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INSECTS

The Asian hornet threat

The Asian hornet, *Vespa velutina*, would not have caused any comment in Europe until a chance event in 2004, when an over-wintering queen arrived in south-west France in a consignment of garden porcelain from China.

Two questions are commonly asked. First, what is the difference between a bee and a wasp or hornet? By and large, bees are vegetarian and wasps and hornets are carnivores. Bees collect nectar for carbohydrates and pollen for protein; wasps and hornets eat other insects, although they will find nectar or steal honey for fuel.

Second, what is the difference between a wasp and a hornet? The general public refer to a non-hairy, slim stinging insect as a wasp (whereas a bee is more rounded and hairy); hornets tend to be bigger – at least two centimetres in length. There are some precise anatomical differences too – the distance between the ocelli and the back of the head is greater in hornets and the relationship between the ocelli and the compound eyes.

Wasps and hornets belong to the family Vespinae and have 19 species in the cavity nest group (Vespula) and 14 species in the open-air nests (Dolichovespula).

In the UK and most of Europe, there is only one species of hornet, *Vespa crabro*, and eight species of wasp or 'yellowjacket'. *V. crabro* is often mistaken for the Asian hornet but is much bigger in size. There has also been a misidentification in the media about the Asian hornet, *Vespa velutina*. The newspapers published lurid articles about the Asian hornet but showed pictures of the giant Asian hornet, *Vespa mandarinia*. The latter is a much more aggressive species than *V. velutina* but, thankfully, still confined to Japan – where 20 individual hornets can decimate a honeybee colony in 30 minutes.

There have been several other instances where hornets and yellowjackets have been introduced accidentally into parts of the world – yellowjackets to southern Australia, for example – usually through the inadvertent introduction of an overwintering queen rather than the specific movement of a nest, which would be deliberate.

Vespa velutina has very distinctive yellow legs – the only species in Europe to have legs this colour. There are 12 sub-species and the one that has invaded France has a black thorax and is known as *V. velutina nigrothorax*. It has been mistaken for the European hornet, *Vespa crabro*, the wood wasp, *Uricerus gigas* and the belted hoverfly, *Volucella zonaria*.

Life cycle

A queen, mated in the previous season, hibernates over winter in a sheltered place protected from the elements. Rising air temperatures in spring cause the queen to awaken, usually in mid-April. It is difficult – if not impossible – for her to re-enter hibernation, so if she wakes up too soon she will die of starvation. She starts to feed on any nectar or tree resin available as her fat reserves are low or exhausted. This helps to activate her ovaries.

It is believed – but not yet proven – that queens undertake a post-hibernation migration and are capable of flying considerable distances. This is a feature of many hornet species and would go some way to explaining the rapid expansion of territory in France and surrounding countries. Accidental movement by human means is also a probable factor.

Figure 1. *Asian hornet larvae in comb cells.*

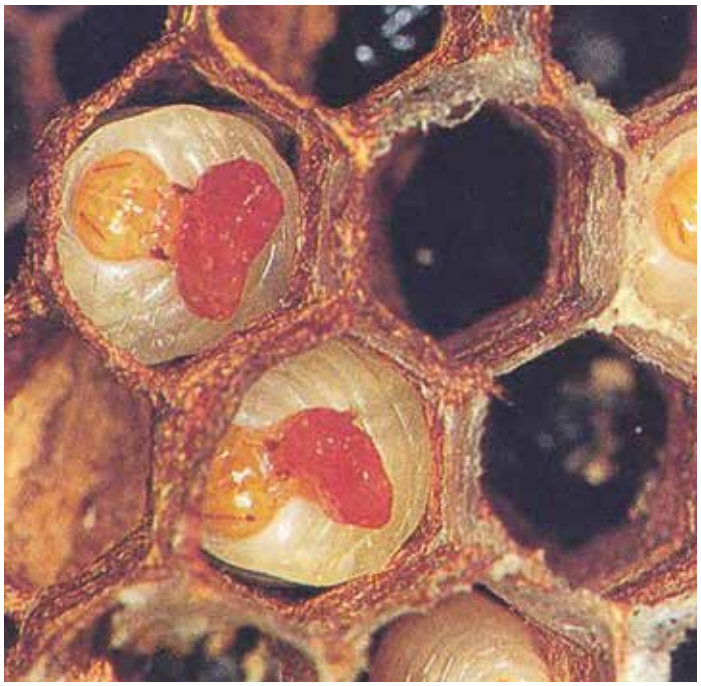

Figure 2. *Hornets enlarging their nest.*

Figure 3. *Asian hornets 'hawking' a bee hive.*

The embryo nest

During the next few weeks, the queen seeks out a nesting site – a wall cavity, garden shed or tree hollow. The nest is secured by a petiole to the surface and is the single point of contact. The entrance is located at the bottom and the lower end has an initial comb of hexagonal cells and is surrounded by a single layer of 'paper' resembling an envelope, only four to five centimetres across.

