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 2 | Apr 2022

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What have we been up to?

There is simply never enough time in the day this time of year, so everyone is trying to get 40 hours out of each day including weekends. Brad, Sharon, and Jennifer have made a great team in the field in setting up a large 40-colony experiment this summer, although Sharon is also simultaneously coordinating the BeeMORE recruitment and hiring process. Dina, our new Genetics Technician, has been quickly getting up to speed on all of our processes and has already cranked out new pathogen samples through our Queen & Disease Clinic. Ali actually came to visit us from Vancouver for a week in mid-March in order to learn some qPCR techniques and even help out in the field when we were making up mating nucs. Right now we have about a half-dozen major projects and even more to write up, so we will certainly stay busy this active research season!

New research on the poor, lowly drone

Research Associate Brad Metz has been investigating the often-neglected honey bee drone, trying to answer a seemingly simple question: what makes a good drone good, and what makes a bad drone bad?

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

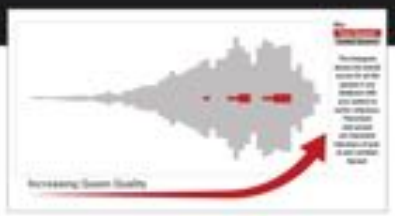
Strong Research Foundations

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		
Reproductive Quality	$24.00	✓	✓	
Standard Pathogen Screen	$55.00	✓	✓	✓
Apiary Pathogen Screen	*$220.00			
Mitotyping (Africanization)	$35.00	✓	✓	✓
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: Morgan Risko

Morgan took our Introductory Beekeeping course last year, but as a Communications major she is interested in working with our program to develop marketing and other media tools to help broadcast our research and extension initiatives. She has been doing a fantastic job using our FaceBook page, including weekly "Trivia Tuesdays" and other posts to engage beekeepers. She has also helped to transition our email listserv to use MailChimp so that our announcements are more streamlined and professional. Finally, she is collecting important data on our social media so that we can get the biggest impact from our efforts, which has been a huge help to the program and our visibility. She will be with us for at least one more semester, so thanks to all your hard work Morgan!

New research on the poor, lowly drone and their reproductive quality

Research Associate **Brad Metz** has been investigating the often-neglected honey bee drone, trying to answer a seemingly simple question: what makes a good drone good, and what makes a bad drone bad?

Drones are often neglected by beekeepers and scientists alike. They are usually thought of as unimportant, lazy, and useless. Of course we all know that they are critical for mating with foreign queens, but otherwise they do not perform any work and therefore are simply drains on colony resources. But a new research paradigm by Brad Metz, a Research Associate in our lab, is trying to get a better handle of the under-appreciated drone so that they can get some much needed respect.

Since the main function of drones is for mating, then how does one quantify their reproductive quality? There are two basic ways. First, their **physical size** is a proxy for their quality, since drone larvae that are better fed, provisioned, and incubated are larger. Previous research has shown that bigger drones take more mating flights and have a higher mating success with queens. To measure drone size, Brad first weighs the adult male then takes a picture of him under the microscope (Figure 1). He can then use digital drawing software to very accurately measure various external body parts, such as the widths and lengths of the head and thorax.

Second, their **reproductive fecundity** is mainly measured by not only how much sperm they produce but how viable it is. This is critical for each male in order for him to inseminate a queen (and thus fertilize her eggs). To measure this, Brad dissects the seminal vesicles from each drone, takes a picture of them to quantify their size like above, then ruptures them in saline solution to release the sperm. Using different cellular stains, he can then quantify both live and dead sperm using our Nexcelom fluorescent automatic cell counting system in only a matter of minutes.

Now that we have a standard way to quantify drone quality, we can then start asking any number of questions that are important to bees and beekeepers alike. At what age are drones sexually mature? How does their rearing environment, particularly pesticides, affect their quality? Why do drones vary in quality so much within and among colonies?

Brad has started to answer these and other questions. For example, in a paper published in the journal *Insects*, we showed that bigger drones are more fecund (Figure 2), and that they tend to peak in their fecundity at the age of 16 days old; even though drones are born with all of the sperm that they will ever produce, the sperm count and viability is not at its optimal in the seminal vesicles until they are just over 2 weeks old.

In another paper published in the *Journal of Insect Science*, we showed that there is a high degree of variation in drone reproductive quality both within and among commercial colonies. It's therefore possible that colonies may be investing in smaller drones for quantity but larger drones for quality.

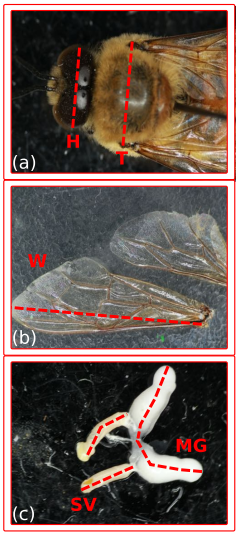


Figure 1. (a) measurement of drone heads is made perpendicularly to the body axis at the widest point of the eyes, and measurement of thorax width is measured as the distance between the tips of the two tegulae. (b) length of the dissected forewings is taken as the length from the base of the costa to the tip of the wing. (c) length of each mucus gland is made along the central axis from the distal bulb to the ejaculatory duct. Length of each seminal vesicle is measured along the central axis from the base of the vas deferens to the mucus gland.

