

Produced by the University of Virginia's Mountain Lake Biological Station mlbs.org

Evol Bio Grad Student Workshop

by Amanda Gibson, University of Virginia

First, identify an important question in evolutionary biology. Then, develop testable hypotheses to help answer that question. Next, design feasible experiments to test those hypotheses. Finally, clearly communicate all those ideas to your peers. You have one week. This is the task that faced eleven intrepid students when they arrived at MLBS in late July for the inaugural session of the Evolutionary Biology Graduate Student Workshop.

The training model is an old one – professors of evolutionary biology have held similar workshops in Switzerland since 1988. Curt Lively, Lynda Delph (both Distinguished Professors of Biology at Indiana University) and I participated in these workshops and found they gave us the rare opportunity to grapple with fundamental ideas and to discuss them in depth with our peers. While chatting on the porch of LeConte last summer, Curt, Lynda and I asked ourselves, “why couldn’t we do something like that here at MLBS?” A year later, we found ourselves immersed in debates with students about the instability of mutualisms, the ideal experimental evolution design, and the measurement of different modes of selection.

The eleven students hailed from nine different institutions and six countries. They were all in the early stages of their career (MS or early PhD) and eager to learn how to design and execute interesting, important research. We gave them the first morning to generate and debate a list of big questions in evolution, and they would have spent the whole week there at the board if we hadn’t pushed

them on to the next stage. With questions in hand, the students assembled into groups of three or four based on shared interest. They worked outside on porches, at picnic tables, and even out on the pond to generate hypotheses, diagram predictions, and identify an ideal study system. They asked, “Why do males fight for mates?” “Is evolution deterministic?” and “Why is there so much variation in mutualisms?” We interrupted the groups occasionally, to serve as sounding boards or to lead hikes around the station. Our only rule was that the students could not use scientific literature for this week. They had to find confidence in their own knowledge and reasoning to work through problems. After a couple of days, the writing began. Curt and Lynda led tutorials on the basics of science writing to help the students turn their far-reaching ideas into concrete sentences. The groups wrestled more and more with their experiments, each conceptual advance bringing new possibilities. At the end of the week, these debates, edits, and sketches coalesced into a final written proposal from each group. Using big sheets of paper and markers, they presented these proposals to their peers. The proposals ranged from evolutionary genetics to behavioral ecology, from bacteria in flasks to fields of clover, but each one outlined a clear, creative approach to tackling a central problem in evolutionary biology. Clare Rodenberg, a PhD student in Environmental Science at UVA, credits the workshop with “pushing [her] to think in a different way.” Hanna Makowski, a PhD student in Biology at UVA took a break from her field work at MLBS to participate.

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“The workshop was a wonderful experience that helped me think in an organizational manner about big evolutionary questions and communication of ideas – both in writing and conversation. Reasoning through ideas in a group and proposing a way to test those ideas without the hindrance of literature empowered me to ask questions, which led to a new confidence in my ability to contribute to discussions.” The experience was just as fun, refreshing, and eye-opening for us instructors, and I look forward to working with a new cohort of students next summer.



Top row from left: Clare Rodenberg, Shelby Moshier, Gus Waneka, Louis Bubrig, and Rebecca Lakin. Middle row: Kristiaan Meritt, Hanna Makowski, Miguel Cruz, Curt Lively, and Isabela Borges. Bottom row: Lynda Delph, Michael Foisy, Rossana Maguina, Mandy Gibson.

From the Director

One of the great benefits of working at MLBS is the incredible community of students that we get to interact with. Lately, I've been thinking about the amazing undergrads that drive so much of our research activity every summer. As I work on writing up results from the past season, the creativity and inspiration that these students bring to our work has come into sharp focus.

I cannot possibly highlight every individual, even for just the 2019 season, but I will say that I recently had cause to make a list for myself of the handful of manuscripts that are top of the pile and closest to submission for this fall. Every project was identified by the name of an undergraduate who had driven the work. On the list were two NSF-REU interns that worked with graduate students to bring new ideas to existing projects. Both will become unexpected dissertation chapters. Three more manuscripts resulted from Beetle Crew students that were pointed at datasets and turned loose. They came up with their own ideas, explored the piles of information available to them, and produced creative and insightful analyses. It is unlikely that any of these questions would have been asked without the curiosity and ambition of these students.

