

PROJECT PRESENTATION

Rise of a new Queen

Modelling Queen Succession Dynamics

WFLS24

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PRESENTED BY: GROUP- I

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17-05-2024

A glimpse of nature...



TheNaturalWeb.org



agric.wa.gov.au



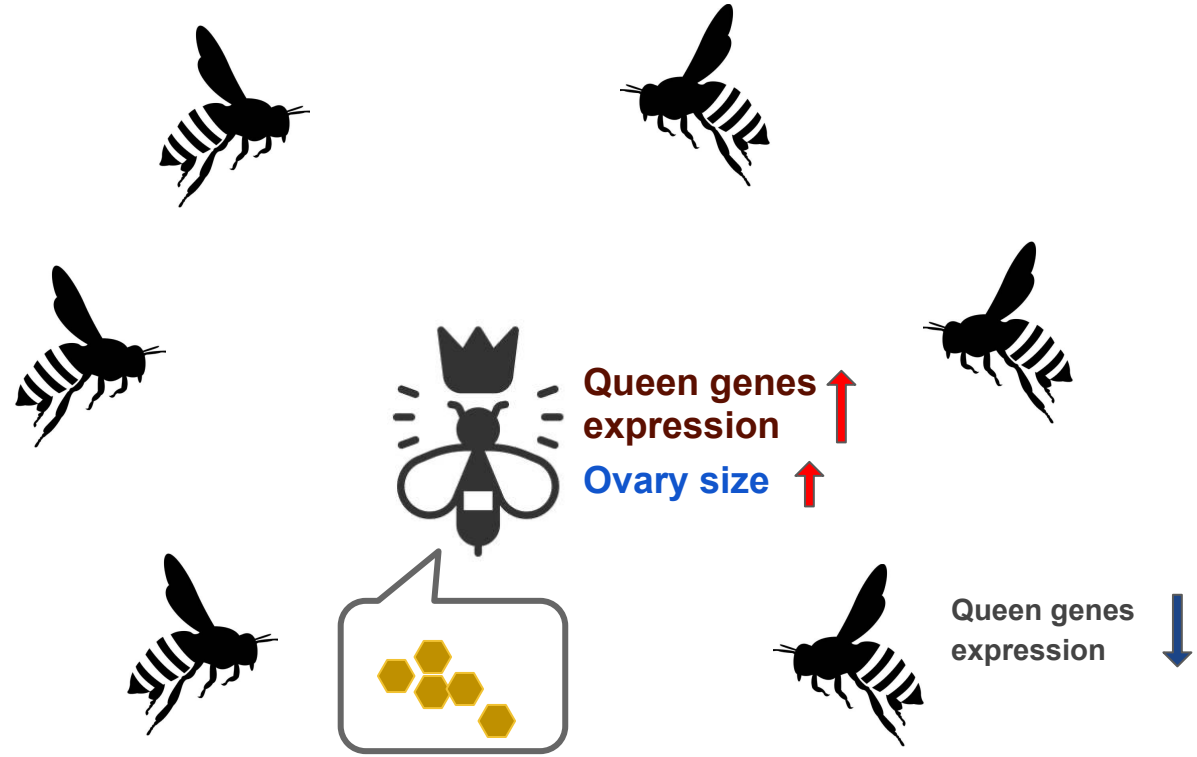
Karen MacDonald

Peeking into the wasp colony

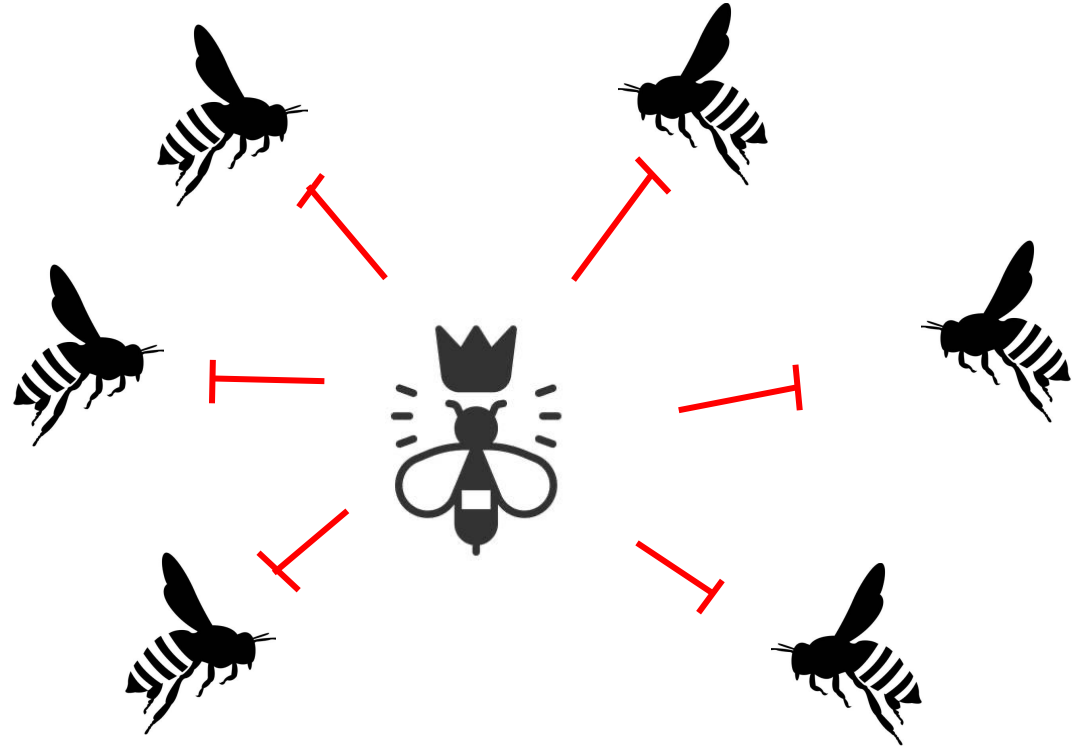


The Queen and the Workers

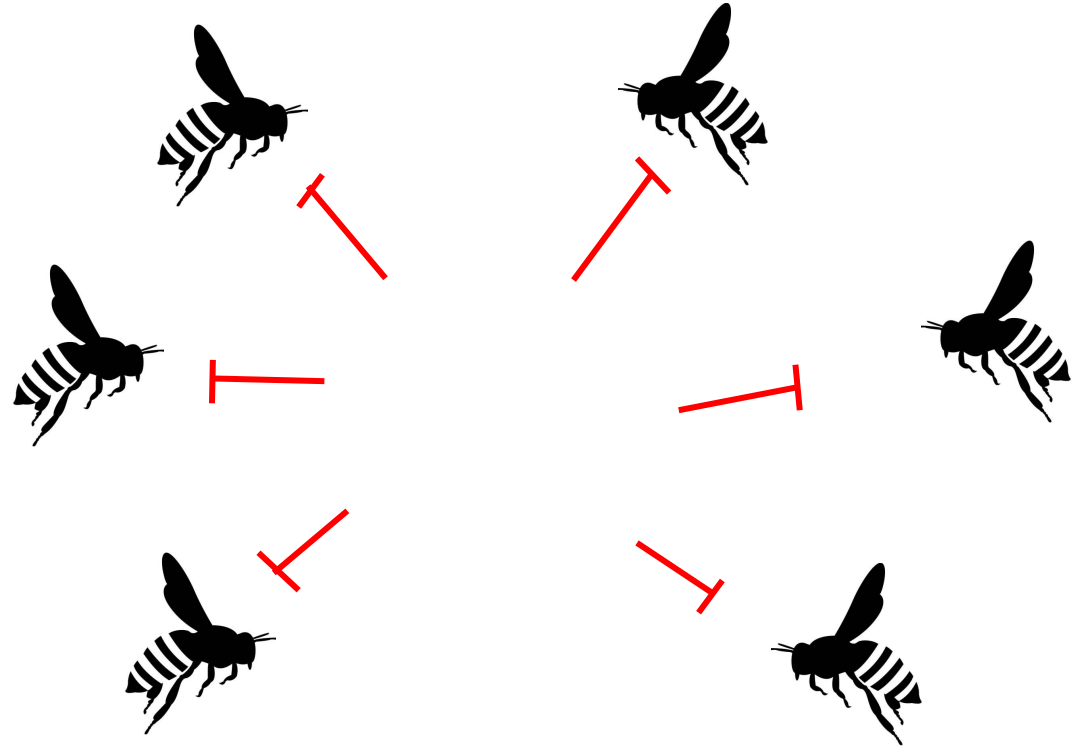
- Genes and expression levels
- Ovary size
- Egg laying



