NC STATE UNIVERSITY

Wolfpack's Waggle

NC State Apiculture Program Newsletter

Dedicated to the dissemination of information and understanding of honey bee biology and management

Issue 1 | Jan 2021

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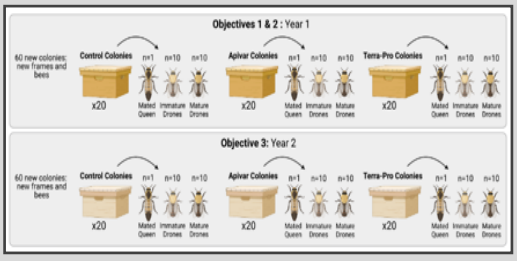
What have we been up to?

It is our second year into the pandemic, and I'm glad to say that things are plugging along well. Brad and Erin have been busy in our Queen & Disease Clinic and their respective research projects, and Sharon has kept our BEES network growing while holding one BEES Academy this past fall. This past year also saw near-record highs in our productivity, with 11 scientific publications, 38 extension presentations, and 6,262 individual contacts. We also had 19 extension publications (26) and $775,000 in new research grants. Hannah Levenson (PhD) graduated and has moved onto greener pastures, although she is still busily writing up her research findings. Esmaeil started his new position at the USDA-ARS at Mississippi State, and Ali has continued her fast pace of publications. Perhaps the biggest news is that we have officially moved out of our old field research site off of Inwood Drive and moved into a temporary facility on the other side of the Lake Wheeler farms while we await the construction of a new facility. In all, we've have a great year, and we hope 2022 will be even better!



New USDA funding to investigate hive treatments

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HONEY BEE QUEEN AND DISEASE CLINIC | BETTER DATA BETTER BEES

Quality Assurance

Morphometric Analyses: multiple measures of queen or drone, body and reproductive tract (rearing quality)

Semen Quality: total sperm count, and sperm viability in queens (mating success), or drones (mating potential)

Quality Report: a "grade" report of a queen or drone's reproductive quality for your quick interpretation

Troubleshooting

Mitotyping for Africanization: genetic analyses of maternal ancestry as African or European using population genetic techniques and markers

Pathogen Screening: identification of presence and relative levels of ABPV, BQCV, DWV(A&B), IAPV, LSV, Trypanosomes, and both Nosema species. Additional and custom pathogen targets available upon request.

Genotyping Analyses: full assessment of paternity for up to 48 workers and an estimate of queen mating frequency

Custom Collaboration

This highly-tailored collaboration involves custom experimental design, analyses, and interpretation. This unique partnership between science and industry has been utilized to:

- Test the impact of various agrochemicals
- Assess the effects of banking on queen quality measures
- Evaluate novel management practices' improvements in queen mating quality
- Observe the effects of shipping on queen health and sperm quality

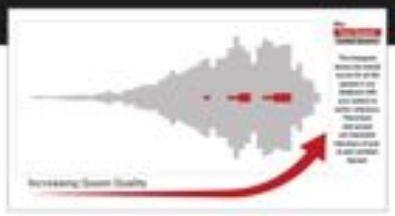
Strong Research Foundations

Established as a natural extension service leveraging basic and field honey bee research at NC State, the clinic has worked to improve colony health for over 10 years.

Queen and Disease Clinic Pricing

Five Sample Minimum • Bulk Pricing Available

ANALYSIS	PRICING	SAMPLES TESTED		
		QUEENS	DRONES	COLONIES
Reproductive Quality	$24.00	✓	✓	
Standard Pathogen Screen	$55.00	✓	✓	✓
Apiary Pathogen Screen	*$220.00	*UP TO 10 COLONIES PER APIARY		
Mitotyping (Africanization)	$25.00	✓	✓	✓
Genotyping (Mating Number)	$320.00			✓



Custom Disease Screening

Additional and custom pathogen targets available upon request.

