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Revealing insect resistance mechanisms in a host-parasitoid interaction

Samuel Gornard, Isabelle Germon, Véronique Borday-Birraux, Claire Capdevielle Dulac, Laure Marie-Paule Kaiser-Arnauld, Florence Mougel

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① Context & biological material



Female *C. typhae* ovipositing in a *S. nonagrioides* larva



Ovolarval development of *C. typhae* inside a permissive host, at 27°C

- *Sesamia nonagrioides* : lepidopteran stem borer from Africa. European populations diverged from African ones 180 000 years¹ ago and are maize crop pests.
- *Cotesia typhae*² : parasitoid hymenopteran originating from Kenya. Specialized on *S. nonagrioides*, it is a potent biological control agent in France³.

- Makindu *C. typhae* strain has a lower success on French host⁴ (30 %, against 90% on Kenyan host) : the host resists by encapsulating the parasitoid.
- There are differences in wasp strain virulence and host population resistance

Objective : determining the encapsulation dynamic in the resistant host and the targeted parasitoid stage

② Methods

Investigation of host's resistance through 3 methods, which use French hosts parasitized by Makindu wasp and observation under microscope. Various times post-oviposition (TPO) are tested for each experiment.

Dissection

- Ether euthanasia (tissues preservation)
- Dissection and retrieval of eggs, larvae and capsules
- TPO investigated : from 1 to 11 days

Immunology

- Capsule fixation
- Immunolabelling with hemocyte-specific antibodies⁵
- TPO investigated : from 3 to 5 days

Histology

- Paraffin embedding
- 15 µm transversal histological cuts
- Hematoxylin/eosin stain, observation
- TPO investigated : from 1 to 2 days

Control : injection of inert chromatography beads, retrieved by dissection after a TPO varying from 1 hour to 5 days.

③ Results

Dissection

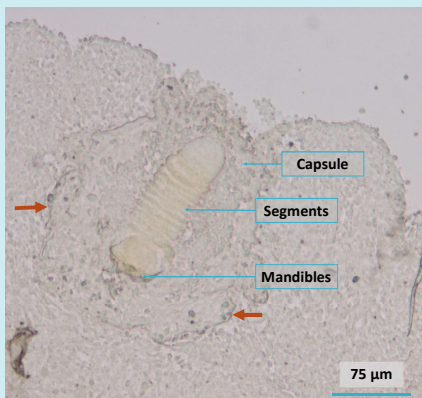
- ✓ Encapsulation targets the eggs
- ✓ Starts on Day 2, completed on Day 5

Immunology

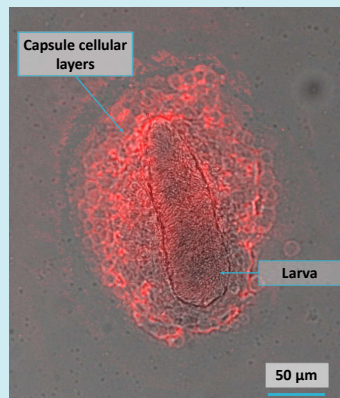
- ✓ Observation of hemocytes building up the capsules

Histology

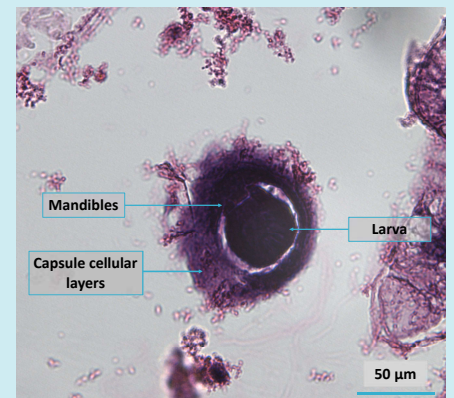
- ✓ Observation of the eggs, larvae, and the capsule's cellular layers



C. typhae larva trapped in a defensive capsule (5 days after oviposition). Encapsulation process is done : the ending basal membrane is visible (red arrows).



Defensive capsule (4 days after oviposition). The larva inside is visible, and only some hemocytes are labelled in red (different populations involved).



Transversal cut of a defensive capsule inside *S. nonagrioides* (2 days after oviposition). The *C. typhae* larva inside hatched from its egg directly into the capsule, and died.

Control : inert beads are encapsulated between 2 and 4 hours after injection, which is way quicker than the eggs. Their capsules melanize, which is not the case for that of the eggs. Host immune resistance remains therefore affected, but not obliterated, by parasitism.

Conclusion : encapsulation in resistant hosts targets the eggs and occurs between 2 and 5 days after oviposition. We could observe the multicellular layers of those capsules and see different hemocyte populations involved. Egg encapsulation is severely delayed compared to normal inert beads encapsulation.

1. Kergoat et al. (2015), Zool. J. Linn. Soc.
 2. Kaiser et al. (2017b), Zookeys
 3. www.cotesbio.org

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4. Benoist et al. (2020), J. Insect Physiol.
 5. Willott et al. (1994), Eur. J. Cell. Biol.

Auteur contributions

This work is part of the thesis project of Samuel Gornard (samuel.gornard@universite-paris-saclay.fr), under the supervision of Florence Mougel and Laure Kaiser. Experiments were conducted at the EGCE laboratory, in collaboration with Isabelle Germon and Véronique Borday-Birraux, and benefited from the advice of Claire Capdevielle-Dulac. We thank Rémi Jeannette and Sabrina Bothorel for their help in the rearings.