Recent collaborative research in France on *Vespa velutina*

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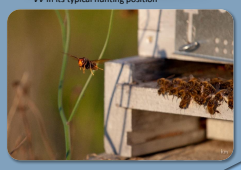
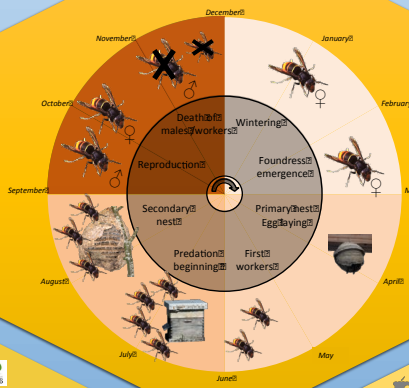
Introduction

Vespa velutina, the yellow legged hornet, was first observed in France in 2004, after being accidentally introduced from eastern China. It has then spread, reaching neighbouring countries such as Spain, Portugal or Italy. This alien is a predator of arthropods, mainly pollinators, especially *Apis mellifera*, and thus deals ecological, economical and societal issues. Several projects have been conducted in France, to enhance our knowledge on this invader and limit its impact. Here, we present the recent outcomes of these collaborative researches.

VV in its typical hunting position



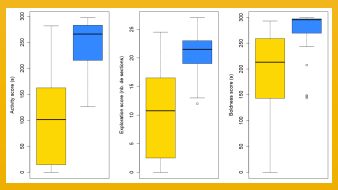
Life cycle



[1]

Behaviour & invasiveness

Comparing the behaviour of *VV* and *VC* can provide valuable information on their invasive characteristics.



n = 26 n = 29

- *VV* outperforms *VC*
- Higher variability in *VC*

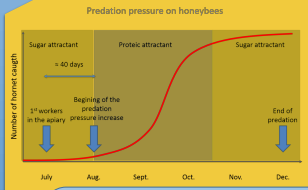
➔ Filter effect of the invasion process ?

[2]

Vespa crabro (VC) *Vespa velutina (VV)*

Experimental apiarie, INRA de Bordeaux

Monitoring



Two monitoring strategies have been tested :

- Queen spring trapping: to decrease the initial populations.
- Worker trapping: to protect apiaries.

Queen spring trapping :

- Water proximity slightly improves the trap efficiency
- Useless if not generalized AND side effects on the entomofauna

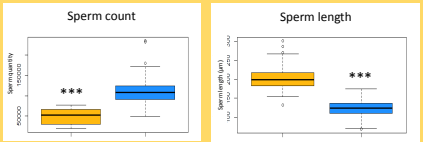
Worker trapping :

- Predation pressure is linked to VV colony size increase
- 40 days delay between the first workers seen in the apiarie and the dramatic predation augmentation

[3] [4] [5]

Fertility of foundresses

After reproduction, sperm is stocked in the spermatheca. At spring season, 204 *VV* and 35 *VC* were dissected to compare their fertility and morphology.



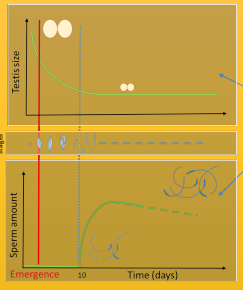
n = 35 n = 182 n = 153 n = 129

Compared to *VC*, *VV* queens

- have 2x more sperm
- have smaller sperm

[6]

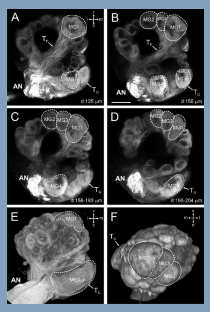
Sexual maturation of males



Male reproducing potential is a key point to understand the control of sex ratio in haplodiploid species.

- *VV* males are not sexually mature before 10 days after emergence
- the spermatogenesis is synchronous

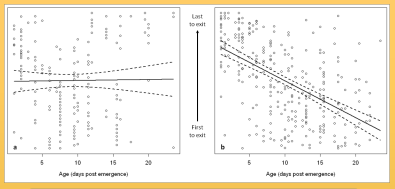
[7]



VV neuronal structure

Nest defense

In social insect, the nest represents the structural basis of the colony and ensure it's survival. Therefore, nest defense is a fundamental behavior that is assumed by the workers. We studied this behaviour in function of the age of workers .



