PennState College of Agricultural Sciences | Huck Institutes of the Life Sciences

Center for Pollinator Research
2019 Newsletter

Events

Workshop on Analyzing Automated Hive Scale Data. Hosts: Doug Sponsler and Christina Grozinger. This workshop will bring together individuals from the USDA-ARS, USGS, U Nebraska, U Wisconsin, Michigan State, and Macquarie University to discuss approaches and challenges in interpreting these data sets. February 18-20, 2020

Managing Landscapes for Insect Biodiversity. Natalie Boyle (nmb5846@psu.edu) will offer a workshop for landscape professionals, Penn State University, August 17-21, 2020

PA Pollinator Protection Plan meetings will be held on Feb 21, May 4, Sept 14, 2020

CPR Spring Seminar Series

Jonathan Koch, University of Hawaii, Jan 24, 2020
Gabriela Quinlan, Michigan State University, February 17, 2020
Sharif Islam, Naturalis Biodiversity Center, Feb 24, 2020
Brian Danforth, Cornell University, March 17, 2020
Anna Dornhaus, University of Arizona, February 28, 2020
Sheila Colla, York University, April 24, 2020
Felicity Muth, University of Texas-Austin, May 1, 2020
Rodolfo Dirzo, Stanford University, April 21, 2020

Special Announcements

Penn State launches the Insect Biodiversity Center

We are very happy to announce that Penn State will be establishing an Insect Biodiversity Center! The Center will create a unique, transdisciplinary ecosystem to integrate currently disparate centers of excellence at Penn State in insect biology, management, ecology, technology development, Earth and environment monitoring systems, data science and modeling, decision support systems, human dimensions, communication science, and education. This transdisciplinary ecosystem will ensure that we leverage expertise well outside of the domain of the biological sciences to tackle the complex environmental, social, economic, and political drivers underlying changes in insect species abundance and distribution. We have hired Dr. Natalie Boyle to spearhead the Educational Programming in the Center, and we are in the process of recruiting students for our Graduate Fellowship Program. Look for more information on the Center and how you can get involved soon!

PSU honey bee extension information has a new location

The Penn State Extension Website is now featuring a new space for content about pollinators. Information is located under "Insects, Pests and Diseases" and content is distributed in five categories: (1) Beekeeping, (2) Habitat and Landscape, (3) Identification and Biology, (4) Pesticides, (5) Pollination Services. We are currently working on developing new information about all of these topics in both English and Spanish. Check out our new "Learn How" video on honey bee package installation, and stay tuned for new videos featuring bee biodiversity and their pollination services to crops.

Faculty Awards and Announcements

Dr. Etya Amsalem was awarded an NSF CAREER grant starting in 2020. The Faculty Early Career Development (CAREER) Program supports early-career faculty who serve as academic role models in research and education. Dr. Amsalem was awarded $1,019,973 for her grant titled "Sterility inducing mechanisms in social insects."

Dr. Reka Albert and Christina Grozinger and were elected Fellows of the American Association for the Advancement of Science.

Dr. Shelby Fleischer won 2nd place in the Semiochemical Technology Contest, from Treece, Inc. at the 2019 ESA meeting in St. Louis for suggestions on modifying traps to avoid bycatch of bees.

Dr. Harland Patch has been named "Director of Pollinator Programming" at the Arboretum at Penn State.

Dr. Kelli Hoover and Christina Grozinger were awarded $199,735 form a USDA NIFA McIntire-Stennis Grant for their project titled: *Relationship between pollination deficiency and decline of black cherry regeneration in the Allegheny National Forest.*

Dr. Michael Skarvla, transitioned to a new job title (Assistant Research Professor) effective January 1, 2020. Michael is an expert in insect identification and the recipient of a $25,000 PSU Extension Multistate & Integrated Program Grant to collect deer keds via the PA Parasite Hunters community science project. He also received $25,000 from PSU Extension Impact Grant to purchase 10 stereomicroscopes to teach insect ID short courses, including two pollinator ID courses!

Dr. Robyn Underwood, was awarded $22,695 for her grant titled: *Does Artificial Feed Impact Health and Survival of Honey Bee Colonies*? Northeast Sustainable Agriculture Research and Education. Robyn will be collaborating with Steve Finke for this project.

