Longevity of *Varroa jacobsoni* away from a living host

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Introduction

Among the parasitic mites associated with honey bees, *Varroa jacobsoni* Oud. is the most economically serious parasite for beekeepers worldwide. This mite species was first discovered as a brood parasite of the eastern honey bee (*Apis cerana* F.) in Java, Indonesia (Oudemans 1904) reportedly having no destructive effect on infested colonies. With the introduction of the western honey bee (*Apis mellifera* L.) into Asia as early as 1950, *V. jacobsoni* extended its host range by shifting to the introduced *Apis* species (Crane 1979) causing devastating results. It has subsequently been distributed to all the continents of the world except Australasia (Griffiths and Bowman 1981).

In the United States, *V. jacobsoni* was first discovered in Wisconsin in September 1987. By using multivariate morphometric analysis on various samples of the mite from different countries, Delfinado-Baker and Houck (1989) claimed that this exotic mite may have been introduced from South America. Since its discovery, 36 states have confirmed infestations by this ectoparasite. Rapid spread of the mite probably has been intensified by movement of bee colonies from infested states for honey production and pollination services.

Although *V. jacobsoni* is known to be specific to *Apis* species, it can also live on honey bee predators and on flowers visited by bees (Kevan *et al.* 1990). However, the longevity of mites on flowers or pollen was not investigated. This ability of the mite to live outside the hive has been shown by various researchers and thus, may

be an important factor in the spead of this ectoparasite. The survival of *V. jacobsoni* on beekeeping tools and equipment, honey bee by-products, and dead bees has not been studied. Therefore, this study was conducted to establish the survival of *V. jacobsoni* on some materials associated with beekeeping and to detemine their potential as agents of dispersal for this mite species.

Materials and Methods

This experiment was conducted in Florida in April 1991, well before *V. jacobsoni* was detected in Louisiana. The substrates used for this experiment were: cloth, wax comb, dead drones, dead worker bees, metal, pollen, wood and no substrate for the control. All substrates were obtained from Louisiana to ensure that they were mite-free. Except for pollen and dead bees, the substrates were cut into small pieces (*ca.* 5 x 4 cm) and placed in insect rearing cups (made of cardboard coated with paraffin wax) with two pieces per cup. For the pollen treatment, one tbsp of dried pollen pellets was used per cup. Twenty bees per cup were utilized for the dead bee (drones and workers) treatments. These bees were frozen for storage and thawed before use. Inoculum mites were collected from a highly infested colony by removing capped drone and worker brood from brood combs having varied developmental stages and brushing mites into experimental cups. All adult female mites contained in infested cells were employed in the experiment. Mites ranging from 33 to 71 in number were introduced per cup.

Inoculated substrates were maintained at 26°C (room temperature) and 13°C (inside a refrigerator with a volume of 1.6 ft^3). Temperature inside the room and refrigerator was monitored using a thermometer throughout the experimental period. Temperature and relative humidity readings were determined later using a hygro-thermograph. Under room temperature, all treatments were replicated five times excluding the dead drone treatment, which had only three replications. All 13°C treatments were replicated three times.

Mite mortality was observed every six hours until the last mite died. At the time of observation, all dead mites were counted and removed from the rearing cups. All mites held at 13°C were allowed to recover for ten minutes before counting dead mites. Moribund mites or mites that showed leg movements but were not able to crawl when touched with an insect brush were considered dead. Data were analyzed using ANOVA (factorial experiment with a nested error term) and means were compared using a multiple t-test.

Results

Substrates differed significantly in their ability to support mite survival (P> 0.0001) irrespective of temperature (Table 1, Figures 1 and 2). Among the eight substrates used, the longest survival periods of *V. jacobsoni* were observed on dead workers (58±0.9 h) followed by dead drones with a mean of 44±1.0 h. Mean survival of mites on cloth and wax comb were not significantly different with mean numbers of 37±0.8 and 36±0.8 h, respectively. Wood provided 28±0.8 h survival, which was comparable with pollen having a mean of 33±0.8 h. The shortest survivals were recorded on metal (23±0.8 h). The control (no substrate) had a mean of 26±0.8 h.

Temperature likewise displayed a significant (P> 0.0001) effect on the survival of the mites. Overall, exposure of varroa to 26°C resulted in longer survival (41±0.4 h). A significant reduction (25±0.5 h) of mite survival was noticed when mites were maintained at 13°C.