The material is gathered by scraping wood with her mandibles from sources such as fences and telegraph poles, which is chewed and mixed with saliva in her mandibles to make paper. Different colours of paper indicate different woods as the queen builds a new brood cell each day. Once the first few cells are finished, she lays an egg in each which is glued to the cell wall. The egg hatches after three to four days and the larva clings to the old egg casing to stop itself falling out of the cell (**Figure 1**). It goes through four moults, spins a silk cocoon, before moulting a fifth and final time into a pupa.

At night the queen sleeps on top of the nest and her body heat assists the larval and pupal development. It takes her about 50 days to build the first 40-50 cells in which she will rear the first 10-15 brood into adult female workers. The time it takes for each egg to develop into an adult decreases as the colony increases, owing to more heat.

The queen has to spend time away from the nest, so it is vulnerable to attack from predators, such as ants. She applies a chemical repellent to the petiole; which is produced from a special set of glands (Van der Vetch glands) found inside her abdomen and spread by an area of small hairs forming a brush on the underside of her abdomen. The repellent has to be applied freshly each day.

Usurpation

Ants may be a nuisance to a nest but the main threat is from other hornets. If a nest is destroyed accidentally, the queen does not attempt to rebuild. Instead she will search for another nest and attempt to take it over by killing the other queen. This is known as 'queen usurpation' and can result in several dead queens being found below an embryo nest – even 'victorious' queens may be injured in these fights, so nests may fail or be smaller than usual. Queen usurpation appears to be an important control mechanism for hornet and wasp populations.

There is a brief period when workers and queen work outside the nest, but after about two weeks the queen stays in the safety of the nest. Her main task is egg laying; whereas the foraging, brood rearing and defence is carried out by the increasing numbers of workers – whose body size is initially small but increases as the colony enlarges. The queen becomes the centre of attention as the workers' behaviour changes to serve her – licking her so she becomes hairless and shiny – and aggressive workers guard the entrance to the nest.

As the nest expands, a series of horizontal combs are built and held to pre-existing combs by pillars. The petiole is strengthened to take the weight and the pillars are strengthened by embedding old cocoons into the paper, making it as tough as concrete. Paper is taken from the inside wall of the envelope to make new cells and new paper is added to the outside wall, such that the nest increases in size (**Figure 2**). Each layer is a series of concentric circles, each larger than the previous one; and every cell can be used up to three times to produce generations of workers.

As the colony grows, the inside temperature stabilises at a steady 30°C and brood development speeds up worker development time – reducing from about 50 days to 30 days.

'Hawking'

Foraging hornets seek out honeybees, in particular, although they will also predate on bumblebees, solitary bees, small wasps, moths and hoverflies. They hover (or 'hawk') outside and around the entrance to a bee hive (**Figure 3**) and will pluck a honeybee out of the air, fly to a twig and pull off its head, abdomen, wings and legs and fly the thorax containing the flight muscles back to the nest to feed larvae.

The adult hornets are unable to eat the bee thorax because 'shucks' of flesh are too big to pass the petiole between their thorax and abdomen. Larvae, however, do not have this restriction and so they eat and digest the meat voraciously. Adult requirement for protein is not high; but if they need it, they stimulate the larvae to regurgitate digested food for them. Their carbohydrate requirements are met by nectar, honeydew and tree