Welcome New Members

Katherine Barie, PhD student in Entomology. Mentors: Amsalem and Schilder. Katie joined us from the University of Illinois. Her research is focusing on the impacts and underlying mechanisms of CO_2 in bumble bees. Katie is supported by funding from our USDA Graduate Training Grant in Integrative Pollinator Ecology.

Dr. Natalie Boyle. We are delighted to introduce our newest faculty member, Dr. Natalie Boyle. Dr. Boyle is an Assistant Research Professor in the Department of Entomology at Penn State University. She is the coordinator for educational programming at Penn State's Center for Pollinator Research and is taking a lead role in building the Insect Biodiversity Center, where she will oversee the development of residential, online and extension courses in pollinator-friendly landscaping and insect conservation. Prior to joining PSU last September, Natalie was a post-doctoral entomologist for the USDA-ARS Logan Bee Lab, studying solitary bee biology and management for use in commercial pollination. Before that, she earned her M.S. and Ph.D. in entomology from Washington State University, where she studied honey bee health and colony performance in agricultural landscapes.

Sean Bresnahan. PhD student, MCBIS program, Mentors: Grozinger and Axtell. Sean joined us from University of Nebraska, where his undergraduate degree was in Neuroscience. Sean's research is focusing on the epigenetic mechanisms mediating social behavior in honey bees. Sean is supported by funding from our USDA Graduate Training Grant in Integrative Pollinator Ecology.

Dr. Priscila K.F. dos Santos is a postdoctoral scholar in the Amsalem lab. Priscila will join us in March 2020 from the University of São Paulo in Brazil where she completed her PhD in Genetic with Dr. Maria Cristina Arias. Priscila's research is focusing on the genetic regulation of worker reproduction by the brood in bumble bees.

Jon Elmquist. MS student from University of Central Florida is co-advised by Drs. David Biddinger and Kelli Hoover. Jon is studying the impacts of systemic insecticide use for spotted lanternfly control on pollinators in the spotted lanternfly quarantine areas in PA.

Sarah Kania. MSc Student, Entomology program, Mentors: Patch and Grozinger. Sarah joined us from University of Illinois, Urbana-Champaign, where her undergraduate degree was in Natural Resources and Environmental Sciences. Sarah will be evaluating the suitability of different mint cultivars for supporting pollinator populations and investigating the sociological factors of establishing pollinator habitats, particularly in solar farms.

Dr. Darin (D.J.) McNeil is a postdoctoral scholar in the Grozinger lab. D.J. joins us from Cornell University's Department of Natural Resources and Lab of Ornithology, where he completed his PhD evaluating how habitat influences bird populations. For his postdoctoral studies, D.J. is evaluating the role of landscape and climate in shaping insect population dynamics, disease ecology, and distributions.

Pamelo Ochungo. PhD student with Elluid Muli, International Center for Insect Physiology and Ecology, Nairobi, Kenya. Pamela visited the Grozinger lab from January-February 2019 to share information on evaluating nutritional and landscape effects on bee health.

Dr. Margarita Orlova is a postdoctoral scholar in the Amsalem lab. Margarita joined us from Arizona State University where she completed a postdoc with Dr. Gro Amdam and after completing her PhD with Dr. Abraham Hefetz in Tel Aviv University. Margarita is working on queen pheromone regulating worker reproduction in bumble bees.

Dr. Rya Seltzer is a postdoctoral scholar with Dr. Eran Levin in Tel Aviv University, Israel. During November she has visited the Amsalem lab to work on a shared project with the Levin lab - The mechanisms underlying CO2 narcosis in bumble bee queens.

Fond Farewell

Dr. Briana Ezray completed her PhD in the Hines lab and is now a STEM Research Data Librarian at Penn State University Libraries, University Park, PA.

Dr. Rong Ma accepted a data scientist position at CVS in Chicago.

Elyse McCormick is now a PhD student in the lab of Ben Sadd at Illinois State University.

Dr. Laura Russo accepted an Assistant Professor position in the Department of Entomology at Plant Pathology at the University of Tennessee.

Dr. Doug Sponsler accepted a postdoctoral fellow position with Dr. Ingolf Steffan-Dewenter at University of Wuerzburg for March 2020.

