

The Asian Yellow-legged Hornet: the implacable advance of a bee-killer

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The Asian Yellow-legged Hornet nest that was discovered in Gloucestershire in 2016. National Bee Unit

The Asian Yellow-legged Hornet *Vespa velutina*, known also as the Asian Hornet, is among the most harmful of all the invasive species listed by the European Union. A relatively recent arrival from China, it is of concern chiefly because of its likely impact on the European Honeybee *Apis mellifera*. The newly arrived insect was first spotted in Europe in 2004, near Agen, between Bordeaux and Toulouse, in south-west France. The European population's starting point appears to have been when a single female mated with four males (Arca et al. 2015); it is striking that the enormous numbers now present – there are probably more than 50,000 nests in France alone – appear not to have suffered because of this genetic bottleneck. The insect rapidly colonised several other countries, including Spain, where it has reached the island of Mallorca, Portugal, Italy, Germany and, more recently, Belgium and Switzerland. It was officially recorded in the Netherlands for the first time in summer 2017. The first confirmed UK sighting occurred in 2016, in Gloucestershire, with a second a year later in

north Devon. Both UK records resulted in the discovery of nests, which were subsequently destroyed. Sightings have been reported also from the Channel Islands; the first in the British Isles was on Alderney in 2016, with several more nests discovered in the following summer on both Guernsey and Jersey.

Ecological impact

The hornet forms a large colony, founded by a single queen, which begins laying its eggs in April and produces thousands of individuals each year. A huge amount of protein is required in order to feed the larvae during the colony's growth, and this is obtained mainly from other arthropods, including honeybees, the latter comprising one-third to two-thirds of the hornet's diet, depending on the environment (Villemant et al. 2011). Wild pollinators clearly must suffer, but we are sorely lacking in reliable data. More research has been conducted on the highly predatory Asian Yellow-legged Hornet's effect on commercial apiaries, where workers hunt during the summer, typically



Hornet larvae inside the nest. Karine Monceau

hovering, or ‘hawking’, near a hive entrance and catching returning honeybees by hooking them with their front legs (Monceau et al. 2013a). They then cut the captured bodies into pieces, extracting sugars by licking the haemolymph (a fluid equivalent in most invertebrates to blood) before discarding all but the thorax, which is carried back and fed to the larvae in order to provide them with protein. In Asia, the insect preys largely on the Asian Honeybee *Apis cerana* and on the European Honeybee, which has been introduced there (Ken et al. 2005; Yang 2005).

Asian Honeybees (known also as Eastern Honeybees) defend their colonies from raiding hornets by deploying a so-called ‘bee-carpet’, in which large numbers mass at the entrance of a hive as a deterrent, or by ‘heat-balling’, whereby they engulf the predator, making its body temperature rise to a lethal level (Ken et al. 2005; Tan et al. 2007, 2010, 2012, 2013). Massed honeybees also sometimes

Asian Yellow-legged Hornet workers hawking outside a honeybee hive in France. Karine Monceau



synchronously wobble their abdomens as a visual warning, a behaviour known as ‘shimmering’. European Honeybees cannot defend themselves as effectively against attacks by hornets; they do sometimes display the bee-carpet reaction, but their attempts at heat-balling are nowhere near so efficient as those of their Asian counterparts (Arca et al. 2014). The mere presence of Asian Yellow-legged Hornets is a significant source of stress to the bees, resulting in reduced foraging by workers from attacked hives, with obvious consequences for the survival of colonies over winter (Arca 2012) and, probably, reducing the ability of attacked bees to learn the scent of, and thus avoid, the predators (Wang et al. 2016). This stress may also interact with the negative effects of neonicotinoid pesticides, further reducing a bee’s ability to avoid predators (Tan et al. 2014).

The Asian hornet may, in addition, be a vector of pathogens such as Israeli Acute Paralysis Virus, which infects European Honeybees in China and in France (Blanchard et al. 2008; Yañez et al. 2012). Finally, the Asian Yellow-legged Hornet is potentially a direct competitor of the native European Hornet *Vespa crabro*, the latter being a predator of many common farmland pests, although early studies have yet to find clear evidence of the occurrence of such competition (Monceau et al. 2015b).