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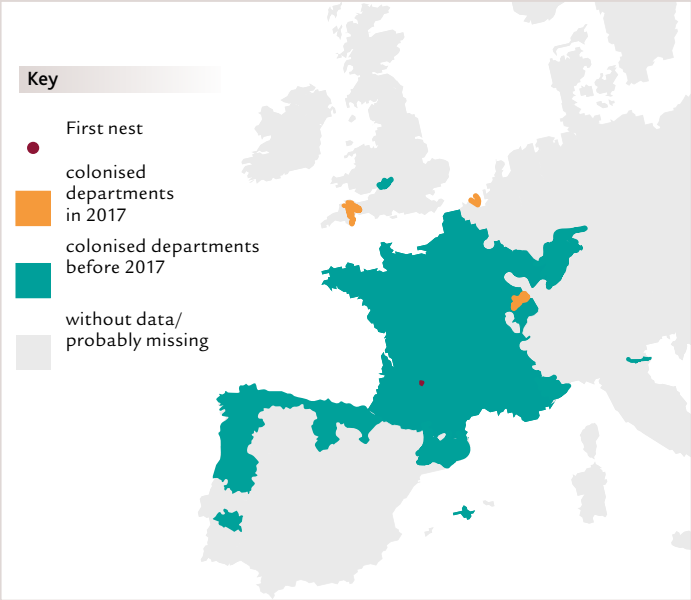

Figure 4. *Map showing the spread of the Asian hornet in Europe since 2004.*

resin, especially in spring and autumn.

Beekeepers can take steps to thwart 'hawking' hornets by draping a 'skirt' around the hive stand to prevent hornets from hiding under the hive to ambush departing or returning bees. Hornets do not like any interference with their wings, so placing a wire cage over the hive entrance – with cage gaps slightly smaller than the wingspan – thwarts their approach. The bees have a much greater volume of space to evade the hornet too and their coming and going is not impeded.

The hornets usually outgrow this initial nest and so the queen will initiate work on a secondary nest at a much higher level above the ground. They do not swarm as honeybees do. A favoured position is found and within a few days a nest the size of a football can be produced – some nests in the Far East have reached a metre in diameter. The queen will be in full lay in this new nest, producing up to 100 eggs a day.

Reproductive phase

In late summer/autumn, the reproductive phase begins. The queen starts to lay eggs destined via parthenogenesis to become males. Worker numbers drop from a peak of 1,200-1,500 and eggs destined to be queens are laid – the mechanism of how a fertilised egg becomes a queen instead of a worker is unknown.

Eggs destined to become males or queens are laid in the larger cells at the bottom combs of the nest. A mature nest can have upwards of 12,000 cells – though whether one of this size could be produced in the UK remains a debatable point. The males and queens lay down fat deposits in their abdomens by eliciting sugars from the larvae; whereas the workers do not lay down fat deposits because they will not be living long.

The numbers of males and queens produced depends on the weather. On average there are 300 queens and 600 males; but in an 'Indian summer' these figures can rise to 1,800 queens and 1,800 males. They remain in the nest for a period of time; although the original queen often disappears at this point.

The males leave first at eight to 11 days and the queens at 13 to 14 days, never to return; and little is known of their mating behaviour. The newly mated queens seek out somewhere to hibernate until spring; and the vast majority – around 99 per cent in some estimates – die during winter. As autumn progresses, more and more 'sexual' larvae are produced, which are attempting to mature whilst also feeding the worker population. At some point the demand for food outstrips supply and the colony fails. In a mild autumn, this point is reached later, so more 'sexuals' are produced before decline. Once all the workers die, the nest will not be reused – which is in contrast to honeybee homes.

The threat begins

In the winter of 2005, two hornet nests were spotted in the Bordeaux region of France by a farmer who destroyed them with a shotgun – subsequent enquiries showed that three nests had been seen in that area in 2004. *Vespa velutina* is a flying athlete and can fly 50 kilometres. The insect has spread through France with remarkable rapidity and spilled into neighbouring countries, possibly assisted by motor vehicles.

French beekeepers have reported that their honey production is down by two thirds since the Asian hornet arrived. This situation is unlikely to improve because the density of nests will increase in those areas already affected. The hornet has now spread into Belgium, the Netherlands, Germany, Italy, northern Spain, Portugal, Majorca and the Channel Islands (**Figure 4**). It has been found in Britain on at least two occasions – firstly in Tetbury, near Bristol, in September 2016, and then in Woolacombe, Devon in 2017. A desiccated specimen was also found in Dorset and a single hornet caught flying in a Tesco warehouse in Scotland.

The Tetbury nest was a surprise because the first sightings of the Asian hornet had been expected to be somewhere along the English south coast, where there is a system of sentinel hives in key areas, such as near ports and harbours. It now seems likely, however, that it could appear anywhere in Britain owing to the mass movements of goods and vehicles.

Is control possible?

The National Bee Unit has a contingency plan to find and destroy nests, but the workforce is very small and will rely on the public to report suspicious sightings; so education of the public to correctly identify the Asian hornet is key. There were 4,000 such reports in 2017, with many people mistaking the European hornet and wood wasp for *Vespa velutina*.