Jesse Starkey completed his MS in the Amsalem lab and has accepted a PhD position in the lab Dr. Cecilia Tamborindeguy in the Department of Entomology, Texas A&M

Dr. Li Tian started a faculty position at China Agricultural University in Beijing, China.

Student Awards and Outstanding Achievements

ALLYSON RAY
(Grozinger and Rasgon labs)

- 2019 NE SARE Graduate Research Award
- 2019 Apes Valente recipient

JESSE STARKEY
(Amsalem lab)

- Penn State CAS graduate student competitive grant award for his work on the role of larvae in regulating worker reproduction in Bombus impatiens

STEPHANIA SANDOVAL
(López-Uribe lab)

- 2019 Jose de la Torre Award recipient

MAKAYLEE CRONE
(Grozinger and Rasgon labs)

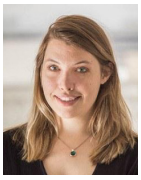
- North American Pollinator Protection Campaign (NAPPC) Honey Bee Health Improvement Project grant award recipient, 2019

SHELDON DAVIS
(undergraduate, Grozinger lab)

- Penn State University Student Engagement Network Grant recipient

GINAMARIA ROMAN-ECHEVARRIA
(López-Uribe lab)

- Northeast SARE Graduate Student Grant "Assessing the Effects of Neonicotinoid Treatments on Pumpkin on Bee Visitation and Pathogen Transmission"



RACHEL MCLAUGHLIN
(Hoover and Grozinger labs)

- 1st place in the student paper competition at ESA in St. Louis with her talk "Survey of Potential Pollinators of Black Cherry."
- 2nd place for her presentation at the Northeastern Pest Council Meeting.
- Ralph Doyle Scholarship
- Sahakian Family Fund for Agriculture Research Travel Award

MELANIE KAMMERER
(Grozinger and Tooker labs)

- Penn State Alumni Association Scholarship 2019
- Penn State Frank A. Andersen Award; travel award for Ecology students, 2019

SEAN BRESNAHAN
(Grozinger and Axtell labs)

- NSF Graduate Research Fellowship

CHAUNCY HINSHAW
(Rosa and López-Uribe labs)

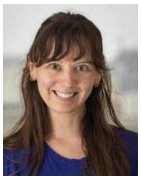
- Penn State College of Agricultural Sciences Graduate Student Competitive Grant Program, 2019
- Alan A. MacNab Plant Pathology Memorial Endowment, 2019

NATHAN DERSTINE
(Amsalem lab)

- International Society of Chemical Ecology travel award to present his research at the annual meeting in Atlanta

LAURA JONES
(López-Uribe & Schilder labs)

- Four Year Scholarship from the Alfred P. Sloan Foundation's Minority Ph.D. (MPHD) program
- NASA Pennsylvania Space Grant Consortium (PSGC) Graduate Fellowship



ERIN TREANORE
(Amsalem lab)

- 1st place in the ESA 2019 student competition - PBT pollinator Biology and Ecology
- Michael Duke Memorial Award - Penn State Entomology department
- Penn State CAS graduate student competitive grant award for her work on Physiological traits underlying successful diapause performance in bumble bee queens
- US-Israel BSF Binational Science Foundation travel award to work with Prof Sharoni Shafir at the Hebrew University in Israel on "Examining the effect of diet on learning behavior in bumble bee queens"
- 2019 Apes Valente research grant recipient`

Student Award Opportunities

Dutch Gold Honey Undergraduate Scholarship

The Penn State Center for Pollinator Research is seeking undergraduate student applicants for the Dutch Gold Honey Scholarship for bee research, preferably on honey bees but projects on other bees will be considered as well. The successful candidates will receive a scholarship of $3000 and the opportunity to participate in research with a faculty member from the Center in the Fall 2020 semester, or longer if desired. Students are expected to commit 10 hours/week to their research project.

This scholarship is awarded to undergraduates enrolled in the College of Agricultural Sciences who have completed or are registered for 300 and 400 level courses in Entomology. However, if you are completing a minor in Entomology, you may also be eligible. For more information, please inquire with Heather Hines (hmh19@psu.edu).

