



Invasive Species

What is an “Invasive Species?”

- An invasive species is an organism that causes ecological or economic harm in a new environment where it is not native. Invasive species are capable of causing extinctions of native plants and animals, reducing biodiversity, competing with native organisms for limited resources, and altering habitats. Invasive species can harm both the natural resources in an ecosystem as well as threaten human use of these resources.
- Invasive species can be plants, animals, pathogens or microorganisms.
- Other names for invasive species include alien, exotic, injurious, introduced or naturalized, non-native, nonindigenous, nuisance, or noxious species.

How do we get invasive species?

- Some of the ways invasive species can be introduced into an area are by ship ballast water, firewood, shipping pallets, horticultural plants, accidental release, and by people. Human actions are the primary means of invasive species introductions.
- Invasion of long-established ecosystems by organisms is a natural phenomenon, but human-facilitated introductions have greatly increased the rate, scale, and geographic range of invasion. For millennia, humans have served as both accidental and deliberate dispersal agents.

Invasive Species:

- Most introduced species do not survive extended periods in new habitats, because they do not possess the evolutionary adaptations to adjust to the challenges posed by their new surroundings.
- Some introduced species may become invasive when they possess a built-in competitive advantage over **indigenous** species in invaded areas.
- Under these circumstances, new arrivals can establish breeding populations and thrive, especially if the **ecosystem** lacks natural predators capable of keeping them in check.



INTRODUCING

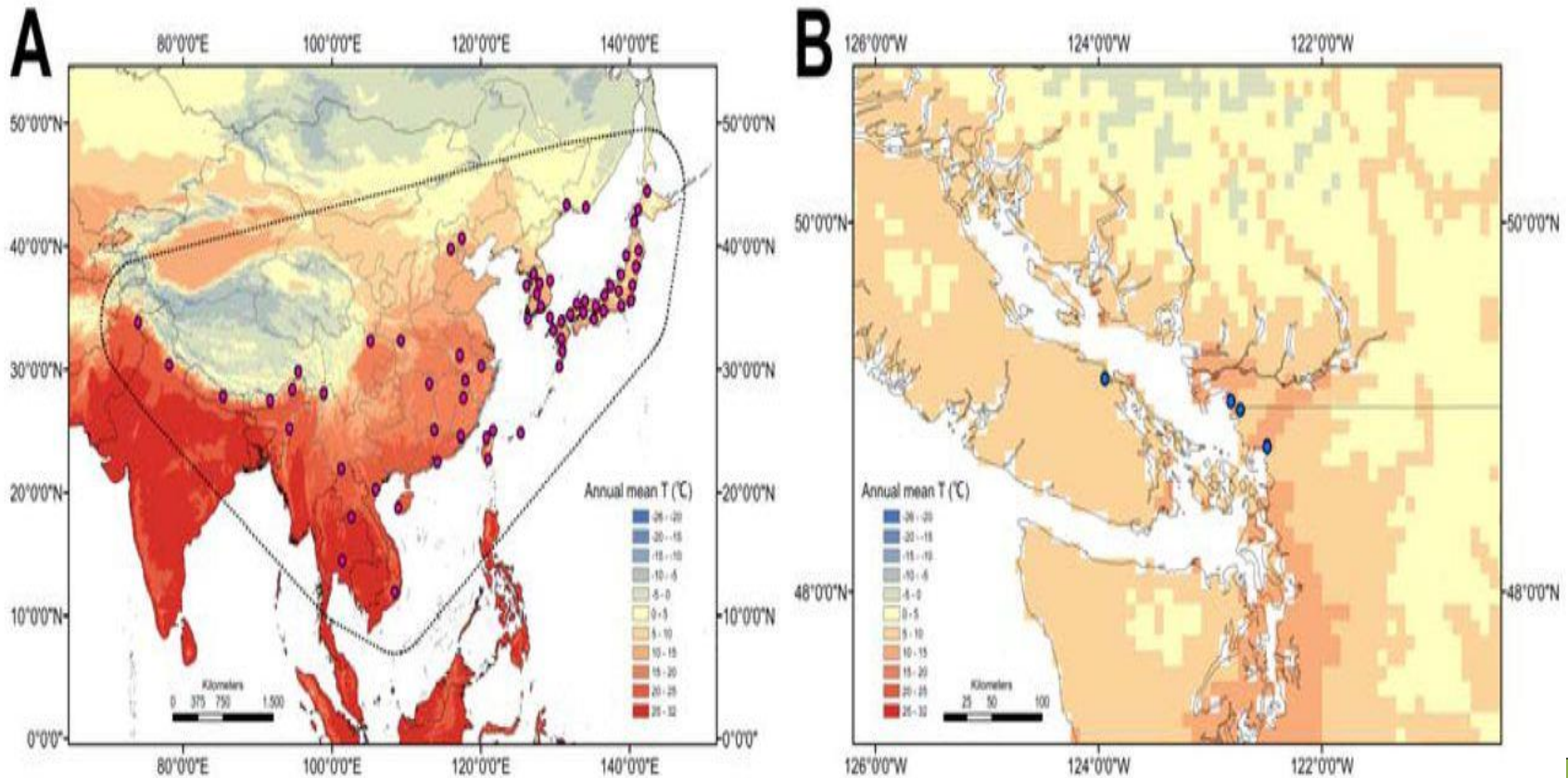


Asian Giant Hornet

*Vespa
mandarinia*

Native Range:

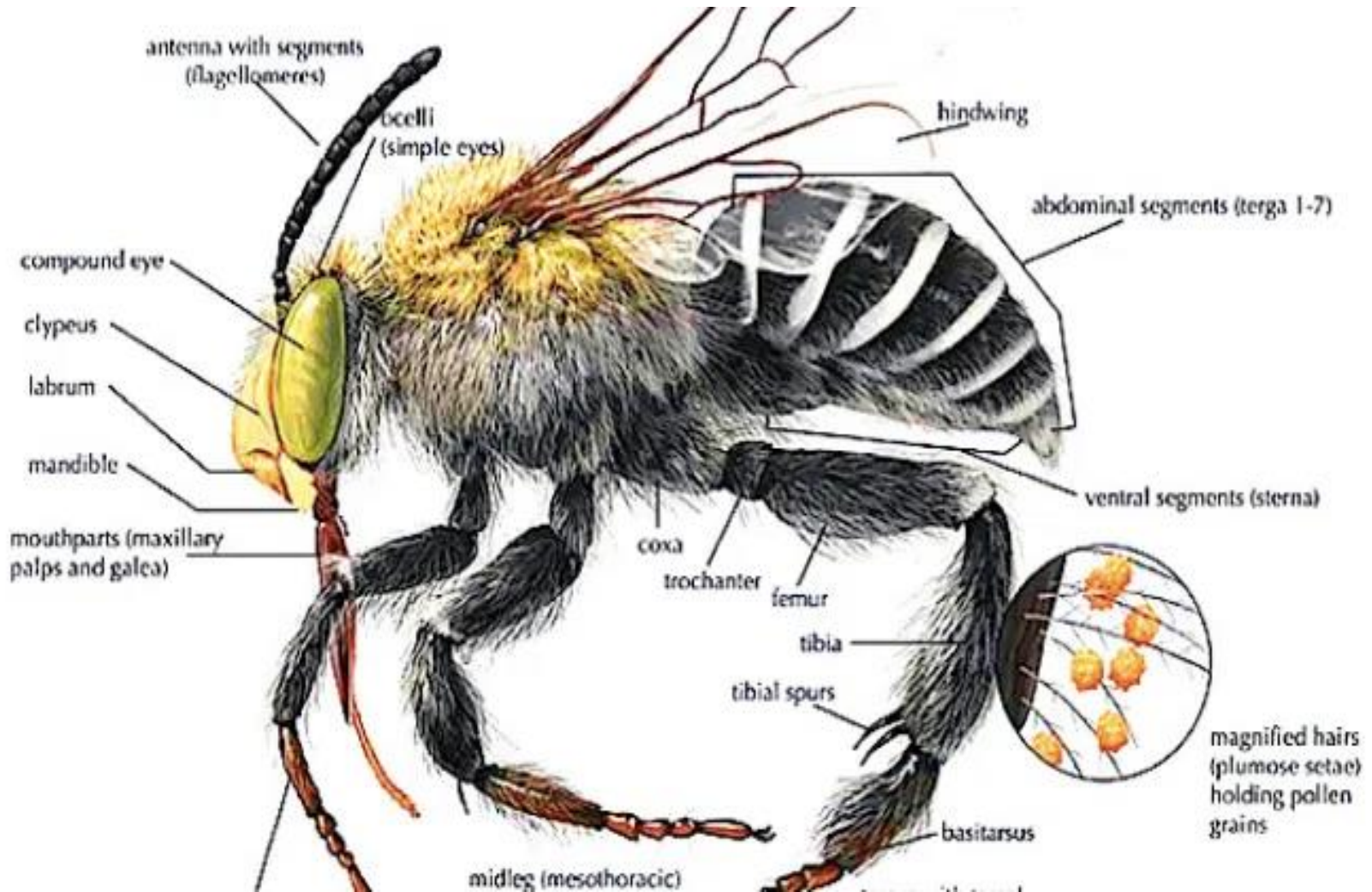
The Asian Giant Hornet (AGH) is a social wasp species. It is native to temperate and tropical East Asia, South Asia, Mainland Southeast Asia, and parts of the Russian Far East.



