DATA *Nugget*

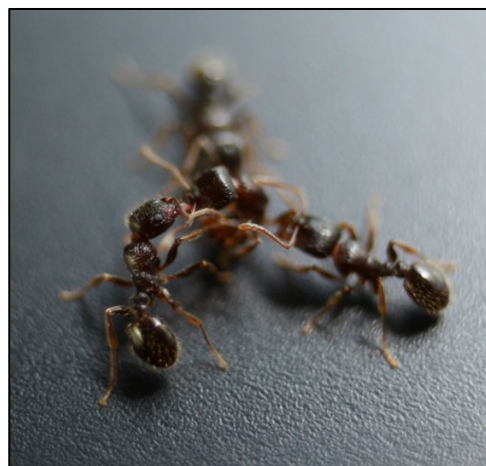**Ant wars!**
Featured scientists: Andrew Bubak, Jazmine Yaeger, John Swallow, and
Michael J. Greene from the University of Colorado-Denver;
Kenneth Renner from the University of South Dakota. Written by: Gabrielle Welsh

Research Background:

The ants crawling into and out of cracks along
sidewalks are called pavement ants. They live in
groups called **colonies**, which are made up of a few
queens and many worker ants. A colony lives
together inside a **nest**, a physical structure. Worker
ants use their antennae to touch the bodies of other
ants. Certain chemicals tell them if the ant is from
their colony or a different colony. **Nestmates** are
ants from the same colony, and **non-nestmates** are
ants from other colonies.

Three pavement ants touch antennae to
determine if they are nestmates. Photo
courtesy Michael Greene.

Neighboring colonies often compete for food,
leading to tension. If an ant finds a non-nestmate, it
organizes a large war against the nearby colony.
This results in huge sidewalk battles that can
include thousands of ants fighting for up to 12 hours! These ant wars often involve
worker ants grabbing body parts of non-nestmate ants.

Andrew, Jazmine, John, Mike, and Ken all work together to study the social and
chemical cues that drive behaviors in animals. They were curious to learn more about
the triggers that lead to colony wars. Worker ants don't have a leader, so the scientists
wanted to know how large wars are organized. The team started by reading lots of
research articles and learned that there are several factors that may affect an ant's
decision to fight. These include the odor of other ants they meet, the size of the ant's
colony, and the season. The team also knew from their own experiments that if an ant
meets a fellow nestmate before meeting a non-nestmate, it was more likely to fight.

All of this information helped the team realize that interactions with nestmates were an
important part of the decisions that start ant wars with non-nestmakes. To build on this,
they wanted to know whether the decision to fight was affected by **ant density**, which is
the number of ants within an area. They thought that at higher densities the ants would
be more likely to interact, leading to more fights with non-nestmates. If more wars are

observed at higher ant densities, increased interactions with nestmates might be part of the story.

To answer their question, the team collected ants from different colonies in Denver, Colorado for two separate experiments. They brought them back to the lab to set up trials in a plastic tank arena.

A colony war involving thousands of pavement ants. Photo courtesy Michael Greene.
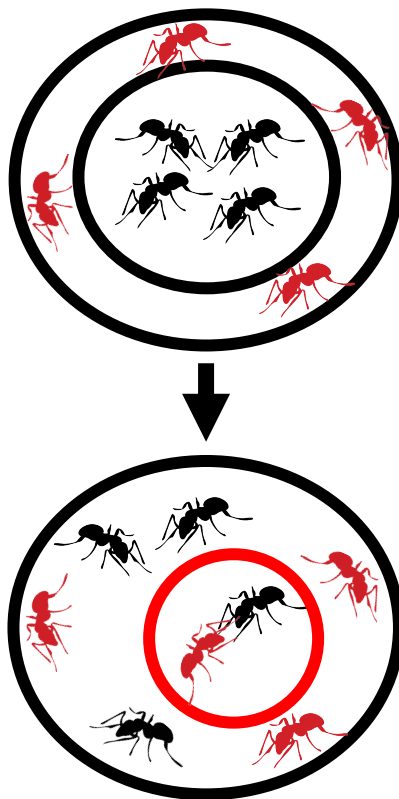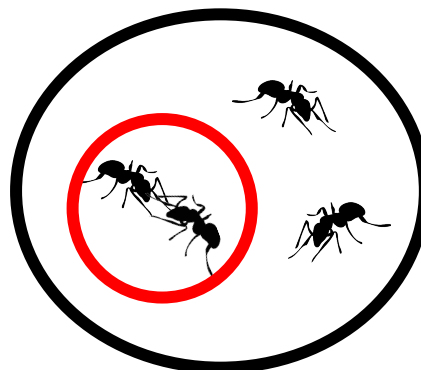

Setup for Experiment 1, shown with a density ratio of 4:4. Black ants are from one nest and red are from another nest. The red circle highlights a fight between non-nestmates.

