The application of taxonomy to applied entomology: genus *Phlyctinus* (Coleoptera: Curculionidae) in South Africa

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PhD Team

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- Dr. Julien Haran (co-supervisor)

- CBGP Team
  - Dr. Gaél Kergoat, Dr. Rémi Allio, Ms. Noémie Hévin, Ms. Laure Benoit

CBGP 2019-2022

Description of five new species in the genus *Phlyctinus* Schoenherr (Coleoptera, Curculionidae): a first step in deciphering the *P. callosus* complex

Julien M. HARAN[1,2,*], Steffan HANSEN[2], Laure BENOIT[3] & Pia ADDISON[4]

Barcoding pest species in a biodiversity hot-spot: the South African polyphagous broad-nosed weevils (Coleoptera, Curculionidae, Entiminae)

Steffan Hansen[‡], Pia Addison[§], Laure Benoit[|], Julien M Haran[|]

Late Cenozoic environmental changes drove the diversification of a weevil genus endemic to the Cape Floristic Region

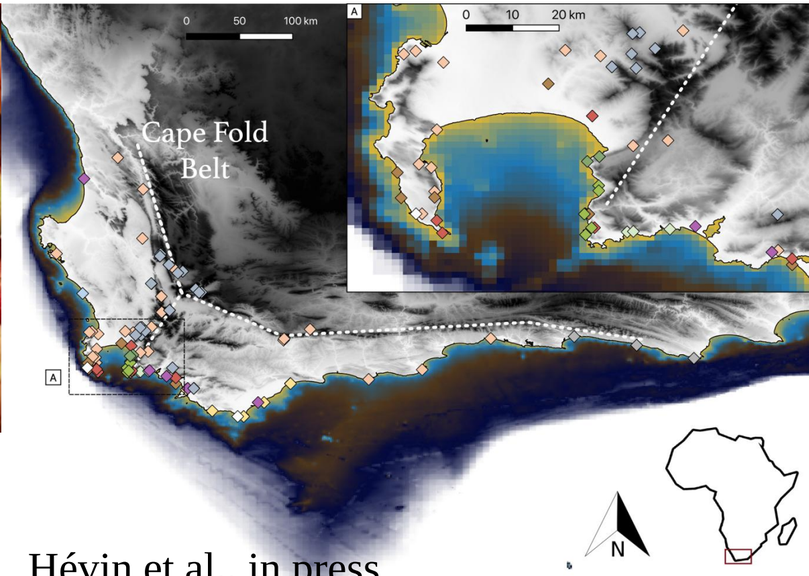
Noémie Hévin[1,2*], Steffan Hansen[3], Pia Addison[3], Laure Benoit[1], Gael J. Kergoat[4] & Julien Haran[1]

The Evil of Weevils

- ***Phlyctinus callosus sensu lato*** (Curculionidae; Entiminae)
  - South African Mediterranean region native

- ***Phlyctinus sp.*** multi-million ZAR problem, apples + grapevines
  - **Adults-**>Primary damage, phytosanitary concern (detected in grape shipments to France 2021)

- Difficult to control
  - Resistance to chemicals
  - Increasing restrictions on chemicals



