SCIENTIFIC NOTE

IN TIMES OF *VARROA* – LET'S NOT FORGET THE INS AND OUTS OF THE SMALL HIVE BEETLE, *AETHINA TUMIDA*

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Summary

The small hive beetle, *Aethina tumida*, one of the most devastating pests of the honey bee *Apis mellifera* has the capability to destroy an entire colony within weeks including by causing slime-out of honey bee colonies due to the fermentation of honey by its symbiotic yeast.

Keywords: Small hive beetle, *Aethina tumida*, wandering larvae, honey bees, Varroa.

INTRODUCTION

The European honey bee, *Apis mellifera* L. (Hymenoptera: Apidae) is one of the most important beneficial insects, providing hive products like honey, beeswax and propolis to humans along with the all-important crop pollination services. It is globalization that has made it possible for *A. mellifera* to reach every continent on Earth (except Antarctica), which proved to be a boon to humanity. But globalization has also shown that it can be a curse, and one of those is the spread of parasites and pests of honey bee. To mitigate this, strict biosecurity regulations and measures are in place in many countries, including Australia. Owing to these, Australia has been successful in intercepting and eradicating several incursions of the most destructive and significant honey bee parasites, *Varroa* mites.

However, when *Varroa destructor* was detected in sentinel and other hives near Newcastle, New South Wales (NSW), in June 2022, the large eradication effort that followed suit unfortunately remained unsuccessful because the mite had already reached areas outside the established eradication zones. Therefore, in September 2023 the focus shifted from eradication to management (NSW DPI, 2024). *Varroa* is now established in many parts of NSW and has also been detected in Victoria. As honey bee-specific ectoparasite, *Varroa* is capable of drastically weakening and reducing honey bee colonies, through direct parasitism but also by vectoring viruses that affect bee health. Importantly, *Varroa* can also make honey bee more vulnerable to attack by other honey bee pests already present in Australia. Among these, the small hive beetle (SHB), *Aethina tumida* Murray (Coleoptera: Nitidulidae) is the most significant.

SMALL HIVE BEETLE

Currently, SHB occurs in many parts of the globe including Africa, parts of America, Europe, as well as Australia. It is native to sub-Saharan Africa, where it is considered a minor pest because of the effective hygienic behaviour of the more aggressive African bees. But in response to their aggressive behaviour, SHB has also developed defence strategies like running away, hiding in cracks, and dropping from frames. However, domesticated honey bees, reared for tameness outside their native range are far more susceptible to SHB attack. In Australia, SHB was first reported in Richmond (NSW) in July 2002. Because it had already spread across other regions by November 2002, and, because it can fly and use alternate resources than the ones found in hives, an eradication was not deemed feasible (Spooner-Hart et al., 2017).

The SHB may, by its name, give the impression of being just a small pest, but it causes a substantial problem for apiculture and has substantially affected honey bees in Australia, especially in the coastal regions of NSW and Queensland. In search of a suitable colony with full honey and pollen reserves, adult SHB may fly long distances (up to 15 km), and, thereby, can quickly spread over a large area. Initially their movement is random, but they can recognize the odour and volatiles from a bee colony when present nearby. In between, they may attack feral colonies or might also survive on alternative resources like ripe fruits (e.g. rockmelon, mango, peach, banana and grapes), or on decaying meat.

Once, the adults reach a hive, they may enter through cracks and crevices, or through the main hive entrance,

bypassing guard bees, the first line of a colony's defence. They are able to do so because of their cuticular hydrocarbon profile that is similar to that of honey bees, but at 10-fold lower concentration (Papach et al., 2021). When inside the hive, the adult SHBs are chased down by the adult worker honey bees that stop them from roaming freely inside the hive. Worker bees achieve this by corralling or confining SHB to specific parts of the hives known as confinement sites, or by simply preventing SHB from ovipositing by encapsulation in propolis. Although, adult SHB have the capacity to live without food for about two weeks, while being corralled by honey bee workers, SHB have developed an unusual strategy of tickling adult honey bees using their antennae. In this way they obtain food from the honey bees, via trophallactic feeding. For these and other reasons, the SHB is a very difficult insect to manage. Both males and females may mate multiple times, either inside or outside of the honey bee colony and the females lay eggs in clusters of 10-30 eggs within capped brood cells, cracks and crevices, or on the outer frames due to the patrolling (second line of defence) of honey bees around the brood area. Oviposition of SHB can be stimulated when SHB females have access to protein (pollen and yeast). A SHB female may oviposit around 1000 eggs during her lifetime, perhaps even up to 2000 eggs. The SHB larvae hatch from the eggs within one to three days, depending on humidity and temperature, and, for 6-14 days, the larvae feed on almost everything which crosses their way inside the hive, from honey and pollen reserves by penetrating the wax cells to honey bee brood (egg, grub and pupa). Apart from this, the adults (and possibly the larvae) have also been reported to show cannibalism by feeding on SHB eggs, as well as weaker and dead conspecifics (Neumann et al., 2016). Thereby, the SHB has the ability of taking down an entire honey bee colony in just a couple of weeks, in the case of a severe infestation.

