OP-096 [Bee Health]
Nosema (Vairimorpha) ceranae infection alters honey bee (Apis mellifera) queen behavior and reproductive capacity

Juliana Rangel, Tonya S Shepherd, Madison Rowe, Keegan Nichols
Department of Entomology, Texas A&M University, College Station, TX, USA

The takeover of Nosema (Vairimorpha) ceranae over N. apis as the primary honey bee (Apis mellifera) gut pathogen in the United States has revealed a knowledge gap regarding how N. ceranae affects the reproductive health of queens and drones. While the general consequences of intense Nosemosis are well-substantiated, the long-term effects of Nosema infection, specifically on queen behavior, are understudied. In this study, we explored the effects of N. ceranae infection on queen egg-laying capacity, mobility, and retinue behavior. We hypothesized that queens would lay fewer eggs, be less mobile, and elicit a smaller worker retinue after inoculation with N. ceranae compared to the baseline values for these behaviors prior to infection. We set up observation colonies headed by sister queens and fed each a sucrose solution. We monitored the queens' egg-laying capacity, mobility, and retinue behavior in the observation colonies for six consecutive days. Then, each queen was inoculated with 200 µL of sucrose solution containing roughly 200,000 N. ceranae spores and measured the same parameters from each queen starting one day post infection, and doing so for six consecutive days. We found a significant increase in mobility and egg-laying capacity with a significant decrease in retinue size in queens post infection. Our results indicate that honey bee queens infected with N. ceranae suffer physiological consequences that is likely to be translated to an overall decline in colony productivity over time.

Nosema ceranae infection alters honey bee (*Apis mellifera*) queen behavior and reproductive capacity

Juliana Rangel, Ph.D.
Professor of Apiculture
Texas A&M University, College Station, TX, USA

Apimondia International Beekeeping Congress
24 September 2025
Copenhagen, Denmark