Taxonomy:

- **Kingdom:** Animalia (Animals)
- **Phylum:** Arthropoda (Arthropods)
- **Class:** Insecta (Insects)
- **Order:** Hymenoptera (Wasps, Bees, Ants)
- **Family:** Vespidae (Yellowjackets and Hornets, Paper Wasps; Potter, Mason and Pollen Wasps)
- **Genus:** *Vespa* (Hornets)
- **Species:** *mandarina*
(Asian Giant Hornet)

Hymenoptera Body Parts:



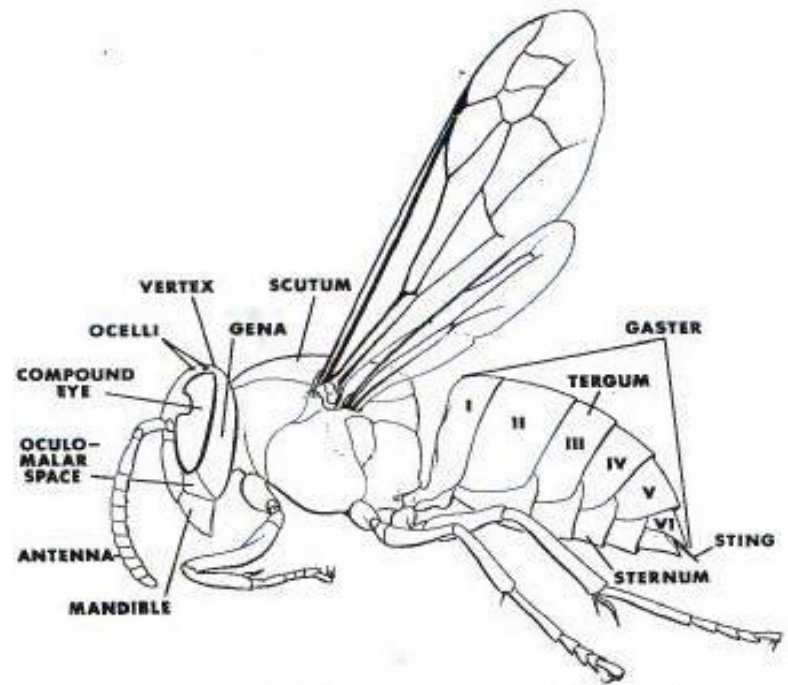
Characteristics:

- **Asian Giant Hornet (*Vespa mandarinia*), including the color form referred to as the Japanese Giant Hornet, is the world's largest hornet, measuring up to 2 inches long. Despite its large size and distinctive markings, people often confuse it for other species.**
- **Although the scientific literature and official government sources continue to refer to this species by its established common name, the popular media have taken to using the nickname "Murder Hornet".**



Characteristics:

- Regardless of sex, the hornet's head is a light shade of orange and its antennae are brown with a yellow-orange base. Its eyes and ocelli are dark brown to black. *Vespa mandarinia* is distinguished from other hornets by its pronounced clypeus and large genae. Its orange mandible contains a black tooth that it uses for digging.



Characteristics:



Characteristics:

The thorax is dark brown, with two grey wings varying in span from 35 to 76 mm (1 $\frac{3}{8}$ to 3 in). Its forelegs are brighter than the mid and hind legs. The base of the forelegs is darker than the rest.

Asian giant hornet
Vespa mandarinia

Enlarged head

1.5-2 in. long

Antenna base
yellow/orange



Brown thorax

Abdominal banding
yellow and brown



Large yellow/orange head

WA State Dept of Ag, Bugwood.org

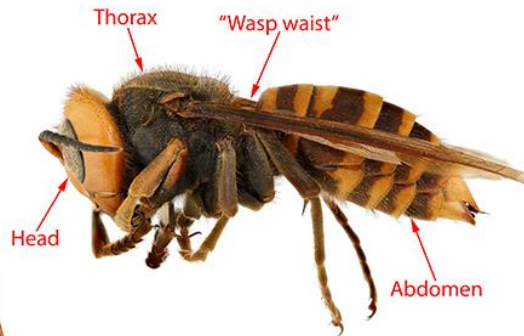


Characteristics:

Adult wasps and hornets have a definite waist.



Bee - no distinct waist.



Characteristics:

- The abdomen alternates between bands of dark brown or black, and a yellow-orange hue (consistent with its head color). The sixth segment is yellow. Its stinger is typically 6 mm ($\frac{1}{4}$ in) long and delivers a potent venom that, in cases of multiple hornets stinging simultaneously, can kill a human - thus the nickname “Murder Hornet”.



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Characteristics:

- The queens are considerably larger than workers. Queens can exceed 50 mm (2 in), while workers are between 35 and 40 mm ($1\frac{3}{8}$ and $1\frac{5}{8}$ in). The reproductive anatomy is consistent between the two, but workers do not reproduce.
- Drones (males) are similar to females, but lack stingers. This is a consistent feature among the Hymenoptera.



Characteristics:

- Larvae cocoon themselves in their own silk in the late stage. Larval silk proteins have a wide variety of potential applications due to their wide variety of potential morphologies, including the native fiber form, but also sponge, film, and gel.



Habitat:

- Asian Giant Hornets prefer to live in low mountains and forests, while almost completely avoiding plains and high-altitude climates. *V. mandarinia* creates nests by digging, co-opting pre-existing tunnels dug by rodents, or occupying spaces near rotted pine roots.



Nesting:

- *Vespa mandarinia* nests in low mountain foothills and lowland forests. As a particularly dominant species, no efforts are directed toward conserving *Vespa mandarinia* or its habitats, as they are common in areas of low human disturbance. Unlike other species of *Vespa*, *Vespa mandarinia* almost exclusively inhabits subterranean nests. In a study of 31 nests, 25 were found around rotten pine roots, and another study found only 9 of 56 nests above ground. Additionally, rodents, snakes, or other burrowing animals previously made some of the tunnels. The depth of these nests was between 6 and 60 cm (2 and 24 in). The entrance at the ground surface varies in length from 2 to 60 cm (1 to 24 in) either horizontally, inclined, or vertically. The queens that found the nest prefer narrow cavities.
- Nests of *Vespa mandarinia* typically lack a developed envelope. During the initial stages of development, the envelope is in an inverted-bowl shape. As the nest develops, one to three rough sheets of combs are created. Often, single primordial combs are created simultaneously and then fused into a single comb.

