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# *Mastrus ridens*' importation in France against *Cydia pomonella*: recapture data and implication of single-locus Complementary Sex Determination in establishment

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## Importation Biological Control (IBC)

Also known as **Classical Biological Control**

The deliberate introduction of an **exotic** biological control agent for its **permanent establishment** and **long-term pest regulation** (Eilenberg *et al.* 2001).

Importation Biological Control

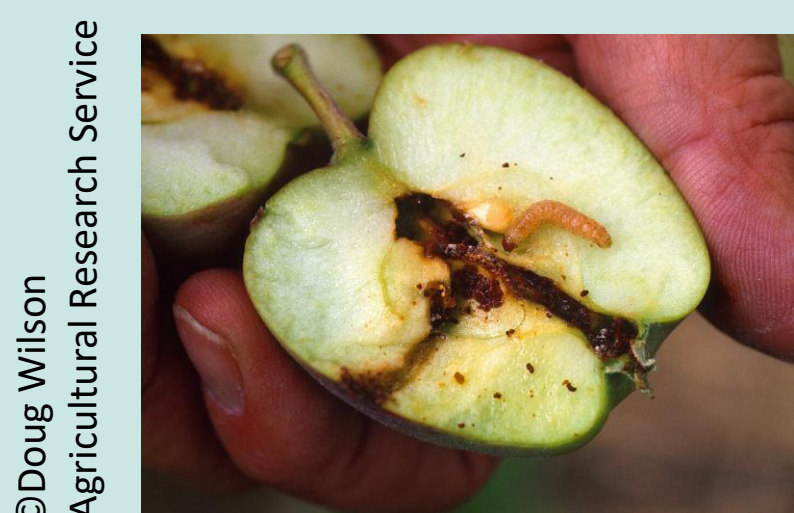
Unique field experiment opportunities

Academic research

Improvement of IBC practices

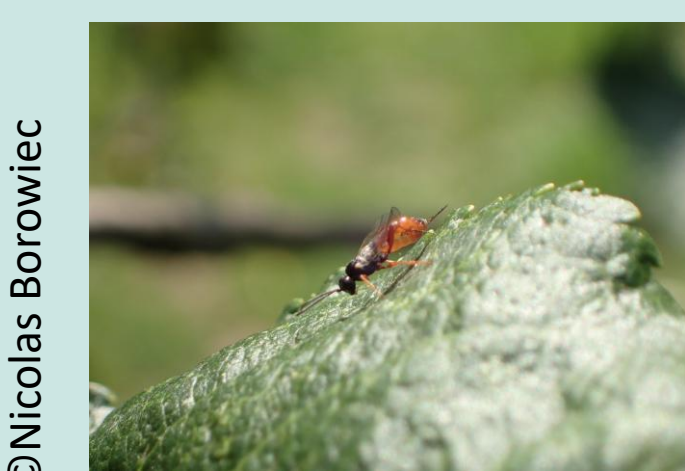
## Operational background

*Cydia pomonella* (Linnaeus) – the codling moth



- Major pest of pome fruits worldwide
- Controlled by broad-spectrum insecticides
- **Originating from Central Asia** (Kuhlmann & Mills, 1999)

*Mastrus ridens* (Horstmann)

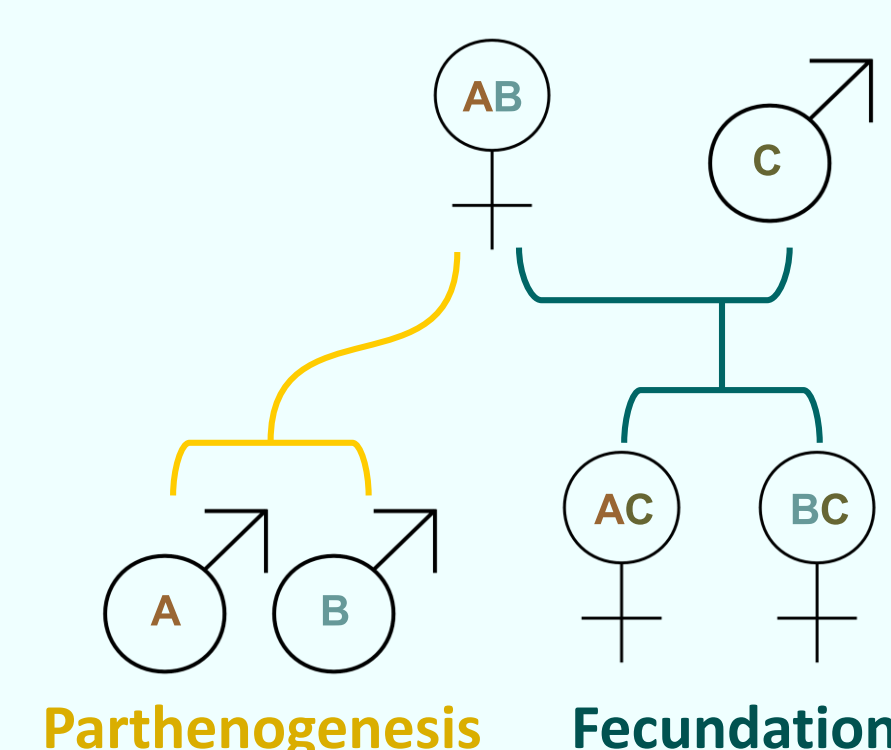


- Gregarious, larval ectoparasitoid
- **Specific** to the codling moth
- **Native to Central Asia**
- Released: USA, Argentina, Chile, Australia, N-Z
- Sex determined by **single-locus Complementary Sex Determination** (Retamal *et al.* 2016)