Barnes, 1989a; Prinsloo and Uys, 2015

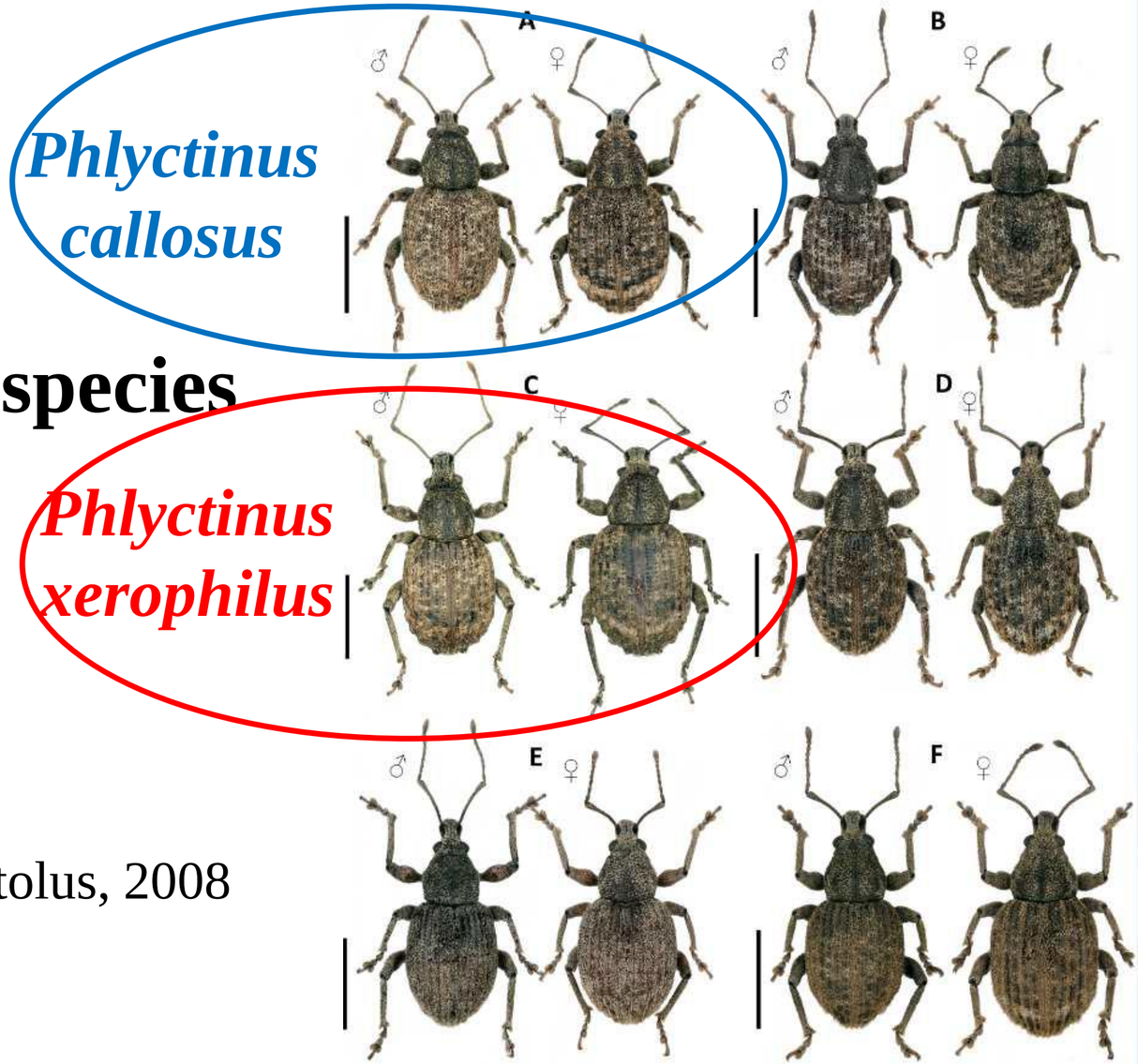
Hévin et al., in press

A Complex Situation

- *P. callosus*-> Long monotypic
  - Actually ≈8 cryptic species

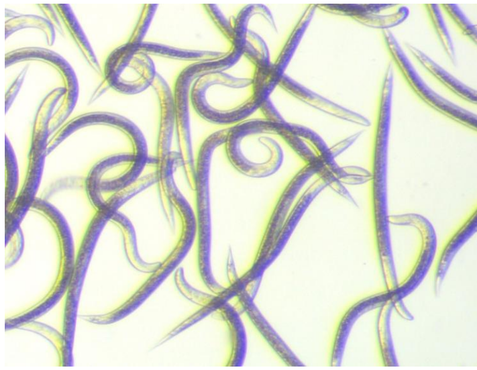
- *P. callosus*, *P. xerophilus*-> **Pest species**
  - Contains distinct lineages

