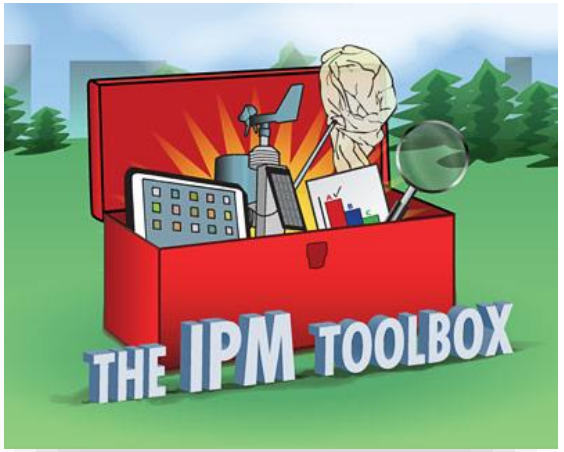
Genetics & Breeding of Mite-Resistant Honey Bee Stocks



November 20, 2024

CENTRAL STATE UNIVERSITY
Research
Bee Lab

USDA United States Department of Agriculture National Institute of Food and Agriculture

Northeastern IPM Center

Webinar Details

Live Transcription

A recording of this webinar will be available within a week at

https://www.northeastipm.org/ipm-in-action/deij-in-ipm/

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Some Questions for You

Northeastern IPM Center

Webinar Presenter

- **Hongmei Li-Byarlay**

- Associate Professor
- Central State University

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Genetics and Breeding of Mite-Resistant Honey Bees Stocks in Ohio and the Midwest

Hongmei Li-Byarlay
(hli-byarlay@centralstate.edu)
Central State University
COBA presentation Jan. 18, 2023

@Insect_Sciences

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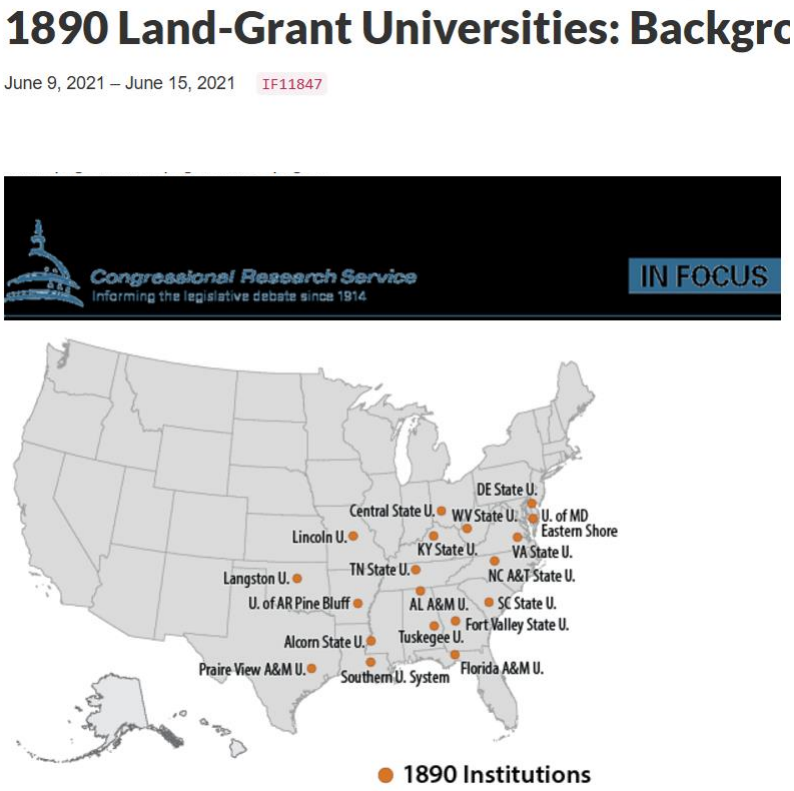
1890 Land-Grant Institution

Central State University – New 1890 Land Grant Univ./H.B.C.U.

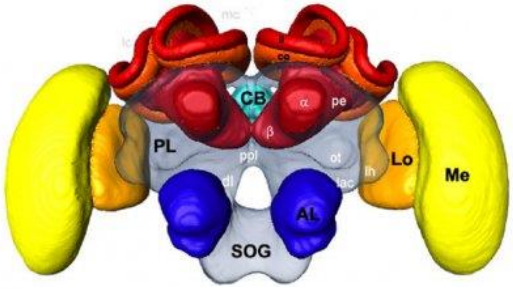
1400 Brush Row Road, Wilberforce, Ohio



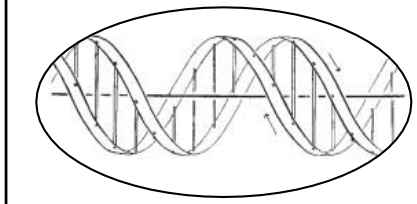
https://www.everycrsreport.com/reports/IF11847.html

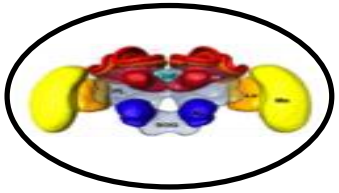
How do genes control the social behavior?

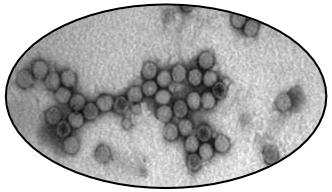
Innate behaviors are encoded in the DNA.



Genomics Brain & Behavior Stress/Physiology







Grooming/Mite Biting Behavior for Mite Resistance

Video Credit: Price Smith/Dwight Wells

Mite Biting Behavior / Mite resistance

Video Credit: Price Smith/Dwight Wells

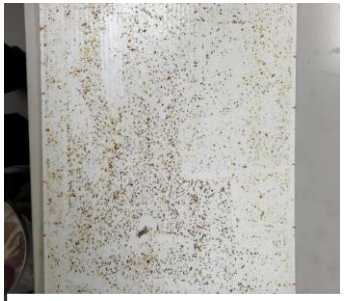
Q: Do feral bees bite mites or groom more?