Nesting:

- A system of one main pillar and secondary pillars connects the combs. Nests usually have four to seven combs. The top comb is abandoned after summer and left to rot. The largest comb is at the middle to bottom portion of the nest. The largest combs created by *V. mandarinia* measured 49.5 by 45.5 cm (19 ½ by 18 in) with 1,192 cells (no obstacles, circular) and 61.0 by 48.0 cm (24 by 19 in) (elliptical; wrapped around a root system).



Nesting:

- On the left is a AGH nest in a hole in a tree trunk. The right image is a nest built around a tree limb.



Nesting:

- In ground nests of Asian Giant Hornets.



In Ground Nests:



Murder Hornet Life Cycle

March/April

Queen wakes up from hibernation.
Starts to build nest and lay eggs

May/June

Eggs hatch and evolve to adults. New
hornets feed and help build nest

June-September

Worker hornets attack bees. 2nd wave
of reproduction (new queens hatch)

October-December

Worker hornets die. New queen
hornets mate and then hibernate



Life Cycle and Biology:

- **Spring:** A fertilized queen emerges after surviving the winter. She enters a brief pre-nesting stage in late April. The queen feeds on sap of Oak trees. Although this timing is consistent among hornets, *V. mandarinia* dominates the order, receiving preference for premium sap sources. Among the *V. mandarinia* queens is a dominance hierarchy. The top-ranked queen begins feeding, while the other queens form a circle around her. Once the top queen finishes, the second-highest-ranking queen feeds. This process repeats until the last queen feeds at a poor hour.
- As the queen is feeding she develops her ovaries, and looks for a suitable nesting site. She usually nests in preexisting underground cavities with a narrow opening, such as rodent burrows.

Life Cycle and Biology:

- **Summer:** Once an inseminated queen selects a suitable site, she enters a solitary phase. During this time, she alone is responsible for building a nest, foraging, laying eggs, and caring for young. She creates relatively small cells in which she raises around 40 workers. When around 40 workers are in the nest, the colony enters a new phase. The queen becomes completely nest-bound, and the workers assume all duties outside of the nest.



Life Cycle and Biology:

- Workers do not begin to work outside of the hive until July. Queens participate in activities outside the hive until mid-July, when they stay inside the nest and allow workers to do extra nodal activities. Early August marks a fully developed nest, containing three combs holding 500 cells and 100 workers. After mid-September, no more eggs are laid and the focus shifts to caring for larvae. The queens die in late October.



Life Cycle and Biology:

- **Late Summer/Early Fall:** When there are many workers, the colony begins producing males and the next year's queens. Workers feed these new "reproductives" within the nest because reproductives do not forage. To obtain food with higher protein, AGHs may attack honey bee hives in the late summer/early fall. The hornets kill all of the adult bees and leave them at the bottom of the hive. Then the hornets remove the hive's brood, taking bee larvae and pupae back to their nests. AGHs may attack other social bees and wasps at this time.



Life Cycle and Biology:

- **Fall:** Males develop and leave the nest before females. They will perch at the entrance of nests waiting to mate with the new queens, which emerge about 1 month later. New queens must mate before overwintering because males will not be present when the queens emerge the following spring.



Life Cycle and Biology:

- **Males and new queens take on their responsibilities in mid-September and mid-October, respectively. During this time, their body color becomes intense and the weight of the queens increase about 20%. Once the males and queens leave the nest, they do not return. In *Vespa mandarinia*, males wait outside the nest entrance until the queens emerge. Once the queens emerge, males intercept them in midair, bring them to the ground, and copulate from 8 to 45 seconds. After this episode, the males return to the entrance for a second chance, while the now-mated queen leaves to hibernate. Many queens (up to 65%) attempt to fight off the males and leave unfertilized, at least temporarily. After this episode, pre-hibernating queens are found in moist, subterranean habitats.**
- **When sexed individuals emerge, workers shift their focus from protein and animal foods to carbohydrates. The last sexed individuals to emerge may die of starvation.**

Life Cycle and Biology:

- Winter: After mating, a new queen will spend the colder months overwintering in a sheltered spot she has excavated in the soil, rotting wood, or piles of straw. The cycle begins again the following spring when the new queens emerge from overwintering.

Asian Giant Hornet



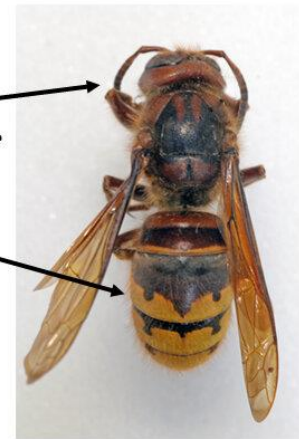
Head large,
yellow or orange

Head smaller,
chestnut or amber

Few bands, some
narrow, some
wide, margins
with dark spots

Many bands of
similar width,
margins uniform

European Hornet



Queen ~ 5 cm (~2 inches)

Queen ~ 3.5 cm (~1.4 inches)

Allan Smith-Pardo, Invasive Hornets, USDA
APHIS PPQ, Bugwood.org

Dr. Michael Raupp, Bug Guy, University of Maryland,
College Park, www.bugoftheweek.com

Food:

- Asian Giant Hornets feed primarily on larger insects, colonies of other eusocial insects, tree sap, and honey from honey bee colonies.



Food:

- Asian Giant Hornets preying on Honey Bees.

