SPOTLIGHT ON A SPECIES

Murder Hornets, A Reality Check

By Lynn Kimsey

The hornet genus *Vespa* contains 22 species, which are all native to Eurasia, but a few species have dispersed (with human help) to North America. Almost two centuries ago, the European hornet, *Vespa crabro*, entered the United States in New York State. It rapidly expanded its range, until today this hornet is found as far west as the Dakotas and Louisiana. European hornets are currently the largest bodied social wasps in North America, with queens reaching up to an inch or so long. Their colonies are annual, and must be started anew in the spring, very much like our native yellow jackets and paper wasps.

*Vespa* nests are built out of paper made from wood fiber mixed with saliva, very much like those of yellow jackets and bald-faced hornets. They make large, elaborate nests, with brood combs enclosed inside a paper envelope. Some species build free hanging nests others construct their nests in preexisting cavities. In temperate regions, the colonies are annual and must be founded anew every spring. In more tropical regions, they can become perennial. At their peak in the late summer or fall, colonies may contain between 700 and 1,000 workers, and this is generally when queens start producing males and young queens. Hornets in the genus *Vespa* are some of the largest bodied social wasps, with queens up to 2 inches long.

Hornets are primarily predators on other insects. The European hornet for example feeds on a wide variety of large insects, such as grasshoppers, flies, bees and even yellow jackets. However, it is relatively benign compared to the species of hornet that everyone is panicking about now. Adult hornets chew their prey into essentially meatballs, which they feed to their larvae. Adults themselves mostly feed on sugary liquids, such as nectar. However, they may also feed on their prey’s fluids. In addition, the hornet’s larvae can produce a clear, amino acid filled fluid on demand to feed their adult nest mates.

The news media has been full of scary stories about exotic hornets in the past few months. The news
MUSEUM NEWS

Coronavirus and the Museum

It has been a tough spring quarter in the Bohart Museum. The University of California has been closed to students, staff and the public since March and all of our spring classes had to be taught online. For most of us this was a big transition, but the largest impact was on laboratory classes many of which had to be cancelled. It’s not clear when we will be open in the future. Certainly not before September.

For the museum it was also a large financial hit. We rely on our outreach programs and gift shop to bring in funds to support public outreach and collection management. We have basically had no revenue for four months now and do not anticipate any additional revenue in the remainder of 2020.

We are not alone. A number of the major museums in the U.S. are feeling the impact of having to close to visitors and lay off staff.

Sorting the Library

Due to the coronavirus shutdown of the university we have had a lot of time on our hands in the museum, so we have been cleaning up all the little nests of things that we never had time to deal with before.

Over the years we’ve had many donations of specimens and personal entomological libraries, including books and reprints. This has resulted in an incredible reprint collection, but also many, many duplicates. We’ve been pulling the duplicates and sharing them with other folks, like the scientists at the California Department of Food and Agriculture.

Despite university closures, research had to continue. Earlier this year we received a contract with the California Department of Water Resources to survey the insects on four islands in the Sacramento River Delta. This work is part of a larger project to survey animals in the Delta in collaboration with the Museum of Wildlife and Conservation Biology here at UC Davis. They are surveying the birds, mammals and reptiles at these same sites.

There is very little native vegetation in the region, except in areas being restored. One recently emptied pitfall trap was found to be filled with hundreds of isopods. Its companion pitfall six feet away had none. Another pitfall trap on another island was filled with adult and larval silphid carrion beetles.

For insects, and the only site in the area that has been collected to any extent was the Antioch Dunes. However, once the dunes were made a national wildlife refuge in 1989 all insect collecting ceased.

We have been trapping since April. Each site has one Malaise trap, two pitfall traps and two blue vane traps. So far we have observed a number of odd things about the invertebrates in the region.

First, as you would expect, many of the species are exotic. Environmentally, this is a highly disturbed series of habitats transformed first by the Gold Rush and later by shipping needs and farming.

Various agencies are involved in restoring some of the habitats that we are surveying, so we are doing a comparison between the insects in restored versus unrestored habitats.