The nests are very difficult to find, especially if they are in an evergreen tree, and the Tetbury incident was a case in point. The nest was 30 metres up in a tree in a garden and was only visible within a small angle (**Figure 5**). Nests are more easily seen in deciduous trees once the leaves fall, but by that stage the 'sexuals' will have left; so finding and destroying the nests before 'sexuals' appear is vital.

Defra is trialling the use of highly sophisticated drones with very sensitive heat-seeking cameras in an effort to find mature nests – and possibly embryo nests too. Professional teams are required to destroy nests because they will have proper clothing and machinery to reach high into trees.

The hornets are very defensive once they sense their nest is threatened, and several people have died in France as the result of being stung whilst trying to remove nests. It is believed that 'guard' hornets will sound a warning and, if not heeded, will return to the nest to recruit a more

Figure 5. *The Asian hornet nest high in a tree in Tetbury.*

substantial force. It has also been reported that, under extreme threat, worker hornets will curve their abdomens under their bodies and 'spit' venom at the assailant in an effort to blind them.

Is there any biological system of control?

Pitcher plants are carnivorous plants that seem to attract Asian hornets in France, so research is in progress to identify the attractant, in the hope of producing a commercial product that would attract the hornets into a trap. Traps of various design are in use but have the disadvantage of trapping 'good' pollinators as well. Japan has the honey buzzard (*Pernis apivorous*) which has feathered feet to prevent being stung; and hornets are eaten by humans as a delicacy – being caught by specialist hunters. Some parts of Asia have a parasitic cuckoo hornet (*Vespa dybowskii*) which takes over colonies of wasps and European hornets. However, its effect on the hornet population is minimal and the drawback is that it is a very aggressive insect.

Hornets can become infected by a variety of highly specialist parasites – about 20 species are known although little is known of their pathophysiology. These include Stylopids, nematode worms, moths, beetles,Trigonalid wasps, ichneumon flies and some true flies. The number of colonies infected is small and so the overall effect is minimal.

Mermithid nematodes infect both wasp and hornet colonies. New Zealand used them by releasing large numbers into the environment in an attempt to control yellow jacket wasps. It did not work; because by the time the nematode population rose to have an effect, it was too far into the nest cycle to prevent the 'sexuals' developing. Unfortunately, these parasites have little overall effect on a resilient hornet either, and any control would need to kill the queen early in the season.

One species that does have a 'strategy' is *Apis cerana*. This bee has evolved with hornets over a very long time and it has a behavioural skill. When an Asian hornet or giant hornet comes too close to the hive entrance, it will sound a warning 'fizzing' sound and perform a 'Mexican wave'.

If the hornet lands, hundreds of bees will engulf it and attempt suffocation, while at the same time vibrating their wing muscles to generate heat. *Apis cerana* can survive heat up to 45°C; whereas the hornet is cooked and dies at a few degrees lower.

Western honeybees do not exhibit this behaviour and are, therefore, vulnerable to attack. It is an unfortunate fact that between 30,000 to 60,000 honeybee colonies are destroyed in Japan every year as a consequence of hornet attack. That amounts to 10 to 20 per cent of Japanese colonies. It is also worrying that *Vespas velutina* is becoming adapted to urban environments in Japan, owing to the abundance of food in towns and cities, and this will bring them into closer contact with humans.

Future prospects

It seems inevitable that *V. velutina* will invade the British Isles at some point and our initial response must be to eradicate it as we have done so far. There is a contingency plan and this will require education of beekeepers and the public. The lesson from France is that, once established, this species is almost impossible to eliminate. There may come a point when we may have to consider that possibility.

Varroa mite has made beekeeping much more difficult and has placed a huge pathogenic burden on the honeybee. The Asian hornet is another unwanted pressure with which it will have to contend; plus the threat posed by the small hive beetle spreading from southern Italy into other parts of Europe.

It has been suggested that the climate in Britain is such that the Asian hornet could only survive in the southern parts of England, Wales and Ireland, or below 55 degrees latitude because temperatures above this location would be too cold for it to survive. On the other hand, some experts suggest that it will go right to the north of Scotland – its presence in the mountainous areas of northern Spain may lend some credence to this.

The hornet has spread rapidly through much of Europe and the number of nests per geographical area will inevitably increase. There is little good news here. ■

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