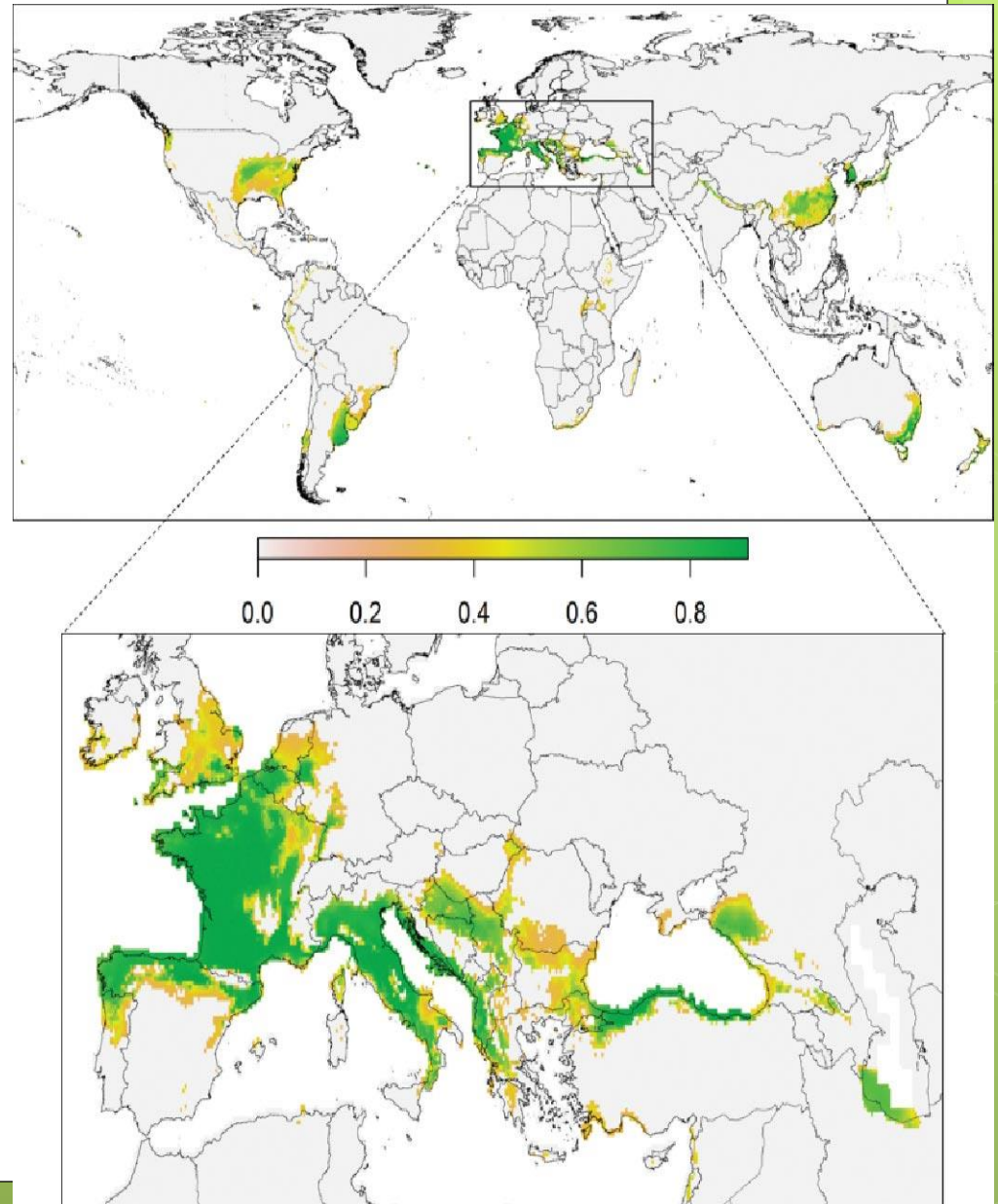


Food:

- Asian giant hornets attack honeybee hives, destroying them in mere hours and decapitating bees in what scientists call their "slaughter phase." They then take over the hive, feeding their own young with honeybee eggs and larvae.
- While they attack other insects too, they're not known to decimate entire populations like they do with honeybees.

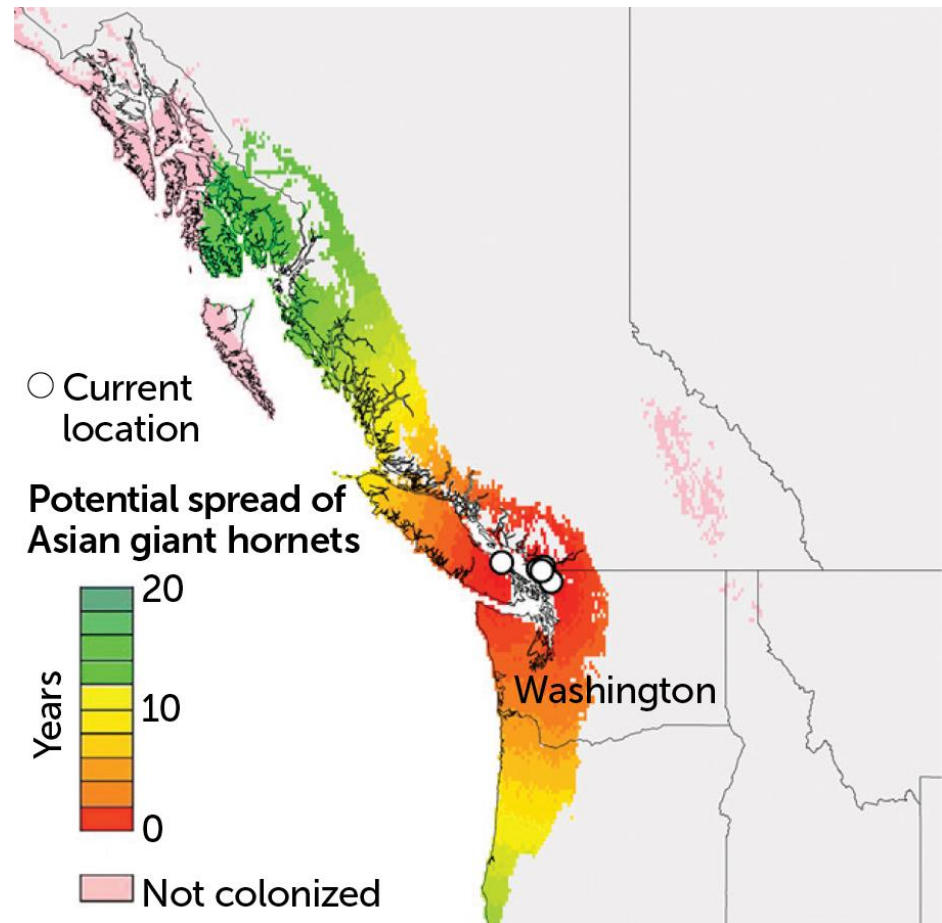
First Invaded Europe:

Asian Giant Hornets and Asian Hornets are similar to European Hornets but they are not native to the UK. They are originally from Southeast Asia. The invasive hornets made it to the UK in 2016, but have not increased significantly in numbers there. The Asian Hornet, *Vespa velutina*, which came from China however, is invading the UK and having devastating effects on the native bee populations.



Introduction to North America:

- The AGH was first reported in the Vancouver Island area of Canada in August 2019. Three hornets were found in Nanaimo on Vancouver Island, and a large nest was found and destroyed shortly thereafter.



Introduction to the United States:

- Meanwhile, a beekeeper in Custer, WA, near the Canadian border, reported finding piles of decapitated honeybees near his hives. The evidence was mounting that these hornets were successfully making their way to this continent.



Introduction to the United States:

- At the end of September 2019, a worker was reported in Blaine, Washington. Another worker was found in October and on December 8, in Blaine. Two specimens were collected in May 2020, one from Langley, British Columbia, about 8 miles north of Blaine, and one from Custer, Washington, 9 miles southeast of Blaine.

