

Hygienic Behaviour: Natural Disease Resistance in the Honey Bee

by Francis L W Ratnieks

The easiest way to maintain healthy hives would be if the bees themselves controlled their pests and diseases. This is not an impossible goal as honey bees have many defence mechanisms. One of these is hygienic behaviour, in which worker bees remove dead and diseased brood from capped cells, thereby slowing down or halting the spread of the infection. Many serious honey bee diseases are brood diseases, or have a crucial stage in their life cycle in brood cells. Varroa mites breed in brood cells and also transmit viral infections when they feed on brood. LASI has been breeding hygienic bees, carrying out research on hygienic behaviour, and running workshops to train British beekeepers on how to test for hygienic behaviour in their hives. LASI hopes to be able to supply beekeepers and queen rearers with hygienic queens, which commenced in 2014.



Killing a patch of capped worker cells using liquid nitrogen to determine the level of hygienic behaviour in a colony. The frame is now photographed, placed back into its hive, then checked two days later to determine the proportion of freeze-killed brood cells that have been cleaned out. Each hive is tested three or four times to determine a meaningful average hygiene level.

Hygienic behaviour is a natural defence against brood diseases. Hygienic workers clean out cells containing dead or infected brood. Hygienic behaviour is not learned. Rather, it is an inherited trait. Previous research has shown that chalk brood and American foul brood can be controlled by hygienic behaviour.

LASI research has investigated both basic and practical questions about hygienic behaviour, including whether it is effective in controlling varroa and viral diseases, how to test for hygienic behaviour, and how to supply beekeepers with hygienic queens.

Hygienic behaviour is widespread but uncommon. Surveys typically show that only about 10% of hives are hygienic. To determine how hygienic a colony is, patches of capped brood are freeze-killed with liquid nitrogen, photographed, returned to the hive and then checked two days later. The proportion of brood cells that have been cleaned out gives the hygiene level. Colonies that clean 95% or more are considered fully hygienic. At LASI, we have been able to breed fully hygienic bees, some even 100%.

One basic research project investigated one possible reason why hygienic behaviour is rare. We determined whether colonies with higher hygiene levels also removed more healthy brood. We found that this was not the case. As far as we know, from this project and from research in the USA, hygienic behaviour is not costly to the colony.

A colony's hygiene level is not constant and we normally test each colony three or four times to get a meaningful average. We investigated factors that may cause the hygiene level to vary. We manipulated the amount of brood, by adding or removing brood frames, and also 'nectar flow' by feeding some colonies with syrup. Neither

factor influenced the level of hygienic behaviour, nor did colony size. This is encouraging as it shows that a beekeeper need not worry about these factors when quantifying hygiene levels, for example in choosing a hygienic breeder colony for queen rearing.

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How can queen rearers produce hygienic queens? We compared the hygiene levels of colonies headed by queens reared from fully hygienic breeder colonies. Half were allowed to mate naturally. The others were instrumentally inseminated with drones from hygienic colonies. Several months later when each colony was full of the new queen's workers we quantified hygiene levels. Colonies headed by instrumentally inseminated queens had higher hygiene levels, but the colonies headed by open-mated queens were also highly hygienic. This shows that queen rearers could supply open-mated queens to beekeepers wanting hygienic hives. Queen rearers could supply beekeepers with young, virgin hygienic queens to mate locally. LASI research has shown that it is simple to keep virgin queens alive in cages for one week prior to mating.

LASI research has also shown that hygiene can control varroa and the viral diseases it transmits. We tested varroa population build up in 42 colonies with different hygiene levels and found that fully hygienic colonies have only 40% of the varroa build-up. We also found that hygienic colonies had lower levels of deformed wing virus (DWW). This is important as DWW can kill colonies.

References

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