When colleagues ask me why I took on the job of directing a field station, I often point to the opportunity to blend my research and teaching lives in a more seamless way. The chance to work shoulder to shoulder with the next generation of scientists, and learn from their perspectives as novel thinkers and unique personalities, keeps me sharp and improves everything I do. I am grateful that so many incredible students stop at MLBS along their lives' paths.



Butch Brodie



ArtLab performance during the 2019 Open House



Craft activities are always popular at the annual Open House.



Microscope activity at Open House.

Student Corner

by Kristoff Magnus, Oberlin College



When I signed up for all three summer course sessions I knew that I was getting myself into a lot, but I think it didn't really register just how much it was to take three full courses in just nine

weeks until I was waking up at 7 am in the morning to get breakfast before my class started on the first day. "Oh man," I thought, "I really threw myself into the deep end with this one."

And it was a lot, but the great thing about being in the deep end is that you get to be fully immersed in what you're doing. I was waking up each morning thinking about what I was learning and feeling more in tune with myself as a student than I ever had before. I really fell in love with the field station lifestyle over the course of the summer. Whether it was attending the weekly lectures and having conversation in the director's cabin or having intellectual debates over breakfast. I felt like on the station I had the space and the resources to really flourish as a student, and as a scientist. I felt like I was really experiencing what life in the scientific community could be like for the first time, and I made connections there that I hope will last a lifetime.

My time at MLBS affirmed for me that I'm on the right life path in pursuing biology, and that this is a field in which I'll meet lots of like-minded people full of enthusiasm for what they do. The level of constant intellectual stimulation was never straining simply because it was fueled by such a genuine passion for understanding life and the world around us.



2019 Plant Diversity, Evolution, and Conservation Class

Research Spotlight

by Elizabeth Ostrowski, Massey University



Elizabeth Ostrowski
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Not many people can say that their study organism may have inspired a 1950's horror movie. In *The Blob*, a slimy alien mass arrives on a meteorite and devours a town. Its likely inspiration is a slime mold, a type of soil-dwelling amoeba. In their single-celled state, these amoebae lack a defined shape and crawl around by extending and retracting pseudopods ("false feet"). They hunt, engulf, and kill bacteria and other microorganisms in the soil. In the sub-group known as plasmodial slime molds, the amoebae can give rise to a massive, moving slimy mass that can quickly cover and devour logs and other forest detritus—hence, *The Blob*.

Plasmodial slime molds have long fascinated biologists, computer scientists and engineers because they exhibit so-called "collective intelligence"—that is, they can work together to solve problems, but have no brain to direct their behavior. For example, scientists have shown that they can solve mazes and find efficient paths between many objects, a difficult analytical problem called the "Traveling Salesman." They can also learn, and some argue that they can also remember, for at least a year and possibly longer.

My lab works on a very different type of slime mold, a cellular slime mold, also known as a "social amoeba." Like their plasmodial relatives, cellular slime molds also exhibit collective behaviors. When starved, they self-assemble into multicellular organisms. Unlike plasmodial slime molds, however, they maintain boundaries around each cell. Cells within these collectives thus retain their independence, and coordination requires that information can cross these borders.

Social amoebae join together when starved, forming masses that contain hundreds of thousands of cells or more. Within these collectives, the amoebae take on different characteristics and roles, a process known as cellular differentiation. Over several hours, the mound of cells slowly transforms into a worm-like creature called a slug, which can move quickly towards light and heat, behaviors that likely direct it to the surface of the soil. Eventually, the amoebae build a structure called a fruiting body, which consists of a ball of spores on top of a thick stalk, constructed from layers of dead cells. The spores survive and can be dispersed by passing animals. When conditions improve, they hatch, each releasing a single-celled amoeba, and the life-cycle begins again.

