Unraveling the Mechanisms Driving Transitions to Parthenogenesis in a Ladybug

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What causes the transition to parthenogenesis?

Features associated with transitions to parthenogenesis[1]:

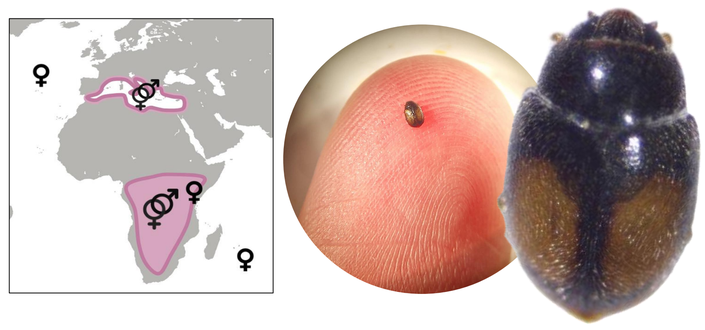
Spontaneous transition:
Mutation in genes associated with meiosis and reproduction

Hybridization:
Consequences of genomic incompatibility from hybridization can induce parthenogenesis

Endosymbiont bacteria:
Bacteria manipulate host reproduction to increase their mother-to-offspring transmission, e.g. *Wolbachia*

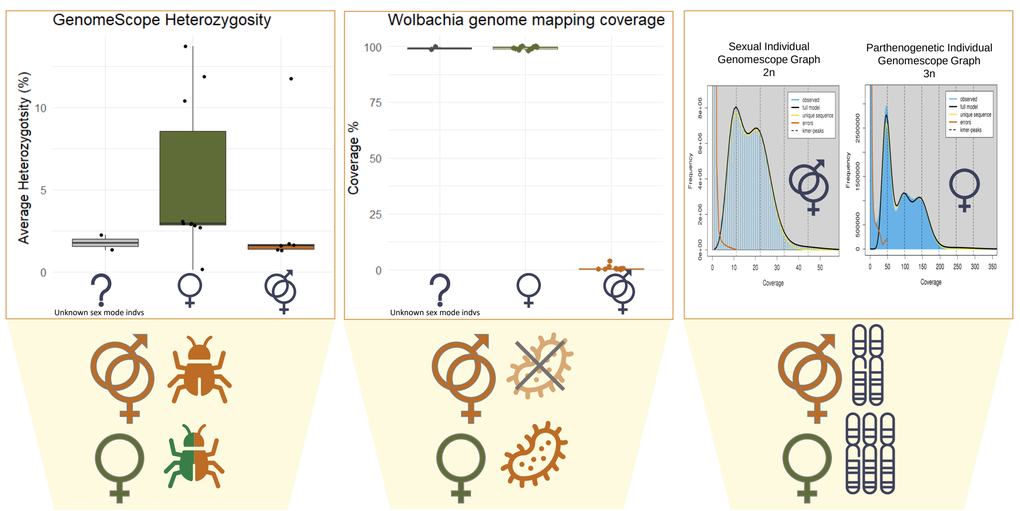
Odd ploidy:
Standard meiosis cannot evenly divide odd numbers of chromosomes. Polyploidy is enriched in parthenogenetic lineages

Sexual and parthenogenetic populations of *Nephus voeltzkowi* discovered[2']



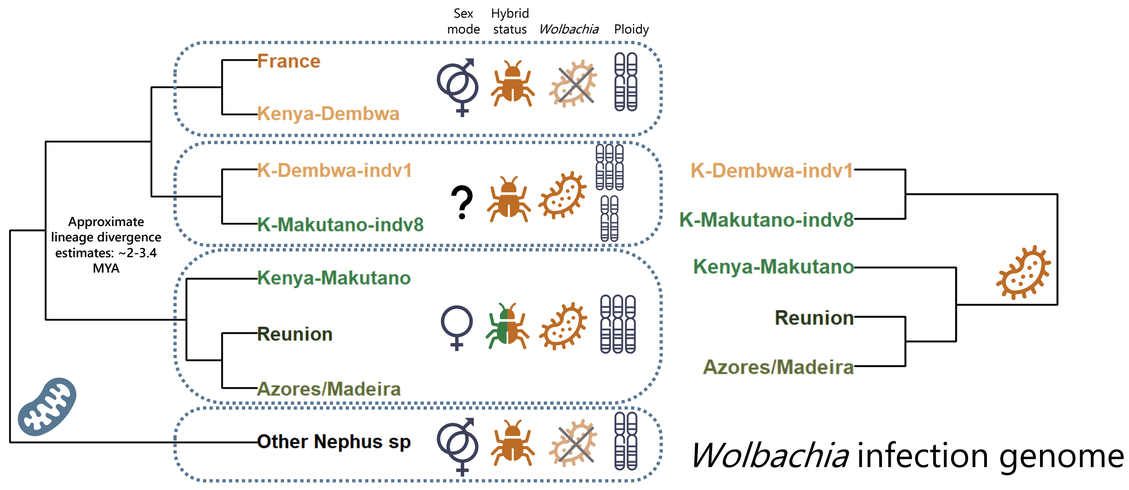
What features could have caused *N. voeltzkowi* to be parthenogenetic?

