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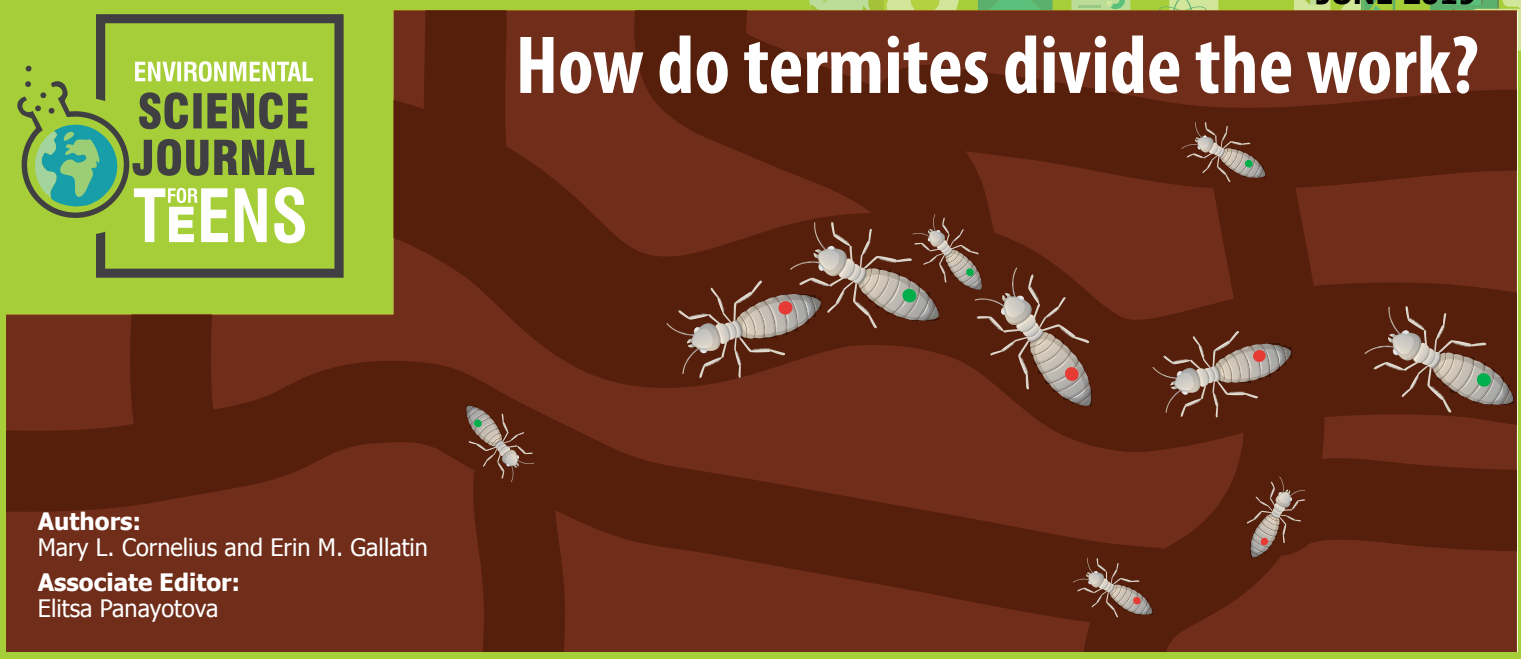
How do termites divide the work?



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Abstract

What do you know about *termites*? Perhaps you've heard that some termites can infest your home. But there are many different species out there. For example, subterranean termites make tunnels in the soil to look for food. Like other social insects, termites divide their tasks by assigning them to different groups. So how do they organize the tunnel construction?

We wanted to identify the specific individuals who are the most active during the start and expansion of tunnel construction. We monitored five groups of 30 termites for three days and found that it was usually three individuals who do most of the work all the time. We believe that these top busy workers are also responsible for the organization of the tunnel network.

Introduction

Termites are very ancient insects (Fig. 1). Like bees and ants, termites are social insects. They have different groups (*castes*) which perform different tasks:

- soldiers - protecting the colony
- queens and kings - producing and fertilize eggs
- workers - finding food in the soil by constructing tunnels. When workers build a network of underground tunnels, they leave chemical signals on the trail so that their nestmates can follow them.