Apes Valentes Research Award

The Penn State Center for Pollinator Research is seeking undergraduate student applicants for the Apes Valentes Undergraduate Research Award for research in pollinator biology and health. The successful candidates will receive an award of up to $5000 to be applied to wages and other project costs. Research, extension, education and/or outreach projects related to all aspects of pollinator biology and health are encouraged.

Projects are expected to be conducted between May and August 2020. Students from both biology and non-biology backgrounds are encouraged to apply. These awards can involve the development of educational or art projects related to pollinators. Students will preferentially be in the third or fourth year of their undergraduate degree program. For more information, please follow this link.

2019 Award Recipients

Apes Valentes Award

Shelby Kilpatrick, López-Uribe and Hines labs, *Form and function: examining coevolution between specialist pollinators and their host plants through comparison of bee pollen-collection/transport and pollen grain structures*

Brooke Lawrence, López-Uribe lab, *Maintaining the colony pantry: impact of pesticides on pollen preservation in honey bee colonies*

Allyson Ray, Grozinger and Rasgon Lab, *Using genomics to understand the tripartite interaction between bees, virus, and Varroa.*

David Stupski, Schilder lab, *HotHive - a prototype hive design to measure seasonal energetics of honey bee thermoregulation*

Erin Treanore, Amsalem lab, *The making of a queen: examining nutrient acquisition and cold tolerance in pre-diapause bumblebee queens*

Dutch Gold Award

Jacklyn Kiner, Advisor: Dr. Amsalem, Project:Kiner, a rising Junior majoring in Veterinary and Biomedical Sciences, is interested in helping declining bumble bee populations. More than half of studied U.S. bumble bee species are showing declines, including *Bombus pensylvanicus*, a species which used to be widespread in Pennsylvania and is now rarely found here.

Matthew Poorman, Advisors: Kate Anton, Dr. Harland Patch. Poorman is a rising Senior at Penn State who began beekeeping two years ago and wants to integrate this increasingly important hobby with his passion for science to create a dynamic experience. Through his project building an observation hive pavilion for the new Pollinators' Garden at the Arboretum at Penn State.

Pollinator News at Penn State

Please click on the titles for links to the full article

Some Pollinators Swipe Right on Annual Ornamental Flowers

When it comes to flowers, the traits humans prefer—things like low pollen production, brighter colors, and changes to the height and shape of plants—are a mixed bag for pollinators. Plants bred for larger flowers or extended bloom times may be a boon for some hungry pollinators, but structural changes in the plants can make it harder for pollinators to handle the flowers, access nectar, or even find the flowers in the first place.

Passionate 14-Year-Old Raises Awareness – and Funds! – to Support Bee Populations

Finian Stroup has been dedicated to helping save the bees since she was 8 years old. Over the years, she has organized numerous events to raise awareness about bee declines.

Fourteen Penn State faculty recognized with lifetime honor

Christina Grozinger was among fourteen Penn State faculty members in areas ranging from physics and engineering to entomology and plant science have been named fellows of the American Association for the Advancement of Science (AAAS), the world's largest general scientific society. A lifetime honor bestowed upon members by their peers, a total of 443 individuals are being recognized for their extraordinary achievements in advancing science.

Much-anticipated Pollinator and Bird Garden underway in Arboretum at Penn State

Recent visitors to The Arboretum at Penn State may have noticed a bright blue construction fence surrounding about 3 acres of open meadow between the botanic gardens and the College Heights neighborhood. The fence delineates the future site of the Pollinator and Bird Garden, which will increase the size of the H.O. Smith Botanic Gardens by about 60%.

Pollinator project will complement Penn State solar power initiative

A unique undertaking in Penn State's College of Agricultural Sciences will shine a light on how solar farms can contribute to healthy ecosystems and boost pollinator populations.

"We have been given a remarkable opportunity to show how renewable energy production can be a platform for biodiversity, especially for valued pollinator species," Harland Patch, assistant research professor of entomology, said of the project, which will complement the University's new solar power initiative. "What we are proposing is new to the U.S., and we believe it will be a model for others to emulate."

He explained that Penn State, in partnership with Lightsource BP, a leader in solar energy, in early September broke ground on a 70-megawatt, utility-scale solar project in Franklin County that will provide 25% of Penn State's purchased electricity over the next 25 years.