The survival of *V. jacobsoni* on the different substrates held at 26°C (room temperature) is shown in Figure 1. Results revealed that on metal and the control, median mite mortality was 24 h. However, the last mite survived on these substrates up to 60 and 78 h post inoculation, respectively. On wood and wax comb, 50%

Table 1. Average survival (Mean±SE h) of Varroa jacobsoni *on eight substrates at two different temperatures*

Substrates	Room temperature (26°C)	Cold temperature (13°C)	Mean
Control	27±0.97	21±1.29	26±0.81
Metal	26±1.00	20±1.13	23±0.76
Wood	32±1.04	24±1.27	28±0.82
Pollen	41±0.96	18±1.28	33±0.80
Cloth	48±1.01	21±1.27	37±0.81
Comb	37±1.01	35±1.31	36±0.83
Dead drones	56±1.41	33±1.35	44±0.98
Dead workers	71±1.06	35±1.39	58±0.88
Mean	41±0.38	25±0.46	

mite mortality was attained after 30 h. The death of the last mite was 84 h post inoculation on wood and 102 h on wax comb. Median mortality on pollen was 36 h after inoculation, and maximum survival was 132 h. On cloth, 50% mortality was 48 h, maximum longevity was 102 h. The longest median mortalities were observed on dead bee treatments; 50% mortality on dead drones was reached earlier (54 h) than on dead worker bees (78 h). The deaths of the last mite survivors on these substrates were observed after 114 and 120 h, respectively.

Figure 2 shows the survival of mites on different substrates maintained at 13°C. Pollen provided the shortest median mortality, which was observed 12 h after mite inoculation. No mite survivor was present on this substrate 84 h post inoculation. On metal, cloth, wax comb, wood and no substrate (control), the median mortality was observed to be 18 h after inoculation. The last survivors lived 48, 60, 78, 72, and 66 h, respectively. Wax comb and drones gave a 30 h median mortality, and both recorded a maximum survival of 78 h. Dead workers were the best medium at 13°C with a median mortality of 36 h and maximum survival of 102 h.

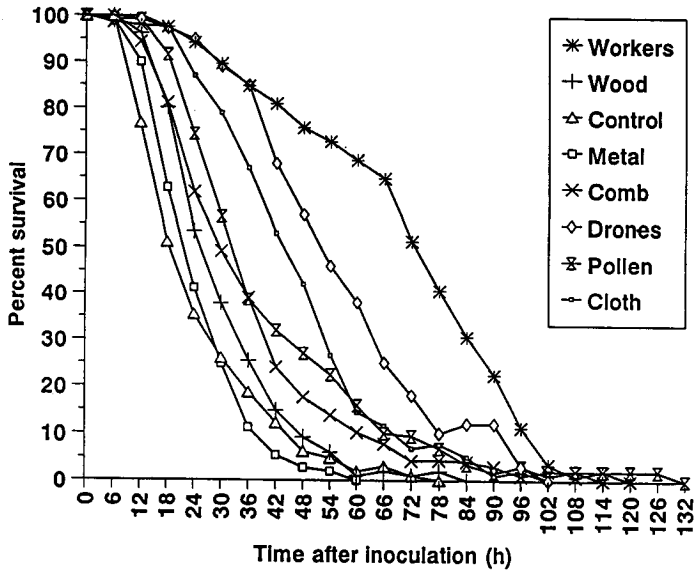

Figure 1. Survival of Varroa jacobsoni *on eight substrates at room temperature (26°C) at 6 h intervals.*

Data indicated that overall, a cooler temperature (13°C) reduced the survival of *V. jacobsoni* on the different substrates tested (Table 1). In both temperatures, the longest survival of the mite was on dead workers.

Discussion

Dead bees were found to be more favorable for the survival of *V. jacobsoni* than any of the substrates used. However, dead worker bees provided significantly longer survival than dead drones. This result is inconsistent with reports on varroa's preference on brood. This ectoparasite prefers drone brood 3.1-8.6 times more than worker brood (Schulz 1984, Fuchs 1990). This phenomenon is correlated to a longer life cycle of drones than worker bees. Perhaps the nutrient requirements for survival are different from those that support reproduction and dead workers are better than drones in this respect.