Your Bees • Your Data

Any results or interpretations from our work is held in the strictest confidentiality and anonymity

Lab Spotlight: Kaitlyn Sage

Kaitlyn joined the lab as an undergraduate researcher to process samples in our genetics lab (specifically to track how viral pathogens cycle within colonies over the course of a season and with the buildup of Varroa mites), but she has also helped out with analyzing samples in the Queen & Disease Clinic and collecting samples in the field. As an Animal Science major with a minor in Entomology, she is the current co-President of the NCSU Beekeepers Club. She just learned that she was accepted into her top choice of Veterinary School at Cornell, so she will be graduating this spring and heading to upstate NY in order to pursue her long-time professional goal of becoming a veterinarian. Congratulations and thanks, Kaitlyn!

New USDA funding to investigate hive treatments

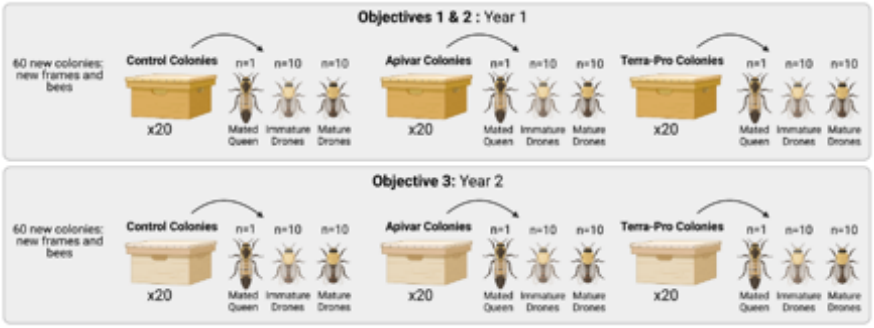
In collaboration with Kasie Raymann's lab at UNC Greensboro, we have secured a new USDA-NIFA grant to determine if there are hidden consequences for treating colonies with antibiotics and miticides, specifically on queens and drones.

Honey bees are the primary managed insect pollinator in US agriculture, yet problems persist in the managed population. Two of the primary problems with honey bee colonies are disease agents (pathogens and parasites) and diminished reproductive quality of queens. For the former, beekeepers regularly apply antibiotics (to control bacterial pathogens) and acaricides (to control Varroa mites) in order to keep their colonies healthy. For the latter, beekeepers often replace their queens because of reduced longevity, premature failure, or early rejection, but the cause(s) of diminished reproductive quality are still unclear.

We propose to test a potential link between beekeeper-applied compounds and reduced quality of queens (and the drones with which they mate). Our objectives are to determine if in-hive treatments, i.e., antibiotics and acaricides impact the reproductive health of (1) drones and (2) queens. Lastly, (3) we will promote clinical services for measuring queens and drones for beekeepers in real time so that they can measure these effects in their own operations. Preliminary and published work has demonstrated that beekeeper-applied medications may have indirect effects on honey bee fecundity, thus finding a balance between maintaining colony health and productivity is paramount to maintain a sustainable managed pollinator population.

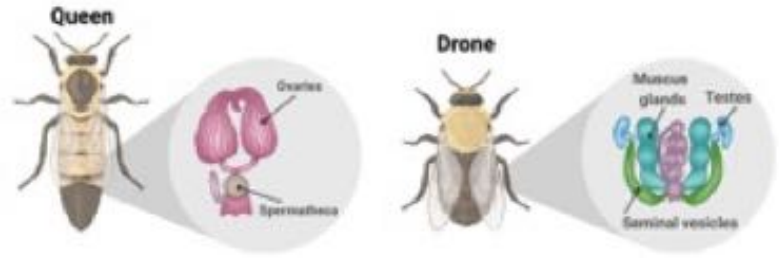
In order to investigate how in-hive treatments impact honey bee reproductive health, we will perform large-scale hive-level experiments and evaluate both queens and drones (Figure 1). We will test two of the most common in-hive treatments used by beekeepers: the acaricide amitraz (Apivar®) and the antibiotic oxytetracycline (Terra-Pro). We will investigate multiple aspects of queen and drone fecundity, including sperm viability and reproductive physiology. We will also evaluate how these chemicals impact the reproductive and gut microbiomes of queens and drones. We will promote these same clinical services for measuring queen and drone fecundity then use our results to communicate and recommend best treatments practices to beekeepers and veterinarians.