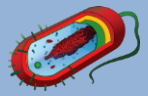
TEXAS A&M UNIVERSITY

TEXAS A&M AGRILIFE RESEARCH

Nutrition

Parasites

Pathogens



Pesticides

Genetics

Mating Conditions

Age/Vigor

Weather Patterns

Habitat

Beekeeping Practices

Queen Quality

Nutrition

Parasites

Pathogens

Pesticides

Genetics

Mating Conditions

Age/Vigor

Weather Patterns

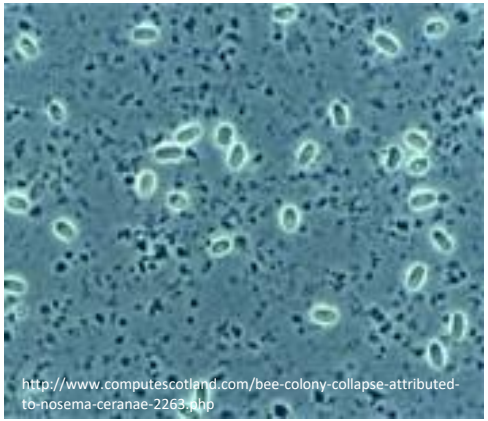
Habitat

Beekeeping Practices

Queen Quality

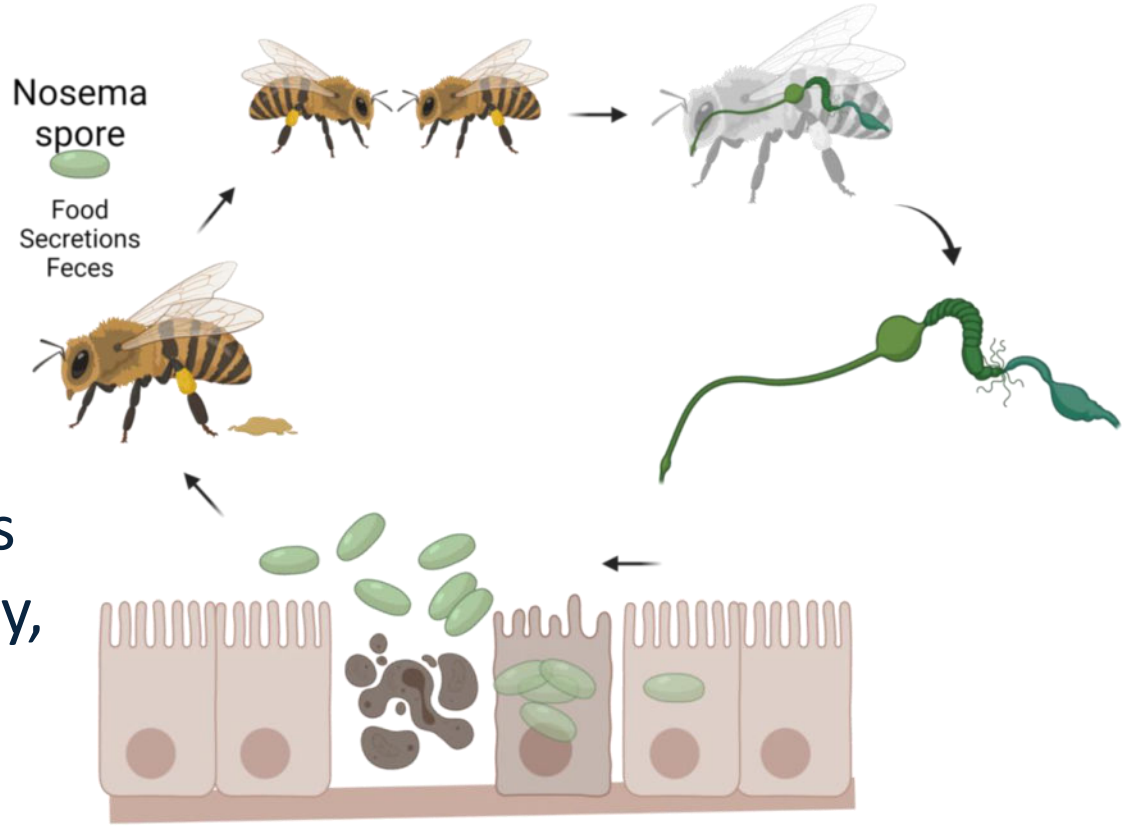
Nosemosis in honey bees

- Microsporidia is a group of parasitic fungi with 200+ species of *Nosema*
- Nosemosis is one of the most prevalent diseases affecting adult honey bee workers (Bailey 1981, Matheson 1993)
- It is caused by two species
  - *Nosema apis* and *Nosema ceranae*
- Infection begins when a bee consumes spores, usually when cleaning bees remove spore-infested feces from comb (Fries 1993, 1997)



Nosemosis in honey bees

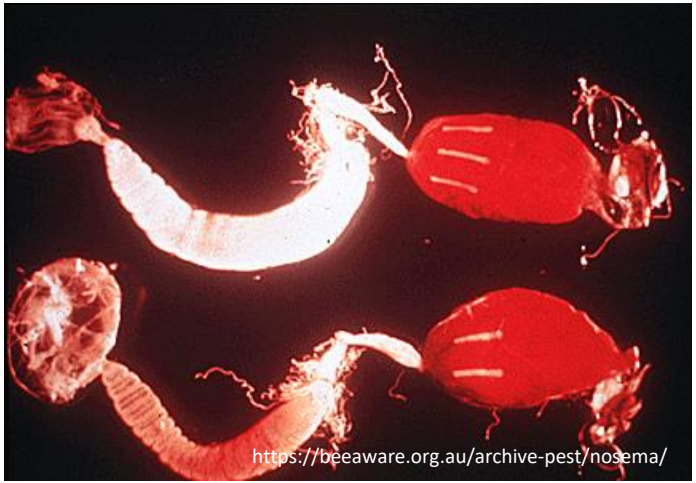
- The spores then travel through the bee's esophagus, the crop, and ultimately into the midgut
  (Webster 2010)
- *Nosema* hijacks the bee's cells to grow and multiply, forming new spores that germinate in the midgut and infect more cells



Created with BioRender

Nosemosis in honey bees

- The midgut of workers infected with *N. apis* appear white and distended, and their colonies exhibit fecal streaking on hive bodies and comb



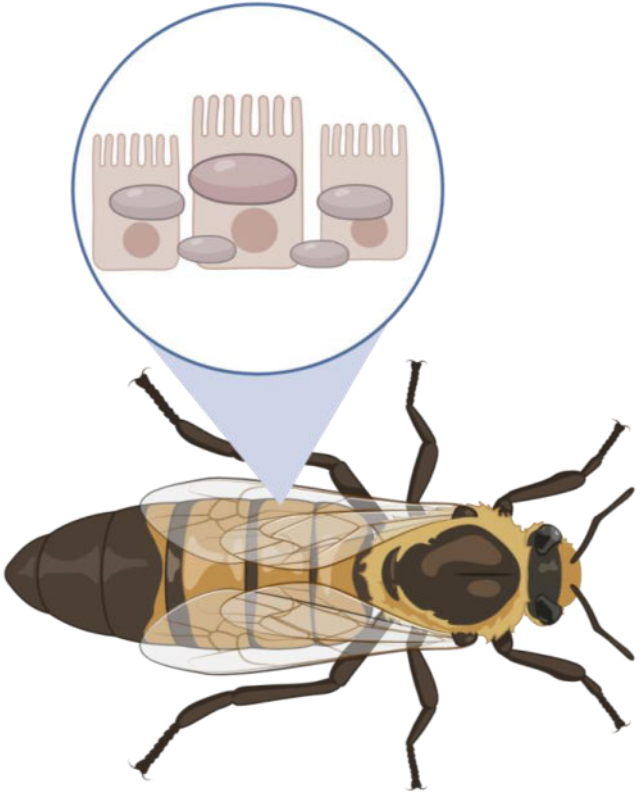
- However, infection by *N. ceranae* does not show obvious external symptoms and thus, it is difficult to diagnose

