

# Biology and Controls of the Asian Hornet

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*To better understand how we can tackle Asian hornet control, we need to know something of their biology. Eric Darrouzet reminds us of the important aspects of Asian hornet biology and describes measures taken in France to control Asian hornet spread.*

## **An orange and black hornet**

The invasive Asian, yellow-legged, hornet, *Vespa velutina nigrithorax*, is easily distinguishable from the European hornet, *Vespa crabro*. The invasive hornet is smaller than the local hornet. Its thorax is brown-black, and the abdominal segments are brown with a small yellow-orange line. Typically, the fourth segment has a large orange strip in dorsal position. The legs of *V. velutina* are yellow (hence its name). Its head is black with an orange face. The European hornet, *V. crabro*, has a yellow and black abdomen with brown legs.

## **The European spread of the yellow-legged hornet**

The yellow-legged hornet is an exotic Vespidae species, which successfully arrived and established itself in Europe. It was first observed in southwestern France in 2004, and the first individual hornet was identified in 2005. The hypothesis is a probable introduction of hornets via bonsai pots imported from China. According to genetic analyses, these insects came from the eastern Chinese provinces of Jiangsu and Zhejiang (near

Shanghai). These genetic analyses demonstrated that very few or just one queen was introduced into France. During fourteen years, the species has very quickly expanded its range in France and in neighbouring European countries. In 2018, the yellow-legged hornet covers more than 80% of France. It is also present in Spain, Portugal, Italy, Switzerland, Germany, Belgium, Netherlands and the United Kingdom. A large part of Europe seems to be suitable for the species' establishment, and it could increase in the future, given various climate change scenarios.

The species seems to possess the capacity to spread in a large area. In France, the yellow-legged hornet spreads at a rate of around 100 km/year, and some nests have been found more than 200 km from the invasion front. Recently, researchers demonstrated that some French locations at which infestations were observed in 2009 were the result of long-distance dispersal capacities of individuals. Distinguishing between dispersal patterns caused by self-mediated flight versus those caused by human-mediated transport is a challenge, because the hornet can fly very long distances. Gynes (reproductive females destined to become future queens and to found new colonies) can fly an average of 18 km/day and can cover up to 200 km over ten days in 'flight experiments'.

## **What is the problem?**

At present, France seems to be the most infested country in Europe, and could be a good example to analyse the problems linked to *V. velutina*. The hornet invasion in this country has three main negative impacts.

1. The species preys on several insect and arthropod taxa, thus potentially affecting local biodiversity. The European situation of entomofauna is clearly not positive, and in such situations, adding a new negative impact on insects with a generalist predator such as *V. velutina* is a major



*Vespa velutina* worker. All photos are copyright of E. Darrouzet (University of Tours, France).



*Vespa velutina* queen building her nest.

problem. However, this point is not yet scientifically demonstrated. Nevertheless, according to the great number of colonies observed in France, consequences on insect preys could be very important.

2. *V. velutina* is a predator of the domestic honey bee, *Apis mellifera*, and could induce economic losses via the destruction of bee colonies. This impact is historically observed by French beekeepers. However, other economic impacts could be observed. Technicians who work in parks and gardens or others who work on roofs could be in contact with hornet colonies. This confrontation could induce accidents which is the third problem. In market places, merchants who sell fish or meat, are sometimes seeing quantities of hornets on their products. This presence is a stress for customers. Consequently, the number of customers decrease, and thus the merchant turnover too. Hornets could also be found on grapes. They cause the fruits to deteriorate and consequently decrease wine production and quality. They are also a risk for harvesters.
3. These hornets present a risk to human health. Accidents have occurred, some fatal, in general when people have inadvertently approached hornet nests.

### The life cycle and biology of *V. velutina*

New colonies of *V. velutina* are established in the spring by mated queens, after the over-wintering period. Colonies first pass through a period in which an increasingly large number of workers are produced in order to ensure colony growth. Workers do not reproduce and perform all the tasks necessary for the colony (food collection, building materials collection to develop the nest, brood feeding, nest defence, etc.). Colonies then produce sexual individuals (males and gynes) at the end of the summer. These reproductive individuals emerge between late August and November and leave their nests for reproductive flights. After copulation, the gynes disperse and the males die. The queen mother dies in November and consequently the colony decreases over time. After Christmas, in general, nests are empty. Nevertheless, some nests with living individuals have been observed in France in January, probably thanks to mild temperatures. Only gynes can survive to the winter, and some of them start new colonies in the following spring.