- **Errror Cascades!**
  - Improper taxonomy
    - Unresolved cryptic species
  - Improper species ID

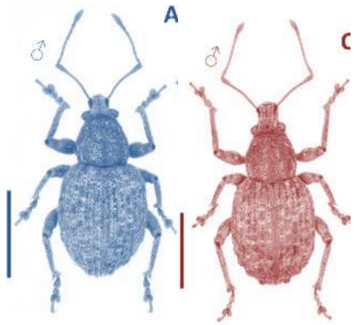


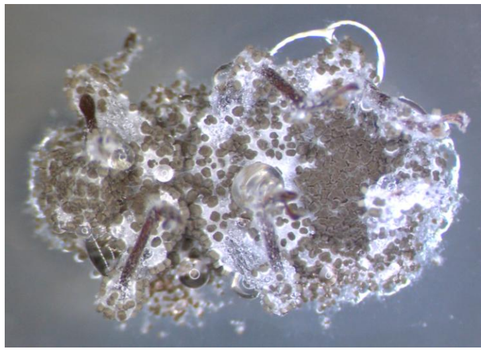
Bortolus, 2008

Application: How Now?



- **SU**->Intense investigation into **Biological Control**
  - **Entomopathogenic nematodes(EPN),**
  - **Fungi (EPF)**





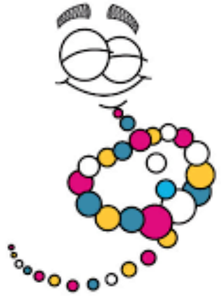
- Aimed at unknown pest species in past (***Pc***, ***Px***?)

- Proper taxonomy **NB** to Bio-Control
  - Closely related tick species ≠ susceptibility to **EPF**

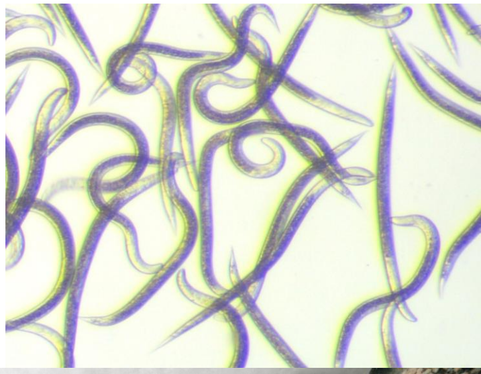
Ferreira, 2010; Dlamini, 2018; Kirkland *et al.*, 2004

PhD Objectives

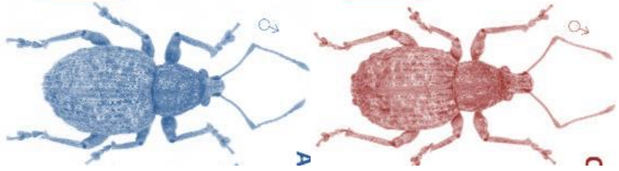
- 1) Barcoding pest Entiminae in South Africa



- 2) Biological Control
  - Lab screening of EPN, EPF against adults, larvae, pupae
  - Semi-field application of select pathogen



- 3) Integrative Taxonomy (***P. xerophilus*** lineages)
  - Geometric Morphometrics (***Px***)
  - Population genomics (***Pc***, ***Px***)



1). Barcoding

- 70 COI sequences, 41 morphospecies

- Mean of Maximum ***intraspecfic*** distances: 2.2%
- Mean of Smallest ***interspecific*** distances: 13.9%

Barcoding Gap

- Deep intraspecific variation, including ***Pc*** (3%), ***Px*** (9.8%)
  - '**Overlumped**' cryptic species decrease ID accuracy