Nosemosis in honey bees

- Colonies infected with either species exhibit high reductions in worker population (Wang et al. 1970, Higes et al. 2008) and honey production (Malone et al. 1995) caused by mortality associated with digestive disorders and shortened lifespan (Hassanein 1953)
- Spores of the two *Nosema* spp. are very similar in shape and thus difficult to differentiate
- Reliable diagnosis of nosemosis caused by *N. ceranae* is usually done with molecular tools (Travel & Fell 2011a, Rangel et al. 2013)

Nosema ceranae effects on queens are unknown

- No studies to date have explored the effect of *N. ceranae* infection on honey bee queen reproductive quality or worker behavior toward infected queens

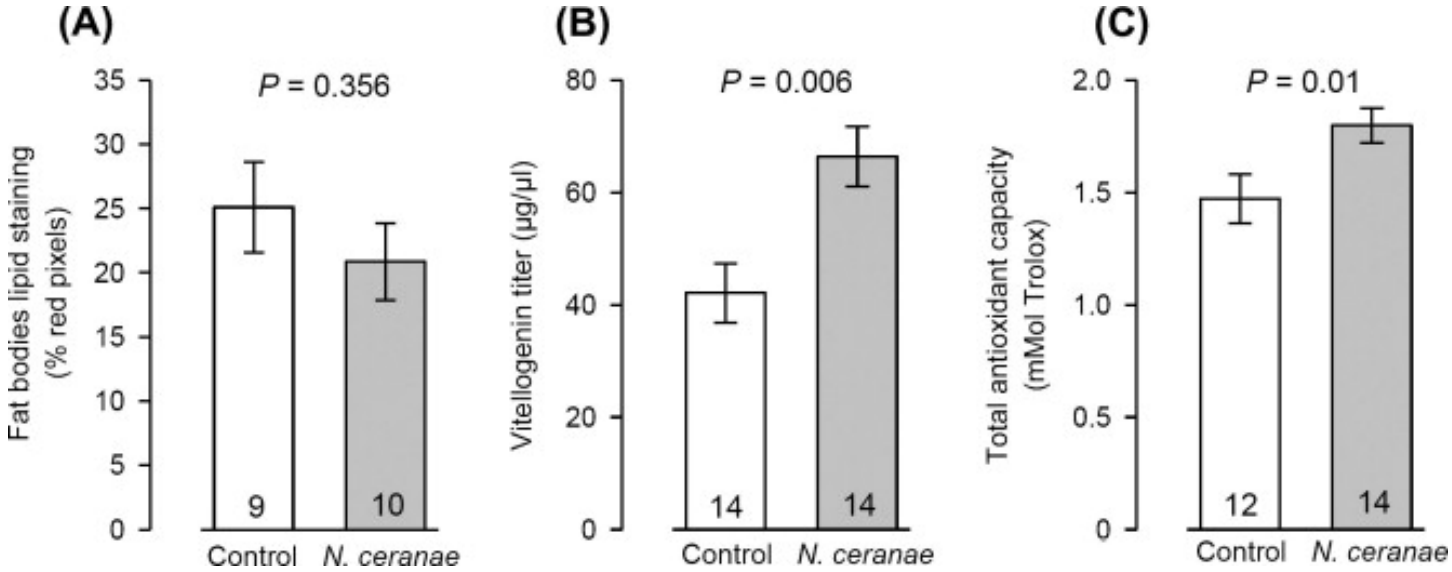


Created with BioRender

Journal of Invertebrate Pathology
Volume 106, Issue 3, March 2011, Pages 380-385

Pathological effects of the microsporidium *Nosema ceranae* on honey bee queen physiology (*Apis mellifera*)

Cédric Alaux [a], Morgane Folschweiller [a], Cynthia McDonnell [a], Dominique Beslay [a], Marianne Cousin [b], Claudia Dussaubat [a], Jean-Luc Brunet [b], Yves Le Conte [a]



