Dynamics of Rafting in Fire Ants
Outline

- Background (Motivation, Research, Theory)
- Experiment (Set-up, Procedures)
- Results (Same Colony, Different Colony)
- Discussion (Limitations and Improvements)
- Conclusion
- What else?
Motivation

Fire ant is an interesting species due to their cooperative behavior not commonly seen, such as formation of a colony, collective foraging, or forming a raft when a large number of ants is stranded in water. The formation of such raft has already been studied, but not much has been done on the merging of two separate rafts. There are many questions which can be asked in this aspect. For example, what is the dynamics between 2 separate colonies? This is the biggest mystery which we will be trying to unravel.
Study that have been performed

Fire ants self-assemble into waterproof rafts to survive floods (Nathan J. Mlot, Craig A. Tovey, David L. Hu)

- Single colony

- Cohesive strength, Water Repellency/Buoyancy, Construction Rate, Fluid like properties of the ants
Modeling Single Colony Spread

From the paper by Nathan J. Mlot, Craig A. Tovey, David L. Hu

Number of ants in the bottom layer versus time is sigmoidal

A wetting model didn’t work and the reason cited was that ants had a source of kinetic energy other than through the gravitational potential

Random Walk model utilised to find the rates of how often ants from the moving layer join the bottom ‘raft’ layer
Modeling Single Colony Spread (2)

\( n(t) \) : Number of ants in bottom layer, \( N \) : Total number of ants, \( h \) : eventual number of layers (~2.5 across colonies) computed as \( N/n(\infty) \)

1st regime: Initial rapid expansion when a whole top layer is mobile

2nd regime: Slowed expansion when only \( N - h \cdot n(t) \) ants are mobile

\[
\frac{dn}{dt} = \begin{cases} 
\beta \sqrt{n(t)} & \text{if } n(t) \leq N/(h+1) \\
\beta(N - hn(t))/\sqrt{n(t)} & \text{if } n(t) > N/(h+1). 
\end{cases}
\]
What are we going to do?

For our experiment, we are intending to build upon just one component of the paper which is construction rate of rafts. To be more specific, we are going to investigate the dynamics of merging 2 different rafts into a single raft.

We will be considering two different cases of mergers: same colony and different colony.
Step by Step

1) Grab some ants from 1 colony and put into one test tube

2) Grab ants from same/different colony and put into different test tube

3) Shake well and make sure the ants clump into a ball before dropping it into a tub of water (do for both tubes)

4) Start recording and watch the show!
Merging rafts - Same colony

- Video separate
Merging raft - Different colonies

- Video separate
Control - Ants on Land

- Video separate
Image Analysis
Same colony merger: Area vs. time
Different Colony Merger: Area vs. time

![Graph showing the normalized area over time for different colony mergers.](image-url)
Analysis

- Different colony rafts don’t stay homogenous; can sometimes tell two distinct regions
- Sometimes raft can even be separated
- Same colony rafts become a final shape within five minutes of merging
Limitations

-Time

-Colony sizes (possibly affect the formation of rafts)

-Behaviour doesn’t stay constant

-Painting of ants were too inefficient

-Possibility of eusocial behaviour (division of labour - maybe even in raft formation)
How to improve?

- Run more trials
- Find a more efficient way of marking the ants
- Up the scale of the experiment by starting with a greater number of ants
- Model the merging of different colony rafts and compare to mixing of oil and water
Conclusion

When in water, it is harder for two colonies to fight since their motion is limited, probably due to limited space. However, some local fights still happen, and ultimately it is harder for different colony rafts to merge than same colony rafts.
What else can we do?

- Determine the type of interaction between different colonies under other different conditions (presence of their queens? limited resources?)

- Correlation between number of ants and time they are able to survive on water

- Pheromones tracking

- Ant raft in different fluids

- Use PIV to track ants motion on top of raft; ants seem to move faster in the different colony case
Here in the entomology department, we have a simple two-step formula for answering any question: (1) ants are cool, and (2) we forgot the question because we were thinking about ants.