We saw some preferences for location by mites on the dead bees. Mites were

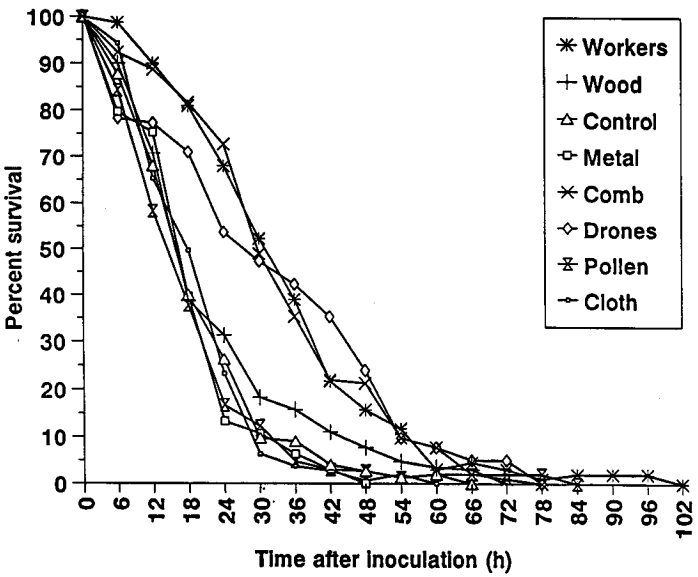

Figure 2. Survival of Varroa jacobsoni *on eight substrates at cold temperature (13°C) at 6 h-intervals.*

observed to be on specific areas of the dead bees' bodies. They were found on the wings, legs, between the thorax and abdomen or between the head and thorax. These parts of the bees' bodies may have provided insulation and protection for the mite from extreme temperature. Inside a colony, live bees act as intermediate hosts for varroa (Ritter 1988). In this setting, the mites usually use the intersegmental membranes for metabolic heat as they seek new hosts.

The small reduction in the ability of the mites to survive on wax combs kept at cold temperature may indicate that cells provide warmth or insulation to the mites. Most of the inoculated mites were seen inside the cells throughout the experimental period, which may have reduced dehydration. These observations support the view that empty frames removed from infested colonies are not safe for immediate use in mite-free colonies.

On wood, mite survival was probably due to the presence of some beeswax and the mites' ability to hide in cracks for warmth and protection from dehydration. This observation suggests that this mite can live on bottom boards, frames and supers for up to a few days.

The reason for the relatively long survival of mites on pollen was most likely due to the ability of the mites to hide under or between the pollen pellets to prevent dehydration. Hence, using fresh pollen from pollen traps may also spread varroa.

Better mite survival on the control (no substrate) than on metal may be attributed to the inability of metal to provide protection and warmth. Nonetheless, some mites survived 3 days under these conditions.

Temperature preference of *V. jacobsoni* has been studied by several researchers. The reduced mite survival at 13°C may indicate that mites cannot tolerate this temperature well. According to Pätzold and Ritter (1989), the tolerable temperature during winter ranges from 16-43°C, which was higher than the temperature in the refrigerator we used. During summer, the authors observed that *V. jacobsoni* can withstand temperatures ranging 24-43°C with a preferred temperature range of 25-40°C. Their observation may explain the increased survival of the mites at room temperature. *V. jacobsoni* evidently can survive away from a living host for several hours under many conditions anytime of the year. All the substrates we tested were potential agents for varroa dispersal if they were transferred and used in uninfested locations, apiaries or colonies. Foraging bees can acquire varroa, especially when robbing (Rademacher 1991). Since empty beekeeping equipment may also be subjected to robbing, it must be considered a potential source of varroa contamination for uninfested colonies.

Conclusions

With the observed ability of varroa to survive 18-71 h on average on the tested substrates, we recommend the following precautionary measures to slow the spread of varroa from location to location, apiary to apiary or colony to colony:

1. Tools, gloves and bee suits used in examining varroa-infested colonies are safer to use with uninfested bees after being washed;

2. Trucks used in hauling infested colonies should not be used immediately for hauling uninfested colonies without cleaning. Dead bees need to be removed since they can still have living mites on them. The presence of honey on the trucks will stimulate robbing, which will enhance the contact of uninfested robber bees with dead infested bees;

3. Supers, queen excluders and empty frames with or without pollen that were recently removed from infested hives should be stored at least two weeks prior to using them in clean hives.

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Abstract

The ability of *Varroa jacobsoni* Oud. to survive away from a living host was investigated using eight different substrates maintained at 26°C and 13°C. The substrates used were: cloth, wax comb, dead drones (*Apis mellifera*), dead workers (*Apis mellifera*), metal, pollen, wood and no substrate (control).

Analysis of variance indicated that substrate type, temperature and their interactions significantly affected the survival of *V. jacobsoni.* The longest survival was recorded on dead worker bees held at 26°C (71±1.1 h). The shortest survivals were observed on cloth (21±1.3 h), control (21±1.3 h), metal (20±1.1 h) and pollen (18±1.3 h), all maintained at 13°C.

This observation suggests that besides queen shipment and location to location transfer of infested colonies, the movement of used beekeeping tools and equipment, empty combs with or without pollen and even dead bees are contributors to the rapid spread of this parasitic mite.

Key Words:

Longevity, *Varroa jacobsoni*, substrates, U.S.A.

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