## Academic background

Single locus Complementary Sex Determination (sl-CSD)

Non-assorted mating



Assorted mating

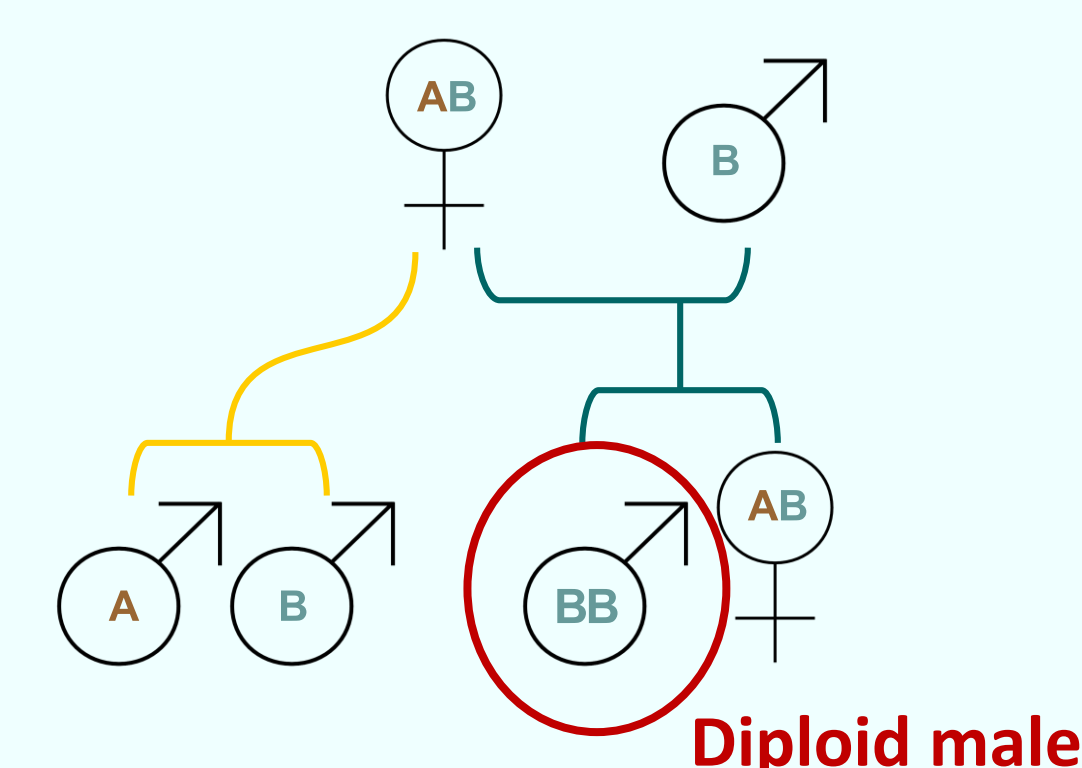


Figure 1 : Mechanism of sl-CSD (A, B, C = different alleles at the *csd*-locus)

- Diploid males are often **non-viable** or **sterile**
- Assorted mating are **more likely** in small or inbred population

**Can *M. ridens* establish in France through an IBC program ?**

**Can low genetic diversity impact *M. ridens*' establishment via its sex determination mechanism, sl-CSD?**

## Methods

### Introduction conditions

- Controls (no introduction) – 6 sites ○
- Propagule size levels
  - 100 females – 3 sites ●
  - 200 females – 52 sites ●
  - 600 females – 4 sites ●
- sl-CSD experimental design
  - Low genetic diversity – 10 sites ◆
  - High genetic diversity – 8 sites ◆
- Recaptures ○