Funk and Omland, 2003; Ross *et al.*, 2008

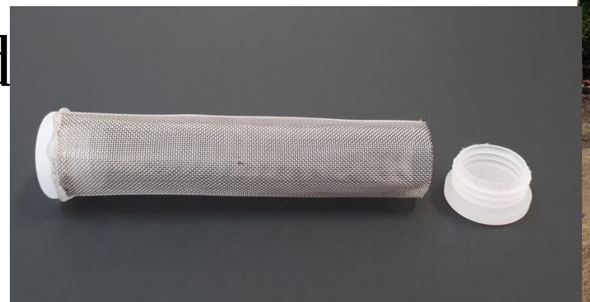
Barcoding pest species in a biodiversity hot-spot: the South African polyphagous broad-nosed weevils (Coleoptera, Curculionidae, Entiminae)

Steffan Hansen[‡], Pia Addison[§], Laure Benoit[|], Julien M Haran[|]

2). Biocontrol

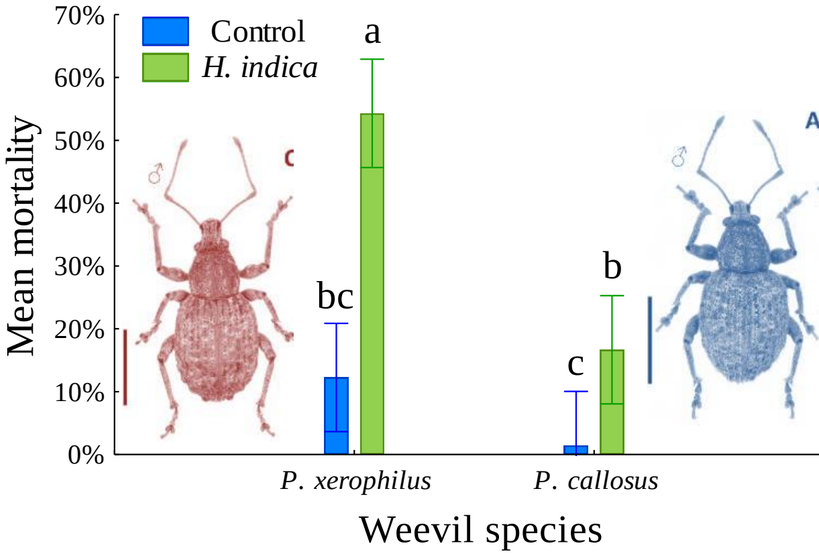
- Laboratory screenings of *P. callosus*, *P. xerophilus*
  - Adults (**EPF, EPN**)
  - Larvae/pupae (**EPN**)
  - 24 well-bioassay plates

- Semi-field trial using **EPN** (*Steinernema yirgalemense*)
  - Apple orchard where both species occur
  - Laboratory-reared larvae
  - Mesh cages buried 10cm, EPN applied



2). Biocontrol Results

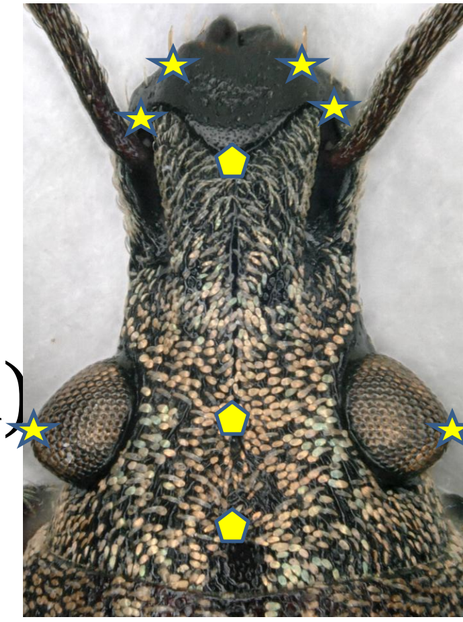
- Adult *Phlyctinus* highly resistant to entomopathogens
  - Soil-living larvae/pupae better control target
- Susceptibility to EPN, EPF: ***Pc*** ≠ ***Px***