Over 100 educators attend the 2019 Penn State Pollinator In-service Meeting

Penn State Extension and the Center for Pollinator Research hosted a two-day in-service meeting in July 2019 to train Extension Educators and Master Gardeners on the latest information about pollinator diversity, health, and management.

Cross-pollination between educators and researchers at the 2019 APPL-RED workshop

The 2019 Authentic Plant Pollinator Landscape Research for Educators (APPL-RED) Workshop at Penn State attracted thirteen K-12 educators from across Pennsylvania and beyond (one educator is currently teaching in the Spangdahlem region in Germany). The workshop allowed educators to work closely with members of Penn State's Center for Science and the Schools and Center for Pollinator Research.

Patterns of Pesticide Use, Exposure, and Toxicity Jointly Determine Impacts on Honeybees and Other Pollinators

Pollinators such as honey bees, wild bees, and pollen wasps contribute to one-third of the world's food-crop production. However, the health and abundance of pollinators has declined in recent decades due to a range of factors that include pests, pathogens, pesticides, and poor nutrition. Farmers use pesticides to treat pests that would otherwise damage our food. Patterns, or "domains," of pesticide use and pesticide effects on pollinators are linked in a complex system through a third domain, pollinator

pesticide exposure. This framework can provide insights into options for reducing risks to pollinators while also improving pest management strategies for crops, as illustrated through the example of apple production.

Methods to Control Varroa Mites: An Integrated Pest Management Approach

Varroa mites (*Varroa destructor*), are the most influential of all of the pests and diseases of the European honey bee (*Apis mellifera*) today. There are many available options to control varroa mite populations in honey bee colonies. Each option has advantages and disadvantages, but understanding the implications of each choice is an important part of decision-making. In an IPM approach, beekeepers should heavily rely on cultural and mechanical practices for mite control before using soft or hard chemicals. Mite monitoring and rotation of treatments is critical for effective management and reduction of resistance to chemicals in these pests. Understanding and considering all of the options before deciding on how to proceed will help to improve success and the well-being of the honey bees.

Student Research Spotlight - Rachel McLaughlin

Discovering the mysterious black cherry pollinators is a complicated challenge. McLaughlin needs to find out which insects are visiting flowers 20 to 50 feet above her head. She plans to suspend traps in the tree canopy to catch examples of the insects present in the trees. But she also needs to see for herself which insects are performing important pollination duties. A lift will give McLaughlin a perch high in the treetops, where she can watch the flowers and the pollinators that visit them.

What are those bees doing at your library?

Recently, bumble bees have been visiting libraries and museums around Pennsylvania. The bees have been helping families learn about the life sciences and how scientists study how bees and other animals live and are adapted to their environments.

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#Beetech: Azavea and Penn State made a tool to see 'bee's eye view' of hive environments

Pennsylvania's beekeepers can now get even closer to their six-legged friends. In April, Penn State University, with the help of Callowhill-based geospatial technology company Azavea, released a new tool called Beescape where keepers can get the buzz on their hives (sorry) with a "bee's eye view" of their environment.

Indiana in the Morning Interview: Christina Grozinger

Christina Grozinger is the director of the Center for Pollinator Research at Penn State. She joined us to talk about the health of Pennsylvania's bee population, and how we can help.

Yard and Garden Area at Ag Progress Days expands offerings

Creating pollinator-friendly landscapes again will be the focus of the Yard and Garden Area at Ag Progress Days, Aug. 13-15, but many other activities will be going on there, as well.

The flowers and plantings in the 9-year-old demonstration plots at the site attract and nourish huge numbers of native bees, butterflies and other pollinators. With pollinators in jeopardy, Penn State Master Gardeners teamed with horticulture faculty members to create and nurture the gardens — located at the end of 11th Street at the show site — to demonstrate that supplying pollinators with food and habitat can be beautiful.

Patterns of Pesticide Use, Exposure, and Toxicity Jointly Determine Impacts on Honeybees and Other Pollinators

Pollinators such as honeybees, wild bees, and pollen wasps contribute to one-third of the world's food-crop production. However, the health and abundance of pollinators has declined in recent decades due to a range of factors that include pests, pathogens, pesticides, and poor nutrition. Farmers use pesticides to treat pests that would otherwise damage our food. Patterns, or "domains," of pesticide use and pesticide effects on pollinators are linked in a complex system through a third domain, pollinator pesticide exposure. This framework can provide insights into options for reducing risks to pollinators while also improving pest management strategies for crops, as illustrated through the example of apple production.