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Kimsey Memorial Day mantis.
Odd Things Insects Do

Insect Parasites of Jellyfish

Oceanic water striders in the genus *Halobates* (Family Gerridae) were first described by Eschscholz when he sailed around the world in the brig “Rurik” from 1815 to 1816. There are 46 known species but only five live on the open ocean, the rest live in shorelines associated with mangroves and other marine plants. The majority of species occur in Equatorial latitudes across the Pacific, Indian and Atlantic Oceans. We had always assumed that they fed on creatures they found on the ocean’s surface, but we came across a 1967 article by Rudolph S. Scheltem that went into more detail. Evidently, they have been found to feed on surface dwelling jelly fish including Portuguese man-of-war and sea buttons (*Porpita* species). Because they don’t kill the jelly fish they have to be considered parasites.

*Bombus bifarius*. Photo courtesy of Kathy Keatley Garvey.

Clear Lake Midge Eruptions

Clear Lake, located in Lake Co., in northern California, is notorious for its midge “blooms”. As we were going through the museum reprint collection we discovered an article written in 1949 describing the problem and the treatment. The chaoborid, *Chaoborus astictopus*, was and is a dominant inhabitant of Clear Lake. In a single season in the 1940’s the lake generated nearly one million pounds of gnats, which left the lake, flying into every nook and cranny in the surrounding towns. They would invade homes, crawl into eyes, nose and ears of inhabitants and cover every light source making driving at night like driving in a heavy snowstorm. At the time residents were concerned about treating the lake with DDT because of the importance of sport fishing for the local economy. Entomologists came up with a “safer” treatment, using the organo-chlorine insecticide Rhothane.

This treatment worked for some years and the lake has seen outbreaks but never again quite on this scale.

*Bombus bifarius*. Photo courtesy of Kathy Keatley Garvey.

Bumblebees Versus Flowers

Bumblebees turn out to have some unusual habits and sensory abilities when it comes to getting the pollen and nectar they need for their nests. Only recently a couple of publications have revealed novel observations of plant cues and bumblebee behavior. It turns out that in addition to the well known cues plants project to attract and guide pollinators to their flowers, such as colors, patterns, aromatic chemicals, local moisture and even petal texture, they are doing something heretofore unrecognized. It turns out that flowers emit electric fields that help bring bumblebees to the right flowers.

In a recent article in Science Magazine the authors reported that bumblebees are capable of detecting and learning to recognize electric fields generated by flowers to find floral resources.

Then there was the odd observation, also published in Science, that bumblebees induce plants to bloom by damaging the plant’s leaves. They found that plants injured by the bees bloomed up to 30 days earlier than those with uninjured leaves.


*Chaoborus astictopus*. Photo by Don Loarie.
stories were all based on a few interceptions of the giant Asian hornet, *Vespa mandarinia*, on the West Coast the previous fall. It seems that media coverage of coronavirus was getting old and someone in the Associated Press dug up the old stories and renamed the wasps “murder hornets”. A nest and several individuals of this hornet had been found in several sites in northwestern Washington State, near Vancouver, all within 60 miles of each other last fall. Since then two more females were found in the same region.

Only recently have any *Vespa* hornets been found on the West Coast of North America. Roughly, a decade ago a nest of *Vespa orientalis* was found near San Pedro, California. The nest, once located was destroyed, and since then there has been no sign of this species in California.

So far the giant Asian hornet has not been found in California, and that is kind of surprising. Transportation of queens during the winter in or on cargo containers seems to be the simplest way that these wasps might reach the West Coast from Asia. Consider how much cargo is shipped across the Pacific Ocean. At the Port of Long Beach alone has between 250,000 and 350,000 cargo containers come and go annually. The Port of Oakland handles more than 2.5 million containers! Even if only 1% of these containers held a queen. The potential for at least one to survive is huge.

So why aren’t they here? Its probably because California is just too dry. These wasps are adapted to humid climates, with summer rain, and a hibernating hornet traveling to California during the winter may have a hard time maintaining a healthy nest in our summers.

The giant Asian hornet is a beast by anyone’s standards. Queens can reach up to 2 inches in length. Asian hornets are somewhat more aggressive than yellow jackets and the European hornet. They have a long sting, and can deliver more venom with each sting than other hornets. A Japanese scientist described the sensation of being stung as being like “a hot nail was being driven into [his] leg”. [I think he’s been studying Justin Schmidt’s sting index] Asian hornets prey on large insects including mantises, and even more problematic, they specifically prey on honeybee colonies.

