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The Mountain Lake Times

EXPLORING MOSQUITO-PLANT INTERACTIONS:

INSIGHTS FROM MOUNTAIN LAKE RESEARCH

Researchers are embarking on groundbreaking research into the fascinating interactions between mosquitoes and fly poison.

By Quianday Worthington

All organisms living together in a community affect each other. Species interactions aren't always positive; for example, when humans get bit by mosquitoes, it's not a positive interaction. Mosquitoes feed on human blood, and their bites can cause itching, swelling, and transmit diseases such as malaria, Zika virus, and many others. This negative interaction between humans and mosquitoes highlights the complexities of species interactions in nature, where not all interactions are beneficial to all parties involved. Simone de Montigny, a Research Experience for Undergraduates researcher at Mountain Lake Biological Station in Pembroke, Virginia, is investigating phytophagy , pollination, and toxin interactions between mosquitoes and fly poison, a highly toxic plant common throughout the Eastern US. Phytophagy means the eating of plants. She is interested in seeing how ingesting the nectar from fly poison impacts the mosquito's behavior and survival because of the poisonous nectar. Understanding how mosquitoes interact with this plant could provide insights into mosquito behavior, plant-insect interactions, and potentially the development of natural mosquito control methods.

Mosquitoes (Culicidae) are small insects that feed on the blood of various animals, including humans, and are known for transmitting diseases. Carbon dioxide and heat produced by humans and animals attract mosquitoes. Fly poison (Amianthium muscitoxicum), a plant native to North America is known for its toxic properties, which can harm animals and humans if ingested. "This mosquito is interesting because it's invasive to this area and pretty recently invasive. So, it hasn't adapted completely to the plants here," De Montigny says.

Through behavioral assays and feeding fly poison nectar to mosquitoes, De Montigny hopes to find the relationship between these two species to the concentration of the toxic substance on the specific species of mosquitoes. Mosquitos use fly poison's nectar as a source of food. De Montigny's goal for these experiments is to understand how mosquito-plant interactions may lead to the development of natural methods for controlling harmful mosquito populations.

De Montigny is setting up bags with fly poison outside to prevent other insects from reaching them. She then places male and female mosquitoes

Photo by Brett Hondow / Getty Images.

in the bag with the fly poison and leaves them overnight. This allows her to see if they are active either at dusk or dawn. In the morning, she takes the mosquitoes out and freezes them to bring them to the lab and screen them for fructose to see if they've eaten anything during the trial.

De Montigny is examining whether the speed of the poison acts on the mosquitoes that could have a detrimental effect on the plants by making the mosquitoes act as nectar thieves. For example, if a mosquito is eating that nectar and killing the pollination service. Using those same mosquitoes from the outdoor experiments, she observes them in the lab to see if they have pollen on them. This allows her to see if pollen is being transported to another flower. She is interested in seeing how ingesting the nectar from fly poison impacts the mosquito's behavior and survival because of the poisonous nectar. De Montigny says, "I want to see if it's hurting them."

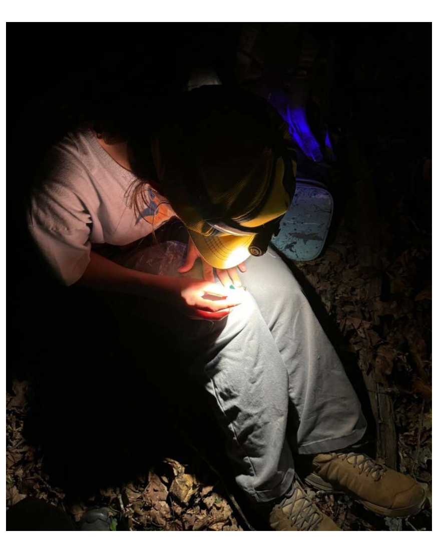
Although De Montigny's experiment is still in progress, she hopes that people know that there are invasive mosquitoes and how to control them without harming the rest of the environment. She is excited to be a part of the University of Virginia's Mountain Lake Biological Station Research Experience for Undergraduates program and do research.

A NEW CANARY IN THE COAL MINE?

STUDY SUGGESTS POWERLINES ARE DAMAGING SALAMANDERS AND THEIR COMMUNITIES

Research at the Mountain Lake Biological Station shows that human disturbances like clear-cut powerlines are reducing salamander population numbers in the vicinity.

By Griffin Jiron



To account for recapturing salamanders, Zink and her team mark them with implants that glow under ultraviolet light. Photo by Griffin Jiron.

In the seemingly untouched mountains of Southeast Virginia, undergraduate researcher Shelby Zink is at work uncovering an unfortunate truth: human disturbances like powerlines are damaging ecological communities.