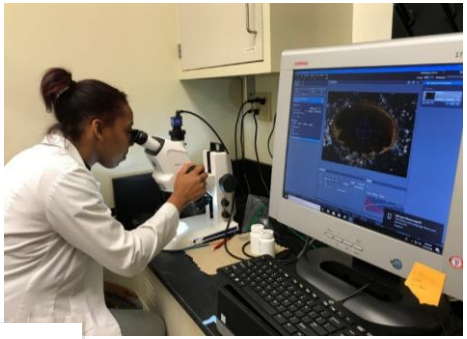
Photo Credit: Hongmei Li-Byarlay

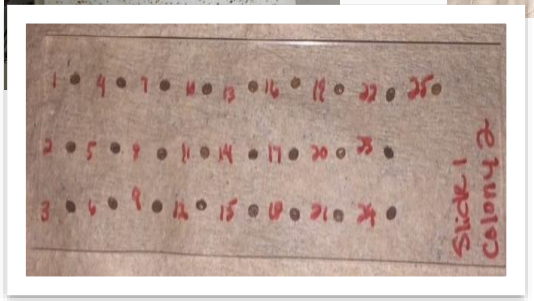
Methods

Mite Samples collected in Western Central OH or West Lafayette, IN in the fall of 2018.
Colony types-

- Comm (OH)
- Mite Biter (IN)
- Mite Biter open-mated (OH)
- Feral (OH)







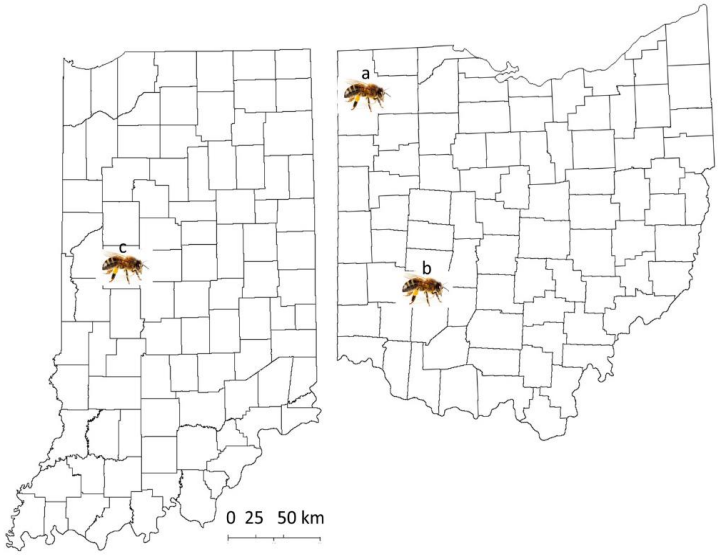
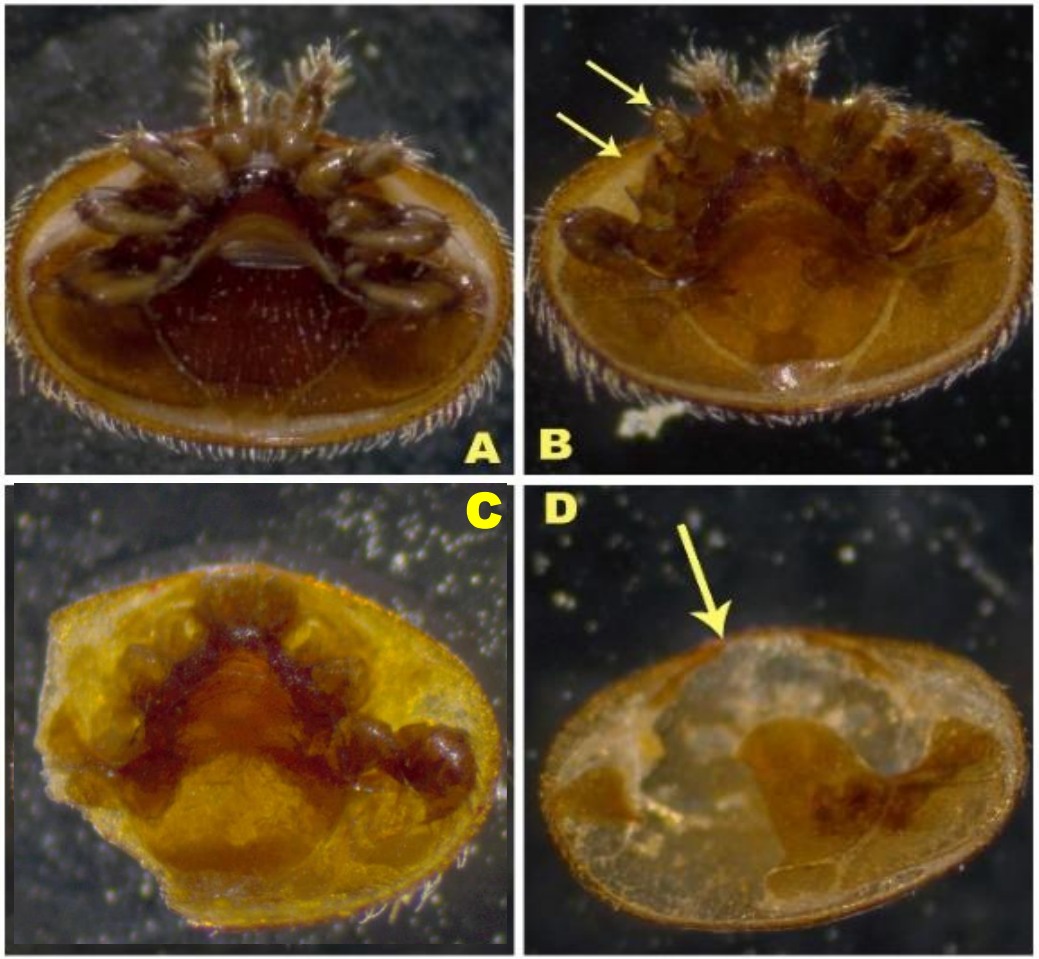