We will use a comprehensive and integrated approach to understand the reproductive toxicity caused by in-hive treatments. Not only will we determine if antibiotic/acaricide treatments reduce honey bee fecundity, but we will investigate which aspects of the reproductive system are affected. To this aim, we will evaluate all the major reproductive organs of each sex (drones and queens). The drone has three main reproductive organs: the testes (2), seminal vesicles (2), and mucus glands (2; Figure 2). Spermatogenesis occurs during development and ceases when the drone emerges. The sperm vacate the testes into the seminal vesicles by the time the drone is reproductively mature, around 18-d old. After sperm migration is complete, the testes degrade and becomes necrotic tissue. When mating, the endophalus (reproductive organ) ejaculates out of the drone abdomen and mixes the semen from the seminal vesicles with the mucus gland. The queen has two major reproductive organs: the ovaries (2) and spermatheca (Figure 2). The ovaries of a queen consist of 150-180 ovarioles that, after mating, start to produce eggs throughout her lifetime. The eggs travel



Experimental design of our project. We will establish new colonies onto new equipment then treat them with either Apivar (amitraz miticide) or Terra-Pro (tetracycline anitibotic) then sample queens, immature drones, and mature drones to test them for their sperm viabilities and gut microbiomes to see how they might be cryptically affected.

New USDA grant (Continued)



down the oviduct, past the spermatheca to be laid. At this time, the queen will choose to release seminal fluid from the spermatheca in order to fertilize the egg; such eggs develop into diploid-female workers. When the queen runs out of sperm or choses to release none, she lays only haploid (male) eggs, the colony can no longer function without replenishing the workforce, and the workers will often supersede her. Thus, the number of sperm stored in the spermatheca is a determinant of the queen's lifespan as well as reproductive fitness.

Antibiotic reproductive toxicity has not been studied in honey bees, but studies in other animals have shown that antibiotics can have detrimental effects on sperm viability and reproductive tissue. Previous experiments at UNCG showed that concentrations at or above 25 μg/mL, oxytetracycline caused a highly significant decrease in sperm viability. These results suggest that if concentrations above 12.5 μg/mL reach or accumulate in the reproductive organs of honey bee queens or drones, it will cause significant death of sperm.

In the end, our goal is to determine if these effects of beekeeper-applied chemicals has real-world consequences.

Current Lab Members

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Brad Metz – NC State Research Associate
Alison McAfee – L'Oreal Postdoctoral Fellow *(UBC)*
Rodrigo Santos – Visiting Research Scientist

Undergraduate Researchers
Morgan Risko (media intern)
Kaitlyn Sage
Glenn Cameron (Meredith)
Matthew Shaw (UNC)
Dana Palmer

Support the NC State Apiculture Program!

The Apiculture Science fund-raising efforts operate under the auspices of the North Carolina Agricultural Foundation, Inc. a 501(c)3 organization. You will receive an official receipt for your donation.

A Gift Toward Emerging Needs

Consider supporting the program with a gift that would go toward the current area of greatest importance. Flexible funding enables the Apiculture Program to address critical needs as they emerge, often enhancing the program beyond what would be possible through restricted grant funding. Funding of any amount, from $10 to $10,000, will be extremely helpful.

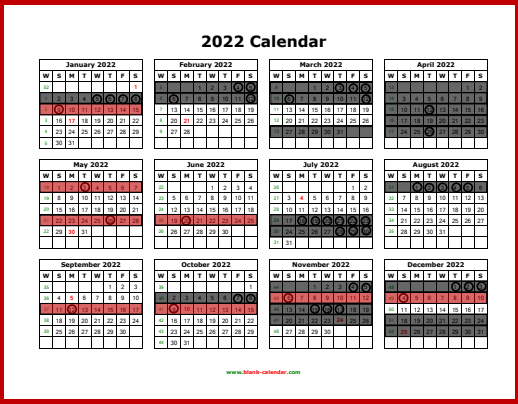
Gift-In-Kind

The Apiculture program is always seeking creative solutions to its material needs. If you have surplus equipment or other non-monetary assets to give (e.g., gently used honey extractors, microscopes, even vehicles), please consider donating them to the program. You will receive credit for the monetary value of the gift and the gratitude of our faculty and students.