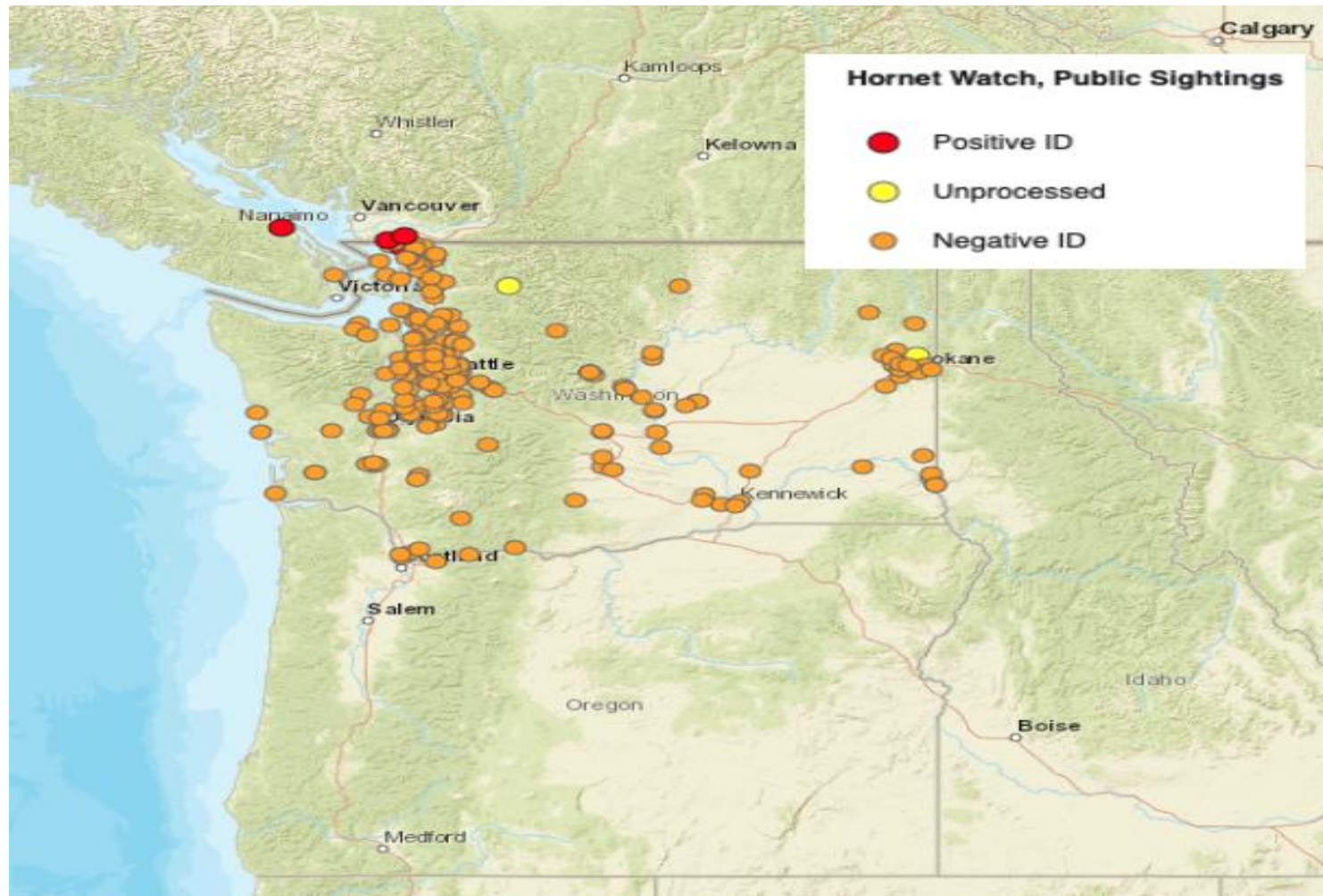


Spread in the United States:

- The race was on to keep Asian giant hornets from spreading in the Pacific Northwest. One queen sighting on June 6, 2020, from Bellingham, Washington, 15 miles south of Custer. An unmated queen was trapped on July 14, 2020, near Birch Bay, Washington, 6 miles west of Custer. A male hornet was captured in Custer on July 29, 2020. A hornet of unknown caste was reported on August 18, 2020, in Birch Bay, and another was trapped in the same area the following day.



Map of Sightings:



Spread in the United States:

- **Three hornets were seen (and two killed) southeast of Blaine on September 21 and 25, 2020, and three more were found in the same area on September 29th and 30th, prompting officials to report that attempts were underway to pinpoint and destroy a nest believed to be in the area. Officials successfully tied tiny radio trackers to three hornets with dental floss and one led them to a tree near Blaine, Wash.**



Spread in the United States:



Tracking AGH with radio trackers.



Spread in the United States:

- On October 23, 2020, the Washington State Department of Agriculture announced that a nest was found 2.5 meters (8.3 ft.) above ground in a cavity of a tree in Blaine, with dozens of hornets entering and leaving.



Asian Giant Hornets in the United States

- The nest was eradicated the next day, including the immediate discovery and removal of about 100 hornets. After further analysis, it was determined that the nest had contained about 500 live specimens, including about 200 queens. Some of these specimens were sent to the Smithsonian Institution to become a part of the NMNH Biorepository permanent cryogenic collection.

 Washington State Department of Agriculture

ASIAN GIANT HORNET NEST ERADICATION

On October 22, 2020 an Asian giant hornet nest was located on a property in Blaine, WA after using a radio tracker attached to a captured hornet. It is the first ever such nest found in the U.S.

 **Nest entrance was about 8.3 feet up in the tree.**
It was in a cavity that was about 8-9 inches in diameter.

Nest length - 14 inches

- **6 combs**
- **6 unhatched eggs**
all in the last and smallest comb
- **190 total larvae**
most had fallen out of the combs
- **112 workers**
85 were removed with a vacuum
- **9 males**
- **76 queens**
all but one should be new queens



108 capped cells with pupae
Based on size, these are likely all queens





Eradication Procedures:

- **The team wore protective suits to extract the hornets. The suits had face shields because Asian Giant Hornets have been known to spray venom that can cause debilitating eye injury that is permanent. However, in a news conference on October 26th, Sven Spichiger, managing Entomologist with the Washington State Department of Agriculture, said the cold weather made the hornets docile on the day the team eradicated the nest.**



Eradication Team Suited Up:



Preparing to Eradicate the nest near Blaine, Washington:



Eradicating the Nest:

- To get rid of the nest, the scientists jammed foam into the entrance, then covered the tree trunk with plastic wrap. The team tried to seal off the nest so that the hornets didn't have another escape route. Then a small opening in the wrap was created to put in a vacuum fixture and suck the hornets out alive into a chamber.



Eradicating the Nest:

- **The Asian Giant Hornets taken out of the nest were contained within the vacuum unit. Then carbon dioxide was pumped into the cavity in the tree to stun and kill any that remained.**



Hornets vacuumed from the nest:



Eradicating the Nest:

- The hornets were put into dry ice and kept for a number of research projects in the U.S. and other parts of the world. Some were sent to labs to be studied. Some were sent to the Smithsonian to be put in the NMNH Bio Repository permanent cryogenic collection.



Nest Site obtained for study:

- The nest site was cut out of the tree and taken to the lab for study and research.



Log and nest opened up for study:



Log and nest opened up for study:



More nests in the United States?

- **After considering the captures of individual hornets in Birch, Blaine, and Custer which were all relatively far from the discovered nest, it was announced that several undiscovered live nests were believed to exist within Washington State. However, cautious optimism was expressed by officials saying that it might still be possible to eradicate the hornets before they can become endemic to the area. A Canadian official said that although individual specimens had been found in Canada and some nests were suspected to exist there, the presence there seemed to be only in near-border regions, and the center of the invasion seemed to be in Washington State.**

More sightings:

- On November 2, 2020, one individual was found in Abbotsford, BC. As a result the BC government asked Abbotsford beekeepers and residents to report any sightings. On November 7, 2020 a queen was found in Aldergrove, BC. DNA analysis determined that the specimens collected in 2019 from British Columbia and Washington were from two different parent populations, Japanese in BC and South Korean in Washington. This suggests that two simultaneous introductions of the Asian Giant Hornet occurred in North America within about 50 miles of one another within a few months.



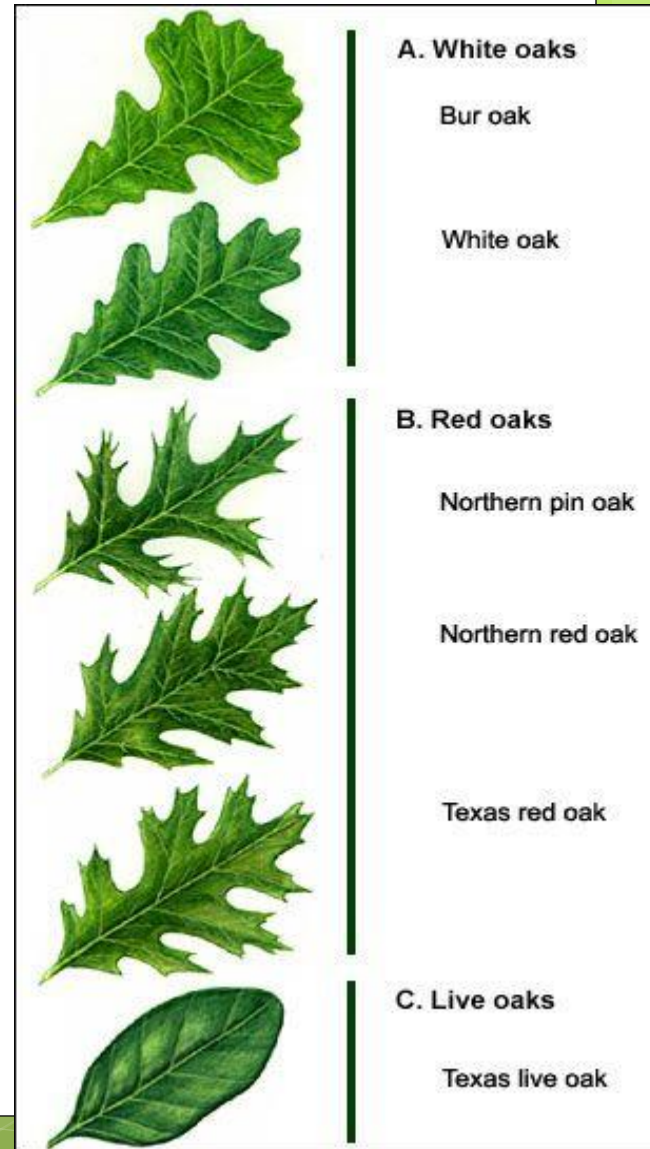
Genetic Tracing:

- How the hornets arrived in Canada and the United States remains unclear, although it is suspected that they travelled in cargo on ocean-going vessels.
- “Most likely, a single, fertile queen hornet entered Canada via shipping packaging and created the colony that was discovered in 2019, according to entomologist Akito Kawahara. More than 19,000 cargo containers arrive daily at U.S. ports, and inspectors can only do random searches of shipping containers.



