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PP-011 [Bee Health]

Nutrition of the honey bee parasite *Varroa destructor*: insights from behavioural and molecular studies

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Introduction

Varroa destructor, major pest of the Western honey bee, infests larval, pupal and adult hosts. As in ticks, the mite follows a feeding sequence [1] that can be broken down as:

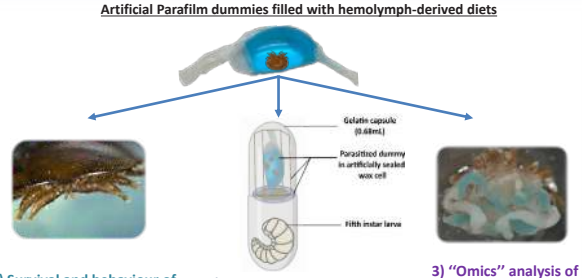
- Host detection that combines appetence and engagement of interactions
- Attachement, host exploration and penetration
- Ingestion, molecular interactions and engorgement
- Separation and meal processing

Many aspects are poorly known, such as host exploration and penetration or molecular interactions, along with their impact on crucial traits of the parasite biology. New methods to explore the parasite feeding biology are needed.

Objective and Methods

- Artificial feeding bioassays were carried out to explore behavioural interactions and survival under controlled conditions.

Artificial Parafilm dummies filled with hemolymph-derived diets



1) Survival and behaviour of artficially-fed mites

2) Reproductive biology in artificial conditions

3) "Omics" analysis of haemolymph-derived diets and gut contents

Results

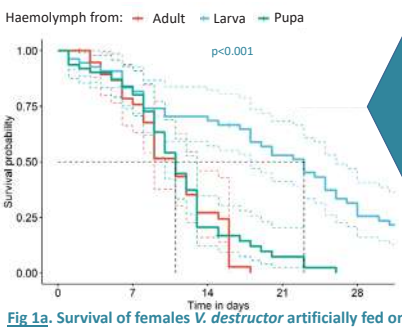


Fig 1a. Survival of females *V. destructor* artificially fed on dummies with honey bee larval, pupal or adult haemolymph [2]

1 Survival and Behaviour

2 Reproduction

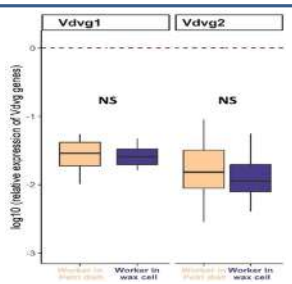


Fig 2. Reproduction (assessed through the expression of Vitellogenin genes) is not triggered in artificial conditions (0 being the natural level when the females lay eggs) [4]

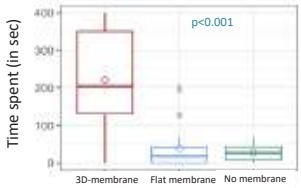


Fig 1b. Amount of time interacting with artificial membranes. Mites interact with a 3D membrane more than with a flat membrane [3]

V. destructor feeding on an artificial diet

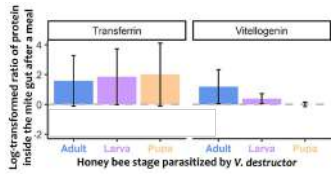


Fig 3b. Example of two major honey bee proteins detected inside mite guts after a meal [5]

Fig 1c. Mites with impaired olfactory organs (*i.e.* varnished forelegs) are still able to detect an artificial food source [3]

3 Omics analyses of diets and mite guts

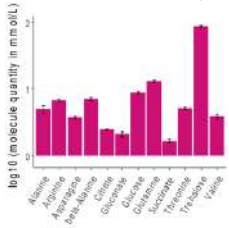


Fig 3a. Log-transformed quantitites of polar metabolites detected through RMN in the larval haemolymph-derived diet [4]

Conclusions

- The mite does not necessarily rely on olfactory cues to feed and can detect artificial 3D shaped membranes.
- *V. destructor* survives for two to three weeks on haemolymph-derived diets; filtered larval haemolymph is the most efficient diet to ensure mite survival.
- Trehalose (a carbohydrate) is the most abundant metabolite detected. Many proteins found in larval haemolymph such as Vitellogenin or Transferrin seem important and can be found abundantly in the mite gut after a meal. The quantity of nutrients depends on the stage parasitized.

Future directions

- This new protocol to explore behavioural interactions and survival paves the way to studies about virus transmission, acaricide efficacy or resistance…
- A better comprehension of the parasite nutritional needs could lead to the development of potential new targets to limit the impact of *V. destructor*.

Sources:
[1] Mans, B. J. (2014). "Heme processing and the evolution of hematophagy," in Biology of Ticks, Vol. 1, 2nd Edn., eds D. E. Sonenshine and R. M. Roe (New York, NY: Oxford University Press), 220–239.
[2] Piou et al. 2023. Hemolymph as a Source of Key Nutrients and Proteins Offers a Promising Medium for *Varroa destructor* Artificial Rearing. *Int. J. Mol. Sci.* 2023, *24*
[3] Piou et al. 2023. *Varroa destructor* relies on physical cues to feed in artificial conditions. Parasite 30, *49*
[4] Piou et al., 2025. Metabolites from honey bee larval hemolymph are essential nutrients for *Varroa destructor* survival but not sufficient to trigger its reproduction. Entomologia generalis
[5] Piou et al. 2024. The proteomic content of *Varroa destructor* gut varies according to the developmental stage of its host. *PLOS Pathogens*, *20*(12), e1012802.

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Varroa destructor is one of the major threats to the Western honey bee Apis mellifera, causing colony weakening in many countries. Relying mostly on olfactive cues, the mite is able to detect suitable host stages to pierce their cuticle and feed on their body fluids. Yet, in artificial environments with few or no odours coming from the bee, V. destructor is still capable of finding a synthetic food source. In our studies, we first explored the behaviour of mites in these artificial control environments. We demonstrated that even deprived from olfactive information, the mite assesses the shape of its substrate to find a proper feeding site. Based on these observations, we developed a feeding device using 3D tube-shaped Parafilm dummies and studied the nutritional requirements of mites. Cell-free honey bee larval hemolymph included into a dummy is sufficient to maintain the mites alive for weeks, which shows that most of their needs are met with nutrients present in the diet. Proteomic and metabolomic analyses ran on these larva-derived diets led to the identification of crucial candidate proteins and metabolites required in the mite physiology. Nevertheless, these nutrients are still not sufficient to trick V. destructorfemales into laying eggs. Altogether, our result shed light on the foraging and nutritional requirements of this major honey bee parasite although further analyses are still needed to explore the link between nutrition and reproduction.