Estate Gift

If you are interested in planning an estate gift to benefit Apiculture, please let us know! We can provide you with the tools you and your attorney will need to ensure that your wishes are fulfilled. Please go to our website for more information: www.ncsuapiculture.net

go.ncsu.edu/apiculture



2022 speakers schedule

If your state or local club is interested in booking a presentation by one of the members of the NC State Apiculture Program, submit a request using our online form! If we cannot make a live webinar, we have many free recordings available on our YouTube channel.

https://ncsuapiculture.net/speaking-engagements

Seeking a new postdoc

We are looking for one PhD-level scientist to join a collaborative research team on a project studying honey bee health, stress resistance, and lifespan. The postdoctoral researcher will be mentored by Dr. David Tarpy (NC State), Dr. Olav Rueppell (University of Alberta), and Dr. Micheline Strand (Research Triangle Park). Please contact us if you're interested!

Random Notes

New Publications

Metz, B. N. and D. R. Tarpy. (2021). Reproductive and morphological quality of commercial honey bee (Hymenoptera: Apidae) drones in the United States. *Journal of Insect Science*, **21**: 2.

Presentations

Our webinar series called Apiculture Online—Hive Chat with NC State wrapped up for 2021, and we appreciate all of those who attended or viewed the recordings on our YouTube channel. Several program members also attended the NCSBA conference in November. In addition, **David Tarpy** was also a co-headliner at the American Beekeeping Federation conference in Las Vegas, NV earlier this month and had a great time.

Welcome aboard!

We are excited to have **Dina Espinoza-Rivera** on board as a new Genetics Technician. Regrettably, Erin will be moving on to greener pastures later this spring, but she is quickly getting Dina up to speed on all of our molecular work. Dina comes to us with a wealth of experience in entomology and insect science, and she has quickly picked up many of the techniques in the lab.

We also welcome two new undergraduates to our program, **Matthew Shaw** and **Dana Palmer**. Both have professional goals of attending veterinary school, although Matthew is attending UNC Chapel Hill and Dana is an Animal Science major at NC State. They will be assisting a collaborator in the vet school, **Julia Annis**, who is investigating alternatives to fumagillin for controlling Nosema.

…and sadly missed.

We're very proud that **Esmaeil Amiri** has secured a new position at the USDA-ARS lab in Stoneville MS. This is a relatively new lab focusing on honey bee health, particularly as it pertains to foraging and pollination of field crops, so we look forward to his continued work in these areas.

Teacher's Corner: Courses at NC State

We just wrapped up the last-ever offering of ENT 203, "An Introduction to the Honey Bee and Beekeeping." Taught since 1975, this 180-student course for non-science majors was a central pillar of the Entomology undergraduate course offerings. However, with our program moving to the Department of Applied Ecology last year, we will be restructuring this same course to be offered as AEC 203 going forward. As such, we will continue to teach one of the most popular GER courses in the university for non-science majors but also have it count towards the new Applied Ecology major.

go.ncsu.edu/honeybees

Tarpy's Back Page

Just before winter break, we finally and successfully moved to a new home, thanks to many beekeepers from Wake, Five County, Franklin, and other locals clubs who graciously donated their time.

If you recall, our field research facility off of Inwood Drive for the last 18 years was partially condemned by the fire marshal for several structural, health, and safety violations, and thus we were working out of the "non-condemned" half ever since. Thankfully, our administration and the Superintendent of the Lake Wheeler Farm were gracious enough to provide an alternative building before we were completely barred from the old one. A former hay barn, it was renovated and used as a retreat site, first for the Dix hospital then for the College of Agriculture & Life Sciences after it was donated several decades ago. It is located on the completely opposite side of the research farm off of Mid Pines road, tucked away behind some horticulture research plots and adjacent to two ponds. The structure was emptied, cleaned out, and cleaned up and so that we could move all of our lab equipment, incubators, freezers, microscopes, and other scientific infrastructure. In early December, we hired a moving company to move all of the heavy machinery and equipment, but many beekeeper volunteers helped us move our hive equipment to the "Fish Barn" since there is no such storage space at the new Dix facility.

Thanks again to all who helped make this move possible!

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Apiculture Program

NC COOPERATIVE EXTENSION