Underneath powerlines and in their vicinity, salamander population numbers are reduced, suggesting that the overall health of the ecosystem may be impacted by human disturbances. "Simple things," Zink said, "even just mowing an area can create such a big impact on what species are there and what's not."

Zink, who is a Research Experience for Undergraduates (REU) researcher, is currently studying the effects of human disturbances at three powerline stations around the Mountain Lake Biological Station in Pembroke, Virginia. Two of the sites contain clear-cut zones that are 20 meters across each, while the third site has a disturbance zone that's 40 meters across. During daytime and nighttime surveying trips, Zink and her team look for salamanders at different distances from the powerlines, ranging from directly underneath to 50 meters into the surrounding forest. By recording salamander observations during these trips, the researchers can estimate the overall salamander abundance in each area.

The team's preliminary findings suggest that there's a marked decrease in salamander abundance closer to and underneath the powerlines, an effect seen across all three sites. Zink suggests that the clear-cutting of forests to build the powerlines changes the environment, making it inhospitable to sensitive species like salamanders.

"[Salamanders] have permeable skin, lay soft eggs, and need clean water. Because of that, they're more prone to being affected by changes in the environment," Zink noted. This sensitivity to the environment is why salamanders are often referred to as an indicator species, or a species that can be used as a measure of an ecosystem's overall health. This means that powerlines may be negatively impacting entire ecosystems—both in their clear-cut paths and in the surrounding forests.

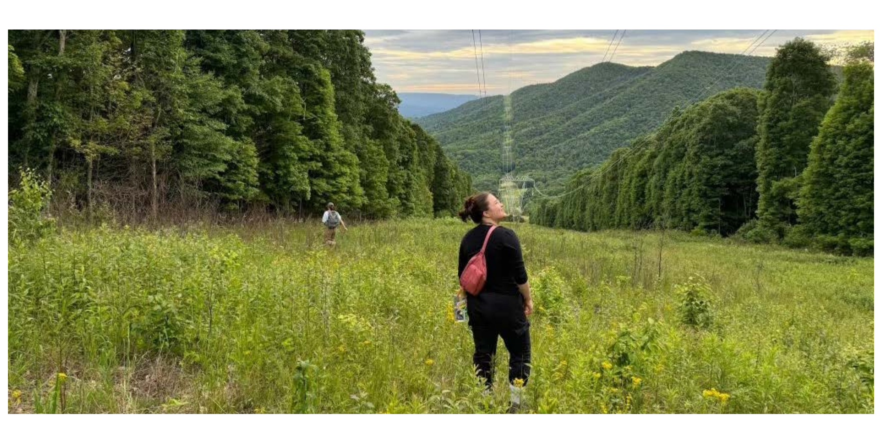
"Powerlines cause environmental problems like soil degradation, localized drought, and can change the balance of trees and plants," Zink said. These factors, as well as the directly disruptive act of building miles of powerlines through forest, can have longstanding effects on salamander habitats.

"It's important to be aware of how disruptions caused by human activity affect the rest of the environment," said Simone de Montigny, a fellow researcher at Mountain Lake Biological Station.

What these findings provide isn't just added stress in a world of climate concerns, but also a diagnosis to a treatable problem . All it takes is more thoughtful construction. Much like wildlife crossings for highways, urban planners can design powerlines to reduce their negative impact.

"If we plan where we make powerline cuts and make sure that we have beneficial environmental factors around it," Zink suggested, "then salamanders can better use that area."

As the need for electricity and transportation grows, it's these small, practical changes that may make the difference between ecological harmony or destruction.



Powerlines, like this site that Zink is studying, can create miles of disturbed area that effectively fragment healthy ecosystems. Photo by Griffin Jiron.

LIFE AFTER DEATH:

HOW WE CAN KEEP OUR FORESTS HEALTHY BY LEAVING DEAD LOGS TO BECOME CRITTER CONDOS

Researchers at Mountain Lake Biological Station investigate what species reside in fallen logs to better inform forest conservation efforts.

By Sarah Garcia

To humans, a fallen tree might be an obstacle on a hike or firewood for the colder months. To some forest-dwellers, however, decaying logs are their entire world. But who exactly lives inside these logs? And which logs are more useful to the decomposers (think grubs, worms, and other invertebrates) that we rely on to recycle essential nutrients and make up the bottom of the food chain?

Taylor Rand, an undergraduate researcher at Mountain Lake Biological Station in Pembroke, Virginia, is addressing these questions alongside her mentor Erin Scott from the Brodie Lab at the University of Virginia.