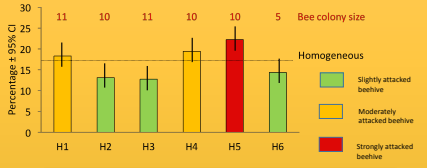
- Nest defence is age-related : older workers are more prone to defend the colony than younger ones
- This relation seems to disappear in queenless colonies

[8]

Hunting behaviour

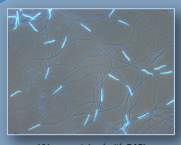
VV hunters capture honeybees in front of the hives. We looked at the attractiveness of different bee colonies given their size.

Distribution of the global hunting VV population between the 6 hives (H)

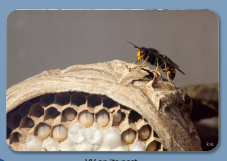


- Predation pressure by *VV* does not seem to be linked to the strength of the honeybee colony.

[9] [10]



VV sperm stained with DAPI



VV on its nest

Honeybee defensive behaviour

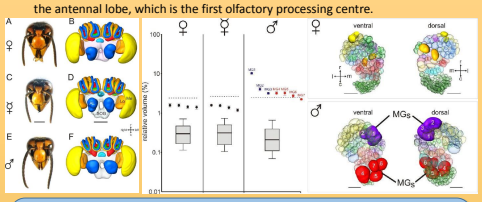
The Asian honeybees, *Apis cerana,* display both efficient defensive and aggressive behaviour against *VV*, like the so called "balling" defense behaviour : several individuals aggregate around the predator. This last behaviour was studied in French honeybees (*Apis mellifera).*

- Some defence behaviours have been observed in French honeybee colonies against VV, but no real protection was obtained, especially due to the low recruitment of defenders.

[11]

Neurobiology

Olfaction plays a crucial role in the social insects behaviour and biology. We studied here the brain's morphology of the different *VV* castes, especially the antennal lobe, which is the first olfactory processing centre.

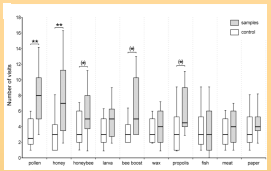


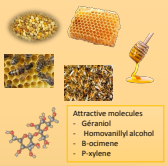
- No dimorphism was found between the female castes (workers and queens).
- Males present a few hypertrophied olfactory glomeruli (macroglomeruli). These neuronal adaptations are thought to process sexual pheromonal signals.
- Identifying molecules which induce activity in males' macroglomeruli might provide good candidates for mating disruption methods.

[12]

Olfactometry

We evaluated the attraction of hornet workers toward their natural food sources (honeybee products, fish, meat). We then tested molecules emitted by these different food sources..





Attractive molecules

- Géraniol
- Homovanillyl alcohol
- B-ocimene
- P-xylene

- VV workers were not especially attracted by the bees themselves, but rather by hive odours (honey, bee aggregation pheromone, queen odours, bee larvae and pollen) which may signal a high prey density.
- Understanding hornets' hunting behaviour and olfactory attraction might help developing techniques for disturbing predation on beehives.

[13]

[1] Monceau, Bonnard & Thiéry. 2014. J Pest Sci, 87, 1–16. / [2] Monceau, Moreau, Poidatz, Bonnard & Thiéry. 2015.Insect Science, 22 , 541-548. / [3] Monceau, Bonnard & Thiéry. 2013. Open J Ecol, 2, 183-191. / [4] Monceau, Maher, Bonnard & Thiéry. 2013. Apidologie, 44, 209-211. / [5] Monceau, Maher, Bonnard & Thiéry. 2015. Bull Entomol Res, 105, 462-469. / [6] Poidatz, Bressac, Bonnard & Thiéry (In prep). /[7] Poidatz, Bressac, Bonnard & Thiéry (In prep). / [8] Monceau, Bonnard & Thiéry. 2013. Insect Soc, 60, 437–44. / [9] Monceau, Bonnard, Moreau & Thiéry. 2015. Insect Sci, 21, 765–774. / [10] Monceau, Arca, Leprêtre, Mougel, Bonnard, Silvain, Maher, Arnold & Thiéry. 2013. PLoS ONE, 8, e66492. / [11] Arca, Papachristoforou, Mougel, Rortais, Monceau, Bonnard, Tardy, Thiéry, Silvain & Arnold. 2014. Behav Process, 106, 122–29. / [12] Couto , Lapeyre , Thiéry , Sandoz, 2016. J Comp Neurol (in press). / [13] Couto , Monceau, Bonnard, Thiéry & Sandoz. 2014. PLoS ONE, 9, e115943.