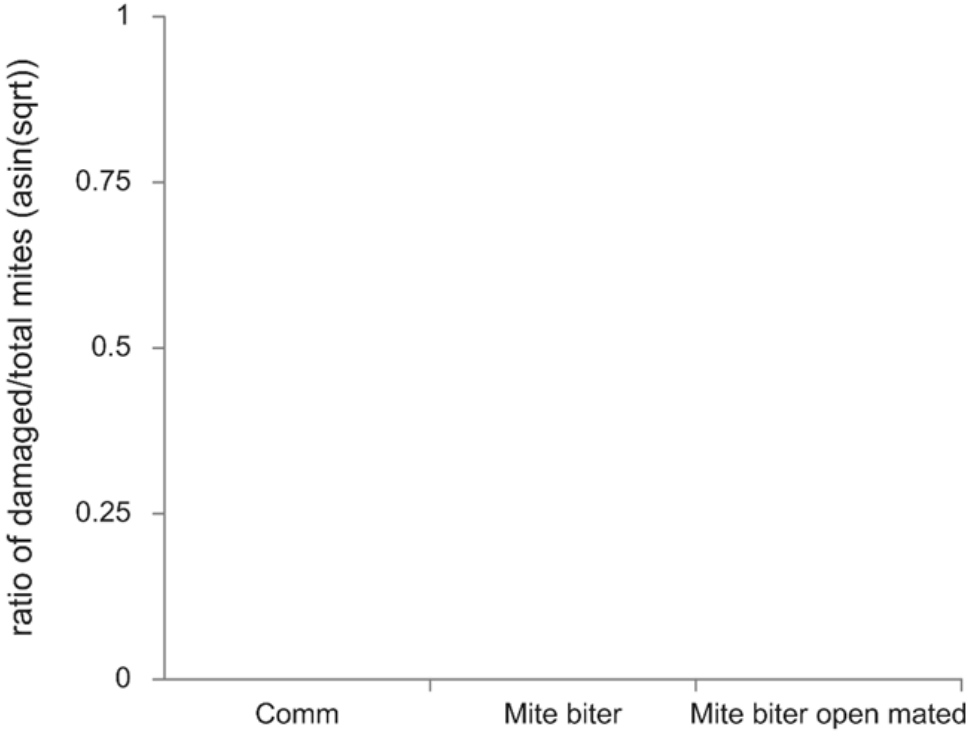
Photo Credit: Hongmei Li-Byarlay

Mutilated mites, loss of legs, Damage to the cuticle of the idiosoma

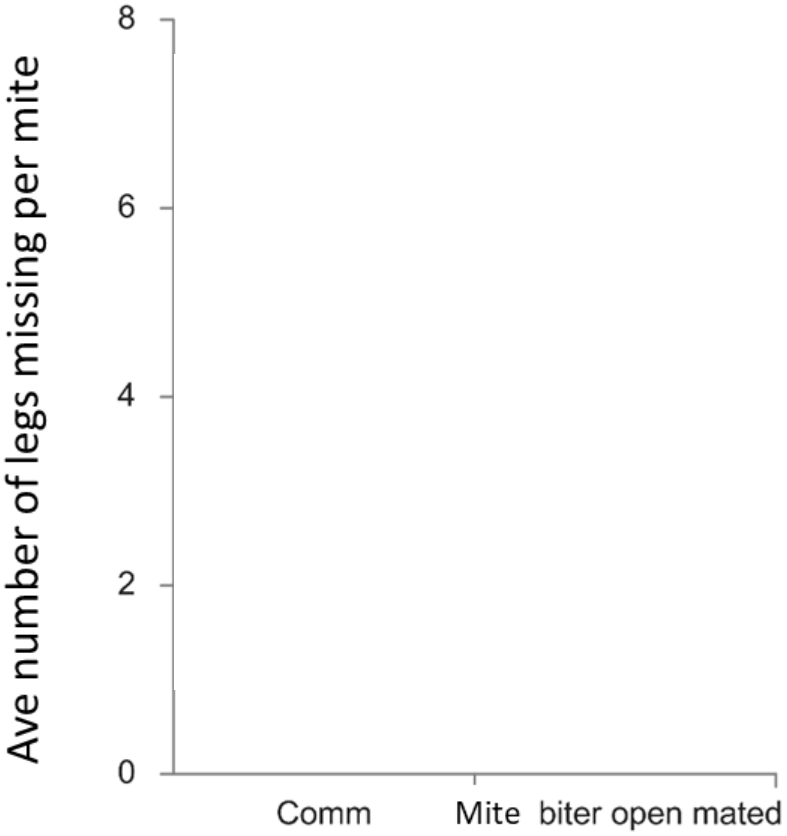


Smith et al., 2021 Frontiers in Genetics

Different biting behavior among groups



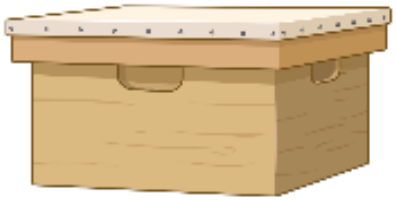
Difference of the average # of legs missing per mite

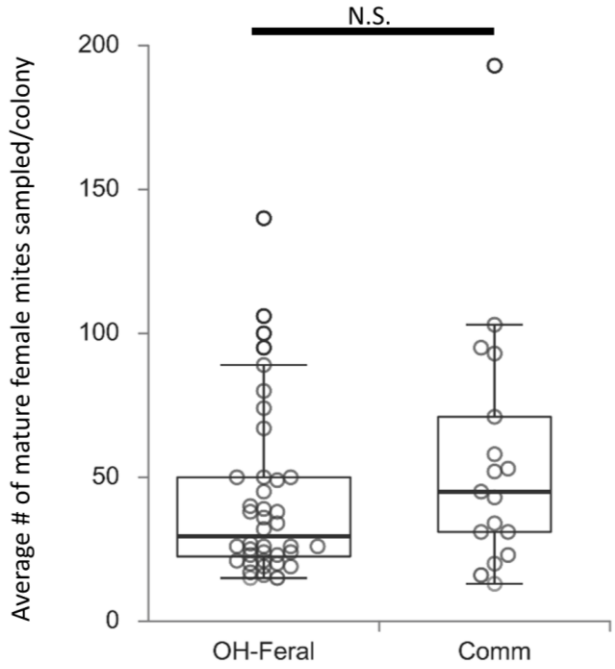


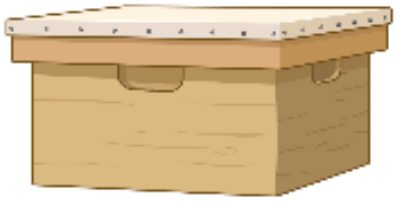
Smith et al., 2021 Frontiers in Genetics