In Japan the native species of honeybees, *Apis cerana japonica*, has developed defensive behaviors to protect their colonies from the Japanese race of Asian hornets. When a hornet approaches their nest, she emits pheromones that let other hornets know what she is found. As soon as the honeybees detect the pheromones, mobs of worker bees surround the hornet in a ball. This prevents it from escaping. They then vibrate their flight muscles, raising the temperature of the inside of the ball up to 115°F, and raising the CO₂ levels in the ball. The combination of the high temperature and high CO₂ levels kill the hornet. A few honeybees will die too but it is a small price to pay. Unfortunately, western honeybees, the ones we raise in the U.S., do not have this behavior and their colonies are vulnerable to attack by Asian hornets.

There seems to be very little fear of these hornets in Asia. In fact the larvae and pupae are considered a special treat. In Japan one region celebrates a wasp or hornet festival where giant hornet larvae and pupae are served in special dishes, including stir fried, agar encased and sushi topped with larvae. Other parts of Asia also serve giant hornets as regular food. Matan Shelomi, an assistant professor at the University of Taiwan, who was a graduate student in the Bohart, posted photos of giant hornet dishes he’s eaten, with the comment that the larvae and pupae taste like French fries. Therefore, if giant hornets invade California, it will be time to pull out the deep fat fryer!
What you are looking at is a living fossil. This is the farthest an insect can get from being an insect. No, it’s not a shrimp. This is a jumping bristletail, order Archaeognatha. If you know about phylogenetic trees, this insect is the sister group to all other insects! In the tiny bit of fossil record we have, jumping bristletails are believed to be the LEAST evolutionarily changed insect of ALL insects, making it a relic of the common ancestor of the Insecta. This common ancestor is believed to have arisen about 400 million years ago!

The jumping bristletail’s morphology reflects its evolutionary relationships. In the photos you can see the “legs” all down its abdomen. It does have six main legs, as all insects have, but it also has many reduced legs/leglets along its body, evidence that insects evolved from a worm-like creature with legs on EACH segment of its body. Over time, insects saw more and more of a reduction in these legs, and evolved 6 main legs. Even more interesting, this jumping bristletail barely has a distinction between its head, thorax, and abdomen. Its body is more worm-like than insect-like. It doesn’t have wings, as wings evolved much later. All of the things we are used to seeing in the more “modern” lineages of insects, are absent in jumping bristletail. So why hasn’t this insect changed much since the middle Devonian period? It seems wild that insects like wasps and bees, with eusocial behavior, bright coloration and defense mechanisms, cryptism, parasitism, and complete metamorphosis, have evolved to be so different from their ancient ancestors…and yet this jumping bristletail has barely changed a bit in comparison! I guess these insects were successful with this body form and life history, and managed to remain practically unaltered by environmental pressures for millions and millions of years.

Gwen is an Entomology major here at UC Davis.

Jumping bristletail face on above and side view to the right. Photos by Gwen Erdosh.
California has a long, checkered history of invasions by exotic species of plants and animals, ranging from annual grasses to earthworms, nearly all facilitated by humans. Today, the majority of invertebrates found in urban and suburban habitats are exotic, including the pollinators, millipedes, slugs, sow bugs, pill bugs, earthworms and most indoor spiders. Exotic species established in the state now number in the hundreds. The vast majority of these animals are pre-adapted to live with us because humans create disturbed or unstable habitats, which we fill with exotic plants.

In a few cases, exotic insects may actually provide ecosystem services in human modified environments. Honey bees were first introduced by the Spanish in the 16th century. Today they are critically important for our food supply. Roughly 60% of our food crops are pollinated by honey bees. Yet honey bees are now threatened by diseases, pathogens and parasites also inadvertently introduced into the Americas. Much as most of us dislike finding spiders and spider webs in our homes, these indoor spiders probably eliminate a large number of mosquitoes and pantry pests that find their ways inside.

In the late 1980’s the first specimens of the European yellow jacket, *Vespula germanica*, were found in the state, and not long afterwards, the European paper wasp, *Polistes dominula*, also appeared. The European yellow jacket does not seem to be competing successfully with our native yellow jacket, *Vespula pensylvanica*, and has remained uncommon. Despite being widespread, the European paper wasp seems to be largely restricted to urban and suburban habitats. Both of these vespids are predatory, particularly on urban pest insects.