2019 - 2023

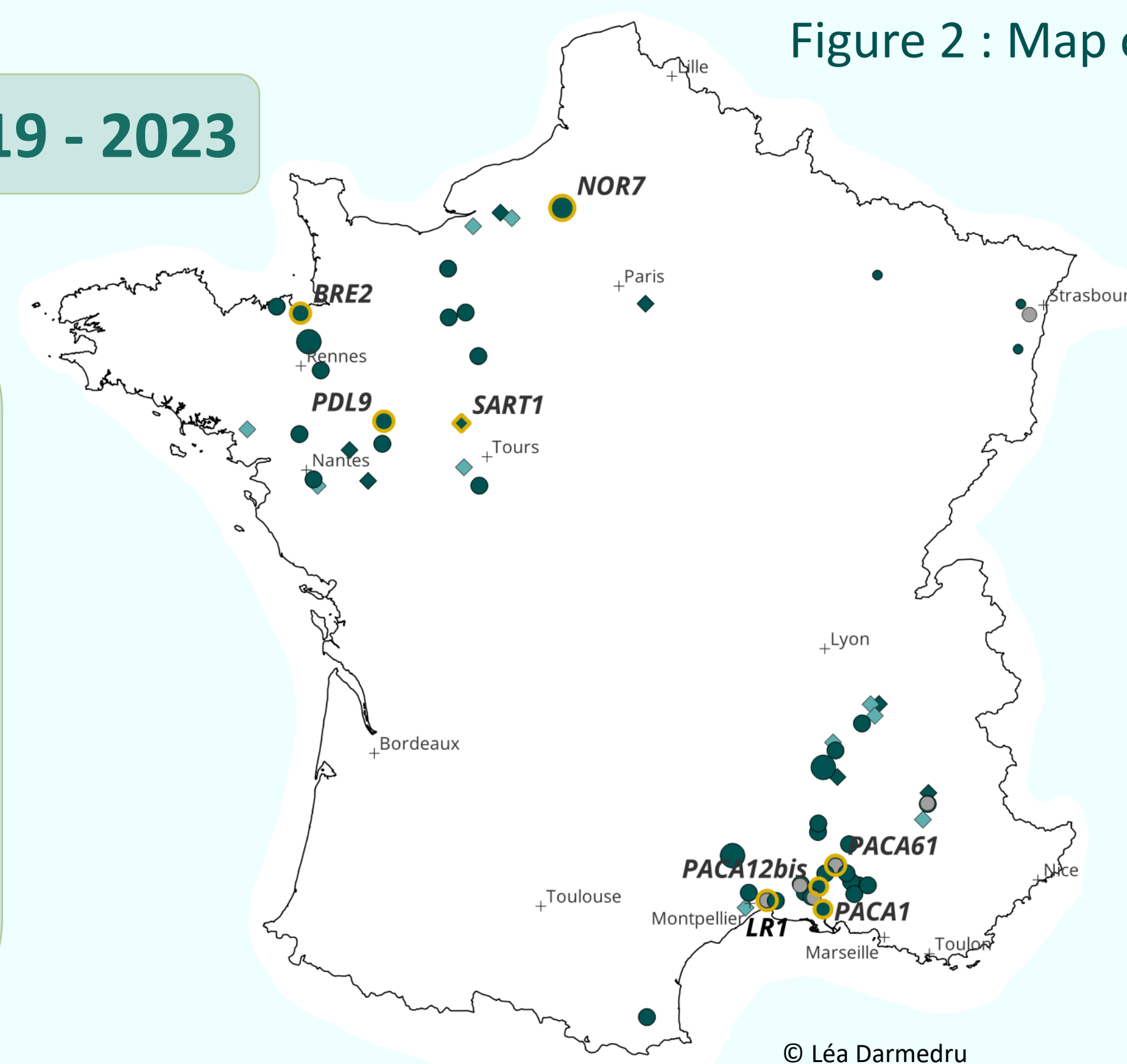


Figure 2 : Map of *M. ridens* releases

### Recapture methods

- Trunk bands (TB)
  - Stripes of corrugated cardboard wrapped around tree trunks
  - Yearly, in end of summer/autumn
- Sentinel larvae (SL)
  - Lab-reared diapausing codling moth larvae
  - Exposed on field in corrugated cardboard rolls

## Results

Table I : Recaptures of *M. ridens* throughout all recaptures campaigns, and related information

Site reference	Release year	Year after release	Recapture method	Propagule size (# females)	Genetic diversity	Number of <i>M. ridens</i> recaptured			
						Adult females	Adult males	Larvae	Total
● LR1	2019	1	TB	200	High	0	3	0	3
● PACA61	2019	1	TB	200	High	2	0	0	2
● PDL9	2019	1	TB	200	High	0	1	1	2
● BRE2	2020	1	TB	200	High	0	8	0	8
◆ SART1	2021	1	TB	200	High	0	2	0	2
● NOR7	2021	1	TB	600	High	0	0	1	1
● PACA1	2019	2	SL	200	High	0	1	0	1
● PACA12bis	2019	2	SL	200	High	0	1	0	1

***Mastrus ridens* recaptures are scarce: no evidence of establishment**

**Few recaptures don't allow conclusion on sl-CSD implications**

Propagule size still too low ?

Recapture methods inadequate ?

Lack of diapausing hosts year-round ?

**What's next ? Local production units will be set up in 3 growing regions, by growers organisations.**

### Bibliography

Eilenberg, J., Hajek, A., & Lomer, C. (2001). Suggestions for unifying the terminology in biological control.  
Kuhlmann, U., & Mills, N. J. (1999). Exploring the biodiversity of Central Asia to assess specialized parasitoids for biological control of apple pests in Europe and North America.  
Retamal, R., Zaviezo, T., Malausa, T., Fauvergue, X., Le Goff, I., & Toleubayev, K. (2016). Genetic analyses and occurrence of diploid males in field and laboratory populations of *Mastrus ridens* (Hymenoptera : Ichneumonidae), a parasitoid of the codling moth. *Biological Control*, 101, 69-77.