Economic impact

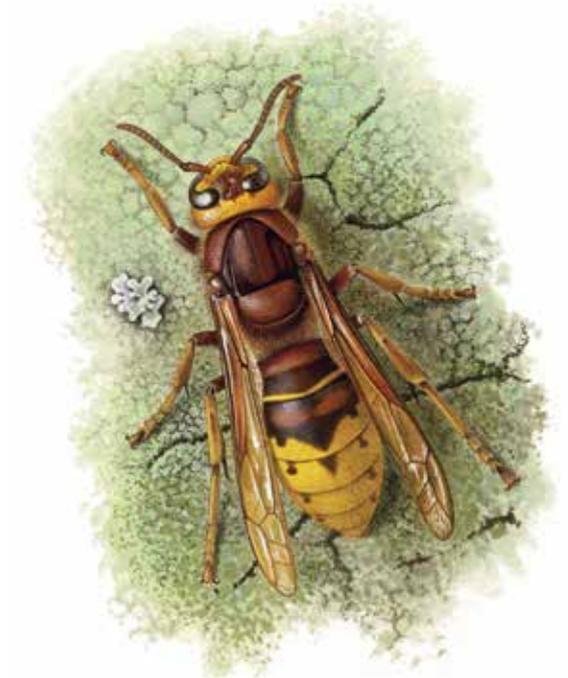
Beekeeping has in the last few decades suffered several crises, these caused by such factors as the use of pesticides, the Varroa Mite *Varroa destructor*, the parasitic microsporidian *Nosema apis* (the pathogen responsible for the disease nosemosis), and agricultural change, all of which

Queen



Asian Yellow-legged Hornet
Vespa velutina

Queen



European Hornet
Vespa crabro

Queen



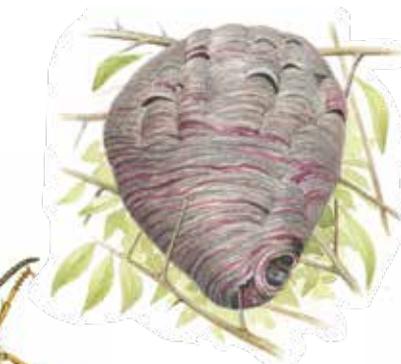
Common Wasp
Vespula vulgaris

Queen



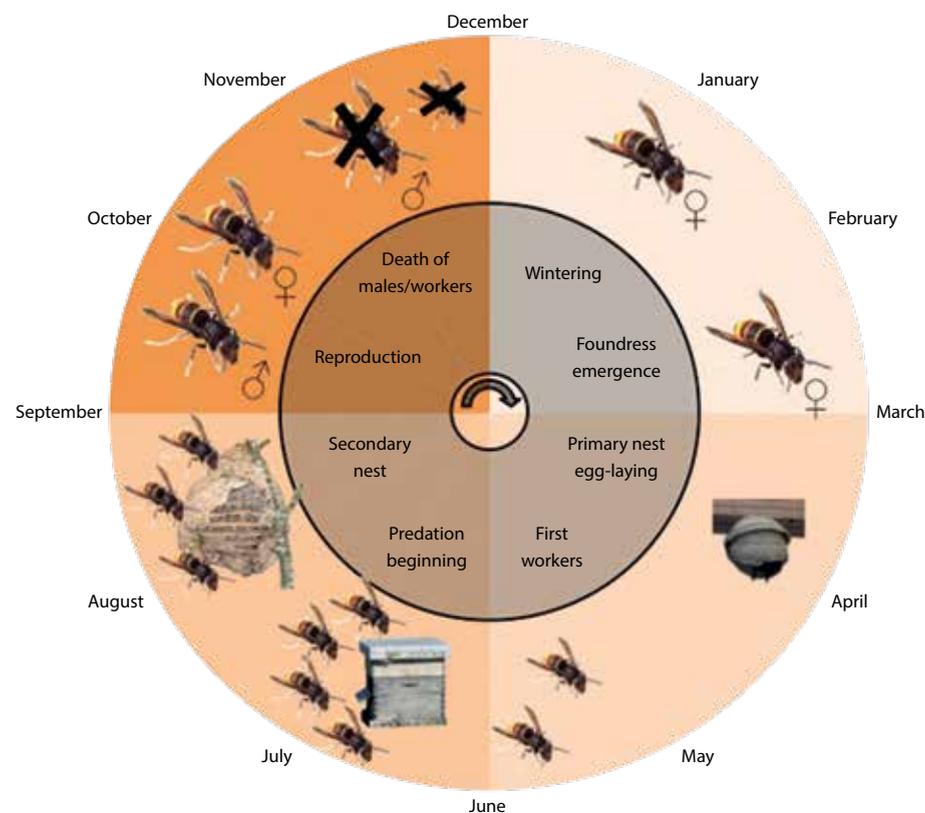
Median Wasp
Dolichovespula media

Worker



Nest of
Median Wasp

The Asian Yellow-legged Hornet is smaller and darker than the European Hornet, and the largely black abdomen, thorax, and top of head help to identify the Asian species. The Asian Hornet is considerably larger and darker than the Common Wasp and similar species, but could potentially be confused with the Median Wasp; the thorax of the wasp, however, has characteristic yellow ‘tick’ marks, while in the hornet it is plain black. The nest of the Median Wasp is superficially similar to that of the Asian Hornet, but is much smaller and is typically constructed lower down in bushes, rather than high in the canopy.
Richard Lewington



A diagram illustrating the annual life cycle of the Asian Yellow-legged Hornet. Karine Monceau & Denis Thiéry

have weakened honeybee colonies. The Asian Yellow-legged Hornet adds yet another problem, although its effects are difficult to separate from those of the others. While beekeepers in south-west France have reported losses of up to 30%, probably from multiple causes, there has been no appropriate assessment of the hornet's overall impact on honey production. Nest removal can also be costly for land owners, as private pest control companies charge several hundred euros for each nest that they destroy.