What if bees disappeared?

In the United States, honey bees and wild bees contribute $20 billion each to agriculture and industries that depend on agriculture, meaning that fewer bees could lead to smaller harvests and increased food prices. Given their critical role in the nation's agricultural industry, Penn State's Christina Grozinger is leading an interdisciplinary team of faculty and students researching and creating solutions to help honey bees thrive.

New Law Would Help Bees—but Could Leave Other Pollinators out in the Cold

Amid the continuing decline of pollinators worldwide, U.S. lawmakers recently revived a perennially struggling bill that aims to save these helpful species. However, pollinator loss is more complicated than many headlines suggest. And curbing it, some scientists say, requires more than just stricter pesticide regulation—a major focus of the bill.

Penn Staters working to reverse bee declines

Within the past decade, beekeepers across the globe have observed massive declines in managed honey bee populations. Similar declines have been observed in populations of wild bees and other pollinators. Understanding what is driving these declines is a vital question for researchers, beekeepers, growers, and the public. Several factors are being investigated, including habitat loss, climate change, disease and pesticide use.

Penn State Extension marks milestone in outreach to Spanish-speaking growers

For close to a decade, Jorge Manzo has worked at McCleaf's Orchard, a fifth-generation family farm near Gettysburg in Adams County, where he is responsible for preparing a wide variety of fresh fruits and vegetables for market, including a few of his favorites — kiwi, blackberries and raspberries.

How the bumble bee got its stripes

Researchers have discovered a gene that drives color differences within a species of bumble bees. This discovery helps to explain the highly diverse color patterns among bumble bee species as well as how mimicry--individuals in an area adopting similar color patterns--evolves. A study describing the gene, which occurs in a highly conserved region of the genome that provides blueprints for segmentation, was led by researchers at Penn State and appears April 29, 2019, in the journal Proceedings of the National Academy of Sciences.

CPR researchers awarded grants from the North American Pollinator Protection Campaign

Six new research projects related to honey bee health issues have been funded by a combination of a **USDA APHIS** grant and donations from **Pollinator Partnership's (P2)** generous supporters. Each project will conduct a valuable investigation into an identified priority area that will expound on the issues faced by honey bees in North America.

New pollinator plant selection tool

Trying to decide which plants to include in your garden? The USDA-SCRI funded, "Protecting Bees" project has developed a pollinator plant selection tool that lets you search for flowering plant species according to zip code, bloom time, sun exposure, soil moisture levels, and relative attractiveness to different types of pollinators - including flies, which are the second most important group of pollinating insects, after bees!

Checking out Pollinators in Pennsylvania

With insect species declining and agriculturally-important pollinators at risk, it's important to know what species are present in an area to help protect them. PhD student Shelby Kilpatrick is trying to find out

what bees are present in Pennsylvania, and is creating a list that could help with future conservation efforts.

Bee dispersal ability may influence conservation measures

The abilities of various bee species to disperse influences the pattern of their population's genetic structure, which, in turn, can constrain how they respond to environmental change, as reported by an international team of researchers.

"Bees are declining around the world, which is a problem because these pollinators are critically important, both ecologically and economically," said Margarita López-Uribe, assistant professor of entomology, Penn State. "Our study has major implications for bee species conservation. For example, the ability of a species to disperse farther can enable that species to move to suitable areas under scenarios of climate change."

Colony Size Drives Honey Bees' Overwinter Survival

When the temperature drops and the days get shorter, honey bees don't hibernate—they huddle. Meanwhile, worker bees produced in the fall are plump and have longer lifespans than their spring counterparts. These winterized workers form a "thermoregulatory cluster" around their queen. Powered by honey stores, they shiver their muscles to produce heat, keeping temperatures at the center of the cluster around a comfortable 21 degrees Celsius (C). Still, winter is a stressful time for honey bee (Apis mellifera) colonies. In the United States around 30 percent of colonies don't survive until spring.