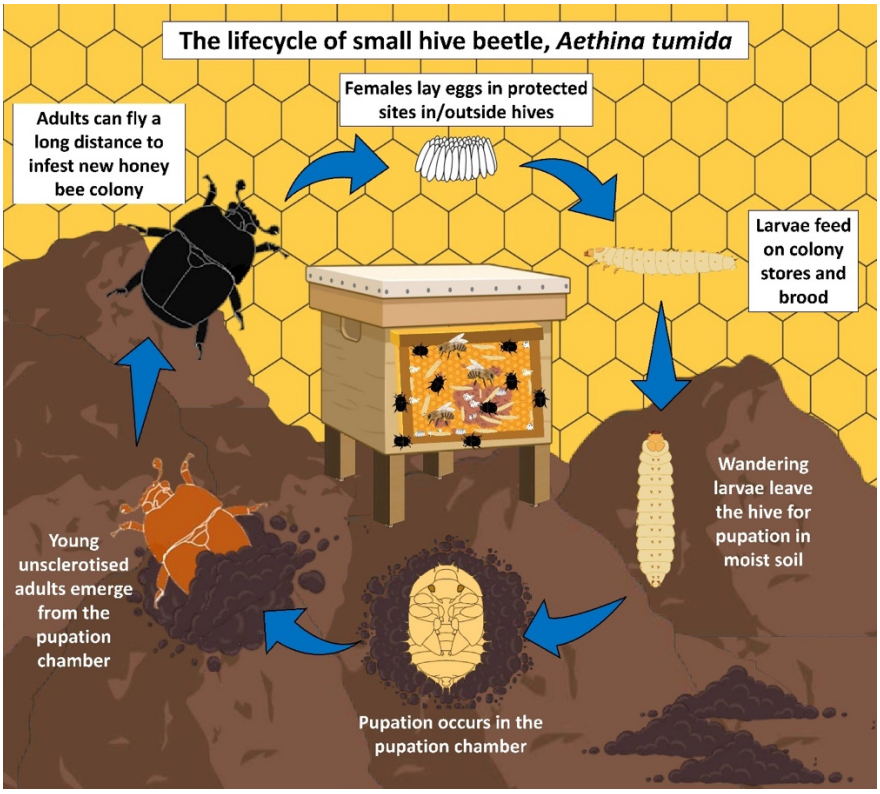

Figure 1. Life cycle of small hive beetle

Larvae have three pairs of thoracic legs, a characteristic row of paired dorsal spines on each segment and two larger paired spines on the rear end of the dorsum, which are helpful in distinguishing them from wax moth larvae that are also common honey bee pests. Most troublesome is though that SHB infestation can lead to the characteristic, smelly and damaging manifestation of the slime-out of infested

hives; this occurs due to the fermentation of honey stores by the yeast *Kodamaea ohmeri* which is symbiotically associated with SHB (Amos et al., 2018).

The SHB can have multiple generations per year and can keep feeding on the hive contents even after the colony has died or absconded. The fully developed last stage larvae, known as wandering larvae, are positively phototactic and leave the hive in search of suitable soil for pupation which occurs within 3-4 days. The wandering larva and the pupa are the most vulnerable stages of *A. tumida*, and hence a good target for the application of management strategies. These two SHB developmental stages are outside the hive. Being outside the hive is an adaptive advantage for SHB to be removed from honey bee defence during this inactive and longest period of SHB life cycle as pupa (21-28 days, depending on temperature). Honey bee workers are capable of eating SHB eggs and deposing SHB larvae and eggs outside the hive (third line of defence), but only in strong colonies (Neumann et al., 2016). The wandering larva can move up to 200 m in search of suitable pupation sites in soil with optimum temperature, soil moisture and soil type to create a pupation chamber. After 3-4 weeks, the unsclerotised brown teneral SHB adults emerge from the soil and become sclerotized to turn black and fly in search of new hives. Even before adult emergence, subterranean mating has also been reported in SHB. The sex ratio of adult populations appears to be biased towards females and the adults may live up to 6 months, depending on temperature and food availability. Hence, SHB may be considered as a successful invasive ecological generalist because it can act as a scavenger and herbivore, parasite, host and vector for a yeast symbiont that damages colonies, vector of bee pathogens such as viruses and predator. This makes SHB a challenging issue for beekeepers in Australia, in particular in the context of the recent establishment of *Varroa* as the two pests have the potential to interactively damage honey bee colonies therefore requiring integrated pest management strategies that target both pests.

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