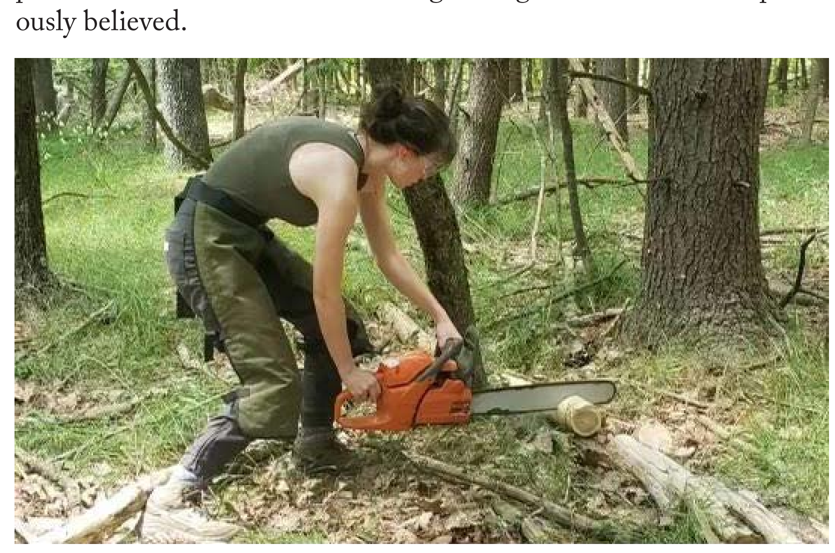
The overall area of forest ecosystems, which are vital for biodiversity, climate regulation, and our water cycle, has declined significantly since the Industrial Revolution. This decline is driven largely by deforestation for agriculture, logging, and urbanization as well as climate change, which negatively impact forests and the species that rely upon them due to rising temperatures and extreme weather events. Forests support many human communities' livelihoods and provide essential ecosystem services like air purification and recreation. Preserving forests is crucial for ecological stability, climate health, and human well-being.

The larger question Rand wants to address is how log-dwelling communities change in response to different habitat factors. The two main factors are whether the log is composed of hardwood (broad-leaved trees, like maple or oak) or softwood (needle-leaved trees, like spruce or pine) as well as the presence or absence of wood roaches. Wood roaches act as miniature architects, digging a series of tunnels in logs that the scientists call "galleries."

"As we realize the importance of forests as delicate ecosystems," Rand explains, "we're understanding that we're missing this entire part of the picture when we overlook dead trees."

A normal day of fieldwork for Rand and Scott involves trekking to one of their many sites surrounding the station wielding a hammer, chisel, and sometimes a chainsaw. With these tools, they split open logs and collect every critter they can find within it. Then, Rand takes her catch back to the lab to identify the log-dwellers under the microscope and quantify them based on the features of their home.

Rand hasn't found a difference in the diversity of invertebrate communities that live in hardwood and softwood logs. This means that both types of wood are likely to be important for log-dwelling critters. They have yet to look at logs where wood roaches are absent. Out of her catch so far, Rand has found mostly non-insect arthropod predators like centipedes and millipedes, which suggests that there are lots of smaller creatures for them to feed on in these logs. This paints an even more biodiverse image of log communities than previously believed.



Rand using a chainsaw to open one of the logs she sampled from. Photo by Erin Scott.

"I chose this project because I really just wanted to see a lot of bugs," Rand remarks. "So the amount of diversity within logs that are not insects has been surprising."

By identifying the invertebrates that live in logs and characterizing which logs are most used by these creatures, Rand hopes to inform conservation efforts. For example, if logs that have been excavated by wood roaches tend to harbor more biodiversity, policies can be implemented so that logs with wood roach entrance holes are not allowed to be removed from forests.

"I'm really interested in decomposing ecosystems because I'm driven by the poeticism of it all," Rand enthuses. She is enamored by the idea that something once so full of life continues to give back to living things after death.

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STUDYING BEETLE FIGHTS COULD REVEAL UNKNOWN SECRETS OF SOCIAL BEHAVIOR, SCIENTISTS SAY

Researchers at Mountain Lake Biological Station are studying beetle aggression to better understand social behavior.

By Connor Erwin

Professional tennis players and boxers can often undergo physical and mental declines after losing a match, leading them to lose more in the future. The increase in losses due to prior losses is what psychologists and scientists call the "loser effect". The loser effect isn't just present in humans, however; but can also be seen in social animals.

The Forked Fungus Beetle is a small critter found under fungal brackets across east North America and is known for their horns. These beetles can live for several years and are another social animal shown to have the loser effect. Male beetles often fight and show aggressive behaviors over resources and courtship. Like tennis players, if a beetle loses an aggressive encounter, that same 'loser' beetle is more likely to lose and stray away from further battles.

Scientists and Mountain Lake Biological Station are currently studying this particular beetle in hopes to better understand aggression in social animals. One of these scientists, Quianday Worthington, an undergraduate at Randolph College and working under PhD student Clara Stahlmann Roeder, has been studying how the duration of the loser effect could be amplified by how intense a fight is. The intensity of a fight is measured by counting the number of aggressive invitations, such as grappling and flipping, there are in the battle. While it has been shown that the loser effect is present among Fork Fungus Beetles, it is still not clear whether the intensity of a battle is relevant to the beetle's memory of past fights.

