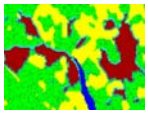
What should we know about *Episyrphus balteatus* to improve the modelling of its individual overwintering survival?

Arrignon, F.; Sarthou, J.P.; Deconchat, M. & Monteil, C.





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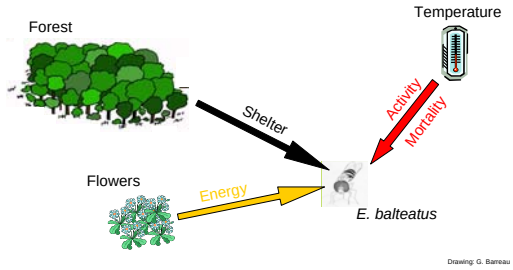
Overwintering sites for *E. balteatus*

- In winter, heterogeneous repartition of *E. balteatus* in the landscape
- More likely found in south edges rather than in north edges and wood centers (Sarthou et al., 2005)
- Other landscape elements may be also important (meadows)

Context and objectives

Factors affecting overwintering success



- Three main factors are concerned.

Context and objectives

How to proceed to estimate these factors?

- Necessity to use a modelling approach:
  - Which one?
  - Build the model: find the key parameters
  - Determine the values of the key parameters:
    - Litterature
    - Expert knowledge
    - Field data
  - Test the model stability
    - Sensitivity analysis

Methodology

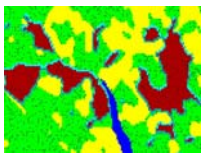
Model choice

- Spatially Explicit and Individual Based:
  - Individual behaviours
  - Tracking the individuals in the space
- Based on a Multi-Agent architecture:
  - Block by block computing
  - Easier to compute complex cognitive behaviours

Model building

Model Spatial Interface

- 2000 individuals evolve in a 650 ha square lattice. (pixel=20m wide)
- 6 landuses are modelled: forest center, north and south forest edges, field, meadow and water.
- Each landuse owns its local climate and its vegetation.
- Vegetation is described by two variables: quantity and quality of flowers.



Model building

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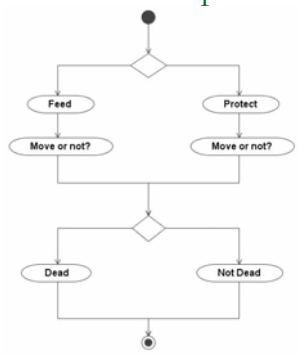
Insect time step

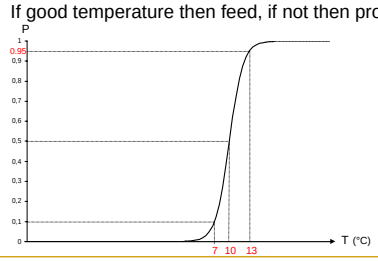


- Each two hours:
  - Feed or protect?
  - Move or not?
  - Dead or alive?

Model building

Feed or protect?

- Night or day?
- Activity probability, adapted from Gilbert (1985):
  - If good temperature then feed, if not then protect



Parameters values

Move or not?

- When protecting: « *is there a better shelter around me?* »
- When feeding: optimal foraging model from McNamara & Houston (1985):
  - estimated Gain rate (G_{n+1}) compared with memorized gain rate (G_n)
  - If $G_{n+1} < G_n$ then « *leave the patch* »
  - Memory effects: possibility to weight the past events according to their age.

Parameters values

Dead or alive?

- When energy < 0 ⟶ P = 1
- Mortality probability depending on temperature, adapted from Hart & Bale (1997)

Parameters values

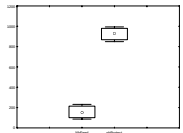
Insect's main parameters table

Name	Description	Origin
Activity probability	**Depending on temperature and « night or day »**	**Adapted from Gilbert (1985)**
Decision of leaving the patch	**Feed: Based on an optimal foraging model** **Protect: « *Better shelter around?* »**	**Adapted from McNamara & Houston (1985)**
Death probability	**Depending on temperature and available energy**	**Adapted from Hart & Bale (1997)**
Perception range = Move capacity	Known environment: a circle around the individual Distance potentially reached by the individual in one time step	Adapted from Mc Leod (1999); field observation
Moving cost	Energy cost when moving	Arbitrary estimation
Feed capacity	How much energy an individual can access in one time step	Arbitrary estimation
Energy stock	How much energy an individual can stock	Field data

Parameters values

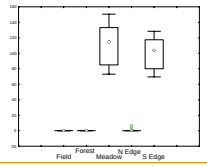
Some outputs of the model

- Activities of the survivors:



⟶ 80% « protect » and 20 % « feed »

- Landscape's elements visited by the survivors:



⟶ Exclusively south edges and meadows, exceptionnally north edges

Outputs and sensitivity analysis

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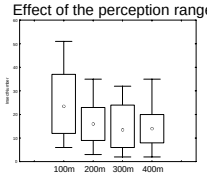
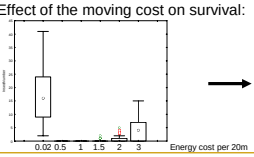
Sensitivity analysis

- Effect of the perception range / move capacity on survival:



→ ↗ Move capacity = ↘ Survival

- Effect of the moving cost on survival:



→ Complex consequences

Outputs and sensitivity analysis

Discussion

- The field patterns are retrieved by the model.
- Moving too much could not improve overwintering success:
  - Depends of the moving cost vs. gain rate after moving
  - Too many moves with middle cost = too much energy spent?
  - More sensitivity analysis are needed to confirm this hypothesis
- Need of more spatial outputs

Discussion

Perspectives

- How to optimize the overwintering of *E. balteatus*?
  - Test of different landscapes:
    - Real
    - Simulated
  - Test of different winter climates

Perspectives

Thanks for your attention !

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