N. ceranae infection alters QMP chemical composition

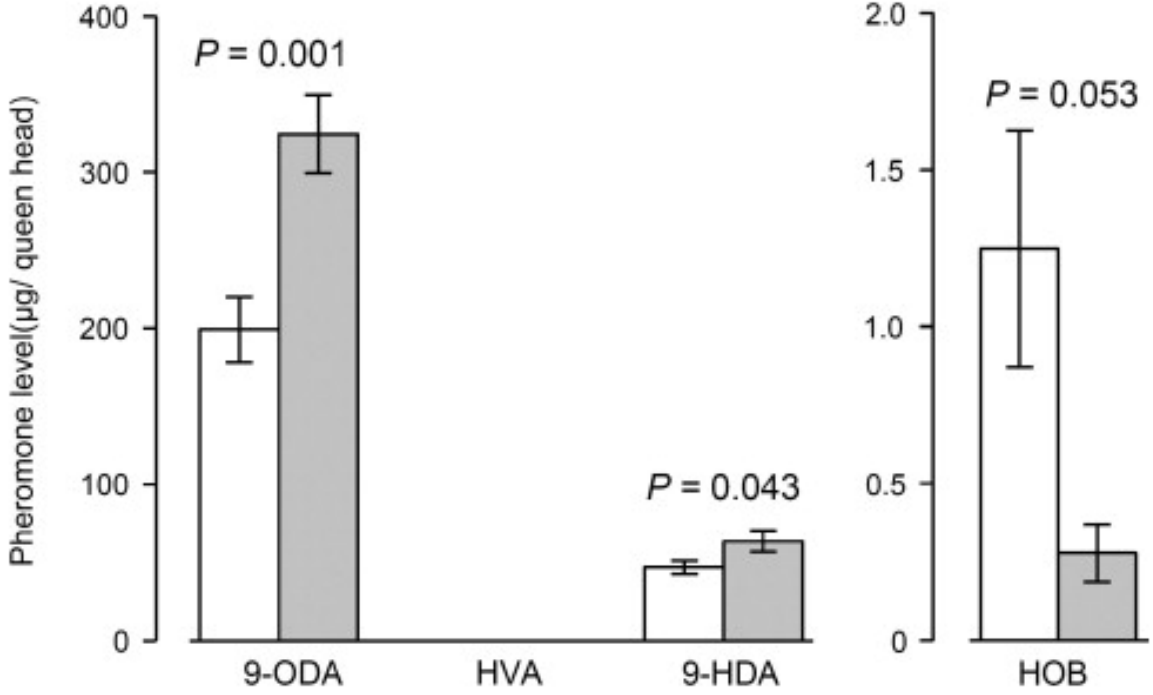


Fig. 2. Pathological effects of *N. ceranae* on QMP levels in queen heads (mean ± SE). The levels of 9-ODA, HVA 9-HDA and HOB (μg/head) between control (n = 9, white bar) and infected queens (n = 10, gray bar) were compared using Mann–Whitney U tests.

How does *Nosema ceranae* infection affect queen reproductive physiology and worker behavior?

Isolation of *N. ceranae* spores from workers

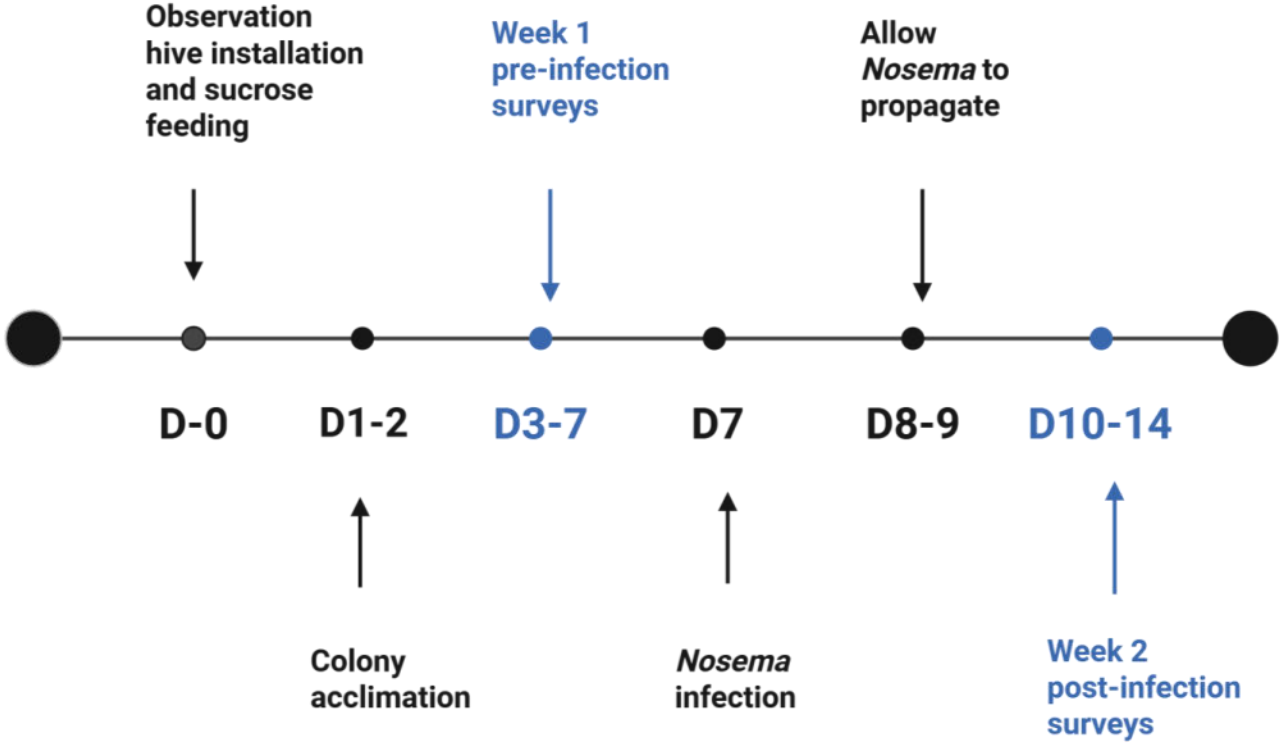
- *N. ceranae* was isolated from workers in naturally-infected colonies at the TAMU research apiary
- The colony with the highest level of infection was identified and used to create a cage of highly infected bees
- An inoculum of 2×10^5 *N. ceranae* spores per µL of sucrose solution was created to infect queens

