier and often will fly up and away and have an extensive flight range. Thus tracking can be difficult. If you can locate a nest, proceed with extreme caution and contact WSDA immediately. Do not try to exterminate the nest yourself.

For smaller non-migratory beekeepers, a hornet trap that works well in Japan may help limit the potential for an all-out attack by the AGH. Only screening the hive will not protect colonies from an AGH attack – The Japanese traps are designed to capture the hornet away from the entrance and allow honey bees to forage with less disturbance. Unfortunately, these traps attached to the hive entrance may not be practical for commercial or migratory beekeepers. The commercial beekeepers' best option to control the hornet may be to use the sticky traps, either baited with sap or a captured hornet. Another option may be to move colonies out of heavily infested areas before the hornets begin making queens and drones in late August through November or until the first heavy frost.

Avoidance and First Aid

If you find yourself in a situation where you are being attacked by any bees, wasps, or hornets - get away from them as quickly as possible. Move quickly, but do not panic! Bees, wasps, and hornets tend to give a warning before they begin an attack. In the case of the AGH, they snap their mandibles (jaws) together, and you will hear a loud clicking noise. But by the time you hear this, it may be too late. The best strategy is to run far away. Do not necessarily run in a straight line. If there are trees or bushes, it is best to weave your way around them to elude the pursuing hornets. If possible, retreat inside a vehicle or structure. The AGH reportedly can fly 19 to 25 MPH. Outrunning them will be difficult, but you can elude them and then get away from their defensive territory. If stung seek medical attention. Also, report the incident to the Washington Department of Agriculture or local authorities as soon as possible.

The type of damage that venom from bees, wasps, and hornets inflict varies from very mild to quite severe. It is estimated that about one to five percent of individuals stung by bees or wasps will develop a systemic allergic reaction, which can be life-threatening. Persons experiencing difficulty breathing following a sting should seek medical attention immediately. Most people receiving one to a few stings will develop a localized reaction such as swelling and itching of the area of the sting(s). Localized reactions can be significant and painful, with some relief by oral anti-histamine taken. An ice pack can also help to reduce swelling.

In summary, the following are the first-aid suggestions for stings:

- Monitor swelling and remove any tight-fitting jewelry or clothing constricted by swelling
- Take an anti-histamine
- Apply ice or a cold compress.
- Monitor for any severe reactions following a sting
- Call 911 or seek immediate medical care if experiencing respiratory distress or anaphylactic shock.
- Wash the site of the sting thoroughly using soap and water

Additional information on first aid is available at the Washington Department of Health website: https://www.doh.wa.gov/CommunityandEnvironment/Pests/BeesandWasps

Additional complications from stings noted in the literature include an anaphylactic reaction (can lead to airway closure or cardiac arrest), necrosis (death of tissue), destroying red blood cells, kidney failure, other organ failures, and death. Seek medical attention, call 911 for difficulties breathing or any other life-threatening symptoms.

Written by Susan Cobey, Tim Lawrence, and Mike Jensen

Literature Cited and Further Readings

Fitzgerald, K. T., and A. A. Flood. 2006. Hymenoptera stings. Clinical techniques in small animal practice 21: 194-204.

Hermann, H. R., and M. S. Blum. Defensive mechanisms in the social Hymenoptera. Social insects 2: 77-197.

Kausar, M. 2018. A review on Respiratory allergy caused by insects. Bioinformation 14: 540.

Laskowski-Jones, L. 2006. First aid for bee, wasp, & hornet stings: Learn how to protect the victim-and yourself-from the potentially dangerous effects of their venom. Nursing2019 36: 58-59.

Matsuura, M. 1984. Comparative biology of the five Japanese species of the genus Vespa (Hymenoptera, Vespidae). Bulletin of the Faculty of Agriculture - Mie University: 1-131.

Matsuura, M., and S. F. Sakagami. 1973. bionomic sketch of the giant hornet, Vespa mandarinia, a serious pest for Japanese apiculture. Journal. Series 6. Zoology Oct: 125-162.

Postma, T. L. 2009. Neurotoxic animal poisons and venoms, pp. 463-489, Clinical Neurotoxicology: Syndromes, Substances, Environments. Saunders, Philadelphia, PA.

Schmidt, J. O. 2016. The sting of the wild, Baltimore : Johns Hopkins University Press, Baltimore.

Schmidt, J. O. 2019. Pain and Lethality Induced by Insect Stings: An Exploratory and Correlational Study. Toxins 11.

Schmidt, J. O. 2020. (Personal Communication. In T. J. Lawrence [ed.].

Schmidt, J. O., S. Yamane, M. Matsuura, and C. K. Starr. 1986. Hornet venoms: lethalities and lethal capacities. Toxicon : official journal of the International Society on Toxinology 24: 950-954.

Steen, C. J., C. K. Janniger, S. E. Schutzer, and R. A. Schwartz. 2005. Insect sting reactions to bees, wasps, and ants. International Journal of Dermatology 44: 91-94.

Strom, S. 2001. Faster Than a Speeding Hornet.(Dining In, Dining Out/Style Desk), pp. F1.

Tripodi, A., and T. Hardin. 2020. New Pest Response Guidelines: Vespa mandarina Asian giant hornet. In U. S. D. o. Agriculture [ed.]. US Government Printing, Washington DC.

Yanagawa, Y., K. Morita, T. Sugiura, and Y. Okada. 2007. Cutaneous hemorrhage or necrosis findings after *Vespa mandarinia* (wasp) stings may predict the occurrence of multiple organ injury: A case report and review of literature. Clinical Toxicology 45: 803-807.

Zhao, Z., H. Zhao, G. Ma, C. W. Wu, K. Yang, and X. Feng. 2015. Structures, properties, and functions of the stings of honey bees and paper wasps: a comparative study. Biology Open 4: 921-928.