Commercial/Package Colonies

OH Feral Colonies







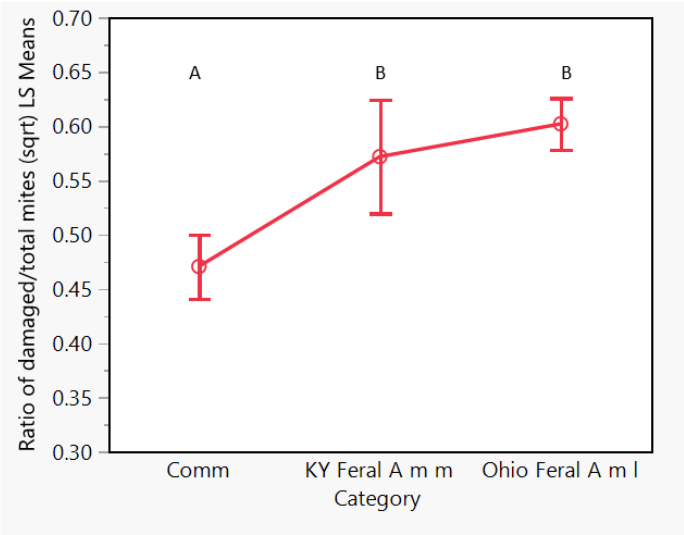
Li-Byarlay et al., in revision

Commercial/Package Colonies

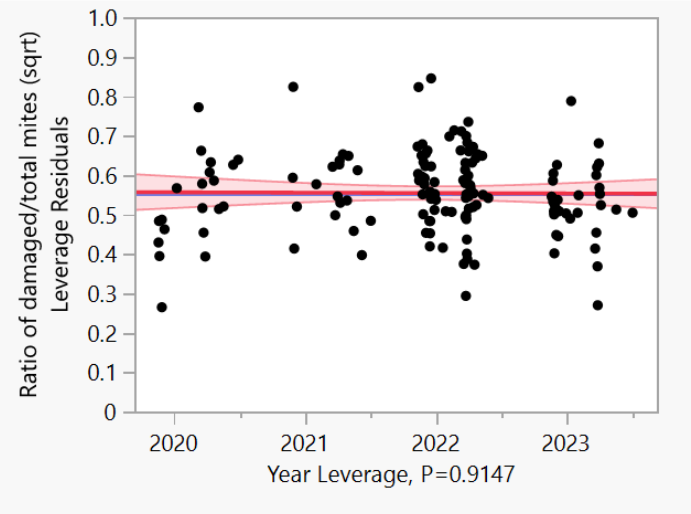
KY Feral Colonies

OH Feral Colonies

Least Squares Means Plot



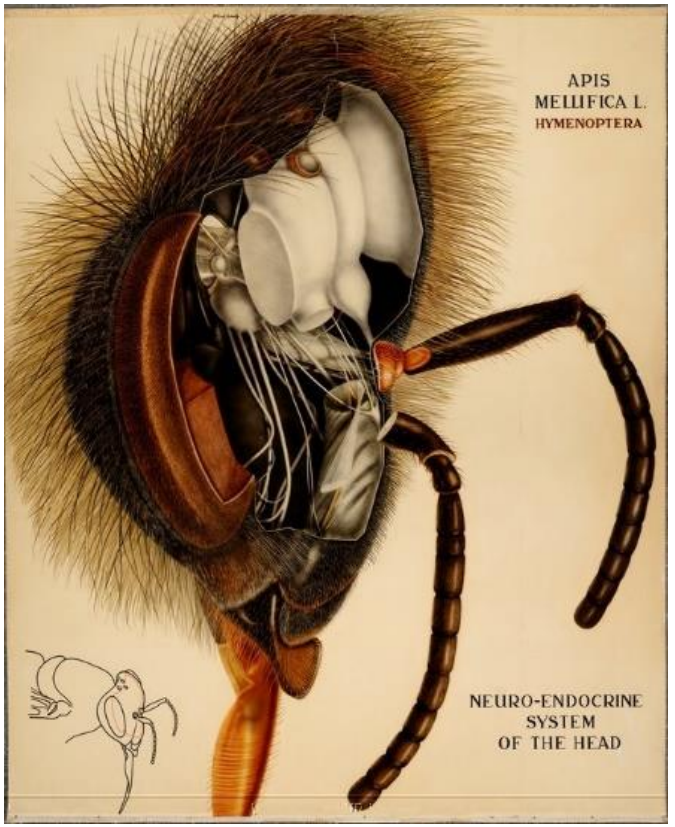
Leverage Plot



Li-Byarlay et al., in revision

Are the Mandibles Different?

H: There is a difference among mandibles of *A. cerana* and *A. mellifera* (mite biting bees and commercial bees).