Previous studies have shown that only a few individual workers are responsible for the initiation of the tunnel construction, and it's usually larger workers who do most of the digging. But how do they excavate these tunnels? Termites transport loads of soil away from the tunnel tip. At first, only one worker can enter the tunnel since there is no room for anyone else. After the first hour, three or four individuals can enter. What happens after that when there are separate branches of the tunnel? Are the same termites who initiated the construction responsible for the expansion as well? Or do they take turns working? These are the questions we wanted to answer.

Figure 1:
Subterranean termite workers and soldiers (*Coptotermes formosanus*). The workers construct tunnels and feed on wood. The soldiers have powerful jaws to protect the workers from enemies. Soldiers do not construct tunnels or feed on wood. Soldiers rely on workers to feed them. Termites resemble ants, which sometimes causes people to confuse the two orders of insects. In fact, they are more closely related to cockroaches.

Methods

In our lab, we observed five groups of 30 workers of *Coptotermes formosanus* termites. We constructed a foraging arena – two Plexiglas sheets filled with moist sand in between. We *marked* every worker with a unique color and placed them inside (Fig. 2). We then monitored the workers' behavior over three consecutive days counting the number of times each termite picked up and moved sand particles.

- **Day 1:** We observed them for two hours to see which individuals initiated the tunnel construction.
- **Day 2:** We observed them for two hours to record their behavior during tunnel expansion.
- **Day 3:** We moved each group of 30 workers into a new arena to check if the same or different individual workers were responsible for the initiation of tunnel construction.

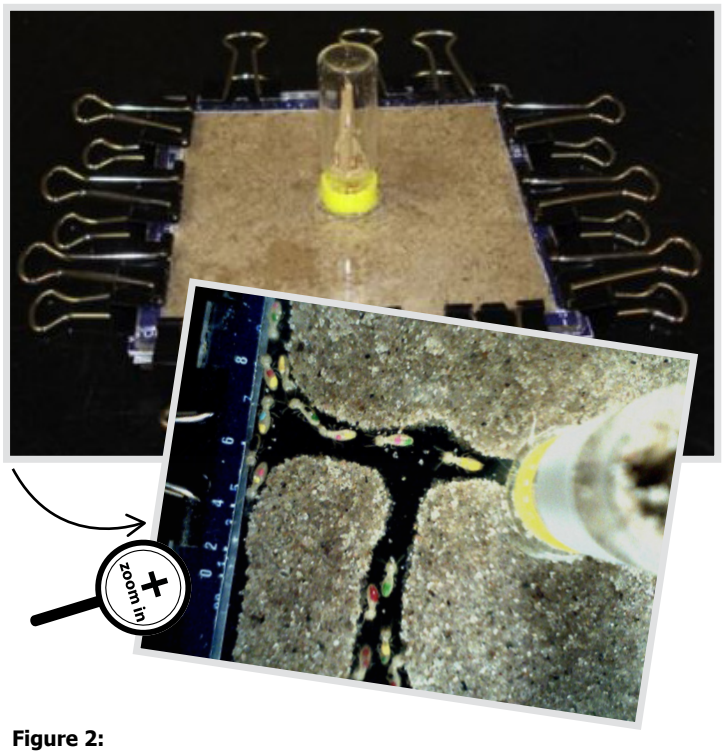


Figure 2:
The foraging arena we constructed for our study (top photo). We marked each termite worker with a unique mark: either a single dot with one color or two dots with two different colors (bottom photo).

Results

We recorded the following observations:

- Within each group, three individuals (on average) transported most of the sand (Fig. 3).
- In two of the five groups of termites, the same individuals moved most of the sand on all three days.
- On day 2 many termites showed activity. On that day, significantly more individuals moved most of the sand, compared to the first and third days.
- The length of the tunnel on day 2 varied greatly between the groups – some expanded it significantly, others just a little.
- As the tunnel length increased, so did the number of individual workers transporting at least a bit of sand. However, the number of workers doing most of the work did not increase.
- The behavior of a termite on day 1 predicted its behavior on days 2 and 3:
  - Specific individuals acted as top excavators – in both tunnel initiation and expansion.
  - Inactive workers often remained inactive.