Isolation of *N. ceranae* spores from workers

- Three-frame observation hives with ≈4,000 workers and a marked queen were installed
- Queens were inoculated with a sham sucrose solution prior to installing the hives
- Pre-infection measurements occurred for 5 days and included retinue size, egg-laying capacity, and movement

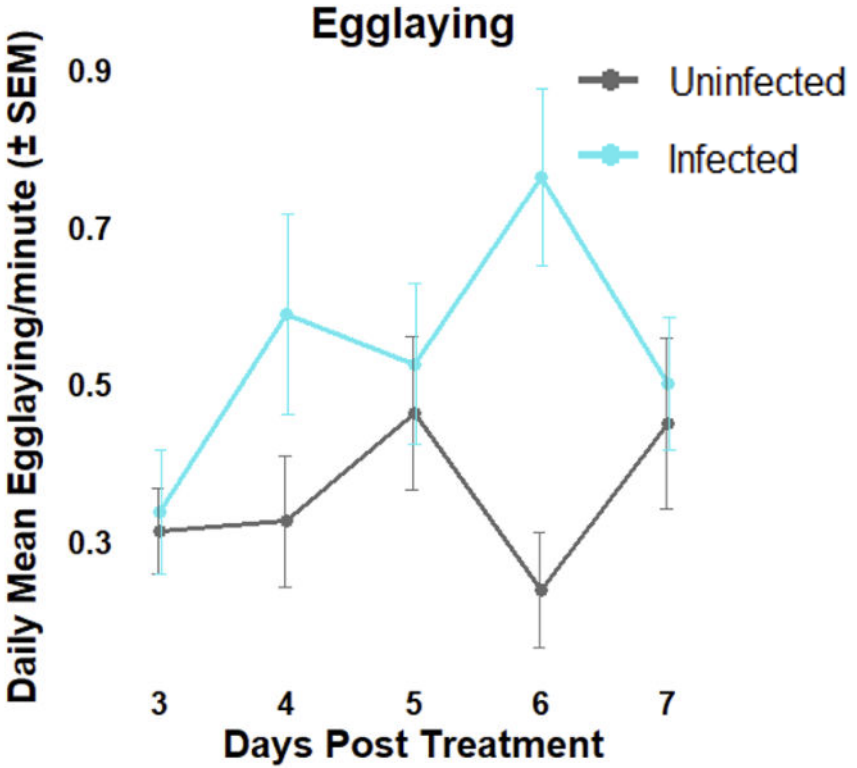
- Queens were then inoculated with *N. ceranae* spore solution
- Post-infection measurements occurred over the next 5 days