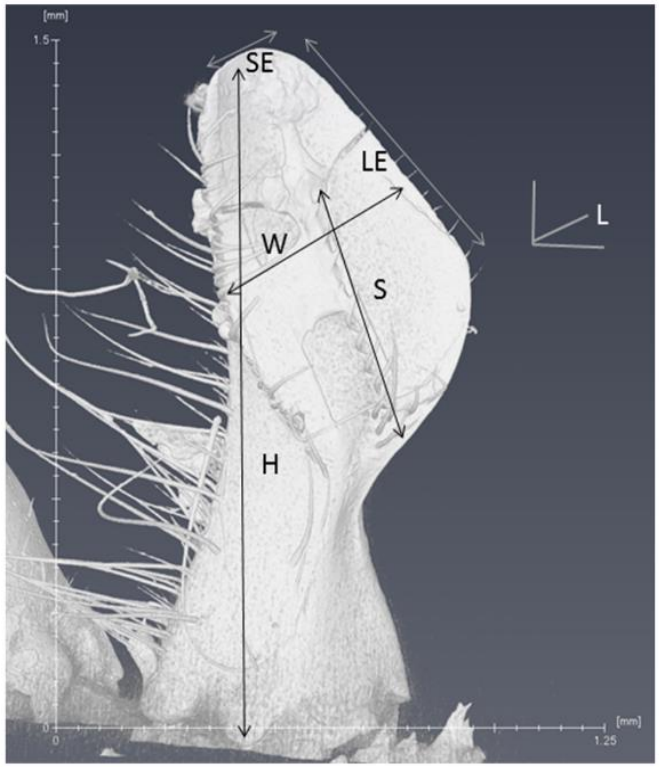


Results: 3-D of honey bee mandibles

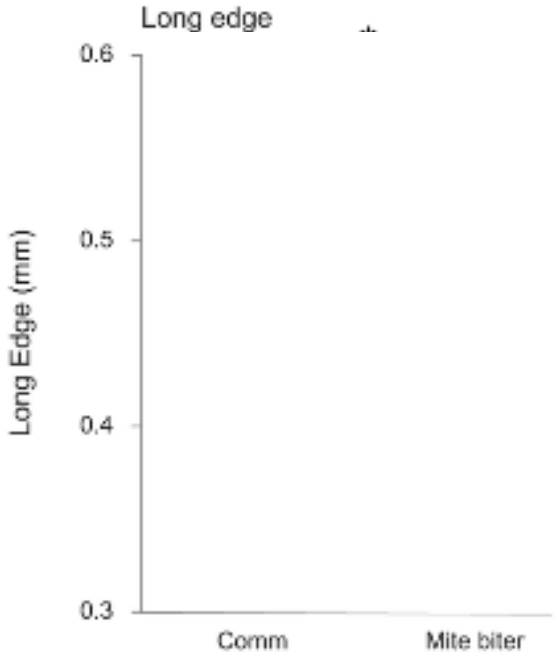
Video credit: Carley Goodwin

Li-Byarlay et al., In prep

Anatomy of the Mandible

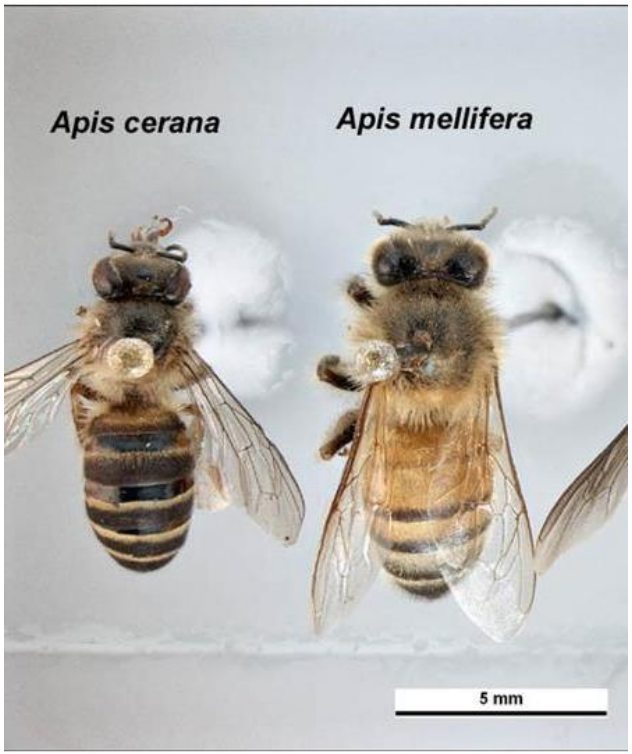


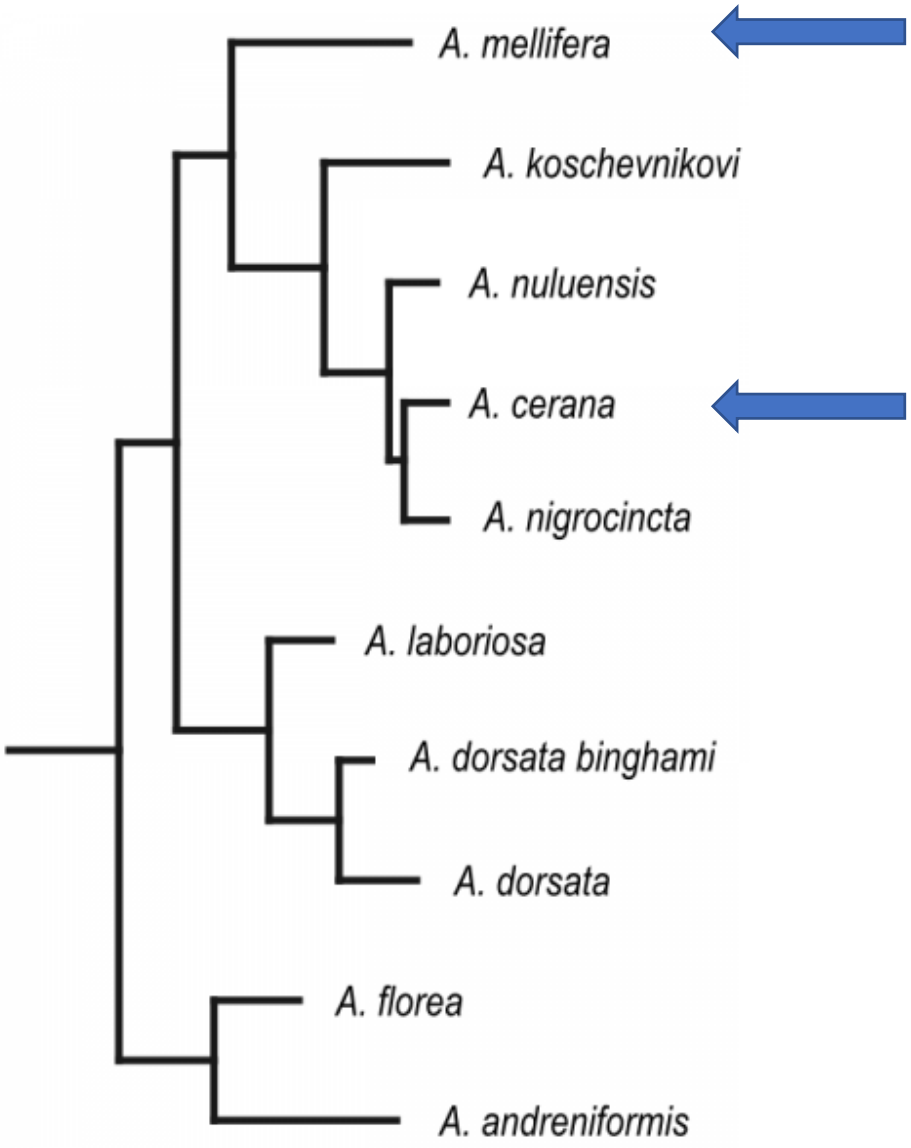