The impact on human health

While the male Asian Yellow-legged Hornet may bite to defend itself, it is only the female that can sting. As a member of the Vespidae – the family that includes nearly all known social wasps – it can, unlike honeybees, sting several times. In its native range it is considered highly aggressive (Martin 1995), but this seems not to be the case in Europe; nevertheless, it is aggressive near its nests and will actively defend them from intruders. In

France, analysis of the number of annual incidents of human envenomation by bees and wasps has failed to find evidence of any increase in the years since this species arrived in the country (de Haro et al. 2010). Its sting is more serious than a bee's and people have suffered anaphylactic shock because of multiple stings, leading to roughly 20 deaths in mainland Europe. Although the species is, so far, extremely rare in the UK, there have been several reports about 'killer Asian hornets' in the media, even if, in virtually every case, what had actually been seen was a native European Hornet. Confusion also arises from the term 'Asian hornet', which in fact covers 22 species of hornet found in Asia, including the European Hornet, the Oriental Hornet *V. orientalis*, and the Asian Giant Hornet *V. mandarinia* and its subspecies the Japanese Giant Hornet *V. m. japonica*. The last-mentioned, known in colloquial Japanese as the Giant Sparrow Bee, is able to destroy a honeybee hive within a few hours, and has been responsible for attacks on humans in Japan and China (Ono et al. 2003).

What should be done?

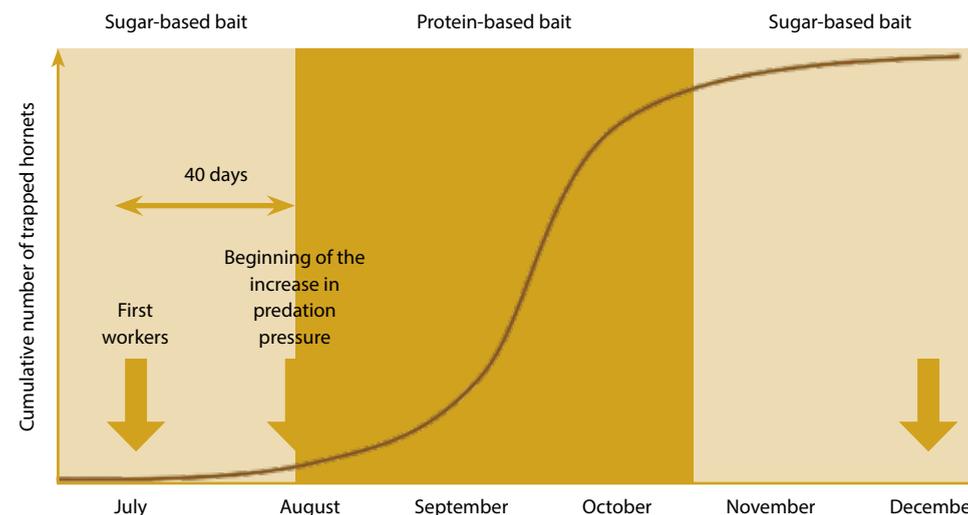
After 13 years in Europe, the invasive hornet has become a real concern in many countries. As the 'invasion' expands, the cost of management increases dramatically (Simberloff et al. 2013), and the cheapest, most effective way of dealing with the problem therefore is to take immediate action to stop the insect's advance before it becomes established. In the UK, an early report of workers preying on honeybees near Tetbury, in Gloucestershire, in 2016 enabled officials from the National Bee Unit quickly to locate and destroy the nest (Defra 2016). Everyone should be aware of the risk and should report sightings to the GB Invasive Non-native Species Secretariat. Recent simulations suggest that most of the UK could be colonised within two decades, once nesting is established (Keeling et al. 2017). Unfortunately, in France, the country with the largest population of the Asian Yellow-legged Hornet in Europe, none of the control techniques (below) has been able to stop this invasive species' advance.