Parthenogens are **hybrid**, ***Wolbachia*-infected**, and **triploid**



Hybrid status | *Wolbachia* infection | Ploidy

No local strains of *Wolbachia* infection
No horizontal transmission between populations



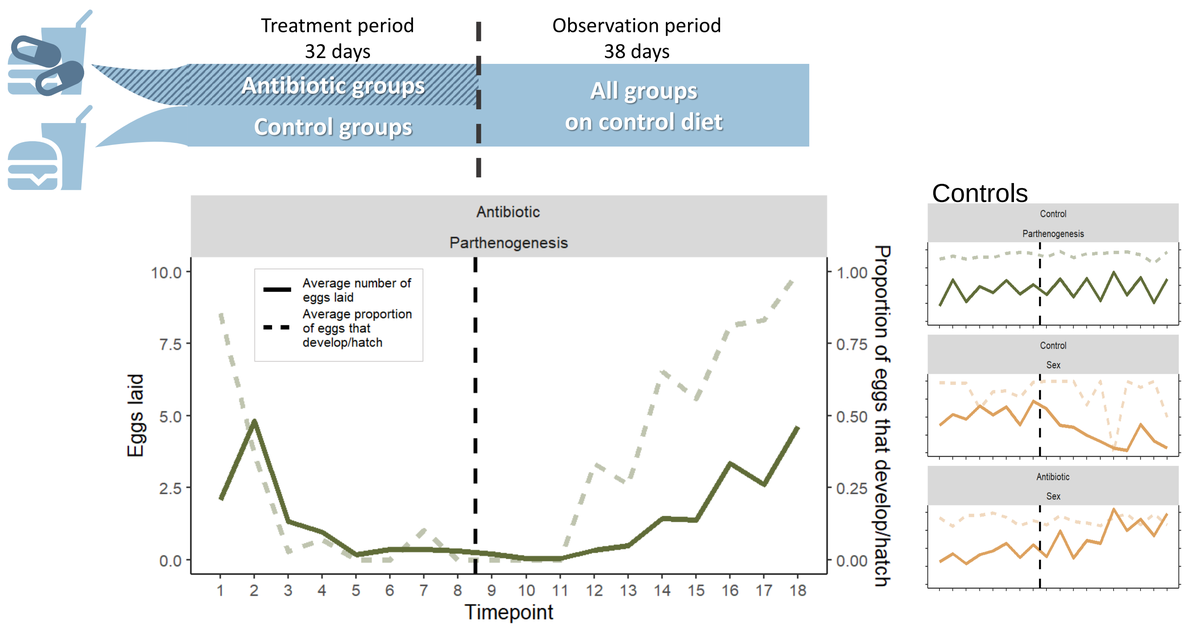
N. voeltzkowi mitochondrial genome

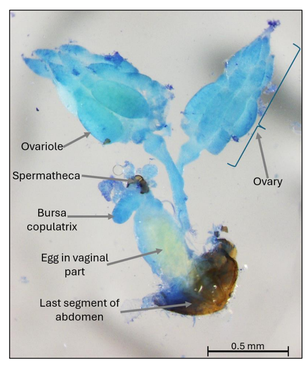
Wolbachia infection genome

What role does *Wolbachia* play in parthenogenetic *N. voeltzkowi* reproduction?

Antibiotic treatment of *Wolbachia*
Reversion of parthenogenesis induction?

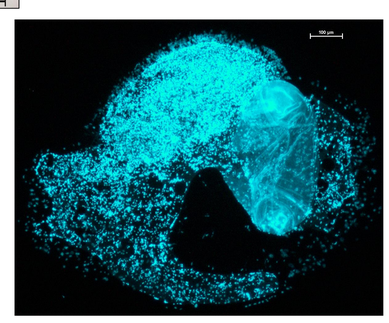
Elimination of *Wolbachia* by antibiotic treatment **reduces egg quality** and eventually **halts egg laying**





Eggs found in ovaries of treated parthenogens
=
Oogenesis not controlled by *Wolbachia?*

Eggs laid with developing nuclei
=
Wolbachia needed for later **embryo development**

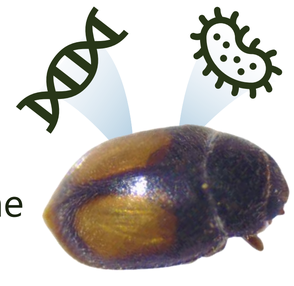


Wolbachia plays a **2-part role** in the reproduction of parthenogenetic *N. voeltzkowi* :
egg laying and **embryo development**

Conclusion

What features could have caused this transition to parthenogenesis?

- Parthenogenetic *N. voeltzkowi* have a unique cooccurrence of multiple parthenogenesis-associated traits in two clades:
  Hybrid + **Triploidy** + ***Wolbachia* infection**
- Further analyses of each trait needed to find the trigger of parthenogenesis



What role does *Wolbachia* play in *N. voeltzkowi*?

- *Wolbachia* needed for successful reproduction in parthenogenetic *N. voeltzkowi*
  - Induced parthenogenesis or coevolved obligate symbiont?
  - First case of *Wolbachia*-induced parthenogenesis in a non-haplo-diploid species?
  - *Wolbachia* plays some role in embryo development

Understanding how these populations of *N. voeltzkowi* transitioned to parthenogenesis can give us a better idea of the circumstances in which this can occur and the consequences of these different traits

1. Tvedte, E. S., Logsdon, J. M., & Forbes, A. A. (2019). Sex loss in insects: Causes of asexuality and consequences for genomes. *Current Opinion in Insect Science*, *31*, 77–83.
2. Magro, A., Lecompte, E., Hemptinne, J. L., Soares, A. O., Dutrillaux, A. M., Murienne, J., Fürsch, H., & Dutrillaux, B. (2020). First case of parthenogenesis in ladybirds (Coleoptera: Coccinellidae) suggests new mechanisms for the evolution of asexual reproduction. *Journal of Zoological Systematics and Evolutionary Research*, *58*(1), 194–208. + authors' pers. obs.

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