A A B



One-way ANOVA, *F* () =12.93, *p*=0.0001, Tukey HSD, ** p<0.01

Smith et al., 2021 Frontiers in Genetics

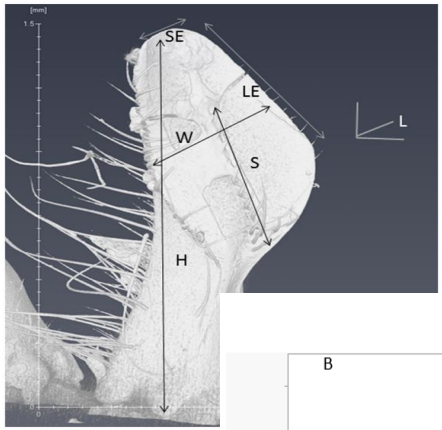




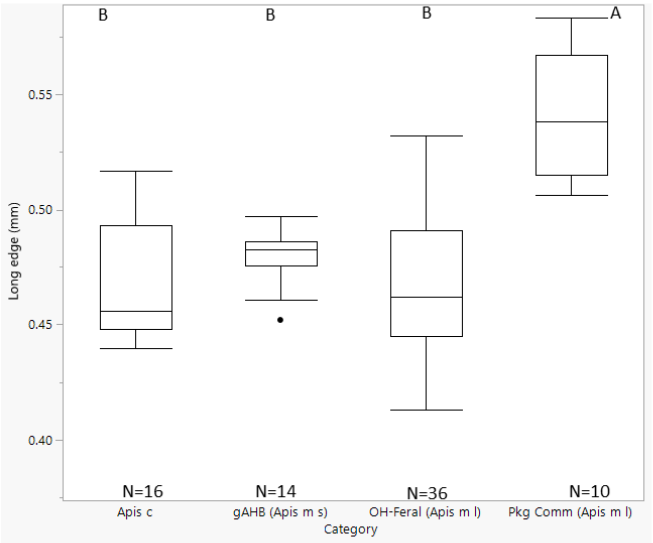
Raffiudin R., Crozier R.H. (2007) Mol. Phylogenet. Evol. 43: 543–552.