"I picked that specifically because I wanted to focus on how social behavior affects future behavior in a male beetles," Quinday said. Future behaviors that could be found include an increase or decrease in aggression due to the intensity of a previous loss.

In her project, Quianday has selected beetles with high fight win streaks, or what she calls "supper winners" to face a beetle for 2.5 hours in little arenas with fungus in the middle. She does this to set up a beetles to lose against a "supper winner" to induce a loser effect. For the next three days day, she records the same loser effect-induced beetles fighting an equally matched beetle per day.

"The purpose of having beetles face a super winner is to see how they fight it, how intense that first fight is, and then the duration of those effects in the second fight," Quianday said. "Seeing, how is your effect occurring after the first 24 hours, or is it occurring more after 48 hours or 72 hours?"

Forked fungus beetle on fungus. Photo courtesy Entomology Department of the University of Florida.

After the fights are over, Quianday analyzes the video recordings and determines whether the beetles lost or won a fight. She determines this by looking to see if the beetle flees from battle.

This research could give insight into how high-intensity fights could potentially result in a longer loser effect duration, leading to an increase in evasions in future fights. There could also be no significance between the intensity of a fight and the duration of the loser effect, which would mean that the experience of losing alone is what generates the loser effect. This would allow scientists to make inferences about how and when social animals choose to use aggressive behaviors based on their surroundings and prior experiences.

"What excites me too is understanding how social behavior works and looking at it through video footage and seeing, oh, does that really matter?", Quianday said.

MANY TRIALS AND ERRORS:

A DAY IN THE LIFE OF A POLLINATOR RESEARCHER AT MOUNTAIN LAKE BIOLOGICAL STATION

Connor Erwin is finding that pollinators choose between different types of nectar, but the project has required some innovative improvisation.

By Evelyn Lepsch

What do you picture when someone says "pollinator?" It's likely a bee is the first image to come to mind. However, beetles make up a significant proportion of pollinating species! In fact, beetles responsible for pollinating nearly 90 percent of the world's flowering plants. And recent studies suggest they're choosy about the flowers they pick. Here at Mountain Lake Biological Station in Pembroke, Virginia, Connor Erwin—a Research Experience for Undergraduates (REU) Program researcher—investigates just what makes these beetles go for one flower over another .

At the station, a strong relationship exists between the flowering plant known as flypoison and a species of longhorn beetle. Erwin is investigating this relationship to answer questions about how pollinator behavior changes with varying sugar resources . Like many other flowering plants, individual flypoison flowers vary in both the amount of nectar and the concentration of sugar they produce . Erwin found that beetles seem to go for flowers with higher volumes of nectar and higher concentrations of sugar.

This may not be surprising; it'd be like finding that a hungry person chose a giant piece of steak to eat over a small stick of celery . However, Erwin's next objective is to contrast nectar volume with sugar concentration: which would the beetles choose, he wonders, the flower with a lot of nectar that's low in sugar or another flower that has a small amount of nectar but is high in sugar? Or, in human terms: would a hungry person choose a large plate of celery or a small bite of steak? Erwin is exploring this question in the next leg of his experiment.

Erwin is now halfway through the REU program, as one of eight students selected to spend 10 weeks at the station conducting an independent research project. However, Erwin reflects, the road to get where he is now hasn't been a straightforward one.

When asked if there have been obstacles thus far, Erwin replies immediately, "Too many." He goes on to list that an unusually dry season forced him to redesign his experiment to conduct his research in the lab rather than outside in the natural environment. Furthermore, the beetles won't eat nectar unless it is directly on a flypoison flower; however, when running these tests, the nectar droplets he places on the flower often soak into the petal, which makes them harder to access for the beetle . The drier season also causes beetles to be more desperate to find food, making it more difficult to find beetles that will be active and make choices between flowers during the trials.

If Erwin can overcome these hurdles and collect enough data, his experiment could uncover some important insights into the future of pollinator behavior. Climate change is causing variations in weather patterns to skyrocket; this increasing variation is reflected in the amounts of nectar present in flowering plants. If Erwin can deduce what makes beetles choose between flowers when variation is present, this could predict what flowers get pollinated – in other words, what flowers will succeed the most in a future altered by global warming.

Along with conducting studies such as this that could provide answers to important questions, Erwin urges future REU students to reflect on the opportunity to conduct research at Mountain Lake . He acknowledges the selectivity of the program and he reminds others to "be grateful for the opportunity that we have… as undergraduates to be here. And also, just… enjoy the station." However crooked or obstacle-strewn the road of research, as Erwin says, "you just have to trust the process."