Inoculation of queens with *N. ceranae* spores

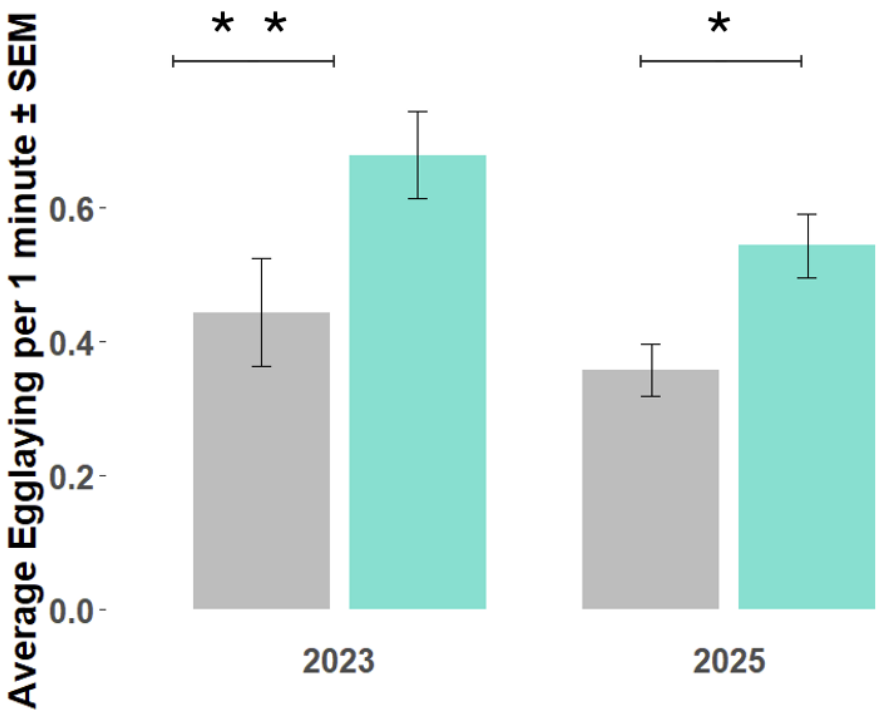


Significantly higher egg-laying capacity post infection

2025 only



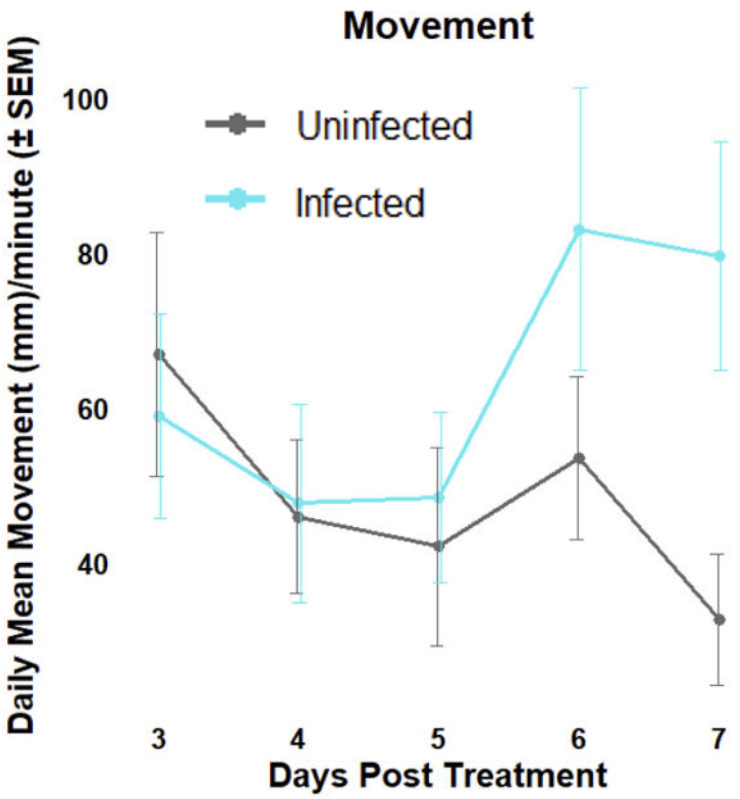
2023 and 2025



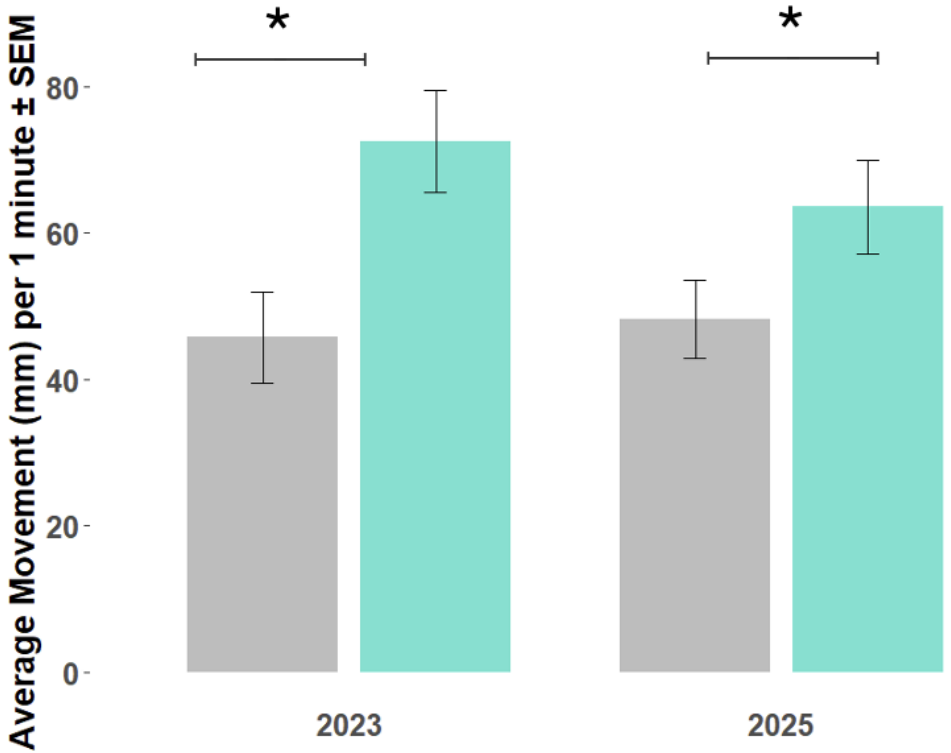
(p=0.03; Linear mixed model and LME test)

