Why are varroa mites the deadliest pest of our honey bees

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The ectoparasitic mite, *Varroa destructor*, is one of the major threats to apiculture in the United States and around the world. However, the distribution of these mites used to be restricted to Korea, Japan, and Thailand. Before the 1950's, varroa mites were exclusively found in association with the asian honey bee (*Apis cerana*), its natural host. With the spread and commercialization of the western honey bee (*Apis mellifera*), varroa mites spread rapidly throughout most of the world, reaching every continent except Australia and Antarctica. *V. destructor* was first reported in the United States in 1987 (figure 1).

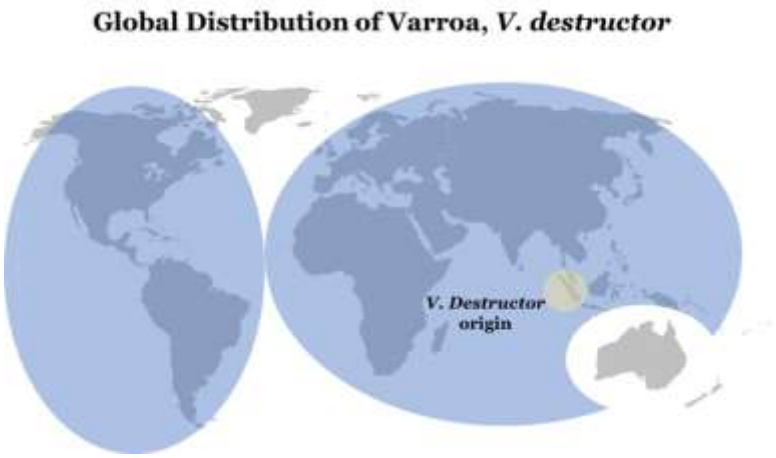

Figure 1. The global span of the varroa mite as of 1998

How do varroa mites reproduce inside the honey bee colony?

V. destructor is an ectoparasite, meaning that it lives outside the body of its host, typically on or in the skin, similar to that of a flea or a tick. In the case of *V. destructor,* mites spend all their lives with their host either attached to a bee or inside the capped brood. There are two distinct phases in the life cycle of *V. destructor*: the <u>phoretic phase</u> and the <u>reproductive phase</u> (figure 2). The <u>phoretic phase</u> occurs when the mite is living outside the brood cell, attached to an adult bee. The mite typically hangs out on the underside of the abdomen and can be difficult to spot. However, it is not uncommon to find them atop the thorax of adult bees. The phoretic phase typically persists 4-5 days and occurs between reproductive cycles. The reproductive phase occurs inside capped brood and is when the mite reproduces.

Figure 2. Two phases of the varroa mite life cycle: phoretic phase of which the mite is attached to a bee outside of the cell (picture A & B) and reproductive phase of which the mite is present inside the capped brood cell (picture C). Pictures by Nick Sloff & Katy Evans.

The <u>reproductive phase</u> of the *V. destructor* is closely linked to that of a honey bee, specifically during the pupal stage when the cell is

capped. Mites are similar to bees in that females develop from fertilized eggs, while males develop from unfertilized eggs. The female mite enters the cell just prior to capping and she begins to lay eggs after approximately 70 hours. The first egg is always a male. Subsequent eggs are females and laid at approximately 30 hour intervals. Mating occurs locally within the capped brood, between brothers and sisters. Not every female mite will reach maturity. The duration of each reproductive phase is dependent upon the duration of bee development during the capped brood stage. A female mite takes on average 11 days to mature; the pupal stage of a worker bee is 12 days. Therefore, on average, only one daughter mite reaches maturity. On the other hand, the pupal stage of a drone is 14 days, thus two daughter mites will reach maturity inside drone cells (figure 3). The capped brood stage of a queen is quite short, only 7 days. Therefore, the developmental time of queens is too short for mites to mature. After bees complete their development in the cell and open the capped brood, the foundress mite and all mature female offspring exit the cell, while all immature females and the male are left behind. The male dies shortly after the emergence of the adult bee, completing its life cycle without exiting the cell. The female mite spends anywhere from 4-5 days in the phoretic phase before entering another brood cell. It is difficult to determine exact populations of mites in a honey bee colony as up to 80% of mites are in the brood and mites spend twice as much time in the reproductive phase as they do in the phoretic phase.