The Queen and the Workers



The Queen and the Workers

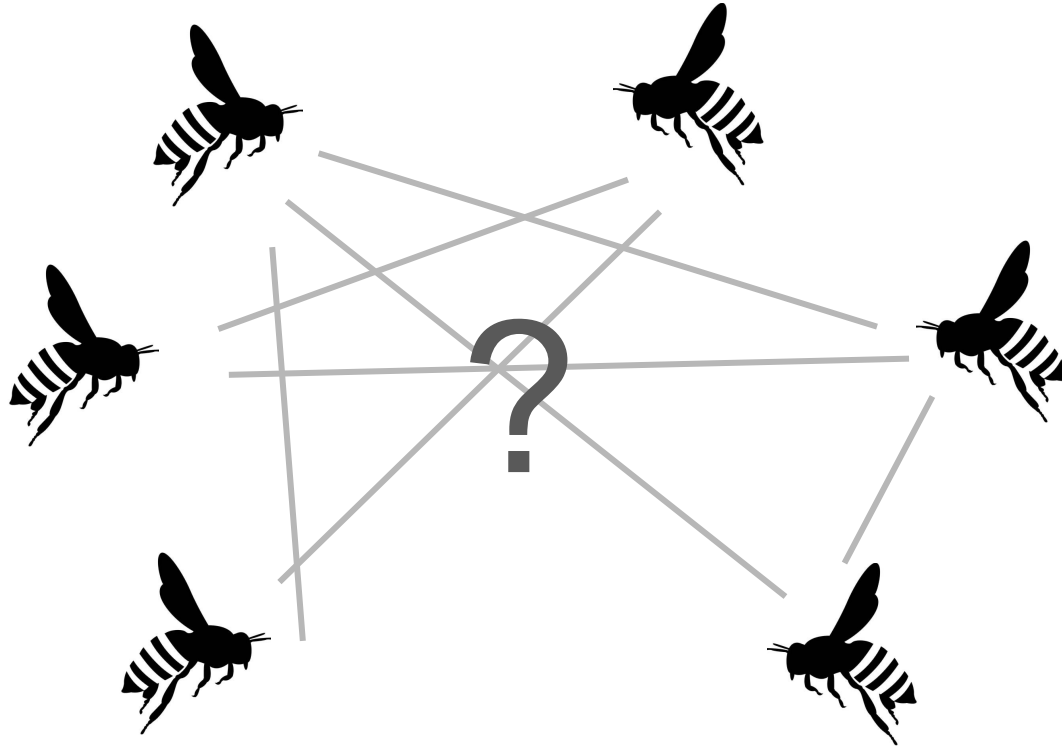


The Queen and the Workers

**Queen genes
expression in workers !**



Who will be the new QUEEN ?



QUESTION

What are the general principles that govern the emergence of a new queen in a wasp species like *Polistes* ?