Trapping

Trapping is a classic control method, one which can be performed at different times in the year in order to target different stages in the Asian Yellow-legged Hornet's life cycle. Traps can be set in spring to catch queens and in the summer and autumn to catch workers and emerging gynes, those females

destined to become queens (Monceau et al. 2014). To date, only traps baited with food have been used, a technique that has attracted controversy because it is not specific to a single species, and is especially problematic when trapping queens in spring. In fact, queens represent only a small percentage of overall catches, which comprise chiefly flies and butterflies (Monceau et al. 2012). In addition, there is little evidence on the efficacy of this method (Monceau & Thiéry 2017); an assessment of the true impact and efficiency of the spring trapping of queens needs to be carried out as a matter of urgency. During a colony's growth, trapping by means of either sugar-based baits in June, July and October or protein-based baits, usually fish, in August can locally decrease predation pressure in apiaries (Monceau et al. 2013a, 2015a, 2015b). This type of trapping has limited side-effects on local insect populations because these are made up predominantly of honeybees, which are not attracted by the traps. Toxic baits, such as growth-inhibitors and insecticides, have also been tested but, in the absence of a specific bait targeted at the Asian Yellow-legged Hornet, these should be avoided because of the effect that they could have on the health of honeybees, and wider concerns about the environmental impacts of pesticides. This problem could, however, be solved by using pheromones as species-specific mediators. Recent studies have revealed the presence in the antennal lobe of male Asian Yellow-legged Hornets of

A graph showing the number of hornets captured in traps with different baits at different points in the workers' flight season. Karine Monceau & Denis Thiéry



several macromolecules that could be linked to sex pheromones (Couto et al. 2016). A recent study by Wen et al. (2017) identified sex pheromones from the Asian Hornet, and these should be tested for use in trapping devices.

Natural enemies

Asian Yellow-legged Hornets in Europe may host a number of different pathogens. Darrouzet et al. (2015) and Villemant et al. (2015), respectively, found a parasitic fly (Conopidae) and a nematode that kills the hornets. The fly, however, is unlikely to be used as a biological control because it is a generalist parasitoid (something which eventually kills rather than only parasitising the host) of social wasps, sawflies, bees and ants. Several entomopathogenic (capable of causing disease in insects) fungi – *Beauveria bassiana* and *Metarhizium* strains – can efficiently infect and kill workers (Poidatz et al. in press); a queen trapped in the UK was found to be naturally infected by a *Beauveria* species. Natural predators include the Eurasian Jay *Garrulus glandarius*, the European Bee-eater *Merops apiaster* and the Badger *Meles meles*. Honey-buzzards *Pernis apivorus* are specialist predators of insects such as these, having scale-like feathers around their bill and eyes to prevent stings, and one has been observed feeding at an Asian Yellow-legged Hornet's nest near Bordeaux (Monceau et al. 2014). The European Bee-eater and the Honey-buzzard are both rarities in the UK, so the potential for biological control by these natural enemies is restricted, but more predators will surely emerge; domestic chickens foraging in apiaries, for example, are known to eat hornet workers.

Nest destruction

Nest destruction is probably the most effective control method, because it ensures the destruction of the colony (Thomas 1960; Spradbery 1973; Hölldobler & Wilson 2008). Before the emergence of the first workers in the spring, the nest, coloured grey, is no larger than a golf ball, and thus almost impossible to detect. Later in the cycle, the much larger nests, which can be up to 80cm in diameter, are often at the tops of the trees and are well camouflaged until the leaves fall. At Woolacombe, in north Devon, where a nest was discovered in September 2017, bee-inspectors followed the flying direction of workers from different apiaries and

found the nest where the flight paths intersected. At the time of writing, however, it is too early to know whether the destroyed colony was the only one in the area. Early detection methods using harmonic radars are being studied (Milanesio et al. 2016, 2017), as is nest destruction by means of drones. A drone belonging to the Jersey Fire and Rescue Service was this summer reported to have been attacked by a swarm of Asian Yellow-legged Hornets as it was used to investigate a nest.

In 2016, at least one female, either actively, by flying across the English Channel, or passively, by hitching a lift on a boat or vehicle, arrived in the UK and founded a nest, which was destroyed. In the following year, a second nest was also destroyed, one hopes before reproduction took place, but the origin of the queen is uncertain: was it another one that came from across the Channel, or could it be a descendant from the 2016 nest in Gloucestershire? It remains particularly important, therefore, that people react at an early stage and contain any invasion before a colony can become established. We believe that the experience in other invaded countries, more precisely the lack of a quick reaction, should serve as an example of how not to do it. The French government took about eight years before legislating on this species, by which point eradication was impossible. The Asian Yellow-legged Hornet is among 37 alien species listed by the EU as harmful to native biodiversity, and we believe that the most effective way of tackling this problem is at a European level. The UK should monitor its beehives closely, destroy Asian Yellow-legged Hornet nests where and when it can, and be aware that if this fails the next step will be to learn to live with this invader.

References

For details of references, see <https://britishwildlife.com/site/suppl-dec-17-hornet>.

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