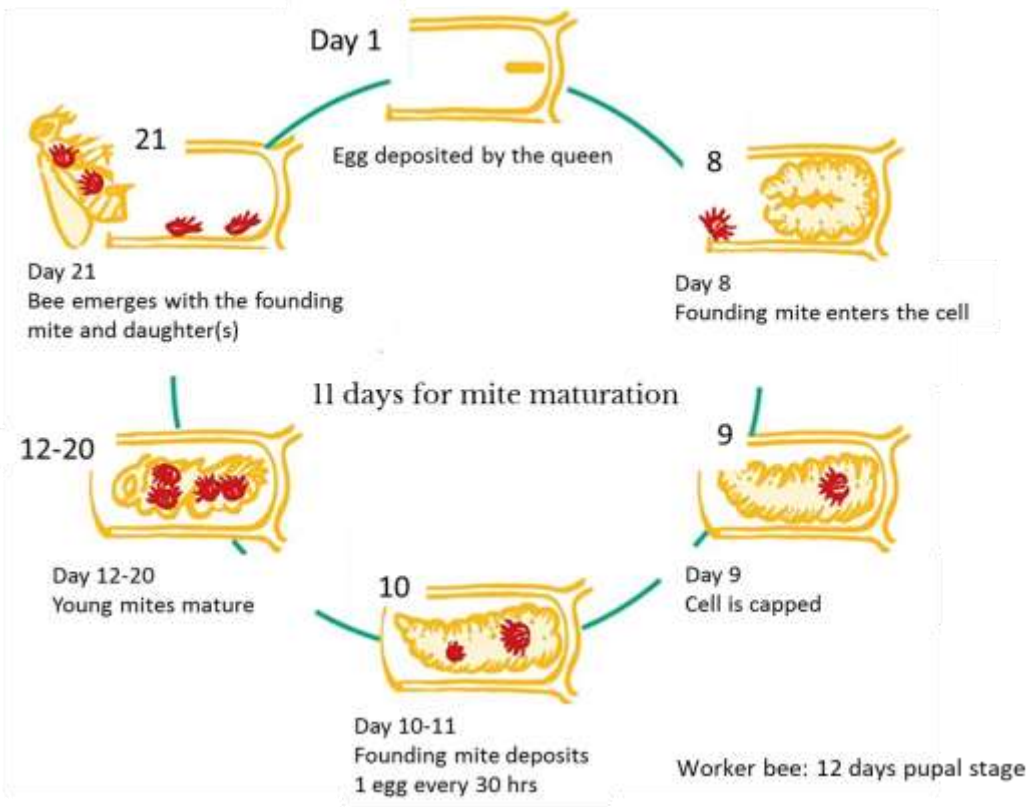

Figure 3. The life cycle of a varroa mite and how it coincides with that of a worker bee, Apis mellifera

Why are mites so abundant in the Fall?

The seasonal cycle of *V. destructor* mimics that of a bee colony. In temperate regions, the number of bees and brood in a colony increases during spring and summer, peaking in July and after which slowly decrease and eventually cease at the onset of winter. As the amount of brood rapidly increases during spring and summer, *V. destructor* populations increase at an exponential rate due to the large production of brood. This leads to an increasing number of infested brood cells throughout the season. *V. destructor* populations peak in early fall, when there are fewer brood cells in the colony. This peak in *V. destructor* population coincides with the production of winter bees resulting in detrimental effects on the overwintering success of a colony. *V. destructor* reduce the body weight and protein content of individual bees, which has shown to shorten honey bee lifespan, and make it difficult for the colony to survive the duration of winter (which in Pennsylvania can span 6 months). Treating the colony before these mite populations peak in early fall is essential to the health and survival of a colony.

Why are varroa mites so deadly to western honey bees and not Asian honey bees?
In addition to physical damage caused by *V. destructor*, they also facilitate the transmission of many viruses including DWV, BQCV, IAPV. There is ongoing research investigating the transmission of many of these viruses, but DWV has been shown to be highly correlated with *V. destructor*. As *V. destructor* populations increase throughout a season, there is a gradual buildup of viruses that will eventually lead to the collapse of a colony.

The Asian honey bee has developed various behaviors and physiological adaptations that limit *V. destructor* population growth. For example, a stark difference between these two hosts is that *V. destructor* is able to reproduce in both drone and worker brood in the western honey bee, while in the Asian honey bee *V. destructor* reproduction is restricted solely to drone brood. Because drone brood is seasonal, *V. destructor* populations oscillate in accordance with drone brood production and are not able to reach devastating populations as seen in the western honey bee.

International efforts are being made to more effectively control *V. destructor* populations. There is an array of chemical treatments including Amitraz, formic acid (MAQS), and oxalic acid that are popular miticides. There are several breeding programs, which are selecting for specific traits in more mite-tolerant honey bees including bees with higher hygienic behavior (e.g. Varroa Sensitive Hygienic bees), or bees that cause physical damage to the mite, (e.g. Purdue Ankle Biters). There is also research investigating feral bee populations throughout the world that have managed to recover and thrive regardless of *V. destructor* infestations. Overall, the most important factors in controlling *V. destructor* populations are to (1) use more mite-tolerant genetic stocks, (2) use of a treatment and (3) the timing of that treatment.

Figure 4. Varroa mite drops on a sticky board. Mites can be observed under a microscope to detect for physical damage characteristic of some mite-tolerant honey bee stocks. Picture by Katy Evans

A wonderful handbook regarding *V. destructor* treatments is available via the Honey Bee Health Coalition.

Resources:
Mite monitoring methods
Oxalic acid application

References

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