About the model we used

Agent-based modelling using NetLogo

Why ?

allows individual-level behaviour, emergent properties

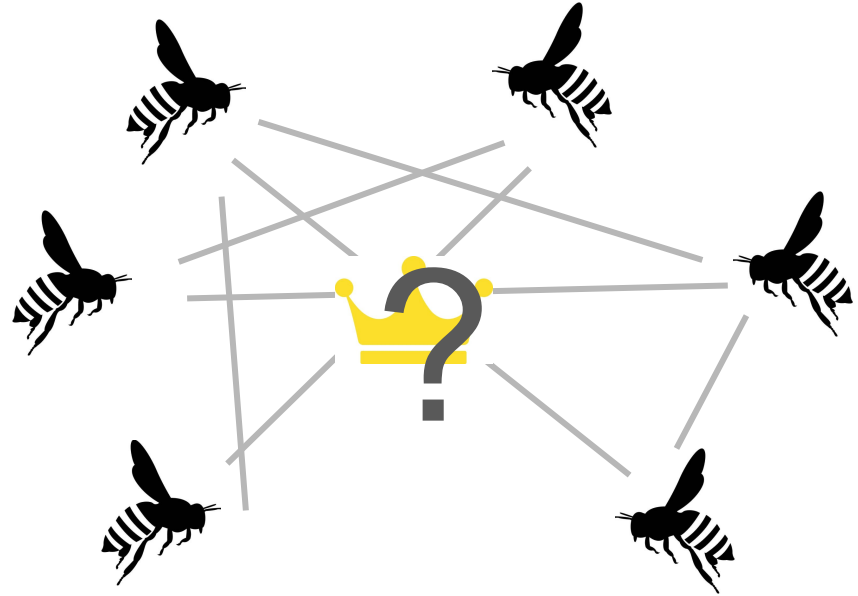
can be modified to simulate experiments

Modelling the Queen Succession Dynamics

Agent-based modelling using NetLogo

Our basic system

'aggression' and
'Queen-gene expression
values' as parameters



About the Model

ASSUMPTIONS

- Closed system
- After QUEEN removal, queen genes expression levels are equal in all worker wasps
- Aggression level among individual is random
- Movement of individual wasp \propto aggression level
- Queen gene expression level in a wasp decreases after interacting with a more dominant wasp

About the Model

Wasp colour in simulation

Yellow - normal worker wasp

Red - wasp with highest expression of queen genes

Logic behind the model

- **Turtle Properties and Globals:** Defines turtle properties including a neighbor flag, aggression, and Q-gene expression level. Globals include the turtle with the highest Q-gene expression and a timer for color changes.
- **Setup Initialization:** Initializes the environment, creating 'n' turtles with random aggression between 0 and 1, a Q-gene expression level of 1, and placing them randomly.
- **Main Loop (go):** Turtles move and interact each tick, either exploring or engaging with neighbors based on their proximity.
- **Neighbor Interaction:** Turtles turn and move away if they find a neighbor, with movements influenced by their aggression levels.
- **Interaction Mechanics:** When turtles meet, they evaluate dominance indices based on aggression and apply a Metropolis-Hastings acceptance rule to determine interaction outcomes.
- **Aggression Adjustment:** After an interaction, turtles adjust their aggression levels based on whether they "won" or "lost," ensuring values remain within [0,1].
- **Q-gene Expression Adjustment:** Turtles modify their Q-gene expression levels post-interaction, decreasing it if they "lost," ensuring it does not drop below 0.
- **Dominance Index Calculation:** Dominance indices are calculated using a scaled Metropolis-Hastings acceptance rule based on the aggression levels of the interacting turtles.
- **Highest Q-gene Turtle Check:** Periodically (every 100 ticks), identifies the turtle with the highest Q-gene expression and changes its color to yellow, resetting others to red.

Simulations

Additions we would like to make to the model

Add more parameters other than 'Aggression' which affect the 'Q-gene expression levels' which have reported to be important in determining the successor - Examples include Amount of spatial overlap, Amount of solid and liquid food exchange.

Other vague questions we wanted to get at but didn't :)

- How does 'robustness' of Queen successor line get established in a species like *Ropalidia marginata*? How does this robustness get affected when some kind of stochastic effects are added to the model itself?
- How does connectogenesis work in neuronal networks and what cues and interactions would one have to imbue into the model to reflect reality

ACKNOWLEDGEMENT

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THANK YOU