Experiment 1: For the first set of behavioral trials, the researchers varied the number of ants in the tank, ranging from 2 to 20 ants. The size of the tank remained constant, and there were always equal numbers of nestmates and non-nestmates. This means the ratio of nestmates to non-nestmates was always 1:1, but the density varied by how many ants were included in the experiment. They performed 18 trials for each density treatment in their experiment.

At the start of every trial, ants from each colony were in separate areas so that they could interact with nestmates first. Earlier work had shown that when ants in each area interact, they touch antennae to another ant's body. These interactions create a brain state that makes an ant more likely to fight an ant from another colony. Then the scientists removed a barrier revealing the ants from the other colony. They watched the ants for 3 minutes. During that time they recorded the number of ants that were fighting. This way they could compare how likely the ants were to fight at different densities. They predicted there would would be more fighting at higher ant densities.

Experiment 2: The scientists also wanted to measure the effect of density on the interaction rates between just nestmates. This experiment allowed the scientists to understand how the rate of interactions affected levels of neurochemicals in brains, creating the brain state that increased the likelihood that an ant would be aggressive. For these trials, they placed different densities of nestmate ants in a tank. They randomly picked an ant during each trial and counted the number of times it contacted a nestmate ant. Different groups of ants were used in each trial and each experiment. They observed the number of interactions at different densities and expected nestmate ants to have more interactions at higher densities.

Setup for Experiment 2, shown with a density of 4 nestmate ants/arena. The red circle highlights an interaction between nestmates.

Scientific Question: In pavement ants, how does ant density impact the decision to engage in fights with ants from another colony?

What is the hypothesis? Find the hypothesis in the Research Background and underline it. A hypothesis is a proposed explanation for an observation, which can then be tested with experimentation or other types of studies.

Scientific Data:

Use the data from Experiment 1 and 2 to answer the scientific question:

Data from Experiment 1: Effect of Ant Density on Tendency to Fight

Ant Density ratio Colony A: Colony B	# of trials with fighting (out of 18)	Percent of trials with fighting
1:1	3	
2:2	8	
3:3	10	
4:4	11	
5:5	13	
6:6	15	
7:7	17	
8:8	17	
9:9	17	
10:10	17	

Which data from Experiment 1 will you graph to answer the question?

Independent variable: _____

_____

Dependent variable: _____

_____

Data from Experiment 2: Effect of Ant Density on Interaction Rate

# of nestmate ants	Interaction rate (interactions/min)	# of nestmate ants	Interaction rate (interactions/min)
2	10	8	21
2	3	8	12
2	5	8	16
2	4	8	37
2	9	8	21
2	9	8	24
2	9		
4	10	10	15
4	8	10	16
4	9	10	26
4	14	10	14
4	19	10	30
4	15	10	25
4	10	10	39
6	14	20	18
6	14	20	25
6	11	20	13
6	20	20	38
6	19	20	45
6	24	20	47
6	18	20	26

Number of Ants	Area of arena (cm^2)	Ant density (# ants/area of arena)	Average interaction rate (Interactions/min)
2	56.5		
4	56.5		
6	56.5		
8	56.5		
10	56.5		
20	56.5		