Significantly faster queen movement post infection

2025 only



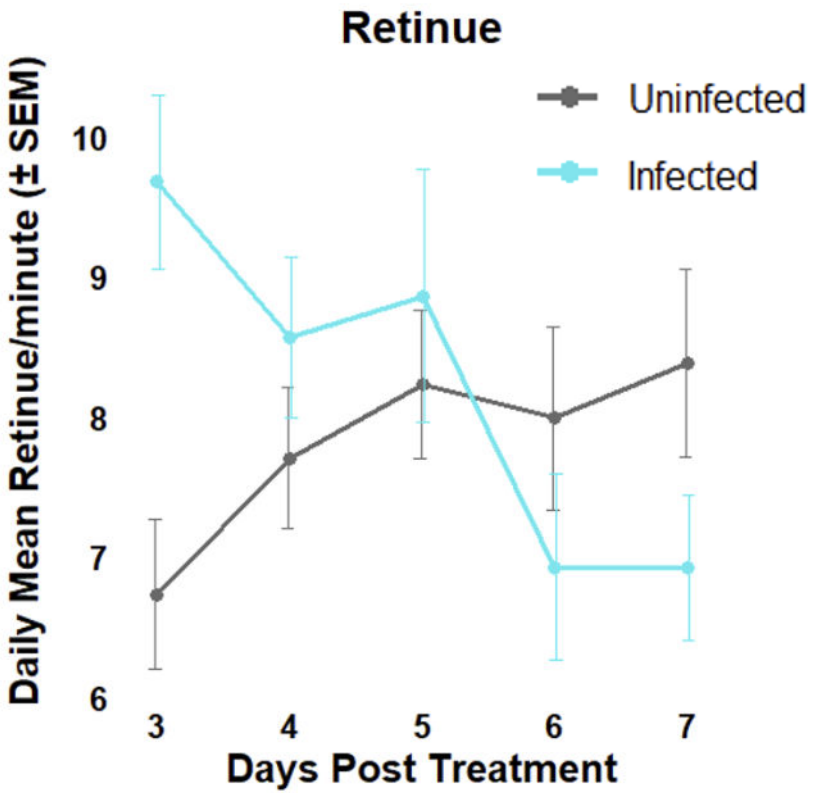
2023 and 2025



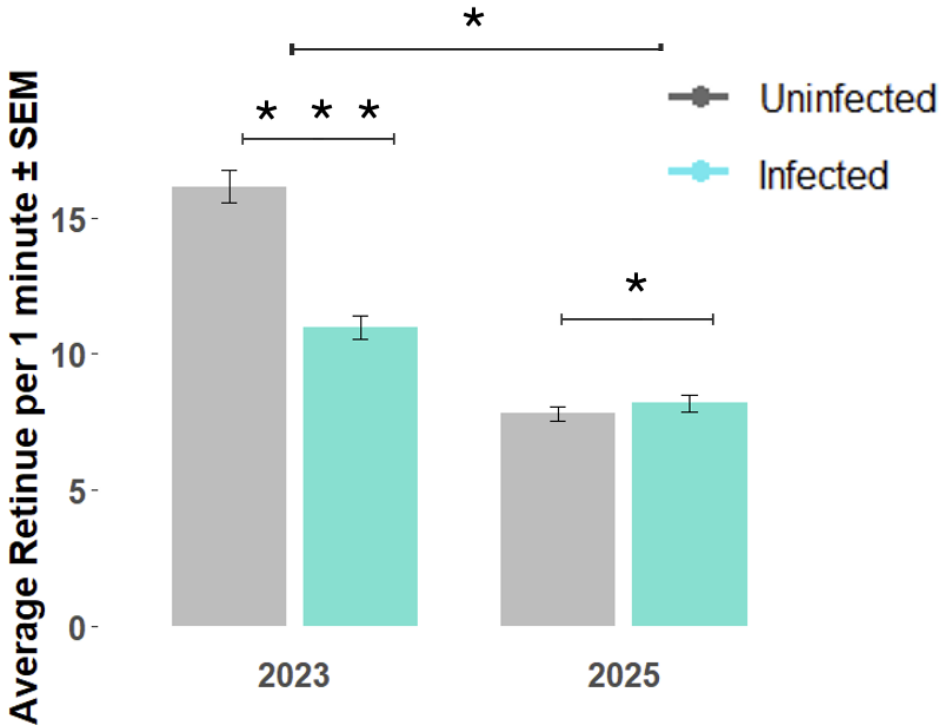
(p=0.02; Linear mixed model and LME test)

Significantly larger worker retinue post infection

2025 only



2023 and 2025



(p=0.02; Linear mixed model and LME test)

Conclusions and future directions

- *N. ceranae* infection affects honey bee queen physiology and worker behavior toward the queen:
  - It causes significantly higher egg-laying by the queen
  - It causes significantly faster queen movement on the comb
  - It causes a significant reduction in worker retinue
- We need to better understand the effects of *N. ceranae* infection on queens and drones

Thank you!