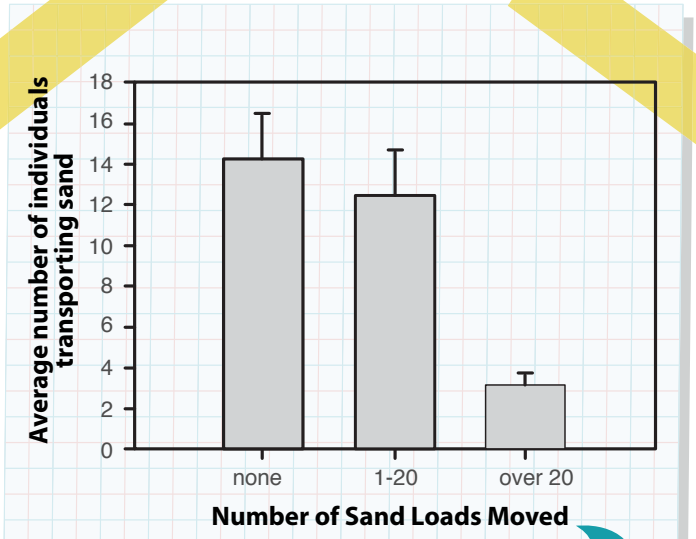


Figure 3:
The average number of individuals transporting sand, grouped into three categories:
no loads, 1–20 loads, and over 20 loads.
(showing mean data with standard error bars)

Do you know what the difference is between standard deviation and standard error?

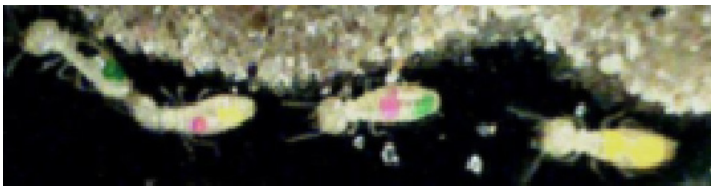
Discussion

Our results confirmed that there are specific individual workers who do most of the work in starting a new tunnel construction - the top excavators. Of course, at first, there isn't room for many other termites to help with the construction. But we found that most of the time it's the same specific workers who do the majority of the work even later when there is sufficient space. Nevertheless, in two of the five groups on day 2, all the workers moved at least one load of sand. This makes us believe that the initially inactive workers act as a reserve workforce.

The top busy workers were also most likely to start the tunnel construction on the third day when we moved the termites into new sand. In two of the groups, it was the same worker who did most of the work on all three days. This not only confirms that a few individuals play the key role in tunnel construction, but also that these same workers organize and determine the orientation of the tunnel and its branches.

Conclusion

Do you want to monitor subterranean termites' behavior? You can build your own termite farm with simple materials. Find out how online.



Remember that some termites can enter your home, because they feed on wood, paper, books, even insulation. These termites are considered pests and you should call professionals to treat and control these insects.

Glossary of Key Terms

Castes (labor castes) – social insects divide labor among castes. The soldiers defend the colony and usually have more powerful jaws. The kings and queens are the reproductive caste (usually there are many kings and one or a few queens). The worker caste does most of the work – searching and storing food and taking care of the brood and nest.

Marking of termites – we painted each individual in every group with a unique dye, which allowed us to monitor each worker's behavior during the three-day period.

Termites – social insects which divide labor among groups. There are different types of termites: some make underground colonies (subterranean termites), others infest dry wood, others like wood with high moisture content.

Mary L. Cornelius, Erin M.Gallatin. (2015) *Task allocation in the tunneling behavior of workers of the Formosan subterranean termite, Coptotermes formosanus Shiraki*. Journal of Asia-Pacific Entomology
https://www.sciencedirect.com/science/article/pii/S122686151500093X

NOLL LAB: How to Build a Termite Farm
http://www.kennethnoll.uconn.edu/nsf-termite-project/how-to-build-a-termite-farm.html

The Conversation: Observing Termite Behaviors, Personalities – and Souls
http://theconversation.com/scientist-at-work-observing-termite-behaviors-personalities-and-souls-46014

Check your understanding

1 What do bees, ants and termites have in common?

2 What tasks do subterranean termite workers have?

3 Do workers take turns in the tunnel construction?

4 When are the majority of the workers most active?

5 In statistics, what is the difference between standard error and standard deviation?