### Natural controls

In 2015, French scientists showed that several *V. velutina* colonies produced 'early males' i.e. males produced before the end of August. The large majority of these early males were diploid males. They were produced throughout the life of the colony. This result strongly suggests the occurrence of inbreeding in this species in



Classical *Vespa velutina* nest in a top of a tree.

France. This hypothesis was supported by genetic analyses. The authors suggested that the Asian yellow-legged hornet population in France was derived from a single introduction event, and they showed evidence of a strong founder effect. Thus the French population sampled in that study suffered a notable loss of genetic diversity compared to native populations in China. These diploid males are produced in place of workers or gynes. Consequently, it is possible that their production affects (1) the colonial activity and fitness, as fewer workers are present (diploid males are produced in place of workers), and (2) the number of gynes produced (these males are produced in place of gynes) and, perhaps, the number of nest foundations the following year. Moreover, if these diploid males mate with gynes, these mated females will produce triploid and sterile progenies. Scientists are analysing the possible consequences of this.

Other natural controls could occur. While introduced species often leave behind their natural enemies in their home area, which benefits them in their new environment, they can also suffer the effects of local recruitment of new natural enemies. Since its arrival in Europe, *V. velutina* has been confronted with several native species as predators, parasites, parasitoids, virus and bacteria. The hornet workers could be the prey of different bird species, such as the European bee-eater. However, the quantity of workers collected by birds is not sufficient to affect colonies. In spring, *V. velutina* queens can be parasitized by parasitoids, as *Conops vesicularis* (Conopidae). Such parasitized queens have died, resulting in the failure of their colonies. Developing larvae were not fed, and thus died. *C. vesicularis* is a parasitoid species that naturally occurs in Europe. Another native enemy, the European parasitic nematode *Pheromermis vesparum*, can parasitize some workers. This nematode is known to be a parasite of social wasps in Europe. Nevertheless, these different enemies seem to not control efficiently the invasive hornet.



Honey bee worker caught and killed by a *Vespa velutina* worker. The hornet keeps only the prey's thorax for its proteins to feed the hornet larvae in the colony.

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Picture 5: A large number of hornet workers, which predate honey bees in front of their colony.

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There is one more photo to come

### Human control measures are necessary

When the yellow-legged hornet was detected in France, beekeepers, among others, became worried about the possible impact the species could have on honey bees and they tried to eliminate it by removing and destroying its nests. However, the main problem for such control is that of locating nests. At the present time in France, no efficient tools are available for such a purpose. Different scientific projects to locate nests were thus proposed: to test drones with thermic cameras on board, to label hornet workers with RFID tags or to use harmonic radar to follow

*“Only gynes (reproductive females) can survive to the winter, and some of them start new colonies in the following spring.”*

them when they return to their nest, etc. However, very few grants were available to fund these tests. Control measures are generally performed with traps using food baits (sugars or proteins). However, they remain inefficient and do not exclusively target the yellow-legged hornet. Mass trapping using food baits could have negative impacts on native entomofauna, and it is uncertain how much it would truly affect the yellow-legged hornet. Due to the hornet's rapid range expansion in Europe and the threat it poses, there is an increasing demand for effective control measures. A mathematic model was developed, which demonstrated the importance of such control measures to decrease European population of *V. velutina* and its impacts. It seems difficult now to eradicate this invasive species in Europe but, if we want to control this hornet by using traps, it is necessary to protect our biodiversity. We must, therefore, develop selective and efficient traps. For example, for some years, scientists in the University of Tours in France, have been developing selective traps by using chemical/pheromone baits (alarm pheromone, sex pheromone, and chemical signature) and, in a few years, these traps will be commercially available.

*“Despite being faced with new, local enemies, such as parasites, Asian hornets have been resistant to control. Human control measures are necessary.”*