Bees, Wasps and Hornets

Technical White Paper

SureScreen Scientifics

Bee, wasp and hornet species in the UK

Bees and wasps are two of the most familiar groups within the extensive order Hymenoptera, which also contains sawflies and ants. In Britain, we have approximately 270 species of bee, and this includes 250 solitary bees, 24 species of bumblebees and one species of honeybee. In comparison, there are approximately 7000 species of wasps in the UK, including seven social species, more than 250 solitary species and over 6000 species of parasitoid wasps.

Hornets are a type of eusocial wasp, meaning that typically one female (usually known as the queen) within a large group is solely responsible for producing offspring for the colony, which also contains a large number of non-reproductive individuals who have specific roles including caring for the young. This is similar to how well known species, such as bumblebees and honeybees work.

Most of the bee and wasp species, however, are solitary. This means that there is no colony; the females simply create a small nest to lay their eggs and little or no care is provided to rearing the offspring. Nests can be created in a large range of places, including in small holes in bricks or wood or some species even excavate their own holes. Females will provide only enough pollen and nectar for the larvae once it is hatched so it can hibernate in a cocoon up until the following spring. Different provisions are used to close the nest, including leaves, mud and resin. The material used to close the nest can help identify the type of bee or wasp, but not necessarily to the species level.

Importance of pollinator species

Around 90% of wild plants around the world and 75% of the global leading crops depend on animal pollination. More specifically, certain species of plants and crops rely solely on specific pollination from certain, specialized species in order to produce fruit or vegetables. For example, there are hundreds of species of fig wasps worldwide, who all pollinate a specific species of fig. Both the fig and the wasps would not be able to survive without the other. Additionally, insect pollination is thought to be essential for certain plant species, as they rely on it for reproduction, and to maintain genetic diversity. Without the insects, the plants would not be able to reproduce as easily.

Wasps can be considered as natural biological controls, as they preying on insects. This helps to regulate the populations of certain “problem” insects, specifically for crops which are prone to pests such as aphids. Therefore, the need for other control methods, like pesticides, which are harmful to the environment is reduced. Some species of wasps also aid in pollination during this pest control – by invertedly transferring pollen between plants when predating on insects.

Why are bees and wasps declining?

Bees and other pollinator species have been in decline across the globe, with some species even becoming extinct. The reasons for this are suspected to be factors such as habitat loss, a change in land usage and pesticides. Habitat loss and changes in land usage can make it hard for bees to disperse between habitats, as habitats become more fragmented. Also, places where bees and wasps would nest, such as hedgerows, field margins and embankments are reduced, therefore it is harder for some species to build a nest and successfully reproduce.

Some forms of pesticides effect every part of a plant, including the pollen and nectar on the flowers. This can have a negative impact on pollinator health, causing them to have poorer immunity for fighting off diseases. It can be catastrophic for social species and cause problems such as colony collapse disorder (CCD), which is where there is a sudden loss in worker populations within a colony. Without the worker bees, the hives would struggle to sustain themselves and would eventually die.

Other problems causing decline include the accidental introduction of pathogens, parasites and other invasive species around the world. At some point in the 1970’s, the *Varroa destructor*, a parasitic mite, was introduced in Europe. This has caused significant colony losses for honeybees and a drastic loss for beekeepers globally. Invasive species such as the Asian Hornet (*Vespa velutina*) have also had a huge impact on honeybees globally as this particular hornet predates on honeybees. In 2016, the first Asian hornet was discovered in the UK, since then a further 22 reports of Asian hornets have been confirmed (As of 2022).

Why we need DNA identification for bees and wasps

Being able to correctly identify species such as bees and wasps is important to determine what conservation efforts may be needed, in order to maintain or improve the current population levels of certain species. Some species of bees and wasps, such as the more common species, are very easily identified by sight alone. However, some species look very similar to others, making identifying them by sight alone more difficult. For example, blood bees (*Sphecodes*) are mostly all black and red and have little hair, and differentiating the species by sight can be difficult. Additionally, some species of bumblebees are so closely related and are morphologically similar that they can sometimes only be reliably identified by DNA testing (white-tailed bumblebees, cryptic white tailed bumblebees and Northern white-tailed bumblebees). There can also be morphological differences between the differing castes of bees (Queen, worker, male/drone), where the bee or wasp may look similar to a different species, leading to incorrect identification.

Box-headed blood bee (left) and Dark-winged blood bee (right), also known as Cuckoo Sweat bees due to their cleptoparasite nature.

Developing a DNA identification method at Surescreen

A method has been successfully developed to identify bee and wasp species using carcasses and pupa / larvae, and we were able to identify honey bee DNA in hornet meconium (the waste product of social wasp larvae). To ensure the method was accurate, known species of wasps and bees, or easily identifiable species (through morphological characteristics) were used and all resulted in accurate identification. The species we have successfully been able to identify include: three bumblebee species (Buff-tailed, Garden and common carder), European Honeybee, Large-headed Resin Bee, Orange-vented Mason Bee, *Ectemnius cavifrons* (a solitary wasp), German wasp and Asian hornet.

(Left to right) Cocoon from an Asian hornet, Asian hornet pupa and meconium (faecal matter) analysed in the lab.

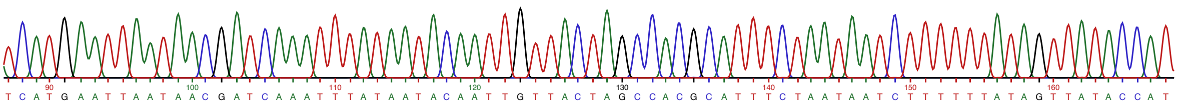
With this method we believe that most species within the Hymenoptera order can be identified, with the exception of species where potential genetic divergence (differences within a species genetics due to hybridization) may occur. It has also successfully identified other arthropods, including Deer ked which was found amongst some of the samples, and some arachnid species. This, however, has not been thoroughly tested.

DNA analysis in the lab

To successfully identify the species, DNA is extracted from the sample. To do this, a small section of the sample is taken and broken down. For the deceased sample, or larva/pupa, the sample is crushed using a mortar and pestle and after some solutions are added it is heated up to encourage the release of DNA. For meconium, the sample is shaken at a high speed to do this. Afterwards, a series of solutions and several centrifugation steps follows (for all types of samples), in order to remove any impurities, resulting in pure DNA.

Polymerase chain reaction (PCR) is then performed using specific molecular markers, also known as primers. These target a specific area of interest. PCR amplifies the DNA present in the extracted samples by a series of heating and cooling cycles. This amplified DNA is then ready to be genetically sequenced, and this results in a species-specific sequence of base pairs. This can be compared on a large scale (internal, national and international) to other DNA reference databases to see which is the closest genetic match to determine the species.

For this method, the primer used is specific for species within the Hymenoptera order, allowing us to successfully identify bees, wasps and hornets, and potentially more.



Part of a DNA sequence form a Honeybee (*Apis mellifera*)

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