What data from Experiment 2 will you graph to answer the question?
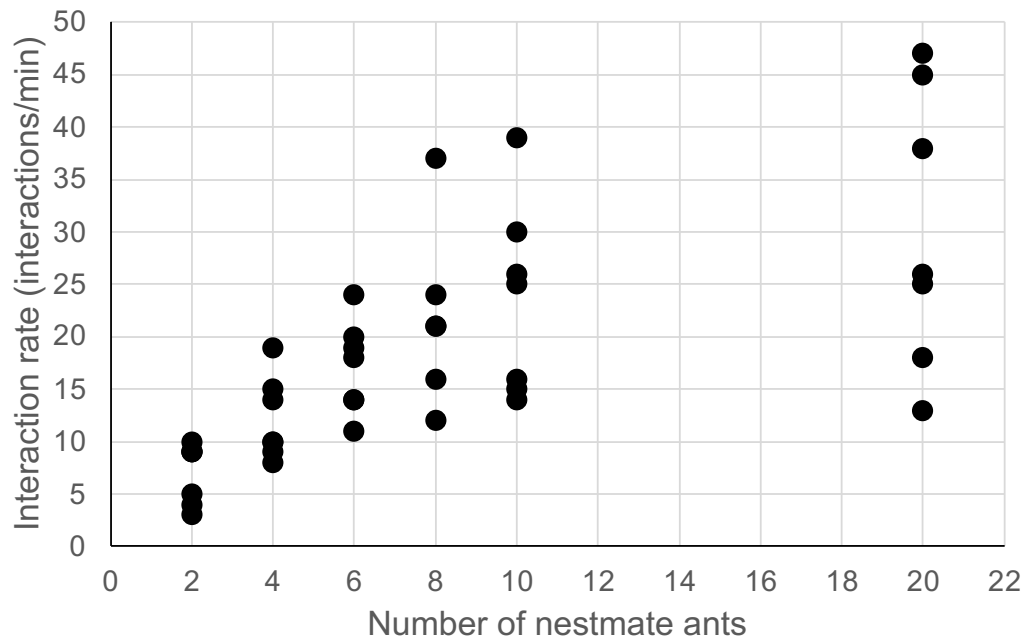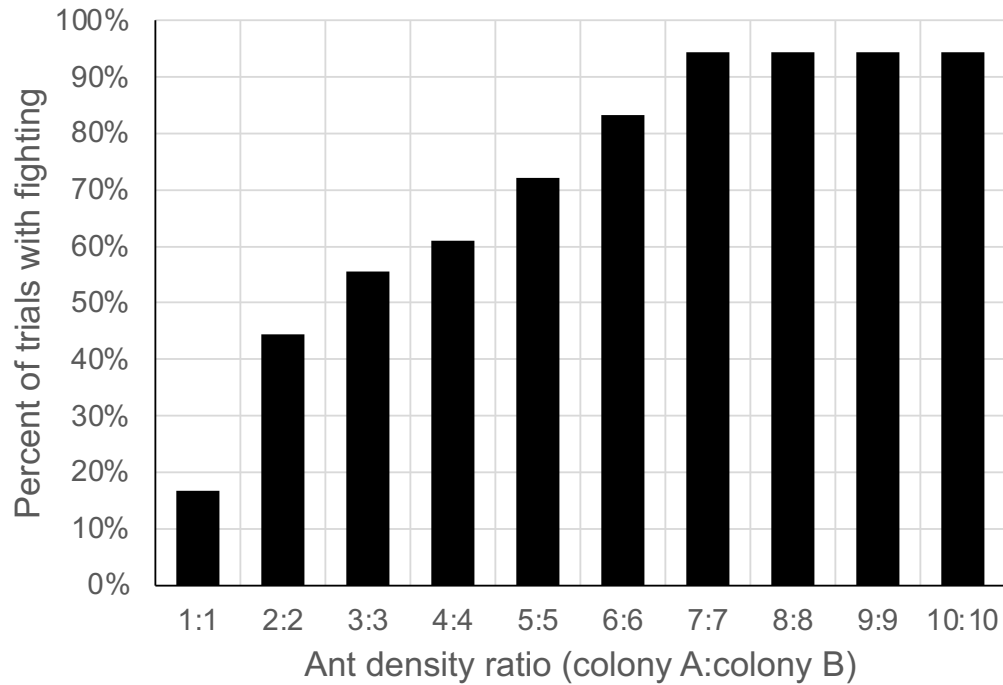
Independent variable: _____

_____

Dependent variable: _____

_____

Below are graphs of the data: Identify any changes, trends, or differences you see in your graphs. Draw arrows pointing out what you see, and write one sentence describing what you see next to each arrow.

Interpret the data:

Make a claim that answers the scientific question, in pavement ants, how does ant density impact the decision to engage in fights with ants from another colony?

What evidence was used to write your claim? Reference specific parts of the tables or graphs.

Explain your reasoning and why the evidence supports your claim. Connect the data back to what you learned about how density affects an ant's decision to fight.

Did the data support Andrew, Jazmine, Ken, John, and Mike's hypothesis? Use evidence to explain why or why not. If you feel the data was inconclusive, explain why.

Your next steps as a scientist: Science is an ongoing process. What new question do you think should be investigated? What future data should be collected to answer your question?