Cellular slime molds can be found all over the world, but the southern Appalachians is a global hotspot for these organisms. We have been studying populations of one species, called *Dictyostelium discoideum* ("Dicty" for short) for seven years. We have been isolating this species and its relatives from the soil



The fruiting stalk phase of the "Dicty" life cycle.

around Mountain Lake Biological Station, where it is unusually common, as well as sites further afield, as far north as New Hampshire and as far south as Texas.

Stalk formation in *Dictyostelium* is thought to be an example of altruism, in that stalk cells give up their lives (and their opportunity to reproduce) to help others in their group. In this case, their death is thought to help the spores survive and disperse. By itself, altruism is not too surprising: we can point to

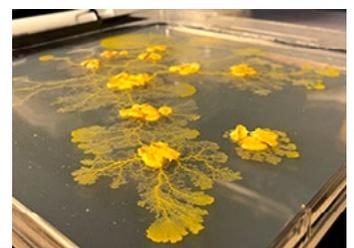
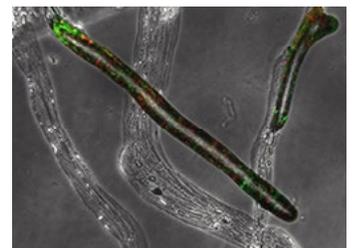
many examples of it in the natural world. For example, sterile workers in colonies of ants, bees, and wasps also give up their opportunity to reproduce and instead help to raise their siblings. Even in our own bodies, cells are divided into two classes, a reproductive germline and a non-reproductive soma. What makes *Dictyostelium* distinct, however, is that its unusual form of multicellularity arises through aggregation. Aggregative multicellularity means that cells of different genetic lineages can co-occur within a slug or fruiting body. This genetic diversity, in turn, creates an opportunity for some strains to benefit by behaving selfishly—avoiding the stalk, yet gaining all the benefits of its production by others. Studies have shown that stalk-avoiding strains exist in nature and arise readily in the lab, but we have little understanding whether these behaviors bring success and whether their presence drives losses of cooperation.

At MLBS, we can sample more than a hundred populations in a matter of days. The cells can then be frozen and later revived, allowing us to carry out

experiments where we compare how well strains cooperate with strains from the present, past and future. We use these collections to assess how common selfish behaviors are, whether selfishness tends to increase or whether it is lost over time—and if so, why. Currently, we are sequencing the genomes of many strains from a collection of sites, across multiple years, which will help us to determine which genetic variants are successful over time. Ultimately, cellular slime molds highlight both the potential benefits and pitfalls of different forms of multicellularity. They also help us to address the general problem of how societies in nature maintain cooperation, especially when there are advantages to behaving selfishly.



2018 REUs Louis Bubrig and Rita Hueston work with graduate student Michael Miller to collect slime mold samples.

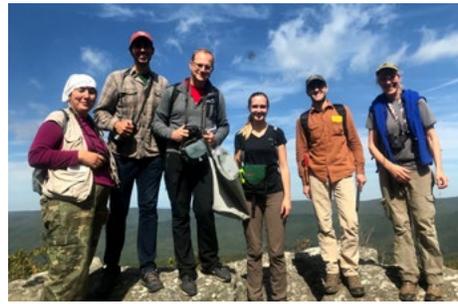


News & Notes



International Visitors Help with Seed Collection

A group from the Missouri Botanical Garden, including two visiting botanists from Russia, spent five days at MLBS in September collecting seeds of native plants for the MoBot international collection of plants for conservation.



From left: Olga Baranova, Michael Jesiolowski, Alexander Kabanov, Alanna Sanders, Travis Hall, Becky Wilbur

ArtLab

Mountain Lake's [artist-in-residency program](#) is now seven years old. Six professional artists spent two weeks at the station this summer bringing with them work in song, light installation, mixed media, print making, drawing, photography, and video. [Margaret Cogswell](#) was our Lucile Walton Fellow. Six UVA art majors also joined the program. For the first time we accepted [applications](#) in addition to nominations, greatly increasing the diversity and number of program candidates. Help us spread the word to your artist friends! Applications for the 2020 program are due February 1.