One serious consequence of our habitat modifications and concurrent invasions of non-native invertebrates and plants are their effects on pollinators. Native bees are becoming increasingly scarce. It is no wonder, we surround ourselves with non-native plants. These may or may not be visited by any bees except honey bees, which are also exotic. Then to further the disruption, we cover bare soil with mulches, gravel or wood chips, leaving few if any sites for native bees and wasps to nest, as the vast majority nest in the ground.

Not all introductions succeed. Over the years we have had a succession of species introduced, become hugely abundant and then essentially disappear. This seems to have happened to the wool carder bee, *Anthidium manicatum*, for example. It was first observed in our region in 2007. By 2014 it was very abundant in gardens in Davis. However, by 2020 it has virtually disappeared from Davis.

The ash whitefly, *Siphonius phillyreae*, is another example of an exotic insect that became incredibly abundant, with a wide range of host plants. It was considered a major pest, but today it is hard to find.

Nature has a way of finding balance despite our best efforts.

How invasive insects get here also varies depending on changing modes of human transportation over the centuries. When the Spanish first came to the West Coast in the 1500’s, their sailing vessels transported insects and other exotic species that could survive onboard either as adults, or their resting stages. Livestock, and seeds in the on-board feed they brought to the West Coast gave us the iconic golden hills of summer now so characteristic of California. They are ironically not natural landscapes at all. The introduction of horses brought *Fannia* and houseflies. During the slave trade, sailing ships probably brought such fun insects as American cockroaches and the yellow fever mosquito to the Americas from West Africa. Transportation of soil, trees and shrubs led to the colonization of the state by earthworms, earwigs, millipedes and even amphipods (often called lawn shrimp).

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Nature has a way of finding balance despite our best efforts.
ASK THE BUG DOCTOR

If you have an insect question, need advice, want an identification of something you’ve found, or would like to see an article in the newsletter on a particular topic let us know. Email us at bmuseum@ucdavis.edu.

Smallest Leafhopper

As we sorted through reprints in the museum library Steve came across an article by E.D. Ball published in 1921 on the smallest known leaf hopper, *Idona* (originally as *Empoasca* minuenda). This leaf hopper discovered on avocado in Florida reached a maximum length of 2 mm! Ball felt that it was probably an exotic introduction but its not clear from where. More recently its been found on Brazilian peppertree, *Schinus terebinthifolia*, in southern California and Baja Mexico.

Oops, Its Not a Murder Hornet

Entomologists have been sent a variety of photos of creatures thought to be giant Asian hornets. An example of one of these is shown above. The best “hornet” by far was a photo sent to Chris Looney, in the Washington State Dept. of Agriculture of... dog vomit. The sender claimed his dog had eaten a hornet. According to Chris it just looked like grass to him. We’ve also received photos of male valley carpenter bees, and hornet images taken from on-line as supposedly observed in parts of California.

Bat Evasion by Insects

Bats feed on insects, and as a consequence insects have developed a variety of methods to avoid them. Quite a number of moths have the equivalent of an eardrum on either side of the base of their abdomen. They use this to hear approaching bats and either change their flight behavior as appropriate or drop out of the air.

In a recent study published in the Philosophical Transactions of the Royal Society the authors found that sword-tailed crickets in Panama do something similar. They monitor bat calls and stop mid-flight, dropping out of the air when bats approach.

Another Giant Hornet?

Another giant hornet was reported to us by a resident of Sebastopol, California. Instead it turned out to be a rarely seen, but really impressive cimbicid sawfly.

World’s Oldest Bug

One of the problems with terms like “bugs” is that they can apply to a wide range of organisms, ranging from bacteria to insects. In the case of the recently reported world’s oldest bug, the creature in question is a 425 million year old millipede, *Kampecaris obanensis*. This millipede fossil from the late Silurian is older than any other insect or arachnid fossils. It was discovered on the Scottish island of Kerrera.

In yet another twist on evading bats, a study published in February in the Royal Society Interface found that two species of silk moths, which lack these eardrum-like structures, instead have sound absorbing scales on their body that are structurally similar to fibers used in noise insulation. They found that these scales can absorb up to 85% of the incoming sound energy from bats.
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