Ecological Impact:

- Preventing these new hornets from becoming established in North America is important as they could have a significant impact on honeybee populations and public enjoyment of parks and forested campgrounds.
- There is little concern about whether they can expand to the colder and drier regions of Canada and no sightings have been reported yet on the East Coast. It is still unclear whether the Asian Giant Hornet can survive and propagate in the Pacific Northwest. While the mountains and temperatures may be similar to their Asian home, the types of trees that support the hornets in the early stages of their life (such as oaks) are less common in Canada's coniferous forests. The Nanaimo nest was thought to have been started by an imported, fertile queen, although time will tell if others have been able to survive over the long Canadian winter.



Control and prevention of spread:

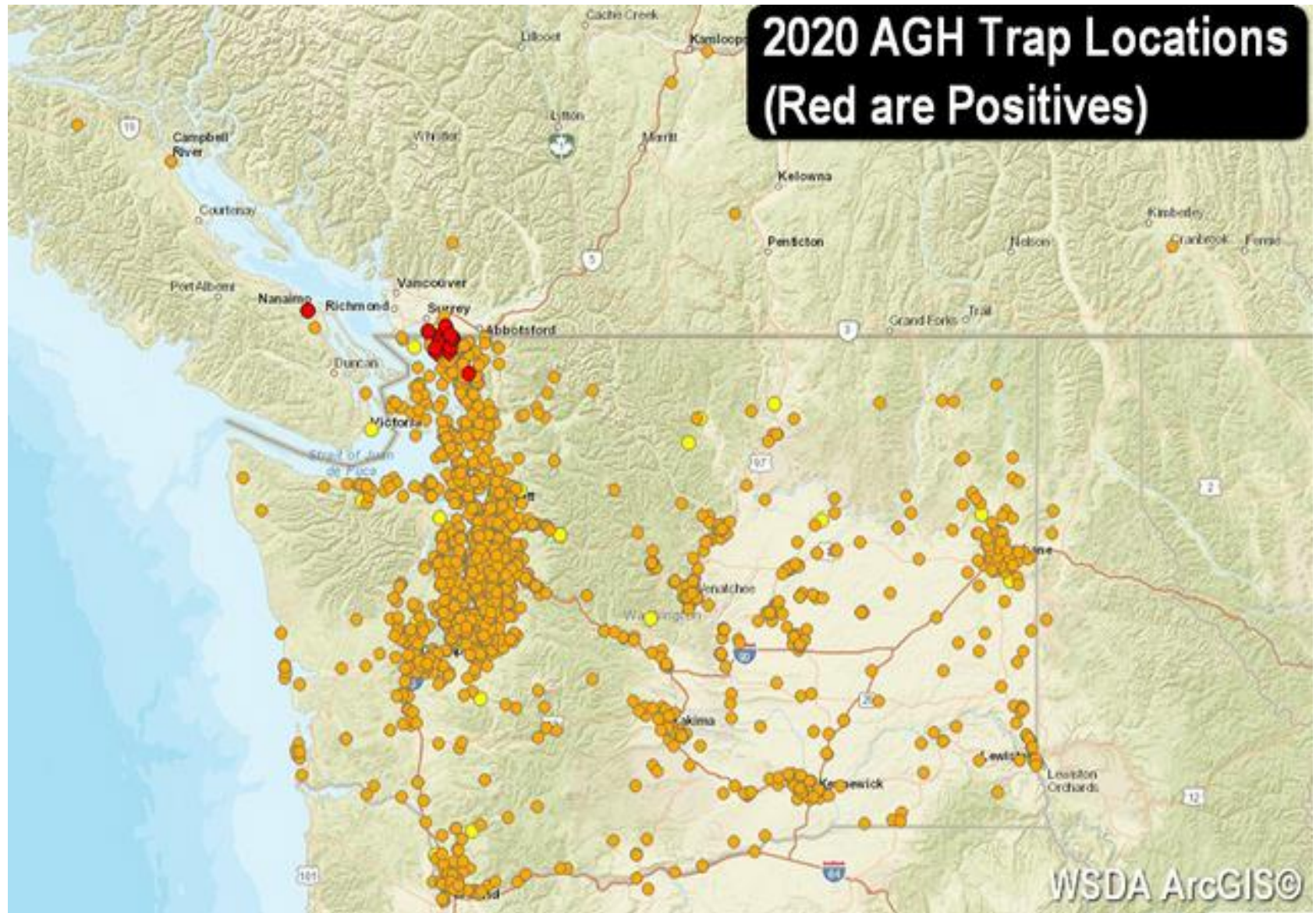
- **Vigilance is key to preventing new colonies from becoming established. Attention to cargo items where insects can hide, such as wheel wells of cars, is important and it is speculated that railway shipments could potentially spread the hornets inland as well as up the coast of the province. The province is calling on people to report sightings of Giant Asian hornets to:**
- **the Invasive Species Council of B.C. at 1-888-933-3722, via the council's Report Invasives app, or online at <https://bcinvasives.ca/report>.**
- **Washington State researchers are collecting information on Asian Giant hornet sightings through their [University Extension](#) program which supports a hornet watch report [form](#).**

Control and prevention of spread:

- The Washington State Department of Agriculture has set traps like the one below, filled with orange juice, to capture live Asian Giant Hornets. The department is also using live traps and “sentinel hives” — honeybee hives with a grate that allows bees to pass through but stops the larger hornets — to attract more hornets. The goal is to find and destroy any other nests that remain.