Artist Bob Kaputof (VCU) with his kinetic light sculpture.

Kitchen Crew

Special thanks to our head chef, Joseph Mitchell, and kitchen crew members, Eli Mitchell & Jared Richardson, for keeping us well-fed this summer! It's no easy task feeding an ever-changing group of people over an entire season, and the guys always kept things creative and served it up with a smile. We look forward to having Joseph and his crew back next year!

Birth Announcement

Welcome to the newest member of the MLBS community. Robin Claire Jones was born on July 24, 2019 to our Station Manager, Jaime Jones. Congratulations to Jaime, Matt, and big sister Sydney!



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Thanks to Suzanne!

An unexpected joy this summer was working with Interim Station Manager Suzanne Allison. Suzanne is a former Mountain Laker who started taking classes here as an undergraduate and then got involved with two different research programs at the station over the years. She stepped seamlessly and fearlessly into the job of running the station in the middle of high season! Suzanne ran such a tight ship it was easy to forget she had not been here forever. She brought new skills to the office and made MLBS a better place for all of us. Thank you Suzanne! We will miss your unflappable nature, your eager and proactive approach to old and new challenges, and your easy laugh. MLBS will always be a home for you. See you soon, we hope!

Open House

Those of us who are fortunate enough to spend time at MLBS know it's a special place, but we don't often get to share it with those off the mountain. On July 20th, we welcomed 158 visitors who explored open labs, art installations, and specimen collections; caught organisms in the pond and took closer looks at them through microscopes; watched video footage of wildlife from camera traps, hiked with expert guides on nature walks, and more! The open house was a great success thanks to the enthusiastic participation of our students, artists, researchers, faculty, staff, and family members.

A Look Back at the 2019 Season

October 1, 2018 - September 30, 2019

Snapshot

4 summer courses
4 internship and professional programs
8 REU program participants
599 station users
52 institutions represented
16 visiting courses and programs
8 station activities
7 facility projects
\$33,590 in fellowships awarded
\$5,030 in donations received
47 research programs
56 journal publications



Financial

Fellowships Awarded \$33,590:

- 12 summer course students \$21,930
- 5 researchers \$9,712
- 5 workshop attendees \$1,948

Donations Received \$5,030:

- Undergrad Students \$1,200
- Friend of MLBS \$3,830

REU Participants

John Bowen
Madeline Cox
Will Fan
Madeleine Gellinger
Molly Sayles
Olivia Shaffer
Katherine Sklaver
Zorimar Vilella-Pacheco

Station Users

7,581 user days

599 individuals from 52 institutions:

- 6 artists
- 115 researchers
- 155 undergraduate students
- 120 graduate students
- 27 K-12 educators
- 69 K-12 students

Station Activities

- Annual Open House
- July 4th Festivities
- Team Triathlon
- Volleyball Tournament
- Walton Lecture and Reception
- Square Dance
- Gourmet S'more Cookoff
- ArtLab Lucile Walton Fellow Lecture

Facility Projects

- Invasive plant removal
- Burns Garden improvements
- Continued chimney renovations
- Bird, fish, and amphibian collections curation, improvement, and digitization
- Installation of GPS base station
- Installation of on-line lightning detector
- Installation of underground conduit for electric and communications lines

Internship and Professional Programs

- Research Experiences for Undergraduates program
- Grant Writing Workshop
- Evolutionary Biology Graduate Workshop
- ArtLab Artists-in-Residency

Summer Courses

- Field Biology of Fishes
- Field Herpetology
- Plant Diversity, Evolution, and Conservation
- Field Biology of Insects