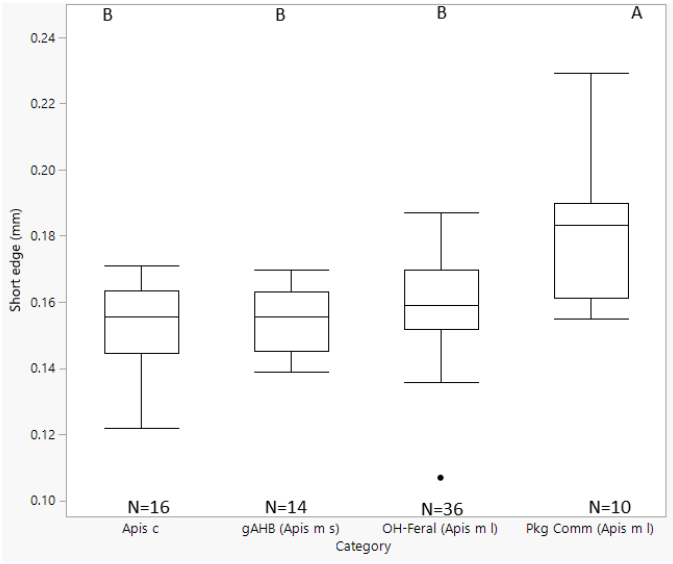
Apis cerana vs *A. mellifera*

Li-Byarlay et al., in revision



$F\ (4, 84) = 11.10 \quad p = 3.24e\text{-}07$





One-way ANOVA of 5 independent trts

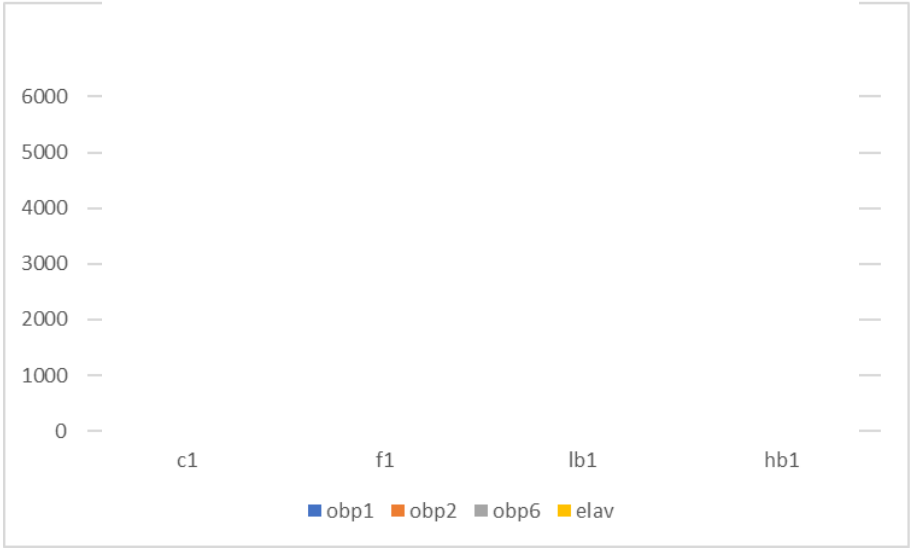
Tukey HSD Tests

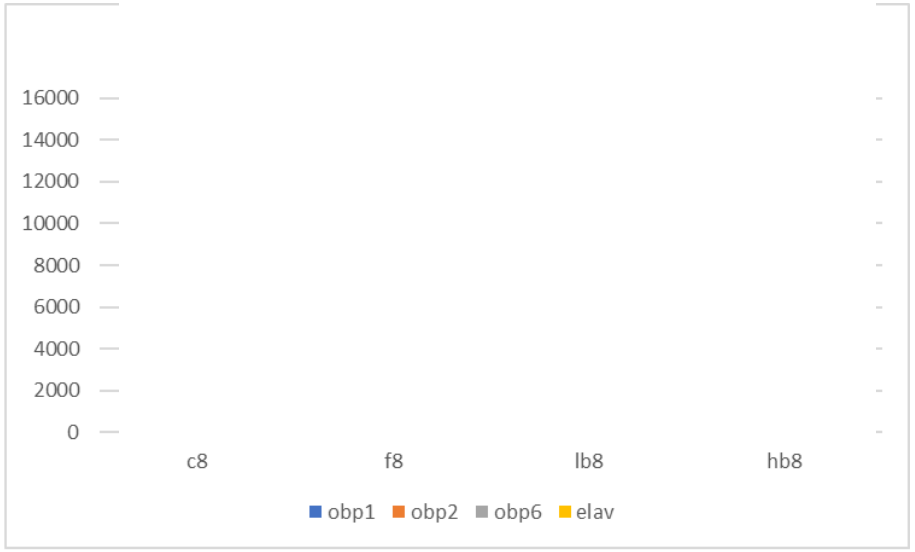
Li-Byarlay et al., in revision

$F\ (4, 86) = 11.89 \quad p = 1.14e\text{-}07$

Are there any gene markers for high grooming/mite biting behavior? - Transcriptomic analysis

- **Olfactory binding proteins?**

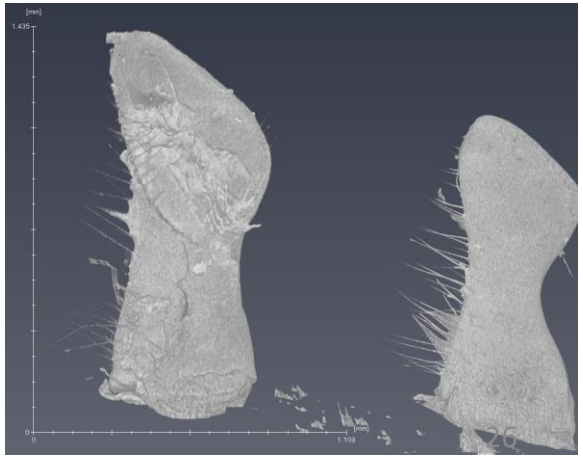




Summary

- The defense mechanism maybe explained by the different shapes and anatomy of mandibles.

- Evidence suggests an evolutionary morphological change in the mandibles for mite biting/grooming.
- Genetic markers for high grooming and mite biting behavior



Managing the *Varroa Destructor* in a Sustainable Way

- Demand for sustainable and non-chemical tools for mite control. Target the brood breaks in honey bee colonies (Gabel et al. 2023)
- The interruption of brood production in the fall can: disrupts the *Varroa* mite's reproductive cycle, for colony to rebuild and recover (Calis et al., 1999; Gregorc et al.,2017).
- Breaking the brood cycle of bees and mites may help to manage the mite population as seen in other countries, but there is not many cases of Brood Breaks being recorded inside of the USA.

- We are testing the *hypothesis* that breaking the brood cycle by caging the queen of the colony can increase the efficacy of varroa control and decrease the mite population comparing to the chemical miticide treatments.

2022 field data

Austin Carey

Colony ID	Treatment	Initial Wash	Initial Wash Mean	Final Wash	Final Wash Mean	P-Value
195	Cage	9	10	62	33	.2649
199	Cage	8		16		
106	Cage	13		21		
133	Formic Pro	9	10	5	6	.2254
138	Formic Pro	11		3		
132	Formic Pro	10		10		
1	Control	7	6	18	15	.0460
2	Control	10		21		
3	Control	1		6		

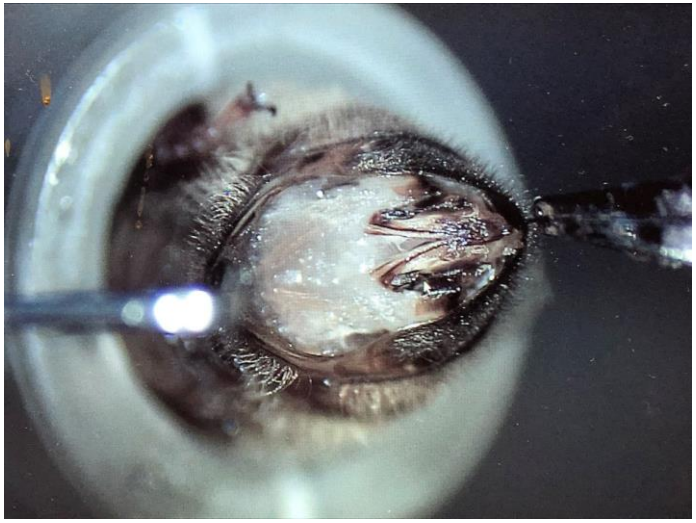
2023 field season

Danielle Kroh

Hive	Mites	Size	Treatment
3	6	10F-2D-1M	Formic
6	6	10F-2D-1M	Cage
199	5	8F-2D-1M	Formic
119	4	8F-2D-1M	Cage
148	2	10F-2D-1M	Cage
33	2	10F-2D-1M	Formic
15	3	8F-2D-2M	Formic
195	2	8F-3D	Cage
110	9	8F-2D-1M	Formic
9	12	8F-1D-2M	Cage
43	2	10F-1D-1M	Cage
200	5	8F-3D	Formic

Table 1. A summary of all the colonies and treatments, including Formic pro or caging the queens. The mite counts from alcohol wash is also provided before the treatments started.