- Semi-field trial with EPN indicates promising control method
  - ≈**22%** mortality ***Pc***; ≈**45%** mortality ***Px*** after 6 days

3). Integrative Taxonomy

- Focus on ***P. xerophilus*** lineages
  - ≈4 Genetic/morphological different lineages
    - 1). Barcoding 2). 6 single genes; 3).morphology
  - Important pest species



- Geometric Morphometrics (Procrustes Superimposition)
  - Landmarks on dorsal images of heads

- Population Genomics -> Potential Species Boundaries
  - Dr Rémi Allio, Dr. Gaél Kergoat, Ms Laure Benoit

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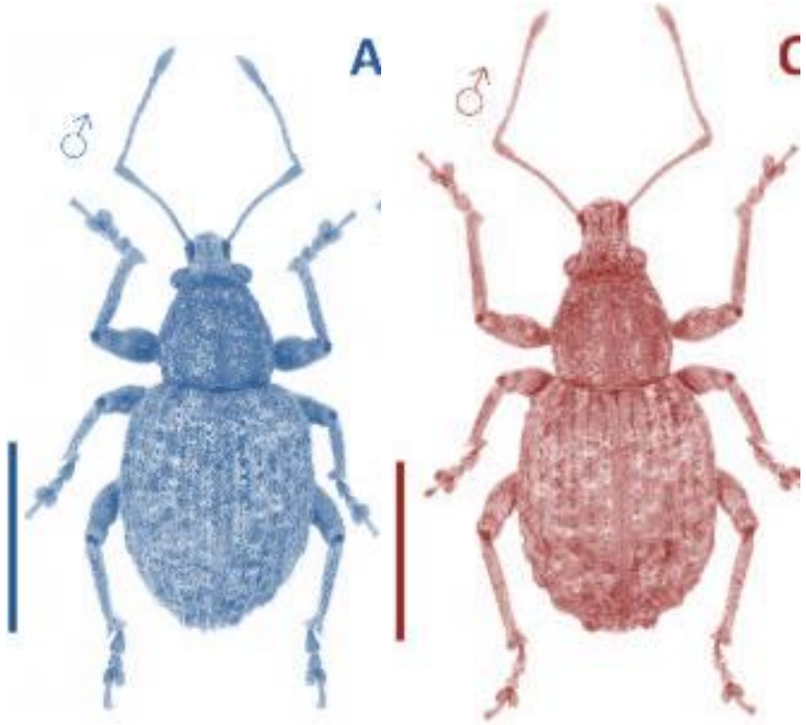
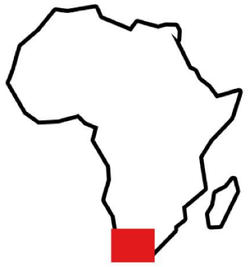
4 populations/species

Represents separate lineages





Perspectives

- Primary taxonomical research is the **first step** to applied studies
  - What are we working on?
  - Presence of cryptic species important for
    - 1).biological control; 2). pest status
  - Can prevent **costly error cascades**
    - **(e.g.** when developing/registering biocontrol products)

Developing **taxonomical skills/projects** are NB to **applied research** and the **agricultural industry**

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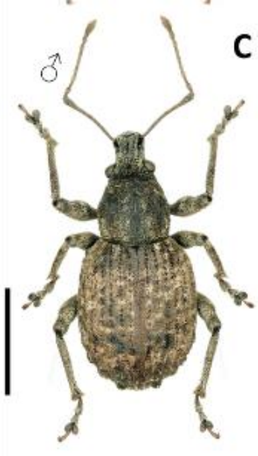

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Key References

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Comments/Questions?

- Merci pour votre attention!

- For any questions or comments on this work, please feel free to contact me on shansen.rsa@gmail.com