Visiting Courses and Programs

- Diversity of Freshwater Fishes of Southwestern Virginia, Virginia Institute of Marine Science, College of William and Mary
- Cave Leader Training, Davidson College
- Chesapeake Bay Watershed Diversity Course, Hampton University
- Herpetology Class, Hanover College
- Herpetology Class, James Madison University
- Ecology Class field trip, Mary Baldwin University
- Plant collection, Missouri Botanical Garden
- Wilderness First Aid Certification Course, SOLO Wilderness Medical School
- Amphibian Ecology Class, University of Richmond
- Evolution Education Teacher Workshop, University of Virginia
- Graduate Workshop in Evolutionary Biology, University of Virginia
- Birdwatching and data collection, Virginia Society of Ornithology
- Wildlife Field Techniques Class, Virginia Tech
- Women Professors Writing Retreat, Virginia Tech
- Environmental Studies Academy Introduction to Natural History of Southern Appalachians, Western Albemarle High School
- Peacefully Productive Academic Writing Retreat

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Click to support the programs at Mountain Lake Biological Station by donating online. All donations are tax-deductible.

Research Programs

- Coevolutionary arms races driven by conflict: A test in social amoeba
- Collaborative Research: Combining NEON and remotely sensed habitats to determine climate impacts on community dynamics
- Combining NEON and remotely sensed habitats to determine climate impacts of community dynamics
- Comparative analysis of salamander limb regeneration
- Development of an unmanned aircraft system (UAS) to collect mosquitoes from remote areas
- Dispersal dynamics and multilevel selection in the forked fungus beetle
- Environment as a selective force on plant reproductive traits
- Evolution of blueberries (*Vaccinium*) in Eastern North America
- Evolution of social behavior in *Bolitotherus cornutus* (forked fungus beetle)
- Evolution of social network position
- Exploratory studies in *Campanula americana*
- Flora of Mountain Lake Biological Station
- Foliar traits and terrestrial ecosystem variability across NEON domains
- From wing pollination to florivory: The reproductive ecology of southeastern azaleas (*Rhododendron* spp.)
- Global change impacts on microbiome mediated plant pollinator interactions
- Habitat requirements and population genetics of fungus-inhabiting beetles in old-growth forests
- Heritability of social network position In *Bolitotherus cornutus*
- Herpetological diversity of Mountain Lake Biological Station
- Hormaphidine and Pemphigine aphids
- Host-seeking, feeding behavior, and pathogen transmission in *Culex territans* mosquitoes
- Infection and co-infection in *Peromyscus* mice
- Integrative and evolutionary biology of the dark-eyed junco
- Investigations on nitrogen fixing capabilities of termites and wood-feeding cockroaches
- Juvenile hormone activity in young nymphs of *Cryptocercus punctulatus*
- Ketterson lab Junco census
- Landscape genomics of American chestnut: Conserving genetic diversity for climate change resiliency
- Landscapes, life histories, and anuran population genetics: Can traits predict connectivity of a regional species pool?
- Male strategic allocation in sperm and ejaculate in response to energetic constraints and female quality in harvestmen
- Maternal effects and mating system evolution in American bellflower
- Mating system evolution in Leiobunine harvestmen
- Mechanistic niche modeling and physiological evolution of Plethodontid salamanders
- Multispecies Interactions: Milkweeds, pollinators and herbivores
- National Ecological Observatory Network
- Phenological LAI and multitemporal forest ecosystem physiology
- Phylogenetic relationships within *Monotropa*: Is *M. brittonii* distinct?
- Phylogeography and species delimitation in North American *Castanea*
- Pine bark adelgid on red spruce and white pine
- Plasticity in the shape of phenology across an elevational gradient
- Polyploidy, hybridization, and cryptic species: a phylogenomic and morphological investigation into the true blueberries
- Proactive risk assessment to the next amphibian threat: Understanding salamander susceptibility to Bsal
- Pupation success of *Laricobius* spp.
- Redirecting directed dispersal in a myrmecochory hotspot
- Reproductive ecology of flame and swamp azaleas
- Sugar feeding ecology of mosquitoes
- Survey of Allegheny woodrat in Virginia
- The effects of social context on consistency of and correlations among behaviors
- The role of habitat structure on social networks of forked fungus beetles



Fireworks at the Lodge

A list of publications related to MLBS are housed in a searchable [Zotero database](#).