2019 Publications

Russo, L., Albert, R., Campbell, C., and Shea, K. 2019 "Experimental species introduction shapes network interactions in a plant-pollinator community." Biological Invasions 21: 3505–3519. https://link.springer.com/article/10.1007%2Fs10530-019-02064-z. https://rdcu.be/bLVvJ

Orlova, M., Starkey, J. A., & Amsalem, E. 2020. "A small family business: synergistic and additive effects of the queen and the brood on worker reproduction in a primitively eusocial bee." In press, Journal of Experimental Biology

Orlova, M., & Amsalem, E. 2019. "Context matters: plasticity in response to pheromones regulating reproduction and collective behavior in social Hymenoptera." Current Opinion in Insect Science *35*, 69-76. doi.org/10.1016/j.cois.2019.07.004

Starkey, J. A., Derstine, N., & Amsalem, E. 2019. “Do bumble bees produce brood pheromone?” Journal of Chemical Ecology 45(9), 725-734. doi.org/10.1007/s10886-019-01101-4

Starkey, J. A., Brown, A., & Amsalem, E. 2019. “The road to sociality: Brood regulation of worker reproduction in the simple eusocial bee Bombus impatiens.” Animal Behavior 154, 57-65. doi.org/10.1016/j.anbehav.2019.06.004

Sponsler, D.B., Grozinger, C.M., Richardson, R., Nurse, A., Brough, D., Patch, H.M., and Stoner, K. A. "A screening-level assessment of the pollinator-attractiveness of ornamental nursery stock using a honey bee foraging assay." Scientific Reports (in press)

Grozinger, C.M. and Zayed, A. “Genomics for understanding and improving pollinator health in a world of multiple stressors.” Nature Reviews Genetics (invited review, in press)

Douglas, M.R., Sponsler, D.B., Lonsdorf, E.V. and Grozinger, C.M. County-level analysis reveals a rapidly shifting landscape of insecticide hazard to honey bees (Apis mellifera) on US farmland Scientific Reports (in press).

Russo, L., Keller, J., Vaudo, A., Grozinger, C.M., Shea, K. “Warming increases pollen lipid concentration in an invasive thistle, with minor effects on the associated floral-visitor community.” Insects 11(1) 20 (2020) https://doi.org/10.3390/insects11010020
Part of a Special Issue on “*Mechanisms of Nutritional Resource Exploitation by Insects*”

Erickson, E., Adam. S., Russo, L., Wojcik, V., Patch, H.M., and Grozinger, C.M. 2019. “More than meets the eye: The role of ornamental plants in supporting pollinators.” Environmental Entomology doi: 10.1093/ee/nvz133

Villar, G., Hefetz, A., and Grozinger, C.M. 2019. “Evaluating the Effect of Honey Bee (*Apis mellifera*) Queen Reproductive State on Pheromone-mediated Interactions with Male Drone Bees.” Journal of Chemical Ecology 45(7): 588-597

Treanore, E., Vaudo, A.D., Grozinger, C.M., and Fleischer, S.J. 2019. "Examining the nutritional value and effects of different floral resources in pumpkin agroecosystems on *Bombus impatiens* worker physiology." Apidologie 50(4), 542-552

Ma, R., Rangel, J., and Grozinger C.M. 2019. “Honey bee (*Apis mellifera*) larval pheromones may regulate gene expression related to foraging task specialization.” BMC Genomics 20(1): 592 https://doi.org/10.1007/s00442-019-04462-5

Russo, L, Vaudo, A.D., Fisher, C.J., Grozinger, C.M., and Shea, K. 2019. “Bee community preference for an invasive thistle associated with higher pollen protein content.” Oecologia 190(4): 901-912

Annoscia, D., Brown, S.P., Di Prisco, G., De Paoli, E., Del Fabbro, S.D., Frizzera, D., Zanni., V., Galbraith, D.A., Caprio, E., Grozinger, C.M., Pennachio, F. and Nazzi, F. 2019. "Haemolymph removal by Varroa mite destabilizes the dynamical interaction between immune effectors and virus in bees, as predicted by Volterra's model." Proc Roy Soc Bio 286 (1901), 20190331

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Flenniken, M.L. and Grozinger, C.M. 2019. "Bee Viruses: Ecology, Pathogenicity, and Impacts". Annual Review of Entomology 64: 205-226

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