Texas A&M University Apiculture
@TAMUhoneybeelab

PAm
Project Apis m.

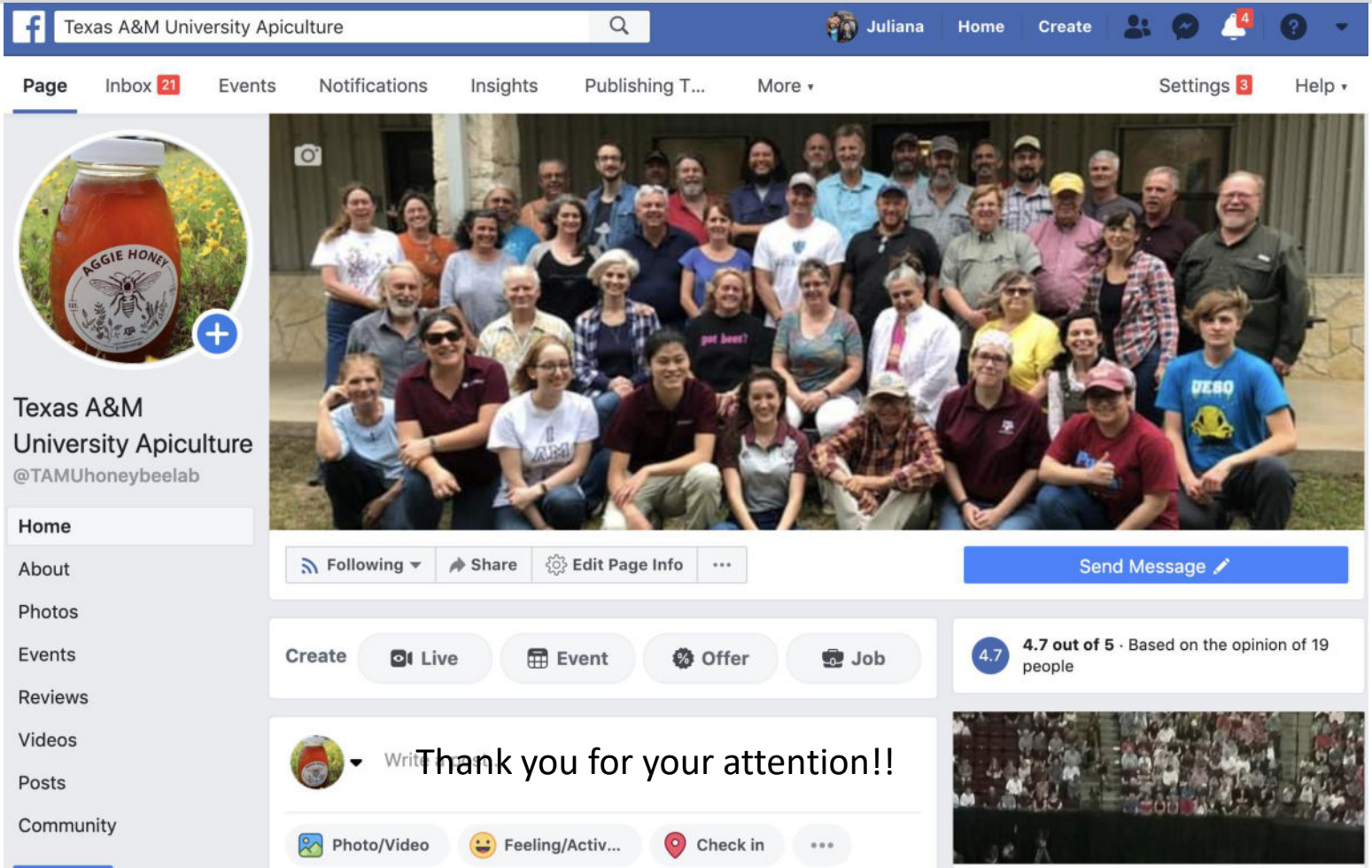
North American Pollinator Protection Campaign

AGGIE HONEY
EST. 2013
Entomology

TEXAS A&M AGRILIFE RESEARCH

UTRGV

https://www.facebook.com/TAMUhoneybeelab



Sweet Safari

TEXAS A&M UNIVERSITY
Department of Entomology

Thank you! Any questions?

jrangel@tamu.edu