Drone reproductive quality (Continued)

Finally, in a paper recently published in *Communications Biology*, we showed that drones are disproportionately more sensitive to temperature and pesticides compared to workers. So while drones might die more readily under these stresses, those that survive seem to do a pretty good job at protecting their fertility so that they can still mate effectively.

Dr. Metz will be continuing this research paradigm, looking at flight behavior of drones (including the development of an RFID tagging system), the effects of disease on drone quality, and how miticide and antibiotic use by beekeepers might affect them, so stay tuned!

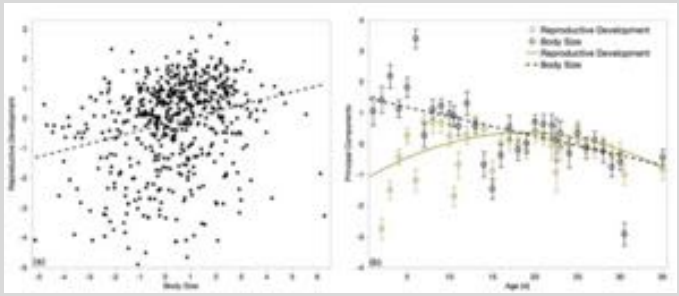


Figure 2. (**left**) Reproductive fecundity (y axis) is significantly correlated with body size (x axis), so that bigger drones have more viable sperm. This correlation holds over the entire lifespan of drones. (**right**) Body size (*black circles*) varied in a relatively linear fashion, with older drones being smaller than younger drones (likely because large drone die more quickly). Reproductive fecundity (*yellow diamonds*) varies non-linearly, with drones aged 16 d being optimally fecund.

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

…and sadly missed!

Erin McDermott Terry had been a Genetics Technician in our lab for over 7 years, but unfortunately she has moved on to greener pastures to help run, own, and operate Midnight Bee Supply. Erin went from a recent graduate who was learning new genetic techniques to an indispensable coordinator, trainer, and manager of our entire molecular operation. We miss you, Erin, and life won't be the same without you!

Random Notes

New Publications

Levenson, H. L., A. Sharp, and D. R. Tarpy. (2022). Evaluating the impact of increased pollinator habitat in surrounding agricultural systems. *Agriculture, Ecosystems, and Environment*, **331**: 107901.

McAfee, A., B. N. Metz, J. P. Milone, L. J. Foster, and D. R. Tarpy. (2022). Drone honey bees (*Apis mellifera*) are disproportionately sensitive to abiotic stressors despite expressing high levels of stress response proteins. *Communication Biology*, **5**: 141.

Simone-Finstrom, M., M. K. Strand, D. R. Tarpy, and O. Rueppell. (2022). Impact of honey bee migratory management on pathogen loads and immune gene expression is affected by complex interactions with environment, worker life history, and season. *Journal of Insect Science*, **22**: 17: 1–10.

Presentations

With the ease of COVID restrictions, we have slowly started to do more in-person presentations. We are still doing a lot of Zoom webinars as well, but it has been great to get back to meeting face-to-face.

David Tarpy has spoken to the Leicestershire & Rutland Beekeepers Association (UK), the Two Bees in a Podcast (University of Florida), three talks and an "ask the experts" panel at the Tri-county beekeepers (Wooster, OH), two lectures at the Stokes County advanced beekeeper training, the Mile Hive Beekeepers Association (CO), and the At Home Beekeeping webinar out of Auburn, AL.

BeeMORE 2022

Once again, we will be hosting ~12 undergraduate students at NC State this summer to participate in research projects that involve bees and microbes. Three of the students will be housed in our lab, one researching alternatives to fumagillin for Nosema disease, one testing how antibiotics affects the pathogen webs within colonies, and one testing how viral pathogens might build over time with or without varroa parasitism. As always, we look forward to working with these BeeMORE interns from other campuses, and we will update everyone on their projects and successes.

Teacher's Corner: Courses at NC State

We do not have any formal courses for the Spring 2022 semester. This fall, we will hold our first-ever offering of AEC 203, *An Introduction to the Honey Bee and Beekeeping*. This is the same course that we have offered under the ENT curriculum for almost 40 years, but with our program's move to the Department of Applied Ecology it will now serve towards their future undergraduate major. Enrollment only recently opened and the course is already at capacity with a waiting list, so we're pleased to see its continued popularity and hope that continues going forward!

go.ncsu.edu/honeybees

Tarpy's Back Page

We have been so fortunate to have the support of the state beekeepers especially in our times of need. As is now commonly known, about 18 months ago our research facility on the Lake Wheeler Research Farm just south of Centennial campus at NC State was condemned by the fire marshal for structural and safety reasons. Our CALS administration has been very supportive of affording us a temporary location and building (the "Dix" facility on the other side of the farm), but it is not a permanent solution. Through their hard work and dedication, the NCSBA has successfully secured $4M in the most recent state budget to help construct a new apiculture research and extension center on the farm complex.

This process has only just begun. The Architects in University Facilities have advertised the work project and are actively soliciting bids. At some point early this summer, they will invite several of the top applicants to present their vision and design. A committee with then select a final firm to fully design and implement the project, which they anticipate will take about a year to complete. We will certainly keep you posted, and thanks again to everyone involved in getting things to this point!