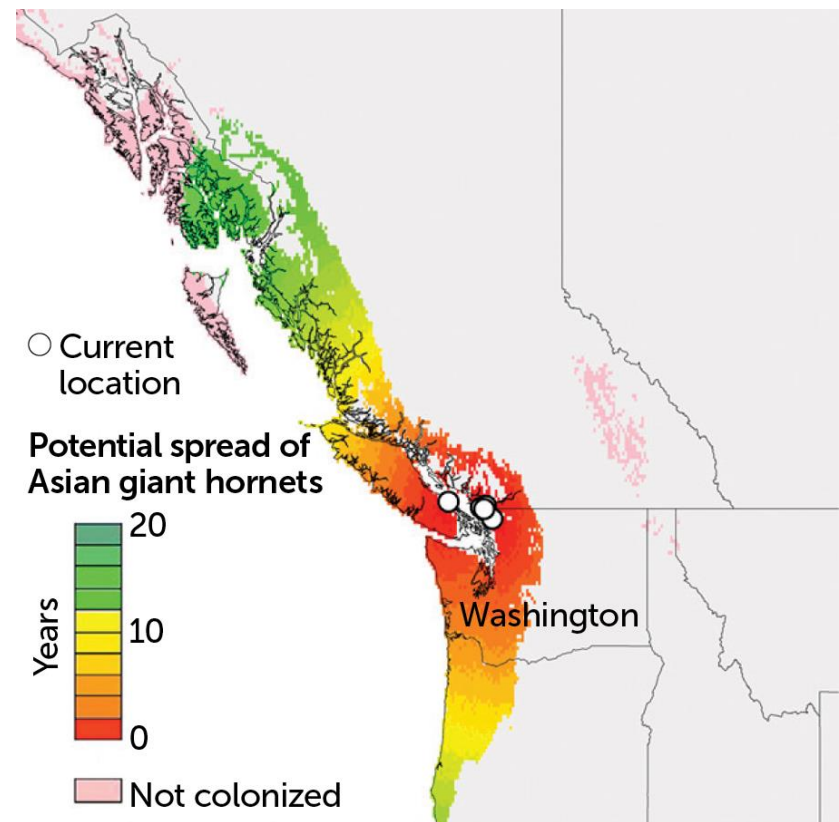


2020 AGH Trap Locations (Red are Positives)



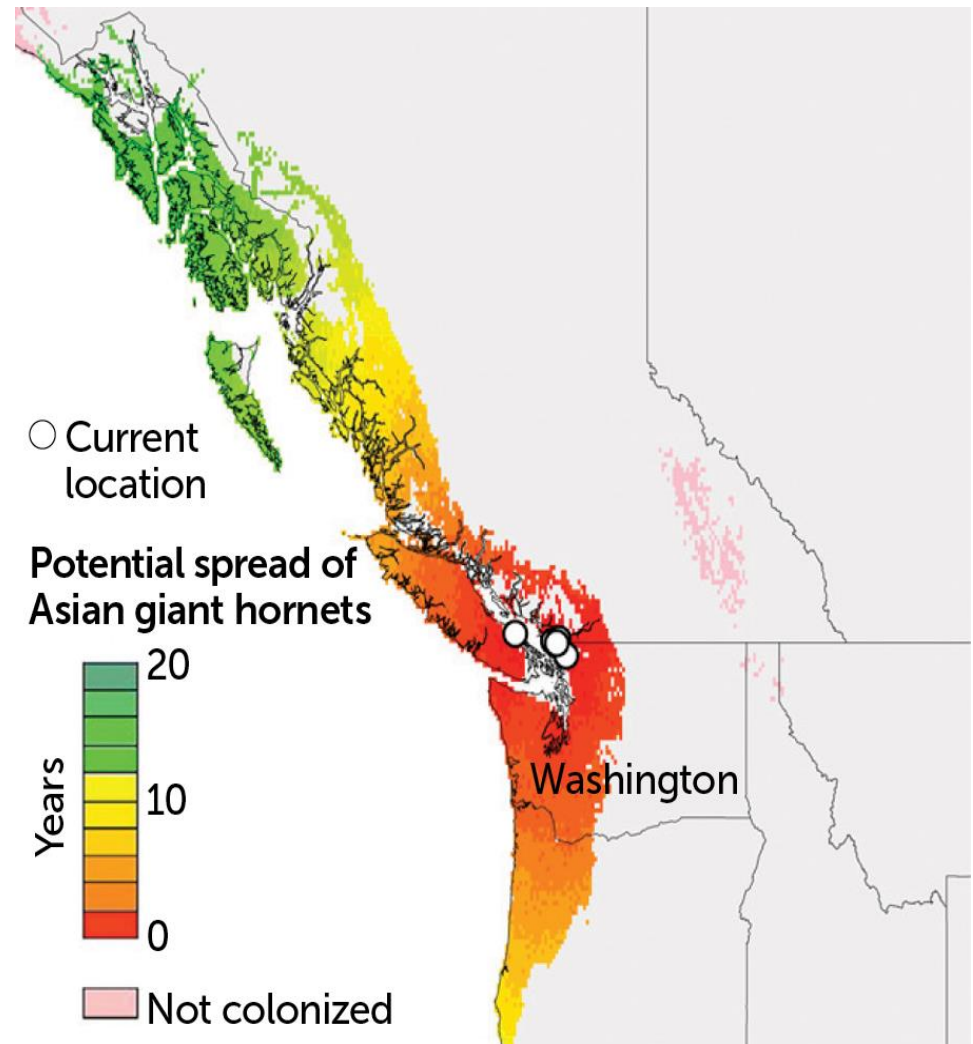
Control and prevention of spread:

- Using the known ecological niche of Asian giant hornets (*Vespa mandarinia*) and the average rate of the spread of a related species, *V. velutina*, in Europe, researchers have mapped the giant hornet's potential spread in the next 20 years, if the species isn't eradicated. The hornets have been found so far in Washington state and just across the border in British Columbia, Canada (circles). Assuming the hornets travel under their own wing power at a rate similar to or slower than *V. velutina*, giant hornets could reach southern Oregon in around 13 years.



Control and prevention of spread:

- If they spread at the maximum rate of *Vespa velutina*, as well as hitch rides on vehicles, the hornets could reach southern Oregon in about 10 years, and as far north as Glacier Bay, Alaska in about 20 years (map at right).



Control and prevention of spread:

- Asian giant hornets thrive where it's mild and rainy — and that makes large swaths of the Pacific Northwest prime real estate for them. Farther afield regions of the United States — including along the East Coast — could potentially support the hornets, but it's unlikely the insects could fly that far on their own, researchers report online September 22 in the *Proceedings of the National Academy of Sciences*.
- The mapping efforts are important because “we really don't know anything about how this species spreads,” says Chris Looney, an entomologist with Washington's agriculture department. Details like how fast the hornets can fly and how their preference for underground nests affects their potential to spread are unknown, he explains. “That's the kind of maddening lack of information that makes responding to this species so challenging.”

Control and prevention of spread:

- But by looking at what sorts of habitat conditions — including rainfall and temperature — the hornets prefer in their native range in Japan, South Korea, China and several other East Asian countries, Looney and colleagues mapped regions of the United States where the hornets might be able to survive. Then, the researchers simulated the insects' spread using information on how the Asian Giant Hornet's smaller relative, *V. velutina*, has invaded Europe. That hornet spread at an average rate of about 100 kilometers per year.

Environmental Ethics:

40 DEADLY ATTACKS IN ONE MINUTE

- The Asian hornet is nearly 2in long with a 3in wingspan – slightly smaller than the European hornet but much more aggressive

- One Asian hornet can kill 40 bees in a minute; a handful can destroy a hive of 30,000 bees in a couple of hours



- They build rugby ball-shaped nests in trees, housing some 500 hornets

- They scare off intruders by sending a lone worker hornet to 'warn' them.

If that fails, the workers attack en masse

- Worker hornets have lifespans of 30-55 days

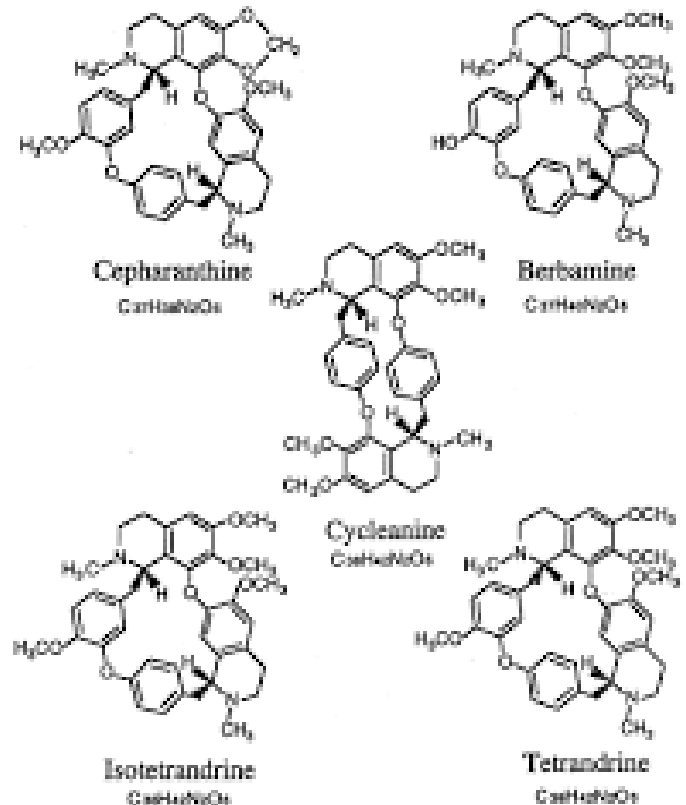
Venom:

- That stinger injects an especially potent venom that contains, like many bee and wasp venoms, a **cytolytic** peptide (specifically, a mastoparan) that can damage tissue by stimulating phospholipase action, in addition to its own phospholipase. Masato Ono, an entomologist at Tamagawa University, described the sensation of being stung as feeling "like a hot nail being driven into my leg". Besides using their stingers to inject venom, Asian Giant Hornets are apparently able to spray venom into a person's eyes under certain circumstances, with one report in 2020 from Japan of long-term damage, though the exact extent of actual visual impairment still remains unassessed.