CSU Selection & Breeding Program

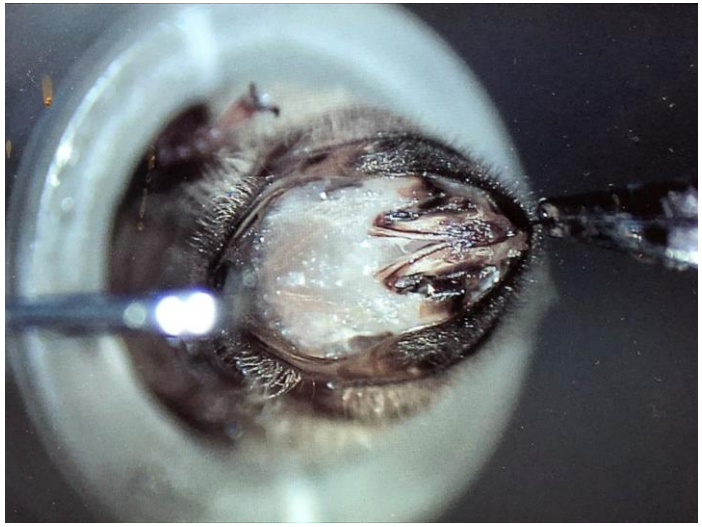


- Ohio mite biter first gen (OB1) strain at CSU
- High biting colonies
- Low biting colonies

Before COVID, 2019

During COVID 2020

2022 HHBBC II Event



NORTH CENTRAL SARE
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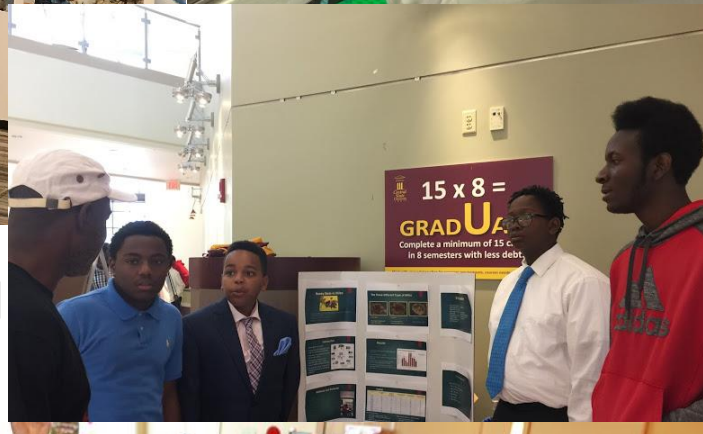
Cabela's

2023 CSU queen grafting class



#BlackInSTEM

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- Gabel, M., Scheiner, R. and Büchler, R., 2023. Immediate and long-term effects of induced brood interruptions on the reproductive success of Varroa destructor. Apidologie, 54(2), p.20.
- Gregorc, A., Alburaki, M., Werle, C., Knight, P.R. and Adamczyk, J., 2017. Brood removal or queen caging combined with oxalic acid treatment to control varroa mites (Varroa destructor) in honey bee colonies (Apis mellifera). Apidologie, 48, pp.821-832.

Funding support and acknowledgements

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USDA-SARE NCR PARTNERSHIP GRANT: IMPROVING THE HONEYBEE QUEEN QUALITIES AND GENETIC DIVERSITY BY TRANSFERRING SELECTED QUEEN CELLS (ONC19-062)

USDA AFRI GRANT: GENETICS AND BREEDING OF MITE BITING BEES FOR RESILIENCE TO VARROA MITES (2020-67014-31557)

USDA **CAPACITY BUILDING GRANT**: INVESTIGATE THE BIOTIC AND ABIOTIC STRESSES IN HONEY BEES AND POLLINATORS (2021-38821-34576

USDA NEXTGEN GRANT: HBCU-HSI-RIU CONSORTIUM: A SYNERGISTIC PARADIGM FOR TRAINING THE NEXT GENERATION AGRICULTURE WORKFORCE FOR A SUSTAINABLE FUTURE (NIFA AWARD 2023-70440-40147)

Thank you for listening!

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https://www.northeastipm.org/ipm-in-action/the-ipm-toolbox/
https://www.northeastipm.org/ipm-in-action/deij-in-ipm/

- **Research Update Conference**
  December 10, 2024

- **Pest Management Strategic Plans and Crop Profiles**
  February 13, 2025
  Presenters: Lacey Belanger

- **IPM Weather Apps**
  February 18, 2025, 11:00am
  Presenters: Dan Olmstead and Glen Koehler

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https://www.northeastipm.org/ipm-in-action/toolbox

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Land Acknowledgment

The Northeastern IPM Center is based at Cornell University is in Ithaca, New York.

Cornell University is located on the traditional homelands of the Gayogo̲hó:nǫ' (the Cayuga Nation). The Gayogo̲hó:nǫ' are members of the Haudenosaunee Confederacy, an alliance of six sovereign Nations with a historic and contemporary presence on this land. The Confederacy precedes the establishment of Cornell University, New York state, and the United States of America. We acknowledge the painful history of Gayogo̲hó:nǫ' dispossession, and honor the ongoing connection of Gayogo̲hó:nǫ' people, past and present, to these lands and waters.

This land acknowledgment has been reviewed and approved by the traditional Gayogo̲hó:nǫ' leadership.

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