Venom:

- The venom contains a neurotoxin called mandaratoxin, a single-chain polypeptide with a molecular weight around 20 kDa. While a single wasp cannot inject a lethal dose, multiple stings can be lethal even to people who are not allergic if the dose is sufficient; but allergy to the venom greatly increases the risk of death. Tests involving mice found that the venom falls short of being the most lethal of all wasp venom, having an LD₅₀ of 4.0 mg/kg. (In comparison, the deadliest wasp venom (at least to laboratory mice) by weight belongs to *V. luctuosa* at 1.6 mg/kg.) The potency of the *V. mandarinia* sting is due, rather, to the relatively large amount of venom injected.



Immunology:

- There is insufficient evidence to believe that prophylactic immunotherapy for the venom of other Vespidae will prevent allergic reaction to *V. mandarinia* venom, because of wide differences in venom chemistry. For more information on this check out the websites:
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5647953/>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4517515/>

Reporting:

- In Washington State only, people should report potential sightings of the AGH through the Washington State Department of Agriculture's website.
- hornets@agr.wa.gov



Reporting:

- Outside of Washington, contact your state apiary inspector. If it is safe to do so, take a photo or collect a dead specimen of the pest to help experts identify the insect. In Kansas contact:
- Jeff Vogel, Program Manager
Kansas Department of Agriculture, Plant Protection and Weed Control
1320 Research Park Drive
Manhattan, KS 66502
785-564-6700
- jeff.vogel@ks.gov <https://agriculture.ks.gov/divisions-programs/plant-protect-weed-control/export-services>

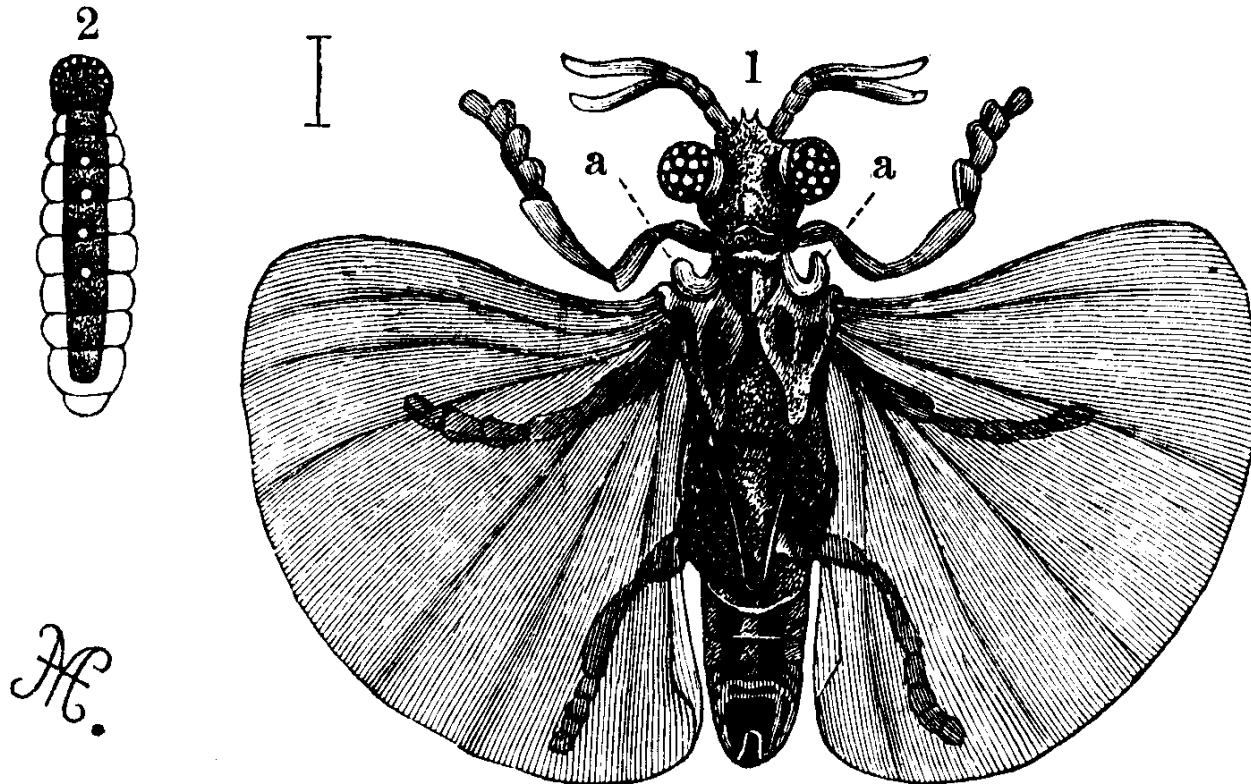
Natural Parasites of Asian Giant Hornets:

- The strepsipteran *Xenos moutoni* is a common parasite among *Vespa* species. In a study of parasites among species of *Vespa*, 4.3% of *V. mandarinia* females were parasitized. Males were not parasitized by stylopoid strepsipterans, such as *Xenos moutoni*) at all. The major consequence of being parasitized is the inability to reproduce, and stylopized queens follow the same fate as uninseminated queens. They do not search for an area to create a new colony and feed on sap until early July, when they disappear. In other species of *Vespa*, males also have a chance of being parasitized. The consequences between the two sexes are similar, as neither sex is able to reproduce.



Natural Parasites:

- https://en.wikipedia.org/wiki/Xenos_vesparum



Natural Parasites:

- **The Strepsiptera are an order of insects with nine extant families that include about 600 described species. They are endoparasites in other insects, such as bees, wasps, leafhoppers, silverfish, and cockroaches. Females of most species never emerge from the host after entering its body, finally dying inside it. The early-stage larvae do emerge because they must find an unoccupied living host, and the short-lived males must emerge to seek a receptive female in her host.**



Natural Parasites:

- Female strepsiptera embedded between the abdominal segments on a wasp.



© Dwight Kuhn

Threatened Species:

- **In it's natural habitat:**

The Asian Giant Hornet is today listed as a species that is Threatened from extinction in the near future, should the circumstances surrounding it's survival not change. Despite their dominance in their natural environments, the Asian Giant Hornet populations are being severely affected by habitat loss in certain areas, predominantly in the form of deforestation



References:

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Look Alikes:

- There are many species of wasps and bees that have similar markings to the Asian Giant Hornet. In the following slides, the Asian Giant Hornet is on the right and the “look alike” species is on the left.



Look Alike: Western Cicada Killer (*Sphecius grandis*)



Look Alike: Eastern Cicada Killer (*Sphecius speciosus*)



Look Alike: European Hornet (*Vespa crabro*)



Look Alike: Various species of Yellowjackets (*Vespula* ssp.)



Look Alike: Great Golden Digger Wasp (*Sphex ichneumoneus*)



Look Alike: Elm Sawfly (*Cimbex americana*)



Look Alike: Various species of Paper Wasps (*Polistes sp.*)



Look Alike: Bald Faced Hornet

(Dolichovespula maculata)



Look Alike: Pigeon Tremex (*Tremex columba*)



Look Alike: Yellow Bumblebee (*Bombus fervidus*)



Look Alike: European Honey Bee (*Apis mellifera*)

